ELECTRONIC INDUSTRIES

★ Airfield Radio and Landing Systems
★ Factory Short Cuts ★ Induction Heating
★ Tube Tests ★ Television ★ Beryllium

MAY 1944

Caldwell-Clements, Inc.

ELECTRONIC INDUSTRIES

Including INDUSTRIAL ELECTRONICS

★ IN THIS ISSUE   MAY, 1944 ★

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CALDWELL-CLEMENTS, INC.—TEL. PLAZA 3-1340—480 LEXINGTON AVENUE, NEW YORK 17, N. Y.

OLD FAITHFUL GEYSER, Yellowstone National Park. Geologists believe it began erupting before the last glaciation, about a million years ago. Within record, Old Faithful has erupted continuously at about 65-minute intervals, spouting a column of water 95—130 feet high for $4\frac{1}{2}$ minutes.

STILL GOING STRONG

LONG, UNINTERRUPTED service under all operating conditions is the characteristic you want most in a capacitor. Tobe Capacitors serve so well and so long because every step in their manufacture is checked and cross-checked by rigid inspections. Constant improvement through constant research is the promise performed by Tobe engineers. An example is the Tobe CA-255 Capacitor, shown below, now available in a new drawn container of improved construction. Why not call on Tobe for prompt, specialized help on your capacitor problems?

SPECIFICATIONS—CA-255

Mineral Oil Impregnated and Filled. Aluminum Foil. Highest Grade Kraft Tissue.

CAPACITY RATING .... 3 x .1 mfd.
VOLTAGE (working) .... 400 V. D. C.

DIMENSIONS: 1 11/16" wide: 9/16" deep: 2 7/16" long, including channel mounting bracket. Mounting centers 2¼". Three terminals ½" on centers. Height of terminal ¾". Diameter of mounting holes, .144.

FEATURES: Rugged Channel Mounting Bracket securely soldered to container . . . Increased terminal insulation . . . Rigid terminal lugs afford ample space to handle No. 14 stranded wire . . . Improved streamlined drawn container instead of fabricated can . . . Type, capacity and voltage die-stamped on container. Meets U. S. Army Signal Corps Specifications 71-516-E.

Other values and voltages may be obtained in above mentioned container construction. Send for details of our "OM" and "OD" Capacitors.

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A small part in Victory today...

A BIG PART IN INDUSTRY TOMORROW!

LETTERS

Did Two-Filament Lamp First Reveal Edison Effect?

Editor, Electronic Industries:

A good many years ago, in correspondence with W. K. L. Dickson, who was a member of the Edison staff for a long time, prior to his dismissal in 1895, he gave me the explanation that "the Edison Effect" had been discovered incidental to experiments with double-filament lamps.

He said that they tried making lamps with a second or spare filament to cut into the circuit when the first filament burned out. They found an unexpected potential in this idle second filament, according to Dickson; and he said that it was part of his assignment, prior to his motion-picture work, to make galvanometer tests of the effect.

Since my interests through many years of contact with Mr. Edison were principally pertaining to the motion picture, I never got around to discussing this with him, and I am wondering now if any of your readers chance to have any information bearing on it.

Terry Ramsaye, Editor
Motion Picture Herald
Rockefeller Plaza
New York City

Scarem Harem—or Video Amid the Houri

Editor, Electronic Industries:

Romantic Pasha here in North Africa has progressive ideas. Talking to Maj. Andre Baruch, former CBS announcer now in Africa, he inquired about the possibilities of a closed-circuit radio set-up in his harem so that he could broadcast whenever he wished. He already has an intercommunication system that allows him to push a button and contact any room in the harem...

But pay-off came in his final remark to the radio officer, when he asked, "And how is television progressing in your country, major?"

Percival Pentode
Algiers APO, Afrique

★ ★ ★

"Nothing is impossible," Thomas A. Edison used to say. "We merely don't know yet how to do it. All that is necessary to overcome an obstacle is to find the right man."

Apparently our German enemies have developed a crewless radio-controlled miniature airplane capable of being directed by the crew of a bomber, and carrying a lethal load of destruction. Well, we had a radio-controlled bomb as far back as 1934, but it was figured that "straight" bombing on a wholesale scale would be more effective. It is.

Says Charles F. Kettering—"I expect to spend the rest of my life in the future so I want to be reasonably sure of what kind of future it's going to be—my reason for planning."

THORIATED-TUNGSTEN FILAMENT

the G-E electronic-tube development that reduced filament power by 80% and made portable radio equipment possible

another G·E electronic FIRST!

IT WAS in 1914 that General Electric's Dr. Langmuir brought to light the startling electron-emission potentialities of thorium in tungsten filaments. The tremendous increase in electronic emission made possible by the harnessing of thorium and pure tungsten as a "working team" permitted power and power-equipment requirements to be reduced to ONE-FIFTH of former needs — for approximately the same life.

As a result of this great development, light, portable radio transmitting equipment became practical for airplanes—police cars—life-boats—Army "jeeps" and foot soldiers.

General Electric's electronic-tube history is a succession of such important "firsts"— in development, in application, and in manufacture. You may be sure that G-E electronic tubes possess the best that research and engineering have uncovered; that they work efficiently, dependably, economically. G-E tubes are manufactured in factories which are among the largest and best equipped in the world—under the most modern methods, and from the finest materials obtainable.

Ask your G-E electronic-tube distributor or nearest G-E office for price list (G-E Bulletin ET-5) and delivery dates on tubes for all of your requirements.

G-E TUBES ARE FIRST IN INDUSTRY, TOO. For example, General Electric developed the thyratron tube, providing precision control that makes possible today's high-speed resistance welding. This versatile tube is also the "heart" of G-E Thymo-trol, which makes it possible to maintain constant speed in electric motors regardless of load.

Write for book "How Electronic Tubes Work." Address *Electronics Department, General Electric, Schenectady, New York.*

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

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161-C5

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USE THE G-E EQUIPMENT RESERVATION PLAN TO ESTABLISH YOUR POST-WAR PRIORITY

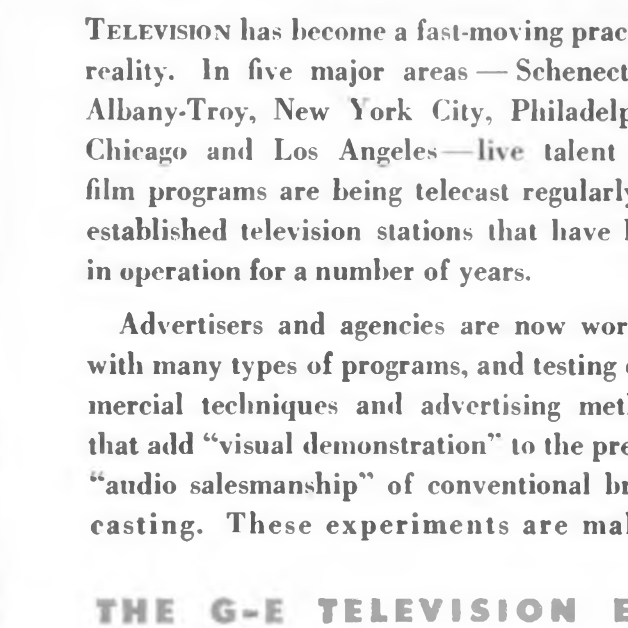
TELEVISION has become a fast-moving practical reality. In five major areas — Schenectady-Albany-Troy, New York City, Philadelphia, Chicago and Los Angeles — live talent and film programs are being telecast regularly by established television stations that have been in operation for a number of years.

Advertisers and agencies are now working with many types of programs, and testing commercial techniques and advertising methods that add "visual demonstration" to the present "audio salesmanship" of conventional broadcasting. These experiments are making television history! A successful television relay system already links Schenectady and New York; New York and Philadelphia—forecasting a practical *nation-wide* system of commercial television service.

At Schenectady, in the world's most powerful and best equipped television station, WRGB, General Electric has built the *complete* television system — from transmitter to receiver — antenna to television relay — right down to the air-conditioning and studio equipment . . . ready for your inspection, demonstration and study.

THE G-E TELEVISION EQUIPMENT RESERVATION PLAN

and the brochure, "Television Broadcasting Post-war"



We have mailed these two G-E publications to our list of prospective television broadcasters. The Equipment Reservation Plan will enable you to establish a post-war priority on television equipment. It will enable us to plan definitely for large-scale post-war production — thereby giving you the fastest possible post-war delivery.

If you are interested in entering television broadcasting and have not received these G-E publications, we shall be glad to send them to you. Address *Electronics Department, General Electric, Schenectady, New York.*

General Electric can supply the COMPLETE television broadcast system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TYPE
DR 17
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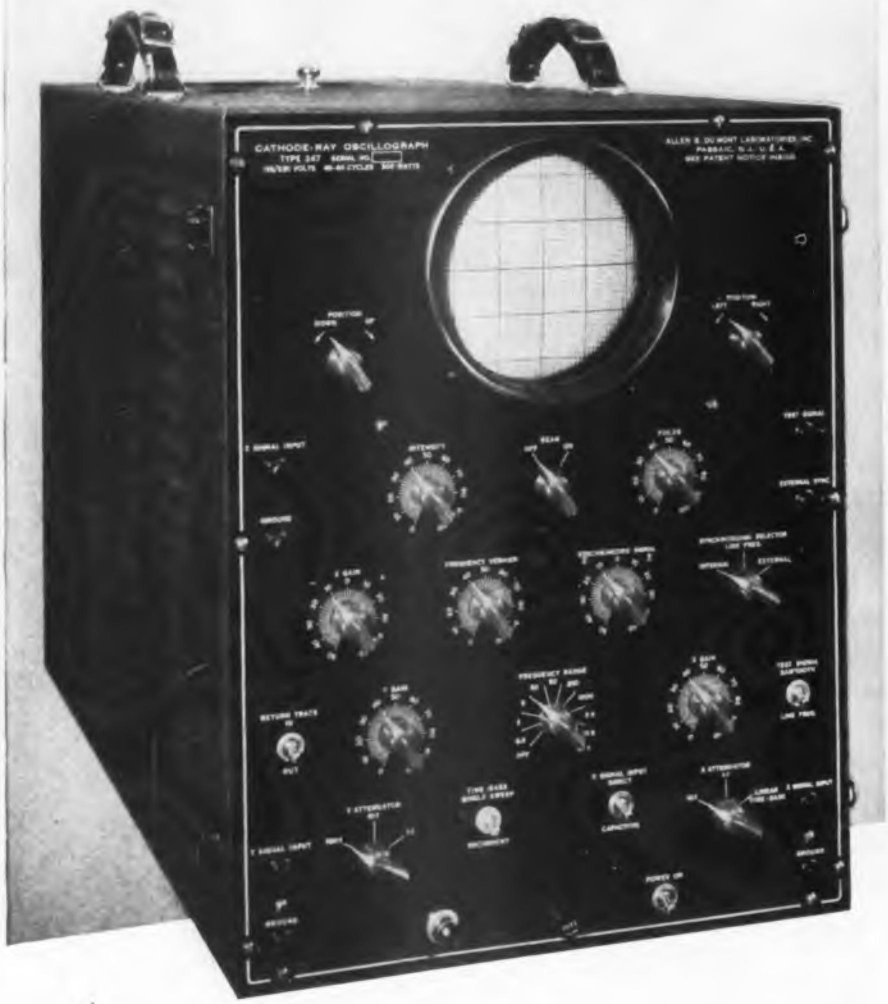
GENERAL ELECTRONICS
DR 17
Grid controlled Rectifier. Combining in its use a high voltage rectifier with a means for varying the rectified DC output continuously from 0 to 1000 volts DC without changing the applied input voltage.
Experienced heads, which among other things, pioneered the graphite anode and carburizing thoriated filament, have joined in this young and virile company to develop and manufacture the finest in vacuum products for electronic applications . . . with no prejudices, no preconceptions, no antiquated equipment or methods to hinder their creative and productive abilities. The tubes shown are modern in design and construction and represent use of the latest knowledge in the electronic field.
GENERAL ELECTRONICS INC.
CHICAGO 47, 1917 NO. SPRINGFIELD AVE. • 101 HAZEL STREET, PATERSON, N. J. • EXPORT DEPT., 85 BROAD ST. NEW YORK 4, N. Y.

Another DuMONT *Contribution...*

TYPE 247 CATHODE-RAY OSCILLOGRAPH



Uses new Army-Navy preferred Type 5CP1 cathode-ray tube with intensifier electrode operated at overall accelerating potential of 3000 v. High-intensity patterns. 5" dia. screen.

Medium-persistence green screen, standard. Also available with short-persistence blue screen Type 5CP5 tube for high-speed photographic recording. Or Type 5CP2 long-persistence green screen for visual observation of low-speed phenomena.

