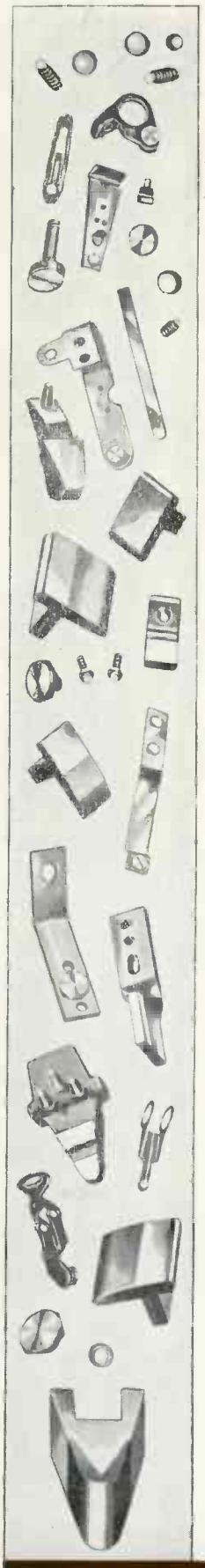
ELECTRONIC INDUSTRIES

- ★ Manufacture of Quartz Crystals for Signal Corps Use
- ★ How Sub-Contracting Speeds Radio Output
- ★ Broadcasting Milestones ★ Acoustic Design

MAY

Caldwell-Clements, Inc.



Not All Bug Hunters Are Biologists

A good many of them are engineers—and the bugs they hunt are performance flaws in vital production. Mallory contact engineers have been making some nice records in quickly "getting the bugs" out of tricky contact problems.

There was, for example, the case of an unusually designed aircraft relay, used in propeller control mechanism. The relay used contacts which butted together, rotating against each other during operation. Ordinary facing materials ground off fine particles which shortly formed an insulating layer to make the contacts inoperative.

It was up to Mallory to find an answer . . . and quickly. Actual conditions of operation were set up; one material after another tested, new alloys originated. Mallory experience and "know how" speeded the solution to a prompt conclusion with a complete contact assembly. A new material was developed, a suitable backing evolved and shortly the contact relays functioned perfectly. Another cog in War Production mechanism was in good working order. It sounds very simple and matter of fact.

But what made the result seem so simple was the applied technique of many years of research and experiment. Mallory engineers have pioneered so long in the contact field that their knowledge brings prompt results as a matter of course.

While the design is still in blueprint form

CONSULT MALLORY
for Contacts and Contact Assemblies

Nowadays, when a contact or complete contact assembly problem arises, it is only natural to call in Mallory. Their services are at your disposal.

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

P. R. MALLORY & CO. Inc.
MALLORY

ELECTRICAL CONTACTS AND CONTACT ASSEMBLIES . . . NON FERROUS ALLOYS POWDERED METAL ALLOYS

Famous for LONG LIFE!

Assurance of long life is what you seek in a capacitor — and it's an asset that must be built into it by the maker.

Tobe Capacitors are *built* to last. From winding to shipping, each step is under rigid inspection to maintain the high standard set by twenty year's experience — and research is constant to raise the standard ever higher.

Below is shown a Tobe RLO Type Capacitor. It is impregnated and filled with mineral oil, made with watchful care and — like all Tobe Capacitors — rated conservatively. Let us know about your capacitor problems.

LONG LIFE ASSURED

CHARACTERISTICS — TOBE RLO TYPE CAPACITORS

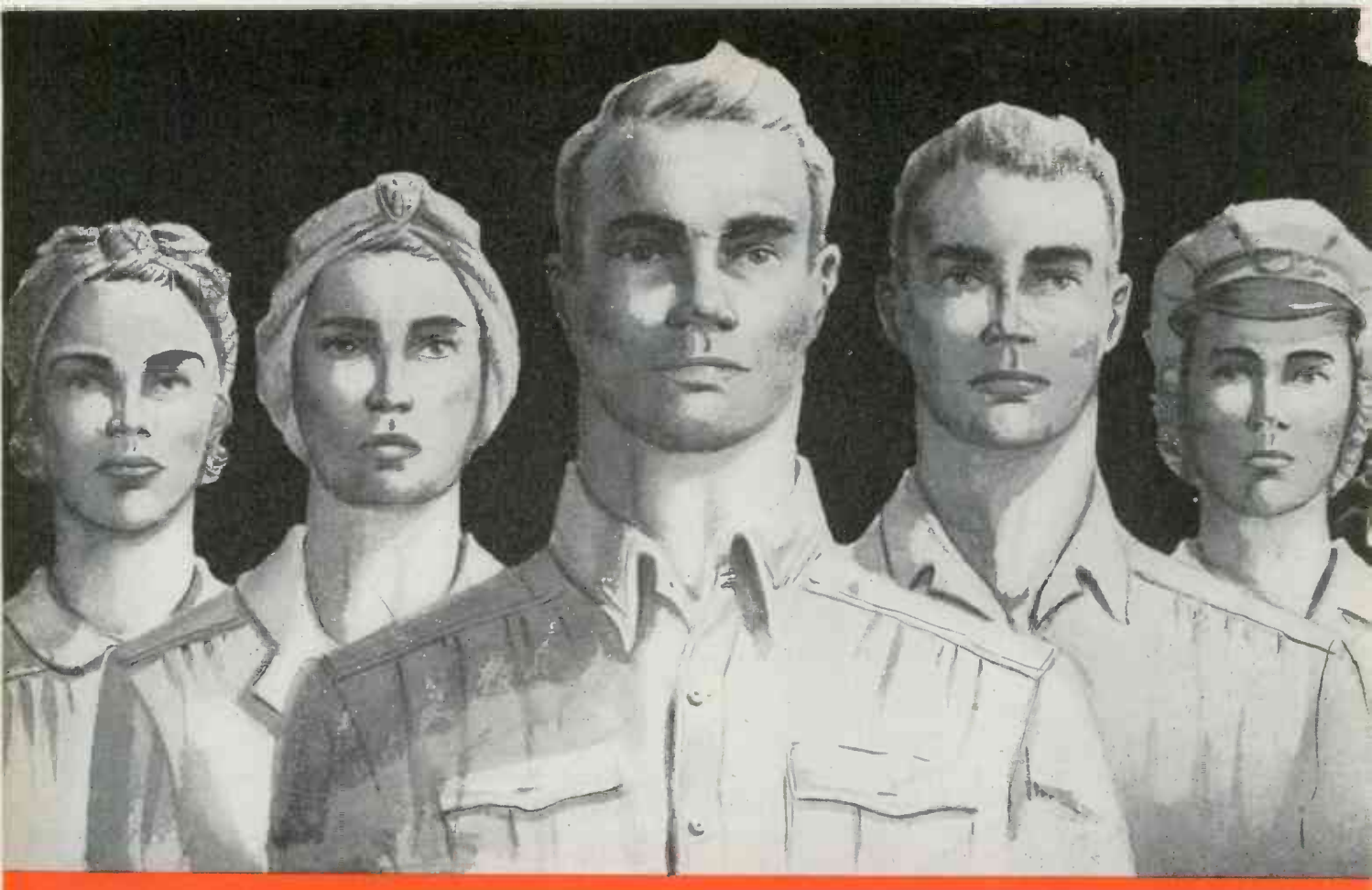
MINERAL OIL IMPREGNATED—Mineral oil filled • RATINGS: .01 to 2.0 mfd., 600 V.D.C., .01 to 1.0 mfd., 1,000 V.D.C. POWER FACTOR: At 1,000 cycles—.002 to .005 • RESISTANCE: 8,000 megohms per microfarad • TEST VOLTAGE: Twice D.C. working voltage rating • TERMINALS TO CASE TEST: 2,500 Volts D.C. • STANDARD CAPACITY TOLERANCE: plus or minus 20% of nominal

A SMALL PART IN VICTORY TODAY

TOBE DEUTSCHMANN CORP. TOBE CANTON · MASSACHUSETTS

A BIG PART IN INDUSTRY TOMORROW

Photo Courtesy of Southern Pacific Lines



One hundred years old

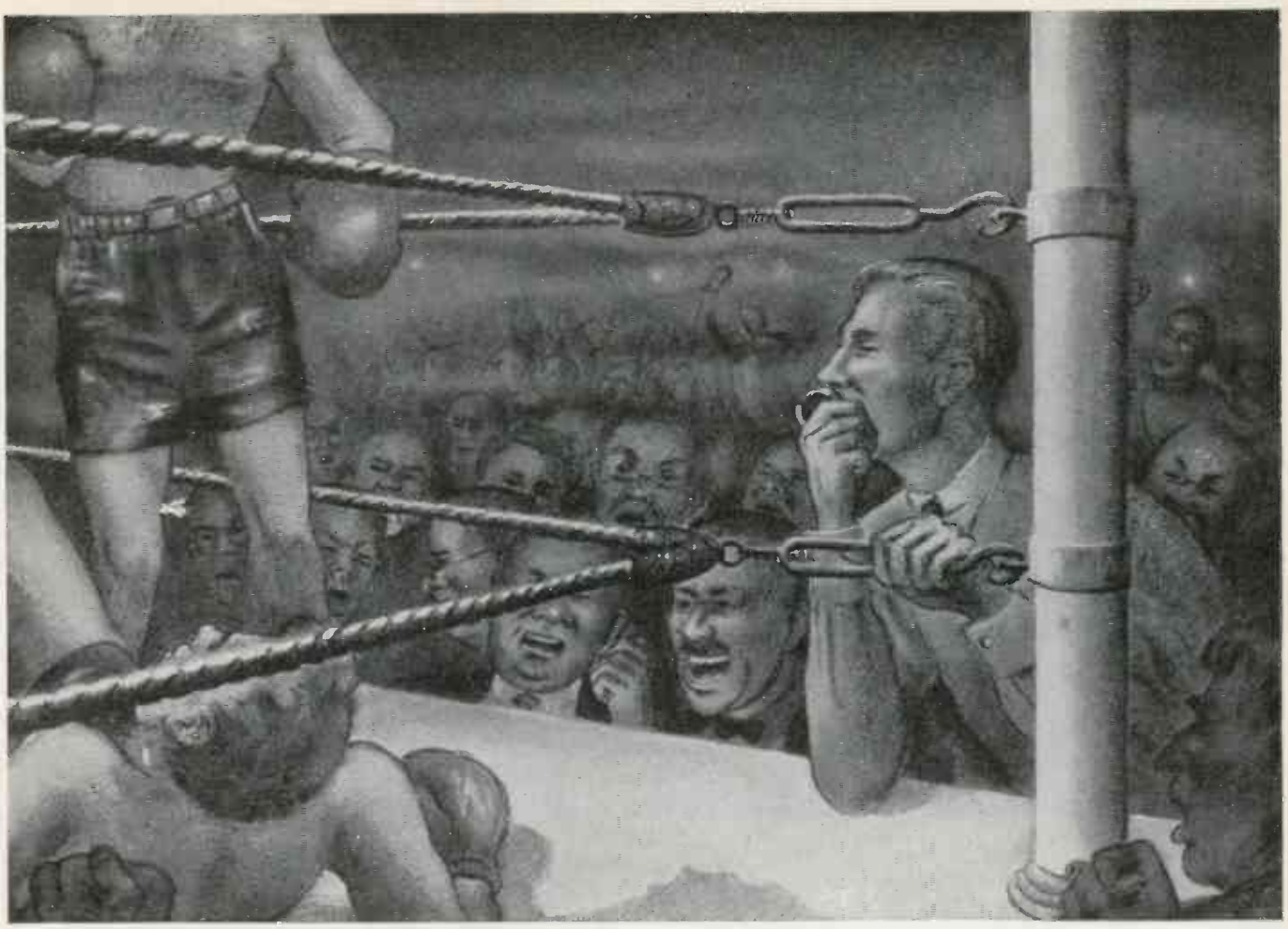
One solution to the present production problem would be through an increase in manpower . . . made available by prolonging the productive span of human life. Eventually, perhaps, medical science may succeed in accomplishing this "miracle".

Accelerated by war emergencies, Amperex laboratory developments have *already* multiplied the life spans of transmitting and rectifying tubes. These major advancements are *reducing tube replacement requirements and effecting substantial economies in critical fabricating materials, man hours and transportation facilities.*

By building *longer* life into our radio and military electronic tube designs, we are contributing to the solution of the all-important production problem.

AMPEREX ELECTRONIC PRODUCTS

79 WASHINGTON STREET **BROOKLYN, NEW YORK**



Effectively Eliminated

As far as future radio audiences are concerned, great, roaring crowds of sports fans no longer will distort the announcer's broadcast. He will be heard clearly and distinctly, above an adjustable volume of sound that may be retained for "color."

Newly designed Electro-Voice microphones make possible an almost complete suppression of annoying background noises. Full particulars may be furnished direct to government prime contractors who have specific need for such microphones with their equipment.

If, however, your limited quantity requirements can be met by any of our standard model microphones, with or without minor modifications, may we suggest that you contact your local radio parts distributor? He may be able to supply your immediate needs from remaining stocks. In all instances, his familiarity with our products and many of your problems will enable him to serve you well. Our distributors should prove to be vital links in expediting your smaller orders.

. . . Any model Electro-Voice microphone may be submitted to your local supplier for TEST and REPAIR at our factory .

Electro-Voice MICROPHONES

ELECTRO-VOICE MANUFACTURING CO., INC. 1239 SOUTH BEND AVENUE, SOUTH BEND, INDIANA

ELECTRONIC INDUSTRIES

MAY, 1943

In this Issue

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Electronic Industries, May, 1943, Vol. II, No. 5. 35 cents a copy. Published monthly by Caldwell-Clements, Inc., 480 Lexington Avenue, New York, N. Y. M. Clements, President; Orestes H. Caldwell, Treasurer.

Subscriptions: Continental United States only, $3 for one year; $5 for two years. Printed in U.S.A. Acceptance under the Act of June, 1934, authorized November 10, 1942.

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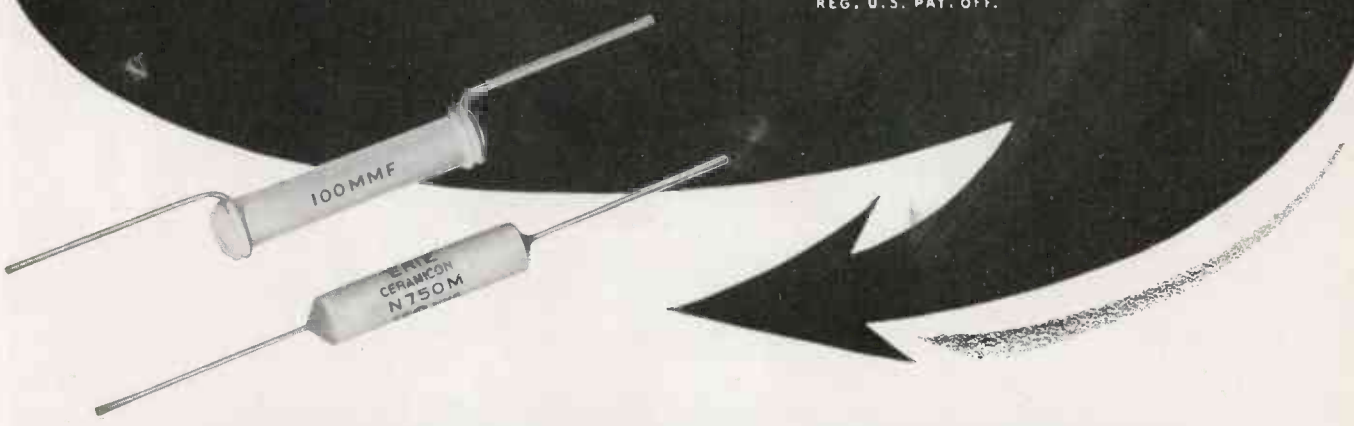
Millions OF ERIE CERAMICONS

REG. U. S. PAT. OFF.



ARE BEING PRODUCED MONTHLY TO PROVIDE COMPENSATION FOR FREQUENCY DRIFT IN ELECTRONIC EQUIPMENT

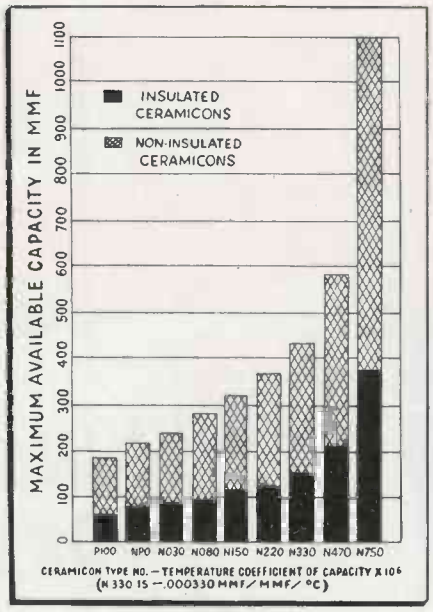
PIONEERED by Erie Resistor more than seven years ago, the demand for Erie Ceramicons has steadily grown because of the increasing need for extremely stable capacitors, and their excellent operating characteristics. As a result of war time requirements, the facilities for producing Erie Ceramicons are being expanded greatly.

Erie Ceramicons are inherently stable in capacity due to the solid nature of the dielectric and the unique method of applying the silver plates directly to the surface of the dielectric. The dependability of this construction has been proven by their use in many types of installations.

Erie Ceramicons are made in nine different temperature coefficients, from + 100 parts per million per °C to — 750 parts per million per °C. Insulated Ceramicons are made in capacities up to 375 mmf; non-insulated units up to 1100 mmf.

The chart reproduced at the right shows the range of capacity and temperature coefficient of Erie Ceramicons. Because of the inherent advantages of insulated type of Ceramicons, this style is recommended where available capacity permits.

For complete information covering operating characteristics of Erie Standard Ceramicons, write for data sheet.



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

HERE'S ALL YOU DO TO MAKE ROCK BOTTOM SAVINGS

READ THIS QUICK CHECK LIST THEN MAIL COUPON FOR COMPLETE STORY!

YOU ENJOY LOWEST PRICES WHEN YOUR COIL FORMS COME WITHIN THESE STANDARDS

*1. **OUTSIDE DIAMETERS** between 1 inch and 3 inches.

*2. **WALL THICKNESSES** between 5/32 inch and 9/32 inch.

*3. **LENGTHS** up to 9 inches (with better prices for shorter lengths).

4. **MAXIMUM** of 20 holes for coil forms ¼ inch and 9/32 inch thick with maximum of 4 holes tapped.

5. **MAXIMUM** of 10 holes for coil forms 5/32 inch to 7/32 inch thick with maximum of 2 holes tapped.

6. **MAXIMUM** of 14 grooves to the inch.

*7. **TOLERANCES** on general dimensions ± 2.0%, but not less than ± 0.010 inches.

**Proposed A.S.A. Standards.*

In addition to low-cost standard types, Corning Multiform Insulators may be had in almost any other size or shape.

CLIP THIS COUPON TO YOUR BLUE PRINT- MAIL TODAY FOR ACCURATE QUOTATION!

Corning Glass Works
Insulation Division, Dept. EI-8, Corning, N. Y.

Please send us estimate on coil forms as per attached blueprint and data below:

Quantity.....

When Needed (date).....

Electrical Characteristics.....

.....

Acceptable Revisions.....

.....

Name.....

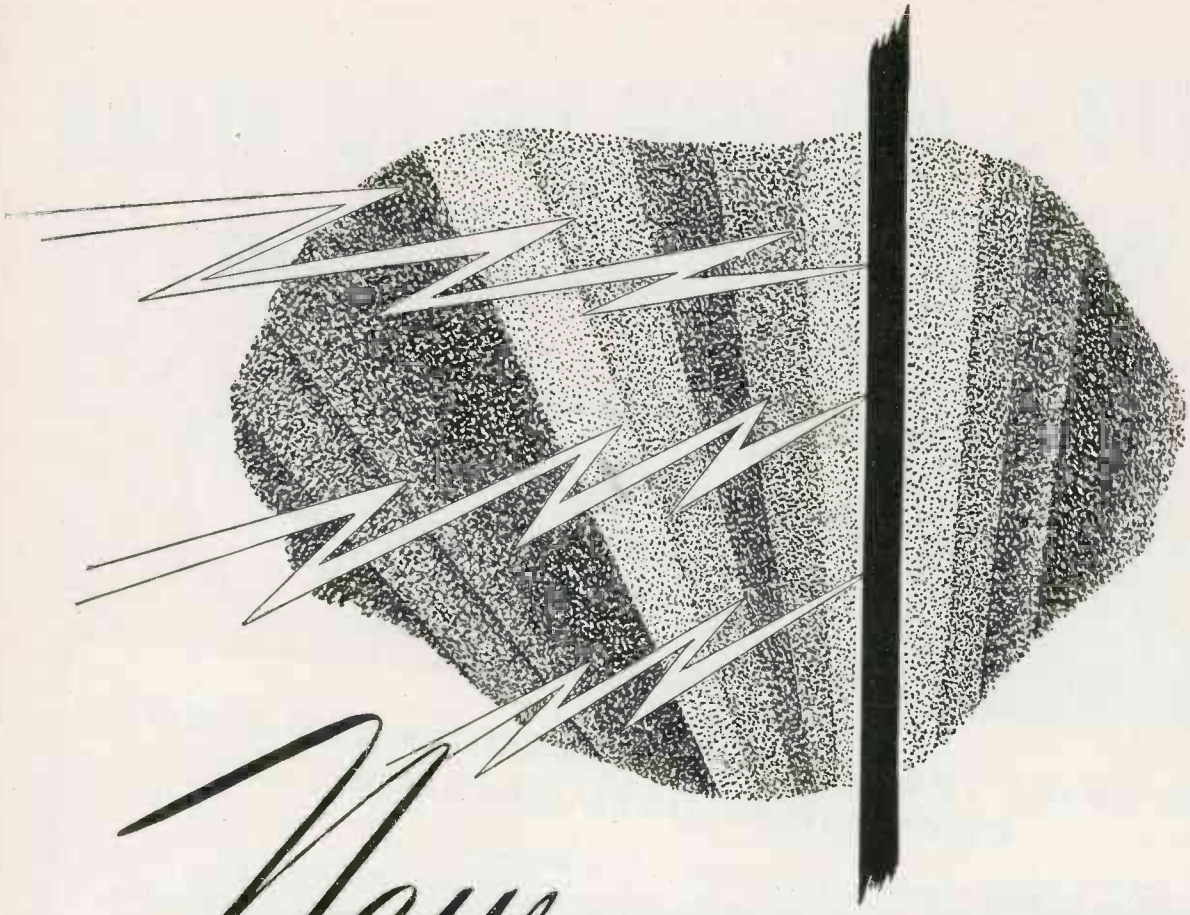
Company.....

Street.....

City.....State.....

Pyrex Insulators
BRAND

"PYREX" is a registered trade-mark and indicates manufacture by Corning Glass Works.



New BARRIERS to Confine Electric Current!

War is destructive but not all effort that goes into the big fight is wasted. Some of it is going to pay mighty big future dividends. That is especially true of the war work that is going on in the country's laboratories.

At Formica this work has resulted in the development of some new insulating materials with new and valuable characteristics which will be doing important jobs in American electrical products long after the war is over.

Three new grades MF, FF-10 and FF-41 accomplish things that could not be done previously with this laminated insulation. MF is a glass mat base for applications requiring low loss at radio frequencies (Power Factor .011; Dielectric Constant 4.6; Loss Factor 0.05 at 1 Megacycle).

F-10 is Fiberglas fabric base material combining good dielectric strength and heat resistance. And FF-41 is designed to resist arcing.

These materials have a new and important usefulness. At present they are available only for the most essential war uses. But later they will be widely applied.

THE FORMICA INSULATION CO., 4647 SPRING GROVE AVENUE, CINCINNATI, O.

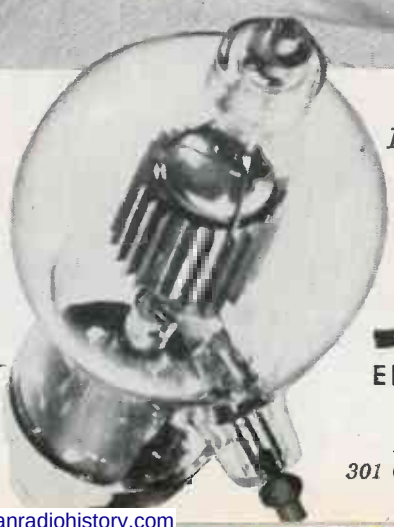
electronic briefs: FM

Radio is simply a method by which electrical energy is transmitted through space. By varying the intensity or frequency of this electrical energy, an intelligible signal can be created. The principle is the same whether dot dash code messages or voice and music are being transmitted. In the case of voice and music transmission the radio wave must be varied (modulated) at the same speed as the vibrations of the voice or music. The characteristics of electrical energy which can be varied or modulated are three: voltage, frequency and phase. Radio transmitters which vary the intensity (voltage) are called amplitude modulated and those which vary the frequency are called frequency modulated. The differences of these two systems can be understood easily by visualizing a beam of light. An audible signal can be transmitted by varying the light intensity (amplitude modulation) or by varying the color of the light beam (frequency modulation).

Static and other man-made electrical disturbances are identical in character to the amplitude modulated signal. Hence these disturbances are extremely bothersome to AM broadcasts. On the other hand these electrical disturbances do not essentially vary in frequency and consequently do not interfere with FM transmission. Another fortunate characteristic of FM is the fact that the stronger of two signals predominates, thus eliminating much inter-station interference and cross-talk. Further, and of great importance, the fidelity of tone can be made nearly perfect even when the heaviest of musical scores is being broadcast.

In frequency modulation as in all things in the field of electronics, vacuum tubes are the most important component. Eimac tubes have the distinction of being first choice of most of the leading electronic engineers throughout the world. They are consequently first in the most important new developments in electronics . . . FM for example.

Army-Navy "E" flag awarded for high achievement in the production of war material.



Follow the leaders to

Eimac REG. U.S. PAT. OFF.

TUBES

EITEL-McCULLOUGH, INC.

SAN BRUNO, CALIFORNIA

Export Agents: Frazar & Hansen
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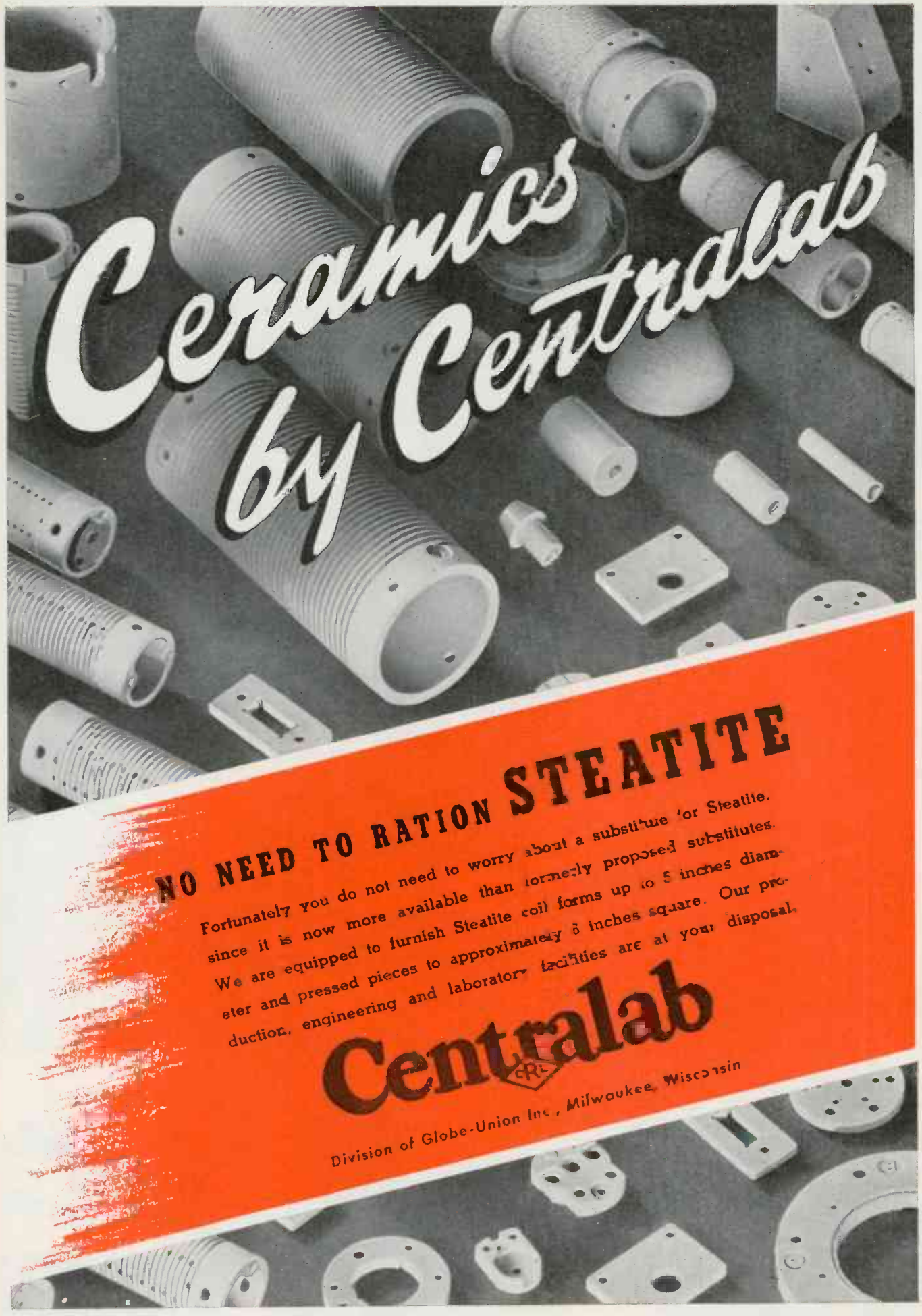


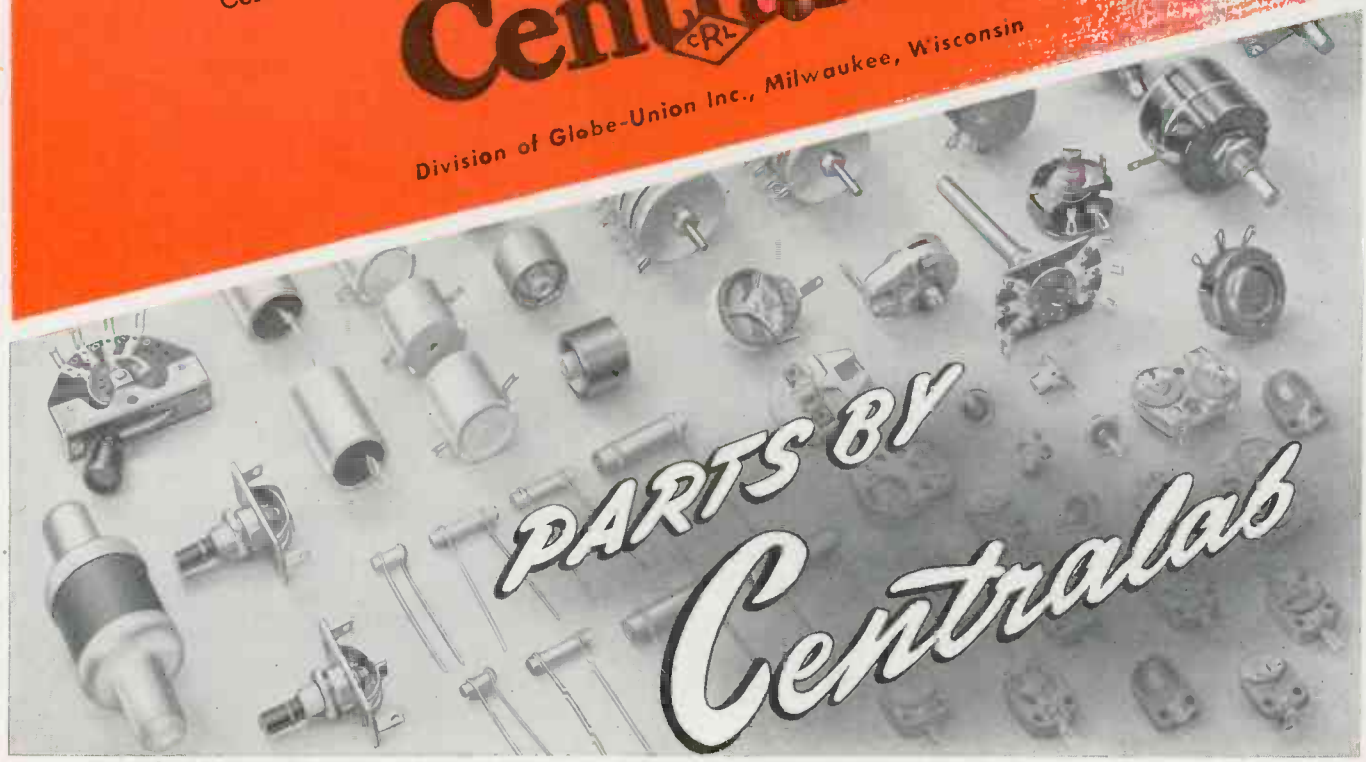
THERE IS NO SUBSTITUTE FOR QUALITY

When the emphasis is on Speed . . . Quality is sometimes forgotten. Not so at Centralab where greatly added facilities insure the maintenance of a quarter-century standard of excellence. Steatite Insulators . . . Ceramic Trimmers . . . High Frequency Circuit Switches . . . Volume Controls . . . Ceramic Capacitors . . . Wire-wound Controls and Sound Projection Controls.

Centralab

CRL

Division of Globe-Union Inc., Milwaukee, Wisconsin



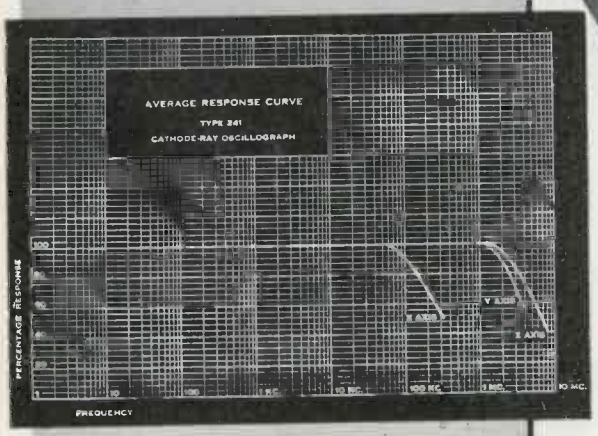
DuMONT *Oscillography*

...from A to X, Y and Z

The new DuMont Type 241 oscillograph is literally an enlarged version of the 3-inch Type 224 already meeting the more critical requirements of oscillograph users.

The 5-inch tube means larger oscillograms for more detailed studies. The added Z-axis amplifier for beam modulation permits use of timing signals or blanking impulses for further applications.

Both instruments—Type 224 (3-inch) and the new Type 241 (5-inch) set *new standards* for commercial-grade oscillographs. Wide-band Y-axis amplifiers permit study of signals of frequencies far beyond the range of usual instruments. Both have a comparably wide-band square and sinusoidal wave response. Both permit a wide choice of panel connections for extreme flexibility in applying signals to the cathode-ray tube. Both are ruggedly housed and supplied with removable front cover for added protection in transit or when not in actual use.



These two expanded-range-expanded-versatility DuMont Oscillographs, along with other DuMont types, round out an outstanding choice of instruments for your particular kind of oscillography.

FEATURES

DuMont Type 5JP1 intensifier-type cathode-ray tube for brilliant, easy-reading oscillograms.

Y-axis or vertical deflection response uniform from 20 c.p.s. to 2 mc. Comparable faithful square and sinusoidal wave response.

X-axis or horizontal deflection amplifier with uniform response to 100 kc.

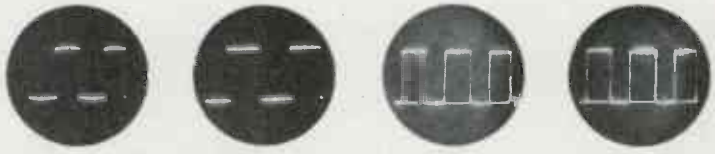
Both amplifiers have input attenuators and distortionless gain controls.

Y-amplifier has input connection for test probe and shielded cable supplied with instrument, reducing input capacitance and eliminating usual stray pickup.

Z-axis amplifier modulates intensity of electron beam with signal applied to input terminal post, or with return trace-blanking pulse produced by linear-time-base generator.

All high-voltage electrolytic capacitors eliminated from circuit.

17½" high; 10¾" wide; 21" deep. 65 lbs.



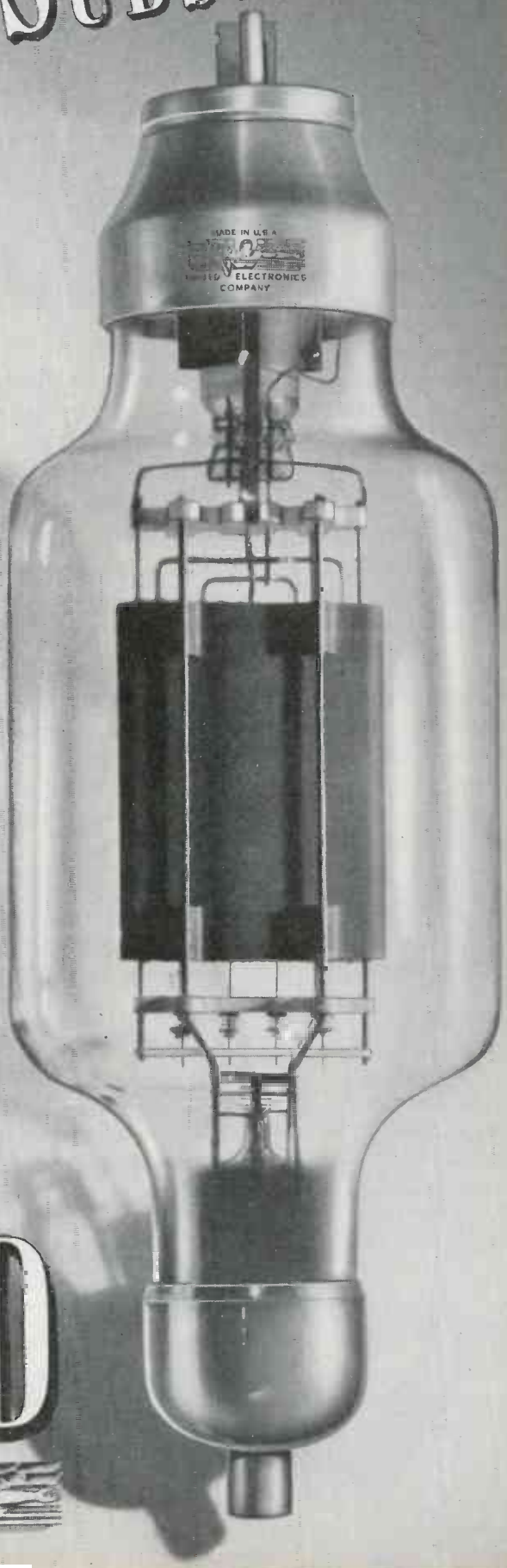
50 c.p.s. 500 c.p.s. 25 KC. 100 KC.

DUMONT

ALLEN B. DU MONT LABORATORIES, Inc.
Passaic • New Jersey
Cable Address: Wespexlin, New York

Write for literature

SHADOW AND SUBSTANCE



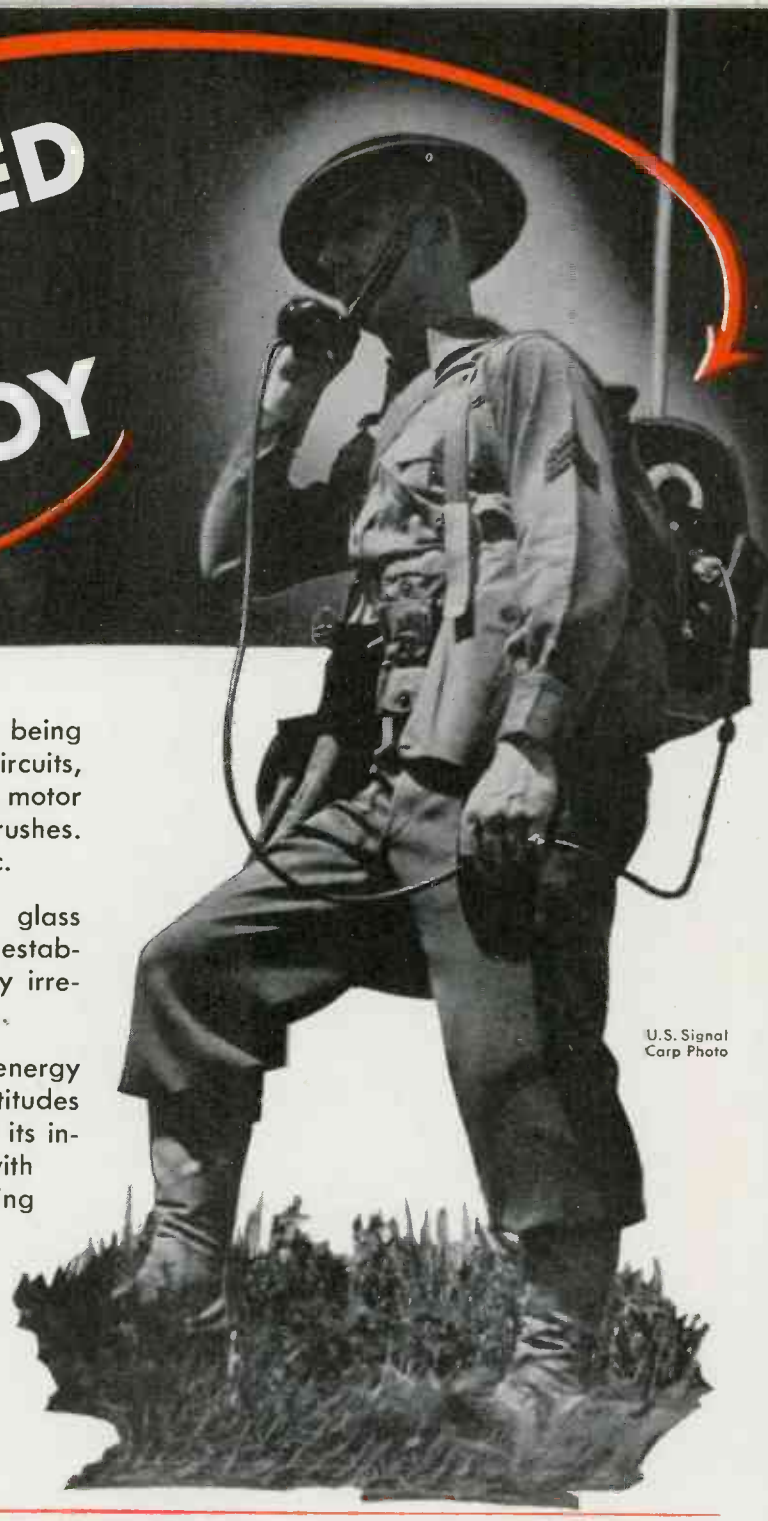
In the highly specialized field of electronics, the question "Who made the tubes?" will always be a matter of vital importance. Power tubes bearing the name "United" are products of original pioneers in the miracle known today as electronics. Step by step these seasoned engineers helped evolve the principles and advance the science of fabricating transmitting tubes which hold a superb record of performance. The early pioneers at United are *still actively pioneering!* The wealth of experience which they have been privileged to accumulate under the demands of war will be available to you when "United" electronic tubes are available again on a peace-time scale for radio and industrial applications.

UNITED

ELECTRONICS COMPANY

NEWARK NEW JERSEY

INSULATED WITH MYKROY



U.S. Signal Corp Photo

THE whole gamut of electrical insulation is being better served today by MYKROY. In radio circuits, MYKROY bars contribute structural strength. In motor generators, MYKROY serves as a component of brushes. In tube sockets, MYKROY is the perfect dielectric.

In countless applications this ingenious glass bound mica electrical insulation material has established its adaptability and is proving absolutely irreplaceable where perfect insulation is imperative.

MYKROY will lose negligible electrical energy through the entire frequency range. In high altitudes MYKROY exhibits no deterioration or change in its insulating characteristics. It binds inherently with metal, will not warp, can be machined to exacting tolerances, possesses high mechanical strength and is resistant to severe shock.

Let our engineers acquaint you with the remarkable performance of MYKROY. It is precisely the material needed for all difficult electrical insulation problems in wartime production.

TYPICAL EXAMPLES OF MYKROY APPLICATIONS

Stand-off Insulators • Mounting strips • Tube and Crystal Sockets • Variable condensers • Structural supports for radio circuits • Motor generator brush holders Insulated couplings • Lead-in insulators • Antenna reel insulators • Padding condenser supports • High voltage arc shields • Radio frequency panel assemblies Oscillator circuits • Fixed condensers • Impregnated resistors • Radio frequency coil forms • Radio frequency switches • Relay bases and arms • Plug-in bases

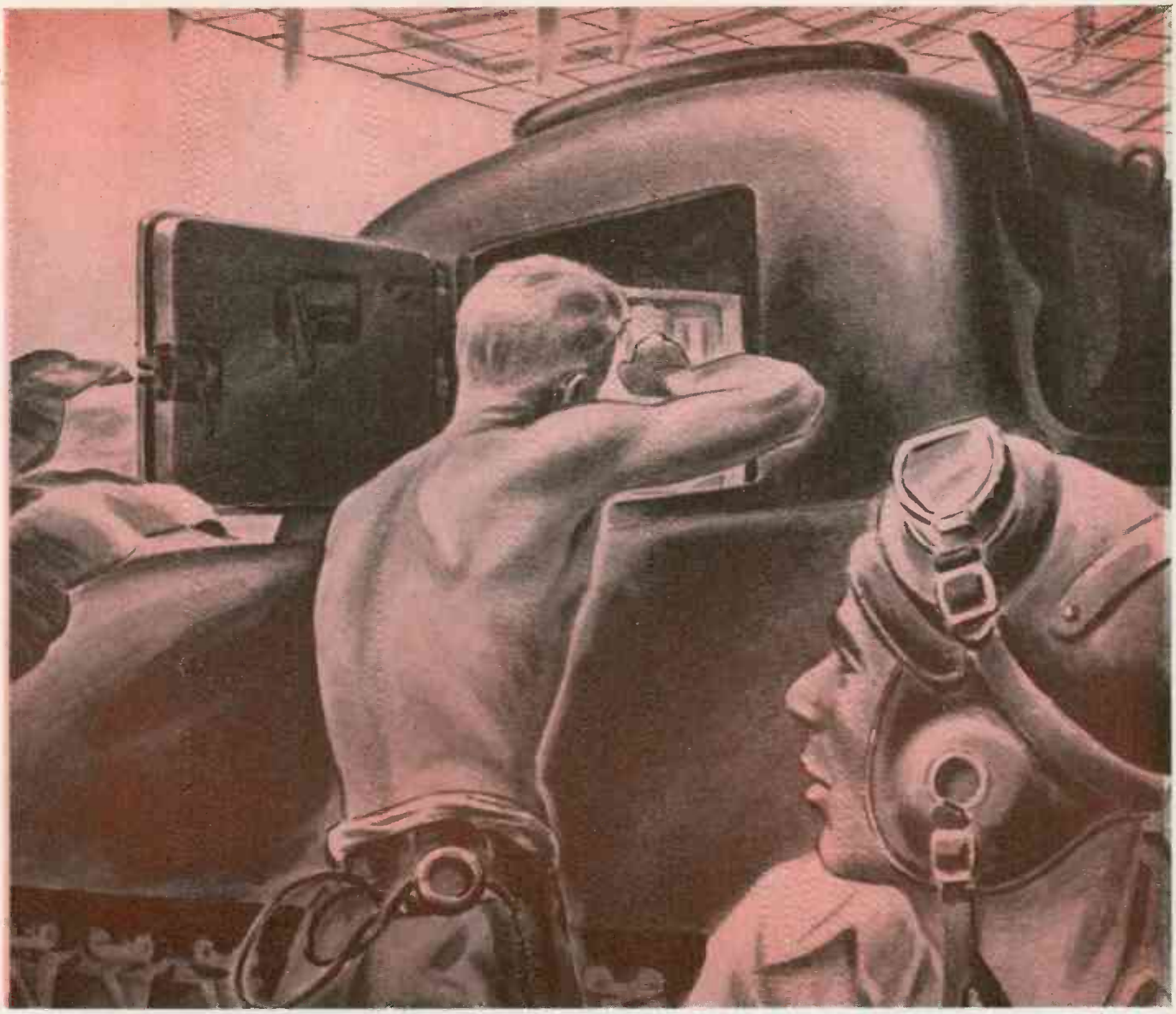
MYKROY is available in ample quantities and can be supplied for war and essential requirements. For further information write us.

MYKROY

CERAMIC INSULATING MATERIAL

SUPPLIED IN SHEETS . . .
MACHINED WITH PRECISION
MOULDED TO SPECIFICATION
. . . MADE EXCLUSIVELY BY

ELECTRONIC MECHANICS INC.
70 CLIFTON BOULEVARD, CLIFTON, N. J.



"Hmm! Nothing wrong with the Capacitors anyhow"

In steaming swamps, icebound wastelands and arid desert—the fighting fronts of global war—Cornell-Dubilier capacitors are revealing the stout-hearted stamina that's in them. Today, as in peacetime, there are more C-D capacitors in use than any other make.

You can give your product this same measure of dependability by using C-Ds whenever the design calls for capacitors. Engineered by specialists and backed by 33 years of manufacturing experience, the C-D capacitor—as a *fighting tool* of World War II—is more reliable than ever. Cornell Dubilier Electric Corporation, South Plainfield, New Jersey.

MICA CAPACITORS
for high frequency applications

The type 75A Mica Capacitor illustrated, was designed for high frequency, high current, continuous heavy-duty applications.

CHECK THESE FEATURES:

Completely oil-filled and hermetically sealed.

Heavy conical ceramic insulator provides maximum insulation and mechanical strength.

Employs C-D patented radial type, series stack construction. This results in low-losses, elimination of corona effects and power losses.

These capacitors as well as others in the complete C-D line are described in Catalog 160 T free on request.

Cornell Dubilier capacitors

MICA • DYKANOL • PAPER
WET & DRY ELECTROLYTICS

MORE IN USE TODAY THAN ANY OTHER MAKE

Wish we could talk about some of this

The mid-western job, with photos, would make a honey of an ad. It's the largest high altitude test chamber in the country. Unusual specifications, too . . . Or the steel-saving, time-saving concrete altitude chamber that everybody said was impossible . . . And the small unit that brought a manufacturer's testing time on production runs down to 8% of his previous average . . .

Most of this information, if published, could be very helpful to manufacturers of equipment requiring Army or Navy high altitude and temperature tests. True, we are permitted to furnish government prime contractors with full particulars, when they ask for it. But ALL of them can't possibly know whether their special problems are within the scope of our activities . . . unless they write, and enable us to recommend solutions.

But, boy, will we have plenty to say to the entire field when the war is over and we can open our lab records!

MOBILE REFRIGERATION, INC.

630 FIFTH AVENUE NEW YORK, N. Y.

They sail with the Fleet

Leland Marine Service motor alternators are sailing with the fleet . . . fighting with the fleet.

They are part of the radio installation aboard ship. They power the transmitters and receivers wherewith *battle orders* are flashed by the commanding officers. Theirs is a vital role in the fight to survive.

This is very special equipment operating on a freqency so close as to require a governor to hold it constant. Its design specifications posed problems only war-pressured engineers would care to tackle . . . the development of skills far advanced from pre-war standards.

LELAND MOTOR ALTERNATOR SET FOR POWERING OF RADIO DEVICES ABOARD SHIP.

Leland

WAR DUTY MOTORS

Present production almost entirely earmarked for the armed services. Sales and engineering service on post-war electronic equipment immediately available.

THE LELAND ELECTRIC COMPANY ★ DAYTON, OHIO

MYCALEX
THE INSULATOR

Production to keep apace of your assembly schedule . . . and precision tolerance to meet your requirements . . . are offered by Precision Fabricators, Inc., in the production of parts in "LDS" (leadless) Mycalex.

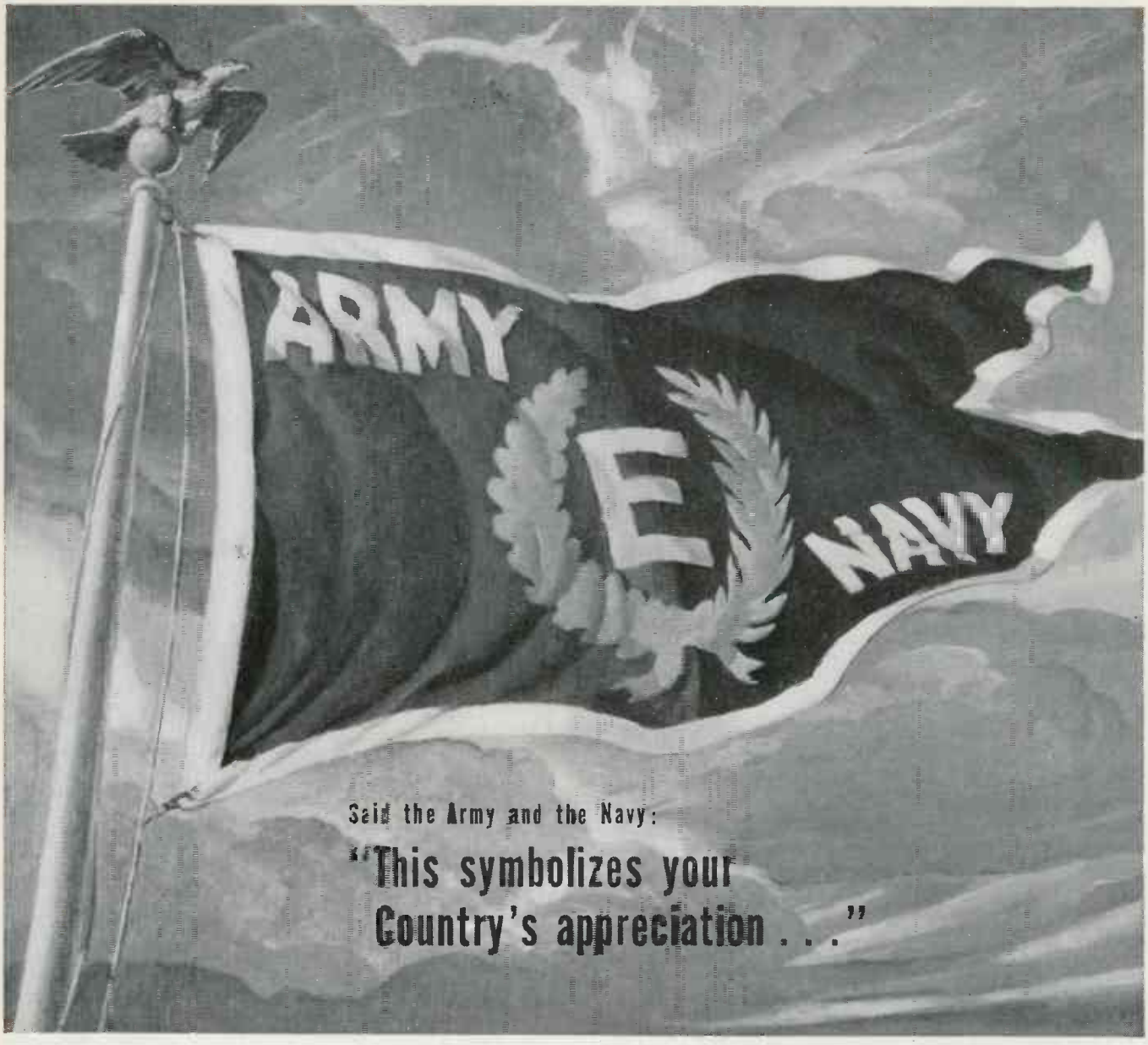
Because of its high mechanical strength, its stability under pressure, high voltage, heat and humidity, its high dielectric strength and its low loss at highest frequencies, Mycalex is preferred insulation for a variety of electronic applications. We are prepared to fill your needs in Mycalex, cut, milled, drilled, threaded, grooved, turned, ground, surfaced or engraved.

Precision Fabricators, Inc. have been appointed fabricators by Mycalex Corporation of America, who are exclusive licensees under patents of Mycalex (parent) Co., Ltd., London, England.

PRECISION *Fabricators* INC.

120 NORTH FITZHUGH ST., ROCHESTER, N.Y. • NEW YORK OFFICE: 369 LEXINGTON AVE.

SPECIFICATION FABRICATORS OF MYCALEX ★ PHENOL FIBRE ★
VULCANIZED FIBRE ★ RUBBER ★ ASBESTOS AND OTHER MATERIALS



There it flies
The coveted
Army-Navy "E" . . .

We can't tell you
Very much about
The electronics research
That won it . . .

Such matters are
Wartime secrets . . .

But this we *can* say . . .
In the words of
The Army and Navy
This pennant
Represents
"Great accomplishment
In the production
Of war equipment."

Today
Modern radio equipment
Designed and developed
By the Laboratories Division of
Federal Telephone and Radio Corporation
An I.T.&T. Associate
Is helping Uncle Sam's fighting forces
Work together
On land, sea and in the air . . .

Tomorrow
It will help build
A better world
For every man.

THE LABORATORIES DIVISION OF

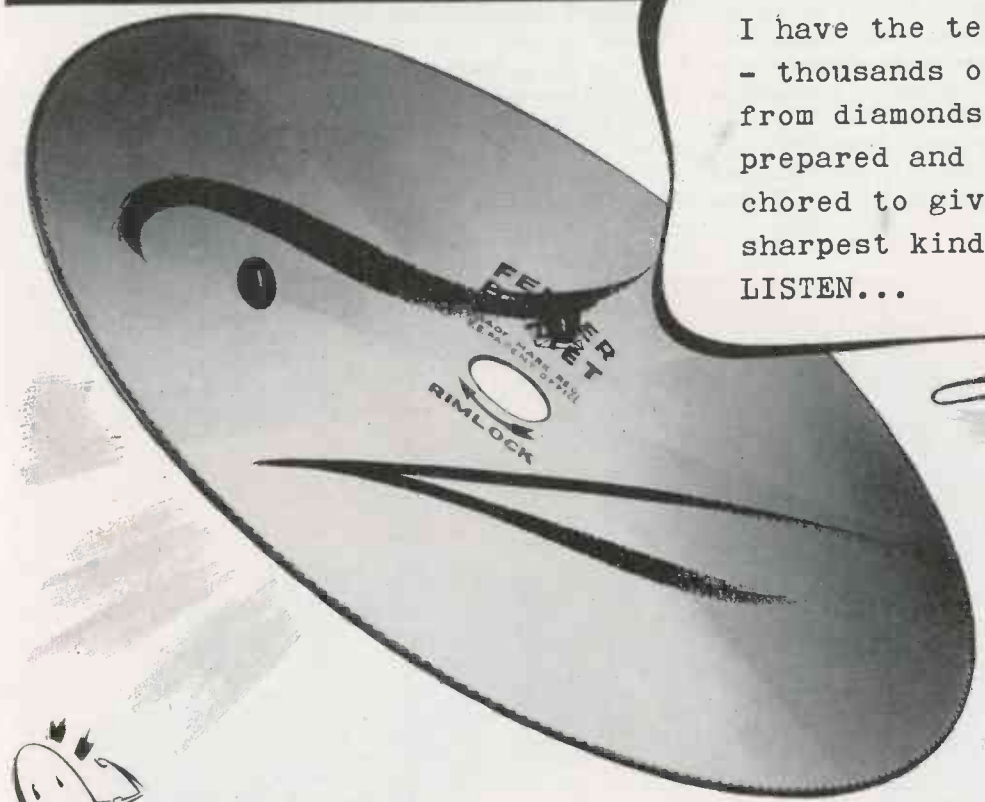
Federal Telephone and Radio Corporation

67 Broad Street, New York, N. Y.

AN I T&T ASSOCIATE

I PUT TEETH

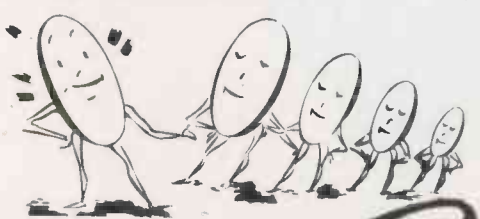
behind any man's quartz program



I have the teeth, too - thousands of them - made from diamonds specially prepared and anchored to give me the sharpest kind of a bite. LISTEN...

NEVER A DULL MOMENT!
Stamina? When I leave the factory I'm really in condition – hand straightened, they call it – nicely broken in and waiting for a chance to mow through that quartz. Guess I keep going because I hang on to my teeth and have plenty of 'em to start with.

I HOLD 'EM ON THE NOSE, TOO.
Precision's the word! I get in the groove and stick to it. No wavering, no runout, but perfectly smooth, parallel cuts morning til night.



HOW BIG AM I?
Heck, my brothers and I vary from 4" to 24" in diameter. There's a 3" baby in the family, too!

* We're sort of busy now, but if it's more WAR WORK, you can count on us!

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

DI-MET *Rimlocks*

FOR SPEED...FOR ACCURACY...FOR LONG LIFE

MANUFACTURERS OF DIAMOND ABRASIVE WHEELS

Dunco Quality
INDUSTRIAL CONTROL RELAYS

Although Struthers Dunn, Inc. makes many more complicated, and therefore more "spectacular," relay types, there are none in which Dunco design and manufacturing care have proved more effective than in these Industrial Control and Power Transfer types commonly used for controlling motors, heats, lights, and for other industrial tasks.

Their success over a long period of time has been largely a matter of refinement of every detail having a bearing on performance and dependability—and topping this off with individual adjustment plus two separate inspections before shipment.

Dunco Industrial Control and Transfer Relays are made in many types and with mounting styles for almost any application.

WRITE for your copy of the Dunco Relay-Timer Catalog and Data Book. Contains details on the largest line of high-quality Relays and Timers, as well as helpful engineering information.

STRUTHERS DUNN, Inc.

1321 ARCH STREET PHILADELPHIA, PA.

LET DUNCO DISTRICT ENGINEERS IN 28 CITIES HELP SOLVE YOUR RELAY-TIMER PROBLEMS

_For lack of a Tube

The Big "B" was limping home over the water with two motors shot away. Too far gone to reach the home field. No visibility for a navigational fix.

Radio Op was trying to locate a closer field when a tube went dead. Which one? No time to test. He yanked out all the tubes. Started putting in a spare set.

But one of the tubes he jerked out was a "special selection." The replacements didn't work. The big bomber never got that bearing. And $350,000 worth of fighting ship drowned in the Pacific.

