ELECTRONIC INDUSTRIES

★ United Nations North Africa Radio Installations
★ RF Heating Applications ★ Captured Enemy Equipment
★ Reference Guide to Electronic Uses in Industry

FEBRUARY

Caldwell-Clements, Inc.

Put Your Weight Behind the Attack —Buy War Bonds

Foreshadowing the Answer to Your Capacitor Problems

FOR strenuous duty, day after day, month after month—under stress of vibration, in great extremes of humidity and temperature—the Mallory WB Capacitor has proved it can take it.

Its size has been reduced to the smallest proportions consistent with good operation and long life, yet it packs from 10 to 50 microfarads, depending on the voltage. It is supplied in a hermetically-sealed tube with waxed cardboard outer sleeve. The ends of this sleeve are spun over the aluminum rim—no chance of "shorts" when leads are bent close to the can.

WB Capacitors are obtainable in 25, 50, 150, 300, 400 and 450 DC working volts, thoroughly aged and individually tested. They can be supplied with radial straps for mounting, if required.

The WB Capacitor is only one of many described in complete detail, with interesting test data, in the latest Mallory catalog. If you do not have a copy, send for one today—and always, when you have a special capacitor problem, call on Mallory technicians. Write Mallory direct or see your nearest Mallory distributor.

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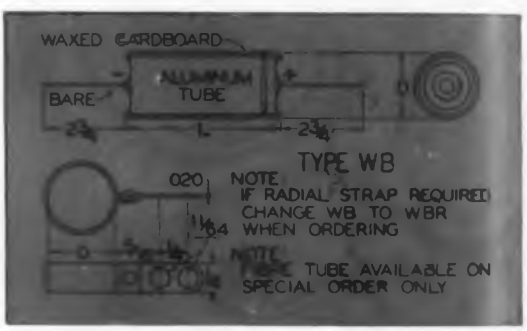

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ELECTROLYTIC, FILM AND PAPER

CAPACITORS

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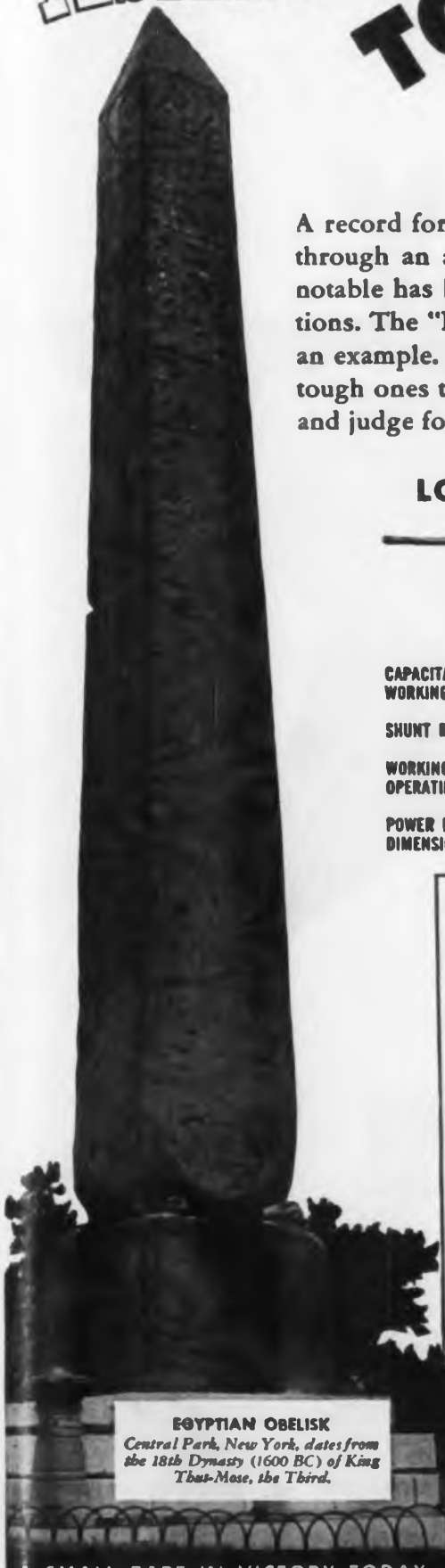


EGYPTIAN OBELISK
Central Park, New York, dates from the 18th Dynasty (1600 BC) of King Thut-Mose, the Third.

A record for long life has been earned by Tobe Capacitors through an almost complete absence of "returns". Equally notable has been Tobe's ability to master difficult specifications. The "DP" Molded Paper Condenser shown below is an example. The new American War Standards "specs" are tough ones to meet—but we meet them. Ask us for samples and judge for yourself.

LONG LIFE  **ASSURED**

SPECIFICATIONS "DP" MOLDED PAPER CONDENSERS

CAPACITANCE.....001 to .04 MFD
WORKING VOLTAGE.....*See chart below*
Flash test 3 times rated DC working voltage
SHUNT RESISTANCE.....At 185° F— 1000 megohms or greater
At 72° F—50000 megohms or greater
WORKING TEMPERATURE RANGE.....Minus 50° F to plus 185° F
OPERATING FREQUENCY RANGE.....Upper limit 40 megacycles
Q at one megacycle—average 20
POWER FACTOR.....At 1000 cycles .004 to .006
DIMENSIONS.....13/16" x 13/16" x 19/64"

Capacity in MMFD.	DC Working Voltage Rating	TOBE & AMERICAN WAR STANDARDS DESIGNATIONS "A" Characteristic	"B"
1000	600—1500	CN35A102	CN35B102
1500	600—1500	CN35A152	CN35B152
2000	600—1500	CN35A202	CN35B202
2500	600—1250	CN35A252	CN35B252
3000	600—1000	CN35A302	CN35B302
4000	600—1000	CN35A402	CN35B402
5000	600— 800	CN35A502	CN35B502
6000	600— 800	CN35A602	CN35B602
7000	500— 700	CN35A702	CN35B702
8000	500— 700	CN35A802	CN35B802
10000	400— 600	CN35A103	CN35B103
20000	200— 300	CN35A203	CN35B203
30000	50— 150	CN35A303	CN35B303
40000	50— 100	CN35A403	CN35B403

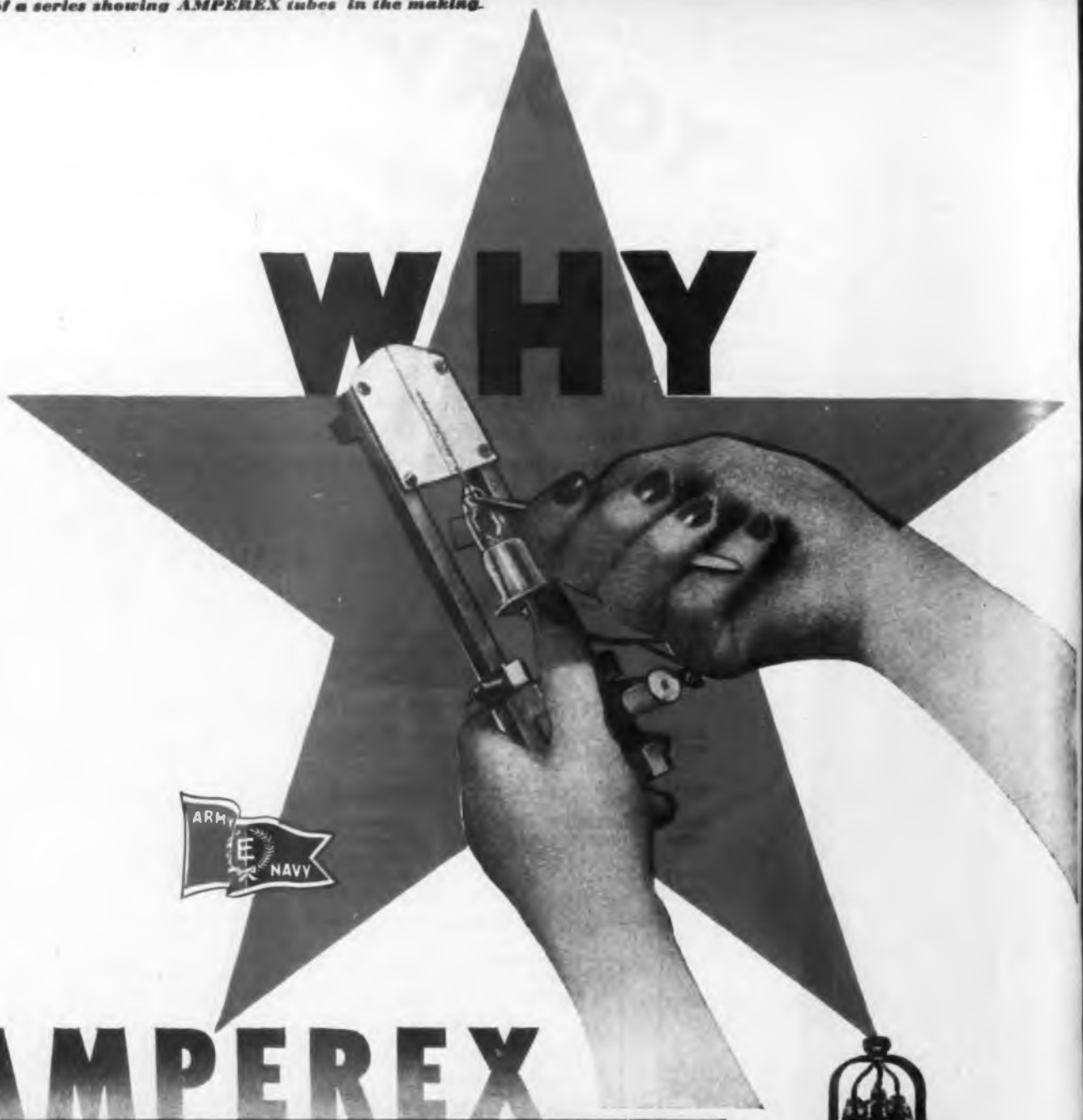
TOBE DEUTSCHMANN CORP. TOBE CANTON · MASSACHUSETTS

A SMALL PART IN VICTORY TODAY — A BIG PART IN INDUSTRY TOMORROW

(For Editorial Contents of This Issue, See Page 4)

One of a series showing AMPEREX tubes in the making

WHY



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TRANSMITTING AND RECTIFYING TUBES

Original ***Amperex*** design and construction refinements result in trouble-free performance of ***Amperex*** tubes . . . effecting natural economies in the operation of transmitting equipment. With replacements difficult to obtain, the extra hours of life inherent in ***Amperex*** tubes are often "priceless." To engineers, everywhere, this ***"Amperextra"*** factor of longevity is the major consideration.

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AS YOU KNOW, there is a wide gap between the *planning* and the final *performance* of any product. Take only one detail—an extension spring, for example. That spring (any spring) is going to play an important part in total performance. It must be exact in every detail. Suppose this extension spring must pull a certain mass over a certain space in a given time. It'll take engineering, chemistry, metallurgy, mathematics to design and manufacture it. It may require new testing machines or testing procedures, an investigation of metals or metal finishes, quality control by statistical methods, or new methods of production or inspection. Whatever's involved, you can be certain Hunter is well equipped for the job—and is ready for you now. You'll have the assurance that, as far as springs are concerned, your products now and for the future will perform—if the springs are designed or made by Hunter.

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HUNTER

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ELECTRONIC INDUSTRIES

FEBRUARY, 1944

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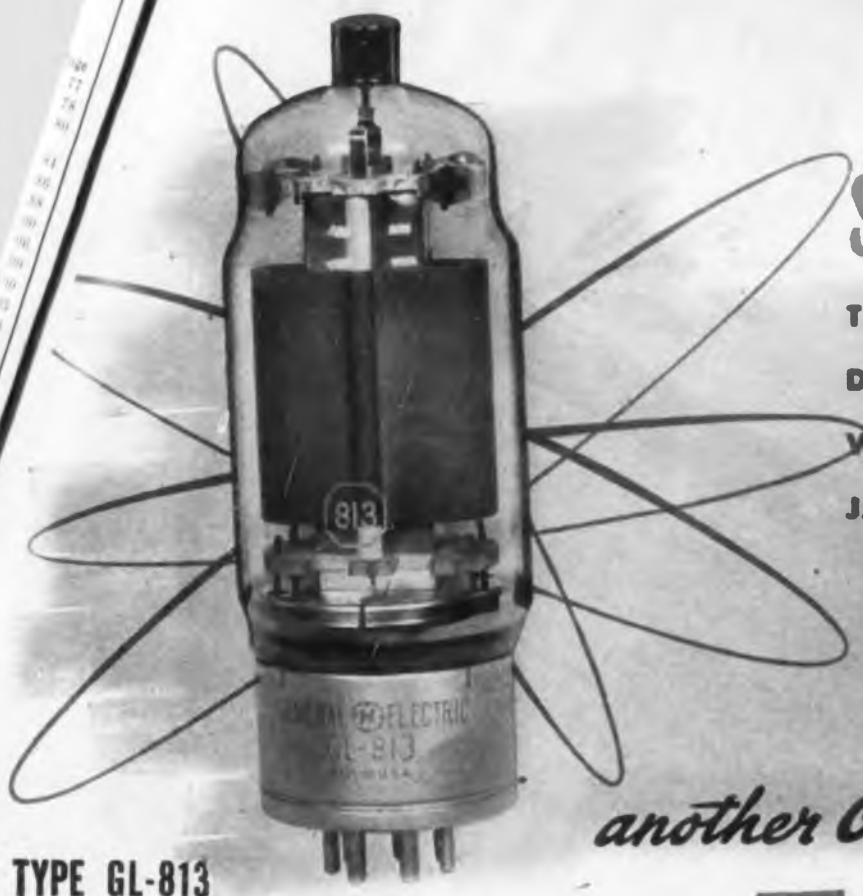

TYPE GL-813

SCREEN-GRID

THE G-E ELECTRONIC TUBE DEVELOPMENT THAT HELPS GUARD WAR COMMUNICATIONS AGAINST JAMMING BY THE ENEMY

another G-E electronic

FIRST!

With a long and notable list of basic "firsts," G.E. continues to set the pace — with today's line of G-E transmitting, receiving and industrial tubes.

The screen-grid, for instance, was developed by General Electric's Dr. Hull. This element, added to a 3-element tube, has made it possible to change transmitting frequencies with the flick of a switch. This helps greatly in preventing the enemy from "jamming" our signals or locating our transmitters.

In addition, the screen-grid tube has greatly reduced transmitter and receiver costs, and has lightened and simplified radio equipment — by eliminating the expensive and cumbersome neutralizing parts formerly required. The screen-grid also made possible the design of tubes that require much less driving power. Radio receivers were made without screen-grid tubes and could be today, but they would require twice as many tubes and circuit elements and would probably cost twice as much.

You may be sure that all G-E transmitting and receiving tubes you buy today, or tomorrow, have everything that electronic research and engineering have thus far uncovered. They also have most exacting construction, highest efficiency, and longest serviceable life the world's finest tube factory can produce.

Ask your G-E electronic tube distributor or nearest G-E office for current prices and delivery dates.

G-E TUBES ARE "FIRST" IN INDUSTRY, TOO! For example, General Electric developed the thyratron tube, providing the precision control that makes possible today's high-speed welding of aluminum and stainless steel. This versatile electronic tube is also the heart of G-E Thy-mo-trol, a compact control unit that makes it possible to run G-E motors directly from A-C lines.

***Ask for the free booklet*—"How Electronic Tubes Work."** Address Electronics Dept., General Electric, Schenectady, N. Y.

• *Tune in "The World Today" every evening except Sunday at 6:45 E.W.T. over CBS. On Sunday listen to the G-E "All Girl Orchestra" at 10 P.M. E.W.T. over NBC.*

GENERAL ELECTRIC

161-C2

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After the war, General Electric will again build complete television systems—cameras and other studio equipment, monitors, relays, antennas, and a complete line of home receivers.

Here is WRGB, the nation's outstanding television station, in action.

"Marriage by Lantern Light" — A typical WRGB television action shot from a Julius Hartt Musical Foundation playlet. Live talent programs predominate at WRGB.

FOR TELEVISION

Studio – Here you see stage props being set in the main studio of television station WRGB. Sight and sound are picked up by G-E television cameras and a motion-picture-type traveling microphone. Mercury-vapor spotlights and revolving ceiling lamps are water cooled and electrically manipulated by remote control. *Cool* light!

Projection Room—Motion-picture projection equipment at station WRGB includes two 35-mm and one 16-mm projectors – all modified by G-E for television.

Transmitter – The main transmitter of WRGB is located in the Helderberg Mountains, 12 miles from studio. Transmitter output: 40 kw video, 4 kw audio.

WRGB – General Electric's workshop television station at Schenectady is the largest and best equipped station in the world. From this studio, programs are beamed through a G-E television relay to the giant transmitter in the Helderberg Mountains nearby.

Control Room – Control desk, and shading desk with picture monitors, manned during a television broadcast from WRGB. All action in main studio is viewed and controlled from here.

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General Electric offers you "The G-E Equipment-Reservation Plan" . . . a plan designed to enable you to complete *your* post-war plans *now*. It will enable you to establish a post-war priority on a broadcast transmitter and associated equipment. It will enable us to plan definitely for large-scale post-war production, thereby giving you the fastest possible post-war delivery and the savings of planned production. Investigate this plan today and assure your place in radio broadcasting post-war. *Write for your copy of "The G-E Equipment-Reservation Plan." Electronics Dept., General Electric, Schenectady, N. Y.*

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GENERAL ELECTRIC FM · TELEVISION · AM

100-C3

"Massaging" white-hot steel with the aid of G-E electronic tubes

G-E STEEL-JACKETED IGNITRONS CONVERT A-C TO D-C EFFICIENTLY AND ECONOMICALLY

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The steel-jacketed ignitron is only one of a complete line of G-E electronic tubes now working for industry on innumerable jobs and many kinds of machinery. It is the purpose of the G-E electronic tube engineers to aid any manufacturer of electronic devices in the application of tubes. Through its nation-wide distributing system, General Electric is also prepared to supply users of electronic devices with replacement tubes.

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168-67

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15 An Excellent Suspension

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1 3 5 14 15

1, 3, 5, 14, 15 CITATION: "When the work rotating chuck of this large honing machine was assembled and run-in using Dag colloidal graphite, running-in time was reduced approximately 35%, operating temperature dropped considerably, and the danger of bearing damage due to temporary oil film failure was eliminated."

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CHECK THE LIST and pick out those properties which you can use. Then state your problem to us and let our engineers give you the benefit of their experience. It is quite possible that they have already studied a parallel application. You'll pin a medal on yourself for calling in Mr. Dag.

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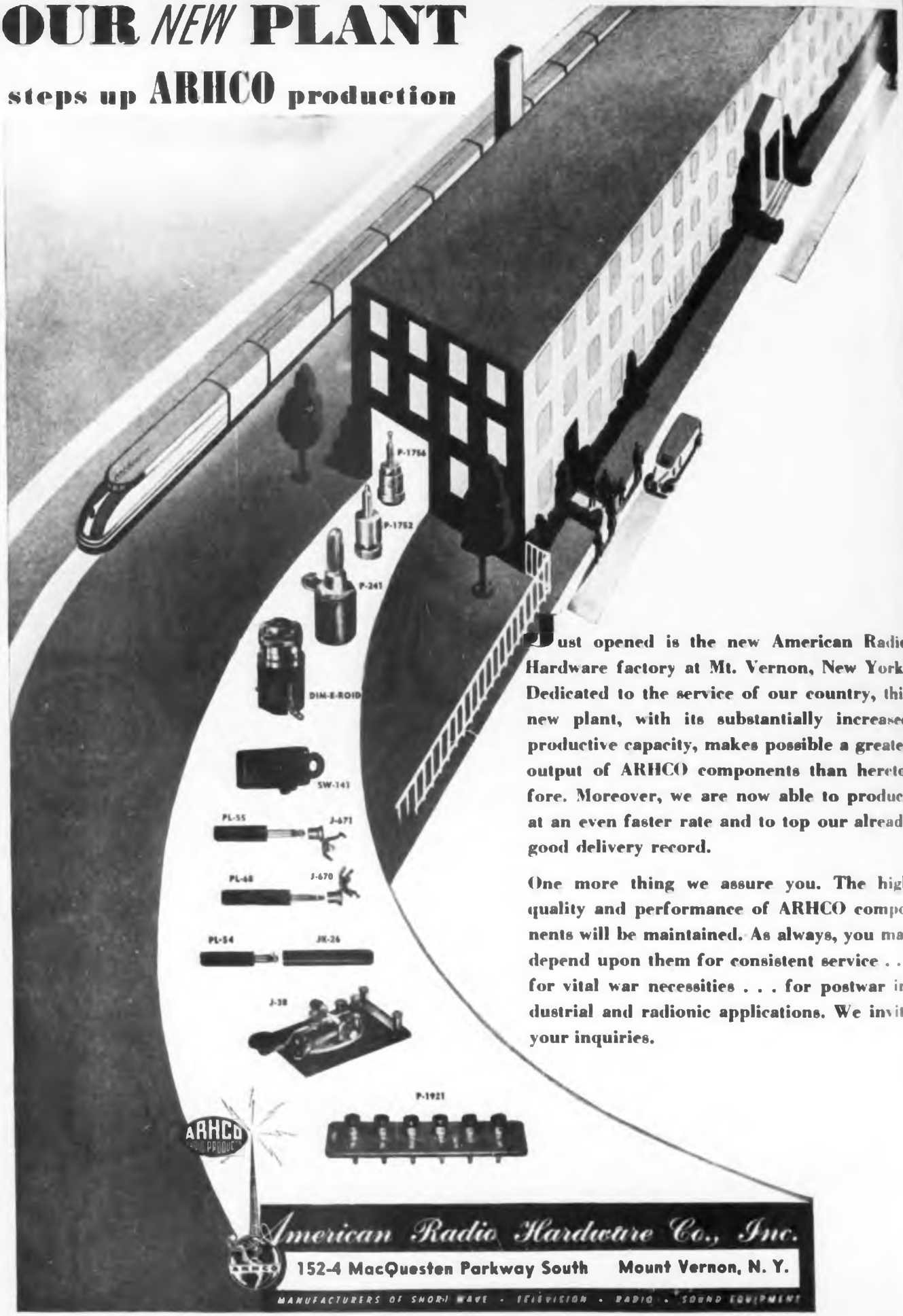

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Two or more standard -*hp*- instruments combined in single cabinet make an ideal set-up for individual stations on the production bench or for a small laboratory. Illustrated is the -*hp*- Model 100AR Low Frequency Standard and the 202DR Audio Oscillator. A quick review of the capabilities of these two instruments will show the value of such a combination.

For example: The model 100A provides standard frequencies of 1-kc, 10-kc and 100-kc. The out-put of each of these frequencies is available through separate terminals so that standards can be utilized at several stations on a production bench simultaneously. Model 202D Audio Oscillator provides extremely wide range of frequencies—2 cps to 70 kc—on a direct reading scale. The dial operates with planetary drive at 5 to 1 reduction for accurate adjustment over 270°. This instrument posesses all the outstanding features of all -*hp*- resistance tuned oscillators — no zero setting is required.

With this combination of instruments you can calibrate audio equipment, make accurate interpolations and standardize such measurements to a high degree. You can make distortion measurements on audio amplifiers, make accurate bridge measurements and work in the supersonics. The power out-put is sufficient to drive signal generators and other equipment.

Get full information about -*hp*- instruments today. There are many combinations other than the one described here that you can use to great advantage. Remember, -*hp*- instruments give you great economy with no sacrifice of accuracy and flexibility. Write today giving details of your problem so that we can be of greatest help to you. There's no obligation whatsoever.

HEWLETT-PACKARD COMPANY

P. O. BOX 335-W—STATION A, PALO ALTO, CALIFORNIA

for

WAGING WAR

WHY have the Government's experts on electronics come to Machlett for aid in connection with the problems which arise when higher and higher voltages are employed in the wartime electronics program?

The Machlett organization has for many years specialized in the development and production of tubes for the x-ray industry, where high operating voltages (50,000 volts upward into the millions) are common-place.

Nowhere else is there such a store of knowledge, skills, and techniques for dealing with extremely high voltages in vacuum tubes.

By undertaking special development contracts, and by providing enormous additional productive capacity, Machlett Laboratories are contributing these skills and techniques to the task of extending the power, the range, the effectiveness of electronic devices for waging war.

MACHLETT

Laboratories Inc.

SPRINGDALE CONNECTICUT

POWER TUBE DIVISION: NORWALK, CONN.

NO Burning
NO Pitting
NO Sticking

ADLAKE MODEL 1040

For panel mounting. Can be supplied with quick or time delay action; normally open or normally closed, and for A.C. or D.C. energization. Contact rating *up to 100* amps. A.C.; proportional D.C. ratings.

Automatic Control Is Really Automatic with Adlake Plunger-type Mercury Relays

Put Adlake Plunger-type Mercury Relays of correct capacity and rating on your control panel and you've really got *automatic* control. No inspection. No cleaning. No servicing. Here's why . . .

The contact mechanism of Adlake Plunger-type Mercury Relays is *hermetically sealed inside* a glass or metal cylinder.

Dirt and dust *can't get inside* to "gum up" operation. And, because contact is made by *liquid metal* (mercury), it is positive, chatterless, silent and *impervious to burning, pitting and sticking.*

For many kinds of service, particularly those considered "difficult," there is no other type of relay that can give such dependable service.

There's a lot more about Adlake Relays that every engineer should know.

Our complete bulletin tells the story. Ask for it —no obligation.

Adlake TRADE MARK

THE ADAMS & WESTLAKE COMPANY

ESTABLISHED IN 1857 — ELKHART, INDIANA — NEW YORK · CHICAGO

MANUFACTURERS OF ADLAKE HERMETICALLY SEALED MERCURY RELAYS FOR TIMING, LOAD, AND CONTROL CIRCUITS


THE IMPORTANCE
OF CRYSTALS IN
Modern Warfare
Success in modern warfare depends greatly upon accurate and dependable coordination between all combat units. Precision crystals by Crystal Products Company are providing sharp selectivity on planes, tanks, ships, in every climate and under the most rigorous battle conditions.
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Producers of Approved Precision Crystals for Radio Frequency Control

FERRIS INSTRUMENTS

ARE FOUND ON THE

PRODUCTION LINE, TOO

The Model 33-A Crystal Calibrator (left) provides accurate frequencies from 10 KC. to 100 MC.

For higher V.H.F. and U.H.F. work up to 500 MC., the Model 34-A (right) is employed.

THE ABOVE CRYSTAL CONTROLLED SECONDARY FREQUENCY STANDARDS ARE USEFUL FOR ACCURATE DIAL CALIBRATION OF RECEIVERS AND TRANSMITTERS AS WELL AS MANY LABORATORY APPLICATIONS

FERRIS

FERRIS INSTRUMENT CORPORATION

110 CORNELIA STREET, BOONTON, N. J.

CONTENTS OF MANUAL

The Cathode-Ray Oscillograph: introduction, general description, high-voltage power supply, amplifiers, linear time-base generator, intensity modulation, low-voltage power supply, mechanical considerations, conclusion.

* * *

Oscillograph Design Considerations: power supplies, amplifier design, time-bases or sweep generators.

* * *

DuMont Cathode-Ray Equipment: description, specifications, accessories, oscillograph type comparison list, speciality products.

* * *

DuMont Cathode-Ray Tube: general information, installation notes, type specification sheets, tube type comparison list.

* * *

Sales and Service Information: how to order, patent notice, price list, etc.

* * *

Instrument and Tube Application Notes: frequency and phase determination, photographic measurements, observation of relay rebounce, etc.

Cathode-Ray Tubes

. . . and how they are applied

For a dozen years past the Allen B. DuMont Laboratories have specialized in the development, production and application of cathode-ray tubes.

DuMont was the first to introduce the *commercialized* cathode-ray tube as a practical tool for research worker, production engineer and technician. Not only have DuMont tubes and oscillographs resulted in savings in time required to investigate the many problems to which they are applicable, but they have also revealed truths in man's laws of the working forces of nature.

And now, as a further service, DuMont engineers have compiled a manual of pertinent data, together with detailed descriptions of DuMont tubes and associated equipment. This data is in loose-leaf form. The binder permits constant revision to keep pace with the fast-moving cathode-ray technique. Each manual bears a serial number so that the name and address of its recipient may be duly registered. Additional pages are mailed from time to time.

* * *

Write on your business stationery for your copy. Our Engineering Department is interested in aiding you with your cathode-ray application problems.

DUMONT *Precision Electronics & Television*

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

AAC

★ **ALONG THE PANAGRA ROUTE** is located AAC transmitting equipment at approximately 30 different points in Colombia, Ecuador, Peru, Chile, Bolivia and Argentina—forming the nucleus of the radio navigation and communications system.

Panagra is today primarily devoting its personnel and facilities to maintenance of aerial lifelines between the Americas, across which are speeding men, mail and materials vital to the success of the democratic war efforts.

TODAY, the skill and experience of the AAC Electronics and Hydraulic Divisions are devoted to serving a fighting America. However, AAC engineers are planning ahead for the great peacetime future when new and improved AAC products will be ready to meet postwar needs.

(Right) Type 500 Transmitter as designed by AAC for Panagra. Consists of multi-channel transmitting equipment, 1,000 watts each channel. Two channels may be operated simultaneously. Telephone and telegraph transmission. Frequency range 250-550 KC and 1500-12000 KC.

AAC Products

Randolph C. Warbey PRESIDENT

AIRCRAFT

Manufacturers of PRECISION

Burbank, Calif. Kansas

TRANSMITTERS

AND OTHER COMMUNICATIONS EQUIPMENT

for

Dependable Operation Of Airlines And Various Communication Services

★ Today, AAC transmitters and other AAC communications equipment play a vital part in dependable operation of warplanes on the fighting fronts, as well as airlines serving the war-busy Americans on the home fronts.

AAC Electronics Division has won distinctive leadership as one of the country's large producers of radio transmitting and receiving equipment. One outstanding example of AAC communications engineering is the equipment designed and built to meet the specified needs of Pan American-Grace Airways, Inc. Consisting of a multi-channel 1,000 watt transmitter, this equipment is used by Panagra for radio homing and communication purposes. It represents one of a complete line of transmitting equipment for use by airlines or services having similar communication needs.

At the present time practically all AAC facilities are devoted to war production. However, your inquiries are welcomed now for commercial equipment which can be supplied in limited quantities if adequate priority ratings are available.

AAC products in transport planes, cargo carriers, troop ships, bombers . . . airport traffic net, police or other services where communications are crucial, can be depended upon as expertly engineered and built to the most efficient performance standards.

Products of ELECTRONICS DIVISION

TRANSMITTERS • AIRCRAFT & TANK ANTENNAS • QUARTZ CRYSTALS • RADIO TEST EQUIPMENT

(Below) Panagra airliner delivers important cargo of mail and passengers.

ACCESSORIES CORPORATION

AIRCRAFT EQUIPMENT • HYDRAULICS • ELECTRONICS

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

— Assuring Today's Production Perfection
— Insuring Tomorrow's Product Prestige

VACUUM TUBE TEST EQUIPMENT

Sherron facilities and experience encompass the full range of vacuum tube test equipment — from the "peanut" size to the giant transmitter type.

Today, when lives and battles are in the balance, Sherron Test Equipment is helping manufacturers maintain reputations for perfection. Existing standards are high, necessarily. They'll be equally high in the postwar tomorrow when they will be spotlighted by vigorous sales competition. Manufacturers of vacuum tubes, as well as other precision instruments, can insure postwar acceptance now — with production testing equipment that assures superior product performance.

MANUFACTURERS: We offer an unusual combination of facilities to companies contemplating design, development, or production of test equipment.

ENGINEERING DESIGN, MANUFACTURING, ASSEMBLY — COMPLETE PRODUCTION (INDIVIDUAL UNITS OR QUANTITIES) TO SPECIFICATIONS.

Sherron Electronics

SHERRON METALLIC CORPORATION

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MORE *Quality* QUARTZ PRODUCTION by maintaining the free cutting action of DI-MET RIMLOCK BLADES

DI-MET Rimlock quartz cutting wheels are characteristically fast, smooth, free-cutting blades ... but—the *proper operation* of Rimlocks not only gives better over-all results in blade life, etc., *but greatly improves wafer quality as well by reducing checking and wedging.* The Rimlock that lasts the longest produces the best wafers... and that's why the free cutting qualities of Rimlock blades should be maintained.

The method is easy—merely follow the simple suggestions outlined below. They have been especially worked out to insure you *more* and *better* quartz production..

1 ***Operate Rimlocks at the proper speed!*** Surface speed should range from 4000 to 4500 s.f.m., which is an r.p.m. of approximately 2000 for an 8" diameter wheel.

2 ***Keep feed pressure light!*** A load of 7 lbs. is generally ample. Maintain a light firm pressure. Too much pressure dulls the blade, results in "dishing," which causes wedging and increases checking.

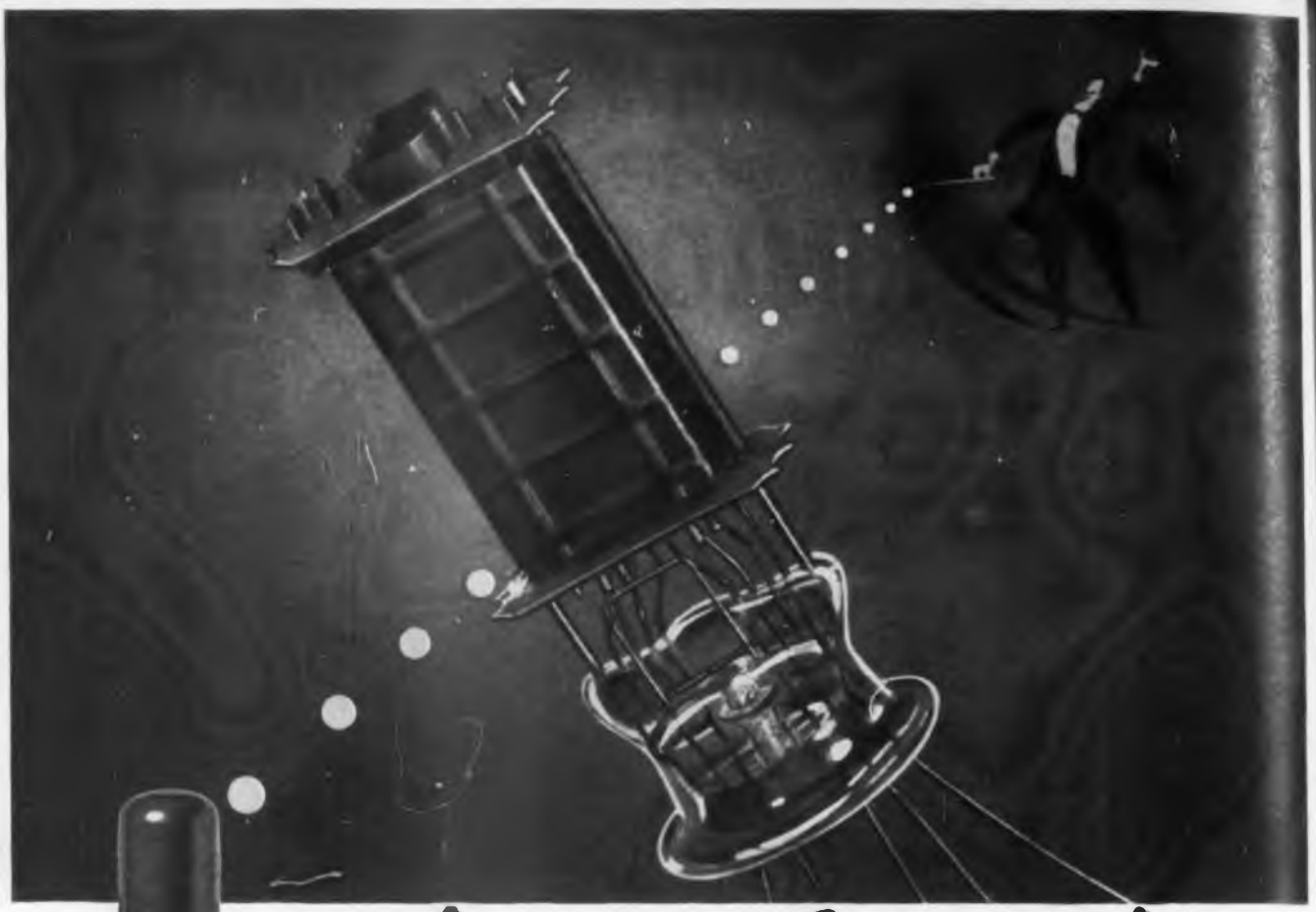
3 ***Use abundant coolant, accurately directed.*** Flood both sides of blade generously and be sure coolant actually reaches the line of cut ... do not compromise. Maintain quality coolant.

4 ***Use ample motor power!*** Variation of blade r.p.m. during cutting lowers blade efficiency, dulls cutting edges and destroys accuracy. A ¼ h.p. motor is recommended for general quartz cutting operations.

Results of following these 4 rules are well worth the effort. Wear is reduced to a minimum ... re-sharpening (which shortens blade life) is less frequent ... accuracy is maintained. *And most important of all, the longer life of your Rimlocks produces more high quality wafers!*

FELKER DI-MET ARMY E NAVY

FELKER MANUFACTURING CO.
1114 BORDER AVENUE, TORRANCE, CALIF.



Metal Magic!

Long ago National Union engineers had to strike out for themselves in search of new metals, alloys and coatings. The extremely high temperatures employed in tube making—brazing, for example, at 2 to 5 times the heat customarily used—ruled out the use of metals common to most industries.

So from the nation's electronic tube laboratories there has come a whole new group of metals and combinations of metals. Here are special alloys for filaments, coils, grid wires, getters, electron guns and many other uses. And as these metals have provided characteristics not previously available, they have literally pulled wonders out of the magic hat of electronics.

In metallurgy, as in other sciences related to tube making, National Union is helping to push back the frontiers of electronic knowledge. And in the war record of National Union tubes you will see how well this scientific approach to tube building is paying off. For better tubes, after the war—*Count on* National Union.

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

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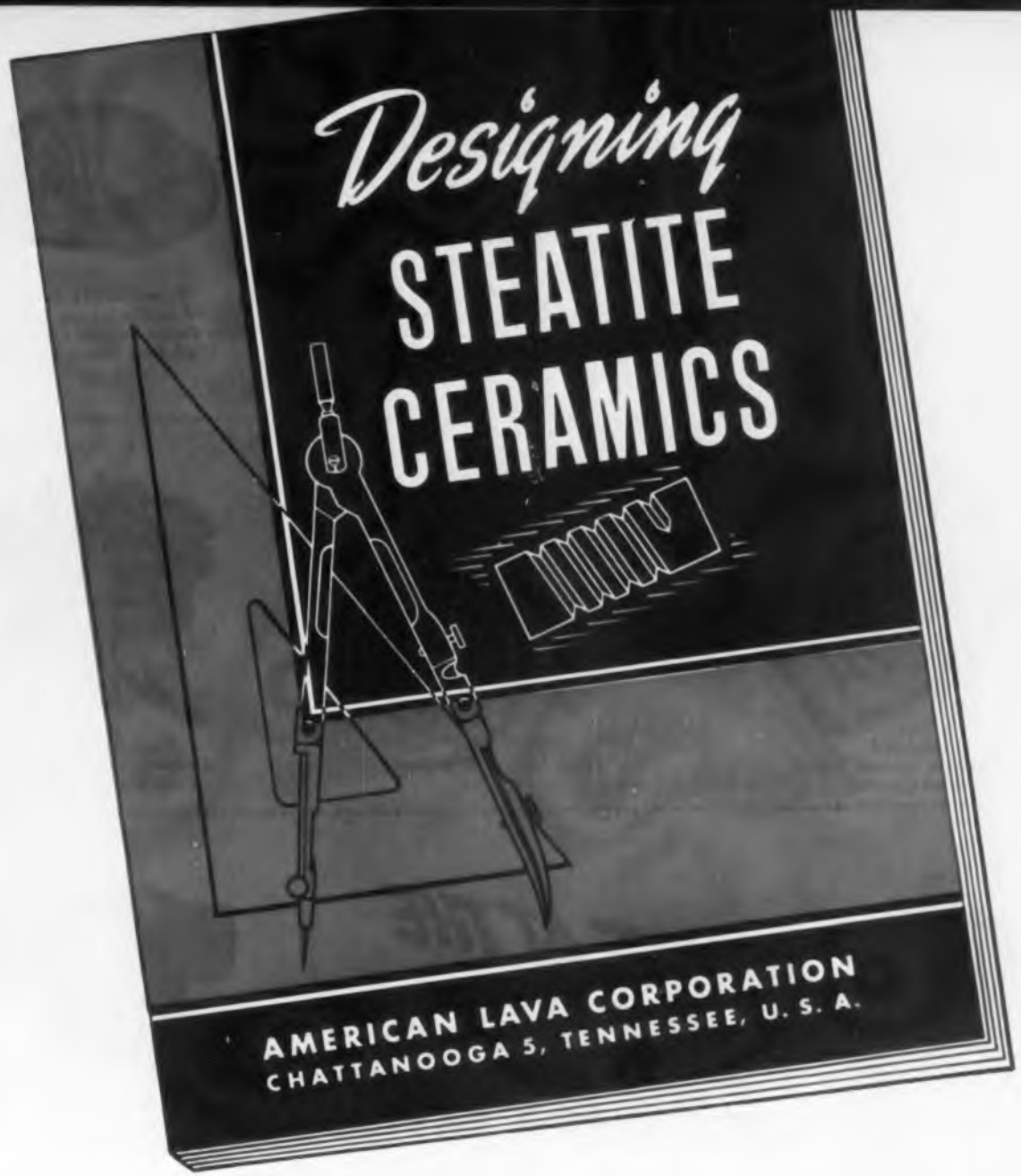

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ENDLESS opportunities for new and improved electrical design are offered with ALSIMAG Steatite Ceramic Insulators. The Engineer will understand, however, that *high speed economical production* of the steatite pieces depends very largely upon the *design* of the insulator. A practical knowledge of the manufacturing processes involved is most useful in designing for low cost production as well as for better assembly.

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Used for Tube Warming, Tube Cooling, and High-Low Limit Controls

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Used as Roughing Controls on Outer Crystal Ovens and High-Low Limit Controls

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Type C-6363
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Type ER Series
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Circuit Breaker

KLIXON SNAP-ACTING CONTROLS

When it comes to controls for motor and transformer overheat protection, electrical circuit overload protection, or temperature controls for radio equipment, you want them to operate surely and accurately—every time.

Klixon Controls meet all operating requirements. Actuated by the foolproof snap-acting Spencer Disc, they always make a quick clean break or positive make. Because they have no fussy, complicated parts, Klixon controls are unaffected by shock, vibration, motion or high altitude regardless of the mounting position. They are space and weight savers, too.

Klixon Controls are available in many standard types to meet your control requirements. See what they can do for you. Our engineering department will help you solve your problems. Write:

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Designing, Engineering and Building for Victory... and the Future...

Air Communications Products include: Radio Range Receivers, Glide Path Receivers, Marker Beacon Receivers, Aircraft Automatic Direction Finders, Aircraft Transmitters, Command Receivers, Command Transmitters, Small Transmitters up to 1 K.W., Interphone Equipment, Radio Telephone Equipment, Adaptors for Radio Compasses. Out of their achievements for war, Air Communications engineers will bring you new knowledge and experience of value in peacetime aviation development. *Cooperative engineering available.* Let us help you solve your engineering problems of the future.

★ The skyways of tomorrow will be paved with new safeguards resulting from new and amazing developments in air communications. Private planes as well as great commercial airliners will pierce the veil of fog, clouds and darkness with an ease and accuracy undreamed of only a few short years ago! Startling advancements already made in electronic communications, and assured developments yet to come, give us this portent of the future . . . *and Air Communications plans are directed toward that future!*

Now, Air Communications precision-built Products are being used to increase the operating efficiency of America's warplanes. After victory, Air Communications skilled organization will be at the service of America's great post-war aviation industry... ready with the advanced engineering and designing ability needed to produce *everything for the safety, convenience and economy of flying.*

AIR COMMUNICATIONS, INC.

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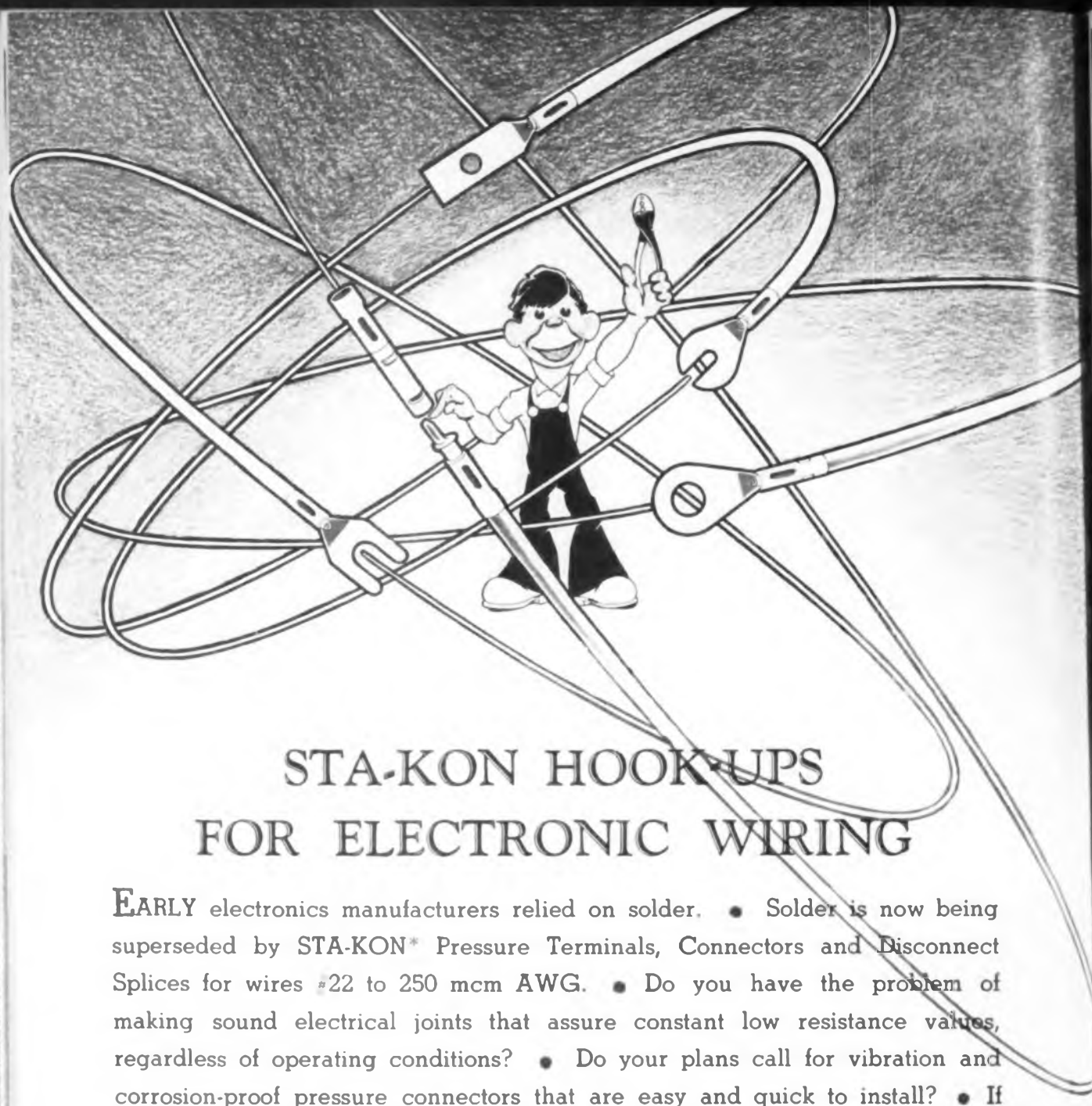

STA-KON HOOK-UPS FOR ELECTRONIC WIRING

EARLY electronics manufacturers relied on solder. • Solder is now being superseded by STA-KON* Pressure Terminals, Connectors and Disconnect Splices for wires #22 to 250 mcm AWG. • Do you have the problem of making sound electrical joints that assure constant low resistance values, regardless of operating conditions? • Do your plans call for vibration and corrosion-proof pressure connectors that are easy and quick to install? • If so, T&B has the STA-KON* answers. • Why not have our engineering specialists call on you to discuss any phase of your wiring problems? • Our service specialists, T&B Wholesalers, through whom we distribute exclusively, stand ready to take care of all your material requirements.

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* Patented STA-KON: Reg. U. S. Pat. Off.

T&B

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INCORPORATED

MANUFACTURERS OF ELECTRICAL FITTINGS SINCE 1899

ELIZABETH 1, NEW JERSEY

In Canada: Thomas & Betts Ltd. Montreal

E Flag awarded April, 1943
White Star awarded October, 1943

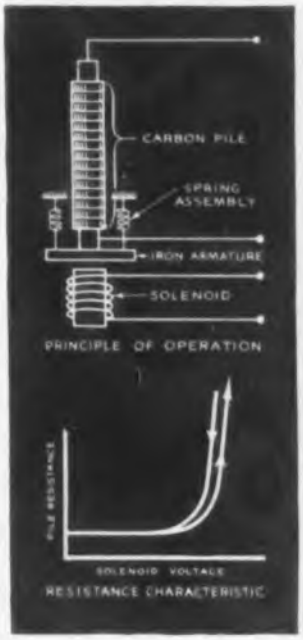
BOTHERED BY VOLTAGE VARIATIONS?

HERE'S HOW WEBSTER REGULATORS SOLVED THIS PROBLEM IN VITAL MILITARY APPLICATIONS

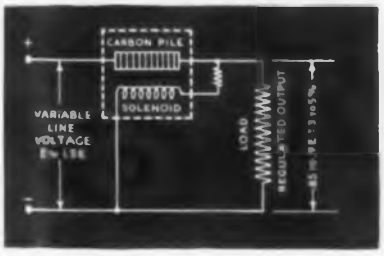
If voltage variations interfere with your design objectives, a Webster Carbon Pile Regulator may solve your problem. Sturdy, compact, reliable, they withstand vibration, shock, moisture, salt spray. Some designs are temperature compensated for minus 55 to plus 70 degrees C. ambient operating range. If yours is a highly rated war project, our engineers will gladly study your application without obligation to see if a Webster Regulator will do the job best. Please include complete circuit data and operating specifications with your inquiry.

THE HOW AND WHY OF CARBON PILE REGULATORS

Webster Regulators function as illustrated at the right. The carbon pile is under spring compression, and this compression is more or less offset by the magnetic attraction of the armature when the solenoid is energized. The result is a steep increase of pile resistance at the critical voltage as illustrated. The solenoid circuit requires from 2 to 15 volt-amperes depending on the application. Maximum pile resistances from approximately ½ ohm to 100 ohms are available. The stable maximum control resistance range for any particular pile is of the order of 20 to 1. **VR-2000** Regulators have a maximum pile dissipation of about 25 watts. ($2^{13}/_{16}$" O.D., $4^{3}/_{16}$" high, wt. $2^{1}/_{4}$ lbs.) **VR-2200** Regulators dissipate 100 watts with adequate air blast, and up to 50-75 watts without blast. ($2^{13}/_{16}$" O.D., $4^{5}/_{64}$" high, wt. 2 lb. 5 oz.)

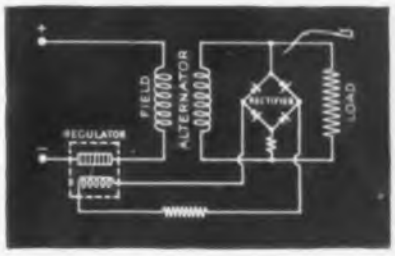


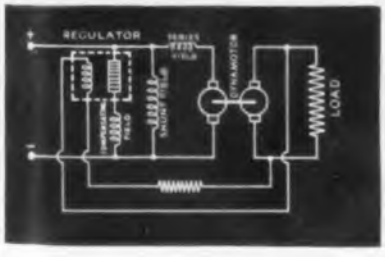
A Few of Many Possible Applications of Webster Regulators



A basic circuit for constant voltage from a variable voltage source. A regulator of this type can be added to practically any reasonably constant DC load provided the apparatus can be arranged to operate on 85 to 90% of the minimum line or battery voltage.

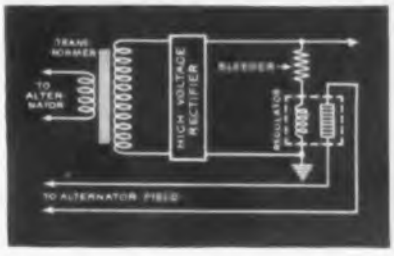
A method of regulating the AC output voltage of an alternator or inverter by field control to compensate for load or source variations. Solenoid voltage obtained from suitable rectifier. Adaptable to existing apparatus if sufficient field excitation is available.





Compensation for variable input voltage by regulator-controlled excitation of a compensating field in a special dynamotor. Requires coordinated dynamotor and regulator design.

Method of controlling high voltage rectifier output. Regulator acts to maintain constant bleeder current by automatically adjusting field excitation, thus holding voltage constant.



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For mobile two-way communication specify KAAR RADIOTELEPHONES

KAAR PTL-10X TRANSMITTER

10 WATTS • 1600-2900 KC*

The PTL-10X is a highly efficient medium-frequency mobile transmitter. It provides communication from a moving vehicle over distances ranging from 50 to 75 miles when used with AUTO-LOAD self-loading antenna.

The "Push-to-Talk" button on the microphone completely controls the transmitter, lighting the instant heating tubes, starting the power supply, automatically silencing the receiver, and switching the antenna to the transmitter. The standby current is zero.

Models for special applications are available, including the PTL-22X medium frequency transmitter with 22 watts output, and the PTS-22X, a 22 watt transmitter for operation in the 30-40 MC band.

KAAR AUTO-LOAD ANTENNA

This antenna, with matching coil in the base, is designed for use with the PTL-10X (or with similar medium frequency transmitting equipment) and matches the 72 ohm transmission line from the transmitter and receiver without auxiliary tuning equipment. It provides an efficient method of obtaining maximum signal strength at medium frequencies with a short antenna. It can be quickly installed on the rear bumper or on the side of any vehicle.

**Special ranges to 7000 KC available on special order*

KAAR 11X RECEIVER

6 TUBES • 1600-2900 KC*

The popular 11X receiver is a crystal controlled superheterodyne for mounting in an automobile or other vehicle. It contains a no-signal squelch circuit, and is designed for commercial, civil, and military applications.

This receiver offers remarkable accessibility. The top is removed by simply pushing aside two snap catches, or the entire receiver can be whisked out of the vehicle by releasing only four catches.

KAAR

ENGINEERING CO.

PALO ALTO, CALIFORNIA

Manufacturers of high grade mobile and control station RADIOTELEPHONE EQUIPMENT • POWER PACKS • CRYSTALS • VARIABLE CONDENSERS MICROPHONES • AUTO-LOAD ANTENNAS

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Whether it's a problem of stepping up d-c power . . . reducing core assembly time . . . locating the right high-frequency insulators or high-voltage d-c capacitors in a hurry, you'll find the answer in these new Westinghouse publications. Complete listings of sizes, weights and dimensions, together with application guides make these booklets an invaluable aid in designing and ordering.

These are only four examples of the help that Westinghouse can offer in the design and manufacture of communications equipment.

Other helpful publications are available on

- Micarta insulating parts and materials
- Thermostats
- Instruments
- Rectox rectifiers
- Relays
- Contactors

Whatever your problem, Westinghouse Communications Equipment and Communications Specialists can help you find a quick solution. Call on Westinghouse for help. Ask for the booklets you want from your Westinghouse representative, or write Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., Dept. 7-N.

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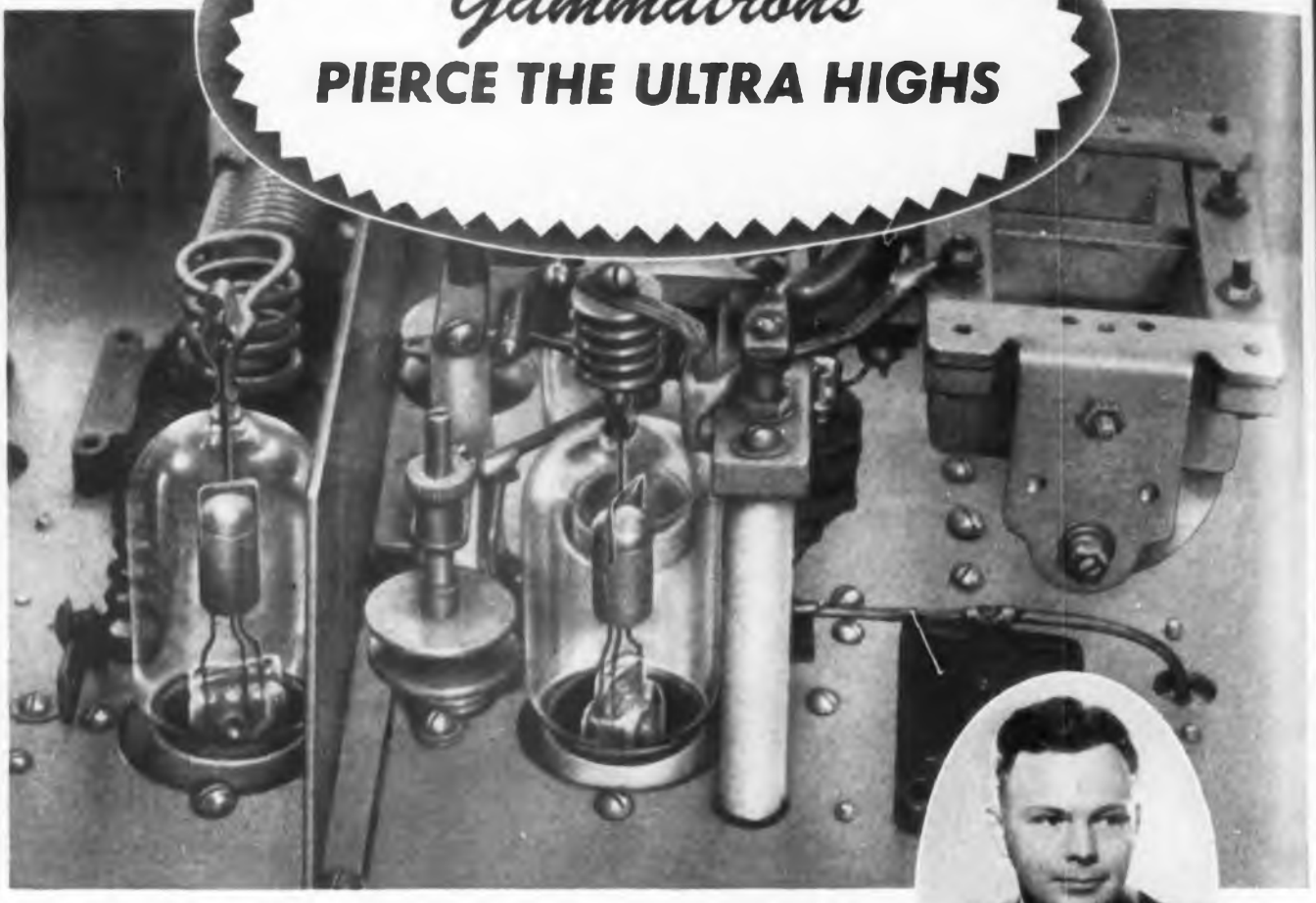

Above: UHF section of 161.1-mc mobile transmitter operated by WGAR, and designed by W. L. WIDLAR, UHF Engineer for the Cleveland station.

"The HK-24 is the best UHF tube for operation at 161.1-megacycles"

The work of W. L. Widlar in the ultra high frequencies is attracting national attention. After several years of research and experiment between 30-mc and 250-mc at WGAR, he designed a 157.5-mc AM mobile transmitter with an operating range of 17 miles.

Two years ago the 157.5-mc special events mobile unit was modified into a 161.1-mc FM transmitter, which reduced noise and improved transmission, and has a satisfactory operating range of 20 miles from the receiving location.

Now he is engaged in testing a 10-watt 225.6-mc crystal-controlled AM transmitter, and the results will be published in the near future.

For the driver-amplifier and power-amplifier stages of these transmitters Mr. Widlar selected Gammatron tubes.

"I know from experience," he says, "that the HK-24, because of its small physical size and high efficiency, is the only available UHF tube that will operate successfully at 161.1-mc."

In addition to small size and high efficiency, there are other reasons for the ability of HK-24's to pierce the ultra highs. For example, confined electron paths, getter-free bulbs that avoid metalized resistor effects, and lack of internal insulators.

Heintz and Kaufman engineers constantly utilize the results of UHF field tests to design more efficient Gammatrons, and thus they are making an important contribution to the opening of new electronic frontiers in the centimeter region.

HEINTZ AND KAUFMAN LTD.
SOUTH SAN FRANCISCO • CALIFORNIA

Gammatron Tubes

ELECTRONIC PERFORMANCE is always exactly predictable with built-in CONSTANT VOLTAGE

Constant, stable voltage comes first in design consideration if the electronic miracles promised for the post-war world are to be realized.

Perfect performance cannot be guaranteed if delicate electronic devices, too sensitive to tolerate ordinary voltage fluctuations, are left vulnerable to the sags and surges of commercial power lines.

FM and television transmitters and receivers, food sorting and testing devices, scientific instruments, X-ray, sound and projection equipment, precision machinery—these are but a few of the products, once requiring frequent adjustments and constant attention by watchful operators, whose performance is now automatic and exactly predictable with *built-in* Constant Voltage.

Many new products that have not yet progressed beyond the laboratory stage because of critical voltage problems will be available to the post-war world, with built-in Sola Constant Voltage Transformers reducing their operation to a simple "just plug in" basis.

Engineers and sales executives who are responsible for product design should bear this fact in mind—that the precisely controlled voltages of the research laboratory *are not* the voltages that will be encountered once the product reaches the user. An otherwise perfect piece of engineering may be headed for trouble at the hands of less experienced operators.

Dependably close voltage control to within ±1% can be made available to all electronic devices, or electrically operated equipment, with built-in automatic Sola Constant Voltage Transformers.

Without manual adjustments or supervision, they instantly reduce voltage fluctuation as great as 30% to the rated voltage required for successful operation. They protect themselves against short circuit damage. Capacities and sizes are available to meet any design requirements.

To Manufacturers:

Built-in voltage control guarantees the voltage called for on your label. Consult our engineers on details of design specifications.

Ask for Bulletin 10CV-74

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

COIL FORMS OF Steatite

*AND Centradite

*Especially indicated where Low Thermal Expansion, High Resistance to Heat Shock, Low Porosity and Low Loss Factor are requisites.

We have adequate facilities to process coil forms up to 5 inch diameter and pressed pieces to approximately 6 inches square.

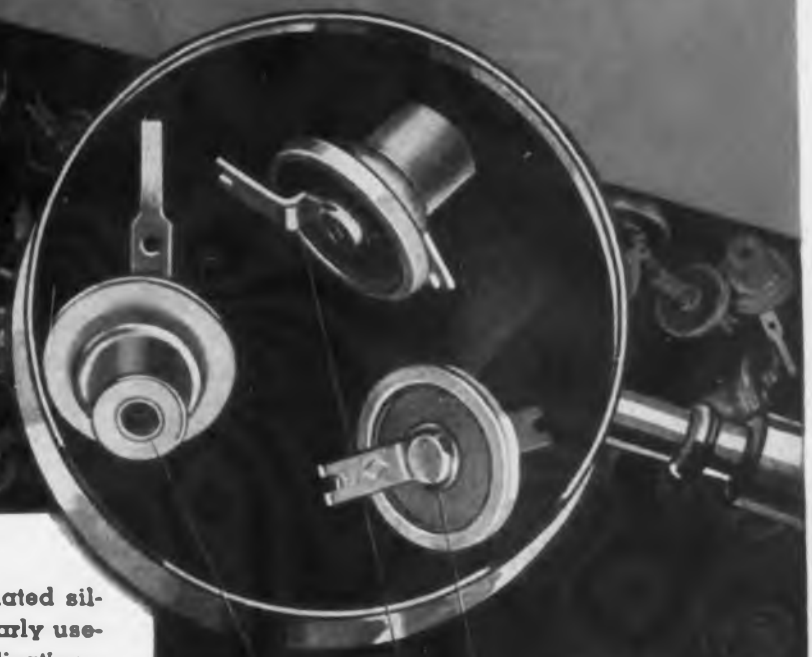
Our ceramic experience dates back to 1930...and our engineering and laboratory facilities are at your disposal.

Centralab

Division of GLOBE-UNION INC., Milwaukee

PRODUCERS OF VARIABLE RESISTORS • SELECTOR SWITCHES • CERAMIC CAPACITORS, FIXED AND VARIABLE • STEATITE INSULATORS

SILVER MICA *Capacitors*



Special purpose oil impregnated silver mica capacitors particularly useful in high frequency applications.

These capacitors made in a diameter of less than ½ inch, in capacities up to 500 MMF are of mica discs of the highest grade individually silvered for maximum stability and stacked to eliminate any "book" effect. The assembly is vacuum impregnated with transil oil. The outside metal ring or cup connects to one plate of the capacitor . . . the center terminal connects to the other plate by means of a coin silver rivet. All units are color coded. For additional information send for Form 586.

Type 831
"lead thru" construction.

Type 830
Cup style assembled to a threaded brass mounting stud.

Type 830
with extra long terminal.

Centralab

CRL

Division of GLOBE-UNION INC., Milwaukee

PRODUCERS OF VARIABLE RESISTORS · SELECTOR SWITCHES · CERAMIC CAPACITORS, FIXED AND VARIABLE · STEATITE INSULATORS

Behind the veil of military secrecy are the wonder stories of Ken-Rad electronic tubes Nearly five thousand of us are now making and sending these tubes which are helping to shatter tyranny And through Ken-Rad dependable tubes will be worked the *constructive* miracles of the great science of tomorrow

K
KEN-RAD

TRANSMITTING TUBES
CATHODE RAY TUBES
SPECIAL PURPOSE TUBES

KEN-RAD

EXECUTIVE OFFICES
OWENSBORO · KENTUCKY
EXPORTS 116 BROAD STREET NEW YORK

METAL AND VHF TUBES
INCANDESCENT LAMPS
FLUORESCENT LAMPS

History of Communications Number Two of a Series

COMMUNICATIONS BY ROMAN POST RIDERS

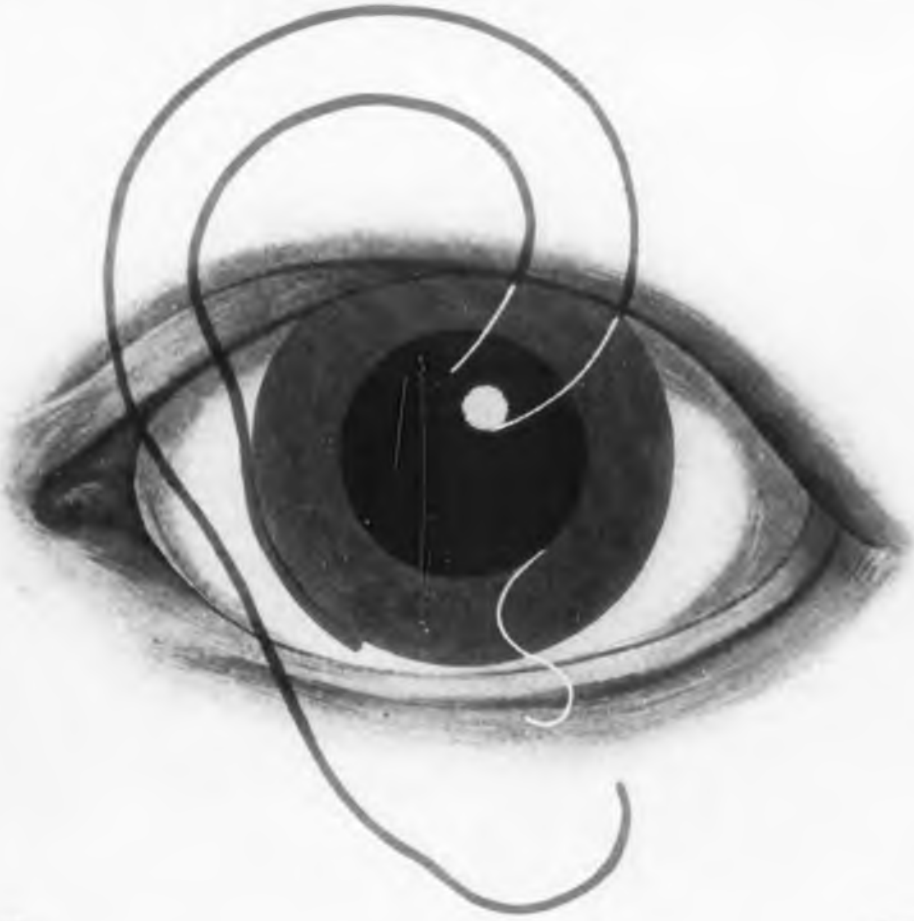
In the early days of the Romans and Phoenicians the fastest means of communication was the post riders, who carried news and War dispatches from the battle front. As fleet as their horses might have been, their speed does not begin to compare with electronic voice communication. The twist of a dial and the pressing of a button—in the flash of a second the message comes through. Clear cut speech transmission with Universal microphones reduces error and expedites the delivery of the message.

Today Universal microphones and voice communication components are being used throughout the world on every battle front filling a vital need and "getting the message through."

< Model 1700-UB, illustrated at left, is but one of several military type microphones now available to priority users through local radio jobbers.

UNIVERSAL MICROPHONE CO., LTD
INGLEWOOD, CALIFORNIA

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



the seeing ear...

Symbolic of modern electronic equipment—these human senses amplified and extended to limitless range . . . thru fog and smoke . . . beyond the limits of normal sight and hearing . . . our fighting forces now SEE and HEAR at distances and under conditions that amaze the uninitiated. Such are the remarkable accomplishments of a war-inspired American Electronic Industry.

Censorship shrouds the Seeing Ear in secrecy but . . . in tomorrow's day of peacetime production G. I. will adapt its share of Seeing Ear developments to new products and to modernization of its pre-war products. Many of these new ideas will have direct applications in our Record Changers—Variable Condensers—Push Button Tuners—and other products.

The first in our industry to be so honored

ARMY E NAVY

GENERAL INSTRUMENT CORPORATION

829 NEWARK AVENUE, ELIZABETH, N.J.

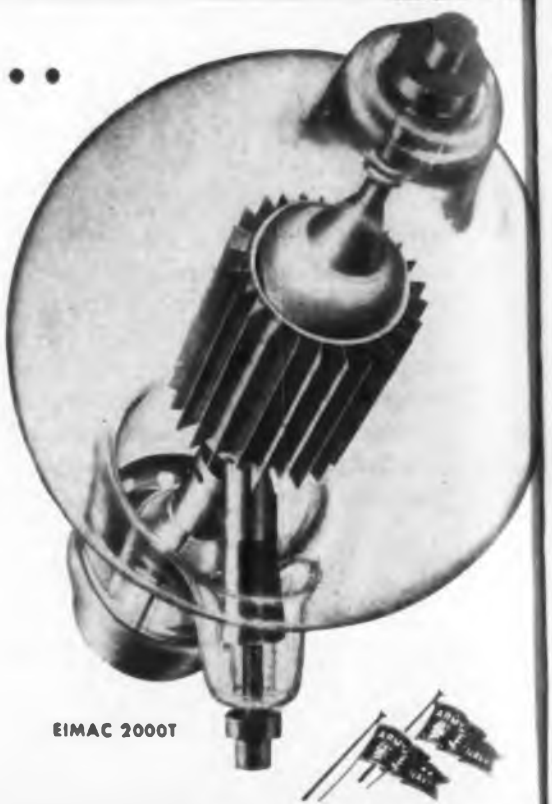
Their *hobby* is radio too...

These are the leaders of science and communications. They are professionals in what has become a most vital element of modern civilization . . . radio communications and the science of electronics. Some of them wear the uniforms of top ranking military officers because we are engaged in war. Others remain civilians as doctors of science . . . the leaders of radio, electronic and electrical industries which are amazing the world through their achievements. Achievements which not only aid in war but which are creating the new era of industry to follow. They are the great men of today . . . they will be still greater tomorrow . . . and they are radio amateurs.

Eimac tubes are leaders too. First choice of these leading engineers . . . first in the new developments in radio. They are first with radio amateurs too, which is no coincidence.

Follow the leaders to

Eimac
REG. U.S. PAT. OFF.
TUBES



EIMAC 2000T

EITEL-McCULLOUGH, INC., 794 San Mateo Ave., SAN BRUNO, CALIF. • Plants located at San Bruno, California and Salt Lake City

Export Agents: FRAZAR & HANSEN • 301 Clay Street • San Francisco, California, U. S. A.