Vertical or Y-axis amplifier response does not fall more than 10% below the uniform value from 2 to 200,000 C.P.S. Sufficient gain for maximum deflection factor of 0.05 r.m.s. volt input signal for 1" deflection of beam.

Distortionless, continuously-variable low-impedance attenuator or gain control. Stepped attenuator with ratios of 1:1, 10:1 and 100:1.

X-axis or horizontal amplifier accommodates signal produced by linear time-base generator. Reasonably uniform response from d-c to 100,000 sinusoidal C.P.S. Signal amplitude of 0.5 v. r.m.s. sufficient for deflection of 1" through amplifier.

Recurrent, repetitive and single-sweep operation of linear time-base generator. Continuously variable from 0.5 to 50,000 sawtooth cycles per second. Single sweep of writing rates corresponding to 0.5 to 10,000 cycles per second.

Z amplifier channel for applying external signal to grid or modulating electrode of cathode-ray tube.

Steel case. Black wrinkled finish. Copper-finished steel chassis. Two carrying handles. 14" w.; 19" h.; 26" d. 130 lbs.

This latest oscillograph facilitates the investigation of transient as well as recurrent phenomena over a wide frequency range. And since a permanent record of transient phenomena is usually desirable, this instrument provides for such photographic recording by applying comparatively high accelerating potentials to its cathode-ray tube. Furthermore, a new type of beam-control circuit is incorporated.

The sweep frequency range has been extended. The instrument may be used for observations on low-speed machinery and for other low-frequency signal functions—even down to ½ cycle per second. At the other extreme, the instrument handles radio-frequency signals as high as 500 kilocycles. The time-base has the necessary range to display such signals properly. Also, the vertical amplifier can satisfactorily accommodate them.

Literature on request ...

DUMONT *Precision Electronics & Television*

ALLEN B. DU MONT LABORATORIES, INC., PASSAIC, NEW JERSEY · CABLE ADDRESS: WESPEXLIN, NEW YORK

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FOR QUICK DELIVERY

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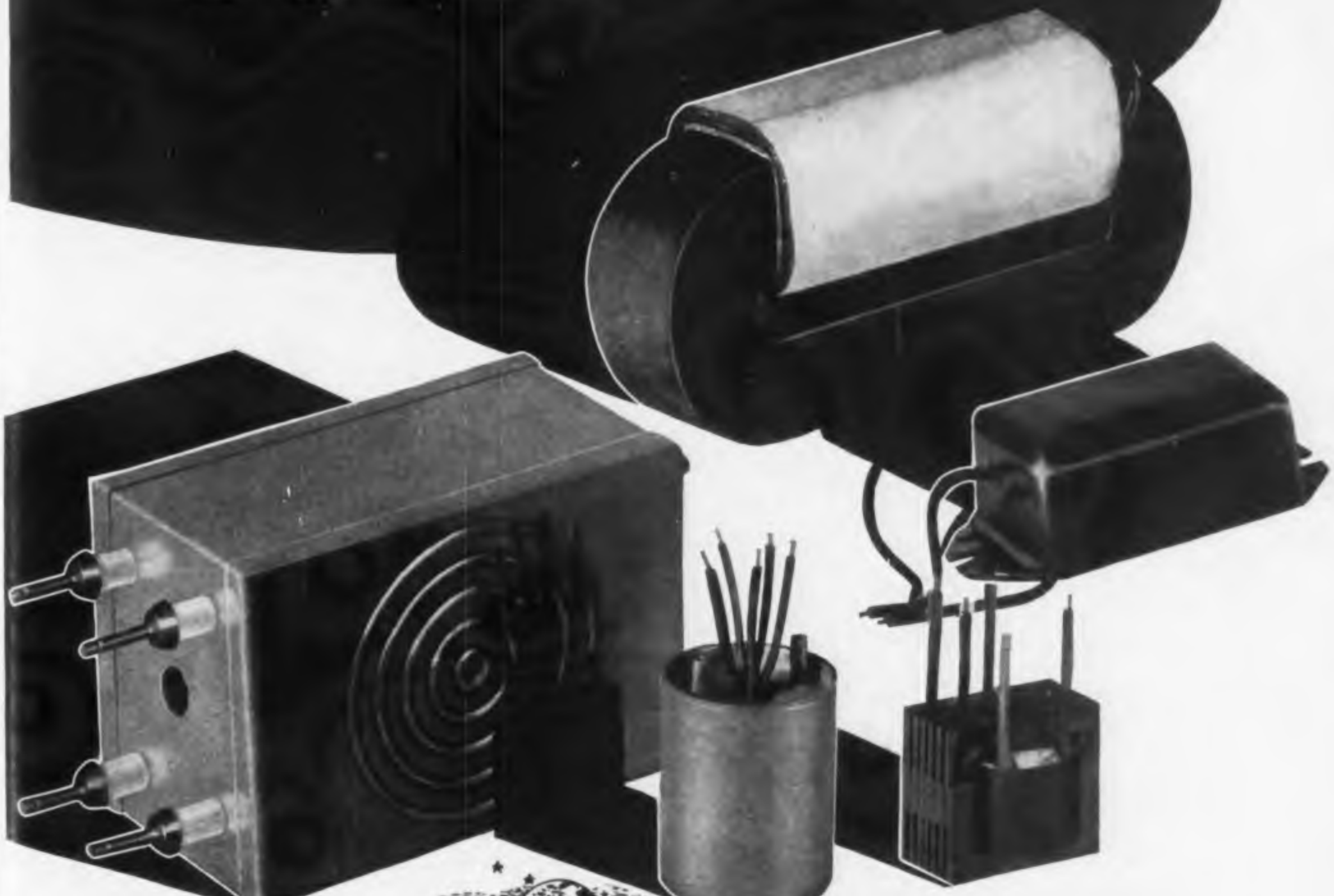
Consolidated Radio Products Company has recently greatly expanded its production facilities on a wide range of small and medium transformers including Pulse Transformers, Solenoid Coils, Search Coils. Other products include Range Filters, Headsets.



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Made-to-order at no extra cost

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"A"—15/32 long x 1/2" dia.—Mountable with 6-32 flat or filester screw. #21 tinned copper wire leads. 1 to 300,000 ohm value—1/2% standard accuracy—non inductive pie wound—1/2 watt, 30° C. temperature rise in free air—100° C. maximum operating temperature—200 D. C. maximum operating voltage. Baked varnish finish.

"B"—15/16 long x 1/2" dia.—Mountable with 6-32 flat or filester screw. #21 tinned copper wire leads. 1 to 500,000 ohm value—1/2% standard accuracy—non inductive pie wound—1 watt, 30° C. temperature rise in free air—100° C. maximum operating temperature—300 D. C. maximum operating voltage. Baked varnish finish.

"T"—1-1/32 long x 7/16" dia.—Inductively wound—1/8 x .015 strap terminals—35 to 35,000 ohms—2 watts, 100° C. maximum operating temperature—normal accuracy 1%. Baked varnish finish.

"M"—1-13/32 long x 3/4" dia.—Mountable with 6-32 screw—1/8 x .015 thick strap terminals—Non inductive wound—1 meg ohm maximum resistance—600 volts maximum operating voltage—100° C. maximum operating temperature—1.5 watts—1% normal accuracy. Baked varnish finish.

Elco wire wound resistors have met the standards of quality demanded by the country's largest radio and instrument manufacturers. These standards have been maintained despite the wartime necessity of speed in production. Our plant is staffed and equipped to do that very thing. We have highly trained workers ready and eager to fill your order promptly.

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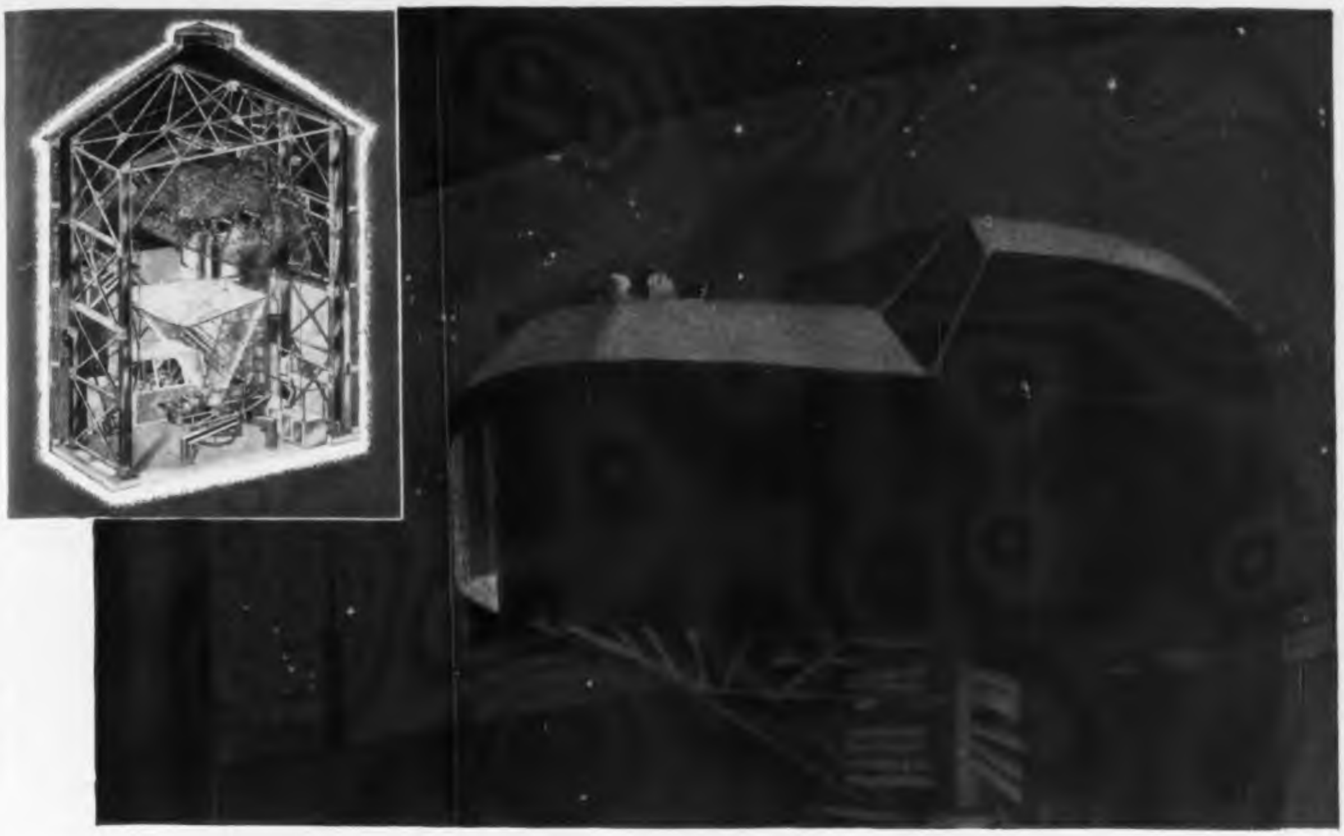

The **Laue Camera** is used for the observation of preferred orientation of grains or fiber textures and the study of cold work and recrystallization.

Typical Laue Camera Diffraction Pattern; shows preferred orientation.

The Back Reflection Camera is used for precise measurement of lattice constants, measurement of surface stresses, observation of distortion in crystals and the determination of composition of solid solution alloys. Sample and film may be rotated by motor.

Typical Back Reflection Camera Diffraction Pattern

For routine identification of substances or unknowns the 70 mm. Powder Camera is used. Specimen can be rotated by motor.

Typical 70 mm. Powder Camera Diffraction Pattern.

For more precise measurement of lattice constants and the determination of alloy constitution diagrams, and for studies where the highest resolution is required, the 200 mm. Powder Camera is used. Specimen can be oscillated or rotated by motor.

Typical 200 mm. Powder Camera Diffraction Pattern. Note the greater resolution of lines as compared with the 70 mm. pattern of the same area above.

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Small, compact and light weight, Klixon Snap-Acting Controls are available in many standard models, such as those illustrated, for most control requirements. Write for complete information.

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"Three years ago we produced the bulk of our plastic parts. But because we are primarily an electrical assembly and metal working plant we were unable to adapt ourselves to quick changes in plastic specifications in such parts as our fuse posts, spacers and terminal strips.

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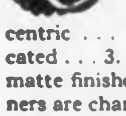
Take the first step NOW—send us blue prints for quotations and delivery promises.