The moral? If you are a designer of radio and radio-electronic circuits for our armed forces, you can avoid the use of special selection tubes in 99 cases out of 100.

There's hardly a radio-electronic circuit today that can't be designed to function perfectly with standard tubes

You might need two of these in place of one "special selection," but standardization makes it worthwhile.

We can and do supply "special selections" but only when authorized by the Army or Navy. Even then your special selection will interfere with the mass production and delivery of our standard tubes — and today time is the essence.

So why not first find out if the circuit you're working on now, can't be designed without the use of "special selections"? Our staff of application engineers is always ready to help you solve your design and manufacturing problems — and they can help you avoid "special selections"!

RCA

RCA RADIO TUBES

RECEIVING TUBES • POWER TUBES • CATHODE-RAY TUBES • SPECIAL-PURPOSE TUBES

RCA Victor Division, **RADIO CORPORATION OF AMERICA**, Camden, N. J.

LORD
BONDED RUBBER

MOUNTINGS
Isolate Vibration in the WORLD OF ELECTRONICS

LORD STANDARD MOUNTINGS

Holder Type Plate Form Mounting

Square Plate Form V.S. Mounting

Square Plate Form Mounting

Square Plate Form Series Mounting

Tube Form V.S. Mounting

Tube Form Mounting

MILLIONS of Lord Mountings are at work today in the electronic industry—protecting all manner of electronic devices from their worst enemy—vibration. The transmission of unbalanced forces causing vibration is reduced to a minimum by means of Lord Mountings, with the result that, in any electronic device, operating characteristics are improved and functional life is increased.

The principal characteristic of any Lord Mounting is the strong bond between the rubber and metal—a distinctive feature which makes possible the design and manufacture of *Shear Type* mountings that are rugged, simple, compact, and easy to install.

Standard Lord Mountings are made in two main types—Plate Form and Tube Form—in various shapes and sizes, with snubbing and non-snubbing features, and in load capacities ranging from a few ounces to 1500 pounds.

The first step in the selection of mountings is to determine the actual static load to be carried and the nature and direction of the disturbing frequency. When loaded so that the disturbance is in the direction of the main axis of the mounting, the mounting deflects readily and the rubber is permitted to operate in full shear freedom, with ample stability in other directions. This action results in a considerable reduction of the natural frequency of the mounted system with a consequent great reduction in the vibratory forces transmitted through the mounting. All Lord Mountings will withstand momentary overloads due to shock greatly in excess of static loadings.

Where equipment may be subjected to frequent, sudden load shocks . . . where movement is to be held to a minimum . . . or where the resonant range is frequently encountered, Lord Vertical Snubbing Mountings are recommended.

The exclusive features of Lord Bonded Rubber Mountings make them particularly adaptable for use on any type of electronic assembly or electronic controlled equipment—from light, delicate instruments to heavy, massive machinery.

For complete information covering all Lord Mountings and an engineering discussion on vibration control, call in a Lord Vibration Engineer for consultation on your design problems or write for Bulletins 103 and 104. There is no obligation.

LORD MOUNTINGS

PROLONG EQUIPMENT LIFE by isolating vibration, which reduces metal fatigue and prevents mechanical failure.

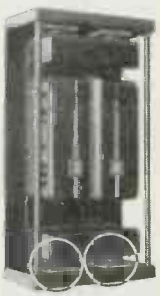
INCREASE PRODUCTION by eliminating the necessity for close machining and precision alignment.

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

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

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

TYPICAL INSTALLATIONS



Air Conditioning Control

R.C.A. Radio Transmitter

Marine Radio Transmitter

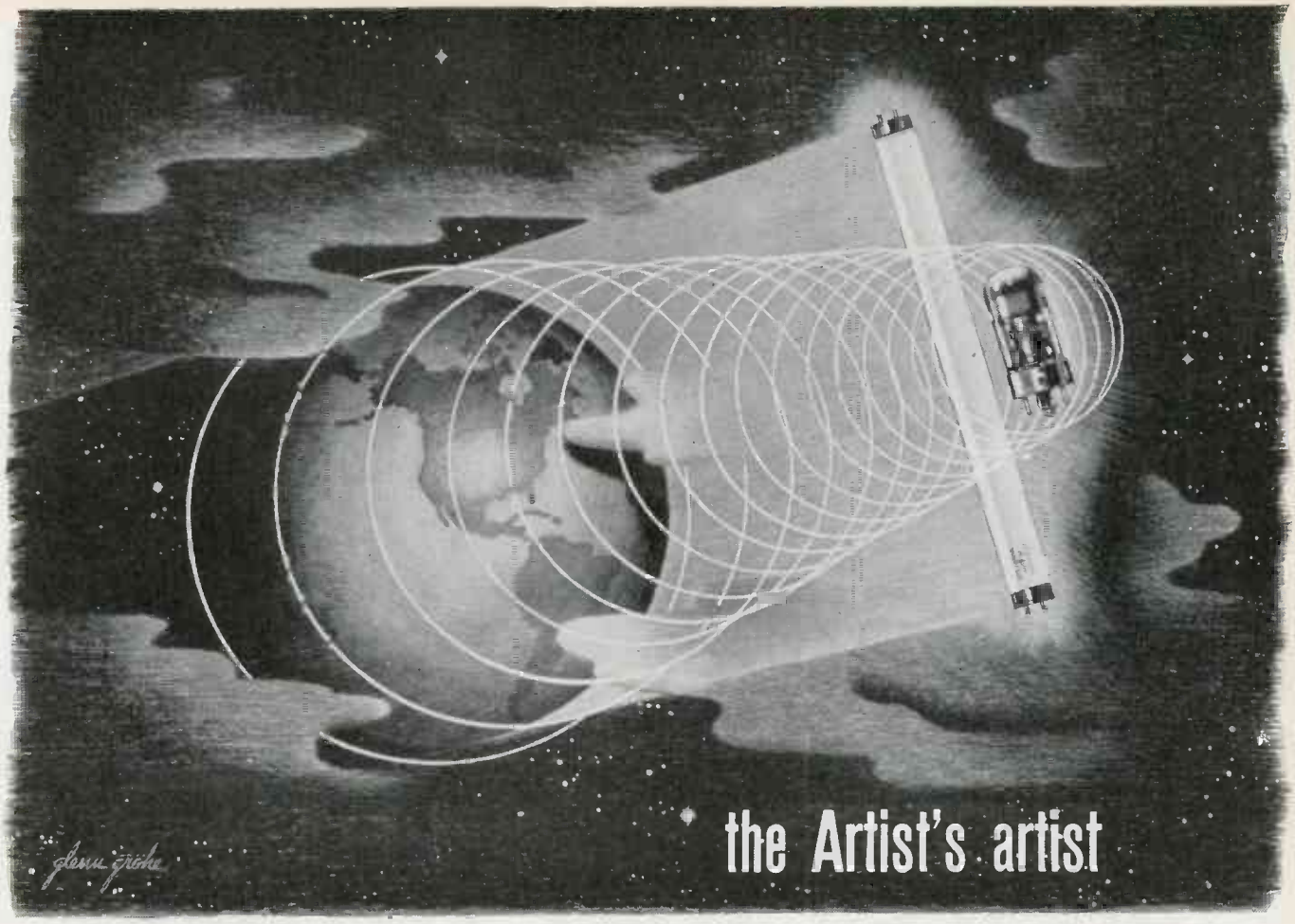
Electronic Control for Medical Apparatus

IT TAKES RUBBER ***IN SHEAR*** TO ABSORB VIBRATION

LORD MANUFACTURING COMPANY . . . ERIE, PENNSYLVANIA

Originators of Shear Type Bonded Rubber Mountings

SALES REPRESENTATIVES • NEW YORK 280 Madison Ave. • CHICA... 7310 Woodward Ave. • BURBANK, CAL. 245 E. Olive Ave.



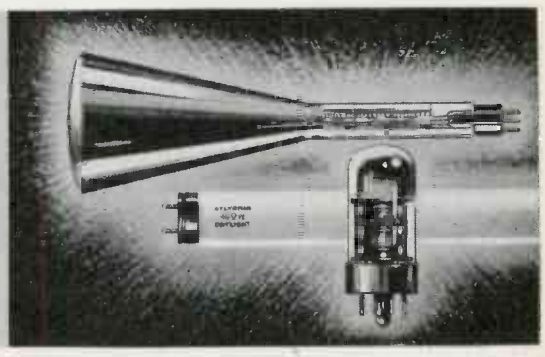
We are not zealous here at Sylvania to be the largest in our field. We had rather be known for excellence than for size. You have heard of the man so painstaking that to his talented fellows of larger fame he is known as the writer's writer, or the painter's painter, or the singer's singer. We understand that, and it seems to us there could be no higher praise. So in all the things we build – incandescent lamps, fluorescent lighting equipment, radio and electronic tubes – we aim uncompromisingly high, high as we possibly can. The function of these things, conceived as they are to amplify the indispensable miracles of human sight and hearing, seems to us to deserve the very best that can be given. So believing, it is only natural we should seek in all our work to attain the highest standards anywhere known.

SYLVANIA ELECTRIC PRODUCTS INC.

EMPORIUM, PA.

MAKERS OF INCANDESCENT LAMPS, FLUORESCENT LAMPS, FIXTURES AND ACCESSORIES, RADIO TUBES, CATHODE RAY TUBES AND ELECTRONIC DEVICES

INDUSTRIAL ELECTRONICS is doing much to help win the war on the production front, but can do a great deal more by more widespread application. Sylvania Electronic Tubes for devices that can automatically gauge, count, control, actuate, test, detect, protect, guide, sort, magnify, heat, transform, "see," "feel" and even "decide" are tested and available. The more electronic "know how" is put to work to make precision war production speedier and more precise, the sooner the Victory.



Typical SPEER graphite anodes

ELECTRONIC WARFARE SHAPES OUR FUTURE

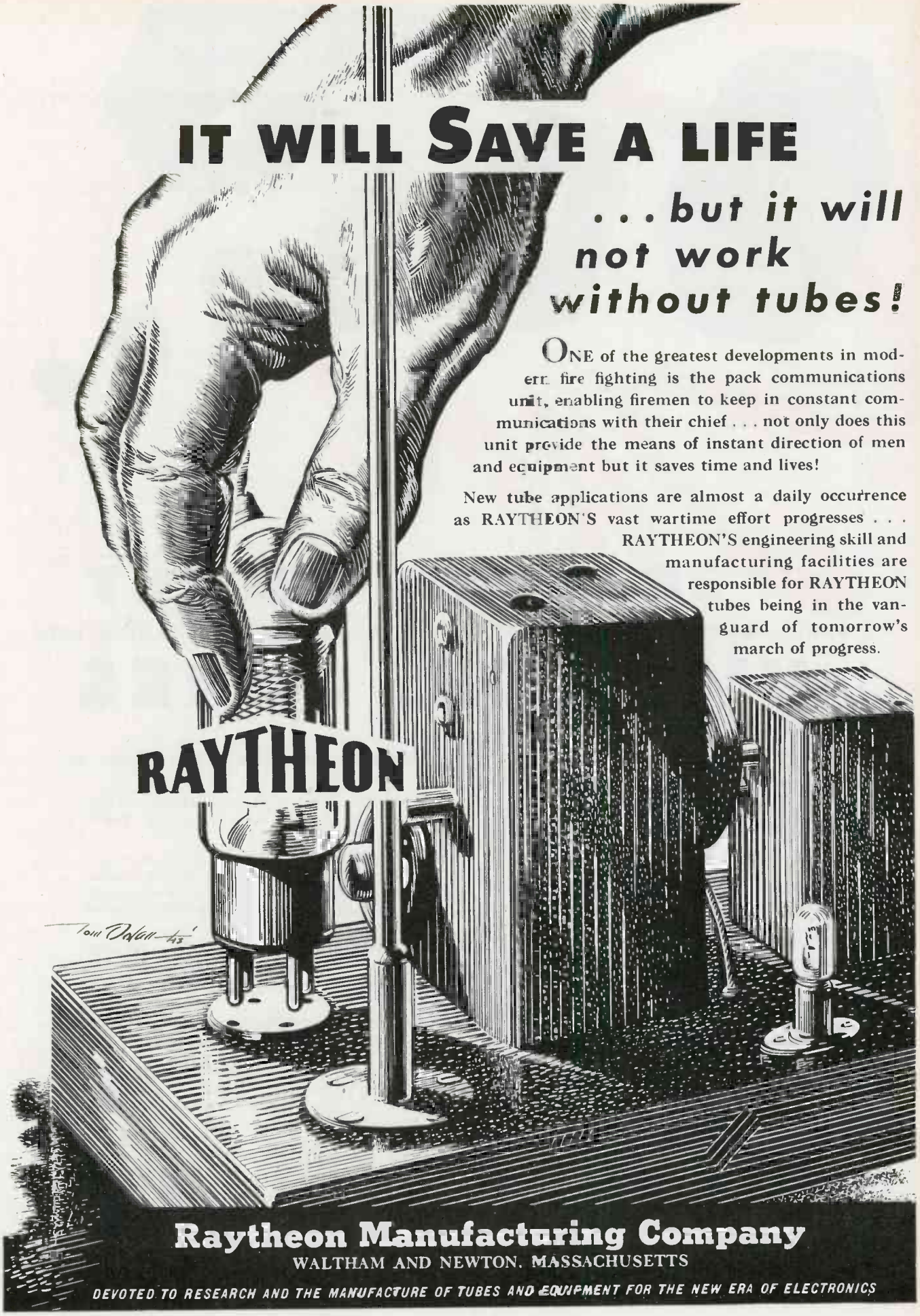
ON LAND AND SEA AND IN THE AIR, electronic communication directs the movements of our armed forces. Only America's best equipment is good enough to meet the stringent specifications designed to implement and protect our fighting men. Significant, therefore, is the fact that SPEER Graphite Anodes are pouring out in ever-growing volume to makers of transmission tubes for war service. Of special significance is this indication of the contributions SPEER Graphite Anodes will be able to make toward the shaping of this new world of electronics, because of this experience.

Electronic devices using tubes with SPEER Graphite Anodes are helping to win the great battles on production line and firing line. Time cannot change the fact that graphite anodes will never warp, fuse, or even soften. They help keep tubes gas-free, release strategic metals.

Anode booklet and list of tube manufacturers using SPEER Graphite Anodes gladly mailed on request.

3673

SPEER
CARBON COMPANY
SCC
ST. MARYS, PA.
CHICAGO · CLEVELAND · DETROIT
MILWAUKEE · NEW YORK · PITTSBURGH



Save 30 to 50% WEIGHT

IN RADIO TRANSFORMERS AND OTHER ELECTROMAGNETIC APPARATUS WITH

HIPERSIL* CORES

On a soldier's back or in a plane, ounces quickly become pounds. That's why a new material that can cut weight *and* increase efficiency is important news.

Hipersil, the new magnetic steel, does just this. It increases flux-carrying capacity ⅓ . . . *saves 30 to 50% weight.*

At present, Hipersil cores are used in a steadily increasing variety of communication applications . . . in radio transformers, chokes, relays, reactors and loading coils. They should be used wherever high permeability is wanted at both high and low densities, and where high fidelity and light weight are of greatest interest.

Hipersil makes possible these design improvements:

SMALLER SIZE of core cross sections and coils . . . ideal for airplanes, tanks, submarines, "walkie-talkie" sets . . .

WIDER RANGE OF LINEAR RESPONSE. Knee of the saturation curve for Hipersil is higher than for ordinary silicon steel. It gives approximately ⅓ greater straight-line response for winding and core cross section.

SIMPLIFIED CONSTRUCTION. Split-core design makes coil and core easy to assemble, saves man-hours. No laminations—just two or four pieces to handle.

Ask your Westinghouse representative about standard Hipersil core sizes now available.

J-70407

*Registered trade-mark, Westinghouse Electric & Mfg. Co., for HIgh PERmeability SILicon Steel.

GET THE FACTS ABOUT HIPERSIL

Write for B-3223, a data book crammed with application and performance facts about Hipersil. Address: Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., Dept. 7-N.

Westinghouse

PLANTS IN 25 CITIES . . . OFFICES EVERYWHERE

HIPERSIL

Where the going is TOUGHEST *You'll find* AlSiMag

The decisive factor in many important battles is the shock action and mobile fire power of a tank charge. Success is dependent upon perfect timing, perfect coordination through instant and sure communication by voice radio between the various units.

Tank radios must be compact. Above all else they must be dependable -- able to withstand terrific vibration, jolts and jars. They must operate under extremes of heat and cold. They must not fail.

That is why you find more and more tank radios of the Allied Nations equipped with AlSiMag steatite ceramic insulators . . . . compact, tough, dependable.

ARMY (E) NAVY

AWARDED JULY 27, 1942

AlSiMag

TRADE MARK REGISTERED U. S. PATENT OFFICE

AMERICAN LAVA CORPORATION

CHATTANOOGA, TENNESSEE

Scientifically Built for the most Critical Requirements...

FAST

Condensers and Capacitors

The recognized quality of FAST products is deep-rooted. It is the result of close to a quarter of a century of specialized experience. Each step in the process of design and manufacture is based on thorough scientific research in the chemistry of raw materials and in dielectrics . . . on engineering skill and manufacturing technique. Each is important in itself . . . together, *all-important.* For it all results in Condensers and Capacitors of high quality, precision exactness and uniformity.

Today, FAST units are designed and built to meet every condition of service on land, sea and in the air. Tomorrow, they will be ready to serve your peacetime requirements better than ever. FAST engineers are glad to help you on any problem.

Standard or Special Units to Meet Every Need...

FAST Condensers and Capacitors are produced in many types and sizes, in standard and special designs, for a great variety of electronic and electrical applications in war and industry. Paper Capacitors—Oil or Wax impregnated—Rectangular or Tubular—in sizes from the smallest to the largest.

Units specially engineered or built to government specifications including thermal cycle and salt water immersion tests.

JOHN E. FAST & CO.

Capacitor Specialists for 23 Years

3129 North Crawford Avenue, Chicago

Canadian Representatives: Beaupre Engineering Works Reg'd.
2101 Bennett Avenue, Montreal, for Power Factor Correction
J. R. Longstaffe, Ltd., 143 Berkeley Street, Toronto, for Special Applications

E·L IS OUT THERE, TOO...

Out where the "fighting front" becomes grim reality instead of a glib phrase, E·L units are powering the "Walkie-Talkie" that serves as the voice and ears of our advance forces.

It's a marvelously efficient two-way radio, of course. But the Signal Corps knew that it couldn't be the useful, reliable instrument it is, unless it had a power supply that would keep it operating, under all conditions . . . whether in the destructive heat and grit of the desert, the paralyzing arctic cold, or the corroding humidity of the jungle.

Such a power supply did not exist until Electronic's engineers designed a special, high-voltage vibrator power supply, combined with storage battery, in a single, incredibly light and compact unit.

Behind this and other E·L power supply achievements are years of intensive development of the technique of *vibrator type* power supplies, and the most extensive research anywhere on power supply circuits. They have not only produced amazing advances for many military purposes, but promise revolutionary benefits for products of peace.

Wherever electric current must be changed, in voltage, frequency or type—for war or peace—E·L Vibrator Converters will give the same outstanding service that has singled them out for battle duty today.

Power Supply using rechargeable, non-spill storage battery for operation of "Walkie-Talkie" radio equipment. Input Voltage: 4 Volts; Output: Numerous Voltages, supplying plate and filament requirements of the equipment. Width, 3½"; Length, 6½"; Height, 4⅜".

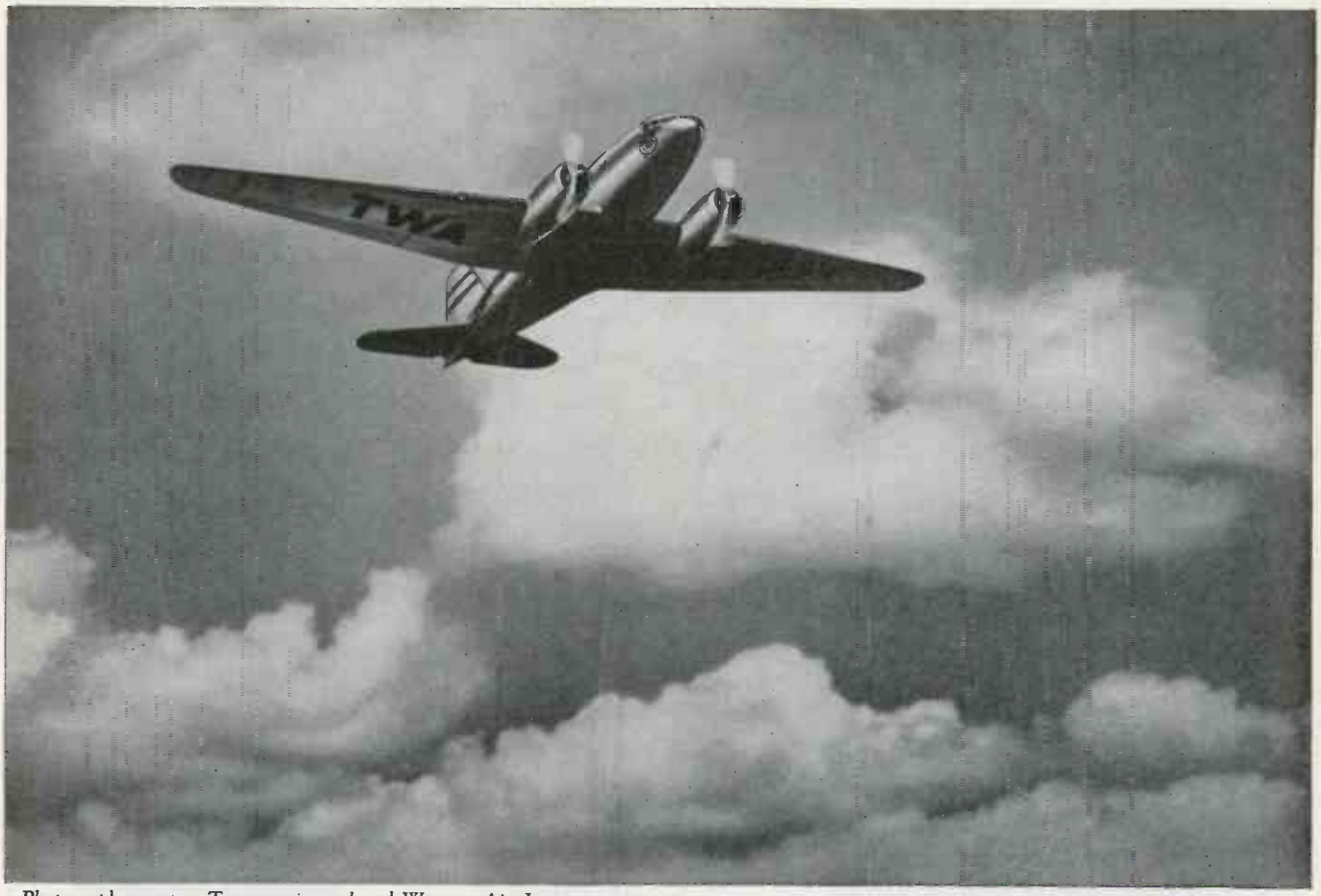
. . . AND E·L WILL BE HERE WHEN PEACE COMES!

● Mobile, two-way radio telephones will be at work in peace-time on big construction projects . . . on farms . . . in countless other places. E-L products will be on the job then, too, solving the power supply problem!

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.



Photograph, courtesy Transcontinental and Western Air, Inc.

THERE MUST BE DEPENDABLE COMMUNICATIONS

The reliability of Wilcox communications and other radio equipment has made them invaluable servants of leading commercial airlines.

Now, the entire output of Wilcox factories is going to wartime uses, and the experience gained during peacetime is standing in good stead for military operations.

Thus, Wilcox is keeping pace with the miracles of flight... and, after Victory, new Wilcox developments will be available for the better-to-live-in, sane, sensible world ahead.

Communication Receivers
Aircraft Radio

Airline Radio Equipment
Transmitting Equipment

WILCOX ELECTRIC COMPANY

Quality Manufacturing of Radio Equipment

14TH & CHESTNUT — KANSAS CITY, MISSOURI

Here's design help on HIGH HUMIDITY PROBLEMS

Solder-seal Prestite bushings for hermetically sealed transformers and condensers.

Motor blower for circulating air within radio transmitter, for tropical service.

Space heater and thermostatic control to maintain air temperature within the transmitter above the dew point.

Protection of sensitive radio parts against the paralyzing destructive forces of tropical high temperature and high humidity no longer need trouble you. Westinghouse engineers have cooperated with many designers to work out a variety of solutions, of which the accompanying illustrations are typical examples. Perhaps these are directly applicable to your problem; or it may be that yours is completely different. In either case, trained and experienced Westinghouse representatives are ready to help you; call them today. Westinghouse Electric & Manufacturing Company, Dept. 7-N, East Pittsburgh, Pennsylvania. J-94560

Westinghouse

PLANTS IN 25 CITIES . . . OFFICES EVERYWHERE

NEW WORLDS TO CONQUER!

FOR ELECTRONICS ENGINEERS!

PRECISION

Under the guidance of highly skilled operators, the finest precision machines are employed to insure uniform high quality in all National Union tubes. In this photograph a bending machine in the Stem Department is shown doing its war job of helping to provide this year the largest number of the finest electronic tubes National Union has ever built.

Sure, winning the War is our big job right now. To that end we here at National Union are exerting our every thought and energy—both on our production lines and in our research laboratories. But after the war—what then? It is certain that for men trained in electronics there'll be new worlds to conquer. For from today's new applications of electronic tubes specifically developed to help win the war—will emerge countless new peacetime applications. It is here that American business will find invaluable assistance in designing, producing and packaging the better products its post war customers will want and demand. With the designers and producers of these new products National Union will welcome the opportunity to share its up-to-the-minute knowledge and research experience.

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

NATIONAL UNION RADIO CORPORATION

NEWARK, NEW JERSEY LANSDALE, PENNSYLVANIA

NATIONAL UNION ELECTRONIC TUBES

THE SHAPE OF *Things to Come*

● Simply a plug-in capacitor. True. The fact that Aerovox spent months perfecting the corrosion-proof base is beside the point here. Likewise that such capacitors—in the electrolytic, wax-filled and oil-filled types—are standard in vital wartime equipment.

The main point is that this capacitor symbolizes "The shape of things to come." The plug-in feature denotes ready checkup and replacement. That in turn signifies continuous, gruelling, accelerated-wear service that wears out the best capacitors in months instead of in years under usual operating conditions. Just as the demountable-rim wheel marked the transition of the automobile from Sunday pleasure rides to everyday essential transportation, so this plug-in capacitor spells an infinitely expanded usage of radio technique, radio components, radio manpower.

Our first job is to win the war. Aerovox is now concentrated on just that. And while tens of thousands of radio men are engaged in waging this war, gaining invaluable training and experience and, indeed, compressing decades of normal progress into as many years, so we at Aerovox are laying the foundation for greatly expanded radio and electronic opportunities in the coming days of peace. Thus "The shape of things to come."

AEROVOX *Capacitors*

INDIVIDUALLY TESTED

AEROVOX CORPORATION, NEW BEDFORD, MASS., U. S. A. • SALES OFFICES IN ALL PRINCIPAL CITIES

Export: 100 VARICK ST., N. Y. C. • Cable: 'ARLAB' • In Canada: AEROVOX CANADA LTD., HAMILTON, ONT.

One thing is certain

. . . the American Military Machine must be equipped with superior materials of war. To this end, DeJur Aircraft and Electrical Instruments, Potentiometers and Rheostats are built to the most critical standards of quality and precision. Behind them are twenty-five years of experience and laboratory research. Before them stands the future of the democratic way of life. Neither you nor ourselves can afford to falter now.

Awarded for Excellence in Production and Quality of Materiel

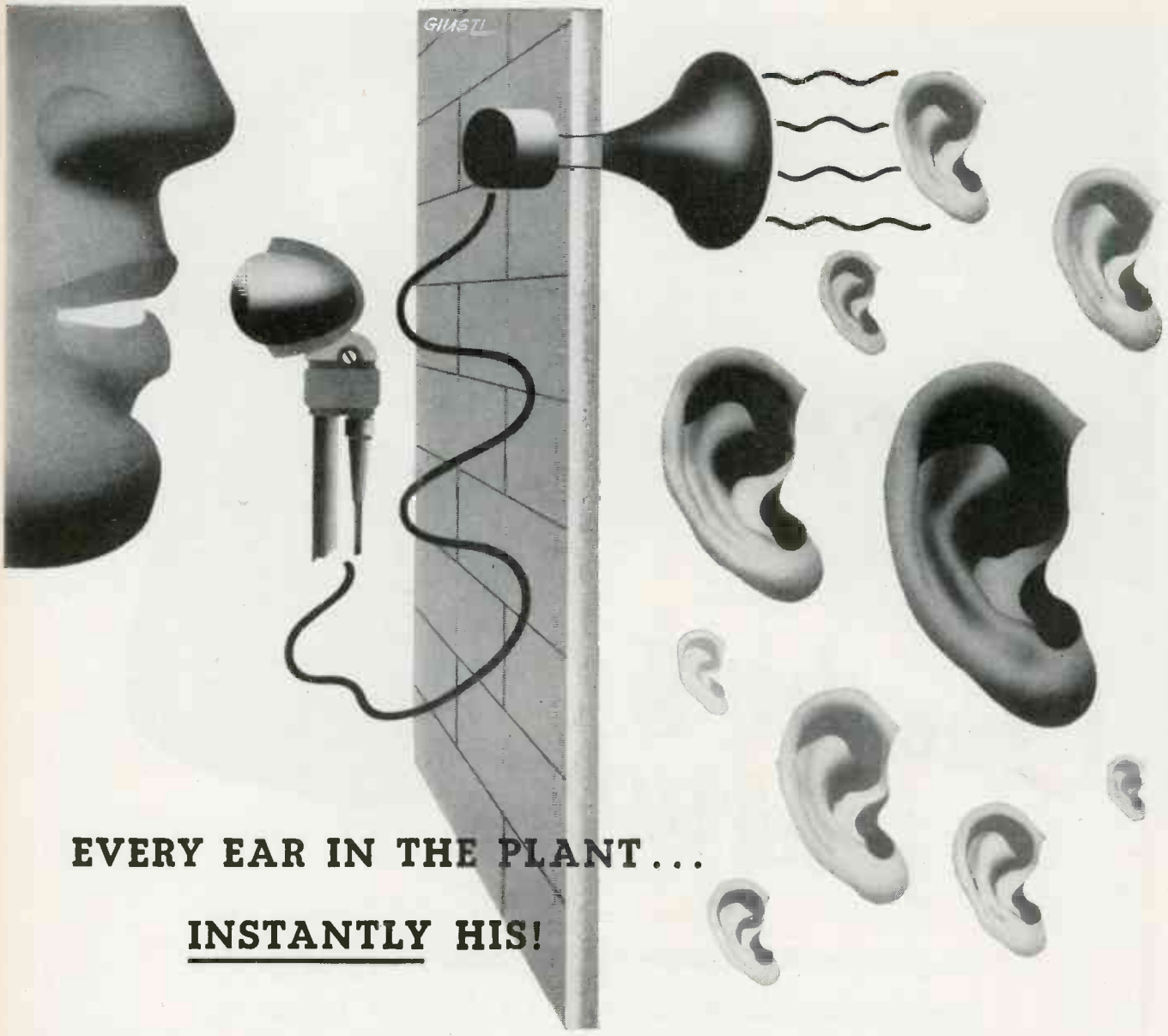
DeJur-Amsco Corporation

SHELTON, CONNECTICUT

NEW YORK PLANT:
99 Hudson Street, New York City

CANADIAN SALES OFFICE:
560 King Street West, Toronto

MORE THAN EVER . . . it's important to keep buying War Bonds and Stamps



EVERY EAR IN THE PLANT...

INSTANTLY HIS!

"Mr. Harker, please! . . . Washington calling . . . report at once to plant manager."

"Calling Mr. Thomas . . . please attend meeting at production engineering office immediately."

★ ★ ★

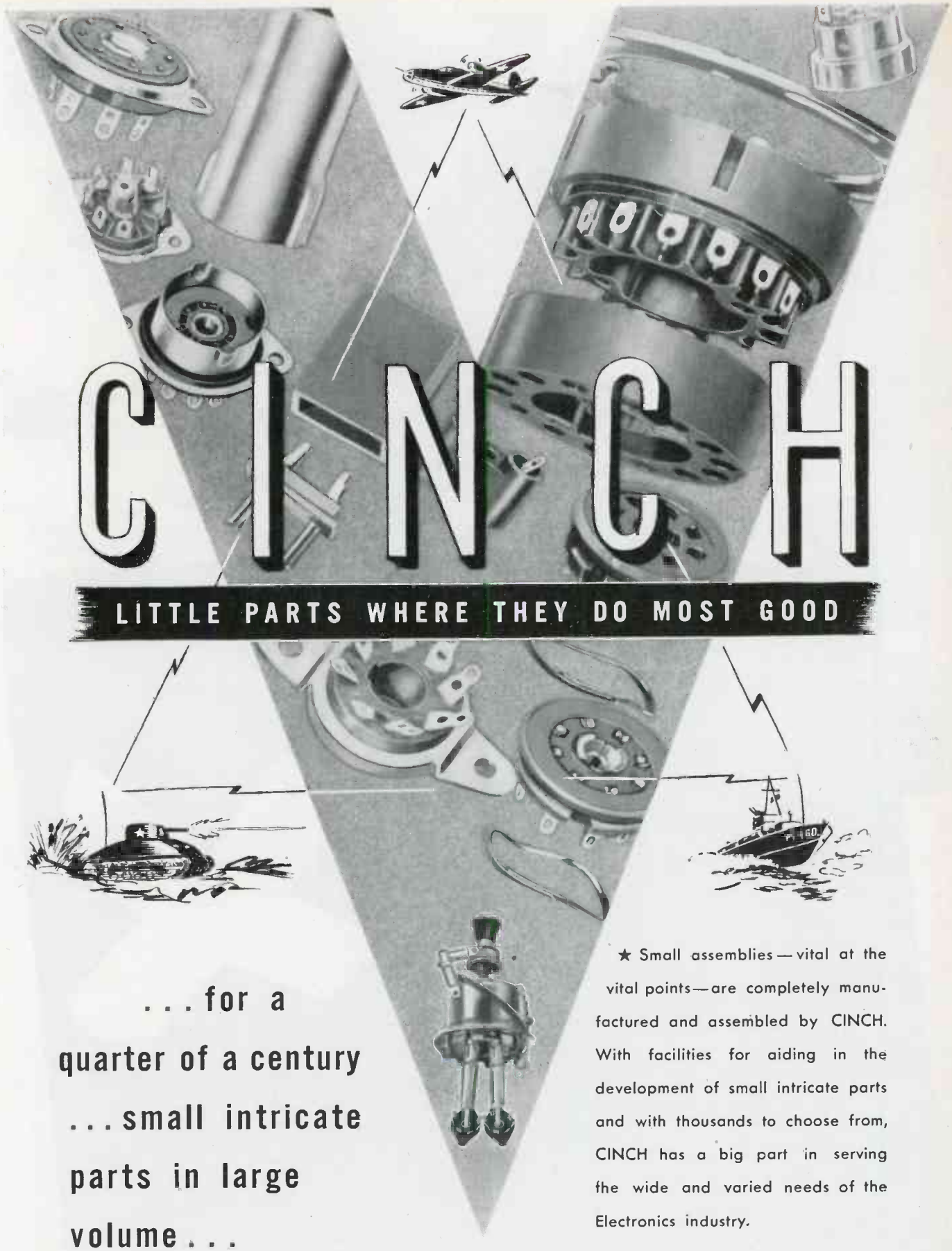
What a savings in manpower . . . what a savings in valuable time . . . when messages are delivered by Straight-Line Communication!

It does the job **QUICKER** and **BETTER** than by any other means . . . and the man-hours it saves more than pay for the installation in an amazingly short period of time.

For 49 years Stromberg-Carlson has been developing the finest type of sound reproducing equipment. Why not let us show you how we can solve your own communication problem? Get in touch with the Sound Systems Division of the Stromberg-Carlson Company, 100 Carlson Road, Rochester, New York. Write for free Booklet No. 1934.

STROMBERG-CARLSON

STRAIGHT-LINE COMMUNICATION SAVES MANPOWER • SPEEDS THE WORK TO VICTORY

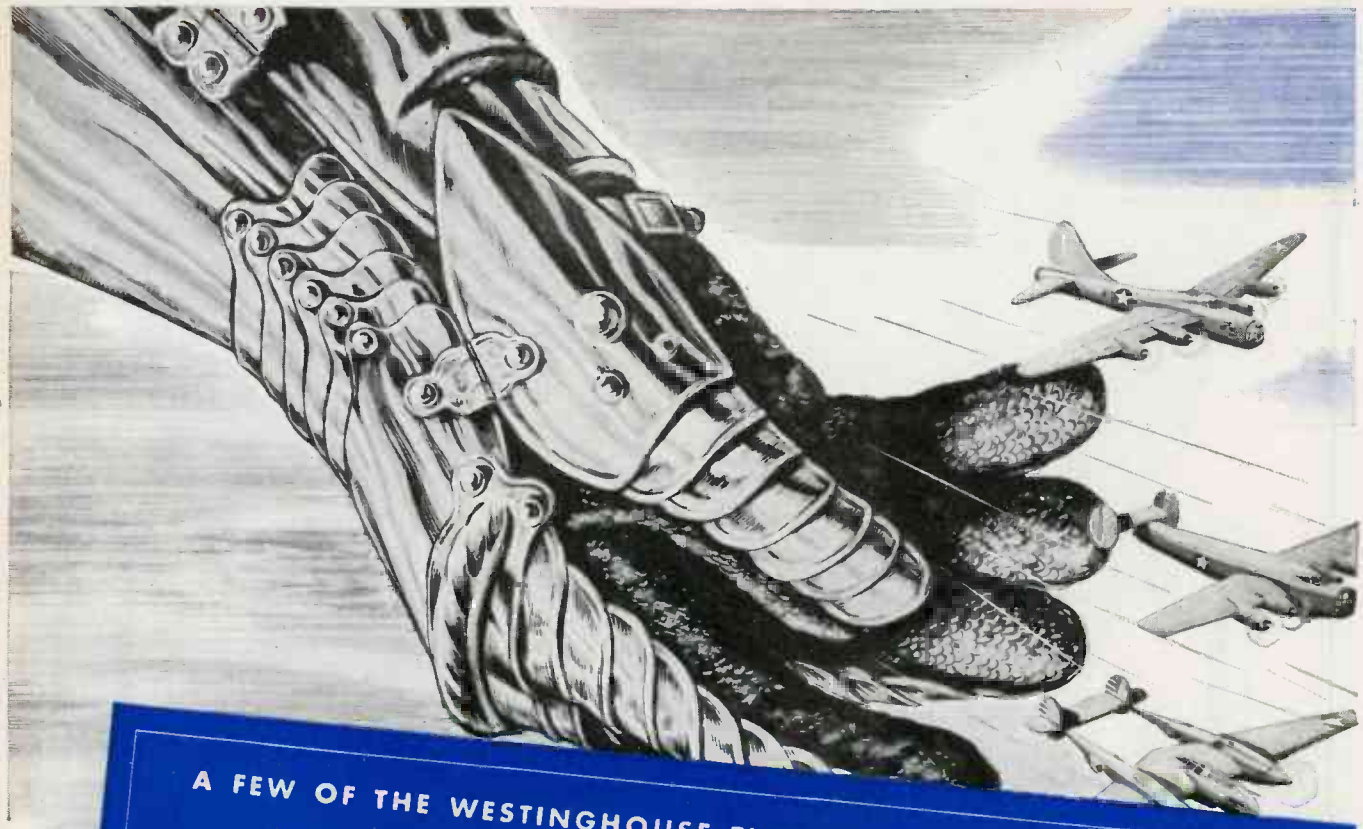


. . . for a quarter of a century . . . small intricate parts in large volume . . .

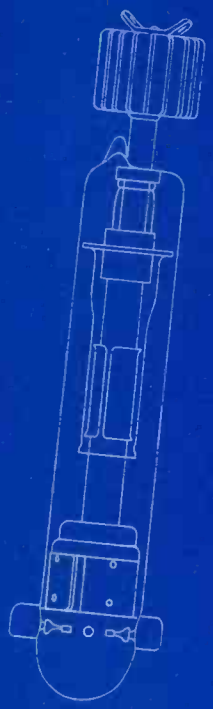
★ Small assemblies — vital at the vital points — are completely manufactured and assembled by CINCH. With facilities for aiding in the development of small intricate parts and with thousands to choose from, CINCH has a big part in serving the wide and varied needs of the Electronics industry.

CINCH MANUFACTURING CORPORATION • 2335 WEST VAN BUREN STREET • CHICAGO, ILLINOIS

SUBSIDIARY • UNITED-CARR FASTENER CORPORATION • CAMBRIDGE, MASSACHUSETTS

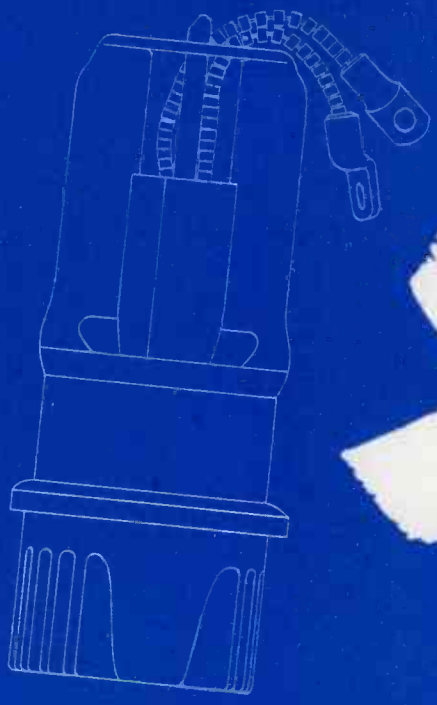


A FEW OF THE WESTINGHOUSE TUBES NOW SERVING INDUSTRY



X-Ray

Westinghouse X-Ray tubes are serving on both the war and home fronts. Ruggedness and reliability are features which have made them outstanding.



Kenotron

These high vacuum rectifiers supply high voltage low current DC for use in Precipitron, X-Ray, high voltage testing and radio.

Censored

Both our government and our allies have entrusted to Westinghouse the development and production of many types of special electronic tubes.

A GOOD HARVEST *from a* GRIM SOWING

There are no bright sides to war. But from the efforts expended to win the war, is coming a harvest of great things.

In Electronics, for example—new weapons of attack, new weapons of defense, new means for aiding production, are already at work. Westinghouse is supplying electronic tubes for many of these operations, tubes that put the principles of electronics to work today. These tubes are winning high honors for accuracy, design, dependability.

Tomorrow, the "know-how" gained from today's war efforts, will be at work in the service of industry.

In your thinking and planning for today and tomorrow, include the use of electronic tubes. Westinghouse — pioneers in electronics — will be at your service. Westinghouse Electric and Manufacturing Co., Bloomfield, N. J.

Westinghouse

Electronic Tubes *AT WORK*

NEED RESISTOR FORMS PROMPTLY?

We can Take on More Large-Quantity Orders

If you need non-inductive resistor forms for pi winding . . . need them promptly and in large quantities . . . send your specifications to Isolantite Inc.

We have production capacity ready to take on additional orders for these forms, and can build them in a variety of sizes to meet your requirements. Lengths can range from ½ to 2 inches, over-all diameter from ½ to 1¼ inches. Section diameters and divisions can be fabricated to your individual specifications.

All of these forms, of course, display the high mechanical strength characteristic of Isolantite*—a feature which reduces to a minimum the risk of breakage. Isolantite's manufacturing processes permit dimensions to be held within close limits if desired. And in addition, Isolantite resistor forms offer such other outstanding advantages as uniformity of product, electrical efficiency, and non-absorption of moisture.

Write, wire, or phone your resistor form needs today.

ISOLANTITE

CERAMIC INSULATORS

ISOLANTITE INC., BELLEVILLE, NEW JERSEY

*Registered trade-name for the products of Isolantite Inc.

BOEING STRATOLINER

Constant voltage protection all the way

Ask the men who produce planes and the men who pilot them. They'll tell you what vital part *constant voltage* plays in modern aviation. In the sky, it's *constant voltage* on the directional beam which guides the ships through night and storm. In the shop, it's *constant voltage* on the production line which maintains the split-hair accuracy of precision airplane parts.

For the aircraft industry—*and for your own*—SOLA CONSTANT VOLTAGE TRANSFORMERS provide this all-important stabilized power. They stand between costly equipment and destructive voltage fluctuations now common on overloaded power lines. Without supervision they instantly absorb power sags and surges as great as 30%.

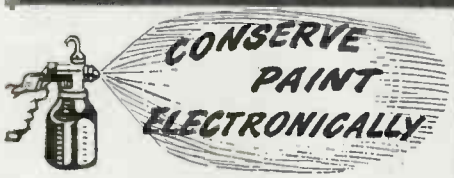
For unerring operation of precision tools, and protection of almost irreplaceable instruments and electronic tubes, put SOLA CONSTANT VOLTAGE TRANSFORMERS on duty in your plant. They're built in standard units from 10 VA to 15 KVA capacity—self-protecting against short circuit and without moving parts. Special units can be built to specification.

Note to Industrial Executives: *Find out how Sola "CV" transformers can solve voltage control problems in your operations. Send for bulletin* ***10CV-74***

Constant Voltage Transformers

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, Ill.**

FOR SALE—ELECTRONIC PRODUCTION AIDS



Have you automatic paint sprays for conveyor lines? Install G-E photoelectric relays to control paint sprayers. They save paint by using it only when object is in exactly the right spot or area; make every unit the same. Bulletin GEA-1755C for details.

HOW BLUE IS SCARLET?

Paint, pigment, dye manufacturers need to know how to match colors perfectly. G-E electronic recording color analyzer does the job. Gives you a complete, accurate, permanent "curve of color" on any of two million shades and tones in two minutes. Helps control manufacturing processes; aids in chemical analysis. Used as basis for ASA war color standard. Get more information in Bulletin GEA-3680.

To Measure Actual Strain in Structural Parts

Now you can check calculated stresses with actual measurements. Improve design, save materials. One railroad saved literally millions of dollars in new construction by reinforcing its bridges to carry increased loads. G-E electronic equipment and electric strain gages enabled them to make this saving. A real electronic tool for the structural engineer. Bring us your problem—bridge, building, airplane, crane, locomotive, or what have you. Ask for Bulletins GEA-3673 and GEA-2543.

HOW TO SAVE ON A-C RESISTANCE-WELDER MAINTENANCE

Replace mechanical contactors with G-E electronic contactors. No moving parts! No tips to dress. No noise. No open arc. No time-lag. Faster production. Electrodes last longer. Timing more exact. Use long-life G-E ignitron tubes. Installations usually pay for themselves in short time. One user, with 156 tubes installed, reports only three tube failures in two years! Act now! Bulletin GEA-3058B gives more information.

DO YOUR WORKMEN SQUINT

WHEN DAYLIGHT DIMS? *G-E electronic light control turns on factory lights whenever daylight level is too low—turns them off when daylight is sufficient. Saves eyes, helps maintain production, saves power. Many other uses. Low cost. Bulletin GEA-2679B gives installation information, diagrams.*

DelicateTiming!

Standard G-E electronic timers go down to 0.045 second and up to two minutes; five ranges to choose from. Special ranges on request. Consistent. Stepless time range controlled by knob on front. Only one moving part. Only one tube. Used to time resistance welders, induction furnaces, conveyors, laboratory operations, and many other applications. Thousands in use. 110 or 220 volts, a-c. Price, $28 and up. Bulletin GEA-2902B.

MACHINE-TOOL USERS!

You can change machine-tool speed instantly with new G-E Thy-mo-trol. This electronic motor control gives you complete motor speed range on a single dial—small as a radio volume control. Thy-mo-trol starts, stops, accelerates, controls speed, and protects the motor. Operates d-c motor on a-c power. Compact. No moving parts. No vibration. Saves operator's time. Users report increased machine output and longer cutter life. Get free Bulletin GED-972A.

IS YOUR METAL-STRIP PRODUCTION LEAKING OUT THRU PINHOLES?

Are pinholes in your rolled-sheet stock causing rejects, complaints—slowing up war work? Catch them, before they get into the stock pile, with G-E electronic pinhole detector. Finds and marks pinholes only 1/100-inch in diameter at 750 to 1000 feet per minute. Operates shear to cut out faulty areas. A real wartime production aid. Ask your G-E representative for the whole story. Get Bulletin GEA-3530.

You lose truck and operator time whenever drivers stop to open doors manually. G-E electronic control opens and closes motor-operated doors automatically—without stopping trucks.

One manufacturer saves $30 a day in time and heat.

Don't waste valuable trucking time by delays in opening doors manually. Get more hours per day out of the trucks you have—with G-E photoelectric control. Bulletin GEA-1755C.

THINKING ABOUT THE FUTURE?

When planning new machines, new processes, new factory buildings—LOOK TO ELECTRONICS. Electronic production aids, like these on this page, offer real opportunities for improvements and economies. Come to General Electric for the electronic answer to your problems. General Electric, Electronic Control Section, Schenectady, N. Y.

Speed Production Electronically

GENERAL ELECTRIC

General Electric, Sec. K676-100
Schenectady, N. Y.

I want to know more about speeding production electronically. Please send me the bulletins checked:

- ☐ GEA-1755C—Photoelectric relays
- ☐ GEA-3680—Spectrophotometer
- ☐ GEA-3673, GEA-2543—G-E electric gages
- ☐ GEA-3058B—Electronic contactors for a-c resistance welders
- ☐ GEA-2679B—Automatic light control
- ☐ GEA-2902B—Electronic timers
- ☐ GED-972A—Electronic motor control—Thy-mo-trol
- ☐ GEA-3530—Electron-tube control for steel mill application

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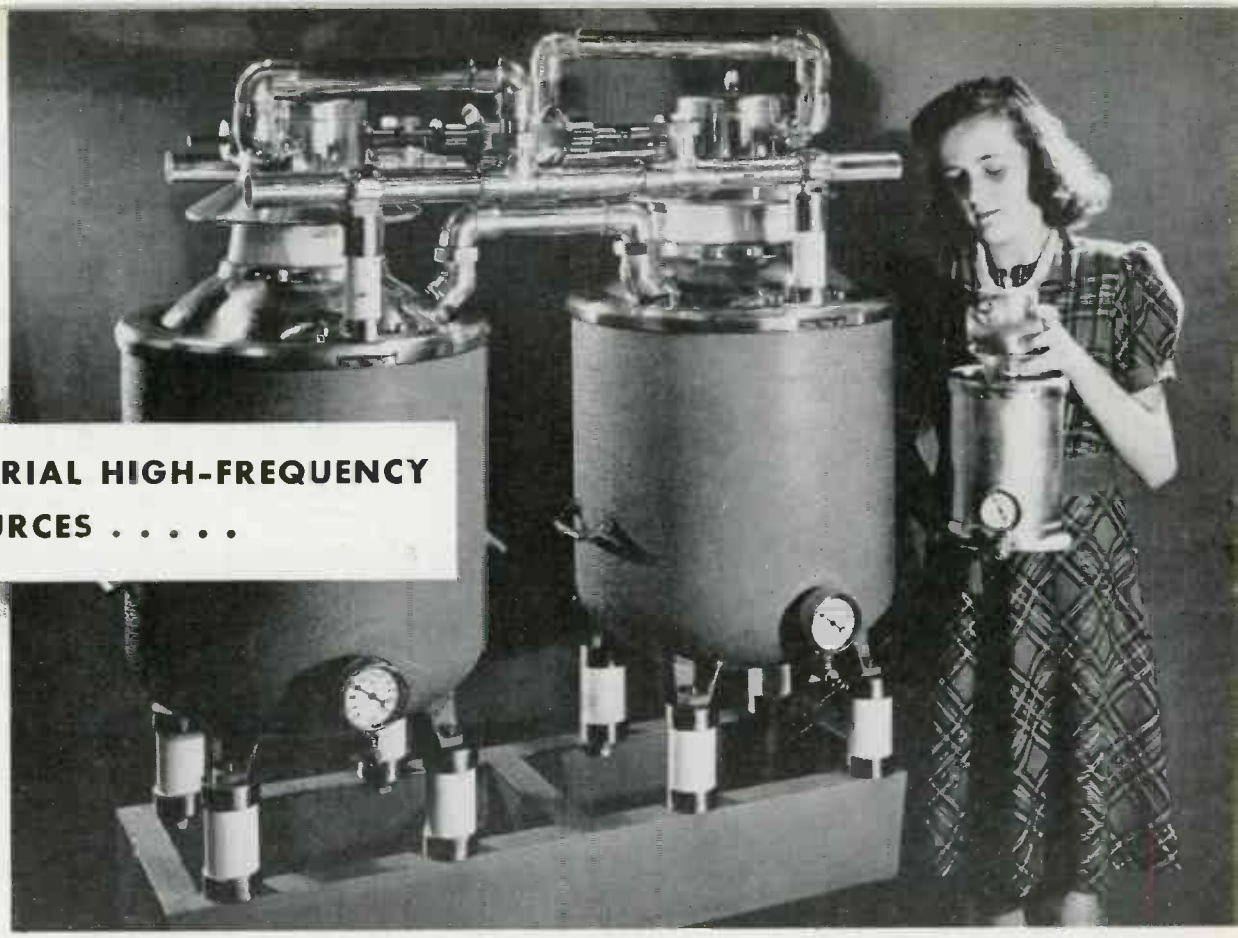


FOR INDUSTRIAL HIGH-FREQUENCY POWER SOURCES . . . . .

LAPP GAS-FILLED CONDENSERS

In any high-frequency high-power circuit, lump capacitance can most efficiently be provided by Lapp gas-filled condensers. They are ruggedly built to maintain their electrical characteristics under all conditions. Fixed and variable-capacitance models are available over a wide range of power and capacitance ratings. *Above is Unit No. 26541, consisting of two No. 25934 units. The assembly provides pivoting bus conductors, arranged so that the units may be used singly, in series, or in parallel, providing capacitance continuously variable from .0022 mf. to .022 mf. Each unit is rated at 200 amp., 6500 volts, capacitance variable .0043 mf. to .011 mf.; the combination in series, 200 amp., 13,000 volts, .0022 to .0055 mf.; in parallel, 400 amp., 6500 volts, .0086 to .022 mf. The small unit in the girl's hands is No. 23722, rated at 50 amp., 7500 volts, capacitance .000045 mf. to .000075 mf.*

ANY REQUIRED WATTAGE AND CAPACITANCE

ZERO LOSS

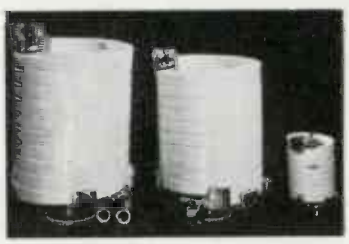
NO CHANGE WITH TEMPERATURE

COMPACT

PUNCTURE PROOF

SOUND, TROUBLE-FREE CONSTRUCTION

● *Standoff, entrance, bowl, and other special-purpose insulators are available in many types. Lapp is equipped also for production of many special assemblies, incorporating porcelain or steatite and associated metal parts.*



● *Lapp porcelain water coils, porcelain pipe and fittings provide a highly efficient means for cooling high frequency tubes. Sludging is eliminated and, with it, need for water changing and periodic cleaning of the cooling system.*

Lapp

INSULATOR CO., INC.

LEROY, N. Y.

ARMY E NAVY

TEST TIME CUT 95%

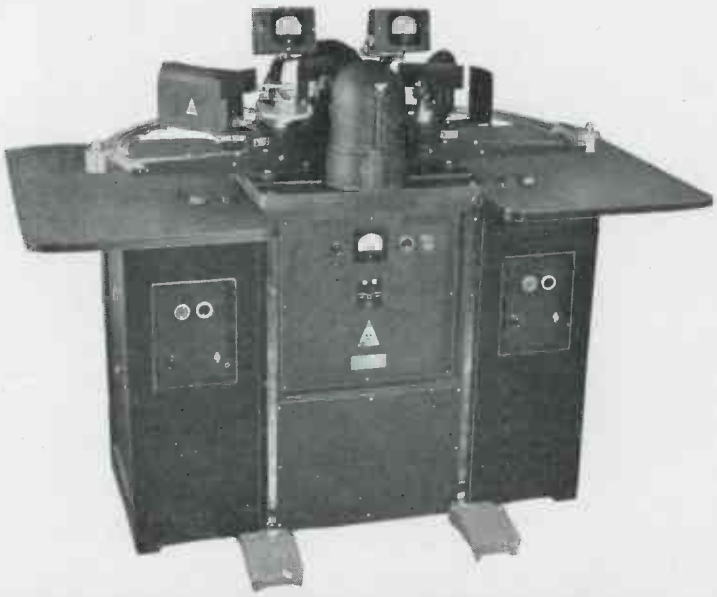
WITH THIS NEW PRODUCTION TOOL!

Philips X-Ray Quartz Analysis Apparatus

Test time cut 95%! Sounds incredible, doesn't it? Yet that's only one of the many unusual features of this really amazing production tool designed by Philips engineers. Listed are ten other advantages of the Philips X-Ray Quartz Analysis Apparatus that have helped quartz oscillator manufacturers break serious war-time bottlenecks.

But the use of X-Ray inspection and test methods is not confined to this one application. Moreover, its postwar applications promise to be even broader than its innumerable war-time uses. Therefore, manufacturers who put it to work today will achieve the additional benefit of gaining an important competitive advantage in the postwar race.

Improve the quality and speed of your war production —install Philips X-Ray diffraction, radiographic or fluoroscopic equipment designed for your war production purposes. At the same time, you will be preparing for postwar applications that will give you a headstart in after-the-war markets. Literature, describing the new Philips Apparatus, is available on request. Philips Metalix Corporation, 419 Fourth Avenue, New York City.



TEN TYPICAL PRODUCTION ADVANTAGES OF PHILIPS X-RAY QUARTZ ANALYSIS APPARATUS:

1. *Philips X-Ray Quartz Analysis Apparatus is a durable, practical mass production tool designed for continuous duty operation.*
2. *Philips X-Ray Quartz Analysis Apparatus is a completely integrated unit — scientifically designed specifically for quartz analysis.*
3. *Philips X-Ray Quartz Analysis Apparatus is a production tool designed for operation by unskilled personnel. It is simple to operate, shockproof and scientifically shielded.*
4. *Philips X-Ray Quartz Analysis Apparatus speeds testing. Tests previously requiring thirty minutes by skilled technicians can now be made in one minute by unskilled personnel.*
5. *Philips X-Ray Quartz Analysis Apparatus is extremely flexible — permitting a wide range of analysis methods.*
6. *Philips X-Ray Quartz Analysis Apparatus permits fast, precise angle measurements of mother quartz, sections, bars, wafers and blanks on a production basis.*
7. *Philips X-Ray Quartz Analysis Apparatus speeds production — the oscillator characteristics can be predetermined by the maintenance of basic cutting angles.*
8. *Philips X-Ray Quartz Analysis Apparatus permits more accurate production — substantially reducing rejects and conserving critical materials.*
9. *Philips X-Ray Quartz Analysis Apparatus eliminates defective units before expensive and time-consuming finishing operations.*
10. *Philips X-Ray Quartz Analysis Apparatus is air-cooled, eliminating need for water connections and drains.*

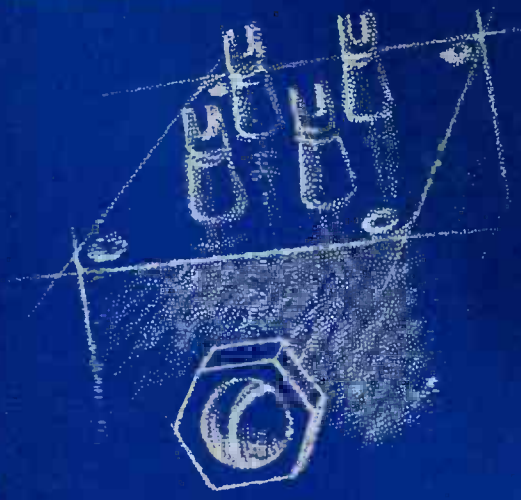
PHILIPS METALIX

specialists in the manufacture of x-ray tubes and apparatus

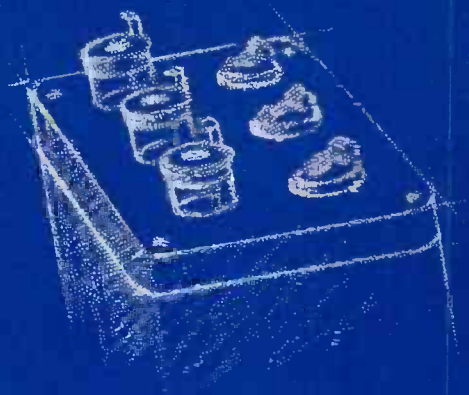
PHILIPS METALIX

Designs for War . . . Transformers

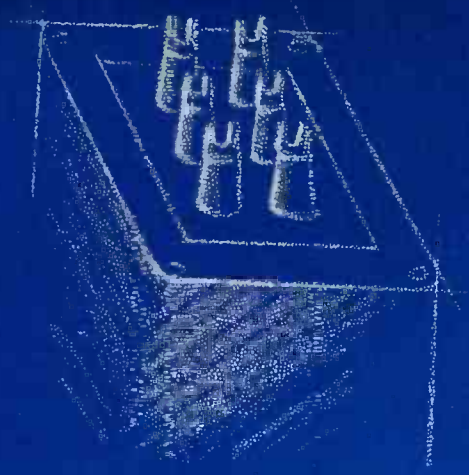
The requirements in war transformers differ considerably from those of commercial units. The UTC engineering staff has pioneered many of the design features which make possible modern war transformers. A few typical designs are illustrated.



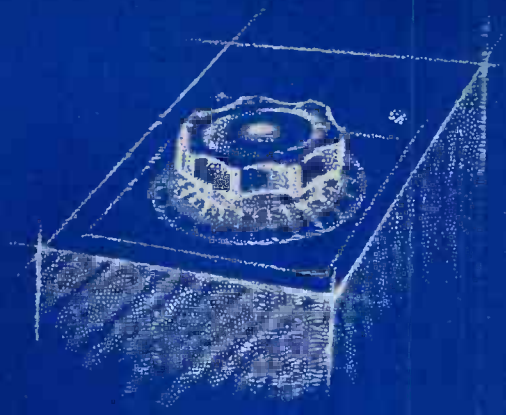
This transformer is tunable . . . ideal for signal frequency amplifiers.



This oil filled transformer is hermetically sealed with glass high voltage terminals solder-sealed to case.



Designed for minimum amplitude distortion . . . this unit has distortion under .01% for a power range of 100:1 . . . Q over 150.