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

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

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

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

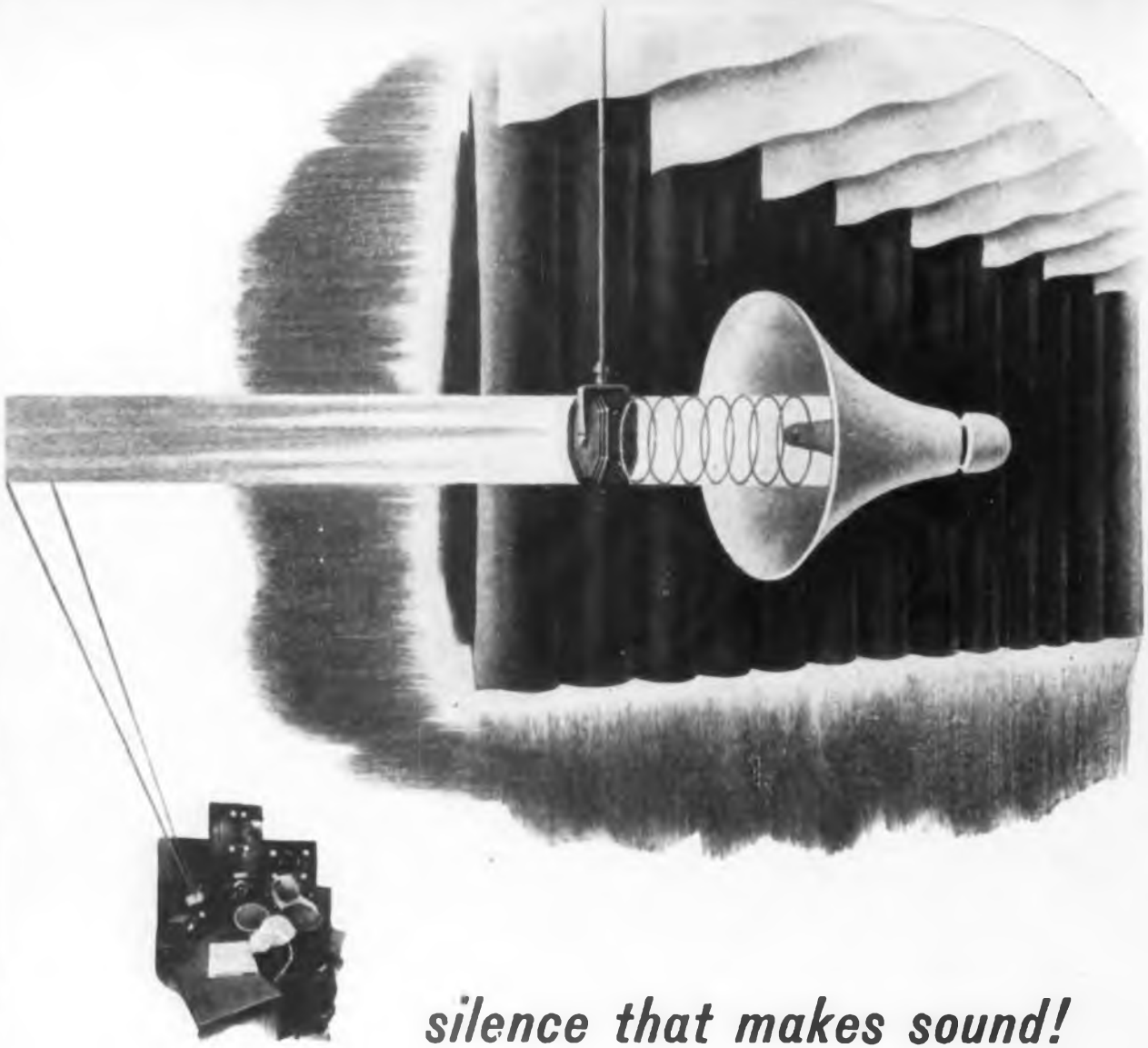
Acquaint yourself with the past performance of Formica and its possibilities for your new or improved peacetime product.

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

THE FORMICA INSULATION CO.

4647 SPRING GROVE AVENUE

CINCINNATI 32, OHIO



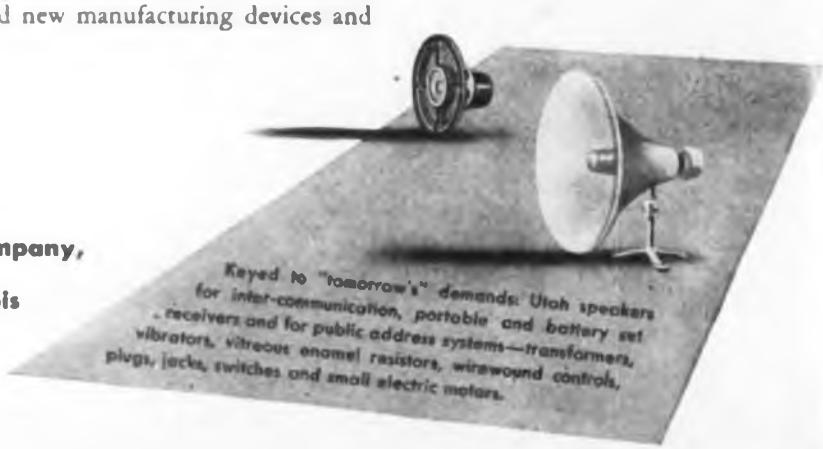
silence that makes sound!

In this "dead" room only the sounds which come out of the speakers are recorded. Sounds which would otherwise bounce back from the walls, ceilings or other objects are trapped and lost forever. The absence of reverberation permits scientifically accurate testing in the sound absorbing room of Utah's *complete* testing laboratory.

In making practical the many war-created radio and electronic improvements—in adapting them to today's needs and for the commercial requirements ahead, Utah engineers have designed new parts and products, developed new manufacturing devices and methods and have instituted new, more comprehensive testing techniques.

★ ★ ★

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



utah **Radio Products Company,**

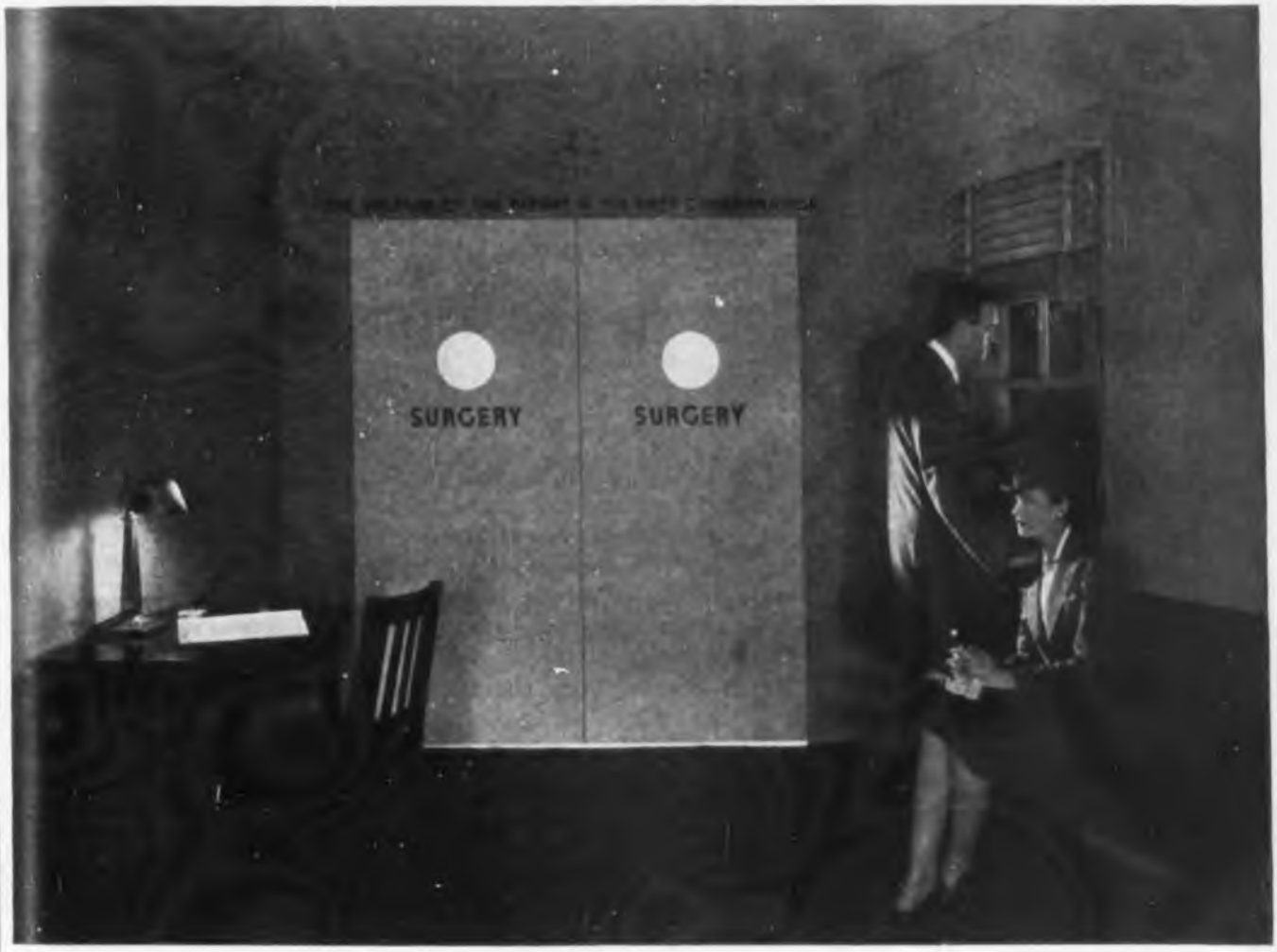
850 Orleans Street, Chicago 10, Illinois

When life and death ride on a slender needle...

If you have ever walked into the white hush of a modern operating room you have seen the metered instruments on which the surgeons depend as the age-old battle of life and death is fought across the operating table. These meters must be true. They must be unfailingly precise. Life itself depends upon them.

It is measuring, metering, and testing equipment of this kind—equipment that accepts the responsibility of *sustained accuracy**—that is built by Boes. Whether it be for the professions, the sciences, or for production, a Boes-made instrument is worthy of the work that it must do.

* **SUSTAINED ACCURACY** is not an easy quality to achieve. It must take into account all factors of use—must then employ the design, the alloys, the construction that infallibly protect an instrument against all threats to its reliable performance. Such instruments, obviously, must be built with performance—not price—in mind. We invite the inquiries of those who are interested in such standards.



Boes instruments

for Measuring, Metering & Testing Equipment ☆ The W W Boes Co., Dayton, Ohio

TO EXACTING LABORATORY STANDARDS..

Over the long period of years separating the past from the present, ECA has been called upon to tackle the development and production of innumerable types of specialized radio and electronic equipment. Consequently, our facilities are geared to exacting laboratory standards. We can handle the most delicate assignments with understanding care and painstaking skill.

Typical of the apparatus produced by ECA is this Rectifier Power Unit for general laboratory operation. Operating from a 105-125 volt, 50-60 cycle line, it delivers a maximum of 150 ma at 300 volts DC and has an open circuit voltage of 450 volts DC and 45 watts power output from 6.3 volts AC centertapped terminals. The hum voltage is 0.1% at 150 ma for all voltages above 150 volts. Continuous panel control of the DC output voltage is provided through a variable autotransformer.

Did you read the list marked "Killed in Action" in your paper today? A pint of your blood might have saved the life of an American boy. Visit your local Red Cross Blood Bank . . . Do it now.

eca

ELECTRONIC CORP. OF AMERICA

45 WEST 18th STREET • NEW YORK 11, N.Y. • WATKINS 9-1870

Can a Vibrator Power Supply Rescue a Boat-Load of Men?

No . . . it can't! But it *can help*—and the rescue *might* be prevented and the boat lost forever, if just one vibrator power supply failed to do its job.

● The compact radio transmitter that is standard equipment in many lifeboats depends on a vibrator power supply . . . The patrol plane that picks up the SOS . . . spots the drifting boat, and summons surface ships with its own powerful transmitter, has a complex electrical system that includes many vibrator power supplies. And in the rescue ship itself are still other vibrator power supplies performing vital functions.

The dependability of *E·L* Vibrator Power Supplies under all climatic conditions — their amazing adaptability in meeting specific current requirements — have brought them into wide use for radio, lighting, communications and motor operation—on land, sea and air.

Electronic's engineers have specialized for years in the technique of vibrator power supplies. They have conducted the most extensive research ever known on power supply circuits. They have extended the practical application of vibrator-type power supplies far beyond previous conceptions.

In the electronic era of peace to come, the efficiency and economy of *E·L* Vibrator Power Supplies will find new applications wherever electric current must be changed, in voltage, frequency or type.

For Operating Radio Transmitters in Lifeboats — *E·L* Model S-1229-B Power Supply. Input Voltage, 12 Volts DC; Output Voltage, 500 Volts DC; Output Current, 175 MA; Dimensions, 7½" x 5½" x 6¼".

Electronic

LABORATORIES, INC.

INDIANAPOLIS

***E·L* ELECTRICAL PRODUCTS** — Vibrator Power Supplies for Communications . . . Lighting . . . Electric Motor Operation . . . Electric, Electronic and other Equipment . . . on Land, Sea or in the Air.

Franklin's

NEW DEVELOPMENTS

born under the lash of wartime necessity

will find welcome use for

PEACETIME PRODUCTS TOMORROW

Sockets, Plugs, Switches, Contacts, Terminal Boards and Assemblies to perform electronic applications unheard of prior to Pearl Harbor Day was the crying need two short years ago.

Franklin engineers, like all American Industry, tackled the job with one purpose in mind . . . to quickly supply the armed services with newly designed electrical fittings to perform required electronic applications while withstanding most severe manhandling.

By discarding every precedent and starting from scratch Franklin engineers developed new Sockets, Plugs, Switches, Contacts, Terminal Boards and Assemblies which found high favor with manufacturers of electronic units and with the armed services.

Franklin's New Line developed for today's war equipment will find many applications for tomorrow's peacetime electronic equipment.

A. W. FRANKLIN MANUFACTURING CORP.

175 VARICK STREET • NEW YORK, 14, N. Y.

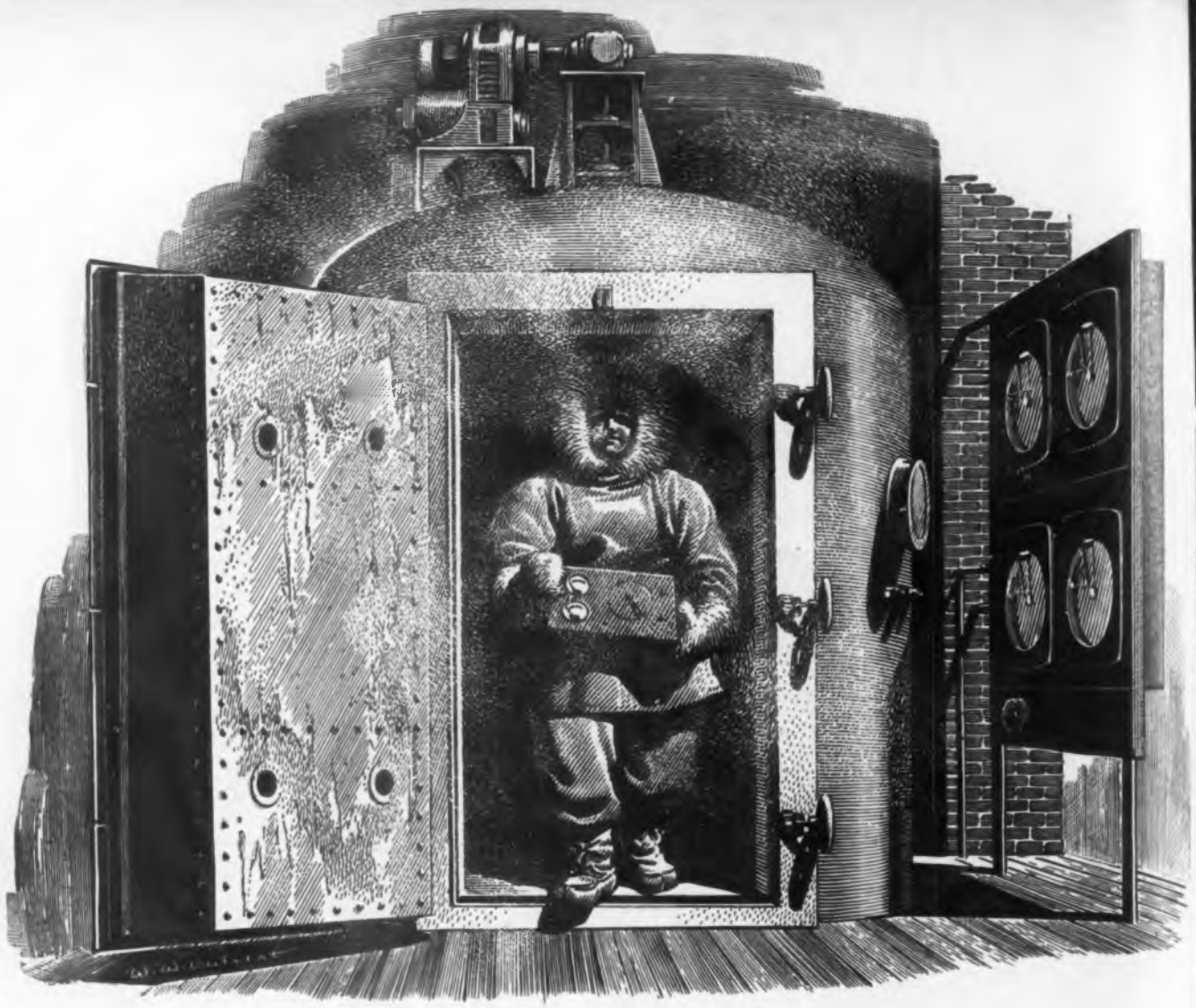
Sockets · Terminal Strips · Plugs · Switches · Plastic Fabrications · Metal Stampings · Assemblies

IT'S WILCOX *in Radio Communications*

For reliable aircraft operations, dependable radio communications are essential. Wilcox Aircraft Radio, Communication Receivers, Transmitting and Airline Radio Equipment have served the major commercial airlines for many years, and now are in use in military communications in all parts of the world.

WILCOX ELECTRIC COMPANY

Manufacturers of Radio Equipment • Fourteenth & Chestnut, Kansas City, Mo.



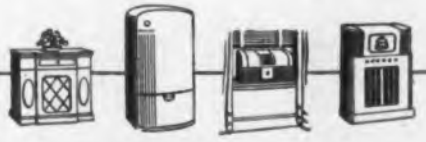
13 Miles above the ground . . . in a Philco Refrigeration Laboratory!

Philco REFRIGERATION engineers solve a tough problem in the production of military equipment . . . another example of how Philco's vast facilities for research and production are serving our armed forces.

AT Philco, airborne electronic equipment and aircraft radios pass the stratosphere test—of thin air and sub-zero temperatures—*in the laboratory.*

This ingenious high altitude chamber faithfully duplicates every condition of temperature and pressure from sea level up to 70,000 feet! When aircraft equipment can maintain absolute accuracy and dependability at 70° below zero, with air pressure 1/20 of normal—it's *right!* And *only* when it's right does it leave the Philco plant.

The stratosphere chamber is just *one* of many instances in which the skill and experience of Philco refrigeration engineers have supplied the answer to the most difficult war production problems. It's an example, too, of the precision and quality which, after the war, will again make Philco refrigerators and air conditioners *first* in engineering, *first* in convenience, *first* in advanced design!



After Victory, Philco peacetime products will offer the highest advancements of modern science for the homes and industries of America.

PHILCO CORPORATION

Since 1921
Designers and Builders
of
ELECTRO-STATIC
or
ELECTRO-MAGNETIC

High Frequency Units

For more than two decades, leading manufacturers of electronic, neon, X-Ray and (more recently) fluorescent tubes, have used our apparatus for such operations as degassing, sealing glass to glass or glass to metal (Kovar or copper).

Use of our apparatus always has afforded highly satisfactory results plus economy.

As dielectric and induction heating equipment, our better-built units are showing many points of superiority in metallurgical, plastics, plywood and dehydration applications.

It will pay you to let us supply the unit of proper frequency and power output for your particular needs Write for further information today.

(Above)
Advanced custom-built heating unit for a wide range of industrial uses.

(Right)
Low voltage, high current supply: 1 to 9 volts at 300 amperes.

Scientific Electric

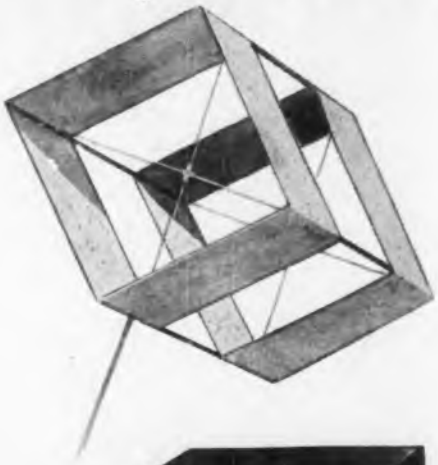
Division of

"S" CORRUGATED QUENCHED GAP COMPANY

119 MONROE STREET GARFIELD, NEW JERSEY

WHERE BOTTLENECKS ARE BROKEN!

You can expect the best postwar production



FROM KITES—

An antenna was needed to expand the range of the Gibson Girl sea-rescue radio set. Hoffman engineers solved the problem with a box-kite — simple, sturdy, built to fly in winds from 7 to 70 miles an hour, at a specified angle. Engineering ingenuity broke a tight bottleneck in design.

TO FREQUENCY METERS

Not many months ago, Hoffman took on the job of producing crystal frequency indicating equipment of vital importance in Navy communications. The plant was tooled up, manufacturing procedures established, testing equipment installed, all in record time. Now, mass-production quantities of this high-precision equipment are rolling off the lines. Another of many important bottlenecks broken.

IT'S INITIATIVE-IMAGINATION

Kites and frequency meters are but two of the many important jobs being done by Hoffman Radio Corp. We've intentionally taken on the toughest jobs — and broken the bottlenecks. We take great pride in the flexibility and fast action of our organization. It has made our contribution to the war effort greater and will result in the production of finer equipment for our dealers as soon as the war is over.

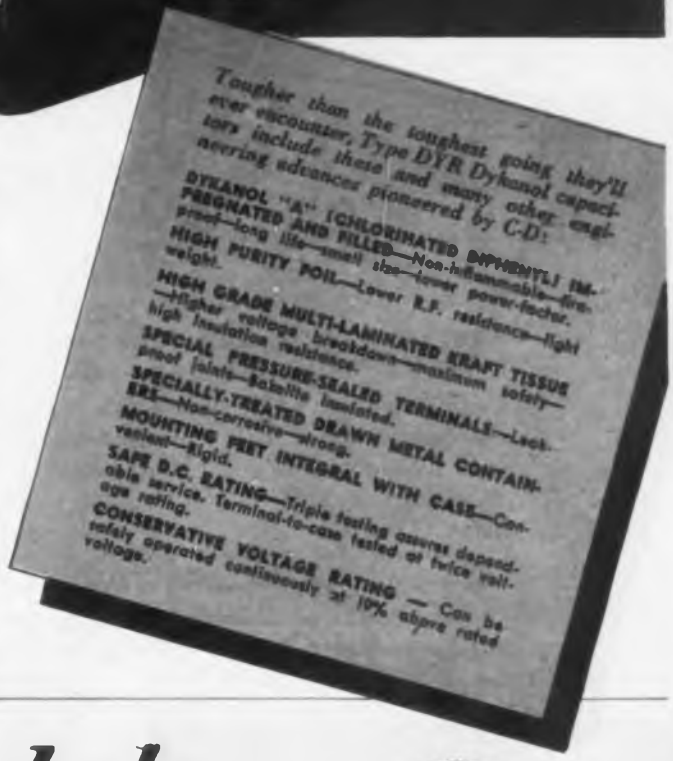
Hoffman
RADIO CORP.

MANUFACTURERS OF MISSION BELL RADIOS . . .
MITCHELL-HUGHES PHONO-COMBINATIONS . . .
ELECTRONIC AND COMMUNICATION EQUIPMENT

3430 SOUTH HILL STREET • LOS ANGELES 7, CALIFORNIA

EXTREMES

Type DY Dykanol bypass capacitors are specially designed for the excessive highs and lows of temperature and humidity—the extremes of everything wind, weather and water can offer on aircraft, submarines and surface ships. The *extra* endurance found in these and all other C-D capacitors stems from 33 years of doing one thing well—making capacitors and nothing else. For complete description of Type DY write to Cornell-Dubilier Electric Corporation, South Plainfield, New Jersey.

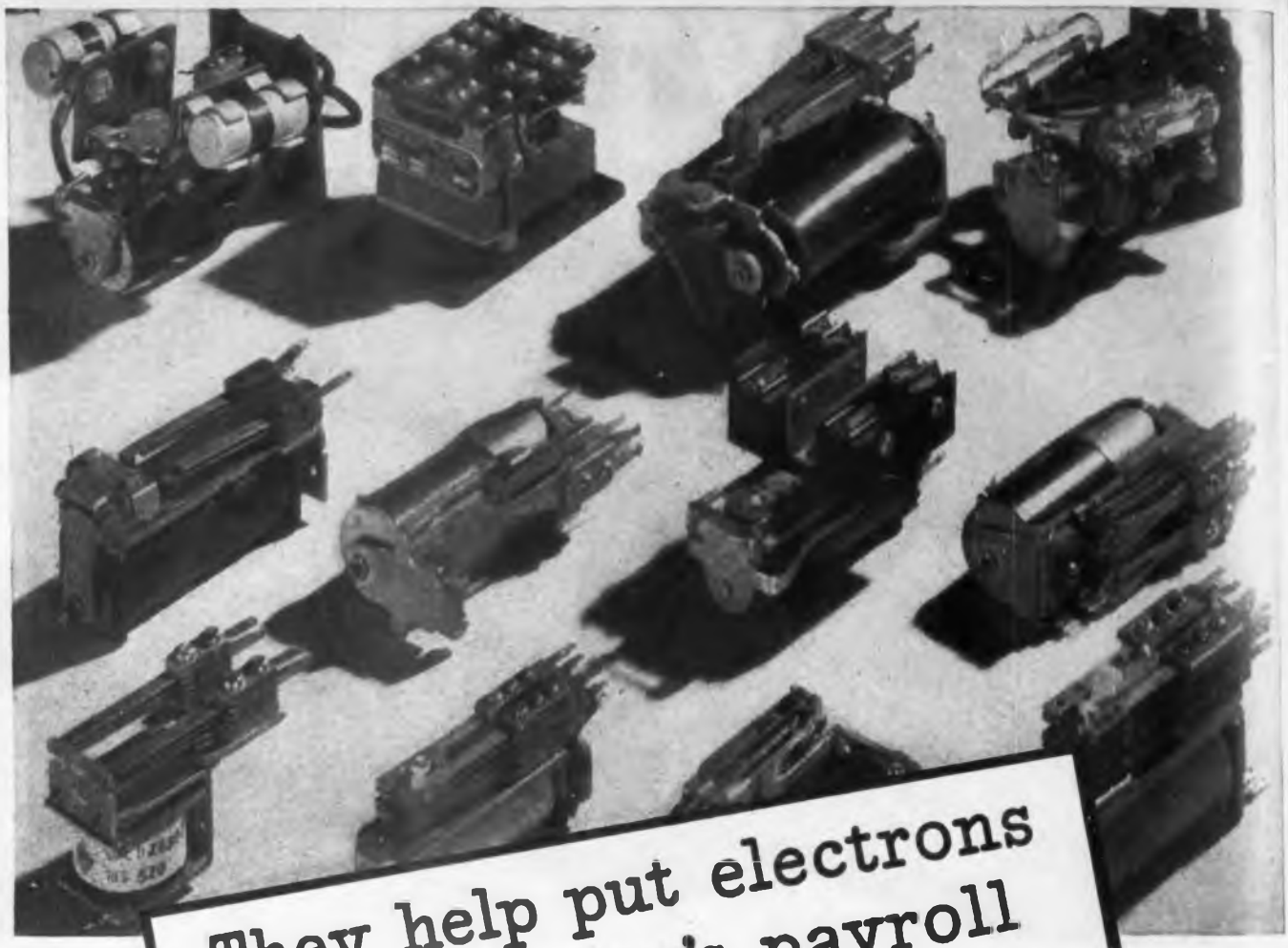


IT'S C-D FOUR TO ONE: In an independent inquiry just completed, 2,000 electrical engineers were asked to list the first, second and third manufacturers coming to mind when thinking of capacitors. When all the returns were in, Cornell-Dubilier was far in the lead—*receiving almost four times as many "firsts" as the next named capacitor.*

Cornell Dubilier capacitors

more in use today than any other make

MICA • DYKANOL • PAPER
WET AND DRY
ELECTROLYTIC CAPACITORS



They help put electrons on Industry's payroll

WITH the aid of Automatic Electric relays and other control devices, electronic science is helping industry do a thousand new jobs—speeding new electronic ideas through the laboratory and putting them to practical use on the production line.

Automatic Electric field engineers, armed with the technique which comes from long experience in electrical control applications, are working daily with the makers of electronic devices of every kind—offering time-saving suggestions for the selection of the right controls for each job.

Let us pool our knowledge with yours. First step is to get a copy of the Automatic Electric catalog of control devices. Then, if you would like competent help in selecting the right combination for your needs, call in our field engineer. His recommendations will save you time and money.

Relays
AND OTHER CONTROL DEVICES
by AUTOMATIC ELECTRIC

ARMY E NAVY

Distributed by

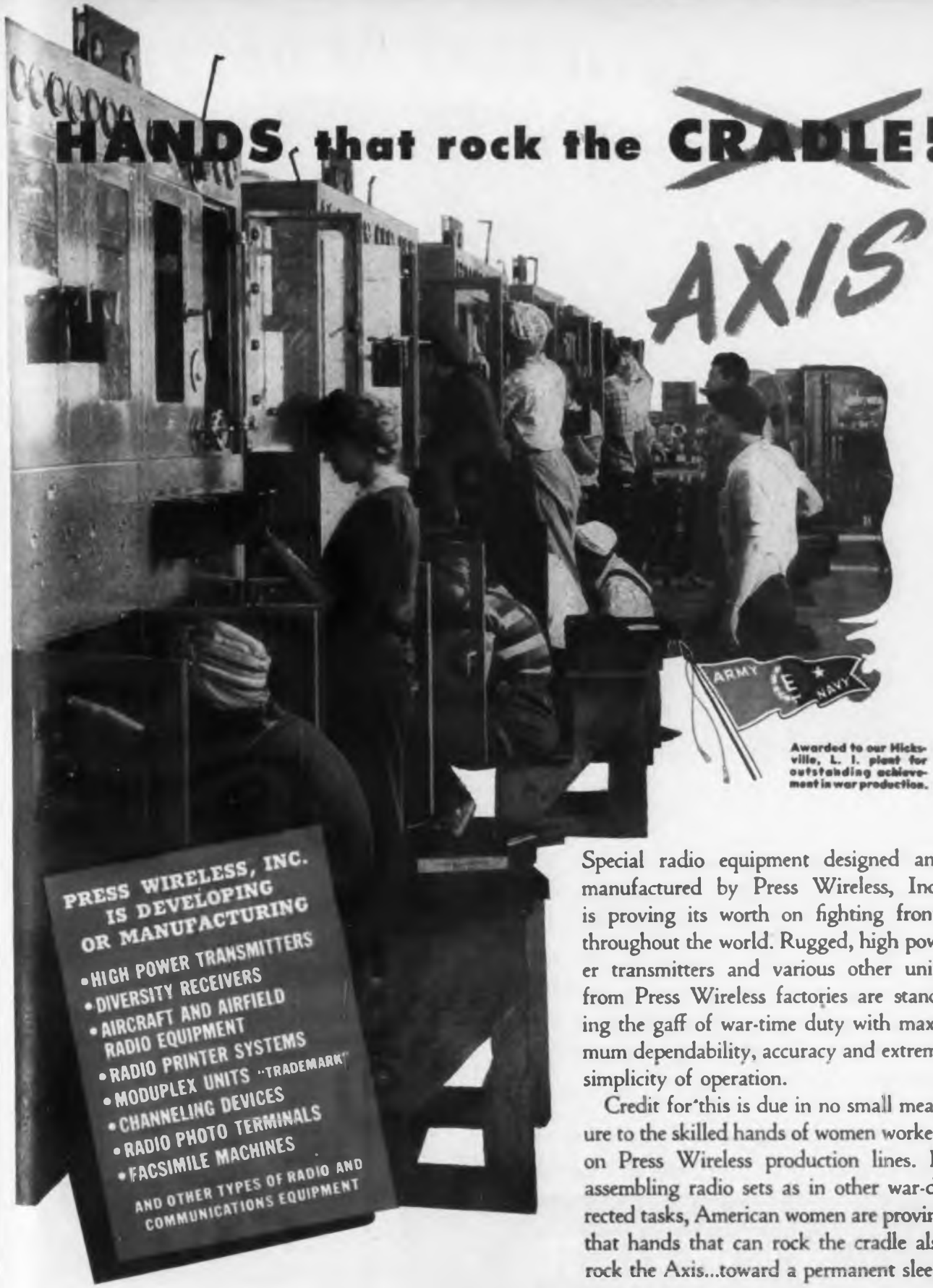
AUTOMATIC ELECTRIC SALES CORPORATION

1033 West Van Buren Street, Chicago 7, Illinois

IN CANADA: AUTOMATIC ELECTRIC (CANADA) LIMITED, TORONTO

MUSCLES FOR  THE MIRACLES OF ELECTRONICS

HANDS that rock the ~~CRADLE~~ AXIS!



Awarded to our Hicksville, L. I. plant for outstanding achievement in war production.

Special radio equipment designed and manufactured by Press Wireless, Inc., is proving its worth on fighting fronts throughout the world. Rugged, high power transmitters and various other units from Press Wireless factories are standing the gaff of war-time duty with maximum dependability, accuracy and extreme simplicity of operation.

Credit for this is due in no small measure to the skilled hands of women workers on Press Wireless production lines. In assembling radio sets as in other war-directed tasks, American women are proving that hands that can rock the cradle also rock the Axis...toward a permanent sleep!

Sales Office, Manufacturing Division
1475 BROADWAY, NEW YORK 18, N. Y.

PRESS WIRELESS, INC.

Executive Offices
435 N. MICHIGAN AVENUE, CHICAGO

RIO DE JANEIRO · MONTEVIDEO · BERNE · SANTIAGO DE CHILE · NEW YORK CHICAGO · LOS ANGELES · LONDON · HAVANA

TEMPERED FOR THE HEAT OF BATTLE!

Remler craftsman heat treats welding and cutting dies and tools for automatic screw machines.

ELECTRONIC TOOLS OF WAR . . . in quantity and on time! There are no delays because Remler has the facilities and experience to do the job from design to finished product —plus the know-how to cut production time which frequently permits quotations at lower prices. This organization of skilled specialists manufactures components and complete electronic equipment for our armed forces and components for your application. Inquiries invited.

Wire or telephone if we can be of assistance

REMLER COMPANY, LTD. • 2101 Bryant St. • San Francisco, 10, Calif.

REMLER

SINCE 1918

Announcing & Communication Equipment

PLUGS & CONNECTORS

Signal Corps · Navy Specifications

Types:					NAF
50-A	61	74	114	150	
54	62	76	119	159	
55	63	77	120	160	1136-1
56	64	104	124	291-A	
58	65	108	125	354	No.
59	67	109	127		212938-1
60	68	112	149		

PLP		PLQ		PLS	
56	65	56	65	56	64
59	67	59	67	59	65
60	74	60	74	60	74
61	76	61	76	61	76
62	77	62	77	62	77
63	104	63	104	63	104
64		64			

OTHER DESIGNS TO ORDER

What's Wrong With This Picture?

The thing that is wrong about this picture is that radio engineers have been doing such a bang-up job meeting and anticipating the vast needs of our military services that not enough good things can be said about them by those engaged in the field of electronics.

Seven days a week and night after night, the radio engineers are working out the multitudinous problems of design required to give our Allies the most of the best electronic equipment in the world.

Raytheon is proud of its part in furnishing electronic tubes and equipment that meet engineering requirements of stamina, high quality and complete dependability under the most severe wartime demands.

ARMY-NAVY "E" WITH STAR
Awarded All Four Divisions of Raytheon
for continued excellence in production

RAYTHEON

RAYTHEON MANUFACTURING COMPANY
Waltham and Newton, Massachusetts

DEVOTED TO RESEARCH AND THE MANUFACTURE OF TUBES AND EQUIPMENT FOR THE NEW ERA OF ELECTRONICS

HERE'S SOMETHING WORTH LOOKING INTO!

IF you're foxy — and your requirements include chassis, chassis mounting assemblies, shelf assemblies, panels, transformer housings or cabinets — you'll look into Corry-Jamestown's ability to build them.

We work in steel—stainless steel or aluminum with a deal of pride in our precision and our production schedules.

In short, with your order before us, you can be sure of two things. It will be built right! It will be delivered on time!

If this sounds interesting to you, send us your specifications. Unless your opinions differ from those of many leaders in electronic industries, you'll say our prices are as fair as our workmanship is good.

SPEED VICTORY ★ BUY WAR BONDS

CORRY-JAMESTOWN

MANUFACTURING Steel Age CORPORATION

CORRY, PENNSYLVANIA

DESIGN ENGINEERS will find the M-R Wall Chart a helpful, handy, easy to use reference of inestimable value!

NO Research NO Checking Text Books ALL DATA ON ONE CHART

M-R WALL CHART CONTENTS

(ACTUAL SIZE 21 x 34 INCHES)

- TAP DRILL SIZES ★
- TWIST DRILL SIZES ★
- MACHINE SCREW SIZES ★
- FRACTIONS TO MILLIMETERS ★
- MILLIMETERS TO INCHES ★
- METRIC EQUIVALENTS: ★ *Lengths, Areas, Volume, Capacity, Weight*
- STANDARD ARMATURE WEDGE SIZES ★
- COSINES LAW ★
- OHMS LAW ★
- ★ VARNISHED TUBING SIZES
- ★ ELECTRICAL SYMBOLS
- ★ VALUE TABLES OF TRIG. ANGLES
- ★ COMPARISON OF THERMOMETRICAL SCALES
- ★ COPPER WIRE CARD
- ★ ALLOWABLE CARRYING CAPACITIES
- ★ INSULATION THICKNESSES AND DIELECTRIC STRENGTH

THIS VALUABLE WALL CHART IS FREE

. . . WRITE FOR IT TODAY . . .
ON YOUR COMPANY LETTERHEAD!

M-R
FOR 55 YEARS THE ELECTRICAL INSULATION HEADQUARTERS
EST. 1889

M-R

EXTRUDED PLASTIC TUBINGS

are non-combustible, extremely high dielectric, great in tensile strength, solderable, flexible, elastic and resistant to solvents, high and low temperatures, abrasion, brittleness and moisture. They are made in five grades of thin or thick walls and in transparent and six different colors.

M-R

FIBERGLAS INSULATIONS

Tubings, Tapes, Cloths and Fabricated Products...are not affected by overloading, high or low temperatures, moisture, corrosive acids, vapors or fumes, oils, greases, dust or dirt. In use M-R Fiberglas Insulations have proven themselves the optimum inorganic electrical insulation.

M-R

VARNISHED TUBINGS

of *Fiberglas* or *Long Staple Cotton Fibre Yarn*...Fiberglas Tubings are made in four grades: STANDARD for high temperature; DOUBLE SATURATED for high temperature and dielectric up to 1500 volts; TRIPLE STRENGTH for high temperature and dielectric up to 3000 volts; IMPREGNATED for high gloss, non-hydroscopic, high temperature, resistance to oils, grease, acids and dielectric to 8000 volts... Cotton Yarn Tubings are comparable to Fiberglas in dielectric rating, tensile strength, flexibility and long life.

M-R

WAXES and COMPOUNDS

there are upwards of 4000 M-R Wax and Compound formulas to resist high voltage breakdown, salt spray atmosphere, humidity, cracking or flaking, acids and alkalis. All have excellent adhesive qualities, flexibility, high cold flow and good thermal conductivity. They penetrate fibre, floss, bakelite, paper and cloth and have low viscosity, high surface tension and good electrical characteristics.

MITCHELL-RAND INSULATION COMPANY, INC.

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

A PARTIAL LIST OF M-R PRODUCTS

Fiberglas Varnished Tape and Cloth
Insulating Papers and Twines
Cable Filling and Pothead Compounds
Friction Tape and Splice
Transformer Compounds
Fiberglas Braided Sleeving
Cotton Tapes, Webbings and Sleevings
Impregnated Varnish Tubing
Insulating Varnishes of all types
Fiberglas Saturated Sleeving and Varnished Tubing
Asbestos Sleeving and Tape
Extruded Plastic Tubing
Varnished Cambric Cloth and Tape
Mica Plate, Tape, Paper, Cloth and Tubing

65

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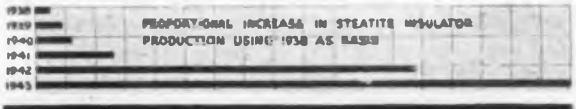

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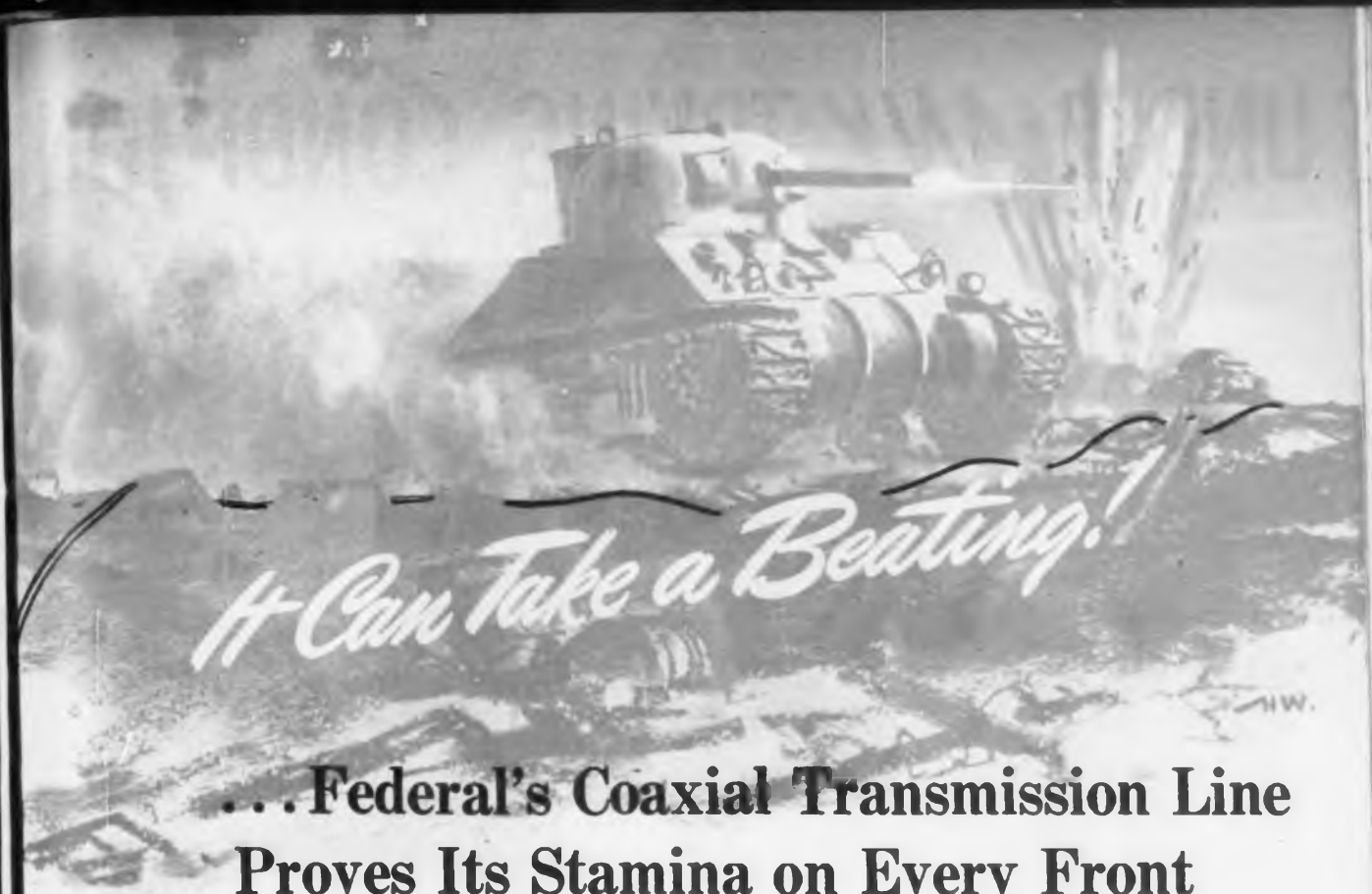

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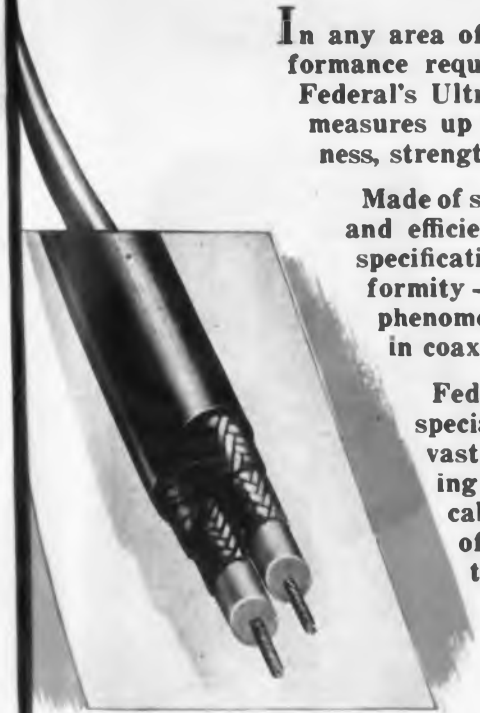

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There is an apparent discrepancy at this point.

The pages are either missing or the pagination is incorrect.

The filming is recorded as the book is found in the collections.

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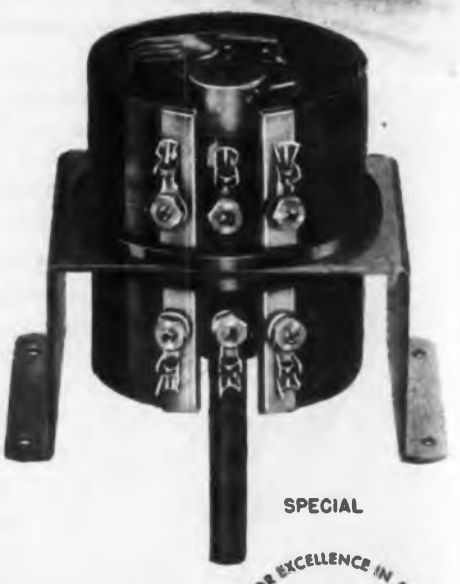

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2½- inch—1 inch deep

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A New Design That Puts More Instrument into Less Space

These new, internal-pivot instruments were developed to fill a vital need—particularly in the radio and aircraft fields—the need for compactness. They are *thin*—in most ratings, less than 1 inch deep.

More important is the way their thinness was achieved. In the sketch below, see how the pivots are solidly anchored to the *inside* of the armature shell so they cannot work loose. The moving parts are permanently aligned with stationary parts by bolting the core assembly to a one-piece cast-comol magnet.

Other features are: large-radius pivots, high torque and good damping, lightweight moving element, and ample clearances. Added up, they give you an instrument well able to withstand vibration and hold its rated accuracy, one that is fast on response and easy to read accurately—a design that packs all-round fine performance in a small space.

For ratings, price, and dimensions, ask our nearest office for Bulletin GEA-4064, which covers instruments for radio and other communications equipment; or Bulletin GEA-4117, which describes those suitable for naval aircraft. *General Electric Company, Schenectady, N. Y.*

Type DW-53 d-c voltmeters, ammeters, and volt-ammeters that are specially designed to measure voltage and current in battery and battery-charging circuits on naval aircraft. They meet applicable Navy specifications.

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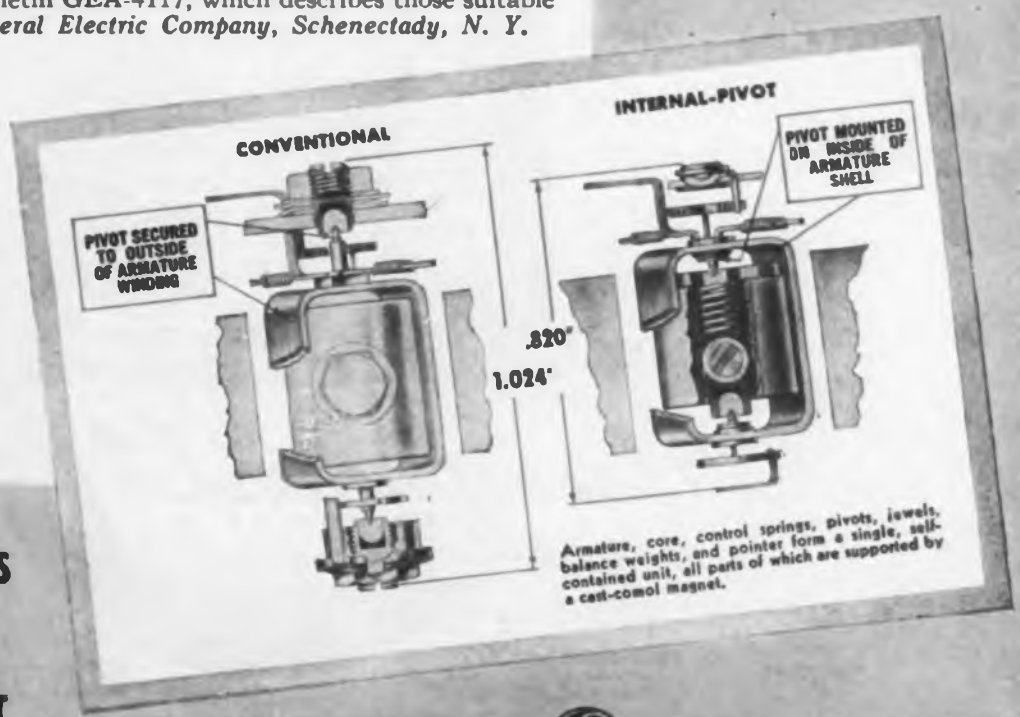


HEADQUARTERS FOR ELECTRICAL MEASUREMENT

GENERAL ELECTRIC

ELECTRONIC INDUSTRIES

O. H. CALDWELL, EDITOR ★ M. CLEMENTS, PUBLISHER ★ 480 LEXINGTON AVE., NEW YORK (17), N. Y

Reconversion Complexities

Reconversion in the radio-electronic field is not a simple problem. As things stand today there are at least three different situations to be taken into account:

1. Concerns which are now manufacturing radio equipment at about the same rate as they did before the war, and are planning to return to radio operation on a similar scale after the war.
2. Former radio manufacturers who have tremendously increased their scale of radio operations during the war period.
3. Concerns formerly in some non-radio field, which have taken on radio production for the duration, and now like radio-electronic manufacturing so much that they plan to continue in radio or electronic production, postwar.

Each of the above reconversion problems will require separate study. The handling of each group will call for a different postwar solution.

About paper: We don't like the paper on which this issue is printed, either. But using the thinnest-possible paper is a patriotic necessity in wartime,—to save pulp, tonnage, labor, coal and transportation. More about all this, on page 252.

Electronic Opportunities in Motor Control

Viewing recent advances in electronic applications, an engineer of wide industrial experience makes this comment:

"I believe more tubes would be applied to industry if this effort were directed by engineers who have a control sense and background, rather than by tube engineers. Certainly, an outlay of $400 for a 1-hp. motor control will not get us very far! Costs will come down with production, of course, but we can't build up production at that price-level.

"Industry works in grooves; commercial men are reluctant to accept radical changes until forced to do so. The keynote of the Depression period was to use what we had. For 10 years executive leaders were chosen with that idea in view. But now the war effort is stimulating development. Still it will take time to influence executive thinking. The tube has developed rapidly for welding, but not much progress has yet been made to use it for motor control on the broad scale it deserves."

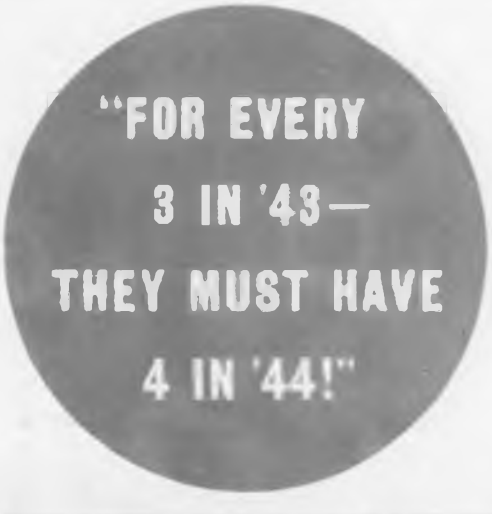
Electronic Railroading

Of all the big postwar markets for radio-electronic applications, our American railroads probably lead the list. For theirs is still a virgin field, electronically speaking. Today both passengers and train crews are isolated while trains are in motion. Even the absurd anachronism of sending a flagman back half a mile remains standard railroad practice. Radio communication, now routine on the sea and in the air, must someday revise rail operation. Electronic signalling is another case in point.

Many of the terrible wrecks that have happened in recent months, might have been prevented had engineers and conductors been continuously in radio touch with dispatchers' headquarters and with other trains.

Surveys of the railroads' postwar plans indicate that the moment the war is over, present heavy passenger equipment will be replaced all over the country by light-weight, streamlined trains, with running speeds of 100 miles per hour. The change will be made as quickly as car manufacturers can produce the new equipment. This will be the railroads' answer to automobile and truck competition. A reduction in long distance rates to about one cent a mile is also proposed. Such "renovation of the rails" calls also for an entire renovation of railroad signal equipment through the country, a project of tremendous magnitude—but one which can be performed quickly and efficiently, as an article on electronic signalling in this issue, clearly outlines.

Someday, we predict, the railroads will be among the electronic industries' biggest customers.



ENEMY RADIO EQUIPMENT

These Signal Corps photos, showing German equipment, together with those on pages 106 and 107, show some of the units included in the display arranged by Major General R. E. Colton at the IRE-AIEE Winter Meeting

(See pages 122-123 of this issue for digests of many of the papers presented before the IRE-AIEE meeting)

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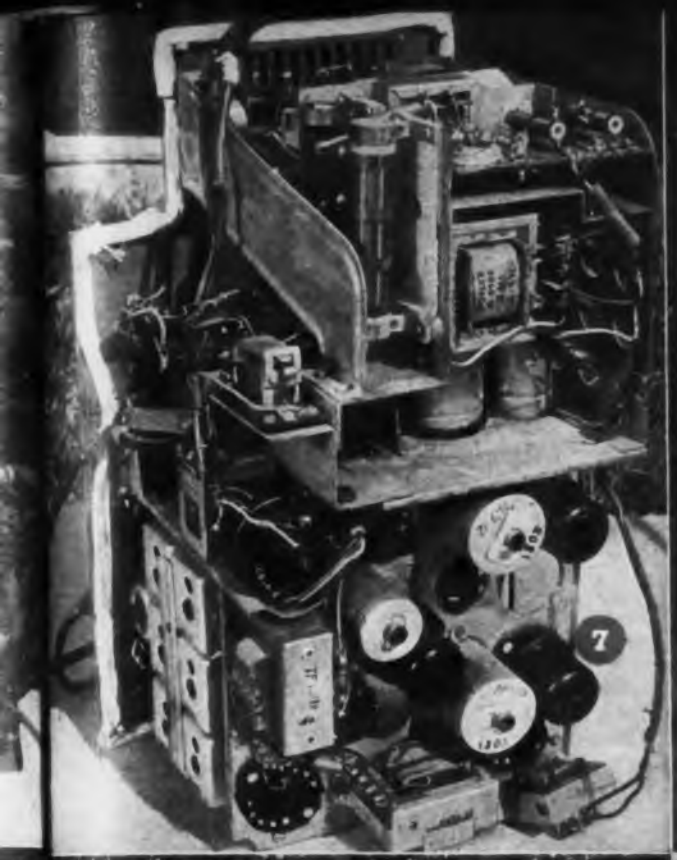
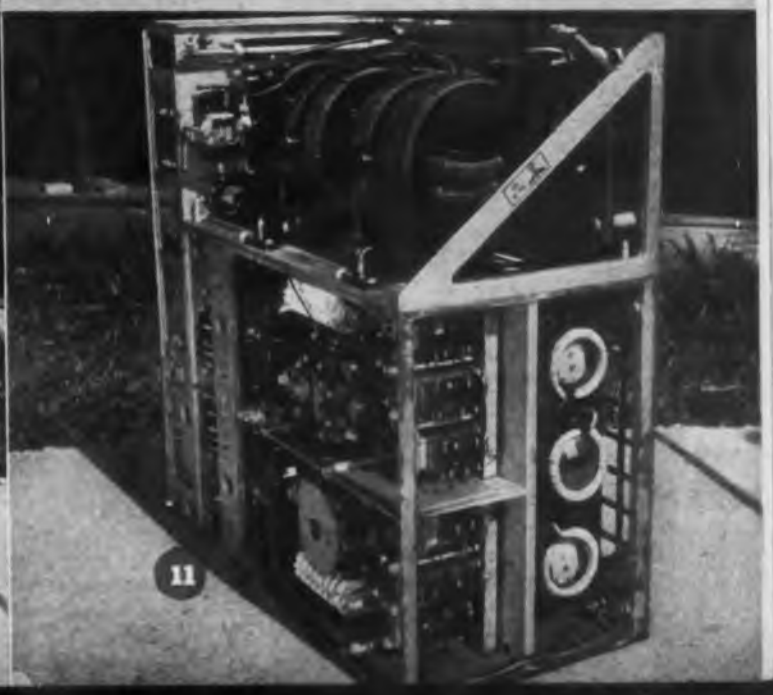


1. FUG 16 receiver, modulator, and transmitter set (left to right) used in fighter planes. All receiver tubes are RV12 P-2000's.
2. FUG 7, another type of airborne set for fighters.
3. FUD 2 pack transceiver. Note phones, hand-mike, and key.
4. Rear view of FUD 2, showing two types of tubes used in this 23-38 mc set.
5. Tank receiver type UKWEe, for 27 to 33 megacycles. Note tubes.
6. Rear view of German frequency meter, showing coil-changing rotor.
7. Insides of a German commercial allwave receiver (150 kc-15 mc).
8. "Mock-up" of famous FUG 10 longwave communication set for bombers.
9. German Torn Eb all purpose pack-type receiver.
10. Type 100 WS transmitter (200-1200kc) used in division command sets, usually mounted on armored car.



OPERATING EXPERIENCE WITH HF HEATING

by **HENDERSON C. GILLESPIE**
RCA Victor Division, Radio Corp. of America

An engineering approach to the solution of problems of cost, efficiency and practical application in industry

● Radiothermics is a term that is coming into use to describe the application of electrical heating at frequencies where effects in addition to the joule effect come into play. These effects have to do with the control and acceleration of heating processes rather than with any action such as might be described by the term "catalytic." That is, we are not concerned with killing bugs or bacteria by anything remotely resembling a death ray, but rather with the efficient and properly controlled use of electric power for heating purposes. The number of processes requiring the use of heat to effect chemical, physical or biological changes is very large, and many have special requirements that ordinary heating means cannot meet.

Because the advantages that can be obtained from radio frequency heating have already been discussed and published many times, it will be the writer's purpose here to classify and analyze them, rather than merely to enumerate them. First, let us remember that a fundamental difference between rf heating and other means of heating is that rf current generates heat within the material being treated, while conventional heat sources apply heat which must penetrate the material from the outside.

Fig. 1—Continuous soldering set-up for sealing capacitor containers

Primary effects

The primary effects of internal heating are that heat flow in the work is either eliminated as a requirement, or is controlled to an extent and in a manner not possible any other way. The advantages resulting from these effects are:

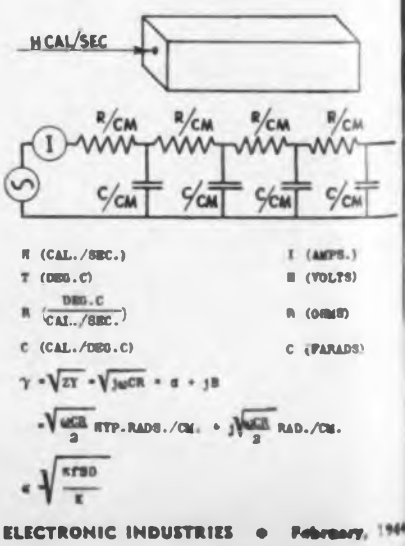
1—Saving of time and improvement in quality in processes where undesired effects are produced by prolonged heating, as the drying out of lumber being glued or oxidation of metals being annealed.

2—The temperature distribution in the work can be made uniform or the usual gradient can be reversed—that is, the temperature made higher inside than out. Uniform temperature distribution is necessary, for example, to achieve maximum plasticity in molding of either thermoplastic or thermosetting materials. An inside-out temperature gradient is desirable, on the other hand, in bonding of thermoplastic sheets, where plasticity is desired at the inner faces of the sheets but not at the outside surfaces. The same kind of temperature distribution is useful in drying materials containing absorbed water or solvent liquids, where excessive outside temperature would cause surface-hardening of the material being dried. These considerations apply to heat and electrical insulating materials.

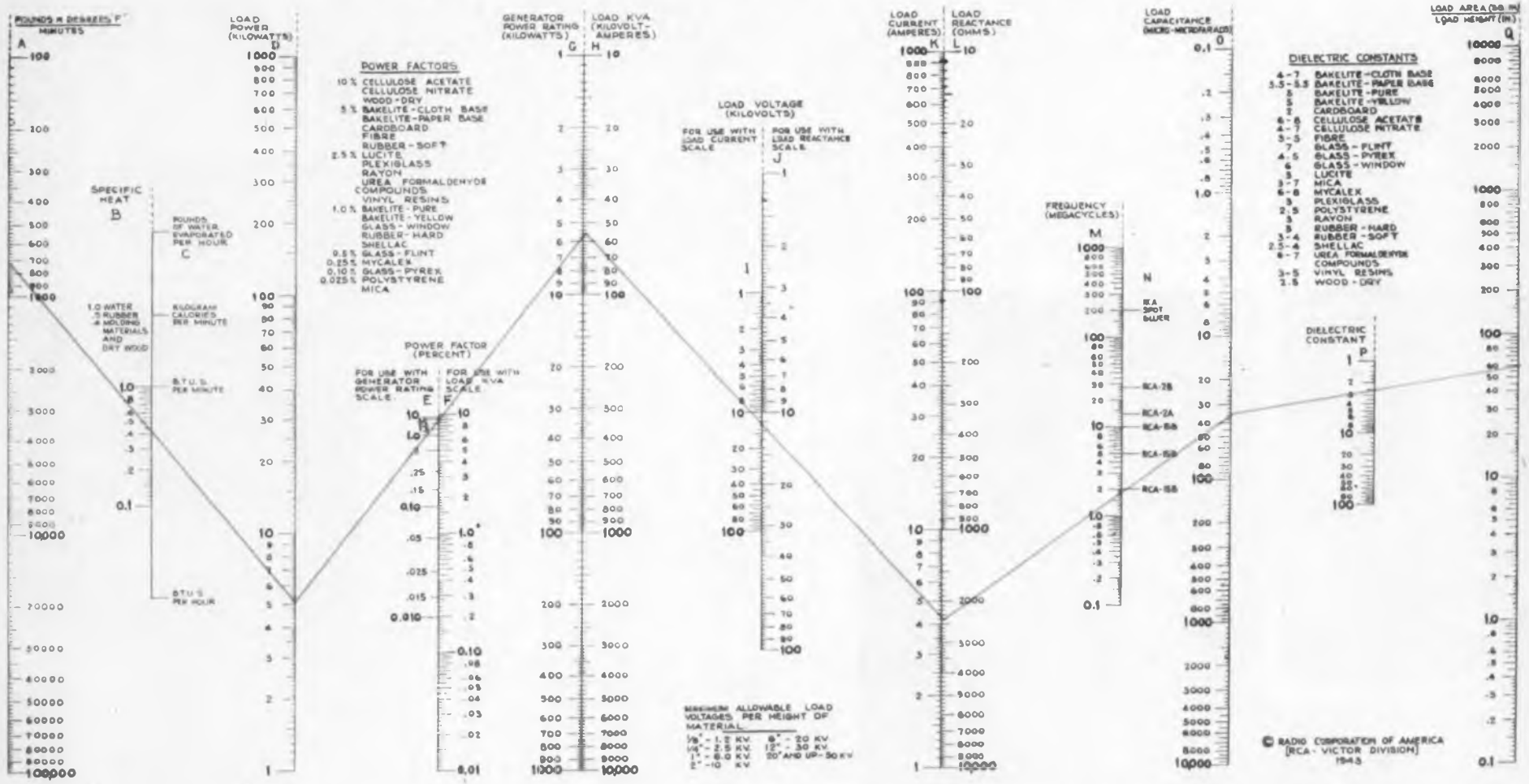
When we come to the heating of metals there is no particular problem in achieving uniform temperature distribution; the high thermal conductivity of most metals ensures that. The problem that often does arise is one of limiting to some desired zone the area being heated. Here the effect of radio frequency induction which sharply delineates the locale of the heat generation, combined with the ability of rf equipment to deliver high concentrations of power to the work, gives us a degree of control not easily achieved by other means, if at all.

This localization of heating can be carried to a point that makes possible the surface-hardening of ordinary steels by using in place of the usual quenching bath heat-flow from the surface layer into the cold metal behind it. That is, so steep a temperature gradient is established by highly localized, very rapid heating that heat flows out quickly enough to yield the quench-

Fig. 2—Illustrating correlation between the thermal and electrical problems. In the last formula, S = specific heat in calories/deg. C. x grams; D = density in grams per cu. cm. and K in the Cal. per second per cu. cm. per deg. C.



RADIO FREQUENCY HEATING CHART



Starting with a heat requirement expressed in pounds x deg. F. per minute, (scale A at left) we can proceed through the specific heat value on scale B to obtain its kilowatt equivalent on scale C. This point is aligned with the value of power-factor of the material, on scales E and F, to yield the output power requirement of the generator, scale G, and the load kva requirement, scale H. Now select a point on the I and J scales, which represents the highest safe operating voltage, and align it with the selected point on the G scale, and we obtain either the current in the load capacitor, scale K, or its reactance on scale L. To determine the reactive ohms from the dimensions of the material and its dielectric constant, compute and locate the ratio of its area to its thickness, on scale Q, and pass a line through the proper value on the dielectric constant scale, P, to find the load capacitance on scale O. The load reactance is related to capacitance and frequency, so a line drawn from scale O to the point on scale L (previously determined) will intersect the frequency scale M at a value which will be the minimum allowable on the basis of the assumptions of maximum safe operating voltage.

A typical problem is indicated. A block of nominally "dry" wood 15 x 10 x 2½ in., weighing 5⅔ lb. is to be raised 129 deg. F. in one minute. The value of 5⅔ x 129 ÷ 1 on scale A, through 4 scale B intersects D at 5.2. At this point a line through scale E, assuming a 10 per cent power factor, gives a point on scale G of 5.5 kilowatts. The load having an active area of 150 sq. in. and a spacing of 2½ in. gives a value of 60 on scale Q. Assuming a dielectric constant of 2.5 (actual values can of course be easily measured and substituted) a line through scale P intersects scale O at 34 mmf.

Now at a frequency of two megacycles a load current of 4.3 amperes will give the required heating (scales O, M, and K). At 5.5 kw (previously found on scale G) and 4.3 amperes, a voltage of 13 kilovolts is indicated on scale 1. If a lesser voltage is desirable, however, say 8 kv, 6.9 amperes would be needed, so that the frequency would have to be raised to 3.2 megacycles. This chart is therefore useful in the selection of operating conditions when certain factors are fixed.

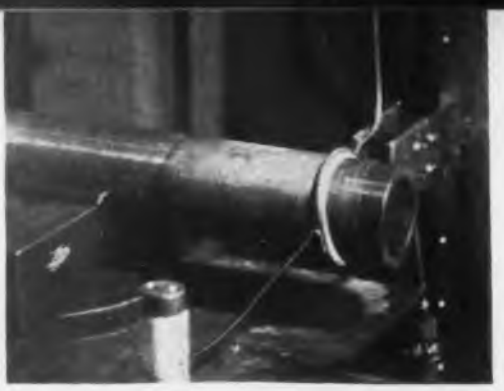


Fig. 3 — Radio frequency induction heating applied to surface hardening

Fig. 4—Soldering of bases on capacitor cans has been stepped up from 100 to 2500 an hour at RCA Victor through application of rf induction heating

ing required for hardening. This effect has opened up new possibilities in surface-hardening and in precision control of other heat treating processes.

Perhaps the most obvious effect of internal heating is that heat transfer from one hot body to another, with its attendant irregularities, is eliminated. The importance of this is most marked in soldering and brazing since heat transfer from a soldering iron or from melted solder in a pot is notoriously erratic., By causing heat to be transferred to the solder or brazing material from the parts to be joined, rather than vice versa, complete wetting of the hot metal by the solder is assured and tighter joints result.

In addition to the effects which follow directly from internal heat generation, there are a number of secondary effects deriving from the method of generation of rf power and its application. The first of these is probably the ability to heat without contact between the heating element, either metallic or fluid, and the work. This factor, taken is conjunction with the flexibility of the equipment as to power output, and the speed that can be attained, makes rf heating especially adaptable to continuous processes. Examples of this are a continuous soldering set-up (Fig. 1) in use in the RCA Victor plant in Camden, N. J., and Westinghouse's tin flowing installations.

Roller electrodes may also be used in continuous processes where it is desired to apply pressure as well as to supply radio-frequency current to the work, as in seaming thermoplastic-coated fabrics with the RCA Laboratories' electronic sewing machine.

In operations such as the bonding of sheets of wood, not adaptable to continuous processes but requiring contact between the electrodes and the material, a secondary consideration is the simplicity of application. All that is necessary is to lay electrodes in the form of thin copper sheets against the surfaces of the parts to be heated and feed current into them through flexible copper straps. This consideration has led to the use of rf heating in the assembly of wooden airplane parts, the electrodes being placed between the assembly and the clamps as a means of getting heating power directly to the thermosetting glues applied between the sheets.

The heat flow considerations that enter are often so complicated as to defy accurate analysis, but can be simplified by assuming that the isotherms are parallel to the surface through which the heat is entering or leaving. The problem then reduces to a one-dimensional one, and the field problem becomes a line problem.

The terms thermal conductivity and heat capacity immediately suggest their counterparts in electrical units and we are enabled to get our line problem down on paper in the familiar representation of series resistance and shunt capacitance: temperature becomes voltage, Cals. per second become current, Cals. per deg. C. become capacitance. Ohm's law still holds, so resistance is degrees Centigrade over Cals. per second.

When the termal quantities have been put into electrical terms, the configuration representing our one-dimensional heat flow becomes recognizable as an electrical cable whose response to various forms of excitation has been analyzed (Fig. 2). We know, for instance, the attenuation constant in terms of the resistance and capacitance per unit length for sine wave applied voltage.

Putting in the values of R and C corresponding to the analogous thermal properties, of, say, steel, we get a value of attenuation con-

Fig. 5—Electronic rivet detonator for firing explosive type rivets

Fig. 6—RCA 15-kw radio frequency generator for industrial uses

stant of 405 db per in. for a frequency of 10 cycles per second, and higher for higher frequencies. This means that if we apply a rectangular pulse to one end of such a line, which is equivalent to applying heat energy to the surface of a block of steel in a .1 second "shot," the fundamental and harmonic components will be very rapidly attenuated as the wave travels down the line, or in from the surface.

Because much of the energy of such a pulse lies in the upper frequency region, we can see the advantage of fractional-second heating where we wish to limit the temperature rise to the surface of a metal such as steel. On the other hand, the values of R and C corresponding to a heat insulating material like wood yield a value of propagation constant which shows high attenuation for frequencies above 10 cycles per minute. Thus we see the futility of trying to raise the temperature at the center of thick pieces of wood in short times by means of hot plates feeding the heat in from the surface.

Supposing now that we have decided to heat a material by high frequency, what are the requirements as to power and frequency? If the material is a dielectric, the problem is relatively simple. The power requirement is set by the heat requirement of the piece to be heated and the time allowable. The minimum frequency can be calculated on the basis of the assumption that the power factor of the material remains constant with frequency. Converting the heat requirement per unit time into kilowatts and then dividing by the power factor of the material gives us the volt-amperes required to be produced in the work. How the volts and amperes will be proportioned will then become a matter of choice, with a maximum value of voltage determined by breakdown considerations. Selecting this value, we can divide the volts by the amperes, and obtain a maximum value of capacitive reactance that our load circuit may have.