"CREATIVE" INSULATING GROMMETS



Five important characteristics save time and labor in wiring operations:—1. All holes are concentric . . . 2. All threads are clean and lubricated . . . 3. All parts have geared collars and are matte finished for quick handling . . . 4. All corners are chamfered to protect against fraying . . . 5. Four standard sizes, all immediately available from stock. *Send for free sample card.*

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NORTHWEST AIRLINES
PAA
Panagra
TCA
TWA
GOES ALL THE WAY
WESTERN AIR LINES
ARMY
NAVY
Today..and Tomorrow
Illustrated at right is a typical crystal manufactured by Aircraft Accessories Corporation and used in both ground and plane radio installations by America's commercial airlines. Many other types of AAC crystal units are being supplied various branches of the armed service and other government agencies.
Today, practically all AAC facilities are devoted to war production. Tomorrow, advanced AAC electronic developments will be available for the post-war world.
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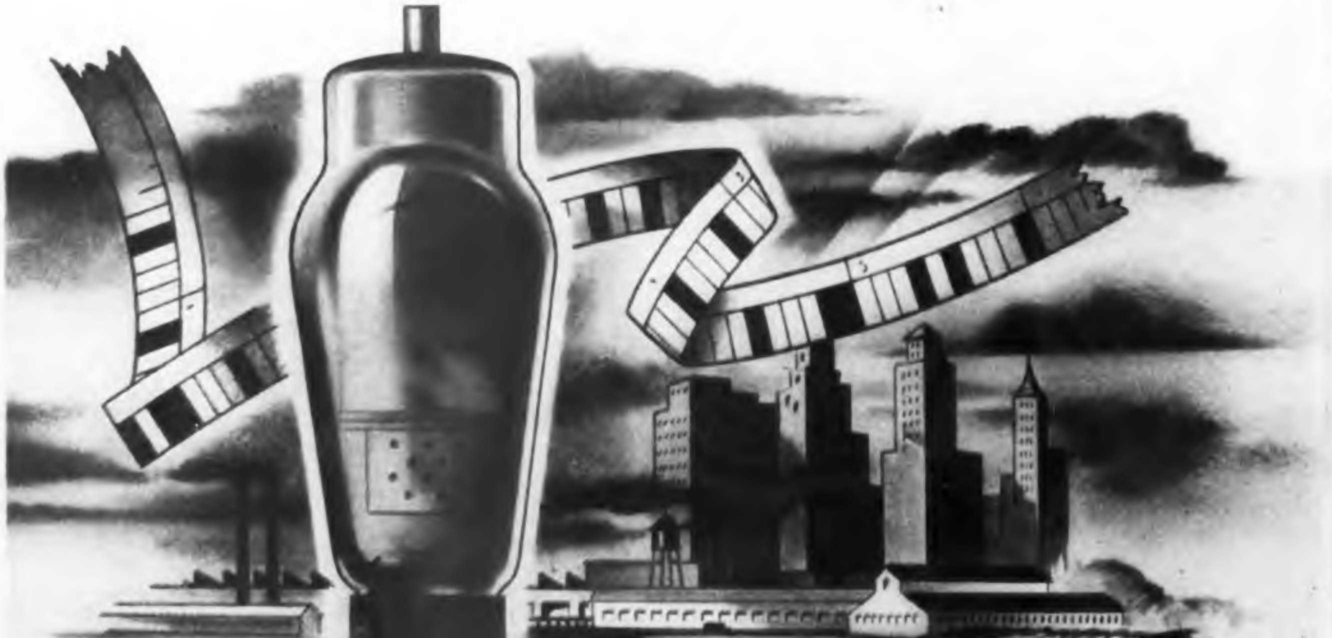

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Material for this Reference was compiled under the direction of the Federal Telephone and Radio Laboratories in collaboration with other associate companies of the International Telephone and Telegraph Corporation. This group of companies possesses experience gained throughout the world over a period of many years in the materialization of important radio projects.

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General Engineering Tables: Conversion, Fractions of Inch, Copper and Copperweld Wire, Machine Screw Data.

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Audio and Radio Design: Condenser and Resistor Color Codes, Inductance and Reactance Charts, Time Constants, Impedance and Electrical Circuit Formulas, Network Theorems, Attenuators, Filter Networks, Arrays, Frequency Tolerances.

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KNIFE-DISCONNECT
SPLICING SYSTEM
The basic design of the AMP Splicing Terminal, using identical ends with a knife-switch wiping action, has proven so superior to conventional splicing methods that AMP now introduces a disconnect splicing system to cover a wide variety of adaptations. Typical examples are shown here. Each of these incorporates the same exceptional electrical and mechanical characteristics inherent in the basic design. All current carrying parts are integral stampings of pure electrical copper, having minimum weight. No reduced conductivity alloys.
Write today for your copy of AMP Bulletin 31
"PRECISION ENGINEERING APPLIED TO THE END OF A WIRE"
AMP
SOLDERLESS WIRING DEVICES
AIRCRAFT-MARINE PRODUCTS INC.
1521-34 NORTH FOURTH STREET, HARRISBURG, PENNSYLVANIA
A&M ACCESSORIES, LTD., 17-19 MELINDA ST., TORONTO, ONTARIO


The Protection You Want
When You Want It
Both
Time Delay
and
Instantaneous
Trip
Types


ICE

Components that help you

NEW AND UNUSUAL ITEMS CONSTANTLY BEING ADDED TO THE GENERAL ELECTRIC LINE OFFER BROAD DESIGN POSSIBILITIES

For electronic accomplishments considered "impossible" a few years ago—but now a commonplace of war—major credit goes to you and your design engineers. But the important part played by G-E electronic components is illustrated by a recent case:

Under newly encountered operating conditions in combat service, it was found that radio communication failed. General Electric engineers were called in. They developed a special pressure switch whose automatic operation eliminated these failures. The new component, simple and inexpensive, has proved to be extremely reliable under combat conditions in all theaters of the War.

Many electronic components of equal importance, and even wider application, are constantly being developed by General Electric. In accordance with long-established practice, every one of these new items is thoroughly engineered and precision-built of the finest materials available, and each is subjected to stringent laboratory and field tests before it goes into production.

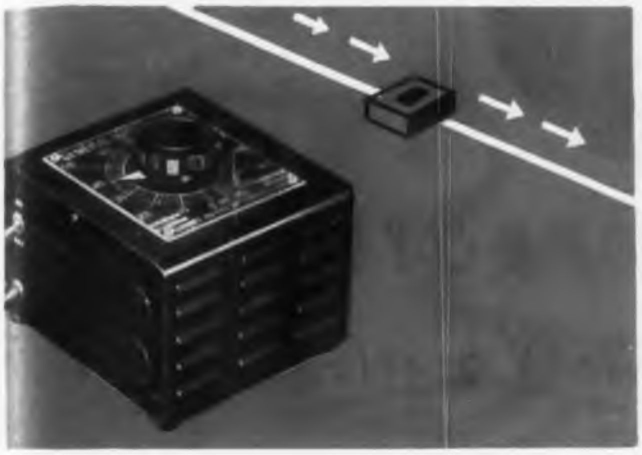
The majority of these new G-E electronic components are available only for military use or for war production. Though little can be published about their design, and less about actual applications, full information can be furnished in confidence to manufacturers of electronic equipment. For such data please get in touch with the nearest G-E office. ***General Electric Company, Schenectady, N. Y.***

A few of the thousands of types and sizes of G-E components.

ACHIEVE THE "IMPOSSIBLE"

Smooth Power Control

AT THE TURN OF A KNOB



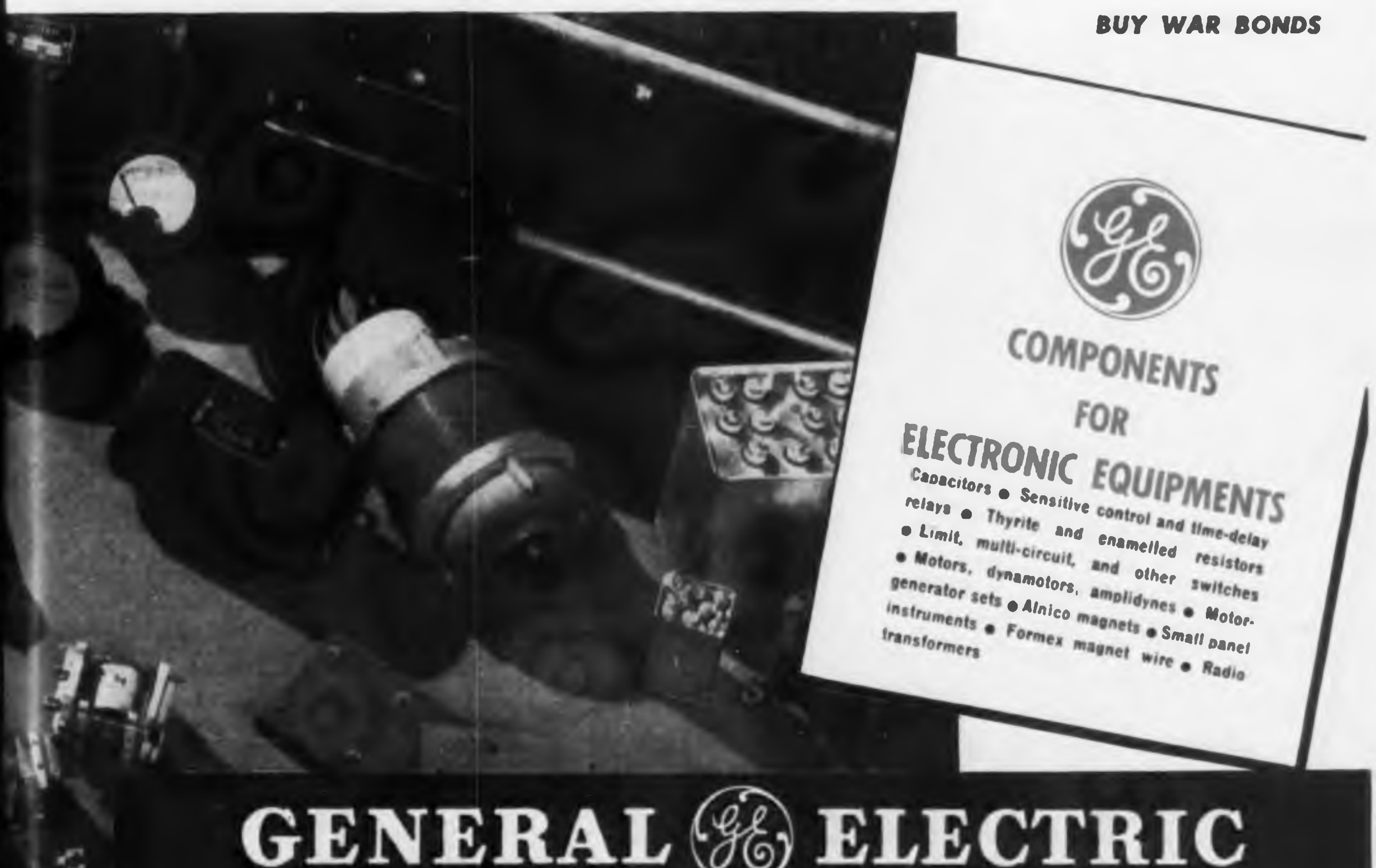
VARIABLE-VOLTAGE AUTOTRANSFORMER used for smooth control of uninterrupted voltage and small amounts of power. Mechanically strong, compact, and light in weight, designed for panel or bench mounting. Operates on low input power and low exciting current, with high efficiency and excellent regulation throughout entire range from zero to full load. Made in three capacities. Bulletin GEA-3635A.

Constant Output Voltage...

FROM VARYING INPUT

AUTOMATIC VOLTAGE STABILIZER used in conjunction with equipment requiring closely regulated input voltage. Provides practically instantaneous correction of voltage changes caused by either a changing input voltage or variation in magnitude of the load. Has no moving parts, requires no adjustments. Bulletin GEA-3634A.

BUY WAR BONDS



GENERAL ELECTRIC

LORD
BONDED RUBBER
Shear Type
MOUNTINGS

FOR *Engineered* PROTECTION

Depend Upon Specialists in Vibration Control

MOUNTING ELECTRONIC CONTROLS
(ASSEMBLY BY SANBORN CO.)

INDIVIDUAL METER MOUNTING

"Engineered Protection" against the disastrous effects of shock and vibration for all types of equipment involves only:

1. Provision in your designs for the use of flexible mountings.
2. Selection of mountings which are of the proper type, size, deflection, and load rating.
3. The correct positioning of the mountings in relation to the direction of the disturbing forces.

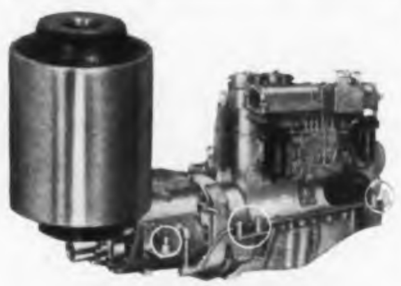
Lord Shear-Type Mountings fulfill the requirements of Engineered Protection. They are the result of 20 years' specialization in the design and production of bonded rubber-to-metal products. Lord Mountings are produced in a few basic shapes, but in a multiplicity of sizes, to cover any loading from ½ lb. to thousands of pounds, with deflection ratings from 1/16" to ½". Vibration Isolation efficiencies from 75% to 85% are commonly obtained, and up to 97% in the case of equipment operating at very high frequencies.