This Varitran supplies fixed filament and bias voltages, as well as variable plate voltage all in one unit.

May we design a War Unit to your application?

UNITED TRANSFORMER CO.

150 VARICK STREET ★ NEW YORK, N. Y.

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

ELECTRONIC INDUSTRIES

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

Gearing Up the Electronic Industries

We can conceive of the electrons inside our radio tubes and electron tubes as being infinitely tiny machines or "gears", which spin around often at a hundred million revolutions per minute. Their diameters are barely one-thousandth the thickness of the film of a soap-bubble—yet, when geared up, they can control and reverse giant masses of moving machinery, —they can reach round the world,—they can detect our emotions, even our thoughts!

Already the great businesses of radio, sound movies, and long-distance telephony have been founded on these tiny electrons. And great new industries are bound to spring from the amazing and varied array of achievements in electronics. And the advantages will be not alone commercial in the after-war period; there will be also a vast enhancement of ease and comfort in our daily lives, especially in our homes.

Pattern for Expansive Growth

Roger Babson, who has been foretelling futures of businesses and industries for many years, has just prepared this interesting chart in which he traces the characteristic growth-curve of principal American industries.

The normal course of any industry, as shown, is: First a long, slow period of incubation. Next, an ascending growth curve. Then a leveling-out along a flat plateau of commercial activity. And finally a "going-to-seed" phase in which the mature industry either shrinks and shrivels — or re-blooms into fresh usefulness.

On this general curve, Mr. Babson has marked the present status of well-known U. S. industries, as he sees their 1943 conditions of infancy and promise; growth and activity; or demise and decay.

Some familiar market-leaders stand revealed as being well past their peaks; some are in mid-stability; others are climbing on the up-and-up.

It is significant that the electronic industries are shown still in the creeping stage with their future all ahead!

Engineering Foresight Needed

Eighteen months of war effort have already swept away many of the old models of equipment for the American standard of living and pursuit of happiness. Tools and designs have been converted to the exigencies of the times. A newer outlook with greatly widened horizons can just as well take their place.

Some engineering societies have already set up committees to investigate methods whereby their organizations can be of future assistance. Manufacturing associations have also formulated some plans. In the radio-electronic field the help of engineering bodies in formulating new rules and standards would be of immediate value.

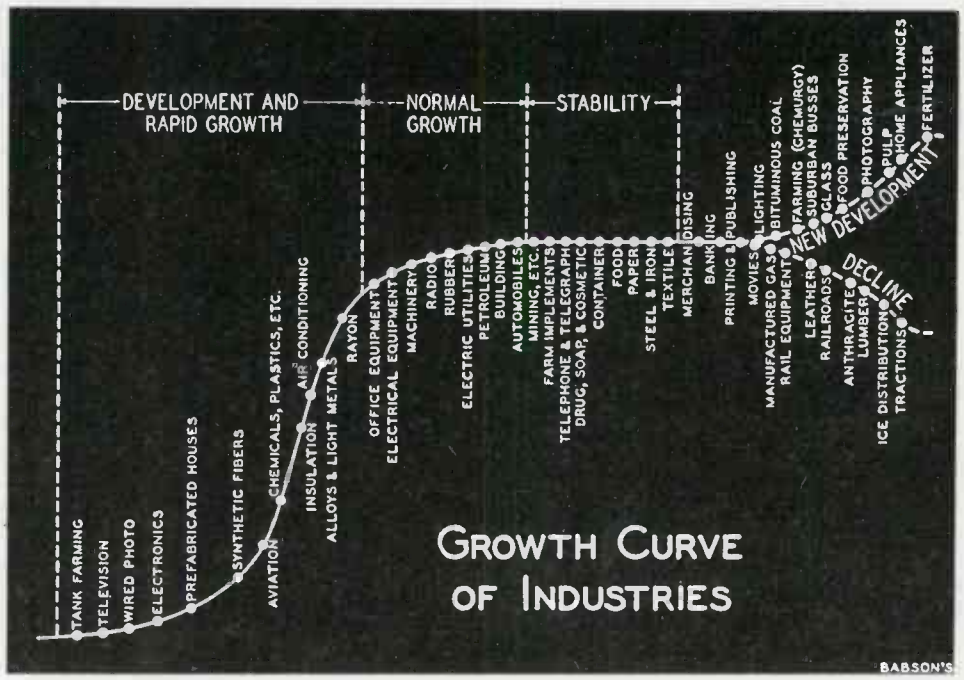
Has the system of standards formulated by the National Television Standards Committee withstood the test of practical experience of actual production, since those plans were completed—or will further modifications be necessary? Will the assigned bands in the present radio spectrum be retained or must they be turned over to other services? These matters are typical of problems that must be settled before post-war planning can become active.

Future Radio Interference

High-frequency heating has become a production necessity in many fields. How will such operations interfere with the regular radio services?

The autos of the post-war era can well have interference-free ignition systems; now that we are to have an entirely new deal in automobile design, such noiseproof systems are not only possible but necessary. But will the automobile people provide them? Legislation cannot settle such questions until engineers and scientists have pointed out the solutions.

The opportunity for small manufacturing organizations is greater than ever before, because of the number of specialties associated with all these electronic activities. There are no patent or legal restrictions on initiative in this country.



Major General Dawson Olmstead, Chief Signal Officer

Major General Roger B. Colton, Chief of Signal Supply Services

Colonel Eugene V. Elder, Director of Materiel Division

SUB-Contracting SIX

★ *Radio-Electronic WAR PRODUCTION*

In the spreading of production to smaller companies to aid them in maintaining their existence during the war, Uncle Sam's armed services—which have had the gigantic job of procuring over six billion dollars worth of electronic and radio equipment—have probably achieved a record of excellence greater perhaps than exists in any other industrial field.

For the Army, the Signal Corps with farsighted vision months before Pearl Harbor, inaugurated a systematic plan of spreading production widely to the smaller businesses of the Nation in every geographical area of the country. On a smaller scale, because its procurement load was about one-fifth of the Army's, the Navy's Radio Division in the Bureau of Ships carried into effect a similar policy before the United States entered the war.

Undoubtedly it was this policy that enabled the two armed services to meet their 1942 supply goals. The Signal Corps by the end of 1942 had reduced the 90 per cent dollar volume of procurement once in the hands of five large radio manufacturing concerns, to less than 60 per cent—and half of that 60 per cent was being subcontracted.

4,000 prime contracts

On current production the Signal Corps is using approximately 4,000 firms or facilities on prime contracts, and thousands of firms are engaged in subcontracting work for these prime contractors. The Navy's Radio Division has around 120 prime

RADIO WAR-PRODUCTION LOAD SOON TO FALL OFF!

While the dollar volume of Army and Navy electronic and radio production is still great and probably will increase during next year, this dollar volume is likely to be represented mostly by the larger equipments which smaller companies cannot hope to make. This is the forecast of authoritative governmental sources.

The load upon the electronic and radio industry in terms of man-hours seems to be declining, due to a number of reasons—materials shortages, changes in the Army Supply Program, and the catching up on the back-log of military requirements.

Even though larger equipments loom as the most important procurement aspects on the horizon, some of the larger concerns in the industry are tending to show severe production declines by the end of 1943.

One of the largest Signal Corps suppliers may be operating at less than 20 per cent capacity by December, 1943, if new orders are not received. Another supplier of seven Signal Corps radio sets may fall below 50 per cent of capacity by June or July.

The outcome may be that the candy manufacturers, golf-club makers, etc., may go back to their former industrial pursuits, particularly if there is a relaxation of materials for civilian supplies.

BILLIONS of Electronic PURCHASES

by ROLAND C. DAVIES
Washington Editor

How vast radio equipment program was spread out among many manufacturers, large and small. Army and Navy policies

and major subcontractors, with several thousand suppliers and subcontractors for the preceding group.

When the preparations for national defense—and a few months later for war — necessitated the spending of billions of dollars for electronic and radio equipment for airplanes, tanks, battleships, destroyers, submarines and for the ground forces, the Signal Corps and the Navy's Radio Division were confronted with the tremendous job of superimposing overnight their procurement program upon a radio manufacturing industry which in peacetime only produced about $250,000,000 of equipment a year. Thus the plans which had been formulated in advance of Pearl Harbor for subcontracting and wide distribution of procurement, were put into effect in rapid order. And, incidentally, these plans have paid real dividends to the armed services in meeting their assignments of furnishing electronic and radio equipment not only to the American Army and Navy but to the United Nations armed forces under the Lend-Lease program.

Ray C. Ellis, director of Radio Division, War Production Board

Three classes

The assignment of producing electronic and radio equipment for military and naval use is divided into three categories:

1. The production of the more complicated apparatus requiring a very high quality of technical skill and care which necessarily had to go to the manufacturing companies with well-organized engineering staffs and technical "know-how," generally the larger companies.

2. The simpler types of equipment which could be produced by the smaller companies.

3. The components and parts which likewise became a function of smaller companies, except in the case of highly specialized components.

Because the radio manufacturing industry in peacetimes, except for the larger companies, had been primarily an assembly industry and was dependent upon suppliers of such component items as dynamotors, tubes, coil forms, meters and test equipment, the Signal Corps and the Navy's Radio Division found the industry's ways "well greased" for its program of expansion through subcontracting.

Early in the fall of 1941, Major General Dawson Olmstead, Chief Signal Officer, and Major General Roger B. Colton, Chief of the Signal Supply Services, recognized the need of subcontracting and as a result pushed the policy among the five major companies in the radio manufacturing field to subcontract at least 40 per cent of their complete equipment contracts to smaller concerns with less engineering and production ability but to educate the latter smaller companies in the art of producing military equipment. Then these smaller concerns as they became proficient were required to divide their business and to instruct still smaller companies in the methods of military production. Much of the specific credit for these achievements goes to Colonel Eugene V. Elder, Director of the Signal Corps' Materiel Division, and under him a key figure in this task has been Lt. Col. P. J. Hannah, Chief of the Procurement Branch.

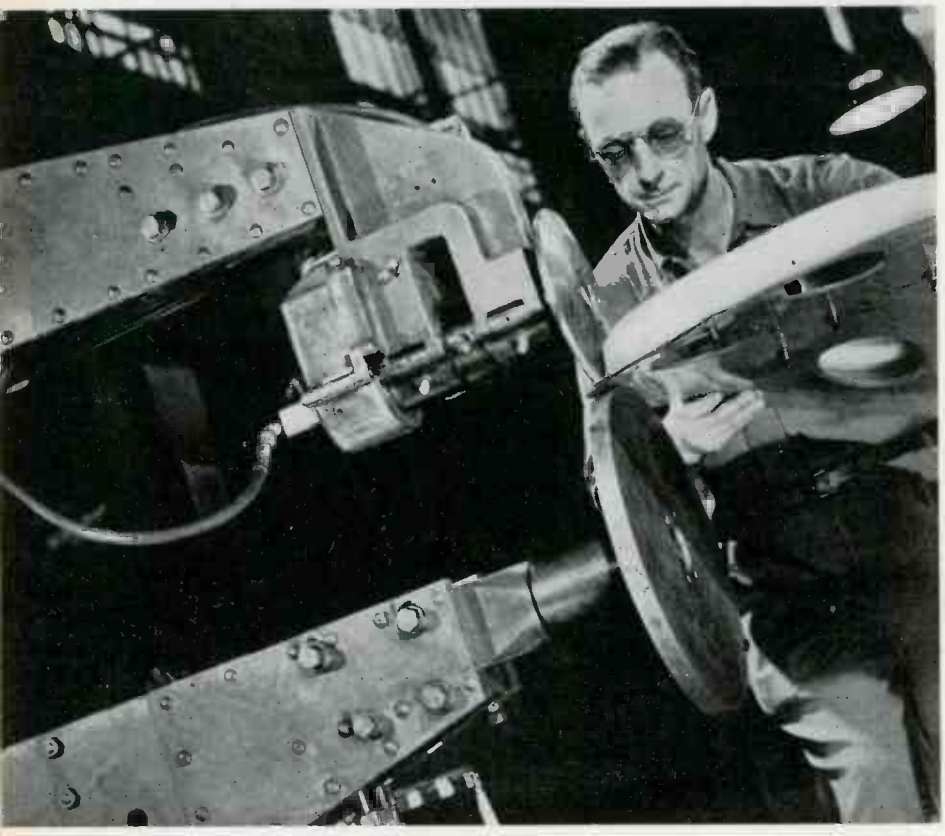
Navy used Hazeltine

The Navy's Radio Division has pursued the policy of educating subcontractors to the point of the desired technical knowledge and skill to meet the Navy's specifications and requirements so that they could become prime contractors. To implement this program which was inaugurated by Captain Dow and his Assistant Director, Captain S. F. Patten, who is going to sea duty, the Radio Division has utilized the Hazeltine Corporation, one of the

(*Continued on page* 151)

AC RESISTANCE WELD

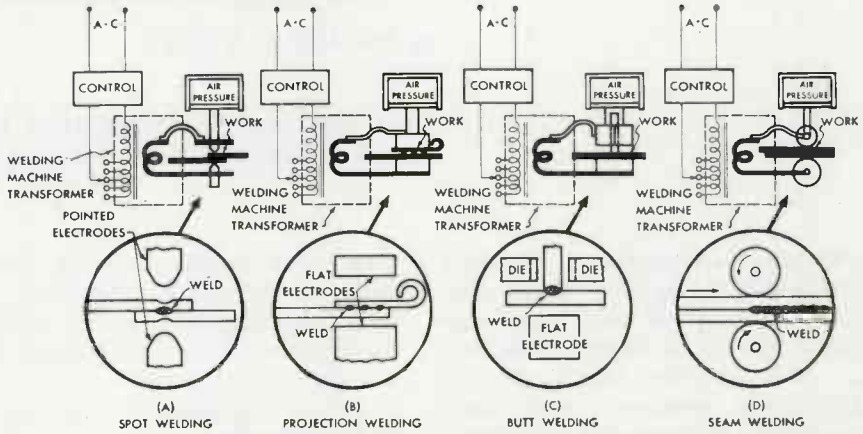
Principles of electronic control. Standardization under new NEMA codes



AC SEAM WELDER of 450 kva capacity used by Lockheed Aircraft Corp., Burbank, Calif.

The joining together of metal parts and structures has been an ever-present production problem since the dawn of the industrial era. Bolts, brackets, studs, rivets, and many other fastening devices have served the purpose, sometimes more or less efficiently, often in a somewhat cumbersome way, but almost always at the cost of excessive man-hours involved in drilling, tapping, riveting, bolting, or other methods of fabrication.

The process of resistance welding has long held out the promise of becoming the fastest and most economical method for joining metal parts. Many manufacturers early replaced bolts and rivets in their products with welds, but only where strength was no great consideration. Achieving real strength in a resistance weld was possible only by trial and error, a rather unsatisfactory procedure in mass production. Today, with a wide variety of precise electronic controls available, resistance welding seems destined to replace a large proportion of the other joining processes. In our production of airplanes and many other implements of war, for example, tube-controlled resistance welding has caused what is virtually an industrial revolution.



FOUR TYPES OF RESISTANCE WELDING. Diagrams at top indicate work positioning, with cross-sections of finished welds shown in circles. Drawing by Westinghouse, East Pittsburgh, Pa.

Basic welding principles

Essentially, resistance spot and seam welding involves pressing flat or semi-flat metal surfaces together between two stud-type electrodes, generally of copper alloy, and passing a current of several thousand amperes through the work. A puddle of plastic or molten metal forms between the surfaces to be joined, then "freezes" into a homogeneous structure. The electrodes, cooled by internally circulated water complete the circuit of the heavy, one-turn, ten to twenty-volt secondary winding of a welding transformer whose primary is fed from a single-phase ac power source. Seam welding differs from spot-welding only in that motor-driven roller-type electrodes are employed, either in continuous or intermittent motion. The welding current may likewise flow steadily, although an on-off method of making "overlapping spot welds" is usually superior for gas-tight seams. This on-off action of the seam-welding current is not to be confused with pulsation welding, in which several bursts of current, with cooling intervals between, are passed through the same spot on the work.

Critical control demanded

The quality of a spot weld depends on many interrelated factors, such as the amount of current, the time for which it is applied, the resistance and the melting characteristics of the metal to be welded, the

ING CONTROL

by GILBERT SONBERGH

type, condition, and pressure of the welding electrodes, the character of the current wave-shape, and many other details. Almost all are determined empirically, and the quality of the welding on a particular job then depends largely on the precision with which the control equipment repeats the weld timing.

Until recent years, magnetic or mechanical contactors were universally employed to make and break the primary circuit of the welding transformer. Because the currents involved may be on the order of several hundred amperes, troublesome maintenance is unavoidable. Because of the large, heavy construction required, mechanical contactors are relatively sluggish. Pitting and burning of the contacts introduces variations in their behavior. No such refinements as making and breaking the circuit on the most advantageous point of the ac voltage wave were possible.

Ignitron contactors

The introduction of mercury-cathode rectifiers with starting electrodes solved the problem. The ignitron tube becomes a conductor a few microseconds after a "firing" impulse is impressed on the igniter and the mercury is ionized, and ceases to conduct when the cathode to anode current descends to zero at the end of the half-cycle. By connecting two ignitrons "back to back," or in inverse parallel, a perfect single-pole, single-throw switch for ac circuits results. One tube conducts the first half of the ac cycle, the other conducts the second, with the circuit remaining closed as long as the igniter electrodes receive excitation impulses from the control circuit.

Ignitrons as contactors for resistance welding do away almost entirely with maintenance costs and production set backs entailed by repairs or adjustments. They are noiseless in operation, virtually instantaneous in their response to the timing controls, and lend themselves to wide-range, stepless heat or welding current control through their ability to serve as conductors for any desired fraction of each half cycle, in response to delayed action of the igniter electrodes.

Tube Uses in Resistance Welding

Ignitrons as power contactors
Thyratrons for weld-current timing
Timing welder-electrode movements
Phase-controlled firing of ignitrons
Rectifiers and contactors for dc welding
Voltage and current compensation

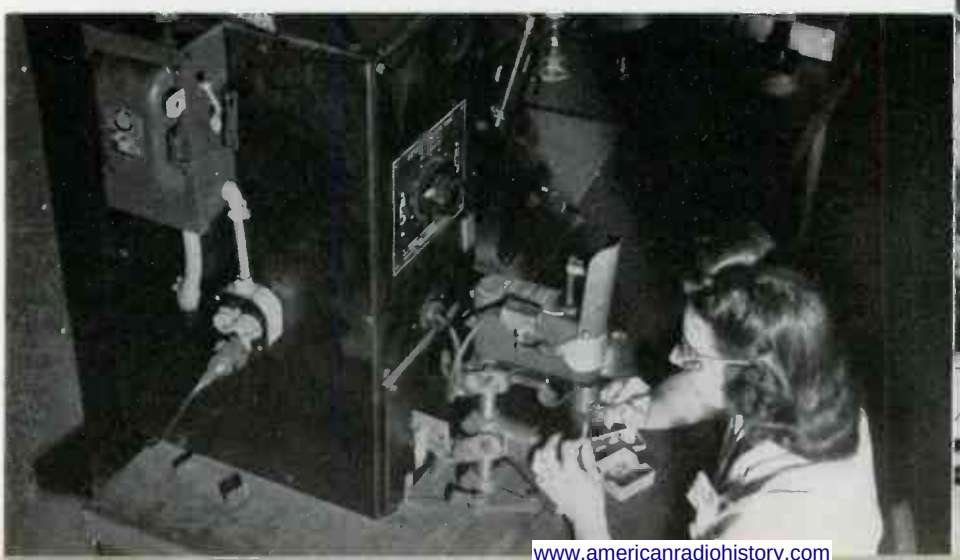
Electronic weld timers

To take advantage of the inherent control possibilities of ignitrons in making and breaking the primary circuit, precisely timed excitation must be supplied to the igniters. Electronic timing circuits of many varieties and degrees of complexity supply the required precision. Basically, all such circuits make use of the time involved in charging or discharging a condenser through a resistor. If the resistor is made variable and calibrated in cycles (referred to the power supply frequency) a reliable, easily adjusted welding time control is achieved. The welding timer is set into operation by manual or other control. The igniter circuits of the ignitrons used as contactors are closed, and the contactor tubes fire. The weld-timing capacitor begins to charge. When the voltage across it has reached a critical value, it "fires" a thyratron or other gaseous type tube. A relay or the tube's plate circuit then operates to open the igniter circuits of the ignitrons, which cease to conduct at the end of the half cycle. It should be pointed out that this is a very simple description of the basic action involved, and that numerous refinements and extensions of the essential principles are incorporated in most of the standized weld-timing controls.

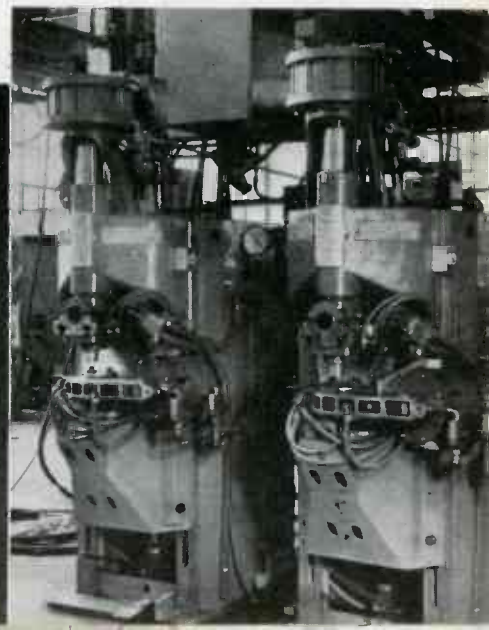
Pulsation weld timers

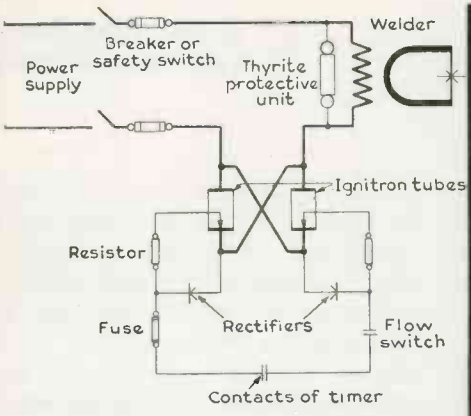
For satisfactory welding of stock much thicker than three-sixteenths inch, to insure longer welding-

HALF-CYCLE THYRATRON WELDING UNIT, made by General Electric, used with bench welder for spot welding vacuum-tube electrode assemblies. Each weld is completed in one half-cycle pulse of welding current

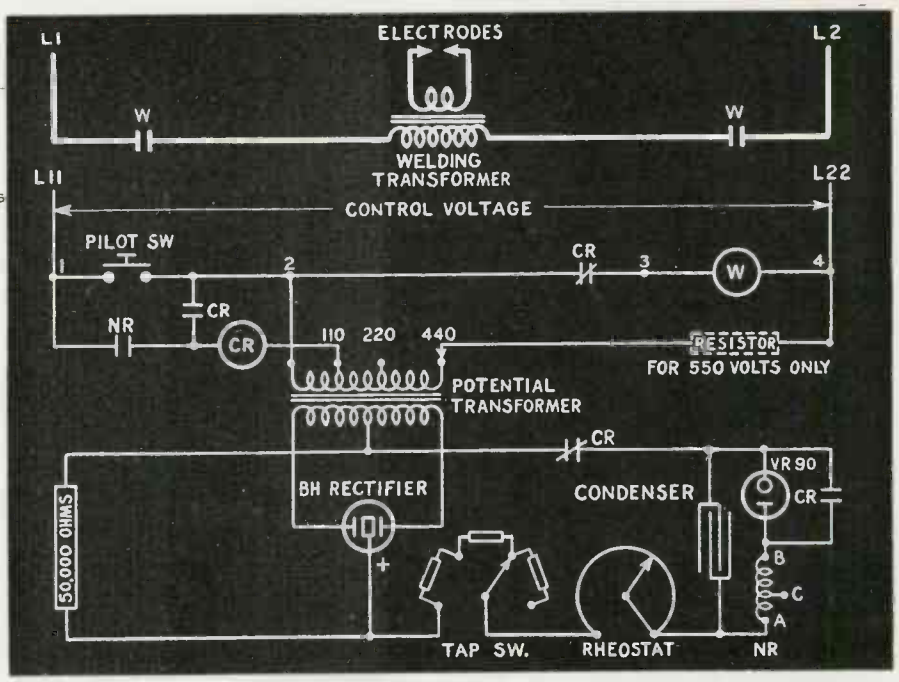


TWO 400 KVA Taylor-Winfield capacitor-storage welding units fitted with electrode fixtures for a special war-job

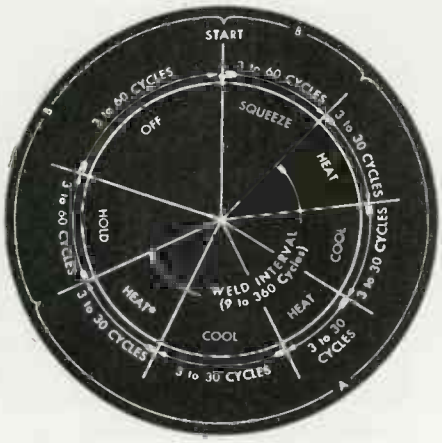




IGNITRON CONTACTORS, with two tubes back-to-back to conduct on both halves of the cycle, are usually wired as shown in this G-E schematic. Flow switch breaks circuit if cooling water is impeded. Weld-timer used may be mechanical or electronic



SIMPLIFIED DIAGRAM of a weld timer using cold-cathode BH rectifier to supply condenser charging current and gaseous discharge tube to end weld timing period, made by Electric Controller and Mfg. Co., Cleveland, Ohio. After work is positioned and welder electrodes closed, operator depresses PILOT SW, energizing potential transformer. Output is rectified, fed through resistance of TAP SW and rheostat to condenser. When charge has reached 115 volts, VR 90 discharges through coil of relay NR, which energizes relay CR, supplied from 110 volt tap of transformer. Normally-closed contacts on CR open, ending welding-current flow. Magnetic or thermionic contactors may be used



PULSATION WELDING CYCLE of fully automatic equipment. Portions "B" refer to mechanical operation of welder, "A" to weld-current flow, both tube controlled

electrode life, and for other performance advantages, it has been found desirable to alternate periods of current flow, usually only a few cycles, with periods of "cool time." In this way, excess heat is conducted away from the outside surfaces of the work and from the electrodes themselves by the circulating coolant. The heat between the pieces of work is, relatively speaking, trapped in, and successive blasts of current bring the area to be welded up to fusing temperature without melting the outer surfaces.

Electronic control for pulsation welding combines several time-delay circuits which provide for timing (1) number of cycles current is on, (2) number of cycles current is off, and (3) total weld time, or "weld interval." All time intervals are adjustable by means of rheostats calibrated in cycles.

NEMA type designations

The National Electrical Manufacturers Association has outlined recommended practice to be followed, in general, by designers and manufacturers of standard welding control equipment. The types are designated by number according to function.

Semi-automatic weld timers, the first group, are simple timers used to fire the ignitron contactors, thus controlling weld time only. Electrodes of the welder are closed manually, by air-pressure, or by motor drive. With the work in place, the operating switch of a type 1-A weld timer is closed, and must be held closed until the weld is completed. The timer does not repeat automatically. The welder electrodes must be opened by the operator. Opening the operating switch resets the control for the next weld. Type 1-B, for pulsation welding, provides "heat times," "cool times," and total "weld interval."

Automatic weld timers, the second group, provide for operation of the welder itself, as well as for timing of the welding current. Opening and closing of the welding electrodes is usually by compressed air, controlled by magnetic solenoid valves which, of course, are energized through the various timing circuits. All of the automatic weld timers incorporate the "non-beat" feature, which means that the initiating switch does not have to remain closed after the timer has begun its cycle.

Type 2-A provides weld time and hold time. Hold time refers to the interval, after cessation of welding current, during which the work should remain clamped between the welding electrodes to allow the fluid or plastic metal to set. This type timer does not repeat automatically. The welding electrodes are automatically released after the "hold" period. The work is moved into position for the next weld and the electrodes are set up against the work before the initiating switch is closed for the next weld.

Type 2-B provides, in addition, for "squeeze time," or the automatic adjustment of the electrodes to the work before the weld is made. The work is held between the open electrodes and the initiating switch (usually a foot switch) is depressed. The control causes the electrodes to clamp the work, the welding current flows, the work is held for the cool-

ing interval, and the electrodes separate to release the work.

Type 3-A provides weld, hold, and "off" time control, differing from type 2-A only in that it will repeat as long as the switch is held closed. During the off time, the operator must position the work and close the electrodes.

Type 3-B, entirely automatic, provides for squeeze, weld, hold, and off times. If the switch is held closed the entire sequence of operations repeats. During the off time the operator has only to position the work for the next spot.

Type 4-A, for pulsation welding, provides heat and cool times, total weld interval, and hold time.

Type 4-B provides, in addition, for squeeze time.

Type 5-A is similar to 4-A, but has another timing circuit, for off time, and will, therefore, repeat.

Type 5-B provides for squeeze, heat and cool times, weld interval, hold time, and off time, for fully automatic pulsation welding. Welders of type 3-B or 5-B have to be seen in operation to be appreciated. These equipments are responsible for the popular stories about welders that work "like sewing machines, and just as fast!"

Phase-shift heat control

For routine welding of ordinary steels, any of the apparatus described is entirely satisfactory. To some extent, some adjustment of the welding current for different types and thicknesses of material may be provided by changing taps on the welding transformer primary. However, for the ultimate in fine adjustment of the current passed through the work, a heat control unit is incorporated in the ignitron firing circuit.

The heat control operates by delaying the firing of the ignitrons on each half cycle, through the use of a phase shifting network which may consist of an auxiliary center-tapped transformer, with a tapped reactor and a variable resistor connected in series between the two outside legs of the transformer. The voltage between the mid-point connection of the resistor-reactor and the center tap of the transformer may be shifted in phase relation to the ac line voltage by varying the resistance or reactance or both.

Taps are provided on the reactor to select the range. This phase-shifted voltage is used to fire a thyratron which in turn fires the ignitrons at the desired phase angle. The effective heating value of the welding transformer current may thus be adjusted from 100 per cent down to 20 per cent, on 440 volt equipment, or to 40 per cent in the case of 220 volt equipment.

Heat control units may be used in conjunction with any of the standard weld timers and ignitron contactors.

Synchronous control of firing

The random closing of the primary circuit of a welding transformer may result in abnormally high transient current during the first few cycles of operation, perhaps reaching a value several times higher than desired. If the circuit is made at the zero instant on the voltage wave, for instance, the transformer core may reach saturation quite some time before the end of the initial half cycle and the current may be limited only by the ohmic resistance of the primary winding.

When welds requiring 8-10 cycles or more are involved, this variable averages out, but for short-time welds some method must be used in order always to synchronize the initiation of the primary current to the same point on the supply voltage wave, namely the zero transient point, which corresponds to the power-factor angle of the welding transformer.

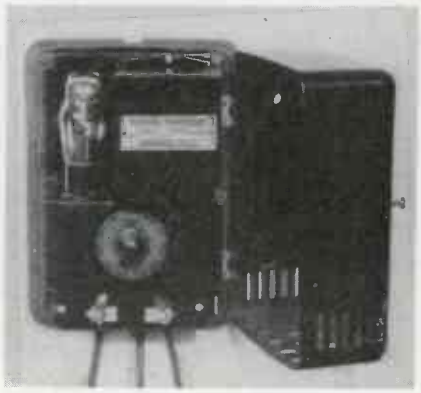
The method generally employed makes use of an impulsing or peaking transformer which may be adjusted by means of a variable resistor to impulse the "starting" thyratron circuit at the proper power factor angle. The thyratron then fires the ignitron. Obviously, other phase shift circuits, such as outlined for the heat control, may be used.

The synchronous weld timer controls ignitron firing for the period of time to which it has been preset, generally from 1 to 30 cycles of the supply-line frequency. It is similar to the simple semi-automatic 1-A weld timer, which, however, closes the welding circuit at random. To provide for pulsation welding, and for automatic operation of the electrodes of the welder, additional timing circuits must be employed. Standardized equipments for this purpose come under the heading of sequence timers.

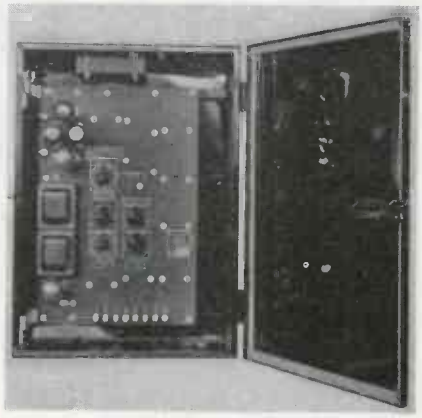
Sequence timers are time-delay circuits for control of the operation of a welder through solenoid valves, and to initiate the operation of a synchronous weld timer at the proper instant. The duration of the welding current flow is controlled by adjustment of the synchronous timer rheostat.

(*Continued on page* 152)

AUTOMATIC weld timer, NEMA type 5B, provides squeeze, weld interval, heat, cool, hold and off times, for spot or pulsation welding, repeat or non-repeat. Westinghouse model illustrated



WELD TIMER for one-half to one kva welders, made by Electronic Products Company, Geneva, Ill.



SPECIAL PURPOSE EC & M automatic weld timer

Tanks and other fighting equipment depend upon ultra short wave communication. And short wave operation depends upon these insulating materials, including steatite, porcelain, glass and glass-bonded mica

★ *Radio-Electronic WAR PRODUCTION*

CERAMIC INSULATOR SPECIFICATIONS

Tests outlined by Military Radio Committee groups under direction of Dr. A. N. Goldsmith and Dr. C. J. Christensen

Clarification of the methods of specifying and testing ceramic insulating materials used in insulators for radio and electronic equipment has been accomplished for the first time in a new American War Standard for Ceramic Radio Insulating Materials, Class L—C75.1-1943.

This specification, written jointly by representatives of the Armed Services and the country's outstanding experts on ceramic insulating materials, will govern future production for and utilization in the electronic industries of ceramics such as steatite, porcelain, glass, glass-bonded mica and similar vitrified inorganic products produced from raw materials by means of heat.

This standard was developed by the War Committee on Radio under the war standards procedure of the American Standards Association upon request of the War Production Board.

Army-Navy approval

Already approved by the Signal Corps Standards Agency for use in lieu of the U. S. Army Specification 71-229D, the new standard is also expected to supplant U. S. Navy Specification RE13A317F. These service specifications were not in complete agreement and classified ceramic materials into only two types, Grades F and G, principally on the basis of their maximum allowable loss factor. With the impact of the war, the desirability of using lower grades of materials for certain applications and the availability of production facilities for such materials became obvious in the attempts to conserve the more strategic materials and to utilize production facilities to the utmost. For these reasons the classification of ceramic materials into only two grades was found to be insufficient.

Six grades

Consequently, the new standard sets up six different grades depending upon loss factor as follows:

Grade	L-1	L-2	L-3	L-4	L-5	L-6
Loss Factor:	.150	.070	.035	.016	.008	.004

These loss factors represent the maximum permissible average of six samples measured at a fre-

quency of 1 megacycle per second after a 48-hour immersion in distilled water with the loss factor taken as the product of the power factor and the dielectric constant.

Quality bottleneck

This classification permits more precise specification of the minimum grade of materials deemed adequate to meet the electrical characteristics of any given circuits, and encourages the use of more readily and economically produced ceramic materials of higher loss factor.

Many equipment designers in the past have specified only the best grades of materials even though other satisfactory materials were available. This has created a "bottleneck" not only in the production of ceramic parts but also in the production of equipment in which ceramic parts are used. Happily, this situation is now rapidly clearing up, both through the education of the equipment designers and through the large expansion in the fabricating facilities for the higher grade materials accomplished under the direction of the Radio and Radar Division of the War Production Board.

Grade L-1 material under this new standard is most usually furnished in dry-process porcelain, while wet-process porcelain is usually grade L-2. Steatites are available in grades L-3, L-4, and L-5, while glass insulating materials are obtainable from grades L-3 to L-6. Glass-bonded mica materials usually fall in grades L-4 and L-5.

Tests outlined

Other requirements in this new American War Standard for these ceramic materials include a minimum average dielectric strength of 180 rms volts per mil of thickness, minimum flexural strength of 3000 pounds per square inch, resistance to visible porosity in a fuchsine dye test, and the ability to withstand 20 cycles of alternate immersion in baths of boiling and ice water. The test methods outlined in the new standard are based on various procedures previously outlined by the American Society for Testing Materials and accepted by the ceramic manufacturing industry.

Heroes on the Production Front

"Unsung heroes on our production battlefront are those who set standards. Indeed, a large share of credit for the swift conversion from peacetime to war production is due them."

—Corrie Cloyes, U.S. Dept. of Commerce

This specification will be followed shortly by a new standard for commonly available shapes and forms of steatite radio insulators, their design criteria, and standardized inspectional procedures. This latter specification is now in its final stage of development by another drafting group of the War Committee on Radio. Other drafting groups are also working on similar product standards for porcelain, glass, and glass-bonded mica ceramic parts. These specifications likewise will be available shortly.

Personnel

This work is all under the direction of Dr. Alfred N. Goldsmith, Chairman of the Subcommittee on Insulating Materials of the War Committee on Radio, and H. R. Wilsey, ASA staff engineer and secretary of the subcommittee.

A specification for high dielectric-constant ceramic materials used primarily for capacitor dielectrics rather than as insulators is also being developed by the same drafting group which prepared the new standard, C75.1-1943.

Dr. Carl J. Christensen of the Bell Telephone Laboratories is chairman of this group, which has as active members, R. F. Field of the General Radio Company, Dr. George J. Bair of the Corning Glass Works, Dr. Hans Thurnauer of the American Lava Corporation, H. L. Curtis and R. F. Geller of the National Bureau of Standards, Frederick Potter of Isolantite, Inc., L. J. Cavanaugh and H. H. Race of the General Electric Company, G. Milton Ehlers of Centralab Division, of Globe Union, Inc., W. A. Yager of Bell Telephone Laboratories, J. S. White of the Stupakoff Ceramic & Mfg. Company, Eugene Wainer of the Titanium Alloy Manufacturing Company, George L. McCreery of the Ohio Brass Company, A. M. Hossenlopp of H. L. Crowley and Company, F. P. Hall of Pass & Seymour, Inc., Francis X. Maida of the Erie Resistor Corp., Robert W. Orr of the RCA Victor Division Radio Corporation of America, and Lt. Gen. Glenn N. Howatt of the General Ceramics and Steatite Corporation, as well as representatives of the Bureau of Ships and the U. S. Coast Guard, Navy Department, and the Headquarters, Services of Supply, and Signal Corps Ground and Aircraft Signal Services, U. S. Army.

Testing and inspecting shipboard radios at Camden factory

Manufacture of QUARTZ

Methods outlined in instructions compiled and issued by the Army Signal Corps. Z-section and direct-wafer methods

Three contrasting general methods of procedure in fashioning oscillator plates from raw quartz are in common use at the present time in industry. These are known as:

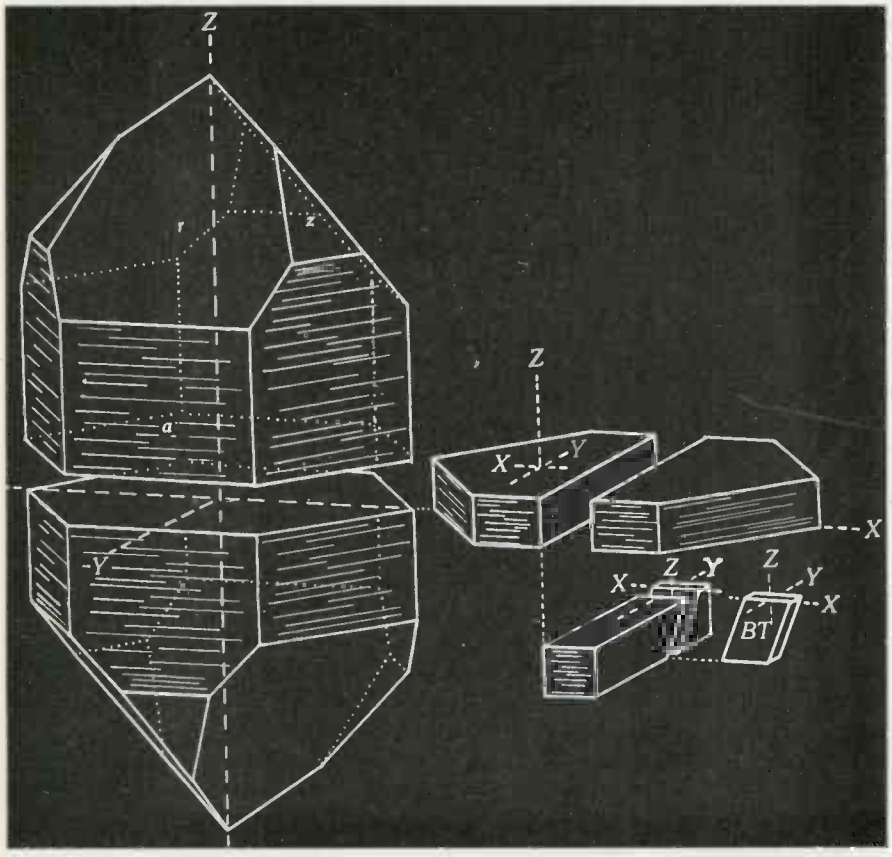
(1) the **Z Section Method**, in which sections are cut perpendicular to Z and then sawed into bars or wafers and finally to blanks,

(2) the **Direct Wafering Method,** in which wafers are sawed directly at the proper angle from the mother crystal, and diced into blanks, and

(3) the **X Section Method,** in which sections are cut perpendicular to X and then sawed into bars or wafers, and finally into blanks. A fourth method of procedure involving the cutting of Y sections also could be devised.

All of the factors which influence the choice of cutting method are not yet clearly defined. The principal factors are the size and shape of the raw quartz available, and the presence or absence of crystal faces. The total area of saw cut per unit blank as imposed by geometrical conditions peculiar to the different methods is an important consideration about which little is known. The different methods also possess certain inherent crystallographic and optical limitations which bear on the type of orienting controls that can be applied. Finally, all of the above considerations must be adjusted to the equipment available to the manufacturer and to the dimensions and orientation of the oscillator-plate desired.

Cutting blanks from Y-bars and Z-sections



Z-section method

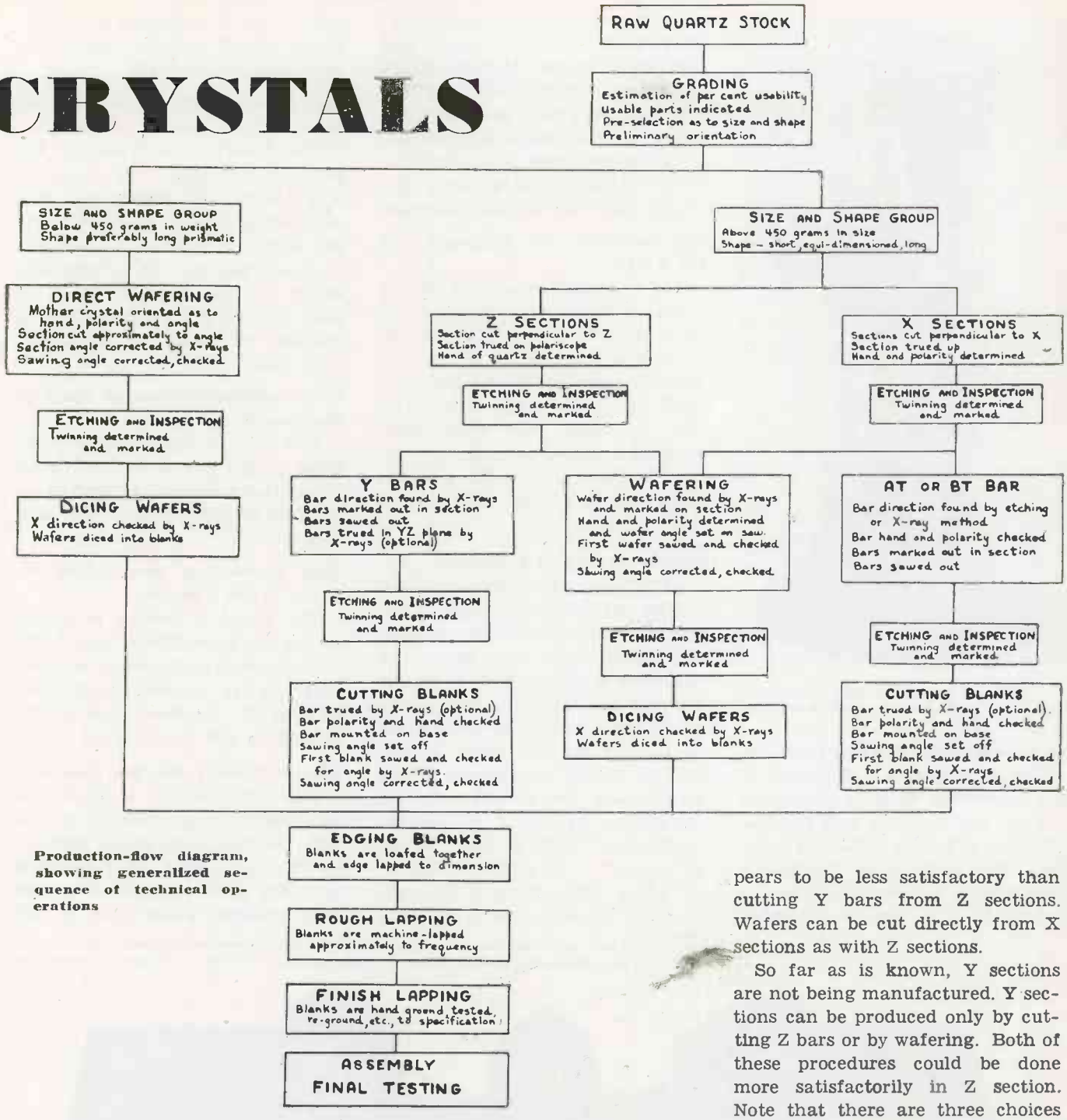
This method has the great advantage that a rapid and accurate polariscopic optical method can be applied to true up the XY plane parallel to which the section is cut. The optical conditions in X or Y sections and in direct wafers are such that advantage can not be taken of the polariscope. The Z section method is probably best suited to material over 400 grams to 500 grams in weight, and is either more or less equi-dimensioned or is shortened along the Z axis. The Z section method probably involves more sawing per unit blank than the other methods. Z sections sometimes are wafered and diced instead of being cut into bars and then into blanks. Wafering in this way is considered to be the best procedure when very small blanks are being cut, and when the Z section is not too broad.

Direct wafering

Material less than about 400 grams to 500 grams in weight, regardless of shape, is probably best handled by direct wafering. Long thin mother crystals (candle quartz) also are well suited to direct wafering. At the present time, most manufacturers using this method require faced crystals in order to orient the quartz in the saw. Unfaced material can be used if X-ray equipment is available. This method probably involves less sawing per unit blank than any other method.

The percentage of recovery of blanks (blanks per pound raw quartz) is relatively high, in large part because twinning and other defects are more readily avoided in dicing. Entire bars are often rejected because a twin by chance extends the length of the bar, but at least one blank can often be recovered from a twinned wafer.

CRYSTALS



Production-flow diagram, showing generalized sequence of technical operations

Wafering becomes difficult as the area of the wafer increases above four or five square inches due to the tendency of the saw to drift off angle. With modern sawing technique, it may be possible to hold the angle more accurately over larger areas in sawing.

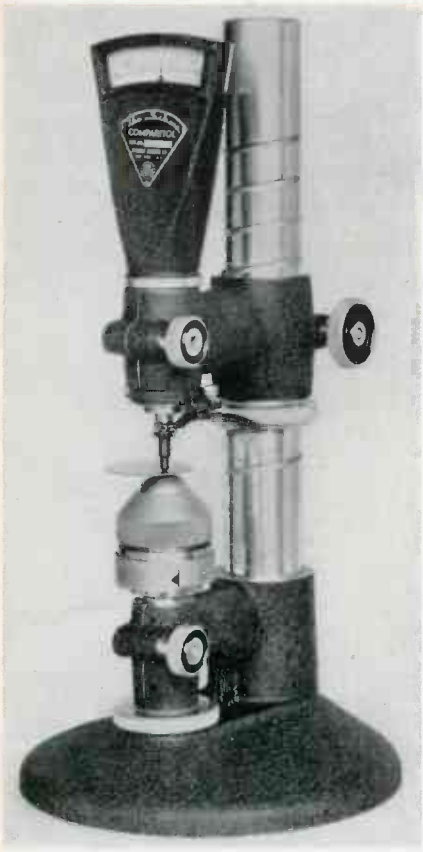
X-section

This method is now being followed by only a few manufacturers. It is applied to raw quartz over about 400 grams in weight, especially to crystals of a rather elongated shape. The method has several minor advantages, and on the whole is believed to be less satisfactory than the Z section method. The principal objection is the difficulty of accurately truing up the ZY plane. It is feasible to lay out AT or BT bars in the section at the complement of the AT or BT angle. Blanks can then be cut perpendicular to the sides and axis of the bar. This is an advantage in edging and lapping operations because there is no champfered edge. Cutting Z bars from X section appears to be less satisfactory than cutting Y bars from Z sections. Wafers can be cut directly from X sections as with Z sections.

So far as is known, Y sections are not being manufactured. Y sections can be produced only by cutting Z bars or by wafering. Both of these procedures could be done more satisfactorily in Z section. Note that there are three choices of barring or wafering direction in Z sections and only one choice in X or Y sections. This is an important factor in avoiding imperfections.

Fabricating Z sections

A detailed description of the technical steps involved in manufacturing oscillator plates by the Z section and Direct Wafer methods is given on the following paragraphs. A summarizing flow chart of the technical steps in all of the commonly used methods is also shown. (*Please turn page*)



Comparitol gauge used for measuring mica thickness

Step 1.—Grading and Pre-Selection.

The stock quartz is examined in the immersion bath to determine the per cent usability and the distribution of defects within the crystal. The position of the usable part within the mother crystal is indicated. The stock is classified as to the method of utilization, depending on the size, shape and presence or absence of faces. Faced or unfaced material over about 400 grams to 500 grams in weight and either more or less equally dimensioned or shortened in the direction of the Z axis is best suited to the "Z Section" method here described.

Step 2—Preliminary Orientation of the Z Axis.

The approximate position of the Z axis is found: (1) by means of the crystal faces and striations, (2) by optical examination in the immersion bath, or (3) by taking a small trial saw cut and orienting in the conoscope. The preliminary orientation should be made to within a few degrees of arc in order to avoid making a larger scale correction in Step 4.

Step 3—Sawing of Z Sections.

The approximately oriented mother crystal is mounted by an embedding or cementing method and is fed into a large saw. The thickness of the section to be cut depends on: (1) the Z to Z′ angle of the blank and (2) on the margin to be left on the edges of the blanks. If the true length of the blank along the Z′ side = L, the margin on one end = M, and the thickness of the Z section to be cut = T, then $T = (L + 2M) \sin (90° - ZZ' \text{ angle})$. The purpose of the margin is to allow for loss of material during the t5 truing-up and etching of the Z section and in the processing of the blank.

Step 4—Truing-up of the Z Sections.

The Z section is placed in the precision conoscope, the direction and amount of divergence from perpendicularity is measured, and the section is trued up on one side by hand-lapping. A mechanical device for this purpose would be desirable. The trued-up side is marked to guide in subsequent operations.

Step 5—Determination of Hand of the Quartz.

The left- or right-handed character of the quartz is determined in the conoscope and is marked on the side of the section. (See also Step 7).

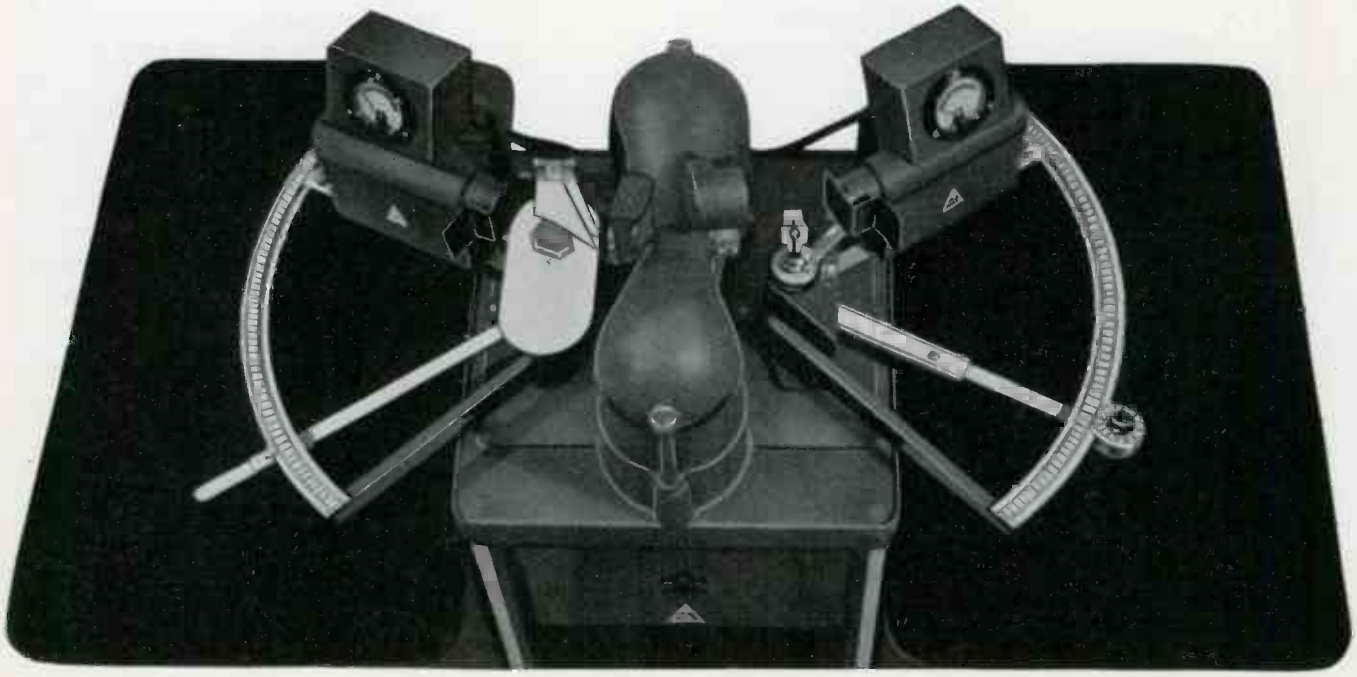
Step 6—Etching and Inspection of the Trued Z Sections.

The trued Z section is deeply etched in hydrofluoric acid. The etched section is inspected for twinning and the defective portions are painted off. Twinned parts are indicated to aid in salvaging.

Step 7—Finding the Bar Direction.

The etched section is layed with its trued face downwards on the table of the "Left Hand Fixture" on the X-ray tube. The direction of a line of intersection of a 1010 face (natural prism face or XZ

Close-up of working head of Philips Metalix X-ray equipment. Left—Natural-face orientation table. Center—X-ray source. Right—Goniometer



plane) with the flat surface of the section is found and marked off with a pencil. This is the X direction and is 30 deg. from the bar direction in the section. The Left Hand Fixture of the Philips' apparatus is supplied with two marking guides, one parallel to the first order prism (XZ), and the other parallel to the second order prism (YZ). It is necessary to use X-rays in finding this direction. (See note at end.) A mechanical orientation by means of natural faces (if present) or an orientation by means of an etching method is not recommended. The upper surface of the section on which the bar direction is marked does not have to be accurately parallel to the lower, trued-up, surface. It is also desirable to locate the position of the major r rhombohedron in the section. This can be done rapidly by means of a small wedge placed on the left-hand fixture of the orientation table. The positive or negative angle of the particular oscillator-cut being made can then be laid off directly on the bar without reference to hand or polarity. If this is done the optical or etch tests for hand and the electrometer test for polarity need not be made.

Step 8—Laying off the Bars.

Bars are marked off on the upper surface of the section in the direction established in Step 7. The bars are so layed-off as to best utilize the untwinned parts. The width of the bar depends on the width of the blank to be cut and the amount of margin to be left to compensate material lost in etching, sawing, edging, etc. Note that there are three alternative barring directions in the Z section, all of which are parallel to the YZ planes.

Step 9—Sawing the Bars.

The Z section is cemented with its trued face down on to a base and is fed into the saw.

Step 10—Etching the Bar.

The sawed-out bars are etched in hydrofluoric acid and are examined for twinning. The defective portions are painted off. Parts of the bar that are twinned at 180 deg. (electrical twinning) and are large enough to be utilized are indicated so that the blanking angle can be adjusted in Step 12.

Step 11—Truing-up the Bar with Respect to the YZ Plane.

The side of the bar sawed parallel to the YZ plane, as found in Step 7, is accurately trued up to the YZ plane. If the marking and sawing have been performed carefully, little or no correction will be required. The correction can be made by placing the bar with its trued Z surface (XY plane) down on the table of the left hand fixture of the X-ray tube and checking against the (1120) reflections. The correction is made this side of the bar by hand lapping or by use of a mechanical device to hold the bar during the lapping. The corrected side is marked for identification in subsequent operations. The hand and polarity of the bar is checked and marked.

Step 12—Mounting and Orientation of the Bar for Cutting Blanks.

The bar is cemented with its trued YZ side down to a glass or other base. All bars must be cemented to the base in the same orientation, for otherwise confusion may arise in the following X-ray checks. The trued Z-XY side is made parallel to a fixed reference direction in the base. The base and its attached bar is then placed on the work-holder of the cut-off saw in a duplicable position corresponding to a zero reading on the graduated arc. The sawing angle for the desired orientation of the blank is turned off. Note that the bar is cemented with its YZ surface down because a down-moving cut-off saw then enters the surface of the bar perpendicularly. A slanting cut is liable to produce a number of errors in sawing.

Step 13—Sawing of First Blank from the Bar.

After the bar is oriented as described in Step 12, the end of the bar and then the first blank is sawed off. The thickness of the blank as sawed off depends on the specified thickness of the finished oscillator-plate and on the amount of excess material to be left as a safety factor in the sawing and subsequent lapping.

Step 14—X-Ray Check for Z to Z' Angle.

The first blank is already within tolerance with respect to the X to

Temperature-control cabinet in which crystals are tested automatically, over the entire temperature range

X' angle, due to controls exerted in Steps 4, 7, and 11, but the Z to Z' angle, roughly fixed in Step 12, still remains to be brought into tolerance. This angle is checked by use of the goniometer fixture on the right hand side of the X-ray tube. The amount and direction of deviation of the blank from the desired angle is measured by X-ray reflections from the appropriate atomic planes. The sawing angle on the bar is reset accordingly. The second blank is then sawed off and checked, and this process is repeated until the blanks are on angle. Thereafter every fourth blank or so should be checked by X-rays to see if the proper angle is being maintained by the saw. See also section on X-rays.

Step 15—Loafing of the Blanks.

The blanks after being brought to angle in Step 14 are stacked and cemented together in parallel position into a rectangular loaf. Paraffin is used as cement. It is necessary to arrange the blanks so that the trued YZ sides and the trued champfered edges of each blank coincide. These surfaces can be identified by means of the marks placed on them in preceding steps.

Step 16—Edging to Dimension.

The squared up loaf is now

lapped down until the blanks are brought to dimension. It is essential that the sides are perpendicular to the major plane surface of the blank and that they are smooth. In addition, the top and bottom edges must be parallel to the XZ plane and the front and back surfaces must be parallel to the YZ plane. No. 303 Alundum abrasive may be used to finish the edges. The blanks are now uncemented by heating. Great care should be devoted to this important step.

Step 17—Lapping Approximately to Frequency (Thickness).

The dimensioned blanks obtained from Step 16 are now lapped approximately to frequency. High frequency oscillator-plate blanks are lapped to about 50 kc of the specified frequency; low frequency oscillator-plate blanks are lapped to about 10 kc of frequency. The detailed operations involved in lapping can not be indicated here. The procedures used vary widely according to the equipment available and other factors.

In one type of procedure, the dimensioned blanks are placed in perforated zinc holders or nests. The nests are ground with a cardioid motion between two simultaneously rotating laps in a drill-press type machine.

Step 18—Final Finishing to Frequency.

After the blanks are brought almost to frequency by machine lapping in Step 17 they are finished off by hand grinding and testing. The blanks are tested, ground individually by hand on a glass optical lap with a fine abrasive, and are retested and re-ground until they meet specification.

Step 19—Mounting in Holder.

The finished oscillator-plate is mounted in the holder.

Step 20—Final Testing.

The mounted oscillator-plate in the holder is tested for activity, the temperature coefficient for both frequency and activity, mechanical strength, and tightness against moisture.

Worker in RCA plant cutting crystal blanks from a block of quartz

X-rays in orientation of quartz

Production figures and studies made by some of the most successful and progressive manufacturers of quartz radio oscillator plates indicate that X-ray equipment is an important key tool for mass production. It has become apparent that a large percentage of the quartz now available is only partially faced or unfaced. Since it is an easy matter to determine the natural face direction by means of X-rays, this unfaced quartz can be used just as easily and economically as faced quartz. In addition, the X-ray method permits the enormous advantage of accurately measuring the angle of cut of a blank or wafer.

The measurement is accurate to within ± one minute of arc, is absolute and unequivocal and requires no interpolation, takes less than a minute, and the apparatus does not require highly skilled operators. The angle of cut thus determined allows one to omit the usual temperature-cycle run for orientation which requires about an hour, and allows the precision saws to be kept in continual operation without the necessity of remounting the quartz on the saw. The Technical Staff of the U. S. Signal Corps strongly recommends that X-ray equipment be purchased immediately by any manufacturer who plans to go into economical mass production. For his purpose it is as necessary a piece of equipment as a saw or lapping machine.