In order that the load circuit be of this value, or lower, a simple calculation of capacitance and computation of minimum frequency from this and the previously obtained reactance are necessary. When the minimum frequency

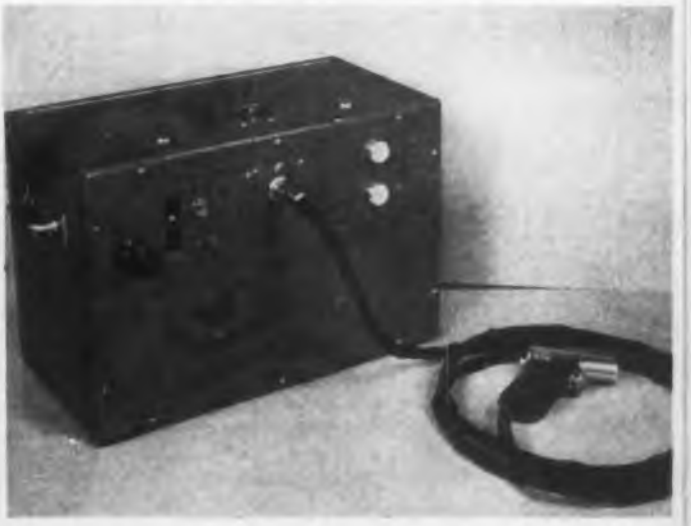
(*Continued on page* 158)

Fig. 7—Radio frequency generator for production of plastic forms

Top—Pre-forms of raw plastic before heating. Center: Electrodes with preforms in position. Bottom: Finished plastic outlet box as it comes from mold

Fig. 8—100-kw radio frequency oscillator operating at 25 megacycles for production of heat to dry rayon

Fig. 9—Radio "nail gun" or spot gluer, for the temporary bonding of thin veneers of wood prior to cutting



IMMEDIACY vs LONG TERM

by STANLEY P. McMINN

Three-stage plan for transition appears best headache insurance—Work of practically all Panels well started

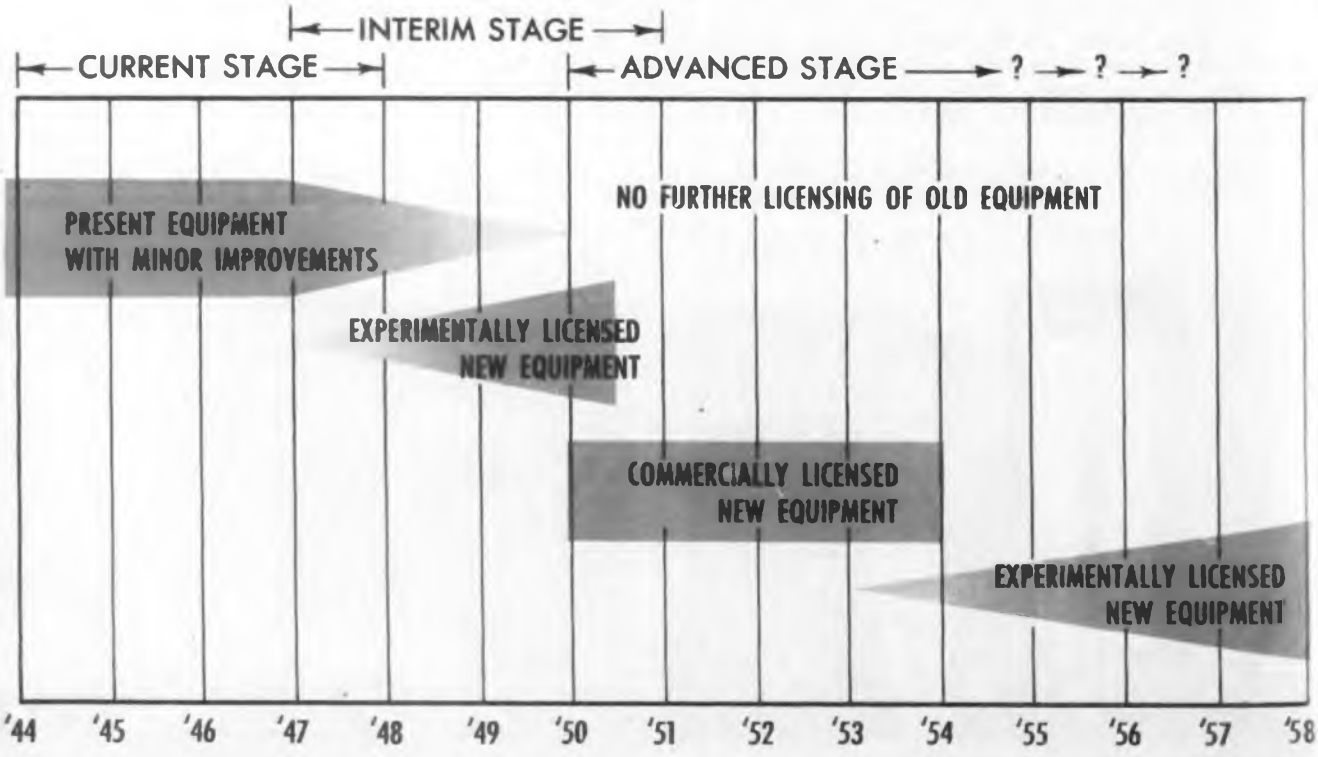
● RTPB's boiling. In the patois of the times, something's cooking. Work has been well started, under the direction of the general chairman, Dr. W. R. G. Baker. And according to Dr. Alfred N. Goldsmith, vice-chairman of the Board and chairman of the important Panel No. 1 on Spectrum Utilization, hub around which practically all other Panel deliberations must revolve. Panel activities are being carried forward with vigor that is commensurate with the gravity of the problems involved. Those problems, as most everyone knows, are nothing if not complex.

By way of further rounding out representation of all interests vitally concerned with matters R'TPB is pledged to investigate, a number of new sponsors have been added to the previously publicized roster of eight industry and scientific groups. These new sponsors are: National Electrical Manufacturers Assn., Edison Electric Institute (electric-light companies), Society of Telephone Engineers, Society of Motion Picture Engineers, the Telephone Group and American Railway Association (operating railroads). Of these, all are non-contributing sponsors except the Telephone Group. Aeronautical Radio, Inc., has changed its status from a non-contributing to a contributing member. A Canadian representative has been added through an Observer credited to Canada's Department of Transport.

With the interval between meetings of individual Panels spaced approximately two weeks, expectation is that it may require at least 90 days, but more likely four months, for each to cover deliberations that will culminate in a complete report. With that phase of the work completed, individual reports will then be turned over to an editing or coordinating committee which will compile the collected mass of facts, figures, opinions and recommendations into a final report which shall represent the considered judgment of the complete Board.

In the meantime, the nub of the whole problem—the kernel of this hard nut to be cracked—that requires the most careful and cautious consideration, involves some

THREE-STAGE PLAN FOR DOVETAILING OLD AND NEW EQUIPMENT



LOOMS as RTPB PROBLEM

sort of a decision regarding the manner in which the solution shall be tackled.

In other words, shall a solution be attempted on the basis of the immediacy of the matters involved, or might deliberations better be predicated on what may be looked upon as a long-term solution? Should the Board base recommendations on a one-year plan, which would represent quickest return to near normal, but quite conceivably might breed quite some headaches for later doctoring; or should more consideration be given to those future headaches right now by moving slower at present and spreading needed and desirable changes over a much longer period, say five to ten years?

Three-stage plan

In any case it appears inevitable that there must be some collision between the ideal and the practical. Dr. Goldsmith believes that the most sensible way of softening such a jolt lies in a compromise between the two thoughts, with the transition taking place under what he calls a "three-stage" plan. In brief, the idea is this:

Stage 1—Normal commercial usages would be continued for a period of perhaps five years, during which time no new major developments would be permitted. Thus existing facilities would be utilized, with such minor improvements in the art as normally take place, without any appreciable disruption in either production or service. This would be a sort of preparatory period.

Stage 2—This might be called an interim stage, and as such could be spread over a period of from three to five years, a little more or a little less. During this time, experimental licenses would be issued, perhaps for higher frequency uses; no more older type equipment would be licensed, although all the older types would be continued in operation. We would then have no disruption of present service, but there would be added new services as part of the transition and in preparation for later complete change-over to something better.

Stage 3—This might be termed the advanced stage. At or near the beginning of this period, all old type transmitters would be killed off, with operation henceforth confined to new type equipment already in operation under experimental license for quite a time. Coincidentally, experimental licenses would be issued for still more advanced equipment. Then the whole plan would repeat itself.

A plan such as this, Dr. Goldsmith believes, represents the only logical manner in which there may be an orderly transition that will minimize present headaches and insure a future that is at least partly pain-free. It was a plan of this sort that made possible smooth enough elimination of the old spark transmitters when vacuum tubes made it inevitable that scientific development had reached the point where they had to go.

Procedure Manual

In order that all concerned may be familiar with matters pertaining to RTPB, Dr. W.R.G. Baker's office has published a Manual, copies of which were distributed at the IRE meeting, end of January. The book contains the original organizational procedure together with amendments and changes, a list of contributing and non-contributing sponsors, a list of all Panel memberships completed prior to publication, and an outline of work assignments for each of the Panels.

Service requirements

It is the assignment of Panel No. 1, having all these matters in mind, and with an eye to see that plans for the present do not hamper those for the future, to do these things: To lay the bases of technical and scientific allocation and to formulate a series of guiding principles which will be helpful in allocation, but not hampered by current practices or established services or equipment. Postwar problems must be considered and such recommendations as are made must be acceptable to all the other Panels.

In order that this work may be carried on with the greatest dispatch and in the best manner, Panel No. 1 has been split into two committees. Their work later will be coordinated. Committee No. 1, of which Dr. Shackleford has been appointed chairman, will consider Service Requirements. These are listed to include:

a) Radio services to be considered.

b) Necessary channel width for each such type of service.

c) Necessary service range for each type of service, with permissible secular and diurnal variations thereof.

d) Transmitter power estimated necessary for each type of service.

e) Number of simultaneously operating stations in each service required in a given locality.

f) Required quality of each such service (maximum permissable signal-to-noise ratio, maximum permissable fading of various types, maximum permissable signal, interference level, and the like).

g) Estimated feasible accuracy of setting of the carrier frequency for each such service (frequency tolerances).

h) Necessary guard-band frequency width for each such service.

Consideration also is to be given to such points as the reason for a choice of particular frequencies for television channels, and the effect and utility of various types of modulation, including the possibility of future uses of pulse modulation.

Members of the Service Requirements committee include in addition to chairman, Dr. Shackleford, these members: C. J. Burnside, W. S. Lemmon, R. Sorrell, H. Frazier, F. M. Link, G. Grammer, G. O. Milne, L. Spangenberg, O. B. Hanson, H. O. Peterson, A. J. Costigan, P. F. Siling, D. W. Rentzel, F. Walker and G. Robinson.

Committee No. 2, which will have to do with Carrier-Frequency Capabilities, is headed by W. C. Lent, formerly assistant to Dr. Shackleford but now an independent consulting engineer, and will consider these matters:

a) Propagation characteristics of each carrier frequency, as such, in relation to distance (including skip distance effects).

b) Secular and diurnal variations in the propagation characteristics in each such frequency.

c) Natural and man-made noise levels on each frequency in urban, suburban and rural locations.

d) Secular and diurnal variations in the noise levels on the various frequencies.

e) Methods of increasing signal-to-noise ratio by specialized transmission and reception methods (di-

(*Continued on page 208*)

FEATURES OF INVERSE

by PHILIP C. ERHORN

How proper application of selective feedback makes it possible to produce equalization not otherwise obtainable

● When inverse feedback is applied to an ordinary amplifier, several important features appear, all very desirable from the standpoint of fidelity of reproduction. For purposes of illustration, Fig. 1 is a typical three-stage amplifier circuit utilizing overall voltage feedback. That is, the feedback voltage is proportional to the output voltage of the amplifier.

Another type of inverse feedback is produced when the feedback voltage is proportional to the output current. Of these two fundamental types, voltage feedback is more desirable, since it effectively reduces the internal impedance of the amplifier. This effect is similar to lowering the plate resistance of the output tubes, namely stabilization of the output impedance of the amplifier when feeding a variable reactive load, such as a loudspeaker.

The chief disadvantage of current feedback lies in the fact that where a transformer is the coupling medium between the tube and the load, current feedback tends to make the primary magnetizing current sinusoidal. Amplitude distortion is thereby increased. The internal amplifier impedance is also increased, obviously an unwanted effect for a loudspeaker load.

An examination of the voltage feedback loop indicates that some portion of the amplifier output voltage is returned to the input and superimposed upon the signal input voltage. If the feedback voltage is in phase opposition to the signal voltage, it will reduce the effective input voltage, and consequently the output voltage of the amplifier also will be reduced. This gain reduction may be offset by an increase in the original input signal.

Excursions in output voltage with frequency will be corrected by feedback. If, at some audio frequency the output voltage is lower than at the reference frequency, the feedback voltage will be low. The effective input voltage will then increase with subsequent increased output for that frequency. Converse action takes

ADVANTAGES

The application of inverse feedback to an amplifier, if present in sufficient quantity, contributes a material reduction of noise and distortion produced in the circuits. When no reactances are present in the feedback path a wide range of flat frequency response is obtained with virtually zero phase shift. The gain is made constant, and the impedance and output voltage regulation is greatly improved. Equalization is easily introduced by the addition of relatively simple networks to the feedback loop. This equalization can be set to apply at either end of the frequency range.

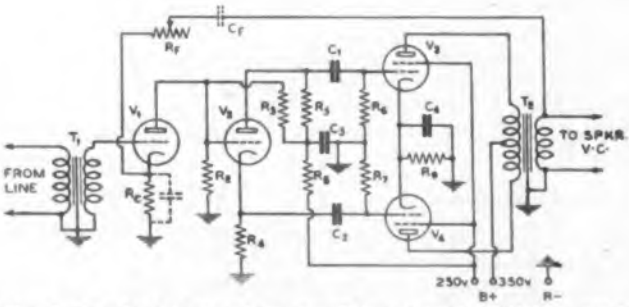


Fig. 1—Typical three-stage amplifier circuit utilizing overall voltage feedback

T_1—Multiple line to grid (20-500 Ω to 100M Ω)
T_2—Push-pull plates to line or voice coil (6600 Ω P-P to 500 or 8 Ω) 35 watts, class AB, 2 tubes
V_1—6C5, 6J5
V_2—6C5, 6J5, 76
V_3, V_4—6L6G
R_f—500M Ω variable pot
R_c—2000 Ω 1 watt
R_2—500M Ω 1 watt
R_3—1.0 megohm 1 watt
R_4, R_5—50M Ω 1 watt
R_6, R_7—100M Ω 1 watt
R_8—25M Ω 1 watt
R_9—250M Ω wire wound, 10 watts
C_c, C_f—See values in Fig. 2
C_1, C_2—0.25 Mfd. paper, 400 volts
C_3—8.0 Mfd. electrolytic, 450 volts
C_4—50.0 Mfd. electrolytic, 50 volts
Note—Power supply should be external to amplifier chassis

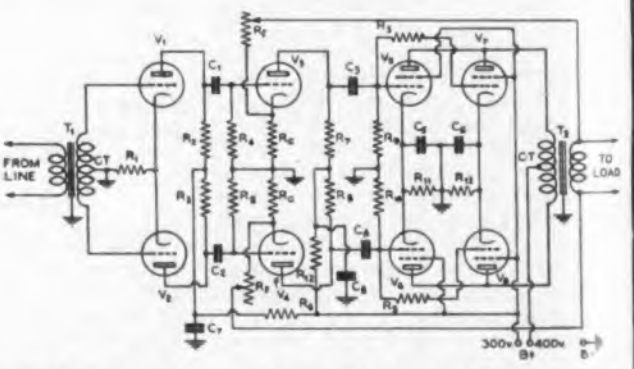


Fig. 4—Push-pull parallel amplifier to deliver 60 watts with 400 volts plate potential

T_1—Multiple line to push-pull grids (30-500 Ω to 125 Ω total secondary)
T_2—Push-pull plates to line (3200 Ω P-P to 500 Ω) 75 watts, class AB, 4 tubes
V_1, V_2—6C5, 6J5
V_3, V_4—6C5, 6J5, 76
V_5, V_6, V_7, V_8—6L6G
R_7—500M Ω variable pot
R_1—1000M Ω 1 watt
R_2, R_3—100M Ω 1 watt
R_4, R_5—250M Ω 1 watt
R_c—2000 Ω 1 watt
R_6—50M Ω 1 watt
R_8, R_9—50M Ω 1 watt
R_9, R_{10}—100M Ω 1 watt
R_{11}, R_{12}—200 Ω 10 watt, wire wound
R_{13}—100 Ω 1 watt (See text)
R_{14}—25M Ω 1 watt
C_1, C_2—0.1 Mfd. paper, 400 volts
C_3, C_4—0.1 Mfd. paper, 400 volts
C_5, C_6—50 Mfd. electrolytic, 50 volts
C_7, C_8—8.0 Mfd. oil filled, 600 volts
Note—Power supply should be external to amplifier chassis

FEEDBACK AMPLIFIERS

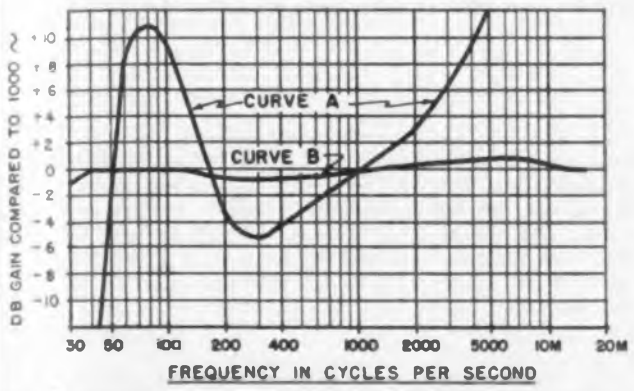


Fig. 2—Circuit of Fig. 1, curve A showing characteristics with no feedback, and curve B with 25 db feedback, with resistive line input and 8 ohm loudspeaker load

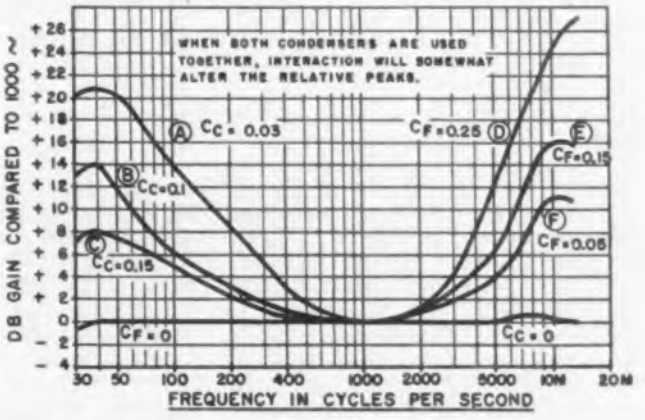


Fig. 3—Equalizing constants for circuit of Fig. 1, curves A and C with cathode condenser, and curves D and F with series loop condenser, 34 db feedback, resistive load

place at frequencies where the output voltage is higher than at the reference frequency. The feedback voltage then will be high, reducing the effective input voltage so that the output voltage will drop.

Output regulation

It can be seen that the output voltage regulation of a feedback amplifier is excellent, and distortion produced by a variable output load will be greatly reduced. For a frequency where the load impedance varies from the optimum value, the feedback voltage also will vary in such a manner that stabilization of the output occurs. In case of a loudspeaker load, cone resonance and "hangover" effects are minimized. The frequency response of the amplifier of Fig. 1 with and without feedback is shown in Fig. 2.

When a harmonic voltage is generated by the amplifier that was not present in the original signal, it will be fed back so as to oppose the original component. Thus distortion is reduced. Because noise, such as hum appearing in the output stage of an amplifier is greatly reduced by feedback, the power supply need not have other than ordinary filtering.

The quantity AB is termed the feedback factor and controls the feedback effect, where A is the gain of the amplifier over the feedback loop and B is the ratio of the feedback voltage to the total voltage. B is negative for inverse feedback. If this feedback factor is considerably larger than unity, the gain will approach —1/B. With AB large and only resistance present in the feedback loop, the amplification characteristics of the loop and consequently of the amplifier will be independent of frequency.

An interesting feature of inverse feedback is its usefulness in equalizing an otherwise flat response band of frequencies. Normal equalization may be carried out without in any way contributing to the distortion in the amplifier. Indeed, the distortion actually is reduced, particularly in the regions of flat frequency response. This method is known as equalization through selective inverse feedback, and at any given frequency the gain of the amplifier and the amount of feedback used are closely tied to-together.

Middle range

For example, if the gain at 40 cycles and the gain at 8,000 cycles are to be raised 15 db compared to a 1,000 cycle reference level, then at least 15 db of feedback must be used. The increased gain at these frequencies is not accomplished by "boosting". Instead, feedback reduces the amplifier gain 15 db for the middle range frequencies, and the gain at 40 cycles and at 8,000 cycles approaches the level existing without feedback. To accomplish this, frequency discrimination networks are inserted in the feedback loop. These networks cause the gain characteristic of the feedback loop to vary with frequency inversely as the desired amplifier gain characteristic varies with frequency. Thus it is seen that the constants of the feedback loop must be altered to give it a response curve opposite to that wanted from the amplifier.

It will be found that at the equalized frequencies, where the feedback is small, the feedback factor AB is small. Hence the gain of the amplifier no longer approaches —1/B. As a result the actual mathematics used in determining the constants of the equalizing networks becomes involved. The characteristics of the amplifier and feedback path with regard to frequency must be known. Because some of the networks are tied across the input cathode resistor (as shown by dotted lines in Fig. 1) current feedback present in this stage must also be considered in the calculations.

The usual "cut and try" methods, however, may be used for rough setting of the capacitor values necessary to produce equalized curves similar to those shown in Fig. 3. As a matter of note, current feedback of the type existing in the input stage normally contributes only a reduction in the gain of the stage and a reduction of distortion. The frequency response is unaffected since only the output current is made constant, and the output voltage may still vary with frequency.

Peaks minimized

Particularly with power pentodes and beam tetrodes in the power output stage, the effects of transient peaks may be minimized only by applying feedback which tends to produce a flat frequency response. Distortion measurements made with the circuit of Fig. 1 run unreasonably high in the absence

(*Continued on page* 212)

PLANNING FOR POSTWAR

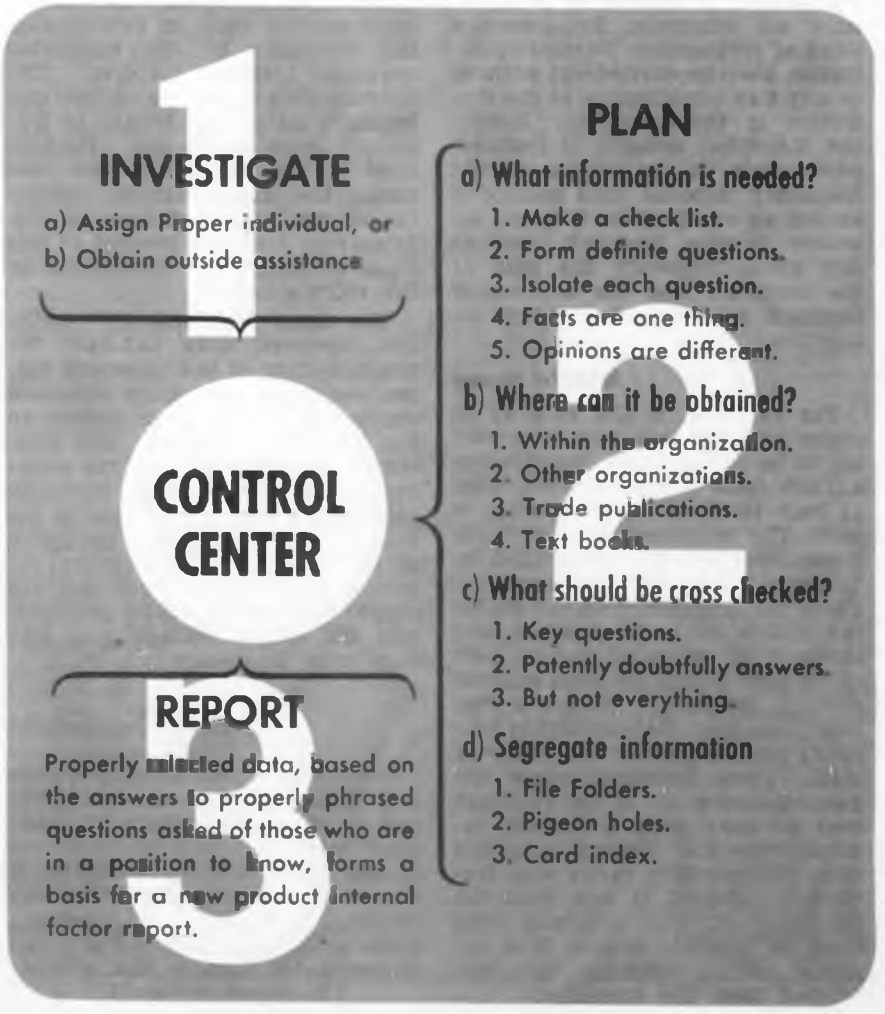
Determining the effect of internal factors on selection of an item suitable for the plant and available personnel

● The horizons of the electronic industries are virtually unlimited. Manufacturers engaged in this type of business are at once fortunate and under a handicap. The stimulation that the war has given to advanced thinking has had a deep rooted effect. The industry is a progressive one and as such is constantly alert to its opportunities. It has benefited by an extraordinary amount of "glamorizing." Much of this has been in some way connected with new uses for electronic devices and new products of an electronic nature.

Any company that is progressive is constantly surveying the field for products most suited to its operation. The merchandising end of the industry and of each particular company has, by now, come to some rather definite conclusions as to which products will "click" with the public. For each product and company there are, however, a number of "internal factors" that must be evaluated before choosing to go ahead in producing a particular new device.

A previous article dealt with the nature of these "internal factors"; this article deals with some concrete suggestions as to gathering the data on the factors, and subsequent treatment will be given to the matter of arranging this material in workable report form.

THREE STEPS TO INTELLIGENT PLANNING



Quick check

No matter whether the product we are considering from an internal standpoint is or is not electronic in nature, there are certain ways in which a fairly quick judgment may be made. To keep us on home base we will assume that our company is engaged in production of electronic equipment of some sort. This means that we are making something between a resistor, condenser or vacuum tube on the one hand and a transmitter, receiver or piece of test equipment on the other.

Our company, probably, has general manufacturing know-how of an assembly nature. It may have some machine shop and tooling facilities and it has some production technic. By the latter is meant planning and scheduling which runs all the way from part of a man's time in a small company to a complete department employing hundreds of people and replete with tabulating machines and comptometers as is the case in some of the large organizations.

Profitable addition?

Our company also has some highly specialized manufacturing ability, possibly vacuum tube exhaust experience or again maybe coil winding or impregnating know-how. There is also the matter of engineering experience and aptitude. Engineering, to compete successfully in the commercial markets, has a tendency to become highly specialized and as a result of necessity becomes somewhat channeled in its thinking.

Suppose we have a new product on our doorstep; our merchandising people say it will sell and they have given us some volume and price predictions. We are now setting out to gather data on the "internal factors" which in the last analysis are going to tell us

PRODUCT DEVELOPMENT

with some degree of certainty whether, if volume and price develop as predicted (with proper discounting for enthusiasm), the product will be a profitable addition to our business.

Our first step should be to assign a person and to set up a central point from which inquiry can be made and to which information can be directed. There are two essentially different ways by which this can be accomplished. Either of these can prove effective and in some cases a combination of both may be required.

If someone thoroughly familiar with the company's operation is available full or part time, the task of compiling the data can be assigned to him. He should be the type of individual who has a general rather than a specific background. Engineering, accounting, production and manufacturing knowledge should be combined in that one person. He does not need to know all about any one phase but he does need to possess enough background to talk intelligently on all.

Balanced opinion

It will be preferable to assign a well-balanced man instead of one who is an outstanding specialist in any field. Even more important are those two somewhat elusive qualities—common sense and good judgment. If such a man is available, the company is fortunate and the work can go ahead immediately. All he will need is his central point and some sort of a plan.

If this individual is not on hand, or, as is more usually the case, is completely overwhelmed by current operating problems, it will be necessary to seek elsewhere. At present and for some time to come, it is and will be almost hopeless to just go out and hire a man to do this job. If he can be had, it will be at a salary which may prove to be a disturbance to the peace of mind of the operating group. Even then, unless he has been specially trained for this type of work, it may take a very long time—too long—for him to catch the "feel" of the operation.

The alternative is to seek the services of specialists in this type of thing, a consultant or a fully competent management firm. The initial expense may appear to be great but the type of result and its definiteness usually more than justifies the cost. Even in this case, inside assistance will be required for speedy progress. The assignment of someone who has an intimate knowledge of the intricacies of the plant, a stockchaser for instance, part or full time, to assist, is of inestimable value. This assistance, plus an organization chart and the privilege of freely consulting any or all members of the organization invariably will bring results.

When the person and the central point have been chosen, we are ready to begin the actual collection of information in accordance with a plan. This plan must include such points as:

(1) What information do we want?

(2) Where do we get it?

(3) How do we cross check it, and

(4) How do we segregate it pending reporting for analysis purposes?

It will be worth while to examine each of these separately.

A check list should be prepared. On this, the various "internal factors" discussed in the previous article should be listed and under each the necessary questions that have direct reference to the particular product being surveyed. Great care should be exercised to separate those points that require facts from those that can only be answered by opinion. More here than at another point, serious error can creep into the findings if complete understanding is not had of the psychology underlying one person's fact and another's opinion.

A fact is a fact and if correct it doesn't matter where it is obtained. Much more weight can be given to the answers on many specific questions of fact when they come from "little men" than when they are abruptly and categorically stated by a top executive. For example, the time-study man or even the timekeeper will know as a fact the hourly production capacity of a certain machine. The foreman, process engineer, production manager or superintendent are in varying degrees removed from the facts. They may, in order to appear intelligent on the subject, state as a fact some figure that is a combination of what the manufacturer of that machine predicted, what it used to do and what it could do if the operator wasn't "laying down on the job."

Mistaken conceptions

As everyone who is familiar with manufacturing knows, any plant is just crawling with mistaken conceptions of fact. Just try to know definitely what radio tube shrinkage was on a certain type on a given day in a typical vacuum tube plant, or even over the period of a week. The same can be said of reject and repair percentage in a set plant or actual scrap in a machine shop.

Opinions on the other hand become more valuable as they are obtained from higher ranking people. The right people, in other words, those who by their place on the organization chart should know, are the only ones whose opinions are of real weight.

Both fact and opinion are necessary to the successful check list. The point is, frame the question so that the same question never calls for both a fact and an opinion.

After deciding what the scope of the investigation should be and properly framing the large number of specific questions, separate them into groups. No single question should contain more than one thought. It is entirely possible to frame every question so that it can be answered by yes, no, a number or a very simple sentence. Each question should then be typed or written on a separate sheet or card. The sheets or cards can then be filed in groups either by subject or prospective source of information. With this done we are now ready to proceed in gathering data.

Every sheet containing a question must be studied for the relation of that question to the whole problem. There are probably four or five key questions in the entire

(*Continued on page* 232)

FINDING the ANSWERS

This is the second of a series of three articles dealing with practical methods of laying plans for postwar markets. The first dealt with the nature of internal Factors that must be considered; the third will cover a method of developing findings into a usable kind of report.—Editor.

MICHIGAN'S FM

by CAPTAIN C. J. SCAVARDA
Communications Officer, Michigan State Police

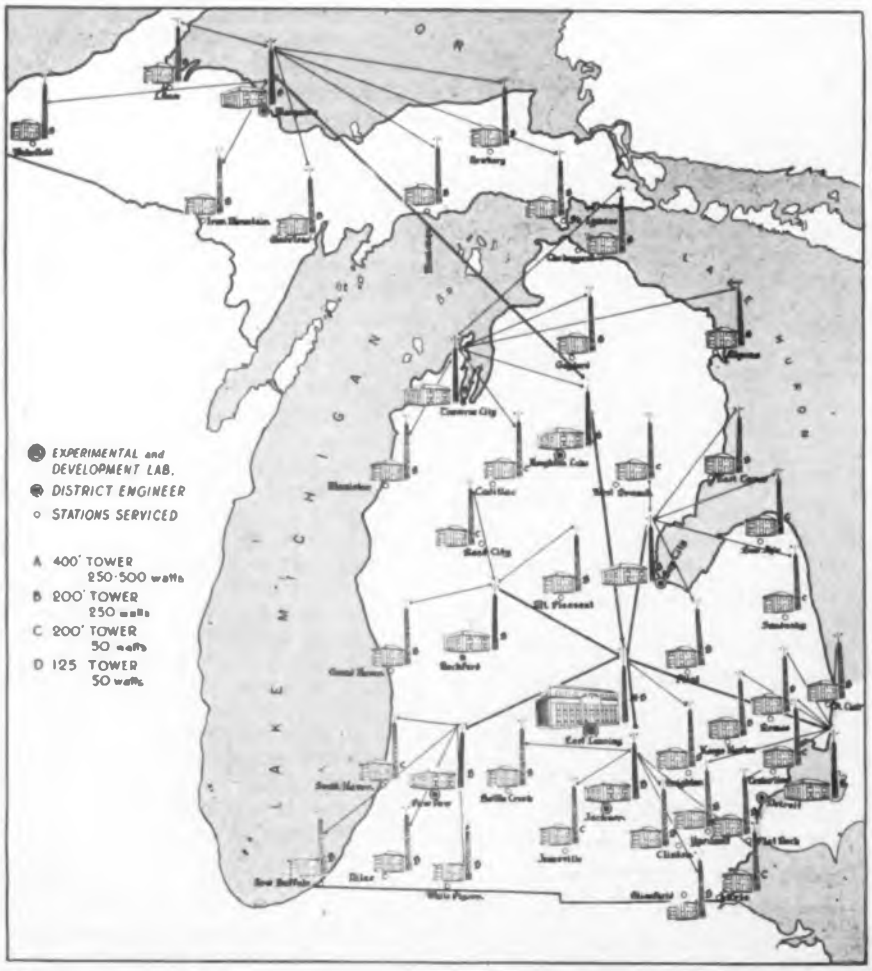
How 57,000 square miles are covered by two-way radio system including 45 fixed transmitters

Administration bldg., headquarters of Michigan's police net

● The Michigan State Police now have in operation one of the most modern and complete two-way radio communication systems in the police world. In developing the network that blankets 57,000 square miles in the state, frequency modulated transmitting stations were installed in forty-five state police posts, in several industrial plants and at military locations; a portable unit that could be operated in any part of the state was built and more than two hundred mobile units were equipped with two-way radio.

In addition to the state police net there is also an extensive State Department of Conservation system, built along the same lines and operating on the same frequencies. This permits the two departments to be tied closely together and has advantages. Since many stations can operate at one time on the same frequency when frequency modulation is used, and a signal strength differential of at least 2 to 1 is present, there is a minimum amount of interference. Every state police car and every conservation department car is always within radio speaking distance of some fixed station.

The manner in which the State is blanketed is illustrated by the distribution of fixed stations of various powers



War speeds program

Before the United States entered the war, Michigan began experimenting with two-way radio on a state-wide basis. The initial installations proved so satisfactory that before their completion, plans were under way for an extension of the system. Entry into the war served to speed up this program and plans for state-wide coverage with a two-way frequency modulated system, which under ordinary circumstances would have required years, were completed within six months.

Radio had been used by the Michigan State Police since 1929. It consisted of broadcasts to cars and stations but provided no method of returning information by radio to the central control station at East

STATE POLICE SYSTEM

...blanketed with a network in-...and over 200 mobile units

Lansing. Radio science had not reached the point where car to station contact could be made over distances as great as represented in a state the size of Michigan.

The advances made in the use of frequency modulation offered the state police the opportunity for which they had been looking. It made possible broadcasts from a car to its station forty or more miles away. This seemed to answer the problem of returning information from cars to their stations and from all stations to the headquarters at East Lansing.

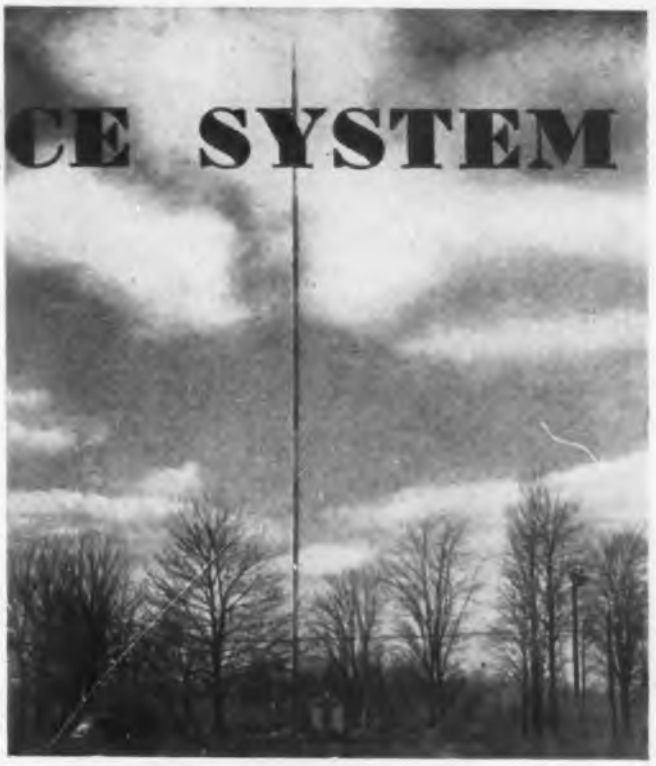
FM solves problem

This program of expansion was started as a part of the usual plan to make use of all radio facilities as fast as developed if they seemed applicable to good police work. Declaration of war served to emphasize the need for speeding up this expansion not only because of added service it would give but also because of the increasing difficulty in obtaining critical materials.

Considerable research and experimental work had been done with facsimile, radio - teletype, alarm systems and other similar equipment but these were largely set aside until the end of the war or at least until restrictions on equipment have been lifted. When this equipment can be obtained, Michigan will be ready to adapt any or all of it to police work.

When the final determination was made as to the extent to which two-way radio would be installed, it became apparent that an extension of such service to the military areas and to certain defense plants would be of special significance to the war effort.

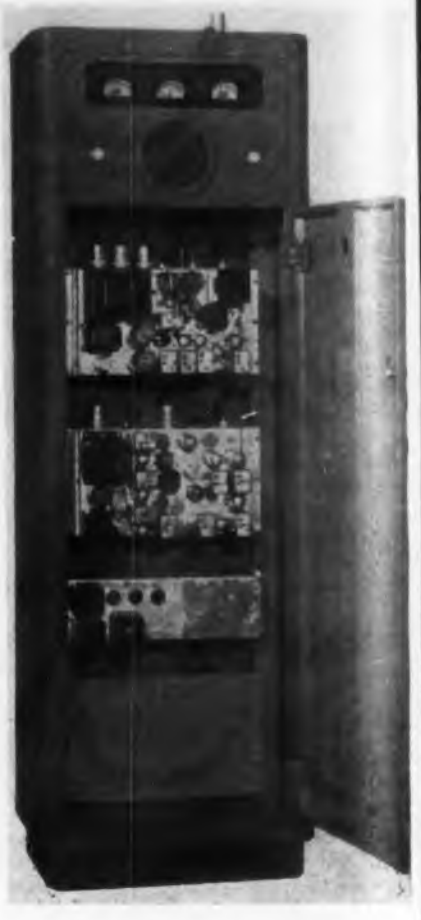
It was necessary to take into consideration the fact that no system of two-way radio even approximating the size of this one had ever been built, and therefore difficulties were bound to arise.



One of the remote-controlled FM stations, 250 watts, 200 ft. tower

General view of dispatch office at State headquarters in East Lansing

An extensive laboratory for maintenance, repair and testing of all equipment

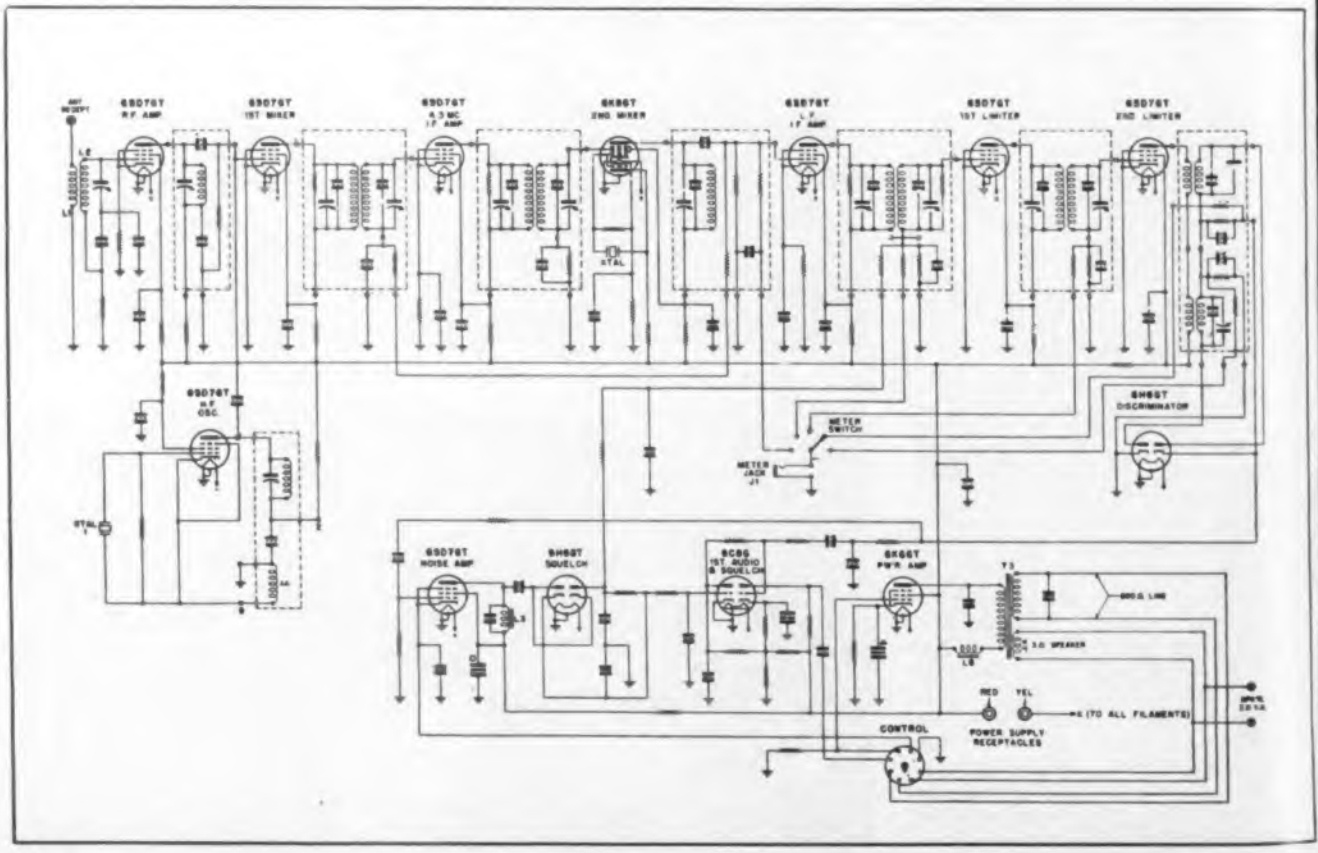


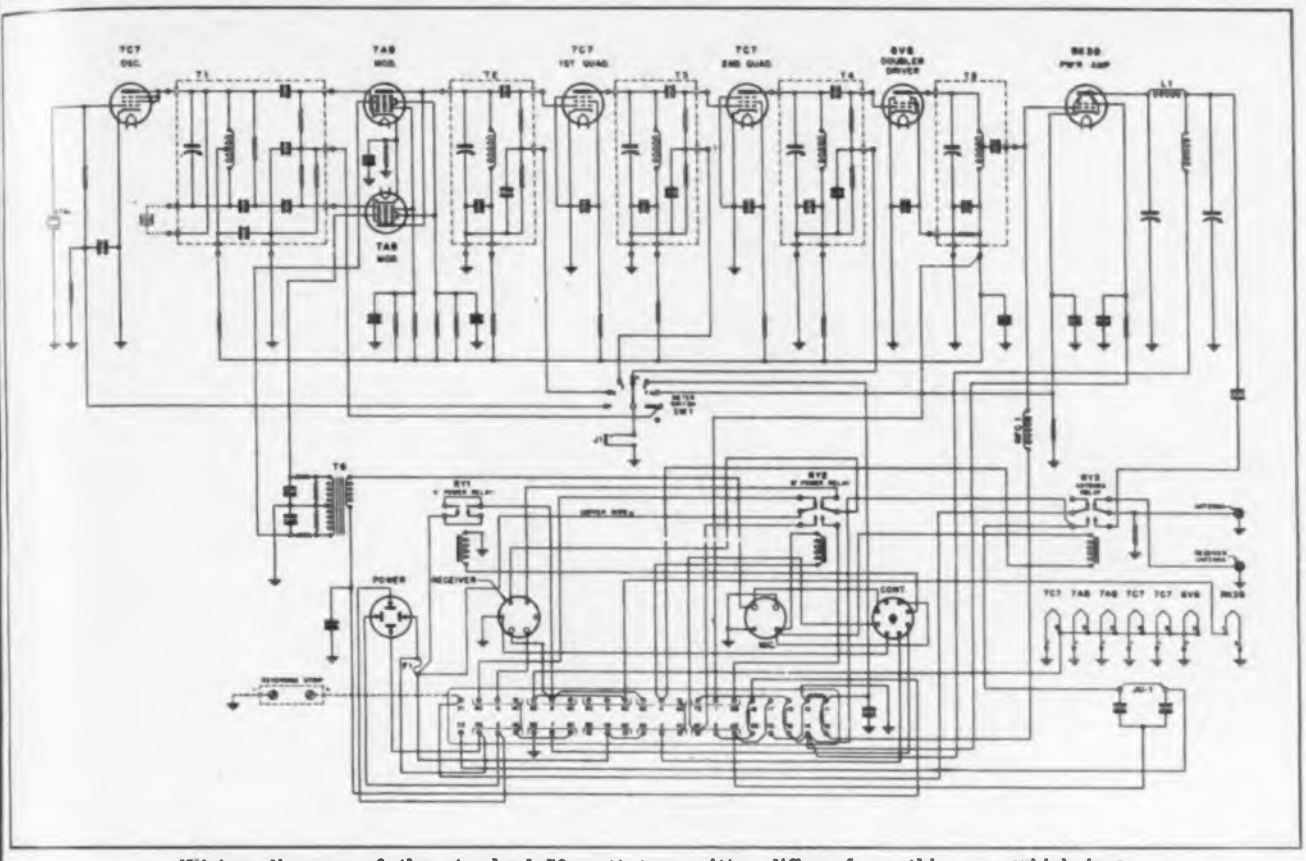
Rear view of the standard FM receiver, both mobile and fixed. (Left)—Front and (right) rear view of 50-watt FM transmitter

The radio engineers were convinced that such a vast expanse as the State of Michigan, including mountains, plains, hundreds of acres of land with an extremely high content of iron, copper and other metals, its large cities such as Detroit, Flint, and Grand Rapids, and its 15,000 miles of paved highways could be completely covered only with ultra-high frequency communication.

Amplitude modulation for this two-way service had been abandoned after conducting tests for some two months. The only FM installation in operation at that time

Complete wiring diagram of the FM receiver, chassis for which is illustrated above





Wiring diagram of the standard 50-watt transmitter differs from this one, which is a 30-watt unit, only in the incorporation of a pair of 807 or RK39 tubes in the output stage

was in no way comparable in size to the area proposed to be covered. Some method of utilizing an extremely weak signal had to be developed if coverage was to be complete and satisfactory during all conditions.

Again, field tests were conducted with frequency modulated equipment and the project all but abandoned, for the coverage under slightly adverse conditions just did

The 250-watt transmitter, shown left and right, is similar to the 50-watt job except for the addition of a high power output stage and accompanying power supplies. Below—Front and back of the remote control unit

Typical district headquarters station. See accompanying map for station locations

not exist. It became apparent that equipment would have to be built and designed which would give substantial limiter saturation and subsequent noise reduction on signals as weak as one half of one (.5) microvolt.

Further tests and data were compiled at the East Lansing laboratory and the laboratories of the University of Michigan and Michigan State College. They all conclusively pointed to the need for extremely high overall gain in the receiver, and what was equally as important, a squelch action which would open upon a carrier input of one tenth of one (.1) microvolt, and which would give positive discrimination against noise, and open upon carrier only. The state police engineers felt that it was poor engineering practice to have squelch action operate at a higher signal input than the minimum saturation requirements of the limiter. This results in squelch cutoff of a carrier which still has sufficient amplitude to give intelligible communication at the fringe of the coverage area.

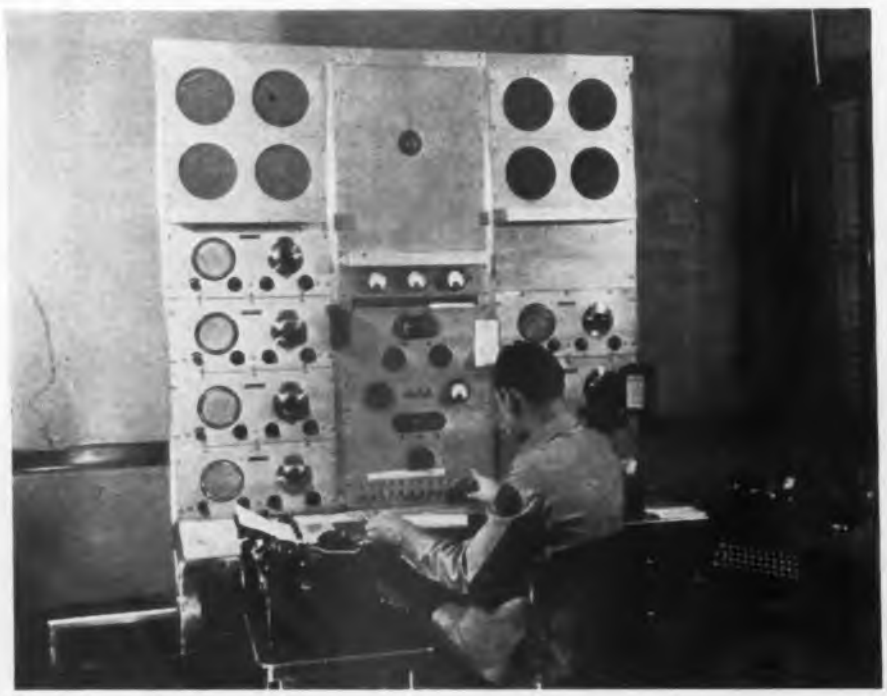
All makes and types of equipment were laboratory- and field-tested under operating conditions. Engineers from the various companies were invited to check and tune their equipment while undergoing tests. However, to insure accuracy of results, the actual field test communications were conducted by non-technical state troopers. Women who were unfamiliar with technicalities of radio acted as receiving operators.

Receiver specifications

The director of research of the Galvin Mfg. Co. designed equipment which met the specifications set up by the state police engineers and which performed equally as well in the field. The receiver gave limiter saturation which produced a 20 db noise reduction upon an input signal of one fourth of one (.25) microvolt. The squelch action was positive on signals of one tenth of one (.1) microvolt.

The discriminator used in the receiver consists of a back to back type with two resonant circuits, each feeding an individual diode of a 6H6. The diode loads are so connected that the voltages developed in each are added to obtain the output. One leg of the discriminator is tuned approximately 25 kc

Below is a view of part of the radiophone control panel at State headquarters in Lansing. At right is shown one of four remote controlled unattended 250-watt transmitters used to cover the city of Detroit



Above, typical police car installation. Right, method of installing antenna which is spring mounted on the roof of the car

above 455 kc and the other an equal amount below. The resultant output is zero when an unmodulated signal is applied to center frequency. Audio voltage is recovered when the carrier is shifted negative or positive by modulation.

As previously stated, the engineers reasoned that with all things equal, the squelch system in a receiver was comparable in importance to gain and limiter saturation. Briefly the subsequent unique squelch design operates as follows: the noise output of the FM receiver is passed through a filter to select the proper frequency band. The selected noise voltages are then amplified and rectified to provide a dc control voltage which will vary in amplitude according to the noise output of the receiver.

Extreme sensitivity

This control voltage will decrease when a signal passes through the receiver because of the well-known characteristics of FM receivers to reduce noise output when a carrier is received. This controlling voltage is used in series with a voltage derived from the current rectified in the grid circuit of the first limiter. The noise-derived voltage tends to close the squelch. A noise increase at the receiver input will tend to increase both voltages, and the squelch remains closed.

A carrier at the input to the receiver will increase the squelch opening voltage and decrease the squelch closing voltage so that the total voltage tending to open the squelch is equal to the sum of the two changes in voltage. This accounts for the unusual sensitivity and discrimination against noise. By other methods, a squelch may be made to open on a weak signal, but the proper discrimination against noise will not be present.

In remote operated receiver installations, an ordinary squelch system may open when there is a general change in noise level and the result is extremely annoying. Bursts of static, high noise levels in cities, and other disturbances which have no carrier component do not trip the squelch of either patrol car or fixed station receivers, no matter how fringy they may be set.

(*Continued on page* 148)

The 50-watt mobile FM transmitter, and the receiver, are mounted on wooden base boards which are floated on rubber on brackets welded to the car frame

WHERE TO FIND SPECIAL INFORMATION ON

Electronic Uses in Industry

by W. C. WHITE
Electronic Laboratory
General Electric Co., Schenectady, N. Y.

● The following list of references supplements those published in the June, 1943, issue of Electronic Industries. Only a few 1943 references were used in this first group. For completeness, some of these have been used again in the following list. Articles on industrial electronic applications during the year 1943 have indicated increased activity in the fields of high-frequency heating, measurements, medical devices, and motor control.

The list of references is by no means complete as many hundreds of articles on the subject were published during the year. The selection is based primarily upon electronic applications in industry and, therefore, particular attention is paid to articles in trade journals where the application was treated from the viewpoint of the particular nature of a business.

Among the references included, some are of the sort describing commercially available units and equipment while others might be classed as of the "how to build" type of article. In both cases, articles have been favored for inclusion that give good basic theory plus actual circuits used.

No attempt was made to include articles in the field of radio, communication, and entertainment and most of the articles have appeared in American publications and all are in the English language. The number of articles selected for each classification is based upon current interest and activity. A few references are included that are not strictly electronic devices but involve items or methods closely associated or widely employed with electron tubes and their application.

Considerable attention was paid in indexing to indicate applications and uses brought out in the articles that might not be apparent from the titles. An effort was made to include many specific uses of tubes. There have also been added certain trade names and coined words to enable the reader to gain further information on the device when only such names come to his attention.

G-E side-register photoelectric control, focused on strip edge for accurate control of alignment of steel strip to insure uniformly wound coil

Amplifiers

1. Behavior of a Balanced D-C Amplifier. Roy C. Spencer and LeRoy Schulz. "Rev. of Sci. Instr.", January, 1943; v. 14, pp. 10-14.
2. An Electrical Transducer Circuit for Use With Capacity Pick-Up Devices. E. V. Potter. "Rev. of Sci. Instr.", May, 1943; p. 130.

Carrier Current Applications

3. Carrier Current Can Provide More Kilowatt Hours. G. S. Lunge. "Electrical West," May, 1943.
4. Carrier-Current Differential Protection for Transformer Banks. T. A. Cramer. "AIEE Transac.", Aug., 1943; p. 545.
5. Train Communication. L. O. Grondahl and P. N. Bossart. "AIEE Transac.", July, 1943; p. 493.

Control Applications

General and Miscellaneous

6. Electron Tubes Available for Industrial Functions. "Prod. Engng.", Sept., 1943; v. 14, pp. 554-557.
7. Electron Tubes as Elements of Control. R. R. Batcher. "Electronic Industries," Aug., 1943; p. 65.
8. Electronics Forges Ahead! Raymond F. Yates. "Mach. Design.", Apr., 1943; v. 15, pp. 141-144.
9. Industrial Controls. S. J. Murcek. "Electronic Industries," Dec., 1943; p. 100.
10. Maintenance Tips Keep Electronic Controls on the Job. W. D. Cockrell. "Power," July, 1943; v. 87, pp. 446-448, 496c, 497a.
11. Electronic Control Maintenance and Trouble-Shooting Tips. W. D. Cockrell. "General Electric Review," Sept., 1943; p. 489.

Furnaces, Heating

12. Thyratrons—For Heat Control. C. B. Stadum. "Radionics," Oct., 1943; v. 1, pp. 19-21, 37-38.

13. Electronic Circuits Actuate Automatic Combustion Control. K. D. Knoblock. "Elec. Wld.", Oct. 2, 1943; v. 120, pp. 1168-1170.
14. Experimental Details for a Precision High Temperature Control Utilizing the Hull Circuit. C. E. Waring and G. Robison. "Rev. of Sci. Instr.", May, 1943; p. 143.
15. A Thyratron Thermal Relay. D. Rittenberg and I. Sucher. "Rev. Sci. Instr.", Feb., 1943; p. 51.

In Specific Manufacturing Operations

16. Electronic Control for Steel Mill Auxiliaries. J. H. Hopper. "Iron & St. Engr.", June, 1943; v. 20, pp. 62-72, 75.
17. Phototube Control of Packaging Machines. W. D. Cockrell. "Electronics," Oct., 1943; v. 16, pp. 94-99, 180, 182.
18. Phototubes Control Perforating of U. S. Stamps. A. W. Hall. "Electronics," Dec., 1943; p. 124.
19. Photoelectric Safety Control for Electric Sewing Machines. "Electronics," Aug., 1943; p. 130.
20. Electronics—What It Is and What It Means to the Printing Industry. W. D. Cockrell. "Printing Equipment Engineer," July, 1943.

Motors

21. Amplidyne Control for Paper Making. "Electronic Industries," Feb., 1943; p. 69. (Uses tube amplifier.)
22. New Electronic Variable-Speed Drive. S. D. Fendley. "Paper Tr. Jour.", Feb. 11, 1943; v. 116, pp. 33-37.
23. A New Electronic Variable Speed Drive. S. D. Fendley. "Power Plant Engng.", Feb., 1943; pp. 64-68.
24. Electronic Control of D-C Motors. E. E. Moyer. "Electronics," 1943:
    Part 1—Outline of General Principles—May
    Part 2—Reference Voltage and Speed Control Methods—June
    Part 3—Extending Speed Range by Electronic Means of Field Weakening—July
    Part 4—Starting, Stabilizing and Reversing—Sept.
    Part 5—Regeneration by Inverter Action and Stopping—Oct.
25. D-C Motor Control with A-C. B. J. Dalton. "Electronic Industries," Oct., 1943; v. 2, pp. 85-87, 174, 176, etc.
26. Electronic Motor Control. S. D. Fendley. "General Electric Review," Apr., 1943; pp. 225-230.
27. Electronic Adjustable-Speed Drive Gives Wide Operating Range. S. D. Fendley. "Power," Mar., 1943; v. 87, pp. 178-179, 210a.
28. Electronic Adjustable Speed Drive. H. J. Hague, Jr. "Mill & Factory," Aug., 1943; p. 92.
29. Wide Motor Speed Range With Alternating-Current Supply. T. R. Lawson. "Steel," June 21, 1943; v. 112, pp. 106, 108, 132.
30. Rectifier Analysis—For Direct Current Motor Drive. E. H. Vedder and K. P. Puchlowski. "Radionics," Aug., 1943; v. 1, pp. 3-7.

Resistance Welding

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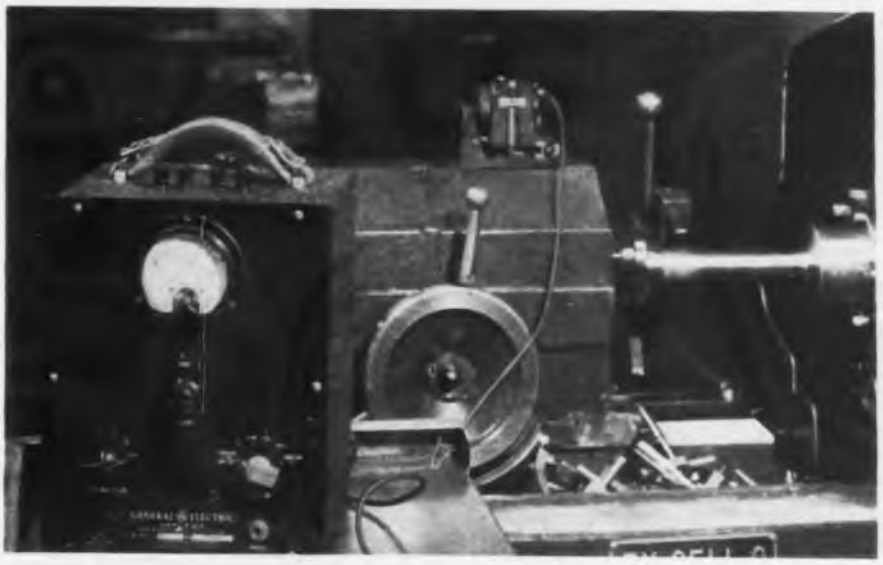
32. Types of Electronic Controls. T. R. Lawson. "Weld. Engr.", Feb., 1943; v. 28, pp. 42-46.
33. A-C Resistance Welding Control. Gilbert Sonbergh. "Electronic Industries," May, 1943; pp. 52-55, 152-153.
34. Resistance Welding Controls. H. L. Palmer. "General Electric Review," Sept., 1943; p. 507.

Electron Tube Applications—Miscellaneous

35. The New World of Electronics. "Electronics," Mar., 1943; p. 83.
36. Electronics in Postwar Industry. A. C. Monteith. "Steel," Nov. 1, 1943; v. 113; pp. 109, 118.

Here a photoelectric relay, widely used for control and limit operations in industry, counts aircraft engine valves leaving a heat-treating furnace



In the development of heavy industrial machinery G-E vibration velocity meters are used to determine the character and extent of harmful vibration

37. Electronics for Present and Postwar Products. "Prod. Engng.", Oct., 1943; v. 14, pp. 643-658.
38. Some Useful Circuits Employing Thyratrons and Ignitrons. A. J. Maddock. "Jour. Sci. Instr.", Mar., 1943; v. 20, pp. 37-46.
39. Experience in the Use of Electrostatic Fly-Ash Precipitators. Irving G. McChesney. "Asme Transac.", Apr., 1943; v. 65, pp. 143-148.
40. Dipping and Spraying Electrostatically. E. P. Miller. "Ind. Heat.", Oct., 1943; v. 10, pp. 1553-1554, etc. (serial).
41. Electronic Elimination of Oil Mists. "Westinghouse Engr.", May, 1943; v. 3, pp. 42-45.
42. Electrostatic Dip Coating Process. "Electronic Industries," Feb., 1943; p. 63.
43. Public Utility Uses of Electronic Devices. "Electronic Industries," Dec., 1943; p. 68.
44. Electronic Megaphones. Staff of "Electronics," Nov., 1943; p. 125.
45. Two-Cycle Flasher. Samuel A. Talbot. "Rev. of Sci. Instr.", June, 1943; v. 14, pp. 181-184.
46. Analysis and Characteristics of Vacuum-Tube Thyratron Phase-Control Circuit. S. C. Coroniti. "Proc. IRE," Dec., 1943; p. 653.
47. Electronic Tubes for Ultra-Violet Radiation. J. H. Laub. "Electronics," May, 1943; v. 16, pp. 80-85, 138, 140, 142.
48. Electronic Machine Balances Rotating Parts. "Electronics," Jan., 1943; v. 16, p. 101.

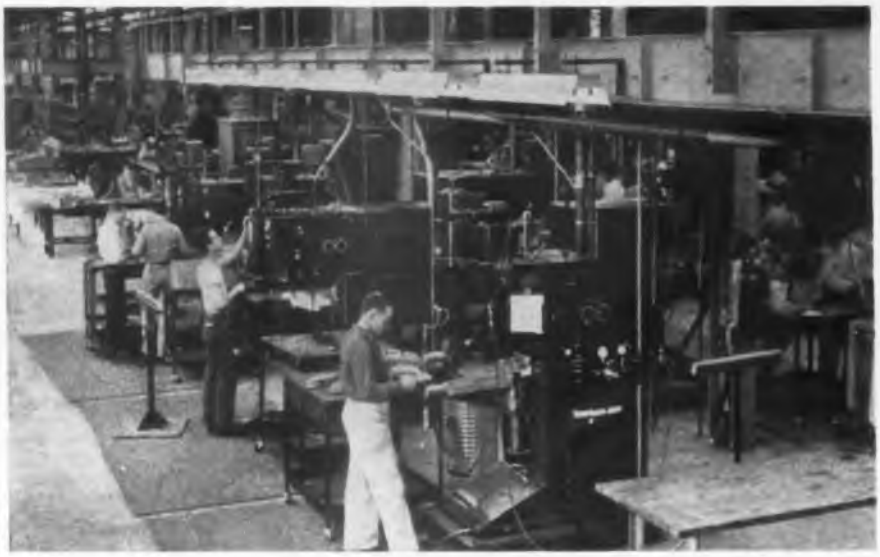
High-Frequency Heating

General and Miscellaneous

49. Electronic Heating Principles. J. P. Jordan. "Electronic Industries," Dec., 1943; p. 81.
50. What High-Frequency Heat Treating Can Do. "Elec. Mfg.", July, 1943; p. 112.
51. Radio-Frequency Electricity in Power Applications. John P. Taylor. "Elec. Weld.", Oct. 2, 1943; v. 120, pp. 1164-1167.
52. The Theory & Practice of Industrial Electronic Heating. J. P. Jordan. "General Electric Review," Dec., 1943; p. 675.
53. Radiothermics Speeds Industry. I. R. Baker. "Radio Age," Jan., 1943; p. 6.

Dielectric

54. Electrostatic High-Frequency Heating Makes Possible Many New Designs. "Prod. Engng.," Jan., 1943; v. 14, pp. 40-43.
55. Radio-Frequency Heating of Aircraft Parts. J. P. Taylor. "Electronic Industries," Jan., 1943; p. 50.
56. Dehydration of Food by Radio-Frequency Energy. V. W. Sherman. "Elec. Communication," v. 21, No. 2, 1943, p. 125.
57. Heatronic Molding. V. E. Meharg. "Mod-



This view, made in a Western aircraft factory, shows a battery of spot welding machines, high voltage control panels being mounted on balcony

ern Plastics," Mar., 1943; v. 20, pp. 87-90.

58. High-Frequency Electric-Field Heating for Non-Metallic Materials. Theodore R. Olive. "Chem. & Met. Engng.," Apr., 1943; v. 50, pp. 102-104.
59. Heating Wood With Radio-Frequency Power. J. P. Taylor. "ASME Transac," Apr., 1943; v. 65, pp. 201-212.
60. High-Frequency Heating Speeds Plastic Molding. V. E. Meharg. "Mach. Design," July, 1943; v. 15, pp. 103, 200, 202, 204.
61. An Electronic "Sewing Machine." C. N. Hoyler. "Electronics," Aug., 1943; p. 91.
62. Heatronic Molding. "Electronic Industries," Aug., 1943; v. 2, pp. 92-93, 184, 186.
63. High-Frequency Gluing of Resins. Walter Godfrey and Paul H. Bilhuber. "Modern Plastics," Sept., 1943; v. 21, pp. 89-93, 154, 156.
64. Radio-Frequency Heating Applied to Wood Gluing. R. A. Bierwirth and C. N. Hoyler. "Proc. IRE," Oct., 1943; p. 529.
65. A Radio-Frequency Gun for Spot Gluing Wood. J. P. Taylor. "Electronics," Nov., 1943; p. 106.
66. Heat Conduction Problems in Presses Used for Gluing of Wood. G. H. Brown. "Proc. IRE," Oct., 1943; p. 537.

Induction (Electromagnetic)

67. Electronic Generators Extend Inducting Heating Field. H. C. Humphrey. "Electronics," Jan., 1943; v. 16, p. 56.
68. Radio Tubes for Heat Treating by High-Frequency Induction. H. C. Humphrey. "Steel," Feb. 1, 1943; v. 112, pp. 111-112.
69. Better Brazed and Soldered Joints Made Possible for Induction Heating. J. P. Jordan. "Prod. Engng.," Feb., 1943; v. 14, pp. 102-105.
70. Thin Case Hardening With Radio-Frequency Energy. V. W. Sherman. "Electrical Communication"; v. 21, no. 2, 1943, p. 127.
71. Electric Fusion of Tinplate. G. E. Stoltz and others. "Iron & St. Engr.," Mar., 1943; v. 20, pp. 49-57.
72. Casehardening Large Gears With High-Frequency Current. Glen C. Riegel. "Metal Prog.," July, 1943; v. 44, pp. 78-83.
73. Magnetic Induction Field of Air Core Coils—Its Application to High-Frequency Heating in Valve Manufacture. C. B. Kirkpatrick. "Wireless Engineer," Aug., 1943; p. 372.
74. Work Coils for High-Frequency Heating. "Electronics," Oct., 1943; p. 112.

Indicators, Locators, Detecting Objects, Prospecting

75. Electronics vs. Sabotage. "Electronic Industries," Mar., 1943; p. 60.
76. Locating Buried Cables Electrically. R. M. C. Greenidge. "Bell Labs. Record," Nov., 1943; p. 106.
77. Metal Locators. W. H. Blankmeyer. "Electronics," Dec., 1943; p. 112.
78. Seismic Prospecting. Gilbert Sonbergh. "Electronic Industries," Oct., 1943; p. 62.

Measurements, Recorders, Counters, Instruments, Testing

General and Miscellaneous

79. Electron Tubes, Their Principles and Their Instrumentation Applications. A. W. Kramer. A serial starting in the May 1943 issue of "Instruments" and continuing thru the year.
80. Electronic Measurements. Clark E. Jackson. "Radio News," Aug., 1943; v. 30, pp. 28-29, 46, 48, 50.
81. Internal Combustion Engine Analysis. "Electronic Industries," June, 1943; p. 64.
82. Electronic Apparatus for Vibration Testing. R. O. Fehr and C. Shabtach. "Electronics," June, 1943; v. 16, pp. 94-96.
83. Detecting Small Mechanical Movements. Joseph C. Frommer. "Electronics," July, 1943; v. 16, pp. 104-105.
84. Calibrating Springs. "Electronic Industries," Nov. 1943, p. 120; Dec. 1943, p. 99.
85. Strain Gages. D. M. Nielsen. "Electronics," Dec., 1943; p. 106.
86. Variable Waveform Unit for Testing Aluminum Welding. John W. Dawson and Hans Klemperer. "Electronics," Feb., 1943; v. 16, pp. 62-66, 201.
87. Smoke Density Measurement Using Photo Cells. R. J. Wey. "Electronic Engng.," May, 1943; p. 507.
88. Film Recording Seismograph. "Electronics," May, 1943; vol. 16, p. 89.
89. Industrial Applications of the Oscilloscope. Guy Dexter. "Radio News," Nov., 1943; p. 41.

Chemical Field Application

90. Electrolytic Conductance Measurements in Industry. Nathan Schnoll. "Instruments," Dec., 1943; p. 730.
91. Titrometer. C. J. Penther and F. B. Rolfson. "Indus. & Eng. Chem.," May, 1943.
92. Self-Recording, Semi-Automatic Mechanized Electrometric Titrations. D. J. Pompeo, C. J. Penther, K. E. Hallikainen. "Instruments," July, 1943; p. 402.
93. Electronic Aids in Chemistry. C. E. Jackson. "Radio News," Nov., 1943; p. 24.
94. Electronics in the Chemical Industries. Gilbert Sonbergh. "Electronic Industries," Apr., 1943; p. 52.
95. Metallurgical Analysis. "Electronic Industries," Nov., 1943; p. 86.
96. Cathode-Ray Oscillograph in Polarography. Tudor S. G. Jones. "Electronic Engng.," Feb., 1943; v. 15, pp. 367-371.

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97. Counting Bees. A. C. Faberge. "Jour. Sci. Instr.," Feb., 1943.
98. Electrical Counting (a book). W. B. Lewis. Cambridge University Press, 60 Fifth Ave., New York City.

(*Continued on page* 176)

In the delicate spot welding operations involved in vacuum tube production a G-E thyratron half cycle welding control panel is used with bench welder

Small Power Transformer Design Factors

by J. M. THOMSON,
Chief Engineer, Ferranti Electric, Ltd., Toronto

Formulas that are usable in computing load and efficiency in small power line units—Leakage reactance

• The following series of formulas comprise a short system usable in the load and efficiency computations for small power line transformers. A few simple relations indicate the extent to which design improvements can be made and the effectivenss of each factor in the overall design.

Using the well known relations between the voltage, turns flux, frequency etc. and the relations between current density etc., the output that can be handled by a given core is obtained in the form of the following equation:

$$va = 2.22\ f_1\ A_1\ f_c\ A_c\ f\ B\ D, \qquad (1)$$

the 10^{-8} factor, sometimes noted in such relations, disappearing because of the choice of the units for B and D. Usually, however, va is known and the more convenient form is

$$A_1 A_c = \frac{0.45\ va}{f_1\ f_c\ f\ B\ D}, \text{ in (ins)}^4 \qquad (2)$$

For the scrapless lamination illustrated in Fig. 1 (which can be punched from stock without waste), $a_c = \frac{1}{2}\ a_1$; $b_c = 1.5\ a_1$; and $t_1 = 2\ (b_c + a_c) + 2a_1 = 6a_1 = 12a_c$.

Then the only other variable is $\frac{b_1}{a_1}$ the ratio —. When the transformer is analyzed for the minimum cost proportions, this ratio is approximately 2. However, difficulties in winding usually limit this ratio to a value less than 2. For a given design and type of winding, however, it will be a constant. Therefore: $\frac{b_1}{a_1} = c$, where c has a value between 1 and 2 in the usual range.

$$t_c = 2\ (a_1 + b_1) + \pi a_c$$

$$= 2\ (1 + c)\ a_1 + \frac{\pi}{2}\ a_1 \qquad (3)$$

$$= 4\ (1 + c)\ a_c + \pi a_c \qquad (4)$$

For a given va and frequency the factors f_1 and f_c are essentially constant. Therefore, when B and D are chosen to meet the temperature limitations, the product $A_1 A_c$ is a constant, K, or $a_1\ b_1\ a_c\ b_c = K$

$$a_1 = \left(\frac{K}{0.75c}\right)^{\frac{1}{4}}$$

$$= \left(\frac{.45\ va}{f_1\ f_c\ f\ B\ D} \times \frac{1}{0.75c}\right)^{\frac{1}{4}} \qquad (5)$$

Therefore, once the flux and current densities are selected, the size of the core is fixed.