The use of flexible mountings will prolong equipment life, lower maintenance cost, insure accuracy of operation, reduce weights by eliminating necessity for inertia masses, and cut down noise by breaking up metallic paths for sound travel. The illustrations show a few applications of widely varied types, all of which fulfill in detail the requirements of, and have gained the benefits of, engineered protection.

For complete information covering all Lord Mountings, as well as engineering discussion on vibration control, write for Bulletins 103 and 104.

Let's All Back The Attack
BUY WAR BONDS

MOUNTINGS ON INDUSTRIAL EQUIPMENT
(ASSEMBLY BY MARION STEAM SHOVEL CO.)



MOUNTING GASOLINE ENGINES
(ENGINE BY KERMATH)

IT TAKES RUBBER *In Shear* TO ABSORB VIBRATION

LORD MANUFACTURING COMPANY
ERIE, PENNSYLVANIA

SALES REPRESENTATIVES
NEW YORK - - 280 MADISON AVE.
CHICAGO - 520 N. MICHIGAN AVE.
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BURBANK, CAL. - 245 E. OLIVE AVE.
CANADIAN REPRESENTATIVES
RAILWAY & POWER ENGINEERING CORP., LTD.
TORONTO, CANADA

Originators of Shear Type Bonded Rubber Mountings

WEBSTER PRODUCTS

Dealing with VOLTAGE and VOLTAGE REGULATION

...*with outstanding performance advantages*

The Webster dynamotors listed here are our standard large-scale production models. The outstanding performance records they have set reflect the care with which parts are machined and inspected before assembly to assure good balance, minimum vibration and maximum durability. You can have more complete details than space permits giving here by just writing for them.

Wattage	Webster Model Number	Input Volts	Input Max. Amp.	Output* Volts	Output* Amp.	Net Wt. Lbs.	Dimensions A	Dimensions B
10 to 15	MD-1020	14	2.4	250	.060	2 9/16	4 13/16	2 3/4
	MD-1021	28	1.15	250	.060	2 9/16	4 13/16	2 3/4
	MD-1022	28	1.15	250	.060	4 1/4	4 13/16	2 3/4
	MD-1024	27	1.15	250	.060	2 9/16	4 13/16	2 3/4
15 to 20	KD-1000	14	2.8	220	.080	5	5 3/8	3 7/16
	KD-1001	12	3.8	220	.100	5 1/4	5 3/8	3 7/16
	KD-1002	13.8	2.5	230	.070	4 7/16	5 3/8	3 7/16
	KD-1004	27.9	1.25	230	.070	4 7/16	5 3/8	3 7/16
20 to 30	LD-1010	12.2	3.3	230	.090	5 3/4	5 19/32	3 7/16
	LD-1011	28	1.6	230	.100	5	5 19/32	3 7/16
	LD-1012	9	6.4	450	.060	5 3/4	6 7/16	3 7/16
	LD-1013	18	3.3	450	.060	5 3/4	6 7/16	3 7/16
	LD-1014	18.5	3.3	400	.080	5 3/4	6 7/16	3 7/16
150	FD-1060	28	10.5	High 300 Med. 150 Low 14.5	.260 .010 4.9	21	12 1/16	5 11/32

*Ratings shown are for continuous duty with temperature rise and secondary ripple voltage well within the limits of Government Specifications. Models listed are also available with mounting brackets or filters when required.

VOLTAGE REGULATORS

VR-2000—Performance when carbon pile is shunted with 4-ohm resistor

Input Voltage	Pile Drop	Pile Current	Pile Resistance (Ohms)	Regulated Output Voltage	Max. Load (Amperes)	Wt. (Lbs.)	O.D. (Inches)	Height (Inches)
21.0	2.2 V.	4.5 A.	.49	18.8	5.0	2 1/4	2 13/16	4 7/16
30.0	11.0 V.	2.4 A.	4.68	19.0				

VR-2001—Performance when used in series with regulating field of dynamotor

Input Voltage	Pile Drop	Pile Current	Pile Resistance (Ohms)	Regulating Field Volt.	Regulating Field Amp.	Regulated Output Voltage	Wt. (Lbs.)	O.D. (Inches)	Height (Inches)
21.6	6.8 V.	1.4 A.	4.85	14.8	1.2	13.1	2 1/4	2 13/16	4 7/16
29.0	25.0 V.	.34 A.	73.5	4.0	1.2	13.2			

Webster Carbon Pile Voltage Regulators are sturdy, compact, reliable—withstanding vibration, shock, moisture and salt spray. Maximum pile resistances from approximately 1½ ohm to 100 ohms are available. Compensation for wide temperature ranges is provided. Typical performance of two models under specific operating conditions is indicated in the tables at left. Our engineers will be glad to study your application to see if a Webster Regulator will do the job best. Please include complete circuit data and operating specifications with your inquiry.

BUY MORE WAR BONDS NOW!

LOOK TO WEBSTER PRODUCTS
TODAY
Dynamotors and Voltage Regulators
TOMORROW
World-Acclaimed Record Changers

WEBSTER PRODUCTS

3825 W. ARMITAGE AVE. CHICAGO 47, ILLINOIS

Compression Molded "LUCITE"

- Close tolerances maintained !
- Better dimensional stability !
- No weld lines or gate marks !
- Mechanically stronger !
- Die cost allows short runs !

ARNOLD BRILHART LTD.

436 MIDDLE NECK ROAD · GREAT NECK, N.Y. · *Phone* GREAT NECK 4054

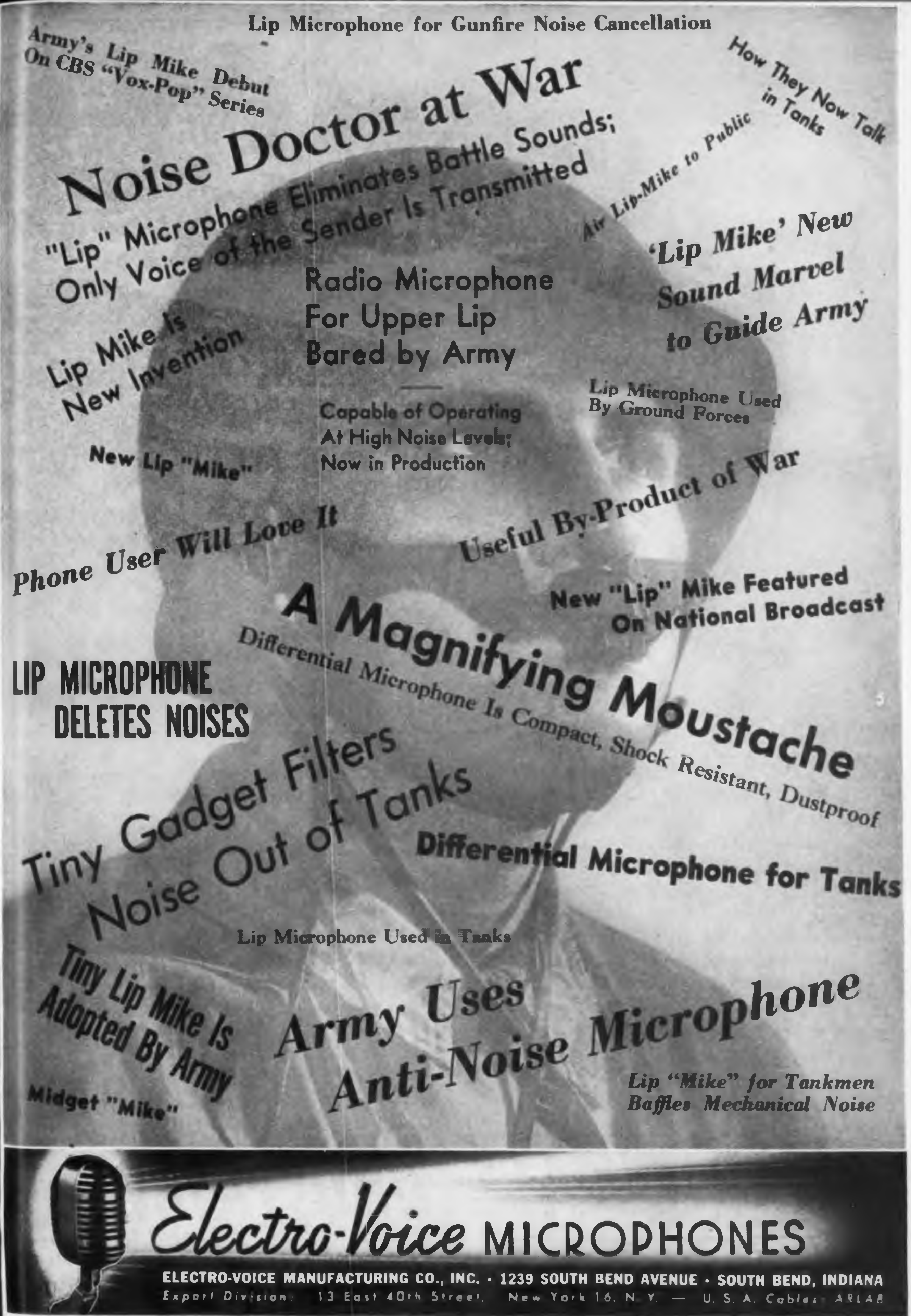
Induction Ceremony

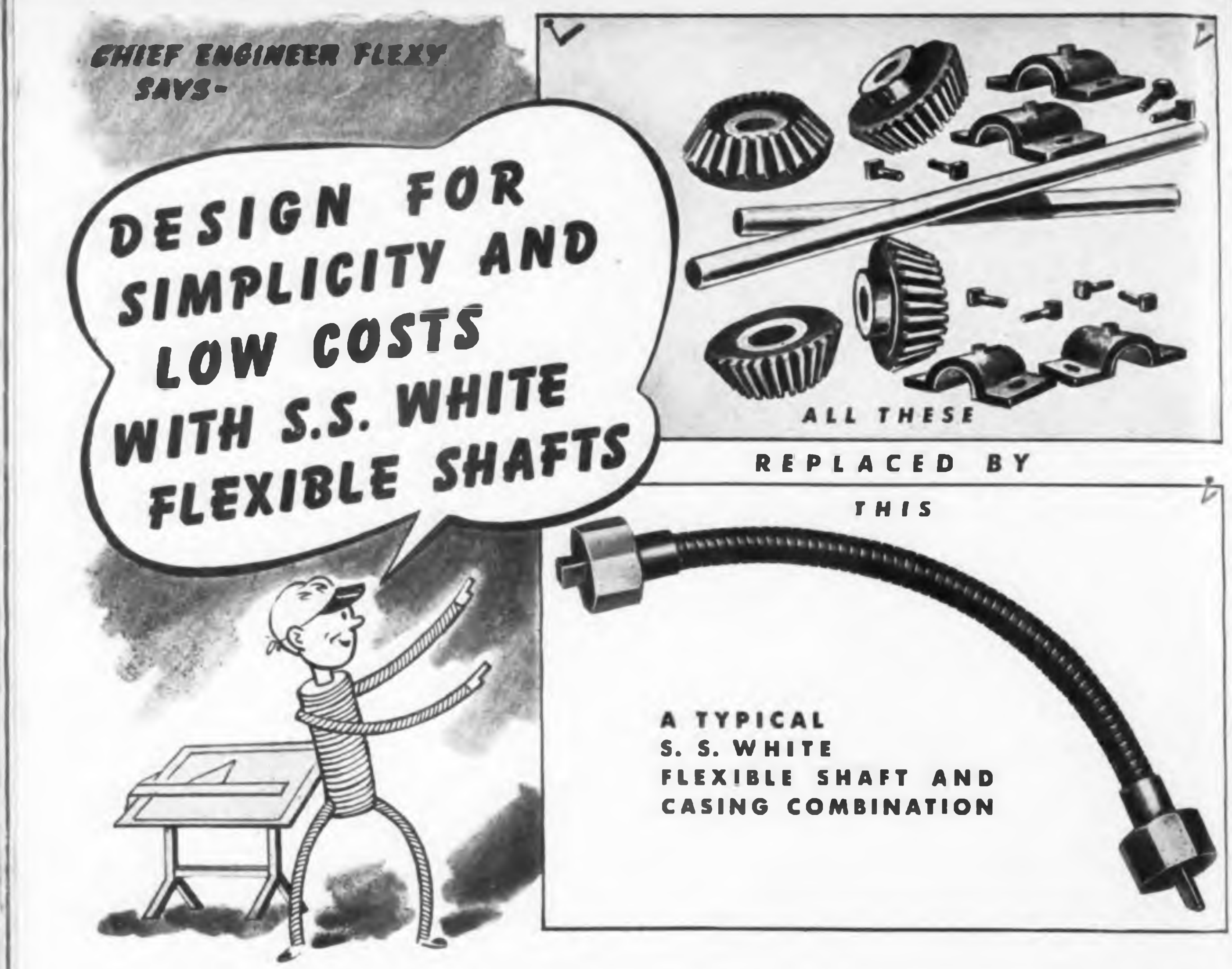
This is an X-ray photograph of the final step in the stiff pre-induction examination which National Union engineers are giving many of the N. U. Tubes now headed for combat duty.