4.441 measurement of angle of cut

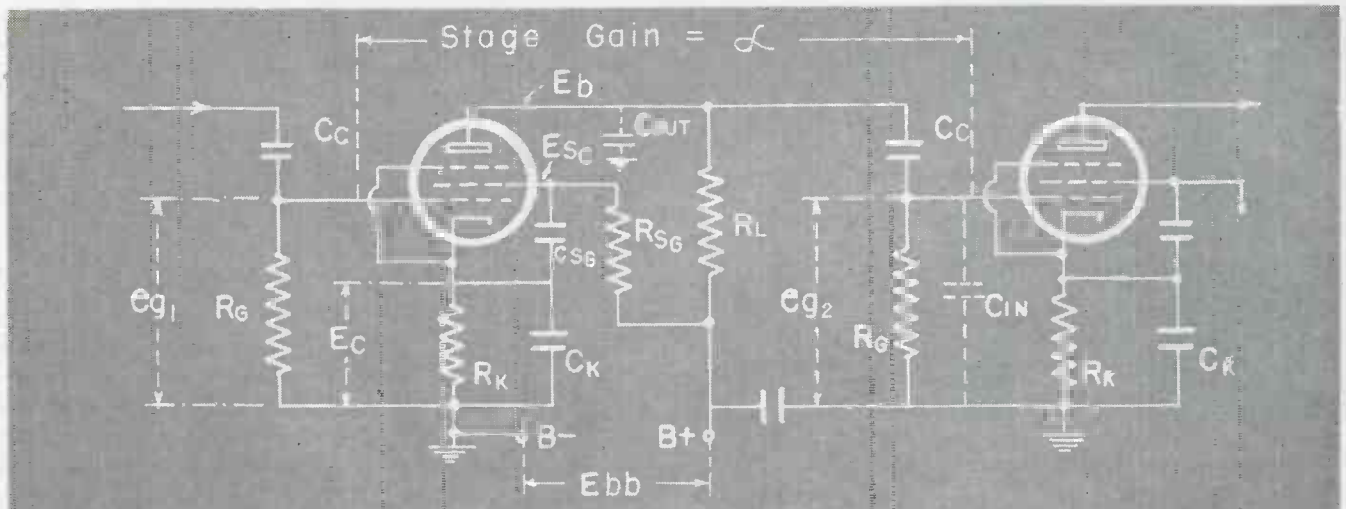
Since the atomic planes are in a precise fixed position with respect to the crystallographic axes it is possible to measure the angle of cuts with reference to the position of a set of atomic planes. An X-ray goniometer is used in conjunction with an ionization tube and X-ray machine.

There are four essential parts of the goniometer: (1) The crystal holder which keeps the blank or wafer in position in the X-ray beam, (2) an arm which turns the holder in the X-ray beam, (3) an ionization chamber which can be adjusted on the arc independently of the table, (4) a scale and vernier which can be set to one min. of arc.

The standard is first placed in the crystal holder, and the ionization chamber fixed to receive the reflection from the chosen atomic planes. For a fixed crystal position there is only one position for the ionization chamber. The chamber should be set as closely as possible to the correct angle to receive the proper reflection. The arm which turns the crystal holder can be moved independently of the holder by loosening the set screws connecting them. The arm should now be set at some convenient position (angle) to allow easy operation. Some prefer to set it at exactly 38° 14′, the Z to Z′ angle for the major rhombohedral planes. Others prefer to see the arm at 35° 15′, the AT angle. It may be necessary to slightly readjust the ionization chamber at this time, but in any case it should not be removed more than one degree from the theoretical setting. The screws connecting the arm and the crystal holder are then tightened. Care must be exercised not to change the original settings.

The AT or BT secondary standard should then be measured. In the former case the maximum deflection should be obtained at exactly 2° 59′ ±1′ and the latter at 10° 46′ ±1′ from original setting with the primary standard major rhombohedral planes, if the secondary standards have been accurately cut and all adjustment carefully made on the X-ray equipment.

FORMULAS for RESISTANCE-COUPLED AMPLIFIERS



CIRCUIT PERFORMANCE CALCULATIONS

1A) $$\alpha = \frac{Gm}{\frac{1}{R_P} + \frac{1}{R_L} + \frac{1}{R_G}} \times B_L \times B_H$$

WHERE

$$B_L = \frac{1}{\sqrt{1 + \left(X_{Cc}/R'\right)^2}}$$

$$R' = R_G + \frac{R_P R_L}{R_P + R_L}$$

$$X_{Cc} = \frac{1}{2\pi f C_c}$$

$$B_H = \frac{1}{\sqrt{1 + \left(R''/X_{Cs}\right)^2}}$$

$$R'' = \frac{R_P R_L R_G}{R_P R_L + R_L R_G + R_P R_G}$$

$$X_{Cs} = \frac{1}{2\pi f \left(C_{out} + C_{in}\right)}$$

WHEN $R_L >> \frac{R_P R_G}{R_P + R_G}$,

2A) $\alpha = Gm\, R_L \times B_L \times B_H$ (APPROX.)

3A) $eg_2 = \alpha\, eg_1$

4A) DB GAIN $= 20 \log_{10} \alpha$

5A) $$N = \frac{\alpha}{\alpha'} = 1 + \frac{R_K (1+\mu)}{\sqrt{1+\omega^2 C_K^2 R_x^2 (R_P + R_L)}}$$

$$\cong 1 + \frac{R_K Gm}{\sqrt{1+\omega^2 C_K^2 R_K^2}}$$

FOR PENTODES WHERE $R_L >> R_P$

CIRCUIT CONSTANT CALCULATIONS

1.) $$R_K = \frac{E_c}{I_b (1+A)}\ ;\ A = \frac{I_{SG}}{I_b}$$

2.) $$R_{SG} = \frac{E_{bb} - E_{SG}}{I_{SG}}$$

3.) $$C_{IN} = C_{gk} + C_{gp}(1+\alpha)$$

4.) $$C_K = \sqrt{\frac{R_K^2 Gm^2 - (N-1)^2}{\omega^2 R_K^2 (N-1)^2}}$$

WHERE, $N = \frac{\alpha}{\alpha'}$

α = GAIN WITH COMPLETE BY-PASSING AS GIVEN BY 1A.

α' = DESIRED GAIN AT FREQUENCY f.

5.) $$X_{Cc} = R' \sqrt{N^2 - 1}$$

WHERE $R' = R_G + \frac{R_P R_L}{R_P + R_L}$

Compiled by
WILLIAM MOULIC

ELEVEN

1. It's Done with Mirrors

Single position examination at work from two angles speeds meter assembly in Weston plant at Newark, N. J.

2. Conserving Paint and Brushes

At certain points on some production lines, paint or other protective coating material is used intermittently. Frequently, letting brushes stand in air between periods of use enable paint to gum up and ruin the bristles in a short time. Since it isn't economical to clean such brushes, one practical solution to the problem is to provide paint-jars or cans with brushes supported in holes through the lids. The brushes should preferably be adjustable for height, like those in the familiar rubber-cement dispensers. In addition to saving brushes, such paint-cans prevent evaporation and waste of the paint itself.

3. Stepped Temperature Stove

For fast determination of vaporization points of large number of insulating and other materials, Westinghouse research men improvised this testing unit consisting of heavy iron bar electrically heated at one end and water cooled at the other. Deep test-tube holes drilled at intervals provide linear "tapped temperatures" which are an arithmetical function of hot end to cold end differential after bar has reached thermal equilibrium

4. Finding Way Around Plant

For electronic industrials whose plants consist of numerous separate departments or of many buildings, some of which may look alike to the new employee, this suggestion might prove helpful: paint the names of the various departments on the buildings or, for inside applications, on definite dividing walls or doors between the areas in question. At a Brooklyn shipyard, adoption of this idea resulted in a decided decrease in the number of new-employees appearing in the wrong shops, asking directions of guards, or wandering helplessly about.

5. Easing Manpower Shortage

One of half-dozen blind workers on knob assembly for RCA. Experience has shown blind are unusually efficient at wide variety of routine tasks

6. Shop Short: Position

Worker on metal-trimming operation stepped up production and cut scrap-waste 10 per cent when his machine was raised six inches! Less cramp, more work.

7. Watch for Waste Motion

Thousands of man-hours may be going to waste in your plant because of the unsuspected existence of unnecessary operations. Many radio - electronic manufacturers have found that periodically asking questions (and questioning answers) about production techniques pays dividends, through elimination or simplification of operations that may originally have been occasioned by plant or product conditions which no longer exist. For example, time-honored small tube manufacturing practice at RCA's Harrison, N. J., plant was to mark a long serial number inside the tube, on the stem, for subsequent control of processing. Prior to shipping, the number was read (with some difficulty) and branded on the tube base. The suggestion to elimi-

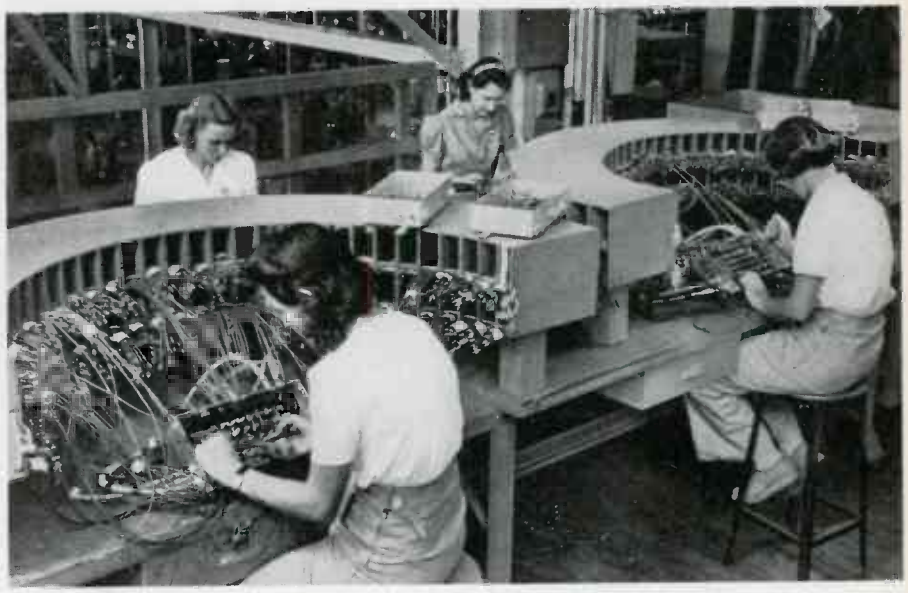
FACTORY SHORT CUTS

nate pre-marking and simply brand the bases consecutively at the warehouse met no objection and will result in a 3,300 hour saving on annual production of about 312,000 tubes.

8. *Terminals in Electronic Equipment*

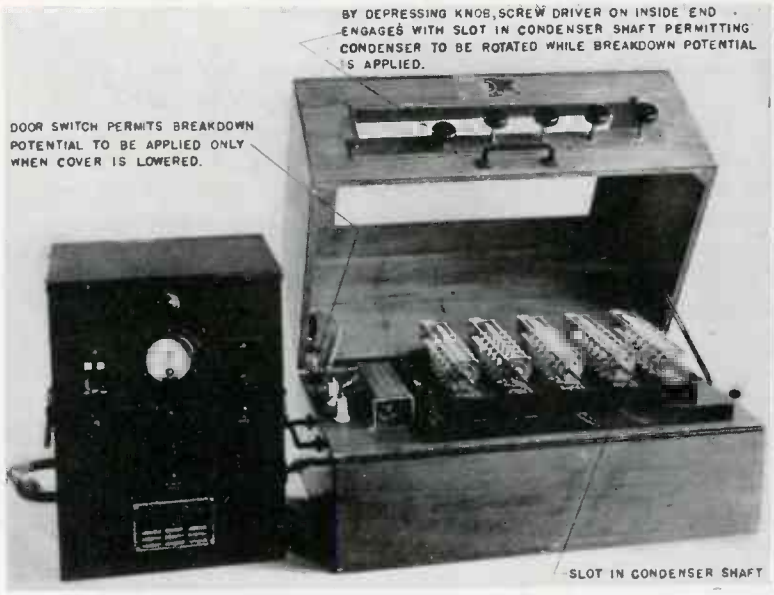
Dr. Paul G. Weiller, Kollsman Instrument Division, Square D Co., Woodside, N. Y., has a good suggestion to offer to designers of industrial or military electronic apparatus, which probably won't be serviced by electronic experts:

When you design a new instrument, never forget the common foibles of factory organizations. One thing, for instance, always to keep in mind is the electrician's big screwdriver. This screwdriver is certainly the worst enemy of an instrument; and think of it when you design your terminals. Some instruments are provided with binding posts screwed home by hand. That is poor policy, because the mechanical strength of such a joint is not always sufficient. Connections in industrial devices should always be made by fairly heavy screws, tightened by a screwdriver. On the other hand, they should be in such a position on the instrument that slipping of the screwdriver cannot cause any harm to the instrument. It is good policy to put all such terminals in a standard junction box with the usual cover so that it does not become necessary to open any part of instrument for connections.



10. *Women Increase Production*

Experience proves girl-workers have greater manual dexterity than men on assembly of electrical and radio control and power supply wiring for basic trainer produced by Vultee Aircraft, Inc., Vultee Field, Calif.



9. *One-Man Hipot Test-Jig*

For 1,000 volt routine test of transmitting condensers, fixture built at Chicago Western Electric plant handles 1,000 units in 30 hours with one operator. Former method took two men 85 hours

11. *Assembly Tool from Valve-Lifter*

Ex radio serviceman at Curtis-Wright soldered four nails to jaws of old valve-lifter to facilitate stretching corrosion-resistant rubber casing over aircraft-radio connector plug. Short cut from "Wings"

A typical seven-cell unitized communications receiver, with power supply shown at extreme end

GANGED RECEIVER UNITS

Afford flexibility and simplicity of manufacture, assembly and servicing

In any radio device, the vacuum tube is the hub of a system of accessories which are necessary to make that tube function. No matter what its use, some sort of signal is applied to each stage and a modified sort of potential is delivered by that stage. A logical step forward in handling these components is to definitely correlate all of them in an individual unit that could be assembled wired and tested as a whole. Later servicing problems are also simplified by avoiding the mixed assembly of parts that must be traced to find out which item goes with a particular tube. Groups of units can be ganged together to produce receiver operating characteristics to meet any specifications.

In an unusually neat application of this principle the Harvey Unitized Communication Receivers, recently introduced by the Electronics Division of the Harvey Machine Co., Inc., Los Angeles, are made up of combinations of three basic cells and use only one tube-type in the entire circuit, regardless of its complexity. Practically any type receiver or other electronic device can be quickly assembled.

Engineers of the Electronics Division, in conjunction with production engineers of the Harvey Machine Company made a joint study of available methods for speeding the fabrication of radio equipment, facilitating field service and interchanging of parts, the result of which, for the first time, custom built radio performance was made possible with mass production methods.

The receivers are an assembly of four or more cells, each cell being a complete element of the radio unit. The three types of cells, now produced in quantities take care of radio, intermediate and audio frequency amplification. They are electrically connected through demountable bus-bars, which eliminates approximately 75 per cent of the hook-up wire usually required in a receiver and permits the use of only one tube-type instead of the usual six or more different types.

The rf basic cell is composed of the standardized metal case, on top of which is a remote cut-off high-mu pentode tube and tuning condenser; within the box is a rotary rf turret coil assembly. With this method the selected rf coil is rotated to engage with a molded plastic contactor assembly having phosphor-bronze springs and solid silver wiping contactors.

The rotary turret coil assembly is mounted on a hollow trunion and the rf transformers are rotated by a band change control, which connects the desired coil to the fixed components of the circuit.

The rf coils are wound upon molded low-loss forms with solid silver contacts. Since components of the rf cell are so arranged as to permit an average reduction of 75 per cent in the amount of lead length, the minimum circuit capacitances are appreciably lower than those usually attained. The

result is a lowering of noise levels and an improvement in sensitivity and selectivity.

This results in higher L/C ratios in the rf circuit which has as low as 40 per cent less minimum circuit capacitance than is found with conventional band switch methods. The exceptionally high Q of Harvey rf circuits is the result of coil design and use of low-loss coil forms, use of the solid silver contactors provided with wiping action, and efficient shielding. These assure multi-band receiver performance equal to the finest single-band receivers with comparable tuning ranges.

The IF basic cell is also built within the standardized metal case, on which is mounted a vacuum tube; within it is an aluminum shielded IF transformer having a high degree of stability. Use of a minimum lead length eliminates the feed-back caused by stray capacitances; increased shielding obviates the remainder. With this stability the IF transformers may be operated at considerably higher gains than is normally possible.

The audio basic cell is also assembled within the standardized metal case, on top of which is a vacuum tube and cathode by-pass condenser. Inside are a universal transformer (output 2½ to 500 ohms) and the necessary resistors and condensers to complete the audio frequency amplifying stage.

The metal cases used for the audio, IF and rf cells are formed from 18 gage steel with end plates spot-welded to them providing extreme rigidity. The cases are given a .0015 in. copper plating which makes them rust proof and serves as a highly conductive shield. Overall dimensions of the cases are: width 5¼ in., height 4½ in. and depth 2⅛ in. The complete audio cell weighs 40½ ozs., the IF cells 22½ ozs., and the rf cell 36 ozs.

Receiver construction

The Harvey Machine Scout-car model consists of two rf cells, one IF cell and one audio amplification cell. Antenna sensitivity is approximately 20 micro-volts; image rejection ratio 500:1 at 1500 kc; IF rejection 40,000:1; IF band width about 35 kc. Overall dimensions of this receiver are: width, 5¼ inches; height, 7½ inches; overall length, 10½ inches. Weight is 12 lbs., 14 ozs., not including power supply.

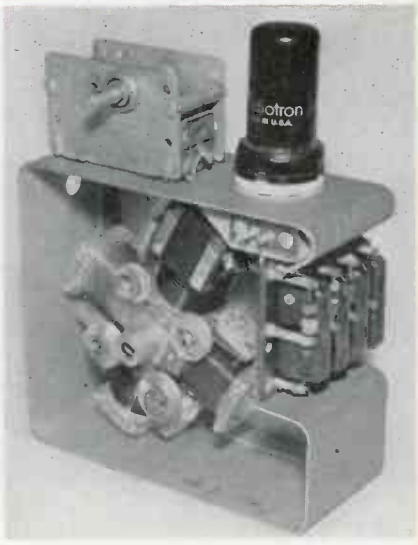
A long range, multi-band, highly selective and sensitive Harvey Direction Finding and Communication Receiver requires four rf cells, three IF cells and two audio cells. Changes in frequency bands involve changing the rf coil assemblies to those designed for the desired frequencies. Such a receiver measures 5¼ in. wide, 7½ in. high, 21⅛ in. deep and weighs only 20 lbs. 4 ozs.

In each instance the receivers are assembled from standardized rf and IF or audio cells, using only one tube-type, one type and capacitance of tuning condenser and a resistor list that is cut to an absolute minimum. Inherently short leads, a characteristic of Harvey "Unitized" construction, minimizes the mutual inductance and stray capacitance between critical portions of the circuit. Enclosed within the metal cases of the assembled cells, the inductors are exceptionally well shielded.

Wide application

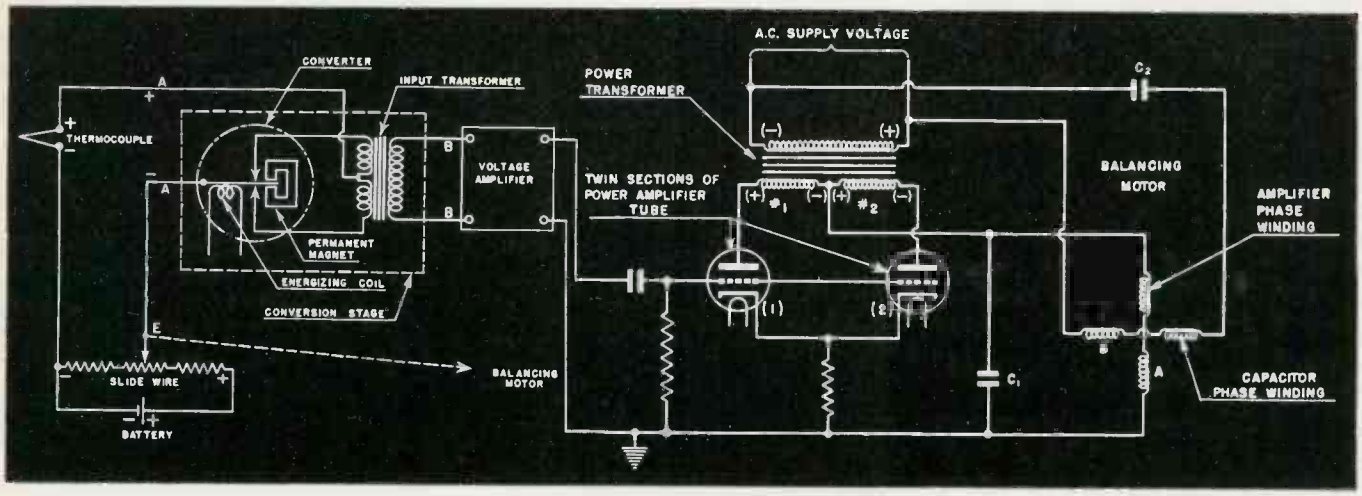
Assembly into communication receivers is by no means the only use to which these cell-units can be adapted. Since the individual cells or groups of cells can be used for such electronic devices as radio transmitters, follow-up devices, remote control units, inter-communication systems, public address, alarm systems, recording and actuating humidistats, laboratory test equipment, etc. Cells for use by other manufacturers of electronic equipment are also being produced.

The servicing of these receivers is simplified, since only a small number of basic cell-units and one tube type are all the stock requirements needed to repair any damaged receiver—whether it is a receiver of four or fifteen cells. Solder is not required to effect repairs, since the entire cell is merely removed and a new one put in its place thus complicated circuit diagrams are not necessary. A person with limited experience can do the servicing equally as well as a radio technician.



Close up of rf cell unit showing the four-band turret coil

Flexibility of construction is shown in this four-cell communication receiver



Potentiometer circuit showing synchronous switch for converting potential unbalances into pulses for amplification and control of grid operated rectifier

A SELF-BALANCING

For many years, self-balancing potentiometers, used with thermocouples for recording and controlling industrial temperatures, have employed sensitive galvanometers to govern the operation of the balancing mechanisms. Usually, these self-balancing mechanisms are cyclic in operation, providing intermittent periods during which the galvanometer is free to assume its proper deflection unhampered by an engaging mechanism.

In many industrial processes, however, demands are becoming more numerous for substantially instantaneous response of the instruments to minute temperature changes, faster pen travel across the chart, freedom from the influence of vibration, and ability of the instrument to operate regardless of changes in its position.

The Brown self-balancing potentiometer functions automatically to maintain a balance in the measuring circuit. The measuring circuit consists primarily of a thermocouple to generate a voltage dependent upon the temperature and a slide wire through which a known current is passed. The two voltages are combined in opposition so that for each value of thermo-potential there is a position on the slide wire that will balance it to zero.

The contactor on the slide wire is moved automatically by an electronic balance control, and is connected mechanically to a pen and indicator. Since every position of this contactor corresponds to a known voltage, the pen and pointer identify the value of the measured voltage. The chart and scale of the instrument are calibrated in degrees of temperature and correspond with the known voltages generated in the thermocouple.

When the thermocouple voltage changes because of a temperature change, an unbalanced voltage appears at the input. The self-balancing potentiometer recognizes both the extent and direction of this unbalanced voltage and rebalances the potentiometer circuit by moving the slide wire contactor to the true voltage point on the wire.

Electronic balancing control

The continuous balance system consists of a reversible two-phase motor, connected through a special reduction unit to the contactor on the slide wire, together with an electronic phase selection circuit which determines the direction and extent of any unbalance that occurs in the thermocouple circuit.

The rebalancing motor converts the amplified unbalanced voltage of the potentiometer circuit into mechanical motion of the slide wire contactor, to a position where true balance is obtained. In addition, this motion can be used to actuate the indicating, recording, and controlling components of the system. The rebalancing motor has a strong field winding B as shown in the schematic permanently excited from the ac supply line. This field is connected in series with condenser C_2, so that its current will be in phase with the supply voltage. The driving motor winding A is located electrically at right angles to the permanent field and is energized from the output of the power amplifier. Both of these fields are located on the stator of the motor. The motor armature is made up of a group of heavy copper conductors embedded in soft iron laminations and short circuited on themselves

The direction of rotation of a two-phase motor may be controlled by reversing the phase of the voltage applied to either of the two motor windings.

The power amplifier that controls the time and direction of motor operation includes two identical twin-triode tubes connected to operate as a parallel-feed, push-pull output stage. The plate voltages for the tubes are supplied by separate windings on the power transformer of the amplifier. The ac potential to one plate circuit is of opposite polarity at any instant to the potential on the other plate. Triodes (1) and (2) will pass current only when the polarity of the ac voltage from power transformer winding No. 1 or No. 2 is such that the re-

spective plate has a positive potential.

If it is assumed that tube (1) can conduct plate current only during the odd half-cycles of supply voltage, as indicated by the polarity markings, then tube (2) can conduct plate current only during the even half-cycles. Thus, a definite timing relationship exists between the power amplifier and the supply voltage.

The voltage supplied to the grid of tube (1) or tube (2) determines the amount of plate current which will be conducted by the tubes. When a positive potential is applied to the grid of either tube during the half-cycle of its operation, the plate current approaches a maximum; when a negative potential is applied, the plate current approaches a minimum. During the non-operating half-cycle of each tube, its plate current is zero regardless of grid voltage. When zero voltage is applied to the grids of the power tubes, both tubes conduct an equal current during their respective operating half-cycles.

Half-wave pulses of current will pass through motor winding A and condenser C_1 during the odd half-cycles of supply voltage. During the even half-cycles, the tubes will pass no current, but condenser C_1 will discharge into motor winding A. Thus, with an in-phase signal on the grid of the power amplifier tubes, a sine-wave alternating voltage in phase with the supply votage is developed across motor winding A.

Conversely, when the grid signal to the power amplifier tubes is 180 degrees out of phase with the supply voltage, tube (2) will conduct current during the even half-cycles of supply voltage so that a half-wave current pulse will then pass through motor winding A and condenser C_1. During the odd half-cycles of supply voltage, condenser C_1 will discharge into motor winding A. Thus, with a grid signal 180 degrees out of phase with the supply voltage, a sine wave alternating voltage 180 degrees out of phase with the supply voltage is developed across motor winding A.

No-signal conditions

During the period of zero grid signal, both tubes conduct equal pulses of current on both the negative and positive half-cycles of supply voltage. These pulses pass through motor winding A and condenser C_1. Action under this condition is similar to a conventional full-wave tube rectifier and the current flow in the motor winding is pulsating direct current. Thus, during the period of zero grid signal, a pulsating direct current flows through motor winding A and is somewhat smoothed out by the filter action of condenser C_1.

In order to have the motor start up in one direction it is necessary to supply an operating potential to the grids of the triodes only during the intervals when triode (1) can function. To secure reversals the operating potential is applied to the same grids during the intervals of time represented by the alternate half cycles of the power supply frequency.

Conversion stage

Since only one control potential is needed therefore, to control these triodes, a conventional type of voltage amplifier provides adequate excitation. It has three stages, with a maximum gain of 125,000.

The principal feature of the control circuit is the method by which any unbalance that occurs in the thermocouple circuit is transferred to the voltage amplifier. The synchronous switch or converter shown in the schematic diagram operates at the power line frequency, and transfers the unbalance potential to the two primary windings of the input transformer. This switch is provided with a permanent magnet and an energizing coil excited through a step-down transformer from the power supply mains. During the odd half-cycles of the supply voltage, contact T is closed; during the even half-cycles of the supply voltage, contact B is closed. These contacts are connected to the opposite ends of the center-tapped primary of the input transformer so that each half of the primary alternately functions as the active primary.

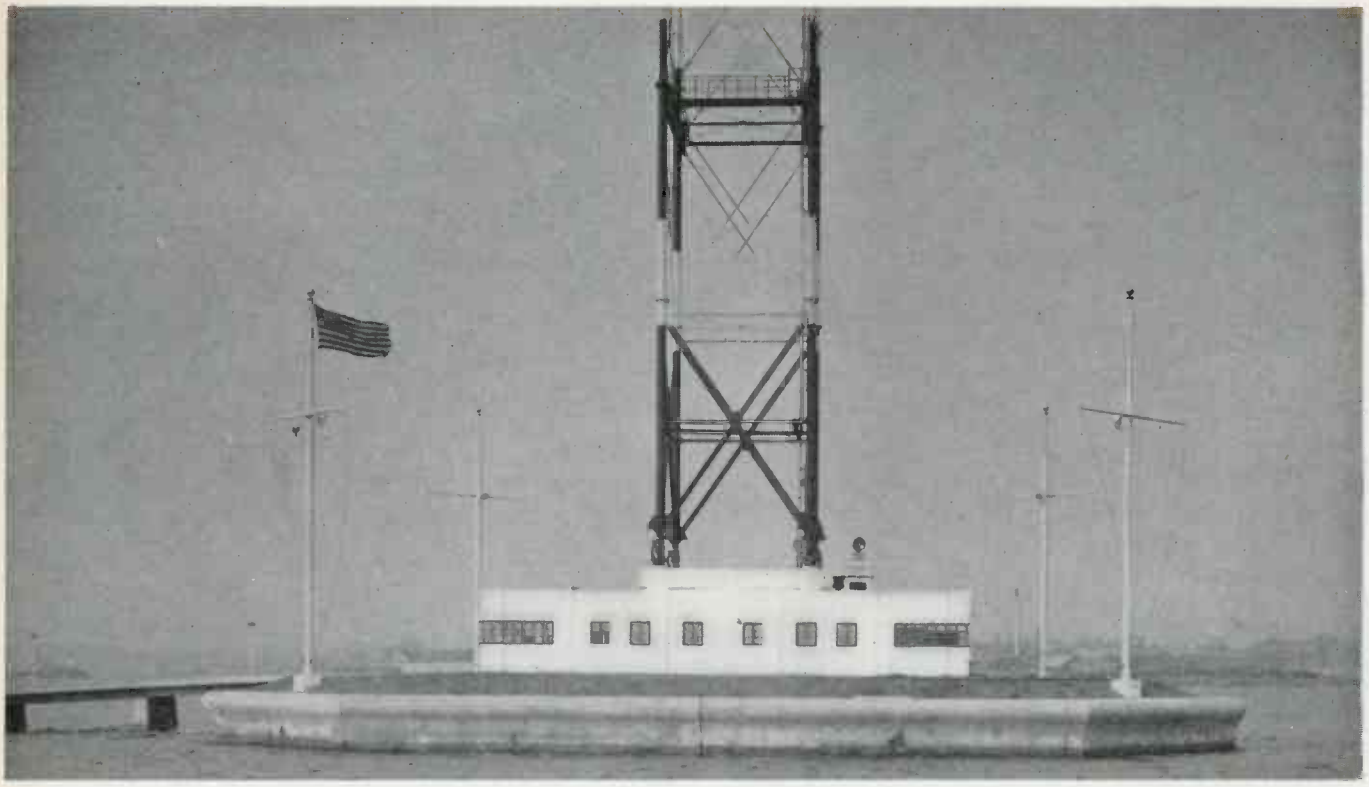
The direction of unbalance of the measuring circuit determines the polarity of the unbalanced dc voltage appearing at the input. During any half-cycle, both the direction of current flow in the primary winding, and the instantaneous polarity of the secondary voltage are dependent upon the polarity of the dc voltage. Since current flow in each of the primary windings is dependent upon supply voltage, the phase relationship between the secondary voltage and supply voltage of any half-cycle is an indication of the polarity of the unbalanced voltage. With the supply-line voltage as a time reference, the secondary voltage either has the same instantaneous polarity (in phase), or the opposite instantaneous polarity (180 degrees out of phase), depending upon the direc-

(*Continued on page* 153)

POTENTIOMETER

by T. R. HARRISON, W. P. WILLS, and F. W. SIDE
Brown Instrument Div., Minneapolis-Honeywell Regulator Co.

Continuous recording of potential differences with vibrator-type converter, amplifier, grid controlled rectifier, and split-phase motor



Close-up of Columbia Island in Long Island Sound, showing reinforced-concrete bulkhead designed to break up wave action

18 Months' Experience with WABC's Island Transmitter

CBS' key station in Long Island Sound has more than fulfilled performance planned by engineers under E. K. Cohan

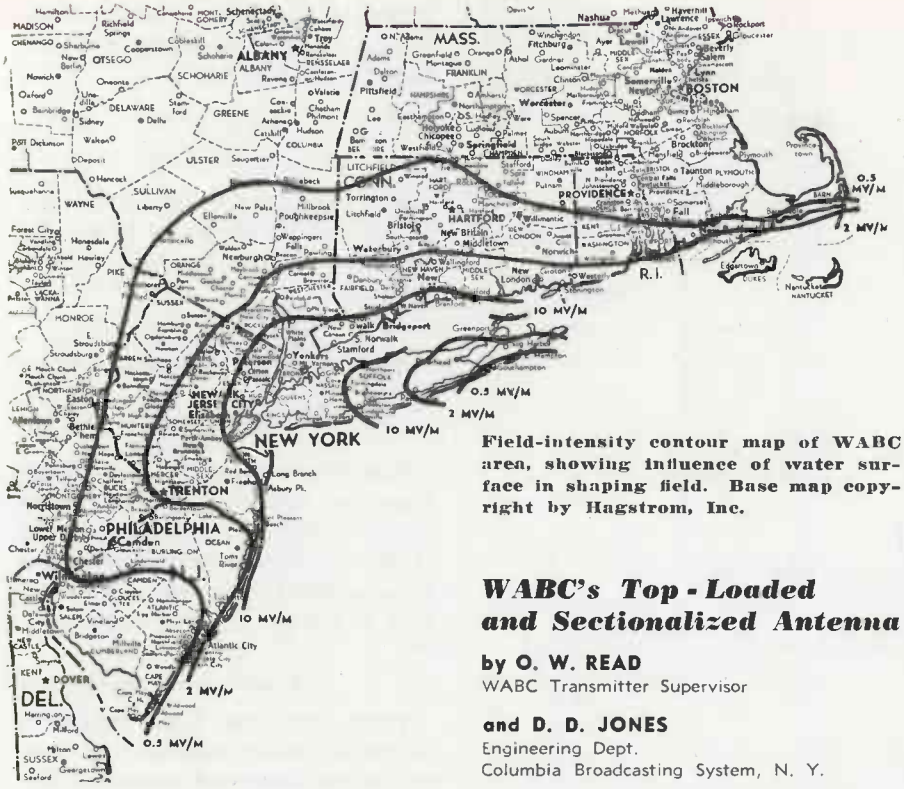
When the new Columbia Broadcasting System key station WABC was planned and built less than two years ago, it was considered a novel experiment from the standpoint of its island location, design of tower antenna, and general transmission equipment.

Located in Long Island Sound about fifteen miles northeast of Manhattan, New York, and about a mile off shore from New Rochelle, is the site of this man-made island of steel, concrete, copper and glass called "Columbia Island." Originally this spot consisted of only a few large rocks which jutted out of the water at high tide and constituted a navigation menace. The island location was selected for two major reasons, namely: It was the approximate center of population of more than eighteen million listeners in one of the most densely populated spots on earth. It also provided initial transmission over an uninterrupted salt water surface for a mile or two in all directions which is an engineering ideal that possibly could not be duplicated elsewhere.

Streamlined design

Above the tons of masonry and steel which make up this everlasting island costing $100,000 rises an unconventionally designed antenna 410 feet high surmounted by a "top-hat" 85 feet square and wider by ten feet than the base of the tower. This vertical type of construction was necessary because of the small size of the island the edge of which is less than fifty feet from the sides of the building. The 342 ton tower of steel was designed to withstand wind velocities exceeding 120 miles an hour and although many violent storms and high winds pass this little island the tower and antenna system staunchly remain unmoved. Even the concrete island is streamlined, its shore line being curved outward like a clipper bow so that the tons of salt water in the high waves which often crash against the retaining wall merely dash back on themselves and do no damage to the vital material on the "island."

Station WABC on its exclusive, isolated island home represents possibly the most expensively built broadcasting station in the world. Much of its equipment, at the time of installation, might have been



Field-intensity contour map of WABC area, showing influence of water surface in shaping field. Base map copyright by Hagstrom, Inc.

classified as luxury refinements, but the exigencies of the war, together with the superb manner in which the station equipment has met all wartime demands, is now seen to justify all the money thus expended.

Signal strength in the primary service area has been shown to be most satisfactory in every direction from the transmitter. Frequency response is essentially flat from 30 to 10,000 cycles with an overall harmonic distortion at 1,000 cycles of less than 1.5 per cent, at 7,500 cycles less than 5 per cent, using 95 per cent modulation. Hum level is exceedingly low, more than 60 db below 100 per cent modulation.

For two months after the station was opened it operated on a daily schedule of 19½ hours which provided for check-ups and adjustments while the station was off the air. Then came Pearl Harbor! Since then the station has been enlisted for unlimited, uninterrupted service round the clock for the duration. Luckily the engineers with skill and foresight provided in advance for just such an emergency. Complete breakdown of apparatus is almost an impossibility since numerous safeguards, duplicate circuits and duplicate equipment have been provided with every piece of vital apparatus.

WABC's Top-Loaded and Sectionalized Antenna

by O. W. READ
WABC Transmitter Supervisor

and D. D. JONES
Engineering Dept.
Columbia Broadcasting System, N. Y.

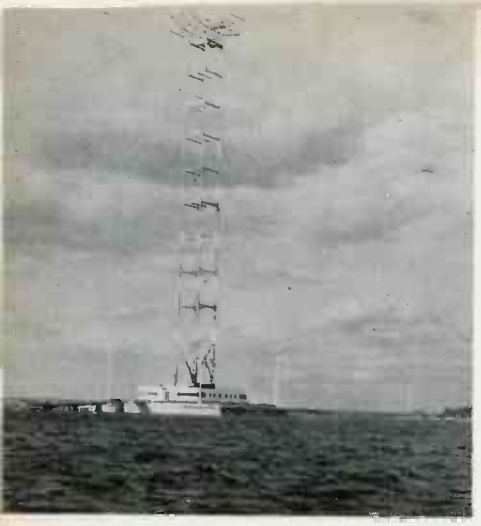
The WABC transmitter installation on Columbia Island in Long Island Sound opposite New Rochelle, N. Y., is one which incorporates many unusual, unconventional and novel features of engineering design.

One of the most interesting features is the top-loaded and sectionalized antenna and this article will deal with its several mechanical and electrical characteristics.

In general the tower is one of the so-called "suppressed" type which has the electrical length of a 190-degree tower with a physical height of approximately 132.

The Octagonal steel latticework at the top forms a large capacitive area to ground and is insulated from the main body of the tower by means of four sectionalizing insulators. A positive reactance is inserted between the tower proper

Base insulator for tower, transformer for tower lights and searchlight. Below —Control room for WABC transmitters —the 50 kw main unit and the 5 kw standby outfit for emergency operation



The top-loaded antenna tower, shown pictorially, and in engineer's elevation sketch revealing features of design and construction. (Fig. 1)

and the "top hat" and loads the system about 58 degrees to make up the difference between the electrical and physical dimensions at the operating frequency of 880 kilocycles. The combined effects of the top hat and series loading gives the desired current distribution and low angle of radiation.

The overall height is 410 ft. at mean low water and since the form of the tower is square in cross-section, being 25 feet on each side, the slenderness ratio is about 16.4:1. This is not optimum of course, but it makes for a very stable structure in a location where the wind forces are sometimes enormous.

Effective height, radiated power

The effective height of an antenna is given by the equation:

$$h_e = \frac{e\,d}{1.25\,f\,I}$$

where H_e = effective height in meters.
e = field intensity in microvolts per meter.
d = distance from antenna where e is measured (in kilometers).
I = antenna current at current antinode.
f = operating frequency in kc/sec.

At a power input of 50 kilowatts to the WABC antenna, the antenna current I is 22.2 amperes, distance d is 4.7 wavelengths or 1.6 kilometers and e has been measured at 1670×10^3 microvolts. (Note). The radial on which e was measured is over a path of sea water so that the absorption factor Ka may be put at unity and the effects of attenuation considered negligible. So that h_e becomes,

$$h_e = \frac{267 \times 10^4}{243 \times 10^2} = 109 \text{ meters.}$$

Having determined the effective height in terms of known power input and measured field intensity it is of interest to compute the theoretical field intensity along the ground plane to verify the measured results.

At distance d (1.6km) the field intensity is

$$\epsilon = 377 \times 10^3 \frac{h_e I}{\lambda d} K_a$$
$$= 377 \times 10^3 \times 4.44 \times 1$$
$$= 1{,}658 \times 10^3 \text{ microvolts.}$$

Which shows excellent agreement between measured and computed values.

The radiation energy W_r from an antenna is based on either of the following expressions for the electric or magnetic components in the equatorial plane,*

$$W_r = 0.0111\ d^2\ e^2 \text{ watts}$$
or
$$W_r = 5 \times 10^{12}\ d^2\ H^2$$

Substituting the effective value of the electric vector of 1670 millivolts for ϵ in the first equation W_r becomes,

$$W_r = 0.0111 \times 1.6^2 \times 1670^2$$
$$= 79{,}000 \text{ watts.}$$

The radiation resistance R_r is then,

$$W_r/I^2 = 79{,}000/22.2^2$$
$$= 161 \text{ ohms.}$$

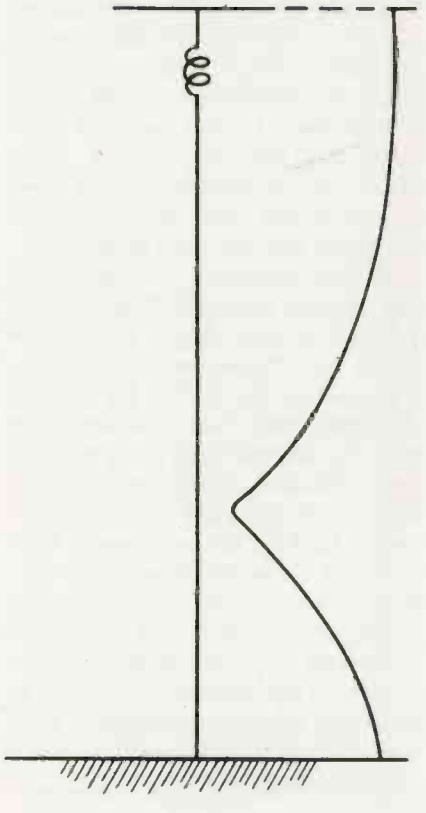
The WABC antenna then clearly shows an apparent gain of power of 79,000/50,000 = 1.6 times (2db) in the equatorial or ground plane by effectively reducing the radiation of energy at high angles.

Tower and insulators

Four rigid type Lapp insulators of special design support the tower on its sub-base and these are designed for safe loads to 390,000 pounds tension, 520,000 pounds compression and 20,000 pounds in shear. The mechanical safety factor of the insulators is 3 which is extremely conservative design. They stand 74 inches overall in

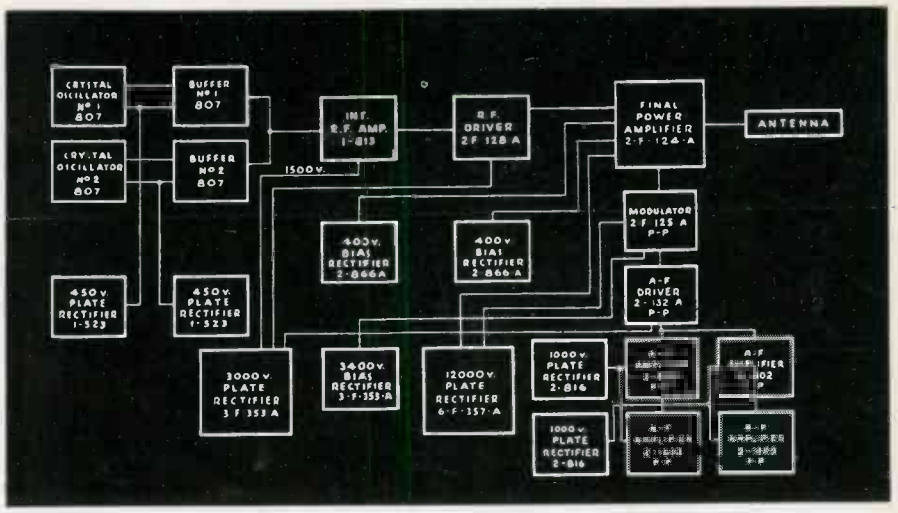
*Hund. A. High Frequency Measurements First Ed. 1933

Fig. 2. Antenna characteristic



height and weigh 2000 pounds each. These insulators withstood flash-tests up to 76 kilovolts dry and 43 kilovolts wet and in normal operation at 50 kilowatts the peak modulated rf potential is in the order of 9.5 kilovolts across the base insulators so that there is a very wide margin of safety.

Each supporting leg of the tower rests in an individual 250,000 pound block of concrete which is poured, reinforced and locked in the bedrock of the island.



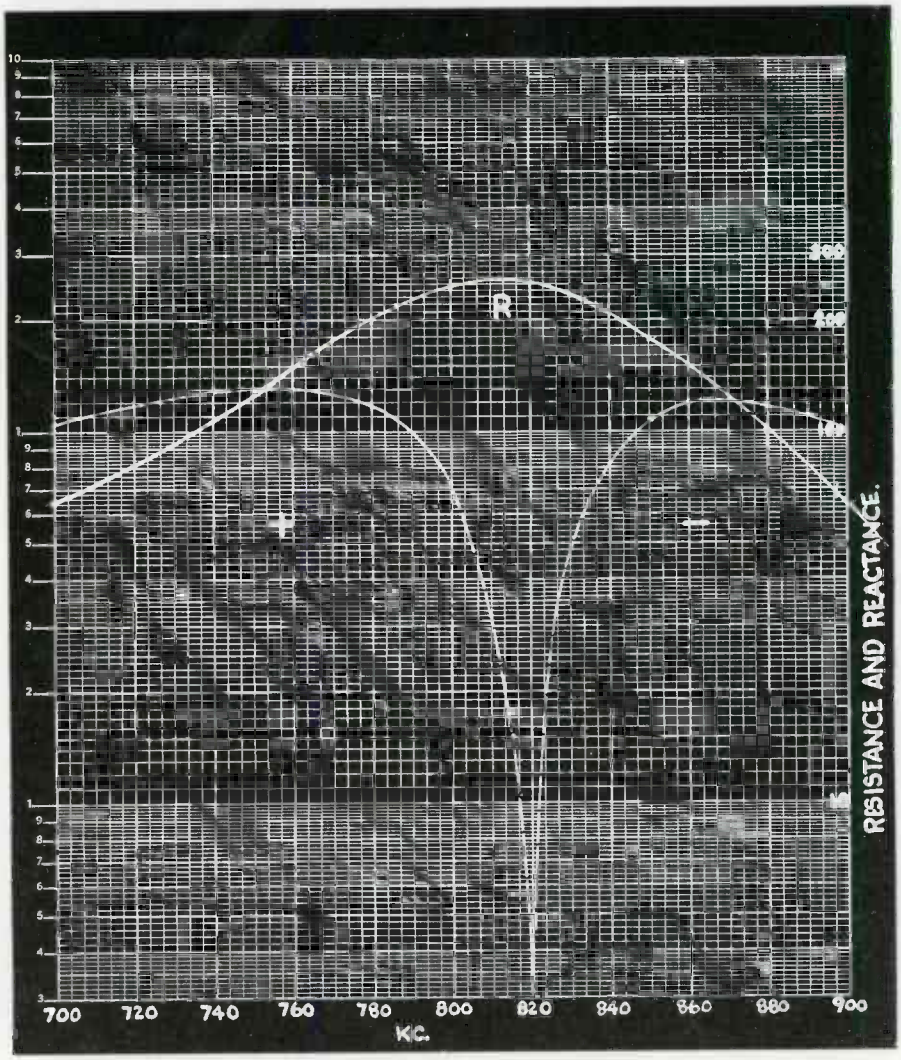
Block diagram of WABC transmitter layout

Ground system

Most radio towers, being of necessity located in alluvial bogs and salt marshes or other high conductivity terrain, must be erected on footings which are at best a compromise. The WABC tower is an exception to this rule with the structural requirements of the tower being satisfied with a bedrock foundation and the propagational needs satisfied by the almost ideal characteristics of salt water, which has a conductivity in e.m.u. of about 5000 x 10^{-14} as compared to about 2 x 10^{-14} for the land bordering Long Island Sound. Locating the transmitter on an island also simplifies the ground system problem. Where it would be customary to extend at least 90 radials from the ground screen at the base of the tower out to a distance of $\lambda/2$, the ground system at Columbia Island consists of 30 radials of #4/0 soft drawn copper wire extending out to a rather irregular acquisition line for an average distance of about $\lambda/4$.

The exterior of the building is completely sheathed in diamond mesh copper screen, and at the soil line, this mesh connects to 90 radials, 60 being No. 6 copper wires which extend to the bulkhead water line and the balance are those which go out into the water.

Fig. 3. Chart of resistance and reactance for WABC antenna



Adjustment of the open wire line

Tuning of the tower is accomplished by means of an unbalanced single conductor open wire line which is mounted on 12 inch insulators along the entire length of one tower leg. The line is adjusted by movable shorting bars, one of which is located near the top and the other not far from the base.

As previously explained, a positive reactance connects in series with the tower itself and the top-hat. This would ordinarily be done with a loading coil but practical consideration involving tower location, icing conditions, and experience with other installations plus the desire to mount a high frequency FM antenna on the top-hat made that form of loading undesirable, and so in substitution for a lumped inductance, the reactive upper end of the open wire line is used.

Adjustment of the upper loading bar was made by simultaneously

(*Continued on page* 153)

Materials and Construction of SPEECH BROADCAST Studios

by LONSDALE GREEN, JR.*

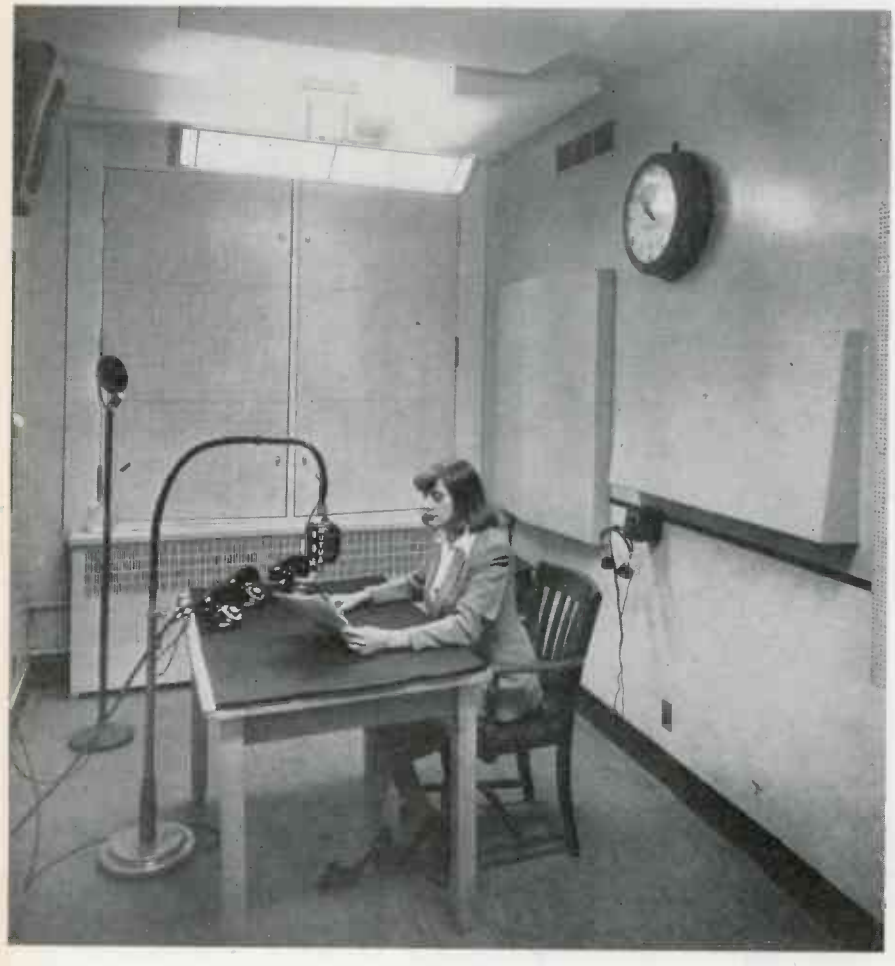
Acoustic treatment given new WOR studios, New York, to produce lifelike reproduction of speakers' voices

The principal objective outlined by Edward J. Content, ass't chief engineer WOR, for his new speech studios was that they "should sound as though the person speaking in the studio, was actually in the room in the home." This result has been attained by adjusting the studio characteristics so that they do not materially change the quality of the speaker's voice. The remarkable fact is that proper acoustical characteristics of the studio improve the reception by all types and grades of radio receivers, regardless of their frequency characteristics. In what follows I shall endeavor to show how, through the use and arrangement of acoustical materials, this objective was accomplished.

About six years ago the Johns-Manville Research Department, at its acoustical laboratory, started work on the development of special sound-absorbing treatments to be used primarily in broadcasting studios, audition rooms and similar spaces. This research resulted in the development of three types of acoustical treatments known as High Frequency, Low Frequency and Triple Tuned Elements.

*From a paper presented before the New York Section of the Institute of Radio Engineers, April 7, by the author, who is Fellow, Acoustical Society of America, President, Acoustical Construction Corp., New York, Professional Engineer, State of New York, and a graduate of the University of Illinois.

WOR's Studio 11—one of three used exclusively as speakers' studios



Three treatments

These three treatments are all composed of rock wool of different densities and thicknesses, used in conjunction with diaphragms of various densities and weights, and all in turn covered with perforated transite. The transite is used as a protective covering material, presenting a hard finished surface, readily capable of maintenance, decoration and repair. Perforated transite also has the acoustical property of proportionately greater reflection of sound for the frequencies above 2000 cycles, as compared to the frequencies from 2000 cycles down.

The actual laboratory sound absorbing values of these three treatments are as follows:

	128	256	512	1024	2048	4096
High Frequency Element	.20	.46	.55	.66	.79	.75
Low Frequency Element	.66	.60	.50	.50	.35	.20
Triple Tuned Element	.66	.61	.80	.74	.79	.75

Chart 1 shows graphically the sound-absorbing characteristics of these three materials. The Low-Frequency Element has a sharply descending curve as the frequency rises, the High-Frequency Element has a sharply ascending curve as the frequency rises and the Triple-Tuned Element has, for a commercial acoustical material, a curve which has a fairly uniform or flat characteristic over the frequency range. It might be considered as the product obtained by combining the other two treatments.

By adjusting the amounts of these three materials on the interior surfaces of any studio, it is readily

seen that the contour of any time-frequency curve can be controlled and adjusted to any desired condition.

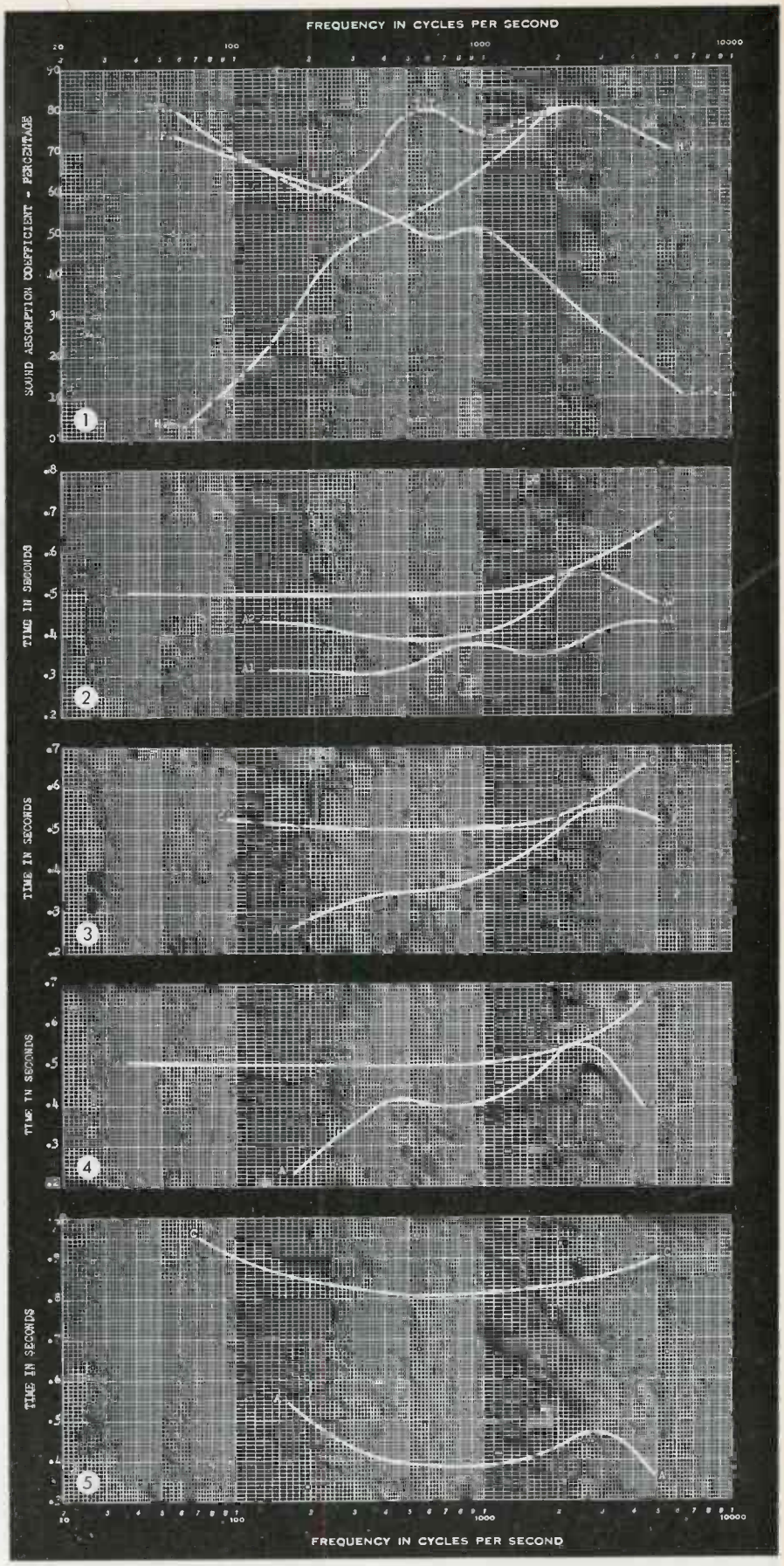
The studios to which Mr. Content referred are WOR studios 8, 9 and 11, on the 24th floor of the building at Broadway and 40th Street, New York City. In estimating the desirable time-frequency curve, we originally believed that we would like fairly flat absorption characteristics up to about the 1000-2000 cycle range, with a rise in reverberation above that not to exceed about 25 per cent of the actual reverberation time. We even believed that a small drop at the low-frequency end would be permissible and in fact might even be desirable. We afterwards found that this was very desirable and we believe that it is because of the extremely low reverberation time below the 500-cycle range that we are able to get away from the "boominess" of the male voice which is so evident in most speakers' studios.

All studios are finished with plaster walls and ceilings, linoleum floor, speaker's table, two microphones and two chairs. Studio 8 had in addition at the time the tests were made, a studio grand piano.

Chart 2 shows the calculated time-frequency curve and the actual time frequency curves which were obtained by tests with a high-speed level recorder, in Studio 8. Curve C, the broken line, is the calculated design curve. Curves A1 and A2 are the conditions as determined by two test runs made with the high-speed level recorder. Curve A1 is the result when the microphone was placed directly in front of the speaker source and about two feet away from it, both near the center of the room. Curve A2 is the result when the mike and speaker were placed back to back, about two feet apart and facing opposing walls.

Decay time

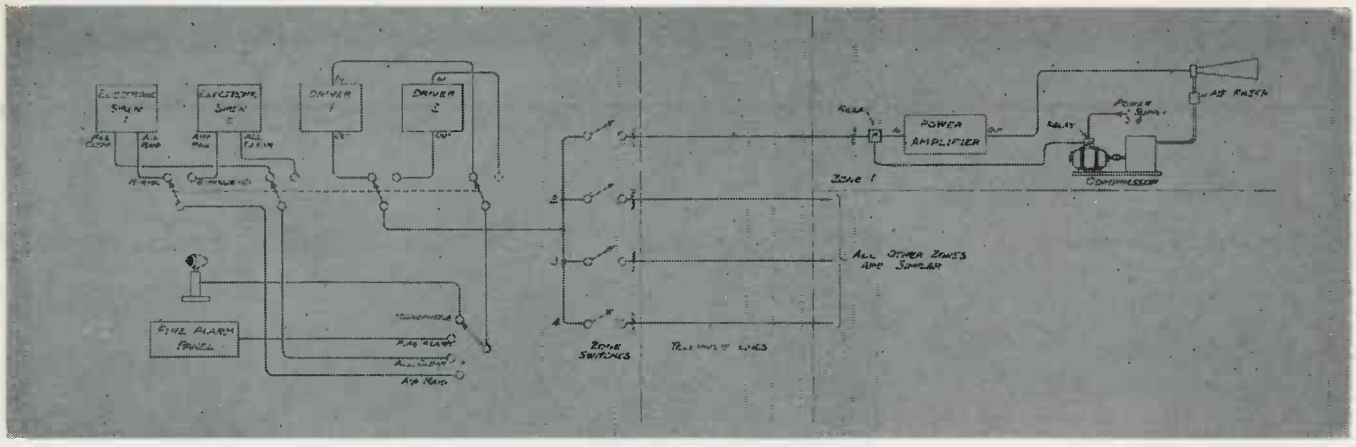
Decay-time records were obtained with the Johns-Manville high speed level recorder. The sound sources were Bell Telephone Laboratories records BTL 108 and BTL 175. These are warble records over the following ranges, cycles per second:



160-250, 260-500, 500-1000, 1000-2000, 2000-3000, 3100-5400.

The warble was rapid, approximately 7 warbling cycles per second. Regular studio loudspeakers and pickup microphones were used with their associated amplifiers.

(*Continued on page* 155)



Block diagram showing overall features and assembly of the combined system

★ *Radio-Electronic WAR PRODUCTION*

SOUND COVERAGE for AIRPORTS

by ALLEN A. SYLVANE
Commercial Radio Sound Corp.