The watts loss per lb. of copper:
$= (1.603 \times D)^2$ at 75°C (6)

Core loss in watts:
$= w_1 \times$ weight of the core in lbs.
$= 0.272\ w_1\ t_1\ f_1\ a_1\ b_1$ (7)

Copper loss in watts:
$= w_c \times$ total weight of the copper in sq. in.
$= w_c \times t_c\ f_c\ A_c \times .321$ (8)

The core loss in watts
$= 1.63\ c\ a_1^3\ f_1\ w_1$ (9)

the copper loss in watts

$$= 0.24 \left(2\ (1+c) + \frac{\pi}{2}\right) a_1^3\ f_c\ w_c \qquad (10)$$

Both of these factors are also fixed.

It follows from this that the only way the ratio $\frac{\text{copper loss}}{\text{core loss}}$ can be changed when using a scrapless punching is by changing the values of B and D.

$$\frac{\text{Copper Loss}}{\text{Core Loss}} = \frac{0.147 \left(2(1+c) + \frac{\pi}{2}\right) f_c\ w_c}{c\ f_1\ w_1} \qquad (11)$$

(*Continued on page 228*)

SYMBOLS

- A_c = gross area of the window (in.²) = $a_c\ b_c$
- A_1 = gross area of the core (in.²) = $a_1\ b_1$
- B = max. flux density in core in 10^3 lines per sq. in.
- D = current density in 10^3 amperes per sq. in. (use mean of all the windings)
- f = frequency, cycles per sec.
- f_c = copper factor
- $f_c A_c$ = sum of all conductor cross-sections in window
- f_1 = core stacking factor
- $f_1 A_1$ = net area of the core in sq. ins.
- I_p = primary load current in amperes
- I_s = secondary load current in amperes
- N_p = primary turns
- N_s = secondary turns
- t_c = mean turn length of all the windings in ins.
- t_1 = mean length of the core (in.)
- V_p = primary volts
- V_s = secondary volts

When there are a number of secondary windings:

- $N_s I_s = \Sigma\ N\ I$ of all the secondary windings
- w_1 = watts loss per lb. of iron, obtained from test data

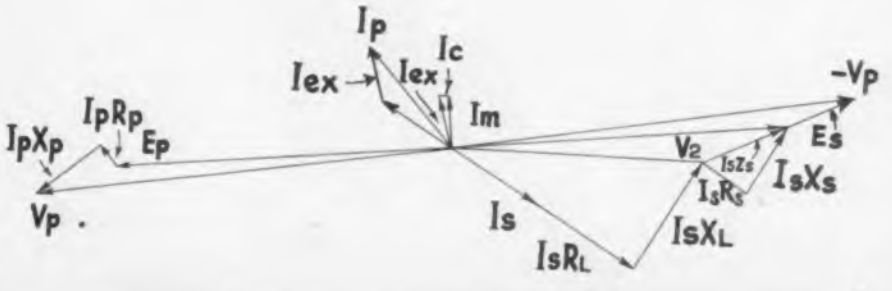


Fig. 2—In this diagram, voltage drops, core loss and magnetizing currents have been exaggerated to make the diagram easier to follow

One end of Nissen hut installation showing dual-diversity receivers used for relaying programs originating in New York

A corner of the master control room in the North African station. Engineers had to rely mostly on plywood for construction

UNITED NATIONS NORTH

Morris Pierce at the antenna tuning equipment for the 50 kw transmitter

● World War II has been called the radio war. In addition to the basic, essential part played by two-way communications services, the potentialities of bombarding the enemy with a blanket of BC and SW propaganda were early recognized. Today, from "somewhere in North Africa," one short wave and four broadcast band transmitters beam 350 kilowatts of constant United Nations programs to parts of Italy, Germany, and to other European enemy and occupied nations.

It is a fine tribute to the skill and perseverance of American radio engineers that, without tools, without adequate personnel and in the midst of constant air-raids, began work on the first of the installations less than one year ago.

The work was accomplished under the command of Colonel C. B. Hazeltine, U.S.A., by the Army Psychological Warfare Branch, which was organized in London just before the invasion of North Africa. Technical head of PWB's Radio Division is Robert M. (Morrie) Pierce, formerly chief engineer of WGAR, Cleveland. He is assisted by Charles Topmiller, former chief engineer of WCKY, Cincinnati, and W. E. C. Varley, formerly of the British Broadcasting Corporation, now chief engineer of North African installations. Lieutenant Victor Tervola, formerly with the National Broadcasting Co., was in charge of design, construction, and operation of studio facilities. Paul Von Kunits, formerly chief engineer of WINS, went to North Africa with his own crew and is still there.

The combined military and civilian forces of the PWB collaborated with the French in operating existing North African broadcast and short wave facilities, and in this way gained valuable expe-

Section of front of the Westinghouse 50 kw transmitter which but for the war would have been the new WINS, New York

Another view of the same transmitter, a model 50HG, which is now broadcasting the Voice of the United Nations

Morris Pierce, who was responsible for construction, at controls of WE 50 kw transmitter, formerly WABC at Wayne, N.J.

Another view of the master control room radio operating now from somewhere in North Africa

AFRICA INSTALLATION

by GILBERT SONBERGH

Plywood control rooms and feeder 6000 feet long small part of problems solved in erection of outpost station

rience while setting up the present broadcasting equipment. This avoided the necessity of waiting many months before they could provide adequate coverage for the Italian and Tunisian people. While none of the existing French facilities are as high-powered as those built by the PWB, some are still in operation.

50 kw WABC transmitter

The PWB originally intended to use Signal Corps technical personnel and equipment in North Africa, but was unable to secure sufficient men and apparatus without the help of the Office of War Information, which office has been responsible for purchasing the major portion of equipment so far used.

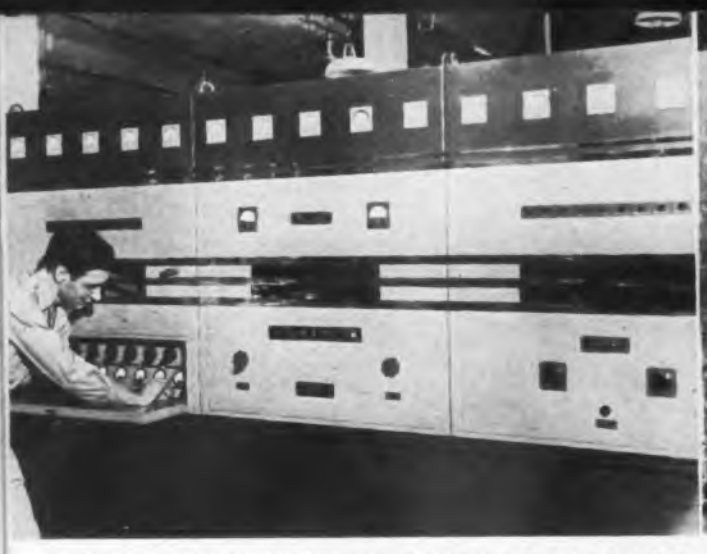
The first transmitter to arrive in North Africa was the old 50-kilowatt WABC unit from Wayne, N. J. The site selected for the transmitter was a small French farmhouse with first floor and walls of concrete. Transformer vaults, generator rooms, and an audio room were started just prior to February 1, 1943. A small brick fan-house for water cooling equipment was put up near the building. The transmitter was installed under the direction of Robert M. Pierce in circumstances which would be considered primitive by American radio engineers, accustomed to reaching for the telephone when they need a replacement part.

No problem shortage

The installation problems which confronted the engineers in setting up this and the other transmitters were enormous. Possibly the two major problems were lack of trained personnel, and insufficiency of supplies. A good deal of the equipment was found damaged on arrival. Broken insulators and other parts had to be replaced or repaired in make-shift fashion with what materials were on hand. The main oil-cooled power transformer had a cracked case. Tools and test equipment were scarce. One of the most amusing and vexatious bugaboos that faced the engineers was the constant deviation of their oil supplies to the Air Forces. On arrival at the docks, the oil barrels, almost without regard to markings, would be shipped off immediately to the airmen, with the result that the radio engineers rarely had enough oil on hand to cool the transformers. This problem was finally solved when the PWB resorted to crating their oil barrels to disguise their shape.

The 50-cycle power presented several problems, in low filament voltage and overheating of power transformers. The 50 kilowatt Westinghouse transmitter, originally intended for use by WINS in New York, was an air-cooled 60-cycle unit on arrival in North Africa. In converting it to 50 cycles, it was necessary to change the pitch on the fan blades and to change the air distribution so as to

Front view of high frequency channel of Westinghouse 50GH



This is one of the smaller transmitters in the North African installation, a Westinghouse job rated at 5 kilowatts

Rear view of the rf portion of the Westinghouse 50 kw transmitter, engineered for 60 cycles, now operating on 50

reach many of the component parts. But because of the extra precautions taken by the engineers in making these changes, the transmitter now runs cooler, even in the intense heat of North Africa, than it would if operating on 60 cycles in this country. This transmitter, while capable of conversion to long wave use, is used almost exclusively for short wave broadcasts into Italy.

100 kw French unit rebuilt

One of the most powerful voices emanating from North Africa is that of the old 100 kilowatt French transmitter which the Nazis failed to destroy properly. In fact, when the Americans arrived on the scene, they found that the only damage to the transmitter was from a couple of hand grenades which had broken most of the tubes and sockets. The antenna tower had been neatly dismantled by the Germans and left on the ground undamaged! But the destruction of the tubes and sockets did not present a major replacement problem, as the tubes had been of French manufacture and were now irreplaceable. However, American tubes and sockets were shipped immediately and the transmitter now has four Western Electric 298A's in the final stage and two RCA 207's in the driver stage. The transmitter was in operation within two months after the PWB took over.

Antenna construction also presented a headache to Pierce and his men. Because of the difficulty of rounding up crews to work on the antennas, barrage balloons were used to support cables which served as antennas. There were both advantages and disadvantages to this system. One advantage was that the antenna could be tuned by raising or lowering the balloon, but this was offset by the difficulty of keeping the antenna vertical in a high wind. Another serious drawback was that occasionally a balloon "took off" with the cable.

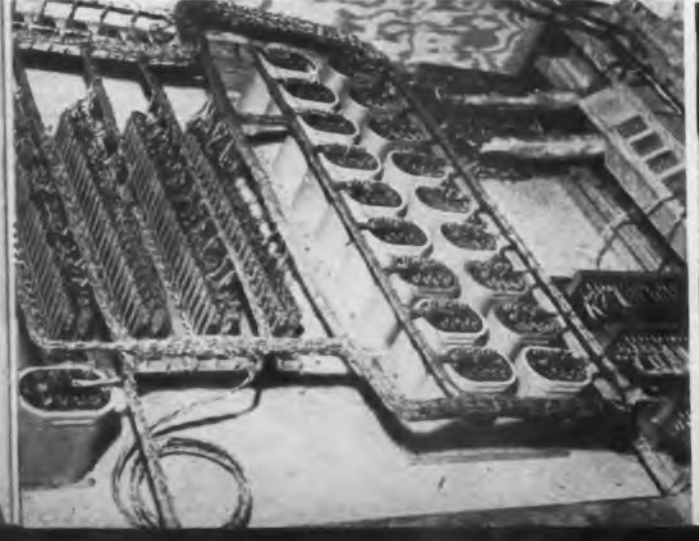
A feature of the complete installation of the 50 kilowatt WABC unit is the fact that the antenna is located over a mile from the transmitter. Perhaps the longest transmission line in existence. this two-wire system extends 6,000 feet to a phasing house and four towers put up by the French.

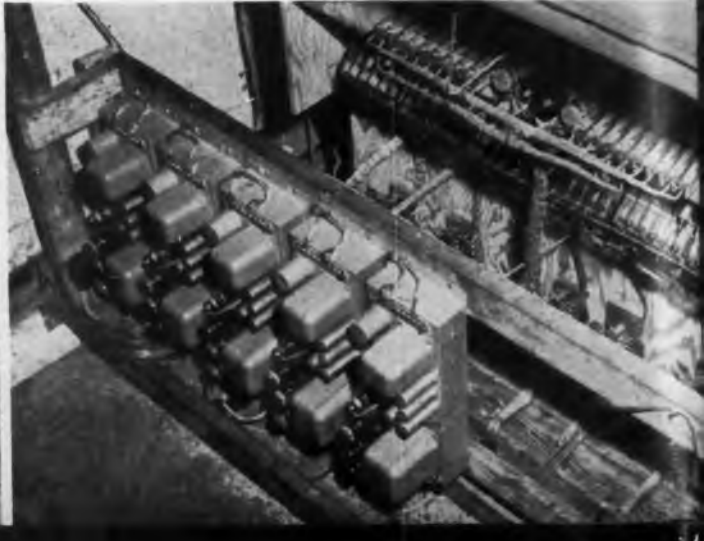
While Pierce and his capable assistants struggled with the farmhouse transmitter, Lt. Tervola selected what had been a combination apartment and office building 15 miles away, and began to build five studios, control rooms and a recording room. There was no acoustic insulating material to be had, and the local cork industry was drafted to supply blocks or slabs some four inches thick with which to line the studio walls. floors and ceilings. Window frames were removed and the space boarded up; whereupon the windows became the double glass observation ports between each studio and its control room.

Each control room was equipped with a Western Electric 23C console. The control panel in the master control room was built out of plywood and whatever materials were at hand, by Lt. Tervola and one assistant, in the space of eight weeks. Here again, supply problems were keenly felt. There was no shielded wire in North Africa

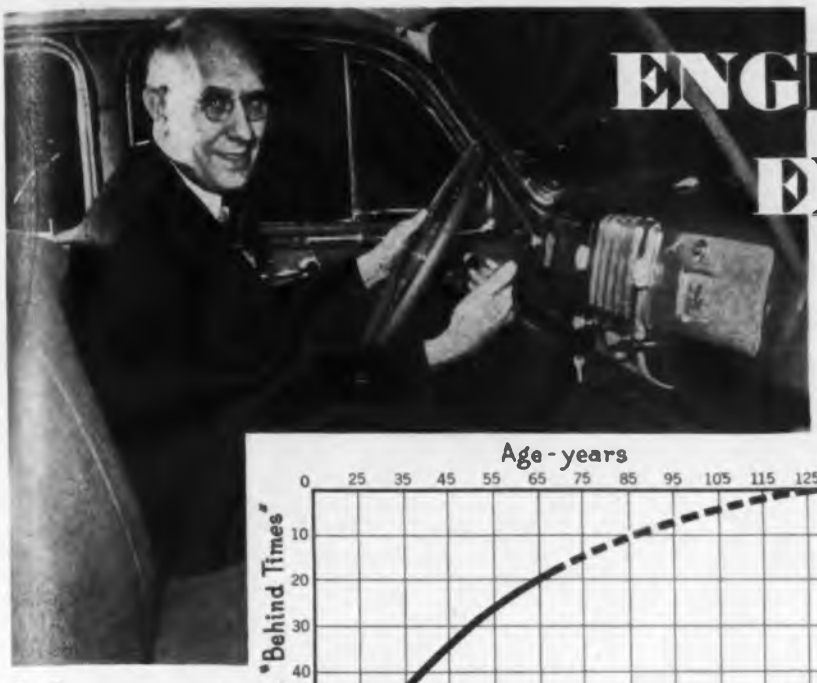
(*Continued on page* 230)

Back of the panels in the master control room of the North Africa United Nations station reveals more plywood construction, this time holding the wiring (left) and the line amplifiers





ENGINEER AS EXECUTIVE



C. F. Kettering, General Motors Research Engineer, plots the time he expects it may require him to make an original invention

• There is quite a distinction on the question of training inventors. There is no sharp line of demarcation between research and invention, with this exception: An invention deals with a specific result, while research deals with the determination of factors which may be necessary to the development of that result.

I think it was the Brookings Institute that made a survey some years ago and pointed out that if you had an education in engineering or science, your chances for making an invention would be only half as great as if you did not have it.

Well, that worried me a little bit and I tried to find out why it was. Out of this I got a definition of what an inventor is. An inventor is a guy who doesn't take his education too seriously.

It is no fault of the educational institutions, because as we are set up, this kid, from the time he is six years old until he graduates from school, has to take three or four examinations a year and if he flunks once, he is out; whereas an inventor can fail a thousand times and if he succeeds once, he is in. The two methods of approach are entirely different. So we say the only thing we have to do is to teach this educated boy how to fail intelligently.

Charles Franklin Kettering, vice-president and Director of Research, General Motors Corp., is one of the most widely known engineers and inventors in the world, and although his fame is founded chiefly on his accomplishments in the automotive field, it is not so well known that he got his real start as a telephone engineer and that his contributions to the science and application of electronics have been substantial.

He is generally credited with being the father of the lighting, starting and ignition system used on all modern automobiles and since 1922 has headed up the great General Motors Research Laboratories. Today he directs a large group of engineers and scientists who have made a wealth of immensely valuable contributions to the electrical, mechanical and aeronautical science. He is himself the patentee or co-patentee of approximately 140 inventions.

Mr. Kettering is a Fellow of the National Academy of Sciences and the holder of honorary degrees in engineering and science from seven universities. The address briefed here is from a talk delivered before the annual meeting of the American Society of Mechanical Engineers, and is characteristic of his logical, common sense view of complex problems, and of his ebullient humor.

Now, here is what I mean by that: anytime you try a new thing and set up any new experiment you are a very rank amateur, because the chances of its being a good experiment are not very great. Therefore, you have to set this thing up and try it. If it doesn't work, you have got to find out whether it doesn't work because the experiment was wrong or because it was not done well. So you have got to try it over and countercheck and check again.

And a lot of people do not want to do that. It is pretty tedious work. I have said that the only reason that I thought our laboratory had ever accomplished anything was because none of us knew enough to get irked by the tediousness of experimentation.

Tediousness brings results

I do not know how to do any new thing without its being tedious. Therefore, the next thing that we teach these young fellows is that tediousness is a thing that you must learn to endure and like, and not resent because you have an education.

We explain to these young men that it is no disgrace to fail and that the only time that you don't want to fail on any experiment is the last time you try it. It doesn't make any difference how many times you try it, but you want to be sure that this thing is worth doing before you start it. Then keep right at it.

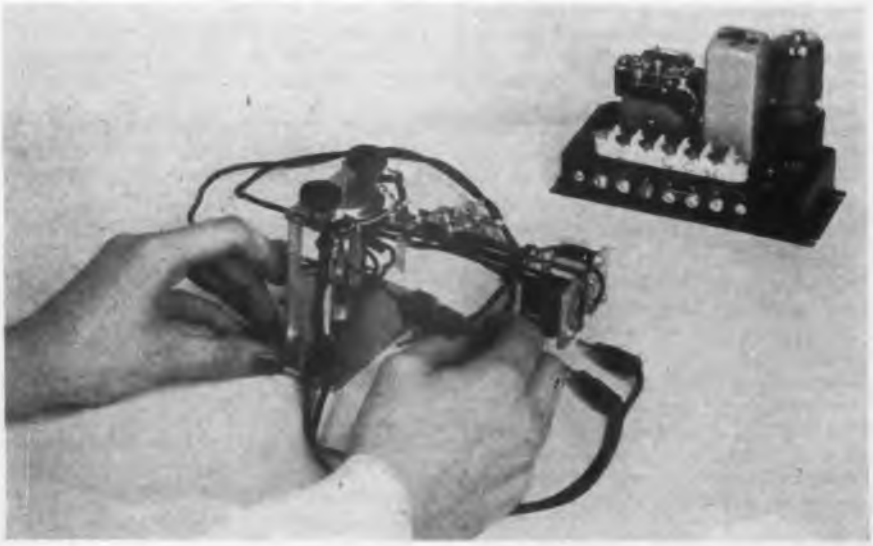
Now, you don't solve these problems and you don't make these inventions in a laboratory. You make them in your head. That is where every bit of this work is done. How thick and how dense the skulls of human beings are is best represented by the amount of technological apparatus we have to have in a place like ours for just getting an idea through a quarter inch of skull bone. That is all that appa-

(*Continued on page* 224)

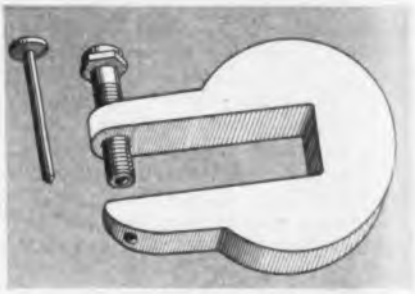
SHORT

1. FIXTURES or templates used with band saw at Yellow Truck and Coach Co., Pontiac, Mich., speeded up production by eliminating time-consuming marking-out operations formerly required

2. ASSEMBLY TIME of electronic pyrometer controller cut down by employing Bristo multiple spline socket screws instead of tiny hard-to-hold slotted-head screws



3. DRILLING JIG for portable use is short cut to straight, accurate holes at Republic Aviation Corp., Farmingdale, N. Y. Pointed pin locates center. Hollow bolt is tightened to serve as drill bushing



4. SPECIAL tool makes quick work of securing cotter pins. Round leg is inserted in cotter pin's head and blade-end does the spreading

CUTS in PRODUCTION

5.→ SOUNDPROOF ROOM at Westinghouse Sharon works for testing and research on transformer noise levels. Big transformers are wheeled into room on trucks, connected to flexible leads and energized. A mike picks up acoustic output, which is amplified and metered on test panel at left

6.↓ FULLY AUTOMATIC exhaust and seal of cathode ray tubes on new high-speed machine at Ken-Rad plant, Owensboro, Ky. Type 5PB4's shown in process. Greater speed and uniformity of production results than with individual trolley exhaust. Each exhaust port has permanently in series with it a mercury diffusion pump which indexes with the tube under exhaust. There are no sweep valves between the tube and the diffusion pump to offer mechanical trouble or interfere with the high vacuum needed in C-R tubes. Automatic controls and solenoid-operated valves or switches isolate any given exhaust position from the main vacuum system if a tube failure should occur on that position. Neon lamps on top of center pedestal indicate any possible tube failure to enable operator to avoid sending such tubes on for further processing

7.↑ IT PAYS TO ADVERTISE safety. Messages, frequently changed, carried about Westinghouse, Louisville, Ky., plant, attract more attention than on bulletin boards

8.↓ WAR MOTHERS holding part-time jobs at Hallicrafters Company at Clearing, Ill., are shown inspecting final amplifier tank coils for the SCR-299

CAPTURED ENEMY RADIO EQUIPMENT

Jap and Italian

These Signal Corps photos, together with those on pages 78 and 79, show some of the units included in the display arranged by Major General R. B. Colton at the AIEE-IRE Winter Meeting

Photos and descriptions of enemy radio previously captured can be found in "Electronic Industries" for November, 1942; July, 1943, and September, 1943

1. Six to ten megacycle Japanese Navy transceiver, model 13, used in twin motored Mitsubishi dive-bomber.
2. Rear view of model 13 Japanese receiver.
3. Baby Jap "Walkie-talkie" transceiver (model 94).
4. Monitoring receiver covering 140 kc to 6 mc with plug-in coils.
5. Rear view of monitoring receiver.
6. View showing underside of monitoring receiver.
7. Italian pedal generator model GR-60. Operator in integral canvas chair.
8. Japanese direction finder equipment set up for operation.
9. Close up of Japanese direction finder receiver.
10. Rear view of Japanese direction finder.
11. Italian pack-transceiver model RF-1.
12. Rear view of RF-1 pack transceiver.
13. Model RF-2 Italian pack transceiver. Note unusual directional loop.
14. Rear view of model RF-2. Inside of cover dated 1935.

MODULATOR LOAD REACTANCE CORRECTION

by **ROBERT M. HANSON**
Thordarson Electric Mfg. Co., Chicago

Design and application of choke which permits constant level grid excitation without excessive plate dissipation

● The upper frequency operating limit of a class B audio modulator can be limited by tube plate dissipation when the class C modulated rf amplifier has a relatively high capacity plate supply by-pass condenser. The addition of a small choke in the modulator circuit can permit constant level grid excitation over the audio range without danger of excessive modulator tube plate dissipation. The load circuit will act as a low-pass filter for the modulating frequencies which may be desirable. It may be of interest to analyze the conditions that affect the design of a choke for this service.

It is not the intention to recommend that these chokes be installed in all transmitters. However, this system does provide a solution for the problem of excessive high frequency modulator tube plate dissipation where large values of rf stage by-pass condensers must be used. It also provides a convenient means of adding a low-pass filter to the audio channel where it is desired to limit the carrier sidebands.

Fig. 1—Conventional circuit for high level amplitude modulation

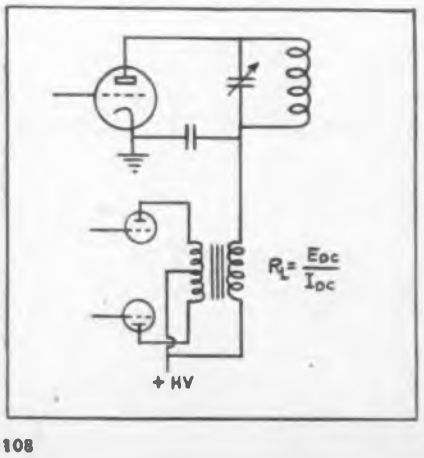


Fig. 1 gives the conventional circuit for the modulator of a high-level modulation AM transmitter. The vacuum tube V1 operates as a class C rf amplifier and delivers carrier and sideband power to the antenna through a suitable coupling circuit. The grid of this tube is excited with a voltage of carrier frequency only. The carrier is modulated with audio frequency intelligence by causing the plate voltage supply of this class C amplifier to vary as a function of the audio frequency voltage.

This audio frequency power is conveniently applied by connecting the secondary winding of a suitable transformer in series with the class C rf amplifier dc voltage supply, and coupling the transformer to a push-pull class B audio amplifier. This transformer secondary winding will be required to supply an audio frequency power equal to one-half of the unmodulated class C stage power input when a condition of 100 per cent modulation exists. The power for lower degrees of modulation will be a function of the percentage modulation.

Load values

It is evident that there will be no load connected to the secondary of the modulation transformer when the class C rf amplifier is not operating. The load to the transformer under proper operating conditions will be equal to the dc supply voltage divided by the direct current for the class C amplifier. For example a transmitter operating with a class C amplifier supply of 2400 volts dc and loaded to a total input current of 0.4 ampere would present a load of 6000 ohms to the modulator. The modulation transformer would be of proper turns ratio to couple this load to the class B audio amplifier tubes. The peak value of the secondary voltage of the modulation transformer for 100 per cent modulation would be 2400 volts, and the rms value for sine wave operation will be 2400/1.4, or 1700 volts.

As this ac voltage is in series with the rf amplifier dc supply, the instantaneous voltage of the supply will vary from 4800 to zero. The current to this amplifier will therefore vary from zero to twice its static value. This means that the secondary of the modulation transformer must cause an additional peak current of 0.4 ampere to flow and the rms value for sine waves will be 0.4/1.41 or .283 ampere. The audio frequency power supplied by the modulator amplifier will be the product of the rms voltage and current flowing in the load or 1700 x 0.283 = 480 watts. This power is equal to one-half of the static input power of the rf amplifier or 2400 x 0.4/2 = 480.

The modulator tubes will be required to deliver 500 watts of power to the primary of a transformer of 96 per cent efficiency. If the operating conditions are such that a reasonable operating efficiency of 55 per cent exists for the class B audio amplifier, the input to this amplifier will be 910 watts and the total tube plate dissipation will be 910 minus 500 or 410 watts. Any substantial decrease in the plate-to-plate load for the class B amplifier tubes will result in increased plate current and increased plate dissipation. This dissipation must not exceed the permissible rating of the tube. However, operating

economy for the transmitter would indicate that the tube rating does not exceed the normal plate dissipation any more than necessary.

Amplitude distortion

Amplitude distortion also can occur when a class B amplifier is terminated in a reactive load. This dictates that the transmitter design should be such that the modulator load is as nearly resistive as possible.

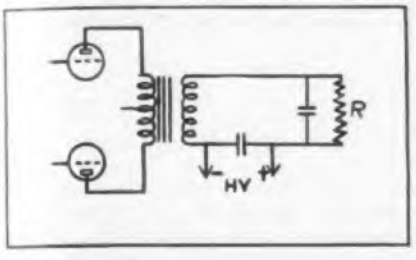


Fig. 2—Equivalent electrical circuit for modulator load

Fig. 2 gives the equivalent electrical circuit for the modulator load. The resistance R absorbs the audio frequency power delivered to the plate circuit of the rf amplifier. The condenser C is the rf by-pass condenser for the class C amplifier. Proper operation of the rf stage requires that the reactance of this condenser be low compared to the impedance of the plate tank circuit at the carrier frequency.

The order of magnitude of the condenser usually installed in broadcast transmitters is .005 mfd, and transmitters for higher frequencies usually operate with condensers smaller than this. Some transmitters originally designed for telegraph operation only may have condensers as large as .02 mfd.

It is apparent from the equivalent load circuit that this by-pass condenser effectively shunts the secondary of the modulation transformer. The condenser is in parallel with the load resistance which means that the load impedance will decrease as the audio frequency increases and it will also become capacitively reactive.

Decreasing load

If a grid excitation voltage of magnitude required to produce 100 per cent modulation at midband frequency be applied to the class B amplifier, and the frequency increased, it will be found that the modulator plate current increases, the plate dissipation increases, and the power delivered to the load decreases. The actual change for a given set of conditions will depend somewhat upon the design of the modulation transformer as it will be affected by the leakage inductance and the coil capacities of the transformer.

This decreasing modulator load at higher frequencies has many disadvantages. It is frequent practice to measure the frequency response characteristic of the transmitter by supplying a variable frequency voltage of constant amplitude to the audio input terminals. It is possible that this frequency may be raised to the point where the modulator plate dissipation becomes excessive and the tubes are damaged. The reactive load may create annoying distortion at higher frequencies.

The fundamental way to correct this difficulty is to decrease the capacity of the by-pass condenser, but effective by-passing of the rf stage sets a minimum value. This minimum capacity will be chosen as the best compromise after considering the load impedance, the carrier frequency involved, and the minimum shunting of the audio modulator. There may be installations of telegraph transmitters having a high capacity by-pass condenser where it is desired to add a separate modulator stage without tampering with the existing equipment.

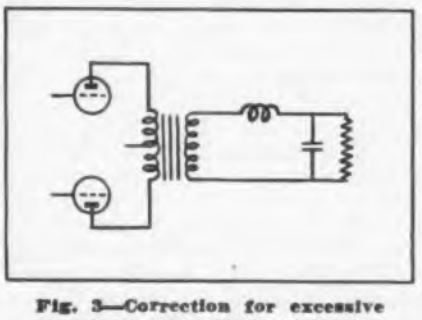


Fig. 3—Correction for excessive modulator tube plate dissipation

A method of correction for modulator load circuits where the high frequency modulator tube plate dissipation becomes excessive, involves the addition of the series inductance L shown in Fig. 3. This reactor and the condenser may be considered as a half-section low-pass filter terminated with the load resistance. Circuit values usually will be such that this system is suitable only for speech frequency equipment, and the cut-off frequency of the modulator stage probably will fall in the range of 2500 to 5000 cycles per second. However, this frequency range is adequate for such service and the attenuation of higher frequency components may be considered desirable.

It is necessary to choose a proper value for the inductance so that the choke and the condenser will form the elements of a half-section low-pass filter when terminated in the class C load impedance. The formulas for calculating these values are quite simple.

$$L = \frac{R}{2\pi f_c} \quad (1)$$

$$C = \frac{10^6}{2\pi f_c R} \quad (2)$$

L—Inductance in henrys
C—Capacity in microfarads
R—Load impedance in ohms
f_c—Cut-off frequency in cycles per second

The modulator given in the previous example had a load impedance of 6000 ohms and a by-pass condenser of 0.01 mfd. By substituting these known values in equation (2) we find that a suitable filter would have a cut-off frequency of 2700 cycles per second. Further substitution in equation (1) gives the proper inductance value to be 0.35 henry. The actual value used is not overly critical and actual tests were made using an available choke of 0.3 henry.

The impedance characteristic of this modulator load with and without the series inductance is shown in Fig. 4. Curve A is the impedance without the choke and shows the undesirable decrease of impedance as the frequency increases. At 5000 cycles the impedance is reduced by one-half. Curve B shows the impedance characteristic with the added choke. The impedance is somewhat lower than the condition with no choke up to about 3 kc but above this frequency the impedance will increase. Curve C shows the amount of reactance in the input of the load with the series choke. The load is seen to be substantially resistive up to 2 kc and the reactance is only 50 per cent of the nominal load impedance at 3 kc. At frequencies above

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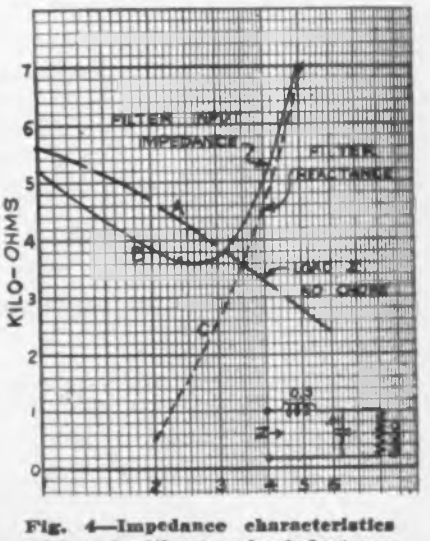

Fig. 4—Impedance characteristics with and without series inductance

Process CONTROL Methods

by RALPH R. BATCHER
Consulting Editor

Part 1 of a survey of electronic circuits and their associated appliances useful in industrial measurements

● For almost thirty years, electron tubes have been definitely associated with radio receivers. Starting in the now-minor role of a detector (or a rectifier) the use of electron tubes progressed into service as amplifiers and oscillators, then, naturally, into the many-sided field of control and supervision in radio equipment. At that time so many tubes were in use in radio equipment that the extension of their use into the purely supervisory field came without comment. In fact tubes became so commonplace, that any use, no matter how important or how trivial, was accepted as matter-of-course.

In view of this, it is strange that industry as a whole has been so slow to consider that many of their problems could so easily be solved by the same tubes and with similar circuits,—circuits that already have been perfected.

In a home-radio receiver, a tube is used to keep the volume at a prescribed level, another tube or so to give a visual indication of the position of correct tuning, another may permit the operation of the controls from a remotely located easy chair. The vast majority of industrial control problems are no more complicated than these in a simple radio receiver.

Utility factors

The greatest difficulties have been in getting the plant process engineer and the radio engineer to talk the same language, since each uses what the other thinks are unusual terms to express what is in general the same effect.

This article attempts to cover the fundamentals of industrial control; to point out the lines of utility where control is easily established in non-radio fields. In the first place, tube applications fall into two main functional classes, which will be designated by the descriptive terms:—those having "survey" duties and those that are "administrative."

In the first of these classes, the electron tube is fast becoming of primary importance as it can be arranged to watch out for and call attention to extremely small changes in many effects. In the latter class, it can also do something to correct the condition that brought about the change. In this latter work, however, the tube has to compete with many other devices that also can effect controlling action, operated by fluids, air, vacuum, electric motors, solenoid magnets and other control agents, usually called servo-mechanisms. In all these fields, the matter of automatic control is tied up closely with that of measurement. In any production process, if it is possible to make a measurement of a variation, it is generally possible to introduce corrective changes that will minimize those variations.

When a tube is used to measure and call attention to such variations, it will be found that (contrary to the usual belief) there are not many basic effects that come into the problem. The list would include the detection of changes in:

1—Electrical properties such as voltage, current or conductivity.
2—The position of an object due to linear or rotary movement.
3—Temperature.
4—Sound effects.
5—Light effects or color.
6—Weight or volume.
7—Balance, symmetry.
8—Magnetic properties.
9—Composition.

Many of these effects are interrelated, as a change in temperature may cause a change in position or a dimension, etc.

Since an electron tube operates in accordance with electrical variations, they can be applied to tube circuits directly. In the case of other items in the above list, it is necessary to convert other conditions of control into their electrical equivalents. This is not an unmixed disadvantage since it per-

Fig. 1—Basic methods of converting dimensional change into an electronic effect

PRINCIPLE:	OUTPUT COMPRISES A CHANGE OF:	OPTIMUM DISPLACEMENT RANGE:
Radio frequency	Frequency of oscillator	1×10^{-5} to 10 in.
Piezo-electric	Displacement	1×10^{-6} to 0.01 in.
Sonic methods	Travel-time, or echo return time	Few feet to few miles
Sonic methods	Amplitude or frequency of a tone	Adaptable to wide range
Resistance shift	Resistance	1×10^{-6} in. to a few feet
Reluctance shift	Magnetic intensity, impedance or ac voltage	1×10^{-6} to 1 in.
Electronic gage	Change in voltage	10^{-6} to 10^{-3} in.
Optical methods	Intensity, direction or color of light	10^{-6} in. to several in.
Radio wave	Travel time of signal	1-100 miles or more

FOR INDUSTRIAL USES

mits the use of a wide range of electrical expedients to modify the original function, so as to bring about a control in accordance with some revised plan—to bring linearity out of an irregular or stepped function, or to convert a linear effect to a quantity that represents a squared relation, or one that follows some other law. It also happens that electrical effects are closely associated with many industrial processes and the necessary electrical variation that can be converted and amplified to serve as a control factor is naturally present.

In any case, before deciding whether electronic devices will assist in some industrial production, it will be necessary to investigate the problems of converting to the electrical system.

Positional studies

It will be found that a great many characteristics of a process can be studied from their effect on the position of some item of its construction, or some part purposely added. For example, temperature influences the expansion of all material, and the expansion can alter the capacitance of a specially designed capacitor. The thickness of enamel, paint, paper, cloth, sheet plastics, and other dielectric materials can be measured by their effect when separating the two plates of a capacitor. If the sheet material to be tested is on a metallic base (as for instance, the thickness of paint sprayed on sheet metal), a single electrode only is needed, since the base metal forms the alternate plate of the capacitor, or it may be found desirable to apply both electrodes to the top surface of the insulator, forming two capacitors in series.

Other insulating materials can be directly placed within clamping electrodes, forming a capacitor. Continuously moving sheets are measured between roller electrodes. Torque can be measured, along with certain other types of force by its effect on a capacitance when it presses on a top electrode resting on a resilient dielectric, such as a block of sheet rubber. Pressure also can be converted to a linear movement by any of several methods; mechanical pressure by direct action against a fixed force, pressure head of a fluid or gas by its effect on a sylphon bellows or

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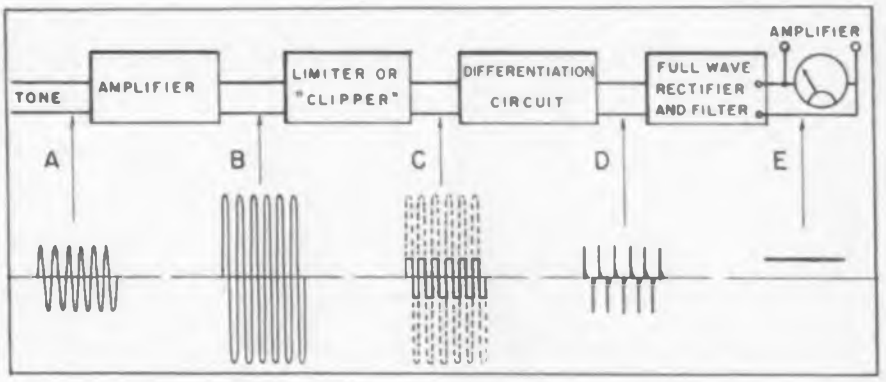
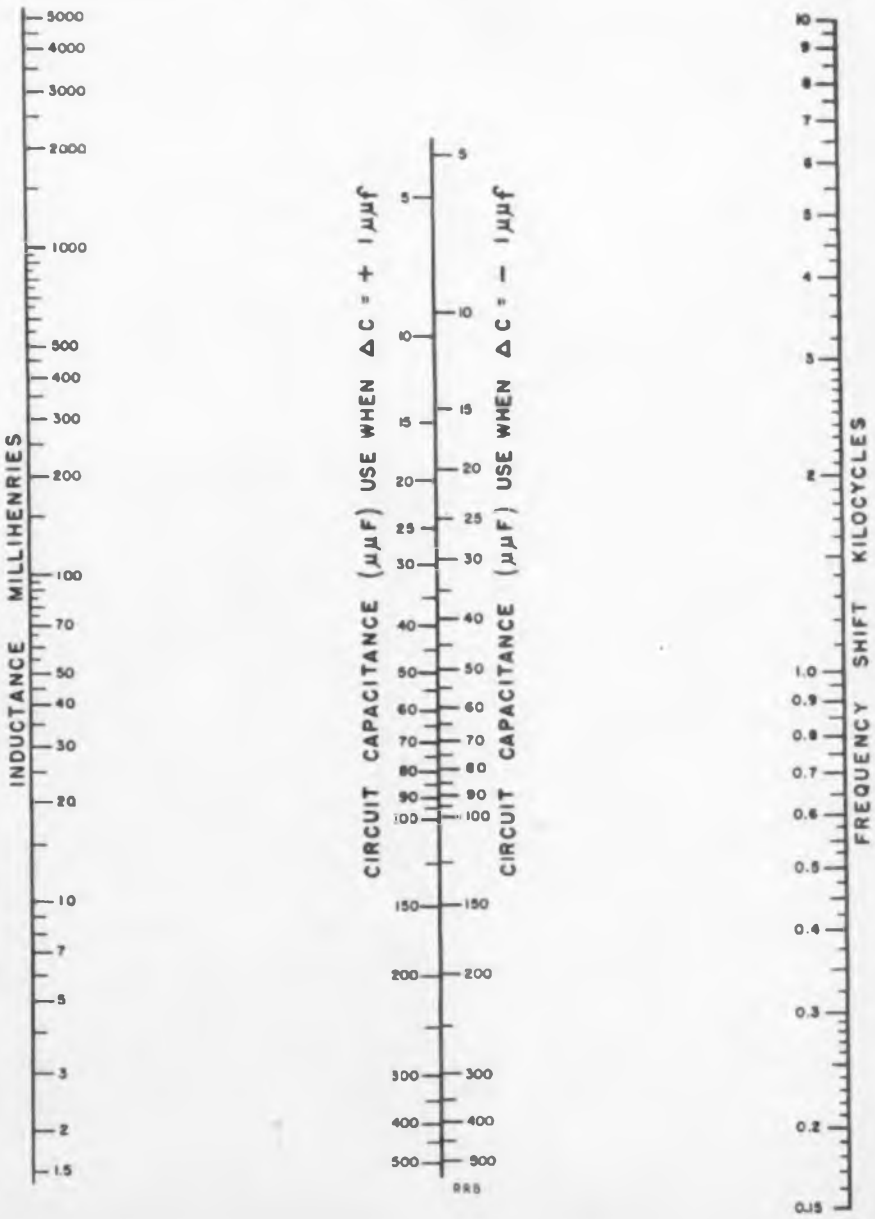


Fig. 2—Block diagram showing method of converting a variable frequency into a proportion change in current. Fig. 3—(below) Chart showing frequency shift produced by 1 mmf capacitance shift



Production MUST Increase

Major General W. H. Harrison, head of Army's Procurement and Distribution service

High output imperative, with no termination in contracts in sight for long time, says General Harrison

● This week's official forecast of the War Department that "war deliveries in 1944 must be in excess of deliveries made in 1943 to meet essential requirements and no immediate relaxation in our production effort is in sight" certainly fits the bill for the Signal Corps in its procurement task, particularly of electronic and radio equipment, for next year. This was emphatically approved Dec. 29 by Major General William H. Harrison, Chief of the Signal Corps Procurement and Distribution Service, who pointed out that the monthly load of production of electronic plants must be substantially increased during the next five or six months. The War Department report was based on answers to a series of specific questions submitted to Major General Lucius D. Clay, Director of Materiel of the Army Service Forces.

General Harrison stated flatly that there was no substance to fears in the electronics manufacturing industry of contract terminations in the sense of cutting off of war orders and such terminations will not loom for months ahead. As has been pointed out there have been and will be terminations for the production of new designs and types of communications equipment which have arisen as a result of battle experience, such as the new, more efficient walkie-talkie apparatus, and the aircraft radio sets which will withstand extremely high altitudes insofar as condensers and other components are concerned. He emphasized that the radio-electronic industry has not had and does not have in prospect cut-backs in production such as have occurred in some other fields of military supplies.

Equalize loads

The Signal Corps Procurement and Distribution Service is endeavoring by every means possible to keep the industry evenly loaded and considers this to be a prime responsibility. Because of the huge task of production ahead the manufacturers realize they have to keep up a very high rate of output.

A let-down in production will be reflected directly in the cost of lives and blood of American troops, General Harrison stressed. Even though the production of Signal Corps equipment has increased 80 per cent during the last six months of 1943, General Harrison declared that there must be continued and renewed effort to boost the output in the coming months. He added his "real appreciation for the splendid job that has been done so far" by the communications manufacturing industry, but there is more to do to push ahead to final victory.

While the holiday season and the flu epidemic have combined to diminish the December deliveries, General Harrison expressed the hope that January will make up any deficiencies. He went on to express the view that any complacency, due to the successes of the last few months, must be replaced by a cycle of intense effort to increase home-front production, if unnecessary casualties are to be avoided.

General Harrison also brought out the fact that it was essential

(*Continued on page* 232)

Modern mobile Signal Corps message center, showing kind and extent of radio transmitting and receiving equipment installed in a large trailer and used to maintain constant communication between ground units and supporting air cover

Kraft paper dielectric is tested for presence of conducting particles with roller and amplifying device

Thickness of aluminum foil is held to close tolerances to insure proper winding and assembly of sections

Winding Industrial Capacitors

Electronic motor control insures uniformity, permits use of thinner foil and greatly increases production

• The electronic drive for winding the foil is typical of the special machinery and technics used by Westinghouse engineers in manufacturing capacitors of all kinds for industrial uses. A foot-operated solenoid enables the operator to shift the phase to provide an extremely "soft" start and a very low speed while threading the metal foil and thin paper. As soon as the foil and paper are started and the torque evenly distributed over the entire width of material, the operator merely presses the foot control and the motor accellerates to top speed smoothly and evenly without breaking the delicate foil. Even a beginner operating this machine will produce as many capacitors in a day as 24 operators would make by hand methods.

A modern capacitor is a completely static, ingenious, and relatively simple device. Its essential elements are: (1) a series of paper-thin electrodes, (2) dielectric sheets to separate the electrodes, (3) a dielectric impregnating medium, and (4) a rugged and sealed enclosure to protect the whole assembly. The materials used in these four elements, and the processing and assembly technic, account for the ability of capacitors to withstand severe electrical stresses and physical conditions of service.

COVER ILLUSTRATION

This Kodachrome picture was made in one of the Westinghouse plants and shows the electronically controlled winding machine used in producing industrial capacitors.

Finished capacitor sections are assembled

The use of aluminum foil as electrode material insures greatest chemical stability and long life. The layers of paper and aluminum foil are wound with electronically controlled, accurately aligned winding machines. These specially designed machines insure freedom from wrinkles and mechanical damage to the foil and paper insulation and permit the use of very thin electrodes requiring a minimum of critical material. The ingots used for making the aluminum foil, are practically 100 per cent pure aluminum. In the winding process, alternate sheets of tested paper and foil are first wound into convenient sized sections with added insulation inserted where taps are made to foil. The area of working insulation going into each section is controlled by measuring foil length by recorder at top of machine. This measurement insures that the kva of finished unit is equal to or more than the normal rating. And this operation is carried on in an atmosphere-controlled room, to insure dust-proof assembly and proper humidity.

The kind of material used for the dielectric sheets depends upon the application. In units from 400 to 250,000 volts for direct current service, such as often used in elec-

(Continued on page 222)

Railroad TRAFFIC CONTROL

by HARRY W. RICHARDS*

Remote control operation of blocks by means of rf currents carried by existing wire lines speeds rail traffic

● Through the application of electronic principles and equipment almost any existing line wire can be used to transmit both controls and indications, instantly and simultaneously, over great distances for the expediting of railroad traffic.

Transportation of materials is a vital part of our war effort. The railroads are doing a back-breaking job. Freight trains are long and heavy, carrying thousands of tons of precious war material. Their maximum speed is about 55 miles per hour. A maintained running speed of 40 mph is considered the top. But this running speed cannot be maintained at all times.

It is the stopping of freight trains that so greatly reduces their average speed. When stopped, there is great difficulty in getting up to speed again; sometimes running for an hour or more and for many miles is necessary before they can really get going. On the other hand, passenger trains can stop and resume speed almost immediately.

FEDERAL AUTHORITIES SHOW INTEREST IN ELECTRONIC SIGNALLING

Washington officials in charge of Defense Transportation have been made acquainted with new electronic means of improved railroad signalling, and are watching with interest the development of this new signalling method, with the purpose of securing its advantages for postwar railroad operation.

Therefore, in meeting the transportation problem of today, it is a matter of keeping freight trains rolling, while the passenger trains do the stopping.

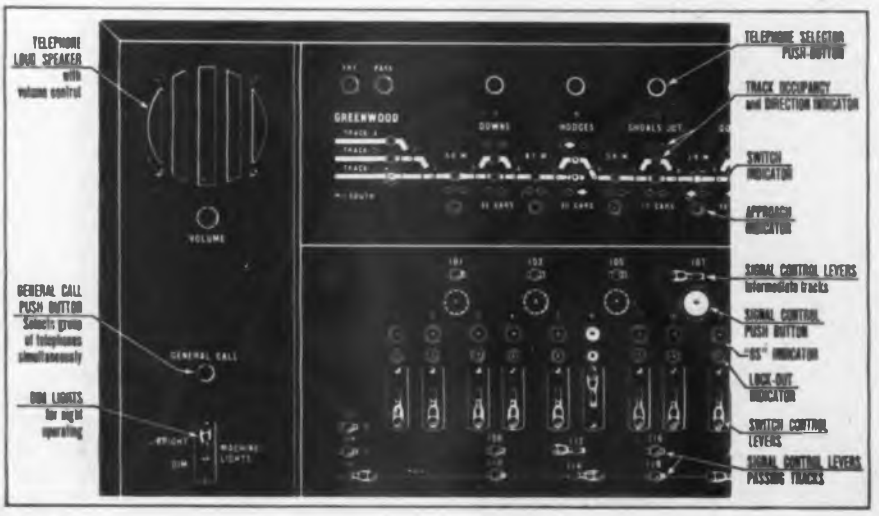
Such plan of train operation may be accomplished through a system of centralized traffic control; the switches and signals being operated over existing wires (such as the telephone or telegraph line) and remotely controlled from a designated point in the territory.

Through centralized traffic control all train movements are handled by one operator at a central office. This system of train dispatching is built around a "control machine" consisting of a miniature track diagram on which indicating lights show the movement of trains over the territory, combined with control levers and push-buttons by which the operator can manipulate remote switches, signals, etc. The necessity for telephone or telegraphic reports of train arrivals and departures is eliminated; traffic can be kept in motion and delays reduced to the minimum. This produces a saving in running time, saves fuel, produces a higher average speed, and greater availability of existing cars and locomotives for service.

Radio-frequency currents are used, each control or function in the territory being operated on a different frequency, to the end that many field units are operated simultaneously and independently on the same wire. Field transmitter units send indication frequencies to the central office. Control frequencies are sent out by the control machine at that office, to the field locations to operate switches, clear signals for train movements, etc., as the traffic situation requires.

Transmitting radio-frequencies over the wire in no way interferes with its original use, since they are above audible range. On the other hand telephones and other apparatus working on the line present a path of sufficiently high impedance, so that the currents being transmitted have negligible losses from the shunting effect of the line equipment.

Richards centralized traffic control machine showing a section of typical panel layout with control and indication features, telephone selector push-buttons, etc.



* 36 Washington Avenue, Greenwich, Conn.

WITH CARRIER CURRENT

Keeping in mind the ever-important factor of safety, great care must be exercised in the design of signaling equipment to the end that any failure will always occur on the side of safety. Should the operator set up an unsafe combination, the transmission does not take place, resulting in a red indication being displayed automatically by the wayside signals. This is accomplished through the interlocking of the transmitter control circuits.

Indications of track occupancy are transmitted on a normally closed-circuit principle; i. e., the frequency is normally transmitted over the line when the track is clear, to hold a relay energized at the central office. When a train enters the block, the transmitter is automatically cut off, thereby de-energizing the relay at the central office, to close the circuit to the red light in the track diagram of the control machine, indicating that the block is occupied. Thus, the indication of track occupancy appears with an absence of line current and so a loose connection, broken wire, power failure, or other interruption, causes the light to show continuously—even with the track unoccupied.

The use of radio-frequency signalling current presents many advantages over that of the low frequency range, as it provides a wide band of frequencies, susceptible of division into many transmission channels, free of interference among themselves.

To avoid harmonic interference, the lowest frequency should be sufficiently high so that its second harmonic will fall outside the highest fundamental frequency used in the territory. For example: starting with a frequency of 2500 kc, the second harmonic will be 5000 kc; so that a band of frequencies ranging from 2500 to 4995 kc may be used without danger of a receiver being incorrectly operated by a harmonic from another control current. Starting with a frequency of 5000 kc provides a band twice as wide, with twice the number of possible transmission channels.

In order to utilize a broad transmission band effectively, channels

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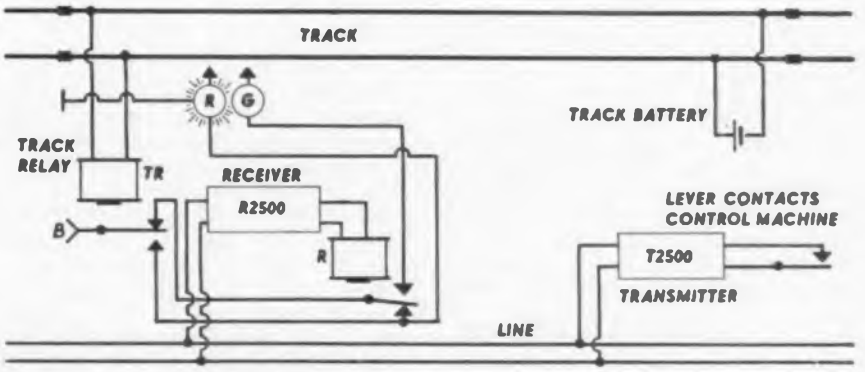
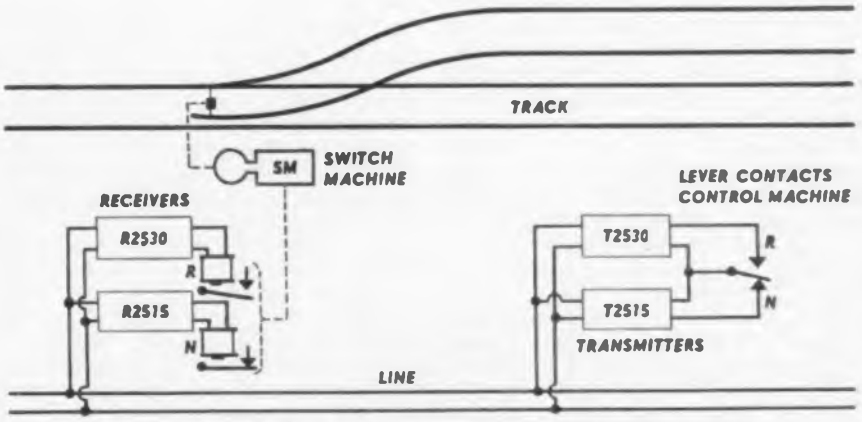
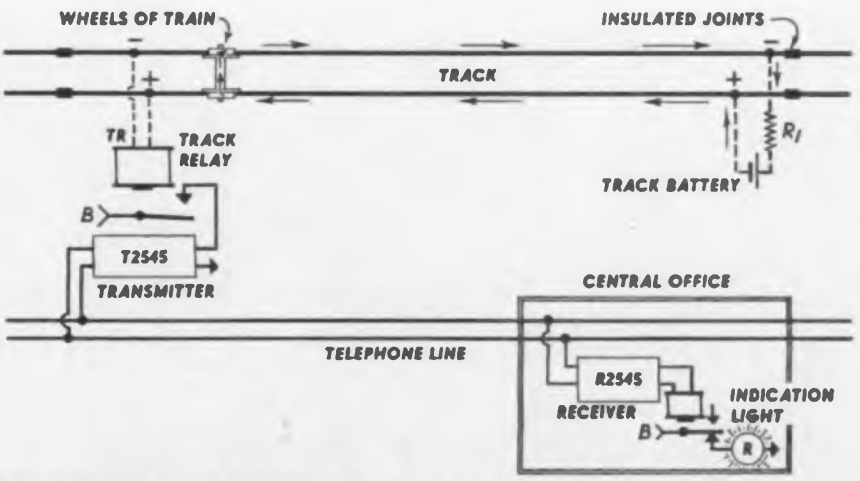


Elements of typical signal control showing method of operation



Manner in which the same type of equipment is made to control switches



Remote control of a transmitter by means of auxiliary track circuit

Recording Frequency Drift

Routine quality control tests make automatic records of temperature effects on precision frequency meters

● The most important condition that sets the pace in the continuous search for precision, is the accuracy and reliability of measuring equipment. Accuracy built in under laboratory conditions is one matter, but in many military operations operating set-ups are far removed from the controlled precision of a laboratory.

In certain frequency establishing standards for portable use, the reliability of operations depends upon the maintenance of the oscillator frequencies under all sorts of adverse conditions. Among operating variations encountered, the matter of temperature and humidity shifts are probably the most important. Temperature may vary from —30 deg C. to + 50 deg. C. or more in a short time and the humidity from near zero to nearly 100 per cent.

It is possible to eliminate a great many of the conditions in a circuit that might cause the frequency of an oscillator to shift, and it is possible to compensate for most of the rest. In any case, there are so many factors involved when both temperature and humidity changes are encountered that it is necessary to establish, by actual test on a percentage of samples, the overall quality of the product under operating conditions.

With the use of best engineering design and adequate follow-up on production processes it is possible to attain a frequency stability comparable with an ordinary crystal.

Therefore, in production tests on quantities of a single item, the establishment of a standard procedure in making routine quality control tests, is of utmost importance. Slight divergences may introduce new factors that would have to be considered when the results were analyzed—and in most cases the diverence from the established routine might be unnoted.

Frequency shift recorder

Tests that fit into this category are found in the production of many items, and in most cases the introduction of automatic test equipment has eliminated inadvertent changes in the order of procedure that come about when single tests are made by different operators, possibly during different working shifts.

The following description of an automatic frequency-shift recorder under controlled conditions will show the method developed at the Allen D. Cardwell Mfg. Corp., to show the reliability of calibration of oscillators under temperature variations encountered in field operations.

Several large test refrigerators were installed, of the type shown in Fig. 1, which hold twelve frequency meters at one time, in such a manner that the dials can be observed and important controls operated externally. These oscillators are then operated under any desired set of conditions, and the humidity level set initially at the required value consistent with the temperature. All oscillators are set at a test frequency, say approximately 4 megacycles, which beats with a fixed frequency of exactly 4 megacycles from a crystal standard. The exact frequency is established in the oscillator so that it is a few hundred cycles above 4 megacycles, so any subsequent drift will show up as a change in the beat note, since the basic problem is to study the drift of the frequency as its ambient temperature is altered from —30 deg. C. to +50 deg. C.

This audio frequency is then converted to a variable current which is applied to a modified Celectray 12 point recorder, Fig. 5, so that one reading of frequency is recorded every 6 minutes. For twelve instruments tested at once, this means one reading every 30 seconds. If the temperature is increased at a rate of 40 deg. C. per hour, the points for the 12 curves are automatically recorded over a 2-hour period. With a range of 2000 cycles for a full-scale (10-in.) deflection, a typical run would appear as in Fig. 2. The recorded

Fig. 3—Circuit for individual buffers and control tubes to prevent interference between oscillator outputs

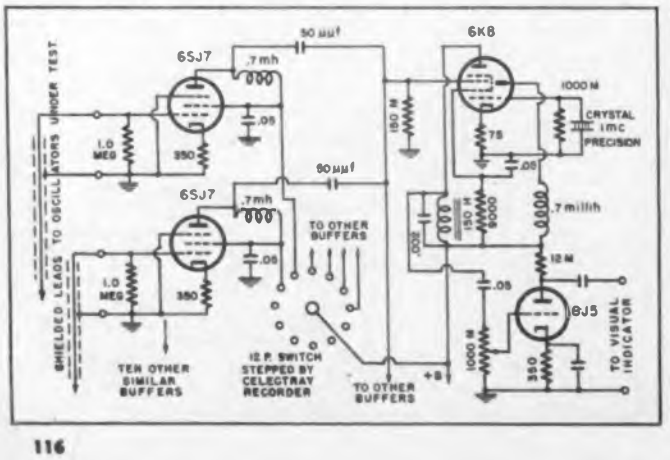
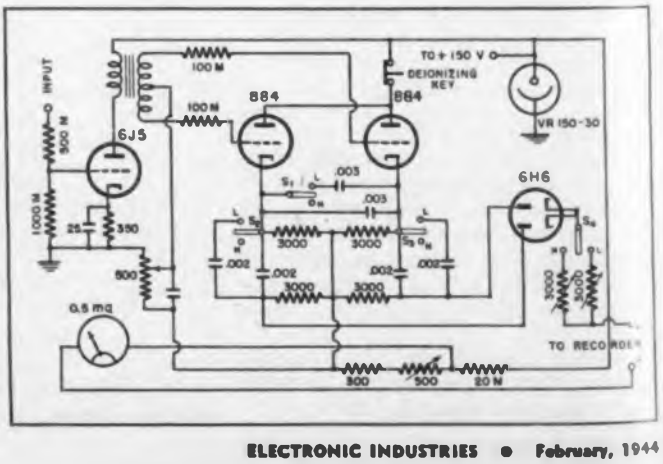


Fig. 4—Circuit to translate variations in frequency to variations in current level, to operate recorder



dots indicate the point on the curve, adjacent to a number which identifies the curve with the position of the set in the temperature compartment. It is noted that sets follow the same drift, more or less, and several of the curves are superimposed. To avoid this, if desired, the initial beat can be set at different values.

Several technical difficulties were taken care of before installation by the application of an electronic "distributor" which isolated each rf output signal from the others and applied these 12 frequencies one at a time to the recording equipment. This distributor is installed in the shielded chassis extending full length over the door in Fig. 1. Separate shielded leads connect each oscillator to its appropriate buffer tube, shown as to its circuit in Fig. 3.

The output of the 12 buffer tubes is combined onto one lead, which runs to the mixer tube section of a 6K8 converted tube. The triode section of this tube is used with a precision crystal as a fixed oscillator, which can be checked frequently with WWV, although slow variations in the frequency of this oscillator do not affect the accuracy of the test.

In order that only one oscillator may be effective at once, only one buffer tube is operated at a time by control of the B supply, using the special 12 point motor-driven switch, that is a part of the Celectray recorder, rewired as shown in Fig. 3. It is necessary to use more than ordinary precautions to shield the outputs of the oscillators from each other, and from common circuits so that sidetones are nonexistent.

The recorder has a motor-driven switch that connects a succession of 12 circuits (normally thermocouples) into a balancing circuit. Here assume that an applied amount of current simulates the thermocouple current. This current deflects a galvanometer whose mirror reflects a telescopic point of light back toward a phototube mounted behind a "controlling edge" or light baffle.

In the balanced position, a long narrow image of the lamp filament is split by this control edge and the illumination level and plate current just suffice to maintain current so that a relay remains closed and another relay open. Relay No. 2 closes at a higher current value than relay No. 1. The difference between the release current of relay 1 and the operating current of relay 2 is the "dead zone" of relay inactivity during balance. The motor is stopped in the balanced position, but drives the carriage upscale or downscale until a balance is established when the relays are both open or both closed respectively.

When the galvanometer current drops slightly from the balanced value the galvanometer mirror rotates to increase the phototube illumination, which raises the plate current of an amplifier tube and closes No. 2 relay also, causing the

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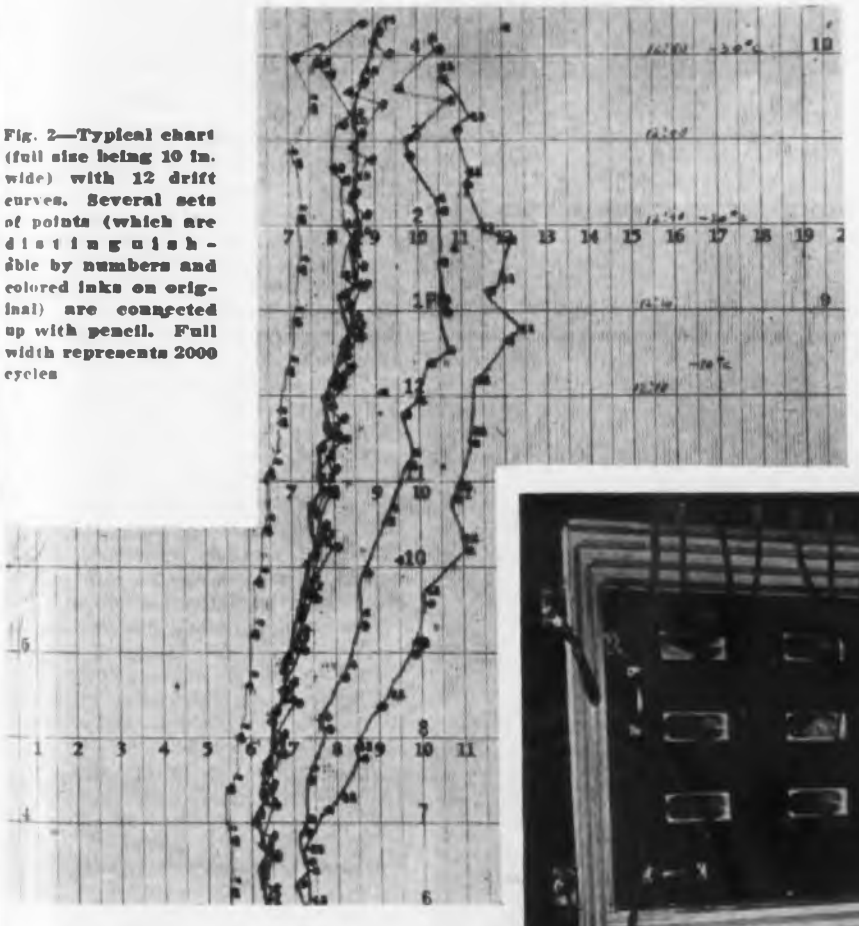


Fig. 2—Typical chart (full size being 10 in. wide) with 12 drift curves. Several sets of points (which are distinguishable by numbers and colored inks on original) are connected up with pencil. Full width represents 2000 cycles

Fig. 1—Temperature compartment (American Coils) equipped with facilities for checking frequency drift of 12 Cardwell frequency meters, mounted behind windows in auxiliary panel of refrigerator. Frequency converter and Celectray recorder on rolling wagon. Buffer and control tubes mounted above door with removable leads disconnected when main door is closed

TUBES ON THE JOB

Mass Spectrometer in Chemistry

Production of high-octane gasoline, butadiene, or styrene involves precise, critical processes. Laboratory-accurate on a huge scale, they need controls that are exact and rapid, and the mass spectrometer has proved to be both. Previously, chemical tests in an oil refinery have been laborious and have required hours to complete. The new device thoroughly checks operation in a matter of minutes—and requires only one or two technicians.

The mass spectrometer has long been used in laboratories, particularly for exploring the field of nuclear physics. It determines both qualitatively and quantitatively the constituents of a gas. With substances that are alike chemically and differ only slightly in weight, chemical analyses are extremely difficult. The mass spectrometer uses only a small quantity of the gas—it need be only a thimbleful—and ionizes it by impact of electrons from a hot filament in an evacuated tube. The stream of charged molecules is drawn along the tube into a strong magnetic field, where it is bent into an arc-shaped path. The heavier the iron, the larger the radius of curvature of its path. As a result, different molecules emerge from the field at various locations—but all of the same kind leave at one particular spot. Different charged molecules are collected successively at an exit slit into a current that can be amplified and measured. In this way, constituents of any gas can be determined as to kind and proportion.

Curved tube passes between two poles of electromagnet of mass spectrometer

Built for use in refineries, chemical plants and similar locations the mass spectrometer is a self-contained tool. No power supply other than 110 volts, 60 cycles is required. The instrument is extremely sensitive and can measure ion beams as small as one-billionth of one microampere. (Average antenna current for the home radio is at least one microampere.) In other words, the mass spectrometer counts as few as 6000 ions per second, which isn't many considering that about three billion billion electrons surge in and out of a 60-watt lamp each second. The device can readily detect, for example, the presence of one part of oxygen in 10,000 parts of nitrogen.

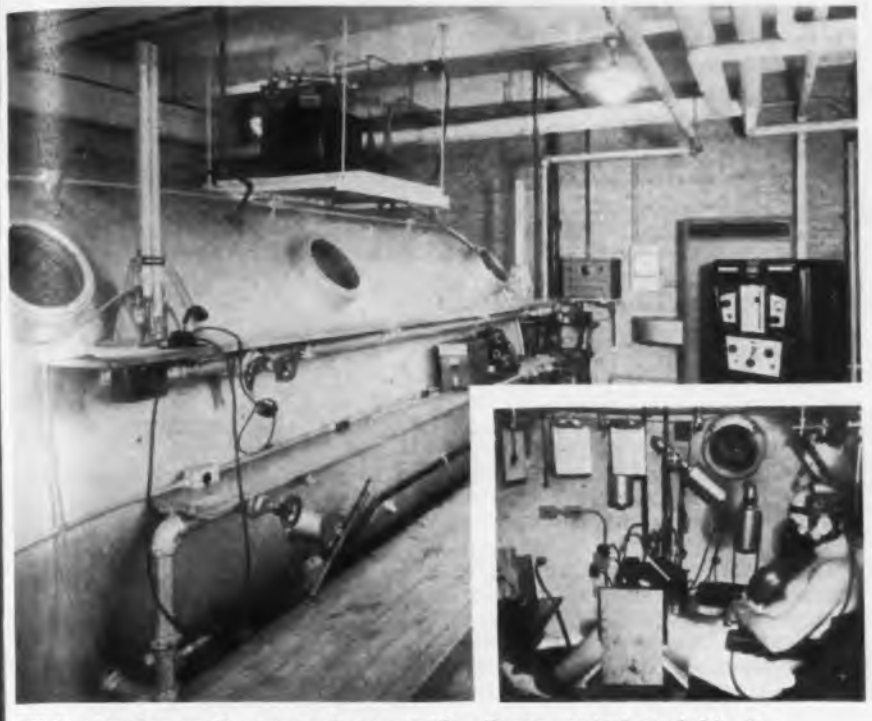
The mass spectrometer is expected to have many industrial uses. It may serve to check gases in protective-atmosphere furnaces, it may check completeness of evacuation processes, or it may detect presence of some undesirable constituent in process gas.

Ready for work in refinery or chemical plant, the latest model of the mass spectrometer uses 15 kw at 110 volts. Cuts time element considerably

X-Ray Decompression Chamber

Something new has been added to the progress of radiology, at the University of Cincinnati, Ohio, where medical researchers are conducting experiments and collecting data on "aviator's bends," "the chokes," and abdominal cramps, all results of rapid ascension and sustained flying at high altitudes.

The chief problem encountered by engineers of the Kelly-Koett Mfg. Co., Covington, Ky., was to in-



Flight chamber as it appears from outside. X-ray control at right. Insert shows subject in typical position for radiography of body reactions

sulate the tubes' anode potentials —up to 125,000 volts—in the rarefied atmosphere representing altitudes up to 50,000 ft. The "tank" is eight ft. in diameter, fifteen ft. long, and accommodates a considerable amount of test equipment for the various radiographic technics.

Already a number of valuable facts have been determined. In "aviator's bends," similar to the symptoms of divers and caisson workers under too rapid ascension to the surface, it has now been determined that the cause is the formation of tiny gas bubbles in the body tissues, not in the bloodstream as was previously supposed. The X-ray has revealed also that "the chokes" is not due, as was believed, to severe disturbances in the heart and lungs. Abdominal cramp, accompanied by swelling, is shown to result from the expansion, up to four times normal volume, of the residual gas in the abdomen. In all, much vital information is being collected through experimentation and radiography which should enable our flyers to do a better wartime job and provide later benefits to the future.

New Plating Method

Certain copper or brass parts of aircraft instruments that carry high-frequency currents must be corrosion resistant. Electrically, they must have high surface conductivity because of high-frequency current skin effect. Nickel, normally used to provide anti-corrosion protection, has high electrical resistance. In seeking a solution to this problem, Westinghouse engineers turned to gold, which is non-corrosive, satisfactorily conducting, but costly. Electrochemists finally evolved an answer that disposed of this particular worry and provided a plating technic valuable in many applications unrelated to the original need. Special plating anodes are made of an alloy of copper, tin, and zinc. With these soluble anodes, copper and brass parts are plated using standard plating practices.

The plated surface has the necessary electrical conductivity for high-frequency applications and is superior to nickel in corrosion resistance. Further, the finish is mirror-like, being surpassed in this respect only by silver itself. As to abrasion, the surface is roughly twice as good as the usual nickel coating. The new plating is entirely non-magnetic (not true for nickel) and is easily soldered.

Eliminating Dust in Tube Manufacture

Dirt and dust particles so small they are invisible to the naked eye are still large enough to ruin a good television camera tube. In the laboratories of the Farnsworth Radio and Television Corp. at Ft. Wayne, Ind., it was found that these minute dust particles caused a spotting of the cathode of television dissector tubes during their treatment with photo-sensitive material. Installation of a 6000 cu. ft. per minute Westinghouse Precipitron electrostatic air filter to clean the laboratory air of the invisible dust and dirt has entirely eliminated the tube cathode spotting, permitting perfect tubes to be made consistently.