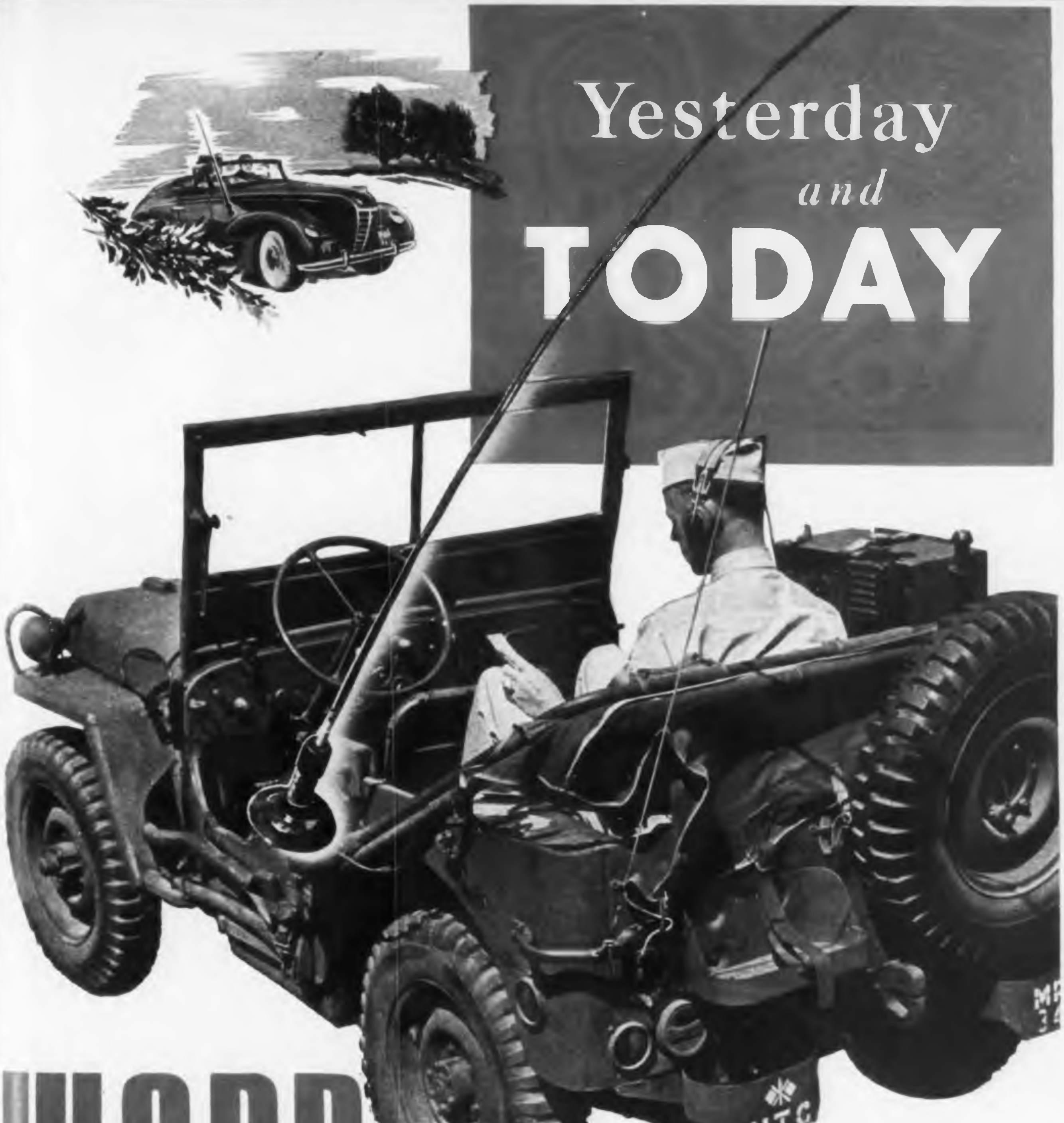
Why X-ray? Because with great objectives and priceless lives at stake, it is a military necessity to know that critical-type N. U. Tubes are sound through and through—equal in every way to the ordeals they'll face in battle. Even tubes which have passed scores of operational tests with flying colors, are scrutinized by the searching eyes of the X-ray engineer. X-ray examination of the finished tubes—after all processing has been completed—helps our scientists to know that there is *no* hidden weakness *anywhere.*

This insistence upon leaving nothing to chance typifies the uncompromising scientific standards which prevail at National Union. It is assurance that every tube which carries the N. U. trademark can be counted on to do its duty, always. And for post-war industrial needs, it is a safe and sure guide to electronic tubes of known performance characteristics and dependability. *Count on* National Union.

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


Lip Microphone for Gunfire Noise Cancellation
Army's Lip Mike Debut On CBS "Vox-Pop" Series
How They Now Talk in Tanks
Noise Doctor at War
"Lip" Microphone Eliminates Battle Sounds; Only Voice of the Sender Is Transmitted
Air Lip-Mike to Public
'Lip Mike' New Sound Marvel to Guide Army
Radio Microphone For Upper Lip Bared by Army
Capable of Operating At High Noise Levels; Now in Production
Lip Mike Is New Invention
Lip Microphone Used By Ground Forces
New Lip "Mike"
Useful By-Product of War
Phone User Will Love It
New "Lip" Mike Featured On National Broadcast
A Magnifying Moustache
Differential Microphone Is Compact, Shock Resistant, Dustproof
LIP MICROPHONE DELETES NOISES
Tiny Gadget Filters Noise Out of Tanks
Differential Microphone for Tanks
Lip Microphone Used in Tanks
Tiny Lip Mike Is Adopted By Army
Army Uses Anti-Noise Microphone
Midget "Mike"
Lip "Mike" for Tankmen Baffles Mechanical Noise
Electro-Voice MICROPHONES
ELECTRO-VOICE MANUFACTURING CO., INC. · 1239 SOUTH BEND AVENUE · SOUTH BEND, INDIANA
Export Division 13 East 40th Street, New York 16, N. Y. — U. S. A. Cables: ARLAB


CHIEF ENGINEER FLEXY SAYS-
DESIGN FOR SIMPLICITY AND LOW COSTS WITH S.S. WHITE FLEXIBLE SHAFTS
ALL THESE
REPLACED BY
THIS
A TYPICAL S. S. WHITE FLEXIBLE SHAFT AND CASING COMBINATION



WARD ANTENNAS

The year before Pearl Harbor, WARD PRODUCTS CORPORATION manufactured and sold *better than* 90% of all aerials used by leading manufacturers of automobiles, radios and portable radios. That commanding position was made possible by superior designing ability, manufacturing knowledge and production efficiency.

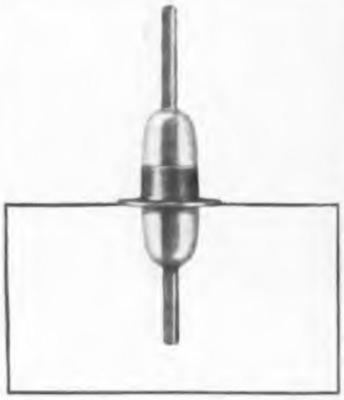
That expertness of antenna manufacturing is today being totally applied to the war effort . . . and in wartime, as in peacetime, WARD is the leading manufacturer of antennas. The name WARD is found on aerials used on command cars, tanks, planes—on communication units of all kinds—on battle fronts all over the world. . . . The knowledge that is being gained from this wartime effort will mean new and improved products in peacetime. If the use or specifying of antennas is included in your post-war planning, look to WARD!

THE WARD PRODUCTS CORPORATION, 1523 E. 45TH STREET, CLEVELAND, OHIO

A Thousand and One Applications

HERMETICALLY SEAL *with* KOVAR

TRADE MARK 337962, REGISTERED IN U. S. PATENT OFFICE



Single Terminal
Kovar-glass lead-through

Kovar Gauge Glass
or Sight Tube

Leak-proof Kovar-glass
Window Assemblies

ARMY E NAVY

"FOR GREAT ACHIEVEMENT"

Use KOVAR for sealing

ELECTRONIC TUBES
TRANSFORMERS
RESISTORS
CAPACITORS
CONDENSERS
VIBRATORS
SWITCHES
RELAYS, ETC.
INSTRUMENTS
GAUGES
METERS
RECEIVERS
TRANSMITTERS

★

Let's All Back The Attack
Buy EXTRA War Bonds

★

THROUGH the use of Kovar and glass, your product can be sealed hermetically against air, gas, moisture, liquid.

Hermetic seals of Kovar and glass are made in a wide range of styles and sizes, ready for quick, easy assembly to your apparatus. For electrical applications, Kovar seals are made with single or multiple, solid or tubular, electrodes.

The seal between Kovar and glass is a chemical bond in which the oxide of Kovar is dissolved into the glass during a heating process. The result — a hermetic seal — permanently vacuum and pressure tight, effective under the most extreme climatic conditions — tropical to stratosphere.

Kovar IS the answer to permanent vacuum or pressure tight sealing. Let Stupakoff help engineer YOUR hermetic sealing problems with Kovar.

SINCE 1897

STUPAKOFF

Products for the World of Electronics

STUPAKOFF CERAMIC AND MANUFACTURING CO., LATROBE, PA.

GLASS . . .

FOR LOW LOSS INSULATION!

● When glass is used as the fibrous component in Formica laminated plastic sheets, tubes and rods the material becomes a low loss insulator comparable to ceramics, and capable of replacing ceramics for many uses. At the same time it retains typical Formica characteristics, of machinability and adaptation to rapid production processes.

Compared to ceramic insulators this glass base Formica—Grade MF 66—has high mechanical strength and resistance to impact and vibration. It is as good as other grades of Formica in that regard.

Formica glass base MF 66 is being used for antenna base insulators on airplanes and ground installations.

Other glass base grades: FF 10—Heat resistant—for such applications as motor slot wedges.

FF 41—arc resistant—for ignition parts and switch parts. It does not support combustion.

All of these grades are immune to fungus growth—a quality that is important in the tropics.

"The Formica Story" is a moving picture showing the qualities of Formica, how it is made, how it is used. Available on loan.

FORMICA

There is an apparent discrepancy at this point.

The pages are either missing or the pagination is incorrect.

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

it's Pre-assembled!

NEW TWO-PIECE HIPERSIL* CORE SPEEDS ASSEMBLY OF HF EQUIPMENT

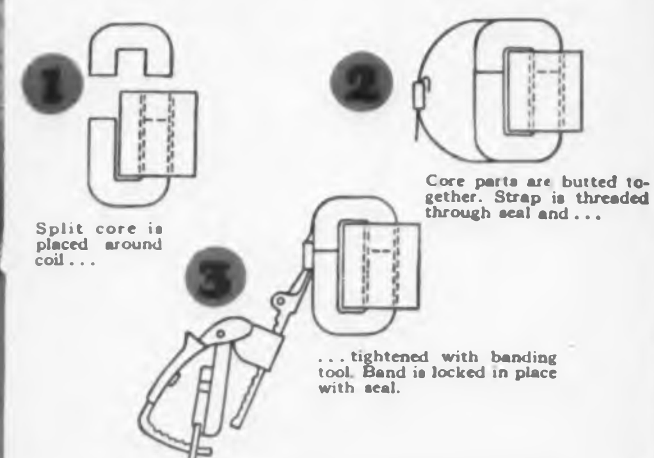
Here's a practical short-cut that will speed assembly of High-Frequency Communications Equipment.

Instead of stacking tissue-thin laminations by hand, you can now get pre-assembled, two-piece HIPERSIL cores, ready for quick, easy assembly. Because there are just TWO pieces to handle per loop, valuable man-hours are saved in production—faults in assembly are prevented. HIPERSIL cores are available in a complete range of standard as well as special sizes and forms.