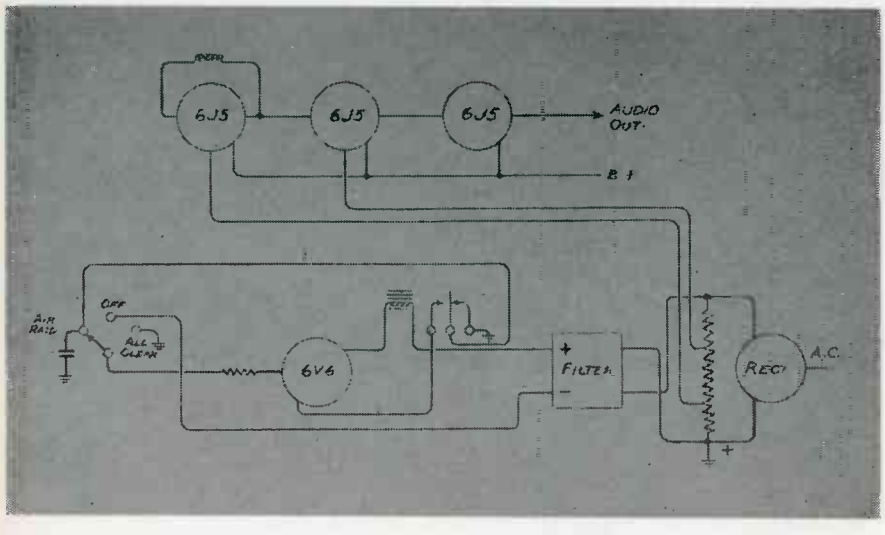
How Dilks fluid-flow transmitter is used to deliver signals and speech at levels from 120 to 130 decibels

Of major importance to our national safety and defense, is the provision of air fields and other strategic locations with an adequate and dependable system capable of transmitting strong sound warnings during air raids. Of perhaps equal importance is the fire alarm system guarding the air fields in their respective locations.

To meet the demand for this need, there has been introduced in service a system of sound amplification and control in which the transforming medium that is employed, instead of using a customary electro magnetic diaphragm, utilizes the principle of pressure fluid flow through an ingenious, compact device consisting of rotor and vanes, coupled to a well designed horn. The essential difference between the conventional loudspeaker and this newer principle is that the older method uses stretched membranes or diaphragms as associated with common horns or dynamic cones, obtaining their pressure only from low voice energy or "audio-power," whereas the latter idea derives its increased intensity by the uniform feed of compressed air applied directly into the transforming unit.

This pressure characteristic is the basic principle of the Dilks fluid-flow transmitter now being used with great success at a naval air station adjacent to the eastern seaboard, the location of which cannot, at this time, be divulged.

Basic circuit used to simulate mechanical siren

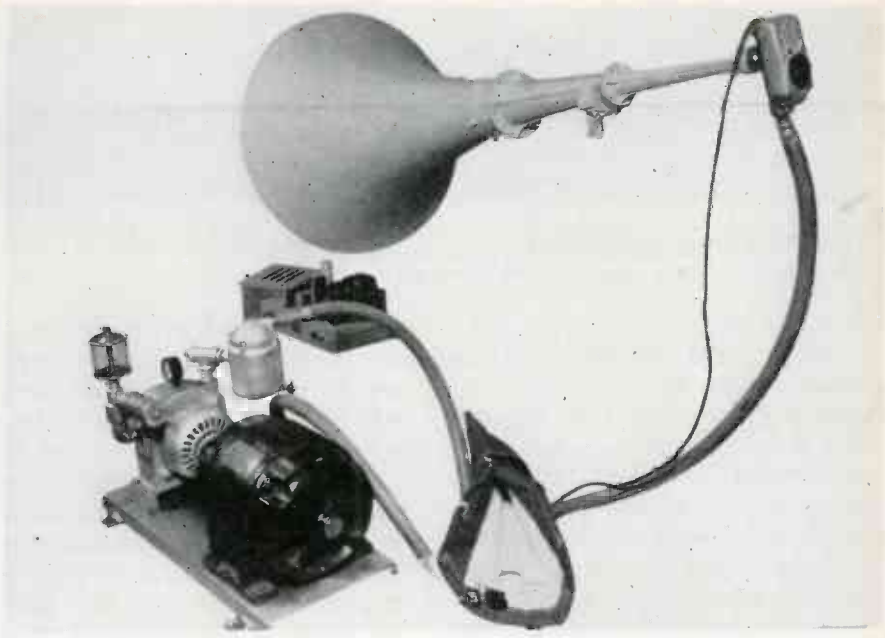


Acoustic power

To realize the magnitude and intensity of the sound output from this type of transmitter, the following comparisons may be cited:

(a) In order to equal in volume the power output of the Dilks transmitter it would be necessary to use approximately 150 conventional loud-speakers, each taking about 20 watts, or . . .

(b) Instead of 20 watts which the Dilks transmitter might use to



Above—Main control panel. At right—The Dilks loudspeaker unit, showing compressor pump, air hose, and modulator element feeding horn

cover a given area, it would require 3000 watts of audio power to equal the two in volume, or . . .

(c) On the particular installation here referred to where 250 watts were used, it would have required about 37,500 watts, or 750 standard 50 watt power amplifiers.

The unit employed in the Dilks transmitter is likened to the human larynx, in that this membrane has one slit formed by a pair of lips which are set in vibratory motion when air from the lungs is forced through them. Following this "acoustical law of nature," the Dilks transmitter, which substantially is a "mechanical larnyx," utilizes a plurality of slits and reeds. The combined area of the slits, or "quick-action valves" is approximately ⅛ square inch with a maximum amplitude of motion equaling about 0.002 inch.

Pressure and velocity

In the design of a loud-speaker, it must be borne in mind that pressure and velocity are two of the major forces required. The common diaphragm principle depends upon acceleration for pressure increase . . . which is never constant . . . but pulsates in unison and conformity with input surge of voice energy or audio power. However, when the transforming medium is designed upon the reed principle and so arranged to accept and utilize an auxiliary fluid-flow under pressure, then the entire operating condition and corresponding results in sound amplification are changed and the output is multiplied to a definite enlarged degree.

The system used at this air station combines the following features:

1. Microphone announcements.
2. Air-raid and all-clear alarm signals generated by an electronic siren.
3. Fire alarm signals from automatic coders.
4. Music for special occasions.

The block diagram gives a general idea of the overall feature and structure of the combined system.

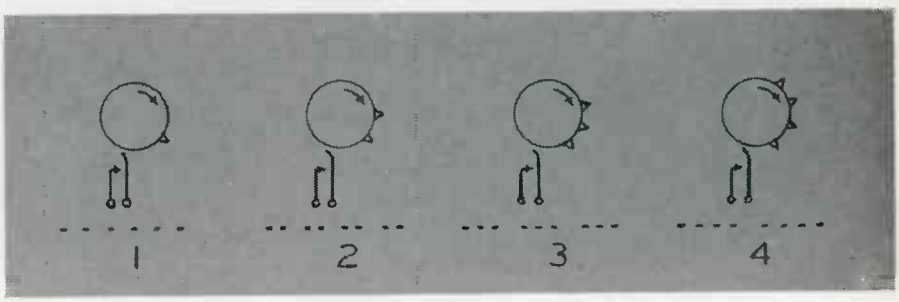
A second diagram shows in block form the basic circuit used to electronically simulate a mechanically driven siren. Although no details of the circuit are permitted to be given now, the manner in which the effects are accomplished may be described briefly, for a better understanding of it.

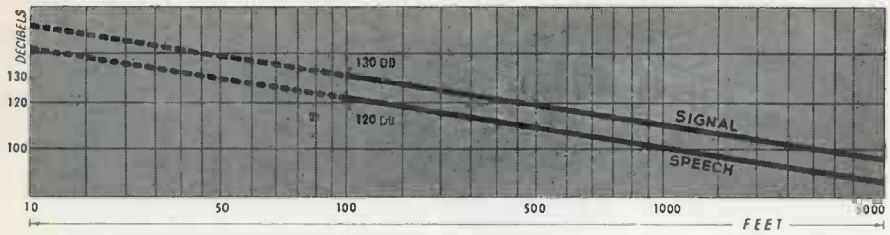
The first type 6J5 tube in the circuit is connected to a conventional oscillator. The second and third type 6J5 tubes serve as audio amplifiers to increase the level of the siren to a value suitable for line transmission. The gain of these two tubes however, is controlled by taps from a bleeder resistor which is actually in series with a relay in the plate circuit of the type 6V6 tube. This latter tube thereby acts as the "timer".

"Alarm" position

When in normally—"Off Position"—type 6V6 tube is biased to plate cut-off so that no current flows through the relay. In "Alarm" position, the grid of the 6V6 "timer" is made less negative, thus causing plate current to flow through the relay coil and through the bleeder resistor. When the plate current reaches a fixed point, the relay pulls up and biases the tube again to "cut-off" . . . releases the relay . . . and starts the process all over again. The result is a rising and falling—warbled signal, familiar to anyone who has heard a mechanically driven siren. (*Turn page*)

Automatic coding wheels for fire alarms





Intensity levels in open air at distances shown. Measurements made with GR 650B sound meter

It was found necessary to automatically bias the 6J5 amplifier tubes in order to increase the volume of sound at the high frequencies and decrease it at the lower frequencies because this latter effect is also characteristic when listening to motor-driven sirens.

In "All-Clear" position—the grid is made positive—the relay is held operated, and so a constant, sustained note (the crest of the air-raid signal) is maintained.

One of the illustrations shows the main control panel, upon the top of which are mounted four hooks for giving fire alarms. When any of these hooks are pulled down, and released, this action sets an automatic code wheel into operation which pulses an audio signal according to a prearranged code (see Chart) giving the location of the fire, the air field being divided into a number of zones.

Six-foot trumpet

Each transmitter, as shown in the block diagram, is connected to its own conventional 6-foot trumpet. The compressed air used in the transmitting unit is obtained from a compressor driven by a 1½ hp. motor. The audio power amplifier supplies 20 watts for its operation. A sound level of 127 decibels at 100 foot input of this unit was obtained in actual operation. An interesting example of the effect of the velocity of sound in air is observed when standing 1000 feet away from one zone transmitter and about 5000 feet away from another zone transmitter; the two signals are clearly heard, but with a lapse of about four seconds between units, indicating the slowness by which sound travels—approximately 1,100 feet per second in free air. The output horns are located on top of the highest buildings in the air field and the compressors, amplifiers and starting equipment are installed within the building, the air lines being connected by tubing. Provision is made to prevent freezing at very low temperature by incorporating a heating element within each mechanism. Any disruption of operation of one zone will not affect the operation of the other areas. General announcements can be made to any one or all four zones simultaneously. Air raid and fire alarms are reproduced to all locations at the same time.

Control features

The complete operation of the system is from the control room located at headquarters on the air field. A switch on the main control panel is provided for each of the four zones, which when operated, starts up the compressors and amplifiers at the particular remote location. A "timer" is provided to indicate, by means of a "ready" signal, when the compressors have come up to speed and the amplifiers are heated and ready for operation. The control circuits are direct current which is brought to the field over the regular telephone lines. Two direct-current power supplies are provided for emergency purposes.

A normally-operated relay allows one of the power supplies to remain in circuit and upon failure of voltage, due to any defect or cause, automatically switches the second reserve unit into action, thus assuring continuity of service. Both the siren generators and driver amplifiers are also duplicated so that in case of failure of one there will be no interruption of this service either. Audio circuits from driver are balanced 500 ohms zero level, and are supplied over telephone lines.

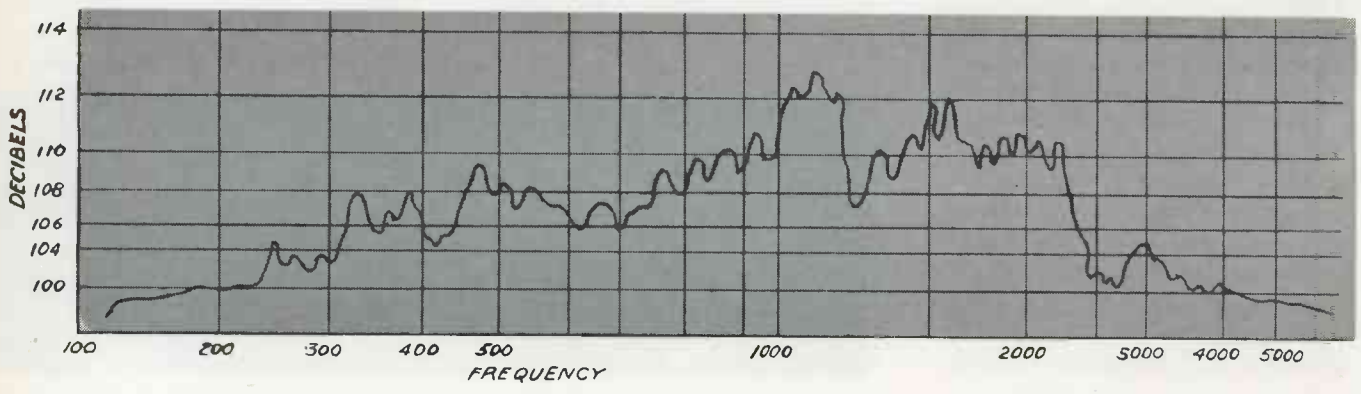
WHAT THIS AIRPORT SOUND SYSTEM DOES

At sound levels of from 120 to 130 decibels, exceeding the noise of airplanes and reaching intensities that cross the threshold of actual pain, this airport sound system can be used to

1. **Make voice announcements from a microphone**
2. **Produce air-raid and "all-clear" alarm signals generated by an electronic siren.**
3. **Deliver fire-alarm signals produced by an automatic coder**
4. **Deliver music for special occasions**

The present system therefore has a far wider range of application and usefulness than the customary public-address system or siren alarm.

Response of air-flow speaker at various frequencies



★ *Radio-Electronic WAR PRODUCTION*

VACUUM RELAY for AIRCRAFT Antenna

by FRANK S. McCULLOUGH
Radio Research Dept., Bendix Aviation, North Hollywood, Calif.

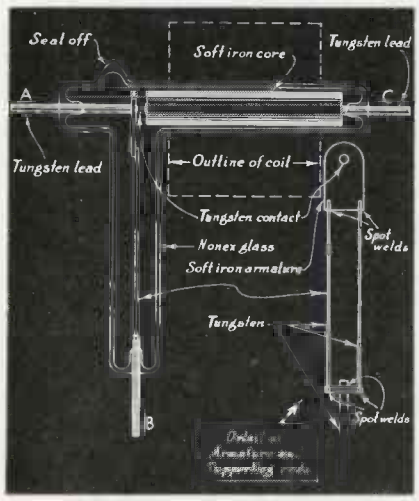
Complete relay, showing size and compactness

To the considerable amount of radio-communication and direction-finding equipment needed in a plane, are now being added new devices of all descriptions. But this equipment, essential as it is, still adds weight and uses space that could be used to carry gas tanks or bombs; hence, there is the problem of making such additional equipment occupy the minimum amount of space and weigh as little as possible. One such unit calling for careful design is the antenna switching relay.

The purpose of this antenna relay is to switch the aircraft's antenna from the receiver to the transmitter. This similar function in ground stations does not present such difficulties because the limitations of space, weight and better antennas, etc., are less rigorous. In some military aircraft operation the use of frequencies from 200 kc to 500 kc, working at altitudes of 30,000 feet into electrically short antennas, is a source of many difficulties.

Voltages up to 20,000 have been encountered; this particular voltage occurred in a transmitter of 75 watts tank power at 314 kc, working into an antenna 40 feet long. The effect of the reduced pressure at 31,000 feet is to increase the required spacings necessary to withstand these voltages by many times. In fact, at this altitude it may take three to six times the spacing required at sea level, to prevent arcing. Since corona stands out from all sharp surfaces, large, smooth contours are necessary; but to increase spacing and size of units results in large, heavy, cumbersome units.

Section through vacuum chamber



Air is good dielectric

It is a known fact that a good vacuum is an excellent dielectric, but it is equally a fact that a poor vacuum is worse than none at all. This is due to a combination of voltage gradient and the mean free path of the electrons necessary to ionize the gas in the intervening space. Though a pressure of a few inches of mercury can hardly be considered a partial vacuum, the reduced pressure at 30,000 feet is decidedly a poor vacuum. Further complicating the problem is that break-in is highly desirable due to the speed of present conditions But, because of the large spacing needed to stop the considerable voltages built up, the relays become large, complicated and quite slow.

Space-weight limitations

Some time ago for a proposed aircraft transmitter the field of existing antenna relays was investigated. The requirements of break-in, space limitations, safe voltage handling, speed of switching and weight were such that no existing units were suitable.

Keeping in mind the foregoing requirements, the design of a relay using a vacuum for the dielectric was undertaken. This development was carried on in collaboration with the engineers of Eimac.

The unit, in addition to the operational requirements, should be easily fabricated of parts readily obtainable. Also, the parts should be few to facilitate the evacuation process. By pumping the tube hard, that is, not using a getter and using only a minimum of parts, a unit was produced that has overcome many of the disadvantages of previous relays.

The envelope is nonex glass and is ½ in. in diameter and each arm is about 3½ in. long. The coil surrounds one glass arm which encloses a soft iron core. The long arm, at right angle to this core, is the transfer or switching arm. Two

tungsten rods carry a soft iron armature which in turn carries the transfer contact. The short arm is a piece of tungsten rod on the same axis as the core and spaced from it. In use, the armature, by virtue of the spring tension of two tungsten rods, is forced against the short tungsten rod contact. Upon being energized, the coil induces in the core sufficient flux to attract the armature to it. A tungsten rod runs through this core; this performs two services, to support the core and to act as a contact.

Switchover action

In service as an antenna relay, the armature or transfer arm is connected to the antenna; the short contact upon which the armature rests when idle is connected to the receiver, while the core contact is connected to the transmitter. Upon energizing the coil, the armature is attracted to the core and transfers the antenna circuit from the receiver to the transmitter. In the idle position the spring pressure is sufficient to withstand a vibration of 10 G's. This is similarly true in the coil energized position. To further aid this, the unit is mounted in the ship so that the plane of the transfer arm is parallel to the earth's gravitational pull. The space the armature has to travel is very small—approximately .017 in.; and since the armature has very little mass, the transfer is accomplished in a very small space of time.

Because the coil is operated from the ship's battery and has one side grounded and high rf potential runs through the center of the coil, the voltage stress between core and coil is very great. Due to the charge existing near the coil, great care must be exercised in its impregnation. All air spaces must be replaced with some substance other than air; in this instance the coil and entire unit are treated with Harvel 612C varnish. This impregnation process is quite lengthy but is required due to the critical conditions of operation. Such problems as moisture on the glass will cause undue corona and leakage which is also reduced considerably by the impregnation process. The contacts to supply the coil energizing voltage are at the rear of the coil, removed from the vicinity of the rf potential.

In this Airplane Relay—

A vacuum provides the dielectric

There are no pivots or moving parts to wear

Contacts are sprung by deflection of tungsten rods

Contacts are impervious to dust, humidity, altitude, etc.

The large sphere contacts are necessary to connect the external wiring to the relay leads, to prevent arcing and corona at the junction.

Anchoring leads

The pillars beside each contact are for anchoring the leads so as to remove the wire pull from the glass.

The relay has successfully withstood voltages of 25,000 volts at 30,000 feet. Even this breakdown was external and not internal even though the distance was about 200 times greater through the air. Since conditions met in ordinary flight vary so greatly, this limit is too optimistic to use as a conclusive working figure. At lower voltages greater altitudes or greater voltages at lower altitudes could be attained.

The relay in the subject transmitter was keyed simultaneously with the oscillator to provide break-in. Because of the speed of the relay, the antenna circuit is completely switched before the power comes on; this is necessary for clean keying and also eliminates any tendency to spark.

In testing the relay, high voltages and low currents as well as low voltages and high currents at various altitudes were keyed. As an example, the unit will easily break eight amperes at low voltage with no sparking, and will break ten amperes with only slight sparking. In another test, 2 kw at 2000 volts was keyed very easily directly in the high voltage lead. With such characteristics the relay can be readily used in the positive high voltage lead to key a transmitter or similar applications.

In explosive gases

In instances where sparking might be dangerous to potentially explosive air or gases, the unit provides safe switching for innumerable purposes.

Due to the unit being enclosed, it is obvious that it is impervious to humidity, dust, altitude, etc. Also, since the springing is done only by a deflection of tungsten rods, there are no pivots or parts to wear or to require adjusting. The coil form shown was designed to handle coils from 6 volts dc to 110 dc and requires about 6 watts at any one of many voltages and is good for continuous duty.

The magnetic circuit, not being completed, is obviously less efficient than a closed circuit but the following consideration led to this design.

By placing an L bracket around the coil to help close the circuit would bring the ground too close to the rf field. When the unit is above 20,000 feet with voltages of 20,000 or so, arcs from the antenna contact to this iron would occur. Arcs two and three inches long are common in such uses. However, a decrease of about 18 to 20 per cent in current could actually be obtained by completing the circuit with this L bracket.

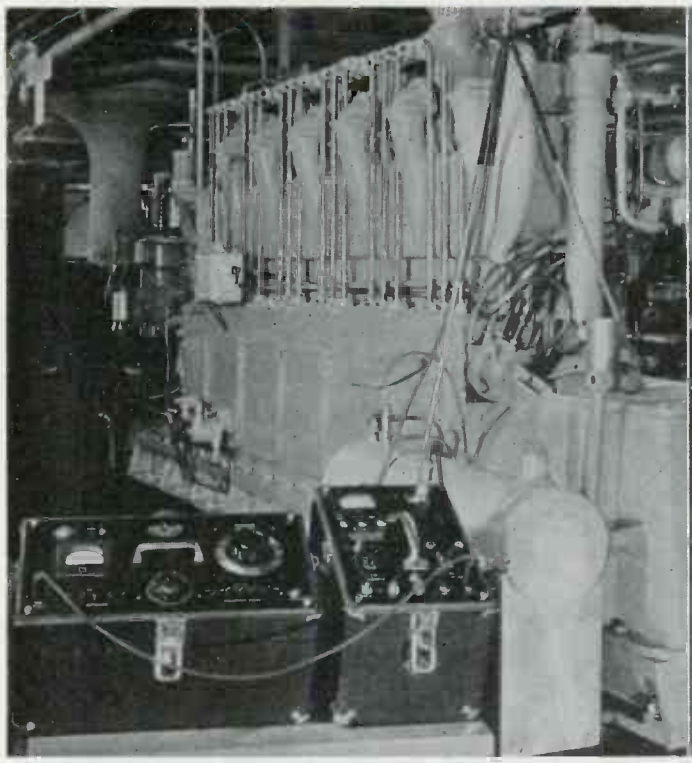
The unit weighs but one pound, fourteen ounces, and the space requirements are but 2⅝ in by 5⅝ in. by 6 7/16 in. overall.

The Electronic Era

At one time military communications meant carrier pigeons and wigwag with flags. But now the electrons have pushed the pigeons and flags back so far that we don't talk much about them any more.—*Maj.-General Dawson Olmstead, Chief Signal Officer, U. S. Army.*

A businessman examines scientific ideas and products as a pearl fisher examines oyster shells, realizing that it is only by accident that a scientist or an oyster produces a pearl and that neither knows the value of a pearl when he has produced it.

—*Lyman Chalkley, Board of Economic Warfare*



Measuring the noise-level and frequency distribution of a Diesel engine with General Radio sound-level meter and sound analyzer

Analyzing the noise of an electric refrigerator in laboratory tests with a Western Electric recording sound frequency analyzer

TAKING GUESS WORK out of Sound Analysis

Modern instruments that measure frequencies over a wide range, for use in the laboratory and on the job

In all fields of human activity, the sense of hearing is an indispensable trouble indicator. When things "don't sound right" the chances are that something is wrong, possibly outside of the immediate field of vision. A fundamental principle of hearing is that, while fundamental tones are of a sinusoidal character, such notes become exceedingly monotonous after a short time. It is only by the overtones that a note has brilliance and character and becomes of interest, and so permits a diagnosis in trouble shooting.

For example, the noise of a plane flying overhead may be heard as a steady tone, but attempts to decide just what its frequency is, will be disappointing. The fundamental tones (and there may be many) are each accompanied by overtones with their own characteristic steepness of inception and amplitude. The propeller itself produces Aeolian tones, having ranges which will generally be independent of the exhaust noises of the engines. With all these complexities, the trained ear detects (generally without particular concentration on the part of the listener) slight divergences which may spell disaster if unheeded.

A General Radio Co. sound analysis set-up, illustrated, used in the measurement of noise level and the determination of its frequency components, is applied to the testing of a Diesel engine. For specific tests on some components of the engine, a vibration pickup is substituted for the microphone shown.

In an entirely unrelated and older field, the physician's stethoscope tells him when abnormal heart action is present. Here, training is required since the actual beats cannot be described in words. In fact, a more or less restricted range of tones have to be analyzed as they emerge from the other end of ear tubes—which do not make up a wide-band tone transmission system, to say the least.

Industrial uses

A list of the commoner industrial applications of noise analysis, as a means of diagnosing troubles, would fill pages. Seismic disturbances, detonation studies and engine strains, vibration at critical speeds, vibration of propellers, "wows" and flutters in film projectors and phonograph turntables, motor and generator hunting, and the multitudinous problems associated with music and its production, are only a few items.

Recording the sound-frequency characteristics inside a closed sedan

The utilization of these studies has been aided for years by the oscillograph, but in many cases the difficulties of deciphering the pictures have retarded its wider use. To get around these difficulties, sound frequency analyzers are becoming increasingly useful. These permit a "spectrum" analysis of tones that are steady in amplitude and harmonic content for a matter of two minutes at a time, the time taken to produce a permanent record of each component when a motor driven sweep is employed. The range may be checked, also, by manual operation, with particular study at certain points.

In the instrument of this type developed by the Western Electric Co. for wide industrial use, to obtain a complete and accurate picture of the frequency components of any sound or vibration, the sweep method of analysis is used. By sweeping through the frequency spectrum under consideration and recording the exact level of each frequency, it is possible to obtain a detailed analysis without incurring errors due to frequency fluctuations in the sound or vibration under test. Since the sweep and paper-drive motors are both of the synchronous type, displacements on the chart will correspond to fixed increments on the frequency dial, regardless of variations in frequency of the power supply.

Rapid recording needed

The sweep method requires a recorder which can accurately follow very rapid changes in level—too rapid for the usual glass-pen used in power plants and industrial practice. While the exact speed depends upon sweep rate, filter suppression and other factors, a minimum recording rate of 50 db per second is generally used. This high speed is accomplished by the special stylus and driving system without stylus overshoot which might be misinterpreted as a noise component or tend to confuse the true shape of the record.

Coverage of a wide decibel range on the chart is required for most analyses, a condition not readily met by voltage-operated recorders. A 50-decibel range is generally satisfactory and a uniform decibel scale is preferable in interpreting the records.

The record is made in from 30 seconds to 2 minutes, depending upon the frequency range covered —a small fraction of the time required when using an indicating meter. This time saving is of real value in tests in which it is impossible to maintain steady speed and load conditions for more than a short period, e.g. moving vehicles.

When used as an analyzer, frequency input is heterodyned to 50 kilocycles by a variable oscillator and the band-pass filter operates at that frequency. A demodulator reconverts the passed band to audio frequencies which are further amplified and rectified for measurement. The two ranges of 10-1000 and 100-9,500 cycles per second are each spread over 180 deg. rotation of the control dial.

Band-pass filter

For special requirements the analyzer can be modified to record harmonics up to 25,000 cycles. For low frequency analysis equipment operating as low as a four-cycle fundamental with a two-cycle filter pass band can be supplied. However, for ordinary use a band pass filter using a lattice network type of quartz crystal is employed. This has a substantially uniform response, 5 cycles wide, centering at the frequency to which the dial is set and suppressing frequencies outside of that range at the rate of approximately 45 db in the first 55 cycles.

This band-pass filter is the heart of the analyzer. The perfect ana-

lyzer filter would pass all energy in a frequency band of specified width and completely reject energy of other frequencies. Response within the passed band is relatively uniform and the suppression of frequencies outside the band is not affected by temperature. Band widths of 5, 20, 50 and 200 cycles are available, although widths of 2 and 10 cycles can be supplied if needed. Any three of the four standard band-widths can be switched in at will.

The output of the analyzer is connected to the graphic recorder which automatically traces on a chart the level of the particular frequency through which the analyzer dial is passing. With this permanent record to refer to, it is a simple matter to divide any sound into its frequency components.

Decibel scale

The recording unit traces on a chart the changes in frequency level applied to the input terminals. Levels are plotted on a linear decibel scale, with displacements proportional to the logarithms of the input voltage. The chart covers a range of 50 decibels on wax coated paper 4½ inches wide, 4 inches of which is utilized by the record. Changes in input level as high as 58 db per second are followed faithfully by the stylus. Several chart speeds, under control of a lever, take care of different operating requirements. Reference lines at 5 db intervals are marked on the paper as its passes through the recorder. These charts can be photostated for permanent record.

Three chart speeds are available under control of a gear shift on the panel, approximately as follows: 1/16 in. per sec.; ¼ in. per sec.; ⅞ in. per sec. The slow speed (1/16 in. per sec.) is normally used for the sweep analysis and with a 2 minute sweep motor produces a record about 8 inches long.

Jobs for the Frequency Analyzer

An enumeration of the commoner industrial uses of sound-frequency analysis would fill many pages, for the method has many applications in diagnosing troubles. Here are some of the uses frequently encountered:

Engine strains
Detonation studies
Vibration of critical speeds
"Wow" and flutters in screen projectors
Motor and generator hunting
Propeller vibrations
Compressor troubles
Building vibrations
Seismic disturbances

Most recently, an interesting application of this sound frequency analyzer is opening a new approach to the study of faulty heart action. The medical profession became interested after plant physicians at one of the country's largest explosives manufacturing companies tested its use as a possible method of accurately determining the degree of heart muscle fatigue on the part of workers in a particular section of the chemical works.

In explosives plant

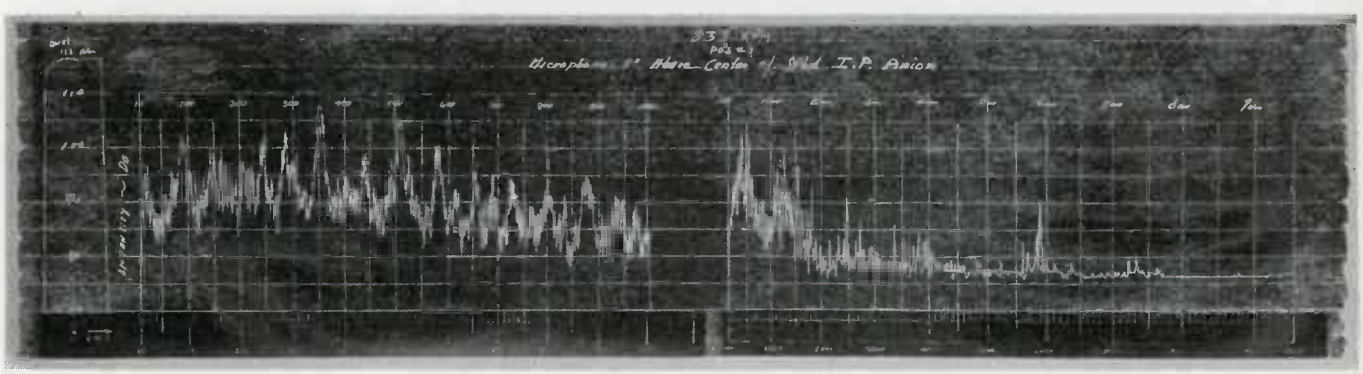
Employees in this department were unavoidably exposed to chemical fumes which caused fatigue of the heart muscles. When that fatigue reached a certain point it induced fainting. The medical problem required a positive method of determining the point at which fatigue of the heart muscles would bring about fainting and thus circumvent a possible explosion that might injure a number of men and wreck the plant if a worker fainted while handling explosive elements. The use of the stethoscope was highly unsatisfactory as the human element — the doctor's interpretation of the sounds heard—was not sufficiently definite. The sounds of a normal and unfatigued heart differed only minutely from those of a heart reaching the danger point of fatigue.

By using three filters, plant physicians found that they could chart the heart sounds of a worker before his exposure to the chemical fumes. These charts were compared with similar charts taken of the heart sounds of workers who had fainted from the fumes. By a regular checkup on all workers in the department and comparison of their charts with those showing the characteristics associated with fainting, the company physicians have been able to prevent further fainting, Workers whose charts show muscular fatigue are immediately transferred to other dements.

Use with cardiograph

How effectively and to what extent a sound spectrum record may be applied to the study of "heart cases" remains to be determined. The electric cardiograph reveals irregularity of heart action by graphically registering the comparative duration and intensity of the heart's movements. The degree to which duration and intensity of the heart cycle varies from the established normal helps to ascertain the seriousness of the irregularity. By running a sound analysis curve in conjunction with the cardiograph, physicians can now determine what part of the heart cycle is responsible for any abnormal heart action charted by the cardiograph.

The recorder tape below gives at a glance the intensity in decibels of all frequencies between 10 and 9500 cycles per second



WGAR's mobile pickup unit in action

RELAY LINKS in Broadcasting

by W. L. WIDLAR
UHF Engineer, WGAR, Cleveland, Ohio

Experience with 30-mc and 157.5-mc AM, and 161.1-mc FM, as pickup carriers

A relay station is a means of transmitting programs—and orders concerning them — from pickup points where wire facilities are not available, back to a standard broadcast station or network for regular broadcast transmission.

The extent to which such facilities have been put to use, may be surprising to some—as, for example, at WGAR, Cleveland, Ohio—where complete community coverage involves many behind-the-scenes facilities of the radio art. The whole relay plan can be compared to a complicated mechanism with little gears to make the big gear turn. Using its relay pickups, station WGAR is able to present, in short order, many emergency or special-event programs which cannot be broadcast by other means.

Starting in 1936, with a single relay transmitter and a receiver, WGAR's relay facilities have been gradually expanded to include three permanently installed transmitters with associated antennas, receivers, and measuring equipment. A block diagram of the present WGAR relay broadcast system is shown in accompanying sketch.

Original mobile-unit equipment

The first relay broadcast equipment was a 30-mc AM, 100-watt transmitter, mounted in a half-ton panel truck. The transmitter was powered with two constant-voltage, 350-watt, 115-volt, 60-cycle generators, belt-driven from the truck motor crankshaft. A shunt-fed quarter-wave vertical antenna was mounted on the truck roof. After trial of many types of 30-mc receivers, four fixed-tune crystal-controlled superheterodynes were built. The reliable range of the best combination of antenna transmitter and receiver on 30-mc AM was about two miles. Beyond this distance, ignition-noise interference from automobiles near the receiver, was a great problem. Many different antenna combinations and receiving locations were tried, without any noticeable improvement in signal-to-noise ratio. With receivers at our studio, transmitter plant, and two outlying locations, we were able to provide only fair coverage of Cleveland. This receiver installation was a complicated and expensive set-up, necessitated by a commercial program schedule which called for a fifteen-minute broadcast each school day, usually from the school playground or nearby park. The school broadcast, called "Vox Pop Junior," originated from a different location each day. The fixed-tune superheterodyne receiv-

Transmitter plant. 1480-kc main antenna on right. 1622-1480-kc antenna at center. 30,820-kc receiving antenna on roof at left

On-the-spot pickups. Above—broadcasting from scene of airplane crash in remote woods. Upper right—Reporting a conflagration in Sandusky. Lower right—Orson Welles interviewed while mobile unit speeds him to air field

ers were operated unattended by remote control over telephone lines.

In spite of the handicap of relatively short range, between 1936 and 1940, approximately 300 relay broadcast programs were transmitted by WGAR from the mobile unit.

Among the special events covered by the mobile unit, the following stand out:

President Roosevelt's Visit to Great Lakes Exposition—1936.
Airliner Crash—1938.
National Air Races—1938-39.
Cincinnati Flood—1937.
Main Avenue Bridge Dedication—1939.
Sandusky, Ohio, Fire—1939.
Orson Welles' Traveling Interview—1940.
Steamboat Broadcast—1941.

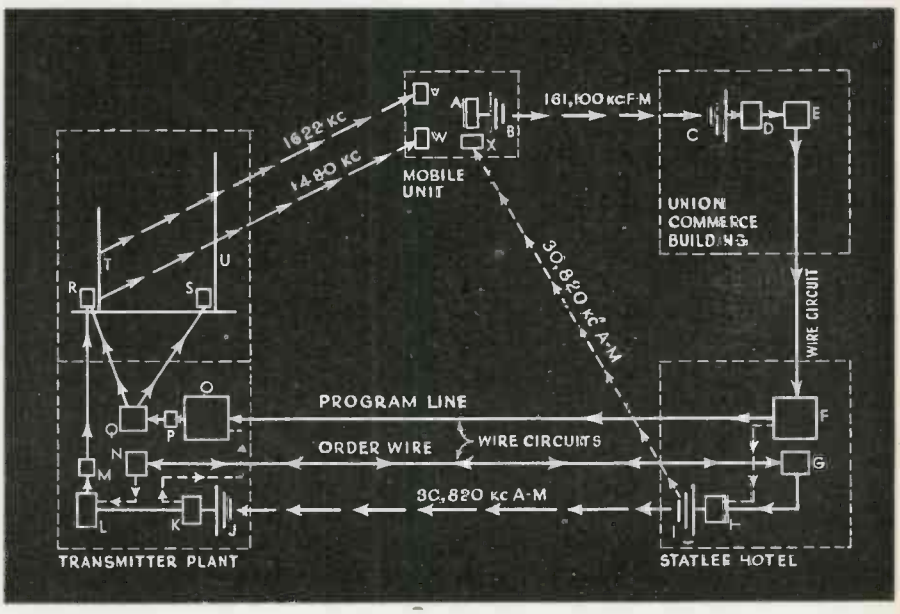
Talk-back transmitter

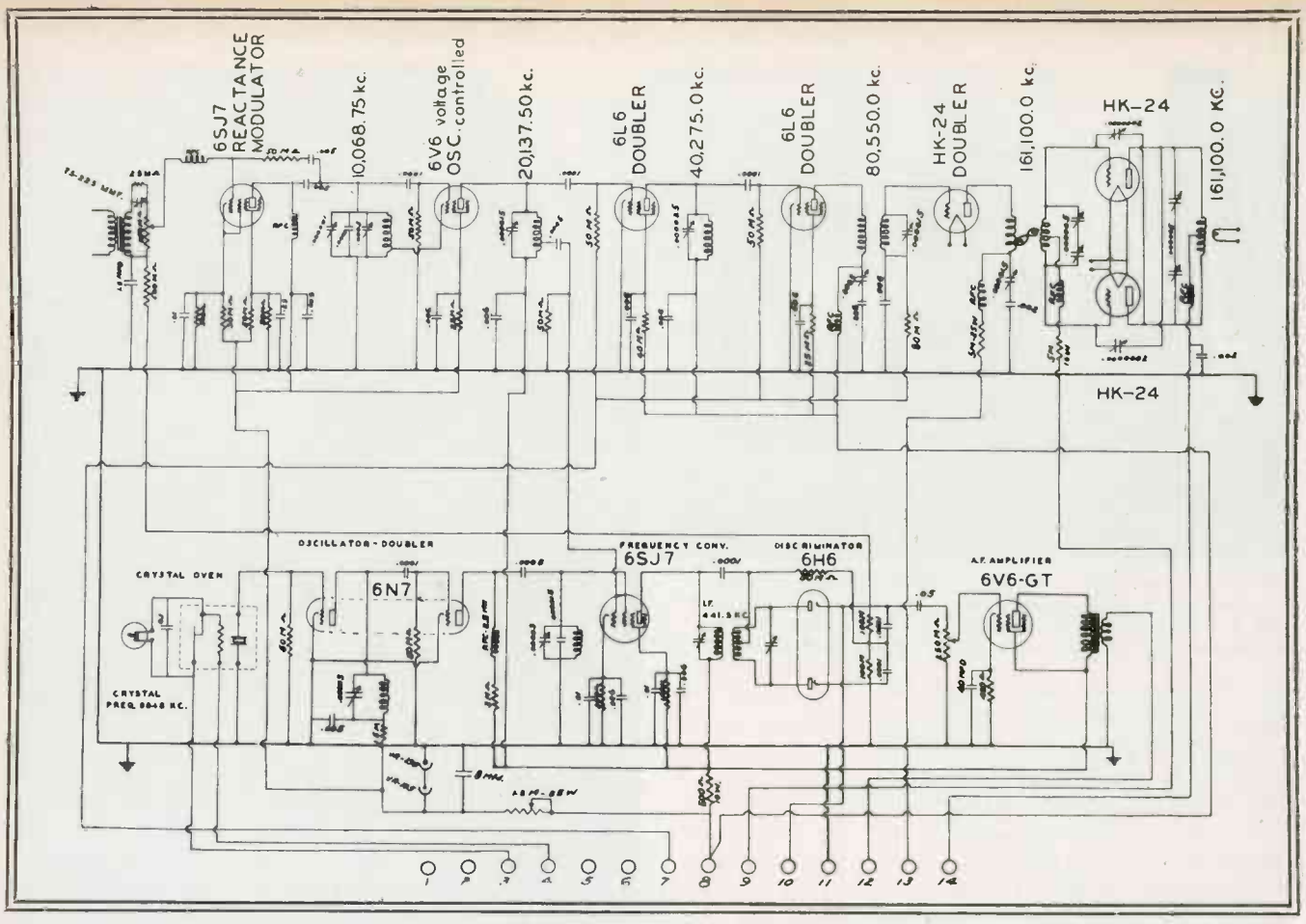
To improve our relay-broadcast service, a "talk-back" or communications transmitter was permanently installed at our transmitter plant. This is a 100-watt unit on 1622 kc, coupled to the reflector element of the directional standard broadcast array. Provision is made for operating this 170-foot vertical reflector antenna simultaneously, on 1622 kc and 1480 kc. The 1622 kc transmitter is normally connected through a spare telephone circuit to the telephone order-wire panel in the master-control room at the studio. This arrangement has given excellent results in providing two-way communication between the mobile unit and the master control room.

(Please turn page)

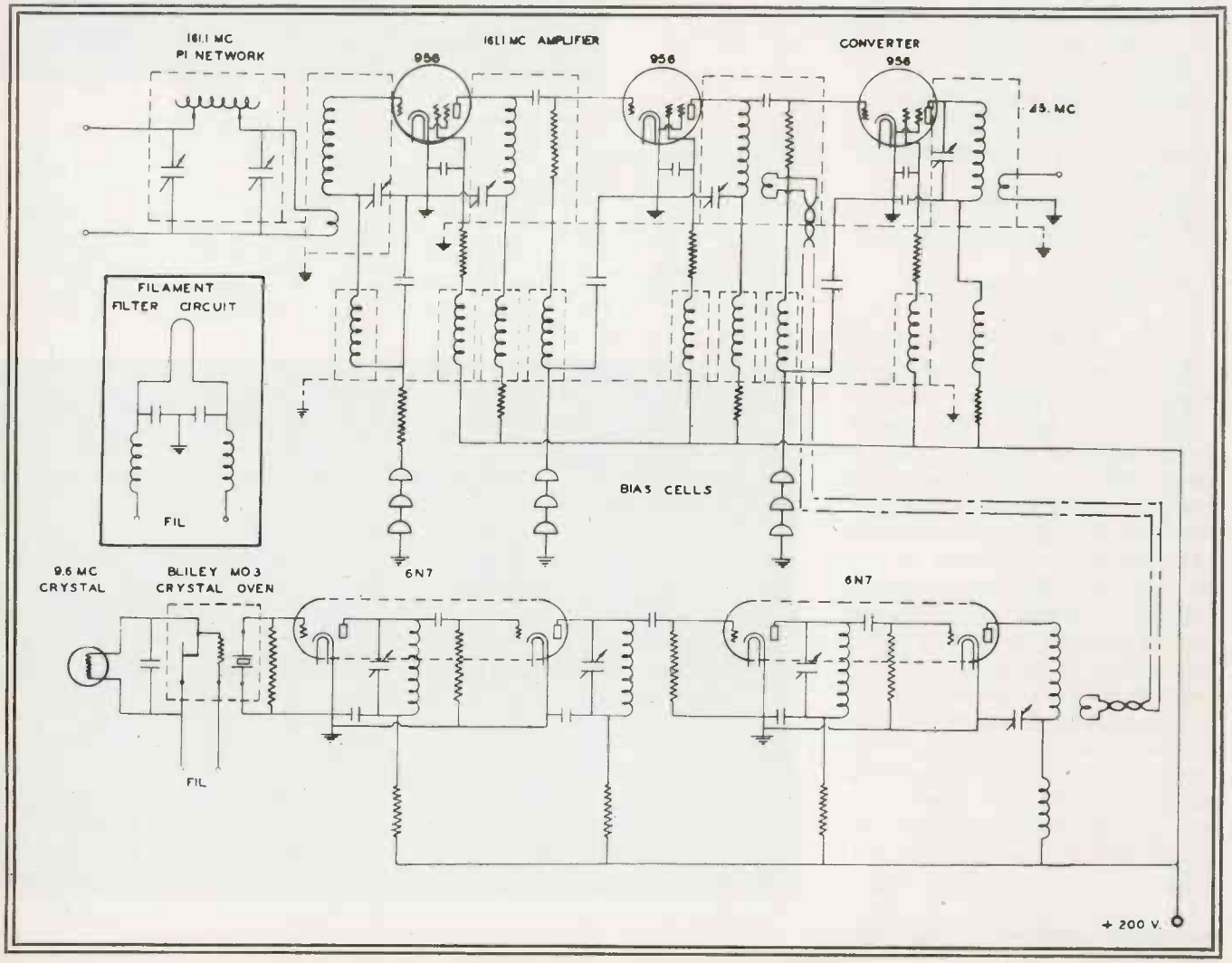
Key to WGAR broadcast-relay system block diagram

A—WEMV, 161,100-kc, FM, 100-watt broadcast-relay transmitter; B—161,100-kc, three-element, directional transmitting antenna; C—161,100-kc, three-element, directional receiving antenna; D—Remote-controlled rotating mechanism for receiving antenna; E—161,100-kc, remote-controlled, fixed-tune FM receiver; F—Master control-room equipment; G—Master control, telephone order-wire panel; H—WEMU, 30,820-kc, 100-watt, AM broadcast-relay transmitter; I—30,820-kc, three-element directional transmitting antenna; J—30,820-kc, three-element directional receiving antenna; K—30,820-kc, remote-controlled, fixed-tune, AM receiver; L—WAAI, 1622-kc, 100-watt broadcast-relay transmitter; M—Filter to isolate 1622-kc transmitter from 1480-kc transmitter; N—Transmitter-plant telephone order-wire panel; O—WGAR, 1480-kc, 5000-watt, standard-broadcast transmitter; P—Filter to isolate 1480-kc transmitter from 1622-kc transmitter; Q—Phasing equipment for directional broadcast antenna system; R—Tuning apparatus for simultaneous operation of reflector antenna on 1622-kc and 1480-kc; S—1480-kc tuning apparatus of main broadcast antenna; T—170-foot, vertical, broadcast, reflector antenna; U—380-foot, vertical, main broadcast antenna; V—Automobile receiver; W—Automobile receiver; X—30-mc AM receiver.





Above: 161.1 mc 100-watt FM transmitter. Below: 161.1 mc FM receiver

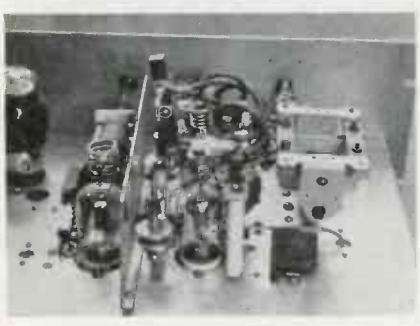


Above—Mobile unit generator (350-watt, 115-volt, 60-cycle each). At right—Interior view of WGAR mobile unit. 161-1-mc transmitter at center, mixer-audio amplifier on left, and 1622-kc receiver below

Several years of research and experiment between 30-mc and 250-mc at WGAR, proved beyond doubt that ignition-noise interference problems decrease as the operating frequency is increased. Accordingly, a new mobile unit transmitter and a receiver were built to operate on 157.5-mc amplitude modulation. With this receiver installed on a tall building at the busiest street intersection in the city, ignition-noise interference was not audible, even with the transmitter carrier off, although a 30-mc AM receiver tested alongside was completely saturated with ignition-noise interference.

With a directional transmitter antenna, the 157.5-mc AM mobile-unit equipment increased the satisfactory operating range of the mobile unit approximately ten miles. The limit of the extended range was the thermal noise generated in the converter tube of the receiver.

Uhf section of 161.1-mc transmitter. Series tuned driver-amplifier plate circuit at left of baffle; parallel-tuned power amplifier plate circuit at right



The first 157.5-mc AM receiver was a modification of our earlier 30-mc AM superheterodyne. It consisted of a parallel tuned 157.5-mc, acorn tube, radio frequency amplifier, followed by a parallel-tuned acorn tube converter. A 9.6-mc temperature-controlled crystal oscillator followed by harmonic amplifiers, supplied a 154.6-mc beat frequency to operate a 3-mc intermediate frequency amplifier, detector and audio amplifier.

Additional amplification ahead of the converter tube proved to be the solution to thermal noise reduction. So another 30-mc receiver was modified to 157.5-mc AM, this time employing a pi-network, followed by a two-stage acorn-tube converter. Direct comparison of the two receivers showed a 30 db improvement in signal to thermal-noise ratio in favor of the series-tuned receiver.

The use of a directional receiving antenna, 350 feet above the street level, connected by a 100-foot open-wire transmission line to the new receiver, resulted in still further improvement. The mobile unit operating range was increased from two miles on 30-mc, AM, to seventeen miles on 157.5-mc, AM.

When the 157.5-mc AM transportable transmitter and receiver were modified to 161.1-mc FM, shortly before Pearl Harbor, the noise-reducing properties of FM transmission resulted in a still further improvement. The satisfactory operating range of the new mobile unit averages twenty miles or more from the receiving location. In addition, the transmission quality of the FM equipment is a great improvement over the older AM equipment.

30-mc equipment as auxiliary

The old 100-watt, 30-mc AM transmitter, was installed adjacent to the master control room and connected to a horizontal, fixed, three-element, 30-mc directional antenna on the roof of the fourteen-story building housing our studios. This antenna was aimed at our transmitter plant five miles away. At the transmitter plant, a 30-mc AM receiver was installed and a fixed horizontal three-element directional antenna, aimed at the studios, was erected on the one-story transmitter house roof. The 30-mc transmitter is now used as an auxiliary to the 1622-kc "talk back" transmitter. It can also be used to feed the 1622-kc transmitter, at the transmitter plant. During a recent emergency the 30-mc AM transmitter was used for

(*Continued on page* 157)

LINEAR-FREQUENCY

by R. R. BATCHER
Consulting Editor

Determination of plate contours to secure linear frequency tuning characteristics

Notwithstanding the fact that variable condensers with linear frequency-control characteristics have been used in radio receivers for nearly two decades, there seems to be a lack of information as to easy methods whereby plate shapes can be developed and circuits established that will carry out the desired relations. Of late, the problem is made more intricate by the fact that numerous receiver arrangements require heterodyne oscillator operation over frequency ranges differing considerably from those of the incoming signals.

It happens that the original design rules formulated by the writer in 1923 and applied to the tuning condensers used in Grebe receivers are broad enough to cover most of these later applications. The actual layout of the plate shape is really quite simple, and involves only slide-rule operations, or easier yet, a set of arithmetical tables, such as Barlow's.

Table 1. S.L.F. formula and tabulated solution

$$R = \sqrt{\frac{K}{\left[1-\frac{\theta}{Z}\left(1-\frac{1}{\sqrt{X}}\right)\right]^3}+r^2} \quad - \quad - \quad 1$$

$$1.25'' = \sqrt{\frac{K}{\left[1-\frac{100}{100}\left(1-\frac{1}{\sqrt{6.25}}\right)\right]^3}+.25^2} \quad - \quad 2$$

TABLE 1

θ	$\frac{\theta}{Z}$	$.6\frac{\theta}{Z}$	$1-.6\frac{\theta}{Z}$	$\left[1-.6\frac{\theta}{Z}\right]^3$	$\frac{.096}{\left(1-.6\frac{\theta}{Z}\right)^3}$	$R^2=$ Col. 6 $+.0625$	R (in.)	θ′
0	0	0	1	1	.096	.158	.398″	15.°
10	.1	.06	.94	.831	.116	.178	.422″	31.5
20	.2	.12	.88	.681	.141	.203	.450″	48.0
30	.3	.18	.82	.551	.175	.237	.487″	64.5
40	.4	.24	.76	.439	.220	.282	.530″	81.0
50	.5	.30	.70	.343	.280	.342	.585″	97.5
60	.6	.36	.64	.261	.368	.428	.655″	114.0
70	.7	.42	.58	.195	.493	.555	.745″	130.5
80	.8	.48	.52	.141	.681	.743	.862″	147.0
90	.9	.54	.46	.097	.987	1.049	1.024″	163.5
100	1.0	.60	.40	.064	1.50	1.562	1.25″	180.

where K = .096 from eq. 2 and R_{max} = 1.25″

Frequency ratio

In any circuit that is tuned in accordance with linear frequency control principles, the first essential factor to set down is the frequency ratio desired—the ratio of the maximum frequency to the minimum. In a practical design it may not be known in advance just what total frequency range will result. Instead, however, the desired operating range over a certain dial spread may be specified; such as a 3:1 range over 165 degrees of rotation, whereby a certain space at each end of dial is reserved, since tuning linearity cannot ordinarily be extended over the full 180 deg. swing.

Let fo = minimum frequency of the operating range.
fm = maximum frequency of the operating range.
f = a reference frequency between fo and fm.
Z = total divisions on dial (or in the operating range).
θ = the dial setting for the frequency f.
Co = capacity at θ = 0.
Cm = capacity at θ = Z.

$$X = \frac{Co}{Cm}$$

The basic design formula* found most convenient is shown in eq. 1. where (K) is a design constant. The factor (r) is the inner radius of the cutout portion at the center

*From patent application. Ser. No. 753973—1924.

CONDENSER Development

of the stator plate. It is best obtained by judgment or by measurement on a typical stator plate from a condenser of a physical size similar to the condenser desired. Production or design considerations will also determine how big the rotor plate ought to be—the maximum radius (Rm).

In equation (2) it is found that $K = .096$ if the values $r = \frac{1}{4}$ in., $Rm = 1.25$ in., $x = 6.25$, $Z = 100$ and $\theta = 100$ are substituted in (1).

Having thus determined K, a series of values for R can then be determined for intermediate values of θ. It is usually advised to tabulate all steps in the solution, such as in Table I.

Column 8 gives the radius at various points in the useful range of the rotor plate contour which, in practical designs, may be considered as from a 150 deg. to 170 deg. portion of a circle. Assuming a 165 deg. range the values of θ in Col 1 are multiplied by 1.65 and adding the 15 deg. that is ineffective at the start, results in Column 9 of the table. Fig. 1 shows a plot of the final values as a polar curve, with values based on the data in the last two columns in Table I. It makes no difference how many plates are put in the condenser or how much the total capacitance builds up from plates of this shape—just so that a trimming condenser is added to the circuit to provide the required fixed value of Co. Co must include all capacitances in the circuit: that resulting when the condenser is set at $\theta = 15$ deg., tube and coil capacitances, wiring capacitance, and the rest provided by the trimmer.

S.L.F. capacitor applications

A condenser with a linear frequency curve is the easiest solution to the superheterodyne tuning problem. The simplest arrangement, when a relatively low IF is used, is to mount similar condensers in a gang with one condenser offset mechanically by an amount equivalent to the IF value desired.

(*Continued on page* 159)

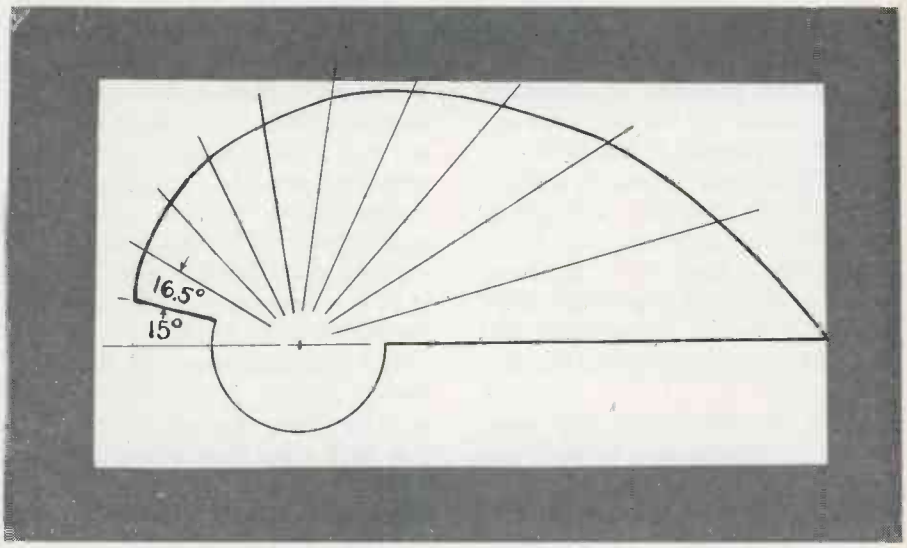


Fig. 1. Polar curves, of R and θ' on Table I showing resulting plate contour, having 10 sectors with 16.5 deg. angles

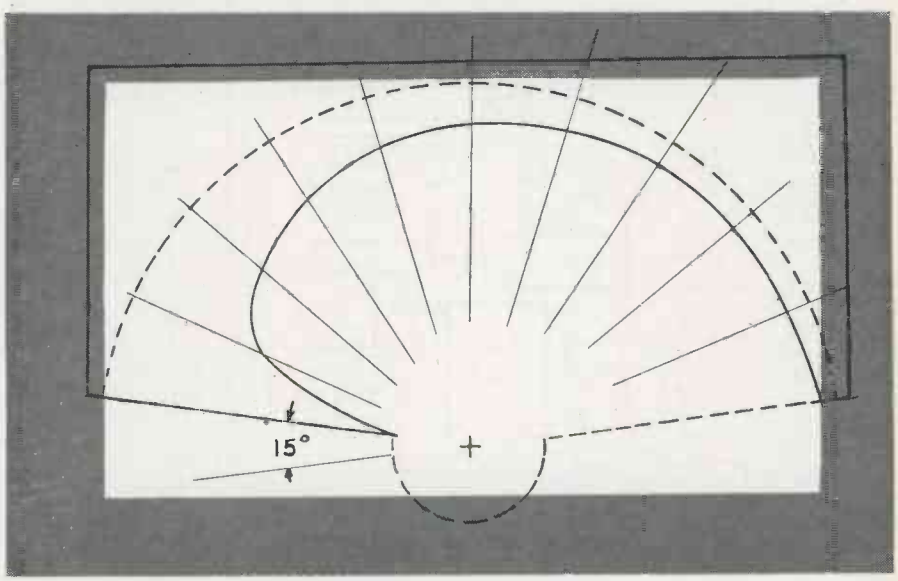
TABLE 2

θ	0	10	20	30	40	50	60	70	80	90	100
Col.6. Tab.1.	.096	.116	.141	.175	.220	.280	.368	.493	.681	.987	1.50
r^2	1.466	1.456	1.421	1.387	1.342	1.282	1.195	1.069	.881	.575	.062
r	1.211	1.207	1.192	1.178	1.158	1.132	1.093	1.034	.939	.758	.250
θ′	15.0	31.5	48.0	64.5	81.0	97.5	114.0	130.5	147.0	163.5	180

Max. R=1.25", Inner radius of stator = r as above

Table 2. Conversion of data in Table 1 to the cut-away stator plate shape

Fig. 2. Stator plate contour with semi-circular rotors to secure straight line frequency characteristics



HI-FI TRANSCRIBING

Special radio and recording equipment developed by T. R. Kennedy, Jr., for high-fidelity records off air

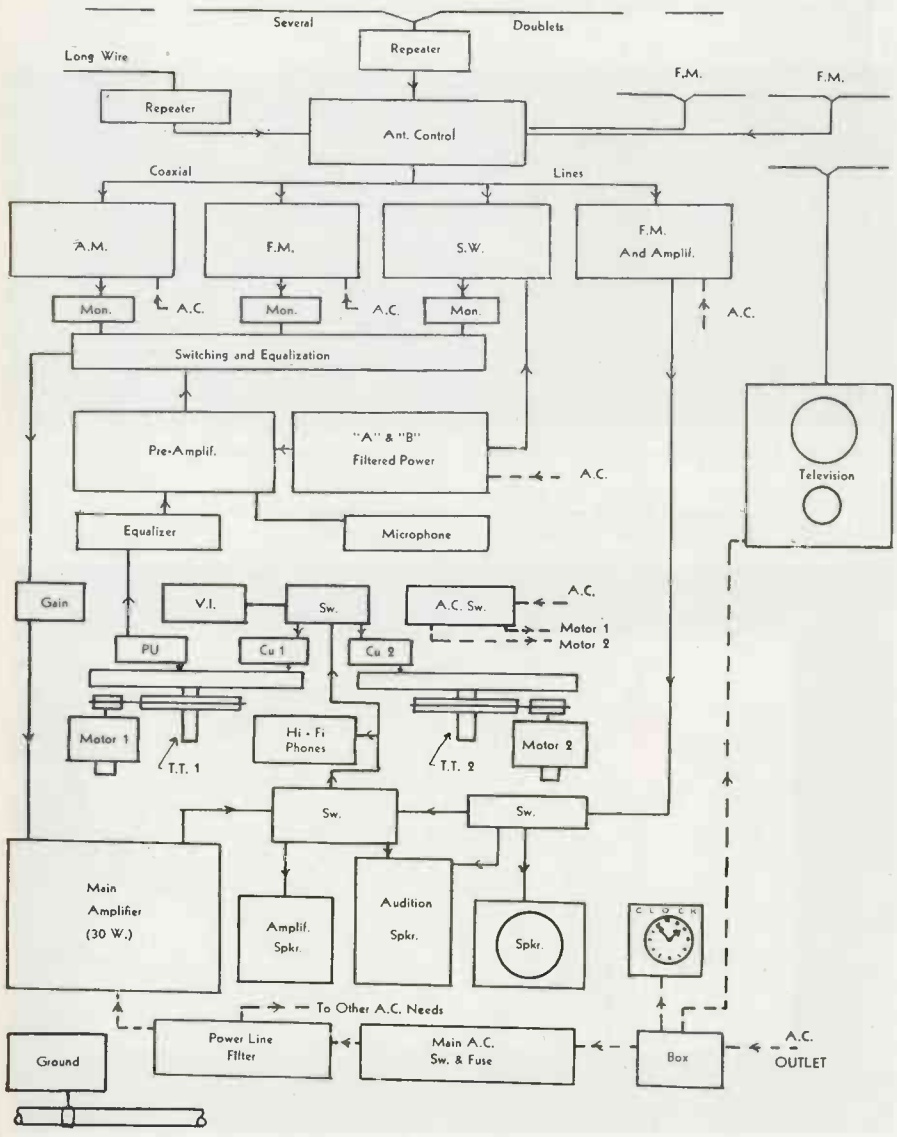
Improved methods of transcribing fine music off the air, were described by Thomas R. Kennedy, Jr., of the New York Times, in a paper prepared for the May meeting of the New York Section of the Institute of Radio Engineers. Mr. Kennedy has recorded more than 12,200 acetate disks on home-made but efficient equipment during the past seven years.