Early stage in manufacture of television dissector tubes at Farnsworth. Installation of Precipitron solved cathode dust spotting problem

SURVEY of WIDE READING

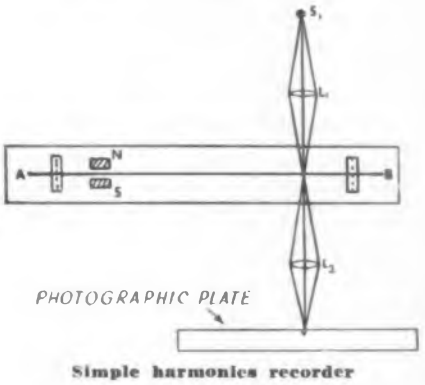
Electronic news in the world's press. Review of engineering, scientific and industrial journals, here and abroad

Harmonics Recorder

T. Tirunarayanachar (Indian Journal of Physics, Calcutta, April, 1943)

The apparatus affords a simple method of investigating the harmonic contents of a current; it is particularly recommended for studying filter performance in power units.

A small current from the output is passed through a wire A—B. The portion of the wire situated between the magnetic poles N, S is acted upon by a force proportional



Simple harmonics recorder

to the current and the magnetic field strength; the magnet can be slid along the wire. When the frequency of any one current component coincides with a possible wire frequency, a large resonant vibration will occur. Light from source S is focussed on the wire, and provided this portion does not correspond to a node, the vibration will be recorded on a photographic plate moved perpendicularly to the direction of wire vibrations. The resonant frequency of the wire may be adjusted by varying its tension.

On Organic Isolators

H. Stoeger, W. Riedert and B. Frischmuth (Schweizer Archiv fuer angewandte Wissenschaft und Technik, Solothurn, Switzerland, September, 1943)

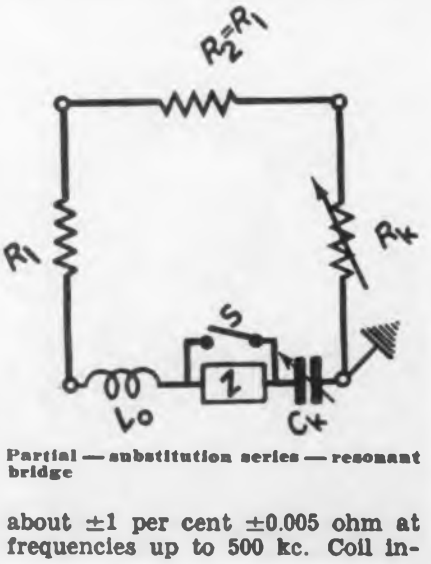
Relations between molecular structure of highly polymerized materials,—i. e. materials of comparatively high molecular weight,—and their mechanical and electrical properties are studied. Tables and diagrams contain a great amount of information on the characteristics of these substances, such as change of dielectric loss factor with degree of polymerization, its frequency and temperature dependence, mechanical resistance, swelling, dependence of the dielectric loss factor on chemical composition.

On Powder-Cored Coils

V. G. Welsby (Electronic Engineering, London, December, 1943)

In the concluding article of a series, a summary of various methods to determine inductance, resistance and capacitance of powder-cored coils is given. Advantages and disadvantages of different circuits are discussed. Approximate errors due to inherent imperfections of standard resistances and impedances used for comparison are evaluated.

The partial-substitution series-resonant bridge circuit shown enables a variable low-loss condenser C_x to be used to measure a wide range of inductances and gives the value of the inherent resistance of these inductances to an accuracy of



Partial — substitution series — resonant bridge

about ±1 per cent ±0.005 ohm at frequencies up to 500 kc. Coil inductance and resistance are obtained from readings of C_x and R_x at balance with switch S open and closed.

Teletypewriter Testing

W. T. Rea (Bell Laboratories Record, December 1943)

In Bell System teletypewriters a character consists of a "start" pulse, which is always "spacing," a "stop" pulse which is "marking," and five equal-length intermediate pulses, each of which may be either "marking" or "spacing." Distortion either retards or advances the time at which a transition from one type pulse to the other type pulse is made, and can be detected by charging a condenser at constant rate beginning at the time a transition should be made and terminating at the time of the succeeding actual transition. The voltage across the condenser is then compared with the voltage it would have obtained had the transition occurred at the proper time. An apparatus to check these transition times consists of a character timer, a pulse oscillator, a condenser discharger, and an indicating circuit. Two condensers are alternately charged and discharged. All four devices and their operation are shown and described in detail.

Design of Frequency Meter

W. H. F. Griffiths (Wireless Engineer, London, November and December, 1943)

A direct-reading frequency meter, covering different ranges of from 100 kc to 60 mc, has been built; its accuracy is 0.01 per cent. The design of resonant circuits incorporated in such meters is considered in great detail. Formulas are developed for the design of a variable condenser to conform to the required linear frequency law. Influence of edge effects on the capacity are studied; these effects may be compensated for by shaping the condenser plates according to formulas derived. Constructional im-

perfections and their consequences are extensively treated. To avoid inaccuracies due to inequalities of dielectric gap distances, adjacent dielectric gaps can be connected in series, electrically. The effect of range coils of different distributed capacitances is investigated. Errors caused by variations in the self-inductance of the condenser are discussed. The formulas are used with a particular circuit.

On Tube Circuits

Harry Stockman (Journal of Applied Physics, December, 1943)

A mathematical treatment of amplifiers, large-signal detectors, frequency converters and similar devices is based on the theory of related linear functions. One general set of formulas and graphs, if applied correctly, covers all circuits, unifying the study of tube behaviour of different type tubes operating under various conditions.

Vacuum-Tube Thyratron Phase-Control Circuit

S. C. Coroniti (Proceedings I.R.E., December, 1943).

In the vacuum-tube thyratron phase-control circuit the phase-shift for the grid voltage of the thyratron is obtained by inserting the plate resistance of a vacuum tube between the thyratron plate (one side of ac supply) and no-grid terminal of thyratron grid resistor, and by inserting a condenser between this no-grid terminal of the thyratron grid resistor and the cathode of the thyratron (other side of the ac supply). Phase relations between plate and grid voltages and currents are explained, and the influence of the condenser, the grid resistor and the vacuum tube characteristics on the performance are discussed and illustrated.

Power Factor of Indian Mica

S. Datta, W. Sen Gupta and P. C. Mahanti (Indian Journal of Physics, Calcutta, April, 1943)

Power factors of mica samples from different parts of India were investigated. Condensers made from the respective materials were tested in a bridge circuit by a substitution method; the results are summarized in the table.

It is mentioned that stained and spotted mica is suitable for use in radio condensers. A few condensers were constructed with some of these mica samples and found satisfactory throughout the year under varying conditions of temperature and atmospheric humidity. Further studies on other properties of these condensers are intended.

ELECTRICAL PROPERTIES OF INDIAN MICA

Source	Designation and color	Kind or quality	Power factor	
			Average %	Spread %
Bihar	Bengal Ruby	Clear	0.0104	0.0092—0.0112
	C—Red	Stained	0.0173	0.0101—0.0259
	D—Red	Stained	0.0252	0.0182—0.0319
	A—Red	Stained and slightly spotted	0.0147	0.0105—0.0210
	F—Red	Stained and slightly spotted	0.0144	0.0102—0.0232
Madras	Muscovite Green	Clear	0.0116	0.0102—0.0126
	C—Green	Stained	0.0241	0.0151—0.0316
	D—Green	Stained	0.0313	0.0250—0.0400
	A—Green	Stained and slightly spotted	0.0294	0.0189—0.0460
	F—Green	Stained and slightly spotted	0.0144	0.0112—0.0177
	M177—Green	Stained and spotted	0.0319	0.0265—0.0366
	M242—Green	Slightly stained with black metallic spots	0.0198	0.0134—0.0272
	M236—Green	Stained and slightly spotted	0.0187	0.0132—0.0234
Rajputana	0273—Green	Slightly stained	0.0165	0.0143—0.0173
	N756—Green	Slightly stained with black metallic spots	0.0186	0.0178—0.0198
	6552—Green	Stained with black metallic spots	0.0216	0.0159—0.0377
	K162—Green	Stained with black metallic spots	0.0227	0.0177—0.0328
	L333—Red	Stained	0.0172	0.0151—0.0199
	N758—Red	Stained and slightly spotted	0.0192	0.0140—0.0280
	N759—Red	Stained with metallic spots	0.0206	0.0163—0.0245
Travancore	M624—Red	Stained and spotted	0.0329	0.0202—0.0387
	R41—Red	Stained and heavily spotted	0.0732	0.0366—0.0962
	L999—Red	Heavily stained and spotted	0.0752	0.0422—0.1010
	M25—Red	Phlogopite, heavily stained	0.0815	0.0494—0.1150
Mysore Orissa U.P Punjab	M620—Green	Clear	0.0118	0.0102—0.0181
	M894—Green	Stained	0.0203	0.0132—0.0264
	1581—Green	Clear	0.0440	0.0245—0.0761
	1306—Red	Stained and slightly spotted	0.0293	0.0162—0.0533

Synchronizer for Motors

F. Kirschstein (Elektrische Nachrichten-Technik, Berlin, February, 1943)

Several circuits all using the phenomenon of frequency-following, are discussed. By frequency-following the author understands that an oscillation of one frequency is made to synchronize another oscillation, the frequency of which is not very much different, by comparing the phases of the two voltages and deriving a controlling magnitude which effects the desired synchronization. A discriminator or frequency measuring circuit, frequency division, circuits used for quartz clocks, synchronization of several transmitter frequencies and the motor control to be described in detail are shown and explained.

The device has been developed to make a motor shaft rotate at definite speeds regardless of variations of the mains voltage, heating in the coils of the driving motor, changing frictional resistances, etc. The arrangement shown in Fig. 1 was used to control the speed of the shaft by the frequency of an electrical oscillation generated by the oscillator (for instance a tuning fork oscillator, supplying a fundamental wave of constant frequency f_g). The frequency divider yields a sub-multiple f_g/n of f_g according to its adjustment.

(*Continued on page* 196)

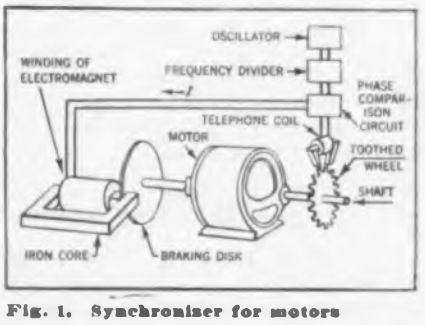
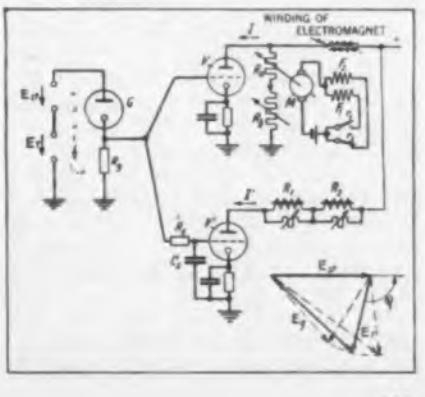


Fig. 1. Synchronizer for motors

Fig. 2. Phase comparison circuit and vector diagram



ENGINEERS ATTEND IRE-

Digests of most of the papers in lengthy program covering practically every phase of electronic applications

● The annual IRE Winter Meeting started off Thursday evening, January 27, with the address of Major General R. B. Colton on enemy communications equipment, to the assembled members of the IRE and AIEE in the Engineering Societies Building, New York City. The major part of the AIEE technical sessions had occupied the first days of the week of January 24.

The paper of Major-General Roger B. Colton, Chief of the Signal Corps engineering and technical services represented the first complete technical description and exposition of captured items of enemy Army communications equipment.

He described the equipment in full detail and discussed circuit design considerations. A highlight of his address was his exposition of the German and Japanese airborne radio system. General Colton discussed in detail the transmitters, receivers, direction finders and interphone systems used by the Nazis and the Nips. He made an extensive analysis of the ground radio equipment used by the enemy forces and the ground wire apparatus including field telephone and telegraph instruments.

CAPTURED RADIO

Many of the units of captured enemy radio equipment referred to on the opposite page, and exhibited by Major-General Colton as a feature of the IRE-AIEE meeting, are illustrated on pages 78-79 and 106-107.

Induction heating

The IRE meeting itself was opened at 10:00 a.m. on January 28 by Dr. B. E. Shackelford, Chairman. Dr. L. P. Wheeler, retiring president of the IRE, handed the gavel to Professor H. M. Turner, 1944 President. The technical sessions followed the ceremony.

H. C. Humphrey, of the Baltimore radio division of Westinghouse, discussed applications of induction heating to the manufacture of tin plate. Application of electronic methods to the fusion of electrolytically deposited tin plate, Mr. Humphrey said, represents an important technological advance in the steel industry. It has played a prominent part in the conservation of tin, whereby tin plate is now produced using considerably less tin than heretofore. Handling operations have been greatly reduced, and the rate of production of tin plate speeded up to 500 feet per minute, with some installations being made in anticipation that in the near future these tin lines may be operated at 1,000 feet per minute. One tin mill alone has 3,730 kw installed capacity of electronic high frequency generators operating at 200 kilocycles, which is comparable to the total installed power of all the broadcast stations in the United States. Advantages of high frequency induction heating using vacuum tube oscillators as source of energy include: (1) No physical contact with the strip; (2) Work is kept at ground potential; (3) Heating can be quickly matched to speed of changes in speed of strip-line; (4) Exceptional speed and uniformity of heating; (5) Makes it practical to combine plating and fusion lines. This pioneering example of high frequency electronic equipment of substantial power handling capacity at work in industry undoubtedly is the forerunner of many processes where high frequency heating has as yet been unthought of but where, if applied, it would produce a superior product, speed up operation, and effect operating economies.

Resonator control of electrons

Lloyd P. Smith of RCA delivered a paper, "The Limitations Imposed by Quantum Theory on Resonator Control of Electrons." When an electron passes through a cavity resonator in which there is a very high frequency electromagnetic field, it is a consequence of the quantum theory of the interaction of the electron with the field that a transfer of energy from the electron to the field or vice versa must take place in steps of one quantum of energy $h\nu$. When this is taken into account it can be shown that when the field intensity in the resonator becomes sufficiently low, the total energy exchange which can take place in transit is less than that calculated on a classical basis. The difference was calculated for short transit times and transit times comparable with a half period. The departure from the classically computed energy exchange becomes serious when the maximum exchange that could take place on a classical basis becomes comparable with the energy $h\nu$ of one quantum. The field strengths and frequencies where this effect is noticed were indicated and the effect of this limitation on velocity modulated beams was discussed.

Maxwell's equations

Three papers authored by General Electric men were delivered by J. F. McAllister, Jr. They dealt with equivalent circuits for Maxwell's Equations. They were:

"Equivalent Circuit of the Field Equations of Maxwell — I" — Gabriel Kron

"A New Approach to the Solution of High Frequency Field Problems" — J. R. Whinnery and Simon Ramo

"A.C. Network Analyzer Studies of Electromagnetic Cavity Resonators" — J. R. Whinnery, C. Concordia, W. Ridgway, and Gabriel Kron

A method has been developed for solving transient or steady-state electromagnetic field problems using equivalent circuits. By means of a Network Analyzer, it is possible to obtain field distributions in the neighborhood of odd-shaped bodies, such as antennas, cavity resonators, and wave guide discontinuities. The circuits apply to conducting and non-conducting regions of space, regions of different dielectric constant and permeability, re-

AIEE TECHNICAL MEETING

glass of lossy dielectric, etc. Moreover, broad physical pictures are suggested by the correspondence between circuits and fields that may have high value.

Circuits have been developed for any orthogonal curvilinear coordinate system. If a type of symmetry exists for which the problem becomes two-dimensional in any of these systems, the general, three-dimensional network can be replaced by a simpler, two-dimensional one. Junction points in the network can be identified with points in space, and currents and voltages at the junctions with electromagnetic field values at those points.

The network itself operates at any convenient frequency, which in general will differ from that of the actual problem. The same network suffices to represent any problem frequency, although for a given network and fixed number of elements, the accuracy increases as the problem frequency is lowered. However, it is possible to realize any degree of accuracy by use of sufficient elements.

Preliminary tests on two-dimensional problems have been made using existing network facilities. In all cases the agreement with theoretical values has been close enough to indicate the validity of the equivalent circuits used, and to suggest that information is potentially available on problems not yet solved.

Design versus service

Irwin W. Stanton of RCA analysed prewar and postwar problems in connection with radio and television instruments. Among the topics covered were:

(a) Interpretation and meaning of service; (b) cause and justification of need for service; (c) service as related to engineering with specific suggestions for improvement; (d) prewar methods, procedures, and problems, and (e) postwar methods, procedures, and problems.

Fluctuation noise

C. M. Burrill, also of RCA, discussed experiments relating to the statistical theory of fluctuation noise. By means of apparatus for counting the number of selected time periods in which the waveform under investigation exceeds a series of given values, the author had made some statistical observations of fluctuation noise. These experiments were planned in order to compare results with the theoretical probability function for the noise envelope, which had been obtained by others from the statistical theory of fluctuation noise. The paper described the tests made and discussed the extent of the agreement found. It was considered likely that limitations in the counter operation were responsible for at least some of the deviation of the experimental results from the theory and the effect of these limitations was discussed.

Noise modification

In his paper, "The Modification of Noise by Certain Non-Linear Devices," Dwight O. North of RCA revealed experiments in which a narrow band of radio-frequency noise, obeying the normal error law, was put through non-linear devices. The spectral composition of, and the statistical law obeyed by the emerging noise were analytically determined. Devices considered were a rectifier, a square-law instrument, and the so-called linear detector. The response of the linear detector to a combination of noise and sine signal was exhibited, leading to a practical arrangement for noise-metering in which the conventional, but far less rugged thermocouple is supplanted.

British radio production

F. S. Barton, of the British Air Commission, discussed the present wartime setup in England for the control of radio research, development, and production so as to direct it completely to the benefit of the war effort and the armed forces. Mr. Barton approached the subject from the historical angle, stressing the cooperation of the RAF, Army and Navy, and their methods of dealing with the trade.

AN tube standardization

Lt. C. W. Martel, Signal Corps, presented a paper prepared by him in conjunction with Mr. J. W. Greer, Bureau of Ships, on the

(*Continued on page* 244)

ENEMY RADIO INFERIOR, SAYS WAR DEPT.

● Captured enemy signal communications equipment, gleaned from world battle fronts, is being turned against its former owners through expert study that reveals secrets of Nazi and Japanese production technique and psychology, the War Department reveals.

In the past year, the Enemy Equipment Identification Service of the Signal Corps, Army Service Forces, has identified, catalogued and studied more than 10,000 pieces of enemy signal material—material which daily gives up important information.

The Identification Service has found, for example, that German design was frozen five years ago. Although the freezing made for speed in production, obtained further through interchangeability of parts, it has boomeranged—the Nazis have been unable to keep pace, at least in this line, with the rapid-fire technical developments of the United Nations. Basically, the German equipment is sound, but often too bulky for completely efficient field service.

German psychology is clearly revealed in the equipment handbook furnished each Nazi soldier. Given minute instructions about each piece of equipment, nothing is left to the German's imagination. He can't make many mistakes if he follows the instructions, but at the same time, he is not likely to be able to adapt himself or his equipment to fluid situations.

The majority of the Japanese radio sets are handmade of inferior material—much of the materials having been purchased on U. S. distress markets during the depression. The Japanese signal equipment is generally small and can be carried into jungle action, but as one returning officer remarked: "If the stuff won't work in battle—and often it doesn't—it doesn't matter if it's smaller and easier to handle than ours."

The Identification Service trains other Signal Corps troops in the battlefield utilization of captured equipment. Captured equipment, after being studied in Washington and at Signal Corps laboratories, is sent to communications schools for study by men in training.

ASSOCIATION NEWS

Pacific Coast Electronic Mfrs. Assn.

Over sixty of the leading electronic and component parts manufacturers in the west have formed the West Coast Electronic Manufacturers Association. Sol Smith has been appointed secretary-manager and can be addressed at 811 W. 17th St., Los Angeles 14, Calif.

The newly formed organization, which reports having approval of the Army Signal Corps and also of the WPB, was to function as a complete West Coast Unit at the formal induction of officers immediately following its January meeting.

The present prime objectives of the members in the Association are: 1.—Full utilization of existing manpower and manufacturing facilities of the electronic industry in the West. 2.—Supply of all proper information to interested Government agencies which will allow the Pacific area to make full contribution to the war effort. 3.—Clarifying various Government regulations and rulings and disseminating the information to all members. 4.—Attempt to secure uniform consideration on problems affecting renegotiation and termination of contracts, selective service, wage stabilization, and other matters of mutual interest. 5.—Distribution of information amongst the membership as to commodities manufactured by them, thus enabling them to utilize the facilities of West Coast manufacturers to the fullest possible extent by their purchasing departments.

Conventions and Meetings Ahead

Institute of Radio Engineers (330 West 42nd Street, New York), Feb. 2, New York.

Radio Club of America (11 West 42nd Street, New York), Feb. 10, Columbia University, New York.

American Physical Society (Karl K. Darrow, Columbia University, New York), Feb. 25, 26, Brooklyn, N. Y.

Society for Measurement and Control (New York Section Meeting), Feb. 29, New York.

Optical Society of America (A. C. Hardy, MIT), March 2-4, New York.

New Panel and Committees for RTPB

Some additional representation on Panels of the Radio Technical Planning Board is to be authorized. Because their particular problems are not entirely amenable to solutions that might suit standard broadcast conditions, international broadcasters have sought and are to be permitted representation through a Panel all their own, bringing the number of Panels up to fourteen. Other interests which have requested representation on various Panels include the railroad people who see the need for careful consideration of the possible use of radio for communications and for other uses peculiar to railroad operation; and the larger taxicab companies similarly want attention to possible use of radio in the more efficient handling of taxicab fleets. Both are to have representation through the formation of committees to work with interrelated committees on the various panels, and thus will be afforded a voice in determining final reports and recommendations.

Ewell K. Jett, who gives up the post of Chief Engineer of FCC to become a Commissioner, has had long experience in administrative work and is considered an allocations expert

Chief Engineer Jett Appointed Member of FCC by Roosevelt

● The selection of FCC Chief Engineer Ewell K. Jett as a member of the Federal Communications Commission by President Roosevelt is regarded as a merit appointment of the highest quality and places on the Commission an outstanding Government radio engineer and a most able administrator and executive. Lt. Jett, who is a retired Navy officer, has been a mainspring in the allocations of radio frequencies since he left the Navy and came with the former Federal Radio Commission in 1929.

The very broad background and experience of Commissioner Jett in Governmental radio engineering activities and in communications in all its fields will be invaluable to the FCC in its coming postwar problems in allocations of radio frequencies and the planning for the many new radio and electronic services. He has the particularly important post in the present postwar technical planning of the radio-electronic industries of being the FCC Observer on the Radio Technical Planning Board with which he has closely worked since its inception. During the creation of the RTPB he was the liaison representative of the FCC and the Federal Government with the Radio Manufacturers Association and the Institute of Radio Engineers, and in the initial conference which led to the RTPB establishment, he was a major participant.

The new Commissioner has also directed the alloca-

(*Continued on page* 236)

"Nothing Like Being Rugged, Eh Kid?"

Our mechanized Army must have brains, but brawn still counts. The big fellow wrestling interminably with 155 millimeter shells serves his greedy howitzer with the broad back developed by endless months of bone-tiring drill.

If it cannot take the jolts, vibrations, concussions, and extreme atmospheric variations of mechanized global war, the best electronic fighting equipment in the world is useless. Hearts of this combat equipment — electronic tubes — have two strikes against them from the start. Inherently delicate and fragile by nature, still they must be as rugged as the men who depend upon them.

Bump, vibration, immersion, life, and other punishing tests prove the mettle of Hytron tubes before they leave the factory. More important still, results of these tests form the basis for continual improvements in construction and processing. Throughout manufacture — in stem, mount, sealing-in, exhaust, aging, basing, and test departments — engineers, foremen, and skilled operators are ceaselessly striving to achieve in Hytron tubes not only the tops in electronic performance, but also the peak of dependable stamina which combat demands.

OLDEST EXCLUSIVE MANUFACTURER OF RADIO RECEIVING TUBES

HYTRON

CORPORATION ELECTRONIC AND RADIO TUBES

SALEM AND NEWBURYPORT, MASS.

BUY ANOTHER WAR BOND

WHAT'S NEW

Devices, products and materials the manufacturers offer

Stratosphere Chamber

Model 20S100 stratosphere chamber is one of a number of special types of such equipment manufactured by Tenney Engineering, Inc., Montclair, N. J., this one having been completed for Eclipse Aviation. The chamber is designed to produce a temperature of —100 deg. F. and to simulate conditions at an altitude of 53,000 ft. Work space measures 30 x 30 x 36 in. Such cabinets are supplied for three ranges of low temperatures: —40 deg., —70 deg. and —100 deg. F. Temperature-humidity cabinets also are supplied but without the altitude feature. Humidification facilities are standard with all cabinets.

Level Control

The Trimount electronic control functions on the principle of variations in the volume of emission of electrons in a standard high current amplifying tube. When the contents, (liquid) of a container make contact—or leave contact—with an antenna or metal rod electrode that is mounted on insulated supports in the container, the volume of flow of electrons in this tube is changed. This variation in electronic flow activates a magnetic relay to open or close an electric load circuit. Because the voltage impressed on the electrode is less than 1 millivolt and the current is .1 milliampere, all possibility of chemical reaction on the contents is eliminated. Standard electrodes are of stainless steel, but may be made of any specified metal, and they are mounted in any of several types of support to meet local conditions.

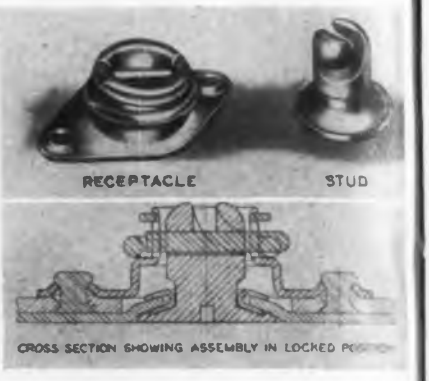
Each electronic switch is fitted as standard, with an auxiliary emergency tube circuit which automatically gives a signal and carries on the operation should the regular electronic circuit fail for any reason. Once installed it requires no attention. The manufacturer is the Trimount Instrument Co., 37 West Van Buren St., Chicago, Ill.

Remote-Control Breaker

The new Klixon, D-7229, D-7230, D-7231, remote-control circuit breakers are designed for operation and control of any remote electrical load. These breaker-relays indicate circuit operation and can be reset from a control panel. The breaker is calibrated to precision tolerances and will carry at least 115 per cent of rated current continuously, and will ultimately trip at 125 per cent of rated current in an ambient of 25 deg. C. (77 deg. F.). The actuating element in the circuit breaker is the snapacting Spencer disk which provides positive make and break. This disk is unaffected by motion, vibration or shock encountered in aircraft and mobile equipment. Breakers can be had for trip-free or non-trip-free operation, and are availble in three frame sizes with current ratings from 35 to 200 amperes for circuits up to and including 30 volts dc or 220 volts ac. Manufacturer is Spencer Thermostat Co., Attleboro, Mass.

Insulating Varnish

The Watson-Standard Co., Pittsburgh, Pa., has developed a new insulating varnish. Although formulated without the use of critical materials, the new product is intended to equal prewar varnishes. The new product designated by the manufacturer as "V-2315", makes use of available materials without sacrifice of any of the requirements of insulating varnish. The new product is heat-enduring, and is resistant to water, acids and alkali. High dielectric strength.



New Fastener

Elastic Stop Nut Corp. of America, Union, N. J., has acquired world rights to a new fastener which will add to the scope of this company's work in present war production as well as in postwar commercial use. The new fastener is a spring-lock lightweight unit of rugged construction suited for holding engine cowlings of high-speed war planes and for radio equipment, or at any point where a quick-acting vibration-proof, non-rattling fastening is needed.

Marking Fluid

Identification marking fluid is being compounded in twelve different distinct colors by the Dayton Rogers Mfg. Co., 2835 Twelfth Ave., South, Minneapolis, to coincide with arbitrary code system in the average stockroom. The compound may be used on layout work or in inspection departments, for the identification of metal parts, etc. The use of the fluid does not require polishing or finishing of the material to be identified. It is simply brushed on and dries instantly. A remover obliterates part numbers and other identification marks no longer needed. Packed in handy combination brush-in-cover containers for shop use. Ink pads and marking pens are also furnished with this identification material.

Don't make Sensitive Circuits Fight Corrosion too!

Dielectrics for precise electrical instruments must have more than good electric properties—their chemical composition has to be such that they do not promote electro chemical corrosion. Lumarith, cellulose acetate plastic, does not form decomposition products harmful to copper when in contact with current carrying wires and moisture. In film and foil form, it is used as a protective lining for coils, tubes, bobbins and spools. Lumarith, too, can be molded into these and other electrical shapes—in any color, opaque or transparent. Lumarith is tough, resistant to solvents, chip-proof and lightweight.

Write for Celanese Celluloid Corporation's electrical booklet. It will supply you with pertinent facts regarding Lumarith's electrical advantages. Complete data on dielectric strength, resistivity, etc. are included. Celanese Celluloid Corporation, *The First Name in Plastics*, a division of Celanese Corporation of America, 180 Madison Avenue, New York City 16. Representatives: Dayton, Philadelphia, Cleveland, Chicago, St. Louis, Detroit, Los Angeles, Washington, D. C., Leominster, Montreal, Toronto.

Lumarith Plastics in Film . . . Foil . . . Molding Materials and Other Forms

Lumarith*

A CELANESE* PLASTIC

*Reg. U. S. Pat. Off.

250,000 Volt Capacitor

The .02 mfd 250,000 volt capacitor illustrated is the latest type industrial specialty unit. It consists of liquid impregnated capacitors housed in a wet process porcelain tube and filled with a liquid dielectric. The end caps are the Westinghouse solder seal type which act both as a mounting arrangement and terminals. This unit is built for total submersion in salt water and for operation under the severest condition. Voltage

ratings range from 7,500 volts to a quarter of a million volts in single units. Manufactured by Industrial Specialty Co., 1725 West North Ave., Chicago 22, Ill.

Wire-Wound Controls

A new space-saving wire-wound control, Type 43, has been developed by Clarostat Mfg. Co., Inc., 285-7 N. 6th St., Brooklyn, N. Y. This midget control measures 1⅛ in. in diameter by 9/16 in. behind mounting surface. The bakelite body is completely enclosed by the dust-tight metal cap, or by the attached switch. The control virtually matches in both size and general appearance the well-known Clarostat Type 37 or midget composition-element control. The wire winding is curved and held in a concentric slot in the molded bakelite body.

The alloy contact arm presses against the inside surface of the winding. The control is supplied with or without switch, in resistance values up to 10,000 ohms, linear tapers only; and is rated at 1½ watts.

Production Plugs

Developed for use with the Rot[illegible] bridge in testing electronic equipment, [illegible] production plugs are now generally available. Plugs are 5 in. long and [illegible] in diameter, so that the handle will project above the average if trans[illegible]

condenser, making it readily accessible. They have a heavy steel barrel and are fitted with a wooden handle to permit ready removal from socket. All pins are case hardened steel and may be replaced when worn or broken. In both the octal and loktal plugs, the center key extends through in the form of a threaded rod to permit a cable to be fastened firmly in position without strain on pin connections. In addition to the octal and loktal types, these plugs are available in 4, 5, 6 and 7 pin models, small and medium. Manufacturer is Communication Measurements Laboratory, 1[illegible] Greenwich St., New York.

Tiny Fluorescent Lamp

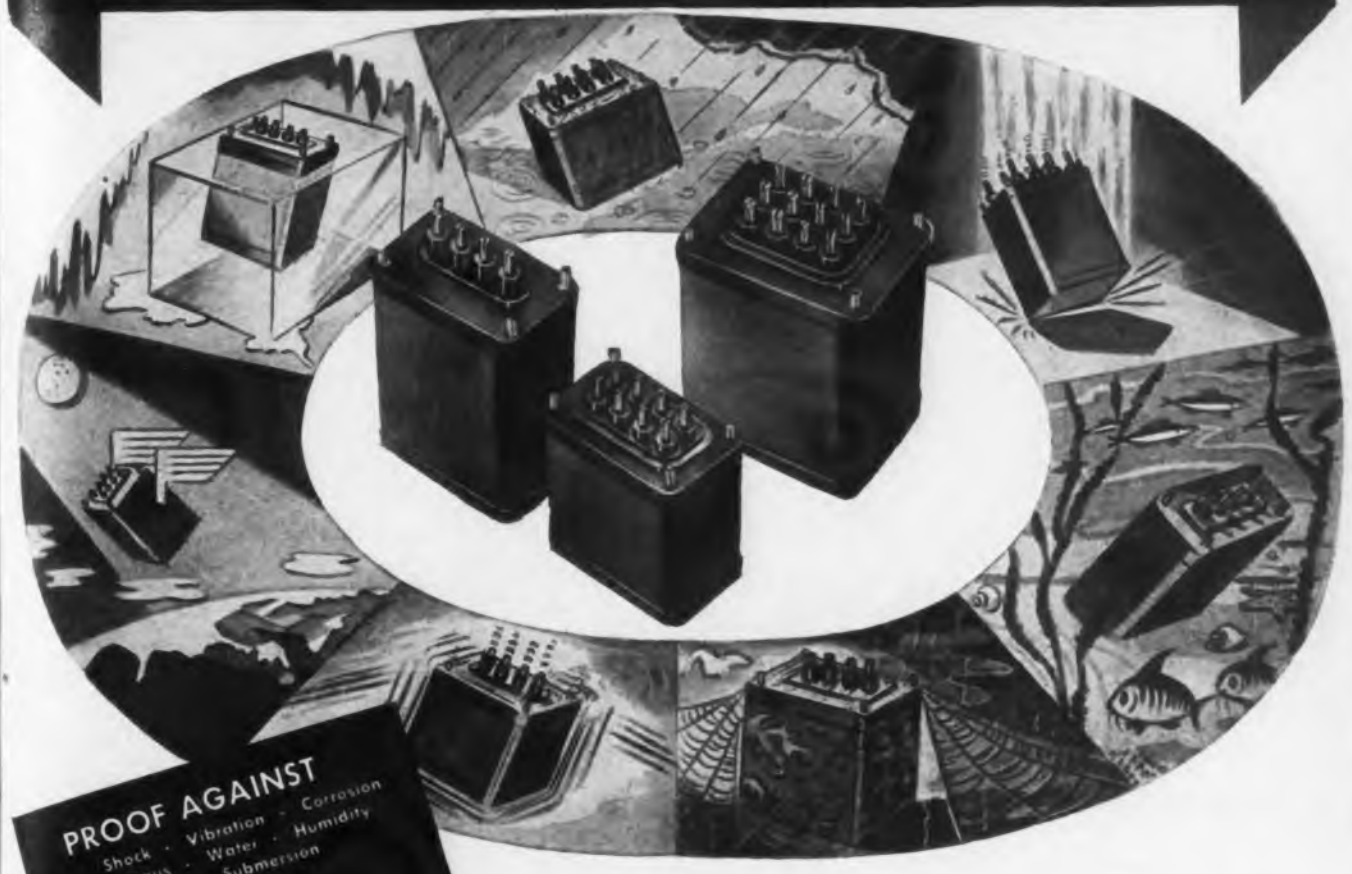
No larger than a marble, a new fluorescent lamp has been developed by Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. For the first time modern fluorescent lamp efficiency has been obtained in a miniature size light source. The lamp contains two spiral electrodes in a gaseous atmosphere. A discharge takes place when about [illegible] volts ac or 140 volts dc is applied across the electrodes. This creates an ultraviolet radiation that is retransformed (at high efficiency) into a green light—accomplished by the phosphor coating on the interior of the bulb. Other colors are possible but green phosphors convert "black light" to visible light most efficiently. A tiny resistor in the lamp base stabilizes current flow after discharge begins.

Ionization Gage

A new Ridenour-Lampson ionization gage control and indicator requires no meter, plate current of the gage tube being indicated by a 6E5 tube both during normal operation and during the outgassing operation. The current in microamperes is read directly from a scale calibrated in 50-scale divisions from 0-100 in which full scale reading may be either 0-2.5, 0-5, 0-10, 0-50 or 0-250 mma depending upon the setting of a range selector. Shadow angle of the eye of the 6E5 can be set reproducibly to about 1/50th of full scale. Provision is made for plugging in a plate microammeter or a protective sensitive relay. Manufacturer is Herbach and Rademan Co., 522 Market St., Philadelphia, Pa.

AMERTRAN HERMETICALLY SEALED TRANSFORMERS FOR 400 CYCLE OPERATION

THE *WORST* BRINGS OUT THEIR *BEST!*



PROOF AGAINST
Shock · Vibration · Corrosion
Fungus · Water · Humidity
Altitude · Submersion

IDEAL FOR
Airborne Installation
Fine Wire Applications

MINIMUM
Weight · Dimensions

FLEXIBLE
Size · Terminal Arrangement

AMER TRAN

Pioneer Manufacturers of Transformers, Reactors and Rectifiers for Electronics and Power Transmission

Anyone familiar with AmerTran test methods will understand why the worst conditions of warfare only serve to bring out the best in AmerTran Hermetically Sealed Transformers. Random units from the production line are constantly subjected to immersion, impact and vibration tests often exceeding in severity those prescribed by the government. Thus, we speak conservatively when we say AmerTran Hermetically Sealed Transformers conform to today's rigid requirements.

Used as transformers, Wave Filters and Reactors in the latest 400 cycle apparatus, these magnetic components may be specified with absolute assurance of dimensional conformance and uniformity. The enclosing cases and terminal boards are die made, meeting close tolerances. In all, AmerTran Hermetically Sealed Transformers are worthy products of a company that has specialized in transformer manufacture for more than forty years.

AMERICAN TRANSFORMER COMPANY
178 EMMET STREET, NEWARK 5, NEW JERSEY

AMERTRAN

Millen Plug

Made in black or red regular bakelite as well as in low loss brown mica, filled bakelite for rf uses, No. 37212 plug, made by James Millen Mfg. Co., Inc., Malden, Mass., has a small circular depression on top for color coding or polarity indication. The plug is designed primarily for use with No. 37222 captive head posts and No. 37202 plates, has standard ¼ in. spacing.

Substitution Sockettes

A complete line of adapter sockettes has been developed by J. F. D. Mfg. Co., 4111 Fort Hamilton Parkway, Brooklyn, N. Y. to permit the substitution of available tube types for types difficult or impossible to get. Adapters are completely wired, largely eliminating the need for re-wiring sets. Adapters include: Loktal to octal; 5-prong to octal; octal to 4-prong; octal to octal; loktal to 5-prong; and others to permit a great variety of substitutions.

Shockproof Relay

Designed for airplane use where the utmost precaution must be taken against unintentional operation Type 17AXX relay will withstand acceleration tests of better than 90 gravitational units. Despite its rugged construction, the relay is small in size, and light in weight. Units of this type are regularly supplied with series coils for any direct current, or with shunt coils for use on 12- or 24-volts dc. The manufacturer is Struthers-Dunn, Inc., 1321 Arch St., Philadelphia, Pa.

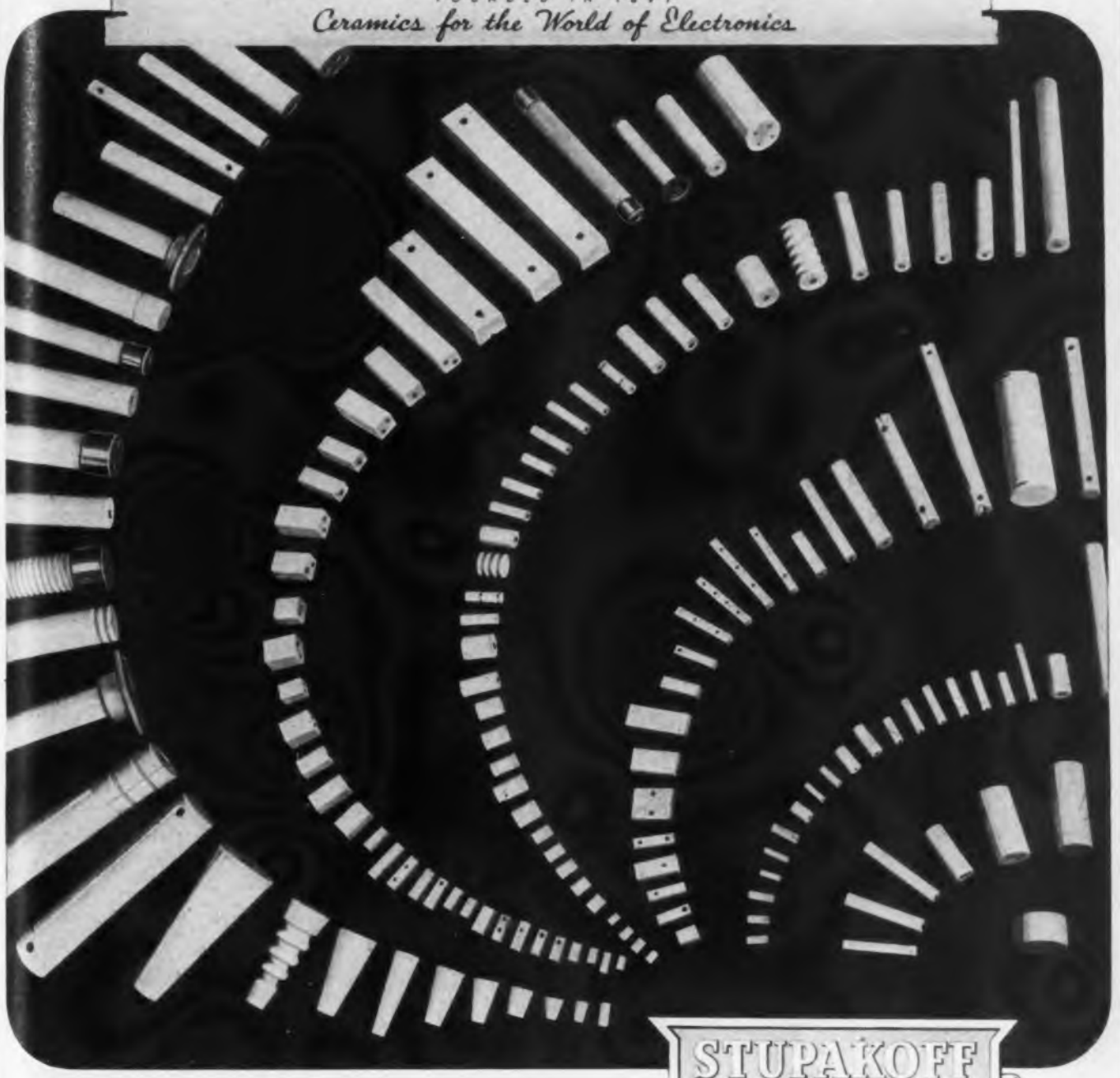
Two-Way Terminals

Developed by Aircraft-Marine Products, Inc., Harrisburg, Pa., the interlocking studs allow two or more terminals to be used on a single stud where there are no barriers to control the positions.

STUPAKOFF

FOUNDED IN 1897

Ceramics for the World of Electronics



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NEW PATENTS ISSUED

FM, PHASE, DIRECTION AND POLARIZATION MODULATION

Direction or Polarization Modulation

It is intended to minimize fading and to receive signals within the dead zone, and further away. Either direction of propagation or direction of polarization of the wave is varied; a transmitter for the former method is illustrated.

The unmodulated output of the oscillator tube 11 is radiated from dipole antenna 13. Dipole antenna 13 lies parallel to the surface of the earth, a quarter-wavelength above it. A similar dipole antenna 23 is placed parallel to antenna 13 and lies one quarter-wavelength from antenna 13 and one quarter wavelength above the surface of the earth; it acts as reflector for the waves radiated from antenna 13, so does the ground. By tuning circuit 24, 25, 26, the reflecting properties of antenna 23 may be controlled and the direction of maximum radiation varied in a vertical plane.

Tube 26 is the tuning element, it is connected so as to operate as capacitance. Its magnitude is controlled by the voltage across resistor 39. Any change in this voltage causes a change in resonant frequency of the circuit and, consequently, in the direction of maximum radiation. With switch 47 in the position shown, audio signals from microphone 42 are amplified and applied to resistor 39 so as to change the direction of maximum radiation from antenna 13 in accordance with the intensity of the audio signals to be transmitted. The different dotted lines in the second figure indicate the paths of maximum radiation at different times.

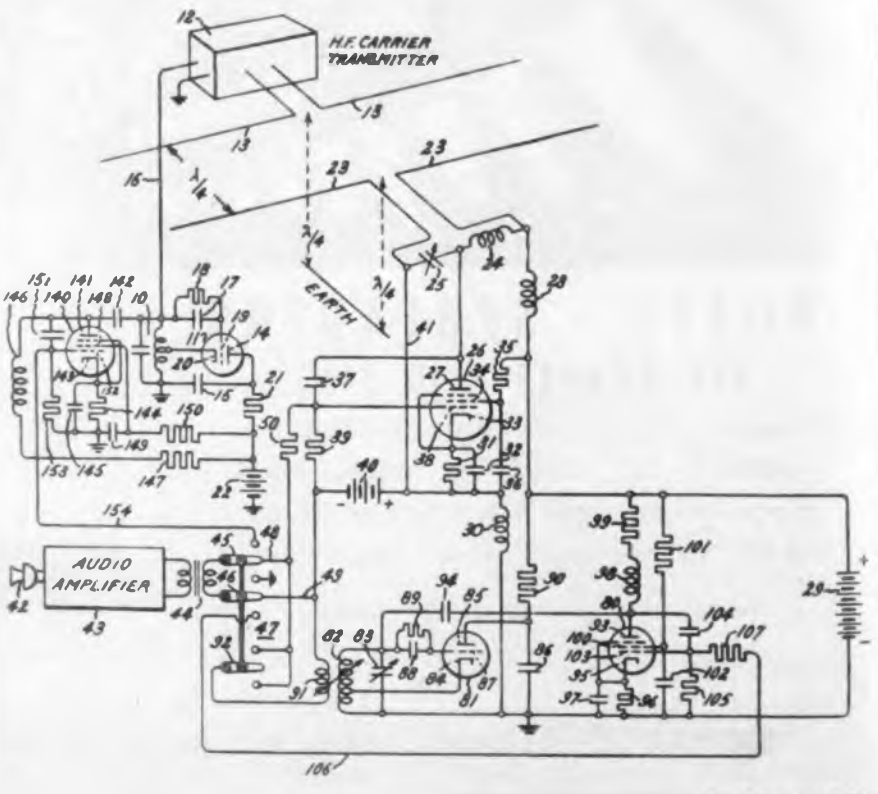
An ordinary AM receiver may be used for reception of these signals, which appear to sweep past receiving antenna 63 for a certain value of audio voltage. Of course, the beam may be swept in a horizontal plane, care being taken in all instances that a reflected beam passes the receiver only once during each sweep.

Alternatively, if switch 47 is moved downward, the beam radiated from antenna 13 will be swept up and down in a vertical plane at a constant rate (for instance, of the order of 20 to 50 kc), when there is no signal from microphone 42; this sweep frequency will be controlled by the audio voltage amplitude. Tube 81 continuously supplies controlling oscillations, the frequency of which is

modulated by reactance tube 80 which has its grid 103 connected to audio amplifier 43. A special receiver designed for this type of modulation is shown; it detects a carrier wave intermittently passing the receiver with a frequency depending on the audio voltage.

A third type of transmission is produced with switch 47 in its upward position. The beam of antenna 13 is swept up and down at a constant rate and the high frequency carrier wave is frequency modulated by varying the voltage on control grid 152 of reactance tube 140 in accordance with the audio voltages as in conventional frequency modulation transmitters. In all instances, the carrier wave intensity is maintained constant to minimize selective fading.

In another method described the plane of polarization of the transmitted wave is varied between a horizontal and a vertical plane in response to the signal intensity. A suitable transmitter circuit is shown and discussed. It has one antenna emit-



Recognition?

THIS ORANGE BOX CONTAINS GOAT ELECTRONIC TUBE PARTS...

Typical electronic tube parts you'll find in GOAT boxes that have been stamped, drawn and formed on GOAT machines, dies and presses.

Wherever electronic tubes are made, you will probably see this orange GOAT box. For GOAT serves almost every electronic tube manufacturer with a tremendous variety of stock and special parts, made of any metal to any specified degree of accuracy. Because of experience gained since the days of radio infancy, GOAT has been able to meet the demands of this industry for greater quality, durability and quantity production. GOAT'S recognition, today, is based on this consistent ability to handle tough jobs requiring skill, precision and efficiency.

GOAT

METAL STAMPINGS, INC.

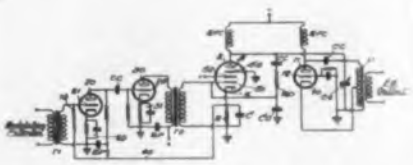
A DIVISION OF THE FRED GOAT CO. INC., EST. 1893
314 DEAN STREET • BROOKLYN, 17, N. Y.

ting horizontally polarized waves and another antenna emitting vertically polarized waves. The intensities of radiation of these antennas are controlled by audio voltages in opposite sense.

Any receiver for amplitude modulation which is more sensitive to waves of one polarization than to the other may be used. Similarly to the three possible modulations of the directional beam, the polarized wave may be modulated in three ways. The second type of modulation consists in varying the frequency at which the plane of polarization changes in accordance with the intensity of the modulating signal; while in the third type of modulation, the plane of polarization is varied at a constant frequency and the carrier wave is frequency modulated. H. W. Kline, General Electric Co., (F) Feb. 21, 1941, (I) Nov. 9, 1943, No. 2,334,011.

Reactance Tube Modulator

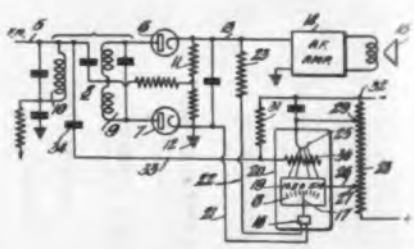
The cathode of the reactance tube 2 is returned to ground through a network RC; C is a complete by-pass at the operation frequency of the oscillator (10, C_4, L_1) but is effective at the modulation frequency so that voltages of modulation frequency and below are developed across R. These voltages are degeneratively fed back by lead 40 and resistor 19 to control



grid 21 of tube 20. Distortion inherent in the audio amplifier tubes 20, 30, and in reactance tube 2 is reduced by the negative feedback. Another embodiment incorporating automatic frequency stabilization is described and claimed. J. A. Rankin, RCA, (F) Dec. 5, 1941, Nov. 23, 1943, No. 2,334,726.

FM Tuning Indicator

Two different visual indications,—corresponding to resonance and off-resonance tuning and to presence or absence of a carrier wave, respectively,—combined in one unit make it possible to distinguish between resonance condition and no signal condition. One indication responds to variation in mean signal frequency and the other to signal intensity. The dc component of the detected signal, which varies in amplitude and polarity with tuning, is utilized to provide one visual indication, in the present example the light pointer 17 of a polarized milliammeter. The scale 18 cooperating with this pointer affords the second indication.

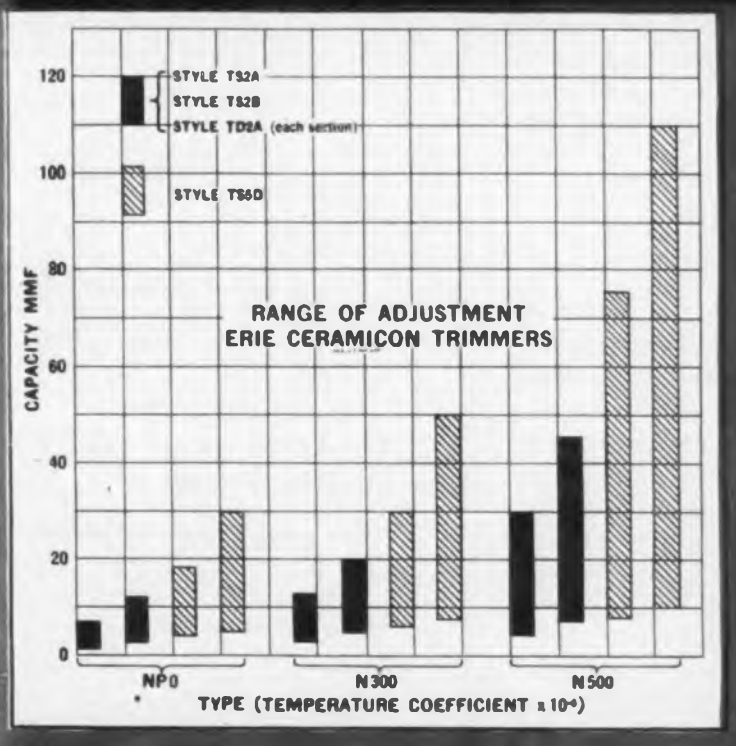


It constitutes part of the plate of indicator tube 20 and is coated with material which becomes fluorescent when bombarded with electrons. Grid 30 controls the electron flow to plate 19; its potential is derived from the incoming signal over coupling capacitor 34. In the absence of a received

Erie Ceramicon Trimmers

Reg. U. S. Pat. Off.

. . . DESIGNED for



- **MAXIMUM STABILITY**
- **EASE OF ADJUSTMENT**
- **WIDE RANGE OF CAPACITY**
- **CHOICE OF TEMPERATURE**

AS shown in the chart above, Erie Ceramicon Trimmers cover the wide range of temperature coefficients and capacities that are in most popular demand.

The three available temperature coefficients, zero, −300 parts per million per °C, and −500 parts per million per °C, provide a choice that covers most practical applications for temperature compensation. The high ratio of maximum to minimum capacity, combined with a low minimum capacity in each of the four standard styles of Ceramicon Trimmers, allows a wide range of applications. The sturdy base, silver-ceramic construction, and soldered connections, assure inherent stability. The rotor of Erie Ceramicon Trimmers is stamped with ℜ for identification. Temperature coefficient and capacity range are also printed on the rotor.

These and many other features are completely described in Erie Ceramicon Trimmer Data Sheets. If you are looking for a high quality trimmer that incorporates temperature compensation in its operation, write for a copy of these data sheets.

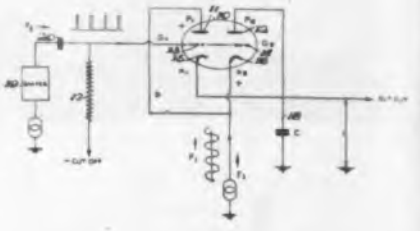
Back The Attack—With War Bonds

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

signal scale 18 is not fluorescent, though pointer 17 is at zero position as it would also be for exact tuning when scale 18 is fluorescent. The two voltages may be connected to any one indicating device which affords two separate indications. W. L. Carlson, RCA (F) Aug. 7, 1941, (I) Nov. 16, 1943, No. 2,334,473.

Phase Discriminator

One of the ac voltages, F_1, the phases of which are to be compared, is applied to plate 11 and cathode 16. The other ac voltage, F_2, is shaped to produce intermittent pulses and these are impressed on the grids 13 and 14 of the twin triodes which are ordinarily biased beyond cut-off. Upon application of a pulse to the



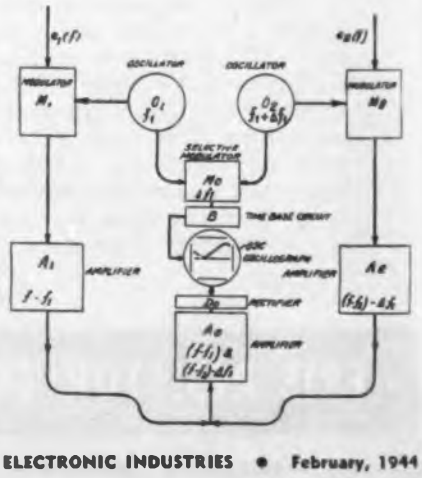
grids, one of the plates will pass current, depending on the instantaneous polarity of ac voltage F_1. A corresponding voltage will be developed across condenser C, its sign and magnitude is an indication of the polarity and amount of phase displacement between the two voltages F_1 and F_2. The voltage across the condenser will remain unchanged until one of the plates again passes current. S. H. M. Dodington, Scophony Corp. of America. (F) July 22, 1942, (I) Nov. 30, 1943, No. 2,335,265.

ELECTRONIC INSTRUMENTS

Measuring Phase Differences

The apparatus indicates the phase difference ϕ between waves e_1 (f) and e_2 (f) of equal frequency f. These waves are modulated with the outputs of oscillators o_1 and o_2 and amplified; the resultant waves may be considered as having the same frequency $f-f_1$, but a phase difference $\phi - 2\pi \triangle f_1 t$, which is a periodic function of time. They are combined, rectified if desired, and applied to one pair of deflection plates of a cathode-ray oscillograph. Frequency $\triangle f$, controls a time base circuit supplying the other pair of deflection plates. The combination wave will have a maximum amplitude if $\phi - 2\pi \triangle f_1 t$ is an even multiple of π and a minimum if it is an odd multiple

(*Continued on page* 204)



THE TYPE 26-B *Loudspeaker*

Type 26-B Loudspeaker equipped with two Jensen U-20 Drive Units. When so equipped will handle safety power input of 40 watts. Weight 23 lbs.

Type 26-B Loudspeaker equipped with single Jensen U-20 Drive Unit. When so equipped will handle safely power input of 20 watts. Weight 22¼ lbs.

THE Type 26-B Loudspeaker is designed for voice reproduction when used by itself. It is also excellent as the high frequency component of a wide range loudspeaking system. One Type 26-B Loudspeaker provides uniform sound distribution both as to frequency and power over a horizontal angle of 120° and a vertical angle of 40°. Made of one piece cast aluminum. 22" wide, 14½" deep, and 20" high, including Drive Unit and Adapter. Supplied with heavy universal mounting bracket. Complete specifications upon request.

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SOUND REINFORCEMENT AND REPRODUCTION ENGINEERING

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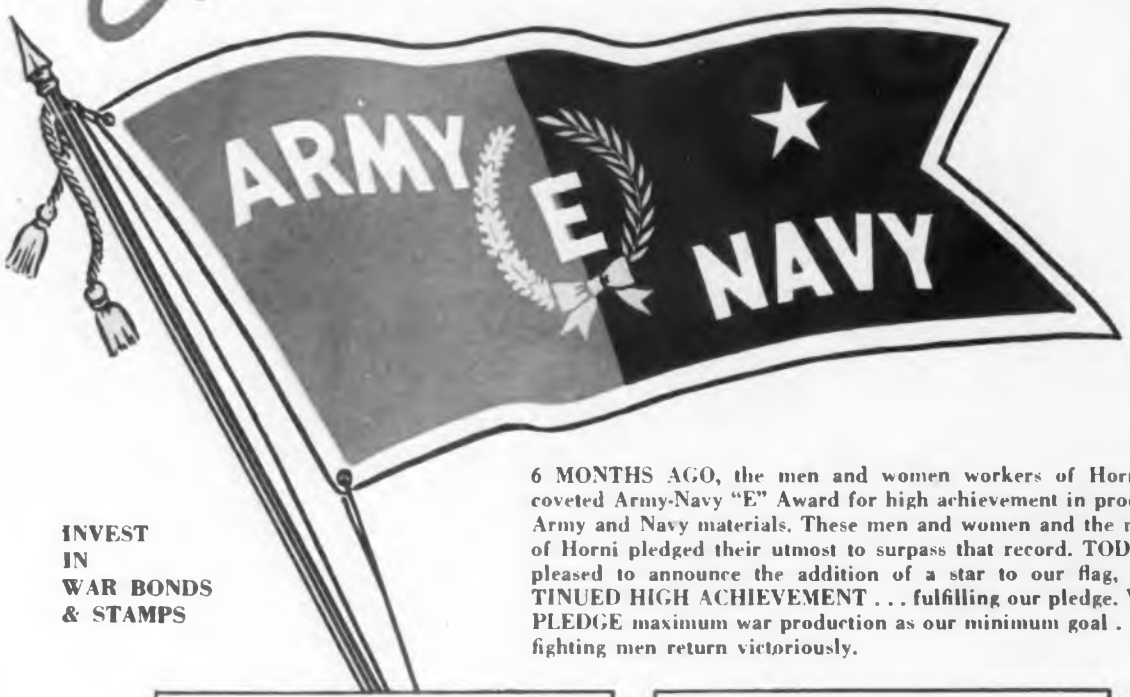
FOR *Continued* HIGH ACHIEVEMENT



INVEST
IN
WAR BONDS
& STAMPS

6 MONTHS AGO, the men and women workers of Horni won the coveted Army-Navy "E" Award for high achievement in producing vital Army and Navy materials. These men and women and the management of Horni pledged their utmost to surpass that record. TODAY, we are pleased to announce the addition of a star to our flag, FOR CONTINUED HIGH ACHIEVEMENT . . . fulfilling our pledge. WE AGAIN PLEDGE maximum war production as our minimum goal . . . until our fighting men return victoriously.

WAR DEPARTMENT
ARMY SERVICE FORCES
OFFICE OF THE CHIEF SIGNAL OFFICER
WASHINGTON

4 October 1943

Mr. Paul P. Horni, President,
Horni Signal Manufacturing Company,
New York, New York.

Dear Mr. Horni:

In talking recently with the Commanding General of one of our Mediterranean Theatre Army Corps here on a short trip, he impressed upon me the urgent need of mine detection equipment of the (Censored) type. This equipment provides us a direct means of saving the lives of our soldiers.

I noted your fine production results of (Censored) in September and hope the men and women of Horni will continue to put everything you have into production this and the coming months. The need is urgent, and the more sets you produce, the less will be the pain and anguish of our fighting troops overseas.

Sincerely yours,

H. C. Ingles

H. C. Ingles,
Major General,
Chief Signal Officer.

WAR DEPARTMENT
OFFICE OF THE UNDER SECRETARY
WASHINGTON, D. C.

28 August 1943

To the Men and Women
of the Horni Signal Manufacturing Corp.
310 Hudson Street
New York, New York

I am pleased to inform you that you have won for the second time the Army-Navy Production Award for meritorious services on the production front.

You have continued to maintain the high standard that you set for yourselves and which won you distinction more than six months ago. You may well be proud of your achievement.

The White Star, which the renewal adds to your Army-Navy Production Award flag, is the symbol of appreciation from our Armed Forces for your continued and determined effort and patriotism.

Sincerely yours,

Robert P. Patterson

Robert P. Patterson
Under Secretary of War

The Horni organization appreciates the understanding and cooperation of the many municipalities, regarding their own needs for the duration.

Horni

HORNI SIGNAL MANUFACTURING CORP.
NEW YORK, N. Y. **NEWARK, N. J.**


HORNI SIGNAL MANUFACTURING CORPORATION
SUPPLYING OUR ARMED FORCES

These are OUR weapons

● Never before in history has a war been fought with cathode ray tubes, transmitting tubes, quartz crystals, tungsten wire, X-ray equipment and other electronic devices.

But these weapons are convincing the enemies of peace that the days of reckless war-making are over. On the battlefronts, on the oceans, and in the skies all over the world, these new weapons are saving lives and winning battles for the United Nations, and bringing confusion, consternation and defeat to the enemy.

We who make NORELCO electronic products are doubly proud of these new weapons because, in addition to helping to win the war today, they are among the devices that will build a new and better world tomorrow.

For our Armed Forces we make Quartz Oscillator Plates; Amplifier, Transmitting, Rectifier and Cathode Ray Tubes for land, sea and air-borne communications equipment.

For our war industries we make Searchray (X-ray) apparatus for industrial and research applications; X-ray Diffraction Apparatus; Electronic Temperature Indicators; Direct Reading Frequency Meters; High Frequency Heating Equipment; Tungsten and Molybdenum in powder, rod, wire and sheet form; Tungsten Alloys; Fine Wire of practically all drawable metals and alloys: bare, plated and enameled; Diamond Dies.

And for Victory we say: Buy More War Bonds.

Norelco

ELECTRONIC PRODUCTS by

NORTH AMERICAN PHILIPS COMPANY, INC.

Executive Offices: 100 East 42nd Street, New York 17, New York

Factories in Dobbs Ferry, New York; Mount Vernon, New York (Metalix Division); Lewiston, Maine (Elmet Division)

MEMO TO J. Smith chief engineer RE: Heating non-metallic materials with "Cold heat"

Westinghouse Thermo-electronic equipment

Jim: this is any non-metallic material like plywood, paper, plastic etc.

electron getting batted around 10,000,000 times a second by radio frequency field -- and that makes him hot!

300°F. throughout material

Jim: This Westinghouse development may be the answer to our heat-curing problems. Imagine putting stuff like plywood between two plates, and heating it uniformly to 300 deg. F. in 3 minutes, with radio waves!

This thermo-electronic heating equipment generates heat uniformly throughout the material—like the "artificial fever" you read about. Best of all, there's no overheating of the outside surface and underheating in the center.

This cuts heating time as much as 95%, they claim, because you don't wait for heat to penetrate to the center—it's already there! This speeds up chemical reactions, too.

As I understand it, Jim, there are some limitations. Some materials with low "heat loss factor" like hard rubber just won't heat as fast as others. Size of surface and degree of dryness required from wet materials are other limiting factors. But aside from these, I think we should check into this. Why don't you give this thing a look?

Joe

J-08055

Bendix Streamlines Pacific Coast Radio Div.

Bendix Aviation, Ltd., North Hollywood, Calif., producer of aircraft radio and hydraulic equipment, is now operating as the Pacific Division of Bendix Aviation Corp. The change-over from Bendix Aviation, Ltd., organized seven years ago by Bendix Aviation Corp. as a California corporation, will affect only administrative and legal considerations. Palmer Nicholls, has been made a vice-president of the parent company. He and Mel M. Burns will continue as executives in the new division, operations and personnel remaining unaffected. Principal reasons for the change are to streamline corporation activities and to avoid confusion which has existed because of the similarity in names of Bendix Aviation, Ltd., Bendix Aviation Corp., Bendix Products and other Bendix subsidiaries.

Philips Completes Removal

Offices of three of the Philips companies have been consolidated and now are located at 100 East 42nd St., New York. Executives and staffs of the wire, electronic tube, quartz crystal and Elmet divisions have been transferred from Dobbs Ferry, N. Y., though purchasing department and all production personnel will remain there. The industrial electronics equipment division, now at 419 Fourth Ave., has moved to the new location, as has the Philips Metalix Corp., the factory remaining at 896 South Columbus Ave., Mt. Vernon, N. Y. Philips Export Corp. has moved from the Hotel Roosevelt, the warehouse remaining at 437 Eleventh Ave., N. Y., and the service department at 40 Cedar St., Dobbs Ferry, N. Y.

RFC Money for 100 Plants

Defense Plant Corporation, subsidiary of RFC, has financed 100 plants doing radio and scientific work, according to Secretary of Commerce Jesse Jones. Last spring the number was 54, the bill being $60,000,000. Present commitments are up nine million and a little more.

ANEPA Cuts Staff

The Army-Navy Electronic Production Agency has dropped nearly one-third of its staff, as compared with the middle of 1943. The reduction amounts to about 50 per cent in the Washington headquarters personnel, and 28 per cent in the field staff.

Speed Made Reeves VP

Hazard E. Reeves, executive vice-president, Reeves Sound Laboratories, 62 W. 47th St., New York 19, N. Y., announces the appointment of William C. Speed as vice-president in charge of manufacturing. Mr. Speed, who has, since the organization of the Reeves company, been identified with crystal production, is a director of the company as well. He is also vice-president of Audio Mfg. Corp., Stamford, Conn., and New York. Prior to his present work, Mr. Speed was associated with the Vitaphone Corp., Paramount Studios, Paris

Harper with Haines

S. M. Harper, one of the deans among manufacturers' representatives, is now general manager and chief engineer of the Haines Mfg. Co., Brooklyn, N. Y., manufacturer of laboratory apparatus and high-frequency heating equipment.

Salinger at Farnsworth; Henroteau Added to Staff

After a year's absence devoted to specialized instructional work at Indiana institutions, Dr. H. Salinger has returned to Farnsworth Television & Radio Corp., Fort Wayne, Ind., and will take up active work in that company's research laboratories. At the same time, Dr. Francois C. Henroteau has been added to the Farnsworth research staff. Dr. Henroteau was for 14 years, chief of the astrophysics division of the Dominion Observatory in Ottawa and is well known for his astro-physics and television research work.

Dr. H. Salinger who has returned to research duties for Farnsworth

HARNESS FOR A MODERN . . . WAR HORSE . . . . .

The ignition harness can well be described as an airplane engine's nervous system. One of Connecticut Telephone and Electric Division's latest war assignments is the production of this assembly for the manufacturer of a world-famous aircraft motor.

"Connecticut" war production also includes military field telephones, head sets, switchboards, electronic devices and special ignition parts.

A pioneer in communications and ignition systems, this division of Great American Industries, Inc. is geared for advanced engineering and manufacturing of precision electrical parts and equipment. When you are planning electrical or electronic improvements in your postwar products or manufacturing methods, our development engineers are ready to offer constructive help.

VICTORY AND JOBS AFTER VICTORY

depend on holding the line against inflation. Never bid up a price; never buy what you don't need; make war bonds your investment in tomorrow.

CONNECTICUT TELEPHONE & ELECTRIC DIVISION

MERIDEN ★ CONNECTICUT

Power Tube Division Added by Machlett

Machlett Laboratories, Inc., which has its home office in Springdale, Conn., has opened a power tube division in Norwalk, Conn. Machlett is the pioneer producer of X-ray tubes in this country, and for a number of years has been a leading source of supply of tubes for the X-ray equipment industry here and abroad.

The production of X-ray tubes demands the utilization of an assortment of specialized skills and talents which extend considerably more deeply into the fields of glass fabrication, metallurgy, and high-vacuum technic than do other conventional branches of electronics. The reason lies in the fact that X-ray voltages (50,000 volt upward into the millions) are so much higher than those heretofore encountered in most electronic devices. However, many of the new applications now being developed under pressure of wartime needs are based on the use of elevated voltages, thus imposing sharp new requirements on tubes for their operation.

Apply X-ray tube technic

To get some of these devices out of the laboratories into large-scale use in the field has been largely a problem of tube production. By the application of X-ray tube production technic to this problem, Machlett Laboratories have demonstrated remarkable capacity in relieving this bottleneck.

The beginning was made in their Springdale plant, but the need for additional facilities to be devoted specifically to the production of tubes other than X-ray types soon became apparent, and led to the establishment of the plant in Norwalk. Work on the new plant was started late in 1942, production on a pilot scale was started in the Spring of this year, and full-scale production of several badly-needed tube items for the U. S. Signal Corps and the British Air Commission has been in progress for some time.

Machlett Laboratories have indicated that they expect the added laboratory facilities and additional production capacity to enable them to develop and make available still more advanced types of X-ray tubes after the war. They also expect to offer a comprehensive line of tubes of the high-power, high-voltage and ultra-high-frequency varieties.

Westinghouse Men Move

Editorial Service of Westinghouse Electric & Mfg. Co. has been moved to the Park Building, Pittsburgh. The new address is 306 Fourth Ave.

FIGHTING COMPONENTS *for* FIGHTING EQUIPMENT

B & W COILS *and* ANTENNA TUNERS *for the Hallicrafters-built* SCR-299

In the vanguard of invasion, you'll find the SCR-299 Mobile Radio Unit built by Hallicrafters—and, in this famous unit, you'll find B & W's specialized facilities well represented.

Standard B & W Air Inductors with rugged, armor-type construction take competent care of all amplifier plate coil requirements. Not only is the complete Antenna Tuning Unit a product of the specialized B & W facilities for electronic equipment production, but B & W engineers collaborated closely with Hallicrafters on its design and construction details.

Proud of their part in the SCR-299, B & W engineers welcome similar assignments where the utmost in performance, ruggedness, and dependability are prime considerations.

AIR INDUCTORS • VARIABLE AIR CONDENSERS
ELECTRONIC EQUIPMENT ASSEMBLY

B&W

BARKER & WILLIAMSON
235 FAIRFIELD AVENUE. UPPER DARBY, PA.

Exclusive Export Representatives: Lindeteves, Inc., 10 Rockefeller Plaza, New York, N. Y., U. S. A.

MICHIGAN'S FM STATE POLICE SYSTEM

(*Continued from page 95*)

All transmitters in the Michigan State Police system are phase-modulated. A pair of 7A8 balanced modulators produces approximately a 400 cycle phase upset of the output of the crystal oscillator. This, when multiplied 32 times throughout the following quadrupling stages, produces a 15 kilocycle deviation each side of center carrier frequency.

Fixed transmitters

Two sizes of fixed station transmitters are in general use in the system. For the smaller areas, 50 watts output is used, while the larger produce 250 watts. Both are now standard Motorola FM transmitters and need no further description with the exception that they were specially constructed to allow installation of two receivers to facilitate reception of split frequency operation.

At the outset of the program, after the engineering and design requirements were standardized and specifications created, the state police engineers started the tremendous task of field surveying each location to determine what was needed in the way of power, antenna height, and location, so as to cover adequately each area two-way with the patrol cars, and to furnish reliable point-to-point communication between East Lansing and the district headquarter stations.

At each survey the initial objective was to cover the area with a minimum amount of power in order to lessen sky-wave or skip interference as well as interference between network stations.. Actual test communications were conducted at each proposed antenna site with portable equipment. Field measurements were taken and the height of the antenna tower thereby computed. The actual location of the tower was dependent upon the noise level.