GET ALL THE FACTS ABOUT HIPERSIL TYPE C CORES . . . write for copy of HIPERSIL Booklet, B-3223-A. It contains performance facts and application data that will help speed the production of vital Communications Equipment for the Fighting Forces. Address: Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pennsylvania, Dept. 7-N. J-70422

**Registered Trade-Mark, Westinghouse Elec. & Mfg. Co., for HIgh PERmeability SILicon steel.*

HERE'S HOW TO SPEED COIL ASSEMBLY



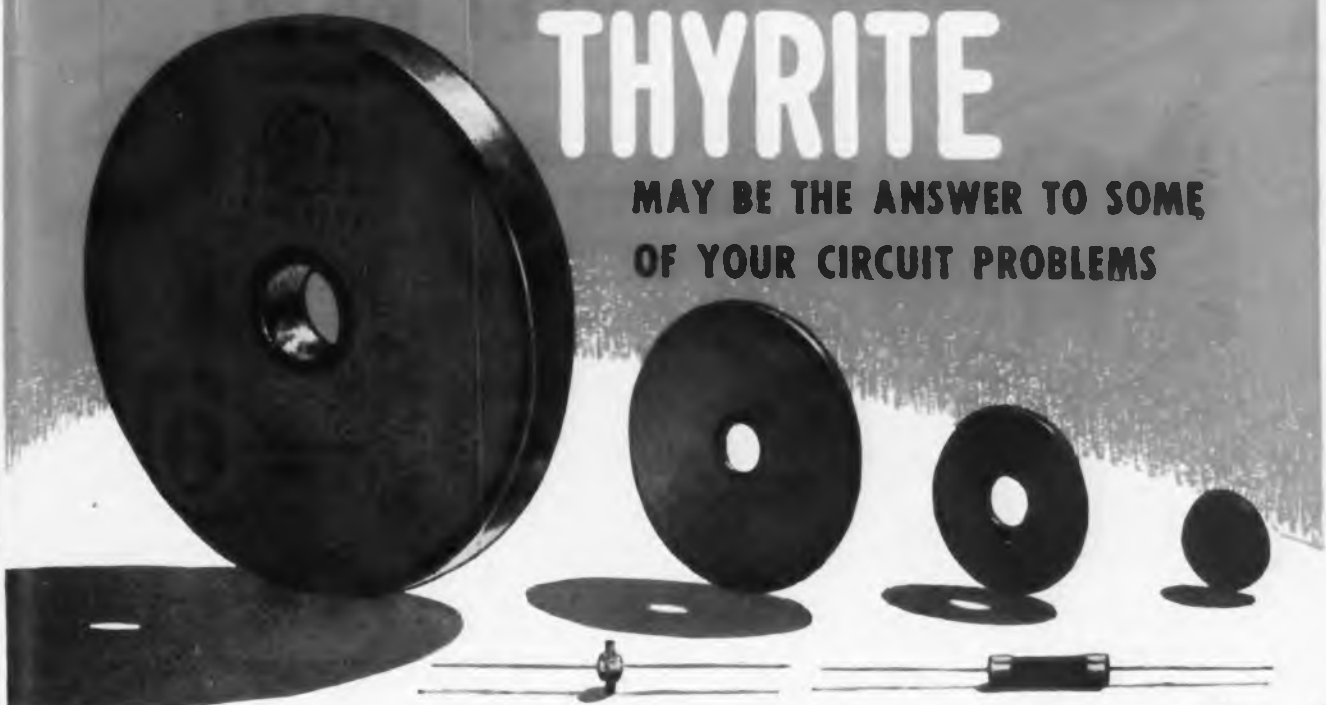
Banding Straps, Seals and Tools available from Westinghouse. See Page 9 of B-3223-A.

DESIGN ENGINEERS

CAN YOU USE A RESISTANCE MATERIAL IN WHICH *I varies as E⁴?*

THYRITE

MAY BE THE ANSWER TO SOME OF YOUR CIRCUIT PROBLEMS



THYRITE* is a silicon-carbide ceramic material, dense and mechanically strong, having nonlinear resistance characteristics—the resistance varying as a power of the applied voltage. Its resistance characteristic is stable, and substantially independent of polarity or frequency. Thyrite has been used for many years in many important applications, including electronic. Thyrite can be produced in various shapes and sizes (those which can be successfully molded).

Typical volt-ampere characteristics of Thyrite resistors of several resistance levels and power ratings. Note that the nonlinear voltage-current characteristic extends over an extremely wide current range. Compare it with the characteristic (orange line) of a 1-megohm linear resistor.

Here are some of its
MANY APPLICATIONS

- For protective purposes (to limit voltage surges)
- As a stabilizing influence on circuits supplied by rectifiers
- As a potentiometer (The division of voltage can be made substantially independent of load current)
- For the control of voltage-selective circuits, either independent of or in combination with electronic devices

*Reg. U.S. Pat. Off.

The nearest G-E office can tell you what data should be submitted as a basis for a quotation. Or write direct to General Electric, Section 16-250, Pittsfield, Mass.

GENERAL ELECTRIC

COLE
STEEL EQUIPMENT COMPANY

fabricating products in

SHEET METAL

Illustrated are a few of the many fabricated sheet metal products we have made for leading manufacturers; some characterized by extreme precision, others held to gauge limits.

Cole Steel Equipment engineers are pioneers in converting from castings to sheet metal. Whatever your problem—housings for marine instruments and firing mechanisms, boxes, or chassis—let us help you. We know how!

Inquiries Invited

Send for Brochure

"The Plant Behind Your Plant"

Cole Steel office equipment
will again be available after the war

COLE
STEEL EQUIPMENT COMPANY

349 Broadway, New York 13, New York

Factory: Brooklyn, New York

For every ship and marine station!

NEW, IMPROVED McELROY ELECTRONIC
CODE TAPE PERFORATOR PFR-443-A

For High Speed Radiotelegraph Transmission

SHIP-to-SHIP
SHIP-to-SHORE
POINT-to-POINT

Entirely mechanical the PFR-443-A not only improves the efficiency of transmission but confines human error to minimum. Comprising two units—the Keying device and Electronic mechanism—this Perforator can be operated by anyone with a basic knowledge of dots and dashes. Those with experience can easily maintain an accurate speed of more than 40 words per minute in all Morse combinations assigned to the Russian, Turkish, Arabic, Greek and Japanese alphabets and languages. Sending is automatic . . . tapes are clean and precise. Time, expense, and even lives, may be saved. The PFR-443-A has aroused more than usual enthusiasm. May we send complete details?

ARMY E NAVY

McElroy MANUFACTURING CORPORATION
82 BROOKLINE AVENUE
BOSTON, MASS.

WE CREATE... DESIGN... BUILD... WE ARE NEVER SATISFIED WITH MEDIOCRITY

KEEP IT UP... BUY MORE AND MORE WAR BONDS

IF YOU NEED

HIGH VOLTAGE RECTIFIERS

FOR SPECIAL WAR APPLICATIONS

CONSULT AMERTRAN!

Recent experience shows that manufacturers can greatly expedite their programs by incorporating AmerTran High Voltage Rectifiers in equipment produced for naval, land and aircraft communications. AmerTran Rectifiers can be completely integrated with your instruments because our engineering staff is thoroughly familiar with present day communications problems . . . and especially well-versed in the application of equipment used in navigating and locating.

Deliveries can be made in reasonable time because we employ a proved, fast production system, including certain recently developed techniques, and have access to stable material sources.

These AmerTran Rectifiers are in every way representative of the quality standards which the American Transformer Company has maintained for forty-three years— a further assurance of acceptance. Responsible manufacturers are invited to forward their specifications.

THE AMERICAN TRANSFORMER COMPANY

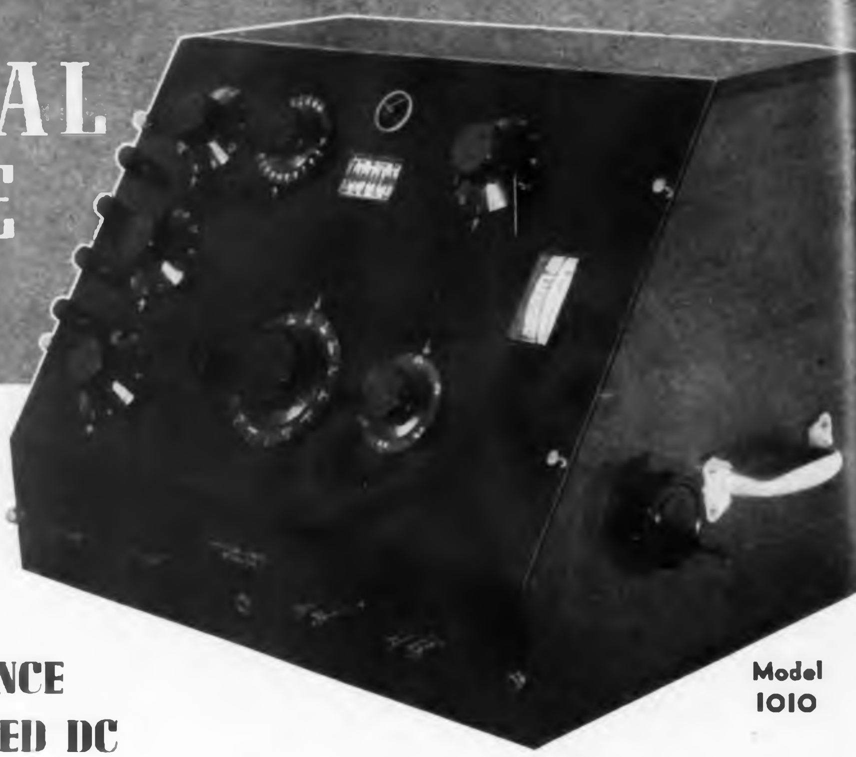
178 Emmet Street, Newark 5, N. J.

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

AMERTRAN

A NEW

UNIVERSAL BRIDGE



Model 1010

★ **WIDE RANGE**

★ **½% ACCURACY**

★ **6 BRIDGES IN ONE**

★ **MEASURES INDUCTANCE WITH SUPERIMPOSED DC**

One of several instruments designed to meet the requirements of our military development program—now made available for general sale.

The Universal Bridge permits measurement of:

- **RESISTANCE** — Range: 10^{-4} to 10^{10} ohms.
  Accuracy: 1 ohm to 1 megohm, within ½%,
  below 1 ohm and from 1 megohm to 100 megohms within 1%
  above 100 megohms the error increases to 5%.
- **CAPACITANCE** — Range: 10^{-6} to 100 microfarads.
  Accuracy: 100 $\mu\mu$f to 1 μf within ½%,
  other ranges, within 2%.
- **INDUCTANCE** — *With no D. C. flowing*
  Range: 10^{-6} to 100 henrys
  Accuracy: 100 μh to 1 h, within 1%,
  other ranges, within 2%.
  With superimposed D. C.
  Range: .1 to 100 henrys
  Accuracy: Within 2%

FEATURES—Inductance of iron cored chokes and transformers can be measured with up to 500 m.a. of D. C. flowing.

Facilities for measurement of frequency, Q and power factor are included in the Bridge.

The bridge contains a 1 megohm resistance decade in steps of one ohm — this is brought out to terminals so that it can be used externally.

Complete and self-contained unit . . . in addition, provision has been made to plug in external facilities such as outside standards, oscillators, null indicators, etc., to extend the usefulness of the bridge.

Your inquiry will receive prompt attention, as will inquiries concerning the application of our engineering facilities to the solution of your industrial control, inspection or instrumentation problems.

INDUSTRIAL PHYSICS—INSTRUMENT DEVELOPMENT

WR WHITE Research

899 BOYLSTON STREET, BOSTON 15, MASS.

A typical group of H. F. radio coils insulated with Q-Max A-27 Lacquer

Q-MAX A-27 LACQUER HAS LOW LOSS FACTOR OVER A WIDE FREQUENCY RANGE

The loss factor of Q-Max A-27 Lacquer is very nearly constant as the frequency increases from one megacycle, which is indicative of its excellent performance in the high frequency range. This feature, together with its low dielectric constant and other special characteristics, makes Q-Max A-27 Lacquer an outstanding high frequency coating medium.

In order to give water-repellent protection, minimize oxidation and corrosion, Q-Max A-27 Lacquer deposits a tough, uniformly heavy, and self-leveling film. In spite of the high solids content—45%—which makes such a coating possible, the low viscosity of Q-Max affords ease of application either by dipping or brushing.

Q-Max provides an excellent coating for R. F. solenoid windings and serves as an impregnant on multi-layer or star coils. It is used as a tape saturant, a stiffening and strengthening medium, and a surfacer for wood or porous materials. Because of its low dielectric constant and excellent high frequency insulating characteristics, Q-Max is used widely in treating radio frequency coils.

New descriptive booklet on request.

FOR TODAY . . . AND TOMORROW: H. F. TRANSMITTING SPECIALTIES

The design and manufacture of H. F. transmitting specialties has long been an important part of the production which Communication Products Company, Inc. has offered the radio industry to meet the requirements of a wide range of applications. Our engineering staff and laboratory facilities are available for aid in the solution of your problem.

Communication
PRODUCTS CP COMPANY, INC.

More than ever before women have come to the front to play their part in this fight. Dorothy Crisp—since 1942 a worker in the factory at Amphenol—was recently picked as Radar-Radio Queen from among all of the workers of Chicago's radar-radio plants. Her skillful hands represent two out of 2500 pairs working daily to maintain the security, dependability and quality behind the name of "Amphenol".