From his handiwork has come unique synchronous turntable drives, more than a score of special radio receivers, amplifiers, equalizers and other things of the professional expert. As a result of much experience he foresees some novel and interesting advances in the recording art after the war, most of it in the field of home phonograph machines and records.

His recording began in the early Spring of 1936. Toscanini was soon to retire from the conductorship at Carnegie Hall, from which his music had been broadcast regularly. Once gone, would he ever return to the radio? No one knew. So why not contrive some sort of permanency for his and a lot of other fine music then—and now—escaping into space to be heard no more. Having had some previous recording experience it was easy for Mr. Kennedy to begin again, so new turntables were made and hooked to an existing radio. New parts were added and others improved.

The room in which the equipment was installed soon contained nothing else except panels, turntables, loudspeakers and stacks of disks. Recording standards rose higher and higher. Today the equipment, as far as quality is concerned, is tops. Barring such things as radio interference and poor studio set-ups, over which the recordist has little control, acetate disks off the Kennedy machines today have the reputation of being second to none.

Fig. 1. Block diagram of outfit from antennas to ground. All units are on one 6-ft. panel except turntables and accessories, auxiliary amplifiers, speakers, television, etc.



Many antennas

Some idea of the completeness of the system can be gained from the block diagram of the system, shown in Fig. 1. Nearly a dozen different antennas or combinations thereof are available to supply programs, through repeaters, to four main receivers, followed by plug-in monitoring jacks, equalizers, and gain control units. All sets are ac-operated except a short-wave receiver and pre-amplifier, which take rectified-filtered A and B current from a selenium rectifier system providing 6 to 7 volts at 3 to 4.5 amperes, and a conventional 80 rectifier-filter unit delivering 30 to 350 volts at 50 mils. One FM set includes its own 20-watt audio amplifier, to be used in case of failure in other parts of the outfit. Other cutter and speaker auxiliaries are included, and rigged for quick change-overs. Ninety per cent of the apparatus, except turntables, is on one 6-foot panel.

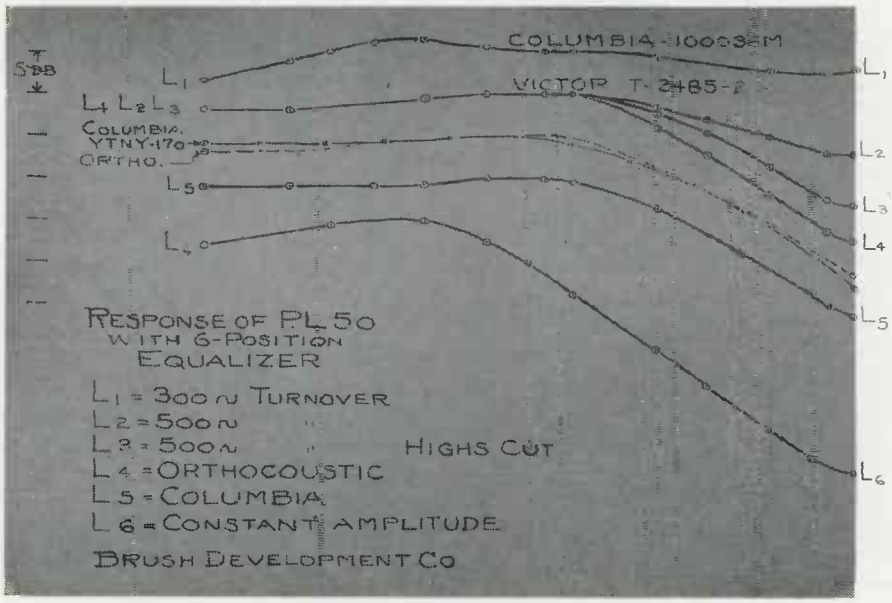
All main operating controls are grouped. Others are on the panel at the operator's rear. A large mirror evenly distributes light. The recordist soon learns to read the main control panel "backwards" as seen in the mirror, just as a printer reads a story from type metal.

Turntable drive

A striking mechanical feature is the turntable drive mechanism. Few early turntables had the advantage of constant-speed motive power, so with the aid of a friendly foundryman and machinist the author made his own and applied two fractional-horsepower sync motors (Fig. 2). Bronze slugs were cast, heat treated, roughly machined, balanced and finished into identical 3-step idler pulleys, each step or diameter having four deep slots for round belts. Motor shafts were fitted with appropriate single-diameter 4-slot pulleys. Turntable rims were similarly grooved. Motors and idlers were wall-mounted to kill vibrations. Turntables were bolted to heavy housings weighted with 300 pounds of dry sand. Motor-idler brackets and turntable housings were further isolated by "acoustic" filters on adjacent flat surfaces.

Fig. 2. Left-hand turntable, drive, motor, etc. Note the single belts passing around driver and driven members, making four pulling members, in each case

Fig. 3. Pickup-equalizer-preamplifier overall response at various equalizer settings. (Brush Development Company)



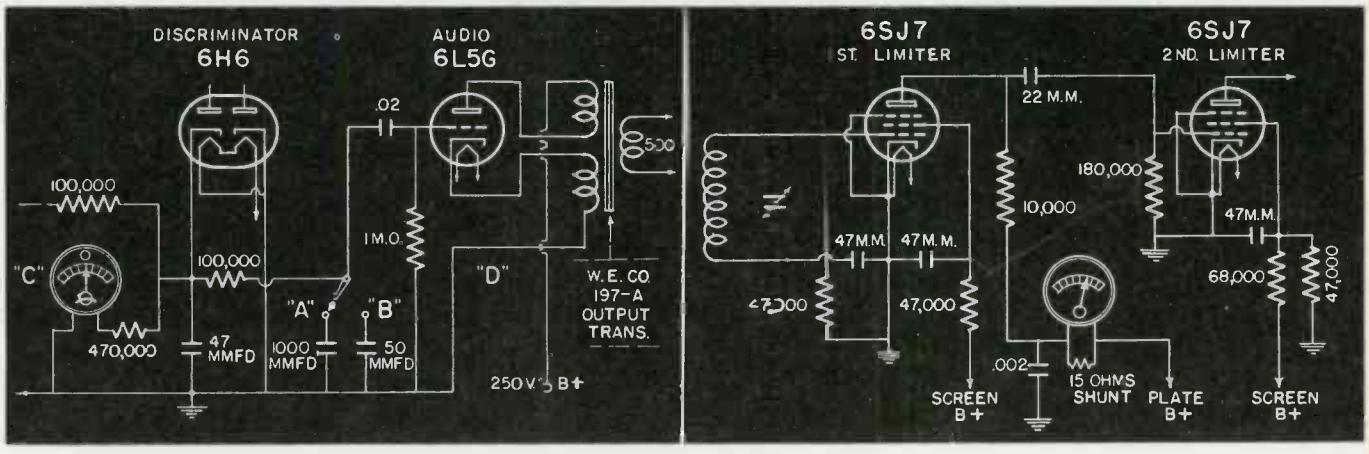
Single round endless belts, redoubled to provide four pulling members, transfer motor power to idler. Another belt, similarly redoubled, is the idler-turntable link. The small idler pulley diameter is for 33 1/3 speed, the medium idler pulley diameter for 78. The motor-idler shelf moves up and down when belts are shifted. The idler moves in a circular slot to preserve motor-idler pulley belt tension.

Records off FM channels can either be transcribed "flat" or "pre-emphasized" (RMA standard) by

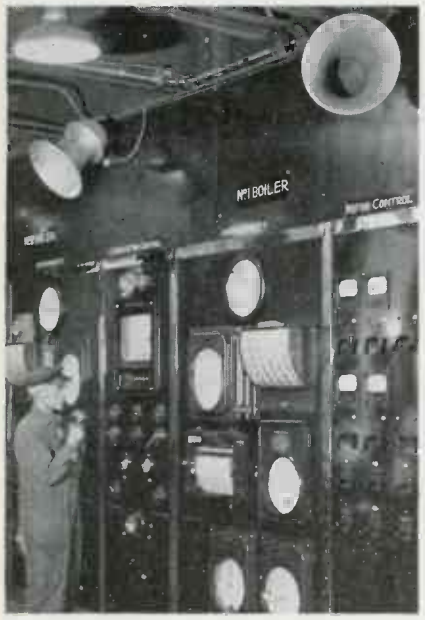
(*Continued on page* 161)

Fig. 4. JFM 90 General Electric FM receiver, with tuning meter, pre-emphasis switch and output stage added

Fig. 5. Limiter "plate" tuning meter in JFM 90 FM receiver



Electronic Tubes ON THE JOB



From boiler-firing level, operator can ask pump floor for more feed water and obtain immediate response

Coordinating Power-Plant Control

Noise surveys and loudspeaker installation represent the newest thing in power-plant operation.

The picture on this page illustrates the location of the loudspeakers above a boiler-control panel in a power house. In this particular plant there is installed a general broadcast type of audio sound system. Loudspeakers are located at all strategic points, such as switch boards, pumps, fans and regulators, boiler control and chief engineer's office. Microphones are also located at each of these control points. When load variations are handled, it is necessary to instantly coordinate the activity of these control points. For example, if an additional turbine-generator is brought in, the activity of the boiler room, pump floor, switch board operator and fans and regulator control must be coordinated.

Such coordination is readily accomplished by means of the communication facilities afforded by this sound system. The voice of any control operator speaking over the system is heard simultaneously by all other control operators. The chief engineer sitting in his office or at any point on the floor of this power house is constantly aware of all activity.

On many occasions, imminent breakdown has been averted by the speedy facilities offered by this sound systems, explains RCA's O. V. Swisher. In one case a pump failure noticed only by the chief engineer was quickly corrected following instant instructions over the sound system while the chief engineer was still seated at his desk. Without the facilities of this system, it would have been necessary for him to run from his office to the pump floor, attract the attention of the pump personnel, with the result in loss of time that could have proven sufficiently serious to have permitted a breakdown of one complete generating unit.

When sound systems of this type are installed in power houses, it is desirable first to make a noise-analysis survey, plotting the results as shown in the chart, so that interference levels for each frequency can be known in advance. In this way sufficient signal volume can be provided to override the noise and interference.

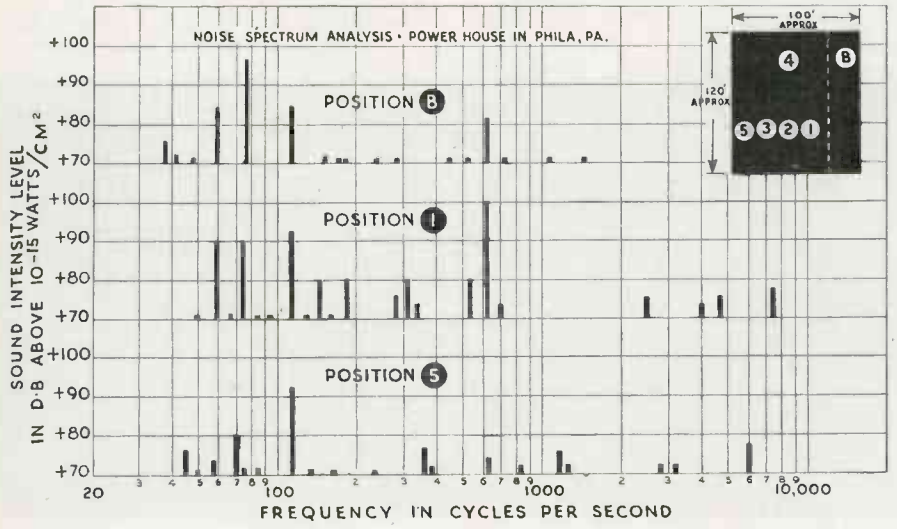
Electron Diffraction Identifies Jade

There are often thousands of dollars difference in value between a really precious stone and a semi-precious one that looks like it. And if experts can't tell the difference —who can?

A Chicago collector had acquired an old Chinese perfume bottle. Some experts told him it was jade and worth eleven hundred dollars. Others said it was agate and worth only twenty-five dollars. Strangely enough, a research man of the G-E X-ray Corporation in Chicago finally settled the matter—electronically.

He used an electronic device—called the X-ray diffraction unit—to study the invisible crystals of the perfume bottle. With this device, different jewels, steels, chemicals and glasses all show patterns as individual and characteristic as human finger-prints. And in this case the perfume bottle, the pattern showed, really was jade!

Typical "noise spectrum" analysis chart



Electronic Determination of Stress

One of the many patents vested in the Alien Property Custodian and which are made available to American industry relates to a simple arrangement for stress measurements.

The device disclosed in patent No. 2,306,137 operates on the well-known fact that the oscillation frequency of a wire depends on its tension. In the apparatus described, the tension of a vibrating wire is controlled by the stress to be measured, and its oscillations are compared with those of another wire

with adjustable tension. Each wire is vibrated by an electronic circuit, the vibration of each wire, in turn, acting as electro-mechanical feedback. The outputs of the two circuits may be conveniently compared by a cathode ray oscilloscope, the adjustable wire being tensioned until equal frequency is obtained. The stress acting on the first wire may then be directly read on a previously calibrated scale.

"Hunting" of Controls Means Wear

"An instrument must have stability—that is, the pointer should not be jittery. It should not have too much tendency to overswing. It should not hunt—that is, if it operates a control, it should not operate too often. Nothing will irritate a production man more than an instrument which is continuously clicking back and forth between limits," observes Dr. P. G. Weiller of Kollsman Instruments, Woodside, N. Y.

"Frequent operation of control causes undue wear which many of the control elements will not stand. It also gives the process supervisor a sense of insecurity. He is always worrying about overshooting or undershooting. This is an influence that even the best and most experienced of them cannot avoid.

"Let me add a word here about too frequent operation of controls. It is comparatively easy to make relays—and relays are mostly involved in automatic controls—to operate satisfactorily over a million or so operations. But it is very difficult to make one stand up for 10 million operations. And it is almost impossible to make one for 100 million operations. Consequently, the maximum usable sensitivity of the instrument has to be adapted to these limitations.

Photocell Measures Hosiery Glamour

"Glamorometer" might well be an appropriate name for an instrument on which a patent has been issued to Jerome Barney of Bethlehem, Pa. The device measures the relative sheerness of hosiery and similar delicate fabrics.

A concentrated light beam of known intensity is projected through a layer of stocking-leg fabric suspended on a frame. A standard photo-electric measuring instrument on the other side receives the part of the light that passes through, converting it into an electric current that in turn swings a pointer across the face of a numbered dial.

Rights in the patent, No. 2,312,-953, are assigned to the R. K. Laros Silk Company of Bethlehem.

M.I.T.'s 4,000,000-Volt X-Ray

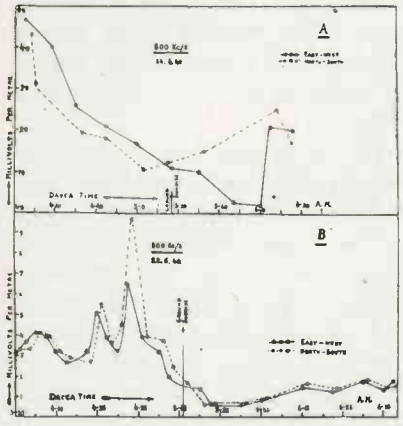
A new 4,000,000-volt direct-current X-ray generator has been developed at the Massachusetts Institute of Technology, Cambridge, for medical research.

The photograph shows the generator structure of laminated metal rings capped by a high-voltage terminal as it appears without the pressure tank in which it is ordinarily enclosed. Close by are the polished voltage dividing shields which are placed over the column assembly. These shields in effect separate the generator into three independent units, one within another. The vertical X-ray tube located in the center of the generator projects into a treatment room below.

The generator has produced for the first time radiation more penetrating than the gamma rays of radium and with an intensity greater than that of the entire available world supply of radium. It is already being used in experimental clinical treatments. The generator, the design of which is based on the Van de Graaff type of electrostatic high-voltage machine, is thirteen feet high, and is insulated by a mixture of compressed air and Freon gas in a sealed tank.

SURVEY of WIDE READING

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



Intensity distribution of atmospherics

Intensity Distribution of Atmospherics

S. R. Khastgir & R. G. Basak (Current Science, Bangalore, India, Oct. 1942)

Intensity distributions of atmospherics during periods of time well covering the sunrise were measured with 800 kc waves and distant wave sources. The plane of the directional receiving antenna was directed towards East-West or towards North-South.

The maxima in curve B are explained by associating them with the ionization minima in the E- and F-layers, about 80 and 150 km up, respectively, occurring at sunrise. It has been shown that ionization begins to increase when the solar rays strike the particular layer by grazing the top of the ozonosphere at the height of about 35 km, otherwise the short waves causing ionization would be absorbed by the ozone. This assumption allows to calculate the time for the two maxima which, obviously, would not occur simultaneously due to the different heights of the E- and F-layers. The results are in satisfactory agreement with the experimental values.

Inductance Set

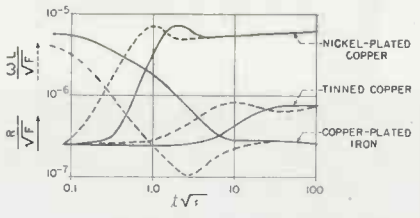
J. Boehse & H. Bielert (Technischer Fernspruch & Telegraph, Berlin, Vol. 5, 1942)

A set of inductances within a given range and increasing stepwise by equal percentages is to be made available by different parallel and series connections between separate coils on one bobbin. From the general expression for the inductance values of the possible combinations of coils it is shown that if the number of windings on the separate coils increases as $1:3:3^2$ . . ., the best approximation to a proportional increase in inductance values may be effected. Similar considerations using more than one bobbin each carrying several separate coils are carried through.

HF Resistance of Plated Conductors

R. Faraday Proctor (Wireless Engineer, London, Feb. 1943)

Based on derivations by Schelkunoff and Howe, resistance and inductance of plane, tubular and rod-shaped conductors plated with another metal are computed. For the mathematical treatment, the



Resistance and conductance of plane, plated conductors

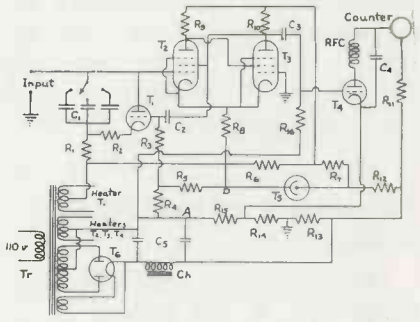
transmission line is split up in small sections perpendicular to the direction of wave propagation and the conventional line equations are applied to these sections.

The more involved expressions are expanded and simplified so as to be readily applicable to practical problems. Tables for numerical evaluation are included, and examples given. It is illustrated how the attenuation constant of a coaxial cable may be equalized by the use of copper-plated iron or thin copper conductors. In the figure, t is thickness of plating, f, frequency considered.

Current Integrator

J. Morris Blair (Review of Scientific Instruments, March 1943)

The circuit, used for measuring the ion beam current in nuclear research, counts the number of times condenser C_1 is charged to a known potential. The discharge through thyratron T_1 is tripped by a separate circuit including pentodes T_2 and T_3, so connected that either one or the other will be much more strongly conducting. At the beginning of a cycle, T_3 conducts until the voltage across C_1 has reached a predetermined value so that T_2 becomes conducting and stops operation of T_3, which in turn causes T_1 to discharge C_1 and at the same time actuates the counter.



Current integrator

The essential potential between the cathode of T_1 and the control grid of T_3 is held constant by means of voltage regulator network R_4, R_5, R_{12}, R_{13}, R_{14}, R_{15}. With sensitivities of about 1, 10 and 100 counts per microcoulomb, respectively, the arrangement was found to be satisfactorily linear.

The Audio Circuit

O. Tuexen (Funktechnische Monatsheft, Berlin, Vol. 4, 1942)

The separation of two radio programs in the audio circuit is treated by means of two equivalent circuits for low and high frequencies, respectively. Amplification, bandwidth, and separation are considered, and it is stated that a desirable compromise between the different requirements may be obtained by making the time constants for high and low frequencies equal to each other.

Power-System Interference

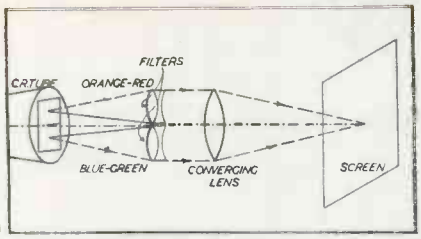
C. V. Aggers, W. E. Pakala and W. A. Stickel (Electrical Engineering, April 1943)

A method of investigating the effect of radio frequencies of a power system on radio-receivers was worked out, and corresponding tests made in a city receiving power from 25-kv transmission lines and 4-kv distribution circuits. Results are graphically shown.

Geiger-Mueller Counter Pulse Size

Carlton W. Miller (Review of Scientific Instruments, March 1943)

An electronic circuit is used to investigate the distribution in pulse size in Geiger-Mueller counters. Various gas mixtures at different pressures were compared as to their influence on the voltage.



Stationary color filter in television

Stationary Color Filter in Television

(Electronic Engineering, London, Jan. 1943)

A method, developed by Mr. Baird, to use a stationary color filter is reported. If two colors are used, two images corresponding to orange-red and green-blue are reproduced one above the other on the screen of a cathode ray tube, as shown in the sketch. Upon passing through suitable filters, both pictures are superimposed on the viewing screen to exactly register with one another. A system of lenses is used for this purpose. A similar procedure may be employed for three-color pictures, and is also applicable to the transmitter.

On Network Theory

Frederick E. Terman (IRE Proceedings, April 1943)

In a survey, the fundamental definitions and network theorems are reviewed, and expressions for image-, transfer-, and iterative-impedance and for transfer constants are introduced. Two and four terminal networks, T, π, and lattice sections are covered.

Attenuation in Transmission Lines

W. Klein (Technischer Fernspruch & Telegraph, Berlin, Vol. 4, 1942)

It is attempted to find simple and practically useful formulas for series connected transmission lines by considering them as networks and applying the corresponding equations. Particular consideration is given to attenuation caused by reflection which is frequency dependent and, therefore, of special interest.

Theory of Coastal Refraction

G. Gruenberg (Physical Review, March 1943)

A theoretical investigation on the way in which electromagnetic waves are refracted and reflected when passing from the sea to the shore is carried through. The common surfaces between air-water, air-ground and water-ground are supposed to be planes, and the surface of the land is supposed to be at sea level. It is pointed out that the problem can not be solved exactly. An approximate solution for very high conductivity of water is sought; then the electric field strength decreases rapidly as it penetrates deeper into the water.

Cathode Follower

C. E. Lockhart (Electronic Engineering, London, Feb. 1943)

A continuation of an article in the December issue, the text gives an extensive mathematical analysis of the cathode-follower circuit. The effects of inter-electrode capacities and of input loading due to electron inertia are considered.

Argentine Air-Radio Service

(Revista Telegrafica, Buenos Aires, Feb., 1943)

Eight ground stations under the control of the Civil Aeronautics Department are now in operation. At least ten additional installations are planned for 1943. One equipment, at Moron, consists of a 200 watt 'phone and cw transmitter, 500 watt beam-flying transmitter, and associated apparatus. Others are lower power stations with at least one stand-by transmitter.

One factor retarding development of radio for civil aviation in South America has been the lack of radio-equipped planes and, consequently, of the demand for service. Call-letter organization is now complete, and the use of aircraft radio has grown fast. LVAAA to LVAAZ are call letters of training or private craft; LVBAA-ZZ of commercial airlines; LVCAA-ZZ are state-owned planes.

Cosmic Rays Underground

V. C. Wilson and D. J. Hugher (The Physical Review, March 1943)

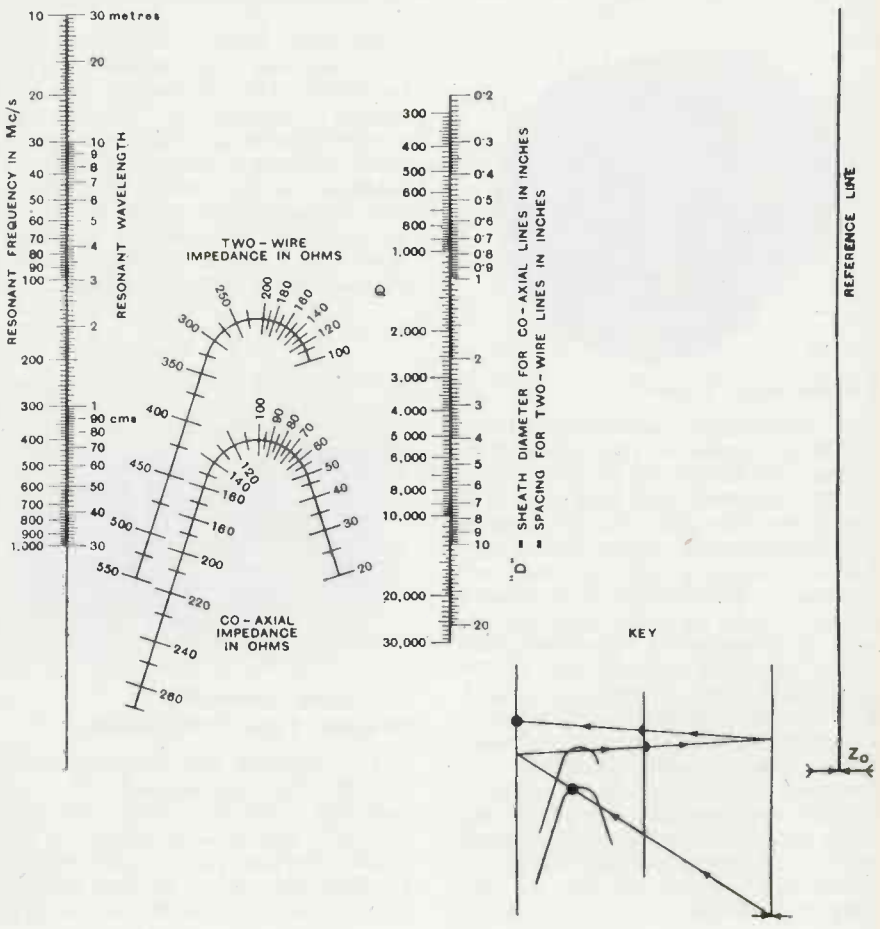
A report is made on observations of cosmic rays underground by means of a counter-controlled cloud-chamber and two counter coincidence sets. The results indicate that the cosmic rays underground are mesotrons accompanied by electronic secondaries.

Q of Quarter-Wavelength Resonant Line

J. McG. Sowerby (Wireless World, March 1943)

Data sheet with this issue gives the Q values of quarter-wavelength, shorted two-wire lines and coaxial cables. The nomogram makes Q available as a function of the resonant wavelength, the dimensions of the line and its characteristic impedance.

"Q" of a quarter-wavelength copper resonant line



WHAT'S NEW

Devices, products and materials the manufacturers offer

Dry Electrolytic Condenser

An electric condenser for the elimination of low frequency ripple (2-100 cycles) can be easily mounted or removed. It is small and light in weight and performs uniformly up to the very last volt on the rating, and will take repeated surges even higher. Special emphasis is placed on the ability of these plug-in type dry electrolytic condensers to operate efficiently under the most adverse temperature and climatic conditions, whether at extremely high or at normal levels. Manufactured by Sprague Specialties Co., North Adams, Mass.

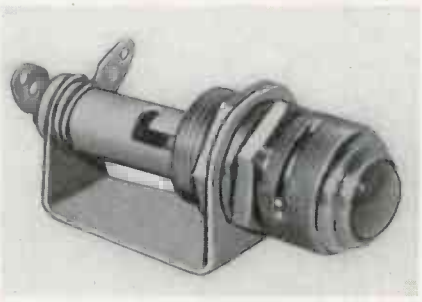
Percentage Timer

A percentage timer which automatically controls the percentage of time at which any ac circuit can periodically be closed and opened is available from The R. W. Cramer Co., Centerbrook, Conn. Where one function bears a definite time regulation in percentage to a second function such as regulating any input to electrically operated furnaces, ovens or heaters, this device is claimed to be particularly useful. Has a self-starting synchronous motor which drives a cam operated switch mechanism through the medium of an enclosed gear train. Timers are available for 7 ranges from 30 seconds to 60 minutes total cycle. The single pole single throw contact is rated at 10 amp. at 115-volt or 5 amperes.

Electronic Pyrometer Controller

The Bristol Co., Waterbury, Conn., announces automatic controlling of temperatures up to 3600 deg. F. in industrial furnaces and ovens by means of an electronic pyrometer controller. Moving parts, such as motors, depressor bars, toggle switches and contacts are

eliminated from the control circuit. Control is accomplished electronically. The pointer of the unit travels throughout its normal range without mechanical engagement, and an accurate indication is obtained at all times. The control unit consists of a single high output vacuum tube of the all-metal type and control circuit elements enclosed in a metal housing.



Variable Intensity Shutter Type Pilot Light

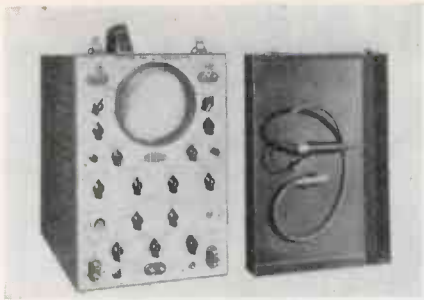
The Gothard Mfg. Company, 1300 N. 9th St., Springfield, Ill., announces a shutter type pilot light which is particularly suited to aircraft, marine, signal and similar applications where various intensities of light are desired under constantly changing conditions. These pilot lights permit a gradation of light from bright, through intermediate glows, to total dark with 90 deg. rotation of the shutters and are available with red, green, amber, blue or opal lens—also with polarized lens.

Photoelectric Glossmeter

Designed for measuring specular gloss of paints and varnishes, ceramics, paper and machined or polished surfaces, the Photoelectric Glossmeter is particularly suited to register changes in specular gloss as a result of age, wear, abrasion, exposure to moisture, heat, light, vapors or sprays. A search unit is connected to the meter by a flexible cable, and may be placed on the sample to be tested. The Glossmeter, manufactured by Photovolt Corp., 95 Madison Ave., New York, is available in two models, operated by dry-cell batteries or operated from 105-125 v., 50-60 cycle ac. Both models can be provided with extra search units for diffused reflection.

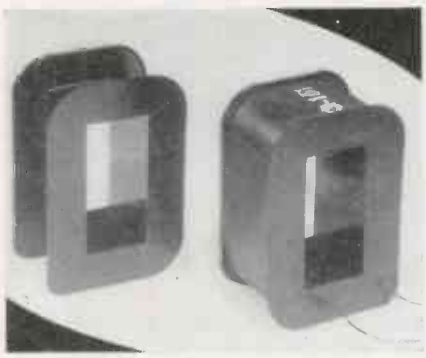
Induction Heating

The Girdler Corporation, Louisville, Ky., announces its No. 1 Thermex induction heating unit for operation on 110 or 220 v., 60 cycle, single phase. It is completely portable, built in steel enclosure and mounted on ball bearing casters. The unit is claimed to have wide adaptability to laboratory and small production heating problems involving non-conducting materials. Overall dimensions, 20 in. wide x 23 in. deep x 44 in high.



Oscillograph Handles Expanded Frequency Range

Larger screen size together with the inclusion of a Z-axis amplifier to modulate the beam with any signal applied to its input terminals or with a return trace blanking impulse produced by the linear-time-base generator, distinguishes the type 241 5 in. cathode-ray oscillograph from others by Allen B. Du Mont Laboratories, Inc., Passaic, N. J. This oscillograph has a uniform Y-axis or vertical deflection response from 20 cps to 2 megacycles. It offers a comparably faithful square and sinusoidal wave response. The X-axis or horizontal deflection amplifier has a uniform characteristic from 10 cps to 100 kc.

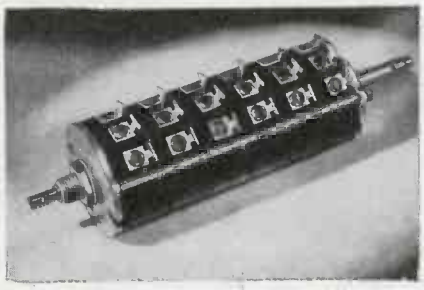


Cellulose Acetate Coil Cores

Electrical manufacturers specify molded Lumarith plastic manufactured by Celanese Celluloid Corp., 180 Madison Avenue, New York, for coil cores not only because it releases quantities of strategic metals, but because it offers no corrosion problems. Light in weight yet strong, these cores have excellent electrical properties and are unaffected by changes in temperature and humidity. Coil cores illustrated molded for General Television & Radio, 1240 W. Homan St., Chicago, by the Chicago Die Mold & Mfg. Co.

Tandem Controls

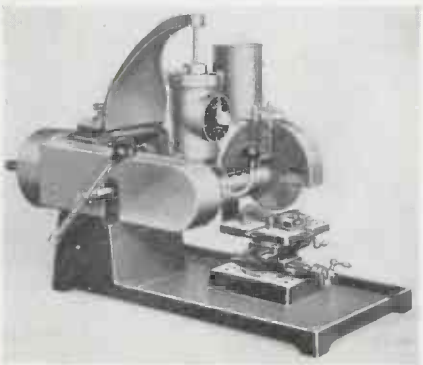
A plurality of circuits—up to two dozen if desired—can be controlled by the single shaft of the 42 Series Control developed by Clarostat Mfg. Co., Inc., 285-7 N. 6th St., Brooklyn, N. Y. This new control was developed to meet certain radio and electronic requirements calling for the single control of several circuits. Designed to produce maximum rigidity in such tandem assemblies, as well as positive rotation of all units without the slightest back-lash. Permits nesting and



locking of all units into a compact stack. The metal end discs and tie rods hold the cases together and provide further rigidity. The single shaft passes through and locks with each rotor in the stack.

Quartz-Cutting Machine

Model 80 is a universal cutting machine designed by the Felker Mfg. Co., Torrance, Conn., to cover the complete range of quartz-cutting requirements. It is capable of both through-feed and down-feed cutting methods. A rotary table supplied with the unit is equipped with a screw-feed motion in two directions: parallel to and at right angles to the blade. Movements can be made in either direction to .001 in. A hydraulic retardant provides



a down-feed and produces accurate cuts, with minimum blade damage and a decided increase in total area cut per blade.

Self-Adhesive Stickers

By order of the War Production Board, the use of decalcomanias has been limited and many firms have turned to self-adhesive labels as a substitute. Kum-Kleen, manufactured by Avery Adhesives, Los Angeles, Calif., is a self-adhesive sticker which can be used in extreme heat, cold, humidity and constant temperature change. When covered with varnish, it is impervious to salt water.

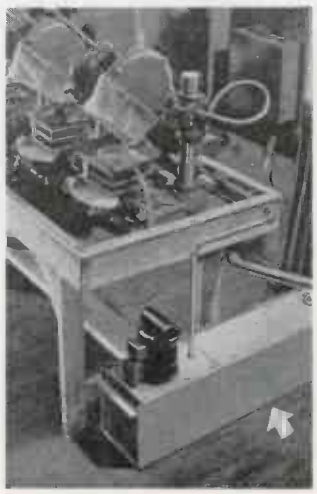
Frequency Meter

The Fred E. Garner Co., 43 E. Ohio St., Chicago, has just announced production of four new models of its Telrad line of frequency meters. All models are crystal-controlled and, by means of a class "C" harmonic amplifier circuit embodied in the units, accurate frequency carrier signals are provided every 10 kc and every 100 kc from one hundred cycles to forty-five megacycles. A carrier signal

is also produced every 1000 kc from 1 megacycle to 120 megacycles. A convenient panel-mounted "on-off" switch permits use of a 1000 cycle modulated note.

Portable Coolant System

A portable system, manufactured by Gray-Mills Co., 215 W. Ontario St., Chicago, supplies coolant to cutting operations where pressure is essential and fine abrasives must be filtered out, in sufficient volume to prevent over-heating of the cutting wheel or work. Special valve prevents a heavy surge of pressure to outlets and secures motor against back pressure. Tank is equipped with 5 baffle plates and 4 perforated scatter baffles to force settling of abrasive or quartz dust.



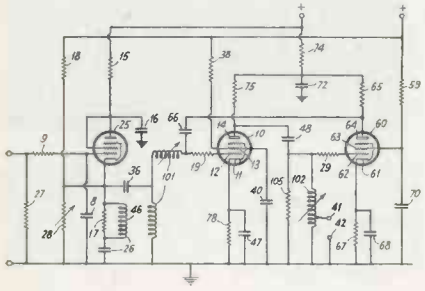
NEW PATENTS ISSUED

Summaries of inventions relating to electronic uses

Note: Date application was Filed shown by (F). Date patent Issued, (I). For the reader's convenience, patents most recently issued are presented first.

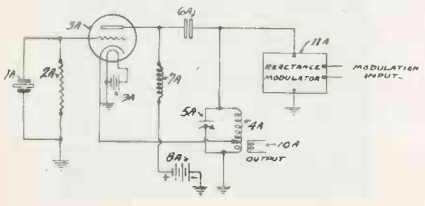
FM MODULATION

FM Circuit—In the circuit shown, positive feedback is obtained by conductively connecting plate of tube 60 to grid 12 of tube 10. The oscillation frequency is varied by applying modulation potentials to the grid of tube 25, changing the slope of its characteristic. Consequently, the damping which tube 25 imposes on circuit 101 is varied



and this varies the effective reactance between the grid 12 of tube 10 and ground. It was found possible to obtain a frequency variation from 10 to 20 megacycles. Several applications of the circuit are mentioned. W. S. Percival, Electric & Musical Ind. Ltd., (F) Oct. 3, 1940, (I) March 2, 1943, No. 2,312,977.

Crystal-Stabilized FM Oscillator—The frequency variation with change in plate load reactance of a conventional crystal oscillator is too small for efficient use. The invention proposes to connect the cathode of the oscillator tube to a tap at the plate tuning coil 4A, and not to ground as is usually done. The cathode-grid potential is, thus, not solely controlled by the crystal, and feedback, besides the plate-grid capacity, is provided. Frequency variation obtainable by plate tuning has been increased many times by this connection, while a degree of stabilization due



to the action of the crystal is maintained. As a non-linear relation exists between plate-circuit reactance and output frequency, a compensating reactance modulator will have to be used. This effect may be obtained by applying abnormally high cathode bias to the reactance tube. N. Bishop, (F) April 24, 1941, (I) Feb. 16, 1943, No. 2,311,026.

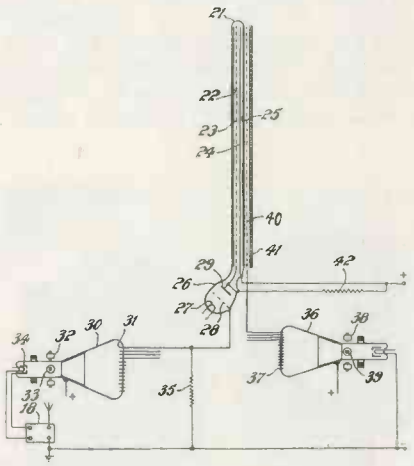
Tuning FM Receivers—The invention is based on the fact that an FM receiver responds to amplitude modulation when detuned, but rejects it when correctly tuned. The incoming signal is amplitude modulated with a readily audible frequency which upon detection will be heard when the carrier or intermediate frequency does not correspond to the center frequency of the balanced detector. The receiver is then tuned until the effects of amplitude modulation appearing in the output are a minimum. Amplitude modulation is then discontinued. Obviously, a visible tuning indicator may also be employed in connection with this principle. C. T. McCoy, Philco Radio & Television Corp., (F) Oct. 21, 1941, (I) Feb. 9, 1943, No. 2,310,304.

Amplitude Compensation—Amplitude modulation introduced by the action of a frequency or phase modulator is compensated for by amplitude modulating one tube of the device with the signal voltage in correct phase relationship. Examples for deriving a suitable amplitude modulating potential, besides the frequency or phase modulating potential, from the signal source are given, as well as various methods of applying the first potential to a conventional modulator. R. E. Schock, RCA, (F) July 18, 1940, (I) Feb. 9, 1943, No. 2,310,260.

TELEVISION

Electron Camera—The light from single elemental strips of a continuously moving film forms a distorted image field on the light receiving element of the camera, thus causing emission of photoelectrons. The distortions are due to too great a dimension in a direction transverse to the longitudinal axis of the strip relative to the dimension in the direction of the axis. The electron stream scans in the direction corresponding to the lengths of the strips and sets up image currents by sweeping the photoelectronic stream once for each strip. H. E. Ives, Bell Telephone Labs., (F) Sept. 24, 1940, (I) April 6, 1943, No. 2,315,621.

Television Receiver—A plurality of elongated tubes 21 are arranged vertically in one plane in close proximity to one another. Line frequency is applied by any suitable device, e.g., cathode ray tube 30, and frame frequency by cathode ray tube 36 and wires 40 which run across the front of the tubes at right angles to the tube axes. Current in one wire will produce a localized magnetic field which will act on the electron stream in that



portion of each tube lying opposite the wire to deflect it from anode 24 on to fluorescent screen 25. Contacts 31 and 37 provide screens 28 and wires 40 with line and frame frequency, respectively. Other means for separately controlling vertical and horizontal deflection may be used. F. Okolicsanyi, Scophony Corp., (F) April 28, 1939, (I) March 9, 1943, No. 2,313,286.

Removing Residual Picture Signals—In interlaced scanning patterns, the interstices carry charges until neutralized by the next succeeding scanning field. These charges must be removed in color television tubes before a change to the next color is made. To neutralize these charges, a second scanning beam arrangement is provided in the tube, the second beam simultaneously scanning the lines not scanned by the first beam during the particular period. However, the second beam also causes signal current to flow which interferes with the picture. To prevent this, the

SELECT for SERVICE

NEW HYTRON TUBES

Type	Description†	Price
836	Half-wave, high-vacuum rectifier	$11.50
837	12-watt, r.f. pentode	7.50
954	Sharp cut-off, acorn pentode	5.00
955	Acorn triode	3.00
956	Remote cut-off, acorn pentode	5.00
1616	Half-wave, high-vacuum rectifier‡	5.75
1625	25-watt, r.f. tetrode (12-v. heater)	3.50
1626	5-watt, triode oscillator	2.50
E1148	3.5-watt, u-h-f triode	2.25
VR105-30	Gaseous voltage regulator	1.25
VR150-30	Gaseous voltage regulator	1.25

OTHER POPULAR HYTRON TUBES*

Type	Description†	Price
2C25	15-watt, medium-mu triode	$3.00
2C45	7.5-watt, triode (modulator)	2.50
10Y	15-watt, general-purpose triode‡	1.50
801A/801	20-watt, general-purpose triode‡	2.50
HY61/807	25-watt, r.f. beam tetrode	3.50
841	15-watt, high-mu triode‡	2.25
864	Non-microphonic voltage-amp. triode	1.00
HY24	2-watt, power triode‡	1.50
HY31Z	30-watt, high-mu twin triode‡	3.50
HY65	15-watt, r.f. beam tetrode‡	3.00
HY69	40-watt, r.f. beam tetrode‡	3.95
HY75	15-watt, u-h-f triode‡	3.95
HY1148	(2C24) 1.8-watt, u-h-f triode‡	2.25
HY615	3.5-watt, u-h-f triode	2.25

*This is not a complete list. Wattage ratings indicate maximum plate dissipation.
‡Instant-heating filament.
†For complete characteristics consult Government specifications.

On this list of tubes which have recently joined the growing legions of Hytron types already marching on to Victory, you may find just the ones you want for your War equipments. Whether you choose the tiny "acorns" or the husky 1616 rectifier, you will discover the same high quality and design refinements which have made other Hytron tubes famous. If you place your orders well in advance, you will also be pleased by Hytron's on-schedule deliveries. Not too infrequently, deliveries are made from stock.

HYTRON CORPORATION
SALEM AND NEWBURYPORT • MASS.
Since 1921 Manufacturers of Radio Tubes

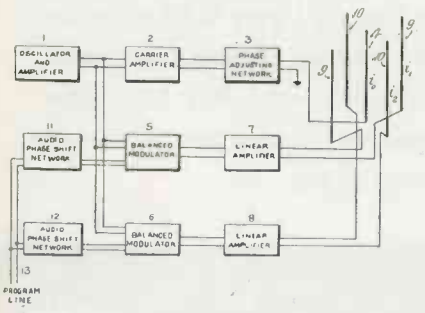
intensity of the second beam is modulated with a frequency higher than the highest picture signal frequency, so that the currents developed due to its scanning can be separated from those due to the first scanning beam by a low-pass filter. H. S. Bamford, Farnsworth Television and Radio Corp., (F) Aug. 14, 1941, (I) March 2, 1943, No. 2,312,792.

Television Color Disc—It is proposed to use a filter of continuously changing color at transmitter and receiver, and to move the discs at such a speed that color repetition period and field scanning interval are in non-integral relationship. Less accurate synchronization between color filters at transmitter and receiver is required than if only three colors were used. M. Cawein, Farnsworth Television & Radio Corp., (F) Aug. 15, 1941, (I) March 2, 1943, No. 2,312,800.

Removing Residual Iconoscope Charges—In color television systems it is essential that all emitted photoelectrons of the mosaic be replaced before the beginning of the next vertical scanning cycle which corresponds to a different color. Residual charges cause infidelity of color in the reproduced picture. Additional cathodes, operative only for a short time interval during the initial portion of the vertical return stroke, supply electrons to all elements of the mosaic simultaneously and provide for a uniform potential before every vertical scanning operation. A new charge image corresponding to the succeeding color is built up on the mosaic screen during the remaining portion of the return stroke. E. I. Anderson and A. Barco, RCA, (F) Feb. 11, 1941, (I) Feb. 9, 1943, No. 2,310,337.

HF AND UHF

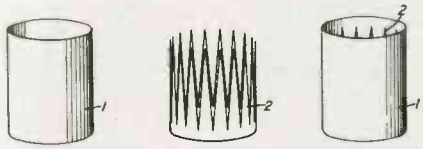
HF Transmitter—In the broadcasting system described, the percent amplitude modulation is the same in all directions, the phase of the modulation is a function of the space angle in the ground plane, while the phase of the carrier is independent of the direction



in space. It is stated that such a system has an exceptionally high efficiency of power conversion. It can be shown that the desired radiation is obtained if carrier frequency is fed to center antenna 4, and 90 deg. out-of-phase carrier frequency to all four lateral antennas, antennas 9 also being supplied with audio frequencies of opposite phase, and antennas 10 with audio frequencies 90 deg. out-of-phase with respect to antennas 9. Other arrangements may be used. J. F. Byrne, Collins Radio Co., (F) June 23, 1938, (I) March 9, 1943, No. 2,313,048.

UHF Antenna — Communication by means of electromagnetic waves having a wavelength below ten meters is impeded by simultaneous reception of direct waves and various reflected waves. It is therefore proposed to radiate circularly polarized waves which upon reflection change their direction of rotation. Thus, provided the receiving antenna will respond only to circularly polarized waves of the type emitted, the reflected waves will have little effect. The radiating antenna may consist of two aerials arranged at right angles to one another and excited by currents displaced in phase by 90 deg. The receiving antenna may be of a similar structure. P. S. Carter, RCA, (F) Feb. 1, 1941, (I) March 2, 1943, No. 2,312,799.

Cylindrical Electrode for UHF—The electrode, to be used in connection with an electron stream provided by an electron gun, surrounds the electrons and establishes a longitudinal accelerating or retarding field. For this purpose, part 2 is inserted in part 1, some insulating material separating the two conductors 1 and 2. If a potential difference is applied to conductors 1 and 2, a uniform accelerating field ranging from the potential of part 1 at the one end to the potential of part 2 at the other



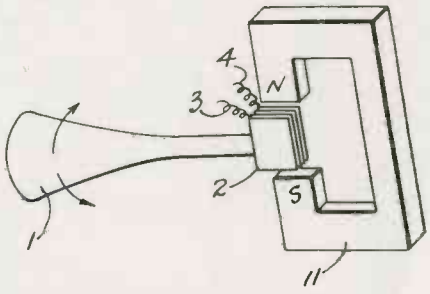
end will exist inside the cylindrical arrangement, both applied potentials being partly effective at the periphery to a continuously varying degree along the axis. Other shapes of parts 1 and 2 may be used. To produce converging or diverging electron beams, crown-shaped part 2 and part 1 may be tapered towards one end. The composite electrode described may be employed in connection with an electron gun and a resonant chamber, a uhf amplifier or oscillator, a split plate magnetron, etc., high current intensities being made available. F. B. Llewellyn, Bell Telephone Labs., (F) Aug. 16, 1939, (I) March 2, 1943, No. 2,312,723.

CATHODE RAY TUBES

Positioning Circuit—The output-load of a positioning circuit for a cathode-ray oscillograph is connected to the cathode of an amplifier tube and consists of two resistive sections. Desired signals are passed undisturbed and variations of the direct-current voltage output of the cathode resistor network causes positioning of the cathode ray beams. The positioning circuit precedes and controls the deflecting-plate circuit. W. A. Geohegan, Allen B. Du Mont Labs., (F) Jan. 4, 1940, (I) April 6, 1943, No. 2,315,848.

MISCELLANEOUS

Conversion of Oscillations—The method is intended for converting oscillatory electrical energy into mechanical energy or vice versa, or for changing the amplitude of electrical oscillations. Torsional vibrations of a solid body 1, preferably of exponentially varying cross-section, are used as the coupling means.



The device is particularly useful in connection with supersonic waves which may cause rod 1 to vibrate and thus produce current in the coil between terminals 3 and 4. J. Bethenod et al, Alien Property Custodian, (F) April 3, 1939, (I) March 9, 1943, No. 2,313,290.

Fog Horn Response—A transmitter-receiver combination is described which emits signals upon reception of sound. The waves from the fog horn of a ship are received by microphones to actuate the device which produces successive trains of sound impulses indicating the position of a lighthouse, a lightship, etc. The apparatus includes relays, a clock work, a tone generator, microphones and several tubes. M. A. Kerr, RCA, (F) May 31, 1939, (I) Feb. 16, 1943, No. 2,311,445.

CRYSTALS

Any TYPE OF CUT AND FREQUENCY

We have facilities for producing crystals to all temperature co-efficient and absolute frequency specifications. Our engineers have wide experience with all crystal types. In our Special Crystal Division we are ready to undertake NOW the development and production of any special and exacting crystal types that may assist you in the war effort. If it's "Rush" phone!

Phone **CRYSTAL SERVICE DIVISION**
PLYMOUTH THREE THREE

JOHN MECK INDUSTRIES
PLYMOUTH, INDIANA

EXCELLENCE IN MUSIC AND VOICE CREATING INSTRUMENTS

War Department Officially Releases STORY of RADAR

TEXT OF ARMY STATEMENT Explaining How Hitherto Secret Detector Works

Ending former official secrecy which had banned the use of even the word "radar," a joint Army-Navy statement released to press and public April 25, gave the basic story of radar as a detection and ranging device. This joint announcement, it was explained, was made "in line with the policy to give the American people as much information as possible, without endangering our own forces or aiding the enemy." The early development of radar was also described by the War and Navy Departments.

Following is the text of the joint Army-Navy statement:

"The term 'Radar' means radio-detecting-and-ranging. Radars then, are devices which the Allies use to detect the approach of enemy aircraft and ships, and to determine the distance (range) to the enemies' forces. Radar is used by static ground defenses to provide data for anti-aircraft guns for use in smashing Axis planes through cloud cover, and by airplanes and warships.

Electronic marvel

"It is one of the marvels made possible by the electron tube. Ultra high-frequency waves travelling with the speed of light can be focussed, scan the air and sea. When they strike an enemy ship or airplane, they bounce back. Radio waves travel at a constant speed of 186,000 miles per second.

"Thus a small space of time is required for such signals to travel to a reflecting surface and return to a receiver, so that, with means provided for measuring this time interval, it is possible to determine the distance to a given target. Radars operate through fog, storms, and darkness, as well as through cloudless skies. They are, therefore, superior to both telescopes and acoustic listening devices.

Saved England in '40

"Radar is used for both defense and offense. In fact, the British, who call their similar apparatus the 'radio locator,' say it was instrumental in saving England during the aerial blitz of 1940 and 1941. At that time the locators spotted German raiders long before they reached a target area, and thus gave the RAF and ground defenses time for preparation. Since then Radar has stood guard at many danger points along United Nations frontiers and at sea, warning of the coming of aerial and sea-borne enemy forces, and contributing towards victory in combat. The new science has played a vital part in helping first to stem and then to turn the tide of Axis conquest.

U. S. discovery in 1922

"It was first discovered in the United States in 1922, when scientists observed that reception from a radio station was interfered with by an object moving in the path of the signals. Accordingly, a radio receiver was set up on the banks of a river and the effects of signal reception caused by boats passing up and down the river were studied. The experiment of installing the receiver in a truck was also tried, and it was observed that similar disturbances were produced in the receiver when the truck moved past large buildings. Development work was immediately undertaken so that that new discovery might be used for detecting vessels passing between harbor entrances, or between ships at sea.

"So far, it had been necessary to have the moving object pass between the radio transmitter and the receiver. This obviously limited the possible fields of application.

Reflections from planes

"In 1925 it was found that the surface of an object, or target, would act as a reflector of high frequency radio waves. In other words, the radio signals sent out by a transmitter could be made to strike a target, and then 'bounce' back to a receiver. This made it possible to have both the transmitter and the receiver at the same location.

"By 1930, research engineers were able to pick up reflected signals from planes passing overhead. By 1934, they had developed a satisfactory means of measuring the distance between the radar transmitter and the target. Since then other advances in the field have been made, some of which, after the war is over, will undoubtedly contribute to the security and comfort of a world at peace."

ASSOCIATION NEWS

RMA War Conference, Chicago, June 10

The Radio Manufacturers Association will hold a one-day War Production Conference at the Palmer House, Chicago, June 10, when plans for war and post-war operation will be discussed. No banquet or golf features will be included in the program, which will be limited to a one-day business discussion. Engineering committee sessions will be included in this June 10 agenda.

At a meeting of the board of directors April 15, decision was made not to change the name of the association to include "electronic" or similar term, opinion being that the present name is adequate to cover the operations of the association.

Conventions and Meetings Ahead

Society of Motion Picture Engineers (Sylvan Harris, Hotel Pennsylvania, New York), May 4-6, Hotel Pennsylvania, New York.

American Institute of Chemical Engineers (50 East 41st Street, New York), May 10-11, New York.

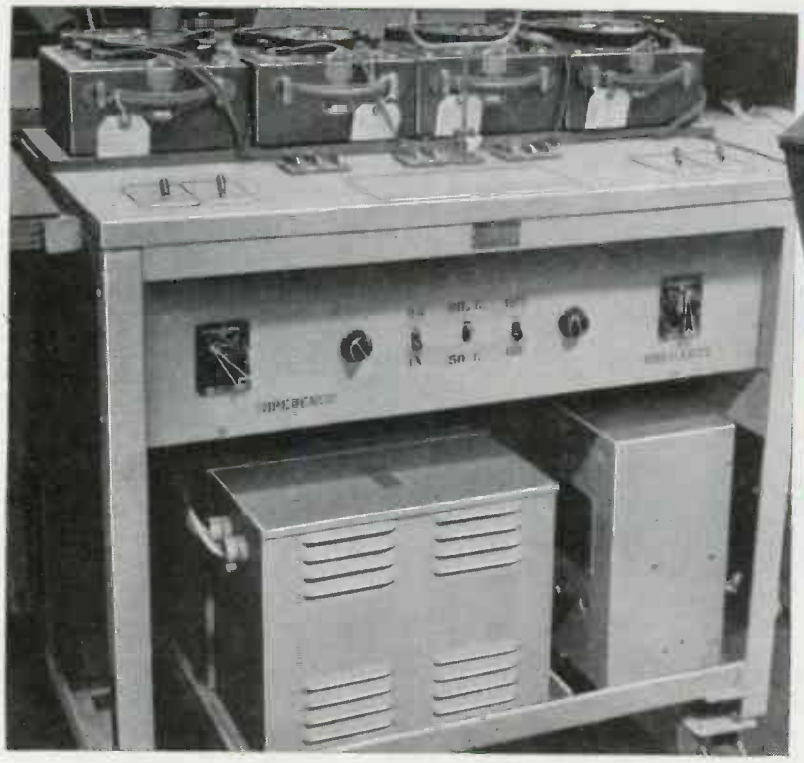
Radio Club of America (11 West 42nd Street, New York), May 13, Columbia University, New York.

Acoustical Society of America (Wallace Waterfall, 120 South LaSalle Street, Chicago), May 14-15, New York.

Society for Measurement and Control, New York Section Meeting, May 25, New York.

(*Continued on page* 112A)

New G-E Voltage Stabilizer Insensitive to Load Power Factor



Provides constant output voltage from a variable input

Applications

CAN BE USED wherever fine voltage regulation is a requisite to good operation.

- Radio transmitters and testing equipment
- Photocell equipment and other electronic-tube apparatus
- Motion-picture projectors and sound equipment
- Telephone apparatus
- X-ray machines
- Precision photographic equipment and photometers
- Color comparators
- Calibration of meters, instruments, relays
- Laboratory precision processes and testing equipment

Benefits

TO THE ELECTRONIC-DEVICE MANUFACTURER: For built-in applications it means better performance and greater salability of your products.

TO THE ELECTRONIC-DEVICE USER: It means improved performance, greater reliability, longer life for your present equipment.

TO RESEARCH LABORATORIES: Precision control of laboratory processes—more accurate test results.

ADDITIONAL INFORMATION

Ask your G-E representative for a copy of GEA-3634 which explains the unique circuit of this stabilizer. Or write General Electric, Section 403-39, Schenectady, N. Y.

Engineering Data

WIDE LIMITS FOR INPUT VOLTAGE—95 to 130 volts—ample for all ordinary voltage conditions.

CONSTANT OUTPUT VOLTAGE—For any fixed load, the output voltage will not vary more than $\pm\frac{1}{2}$ per cent. For any load that varies between full load and half load, and power factor between unity and 0.8 lagging, the output voltage will not vary more than $\pm 1\frac{1}{2}$ per cent. For simultaneous variations in input voltage, load, and load power factor—with load between no load and full load, and load power factor between unity and 0.8 lagging—the output voltage will not vary more than $\pm 2\frac{1}{2}$ per cent.

QUICK RESPONSE—Stabilizing action takes place in less than three cycles.

LEADING INPUT POWER FACTOR—Approximately 20 per cent at no load, and 70 per cent at full load.

CURRENT-LIMITING FEATURE—On short circuit the output is limited to approximately 130 per cent of full load—especially valuable for electronic-tube apparatus during the filament warming-up period.

LOW HARMONIC CONTENT—Only about 6 per cent at or near full load, unity power factor. Only slight variations in harmonic content result from variations in input voltage.

SELF-PROTECTING—Will operate continuously throughout the range from open circuit to short circuit without damage.

RATINGS—50 va to 5000 va.

GENERAL ELECTRIC

403-39-5205

THE TRUTH ABOUT STEATITE INSULATORS

Let's get this straight . . .

General Ceramics Steatite Insulators are available *NOW* . . .

There are adequate raw materials to meet the demand . . .

Our production facilities are greater than ever . . . our backlog of Steatite orders has been melted down . . . there's no basis for the belief that there is a current shortage of General Ceramics Steatite Insulators.

Sure, there *was* a shortage . . . a serious one, but we at General Ceramics met the problem with the "do-it" spirit which typifies American War Production . . . by the location of new sources of supply, rapid plant expansion, procurement of necessary equipment and the training of new employees—*all in record time.*

As a result, delivery time on General Ceramics' Steatite Insulators has been cut in half. Here is our record on that:

June 1942—delivery time—four months.

April 1943—delivery time—two months on standard parts from stock.

General Ceramics Steatite Insulators are available for you NOW

If you have any insulator problem—whether specialized or standard—we'd like a shot at it. Your request will be given prompt, individual action.

3340

General Ceramics

GENERAL CERAMICS AND STEATITE CORPORATION — STEATITE INSULATORS

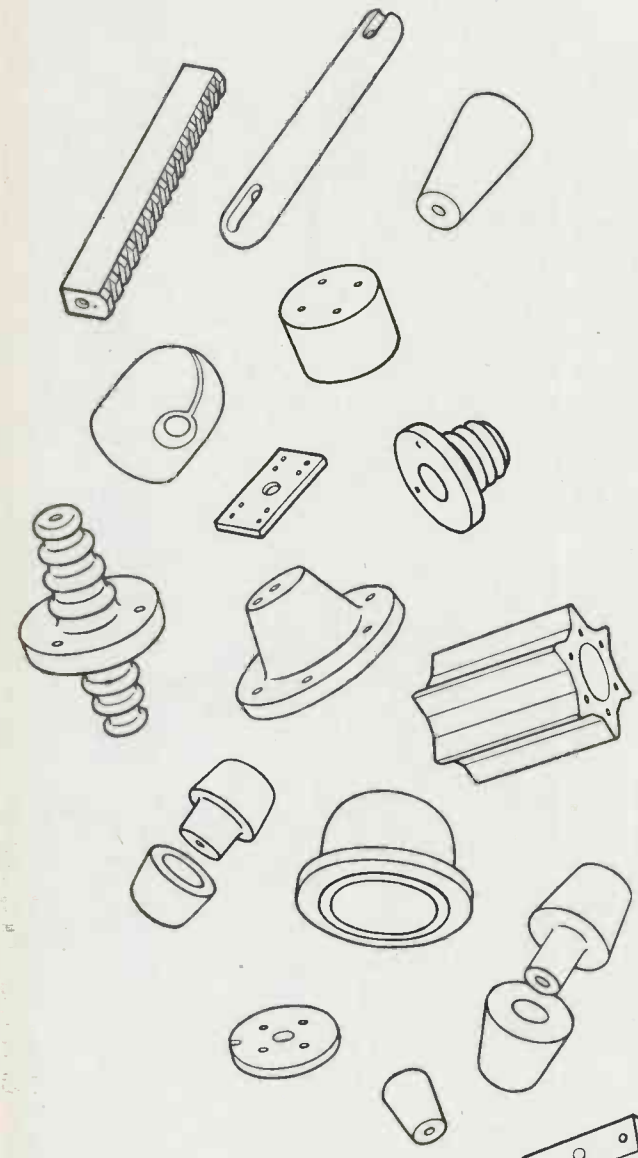
AND STEATITE CORP.

KEASBEY NEW JERSEY

STUPAKOFF

FOUNDED IN 1897

Ceramics for the World of Electronics



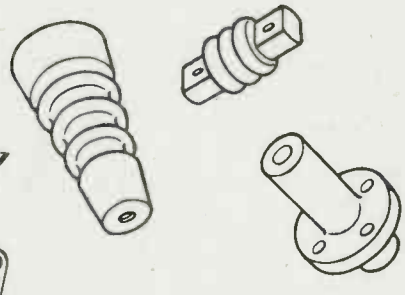
Dependable, Low Loss Steatite Insulators

"STEATITE" has become a magic word. It is not a copyrighted trade name, but is the geologic name for massive talc, a magnesium silicate, used in the production of "radio grade" ceramic insulators. However, Stupakoff Steatite Insulators, for low loss at high frequency, are superior in quality and dependability.