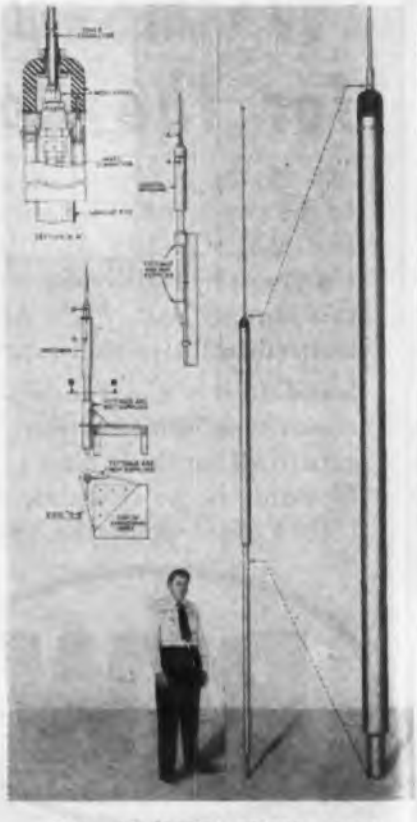
In many cases the station was built five to ten miles from the control point, at great expense, involving property procurement and control line rental, in order to insure perfect coverage. An attempt was made in each instance to increase the antenna height or improve the location, rather than increase the power output. A coaxial antenna is used at all stations and is fed by ⅞ in. concentric, gas-filled transmission line.

Due to the long distances of communications from Michigan's patrol cars, as much as 50 to 60 miles in many places, it was decided to standardize upon a power output of 50 watts for all mobile transmitters. This transmitter uses a pair of 807 tubes in the output stage and, when using the receiver power to supply current to stages preceding the final amplifier, a power output of 60 or 65 watts is realized. This also has now become a standard Motorola mobile transmitter.

All mobile antennas are ¼ wave roof-top-molybdenum steel rods mounted through the center of the top upon a coiled spring which allows them to strike obstructions without damage. They are fed with Copalene concentric transmission line. Due to a slight mismatch between the transmission line and antenna, standing waves appear upon the line which result in points of high and low impedance. For this reason, the length of the line is critical and it must be terminated at an impedance slightly higher than its characteristic impedance to match the base of the whip.

All mobile units are first mounted upon a piece of ¾ in. treated plywood covered with copper screen. This, in turn, is floated in rubber mounts on bolts which have been electrically welded to the floor of the trunk compartment. This method has proved superior to screwing the base plates directly to the metal floor, especially from a water damage standpoint.

All fixed stations operate upon a frequency of 37,500 kilocycles, while mobile units transmit on 37,380 kilocycles. This split frequency



Type of coaxial antenna used in Michigan FM police system

Motorola

INSTALLED THE STATE-WIDE 3-WAY F-M POLICE RADIO SYSTEM FOR THE STATE OF MICHIGAN

STATE OF MICHIGAN COMPLETELY COVERED

45 CENTRAL STATION TRANSMITTER - RECEIVER UNITS AT POLICE POSTS THROUGHOUT THE ENTIRE STATE OF MICHIGAN

REMOTE STATION HOUSING TRANSMITTER AND DUAL RECEIVERS AT BASE OF ANTENNA TOWERS

260 PATROL CARS USING 50 WATT TRANSMITTERS AND 2 CRYSTALS FOR DUAL-CHANNEL 3-WAY OPERATION

Write for Our New F-M Communication Equipment Booklet

GALVIN MFG. CORPORATION · CHICAGO

operation for a system of this magnitude has advantages, particularly in that at no time can another fixed station cover up the weak signals from a mobile unit which may be operating at the area fringe. It does, however, eliminate car-to-car transmissions due to the fact that all mobile receivers are tuned to 37,500 kc, while transmitters operate upon 37,380.

Each fixed station is equipped with a switch which allows the operator to cut off his 37,500 kc fixed station receiver which is at the transmitter remote location. This leaves only the output of the mobile receiver on the control line and greatly facilitates copying a mobile unit with a weak signal. This is seldom used, however, for all mobile receivers are adjusted with higher audio gain which results in mobile signals predominating over fixed station transmissions.

As car-to-car transmissions may at times be highly important, Michigan has installed the extra 37,500 kc crystal in each car, which may be switched into the circuit by a small push-to-hold switch mounted upon the control head at the driver's fingertips. As the two frequencies are but 120 kilocycles apart, the various tank circuits in the transmitter are able to follow this frequency change with but little loss in efficiency. Reliable car-to-car transmissions are possible over distances up to 20 miles, and even beyond, when one of the cars seeks a more favorable location from which to operate.

Little interference

In spite of the unusually large number of stations operating in the Michigan system, all on one frequency, very little interference is encountered. In the Detroit area, for example, four class B stations (250 watts of power and 200 ft. towers) operate within a 40-mile radius, all able to cover Detroit's highly industrial area. Ten to twelve patrol cars operate out of each station, without interference from any one of the other stations. At all times they can communicate with any one of the other stations. However, when their own station transmitter comes on the air, it completely obliterates the other three. This is due to the well known characteristic of FM, in which the strongest signal takes control. This again calls for a comprehensive study in the design, antenna location, and height, as well as the power output of any multi-station system. As long as a 2 to 1 power ratio is maintained, no loss of communication will result from other transmitters in the system.

This immediately creates a reason for single frequency operation

MEDIUM TANK, M-4
PHOTO BY
US ARMY SIGNAL CORPS

BUTTONED DOWN *and ROLLING*

Rolling all over the world. Hitting the enemy where it hurts him the most, covering infantry, scouting, fighting. Fighting and talking. Talking by radio to coordinate all in a pattern of Victory.

NATIONAL COMPANY, INC.
MALDEN, MASS.

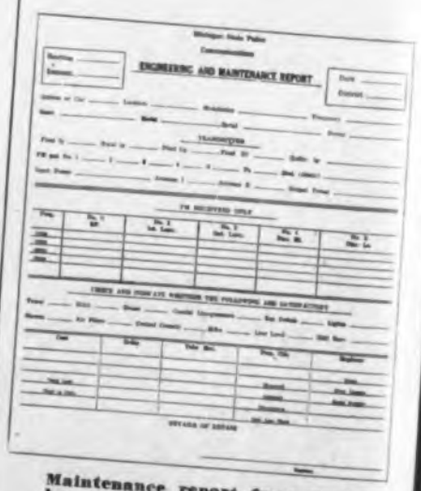
for not only state systems but all stations in a county network or a city network which will definitely eliminate, once and for all, the isolated communication problem we have at the present time by the adoption of separate and random channels of communication by adjacent county or city instrumentalities.

The Michigan State Police has a program now underway whereby all new city and county FM installations are adopting the frequency of 33,100 kilocycles. This is resulting in a city and county network that is highly mobile and efficient in combating rapidly moving criminals. It provides constant emergency communication to all mobile units which may, when necessary, leave their own area and travel in other sections of the state so equipped. It further provides simplification of the State's monitor and communication problem with these county and city agencies. Under this system only one receiver operating on 33,100 kc will be required in each state station; whereas, at present they are compelled to install as many receivers as there are frequencies in operation.

System operation

The entire radio system revolves around the headquarters station at East Lansing. Here there is a five thousand watt amplitude modulated transmitter on 1642 kc, a 500 watt radio telegraph transmitter for inter-state traffic and the 250 watt FM transmitter for two-way communication. At Houghton Lake there is another five thousand watt AM transmitter and at Paw Paw a 1000 watt unit. These serve as relay points for the East Lansing station.

The hub of the system is the dispatch office, manned twenty-four hours a day by uniformed dispatchers with many years' experience in the police field, civilian



Maintenance report form used by Michigan field engineers

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telephone operators, radio operators, and clerks.

For administrative purposes the state is divided into eight districts. In each district is a district headquarters station which has supervision over from 1 to 7 sub-stations. The headquarters dispatch office at East Lansing has direct contact with each district headquarters with the exception of district number 8 which is reached by relay through Houghton Lake. Thus it is fairly simple to route traffic from sub-station to district headquarters and thence to dispatcher. Information going back to a sub-station may follow the same channels or go direct over the 1642 kc network. Many of the sub-stations are heard at East Lansing so that much of their traffic can be handled direct, with the district station copying for record purposes.

Traffic routing

The dispatch office is a supervising agency with full authority, as well as a coordinating office and information center. The dispatcher's authority over all movement of mobile equipment is absolute and can be questioned only by the Commissioner or the superintendent of the uniformed division. With this authority goes also a very large measure of responsibility and for that reason great care is used in the selection of this personnel.

All traffic coming to or going from the dispatch office must go over the dispatcher's desk. Here records are compared on thousands of file cards which are constantly being made, revised, or cancelled. The information gained through these operations is passed on to other departments as the case may indicate.

The dispatch office has access by telephone to all state departments in Lansing. The records on automobile and operator licenses are available 24 hours a day and in an emergency the dispatcher can locate practically any state official needed. The files of the record bureau, identification bureau, detective bureau and other headquarters offices of his own department are accessible to him at any hour when an emergency demands.

Car spotting

A large map of the entire state is maintained in the dispatch office upon which the movements of cars are recorded. For this purpose the state is divided into patrol areas, each distinguished by a letter and number. As cars go out on patrol from their various stations the dispatch office is notified by radio and these car numbers are pinned on the map at the appropriate location. The dispatcher

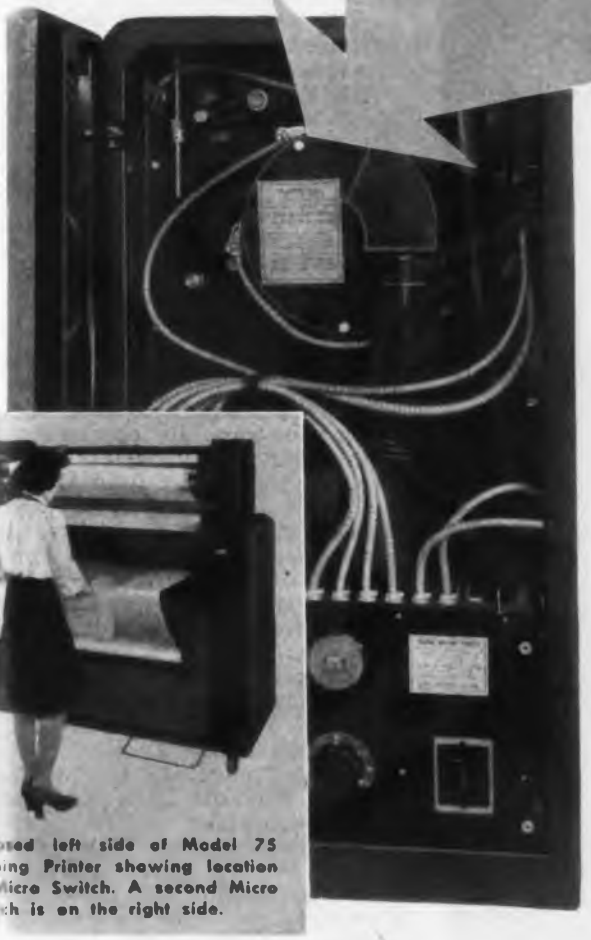
Charles Bruning Company Uses Two

Micro Switches

to Provide Utmost Protection

to Operator of Bruning Printers

Thumb screw holds down plate and actuates Micro Switch



Exposed left side of Model 75 Bruning Printer showing location of Micro Switch. A second Micro Switch is on the right side.

The basic Micro Switch is a thumb-size, feather-light, plastic enclosed, precision, snap-action switch, Underwriters' listed and rated at 1200 V.A., at 125 to 460 volts A.C. Capacity on D.C. depends on load characteristics. Accurate repeat performance is experienced over millions of operations. Wide variety of basic switches and actuators meets requirements varying from high vibration resistance to sensitivity of operating force and motion as low as 2/1000 Oz. In. Many types of metal housings are available.

Charles Bruning Company of Chicago are the manufacturers of Bruning Printers and Developers, widely used by engineers and draftsmen in every branch of industry. Bruning Printers, which produce black and white prints, are compactly built to do a big job in small space.

The thumb-size, feather-weight Micro Switch is a natural complement to such a design, and the Charles Bruning Company uses two Micro Switches to provide utmost protection to the operator.

The two Micro Switches are located at each end of the Bruning Printer to make it impossible to remove the end plates, which shield the quartz lamp, while the lamp is still burning. This is accomplished by so locating the thumb screws, which hold the end plates in place, that they cannot be turned without actuating the Micro Switch and automatically disconnecting the power from the quartz lamp.

This use of Micro Switch by the Charles Bruning Company is typical of the varied applications in which this small, compact, precision switch is filling the needs of industry. Wherever space is at a premium, wherever small movement and small energy are vital factors in design—Micro Switch has come to be recognized as the one precision switch that will best meet all requirements.

Micro Switches represent a distinct saving in engineering expense over the cost of specially-designed switches. They insure a better product because they are absolutely dependable for millions of accurate repeat operations. The basic Micro Switch is no larger than your thumb—11/16" x 27/32" x 1 15/16". It weighs only an ounce.

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therefore knows the approximate location of all state police cars at all times when they are on patrol.

The dispatcher's desk is in the center of a large room, with the switchboard office and the radiotelephone and radiotelegraph rooms opening from it. It is set up in duplicate so that two officers can operate it at one time, each having ready access to all controls and telephones. There are also a third and fourth position which have access to the telephones.

The dispatchers can broadcast on either the FM two-way system or the one-way AM or on both at one time. Or one can be operating the FM while the other is putting out an emergency dispatch to all cars and stations on the 1642 kc transmitter. Ordinarily the radio operator handles most of the traffic on the 1642 kc system, but when seconds count, as they quite often do in this work, the dispatcher uses that method for the first broadcast. The operator copies and repeats.

The East Lansing post of district No. 1, located in another building, uses the same FM transmitter that is used in the dispatch office. Duplicate control consoles answer this requirement and it is seldom, if ever, that both offices really need to go on the air at the same time.

Engineers' duties

In order to maintain this vast system of communication, a field engineer is assigned to each engineering district. He operates out of the district headquarters station servicing from 6 to 8 fixed stations and 40 to 50 mobile units. Each engineer is supplied with a two-way equipped automobile and a complement of testing equipment including tube testers, oscillators, meters, frequency excursion indicators, as well as complete frequency measuring equipment.

All equipment, both mobile and fixed, is checked and the frequency measured at least once every two months. An engineering report is filled out after each such routine check and is sent to engineering headquarters at East Lansing, where it is carefully tabulated for cost and the use of expendable parts. Thus, through this system, any unit which is costing too much becomes immediately apparent, and the Chief Engineer may order it removed from service and sent to the East Lansing laboratory for analysis.

A two-man tower crew is employed the year around to maintain the 45 radio towers and the 10,000 ft. of ⅞ in. gas-filled coaxial transmission line. They have a specially designed truck equipped with a winch and all necessary tower maintenance materials.

As the communications channel map indicates, some point-to-point

ELECTRONIC INDUSTRIES is published under wartime conditions in conformity with all government regulations controlling the use of paper and other materials

Paper tonnage used in this issue is actually less than that used in our small initial issues of 1942, the base year for computing paper quotas.

ELECTRONIC INDUSTRIES' paper stock is lighter in weight and its dimensions are smaller because this magazine is conforming with the spirit as well as the letter of the government regulations. These regulations, while uniform in principle, do not affect all business magazines alike, being applied to publishers rather than to individual magazines.

Having published only its first three issues in 1942, ELECTRONIC INDUSTRIES has had an unfavorable base which makes its present paper usage less than that of an older contemporary. When paper restrictions are removed, ELECTRONIC INDUSTRIES will return to its former standards of paper quality, weight and page size.

The Publishers

circuits operate successfully over distances as great as 180 miles. This is not just a fortunate happenstance but the result of sound equipment and system engineering and an understanding of propagation of the ultra-high frequencies, which today are giving better communication than low frequency amplitude transmitters using twenty times the power output.

The results of careful pre-installation planning and engineering are amply repaying the State of Michigan. Coverage and point-to-point circuits of communication perform in exact accordance with the original specifications created on paper at the outset. Two-way mobile communication is absolutely solid up to and including their minimum requirements of 40 miles from fixed stations. Where this radius, by necessity, had to be increased to handle a larger area, careful thought, planning, and engineering made it a reality.

Additional plans are underway to make the state headquarters at East Lansing even more capable of complete supervision. A 400 ft. tower has been erected at a remote location, free from man-made and electrical interference. Present indications are that coverage from this antenna will be exceptionally good and that the value of the entire system will be substantially increased.

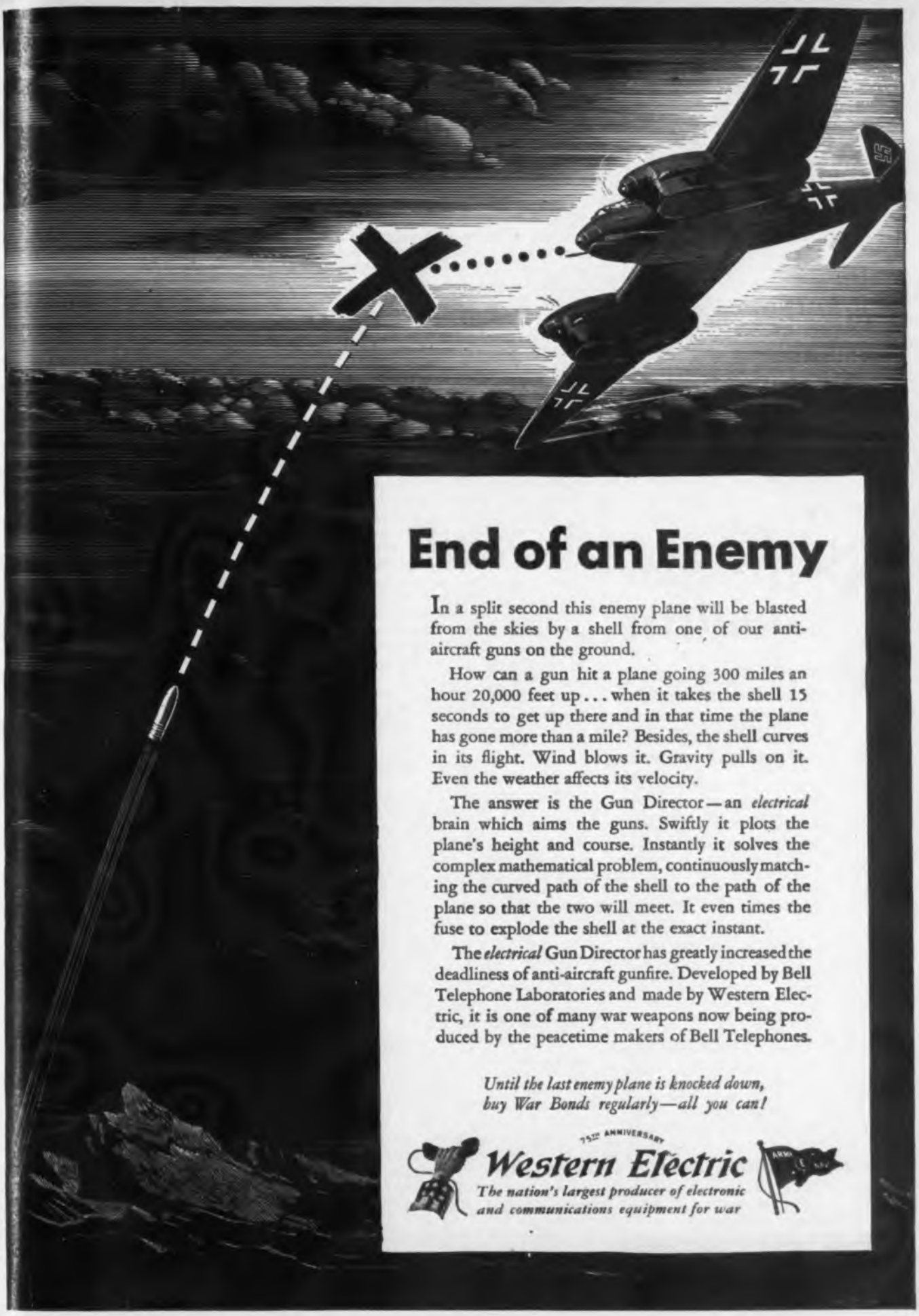
Editor's Note — Oscar G. Olander, State Police Commissioner, has directed this program from its inception. Captain C. J. Scavarda, Communications Officer of the Department, and Chief Dispatcher William W. Bouck have been responsible for the immediate supervising of all activities. All technical and engineering details have been handled by Chief Engineer Frank W. Walker. Professor Daniel E. Noble, Director of Research for the Galvin Mfg. Co., Chicago, collaborated on technical design.

HF HEATING

(Continued from page 83)

has been established, we can then check our assumption of a value of power factor, and allow a factor of safety for voltage determined by conditions. For instance, voltage should be lower than shown for wood gluing operations where squeezed-out glue will reduce the breakdown voltage; higher frequency is then indicated. The feasibility of the application is immediately determined from the standpoint of generating equipment.

This determination of power and frequency is made as simple as it is by the assumption of constant power-factor with frequency. Published tables of this quantity for a wide variety of materials, as well as measurements in our own labor-



End of an Enemy

In a split second this enemy plane will be blasted from the skies by a shell from one of our anti-aircraft guns on the ground.

How can a gun hit a plane going 300 miles an hour 20,000 feet up . . . when it takes the shell 15 seconds to get up there and in that time the plane has gone more than a mile? Besides, the shell curves in its flight. Wind blows it. Gravity pulls on it. Even the weather affects its velocity.

The answer is the Gun Director—an *electrical* brain which aims the guns. Swiftly it plots the plane's height and course. Instantly it solves the complex mathematical problem, continuously matching the curved path of the shell to the path of the plane so that the two will meet. It even times the fuse to explode the shell at the exact instant.

The *electrical* Gun Director has greatly increased the deadliness of anti-aircraft gunfire. Developed by Bell Telephone Laboratories and made by Western Electric, it is one of many war weapons now being produced by the peacetime makers of Bell Telephones.

Until the last enemy plane is knocked down, buy War Bonds regularly—all you can!

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atory, show that it is always useful for the purpose of making an estimate of the feasibility of a dielectric heating application. Borderline cases—that is, where the problem requires frequencies near the limit of present-day generating equipment—demand further investigation, usually in the form of experiment, to arrive at a final decision.

The simple multiplications and divisions involved in computing operating parameters for a dielectric heating application can most easily be carried out on the nomographic chart which has been prepared for the purpose.

Two disturbing factors enter into many dielectric heating applications, namely, water and air. The first makes the power requirement higher than calculated from the specific heat of the material, even when present in small percentages. It is often necessary to raise the temperature well above the boiling point; under this condition a moisture content of 10 per cent will double the power requirement if the material is porous enough to allow the complete escape of the water. Although the presence of water raises the power factor and thereby reduces the number of load circuit kwa required, this effect is almost always over-balanced by the increased kw requirement. When water is present in localized regions in the material, it may cause an uneveness in heating that will vary in magnitude according to the manner in which the wet spots enter into the electrical field.

Effect of dampness

To generalize, it may be said that when the damp region is essentially in shunt with drier parts, the excess power taken by it tends to equalize temperature rise, whereas a layer of high moisture content in series with a layer of low moisture content may well cause overheating of either. An instance of the first case occurs when a laminated wood structure is heated with the lines of electric flux extending parallel to the plane of the boards: here relatively dry boards and wet glue lines are in a parallel relationship as far as current flow goes, and more power is absorbed by the glue. This may be sufficient to raise the temperature of the glue more rapidly than that of the wood until the water is boiled out of the glue line, after which power absorption swings over to the wood and at elevated temperatures, say 275 deg. F. practical equality of temperature will exist.

On the other hand, it is possible, if proper precautions are not taken in certain drying operations to produce wet and dry layers in series relationship as regards current flow, with the dry layer taking more than its share of the power. One case of this went to the extent of producing a red hot surface on a block of asbestos-like material while the core remained damp and cool. Such a condition is far from typical of drying by rf, but is mentioned to illustrate what may be encountered.

Getting power in

Air enters into the dielectric heating picture because of its effect on maximum operating voltage. It usually is necessary that the condenser plates extend to or beyond the edge of the block being heated, so that breakdown between the electrodes is determined by the dielectric strength of the air. We are much more limited as to voltage if a series air gap becomes necessary. For dielectric materials of low power factor, say below 10 per cent, the gradient in the air gap is proportional to the square root of the dielectric constant;

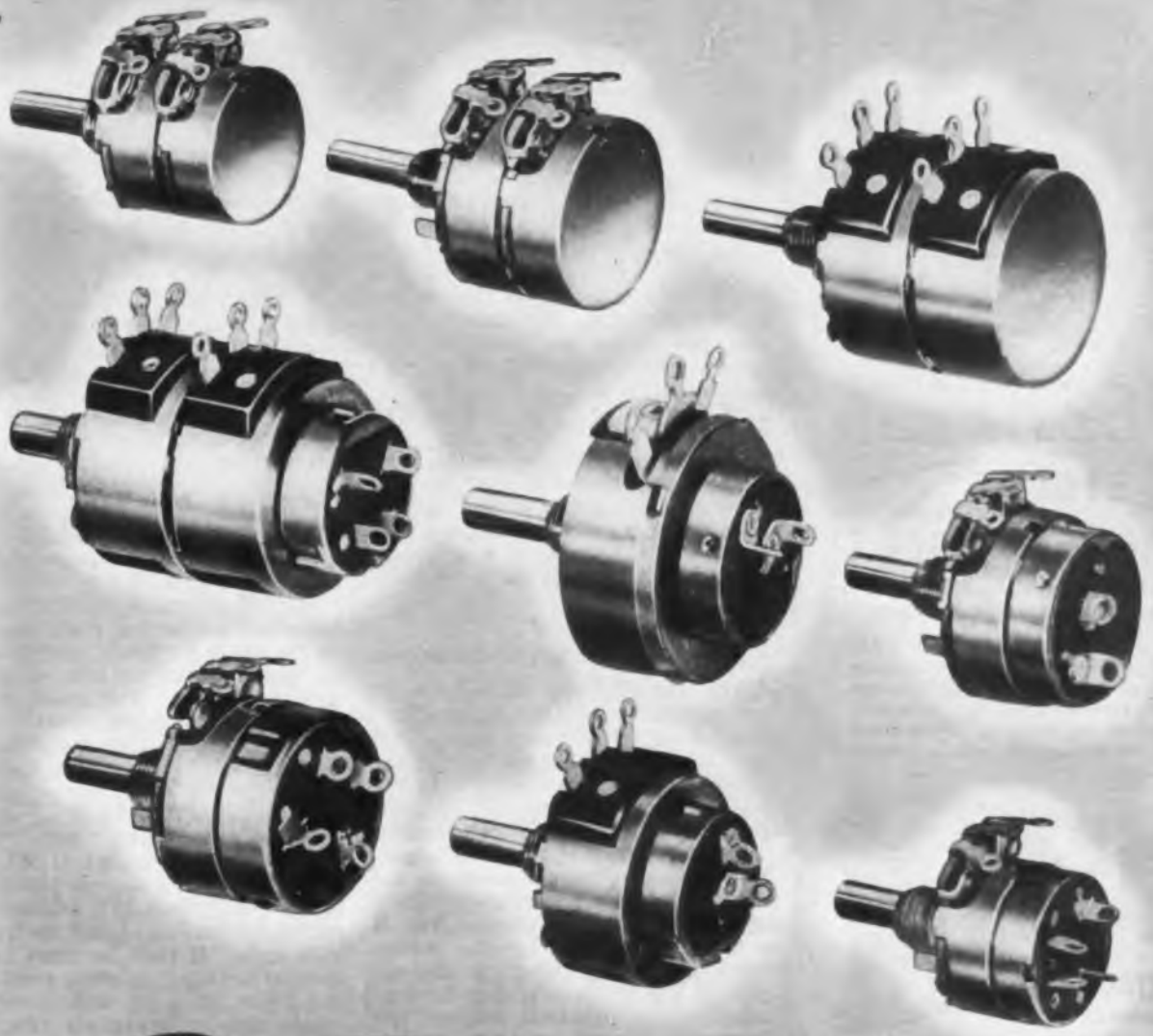
$$\frac{E_a}{d_a} = .84 \times 10^6 \times K^{\frac{1}{2}} \sqrt{\frac{\text{Watts/cu. in}}{\text{P.F.} \times \text{F.}}}$$

whereas for dielectric heating with plates in contact with the work, the gradient is inversely proportional to the square root of the dielectric constant. The ratio of the gradients in the two cases is then seen to be the dielectric constant.

Tight coupling required

The problem of getting power into dielectric materials becomes one of feeding a capacitive load of a power factor ranging between wide limits and of a value of capacity that may vary from a few micromicrofarads to several thousand. The generator proper consists of a vacuum tube oscillator operating at plate voltages of, say, 5,000 or 10,000. Where the voltage required at the load is below the plate voltage, tight coupling to the tank circuit, either by the mutual between the tank coil and a secondary or pickup coil, or by direct coupling to a tap on the tank coil, and parallel resonating of the load capacitor, offer the simplest means consistent with flexibility. Series resonating of the load when the capacity is small is generally used when an rf load voltage higher than plate voltage is required. Quarter wave lines or equivalent networks for impedance inversion and matching are also useful.

Turning now to heating of conducting materials, we will recall that the statement was made that a high degree of localization could



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be obtained. This is made possible by the attenuation suffered by alternating magnetic fields in conductors, and is a function of the electrical characteristics—resistivity and permeability—of the material, and of frequency.

As in the heat flow problem, our thinking can be much simplified by reducing the problem of calculating the penetration of varying flux inward from the surface of a conductor to a line problem, the equivalent line consisting of the inductance per unit length and the shunt conductance per unit length of the material. We then have a line containing one reactive component per element of length and one resistive, just as we had in the case of the heat flow analog. The transmission characteristic can then be expected to be similar, and because the interchange of position from shunt to series of the reactive element cancels the change in its sign, the attenuation and phase shift constants turn out to be identical in form.

Frequency requirements

The steady state solution is all we need to know here, so substitution of values of series inductance and shunt conductance in the expression for attenuation yields the penetration depth, as usually defined, by solving for the case when the attenuation equals one neper. The frequency requirement for induction heating applications is now apparent: if the magnetic flux is entirely dissipated in the metal, there will be as complete absorption of the incident energy as possible. As a practical matter, the frequency should be high enough so that the penetration depth is small compared to half the thickness of the piece being heated.

It is of interest to note what happens to the penetration depth in the induction heating of steel for hardening. The temperature to which it is necessary to go to harden is so high as to raise the resistivity almost ten times while the permeability is falling to that of space. Between the two effects a ten to thirty times increase in penetration depth occurs. At a megacycle, actual values for steel are 1.5 mils at room temperature and fifty mils at temperatures above the Curie point. The value of penetration depth given for the cold steel is based on the full value of permeability.

In hardening by the self-quenching process, the power concentration may be as high as 500 kilowatts per cu. cm. This throws an interesting sidelight on the role of hysteresis losses. If we take the Steinmetz coefficient of hysteresis loss for an ordinary steel and apply it to a calculation of loss per cu. cm. for saturation value of magnetization, we get a maximum value of hysteresis loss of something like five thousand watts per cu. cm., or one-half of one per cent of the total. It becomes evident then, that we are dealing with eddy current heating only. The conclusion to be drawn as to the effective permeability is that it is practically unity, and our calculations of penetration depth should be modified accordingly, to yield a value of five to ten mils for steel at room temperature, at a megacycle.

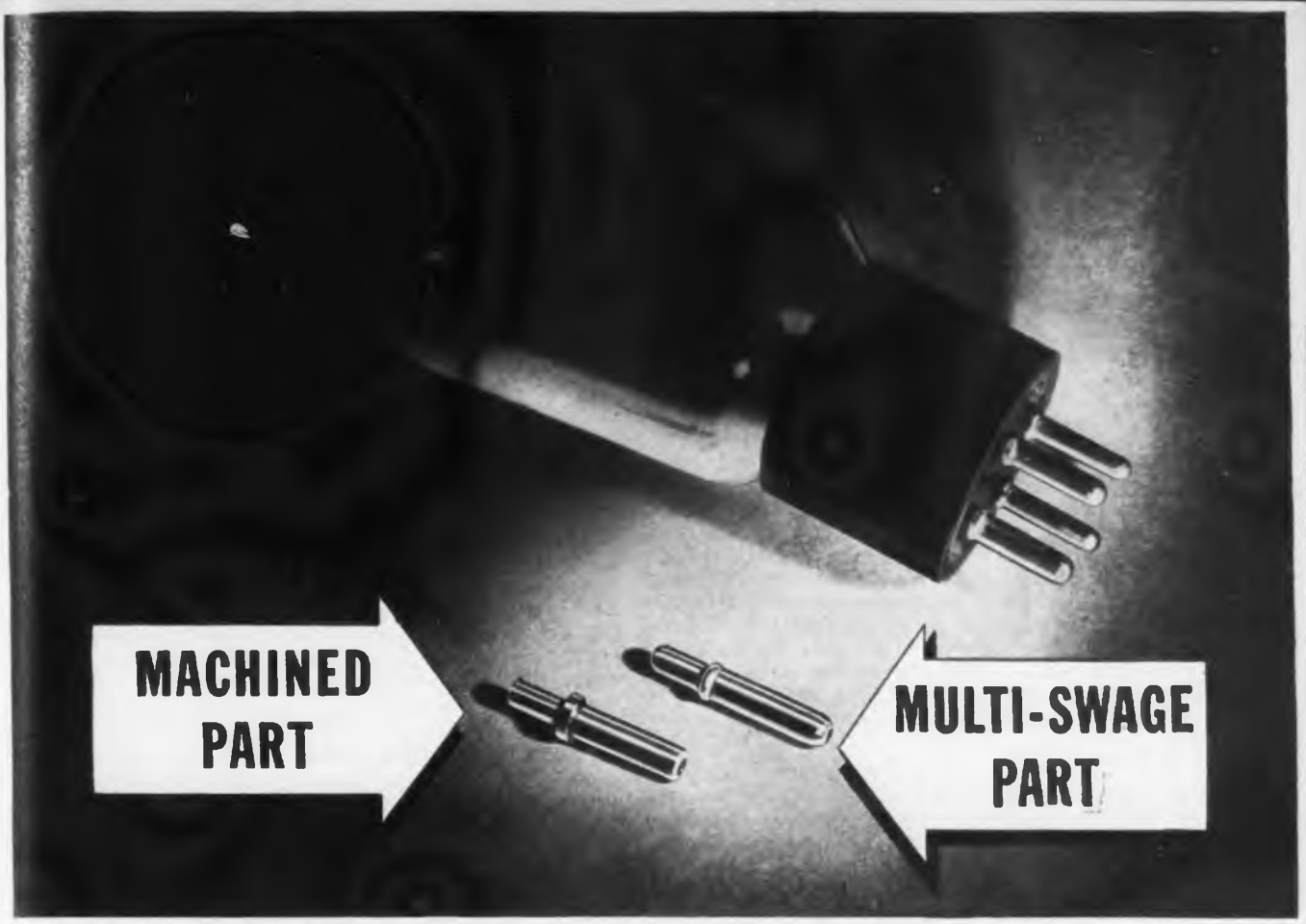
The effect of frequency on distribution laterally of the current under an inductor cannot be estimated by the simplifying procedure of reducing it to a line problem; it must be treated as a field problem and therefore remains correspondingly complicated. It can be said, however, that the penetration depth is the scale factor that applies, so that frequency enters in a square root relation.

For experimental confirmation, a series of hardening tests was run on samples of plain carbon steel at two frequencies: one-tenth and one megacycle. The chief results of these tests show that at the higher frequency, full hardness can be obtained down to a thickness of five mils, but that the minimum thickness obtainable at .1 mc. is something like twenty mils. From the power requirement of 500 kilowatts per cu. cm., or 10,000 per sq. cm. of surface, it is evident that not many sq. cms. can be treated at a time. It then becomes necessary to heat only a small portion of the piece at once, and cover the whole area progressively (Fig. 3).

Depth of hardening

This particular application of induction heating, that is, surface **hardening** by self-quenching, makes necessary the use of frequencies in the range between .1 and 1 mc. Other surface treatments make similar demands on frequency to obtain the desired results. Heating plated surfaces, for example, to improve the quality of the plate, can be done at these frequencies without unduly disturbing the base metal. The use of higher frequencies for limiting the heating to thinner layers cannot be expected to achieve the desired results without markedly increasing the power concentration above that already obtained.

Although it is not meant to imply here that a limit has been reached in this direction, it is true that voltage breakdown of the air between the inductor coil and the work is the limiting factor and rather special means will have to be taken to go much farther. Of course, where the dimensions and electrical characteristics of the



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ORIGINALLY, electronic tube contacts were machined out of solid rod of a section as large as the largest diameter of the finished piece. The center hole was drilled out. When made by the Bead Chain "Multi-Swage" Process, contacts are automatically swaged from flat stock. As no machining or drilling are required, there is no waste from cutting down or drilling. Therefore the economy of "Multi-Swage" is considerable.

Savings of over seventy-five percent in the cost of finished contacts has been realized by electronic tube manufacturers through the use of "Multi-Swage" parts. Assembly, also, proved less costly. Any number of "Multi-Swage" contacts can be staked-in simultaneously.

It is well worth your while to see if the small solid or hollow cylindrical metal parts you are using can be made by the "Multi-Swage" Process. Our Research and Development Division will gladly work with you. Plan to have the parts of your post-war products made by "Multi-Swage."

These are typical "Multi-Swage" products. This process will turn out large volume speedily while maintaining close tolerances accurately.

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WASHINGTON

Latest Electronic News Developments Summarized by *Electronic Industries'* Washington Bureau

LAST LAP—The Army Signal Corps and the Navy have asked the electronic-radio manufacturing plants to race their production at the greatest speed possible, as if they were runners on the last lap, to secure during this first half of 1944 the apparatus and equipment needed for the projected European invasion. Yuletide holidays and the "flu" attacks caused a setback in the month by month gains in deliveries which had been achieved in such magnificent fashion by the industry during the last half of 1943. Therefore, since production had picked up during the past three weeks of January, the months of February and March are all-important.

POSTWAR ACTIVITIES—Military authorities, charged with the responsibility of placing the vital electronic-radio apparatus in the hands of the fighting forces, are sympathetic with the manufacturers' blueprinting of their conversion schemes during off-work moments. But a few manufacturers, behind with their Army-Navy deliveries, have been reported as having engaged in actual negotiations on post-war sales of apparatus. This is unfair to the other companies.

CRACK DOWN?—The military authorities could well "crack down" on such recalcitrant manufacturers. Lack of adequate electronic-radio equipment may well mean loss of American lives—two years ago, it was "too little, too late," which should not be repeated.

CONTRACT TERMINATIONS—The Baruch-Hancock blueprint for a standard form of a fixed-price war contract termination clause will aid manufacturers in their postwar planning by letting them know what they uniformly may expect in present and future cutbacks. The 6 per cent ceiling for profit on termination claims with reimbursement for items of operating costs like depreciation, research, engineering development, advertising, special tooling, etc., generally is felt to be fair treatment.

BLUEPRINT DETAILS—The War and Navy Departments and other Government procurement agencies are slated to follow up this blueprint with detailed regulations. The Baruch-Hancock report was important enough for the Radio Manufacturers Association to transmit its full text to all member companies.

COMPONENTS' BOTTLENECK—For the Army and Navy and the WPB Radio and Radar Division it has been just one headache after another, or maybe call them "bottlenecks." Now the cycle of troubles has turned away from the subcontractors to the prime contractors who at present have not been placing their orders fast enough among the components' manufacturers. Thus the prime contractors, at least many of them, now have a larger backlog of piled-up orders than the component subcontractors. Six months ago it was the other way around.

ALLOCATIONS EXPERT—The designation of Chief Engineer E. K. Jett as FCC Commissioner not only is one of the few appointments to that Commission in which qualifications and knowledge were the measure but also is most important to the electronic-radio industry because it places on the FCC a man thoroughly versed in the problems of postwar frequency allocations.

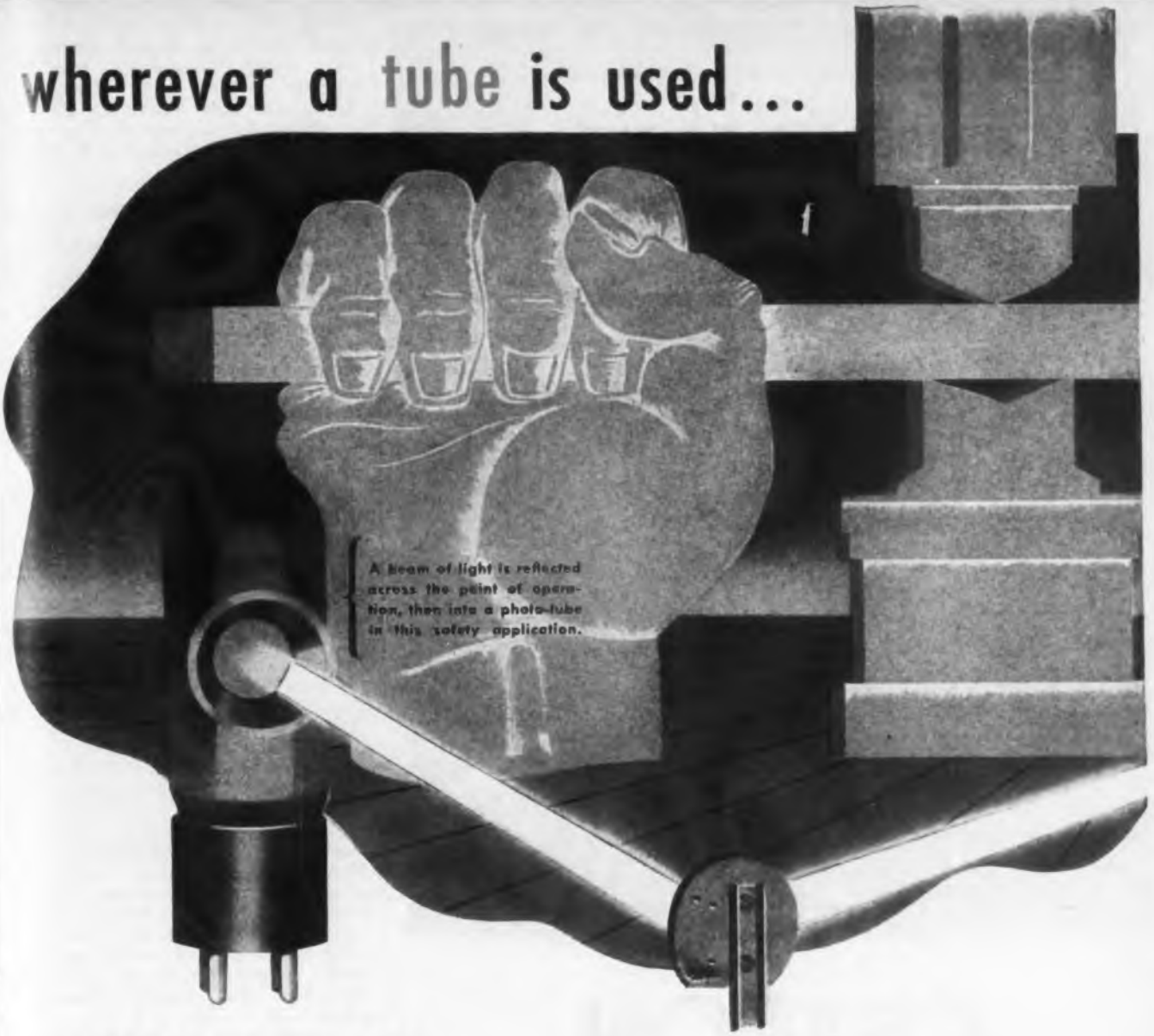
CLOSE COLLABORATION—Mr. Jett has been a leading figure in allocations of radio wavelengths at a number of international conferences and for the domestic spectrum. Incidentally, the Interdepartment Radio Advisory Committee which handles government frequencies is collaborating more closely with industry on the latter's postwar needs than ever before.

TEMPORARILY RETARDED—The invasion military needs are coming first. Therefore, the recent program to provide half a million radio tubes for civilian receiving sets has to stand aside for the time being and these tubes are not yet being distributed to the retail market except in driblets. After the pressing military requirements have been fulfilled, the civilian tube manufacturing situation will be greatly relaxed. The problem was under discussion at meetings of the WPB Radio Tube Industry Advisory Committee on Feb. 3 and the Radio Tube Distributors Committee will take it up on Feb. 10.

MICA CUTBACK—Because of famine and political unrest in India, the principal source, the WPB has announced that allocations of good stained and better quality mica for capacitor manufacture for 1944 have been revised downward to 85 per cent of the average consumption during the first nine months of 1943—it may go lower as the situation worsens. Mica requirements over the 85 per cent allowance must be obtained from lower qualities, WPB officials stated. India has been the major supplier of high grade mica for several years, and is contributing about 95 per cent of all mica for the war needs of the Allies.

MISCELLANY—An unfortunate newspaper criticism of the WPB Radio and Radar Division's Labor Advisor Harold Sharpe of the CIO UERMWA has been rectified as untrue; this able union official has been most valuable in solving the industry's manpower "headaches." —Baruch soon is scheduled to formulate broad government policies on disposition of military surplus apparatus and materials; Jesse Jones likely to head this program; no concrete plans yet in sight for electronic radio equipment as Army and Navy need all for pending offensives.—**Roland C. Davies, Washington Editor, National Press Building.**

wherever a tube is used...



THERE'S A JOB FOR

Relays BY GUARDIAN*

Where makeshift mechanical devices rudely thrust your workers' hands and fingers away from punching and forming dies, the electron tube in combination with a relay offers definite advantages for safer power press operations.

Instantly responsive, dependable and simple—a beam of light, if broken or modulated, actuates the electron tube; the relay breaks the circuit and locks the controls in the "off" position until the full light beam is restored. Typical of relays which may be used in conjunction with such a photo-tube safety application, is the Series 5 D.C. Relay by Guardian. In hundreds of other ways—especially in your postwar developments—*wherever a tube is used there's usually a job for Relays by Guardian.*

*** Not limited to tube applications but used wherever automatic control is desired for making, breaking, or changing the characteristics of electric circuits.**

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

GUARDIAN ELECTRIC

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metal being heated demand it for good efficiency, higher frequency may become necessary. However, calculation of the penetration depth will show that even so poor a conductor as carbon has only a 1/16-in. penetration at a megacycle.

Coupling to load

The problem of coupling between generator and load becomes, on the basis of the consideration just outlined, one of obtaining sufficient concentration of flux to localize the heating to the desired degree. Normally this concentration will not exist in the inductive element directly associated with the tube; the amount of positive reactance needed in the oscillator circuit proper being of such a value that, the permeability of space being what it is, several feet of wire are needed. Voltage and current carrying considerations make this reactance take the form of a coil of copper tubing ¼-in.—1 in. in diameter and something of the order of ten to twenty ft. long, wound up into a single layer solenoid.

To bring the field of a coil like this down to the point where it is concentrated in the region immediately about a ring of metal ⅛ in. wide by 2 or 3 in. in diameter requires something differing from the usual coupling scheme. The device found most useful for this kind of work is the current transformer, consisting of a broad sheet of copper wrapped as closely around a ten to twenty turn coil as voltage limitations will permit. A coupling coefficient of 75 per cent or better is obtained and the need for tuning of the secondary circuit is eliminated.

The elimination of tuning capacitors in the secondary circuit has two advantages: the difficulties involved in carrying the high secondary currents, which may reach a value of over a thousand amperes at powers of 100 kw, are limited to the inductor coil and leads, and there is no need to follow the changes in reactance of the secondary circuit that accompany the rise in temperature of the work. When the total heating time is less than a second, this latter advantage becomes very considerable.

Inductor forms

The inductor coil itself consists of one or more turns of copper tubing, bent to shape or machined out of a solid block of copper and provided with a channel capable of carrying up to three gallons per minute of cooling water, depending on the power level. For heating objects in a continuous process, as on a conveyor belt, one or more inductor rails on each side of the belt can be used, cross connected at the

This Aircraft Relay Is a Military Secret

...But Here Are the Clues to Its Better Performance

In wartime, we can't mention names or tell the story in full. But the facts are not without significance, even with many details omitted.

One of the first types of aircraft relay to be accepted for military use was equipped with Mallory contacts. As planes improved, and greater performance was demanded, the relay needed further development. The manufacturer needed a better material—and, being pressed for delivery, he needed it fast.

Thanks to Mallory engineering research, it was possible to recommend a new material manufactured by an entirely new metallurgical process —Elkonite* G-12. When this was backed with Mallory 3 Metal, the improved specifications were met. Production was started without a moment's delay *because previous development had paved the way.*

Like the relay manufacturer of this story, many design engineers prefer to consult Mallory *first* —often while plans are still on the drawing board. They've learned that Mallory engineering saves time and money: that it frequently anticipates tomorrow's trends. Why not bring your next problem to these same engineers who, for over a period of twenty years, have earned for Mallory the name of "Contact Headquarters."

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ELECTRICAL CONTACTS AND CONTACT ASSEMBLIES
NON FERROUS ALLOYS, POWDERED METAL PARTS

ends of the current transformer so the current is carried up one side and down the other, (Fig. 4). In any case, the inductor must be accurately made if even heating is to be obtained. For surface hardening this requirement is especially rigid, because, in order to concentrate the power to the necessary degree, a spacing of 1/32 in. must be maintained with a maximum variation of ±5 mils allowable if uniformity of case is to be had.

Efficient inductor

An example of an inductor design that meets the requirements for good efficiency is shown in the current transformer and inductor assembly of the rf rivet detonator (Fig. 5). The problem was to couple inductively to the rounded head of an aluminum alloy rivet. The outside diameter of the rivet head is ¼ in., and, to get tight coupling the current had to be led in a circular path less than ⅛ in. in radius, with the additional requirement that the inductor and leads be rigid enough to withstand the application of some 50 lb. pressure.

R. A. Bierwirth of the RCA Laboratories produced the design illustrated, which is essentially an edge-wise wound strap of copper making a complete circular loop at the small end. Lead inductance is kept at a minimum and tight coupling to the head further assured by cupping the end of the coil to the radius of the rivet head. The anodic film on the rivet head serves as electrical insulation between inductor and rivet. The reason for heating the rivets is to detonate an explosive charge in the rivet which serves to expand the far end. They are used for "blind fastening," where access can be had to only one end of the rivet. These rivets are a development of the DuPont Co.

Propeller molding

Wartime requirements and the factors involved in meeting them as quickly as possible have largely determined the equipment development program to date. Because of our ability to supply converted rf transmitting equipment in the 15 kw power range immediately, we were able to render assistance to the aircraft industry in accelerating ordinary gluing operations as well as the curing of compregwood airplane propellers. The latter are propellers for variable pitch assemblies made of laminated wood impregnated with phenolic molding resins. Before molding, the preform is about 9 in. thick at the hub, and heating to the curing temperature by steam-heated die is a tedious process. By pre-heating to within 40 or 50 degrees of the curing temperature, the overall time of the molding cycle has been cut from 8 or 9 hours to 4 hours and, as

A NEW PLASTIC*

*1421 CAST ROD

FORM AVAILABLE

Cast Rod — Maximum length—10"

PHYSICAL PROPERTIES

COLOR— pale yellow to water white

MACHINABILITY—good, similar to brass

SPECIFIC GRAVITY— 1.04–1.06

IMPACT (Dynstat)— .07–.08 ft. lbs.

FLEXURAL STRENGTH— (Dynstat) 7500–10,000 lbs./sq. in.

WATER ABSORPTION— less than 0.1% in 24 hrs.

DIELECTRIC CONSTANT— 2.4 to 2.5

POWER FACTOR— .0006–.0009

SOLVENT RESISTANCE—Generally insoluble in most solvents but swells in aromatic hydrocarbons.

The General Electric Plastics Divisions have developed a new material with unusual characteristics. This new plastic has the ability to withstand very high temperatures without melting. It has high dielectric strength, low power factor, and low dielectric constant. This material has been successfully used for applications in the radio industry where other plastic materials have proved unsatisfactory. For further information write section 0-248, One Plastics Avenue, Pittsfield, Mass.

Hear the General Electric radio programs: "The G-E All-girl Orchestra" Sunday 10 P.M. EWT, NBC. "The World Today" news, every weekday 6:45 P.M. EWT, CBS.

GENERAL ELECTRIC

PD-248

BUY WAR BONDS

mentioned earlier, a better product obtained.

By designing specifically for rf generating purposes, a substantial reduction in size, as compared to modified transmitting equipment, was achieved in the RCA 15-B generator (Fig. 6).

In the field of more conventional molding than that of the compreg-wood propellers, a large number of applications can be handled at considerably less power, so a 2 kw unit has been found useful (Fig. 7) A generator of this size serves to preheat to curing temperature in 45 seconds a mass of molding material weighing approximately 1 lb. Such equipment, applied to compression molding work, is capable of speeding the operation two or three times for the larger pieces. Molding times on smaller ones may not always be reduced to this extent, but application of rf heating may still justify itself on the basis of improving quality by uniform plasticizing prior to molding.

Drying applications, as may be expected from the high heat of vaporization of water, require equipment of somewhat greater capacity. A 100 kw 25 mc generator, developed for a pilot plant installation for rayon drying, is scheduled to go into operation at an early date (Fig. 8).

High speed heating

For very high-speed heating, the highest frequencies are necessary to prevent difficulties with voltage breakdown. A 200 mc oscillator has been used in "spot gluing" operations where it is desired to set up a thermo-setting glue in a matter of a second (Fig. 9).

The overall cost of heating by radio-frequency has been worked out on the basis of present day equipment costs, tube depreciation and power rates. As is to be expected, it decreases with increasing powers, due to lower cost per generated kw of the equipment. An average figure of 4 cents per kwh can be used for estimating purposes. In using this kind of information, it should be borne in mind that the kw requirement meant is that actually delivered to the work, and does not in general involve heating auxiliary apparatus such as hot plates, dies, or ovens.

In carrying on the development work in connection with these applications it has been a matter of prime importance to be able to make contact with the potential users of the equipment. They have served to suggest the application and to guide us in carrying it out in a practical way. Now that equipment is in the field, a considerable body of information built up on operating experience is being obtained, from which we will produce more efficient equipment.

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TUBE CONTROL CIRCUITS

(*Continued from page* 111)

on a Bordoni tube. The capacitance shift method of altering the frequency of an oscillator is mentioned because it is so common.

Fig. 1 lists a few of the principal types of motion and displacement converters that are in common use. Some of these work best when handling rapid and continuously varying displacements, others with slow changes. There are, however, many other devices that should be considered when laying out any test.

A motion of only a few millionths of an inch applied to the positioning one of the elements of a tuned circuit will produce large changes in the resulting frequency. On the other end of the range, by using other set-ups, a movement of several feet can be converted to a similar shift, so the method is not only simple but is quite versatile in its range.

Basic rules

The following basic rules hold for any oscillator circuit tuned by a capacitor:

Let C equal the normal capacitance in the circuit, and $\triangle$ C the incremental capacitance caused by some movement to be measured.

It will be found that a one micromicrofarad change in capacitance affects the output frequency as follows:

Let C=total capacitance of circuit in mmf, and L=millihenries.

Then the frequency change=

$$\triangle f = \frac{5.033 \quad 10^6}{\sqrt{LC}} \left(1 - \sqrt{\frac{C}{C \pm \triangle C}}\right) = \frac{5.033 \quad 10^6}{\sqrt{L}} \left(\frac{1}{\sqrt{C}} - \frac{1}{\sqrt{C \pm 1}}\right)$$

cycles per second. A somewhat larger frequency shift is occasioned when C reduces the capacitance in the circuit than if it increases the total capacitance. This accounts for the double sign in the denominator of the last term of the formula, and the double-indexed scale at the center of the nomographic chart, Fig. 2, that permits the selection of circuit constants to give a desired frequency shift when the capacitance is altered by one micromicrofarad.

As is usual in a chart of this sort, a straight line from the point on the frequency-shift scale at a value where a conveniently measured frequency change is to be found, crossing the other two scales, will indicate the circuit capacitance and inductance that will produce that shift with a one micromicrofarad capacitance change. For other ranges, if the values on

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[illegible] ing transmitting equipment that will meet your specific requirements.

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the inductance scale are divided by 100, the frequency scale is multiplied by 10. A capacitance change of less than 1 mmf will cause a correspondingly lesser shift.

Now consider that a pair of plates separated .001 in. in air has a capacitance of 225 mmf per in. of (dielectric) area. For other spacings the reciprocal law holds —with a normal spacing of .0225 in. the capacitance would be 10 mmf and a spacing of .0204 would give 11 mmf or 1 mmf additional capacitance. Thus a movement of .002 in. in this case would result in a capacitance change of one mmf which would fulfill the condition of the above relation. In any given circuit, tuned with a variable capacitor, the value of $\triangle f$ varies as the third power (cube) of the emitted frequency, as the latter is changed by altering the setting of the capacitor.

Capacitive pickup

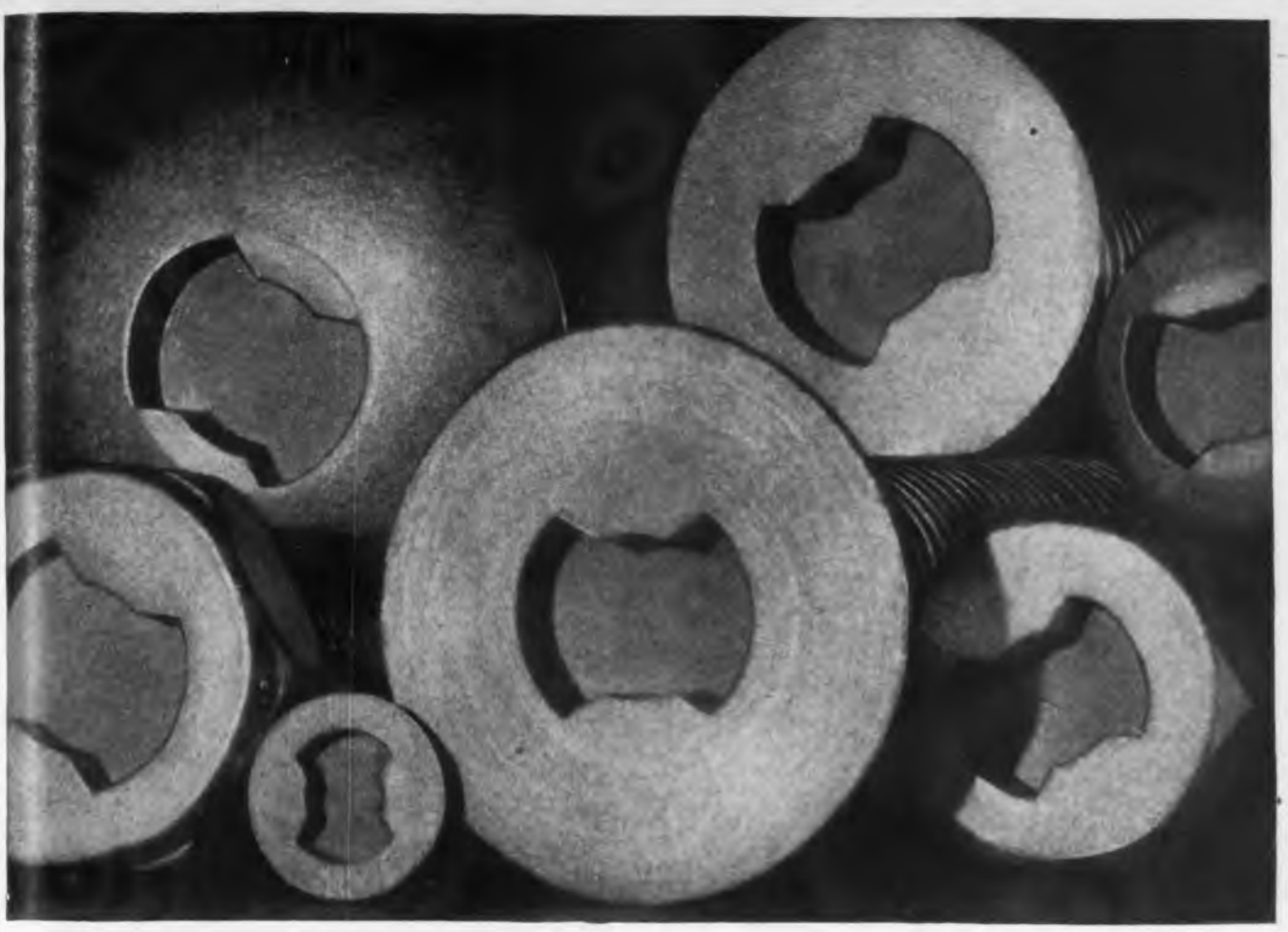
The variety of shapes and materials that might go toward making up a capacitive type of displacement pickup, is large. It is not even necessary to use air as the dielectric and at least one installation uses the capacitance between two wires in an oil tank to indicate the oil level.

An advantage of the capacitive type is that it can be arranged to work in both directions, that is with a push and a pull. It is independent of temperature, humidity, and its driven plate can be made light enough so that it does not interfere with the operation of the mechanism to which it is attached. Change in the capacitance of an oil film in a bearing has been used to determine its thickness, (although the shunting resistance also found will modify the test method somewhat).

In converting greater displacements of the reciprocating type, the motion of a sheet of dielectric between a "live" plate and the grounds of a machine can be used to alter the capacitance.

By the proper selection of the L and C values in the circuit, almost any frequency change desired can be obtained from a very small capacitance variation. Methods whereby frequency variations can be converted to an electrical voltage variation will be outlined later in this review.

It is also possible to alter the frequency of an oscillator by the physical movement of an iron core moved in-and-out of an inductance. The computation of an anticipated shift, however, in this case is not reliable from formulas, as the variation in inductance with the position of the core cannot be determined accurately except by actual measurement. The method has advantages, however,



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The phrase isn't ours. It comes from the assembly lines . . . where new factors for speed, safety, simplicity, and lower cost are rated high. CLUTCH HEAD Screws "cancel-out" the handicap of slow-down hesitation. The wide roomy clutch offers an easy bull's-eye target for the "greenest" operator, inviting speed born of confidence . . . the automatic entry of the Center Pivot Driver into dead center of the recess speeds and eases the drive home . . . and that same definite torque grip assures the operator there is no hazard of slippage. Then there is the CLUTCH HEAD Lock-On feature which nullifies the handicap of fumbling around hard-to-get-at spots by uniting screw and bit as a unit for easy one-handed reaching. In field maintenance, too, CLUTCH HEAD simplifies operations by solving hitherto accepted problems. Service men prefer this modern screw because it may be operated with the ordinary type screwdriver . . . even with a piece of flattened steel rod in an emergency. They know also that, where screws have to be removed, saved, and used again, the CLUTCH HEAD Lock-On feature obtainable with the Center Pivot Hand Driver "cancels-out" the serious handicap of dropped and lost screws.

Get personally acquainted with these many exclusive features. Send for assortment of CLUTCH HEAD *Screws, sample Center Pivot Bit, and fully illustrated Brochure.*

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ECONOMY is an important feature of this Center Pivot Assembler's Bit. No "back-to-the-factory" shipment is necessary for reconditioning. A brief application of the end surface to a grinding wheel fully restores original efficiency.

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over the capacitance-change arrangement in certain cases.

Reconversion

Having produced a frequency modulated signal, the next question concerns the translation of the frequency drift into a variable voltage or current.

The most usual conversion consists in amplifying, limiting, differentiating and then integrating the incoming frequency so that what comes out is a current that is proportional to the frequency. This process is outlined in Fig. 3, and an example of a typical circuit is shown in Fig. 4 on page 116 of this issue.

The signal is amplified and "clipped" so that its amplitude above a certain level (plus and negative) is eliminated. This is often done by a push-pull stage of thyratron tubes. The resulting square wave is passed through a differentiating circuit which takes note only of the voltage changes as the square wave reverses from positive to negative. A series of constant level pulses, having a frequency equal to the original frequency results, which is rectified in a full wave circuit and smoothed out in a filter to operate a control mechanism.

Conversion of a frequency modulated signal into a change in level also can be accomplished by the now-well known discriminator circuit in an FM receiver although this method is not so frequently used. Another conversion method makes use of the pull-out energy transfer as the circuit values in one of two equal frequency oscillators is altered. This method is useful when the frequency shift is not large.

(NOTE—other types of control and conversion systems will be taken up in later parts of this series, followed by data on the common methods for actuating the process control devices themselves so as to bring about corrective influences.—R.R.B.)

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(*Continued from page 98*)

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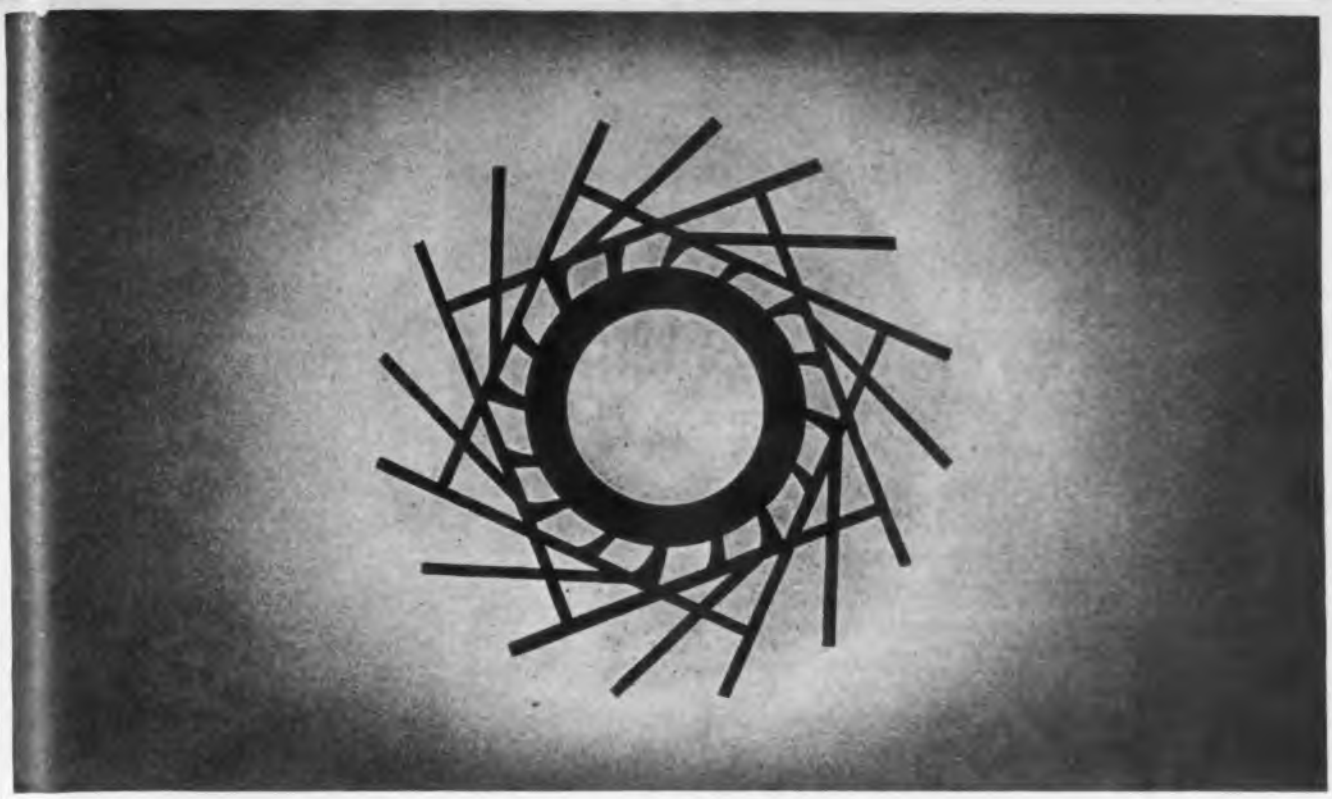

American Airlines tangent airport plan for New York City from "Airports and Air Traffic Control" by Glen A. Gilbert, Chief Air Traffic Control Division, C.A.A.

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Our non-technical booklet, "HIGHWAYS OF THE AIR," *explains the importance of radio to aviation. It will be sent to you upon request. Address Desk E.I.-2.*

> ***"Although an airway may be loosely defined as a designated route for aircraft plying from airdrome to airdrome, it cannot really be said to exist on a practical scale without airways communications, airdrome traffic control, and radio navigational aids. These are the three components furnished, over some 70,000 miles of foreign military airways, by the Army Airways Communications System Wing."***—An excerpt from "The Army Airways Communications System," by Lt. W. Fawcett, Jr., Headquarters, AACS.

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147. An Automatic Frequency-Controlled Oscillator and Amplifier for Driving Mechanical Vibrators. E. V. Potter. "Rev. of Sci. Instr.," July, 1943; v. 14, no. 7, p. 207.

148. Flip Flop Circuits. S. E. M. Susskind. "Electronic Industries," Nov., 1943, p. 78.

149. Wide Range Electronic Generator. E. Mittelman, F. S. Grodins and A. C. Ives. "Electronics," Dec., 1943; p. 132.

Rectifiers

150. Ignitron for Direct Current Power. W. E. Schwarz. "Power Pl. Engng.," Mar., 1943; v. 47, pp. 76-79, 110.

151. Ignitron Rectifier Testing. L. F. Dytrt. "Electronic Industries," Nov., 1943, p. 102.

152. Why Use Rectifiers for Plating? L. W. Reinken. "Metals & Alloys," Mar., 1943; v. 17, pp. 533-535.

153. Analysis of Rectifier Operation. O. H. Schade. "Proc. IRE," July, 1943; pp. 341-361.

154. Vacuum Rectifiers Working With Condenser Input. R. G. Mitchell. "Wireless Engineer," Sept., 1943; p. 414.

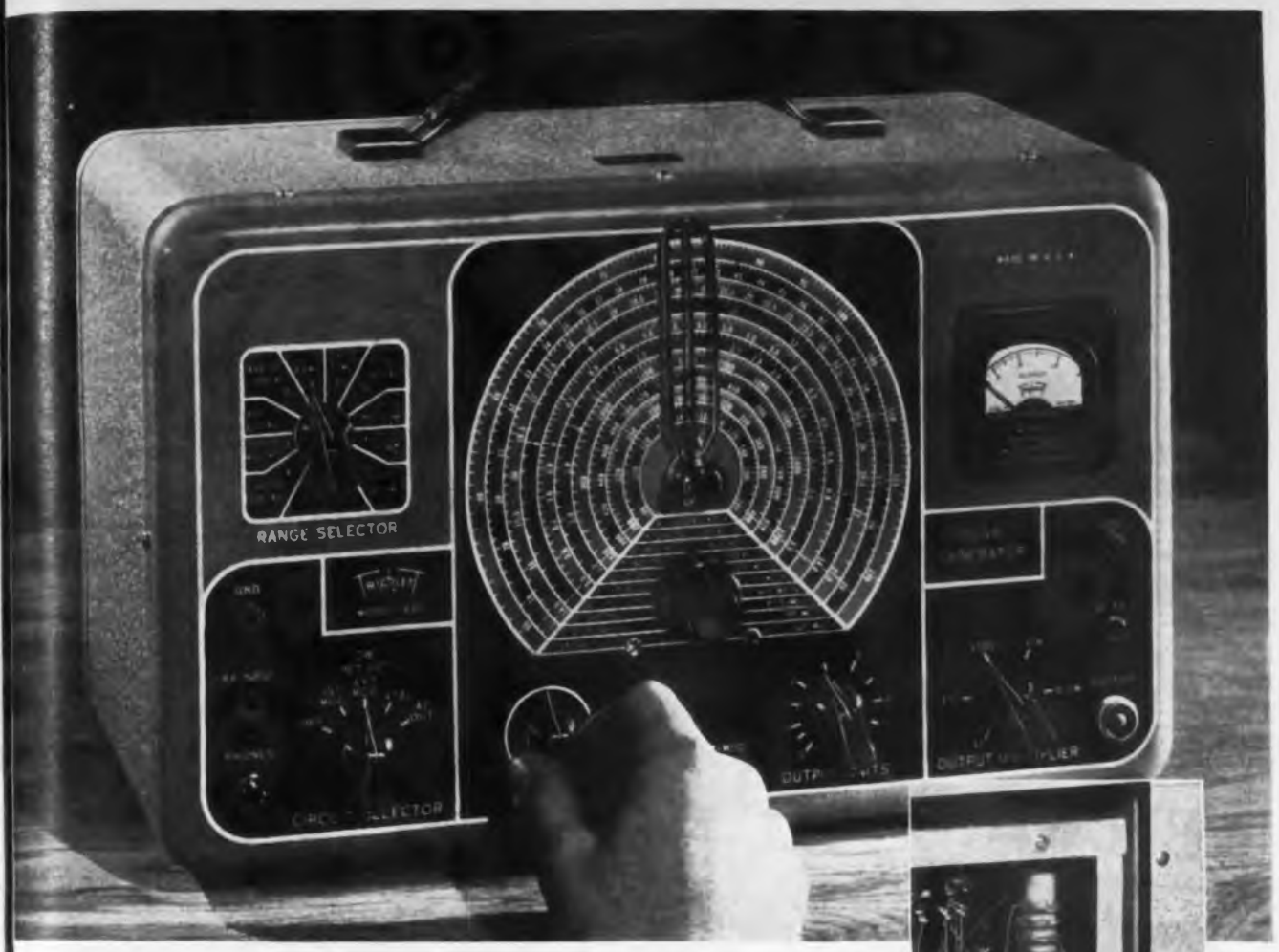
Regulators, Exciters, Stabilizers

155. Voltage Regulating Transformers. R. O. Lambert. "Electronic Engng.," Feb., 1943.; v. 15, pp. 384-387.

156. Electronic Regulators for A-C Generators. Arnold Benson. "Electronics," Apr., 1943; v. 16, pp. 104-107.

157. Electronic Exciter for A-C Generators. Arnold Benson and Ralph Heidbrink. "Electronics," Aug., 1943; v. 16, pp. 112-114, 261.