Dorothy's smile is offered here, as an encouragement to the army of workers who are using Amphenol products in building the electrical and communications war equipment . . . and to the men in the Armed Forces who are so effectively using that equipment in the field.

Amphenol's products—connectors, cables, fittings, radio parts—prove their quality in meeting the exacting specifications and laboratory tests called for in AN requirements.

Send for a Photo of Dorothy—Radar-Radio Queen

American Phenolic Corporation
1830 S. 54th Ave., Chicago 50, Illinois

I would like to have a photograph of Radar-Radio's Queen and Pin-Up Girl, Dorothy Crisp.

Name .... *Position* ....

Company ....

Address ....

Some of the busiest men in the field of electronics today are the engineers and designers. They are spending untold "overtime" hours at the special skills for which they have trained. But they still have time to donate to the blood bank, to be air raid wardens, to participate in scrap drives, to aid the U.S.O. — and they buy war bonds, too. In short, the electronic engineer is going all out to win the war.

Raytheon engineers are meeting and *anticipating* the vast needs of the military. Raytheon is proud to be a leading manufacturer of electronic tubes and equipment that more than meet the severe wartime requirements for high quality and complete dependability.

RAYTHEON

ARMY-NAVY "E" WITH STAR
Awarded All Four Divisions of Raytheon for Continued Excellence in Production

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


ACTION!
When Every Second Counts
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Positive resistance against mold and fungi growth and Pyro-Welded to a density that permits easy machinability, with high dieletric strength and no deterioration due to age Pyro-Plastics "PemQue" is designed for the electronic insulating problems of today and tomorrow! Its performance under stress emphasizes its superior quality.
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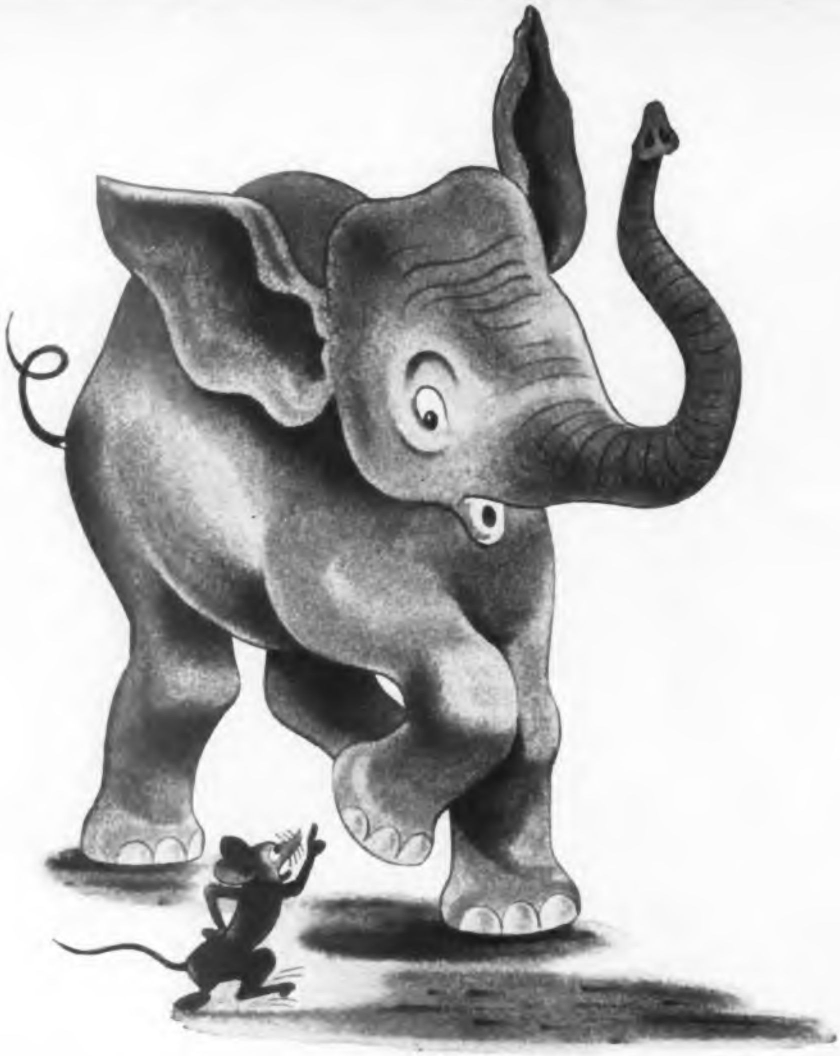

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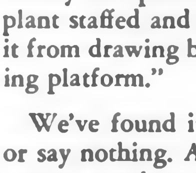

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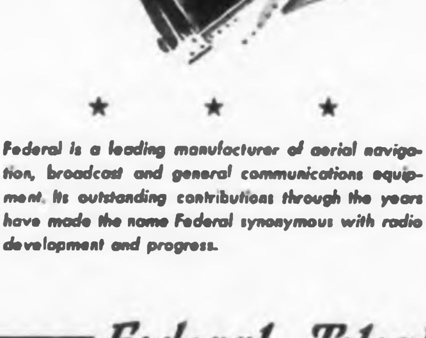

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In laboratories like the one shown and in high-production foundries, Ajax-Northrup furnaces give faster melts with greater accuracy and flexibility.

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Six perfect brazed joints per minute with the unit at left! Ajax-Northrup heat can also speed your heating for forging, heat-treating, and countless other jobs.

Tube converters for frequencies above 100,000 cycles. The 5-kw. unit is shown.

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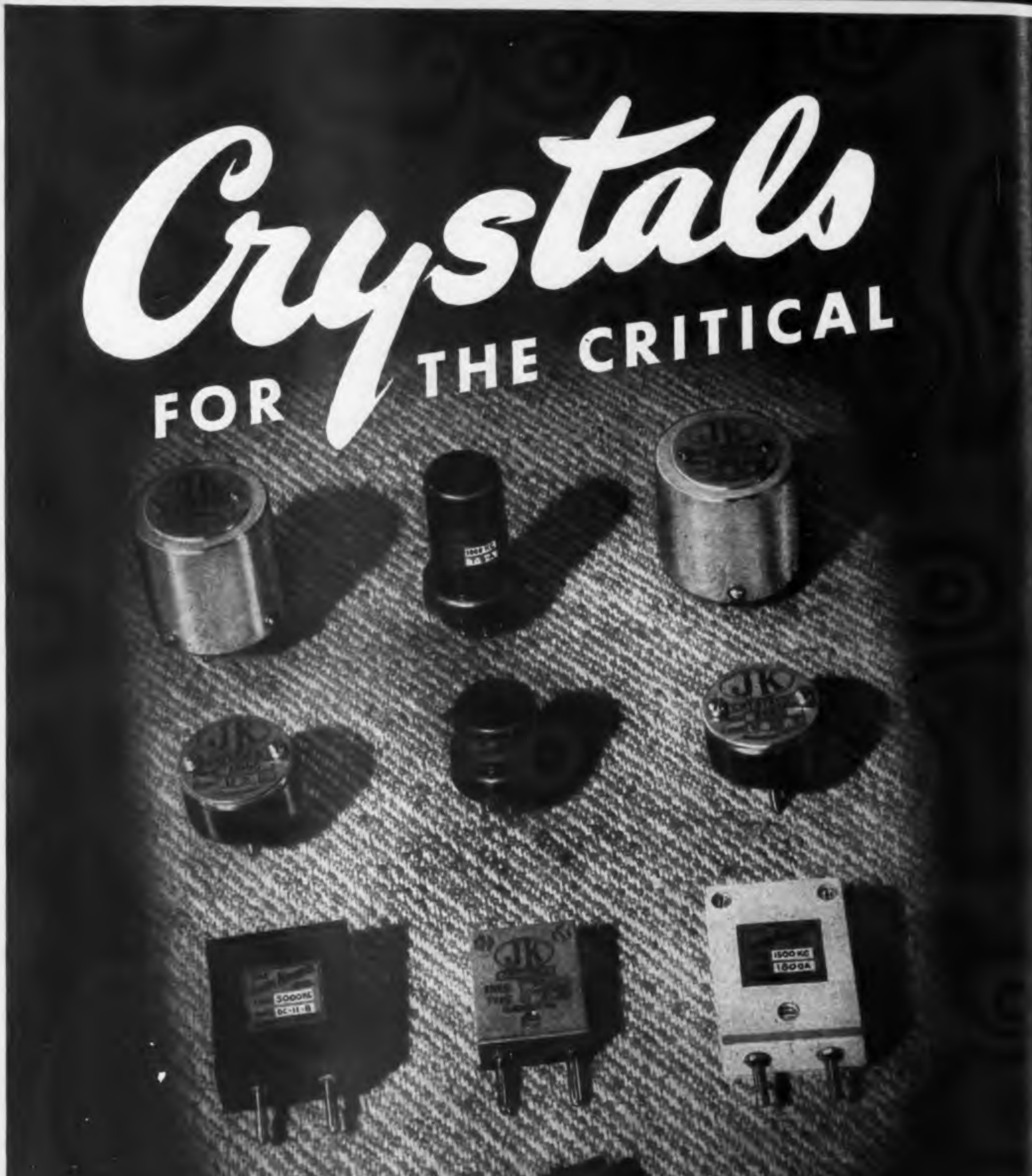
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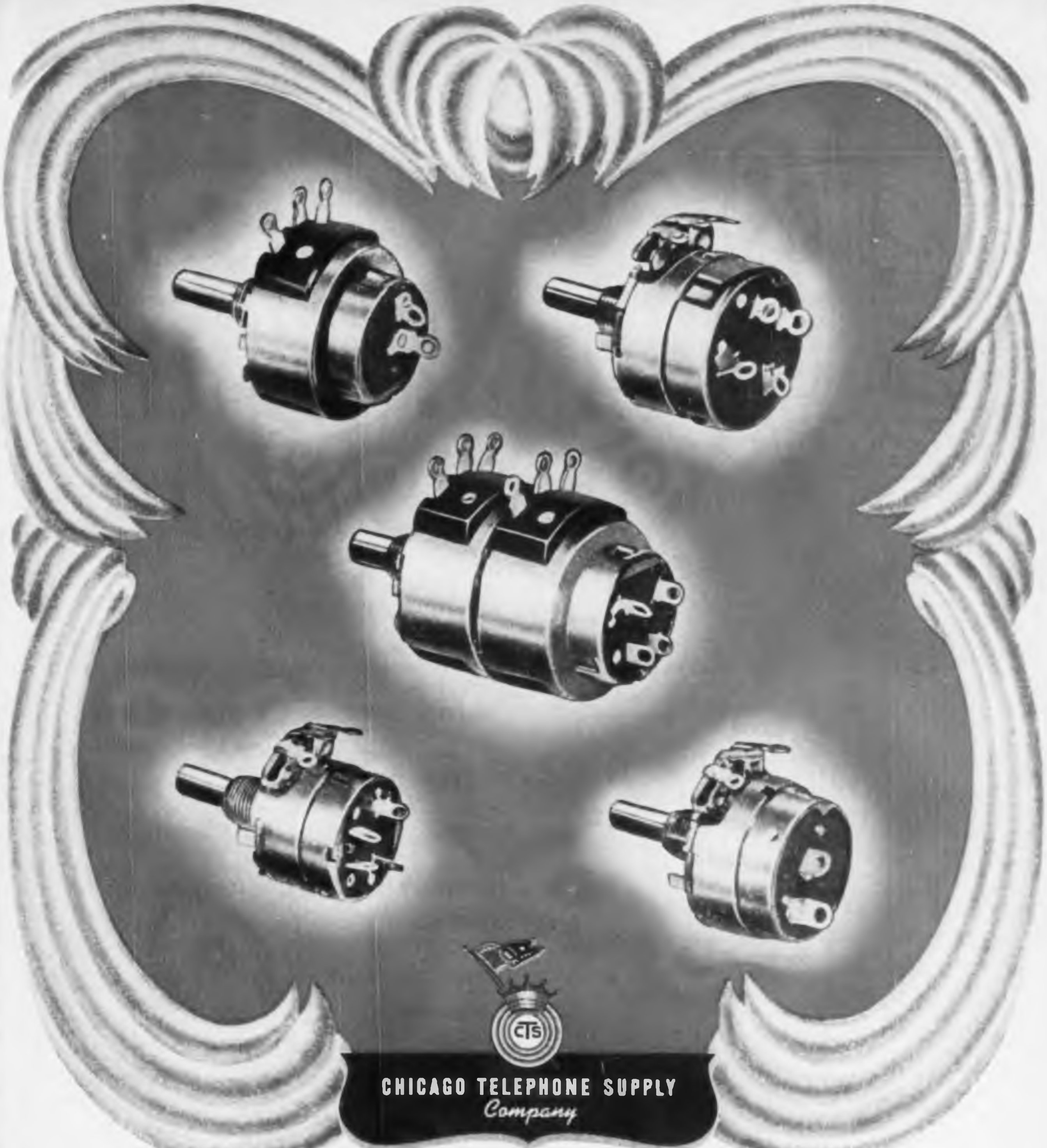