The dependability of Stupakoff Steatite Insulators is the result of a combination of important factors. They include the absolute control over raw materials, modern manufacturing facilities equipped with precision tools, correct engineering, and most important of all, the invaluable experience and knowledge gained through years of producing ceramic insulators.

Our ceramic manufacturing facilities are devoted entirely to the production of Stupakoff insulators for equipment used by the Signal Corps, Army and Navy. Never before has it been so important to have radio and electronic equipment perform with such a high degree of dependability. With this thought in mind, extra precaution is taken throughout our entire manufacturing process, so that Stupakoff Steatite Insulators will function under the most severe conditions.

STUPAKOFF CERAMIC AND MANUFACTURING CO.
LATROBE, PA.



STUPAKOFF
Steatite
INSULATORS

LATEST

NEWS FROM WASHINGTON

Concerning the Electronic Industries

CHANGING DEMANDS OF WARFARE—Electronic and radio manufacturers are being called on to an increasing degree, according to indications from the armed services, for the production of quick and short orders of equipment necessary to meet the changing conditions of warfare—and often to produce apparatus to match changing fighting conditions and frequency uses of the Axis forces' electronic and radio devices. This means speedy development and research. The latest WPB move to have U. S. laboratories aided by the Electronics Research Supply Agency in getting their critical components, will implement this phase of production.

EVEN FLOW OF MATERIALS SOUGHT—Emphasis on care in scheduling of contracts so as to keep an even flow of critical materials to manufacturers, in conformity with the Controlled Materials Plan, is the main keynote of both the Signal Corps and the Navy's Radio Division. Scheduling is to be founded on the objective of maintaining production levels in a pattern so as to avoid deep peaks and valleys. However, Washington authorities concerned with the furnishing of electronic and radio equipment for the war effort stressed that deliveries must be met at the specified time so the armed forces will have the proper weapons. Recent statements of General MacArthur, seeking a greater flow of supplies and airplanes to the Southwest Pacific, have demonstrated that the fighting troops must be quickly and amply supplied.

SPECTRUM STILL CROWDED—In allocations of frequencies and division of the spectrum alone there is a tremendous job of postwar planning for electronics and radio—and the task is soon to be commenced by a group of leading IRE, RMA and FCC engineers. The war effort has brought forth new undreamed-of uses of electronics and radio, and new bands have been opened up and proven valuable. FM, from reports picked up in Washington, definitely must be shifted to a higher location in the spectrum than at present. Aviation, with radio markers, ranges and landing systems, will need new space, as will the maritime radio services.

POST-WAR COMMUNICATIONS TO EXPAND—There will be more direct point-to-point radiotelegraph and radiotelephone circuits throughout the world. And international broadcasting's present bands are wholly inadequate postwar-wise and must be enlarged. There will be a pressing need for the bands which are vacated, as in the case of FM or when and if present standard broadcasting operations shift to the newer arts of FM and television such as the use of the conventional high frequencies for international flying routes. In other words, after the war, the spectrum still looks as if it will be congested.

COORDINATION OF WORLD RADIO—After the war, according to a growing feeling in the Washington circles directing the nation's communications and radio policies, a new principle of allocations must guide the first international telecommunications conference following peace. International conferences in radio after the war must not think in terms of exclusive rights for nations as prevailed before the conflict and the guideposts will be instead the coordinated use of facilities and coordinated engineering standards.

HIGH TECHNICAL STANDARDS—In the opinion of Washington officials the United States and its radio and communications companies should exercise sufficient foresight to require installations of high engineering standards and directional antennas, taking in the new developments and improvements such as multi-channel operations and sharing of frequencies, so that this nation may prove to the rest of the world such technical steps are necessary. It is viewed by the Washington radio leadership that there will be a keynote of coordination in the future postwar telecommunications treaty rather than a consideration in its provisions of the desires and rights of the various nations.

CANCELLATION CLAUSE—The Army and Navy are studying the formulation of a uniform procurement cancellation clause and policy to be inserted in all war-production contracts,—with a tapering off of military production projected—but so far no final formula has been evolved by the services. . . . . Manpower problems constituted the major subject of discussion of the recent WPB Radio Industry Advisory Committee meeting and a recommendation for the uniform presentation of requests to draft boards by companies in the field in seeking deferment of key skilled workers was formulated.

to clear it up. This investigation gave *meet Captain Round of the British*

Motion-Picture Engineers Convene May 4-6

Engineering reports showing how the motion-picture art and industry are aiding the armed services and the war effort will highlight the 53rd Semi-Annual Convention of the Society of Motion Picture Engineers, to be held at the Hotel Pennsylvania May 4, 5 and 6.

Sylvan Harris, chairman of the papers committee, and editor of the SMPE Journal, said that many extremely interesting papers have already been received, but refused to disclose their titles as this issue went to press. Mr. Harris, who was executive secretary of the Society, is now engaged in special research at Johns Hopkins University. The Society's present executive secretary is Harry Smith, Jr.

Ed Kuykendall, President of the Theatre Owners Association, will deliver the featured address at the get-together luncheon on the opening day of the convention. The luncheon, for members, their families and guests, will be held at 12:30 o'clock. Registration will begin Tuesday, May 4, at 9 a. m., in the Pennsylvania Hotel, followed by a business and technical session.

Another technical session will be held Tuesday afternoon, with two more on Wednesday and two on Thursday. The 53rd Semi-Annual banquet and dance will be given on Wednesday evening at 8:30 o'clock in the Georgian Room of the Hotel.

New Electronic Research Supply Agency

Laboratories working on radio research for the Army or Navy hereafter will be able to get from a central stockpile, administered by the government, critical electronic components not quickly available in commercial channels. Administration of this central source of supply will be housed in the Electronic Research Supply Agency, set up at the urgent request of the armed services, the Office of Scientific Research and Development and WPB.

For several reasons, a central stockpile for electronic parts to be used in research labs will expedite completion of important developments for war uses. Laboratory orders, a WPB source pointed out, are for small amounts which can be fitted only with difficulty into the schedules of manufacturers. Laboratories are therefore often forced to canvass many manufacturers and dealers to obtain swift delivery of small amounts of equipment which are holding up vital research projects. In addition, the Electronic Research Supply Agency will make it unnecessary for labs to build up their own complete stockpiles of components. Formerly many components used in research laboratories did not meet Army or Navy standards.

Maurice Despres, well-known New York radio distributor, who has been appointed managing director of the new Electronic Research Supply Agency, 460 Fourth Avenue, New York

The new ERSA, operating without profit, will be located in New York City. Laboratories will, of course, not be compelled to place their purchase orders through the ERSA and should continue to use available sources to the fullest extent reserving the agency for the last resort, the WPB stressed. Approved laboratory orders which may be filled by ERSA can be placed directly with the agency or can be channeled to the agency through commercial distributors.

Civilian Tubes to Carry Brand Names

The WPB Radio Division's program to keep civilian radio sets supplied with receiver tubes was further implemented when the seven manufacturers who will manufacture tubes for civilian use decided to carry familiar brand names instead of the general designation "Victory Line." The brand names will be used for at least ninety days and probably will be continued thereafter, WPB sources indicated.

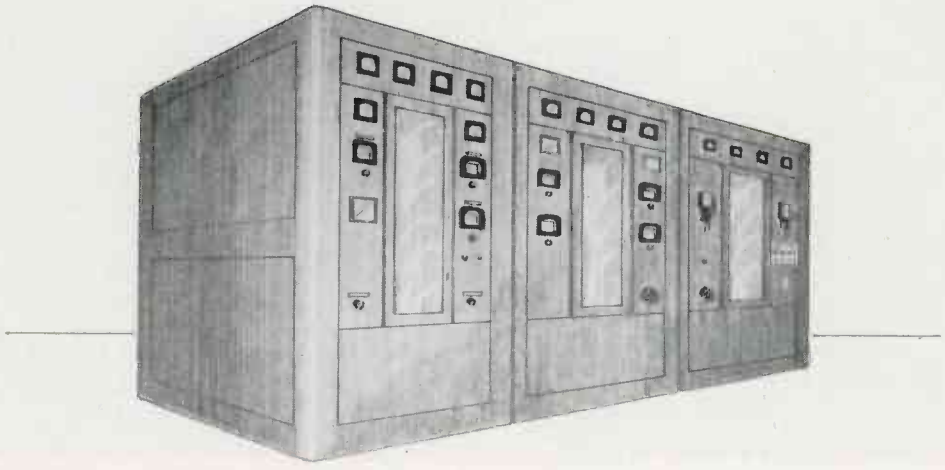
Most of the tube manufacturers have said they intend to mark tubes made from materials allotted by the WPB for civilian use by the initials "M.R." standing for "Maintenance and Repair." This designation should effectively stop the raiding of civilian stocks to meet emergency military needs, which last year was responsible for many local tube shortages. It was understood that the WPB had set the production goal of 44 million receiving tubes during 1943.

Meanwhile, the WPB April 5 placed under allocation, effective May 1, polystyrene, a thermoplastic used for high frequency insulation.

CONTINUOUSLY SINCE 1878

Manufacturers of

COMMUNICATION EQUIPMENT



DESIGNING ENGINEERS & MANUFACTURERS OF

ELECTRONIC {INDUSTRIAL DEVICES
HIGH POWER RADIO FREQUENCY GENERATORS
TRANSMITTERS
RECEIVERS
AUTOMATIC TELEGRAPH EQUIPMENT
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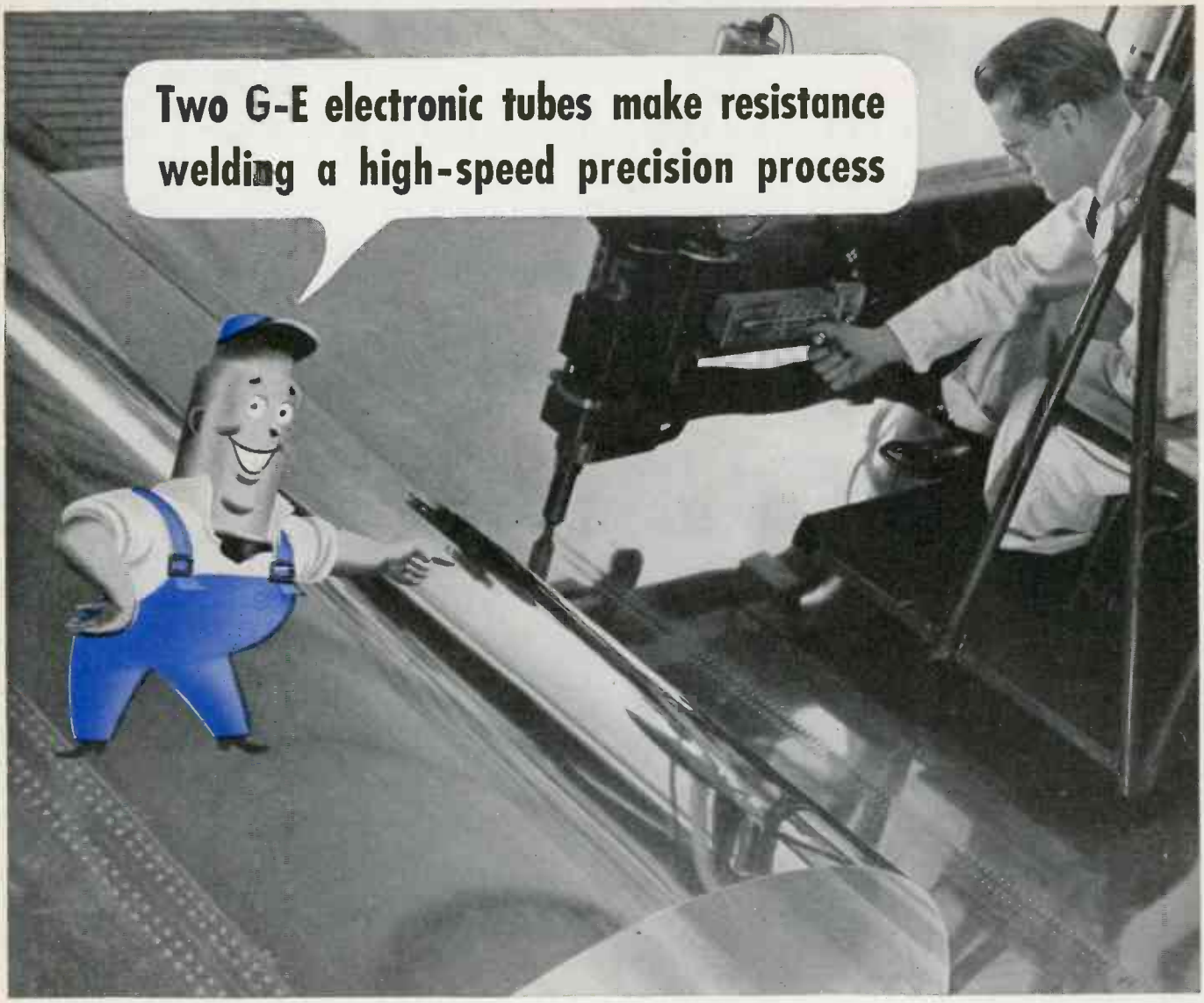
Two G-E electronic tubes make resistance welding a high-speed precision process



Without the ignitron and the thyratron, today's high-production resistance welding of aluminum and stainless steel would not be possible

METALS such as aluminum and stainless steel, once difficult or impossible to weld, now may be fused easily in spot welds — or in a neat seam (as in the production of the Boeing Flying Fortress) at a rate as great as seven feet per minute and at a fraction of the cost of riveting or other means of fastening.

This operation utilizes two types of electronic tubes. The ignitron is the *power tube*. Sturdy and steel-jacketed, it provides the high current which applied for a fraction of a second fuses the metals permanently.

The thyratron is the *precision timer*. This automatic switch controls the passage of the heavy welding current, supplied by the ignitron, with an accuracy of 8 thousandths of a second.

Together, ignitron and thyratron provide power suited for welding loads that range from thin aluminum parts to heavy slabs of steel. In any range, they offer uniform control, dependability and high production.

It is the purpose of the G-E electronic tube engineers to aid *any* manufacturer of electronic devices in the application of tubes. General Electric, through its nation-wide distribution system, is also prepared to supply *users* of electronic devices with replacement tubes.

We will be glad to place interested men in your plant on our electronics mailing list. For example, we would like to send a full color spectrum chart showing typical electronic tubes and applications. Write on company letterhead. *Electronics Department, General Electric, Schenectady, N. Y.*

• *Tune in on Frazier Hunt and the News every Tuesday, Thursday, Saturday evening over C.B.S. On Sunday night listen to the "Hour of Charm" over N. B. C. See newspapers for time, station.*

GENERAL ELECTRIC

162-84-8850

Conventions and Meetings Ahead

(*Continued from page* 102)

Institute of Radio Engineers (W. B. Cowilich, 330 W. 42nd St., New York), June 2, dinner meeting, New York.

American Society of Mechanical Engineers (Ernest Hartford, 29 West 39th Street, New York), June 14-16, Los Angeles, Cal.

American Association for the Advancement of Science, 27 Washington Square, New York, June 14-19, Corvallis, Oregon.

American Mathematical Society, June 16-17, Corvallis, Oregon.

American Institute of Electrical Engineers (H. H. Henline, 29 West 39th Street, New York); National Technical Meeting, June 21-25, Cleveland, Ohio.

American Society for Testing Materials, June 28-July 2, Pittsburgh.

Associated Police Communication Officers, Inc. (Buffalo, New York), July, Buffalo, New York.

American Welding Society (Miss M. M. Kelly, 29 West 39th Street, New York), Oct. 18-21, Chicago.

National Electrical Manufacturers Association (W. J. Donald, 155 East 44th Street, New York), Annual Meeting, Oct. 25-29, Waldorf-Astoria Hotel, New York.

Radiosonde and Air-Mass Analysis

The electronic development of the radiosonde was described and discussed by Leo A. Weiss, instrument design supervisor of Simmonds Aerocessories, Inc., at the April 8th meeting of The Radio Club of America at Columbia University.

A number of methods have been devised for securing a record of temperature, humidity, and pressure at various heights above the earth for long-range weather forecasting. The many advantages of the radiosonde were pointed out. Basically, the radiosonde consists of an ultra-high-frequency, battery-operated oscillator whose cw signal is "keyed" by a low frequency relaxation oscillator. The frequency of the latter is controlled by time-constant variations introduced by mechanisms varying resistors to correspond with temperature and humidity changes. Known pressure-changes switch the relaxation oscillator between the temperature, humidity, and precision calibration-check resistors by means of an ingenious mechanical system. The signals emitted by the radiosonde are received, recorded, and interpreted in various ways which were interestingly described. Mr. Weiss told members there are about sixty weather stations in the United States from which balloon-carried radiosondes are now sent up several times daily and predicted that post-war advances in the quantity and quality of information gathered by the radiosonde would introduce a new era in weather forecasting.

RMA Transmitter Organization

Further organization of the RMA Transmitter Division, of which G. W. Henyan of Schenectady, N. Y., is chairman, has been effected. Five product sections of the division are being organized and activities planned to include RMA members manufacturing transmitting and related products.

Following are product sections which have been organized with their respective chairman: Broadcast Transmitters—C. W. Miller, Baltimore, Md.; Emergency Service Communication Equipment—F. A. Gunther, Long Island City; Aircraft and Marine Equipment—J. W. Hammond, Baltimore, Md.; and Piezo-electric Quartz Crystals—G. E. Wright, Erie, Pa. Organization of a fifth product section of radio transmitter tubes, with the chairman to be named later, also has been arranged.

WPB Resistor Consultant

Clarostat's Vic Mucher has been appointed a consultant to the Radio and Radar Division of WPB on the dollar-a-year basis. He is subject to call at any time and spends several days in Washington each month.

Victor Mucher

Electronic Weather Observations

The March 30 meeting of the New York Society for Measurement and Control was addressed by Charles H. Colvin, director Guggenheim School of Aeronautics, on "Instrumentation in the Weather Service." The weather service, formerly a service of news and agricultural interest, said Mr. Colvin, has now become of vital importance in aeronautical operations, and the added requirements have taxed the reliability and capabilities of the previous measuring techniques. Among the newer problems which, with electronic aids, have received much attention of late, are altimeters of increased accuracy, better ways of measuring humidity in selected areas and at specified levels, wind speed, evaporation rate, and vertical visibility.

In many branches of the service automatic tele-recording methods have been put into use, and more are needed, to reduce the difficulties of providing sufficient attention and for the recording of data in remote places. Newer services, such as the starting time, duration and rate of precipitation are being considered.

Among the modern technical advances are the greater use of radiosonde equipment for exploring the upper atmosphere by balloon-transported radio sets that survey the air as to temperature, pressure, humidity and, to some extent, wind direction. Some fifty weather stations start and analyze these balloon ascensions twice daily. Each balloon carries a 700-gram radio transmitter operating on 72.2 megacycles and automatically translating weather conditions into specific coded signals.

Cloud height, humidity

An interesting application of electronics utilizes a photocell amplifier that is capable of analyzing small light differences brought about by the projection of modulated light into the clouds. The light intensity modulation ratio reflected in daylight by clouds, if present, is sometimes as small as one part in four million, but this small change is capable of being interpreted by a triangulation method, in terms of cloud height.

A very reliable system for measuring humidity has been developed, using spectroscopic means wherein the differential absorption of two light rays of different wavelengths, one of which is not affected by water vapor, is recorded. This system gives the total length of the water path that exists between two points, say 100 feet apart, from which information the humidity conditions can be computed.

BLAZING THE

HOW ELECTRONIC TELEVISION WAS CREATED BY RCA LABORATORIES . . . HISTORIC STEPS IN THE EVOLUTION OF THIS NEW SCIENCE

BACK IN 1929 a modest man with a quiet voice calmly announced two inventions . . . two amazing almost magic devices that made it possible for radio to "see" as well as to "hear."

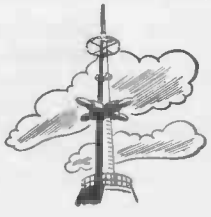
This man was Dr. V. K. Zworykin of RCA Laboratories. And his research in electronics gave radio its electronic "eyes" known as the Iconoscope and the Kinescope. The former is the radio "eye" behind the camera lens; the latter is the receiver's screen.

Since that red-letter day in television history, ceaseless research in the science of radio and electron optics has established RCA Laboratories as the guiding light of television.

The decade of the thirties saw television's coming-of-age. It brought new scientific instruments and discoveries; it developed new techniques of showmanship; it even created new words—televise, telecast, teleview, and telegenic.

In the evolution of television there have been "high spots"; historic milestones of progress; definite "firsts" —made possible by the services of RCA.

1928—1932—FROM THE FIRST EXPERIMENTAL STATION TO ALL-ELECTRONIC TELEVISION



Station W2XBS, New York, was licensed to RCA in 1928 to conduct television experiments. Transmitter located at laboratory in Van Courtlandt Park, was later moved to Photophone Building, 411 Fifth Avenue; then to New Amsterdam Theatre until 1931, when operations were transferred to Empire State Building.

On Jan. 16, 1930, Television pictures were transmitted by RCA from W2XBS at 411 Fifth Avenue and shown on 6-foot screen at RKO-Proctor's 59th Street Theatre, New York.

Television station W2XBS, operated by National Broadcasting Company, atop New Amsterdam Theatre, New York, opened for tests July 7, 1930, with the images whirled into space by a mechanical scanner.

Empire State Building, the world's loftiest skyscraper, was selected by RCA as the transmitter and aerial site for ultra-short-wave television experiments using both mechanical and electrical scanners. Operation began October 30, 1931.

Field tests of 240-line, all-electronic television were made by RCA at Camden, N. J., with television signals relayed by radio from New York through Mt. Arney, N. J., for the first time, May 25, 1932.

1936—OUTDOOR TELEVISION

Television outdoors was demonstrated by RCA at Camden, N. J., on April 24, 1936, with local firemen participating in the program broadcast on the 6-meter wave.

All-electronic television field tests of RCA began June 29, 1936, from ultra-short-wave transmitter in Empire State Building and aerial on the pinnacle releasing 343-line pictures.

Radio manufacturers saw television demonstrated by RCA on July 7, 1936, with radio artists and films used to entertain.

1937—ELECTRON "GUN"

Electron projection "gun" of RCA was demonstrated on May 12, 1937, to Institute of Radio Engineers, with pictures projected on 8 x 10-foot screen.

Television on 3 x 4-foot screen was demonstrated by RCA to Society of Motion Picture Engineers on October 14, 1937; pictures were transmitted from Empire State Building to Radio City.

Mobile television vans operated by RCA-NBC appeared on the streets of New York for first time, December 12, 1937.

1938—BROADWAY PLAY TELEVISED

Scenes from a current Broadway play, "Susan and God," starring Gertrude Lawrence, were telecast on June 7, 1938, from NBC studios at Radio City.

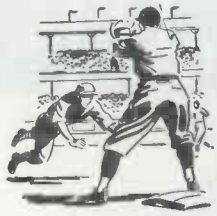
RCA announced on October 20, 1938, that public television program service would be inaugurated and commercial receiving sets offered to the public in April, 1939.

1939—BASEBALL—KING GEORGE VI—FOOTBALL

Opening ceremonies of the New York World's Fair televised by NBC on April 30, 1939, included President Roosevelt as first Chief Executive to be seen by television.

"A first from the diamond." Columbia vs. Princeton, May 17, 1939, televised by NBC.

TELEVISION TRAIL



Improved television "eye" named the "Orthicon," introduced by RCA on June 8, 1939, added greater clarity and depth to the picture.

Television spectators in New York area on June 10, 1939, saw King George VI and Queen Elizabeth at the World's Fair, telecast by NBC.

Brooklyn Dodgers-Cincinnati game telecast by NBC on August 26, 1939, was the first major-league baseball game seen on the air.

First college football game—Fordham-Waynesburg—televised by NBC, September 30, 1939.

Television from NBC station in New York was picked up by RCA receiver in plane 20,000 feet over Washington, D. C., 200 miles away, October 17, 1939.

Television cameras of NBC scanned the scene in front of Capitol Theatre and in lobby at premiere of motion picture "Gone With The Wind," December 19, 1939.

1940—HOCKEY—COLOR—TRACK BIRD'S-EYE TELEVISION

Color television was demonstrated on February 6, 1940, to Federal Communications Commission by RCA at Camden, N. J.

First hockey game was televised by NBC camera in Madison Square Garden, February 25, 1940.

Basketball: Pittsburgh-Fordham, also NYU-Georgetown at Madison Square Garden were televised by NBC, February 28, 1940, as first basketball games seen on the air.

First Intercollegiate track meet at Madison Square Garden telecast on March 2, 1940.

Using RCA's new, compact and portable television transmitter, a panoramic view of New York was televised for the first time from an airplane on March 6, 1940. Television sightseers as far away as Schenectady saw the bird's-eye view of the metropolis.

Premiere of television opera on March 10, 1940, featured Metropolitan Opera stars in tabloid version of "Pagliacci."

First telecast of religious services on March 24, 1940, from NBC Radio City studios, were seen as far away as Lake Placid.

Ringling Brothers-Barnum and Bailey circus viewed on the air, April 25, 1940, through NBC electric camera in Madison Square Garden.

Television pictures on 4½ x 6-foot screen were demonstrated at RCA annual stockholders meeting May 7, 1940, at Radio City.

Republican National Convention was televised on June 24, 1940, through NBC's New York station via coaxial cable from Philadelphia.

Democratic National Convention films rushed by plane from Chicago for NBC were telecast in New York, July 15, 1940.

President Roosevelt was seen by television throughout the Metropolitan areas as he addressed Democratic rally, October 28, 1940, at Madison Square Garden.

Election returns on November 5, 1940, televised for first time by NBC, showed teletypes of press associations reporting the news.

1941—COMMERCIAL TELEVISION

Television progress demonstrated to FCC on January 24, 1941, included: home-television receiver with 13½ x 18-inch translucent screen; television pictures 15 x 20 feet on New Yorker Theatre screen; pictures relayed by radio from Camp Upton, Long Island, to New York; also facsimile multiplexed with frequency modulation sound broadcast.

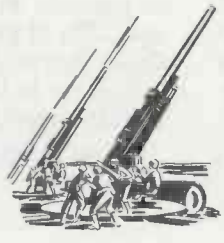
Television pictures in color were first put on the air by NBC from Empire State Building Transmitter on February 20, 1941.

Large-screen television featuring Overlin-Soose prize fight on May 9, 1941, at Madison Square Garden was demonstrated by RCA at New Yorker Theatre; also, on following days, baseball games from Ebbets Field, Brooklyn.

Commercial operation of television began July 1, 1941, on a minimum schedule of 15 hours a week. NBC's station WNBT, New York, the first commercially licensed transmitter to go on the air, issued the first television rate card for advertisers, and instituted commercial service with four commercial sponsors.

Entry of the United States in World War II, enlisted NBC television in New York to aid in illustrating civilian defense in air-raid instructions in the New York area.

1943—AMERICA AT WAR!



Today RCA Laboratories, pioneer in the science of electronics, is devoting all its efforts to the war.

Yet, from the discoveries, developments and inventions made under the urgency of war, will come greater wonders for the Better Tomorrow of a peacetime world.

RADIO CORPORATION OF AMERICA

RCA BUILDING, NEW YORK

CREATOR OF ELECTRONIC TELEVISION

LAST YEAR'S BONDS GOT US STARTED

THIS YEAR'S BONDS

ARE TO WIN!

★ Last year saw nearly 30,000,000 workers voluntarily buying War Bonds through some 175,000 Pay-Roll Savings Plans. And buying these War Bonds at an average rate of practically 10% of their gross pay!

This year we've got to top *all* these figures—and top them handsomely! For the swiftly accelerated purchase of War Bonds is one of the greatest services we can render to our country . . . and to our own sons . . . and our neighbors' sons. Through the mounting purchase of War Bonds we forge a more potent weapon of victory, and build stronger bulwarks for the preservation of the American way of life.

"But there's a Pay-Roll Savings Plan already running in my plant."

Sure, there is—but how long is it since *you've* done anything about it? These plans won't run without winding, any more than your watch! Check up on it today. If it doesn't show substantially more than 10% of your plant's pay-roll going into War Bonds, it needs winding!

And you're the man to wind it! Organize a vigorous drive. In just 6 days, a large airplane manufacturer increased his plant's showing from 35% of employees and 2½% of pay-roll, to 98% of employees and 12% of pay-roll. A large West Coast shipyard keeps participation jacked up to 14% of pay-roll! You can do as well, or better.

By so doing, you help your nation, you help your workers, and you also help yourself. In plant after plant, the successful working out of a Pay-Roll Savings Plan has given labor and management a common interest and a common goal. Company spirit soars. Minor misunderstandings and disputes head downward, and production swings up.

War Bonds will help us win the war, and help close the inflationary gap. And they won't stop working when victory comes! On the contrary—they will furnish a reservoir of purchasing power to help American business re-establish itself in the markets of peace. *Remember, the bond charts of today are the sales curves of tomorrow!*

You've done your bit Now do your best!

THIS SPACE IS A CONTRIBUTION TO AMERICA'S ALL-OUT WAR EFFORT BY

ELECTRONIC INDUSTRIES

Kellogg Gal Tries Army Walkie-Talkie

When the Army Signal Corps put on a show at the Chicago plant of Kellogg Switchboard & Supply Co., the telephone manufacturer's employees, who know all about wire telephones, got some demonstrations of Army wireless "walkie-talkies"

Pigeons Will Stand-by for Radio

The Directorate of Communications of the Army Air Forces has established the first Pigeon Company of the Air Forces, out of a total of fifteen to be activated. The first company, composed of 11 officers and 168 enlisted men, is to be located at Pope Field, Fayetteville, N. C.

The pigeons are to be used for emergency purposes when planes are forced down or radio secrecy is necessary. In the latter case pigeons can be dropped out of planes in flight, some times with no protection and in other cases covered with loose paper bags to enable them to get away from the slipstream. Captain A. C. Eastburn is the officer-in-charge of pigeon training.

FM Station W75NY's Mysterious Fire

On the night of Saturday, April 10, a mysterious fire broke out in the transmitter rooms of FM Station W75NY, located atop the 45-story tower of Hotel Pierre, corner of 61st and Fifth Avenue, New York City.

The station had been operating satisfactorily all that day and had signed off at 9:29 p. m. The carrier signal was turned off at 9.36 p. m., after which the engineers in charge made their customary overall check and inspection of switches and all safety devices, including the adjoining room containing work bench tools, supplies and testing equipment. No circuit was left alive. At 9:45 p. m. the lights were turned off and the engineers went home.

Access to the station is by way of stairways, and visitors are not allowed. All of the wiring throughout the station is in approved conduit and maintained in first-class condition, as the equipment is periodically inspected by city inspectors. There were no soldering irons left running, nor any waste refuse around that could possibly have caused spontaneous combustion. Yet at 10:26½ p. m. the fire in the work room had become so intense it stopped the large clock on the other side of a five-inch thick concrete wall. At 10:53 p. m. the fire alarm was turned in by passersby on the street who noticed the fire and smoke pouring from the slanting copper roof of the penthouse 700 feet up in the air. Station W75NY was fully described in an article published in the February, 1943, issue of "Electronic Industries."

At the time we go to press no definite explanation of the fire has been ascertained and the above story of what happened, so far as is known, is given to our readers for the purpose of showing what great care and caution should be always taken to guard against any such accidents to transmitter equipment.

Electronic Head for Philips

A. E. Snyder, just appointed manager of the industrial electronic division of the North American Philips Co., with factory at Dobbs Ferry, N. Y., was for 33 years with Westinghouse Lamp Co. at Bloomfield, N. J., where he recently served as assistant general manager. Industrial X-rays will be among the first fields engaged in by the American subsidiary of the great European Philips firm

Ziegler on Quartz Committee

John M. Ziegler, Crystal Products Company, Kansas City, Mo., has been appointed to the National Quartz Crystal Industries Advisory Committee of the War Production Board. Mr. Ziegler has, for some time, been a member of the Crystal Standardization Committee. A pioneer in the crystal field and a former member of the RCA Research Laboratories for crystals, Mr. Ziegler taught the first piezo-electrical application courses in the Government Engineering Science, Management, War Training Program sponsored by the University of Kansas.

Navy Seeks UHF Engineers

The Navy has urgent need of trained engineers to handle and maintain ultra-high frequency radio equipment and is offering commissions to qualified men, the Third Naval District has announced.

"Hundreds of billets" await electrical engineers now engaged in work not essential to the war effort.

Wartime expansion of the Navy has greatly increased the need for men with ultra-high frequency experience, according to Capt. Kenneth G. Castleman, U.S.N. (Ret.), Director of Naval Officer Procurement, 33 Pine Street, New York, N. Y. To fill this need the Office of Naval Officer Procurement has been permitted to relax the usual physical requirements. Applications will be accepted from qualified engineers up to 50 years of age with slight physical defects which would not interfere with performance of duty.

"Experienced men holding degrees in electrical, radio or communications engineering, or with background in physics and mathematics, are technically qualified for

electronics work," the announcement said. "Newly-commissioned officers in ultra-high frequency work are given the Navy's three-months' course in electronics either at Harvard University or Bowdoin College, followed by an additional three months' laboratory course at Massachusetts Institute of Technology.

Applicants may communicate with the Office of Naval Officer Procurement.

Batt to Address Electrical Jobbers

C. G. Pyle, managing director, announces that the National Electrical Wholesalers Association will hold an Industry War Conference at the Hotel Statler, Buffalo, N. Y., May 24-26.

An address by W. L. Batt, vice-chairman WPB, will point up the whole meeting because Mr. Batt will describe, from the Government's viewpoint, what electrical wholesalers are doing and can do to further the War Production Program.

Long before the Defense Program came along Mr. Batt, President of SKF Industries, was a national figure on the production front of business. Even before Pearl Harbor, he was giving his time, effort and skill to the Defense Program as one of OPM's dollar-a-year men. Today, to Mr. Batt as vice-chairman of the War Production Board, goes a large share in the gearing up of our industries to turn out huge quantities of war material.

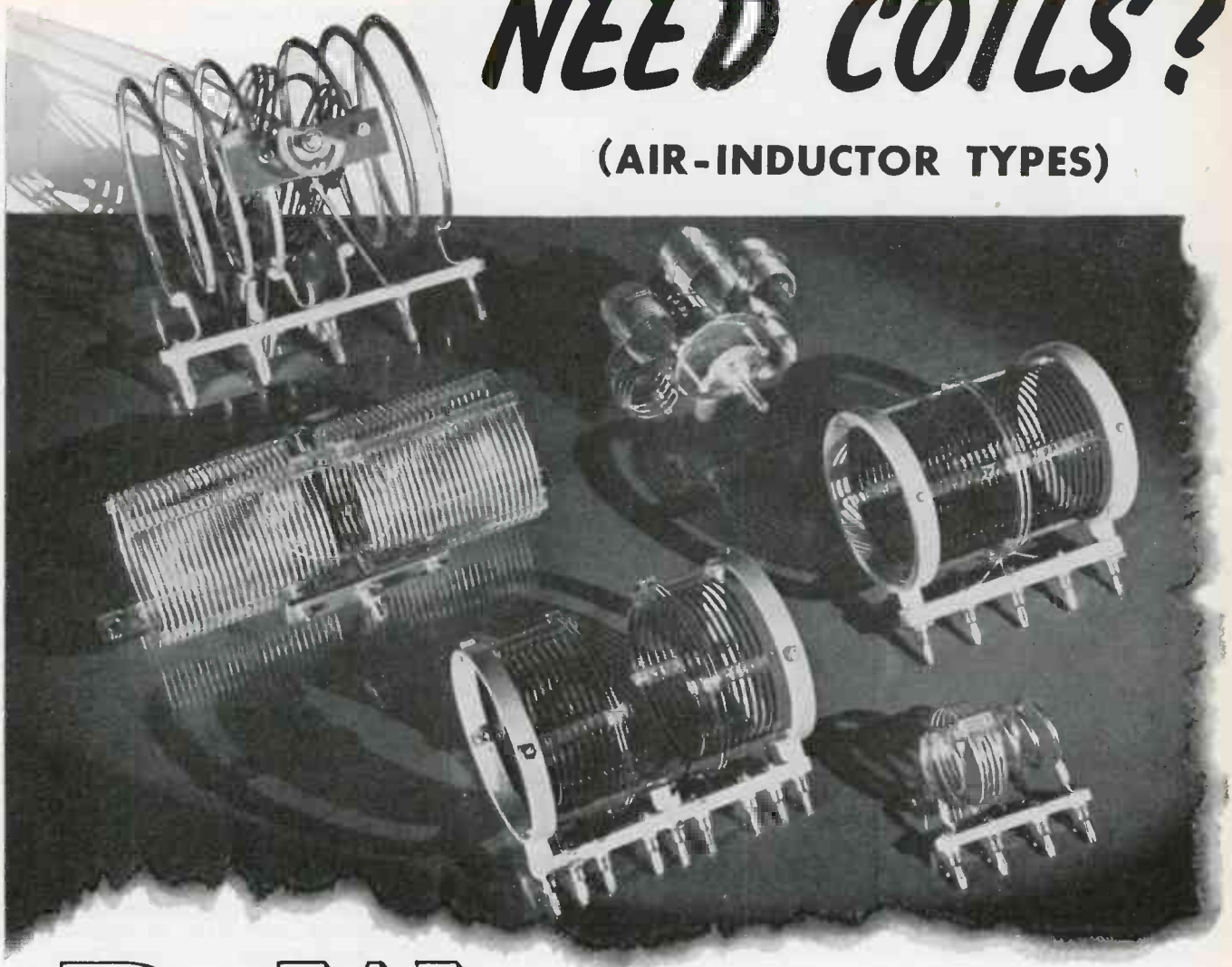
The Wholesalers' conference will also deal with distribution problems of the electrical industry affecting the all-over-Win-The-War Production Program.

Heads Tung-Sol Sales

George A. Bodem who has been appointed sales manager of Tung-Sol Lamp Works, Inc., Newark, N. J., in charge of radio tubes, lamps and special products

NEED COILS?

(AIR-INDUCTOR TYPES)



B & W CAN SUPPLY THEM!

in large quantities or small —on line production runs

It took many years of peace to engineer B & W Air Inductor Coils to their present state of perfection, but . . .

It took less than one year of war to teach us how to produce them by modern line methods—better and faster than coils have ever been made before!

We'd like to stack these expanded facilities against your next coil order—whether it calls for a few coils or a thousand—for relatively common or highly special units—and regardless of any difficult "fixed for fightin' " specifications that may be involved. B & W delivers the goods—and that not only means promptly, but with rigid maintenance of our highest quality standards!

VARIABLE AIR CONDENSERS

The war has meant ten league strides in the production of B & W Variable Air Condensers, too. They're shorter than conventional units, have built-in neutralizers and coil-mounting feature, and are unexcelled for exacting high-power uses. Technical Data Sheet upon request.

BARKER & WILLIAMSON

Manufacturers of Quality Electronic Components for 10 years

235 FAIRFIELD AVENUE, UPPER DARBY, PA.

International BC Coordinators

A new International Broadcasting Coordinating Committee, headed by FCC Commissioner T. A. M. Craven, has just been created by the Board of War Communications to study methods of making available the necessary radio equipment for psychological radio warfare and to determine the problems of manufacturing such short wave broadcasting equipment in comparison with the military needs.

Besides Commissioner Craven, the other members of the Committee are Brigadier General Frank E. Stoner, Chief of the Signal Corps Operating Services, for the Army; Lieutenant Commander A. B. Chamberlain, former CBS Chief Engineer, of the Radio Division of the Bureau of Ships for the Navy; Roy C. Corderman, Assistant Chief of the OWI Overseas Branch's Bureau of Communications Facilities, for the OWI and CIAA; and Frank H. McIntosh, Assistant to the Director of the WPB Radio Division, for WPB. Philip F. Siling, Chief of the FCC International Division, is secretary of the committee and is alternate on the committee for Commander Craven, both as representatives of the FCC.

Mr. Corderman was recently appointed Assistant Chief of the OWI Overseas Communications Bureau. He is exceptionally well qualified for this work in planning and arranging the communications facilities of the OWI in its international broadcasting and news transmission functions because of his long service with the A. T. & T. Long Lines Department as radio and transmission engineer. He also has played an important role in the amateur radio and broadcasting fields. For many years he was the Coordinator of the American Radio Relay League Emergency Network in the middle Atlantic and southeastern regions.

Signalman Walks a Mile, Finds a Camel!

One Signal Corps telephone squad in North Africa had to encounter a new problem of preserving telephone service recently at the Tunisian front—camels proved the trouble source.

At a headquarters signal office, an important communication line suddenly went dead and no one could account for the trouble until a sergeant discovered the difficulty. A drove of camels had been driven into a shady patch beside the headquarters and had begun to munch at grass and telephone lines on the ground with equal relish. The trouble difficulty cleared up as soon as the camels were driven away.

CHAINED . . . FOR SAFETY

From the time of their earliest use in hospital operating rooms, the handling of most inhalation agents has been fraught with danger of fire or explosion from static sparks. However, this risk did not receive serious recognition until recent years when accepted engineering principles were applied to this aspect of anesthesia and surgery.

With the introduction of cyclopropane and other newer types of gases, further attention was focused on the elimination of this hazard. How could the electrical potentials of the anesthetists, the patient and the apparatus be equalized to eliminate the possibility of spark?

The answer was found in fastening the group together by means of silver chains and other conductive materials. Connected into the circuit, a device consisting of high resistances prevents the formation of a static charge of any important degree of intensity.

IRC is proud to have been consulted and to have lent the aid of its research laboratories to this important scientific development.

• • •

Though we may not be able right now to supply you with the Resistors you need for other than war uses, our engineers and executives are at your service for counsel, without obligation, to help you solve your Resistor problems. Please feel free to consult them in your search for the best obtainable resistance devices.

★ PREFERRED FOR PERFORMANCE ★
IRC
★ FIXED & VARIABLE RESISTORS ★

INTERNATIONAL RESISTANCE COMPANY

425 N. BROAD STREET, PHILADELPHIA

Ken-Rad to Spend $2,215,000

Authorization of a contract with Ken-Rad Tube & Lamp Corporation, Owensboro, Ky., by the Defense Plant Corporation, Washington, for plant facilities in Indiana and Kentucky to cost $1,300,000 is announced by Roy Burlew, Ken-Rad's president. This appropriation is allocated to the construction of a branch plant in Tell City, Indiana, and the installation of new equipment in the company's Owensboro plants. Construction and installation work will begin soon. The Tell City plant is expected to employ 1,500 persons.

The Defense Plant Corporation's authorization follows closely upon a government appropriation of $915,000 for the Bowling Green, Ky., branch plant of the Ken-Rad Company, for which materials for construction are now being shipped. The 80,000-sq. ft. Bowling Green plant will manufacture "radio and secret ordnance equipment for the armed forces" and will employ 2,300 workers, earning an estimated annual payroll of $2,200,000. The branch is under the parentage of the Ken-Rad Tube & Lamp Corporation — the original Ken-Rad Company — and the Ken - Rad Transmitting Tube Corporation, younger affiliate.

Spates, Vp. Littelfuse, Inc.

New vice-presidents of Littelfuse Incorporated, are Ash Wood, sales manager at the El Monte, Calif., plant, and Gerald E. Spates, general manager of the Chicago plant. Littelfuse Inc. manufactures aircraft and instrument fuses and accessories. The main plant is at 4757 Ravenswood Ave., Chicago. A large modern plant was erected and opened fully staffed at El Monte, a suburb of Los Angeles, in 1942.

G. E. Spates

SENTINEL OF WAR TODAY...

GUIDE POST TO A NEW WORLD TOMORROW

Today, the research and experience of the North American Philips Company in electronics are devoted to the single aim of aiding the United Nations war effort. Tomorrow, this knowledge will aid industry in creating a new world for free men.

* * *

Products for Victory include: Cathode Ray Tubes; Amplifier Tubes; Rectifier Tubes; Transmitting Tubes; Electronic Test Equipment; Oscillator Plates; Tungsten and Molybdenum in powder, rod, wire and sheet form; Tungsten Alloys; Fine Wire of all drawable metals: bare, plated and enameled; Diamond Dies.

X-Ray Apparatus for industrial, research and medical applications. (Philips Metalix Corporation.)

NORTH AMERICAN PHILIPS COMPANY, INC.

Electronic Research and Development

Factories in Dobbs Ferry, N. Y.; Mount Vernon, N. Y. (Philips Metalix Corp.); Lewiston, Maine (Elmet Division)

FTR Gets "E" Award

Presentation of the Army-Navy "E" Pennant to the Laboratories Division of Federal Telephone and Radio Corporation, manufacturing affiliate of International Telephone and Telegraph Corporation, was made April 20 at the International Telephone Building, 67 Broad Street, New York City. Colonel Ira H. Treest of the U. S. Army Signal Corps, was the principal speaker.

The award was accepted for the company by Major General George S. Gibbs, Vice Chairman of Federal Telephone and Radio Corporation, and for the employees of the Laboratories by W. E. Boehle. Lieutenant John D. Lodge of the United States Naval Reserve, presented "E" pins to representatives of the employees.

The Laboratories is engaged 100 per cent in the development and production of technical equipment for the armed forces.

Supply of Fine Wire

Manufacturers of resistors and fine wire, used in military radio, are urged to place orders quickly for fine wire in a letter by S. K. Wolf, Chief of the Resources Branch of the Radio Division, War Production Board.

Mr. Wolf pointed out that while orders for many sizes of fine wire are being delayed, the wire producers are working below capacity. He stated that facilities for producing some sizes have not been completed so that complaints of slow deliveries may be justified. He urged those who are experiencing difficulty in the delivery of fine wire, 0.002 or smaller, to seek the direct assistance of the Resources Branch.

"There have been complaints from some of you regarding fine wire deliveries," he wrote to manufacturers. "These complaints may be justified in certain sizes of fine wire where there are definite bottlenecks since some extensions have not been completed. However, there are sizes which are still not up to capacity of production in spite of the fact that these sizes are likewise necessary to meet the requirements of your industry. Apparently some of you have yet to place orders to meet your requirements in these latter available sizes.

"In the event you have placed your orders for fine wire (.002 and smaller) and are experiencing any delivery difficulties, we will assist you if, with your request, you send us a list of all your fine wire orders on which you are having delivery troubles. Report for each order the name of the supplier, purchase order number, size, quantity, description, delivery, date promised and date required."

WANTED

TECHNICAL SPECIALISTS

MEN and WOMEN

The COLONIAL RADIO CORPORATION needs immediately, for WAR RADIO WORK, the following technically trained personnel:

RADIO ENGINEERS
PHYSICISTS-RADIO
VACUUM TUBE ENGINEER
CALIBRATION TECHNICIAN
MECHANICAL ENGINEERS
ELECTRO-MECHANICAL ENGINEERS
MECHANICAL DRAFTSMEN
TOOL DESIGNERS
ENGINEERING SPECIFICATION WRITERS
FIELD ENGINEERS-RADIO
FIELD INSPECTORS-RADIO
MODEL MAKERS
TECHNICAL ASSISTANTS-RADIO

These are NOT temporary positions. Satisfactory employees may expect PERMANENT employment. Qualified applicants, NOT NOW IN WAR WORK, should write, giving full history of education, experience, and salary desired.

ARMY E NAVY

COLONIAL
RADIO CORPORATION
254 RANO ST.
Buffalo, N. Y.

COLONIAL

Chief Engineer of Heintz & Kaufman

The appointment of Winfield G. Wagener as chief engineer of Heintz & Kaufman, Ltd. has just been announced. Mr. Wagener has been associated with the firm for five years, during which time he has been working out practical applications of vacuum tubes in uhf circuits, and has headed up the development of two new tubes for military service.

Winfield G. Wagener

Wagener was graduated from the University of California in 1928 with honors in electrical engineering, and obtained his master's degree while on a John W. Mackay scholarship at that university. He later did post-graduate work under Dr. F. E. Terman at Stanford. Since the days of his undergraduate thesis on 1½-meter generation and antenna patterns, Wagener has had a consistent interest in the uhf field, and declares: "The most spectacular new tube developments in the immediate future will undoubtedly be in the centimeter range."

Mr. Wagener is a member of Tau Beta Pi and Eta Kappa Nu honor societies. Before joining Heintz & Kaufman he did developmental work with the Federal Telegraph Co. and was with R.C.A. for five years. He is the author of an article on calculating the performance of vacuum tubes which is considered fundamental, as is indicated by its use in many of the standard text books on radio.

Hoglund Now Vice President

Helge G. Hoglund, sales manager of the Machine Tool Division of Van Norman Machine Tool Co., Springfield, Mass., for the past ten years, was appointed vice president of the company. Mr. Hoglund will continue to be in charge of sales of the Machine Tool Division, and in addition will have complete control of sales of the new Electronics Division which is manufacturing induction heating equipment.

OUR LIGHTS BURN LATE HERE, TOO!

WAR'S grim needs keep our plants busy day and night, producing AmerTran Transformers, Reactors and Rectifiers. In our Engineering Department, also, the lights burn late these days. Here we are busy applying the principles we have learned in many years of transformer specialization, to the rigorous requirements of our armed forces. Much of the seed of this war-time development work will bear fruit later in the more fertile soil of a world at peace.

Some of our war research has resulted in pilot models that reveal new performance characteristics to meet the advances in the electronics and power fields. War's emphasis on economy and stamina under extreme load and climatic conditions has had its effect on our designs. Tests show losses lowered, efficiencies raised. Ease of installation has been stressed.

Today AmerTran Equipment goes to the Government and to customers with high priorities. Tomorrow we hope to serve again those good companies that cannot, for the time being, qualify in either of these categories.

AMERICAN TRANSFORMER COMPANY, 178 EMMET ST., NEWARK, N. J.

AMER TRAN

PIONEER MANUFACTURER OF
TRANSFORMERS, REACTORS AND RECTIFIERS
FOR ELECTRONICS AND POWER TRANSMISSION

AMERTRAN
MANUFACTURING SINCE 1901 AT NEWARK, N. J.

Solar's Use of Blind and Deaf. Wins "E"

At the Waldorf-Astoria in New York, April 10, Solar Manufacturing Corp. was awarded the Army-Navy "E" in the presence of 2000 employees and their 2000 guests. Heading the Solar group was Otto Paschkes, president, Paul Hetenyi, vice-president, and Wickham Harter, general sales manager.

Unusual labor policies and practices have been developed by Solar to offset the manpower shortage. The firm's personnel has always consisted of over 75 per cent women workers. Today it employs about 82 per cent women. Women have been found highly satisfactory in handling most bench-work operations, assembling and stacking mica, etc. Men are employed only in the heavier jobs.

To circumvent inroads of the draft, the firm has made notable use of the specially developed talents and abilities of blind men and women, the deaf, and other physically handicapped. Solar was the first firm to employ a blind woman after Pearl Harbor, and so successful was the experiment that today the firm employs more than a dozen totally blind workers as mica gaugers.

The great powers of concentration of the deaf have proven valuable to the firm in all operations where the large number of deaf men and women are employed. Excellent results have also been secured in the cases where elderly men and women, formerly considered unemployable, are now working.

Solar plans to retain its blind and other physically handicapped workers in their present jobs after the war; is now considering establishing day nurseries to care for small children of women workers as a means of preventing absenteeism.

Onstad Heads Thordarson

R. E. Onstad, formerly vice-president and general manager of Thordarson Electric Manufacturing Company of Chicago, has been elevated to the post of president and general manager, following the resignation of C. H. Thordarson as president. Mr. Thordarson, who founded the company nearly a half century ago, and who is now nearly 76 years of age, wil continue to lend his talents to the organization as technical consultant.

At the same time the board of directors announced the above changes. L. G. Winney, former treasurer was named vice-president and treasurer, and W. R. Mahoney, formerly connected with Arthur Anderson & Company, was elected assistant treasurer.

One basic symbol....

.... wherever the familiar symbol for *transformers* appear—Stancor Engineers have the correct answer waiting for you—or they will find it. No matter whether the job is easy or tough — simple or complex — their broad experience and facilities may save you precious days of time and worry on rush work. And, when Tokyo and Berlin are finally blasted off the map these same brains — plus new knowledge gained in vital war developments — will be ready to help you swing back into profitable peacetime production.

STANCOR

STANDARD TRANSFORMER CORPORATION • 1500 N. HALSTED STREET • CHICAGO

Yellow Fluorescent Material

A new fluorescent material which produces a warm yellow color when exposed to ultra-violet rays, instead of the glaring white or bluish-white color characteristic of present-day fluorescent lighting, is announced by the American Optical Company, Southbridge, Mass.

The new fluorescent was discovered by Dr. W. A. Weyl, member of the concern's research staff and professor of glass technology at Pennsylvania State College. It not only produces light of a radically new color, but also retains, unlike previous fluorescents, the power to emit light even if the material contains impurities in the form of iron or nickel. Also the substance glows without the addition of an activating agent like manganese, a necessity in present fluorescents.

General Manager of Turner

Renald P. Evans of Cedar Rapids, Iowa, has been elected a partner and made general manager of the Turner Company of Cedar Rapids, pioneer manufacturers of microphones and electronic equipment.

Mr. Evans had been associated in other businesses for the past eight years with David Turner, founder and senior partner of the Turner Company, and John B. Turner, II.,

Renald P. Evans

also a partner of the company. Before that time, he was engaged in sales and service work of electronic equipment, including legal and specialized business training.

At present a large share of the Turner business has been converted into war production. However, a microphone service and engineering research department is being maintained; and some microphones are being produced for users having a high priority.

Tomorrow's pictures were made possible in 1928

RECENT development in television techniques lends weight to the belief that within due time after the war's end telecasting stations will be erected throughout the nation and television will become a revolutionary force for the betterment of humanity.

To us at Farnsworth, the magic of tomorrow is the reward for more than 15 years of research and development work.

It was 1928 when Farnsworth first picked up a picture electronically with the then newly developed "Image Dissector" tube, and reproduced the image on the end of a special electronic tube, proving that the Farnsworth revolutionary theory of *electronic television* was the answer to television of the future.

Continued Farnsworth research has produced many additional basic inventions. Research on electronic tubes and circuits has been carried on simultaneously with the knowledge that the full potentialities of this science are to be achieved by the correlated development of both.

Farnsworth created electronic television and will continue as a pioneer in this field. Perfected television has been the primary objective of our research . . . our production facilities are eminently fitted to produce the precision devices that will be the television apparatus of the future.

Today, all of our resources are devoted to the needs of our Armed Forces. But, in the peacetime world of the future, Farnsworth will be ready with the answers to your television problems.

FARNSWORTH TELEVISION

• Farnsworth Television & Radio Corporation, Fort Wayne, Indiana. Manufacturers of Radio and Television Transmitters and Receivers; Aircraft Radio Equipment; the Farnsworth Dissector Tube; the Capehart, the Capehart-Panamuse, and the Farnsworth Phonograph-Radios.

J. M. Allen Joins Erie

Erie Resistor Corporation, Erie, Pa. announces the appointment of J. M. Allen as works manager. Mr. Allen is well known in the radio industry, having been actively connected with many phases of radio work since 1923, when he joined Fansteel Products Corporation at North Chicago, Ill. He was superintendent of radio receiver manufacturing for Fansteel during the latter part of his connection there. In 1930 he went to Stewart Warner Corporation as superintendent of radio receivers and component parts. In 1934 he joined Fairbanks Morse in Chicago as manager of radio manufacturing.

J. M. Allen

A year later Mr. Allen went to R. C. A. at Camden, where he was successively coordinator of inspection and test laboratories and in charge of purchasing of all radio receiver production materials. When R. C. A. created its Bloomington, Ind. works in 1940, Mr. Allen organized the manufacturing facilities, and served as works manager until shortly after the first of the year, when he resigned to come to Erie Resistor.

Frank Butler to Address IRE "Old Timers"

The New York Section of the Institute of Radio Engineers announces June 2 as the date for its annual Old Timers' Get-Together informal dinner and meeting. Later announcements will be mailed to members, notifying them as to exact time and place of this meeting.

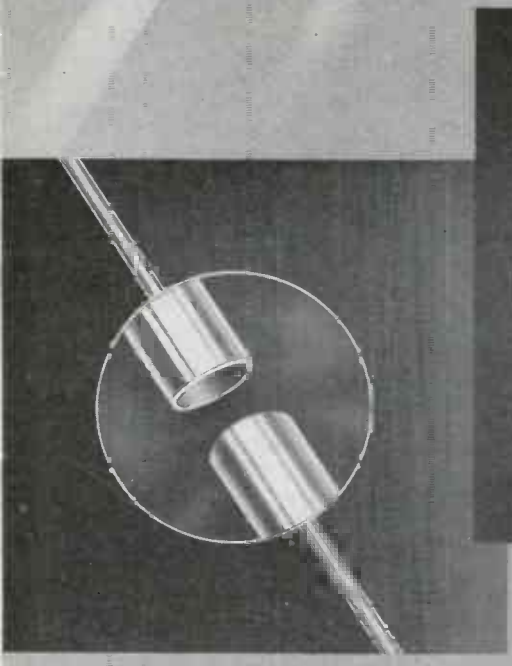
On this occasion, Frank E. Butler, associate editor of "Electronic Industries" and formerly chief assistant to Dr. Lee deForest, will discuss and illustrate by means of slides, the first-hand story and intimate details of the discovery of the three-element vacuum tube as invented by Dr. deForest in 1906-7. A group of 18 replicas or models showing the actual steps taken by Dr. deForest from the inception of

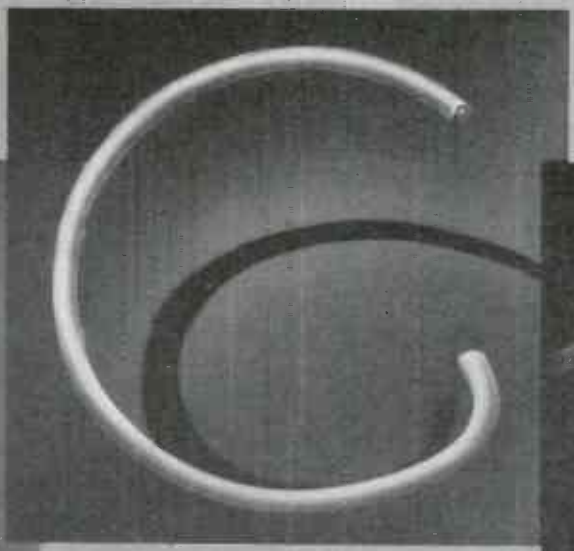
TUBING OF DESTINY

We at Precision take justifiable pride in the privilege of contributing in a small way toward our Country's Destiny . . . our Freedom . . . and the Freedom of all men fighting for Liberty and Democracy.

Tubing, as used in Instruments, Aircraft and Electronics, is shaping that Destiny, *that Victory which comes to all free men.*

Accurately drawn small Tubing and Metal Shielded Wire are our Specialties. Your inquiry concerning your requirements is invited.





INSTRUMENTS

Precise Instruments, vital to all Communications, must depend upon accurately made, positively balanced Pointer Tubing. Today Precision Tube Company supplies this high grade Aluminum Alloy Pointer Tubing to over 80% of the Instrument Manufacturers in this free Land. There *must* be a reason.

AIRCRAFT

Rate of Climb, Air Speed and similar Aircraft Instruments depend for their accurate measurements upon the amount of air passing through a predetermined length of formed tubing. Precision Tube Company's new method of manufacture steps up production 800%.

ELECTRONICS

Metal Shielded Wire — insulated wires shielded with Seamless Aluminum or Copper Tubing — offers the only positive protection against Moisture, Electrical Interference and Mechanical damage. It is a MUST for dependable Electronic Equipment where failure cannot be tolerated. Made in a wide variety of sizes and combinations.

PRECISION TUBE CO.

SPECIALISTS IN ACCURATELY DRAWN TUBING AND METAL SHIELDED WIRE

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the idea, on through the bunsen-burner stage and finally the introduction of the glass tube, have been reproduced by Mr. Butler and are now being prepared for exhibit in The Franklin Institute at Philadelphia. Photographs of these replicas, together with reproductions of other historical material pertaining to the tube and the first wireless-telephone experiments, will also be shown. The several patents taken out at the time, totaling about 335 claims, will form the basis of the talk and will be used to show the sequence of deForest's logic during the progress of his experiments together with the motives which prompted him to embark on this research.

North American Philips Plant Completes First Year

North American Philips Company, Inc., has completed a year of operation of its plant at Dobbs Ferry, N. Y., where it manufactures parts for communications equipment, entirely for war purposes, and carries on research in electronics.

The quartz - crystal division, which started turning out piezo-electric quartz crystals there in March, 1943, was the first department to begin production at the plant. Its facilities have been used by the armed services for research work in new methods of manufacturing, measuring and mounting crystals.

Next to begin work at Dobbs Ferry was the wire division, which was transferred from the plant of an affiliated company, Philips Metalix Corporation, in Mt. Vernon, N. Y. It produces fine wires for various military and naval purposes.