158. Electronic Voltage Regulators. F. L. [illegible]



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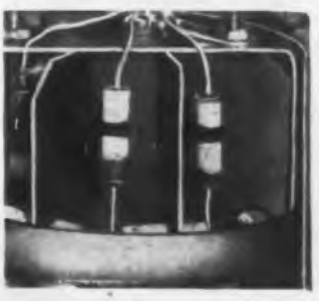

• Note sections individually shielded with pure copper. Entire unit encased in aluminum shield.

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Ingston Hogg. "Wireless World," Nov., 1943; v. 49, pp. 327-331. (Part I of a serial.)

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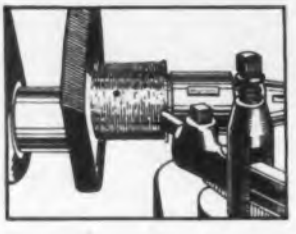
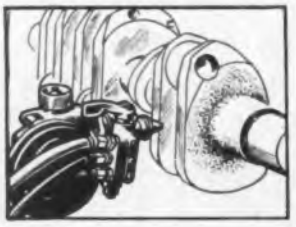


Rough threading—cooling locks metal firmly to surface, producing a permanently tight bond.



Sprayed journal before finishing—Main bearing journal after surface has been Metallized.

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ALPHABETICAL FINDING LIST of Electronic Manufacturers

Use this list if you know the name of a company and want to learn its principal products. Asterisks following listings indicate companies making products too numerous for individual inclusion.

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Antennas
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—Transmitters
Ace Mfg. Corp., Philadelphia, Pa.—Metal
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Acheson Colloids Corp., Port Huron, Mich.
—Graphite
Ackermann, Stefan Co., Chicago, Ill.—
Tools
Aclin Stamping Co., Toledo, Ohio—Metal
Stampings
Acme Battery Co., Brooklyn, N. Y.—
Batteries
Acme Electric & Mfg. Co., Cuba, N. Y.—
Transformers*
Acme Welding Co., Logan
—Antennas
Acme Wire Co.
The American Brass Co., Waterbury, Conn.
—Metal
American Coils, Inc., Newark, N. J.—
Laboratory Equipment
American Communications System*
New York, N. Y.—Sound Systems*
American Condenser Corp., Chicago, Ill.
—Capacitors
American Cyanamid Co., N.
—Plastics
American
York
American Automatic Electric Sales Co.,
Chicago, Ill.—Relays*
The Arnold
Ill.—M
Technical Apparatus Co., Brook-
—Test Equipment
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Barber-Coleman Co.
Rockford

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The Muter Co., 1255 S. Michigan Ave., Chicago, Ill., "Muter"—RL, T
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The National Screw & Mfg. Co., 2440 E. 75th St., Cleveland, Ohio—R, S, SS
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New England Screw Co., Keene, N. H.—SS
The North Electric Mfg. Co., P. O. Box 267, Galion, Ohio—T
Northam Warren Corp., War Works Div., Stamford, Conn.—P, SKT
The Pelmet Co., 63 Cordier St., Irvington, N. J.—NL
Parker-Kalon Corp., 200 Varick St., New York, N. Y.—SS
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Paul & Beckman, Div. of Philadelphia Lawnmower & Mfg Co., 18th & Courtland Sts., Philadelphia, Pa.—TS
Penn Fibre & Specialty Co., 2030 E. Westmoreland St., Philadelphia, Pa.—FW
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Perm-O-Flux Corp., 4916 W. Grand Ave., Chicago, Ill.—MB
Pheoll Mfg. Co., 5700 Roosevelt Rd., Chicago, Ill.—N, S, SS, WB
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Kratzer Ave., Chi-
The S. S. White Dental Mfg. Co., Industrial Division, 10 E. 40th St., New York, N. Y.—FS
Whitehead Stamping Co., 1683 W. Lafayette Blvd., Detroit, Mich.—WB
Wilmington Fibre Specialty Co., Wilmington, Del.—FW
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Yost Superior Co., Springfield, Ohio—SP
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Atlantic India Rubber Works, Inc., 1468 W. Van Buren St., Chicago, Ill.—B
St., Middletown, Conn.

Classified Listing of Products & Mfrs.

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6—Tell story of contribution to war and explain delivery situation.
7—Maintain association of company name and product.

To be published as a section of

ELECTRONIC INDUSTRIES

in March

REGULAR CLOSING DATE, FEBRUARY 1st

(Advertisers who desire space but did not reserve same before February 1st, should wire (collect) for deadline of final form.)

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CALDWELL-CLEMENTS, INC., 480 Lexington Avenue, NEW YORK 17, N. Y.—Telephone PLaza 3-1340

RAILROAD TRAFFIC CONTROL

(*Continued from page* 115)

must be placed as close together in frequency as practical. The factors which limit the spacing are: (1) the width of the band required to be transmitted and (2) the sharpness and selectivity of the filters employed in the receiving units.

As only a narrow band is required for the operation of relay circuits, the channels may be spaced as close as 5 kc, provided a sharply tuned filter is used at the receiving end. However, from the standpoint of conserving materials in manufacturing, the channels can be spaced further apart, say at 15 kc intervals, thereby securing equally satisfactory operation with broader and simpler tuning.

Transmitter, receiver units

The transmitter and receiver units are small and compact, each occupying a shelf space approximately six inches square. They are housed within the standard signal instrument case on the roadway. In the photographs the units are shown equipped with metal tubes. However, under present war conditions, glass tubes can be more readily obtained; and this substitution is intended in connection with the accompanying circuit diagrams of the units.

Traffic control transmitter and receiver units

The transmitter, in simple form, consists of a self-controlled electron-coupled oscillator coupled to a power amplifier output stage, as shown. Two tubes of 6L6G type are used in the unit.

The output of the amplifier stage goes to line wire L1 through the condenser C1, of about .05 mfd capacity. The L2 side of the line is grounded to the transmitter chassis through condenser C2 of like capacity.

The unit is keyed by an external switch or relay contact SW, connected in the B+ lead to the amplifier stage; so there can be no output to the line when the switch is open.

A simple form of receiver circuit is shown diagrammatically. The unit includes a built-in sensitive relay mounted in a vertical position, so that its back contact would be closed by gravity when the relay is de-energized—a safety precaution, in accordance with good signal practice. Contact terminals are brought out to the top of the instrument case. Terminals are also provided for connections to the transmission line and to the power supply.

The unit comprises a 6J7G amplifier tube, a 6H6 diode detector, and a 6Z7G power amplifier output tube. When no signal current is received from the line, the output tube is biased to cut-off through the bias resistor R1 and the Mallory cell MC, connected in its grid circuit. There being no line current, no current will flow in the circuit of the diode 6H6.

When the designated frequency is present on the line, the current received is amplified through the 6J7G. The amplified current then flows through the plates and cathodes of the 6H6, producing a positive bias voltage which flows from the cathodes to the grids of the 6Z7G, making the grid more positive, so that plate current will flow to energize the relay K. By this circuit arrangement, a failure of the plate current would leave the relay de-energized, so that the red indication light would be continuously displayed.

The rheostat R2 in the cathode circuit of the 6J7G provides an adjustment of sensitivity so that the plate current through the relay can be regulated to the desired value, regardless of the strength of the signal received from the line.

The receiver pickup coil is coupled to line terminal L1 through a condenser C1, which may have a capacity of .002 mfd. The bottom end of the coil and the L2 line terminal are connected to the chassis ground through a condenser C2, of .05 mfd capacity.

A milliammeter may be inserted in the closed-circuit jack, for ad-

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justing the pickup current on the relay through the setting of the sensitivity control R2.

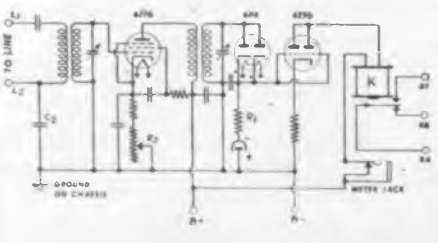
Control machine

The traffic control machine, located at the central office comprises a layout of switch and signal controls, indicating devices, etc., by which the operator can handle traffic over any given territory, with efficiency and safety. The illustration covers a single track railroad with passing sidings, but the layout can be arranged to cover multiple-track operation as well. While the centralized traffic control system eliminates the telephone in train dispatching, certain telephones can be selected by push-buttons on the control machine for emergency use.

The upper portion of the machine comprises a diagram of the trackway, the track being represented by a white line 3/16 in. in width, painted on a black background. Electro-magnetically actuated switch indicators in the diagram display a clear picture of the routes set up. Small red lights are illuminated to show the occupied track sections. Both the switch indicators and the occupancy lights are operated by frequencies transmitted from the roadway, as hereinafter explained. Amber colored lights indicate the approach of the train, while arrow lights show direction of traffic movements.

Across the lower portion of the control panel are mounted the switch control levers, the signal control levers, and push-buttons. The switch control levers, when moved to the down or to the up position, send out the control frequencies to operate the switch machine on the roadway to the normal or reverse position, respectively.

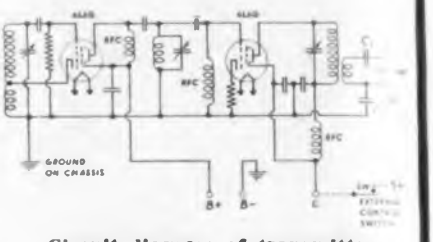
Accompanying each switch lever is a white "OS" light and a red "lock-out" indication light. The "OS" light is illuminated when the train is occupying the switch track circuit, and is also lighted momentarily during the time the switch is traversing its stroke while being moved from one position to the other. The red light is illuminated when the switch forms part of a route over which the signal has been cleared for train movement, the transmission of the control



Circuit diagram of receiver

frequencies to the switch being cut off while the light is showing. To change the route after the signal has been cleared, the operator must first move the signal lever to its center (stop) position, after which the switch control can be changed, provided there is no train approaching.

The signal control levers, located above the signal control push-buttons, are moved to the right or to the left to establish direction of traffic movement; while the push-button, when pressed, sends out the frequency that will clear the signal for that direction.



Circuit diagram of transmitter

Individual push-buttons can be provided to select certain telephones, the pressing of the button actuating a transmitter to send out the frequency selected to operate the 'phone bell. A "general call" push-button, when pressed, selects a group (or all) of the telephones simultaneously. When general information is to be given, the operation of this button eliminates the necessity of calling each one individually. This feature is useful in locating persons who are "somewhere on the line." A switch is provided on the panel to dim the machine lights for night operating, by reducing the voltage on the lamps.

In dispatching traffic, the operator follows the indication lights on the track diagram, and to manipulate the switch and signal controls, in order to clear the way for the heavy freight train, while the passenger train is put through the side track, stopping the passenger train if necessary, in order to let the freight pass it.

Typical transmission circuits

The following typical circuits will serve to illustrate the simplicity of the system described, when applied to the remote control and indication of switches, signals, and the like.

In a typical signal control the "normal" (or red) position of the signal control lever is with its contact open, so that the transmitter T2500 delivers no current to the line. The receiver R2500 at the signal location will have its relay R de-energized, thereby completing

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a circuit over its back contact to the red signal light.

When the signal lever is moved to its "clear" (or green) position, the closing of the contact causes the transmitter to deliver its output (2500 kc) to the line. Relay R will then be energized through receiver R2500, thereby opening its back contact, and through the front contact the circuit is established to the green signal light.

When the track relay TR is de-energized by the passing of the train, current is cut off from the green light and the circuit established over the back contact of TR, to the red signal light.

The switch control lever operates in two positions, in a vertical direction, down for the switch "normal" (position for the train to pass straight through) and up for the switch "reverse." When in its normal position, the lever contact N is closed, thereby causing transmitter T2515 to deliver its frequency to the line wire. Relay N, associated with the receiver R2515 at the switch location, will then be energized, and through one or more contacts of this relay the circuit is established to the switch machine SM, thereby operating the switch to its normal position.

When the control lever is moved upward to the reverse position, contact N will be opened and contact R will be closed, so that transmitter T2530 will now deliver its frequency to the line. Relay N then will be de-energized and relay R associated with receiver R2530 will be energized, thereby establishing the circuit to the switch machine SM to operate the switch to its reverse position.

Track circuit control

The running rails are divided into blocks by insulated rail joints, which isolate each track section electrically from the adjacent sections. The intermediate rail joints in the block are "bonded" so as to form a continous conductor for the track current. Across one end of the block is connected the terminals of a track battery, usually about 2 volts for a track circuit one mile in length. Across the far end of the block is connected the terminals of the track relay, having a resistance of about 2 ohms. The length of a block may be anything from a few feet up to a mile, the latter being considered maximum for positive operation under all weather conditions. When the track is clear, current flows down one side to the track, through the coils of the relay, and back over the opposite rail to the battery, energizing the relay. A resistor R1 is usually inserted in one of the battery leads to limit the current drawn

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from the battery when the track is occupied.

When a train enters the block from either end, the relay is shunted out by the path of low resistance offered by the wheels and axles of the train across the running rails, whereupon the track relay will become de-energized, remaining open as long as the train is in the block.

A transmitter T2545 is controlled over the front contact of the track relay, so that the frequency will be continuously transmitted over the line while the block is clear. A receiver R2545 at the central office energizes a relay R. When the track relay is de-energized by a train, the transmitter will be cut off through the opening of the relay contact. The receiver relay R then will become de-energized; and through the back contact of this relay the circuit is completed to the red track occupancy indication light on the track diagram of the control machine.

The railway field offers unlimited opportunity for the application of electronics devices to the operation of automatic block signals, cab signaling, automatic train recording, detection of dragging car equipment, communication, etc. In fact, the multiplex transmission of frequencies, all operating independently of each other, can be utilized in so many ways that its adaptability is almost beyond present comprehension.

In the operation of yards and terminals, an entire route may be set up by the transmission of a single frequency, involving the operation of a number of switches and crossovers which are controlled simultaneously through one "route" control lever. Through a frequency allocation, the important routes can be set up selectively, using a different frequency for each route. A study of traffic movements at a particular location will, in many cases, disclose the possibility of consolidating the operation of controls.

While this system is most important in the present emergency, it also is a most valuable improvement for postwar use. Any installation can be easily expanded by adding the required transmitting and receiving units to the line.

WIDE READING

(*Continued from page* 121)

The toothed metal disk rotating with the shaft generates an ac voltage, proportional to the speed of the shaft, in the telephone coil. The voltage from the frequency divider and the voltage derived from the telephone coil are compared as to their relative phase, and a current I which is a function of this phase difference is passed through the winding of an electromagnet hav-

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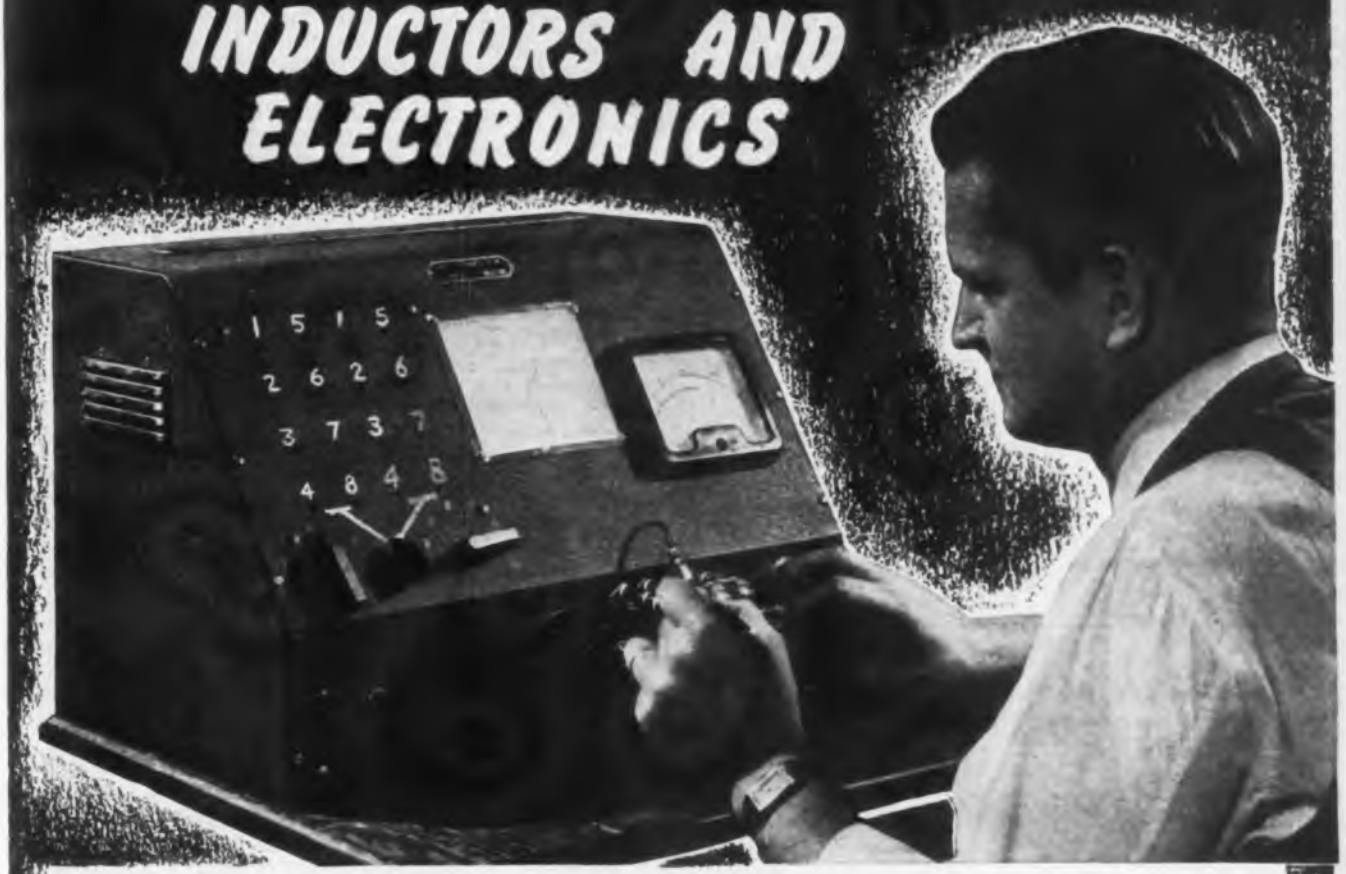

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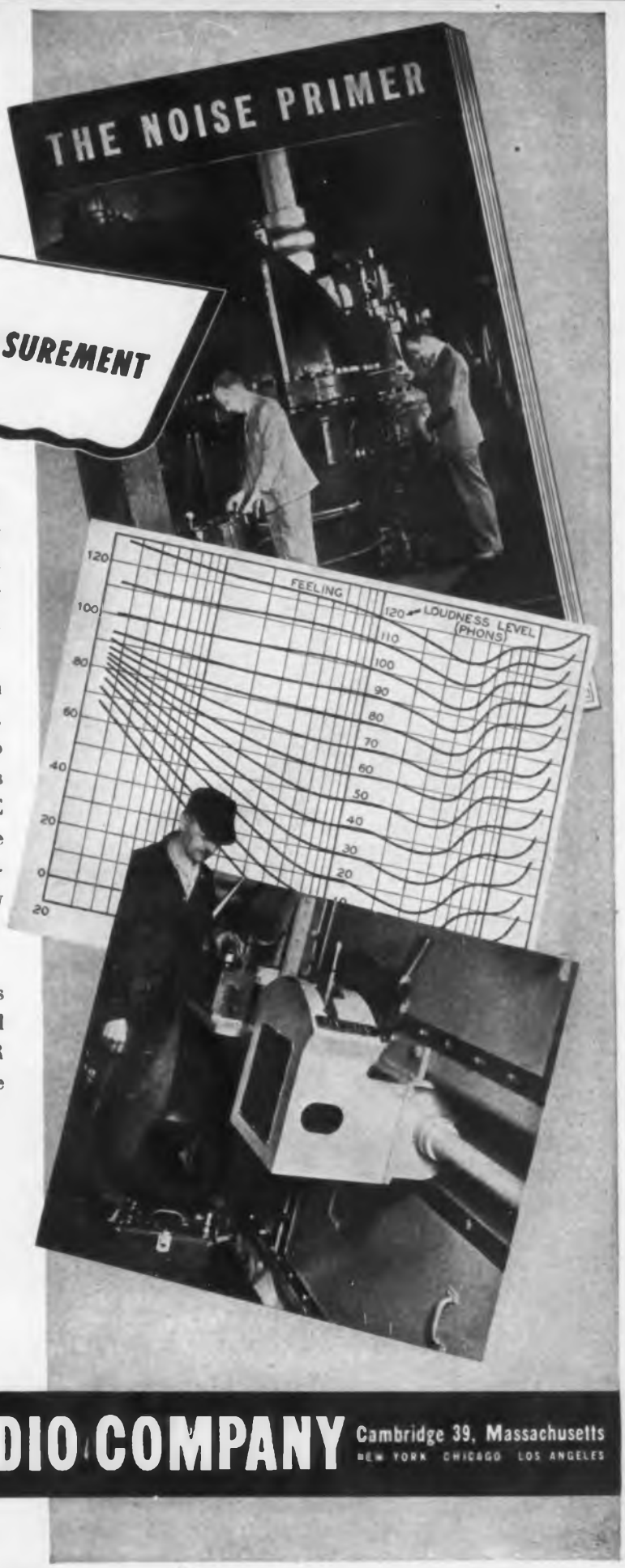
ing a soft iron core. A copper or aluminum disk rotates in the air space of the electromagnet and the eddy currents in the disk effect the desired braking on the shaft.

If by suitably connecting the motor, the shaft is made to rotate with a speed such that the telephone-coil voltage frequency is approximately f_s/n, frequency following sets in, and the shaft rotates synchronously just as if driven by a synchronous motor.

This may be seen from Fig. 2, which shows the voltage vectors in the phase comparison device and a circuit diagram of the electrical apparatus. The controlling ac voltage E_{s_1} plus the telephone coil voltage E_t are rectified and applied to resistor R_g, and the voltage E_g across this resistor controls the plate current of the amplifier tube V; this current flows through the coil 8 of the braking electromagnet. The other parts may be omitted in a simple modification of the apparatus. Assuming the arrangement to be synchronized and E_{s_1} and E_t to be approximately 90 deg. out of phase (heavy lines in the diagram), there will be a synchronizing force immediately the wheel departs from the synchronous speed. Should it tend to rotate at a higher speed, vector E_t would rotate to the right and the resulting voltage E_g would increase. Consequently, the braking current also increases reducing the speed of shaft and wheel. Similarly, a decrease in speed causes a reduction in braking current and an increase in shaft speed. It will be seen that, once the arrangement has been made to operate synchronously by a suitable regulation of the driving motor, the driving torque acting on the shaft may vary without disturbing synchronous operation. The limits, according to Fig. 2 are set by the condition that the phase difference ϕ between E_{s_1} and E_t, in the optimal case 90 deg., must not reach 0 or 180 deg.; at these values changes of ϕ will not cause corresponding changes in E_g so that the brake has no synchronizing effect.

For small control voltages E_{s_1} and small telephone coil voltages E_t, the braking force of the disk is small, and small variations in the driving moment will make the phase difference ϕ pass through the whole range from 0 to 180 deg. At larger amplitudes of E_{s_1} and E_t and corresponding stronger braking effects, the permissible variations in the driving moment are greater. It is, however, impossible to compensate for any desired variation of the driving torque by correspondingly increasing the control voltages because, at a certain strength of the control, oscillations of the rotating arrangements about its synchronous position occur which increase until synchronization stops. The reason is the lag of the braking cur-

THE ABC OF NOISE MEASUREMENT



Acceptability of a product, for military use now and for post-war markets, may hinge on the noise and vibration factors. At all times, in any product with moving parts, noise and vibration are important.

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rent with respect to the phase difference ϕ, caused by the inductance of the electromagnet.

The simplified device can therefore only compensate for small variations in the driving torque, for instance those variations occurring while the driving motor is left to itself for a couple of minutes. If wider variation of the driving motor are to be compensated for, the additional regulator shown in the diagram may be used, provided the variations are gradual and not abrupt. The operation of the additional regulator is based on compensating for slow variations of the driving torque by an additional braking torque; then the resulting driving torque varies about the mean for which the simpler circuit alone has its optimum working condition.

A second similar tube V′ is connected parallel to tube V. The grid of tube V′ obtains the controlling dc voltage over an RC element; two relays R_1 and R_2 are inserted in the plate circuit.

There are two resistors connected in parallel to the plate circuit of tube V: R_a which is adjusted by dc motor M, and R_b which is adjusted by hand. M is a series-wound motor with two field windings F_1 and F_2 oppositely wound, so that the motor rotates in either direction according to whether the armature is supplied by F_1 or F_2. The supply voltage is connected by relays R_1 and R_2; R_1 operates a connecting contact r_1 and R_2 a separating contact r_2. At both relays, the difference between attracting and releasing current is about 10 per cent of the attracting current. Furthermore, resistors parallel to R_1 and R_2 cause R_1 to operate at greater currents than R_2 so that R_1 releases at a current considerably higher than R_2 attracts.

At normal driving torque, the dc current has a value so that the complete current through the winding maintains phase difference ϕ at 90 deg. Then a current J′ flows through V′ at which relay R_2 is operated while R_1 is inoperative so that motor M does not rotate. Upon an increase of the mean driving moment, angle ϕ decreases and current J′ increases. Relay R_1 operates and motor M reduces the resistance of resistor R_a until the additional braking current has reduced the resulting driving torque to such an extent that the phase angle ϕ is again 90 deg and J′ has again its normal value. Then R_1 is released and the main regulation only is operating. Similarly, upon an extended decrease of the driving moment, current J′ decreases and the control motor M increases R_a until the effective driving moment and J′ have again their normal values.

In this manner, it is possible to maintain the rotating arrangement

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at synchronous speed for hours, without regulation by hand being necessary.

The braking magnet must be adjusted to the no-load torque required for the driving of the uncontrolled device. It may be taken as a guide that the mean of the additional braking torque of the eddy current brake should equal this no-load torque, and that the variations of the braking current due to the main regulation should be about 10 per cent of the mean braking current. As a rough approximation, the braking force P acting on the disk may be computed from the formula: $P=vB^2 Fgd$; where v is the velocity at the circumference of the disk, B the density of the magnetic flux in the disk, F the cross-section of the disk within the magnetic field, g the conductivity and d the thickness of the braking disk. B is found from $B=\mu wJ/d'$, where w is the number of windings, J the current, d' the width of the slot in the electromagnet in which the braking disk rotates. The actual magnitude of the braking force was, in the reported experiments, found to be about three times the computed one.

To obtain as great a braking torque as possible, the lever on which the braking force acts should be made as long as possible. In the arrangement described, for which the no-load torque was 2 kgm, the lever had to be 35 cm, though a large electromagnet was used. A large ring made of strong Duraluminum (5mm) was mounted on the rotating arrangement in a suitable way.

The function of the regulating device corresponds essentially to that of a synchronous motor which acts on the same shaft in addition to the actual driving motor. The advantage of the device described over a synchronous motor is that the telephone coil and the braking disk are much easier added to an already existing arrangement than a correspondingly strong synchronous motor. Further, the synchronizing torque is comparatively great because of the amplification of the eddy current brake. Actually it has been possible to satisfactorily synchronize a big ring-shaped turntable with a tube of 12 W plate dissipation.

Impedance of a Transverse Wire in a Rectangular Wave Guide

S. A. Schelkunoff (Quarterly of Applied Mathematics, April, 1943)

Approximate formulas are derived for the internal and external impedance of a thin wire carrying uniform current and extended between two walls of a rectangular wave guide.

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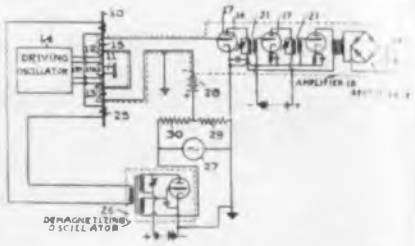
NEW PATENTS

(Continued from page 136)

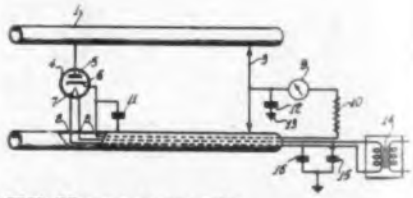
of π. From the location of these maxima and minima on the cathode ray screen the phase difference ϕ between the original input waves e_1 (f) and e_2 (f) can be derived. Calibration may be made experimentally. It is suggested to employ the apparatus for determining the altitude of an airplane, e.g., by measuring the phase difference between waves reflected by the airplane and picked up by two distant receivers. M. M. Levy, International Standard Electric Corp., (F) Sept. 30, 1941, (I) Nov. 2, 1943, No. 2,333,[illegible].



Measuring Magnetic Fields

Intensity and direction of an unknown magnetic field are to be determined. Bar or rod 10 is made of magnetostrictive material, the permeability of which is a function of stress. It is supported in the middle at 11 and made to vibrate longitudinally by piezoelectric crystals 12 and 13 which are driven by oscillator 14 (3 to 20 kc). As it vibrates, its permeability varies periodically causing the magnetic flux induced by the unknown ambient magnetic field to vary with it. The voltage induced in coil 15 by the changing magnetic flux is amplified in tubes 17, rectified in rectifier 19 and indicated by ammeter 20. Oscillator 26 operates intermittently, 1 to 10 times per second, and supplies ac current (the frequency of which is different from the frequency of oscillator 14 and several times that of the ac supply 27) in coil 25 which serves to demagnetize the bar once in every cycle. During the demagnetizing period, tube 17 is biased beyond cut-off by the ac voltage supplied by source 27 which also energizes demagnetizing oscillator 26. Other embodiments are described. R. D. Wyckoff, Gulf Research & Development Co., (F) May 8, 1941, (I) Nov. 16, 1943, No. 2,334,593.

HF AND UHF



HF Measurements

The circuit is intended to measure voltages or wavelengths of balanced parallel transmission lines without destroying the balance. For this purpose, the heater and cathode leads of the diode voltmeter run wholly inside one of the lines. The voltmeter circuit is shown in the diagram. T. H. Clark, RCA (F), June 5, 1942, (I) Nov. 30, 1943, No. 2,335,486.

UHF Push-Pull Amplifier

An influence of the plate voltage on the control grid voltage is caused by the grid plate capacitance at low frequencies and at high frequencies, is counteracted by the inductances of the electrode supply leads. However, at still higher frequen-

(Continued on page 234)

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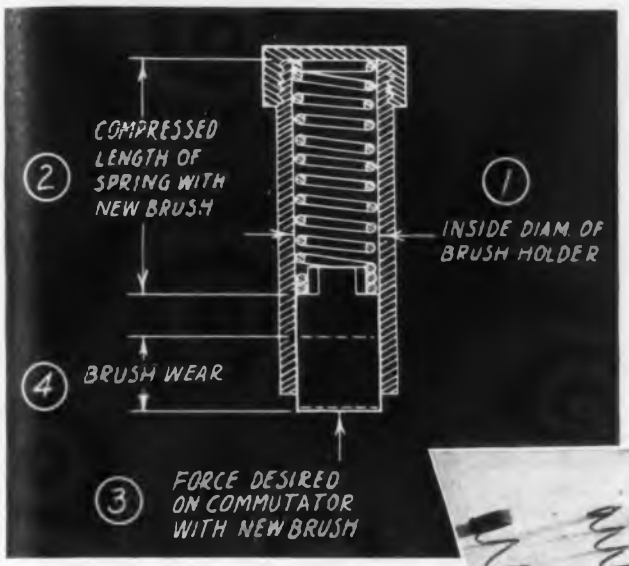

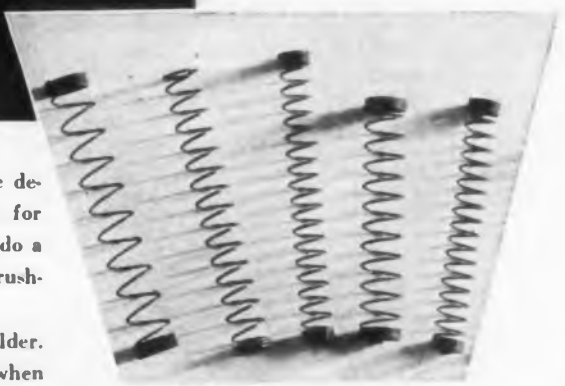

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(*Continued from page* 117)

motor to drive down scale the potentiometer contact and the carriage that holds the ink pens. When a new position of balance is reached, the potential across the galvanometer decreases to zero and the light beam returns to the balance position, thus reducing the illumination that reaches the phototube, opens No. 2 relay and stopping the motor at the correct position. A similar change occurs when the applied current level rises —the illumination on the phototube decreases, relay 1 opens and the carriage is reversed and driven upscale.

Automatic rebalance

The net result is that any current injected into the galvanometer circuit is automatically balanced out by the motor-driven rheostat that tends to follow up all the changes. The position of this rheostat therefore is a measure of the current level. Every 30 seconds the position of the rheostat pointer is recorded on a chart. The circuit is changed between each reading to energize another buffer tube so that the next reading indicates the result of the frequency shift on a different instrument, until all 12 are recorded whereupon the series is repeated. By the use of colored inks and a printed number alongside of each dot, the separate curves can be easily distinguished. In Fig. 2 a pencilled connection between some of the sets of points has been added to show what is lost by not having colors appear on the printed reproduction.

Frequency to current conversion

The final problem is that which converts a variation in frequency into a variable current. This is accomplished in the circuit in Fig. 4.* This circuit delivers a maximum of 500 microamps. to the recorder if exactly a 2000 cycle (or 4000 cycle) tone is applied to its input, depending on the L-H switch position, shown. These switches are all operated by a single control. All frequencies less than these maximums are directly proportional to the current. Thus the chart scale is 2000 or 4000 cycles wide and the drift readings are easily interpreted. The chart speed is adjustable and in special cases a higher speed than two readings per minute can be made, although this rate is satisfactory for a two-hour run.

Humidity and temperatures are recorded manually although the temperature time curve for the refrigerator shown in Fig. 1 follows a close repetition pattern and the rate of temperature rise need not be checked. R.R.B.

*See also Fig. 2 on page 111 this issue which describes the operation of this frequency indicator.

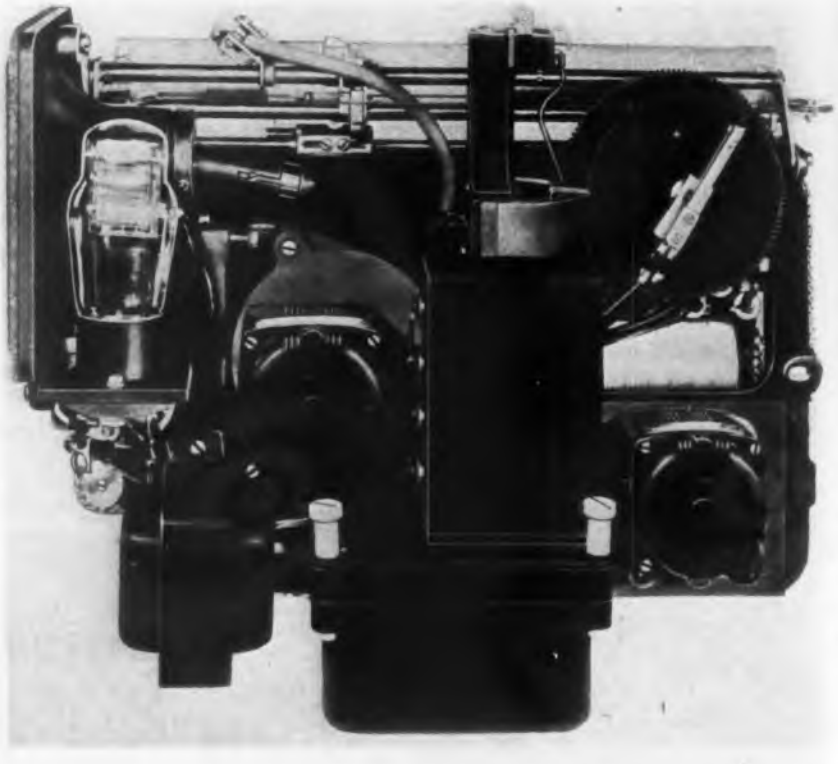

Fig. 5—Rear view of Celectray (Tagliabue) 12-point recorder. Amplifier tube and light, focusing lens, (upper left), and reflecting galvanometer (center). One motor drives the pen movements, and the other advances the chart

A Message to Garcia . . .

1898

After weeks of torturous travel at sea and through matted jungles the famous message was delivered to General Garcia.

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Today military messages of vital importance are delivered in a split second by means of modern radio and electronic devices.

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THE effectiveness of modern radio communications is playing a prominent part in winning the war for the United Nations. And Sentinel Radio is proud to be playing an effective part in it. Four Sentinel plants are producing vital wartime equipment to help the quick conversion of battle strategy into victorious action.

After the war Sentinel, conditioned by wartime experiences, will produce radio and electronic equipment to convert sales strategy into actual sales for Sentinel dealers.

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G-E Operates Course on Naval Equipment

A thirty-day course in electronic applications for Navy personnel and civilian instruction is being conducted by the Receiver Division of the General Electric Co.'s Electronics Department. According to George Devine, who is supervising the course, "the purpose is to instruct those attending classes in (1) fundamental electronics theory, (2) installation and maintenance of specific equipment, and (3) practical application and operation of the equipment. Daily quizzes are given, both for the purpose of grading students and to serve as a check not only on the instructor but to rate the ability of class members to absorb the day's work."

Classes were started about three months ago, each class running about thirty days with sixteen students attending the first two classes. The course has been so successful that the present class has jumped from sixteen to thirty-two pupils. The men taking the course come from navy yards all over the country, including Pearl Harbor, Alaska, and inland ports, such as those located on the Great Lakes. About one-third of the students are civilian maintenance electrical engineers, the other two-thirds being navy men and officers.

RTPB PROBLEMS

(*Continued from page* 85)

rectional operation, type of modulation and the like).

As a part of deliberations on these subjects the chairman has asked that only technical and not human factors be considered, and proposed that pulse transmission versus continuous wave be studied with regard to fading and general performance to determine which system should be recommended for each frequency range. He also asked for consideration of bandwidth ratio, which is the ratio of channel to carrier-frequency, and recommendations as to whether it should be constant or vary with each service and with each carrier-frequency.

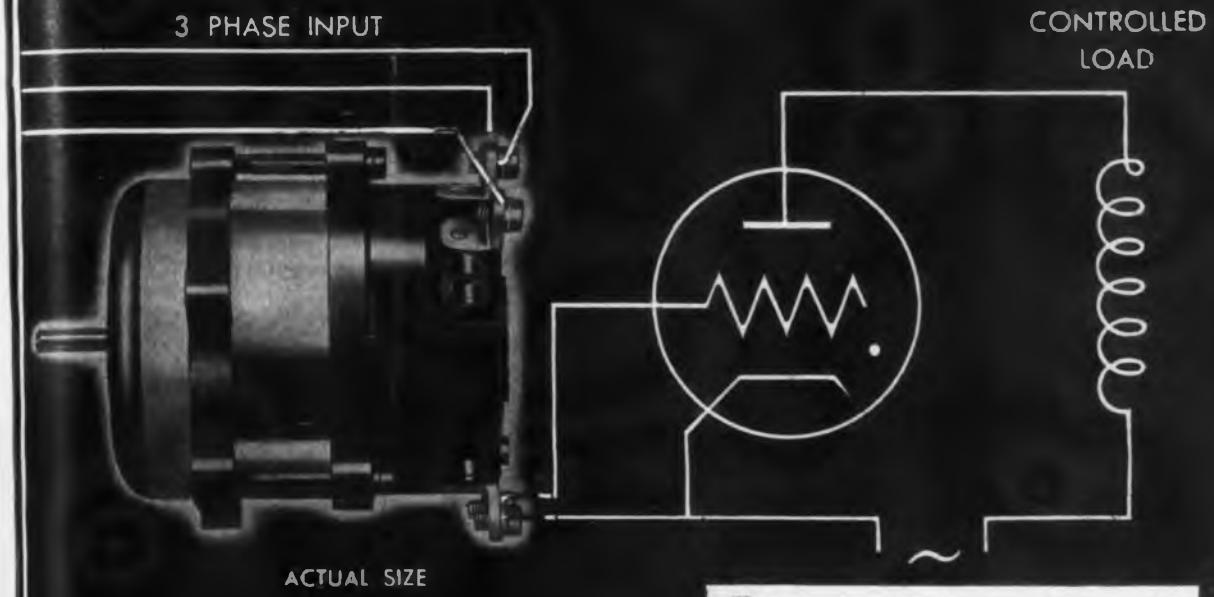
Members of the Carrier-Frequency Capabilities committee include: W. C. Lent, chairman, M. L. MacAdam, L. P. Wheeler, W. B. Lodge, H. B. Marvin, C. M. Jansky, Jr., G. F. Leydorf, W. S. Alberts (alternate) and H. O. Peterson.

"Cleared" members

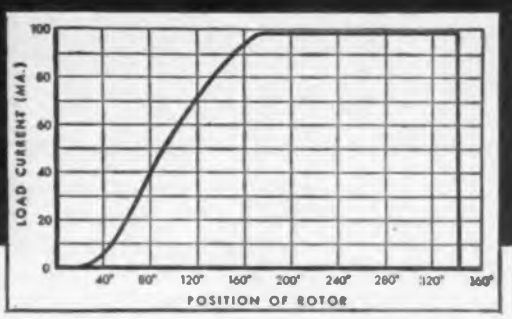
It is obvious that in any deliberations concerning frequency allocations, consideration will have to be given to various government and military services which for security reasons are secret and must remain so for quite some time. Nevertheless, some members of some Panels

Design Engineers!

Here's a versatile unit with many electronic control applications...THE KOLLSMAN CIRCUTROL

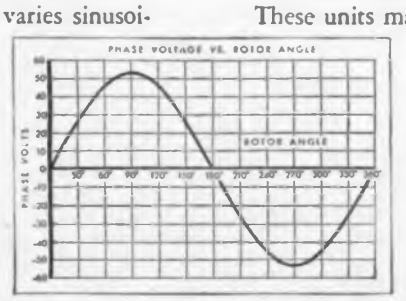


CIRCUTROL UNIT
used as
Thyratron Phase Control



Typical of the many special applications for which design engineers have found the Kollsman Circutrol particularly suited, is phase control of Thyratron type units. In this application the unit offers accurate linear control, as shown by the above graph.

When used as a rotatable transformer, the Circutrol Unit produces a phase voltage which varies sinusoidally with the angular position of the rotor as shown in the graph at right.



Another advantage of the unit as a rotatable transformer is that it is designed to withstand continuous rotation at speeds up to 1800 R.P.M., although many applications require nothing more than positioning of the rotor.

Electrically, the Circutrols are motor-like precision units having high impedance two- or three-phase stator windings and single-phase rotors. Units are available which operate from 32, 115 and 220 volts, 60 cycles, and 110 volts, 400 cycles.

These units may also be used as single or polyphase induction regulators, controllable voltage modulators, single or polyphase alternators or phase shifters.

For complete information about the Kollsman Circutrol write to Kollsman Instrument Division of Square D Co., 80-12 45th Ave., Elmhurst, N. Y.

ELECTRICAL EQUIPMENT • KOLLSMAN AIRCRAFT INSTRUMENTS

SQUARE D COMPANY

ELMHURST, NEW YORK • GLENDALE, CALIFORNIA

have been cleared as appropriate persons to receive classified data for use in guiding their deliberations and shaping recommendations. Thus Panel No. 6 has a committee of cleared members; Panel No. 1 includes 16 members who have been cleared, some for designated frequencies and some for the entire spectrum. Other Panels also include cleared members. It is expected that there will be no great difficulty in getting additional members cleared should that be required.

Dr. Goldsmith points out that while certain groups in RTPB may restrict their efforts to a relatively few problems, others must of necessity consider the entire field. He feels that RTPB as a whole will work for many years and this applies particularly to the engineering groups and the broadcasting people who will desire to study radio technical matters probably into the indefinite future.

For the present, immediate plans of Panel No. 1, summarized following its first meeting on December 22, are the preparation of an ideal frequency spectrum as the basis for deliberation from which it may be possible to weld the ideal and the practical together into something workable for a long time. In any case, both committees are to focus attention on broadcasting problems, including television, in this order: standard broadcasting, high frequency broadcasting, television, and relay links essential to television.

Television objects

Members of Panel No. 6, which has to do entirely with Television and has D. B. Smith as chairman, met in New York on November 26 and as a result of that gathering has been divided into a number of committees each charged with consideration of specific problems. The committees are:

1—Television Channel (Chairman, D. E. Harnett): Number of channels; desirability of commercial operation on all channels versus desirability of reserving some channels for experimental operation; width of channels; UHF channels to be opened in the next five to 10 years; color television.

2—Synchronization and Video Modulation (Chairman, T. T. Goldsmith, Jr.): Desirability of specifying a single synchronizing signal; RMA, Philco and DuMont synchronizing signals; video amplitude modulation versus video frequency modulation.

3—Review of Old Standards and Proposed New Standards (Chairman, Dr. G. R. Town): Review of technical developments during the war period; review of old television standards in view of these developments; consideration of new standards.

(*Turn page*)

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4—Frequency Allocation and Service Limits (Chairman, B. Ray Cummings): Frequency allocation; service area minimum acceptable signal; propagation characteristics; location of carrier within channel; inter-channel interference; channel separation within a given area.

5—Standards of Good Engineering Practice (Chairman, J. E. Brown): Characteristics and adjustments of transmitters; single sideband filter; methods of measurement:

6—Relay Links (Chairman, F. J. Bingley): Studio-transmitter links; remote pick-up links; inter-station links; chain broadcasting of television programs; frequency allocations for relay links.

Future equipment

The matter of frequency allocations for television obviously will depend to a degree upon the development of equipment suitable for operation at higher frequencies presently under deliberation. To help in clarifying this question, Panel No. 6 has requested Panel No. 3 which has to do with High Frequency Generation, to furnish it with curves of the maximum steady state power available at bandwidths of 4, 5, 7 and 10 megacycles, as a function of carrier frequency. Curves are desired based upon high frequency generating equipment at present available and on equipment which may reasonably be anticipated to be available in the future, for example, after two, five and 10 years. The information is to be based on the assumption that present television standards will be maintained except in matters pertaining to band width.

Meetings of practically all the various RTPB Panels either have been held recently or are scheduled for the immediate future. In the meantime all minutes and reports are being handled through Mrs. Martha Kinzie, secretary to Dr. W. R. G. Baker, chairman of RTPB, at the General Electric Co., Bridgeport, Conn.

FEEDBACK AMPLIFIERS

(*Continued from page 87*)

of feedback. Logically then, extensive equalizing should not be carried out altogether in the power amplifier. Distortion will not be reduced for high and low frequencies where its presence is most objectionable to the ear. Some equalizing can take place in the power amplifier, and the remainder can be delegated to a preceding preamplifier. Note also that any distortion and noise introduced by circuits external to those within

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The "flat grid" for beam type tubes was a Tung-Sol refinement. "Flat" winding made possible the perfect alignment of beam type grids, which was difficult to achieve with the conventional circular or oval winding. Another grid-making "bug" eliminated by Tung-Sol was the tendency of grid supports to "bow" in any direction. The supports of all Tung-Sol grids remain true and parallel.

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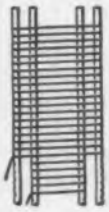
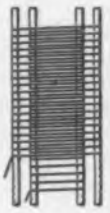
ADVANTAGES OF FLAT GRID WINDING



(Left) The flat-wound grid in TUNG-SOL tubes is sized on a machine that "sets" the grid, thus holding perfect pitch and alignment.

(Right) In the circular-wound grid, there is no "set" or rigidity established, hence wires can sag and get out of alignment.



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the feedback loop will not be affected by this feedback.

An apparent loss of intelligibility may be noted when listening at low volume levels. This is caused by the natural characteristics of the ear, augmented by the reduced output of the loudspeaker at extreme frequencies. Definition will be restored if sufficient equalization is used to compensate for the loudspeaker, although some additional compensation may be used when the signal source is not flat.

Imperfections exaggerated

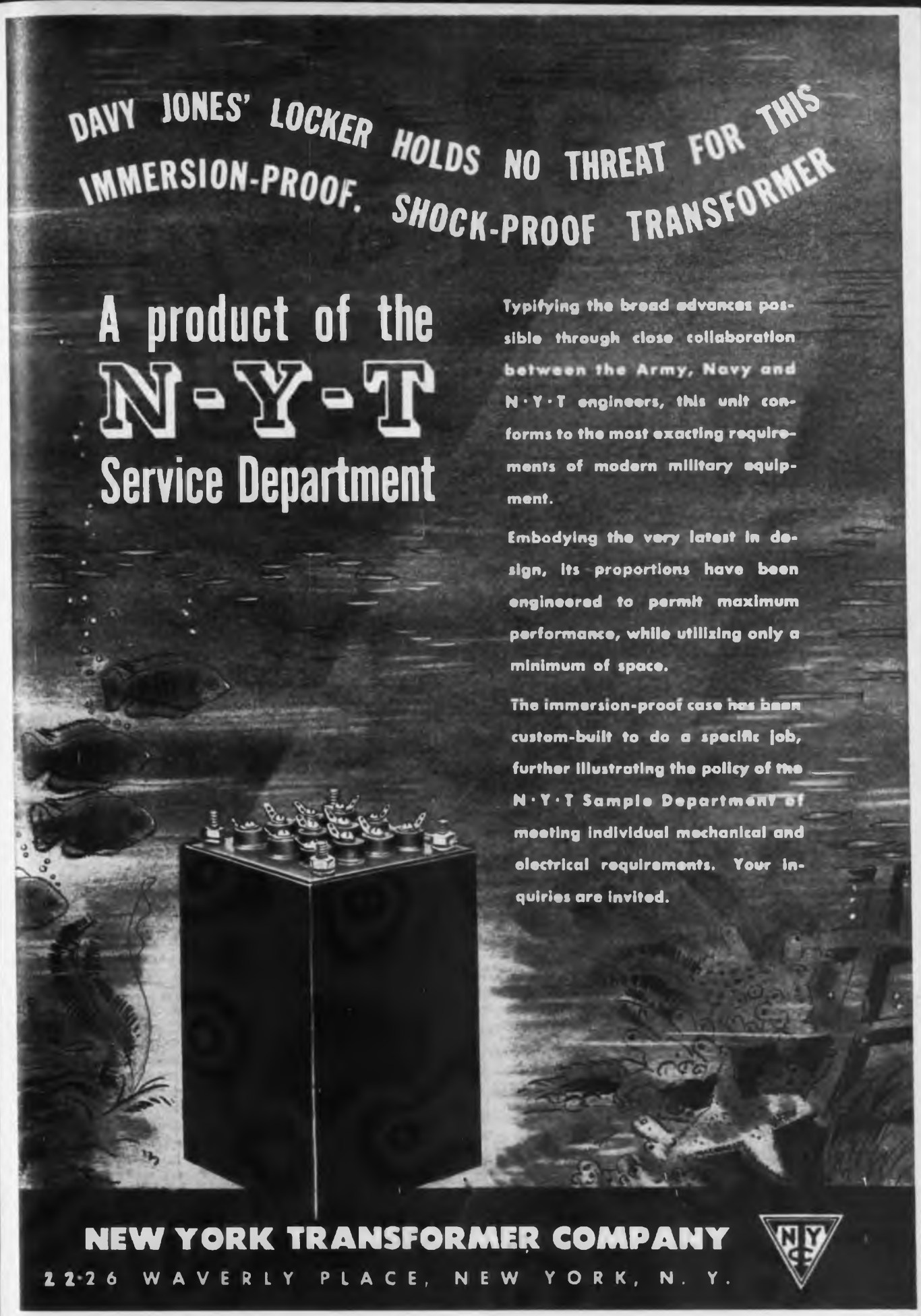
It is important to note that a high fidelity amplifying system will accurately reproduce any imperfections present in the signal source. When extensive equaliz- -an or reason one for used is push is But other, these imperfections will be tremendously exaggerated. Obviously, cheap microphones and phonograph pickups should not be used with such a system, particularly from the standpoint of amplitude distortion.

Although the basic circuit of Fig. 1 is not new, it has proved to be an excellent medium for experiments with large amounts of feedback. An unusual feature is presented by the single-tube phase inverter which gets its bias from the "B" supply and is direct-coupled to the input tube. With 200 volts applied to the plate load resistor R_a from the decoupling network, and R_g set at 1.5 megohms, the plate, grid, and cathode are all 50 volts above ground for a plate current of 1.0 ma. In operation this plate current increases slightly so that approximately 4.5 volts of bias is applied to the grid. The value of R_a has been reduced to 1.0 megohm to compensate for plate current drawn by the input tube, and the 50 volts available at the grid of the phase inverter is directly applied to this plate.

Bias adjustment

Bias adjustment for the phase inverter is automatic, and tolerance in the value of R_g may be ordinary. The signal input to the phase inverter appears between grid and ground, an excellent feature for hum elimination. Driving voltage for the output grids is adequate and is taken from the plate and cathode of the phase inverter (180 deg. phase difference). No bypass capacitor can be used across R_k or serious unbalance would occur.

A very slight high frequency phase difference in the two signals at the output grids does exist, and is caused by some capacity between cathode and heater. This may be minimized by using a separate heater transformer for the phase inverter, connecting the center tap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Typifying the broad advances possible through close collaboration between the Army, Navy and N·Y·T engineers, this unit conforms to the most exacting requirements of modern military equipment.
Embodying the very latest in design, its proportions have been engineered to permit maximum performance, while utilizing only a minimum of space.
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to a circuit point about equal in potential to the cathode, rather than to ground. However, when the heater is operated from a transformer common to the other stages, this phase shift actually is of no consequence compared to that realized with an ordinary interstage transformer, or the more usual two-tube phase inverters.

The elimination of the coupling capacitor and any decoupling network between the first two stages, the absence of cathode by-pass capacitors in these stages, and excellent balance in phase inverter contributes materially to the low inherent phase shift of the amplifier. Because rather large current feedback is also present in the cathode circuit of the phase inverter, no gain is contributed by this stage. The actual stage gain is close to unity for each side.

Tube capabilities

An example of receiving type tubes doing the work of more expensive class B tubes is shown in the circuit of Fig. 4. Four type 6L6G tubes connected in push-pull parallel deliver an output in excess of 60 watts at a plate potential of only 400 volts. Since these tubes are capable of high distortion, inverse feedback is applied in a balanced fashion to both sides of the amplifier comprising the voltage driver and power output stage.

Any distortion generated in the push-pull input stage is reduced by current feedback in the common cathode circuit and the balance is improved. The resistors R_s connected between each parallel pair of 6L6 grids are sometimes necessary to squelch parasitic oscillations at inaudible frequencies common to this connection. Transformer input is shown since perforce a balanced input is necessary. A two-stage preamplifier should easily drive the power amplifier from an ordinary source.

Ordinary power supplies may be used for either of these amplifiers, but a heater winding on the plate transformer should not be used for the amplifier heater circuits. The amplifier tubes should be allowed to reach proper operating temperature before the plate voltage is applied. A voltage surge caused by light loading of the power supply during this heating period may cause momentary oscillation to occur. If the amplitude of the oscillations reaches a high value, stem flashover in the 6L6's may result as well as puncture of the output transformer insulation. The presence of such oscillation may be noted on an ac voltmeter connected across the amplifier output. A slight reduction in the amount of feedback used will also clear up the condition if a check shows that it exists.

RATING DATA

Voltage and Wattage Ratings:—

Resistance Value	TYPE 1 Maximum Wattage Rating	R.M.S. Voltage Rating
Up to 1.9 megohms	12 watts	based on wattage
2.0 to 10 megohms	9 watts	9 kv. max.
Above 10 megohms	based on voltage	10 kv. max.

Resistance Value	TYPE 2 Maximum Wattage Rating	R.M.S. Voltage Rating
Up to 3.9 megohms	22 watts	based on wattage
4.0 to 20 megohms	15 watts	15 kv. max.
Above 20 megohms	based on voltage	20 kv. max.

Temperature Rating:—
Maximum recommended hot spot temperature for continuous operation: 130°C (Ambient plus rise).
Maximum recommended ambient temperature for full wattage ratings: 70°C.

Temperature Coefficient:—
Approximately .04% per degree C between 20°C and 130°C.

Resistance Tolerance:—
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(a) Hermetically-sealed to withstand salt water immersion tests.

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Entirely unique in construction, Meg-O-Max Resistors are formed of a series of molded segments. These are joined non-inductively, and the assembly is then encased in a hermetically-sealed, rugged glass envelope provided with ferrule terminals to withstand aircraft vibration tests, salt water immersion tests, and tests for mechanical shock produced by rapid acceleration.

In addition to use as a high-voltage bleeder and as a broad accuracy meter multiplier for a voltage indicator, Meg-O-Max Resistors find many applications in measuring instruments, rectifier systems, high-voltage dividers, and as broad accuracy meter multipliers. Specify Meg-O-Max for High-Resistance—High-Voltage requirements.

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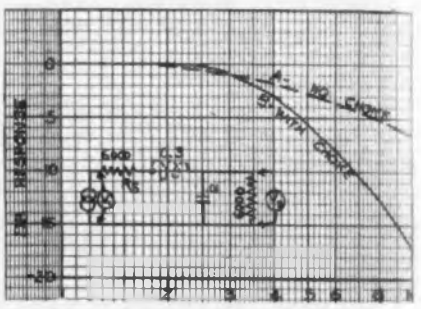
TRADEMARK REGISTERED

MODULATOR LOAD REACTANCE CORRECTION

(*Continued from page* 109)

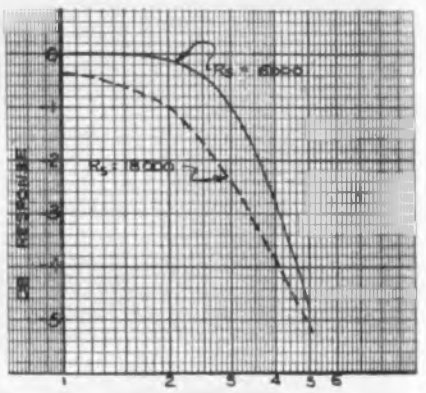
4 kc the load appears as an inductive reactance.

The frequency response characteristic of the circuit for a generator internal impedance of 6000 ohms is given by Fig. 5. Curve A shows the attenuation without the choke and illustrates the effect of the by-pass condenser. Curve B represents the condition with the choke added and shows an improved frequency response up to the cut-off frequency and increased attenuation at higher frequencies.



KILOCYCLES PER SECOND

Fig. 5—Frequency response



KILOCYCLES PER SECOND

Fig. 6—Frequency response

These curves represent the condition where the source impedance is equal to the load impedance.

A class B audio amplifier will present a higher ratio of source to load impedance but this does not seriously affect this system. The effect is to cause the attenuation of the output voltage beginning at slightly lower frequency, and the attenuation at frequencies above cut-off is slightly increased. The change in frequency response for a generator impedance of 18,000 ohms instead of 6,000 ohms is shown in Fig. 6.

Fig. 7 shows the relative magnitude of the excitation voltage of the series choke operating in the circuit of Fig. 5. The ordinate expresses this rms voltage as a percentage of the 100 per cent modulation output voltage appearing

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across the load resistance. The terminal voltage reaches a maximum of about 1.3 times the output voltage at a frequency slightly above the filter section cut-off frequency. A choke operating in the modulator example previously described would have an inductance of 0.35 henry, and the maximum terminal voltage would be approximately 1700 times 1.3 or 2200 volts rms at 3500 cycles. This voltage would be expected to drop to around 500 volts when the frequency is decreased to 1000 cps.

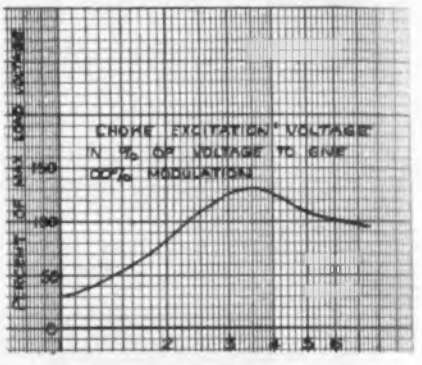

Fig. 7—Excitation voltage of series choke in Fig. 5 circuit

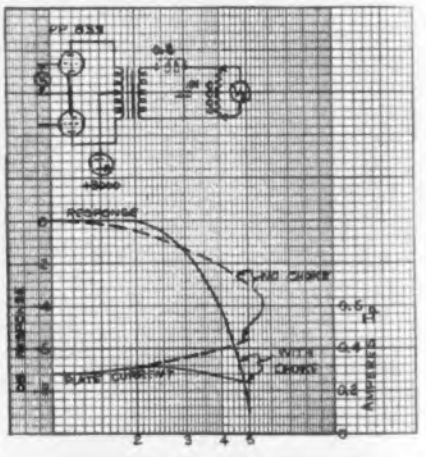

Fig. 8—Effect of addition of series reactor on attenuation

Fig. 8 gives the results of an actual test of this system. The circuit diagram illustrates how a push-pull type 833 class B amplifier was coupled to a 6000 ohm load through a suitable ½ kw modulation transformer. The grid voltage was maintained constant and the output voltage at the 6000 ohm load measured over the desired frequency range. The actual transmitter load circuit was simulated by connecting a 0.01 mfd by-pass condenser across the load resistance.

The response curves of Fig. 8 indicate that the addition of the series reactor will increase the attenuation of the output signal for frequencies above 3000 cycles but the attenuation is decreased for frequencies between 1 and 3 kc. The plate current for the uncor-

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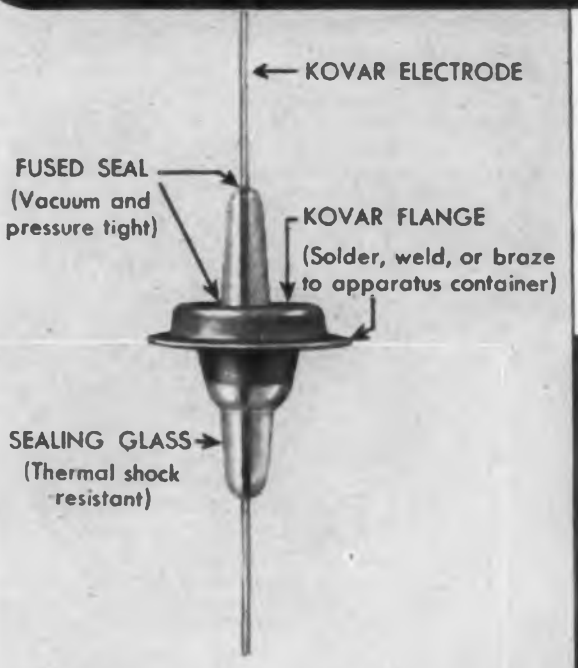

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STUPAKOFF CERAMIC AND MANUFACTURING CO., LATROBE, PA.

rected system increased from 0.28 ampere at 1 kc to 0.44 ampere at 5 kc indicating that the load impedance was decreasing. The plate dissipation of the amplifier tubes was greatly increased at the high frequency. When the choke is included, the plate current increases slightly for frequencies up to 2500 cps as would be expected from data shown by curve B of Fig 4, and then it decreases for higher frequencies. It is now possible to further increase the input frequency beyond 5 kc at constant amplitude without danger of damaging the amplifier tubes.

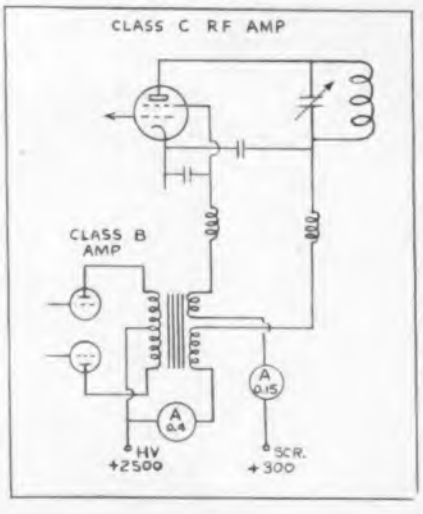


Fig. 9—Circuit with separate plate and screen windings

This system may also be used for pentode types of rf amplifier tubes. Fig. 9 shows a typical installation where separate plate and screen modulator windings on the modulation transformer are used. The usual system is to arrange the turns ratio of the secondary windings so that the plate and screen instantaneous voltages will become zero at the same time. Assumed operating conditions for the example are a plate supply of 2400 volts at 0.4 ampere with 0.01 mfd by-pass condenser. The screen grid supply is assumed to be 300 volts at a current of 0.15 ampere and a 0.02 mfd by-pass condenser is assumed to be installed.

It is necessary to install the series chokes in both plate and screen supply leads, and the circuit constants should be adjusted so that both plate and screen circuits have approximately the same cut-off frequency. Failure to do this will result in unsatisfactory operation of the class C amplifier as the ratio of the plate and screen voltages would not remain constant, and they would not be in phase at all frequencies.

We have previously determined that the plate circuit would have a choke of 0.35 henry installed and the cut-off frequency would then be 2700 cps. The screen circuit has a load impedance of 300/0.15 or 2000 ohms. Substitution of this value and the above cut-off frequency value of 2700 cps in equation (2) gives a condenser value of 0.03 mfd. The shunt condenser in the transmitter should therefore be increased from 0.02 to 0.03. Now by substitution of the load impedance value of 2000 ohms and the cut-off frequency of 2700 cps in equation (1) the required series choke is found to be 0.12 henry. The maximum rms signal voltage for the screen winding of the modulation transformer would be 300/1.4 or 215 volts. The maximum excitation voltage for the screen supply choke would be 215 times 1.3 or 280 volts rms.

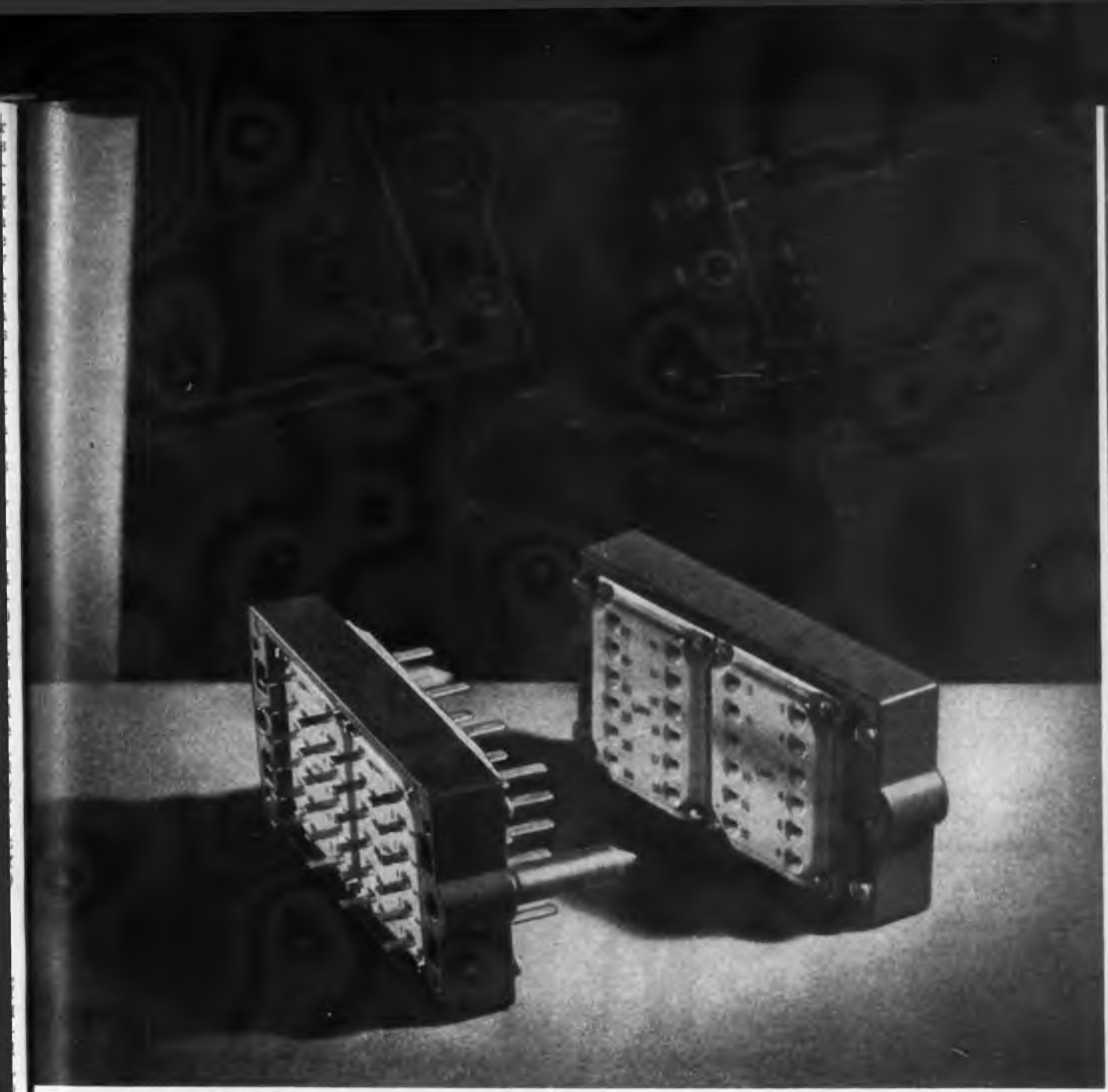
These chokes must be carefully designed for satisfactory operation. The plate circuit should have an inductance of 0.35 henry with a direct current component of 0.4 ampere and a variable ac excitation reaching a maximum of 2200 volts rms at 3500 cps. The dc resistance of the winding must be low and a value of 50 ohms would be reasonable. The winding must be properly insulated to withstand this excitation voltage and possible transient voltages during operation. The screen supply choke would have an inductance of 0.12 henry with a direct current component of 0.15 ampere and a maximum excitation voltage of 215 volts rms at 3500 cps. A reasonable value of winding resistance would be 200 ohms.

WINDING CAPACITORS

(*Continued from page 113*)

tronic and communication circuits, the working insulation consists of special capacitor paper of purified wood cellulose. Research and experience have proven this material best for high voltage dc service, particularly when necessary to operate at elevated temperatures. A multiplicity of thin sheets of the insulation is wound into working sections with thin aluminum foil electrodes. A minimum of three sheets at any voltage, and an increasing number of sheets for higher voltages, insure against the possible line-up of defects and conducting particles that may be encountered in the use of a fewer number of relatively thick sheets. For ac applications, a kraft paper is often used.

To remove any trace of moisture after assembly, the capacitor units are vacuum-processed and then impregnated with a non-explosive, non-inflammable liquid dielectric called Inerteen. In processing, a group of units is placed in a vacuum treating oven and dried for approximately 200 hours by application of heat and vacuum. This process is continued until the rate of moisture emission, as determined by direct measurement, has reached



An Electronic Part... ENGINEERED TO A SPECIFIC NEED

This is a special-purpose electronic part. It is a plug-receptacle assembly for use with rack-panel type of mounting. Twenty-four silver-plated phosphor-bronze contacts are provided, each male and female contact full floating between steatite plates. Heavy guide pins and matching holes in the frame assure perfect alignment.

We don't know that your product has any need for such a part as this. We do know, however, that this part is most exactly suited to its special requirement, just as are hundreds upon hundreds of other parts which have been created through Lapp engineering and Lapp production facilities directed to the solution of specific problems.

With a broad basic knowledge of ceramics—their capabilities and their limitations—Lapp has been able to simplify and to improve many types of electronic equipment through engineering and production of sub-assemblies that make most efficient use of porcelain or steatite and associated metal parts.

There may be a way you can improve performance, cut costs and cut production time through use of Lapp-designed and Lapp-built sub-assemblies. We'd like to discuss your specific requirements with you.
Lapp Insulator Co., Inc., LeRoy, N. Y.

Lapp

ARMY E NAVY

a minimum under the correct temperature conditions and a pressure of less than 100 microns. Provisions are made for feeding Inerteen into the capacitors individually and from the bottom of the capacitor container and at a carefully controlled rate to permit the escape of surface moisture that is released as the Inerteen impregnates the paper. Previously dehydrated Inerteen is being allowed to flow gradually into the capacitor units. It is transferred from the sealed drums through filters directly into the capacitor units, avoiding any contamination through contact with the oven walls or external surfaces of the capacitor cases.

Many capacitors are hermetically sealed by soldering the porcelain bushing to the metal case. This eliminates all gaskets, or the use of cork, gum, or similar materials for sealing terminal bushings to the case. A metallic band, integral with the porcelain glaze permits bonding direct to the porcelain. A typical design consists of a single piece of wet-process porcelain. Metallic bands are made a part of the glaze, forming a surface to which solder adheres.

The metal mounting ring and terminal stud are soldered to these bands to form the complete bushing, after which the assembly is threaded over the lead and soldered to the capacitor case. The lead is soldered at the top of the terminal stud to form a hermetically sealed capacitor. This insures against moisture entrance, or any contamination of the insulating medium. It is positive insurance against leaks regardless of position in which unit may be mounted or operated. The one-piece porcelain and solder seal eliminates the two-piece porcelain, and the multiple gaskets. Should the bushing ever become damaged through accident or abuse, it may be replaced with minimum expense or loss of operating time.

ENGINEER EXECUTIVE

(*Continued from page* 103)

ratus is for, not to solve the problem—but to change a mental attitude that is inside the skull. And that is a very difficult thing to do.