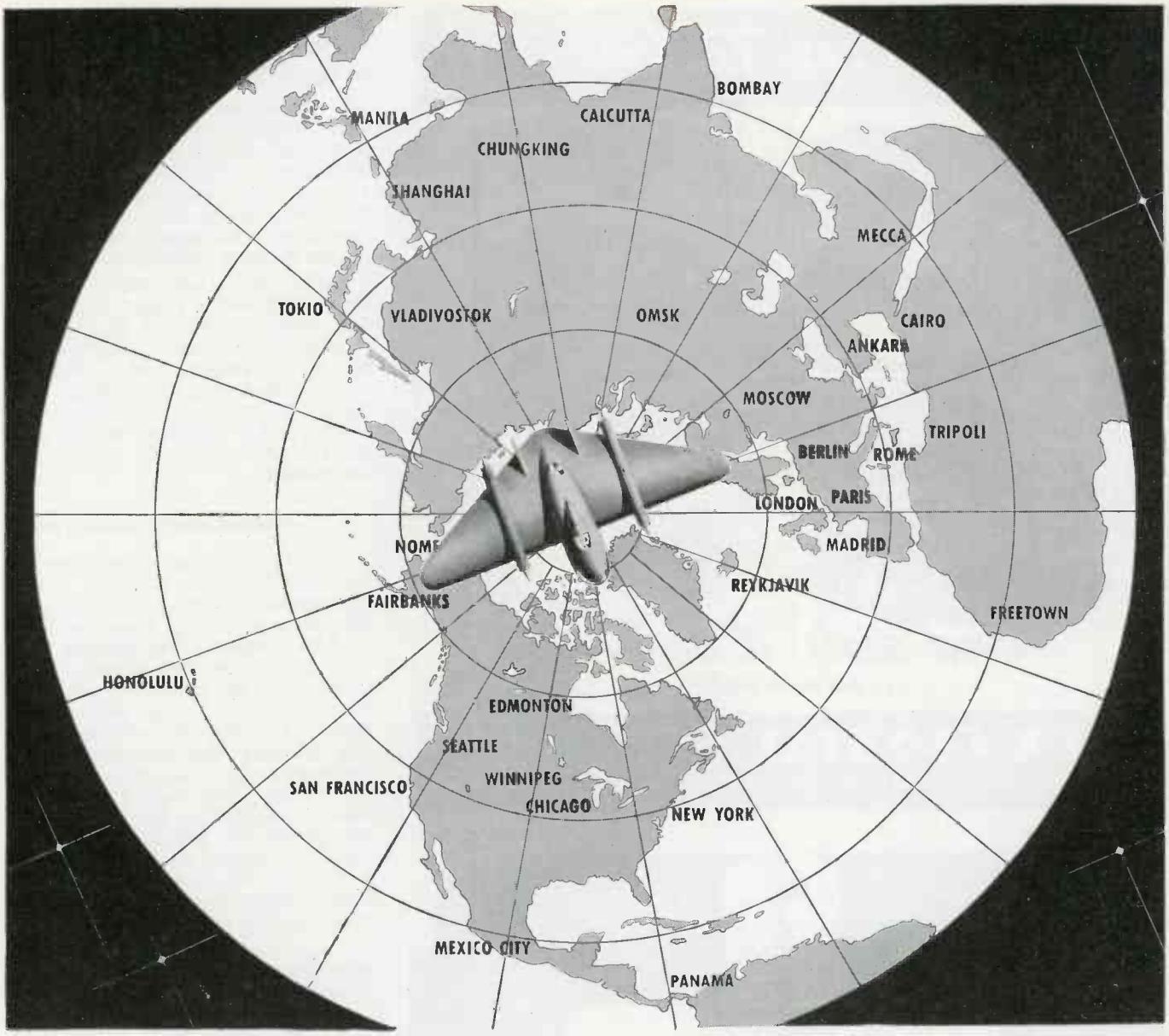
Last summer North American's electronic tube division began operations at Dobbs Ferry. It manufactures cathode-ray, rectifying, transmitting and special tubes.

Engineers of North American Philips have designed and made a number of pieces of equipment for the crystal, tube and wire divisions and have been working on many electronic problems. An industrial electronics division has recently been established.

North American has a second plant at Lewiston, Me., in which it fabricates molybdenum and tungsten wire and rod. The floor space has been doubled since North American bought the Lewiston plant last June.

Philips Metalix Corporation makes X-ray tubes and apparatus at its Mt. Vernon plant, and has developed an X-ray crystal analysis machine which is being used by many American crystal manufacturers.

The Philips factories are at present 100 per cent on war work.



WORLD CONCEPTS ARE CHANGING

TUNG-SOL
vibration-tested
RADIO TUBES

With the world map projected from over the North Pole, we see Seattle some 5,000 miles nearer to Calcutta and all of Asia and Europe as our next door neighbors. The World is unchanged . . . it is our concept that is new.

Polar flying is changing our concepts of distance. So it is with every advancement in science. It alters our viewpoint and reflects itself in our daily lives. Electronics is one of the great scientific developments of our time.

The post-war world will be an age of electronics . . . new ways of living in which our industries, our communications, our transportation and even our personal activities and pleasures will be affected. Manufacturers who will produce the machinery, the goods and the equipment we will buy and use will have to think in terms of electronics to meet our new concepts.

TUNG-SOL looks forward to peacetime uses of the transmitting, receiving and amplifying electronic tubes that we are now making for our government. We will be glad to share our experience and knowledge with manufacturers who wish to incorporate electronics as part of their product. Our advisory staff of research engineers is at your service.

TUNG-SOL LAMP WORKS INC., NEWARK, N. J., *Sales Offices:* ATLANTA, CHICAGO, DALLAS, DENVER, DETROIT, LOS ANGELES, NEW YORK
ALSO MANUFACTURERS OF MINIATURE INCANDESCENT LAMPS, ALL-GLASS SEALED BEAM HEADLIGHT LAMPS AND THERMAL SWITCHES

Army Bomber Drops Telephone-Wire Reels to Span Glacier

A glacier has just been "bombed" with telephone wire in Alaska so that communications could be established, reports Colonel Harry L. Vitzthum, who has returned to the War Department from a 30-month tour of duty as signal officer of the Alaska Defense Command.

While the Alaska Railroad was being extended, a tunnel had to be dug under a moving glacier but communications were badly needed before the completion of the tunnel. It was found that it would be virtually impossible to transport the heavy reels of telephone wire across the icy and impassable expanse of the glacier.

Signal Corps man's idea

The difficulty was solved when at the suggestion of a Signal Corps lieutenant, ten reels of twisted pair telephone wire were loaded aboard an Army bomber. The bomber flew over the glacier and aimed a reel at each of the stakes which had been lined up in the deep snow. Only one of the ten reels was lost. The line crew then struggled across the glacier and strung the wire from reel to reel. But even without the task of transporting the reels across the glacier, the task of establishing communications was not easy or safe, and one workman froze to death trying to cross the glacier after the line was completed.

Westinghouse Electronic Motor-control

A "packaged unit" adjustable-speed electronic motor drive has been announced by Westinghouse, to be used in any application that requires constant, adjustable speed at varying loads over a 20 to 1 range. Flexibility of direct-current motor drive with alternating-current supply is obtained, as the incoming ac is converted by grid-controlled rectifiers and supplied to the armature and field of the dc motor. Electronic control provides constant torque for all speeds up to the base speed of the motor and constant horsepower above base speed.

In general, the system consists of a single or polyphase grid controlled, thyratron rectifier, that takes power from an ac line and rectifies it into direct-current output. The rectified dc is applied to a regular shunt-wound, dc motor and may be varied from zero to motor rated voltage (or above) for dc armature control. Smaller thyratron tubes provide rectified dc field current. The field voltage is

For Continuing Achievement

A STAR FOR WESTON

—evidence that the vital instrument situation rests in good hands!

A star now adorns the ARMY-NAVY "E" pennant awarded to WESTON just 6 months ago . . . the first such pennant awarded in this highly specialized instrument field.

It's a star that has *real meaning*. Because, from the very beginning of our defense period, the responsibility for producing the vast quantities of instruments vital to the success of our country's efforts, has rested largely on the instrument leader.

This star signifies that the responsibility *rests in good hands*. "The men and women of the WESTON Electrical Instrument Corporation," writes the Chairman of the Navy Board for Production Awards, "have achieved a signal honor by continuing their splendid production in such volume as to justify this award . . . indicating their solid determination and ability to support our fighting forces with equipment necessary for victory."

But a great instrument task still remains . . . before victory is ours. So WESTON workers continue reaching for new goals . . . with the same determination, the same painstaking devotion to the quality ideal, responsible for WESTON'S *continuing leadership* in the instrument field.

WESTON ELECTRICAL INSTRUMENT CORPORATION, NEWARK, NEW JERSEY

held constant throughout the range of armature voltage and then is reduced to provide greater speed range by field weakening above the base speed of the motor. Speed-control potentiometers and reversing and dynamic-braking-stop contactors are provided.

An article in a forthcoming issue of "Electronic Industries" will discuss electronic motor-control systems and describe typical industrial applications.

Engineers Become Zenith Execs

Three new engineering officers of the Zenith Radio Corp. have been elected, announces Commander E. F. McDonald, Jr., Zenith president.

G. E. Gustafson, who has been with the company since 1925, has held the post of chief engineer since 1933, and has been assistant vice-president since 1940, was elected vice-president in charge of engineering.

G. E. Gustafson

Karl E. Hassel, engineering executive, who with Commander McDonald and Ralph Mathews was an original founder of the company and who has been a director of the corporation since 1932, was elected assistant vice-president.

J. E. Brown, Zenith's engineer specialist in television and frequency modulation since 1937, was elected assistant vice-president.

New Bottleneck in Quartz

A shortage in quartz crystals for radio work, has led to an amendment to WPB General Conservation Order No. M-146. The board thus moved to conserve the available supply of quartz crystals and assure proper grading and utilization of

this highly strategic material when, Mar. 8, the Quartz Crystals Section tightened the regulations governing the use of quartz crystals.

So acute has the shortage become that it is learned quartz for radio use is now being flown by airplane from South America.

Brazil and other South American countries are the sources of the present supply. In the United States there are plenty of quartz crystal deposits, but satisfactory crystals for electrical uses had not been developed from them in prewar days. An intensive search is now being made by the U. S. Geological Survey, the Bureau of Mines and other agencies, to locate quartz crystals with the necessary properties.

American crystals

Results of the search are promising, although specific information will not be released until after the war. The best prospects appear to be in the crystals found in North Carolina, Virginia, Arkansas and California. The western mountain states are being searched as well.

Not all quartz crystals, regardless of their general resemblance, are usable in electrical work. They must be first cut, and then carefully tested in well-equipped laboratories for their electrical properties. Size and appearance are, however, important factors. To be usable they should be at least an inch in diameter and over two inches long. They should be clear, and free from fractures and discolorations.

Ceilings on Capacitors for Military Radios

The Office of Price Administration April 6 placed price ceilings reflecting current price levels on all fixed capacitors used for military radio equipment. Up to April 1, 1943, this type of radio condenser was exempted from price control in order to enable increased production and to allow the rapidly-expanding industry an opportunity to stabilize production costs. Prior to this date, the War and Navy Departments had agreed to exercise control over prices of the product. While no dollars-and-cents ceilings are specifically listed by OPA, all manufacturers of military radio capacitors must file their prices for approval with OPA.

Change of Address

Communications Measurements Laboratory, formerly of 131 Liberty Street, New York, has moved to larger quarters at 120 Greenwich St., New York.

Chief of Signal Operations

Brigadier General Frank E. Stoner, who in the past year has directed the growth and operations of the Army Communication Service to its present tremendous size, has been appointed to be Chief of the Signal Operating Services under the Chief Signal Officer

Solar "Preferred Type" Capacitors

Solar Capacitor Sales Corporation, Bayonne, N. J., announces the adoption of a new policy of capacitor standardization, in anticipation of inevitable Government-enforced standardization.

New Catalogs V-1 and V-2 have been issued, illustrating a minimum number of types specifically designed for a maximum number of applications.

Lyman Athey, Vp. International Products

The International Products Corporation of Baltimore, manufacturers of low-loss-factor inorganic plastics for the radio, electronics and electrical industries, announces the election of Lyman C. Athey as vice-president. Mr. Athey was formerly associated with the Porcelain Enamel and Mfg. Co. of Baltimore as director of research.

Aircraft Accessories Opens Radio Plant

Aircraft Accessories Corporation has opened a seventh plant in the Kansas City area, according to announcement by R. C. Walker, president.

The new plant will occupy space in a building formerly used by an automobile company, where 45,000 square feet will be devoted to production of radio equipment.

The seventh plant will be under the supervision of Guy Melanger, general manager of radio production for the company, who will also have supervision of Plant Two of the company in Kansas City, Kansas, and the company's Plant Two in Slater, Mo.

Sprague Wins Army-Navy "E"

At North Adams, Mass., April 2, in a colorful ceremony, the Army-Navy "E" was awarded to the Sprague Specialties Co., for exceptional production in the war effort.

The production banners were presented by an army representative, Brig. Gen. A. A. Farmer of the Army Signal Corps in Philadelphia, who called to the attention of the audience the significance of the award and pointed out the vital necessity of maintaining an uninterrupted flow of war material until the war is won.

Recipient of the banners was Robert C. Sprague, founder, president and general manager of the Sprague Specialties Company, who in accepting the award on behalf of his employees, spoke, in part, as follows:

Rob't Sprague speaks

"This is a day we will never forget. We must work hard, long and intelligently, never forgetting that every added unit we ship will help shorten the war.

"It is with umost confidence that we will in the future surpass anything we have already done, that I personally congratulate and thank each and every one of you for your part in winning this award, and pledge to the armed services our maximum possible production."

Capt. J. S. Evans, U.S.N., made the presentation of the employee emblems, pointing out the importance of each individual Sprague worker in the achievement of its outstanding record and called upon all to continue the fine work.

Electronic Horror Chamber

An ingeniously devised "horror chamber" which goes under the descriptive name of a "lunk trainer" is now part of the combat training for staff officers in the Army, to condition them to withstand the first shock of battle. The lunk trainer is designed to represent the fully-equipped dugout of a command post with telephone-connected trenches. In this simulated death trap, officers are tested in routine performances under nerve-shattering conditions.

For instance, by electronic reproduction, the screams of dying men rend the air, and shell fire deafens the victims. The smell of decomposed flesh fills the air, and to add a last gruesome touch of realism the field telephones are sticky and damp with a red mucilaginous coating of the texture of blood which slimes hands, pencils and maps.

NEW BOOKS

Applied Electronics

By the E. E. Staff, Massachusetts Institute of Technology, published by John Wiley & Sons, Inc., New York, Chapman & Hall, Ltd., London, 1943, 772 pages, $6.50.

A first course in electron tubes and radio-electronic principles, this exhaustive treatment, an outgrowth of MIT's reorganization of its E. E. courses demonstrates depth and detail seldom, if ever, found in a work by a single author.

The title is misleading for those who have come to think broadly of the term "electronics." The book does not deal with applications of electronics to industry or the military. It is, rather, a thorough college-level course in electron-physics, and the design and operating characteristics of the most important and most familiar types of tubes. The emphasis is on the electronics of communication—oscillators, amplifiers, modulators, and detectors. Such material is, of course, basic to any branch of electronic engineering, and the purpose of the volume is to prepare the student so thoroughly in basic electronics that his later branching out into any chosen specialty may rest upon a solid foundation.

Elements of Radio

By Abraham and William Marcus, with Ralph E. Horton, published by Prentice-Hall, Inc., New York, 1943, 699 pages, $4.00. (In two volumes, $2.45 each.)

As the name implies, this book begins with the beginner. The first volume takes up principles of reception, step by step, roughly in the order of historical development. Designed as a pre-induction course text, no formulae are to be found in the first 300 pages. Drawings, simple circuits, and frequent analogies of the intangibles of radio with well-known phenomena make basic radio principles crystal clear without demanding previous knowledge on the part of the reader or student.

The second half of the book is devoted to electrical and radio theory, transmitters, and the more advanced aspects of radio communication.

Each chapter is preceded by several questions or "problems" intended to give the reader a few thoughts to hold in mind about what he is to learn from that chapter. Called by the publishers "A streamlined home-study course," the book fills a long-felt need for an introductory volume on radio.

Electrical Fundamentals of Communication

By Arthur Lemuel Albert, published by McGraw-Hill Book Company, Inc., New York, 1942, 604 pages, $4.00.

"Electrical fundamentals of communication" correctly defines the scope of the book. Starting out from the elementary concepts of matter and electricity, it explains in simple language the laws and phenomena of alternating-current circuits, measuring instruments, simple filters and bridge circuits, and the operation of the most widely used types of electron tubes and their various circuits. Examples are mostly taken from communication industry, and hardly any mathematics is used in the text.

The book is written by an experienced teacher who finishes each chapter with a short summary, review questions and problems, covering the most important subject matter treated. Therefore, the text is well suited as a basis for self-study as it almost compels the reader to check on correctness of understanding so essential for efficient working knowledge of the subject.

Our Front Cover—Putting Finishing Touches on Crystal

The girl in the picture on the front cover of this issue is doing the final grinding on a precision crystal. These finishing touches are added by "hand lapping," to borrow a phrase from the optical field where lenses are similarly finished by careful hand strokes on a lapping plate.

In finishing the crystal, the small wafer of quartz is held beneath the girl's finger, and after a few delicate grinding movements on the circular lapping plate, the crystal is tested for activity, temperature coefficient, and frequency.

The test equipment on the rack shown in the picture includes the standard crystal oscillator with its three meters just above the girl's hand.

At the extreme top of the rack, in the panel half seen, is the primary standard of frequency which is "mixed" within the communication receiver to produce an audible beat-note. This beat-note is measured by the visual audio-frequency indicator meter with the large dial at the center of the panel.

The circular lapping plate and the "hot" and "cold" crystal test plates are seen on the table. The picture was taken in the factory of the General Electric Company.

NEW LITERATURE

Stancor's New Transformer Catalog

A "Transformer Encyclopedia of the Radio and Electronic Industry" is announced by the Standard Transformer Corp., 1500 N. Halsted Street, Chicago. Detailed specifications covering the company's line of transformers and chokes; classified and numerical index and price list and illustrations of transformers designed for shop, laboratory and industrial applications, are included.

Felker Di-Met Quartz Cutting Machines

A 16-page illustrated booklet describing quartz cutting procedures and identifying various types of quartz also includes illustrations and descriptions of the various units manufactured by the Felker Manufacturing Co., Torrance, Calif., for quartz cutting and finishing of Piezo electric crystals.

Zinc Alloy Die Casting

The New Jersey Zinc Company, 160 Front Street, New York, publishes the answers to questions most often asked about zinc alloy die castings in its 24-page booklet. Directed to readers unfamiliar with the fabrication of metals, the booklet does not cover the details of die casting processes, but illustrates the different shapes possible in die casting as well as the machines used in production.

Radio Communication Equipment

An attractive 12-page booklet on radio communication equipment is released by Transmitter Equipment Mfg. Co. Inc., 345 Hudson Street, New York, which illustrates and describes equipment produced for various branches of the government. There are also specifications for marine radio telephone systems on pleasure boats, yachts, etc.; point to point and amateur transmitters; and commercial broadcasting equipment.

Miniature Precision Bearings

Bulletin 43 has just been released by Miniature Precision Bearings, Keene, N. H., showing the company's complete line of radial and pivot type bearings from 1/8 to 5/16 in. outside diameter in both steel and non-magnetic beryllium. A convenient tabulation gives dimensions and load ratings at varying speeds for each size and type of bearing as well as illustrations in actual size.

Mica Insulation

The physical properties, temperature resistance, electrical insulation, chemical resistance and specifications of composite bonded mica insulation are outlined in a spiral-bound 48-page booklet and a 4-page pamphlet issued by the New England Mica Company, Waltham, Mass. The various products the company manufactures are also listed.

Electrical Contacts by Callite

In a 36-page, illustrated catalog, Callite Tungsten Corp., 544 39th St., Union City, N. J., discusses the design, manufacture and application of electrical contacts of silver, platinum, tungsten, molybdenum and a variety of other metals and alloys. Covering types of contacts, their physical size and shape, and the particular applications to which each metal and alloy is best suited, this catalog offers the design and production engineer a complete story on electrical contacts.

Plastics for War Production

Plastic parts in war production applications is the subject of a pamphlet released by Creative Plastics Corp., Kent & DeKalb Avenues, Brooklyn, N. Y. Fifteen critical parts, fabricated of plastic materials, without molds and to closest tolerance specifications, are illustrated.

Guide Book

A 44-page Guide Book to the electrical insulating materials available from Mitchell-Rand Insulation Co., Inc., 51 Murray St., New York, has just been released. Prices, terms and complete specifications are listed.

New Additions to Line

Bulletin No. 127 describing new additions to its line of electrical and electronic instruments has been released by Radio City Products Co. Inc., 127 W. 26th St., New York. This bulletin describes a signal generator, master multitester, pocket multitesters and ac-dc multitester.

Electrical Contacts by Brainin

A 4-page broadside on electrical contacts and thermostatic bimetal discusses the importance of the composition and purity of contact metal, as well as describing the solid rivets, contact screws, laminated strips and composite contact rivets available. Published by C. S. Brainin Company, 233 Spring St., New York.

Engineering Bulletin

Engineering Bulletin No. 201 describing a line of new fixtures and accessories has been made available by the Philips Metalix Corporation, 419 Fourth Ave., New York. These accessories and fixtures will greatly extend the usefulness of the Philips X-Ray quartz analysis apparatus. A few of the fixtures listed in this engineering bulletin are crystal blank holders, rotating wafer and rotating crystal blank holders, edge correction holder, angle correction holder and Bragg angle scale.

Glass Worker's Catalog

The Eisler Engineering Co., 740 S. 13th St., Newark, N. J., has just published a new 94-page catalog for glass working and glass laboratory school and colleges. It describes all types of gas, air and oxygen burners, economizers, gas and air mixers, and glass rollers. The catalog is also interesting to electronic tube making plants.

Pre-plated Metals

To provide rust resistance, corrosion resistance, electrical properties, non-toxic surfaces and high reflectivity zinc, nickel, brass and copper are applied as a coating for many diversified purposes. Pre-plated metal saves handling of separate parts in finishing procedures after the product has been stamped or formed. Pamphlet issued by Apollo Metal Works, 6650 S. Oak Park Avenue, Chicago.

Sound Equipment

Two catalogs are available from the David Bogen Co., Inc., 663 Broadway, New York; "The Blue Book of Sound Equipment" and "Communo-Phones and Industrial Paging Systems". Illustrations of the systems, tables of characteristics and prices are included.

Spee-Dee Printer

Peck & Harvey, 4327 Addison St., Chicago, has issued a 4-pg. pamphlet on the Spee-Dee Printer which prints blueprints or black and white prints speedily and easily. Letters, invoices or any printed material can be duplicated with considerable saving in time and error.

Electronic Paper Thickness Tester

A 4-page bulletin on the company's electronic micrometer is available from Instrument Specialties Co., Little Falls, N. J. The tester takes all the guesswork out of thickness testing on paper of any weight. Highly sensitive electronic tubes measure exact thickness to .0001 in. of any portion of tested material.

Letters to the Editors

Protecting Equipment Against Humidity

Editors, Electronic Industries

Undoubtedly all manufacturers like ourselves, interested in the protection of radio equipment used in the tropics, are very thankful for the painstaking work conducted on this subject by D. H. Gardner and J. S. Watt of the Geophysical Research Department of the Humble Oil and Refining Company, as per their report published in "Electronic Industries" of February, 1943.

Complete as the report is, it contains a few statements which are apt to give more trouble than help. We refer to the recommendation of WE Superior Compound and Ceresin. It is to be assumed that manufacturers of radio equipment will be looking for these materials with considerable loss of time, because we understand they are not available.

Under today's specifications, in most cases, Superior Compound would not meet requirements because of its low cold flow, but there are a large number of compounds having the same approximate properties as Superior Compound and that meet specifications. The bulk of Ceresin, which is Refined Ozokerite, was imported from countries which are either enemies or enemy controlled, and we have many American products which are superior in every respect for most requirements where Ceresin was used before. By being forced to use our own American produced wax, we have gained more than we have lost.

Widened tests

It is unfortunate that manufacturers of insulating waxes, like ourselves, for some reason or another were not aware of the work being conducted by Mr. Gardner and Mr. Watt, as a considerable number of other products could have been tested and the results would have been still more beneficial all the way around.

We alone have some fifteen hundred products for the radio indus-

DI-ACRO Brake forms non-stock angles, channels or "Vees". Right or left hand operation. Folding width—Brake No. 1—6". Brake No. 2—12". Brake No. 3—18".

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The destinies of armies, fleets and flying squadrons often depend upon the quick, accurate availability of crystal-selected communication channels. Necessity draws a veil of secrecy over the communication marvels that have been developed by war-inspired electronic engineers. But without divulging military secrets we point out that many war-time applications are readily convertible to peace-time devices. While we are working around the clock on special equipment for our armed forces, our post-war planning facilities have not been "frozen". The skill and experience of our electronic engineers are at your command for designing and specifying crystal - controlled applications that will give your products competitive advantages in after-the-war markets.

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BE RELIEVED of the time, the tension and trouble all too often required to buy and *get delivery* of the various Radio and Electronic Supplies you need! *Save* that time and energy for the carefree cultivation of that victory garden you ought to be growing this spring. NOW, whether you need *one* or *one hundred items* by as many different manufacturers, you have only ONE order to write . . ONE bill to pay . . ONE large reliable source to depend upon for the service and satisfaction you want! For, we three cooperating distributors have established special departments, technical staffs, and stocks, coordinated to function with what we believe to be the greatest SPEED and EFFICIENCY in the history of our industry! Try this emergency service. SPEED is the thing of which VICTORY is made!

FREE Purchasing Agents and others responsible for specifying or buying may ask for this big catalog, reference book, and buyer's guide on company stationery. It is packed from cover to cover with information on thousands of radio and electronic products. Send for your copy today. Keep it handy . . . always. You'll find this valuable volume an indispensable technical and buying aid. FREE to industrial users of radio and electronic parts and equipment.

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RADIO SPECIALTIES COMPANY
20th & Figueroa Streets LOS ANGELES
Telephone: Prospect 7271

try of which at least eighty have been and are in constant satisfactory use.

We hope that by this statement as manufacturers of waxes and compounds, we enhance the value of the published report and that we may, by the same token, help to enlarge the door for flow of available products, which may appear to some to be restricted to only two materials, and thus further assist Mr. Gardner and Mr. Watt in their desire to supply the best for our military equipment.

A. Saunders,
Technical Director
Wax Division,
Zophar Mills, Inc.
112—26th St.,
Brooklyn, N. Y.

H-F Heating Is Non-Uniform

Editors, Electronic Industries

Many experimenters and scientists have concluded that the heating effect of radio wave penetration is uniform where wood is used as the high-loss dielectric and the platten electrodes are next to the mass being heated. One major factor in this type of experiment which has not been properly considered is the moisture content of the high-loss dielectric.

It is above the boiling point that a noticeable differential in temperature appears between the center of the wood and outer parts, leading many experimenters to the incorrect conclusion that heat differentials are caused by the effect of radiation losses, etc.

Heat varies as I^2. If the heating effect is uniform as some claim, and since all agree that heat is caused by electron displacement, then electron displacement should be relatively uniform throughout the mass of the high-loss dielectric. This is illustrated by a simple wave meter circuit with a series of electrons suspended as pendulum weights in the dielectric, whether it be air or wood, and moving in the same sense and with equal amplitudes. Such a condition is illustrated by Figure 1. Note that the electron displacement as shown by the arrows is the same in both the

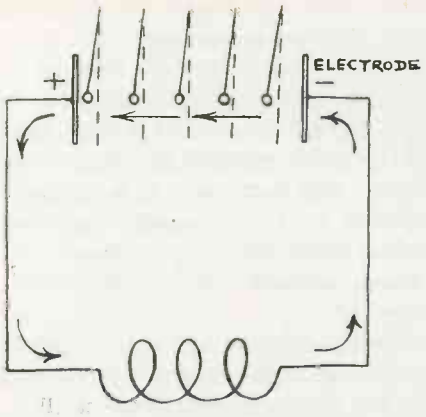

Fig. 1. Displacement of electrons in a circuit were there to be an even distribution of current, with no standing wave. Note equal displacement of electrons

dielectric and the inductance. This condition is an accepted concept. A current measuring device placed at any point in the oscillating circuit would read the same value. It has been an accepted theory, for what reason no-one seems able to explain, that current distribution in an oscillating system is uniform. If this assumption were correct, there might be little reason to doubt that uniform heating, as shown in Figure 1, would follow.

However, we have concluded that because of the standing wave in a resonant oscillating system, the electron displacement in a high-loss dielectric is non-uniform. This conclusion is startling and confirms, while at the same time it amplifies, the work done by some technicians who have admitted such things as standing waves.

Traveling and standing waves

The difference between a traveling wave and a standing wave is merely that the standing wave is reflected, while the traveling wave is one in which no reflection takes place. Where no reflection takes place, electrons distributed along the circuit will average an equal displacement. Where reflection takes place, electrons distributed along the circuit will vary in displacement according to their placement with respect to the fixed nodes and antinodes in the oscillating system. In his "Evolution of Physics," Professor Einstein in discussing standing waves has the following comment to make: "The wave stands, so to speak, between

the nodes, on points of the cord reaching simultaneously the maxima and minima of their deviation." Traveling nodes and antinodes in an alternating current system tend to produce uniform heating; fixed nodes and antinodes, in a resonant system have of necessity non-uniform distribution of current and hence produce non-uniform heating.

Recently there has been evidence presented that between electrodes in the output circuit of an oscillating system, either for wave transmission or for dielectric heating,

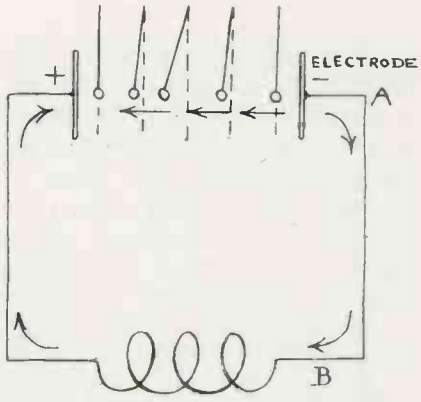

Fig. 2. Displacement of electrons in a circuit where there is a standing wave. Note unequal displacements of electrons

there is the equivalent of one-half standing wave. (Refer to Simon Ramo, General Electric Review, Oct., 1942.)

Experiments confirm conclusions

Our experiments confirm the conclusion that there is a half standing wave between the plates of a condenser in which a dielectric loss takes place. That there is in the remainder of the oscillating circuit system another half standing wave is confirmed by other experiments among which is that involving the time required to blow a given size fuse inserted in the oscillating circuit starting from the condenser plates and progressing toward the middle of the inductance. The fuse located near the plate of the condenser, and marked "A" in Figure 2, held for a period of 20 seconds. A fuse located near the inductance coil at point "B," and therefore closer to the center of the inductance than point

"A," was blown in under 5 seconds. The placement of fuses in different parts of the circuit confirm the pattern of current distribution with the current antinode in the inductance portion symmetrically and electrically centered. Figure 2 illustrates a simple oscillating circuit where there is one full standing wave; that is, one half standing wave betwen the electrodes of the capacitance and one half standing wave in the inductance portion. Referring now to the half standing wave in the capacitance, we will recall that heat varies as I^2. Since in a standing wave electron displacement is greatest at the current antinode and least, or non-existent, at the current node, and since there is a half standing wave of current between the electrodes of a condenser as in Figure 2, the current antinode will be at the center and current nodes at either plate resulting in the greatest heating effect midway between the plates. If the heat is non-uniform within the dielectric, electron displacement must be non-uniform. But since heat is proportional to I^2, the heat therefore, must be even more non-uniform than the current because of the square of instantaneous values.

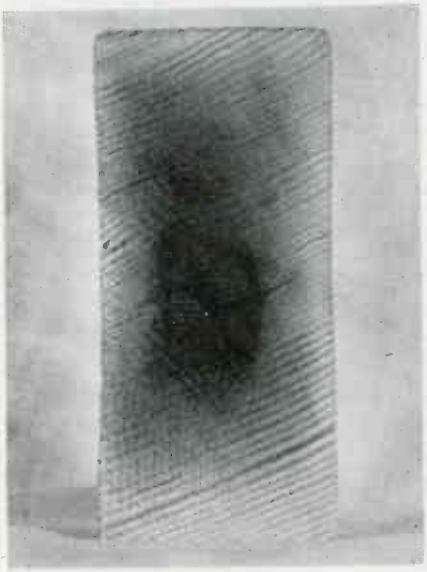

Fig. 3. Cross-section at center of wood block where electrodes of generator were spaced away from sides of block; one at left and one at right—showing center burned area with distribution as the square of sine values

Figure 3 shows a wood block burned as a result of high-fre-

quency internal heating when the electrodes were placed so that an air space separated each electrode from the outer faces of the block.

To confirm the conclusion that this uneven heating effect is not a result of radiation losses or other losses due to absorption of energy from the edges of the work, three blocks of wood were placed in the radio frequency field separated from each other by an air space of ¼" while the electrodes were ¼" from the outside blocks. The result is shown in Fig. 4.

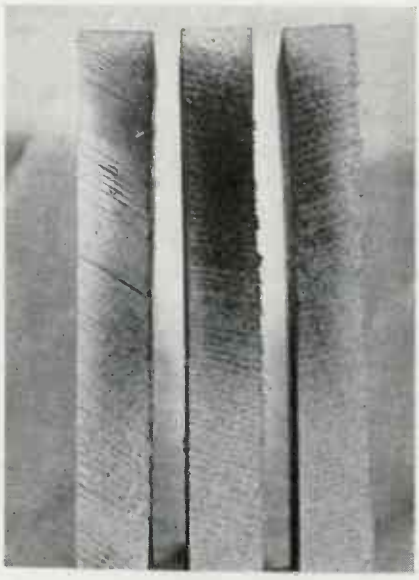

Fig. 4. Cross-section at center of three separated wood blocks where electrodes were placed one at left of outside block and one at right of outside block with air space between electrodes and blocks. If heat were uniform between electrodes, burned areas would be uniform in each block—but note area of burn showing heat unequal and distributed as the square of sine values.

Were radiation losses to be the correct answer to non-uniform distribution of heat, this arrangement would have shown a like heating effect on all three blocks with burned areas at the center of each. The two outside blocks were charred only on the faces nearest the center. A pattern drawn of the burned area in the three separated blocks considered as a single unit of dielectric parallels very closely the burned area in the solid block shown in Fig. 3, and points only to the conclusion that radiation losses are not a satisfactory answer to uneven distribution of heat effect and to the conclusion that the standing wave pattern resulting in

non-uniform displacement of electrons is the only reasonable explanation of this phenomenon.

Julius W. Mann
George F. Russell
Mann & Russell, Tacoma, Wash.

SUB-CONTRACTING

(*Continued from page* 51)

ablest engineering and research concerns in the radio production field, to aid smaller companies in attaining the desired technical skill.

The cooperation of the War Production Board's Radio Division, headed by Ray C. Ellis, has also contributed to a major extent to the Signal Corps' success in subcontracting and to the progress in distributing production by the Navy. In correlating and speeding up the activities of subcontractors in the electronic and radio manufacturing field, the expediting staffs of the Army-Navy Electronics Production Agency, directed by F. R. Lack, have likewise been valuable.

Help smaller businesses

The Signal Corps in pioneering subcontracting established facilities sections in the Office of the Chief Signal Officer in Washington and in its field procurement districts to survey plants and to furnish manufacturers with information, drawings and specifications as well as giving them opportunity to inspect Signal Corps equipment. This groundwork for a huge distribution of procurement business to small companies was done long before the WPB order of April 22, 1942, shutting down all civilian radio receiver set production.

When drastic action was needed to save small businesses in the summer of 1942, the Signal Corps spread a pool of some $17,300,000 in contracts among some twenty small companies. Likewise, a few weeks ago, another pool of $59,000,000 in equipment contracts was created and was to be distributed through the WPB Smaller War Plants Corporation. Necessarily, these contracts comprise only the simpler items of production.

To illustrate how the Signal Corps has not only utilized to the fullest the small companies in the electronic-radio industry and its components' manufacturers, but also

developed parts manufacturers in industrial fields, not related at all in peacetimes to the electronic or radio industry, a golf club manufacturer has been making antennas, an orchestra-instrument concern is producing crystal holders, an embalming-fluid firm made special fluids for radio sets.

Crystals hundredfold

The crystal industry of mainly small businesses which produced 148,000 crystals in 1941 will make 15,000,000 crystals in 1943 and most of these companies have less than 500 wage earners. Another interesting innovation has been in Nebraska where a non-profit organization binds together about 150 companies and today holds a prime contract for the Signal Corps being filled by 30 member firms.

The Signal Corps is cooperating excellently with the Smaller War Plants Corporation of WPB. Every requisition originating in the Office of the Chief Signal Officer is examined by the Smaller War Plants Corporation and where a smaller company can do the job a recommendation is made to the WPB Radio Division. In addition, there are two Signal Corps teams of procurement officers in the field examining prime contracts to urge the spreading of subcontracts.

AC RESISTANCE WELDING CONTROL

(*Continued from page* 55)

When it is desired to use synchronous welding-current control with pulsation welding, the sequence timer provides the several initiating impulses for the synchronous timer, which starts the welding current at the natural PF angle of the welding transformer after the initiating impulse is received.

Variety of types

Sequence timers, the third classification under NEMA recommended practices, are numbered in consecutive order following automatic weld timers.

Type 6-A provides for hold time of the electrodes after the welding current has ceased to flow.

Type 6-B sequence timers control squeeze and hold times.

Type 7-A timers provide hold and

off times, and will repeat indefinitely if the foot switch is held closed.

Type 7-B provides squeeze, hold, and off. Used with the synchronous timer, this type sequencing control provides fully automatic welder operation, with repeat action, corresponding to the type 3-B nonsynchronous welding control.

Type 8-A, for pulsation welding, controls weld interval, cool time intervals, and hold interval. The duration of each heat time interval will be in accordance with the setting of the synchronous weld timer rheostat, and the number of pulsations delivered to the work will then be a function of the cool time and weld interval settings of the sequencing timer.

Type 8-B provides squeeze time control, in addition.

Type 9-A, for automatically-repeating pulsation welding, provides for weld interval, cool time, hold, and off time.

Type 9-B, the ultimate in sequencing control for use with synchronous welding-current timer, provides squeeze time, weld interval, cool time, hold time, and off time.

SELF-BALANCING POTENTIOMETER

(*Continued from page* 69)

tion of the potentiometer unbalance.

Thus, the synchronous contacts, together with the transformer, convert the unbalanced dc voltage in the measuring circuit line into an alternating voltage proportional in value to the unbalanced dc voltage and of a phase relation dependent upon the direction of unbalance of the measuring circuit. The input circuit of the conversion stage is designed so that external resistance as high as 500 ohms does not affect the sensitivity of the measuring system.

Stray ac voltages of the power supply may be induced in the thermocouple leads or measuring circuit. The full-wave conversion unit functions to convert such voltages of supply-line frequency to ac voltages proportionately smaller in magnitude and equal in frequency to the even harmonics of the supply voltage. Since the motor responds only to voltages possessing the fundamental and odd harmonics of the supply voltage, no turning of the motor will take place.

Since the input signal to the power amplifier grids is directly related to the direction of the measuring circuit unbalance, it follows that the direction of potentiometer unbalance determines the direction of rotation of the motor armature. Accordingly, the slide wire contactor is driven to the correct balance position, where it stops.

When the measuring circuit is balanced and the voltage-amplifier signal to the grids of the power amplifier is zero, the direct current flowing in motor winding A acts as a substantial brake on any motion of the motor armature. This braking action permits the employment of sufficient amplification to produce high power torque for small extents of measuring circuit unbalance. At the same time, the braking action eliminates any overshooting of the balancing system. The result is very stable and positive operation of the recording system.

WABC

(*Continued from page* 73)

observing the ground wave field intensity at a distance of 1 mile and the reflected space wave component at a distant point. The current distribution takes the form of Fig. 2. This test was made at low power with power input to the antenna held constant.

As the position of the lower shorting bar is varied, the input impedance looking into the antenna also changes. Proper adjustment of this bar is a matter of expedience and permits some flexibility in the choice of impedances for matching different transmitter output circuits.

Plate output-antenna matching circuits

Fig. 1 will help to clarify details of the complete output circuit and method of feeding power to the antenna. In the Federal Type 162A 50kw Broadcast Transmitter used, the final power amplifier consists of two Federal Type 124A water-cooled tubes which operate as a high efficiency class C amplifier. The plate tank circuit consists mainly of L8C and C4C with the low impedance input of the "T"

network coupled in. The "T" network, consisting of L10C, L11C and shunt element C3C is adjusted so that the input impedance matches 27 ohms effective series tank resistance when the load is 75 ohms. Output power through the "T" network may be fed either into the pi type antenna matching network or a 75 ohm water-cooled dummy antenna. At the antenna ammeter or point (A) in Fig. 1, the antenna impedance $Z_a = 101.6 - j115$ ohms and a modified pi network affects the impedance transformation from the 75 ohm "T" network bus to antenna.

To operate the antenna at unity power factor, the reactive component of —j115 ohms is equated to zero by insertion of the opposing reactance jX_a (LID) and is an inductance of approximately 20.7 microhenries.

Modified pi network

Operating at high plate efficiency, the power amplifier generates considerable even order harmonics of which the second is dominant. To attenuate this harmonic, a special form of pi network is required. Again referring to Fig. 1 it will be seen that the usual purely capacitive input element to the pi network is replaced with a combination of reactances L5D, CID, which we may call X_a. For the operating frequency of 880 kilocycles, the net reactance of $X_a = X_c = -Xb$.

And the value of X_a, $X_c = -\sqrt{Z_1 Z_2} = -j87.5$ ohms $= .022$ ufd. and $X_b = \sqrt{Z_1 Z_2} = +j87.5$ ohms $= 15.8$ microhenries, where $Z_1 = 75 \pm j0 \pm Z_2 = 101.6 \pm j0$.

Actually, the three reactance arms Xa, Xb, Xc are set to 96 ohms and the two reactances L5D, CID are so proportioned that at 880 kilocycles L5D = +j32 ohms and CID = —j128. At X_a then, the net reactance at the operating frequency is $-j128 + (+j32) = 96$ ohms.

At the second harmonic, the inductive component X_L of Xa becomes $2X_L = j64$ ohms and the capacitive component X_c of Xa becomes $Xc/2 = -j64$ ohms and the input combination acts as a series resonant second harmonic filter.

A very interesting solution to this type network is given by W. L. Everitt in the 2nd edition of "Communication Engineering" pp 267-268.

Coaxial line for FM receiving antenna on top-hat

It should be noted that the open wire line running up one leg of the tower is actually a 70 ohm coaxial line with an outer shell ⅞ in. diameter. The inner conductor of this line carries received signal energy from the high frequency FM antenna at the top of the tower down to the input of an FM receiver. From Fig. 1 it is obvious that the radio frequency potential on the outer shell of this line is zero at the point where connection is made to the receiver.

The quarter wave stub

The λ/4 wave matching stub which connects between the transmitting antenna input terminal and ground consists of an outer shell 3 in. diameter and an inner conductor of ⅞ in. tubing. The inner conductor of the 3 in. line is actually the outer shell of the FM transmission line. The characteristic impedance of the 3 in. line is 70 ohms, but being used as a dissipationless matching section with one end shorted the open end Z is of course much higher. Since the antenna system is top loaded and operating at an electrical length exceeding 180 deg. current maxima occur at two points along the tower (see Fig. 2), and at these points the antenna resistance is very low.

The lower current antinode occurs at the base and point of feed but by connecting in the λ/4 stub at this point a resistance transformation takes place and the antenna resistance is increased from 46 —j95 to 101.6 —j115 ohms which shows an apparent increase in antenna resistance of 2.2 times with a small change in antenna reactance.

The stub, therefore, serves to increase the effective antenna resistance; reduce the I^2R power losses that would otherwise take place with greater antenna current; makes the problem of coupling from the transmitter easier, and brings the FM coaxial line safely down to ground rf potential.

For λ/4 wave operation at 880 kilocycles, the stub must be approximately 67.5 meters long and so

it was constructed in folded form and suspended from the basement ceiling. Both 70 ohm coaxial lines are kept charged with dehydrated air at slightly above atmospheric pressure. A small compressor and air dehydrating chamber serves this purpose nicely. Dried air supply lines to both coaxial lines feed in at ground potential.

Antenna measurements

Measurements of resistance and reactance on the tower were made after satisfactory completion of all adjustments for optimum performance. Measurements were made at point A. The results yielded are plotted graphically in Fig. 3 and were obtained with a General Radio Type 516C Radio Frequency Bridge.

The authors are indebted to Mr. Guy Hutchinson for his interest in and criticism of the manuscript.

SPEECH BROADCAST

(*Continued from page 75*)

The signal was broken by quickly pulling out a lead plug in the loudspeaker circuit. Three decays were taken at each frequency range and averaged for the data given.

The values shown are reverberation times—that is, time in seconds for the sound pressure level to drop 60 db from its initial steady-state condition. A straight line slope was drawn on the record, using the first 40 db of the decay. The tape speed was 50 mm per second. From these the reverberation times were computed.

The microphone-speaker position relation was chosen and a record taken over the frequency range. Another microphone-speaker position relation was then taken, and a second record run. Except in studio 8, these relations avoided directing the speaker into the microphone, so the record gave random sound energy.

Studios 9 and 11 are twins but not quite duplicates. Each measures 8 ft. 4 in. x 13 ft. 9 in. x 8 ft. 3 in. high and has a volume of approximately 1050 cu. ft. They are not duplicates because one is right hand and the other reversed. Building considerations made the arrangement of acoustical materials, doors, etc., somewhat different, but the amounts of acoustical

treatment and the furnishings of both studios are the same.

Chart 3 shows the calculated and actual time-frequency curves for Studio 11, which is pictured. Through the middle range, the actual and calculated results came fairly close together, but at the low frequencies the actual was considerably less than the calculated.

Chart 4 shows the calculated and actual results in Studio 9. Here again the actual and calculated came reasonably close in the middle range, but again the actual results were much lower at the low frequencies.

Speakers note difference

It is interesting to compare the actual and calculated time frequency curves of Studio 10 in Chart 5 with the three studios previously discussed.

The actual reverberation times, as shown by the high speed level recorder, are considerably less than the calculated times over the entire range. The graph of the actual times is entirely different from that of the other three studios. It shows high reverberation times at the low frequencies and after vacillating around in the middle range, drops down at the high frequencies. The quality of speech from this studio is distinctly inferior to that of the other three studios, and the only possible cause for this is the difference in acoustical adjustment. The comments on this studio have been borne out by various commentators who have used all of the studios. They uniformly are loud in their praises of the first three studios, and all prefer them to Studio 10 for their work. Since this paper was written, the acoustical material and arrangement of this studio have been made to conform to the other three.

You will notice from observing the photograph that we have broken up the acoustical treatment in small panels and distributed these panels in irregular arrangement on walls and ceilings. This tends to break up the large order reflections. In addition to this, we have sloped the surface of nearly all the acoustical panels. This degree of slope varies in the different panels, the degree of slope being between 5 and 10 degrees. This slope tends to break up the standing sound waves

in the room, and in this manner minimize the serious peaks that often occur in time frequency reverberation curve. Then, too, there was absolutely no symmetry about the arrangement size or slope, within the limits mentioned of the acoustical panels. The sloping of the panels and degree of slope were studied from a common-sense viewpoint, care being taken that the slopes on opposing parallel surfaces were placed in different planes so as to obtain as much as possible three-dimensional dispersion of the surface reflected sound.

Natural effect

The three studios have received nothing but favorable commendation from all speakers who have used them. When a person speaks in one of these studios, the effect is very pronounced in the natural tonal quality of the voice. Several news commentators have remarked at the ease of speaking in these studios, as their voices in these studios have a natural ring and not the blanketed effect that comes from a predominance of high-frequency sound absorbing material.

The net result to the auditor in his home with a fairly good commercial receiving set and speaker seems to be very similar to the effect of a person talking in the room without any appreciable loss due to transmission and reproduction facilities.

RELAY LINKS IN BROADCASTING

(*Continued from page* 87)

ten hours to supply program to our standard broadcast transmitter, when a plumber punctured and flooded an underground telephone cable, containing our studio-transmitter lines.

The 30-mc AM circuit between our studio and transmitter plant is not entirely free of ignition-noise interference, but it is a valuable emergency facility.

Secondary frequency standard

At the transmitter plant, the operating frequency of each transmitter is checked monthly with station WWV, on a secondary frequency standard. This equipment consists of a calibrated communications receiver, a 100-kc crystal, with multivibrator and frequency multiplier, a direct-reading audio frequency meter, and a calibrated beat-frequency audio oscillator. With this apparatus, the operating frequencies of all of our transmitters can be measured with an accuracy sufficient to meet FCC requirements.

Frequency monitors

Each permanently installed relay broadcast transmitter is equipped with a crystal-controlled frequency monitor and a receiver. These units are independent of the frequency control of the transmitter, and are used to determine that the operating frequency is within one-half of the allowed tolerance.

Generators

The two constant-voltage, 350-watts, 115-volt, 60-cycle generators, belt driven from the truck motor, are connected to the transmitter so that each generator has approximately equal load. One generator supplies power to the filament transformers and the low voltage rectifiers. The other generator supplies power to the high-voltage rectifier. Connecting the generators in this manner serves to compensate for their inherently poor regulation. Adjustments in tuning, and changes in the loading of the final amplifier do not reflect in a change of excitation or filament voltage, as was the case when the transmitter was supplied from a larger single generator.

Each generator is provided with a field rheostat to adjust voltage. Pulley sizes were chosen to provide normal output at any motor speed above that required to propel the mobile unit at approximately twenty miles an hour.

161-mc FM transmitter

The 161-mc 100-watt FM transmitter pictured employs a 10-mc electron-coupled oscillator followed by harmonic amplifiers which multiply the oscillator frequency sixteen times. The last harmonic amplifier also serves as a power driver for the push-pull power amplifier. The design of the ultra-high-frequency portion of the transmitter is conventional except for the series-

tuned 80-mc and 161-mc harmonic amplifier plate circuits. It is shown as installed in the truck, in one of the pictures.

The 10-mc oscillator is frequency modulated directly by a reactance-tube modulator. The electronic center-frequency stabilization is accomplished by combining the second harmonic of a temperature-controlled 9.8-mc crystal oscillator and the second harmonic of the 10-mc electron coupled oscillator, into a mixer tube and then to a discriminator. The voltage output of the discriminator is applied to the reactance tube modulator for center-frequency stabilization. An audio amplifier, also coupled to the discriminator, serves as a monitor.

Audio frequency voltage is fed to the control grid of the reactance modulator through a line-to-grid transformer, preemphasis network, and radio frequency filter.

161-mc FM remote receiver

The 161-mc remote-controlled receiver consists of pi-network, followed by a two-stage, acorn-tube, radio-frequency amplifier and a mixer. The grid and plate circuits are coupled by capacitance and series tuned similar to the 157.5-mc AM receiver. There is a temperature-controlled crystal oscillator, and harmonic amplifiers, to furnish a beat frequency that provides a signal at 45-mc in the FM broadcast band. The 45-mc signal is coupled to a standard FM translator chassis. A 100-foot open-wire radio frequency transmission line connects the antenna to the pi-network of the receiver. A two-wire telephone circuit connects the receiver to the master control room. A center-tap connection to ground on the same circuit carries direct current to operate the differential relays that apply power to the receiver and the antenna rotating mechanism. A continuous low current operates a relay that applies power to the receiver, and an intermittent higher current operates the relay that applies power to the motor of the antenna rotating mechanism, and a latching relay that reverses the motor with each high current impulse. The remote control of the receiver from the master control room is simple: the remote receiver is turned on, and

the audio circuit completed, by merely plugging in a single patch cord. The antenna is rotated and reversed by the manual operation of a push key. Each time the key is operated the antenna rotates in a different direction. The correct orientation of the antenna can be determined either by means of a VU meter or by ear.

LINEAR FREQUENCY CONDENSERS

(*Continued from page 89*)

Some designers prefer to use a different plate shape in the oscillator section of a superheterodyne tuner. This shape can be figured in the same way, again using eq. 1, where all factors are the same, except X.

In this case $X' = \left(\frac{f_o \sqrt{X + IF}}{f_o + IF}\right)^2$ 3

where IF is the desired intermediate frequency.

The series of computations illustrated in Table I, are then repeated with this value of X' substituted for X in equation 1.

In some designs the oscillator section may use a range that is radically different from that of the main section, as for instance 20-23 mc., and 2 to 5 mc., respectively, both having a frequency difference of 3 mc, and calling for an IF of 18 mc. A tabulation similar to Table 1, based on a value of $X = (23/20)^2$, with other factors unchanged, will give a condenser that will gang properly in the oscillator circuit. The rest of the condensers will have a curve based on $X = (5/2)^2$ which was the value assumed in the example, Table 1.

In tailoring an experimental condenser for some such use as above, it may be convenient to cut the high-frequency section rotor plates out of the lower frequency section plates. This can be done if the minimum radius of each section is the same, instead of the maximum radius. In Table 1 $R_0 = .398$ in. The revised plate shape can then be determined from eq. 1 by using the new value of X. Since this plate is smaller than the original plate it may be fabricated by cutting down the original shape.

Shaping the stator plates

Linear frequency characteristics can also be obtained using semi-

circular rotor plates and a set of specially-shaped stator plates with their inner radii cut away. The shape of the stator plate for this arrangement is obtained from eq. (1) by letting (Rm) equal the outer radius of the rotor plates, and then solving for the values of (r) at each of the various ratios of θ/Z, in a similar manner to that illustrated in Table 2. The resulting curve is shown in Fig. 2 with the semi-circular rotor plate shown in a dotted line. Ordinarily there is a less efficient utilization of plate area found with this arrangement however.

In assembling cut-away plates of any type in a condenser, it is necessary to know the effective area of the plate so that the correct number of plates can be provided. In Col. 8 of Table 1 the values of R^2 at various points are recorded. The sum of these squared terms divided by the number of terms added gives a figure which is approximately proportional to the effective area. This average can be compared with the final term in this column, Rm^2. In other words, the ratio of the value of Rm^2 to the average of the whole series, shows the increase in the number of plates that must be provided, compared with a semi-circular plate condenser having the required capacitance.

Area of plates

Actually each plate has an effective area somewhat larger than its true area, on account of the fringing field, or the "edge effect." In receiving-circuit condensers which have air gaps of .020 in. or .030 in. this is equivalent to the addition of a narrow strip around the edge equal to about 40 per cent of the air gap. This is the same as adding about .010 in. to each radius dimension. A correction should therefore be made if greatest accuracy is needed, by reducing each value of R by a fixed amount equal to about 40 per cent of the air gap.

Many experimenters have attempted to use condensers stated to have linear frequency characteristics, the design factors of which have not been stated. The manufacturers design information as to the correct value of Co is important if such a condenser is to be used with greatest operating linearity.

HI-FI TRANSCRIBING

(*Continued from page* 91)

switch "A-B" (Fig. 4), installed in a General Electric JFM 90 FM receiver—"B" for pre-emphasis and "A" for "flat" recording. Pre-emphasized disks are de-emphasized in the playback system—a P.L. 50 Brush pickup feeding a special equalizer-preamplifier. Almost exact de-emphasis is secured. This system is especially effective for 78-speed recordings, providing low background noise and electrifying "presence" of speech or music.

Frequency standards

Performance was checked with various frequency standards. Resulting curves L_1 to L_5 (Fig. 3) show response at various equalizer settings. L_6 is the P.L. 50 constant amplitude curve, which produces very agreeable de-emphasis for small rooms, or when highs must be reduced for other reasons.

Tuning meters were inserted in the JFM 90 circuit (Figs. 4 and 5), an output tube and transformer adapted it to a 500-ohm line, and the whole was rack mounted.

Much of today's recording "art" is outmoded, especially so as to the results produced by the machines and disks made for use in the home, according to Mr. Kennedy. This, he is convinced, will be corrected after the war, because "FM and television tone have and are continuing to broaden the public's tonal appreciation, also that of engineers." He believes home phonograph records will be made with recorded musical pre-emphasis and greater dynamic range, as many transcriptions are now made for broadcast purposes. Home disks will be flexible, perhaps unbreakable, made of a material to cut out needle "hiss." Drummy, boomy cabinets will be outlawed. Perhaps loudspeakers will be installed in detachable tone chambers so they can be isolated from the vicinity of delicate tubes, pickups, etc. "Wows" and "wobbles," from record eccentricities will go. Precision turntables and silent electric motors will come in. In short, phonograph machines and disks for tomorrow's home entertainment will have to possess many virtues they don't have today or suffer eclipse.

Regal Electronics Corp.

Above is the new name of the former Regel Mfg. Co., Inc., 20 W. 20th St., New York. "The change in name does not include any change in ownership, policy or personnel", declares Walter Spiegel, president. "Our experienced engineering organization will be maintained intact for the coming electronic era."

DR. BAKER DISCUSSES TELEVISION'S FUTURE

If television did nothing more before the war than train engineers in the art of high-frequency work, it was well worth while, for this knowledge has been extremely important to the Allies in the war now being fought, Dr. W. R. G. Baker, General Electric vice president, told a Schenectady, N. Y., group on April 7.

When peace comes, radio manufacturers, now devoting all their facilities to war production, will be prepared to build reasonably priced television sets in large volume, he said. They will be clamoring for work, but before they can produce these sets a decision must be made on standards, just as such a decision was made in the pre-war era by the National Television System Committee. The place of television in the frequency spectrum must be determined, he said. What the standards should be will be the big problem to decide, for the decision will affect the industry for many years, Dr. Baker explained.

New channels

High frequencies never before available to the television engineer have been brought into use as a result of war research, he said, comparing the pre-war television frequency band with a small boat. "Let us imagine this small boat as the only means of contact between two countries on opposite sides of a river, and the amount of trade and intelligence passing between the countries being limited by the boat's capacity. War research has broadened the usable television frequency band just as a bridge built across the river between the countries would provide greater capacity for traffic between these countries."

The television sets built after the war probably will produce pictures in black and white because color television may be too expensive and still has not been worked out to the engineer's satisfaction, Dr. Baker pointed out. Color television will come, he said, but probably not for some time after the war ends. Then, too, any immediate adoption of color television would make obsolete much of the transmitting equipment of the nation's eight television stations which will form the nucleus for immediate post-war television broadcasting. These stations probably will start branching out with full-scale programs shortly after the war ends, it was explained.

Dutch tubes

Before the war, a sizable portion of picture tubes, the most expensive part of television sets, were imported from Holland because they could be bought by U. S. manufacturers cheaper than they could be built. But the war has changed that, Dr. Baker explained, and when peace comes U. S. manufacturers will have tremendous capacities to make these tubes in America. Large scale production and other developments will drastically reduce the pre-war price of these tubes which will be among the elements that will bring about reasonably priced television sets, he said.

Post-war relaying of programs will be done with coaxial cables or television relay stations, or possibly a combination of both, it was explained, and only developments will tell who will operate these relay links. Dr. Baker pointed out that General Electric has had a relay station in operation for over three years. Located in the Helderberg Mountains outside Albany, N. Y., the station picks up programs from the NBC television station in New York City and relays them to the Albany-Schenectady-Troy area through G.E.'s WRGB transmitter. This is the nation's pioneer television network, he pointed out, being in service since January 12, 1940.

Television is essentially a line-of-sight operation from transmitter to receiver. Stations will therefore probably be located in the larger cities, with transmitters located

where they can reach the most receivers, he said.

The size of the picture produced by a television set will depend on public demands, the advertising audience was told, but Dr. Baker pointed out that in his opinion the American people will not want a picture the size of the wall in their living rooms. The average person probably will want a picture from 12 to 15 inches square so that he can sit seven or eight feet away from the television set and enjoy the program, it was explained.

LUMINOUS MATERIALS ON BATTLE FRONT

Luminescent instrument panels which glow in the dark are enabling submarine crews to navigate despite electric power failures caused by the explosion of depth bombs, Samuel G. Hibben, director of applied lighting for the Westinghouse company, Bloomfield, N. J., told the Royal Canadian Institute at a meeting in Toronto recently. He also told how fluorescent and phosphorescent materials are helping to save the lives of soldiers, sailors and even war production workers.

Luminescent materials are becoming important lighting tools in places where it is either impossible or undesirable to apply ordinary sources of light, Mr. Hibben said. On board a war vessel where the batteries or lamp bulbs have been destroyed or temporarily damaged, the ability of the crew to see the essential instruments and control valves by means of phosphorescent coatings, is an important factor in saving lives until rescue can be effected or repairs made.

Mark danger spots

In dock areas, where wartime precautions make even a dim light undesirable, luminescent materials make possible the marking of danger spots such as the edge of piers and obstructions which would constitute an accident hazard in the event of a blackout. Fire extinguishers, first-aid kits and other objects which must be readily distinguishable in case of a blackout are being given markings which glow in the dark.

On the instrument boards of fighting aircraft, the dials are given a fluorescent coating which shines when irradiated by invisible ultraviolet light. This enables the night fliers to see their instruments without being "blinded" by the glare of ordinary light. Already luminous signs and markers have been installed in some war production plants to denote exits, doors, factory aisles and raid shelters, Mr. Hibben reported. Phosphorescent coatings may be used also to outline door knobs, switches and stair railings.

Ultra-violet stimulation

The commercial and military possibilities of luminescent materials are still being explored, Mr. Hibben explained. The fluorescent lamp makes use of special powders known as phosphors which fluoresce when they absorb ultraviolet radiations. Invisible radiant energy called "black light" is produced in essentially the same way, except the invisible ultraviolet rays are used to make materials luminescent which are at a distance from and outside the lamp.

(*Please turn page*)

The two terms fluorescence and phosphorescence, he added, are sometimes confused. They both represent the ability of certain substances to transform some form of energy into visible light. The results are indistinguishable to the eye, but between them there is one important difference. Fluorescence lasts only while the exciting energy source or ultraviolet "black light" is present; phosphorescence continues after the light has been removed.

WHAT NOISE DOES TO PEOPLE — AND WHY

by DONALD A. LAIRD, Ph.D., Sci.D.
Rivercrest Laboratory, Middle Haddam, Conn.

Why does noise do things to people? Because for hundreds of centuries in our development loud or sudden noises meant danger. Our ancestors of long ago who were not frightened by such loud or sudden noises as the snarl of a wild animal or the rumble of an avalanche, were killed off. Our present races have developed from people who were frightened by loud noises, and who got to safety.

As a result, a fear reaction is started in people of today by a loud or unexpected noise. Originally this fear reaction helped our forefathers survive. Today it may make life a bit more strainful because we are all too often surrounded by noise which man makes today and of which our progenitors never dreamed.

The fear reaction in moderns

This fear of noises is one of the very few fears which are born into all moderns. Fear at the loss of support—as when a chair is pulled out from under us—is another one.

In moderns the fear reaction to noises is shown, as pointed out in my book on "How to Use Psychology in Business," by: "Increased tension of voluntary muscles, lessened activity in the digestive tract, increased pulse rate, increased blood pressure, diminished secretion of saliva and digestive juices, and a vague feeling of apprehension, sometimes accompanied by restless general behavior."

How much noise does it take to do these things to people? If our environment is noisy enough so that we have to raise our voices when talking, it is probably too noisy. If we have normal hearing, yet have to give close attention in order to hear others talk, it is probably too noisy for our good.

If we can hear the noise while going to sleep, or if noises waken us from sleep, they are doing us no good. High pitched noises, such as the whine of a falling bomb, appear to be worse than ordinary noises of the same loudness. Consider the vacuum cleaner. Wavering noises, such as a siren, are also probably worse than steady noises of the same volume. Irregular, intermittent, and especially unexpected ones are bad.

The growing menace of noise

There are indications that a little noise may stimulate, but in most city streets and work shops the noise is above this stimulating level. With the growth of factory production and the mechanization of offices and homes, noise has grown much more than the average person realizes.

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