That brings up another fundamental thing; to try to find out what the limiting factors are on the job at which you are working. For the last twenty-five years, between the two wars, fuels have improved fifty octane numbers. We fought the other war with 50 to 60 octane, and now we are from 100 to 150. That is two octane numbers a year or so. After we moved up two octanes, everybody would tell you it didn't do any good to go up another two, but you couldn't go back the two that you just last came up

on, but we said, "Why don't we find the limiting factor of octane? What is the limiting factor?"

Well, everybody said, "Why, we wouldn't want to know that. You haven't any engines that will use it." And so we have tried to find out what the limiting octane fuel rating is. We think it runs on an extended scale, if we extend our present octane scale, it will run up some place between 350 and 400, you see, and I think it just as easy to go up there as it is to take cuts on it every year, or go up two octane numbers a year.

Well, now, you get into all sorts of problems with the commercial fellows because they say, "Well, you can't move up because we haven't got the equipment," and so forth; if we go up there, they say, you haven't really got the engines that would use it. We know that, but nevertheless if you know what your limiting factor is, then you know how to work the thing.

One of the things that you must take into consideration, that is very much more important than a patent, is, a great many people will think you crazy, and that is very much better protection than any patent.

Ignorance factor

I would sooner have my competitor think I am crazy than have a whole pack of patents, because he won't pay any attention to what I am going to do as long as he knows I am crazy. I had a monopoly of the lighting and starting ignition business for five years because everybody knew the breaker mechanism I used in my ignition system was all wrong and nobody copied it. They infringed every patent I had, but they didn't infringe my ignorance factor.

Therefore, whenever you look at a thing and whenever you get these young fellows to look at something and they say, "Well, the fellow who did that was crazy"—if you are going to train him to be an inventor, you say, "Well, now, I wouldn't say it that way." I would say, "One of us must have been crazy, or maybe both of us, a little bit."

Whenever you look at a piece of work and you think the fellow was crazy, then you want to pay some attention to that because either he is or he isn't. But, one of you is likely to be, and you had better find out which one it is. It makes an awful lot of difference.

I have been taking out patents for many years and making inventions for many years. When I first began to apply for patents, I found out that almost all of my inventions had been made fifty or sixty years before. So I drew a set of coordinates and I plotted how

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SYLVANIA

ELECTRIC PRODUCTS INC.

RADIO TUBES, CATHODE RAY TUBES, ELECTRONIC DEVICES, INCANDESCENT LAMPS, FLUORESCENT LAMPS, FIXTURES AND ACCESSORIES

much behind I was. Then as I went along a little more in the industry I gained, and so the curve began to have a slope. In other words, I was only forty, thirty, twenty-five or twenty years behind, and so on. Now, when I project that curve down until it cuts the base line, that's how old I will be when I make an original invention. That comes out to be a hundred and twenty-five. That is the reason why I am trying to take good care of myself, because I would like to live to make an original invention.

The job's the boss

We have one rule, and only one rule, and that is: The only boss in our laboratory is the job. The job is the boss. Do you think that engine is any good? What does the engine think about it? Is that piston better than the one you had in the engine before? What does the engine say about it? Your opinion isn't worth anything.

If the engine says, "I like this one and don't like that one," and that happens to be contrary to your own ideas, that's just too bad; you were wrong. After all, all this work and all this research is only to correct the mentalities or to turn over a few molecules in our heads so we think straight.

We try to teach our boys in the laboratory and every other place that this getting a new idea, this questioning of things, is a very important idea. We have done a lot of questioning on various things, and we get certain rules and regulations which we write down; and we kind of accept those things as being fundamental dicta.

We have taken ordinary lubricating oils that, on our Diesel engines, would not run a thousand miles without gumming up, and have gotten them to run a hundred thousand miles without gumming up, by adding certain anti-oxidents and detergents and so forth. From a thousand to a hundred thousand is a good gain in percentage.

Positive results

Therefore, all along the line of these perfectly obvious things, when you get not 5 or 10 per cent but thousands of per cent gain, by questioning the thing intelligently, and intelligently analyzing it, you get the inspiration of the fellow working against a perfectly negative objective, by giving him a perfectly positive result.

You can't slow down too far or you just never get any place at all, because there is a normal increment of improvement made by the development of the industry. But there are a lot of these problems where, if you have any solution at all, the question of how long it is going to take to get it doesn't mean anything. But you must show the fellow who is going to work on that job that there is some chance to get out on the thing, or he won't try it.

But you must know whether the thing is worth doing first, and then you are always going to come to the time when you cannot solve the problem. Those are dark days. Those dark days, of whether you go ahead or stop, are the determining factor of whether you are a success or a failure. But you must intelligently analyze that point.

Therefore, you have to teach these boys how to get along with people, especially when you are working on a new thing and everybody comes in and says, "What the hell are you doing that for? That is no good." You have got to keep their spirits up under those conditions.

We believe that we can even take educated young men and teach them to be inventors, without ruining their educations.

TRANSFORMER DESIGN

(Continued from page 99)

The ratio is increased by increasing the current density or by decreasing the flux density.

Returning to the core of general dimensions since $A_i\ A_c = K$, then for a given rating an increase in A_i decreases A_c, and the copper loss will decrease as A_i is increased (B and D assumed constant). The core loss is increased since the weight of the core is increased. The ratio $\frac{\text{copper loss}}{\text{core loss}}$ can therefore be changed by varying A_i or by varying the flux and copper densities.

Since power is required to magnetize the core the ampere-turns in the primary winding are greater than the total ampere-turns in the secondary windings. This current is wattless but increases the copper loss in the primary winding because of the higher current flowing in the primary winding.

Magnetizing Voltamperes

$= w_m \times$ weight of the core in lbs.

$= w_m \times t_i\ f_i\ A_i \times 0.272$

w_m is obtained from tests on a large number of cores so as to obtain a minimum and maximum value as well as an average value as it varies widely even for cores of the same punching made of the same lot of steel at the same time.

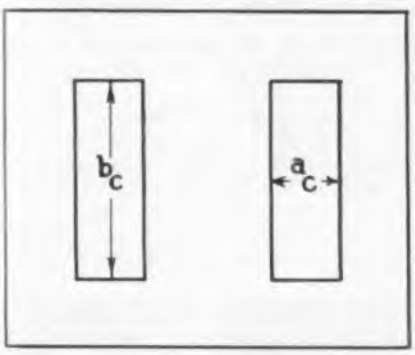
In addition there is a drop due to the resistances of the primary and secondary windings. When there is only one secondary winding these drops and their vector addition can be shown very simply by a vector diagram. This diagram is given in Fig. 2 with the voltage

drops and core loss and magnetizing currents exaggerated to make the diagram easier to follow. It is also assumed that the transformer ratio is one to one.

This diagram shows that the voltage drop is the vector difference between V_p reversed and V_s and that the resistance component is important at high power factors and the leakage reactance at low. The drop is a maximum when the power factor of the load is the same as the power factor of the transformer leakage impedance.

When there are two or more secondary windings, the calculation of the voltage drops becomes involved and soon becomes impossible. However, in small units, 500 va or less, the power factor of the load is high, nearly 100 per cent, and the resistance drop in the windings is the most important factor and can be calculated quickly. Further, there is usually one winding with a va rating very much greater than the others and its voltage drop can be calculated fairly simply.

When, however, the large va winding feeds a rectifier with a condenser input or a voltage doubling connection, then the leakage reactance becomes important. In these circuits power is drawn from the capacitors at a constant rate while the transformer feeds power back into the capacitor during a small part of the cycle. The



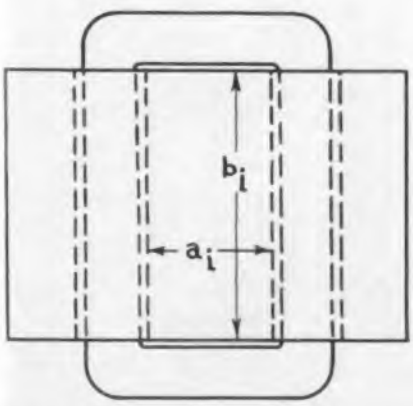


Fig. 1—Scrapless type of punched out lamination

shorter the time of current input, the higher the peak value of the current. This current must flow through the leakage reactance of the transformer. The leakage reactance therefore reduces the peak value of the current but lengthens the time interval during which the current flows.

The output voltage drops in order to give the necessary differences between the transformer input voltage to the capacitor and the average voltage retained by the capacitor, and thus supplies the condenser with the energy necessary to carry it through the non-charging period.

NORTH AFRICA INSTALLATION

(*Continued from page* 102)

for the many audio circuits. Finally metal braid was secured from the Air Forces and insulated wire threaded through it inch by inch. Eight radio lines—some of them phantoms within phantoms—connect the studies with the various transmitters, all within a radius of 15 miles. These lines, part French, part British, part American, have so far rendered good service.

The first station went on the air June 14, Bastile Day, and was operated in part by control room and other engineers who had been trained on the spot. Besides the two 50kw and one 100kw stations in the broadcast band, there is the former WINS 50kw transmitter, which is capable of both long and short wave emissions.

About results

At a nearby point an installation of dual diversity receivers permits the rebroadcasting of OWI New York and BBC London short wave programs. The North African studios maintain their own news desk and program staff and command four languages. The intensive effort involved has been repaid in this modern war of ideas and propaganda. Although technics involved cannot be discussed, it is a well-known fact that among the more tangible results have been the blowing up of bridges and other transportation mediums, and communication and manufacturing centers by friendly Italians instructed to do so over these OWI stations.

It has been officially admitted that the 50kw WABC transmitter did what the British Navy had tried in vain to do for three years. When the Allies struck at the Italian mainland, the North African radio staff, working at white heat, shifted the frequency of this powerful transmitter to 500 kilocycles, the International distress band, and persuaded almost the entire Italian fleet to put to sea for Allied ports.

NEW STAR

Time was when entertainers
On the air
Were feted guests at parties
Everywhere,
But now the guest who steals
The party-show,
Is the fellow who can fix
The radio!

—Mary B. Ward

Televisors Organize

Television Broadcasters Association was organized in Chicago Jan. 18. Allan B. Du Mont, chairman of the organization committee, stated that interests represented in the new association expected immediate aggressive action to obtain for television allocations of radio channels in keeping with the possibilities of television. In addition to Du Mont other members of the organizational committee are: F. J. Bingley, (Philco); Robert L. Gibson, (General Electric); O. B. Hanson, (NBC); C. W. Mason, (Earle C. Anthony, Inc.); E. A. Hayes, (Hughes Tool Co.); Worthington Miner, (CBS); Paul Raibourn, (Television Productions, Inc.), and Lewis Allen Weiss, (Don Lee Network).

Army-Navy E Awards

The H. M. Harper Company, 2620 W. Fletcher St., Chicago, Ill. (third award)

Orange Screen Company, Maplewood, N. J. (star added)

Radiomarine Corp. of America, 75 Varick St., New York., N. Y. (second star added)

J. P. Seeburg Corp., 1500 Dayton St., Chicago, Ill. (star added)

Floyd W. Bell, president, and Earl W. Hosier, vice-president of Bell Sound Systems, Inc., Columbus, O., receiving "E" pennant from Col. H. R. Yeager

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NATIONAL INDUSTRIAL EMERGENCY SERVICE

INCREASE PRODUCTION

(*Continued from page* 112)

to have an adequate supply of electronic-radio equipment for training purposes as well as for the use by combat troops. Because equipments, now in use, require complete familiarity with their operating technics, it is imperative for troops to have sufficient training before going into battle so they can use the equipment efficiently — almost as second nature — during the tremendous strains and stresses of actual combat.

General Harrison stated that the indicated 1944 demands will be approximately 30 per cent greater than during 1943. The needs next year of getting the equipment to the theaters of war must be carried on with sustained emphasis in production. The manufacturing of electronic equipment is generally across-the-board embracing all types of military communications apparatus.

In the wire communications manufacturing field, General Harrison stated that there is a huge demand for drop wire and cable and field telephones, particularly for shipment to the United Nations under the lend-lease program. Thus there can not be any let-up of a substantial nature for this industry. (An illustration of the importance of telephone equipment in the lend-lease program was reported Dec. 28 by Foreign Economic Administrator Leo T. Crowley who stated that in the shipment of goods to Russia up to the end of last October there was included 225,000 field telephones and 750,000 miles of field telephone wire.)

General Harrison declared that the Signal Corps was trying to press ahead as speedily as possible with the task of renegotiation of completed contracts, but he brought out that this renegotiation activity necessarily has to take a place behind the imperative job of producing equipment for the combat forces. The Signal Corps is now completing renegotiating processes in regard to 1942 contracts.

PRODUCT DEVELOPMENT IN POSTWAR

(*Continued from page* 89)

group. Unless there is a reasonable certainty that these will draw favorable answers, there could be no use going further. For example, "tooling cost"—suppose $20,000 were necessary for an item with a $1 selling price and a 20,000 annual volume. It would be foolish to even waste paper or one minute's time getting to that particular point. If that is the tooling charge and no alternate method is in sight, the product then and there is out.

This illustration may seem exaggerated, but time after time individuals and companies have spent weeks on a product before finding such a glaring flaw. The trained mind will recognize a defect of this nature immediately, but he might overlook an objection just as serious but of a less obvious nature.

Once these key questions have been pulled out and given a superficial examination to see that the product looks well enough to investigate fully, the remaining questions should be arranged in a convenient order, such as importance, department, individual or class. Each particular question should be then studied in conjunction with the organization chart to see who would be best qualified to state the facts or give an opinion on that subject.

Less tangible factors

For example, there will be some things that will require a machine adaptability answer, others the cost of an item of machinery. Other less tangible factors will require personal discussion with engineers, supervisors or department heads. Still others will require reference to textbooks, or trade publications. It may be necessary in certain cases to travel to another company to delve into their experience along similar lines.

Any question should be considered in its relation to the whole before going to extraordinary expense in tracking it down. Generally speaking, if the questions are framed properly, the great majority will require only a few minutes for obtaining complete answers. Again it should be stressed that only by directing the question at a source that normally should know,—rather than haphazardly asking around—can a clear, intelligent and unconfused pattern result. The same is true of a question calling for an opinion.

The answer to each question should be written or summarized on the sheet or card on which that question appears. The source of the answer—name, title or job, if verbal; page, text and author, if written—should be put right down at the same time with any pertinent comments that seem necessary.

Cross checking

It is not necessary to verify all facts or to substantiate all opinions. Those that are of vital importance or anyone that shows signs of being weak, poorly considered or hasty should be subjected to a routine double check.

The care with which this is to be done naturally varies with the type

of product under scrutiny. If it is one that may possibly have a profound influence on the company's operation, no stone should be left unturned. On the other hand, if it is merely some accessory product, the direct examination of all factors should suffice.

Cross checking can be done in a number of ways. In most cases, alternative answers obtained from other persons in the organization will prove quite satisfactory. On certain doubtful points, it will be necessary to go outside of the company. An instance would be the case where the speed with which a certain operation could be performed doesn't look right. It becomes desirable, therefore, to find out how that operation is being done elsewhere. On occasion, a cross check of this type has shown a two or three to one difference existing. The development of such a situation as a fact does not necessarily mean that one company is deficient—good reason may exist—but it does mean that the information might be decidedly misleading if the situation were not laid on the table as a part of the data presented.

Preparing conclusions

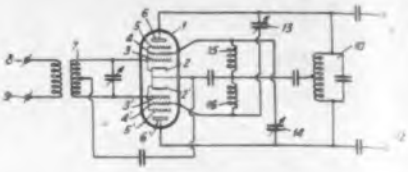
When a sufficient number of answers to the "internal factor" questions have been obtained, it is necessary to see that our file on the subject is in such condition that it is of maximum use in preparing conclusions. More studies of products, operations and the like, have been made to an end result of merely having on hand an accumulation of confusion. But setting up a "mechanical" system of arrangement, this can be avoided.

The whole theory of a check list, single questions (fact and opinion separated) and a central control point, will tend to channel the data. The questions should be grouped into proper sections and arranged, not alphabetically, geographically or departmentally, but rather by the relation—or if you will, by pigeon-holes, card indexes or file folders—that they bear to the whole "internal factor" picture. Until such an arrangement is completed, the compiling of data cannot be said to have been more than merely "interesting."

By properly selecting the data desired, going to the right persons and places to find the answers, cross checking these where indicated, and then segregating the material into a usable arrangement, it is possible adequately to find out how the various internal factors for a new product affect its possibilities. The next step is to relate this assembly of information in such a way that it is understandable. A forthcoming article will deal with the manner of its presentation in report form.

NEW PATENTS

(*Continued from page* 204)



cies the inductive feedback considerably exceeds the capacitive feedback. By connecting the screen grid of one tube through an adjustable condenser to the plate of the other tube, the inductive feedback may be compensated for. A. Van der Ziel and M. J. O. Strutt, Alien Property Custodian, (F) May 9, 1941, (I) Nov. 30, 1943, No. 2,335,820.

HF Remote Control Relay

A gas-filled tube 1 is used to effect remote control of a relay by radio signals; the relay may control a model airplane. The voltage of battery 7 is adjusted to a value above the breakdown potential of the gas filling. When a carrier radio signal is tuned into the

antenna circuit, the anode current flowing through coil 12 will decrease to a considerable degree; it may become ten per cent of the current before the reception of the carrier wave. This difference in current is made to actuate the armature 13 of the control relay. R. H. Packard, Raytheon Production Corp., (F) Aug. 1, 1940, (I) Nov. 2, 1943, No. 2,333,119.

MISCELLANEOUS

Electron Microscope

In electron microscopes, electrons slowed down during their passage through the object, or of lower velocity when emitted, produce blurring of the image. To minimize this effect, a braking electrode is provided in proximity to the image-reproducing surface for preventing slowly moving electrons from reaching the surface. Due to the fact that the braking electrode is close to the image-reproducing surface, its shadow does not obscure the image to an objectionable degree. Various embodiments are shown. Thick objects may be investigated with the improved apparatus. H. Boersch, General Electric Co., (F) Aug. 23, 1940, (I) Nov. 30, 1943. No. 2,335,637.

Protecting Transmitters

A heat-responsive element (for instance the plate resistance of an electron tube the cathode of which is heated or a resistor having negative temperature coefficient), is connected in parallel with the energizing winding of the transmitter

keying relay. Should the switch which closes the relay winding circuit be closed longer than is desirable, the element becomes warm, its resistance is lowered, and the current through the relay winding diminishes to such an extent as to make the relay open the transmitter circuit. P. D. Andrews, General Electric Co. (F) May 9, 1942, (I) Nov. 16, 1943, No. 2,334,530.

Induction Compass

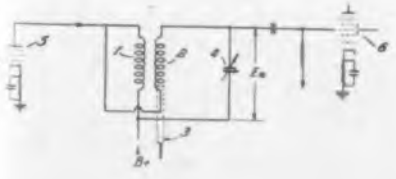
Two cooperating induction compasses are used which are polarized in different directions, whereby two cardioidic voltage patterns, differing in phase by 180 deg., are obtained. The voltage difference is rectified, amplified and used to control a motor which rotates the compass so that it always indicates correctly. H. V. Alexandersson, and A. S. Dahlstedt, Aga-Baltic Aktiebolag, (F) Jan. 12, 1942, (I) Nov. 16, 1943, No. 2,334,469.

Color Television System

Three picture signal sets, corresponding to three different colors, are transmitted. Two color signals are transmitted as frequency or phase modulation, alternate frames being scanned with different colors so that the odd lines represent one color and the even lines the other color; simultaneously, the third color signal is transmitted as amplitude modulation of the some carrier. Alternatively, two colors may be transmitted as amplitude modulation and one color as frequency or phase modulation. At the receiver, the carrier is demodulated as to amplitude and frequency or phase; one demodulation is applied to one cathode ray tube, the odd lines of the other to a second cathode ray tube and the even lines to a third cathode ray tube. The three colored pictures are optically superimposed. Transmitter and receiver are described. E. F. W. Alexanderson, General Electric Co., (F) May 27, 1941, (I) Nov. 9, 1943, No. 2,333,969.

Permeability-Tuned Circuit

It is intended to obtain a uniform radio frequency response and high overall selectivity over a complete tuning range of a resonant circuit tuned by moving a magnetic core into and out of two coils. Serially-connected coils 1 and 2 are concentrically arranged, coil 2 within coil 1, but spaced from one another so that their inductances are varied uniformly and concurrently but at different rates when core 3 is moved along their common axis. The mutual coupling coefficient between the two coils is also changed. As core 3 is brought into the field of coils 1 and 2, the inductance of coil 2 is



changed by a greater proportion than that of coil 1 because of its closer proximity to core 3. With the proper choice of the diameters of coils 1 and 2, the change in the impedance of the plate circuit can be varied in such a manner as to produce a constant voltage across the grid of the succeeding tube 6. Plate of tube 5 and grid of tube 6 may be connected at other points of the resonant circuit than shown. R. De Cola, Belmont Radio Corp., (F) Dec. 13, 1940, (I) Nov. 16, 1943, No. 2,334,670.

JETT APPOINTED

(*Continued from page* 124)

tions of Governmental and military radio-frequency requirements as Chairman of the Interdepartment Radio Advisory Committee, the agency which recommends government frequency allocations to the President, when he was Chairman of that committee during 1939-41. He also has been an important governmental expert in aviation radio operations and frequency planning activities.

The new Commissioner was to make his first address since assuming that post on Jan. 29 before the New York meeting of the Institute of Radio Engineers. Commissioner Jett has been a leading member of the IRE for many years and is a Fellow of the Institute. While he was still Chief Engineer, Commissioner Jett presented a most interesting and constructive exposition of the frequency allocations problems and postwar radio and communications needs before the Senate Interstate Commerce Committee while it was considering the White-Wheeler Bill.

He has had his fingers on the pulse of the role of radio and communications in war for the past four years from 1940, the period of national defense preparedness, to the present time. He was the main cog of the Defense Communications Board, since its establishment in 1940, and of its successor, the Board of War Communications as Chairman of the two Boards' coordinating committees which directed the work of the sixteen industry and technical advisory committees of the BWC.

Commissioner Jett has been called upon to serve the United States in the capacity of a communications-delegate and expert at seven major international conferences. He was named by President Roosevelt as a delegate of the United States at the Cairo International Telecommunications Conference in 1938 during which he played a leading role in that conference's formulation of the prewar allocation of ultra-high frequencies. He also represented the United States at the Inter-American Radio Conference at Havana and the North American Regional Radio Conference there in 1937. The same year he represented the FCC at the Alaskan Radio Conference at Juneau. In 1933 he was a member of the American delegation to the North and Central American Radio Conference in Mexico City.

Commissioner Jett has served continuously in the Navy and in Federal Government service, the Radio Commission and the FCC, since he was 18 years old. He is particularly proud of his Navy career and radio experience from 1914-16 and during World War I and for the nine years after that war before he retired from the Navy and joined the Radio Commission as a Senior Radio Engineer.

During 1914-16 he participated, while serving at the Arlington Radio station of the Navy in many significant pioneering ventures in radio — the testing of one-way radio telephone service, which was conducted by Bell System's engineers in cooperation with the Navy, for the first time; the first vacuum tube receiver work; the first arc continuous wave transmitter testing; and the first remote control system operation. From 1919-22 he directed all trans-Atlantic radio communication traffic for the Navy Department, utilizing the transmitters at Arlington, Annapolis, Washington Navy Yard, Tuckerton, N. J., New Brunswick, N. J. and Sayville, N. Y., and the receiving station at Otter Cliffs, Me. During his Navy service he spent a number of years as Radio Officer of battleships and of the Fleet Base Force at sea.

Television Society Clinics

American Television Society plans the establishment of additional services to members, including a series of clinics for various phases of television activities. Clinic meetings will be held at frequent intervals. Included among subjects to be covered are: programming, engineering, advertising, education, motion picture and theater television, industrial relations and television receiver sales.

Celebrate Edison's Birthday

The Edison Pioneers, early associates of Thomas A. Edison in his experimental and inventive work, will celebrate his birthday anniversary Feb. 11 with a luncheon at the Hotel Astor, New York. The Pioneers will come from the New Jersey area around Menlo Park, in a special electric train, thus typifying another of Mr. Edison's many inventions. At the luncheon, Mr. Edison's discovery of the Edison Effect and its wide results in laying the foundations for the present great electronic development, will be discussed by Dr. Orestes H. Caldwell, editor of Electronic Industries. Dr. Caldwell is chairman of the 1944 committee for the general celebration of Edison's birthday.

Ceramic Insulation

A new type of ceramic insulating material, styled Centradite, has been developed by Centralab Division of Globe-Union, Inc., 900 East Keefe Ave., Milwaukee, Wis. The product is described and complete application specifications are included in a new bulletin, 720-A, just issued.

Klingenschmitt New President Radio Club

Frederick A. Klingenschmitt (Amy, Aceves and King) is the new president of Radio Club of America. Other officers, newly elected, are: vice-president O. James Morelock (Weston); corresponding secretary Milton B. Sleeper; recording secretary John H. Bose (Dr. Edwin H. Armstrong); treasurer (re-elected) Joseph J. Stantley.

Edison Medal to Bush

Dr. Vannevar Bush, has been awarded the 1943 Edison medal by the American Institute of Electrical Engineers. Dr. Bush is president of the Carnegie Institue of Washington and director of the office of scientific research of the office of emergency management. The award was presented for his contribution to the advancement of electrical engineering, particularly through the development of new applications of mathematics to electrical problems.

Television Personnel

Organization of Panel No. 6 of the Radio Technical Planning Board, which has to do with television and is headed by D. B. Smith (Philco) has been completed. The personnel includes:

D. B. Smith, Chairman, Philco Corp.
I. J. Kaar, Vice Chairman, General Electric Co.
Dr. G. Town, Secretary, Stromberg-Carlson Co.
G. L. Beers (M), RCA Victor
F. J. Bingley (M), Philco Corp.
B. R. Cummings (M), Farnsworth Tel. & Tel.
A. B. DuMont (M), DuMont
O. B. Hanson (M), NBC
J. D. Reid (M), Crosley Corp.
R. Serrell (M), CBS
C. A. Priest (M), General Electric Co.
R. H. Manson (M), Stromberg-Carlson
J. E. Brown (M), Zenith Radio Corp.
D. G. Fink (M), McGraw-Hill
H. R. Lubcke (M), Don Lee
W. A. MacDonald (M), Hazeltine Laboratories
T. B. Grenier (M), Metropolitan Television
C. E. Noble (M), Westinghouse Electric Mfg. Co.
J. Brand (M), Raytheon
Howard Gates (O), Warwick Mfg. Co.
N. P. Case (O), Hamilton Radio Corp.
J. A. Ouimet (O), Canadian Broadcasting Corp.
Norman Snyder (O), Ansley Radio Corp.

(M) Member; (O) Observer

Precision Expands

The Precision Paper Tube Co., 2035 West Charleston St., Chicago, has considerably enlarged its production capacity. The company now has four times the area devoted to the manufacture of dielectric coil bases and spirally wound tubes of kraft, fish paper, transparent cellulose and combinations, and precision bobbins.

Electron Microscopists See Portable Instrument

The Electron Microscope Society which is an associate society of the American Institute of Physics, held its first meeting Jan. 14 and 15 at Columbia University, New York, where members listened to a long series of addresses covering various phases of work that is being done with the instrument. President of the society is R. Bowling Barnes, American Cyanamid Co., Stamford, Conn., other officers being: vice-president Albert F. Prebus, Ohio State University; secretary-treasurer M. C. Banca, Magnolia, N. J.; directors are Dr. V. K. Zworykin, RCA Laboratories and O. F. Duffendack, University of Michigan. Several of the addresses had to do with late developments in the design of the electron microscope; most were devoted to examinations of the character of research work made possible by the instrument.

One particularly interesting new development was shown, the experimental model of a completely portable "suitcase" electron microscope. The elements of this electron microscope were assembled in two portable units of suitcase size. It was described by Igor Bensen, development engineer of the General Electrical Co.'s electronic laboratory. The experimental model of this electrostatically focused microscope has a range of 300-1000 diameters. While it is not a production model, it seems to be the forerunner of a small, compact, and easily operated electron microscope for use by doctors and research men. The microscope, its controls, diffusion pump and power unit weighs 78 lbs. and the associated evacuation backing pump, also of suitcase size, weighs 55 lbs. It is expected that this weight can be reduced still further when certain lightweight alloys are substituted for other heavy metals

Revised Standards List

The American Standards Association, 29 W. 39th St., New York, N. Y., has published its new list of standards. More than 600 standards are listed, of which 64 have been approved or revised since the last list was printed (April, 1943). The standards cover specifications for materials, methods of tests, dimensions, definitions of technical terms, procedures, etc. One important phase of the work built up during the 25 years that the ASA has been in existence, is in the field of safety engineering. The new list includes 95 safety standards. American Standards are constantly revised to keep up with the advances in industrial methods. This list represents the cumulative work of the past 25 years in practically every field of engineering.

New Allied Factory

To expand manufacturing facilities for relays, electrical control devices and fiber lock-nuts, the Allied Control Co. of New York has started construction of a new factory in the industrial clearing district of Chicago. This new plant will add 55,000 sq. ft. of working floor space to existing manufacturing facilities in New York and Plantsville, Conn. The new Chicago plant is expected to be completed within ninety days and in full operation shortly thereafter.

D. Gross Heads Cyclograph Sales

David Gross has been appointed sales director of the materials-test division of Allen B. Du Mont Laboratories, Inc., Passaic, N. J. This division handles the Du Mont Cyclograph for non-destructive testing the metallurgical properties of ferrous and non-ferrous metals. Gross has been identified with Du Mont for several years past, specializing in television equipment sales until the outbreak of the war. It is planned to make the instrument available under a license agreement for a minimum period of six months. Representatives throughout the country will have their own service depots to provide service.

Automatic Steering of Cars

An apparatus that automatically guides a car along a reflecting stripe pointed on the ground is described in Patent No. 2,331,144 to Evan L. Sitter, McLean, Texas. The light from a lamp mounted in the center between the two front wheels of the car is reflected by the stripe onto two photocells arranged at opposite sides of the lamp. Both photocells obtain an equal amount of light as long as the stripe runs exactly below the center line of the car. Two motors are controlled by the photocell circuits, one steering the car to the left, the other steering the car to the right; if equal amounts of light impinge on the photocells, the motors run at the same speed, keeping the car on a straight course. However, if the car deviates from its desired course, one of the photocells obtains more light than the other and one motor runs faster than the other so that the car is always made to follow the reflecting stripe.

Nice Work, Ike

Meet "Miss Electronics," winner of the title from 23 other 100-per-cent-on-the-job Bridgeport General Electric girls selected from among 2000 as candidates for the job. Rest of the picture involves I. J. Kaar, manager of the receiver division

Dunlap Made Director of Advertising for RCA

Orrin E. Dunlap, Jr., who has been appointed director of advertising and publicity of the Radio Corporation of America was radio editor of The New York Times for eighteen years. His association with radio dates from 1912 when he built an amateur wireless station at Niagara Falls, N. Y. He was one of the early members of the American Radio Relay League and has been a member of the Veteran Wireless Operators' Association and Institute of Radio Engineers. In 1917 he was chief operator of the Marconi Wireless Telegraph Co. aboard the S. S. Octorora. During the First World War he served as radio operator in the U. S. Navy, graduating from the U. S. Naval Radio School at Harvard as one of the three honor men of the class. He was assigned to duty at the Naval radio station NBD, Otter Cliffs, Maine.

Mr. Dunlap was graduated from Colgate University in 1920 after which he attended the Harvard Graduate School of Business, specializing in advertising and marketing. After a year on the staff of the Hanff-Metzger Advertising Agency in 1922 he was invited by Carr V. VanAnda, managing editor of The New York Times to organize a radio section and to direct the coverage of radio news.

Mr. Dunlap's nine books on radio include two on advertising, "Advertising by Radio" and "Radio in Advertising." His other books are: "Dunlap's Radio Manual," "The Story of Radio," "Talking on the Radio," "The Outlook for Television," "Marconi: His Life and His Wireless," "The Future of Television," and "Radio's 100 Men of Science" a collective biography, recently completed for publication by Harper & Brothers in 1944.

Hytron Quadruples Production

The fact that this is an electronic war is nowhere better illustrated than at Hytron Corp. where expansion at Salem, Mass., and a new plant at Newburyport, Mass., have quadrupled production facilities. June 12, 1942, saw Hytron go completely all-out for war production—the first receiving-tube manufacturer to do so. Rather than wait for new equipment to be procured through regular government channels, Hytron converted its own machines at its own expense, saving months of time and putting hundreds of thousands of extra tubes into the hands of the armed forces. Since that time the plant size has quadrupled.

Dr. Caldwell to Address Joint IRE-Franklin Meeting

Dr. Orestes H. Caldwell, Editor of **Electronic Industries,** is to address a joint meeting of the Philadelphia Section of IRE and the Franklin Institute, in Philadelphia on Wednesday, February 2. Subject of the talk is "What the Electronic Future Has in Store for You." The talk will cover many of the ways in which the new art of electron control is revolutionizing warfare, science, chemistry, surgery, metallurgy, music and printing.

Electronic Autopilot Has Saved Fifty Bombers

More than fifty American bombers have returned safely to their bases on electronic automatic pilots although control cables were shot away completely, an Air Forces officer back from England reports. According to the cases on record this means that at least 500 men have been saved from what formerly meant disaster, he told officials of the Minneapolis-Honeywell Regulator Co., co-makers of the autopilot which for two years has been standard equipment on the Air Forces' four-engined bombers.

Designed primarily for high altitude precision bombing, the electronic instrument has the added advantage of remote control which permits airplanes to be flown from two or more stations, he said. With control surface motors connected by fine wires, it is approximately thirty times more difficult for gunfire and flak to put the autopilot out of commission as compared to mechanical or pneumatic systems, the returned flier added. In use for more than two years, the Minneapolis-Honeywell autopilot was unknown outside the services until recently when the Army permitted its disclosure after it was known that the enemy had learned America's precision bombing secrets.

RTPB Elects Mrs. Kinzie Its Assistant Secretary

Sponsors of the Radio Technical Planning Board have elected Mrs. Martha Kinzie assistant secretary of the board, according to an announcement by Dr. W. R. G. Baker, chairman of the board and a vice-president of the General Electric Company. Mrs. Kinzie is secretary to Dr. Baker and resides at Bridgeport where she works in the company's electronics department. Mrs. Kinzie, with the cooperation of L. C. F. Horle, coordinator, and W. B. Cowilich, secretary of the board respectively, will be responsible for processing of the papers in connection with the work of the board.

Foote to Littelfuse

William A. Foote has been appointed sales coordinator of Littelfuse, Inc., Chicago and El Monte, Calif. His business career includes the presidency and general sales management of Wingfoote Petroleum Co., an affiliate of the Standard Oil Co. of New York and sales directorship of the Deoxolin Chemical Corp.

E. V. Sundt, President of Littelfuse, Inc., Chicago and El Monte, Calif.

ANESA TAKES MILITARY-NAVAL STANDARDS

• ANESA (Army-Navy Electronic Standardization Agency) is the designation of the new official group which hereafter will be responsible for standardization and simplification of military and naval radio and electronic devices. This work was formerly handled by the Radio and Radar Division of the War Production Board under the supervision of Assistant Director (now Lt. Col.) Sidney K. Wolf, working through the American Standards Association of New York. ANESA headquarters are at Red Bank, N. J., and are being operated under the supervision of Colonel Gordon C. Irwin for the Army, and Lt. Comdr. Paul G. Haas for the Navy.

Twenty "specs" completed

WPB and ASA will turn over to ANESA a compilation of standard specifications for 20 electronic components. Of the components on which standard specfications were drafted for WPB by the American Standards Association, eleven have been approved for procurement purposes by the Army and Navy. Drafting of standard specifications on the remaining nine is expected to be completed and turned over to ANESA by March 1.

The Radio and Radar Division of WPB, which has been responsible for the standardization study for the past year, said its work is now reaching the important stage of application of the approved standards, a function which is primarily one for the Armed Services. The Army and Navy have indicated that they will continue the study and application of standard specifications for electronic components both for the duration and as a peacetime operation through ANESA and the joint Army-Navy Board for Approving Standards, also formed recently. ANESA's location at Red Bank, N. J., is in close proximity to Fort Monmouth.

Cover 75% of components

WPB pointed out that the standards on the 20 components, when completed, will be 75 per cent, item-wise, of all components used in electronic devices. That is, they make up three-fourths of the components which reoccur frequently in radios or other electronic equipment.

The Armed Services, in deciding to take over the future work on standardization in electronics, gave credit to WPB for having initiated and carried forward this task. They also credited the accomplishment of WPB for having brought the Army and Navy together on the use of common standards for electronic equipment. These common standards have resulted in increased industrial production and more efficient functioning in the combat theaters through the interchangeability of components for replacement, maintenance and repair purposes.

Products listed

The components on which American War Standard specifications have been approved by the Army and Navy are ceramic radio

Colonel Gordon C. Irwin, and Lt. Commander Paul G. Haas, who will administer ANESA for the Army and the Navy respectively

insulating materials, steatite radio insulators, fixed mica dielectric capacitors, ceramic radio dielectric material, external meter resistors, glass bonded mica radio insulators, fixed composition resistors, electrical indicating instruments, shock-testing mechanism for electrical indicating instruments, dimensions for external radio-frequency thermocouple converters, and glass radio insulators.

Components on which standards are expected to be completed by March 1 by WPB include fixed paper dielectric capacitors, porcelain radio insulators, fixed ceramic capacitors, dynamotors, external ammeter shunts, variable wire-wound resistors (low temperature), tower-type wire-wound rheostats, and toggle switches.

Haines Dielectric Heating

Haines Mfg. Co., 248-274 McKibbin St., Brooklyn, has developed a new line of dielectric heating equipment designed specifically for preheating plastics. The Haines equipment is readily adaptable to the baking and dehydrating industries. Moderately priced, the line is within the range of the small production factories.

Belmont Enlarges Laboratory

Soon after March 1, Belmont Radio Corp., Chicago, will occupy expanded laboratory facilities. An addition to the plant, to cost around $70,000, will house the laboratory staff.

Electronic Course at Milwaukee

Milwaukee electrical men will have an opportunity to get inside details on electronic subjects by taking advantage of a 12-meeting course now being sponsored by the Electrical League of Milwaukee. All persons attending the course will pay an attendance fee of $2 at the first meeting, one-half of which will be refunded to those who attend at least nine of the twelve meetings.

No registration is necessary and those wishing to participate need only report at the Lodge Room, Public Service Building. The course started Monday, January 10, at 7:30 o'clock. Admission is a League membership card and the $2 attendance fee. Meetings are to be held each Monday night, from 7:30 to 9:30, through March 27. All phases of the subject of electronic applications will be covered during the various meetings.

Sylvania Advances Kievit

Dr. Ben Kievit, supervisor of customer services of Sylvania Electric Products Inc., in Emporium, Pa., has been moved to the New York office as field engineer in the Equipment Sales Department for the metropolitan and New England

area. Dr. Kievit has been with the Sylvania corporation since 1930, when he joined the company as a research physicist. He became supervisor of the Tube Application Department in 1931, and in 1934 was advanced to assistant director of the department. In 1941 he was appointed assistant director of commercial engineering, and the next year became supervisor of Customer Services in Emporium. He is a senior member of the Institute of Radio Engineers, and a member of the Electronics Committee of that group. His other affiliations include fellowship in the American Association for the Advancement of Science, and membership in Sigma Xi and the American Physical Society.

Mr. Hoffman resigned recently from the Westinghouse electronic division at Bloomfield, N. J., where for the past seventeen years he had been manager of the special products division.

Hoffman to Machlett

H. J. Hoffman, who is chairman of the Electronic Section of the National Electrical Manufacturers Association, has joined Machlett Laboratories at Norwalk, Conn., as sales manager. This Norwalk plant has been developed by the Machlett organization, whose X-ray tube factory at Springdale, Conn., near Stamford, is now the largest producer of X-ray tubes in the United States. The new Norwalk plant is devoted exclusively to the manufacture of radio transmitting, industrial, and special-purpose tubes.

ENGINEERS ATTEND IRE-AIEE MEETING

(*Continued from page* 123)

Joint Army-Navy Standardization program for tubes. Lt. Martel discussed the steps taken by the Bureau of Ships and the Signal Corps to effect standardization of radio and electron tubes previously produced in many slightly varying types for the Army, the Navy, and civilian use. The suggested procedures for handling tube problems apparently outside the boundaries of the written specs were described fully, in connection with a description of the method of operation of the JAN-1 Tube Subcommittee and its duties and responsibilities. Lt. Martel emphasized the necessity for avoiding the use of special selection tubes in military equipment. Tube specs, the occasionally revised Preferred Lists, and type approvals were among the subjects discussed.

Oscillating circuits

In a paper titled "Intermittent Behavior in Oscillators," William A. Edson, Bell Telephone Laboratories, New York, discussed the fact that oscillating circuits of all sorts are subject to low-frequency disturbances. Usually the normal oscillation is interrupted at more or less regular intervals, Mr. Edson said, although the output may merely be modulated in amplitude and phase.

The operation of such circuits was studied by considering the disturbance as a self-generated low-frequency modulation superimposed upon the desired oscillation. A considerable amount of information was secured by a study of circuits intended purposely to generate self-modulated oscillations.

The criterion which determines whether or not any particular oscillator will spontaneously generate modulation is closely analogous to Nyquist's well-known criterion for determining whether or not a feedback amplifier will spontaneously generate oscillations of any form. Stated briefly: Intermittent behavior is to be expected if at the normal oscillating frequency and voltage an assumed small modulation at some low frequency is returned amplified in magnitude and in its original phase by one full trip around the oscillating loop. Such a criterion is useful because it shows what design features are required to secure the desired performance.

War-radio standardization

Commander A. B. Chamberlain, U. S. Navy Bureau of Ships, Radio Division, spoke on past, present, and future standardization of service equipment.

Mass production technics have been applied to wartime radio and electronic devices, Commander Chamberlain said, despite (1) the complexity of modern equipment, (2) the high quality of products built for service use, and (3) frequent redesign in order to keep technologically ahead of the enemy. The need for maximum standardization compatible with progress was felt from the first, both at the battlefronts and at home. Inventories at shore bases and afloat had to be kept down to facilitate making replacements in the field. The number of different parts and equipment made had to be reduced to a minimum in order to best utilize manpower and production facilities in the United States.

The policy of standardization was broadly interpreted by the Navy at first. However, the attempt was made to use large production stock items instead of special parts wherever the quality of the former made this justifiable. The time required to determine the best design for each component or equipment was (and is still being) cut down by pooling knowledge between the Naval service and industry; by exhausive testing of products so as to simulate actual conditions of use, and by thorough, immediate investigation into all troubles encountered in the field. The results of this program have made it possible for the Navy to concentrate on relatively few new basic models, and quickly reject unsatisfactory designs. These basic models are modified, rather than completely redesigned, to meet the requirements of various classes of vessels and shore stations. Modifications are also made when faults develop, or new refinements become available.

Components taken singly, rather than in combination as in an equipment, have been the most logical and fruitful field for a broad standardization program between the services. The aim here has been to write suitable specifications for parts based on joint Army-Navy requirements, the facilities of industry, and the advice of other agencies concerned, such as the WPB. Some of the advantages that have accrued from this practice in certain specific cases are: improved design; reduction in the number of types required, with consequent increase in interchangeability, assurance of several sources of supply for an item; maintenance of product quality; known grading methods to assist in equipment design; common Army-Navy nomenclature; and conservation of critical materials. The coordinating group working on component standardization has been the Signal Corps Standards Agency established in early 1943, and its suc-

cessor organization, the Army-Navy Electronics Standards Agency. These groups have set up standards for many common components.

The standardization of complete equipments into joint Army-Navy types is a more limited field, since (1) the requirements of the two services—with the notable exception of the aircraft branches—are usually different, and (2) interchangeable components solve most of the difficulties encountered in the field. However, close liaison has been maintained between the Army, Navy and the British with a view towards cooperative action whenever possible, and a number of aircraft radio and electronic equipment have come out under joint sponsorship.

Wave propagation

Dr. Arthur B. Bronwell, of Northwestern University, read the paper "Transmission Line Analogies of Plane Electromagnetic Wave Reflections."

The phenomena of wave propagation along a transmission line may be expressed either in terms of the voltage and current on the line, or in terms of the resulting electric and magnetic field intensities. The fields comprise a guided transverse electromagnetic wave propagating through the dielectric material surrounding the conductors with reflections occurring at points of discontinuity. The close resemblance of the mathematical expressions for the two methods of representations suggests that the familiar transmission line equations may be used for expressing the more general case of unguided plane wave propagation. It was shown in this paper that the field equations for normal incidence plane wave reflections may be expressed by the transmission line equations. Discontinuities occurring when the wave passes from one medium to another are analogous to impedance discontinuities on transmission lines. The incident and reflected waves resulting when a plane wave impinges upon a perfect conductor at normal incidence are analogous to the short circuit transmission line. Losses in the media through which the plane wave propagates are similar to losses in the transmission line. Multiple reflections from successive surfaces of discontinuities are similar to multiple discontinuities in transmission lines.

It is interesting to note that the method of matching impedances by the use of a quarter wavelength transmission line having the proper characteristic impedance has its counterpart in field theory. If a quarter wavelength plane slab having a proper value of "intrinsic impedance" is inserted between two dissimilar media, it is possible to achieve an impedance match and avoid reflections at the surfaces of discontinuity. It is necessary to modify the transmission line equations for waves impinging upon plane surfaces at oblique incidence. These lead to Fresnel's equations for wave reflection and refraction.

This method of expressing wave propagation makes it possible to use all of the technics employed in the analysis of transmission lines including the use of the circular and rectangular transmission line impedance charts. The procedure is to first set up the equivalent transmission line circuit. The analysis then proceeds exactly as for the solution of transmission line problems.

Amplidyne principles

A paper, "The Amplidyne System of Control," by Dr. E. F. W. Alexanderson, M. A. Edwards, and K. K. Bowman, all of the General Electric Co. described the methods whereby the operating and regulating technics of amplidyne control can be determined, the fundamental characteristics of the amplidyne system, and the conditions under which it can be utilized in particular applications. This system utilizes an ingenious application of the magnetic fields in a specialized type of dc generator. In the usual application in the power field, the controlling agency, which may be a variation in some function in a process which affects the final output, is used to minimize all deviations of that output from the ideal value. This is seen to be one of the functions usually handled by electronic equipment, but here is an amplifier for power control without tubes. It was at one time customary to describe electronic devices by comparison with known electrical devices.

Dr. Alexanderson referred to amplidyne operation in terms of voltage amplification, current amplification, oscillations, hunting, rate of response, etc., using the new well known methods of analyzing electronic tube circuits on this purely mechanical counterpart. Many unusual concepts were mentioned when these characteristics were analyzed in these terms, such as the attaining of capacitive effects equal to one farad or more. With the listing of this information, which corresponds to that needed by the radio engineer in using electronic tubes, the work of the application engineer who attempts to select an amplidyne for a particular job, is simplified.

Transmission line problems

Presented by J. R. Whinnery of

General Electric, a paper written in collaboration with H. W. Jamieson dealt with equivalent circuits for discontinuities in transmission lines.

Sudden discontinuities in transmission line systems, such as sudden changes of inner diameter, outer diameter, or both for coaxial lines, or change in height of radial lines may occur frequently in practical applications. This is true even when lines are used in power transmission or measurement applications, but particularly so when they are used as elements in resonant cavity type circuits in the centimeter wave region.

It was shown in the paper that the effect of certain of these discontinuities can be exactly represented in loss-free cases by an equivalent circuit in which a lumped "discontinuity admittance" is shunted between lines at the change of section; ordinary transmission line equations for the principal wave only are used in the transmission lines on either side of the discontinuity. If transverse dimensions between line conductors are small compared with wavelength, this discontinuity admittance is a pure capacitance, usually of the order of a few tenths of a micromicrofarad for typical discontinuities in lines of common size. Thus its effects are negligible at radio frequencies below a few hundred megacycles, but may be of primary importance in the centimeter wave region.

It was shown that approximate values of the discontinuity capacitance may be obtained for many different cases from a single curve derived for a simple step in a parallel plane transmission line. For example, rules deducted from the more accurate equations for the coaxial problem are given for approximate application of this single curve to several typical discontinuities in coaxial lines.

More complete set of curves was given for more accurate values in several of the important discontinuities. Certain curves of a frequency factor showing the effect of transverse dimensions comparable to wavelength and curves of proximity factors showing the effect of disk type terminations near the discontinuity or of two discontinuities electrically near one another were also given.

The general approach and physical reasoning followed closely that used extensively by Schelkunoff in radiation problems; the method of analysis was a method based upon series wave solutions as presented by Hahn. By means of the equivalent circuits and curves presented in the paper, calculations for these discontinuity problems—which are fairly complicated boundary value problems—were thereby reduced to circuit and transmission line calculations using well-known equations and charts.

Piston attenuator

The piston attenuator, reported Harold A. Wheeler, Hazeltine Electronics Corp., in a paper on this subject, in a cylindrical shield is a coupling device whose attenuation varies exponentially with distance. This principle is applicable to resistive, capacitive or inductive coupling. The piston mutual inductor uses coaxial or coplanar coils, the latter being preferable. Since its origin in 1929, the piston attenuator has come into wide use, especially at the higher frequencies. Its calibration is determined by structural dimensions so the dial scale is calibrated in decibels by computation.

NEW BOOKS

Small Radio—Yesterday and in the World of Tomorrow

By Ben Abrams, Emerson Radio & Phonograph Corp., New York, N. Y. 88 pages.

Receiver engineers and designers will be interested in this book which traces the history and commercial development of the small home receiving set since its inception in 1929 as a "midget" model. In this narrative of the "compact" receiver in its many forms, the diverse improvements from year to year are chronicled.

The meteoric popularity of the battery portable, and the battery-and-light-socket portables (the production of which jumped from 850,000 sets in 1939 to 1,570,000 in 1941), afford other examples of the public's preference for small units. This development forecasts what may prove to be one of the most momentous radio and electronic advances of the future, comments Mr. Abrams. The military "Walkie-Talkie" is vastly improved today because of the civilian portable-radio engineering background. Civilian communicating instruments of tomorrow will stem from the same origins.

A huge backlog of new-home demand, in addition to the replacement market, has been piling up since civilian-radio production ceased in 1942. Distributor and dealer stocks of radios all over the country have become virtually depleted. The breakdown and obsolescence of sets have been continuing at an accelerated rate due to shortages of repair parts and service.

All of these factors, aided by a vast accumulated purchasing

power and an ever-growing interest in and use of radio, are combining to build up a waiting market for from 20,000,000 to 25,000,000 sets—with progressively higher proportionate levels of demand in years to follow.

Mathematics Dictionary

By Glenn James and Robert C. James, published by The Digest Press, Van Nuys, Calif., 1943, 320 pages. $3.00.

The dictionary is designed primarily to provide a condensed source of facts and principles for men in the practical field. It contains "definitions of the basic words and topic phrases used in mathematics, including a complete coverage of those ordinarily used in arithmetic, elementary algebra, plane and solid high school geometry, and differential and integral calculus." The dictionary is essentially a condensation of these subjects.

Formulas for solving triangles, trigonometric reduction formulas, etc., are also included. The contents are arranged in alphabetical order. The revised second edition contains new terms and examples, definition are simplified, five place logarithm tables are substituted for four place tables, and extensive integral tables have been added.

For anyone working with mathematical concepts or formulas which are not quite familiar or no longer familiar, the dictionary will be extremely useful as a reference book. Unknown, forgotten, or vaguely remembered terms can be readily checked and their exact meaning, so essential for most mathematical statements, established.

Graphical Construction for Vacuum Tube Circuits

By Albert Preisman, Director of Engineering Tests and Consulting Engineer of Capitol Radio Engineering Institute. Published by McGraw-Hill Publishing Co., 330 West 42nd St., New York City. Price $2.75. Approximately 240 pages.

This volume deals with graphical methods of predicting the performance of vacuum tubes as circuit elements.

The first three chapters are a discussion of the non-linear circuit problem, the basic characteristics of the thermionic vacuum tube and elementary graphical constructions such as load lines, power output, distortion, etc.

The subject of reactive loads in the plate circuit of vacuum tubes is treated in considerable detail. Combinations of inductance capacitance and non-linear resistance are used in the examples of the method of constructing the operating path for the tube. Experimental verification in the form of oscillographs are included for each type of complex load.

Balanced amplifiers are treated in a separate chapter and the effects of winding resistance, self-bias, etc., are included in the graphical interpretation.

Diode detectors are analyzed in Chapter VI where the operating path for the complex impedance is given. Miscellaneous graphical constructions are given for voltage and current types of feed-back.

This book should be a valuable tool to the circuit design engineer.

Wartime Refresher in Fundamental Mathematics

By Eddy, Brolly, Pulliam, Upton and Thomas, all of U.S. Naval Training School, Chicago. Published by Prentice-Hall, Inc., New York City, 1943. 248 pages, $1.40.

A four-week course in simple arithmetic, algebra, geometry, specialized algebraic factoring, advanced algebra. The book is offered to the public for study one hour per day for twenty-four days, but is an outgrowth of a refresher course in mathematics at the Chicago Naval Training School. Each day's problems are followed by a cue sheet, giving hints about setting up and solving the more difficult problems, and the solutions to the problems. A review section follows each five days' work.

Short Wave Wireless Communication

By A. W. Ladner and C. R. Stoner. Fourth edition. Approximately 575 pages. Price $6.00. Published by John Wiley & Sons, 440 4th Ave., New York, N. Y.

The three previous editions of this volume were published in England and this, the fourth, is the first American edition.

This book is a practical treatment of the general subject of short and ultra short waves. It includes essentials of propagation of high and ultra high frequency waves, characteristics, calculations and construction methods of high frequency transmission lines, aerials and aerial arrays. Vacuum tube circuits are covered under the headings of power amplifiers, oscillators and modulation circuits. The chapter devoted to electron oscillators covers the positive grid types, magnetrons, velocity modulation oscillators and deflected beam oscillators. A section devoted to commercial equipment deals with the problems of reception from a theoretical and practical standpoint. Commercial receivers, transmitters

and wireless telephone circuits are analyzed with block diagrams and schematics.

The last chapter of the volume is titled High Frequency Therapeutic Apparatus and includes circuits and photographs of diathermy generators and electrodes as used in England.

An appendix to this volume includes a number of propogation curves, formulas for transmission lines and essential characteristics of English high vacuum tubes useful at ultra high frequencies.

NEW BULLETINS

Electronic Controls

The fundamentals and the various applications of electronic control are interestingly described in a new 12-page bulletin (GEA-4126) issued by the General Electric Co., Schenectady. Well illustrated, the publication explains in clear simplified language the fundamental principles of electronic tubes and their operation, describes the construction of the well known thyratron tube, and lists the functions of eight of the more widely used industrial-type tubes.

The publication also describes and illustrates many practical applications of electronic control, including rectification, resistance, welding, timing, and processing operations, as well as photoelectric installations involving counting, sorting, weighing, measuring, registering, illumination and the control of cement kiln temperatures.

Variable Condensers

A new catalog has been issued by Barker & Williamson, 235 Fairfield Ave., Upper Darby, Pa. giving complete information on the line of B & W Type CX variable air condensers for heavy-duty requirements. Features of the condensers include electrical design symmetry, built-in neutralization with mounting of standard B & W coils in such a way that lead lengths and resulting lead inductance are reduced to a minimum and mechanical durability.

Special Purpose Capacitors

To supplement a recent bulletin on ceramic capacitors, Centralab, Division of Globe Union, Inc., 900 East Keefe Ave., Milwaukee, Wis., has just released a 4-page folder which contains condensed information on special types of capacitors now in production. Several diagrams are included.

Prefabricated Enclosures

To aid engineers in postwar planning, a new 40-page Lindsay structure manual has just been published by Lindsay and Lindsay, 222 W. Adams St., Chicago 6. Lindsay Structure is a strong light-steel prefabricated construction that can be assembled with simple wrenches. It is particularly suited for cabinets and enclosures on various types of electronic equipment, as well as for machine housings refrigerator units, processing rooms, industrial buildings, truck and trailer bodies, and other structures. The manual shows how Lindsay Structure can be used in the industrial, automotive, and marine fields. It contains technical information about the structure and construction suggestions for both plain and refrigerated units.

Decal Nameplates

The Meyercord Co., 5323 W. Lake St., Chicago (44), is distributing an informative check-chart showing how to select and specify the right decalcomania nameplate for 16 different types of surfaces. Published in file folder form to hold subsequent data sheets to be distributed periodically, it also contains a check-list of 25 wartime uses for Meyercord decalcomania now used on 34 different types of combat equipment.

The chart illustrates actual decal nameplates and describes application methods, types and uses, as well as special features such as retention and shut-off fluorescent, non-specular, mar-proof and elasticized decals. Meyercord wartime research has developed or improved decalcomania to a point heretofore considered impossible, resulting in decals that are reistant to acid, petroleum products, alcohol, abrasion, extreme heat and cold, humidity and moisture that can be applied to any known commercial surface, rough or smooth.

Victory Line Parts

Lafayette Radio Corp.'s 1944 catalog, No. 94 is a veritable catch-all of the latest supplies available. In its 104 profusely illustrated pages, there is information on nearly 50,000 items, including a complete line of communications and public address equipment, test materials for every purpose, cathode ray and special purpose tubes, batteries and power supply equipment, radio training kits and code apparatus, plus the usual radio components, such as condensers, transformers, volume controls, etc. A greatly expanded list of new "Victory Line Parts", especially prepared for factory and as-

SURE, that Saturday night pay envelope's bulging. But let me tell you something, brother, before you spend a dime . . . *That money's mine too!*

I can take it. The mess out here. And missing my wife and kid.

What I *can't* take is you making it tougher for me. Or my widow, if that's how it goes. And brother, it *will* make it tough—if you splurge one dime tonight. You're making money. More money than there's stuff to buy. Money that can sock the cost of living to kingdom come—if you blow it! So hang on, till the job's done. On to every last dime—till the squeal means a hole in the seat of your pants!

You're working . . . and *I'm fighting* . . . for the same thing. But *you* could lose it for both of us—without thinking. A guy like you could start bidding me right out of the picture tonight. And my wife and kid. There not being as much as everybody'd like to buy—and you having the green stuff. But remember this, brother—everything you buy helps to send prices kiting. Up. UP. AND UP. Till that fat pay envelope can't buy you a square meal.

Stop spending. For yourself. *Your* kids. And mine. That, brother, is sense. Not sacrifice.

Know what I'd do with that dough . . . if I'd the luck to have it?

I'd buy War Bonds—and, God, would *I* hang on to them! (Bonds buy guns—and give you four bucks for your three!) . . . I'd pay back that insurance loan from when Mollie had the baby . . . I'd pony up for taxes cheerfully (knowing they're the cheapest way to pay for this war) . . . I'd sock some in the savings bank, while I could . . . I'd lift a load off my mind with more life insurance.

And I wouldn't buy a shoelace till I'd looked myself square in the eye and knew I couldn't do without. (You get to knowin'—out here—what you can do without.)

I wouldn't try to profit from this war—and I wouldn't ask more for anything I had to sell—seeing we're all in this together.

I've got your future in my rifle hand, brother. But you've got both of ours, in the inside of that stuffed-up envelope. You and all the other guys that are lookin' at the Main Street shops tonight.

Squeeze that money, brother. It's got blood on it!

Use it up . . . wear it out, make it do...or do without

HELP US KEEP PRICES DOWN

A United States war message prepared by the War Advertising Council; approved by the Office of War Information; and contributed by the Magazine Publishers of America

sembly use, advance notice of 1944 radio and electronics books and an eight-page bargain section of values, as well as postal and shipping data complete the booklet. Addresses of Lafayette Radio Corp. are 901 Jackson Blvd., Chicago 7, or 265 Peachtree St., Atlanta 3.

Facts About Plastics

A new twenty-four page, non-technical booklet covering all types of plastics, their uses, and general information on the plastics industry has just been released by The Richardson Co., Melrose Park, Ill. This illustrated book explains the host of properties which fit Insurok and other plastics to the wide range of present and postwar uses. The limitations of plastics are also covered.

The two main groupings of plastics, Thermosetting and Thermoplastic, are described and illustrated in layman's language. Special sections are devoted to the forms of plastics, laminated and molded. The manufacturing and production processes of each are well illustrated.

The book is designed primarily for the non-technical man who may be serving on his company's postwar product committee.

Connor Promoted

George C. Connor, radio field engineer with Sylvania Electric Products, Inc., has been appointed manager of the California division of his company's equipment tube sales. Headquarters will be in the Los Angeles office, 555 S. Flower St.

Glass Insulator Standard

The American Standards Association has published approval of a new American war standard for glass radio insulators (C75.8-1943), developed by a group of representatives of the radio industry in conjunction with representatives from the U.S. Army Signal Corps and the U.S. Navy Bureau of Ships. This work was undertaken at the request of the WPB. This standard should be vitally important in the preparation of new manufacturing facilities for glass insulators and will facilitate their production as well as simplify their procurement.

The specifications cover the performance requirements, test methods, and standard dimensions for a standard series of glass insulators of the quality required by the Army and Navy. The basic specification for glass material is the American War Standard Ceramic Insulating Materials, Class L, C75.1-1943.

Sir Watson-Watt Visits With Philco

Heading a distinguished British Radio Mission to the United States, Sir Robert Watson-Watt, one of Great Britain's most outstanding scientists, watches an intricate manufacturing operation in a visit and tour of inspection of the Philco plants. Joseph H. Gillies (left), vice president in charge of radio production at Philco, explains the process to Sir Robert, while Rear Admiral Julius A. Furer, U.S.N., Coordinator of Research and Development, looks on next to Mrs. Munroe, Secretary to the Commission, and John H. Teeter of the National Defense Research Committee. In the background are Captain Frank Akers, U.S.N., and H. J. Kenworthy, in charge of materiel control for Philco.

ELECTRONIC INDUSTRIES

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While every precaution is taken to insure accuracy, we cannot guarantee against the possibility of an occasional change or omission in the preparation of this index.

Sorry, We Don't Like This Paper, Either! But It's a Necessity in Wartime

The paper on which this issue is printed, is used as a wartime necessity, to save paper tonnage, manpower, coal and transportation. Compared with our former glossy white printing paper, we don't like this present paper stock any better than you do.

But we hope you'll bear with it, —as we are doing,—until paper restrictions are lifted by Washington. Then we promise you one of the handsomest printing jobs in the whole industrial publishing field—a return to the fine coated-stock quality format we used before the WPB cut our paper use 25 per cent.

Meanwhile, you probably ask why other magazines that come to your desk are able to use heavier, glossy paper at this time. The answer is in the current quota practice which enables publishers to discontinue or diminish unsuccessful magazines and throw their paper quotas into increased paper tonnage on particular magazines. Such increased tonnage, although running directly contrary to the wartime spirit, results in the better appearance which has aroused your curiosity. Unfortunately we had no paper quota to switch in that way.

Today, in line with patriotic requirements we have reduced our own paper tonnage per issue actually below that of our first issues in 1942,—although meanwhile the present service of our publication, has been greatly increased.—THE PUBLISHERS.

Aptitude Measurement

To prevent employment of "square pegs in round holes," a scientific measurement or rating of aptitudes and abilities before actual employment begins is made by the Formica Insulation Co., Cincinnati, and may be of interest to other large employers. Applicants are told of the policy to assign each employe — those already at work and new applicants—to the job for which he or she is best suited. Applicants are made to feel at ease and are given a preliminary brief explanation as to the meaning and the purpose of the tests.

Paper tests—marking designs and figures and questions and answers in writing—are used as a measure and gage of practical thinking ability, general intelligence, and quick observation or familiarly known as an inspection test. Then follow simple machine tests to determine abilities of the applicant to think, see and act with good coordination on a simple machine job.

Simple peg-board tests—use of a tool plate with machine screws and a pattern board—are included in the aptitude program for determining dexterity and coordination of hand-arm, hand-finger and hand-tool control. Another simple test which determines whether an applicant has the aptitude to perform the same job continuously over a long period without becoming unduly erratic, restless or nervous is also provided.

The machine tests are all controlled through electrically operated timers and recorders which indicate time involved and the count on errors. The tests are supervised by a trained member of the personnel department who is equipped to interpret the results and ratings. Because of the demand for manpower at Formica, the aptitude tests are now used chiefly in placement of applicants. The manpower situation at the plant has been so critical in the wartime period that it was not feasible to apply the tests to employes.

Only applicants who obtained a satisfactory percentage rating are employed. Since employes are engaged for the services they can perform, the principle of the personnel tests is that they require proof of an applicant's ability to produce on a certain job.

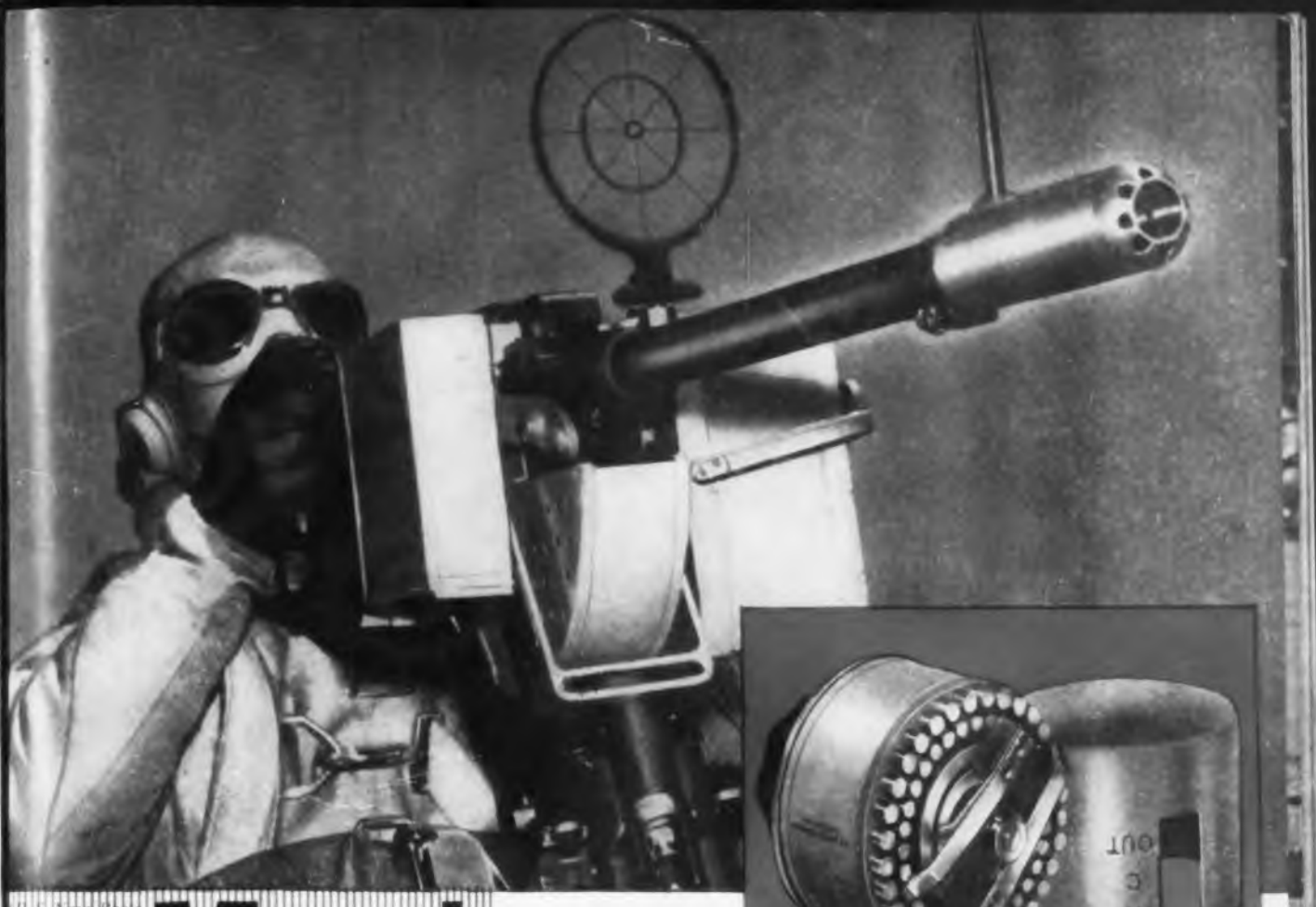
Philco in Communications Field, Postwar

As a result of its war experience in the manufacture of electronic devices, Philco, Inc., is reported planning to set up a communications division after the war, to make radio apparatus for airlines, steamship companies, and others.

At present, Philco's operations are at the highest rate in its history, with practically all its sales going to the armed forces. Most of the equipment which it is making is under strict censorship regulations, but the use of some of the products has been revealed directly or indirectly in news from the war fronts. Among these are electronic equipment for special use, the walkie-talkie radio, and rocket propelled ammunition for the "bazooka."

Radio Sets in U. S.

In the statistical summary appearing in our January issue, page 91, the column headed "Total Radio Sets in Use in U. S." should have been marked "Number" rather than "Value," since the figures show the number of radio sets believed to be currently in operation for the years indicated. Also for the year 1922, the number should have been "400,000" only, the additional digit being a typographical error.



U. S. Navy Photo

More than you can see...

Behind the "business end" of any weapon are carefully synchronized controls, intricate devices, and complex mechanisms. These delicate component parts are important factors contributing to over-all efficiency.

Behind each DAVEN component is a specialized engineering skill. Behind each DAVEN instrument is the collective experience of trained craftsmen. These factors, in conjunction with our unexcelled mechanical and laboratory facilities, combine to form the unseen foundation upon which we construct precise and dependable apparatus. DAVEN instruments are *preferred* for radio, sound picture, television, and industrial applications.

Have you a DAVEN catalog? In it, we list the most complete line of precision attenuators in the world, in addition to such specialized apparatus as Output Power Meters, Decade Resistance Boxes, Transmission Measuring Sets, Electronic Frequency Meters, and many other types of Electrical Laboratory Test Equipment.

THE DAVEN COMPANY

191 CENTRAL AVENUE • NEWARK 4, NEW JERSEY

Back the Invasion . . . Buy Another War Bond Today

A New Multiplier Phototube for

VERY LOW LIGHT LEVELS...

RCA-931-A

SENSITIVITY 3 TIMES THAT OF RCA-931

BUY MORE WAR BONDS

SIGNALS are amplified up to 200,000 times and more in this new RCA multiplier phototube—over three times the amplification possible with the famous RCA-931—because manufacturing techniques have been improved materially by RCA engineers.

This really amazing sensitivity is made possible by the skillful use of secondary emission as cathode electrons are impelled against 9 successive dynodes before they reach the plate. At each dynode, secondary electrons are produced to multiply the electron current enormously.

Because this high amplification is accomplished within the phototube itself, extremely low light levels will produce high outputs without the high-gain amplifier stages required with conventional phototubes.

HIGH SIGNAL-TO-NOISE RATIO Because high-gain amplifier stages are unnecessary with the RCA-931-A, sources of extraneous electrical "noise" (such as grid leaks, etc.) are eliminated, and a favorable signal-to-noise ratio can be obtained for very low light levels.

HIGH SENSITIVITY The 931-A operated at 100 volts per stage has a sensitivity of 2 amperes per lumen; or over 3 times that of the superseded 931 at the same voltage per stage.

CIRCUIT SIMPLICITY Where light signals are very small and high gain is needed, the 931-A provides a simpler circuit than that for a conventional phototube and its accompanying high-gain amplifier stages; also when the 931-A is used as a d-c amplifier, its zero-reading has excellent stability, and there is no problem of circuit feedback.

COLOR SENSITIVITY The 931-A—like the 931—employs the S-4 photosurface which is highly sensitive to blue light; peak sensitivity is at about 3750 A . Frequency response is flat up to a limit determined by transit-time effects, well above 10 million cycles per second. Dark current is very low. Full details are available on request (see coupon).

APPLICATIONS A typical application of the 931-A is in quantitative spectrographic analysis. The 931-A and its associated circuits are substituted for the photographic plate commonly used in such analyses. This method is speedy, and results can be observed with excellent accuracy. This method of spectrographic analysis is widely used in vitamin measurements.

Cross section of the 931-A, showing electron paths in red.

RCA application engineers will be glad to help you apply the RCA-931-A—or other RCA electron tubes — to the solution of your design problems. Write, outlining your problem, to Commercial Engineering Section, RCA, 588 South Fifth Street, Harrison, N. J.

TECHNICAL DATA Nine multiplier stages. Cathode photosurface, S-4. Max. seated height, 3⅛". Max. diam., 1-5 16". Base, small shell submagnal 11-pin. Mounts in any position.

MAXIMUM RATINGS (Absolute values): Plate volts (d-c or peak a-c), 1250. Volts between dynode No. 9 and anode, 250. Plate current, 2.5 milliamperes. Plate dissipation, 0.5 watt.

CHARACTERISTICS:

Volts per stage	75	100	Volts
Luminous sensitivity	0.3	2.0	μAmp./μLumen
Current amplification	30,000	200,000	
Sensitivity at 3750 Angstroms	270	1800	Amp./Watt

Order through your local RCA Tube and Equipment Distributor or contact Radio Corporation of America, Harrison, N. J.

RCA

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FREE!

(Please check items wanted)

☐ 4-page technical data sheet giving description, ratings, characteristics, typical circuit diagrams, performance curves, and typical circuits for the RCA-931-A.

☐ 16-page booklet entitled "RCA Phototubes" chock-full of valuable tube data, application notes, etc., for RCA phototubes.

RCA, 588 So. Fifth Street, Harrison, N. J.

Gentlemen: Please rush me the items checked above.

Name_____

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