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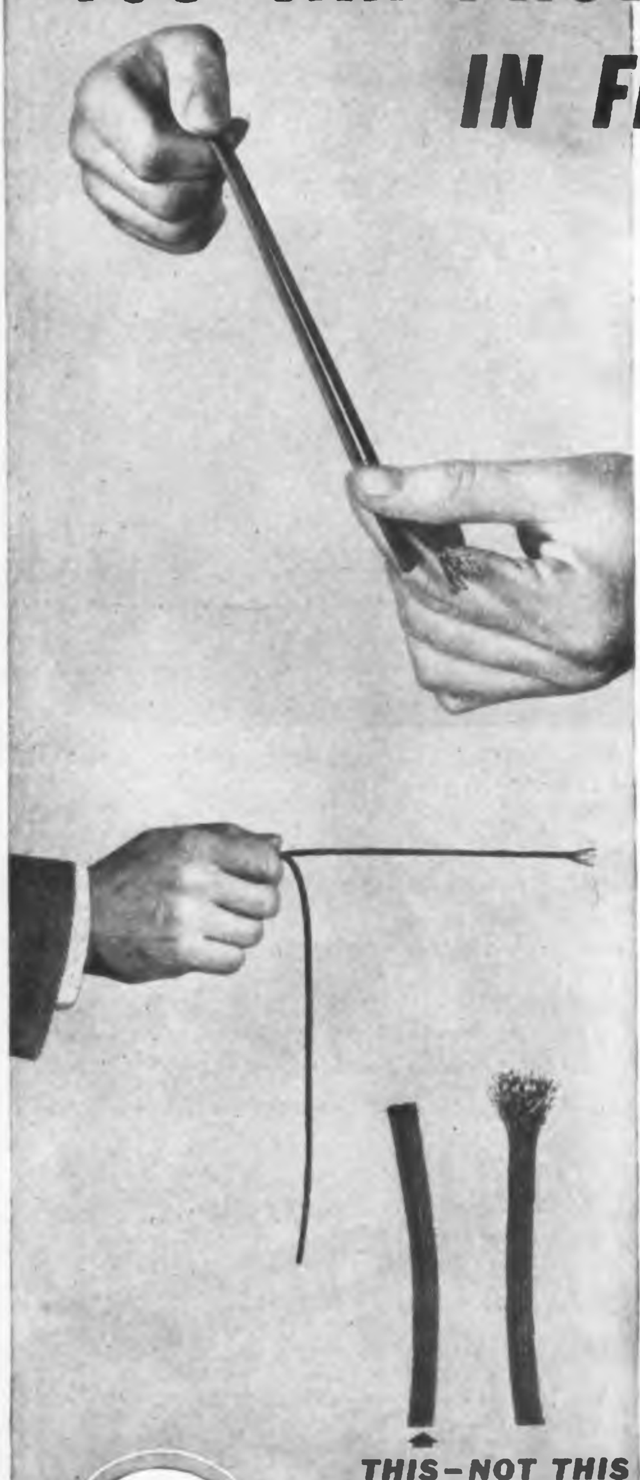

That new BH Fiberglas "extra Flex" Sleeving is more flexible than saturated sleeving

WE'VE TOLD YOU about the non-fraying quality of the new BH Sleeving. But don't forget the extra flexibility we've built into it. You can prove this to yourself with the five-second test of sleeving flexibility:

Obtain from us a sample of BH Extra Flexible Fiberglas Sleeving equal in size to the saturated sleeving you use now.

Following Figure 1, hold eight-inch lengths of both BH Extra Flexible Fiberglas Sleeving and saturated sleeving between the thumbs and fingers of both hands. Stretch both sleevings to make them straight.

Now release the sleeving ends held in your left hand. Instantly, the new BH Fiberglas Sleeving will fall limp, proving its extra flexibility. The saturated sleeving will remain straight, practically inflexible. The comparison is shown in Figure 2.

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The new BH Extra Flexible Fiberglas Sleeving is woven from the choicest continuous-filament Fiberglas yarns. It possesses high dielectric strength, is water-resistant and, like all BH Sleeving and Tubing—is non-inflammable.

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It's a better electrical conductor, too; since the Burndy HYDENT connectors used are of one-piece, pure copper construction. *No seams or joints to loosen, or increase resistance!*

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The Stuff Stands Up!

The American high command in the Pacific theater—Admirals Nimitz and Halsey and General MacArthur—have never had their operations delayed through the lack of adequate and efficient communications-radio equipment! This was the word brought back by Major General Harry C. Ingles, Chief Signal Officer of the Army.

General Ingles declared he found no critical shortages of any types of communications-radio-electronic equipment to exist in the Pacific combat zones.

The radio apparatus takes an awful beating from the jungles, he related, and only through the waterproofing and fungi-protective measures does the equipment stand up. Dry-cell batteries have to be kept in cold storage. In unloading in nets into barges and in standing on the beaches in rain for days, the radio sets are given the toughest treatment, but they come through.

The blanketing effect of wet jungles cuts down the range of the mobile radio apparatus, especially walkie-talkies. It often reduces the distance by one-half.

Wider Executive Usefulness for Engineers

More and more, as the electronic arts expand, the engineer is needed broadly in industrial management,—all the way through production, distribution and application, as charted on a following page. Engineering leadership in all the functions of management, will pay big dividends to the engineer, to his individual firm, and to society in general.

Too often has the engineer "built a wonderland" and then let others run it. They have not always run it well. The engineer must lend a hand in tomorrow's steering. What he learns in the process (and he will learn a lot) he can occasionally carry back into research, design, and development—to the benefit of all concerned.

Feet on the Ground, Everybody!

It may be a surprise to some of our industrial readers that one of our objectives is to acquaint tube-minded engineers with the fact that there are actually other ways of doing certain jobs than by using tubes! Actually in many places tube men have of late made use of air-operated, or magnetic, or motor-driven devices, instead of tubes. And on the other hand, industrial control engineers are becoming used to tubes.

Efficiency and reliability are expensively-purchased components in any design of industrial control, especially when an intricate and precise mechanism is needed.

Tubes as Instruments of Precision

Regarding tubes, there are two things to remember: (1) A tube is one of the cheapest instruments of precision that can be found, for its development costs have been spread over a sale of many millions.

(2) A tube will generally function to make a less precise and more bulky mechanism do the work of some delicate mechanism that was formerly a problem even to a watchmaker.

Electronic-tube engineers are learning the details of industrial instrumentation and control, and production men no longer become scared by even the thought of a "fragile vacuum tube" in a device. When this interchange of thinking-methods is more complete, both may have the same motto: When some unusual effect has to be provided, find out some way to make an electron tube do it.

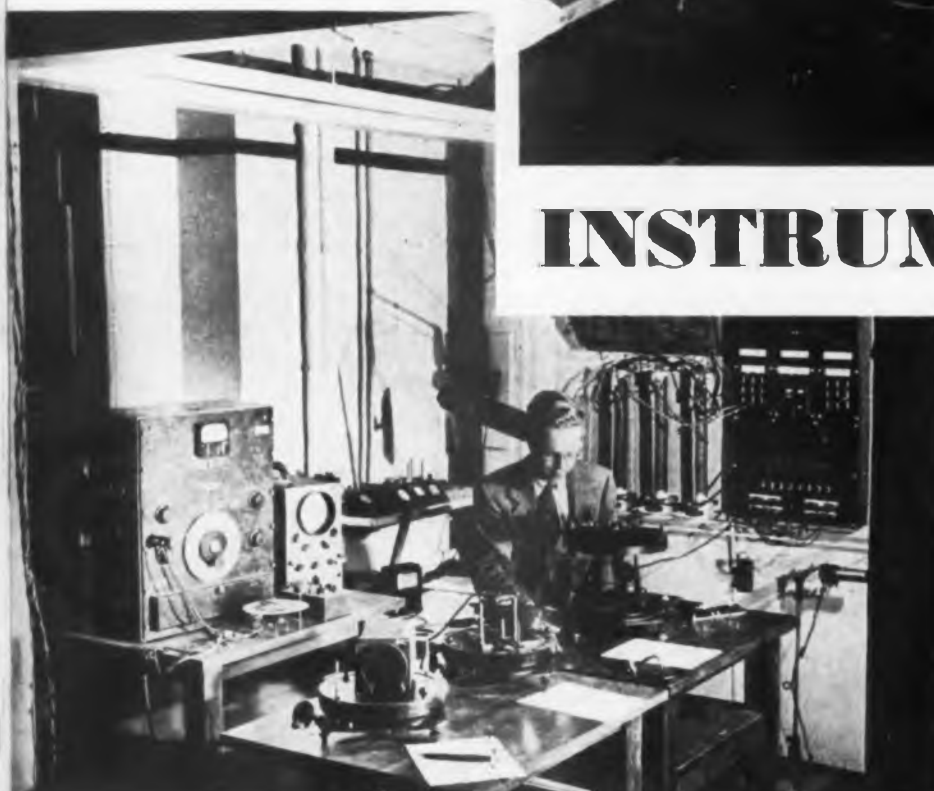
NEXT MONTH—REPORTING CALIFORNIA!

To acquaint our readers generally, with the electronic development which is now taking place in various sections of the United States, the editors plan to present in coming issues a series of reports on electronic production facilities, products, and operations in principal U.S. electronic centers.

First of such regional studies will be our California Issue, scheduled for next month, June. This number will afford a complete survey of the electronic development, resources, output and personnel of the Golden State.

1. Set-up for tests on Sperry's electronic type automatic pilot. One-fourth to 250 cycle oscillator at far right modulates test signal (400 cycles) for study of amplifier characteristics. In the electronic autopilot, 3 amplifier channels feed 3 reversible servo motors controlling aircraft's control surfaces.

Gyro-horizon unit on calibrated tilt-table at extreme left, and directional gyro (above operator's head) on oscillating scorsby table constitute the master units of the auto pilot. Gyros are 400 cycle induction motors running at 23,000 rpm and differ only in attitude of rotor suspension. Signals to amplifiers are obtained from built-in selsyn units (one in directional and two in vertical gyro). Signals are amplitude modulation of 400 cycle carrier. Indicating gyros shown



INSTRUMENT DEV

FACILITIES OF THE SPERRY

2. Test set-up for gyrosyn compass, a new development obviating necessity of setting directional gyro of autopilot to magnetic north. Test area is novel in that it is bounded by six Helmholtz coils built into wood framework to degauss test space. A "flux valve" is mounted on far turn-table. Excited by 400 cycle ac, it provides a signal determined by its azimuth position relative to the earth's field.

Because it is mounted on a swinging pendulum, instantaneous signal of valve imposes instantaneous torques on the gyro. But, since the gyro has a very long period of response, the resulting indication of the gyro is an integrated result, which is the stabilized magnetic heading

3. Attitude gyro, a new instrument designed to give exact visual indication to the pilot of the plane's attitude—whether it is climbing, diving, or banking. Operator shown with stroboscope checking behavior of an attitude gyro rotor on bench. Complete unit shown on right

4. Vose Memorial Laboratory for refrigerated high altitude test. The refrigeration equipment makes it possible to maintain a temperature of —75 deg. F. at the pressure equivalent of 60,000 ft. altitude with a fresh air bleed of 10 cu. ft. per minute. This is done by means of a 3 stage Freon 12 system which requires 115 hp for operation. The total horsepower used to operate all equipment in the chamber is 170. The main test chamber is 16 ft. long and 12 ft. in diameter. Welded on to one end of it is a lock chamber 8 ft. long and 8 ft. in diameter. Photo shows gyropilot mounted on large oscillating scorsby table

ELOPMENT LABS

CORPORATION, NEW YORK CITY

5. This dynamic balancer uses mechanical means to isolate the two planes of unbalance. Amount of unbalance in each plane is determined by the amplitude of the vibration as recorded from an electro-magnetic pickup. The location is determined by measuring the phase-difference between the vibration and reference signal. Obtained from a light reflected from the underside of the rotor into a photocell. By shifting the two 180 degrees out of phase, a null is obtained on the output meter. The amount of phase-shift indicates the location of the heavy spot on the rotor. In the background is a balancing machine which automatically "emery papers out" the heavy spot

6. Detonation detector equipment on engine in soundproof chamber. Photo shows tests in progress on improved detonation detector equipment being developed by the research laboratories at Sperry Corp. Tests involved are similar to the actual operation of the equipment as used in work on aircraft engines

CAA-RTCA INSTRUMENT

Details of radio beam plane landing system and equipment installed at Indianapolis Municipal Airport

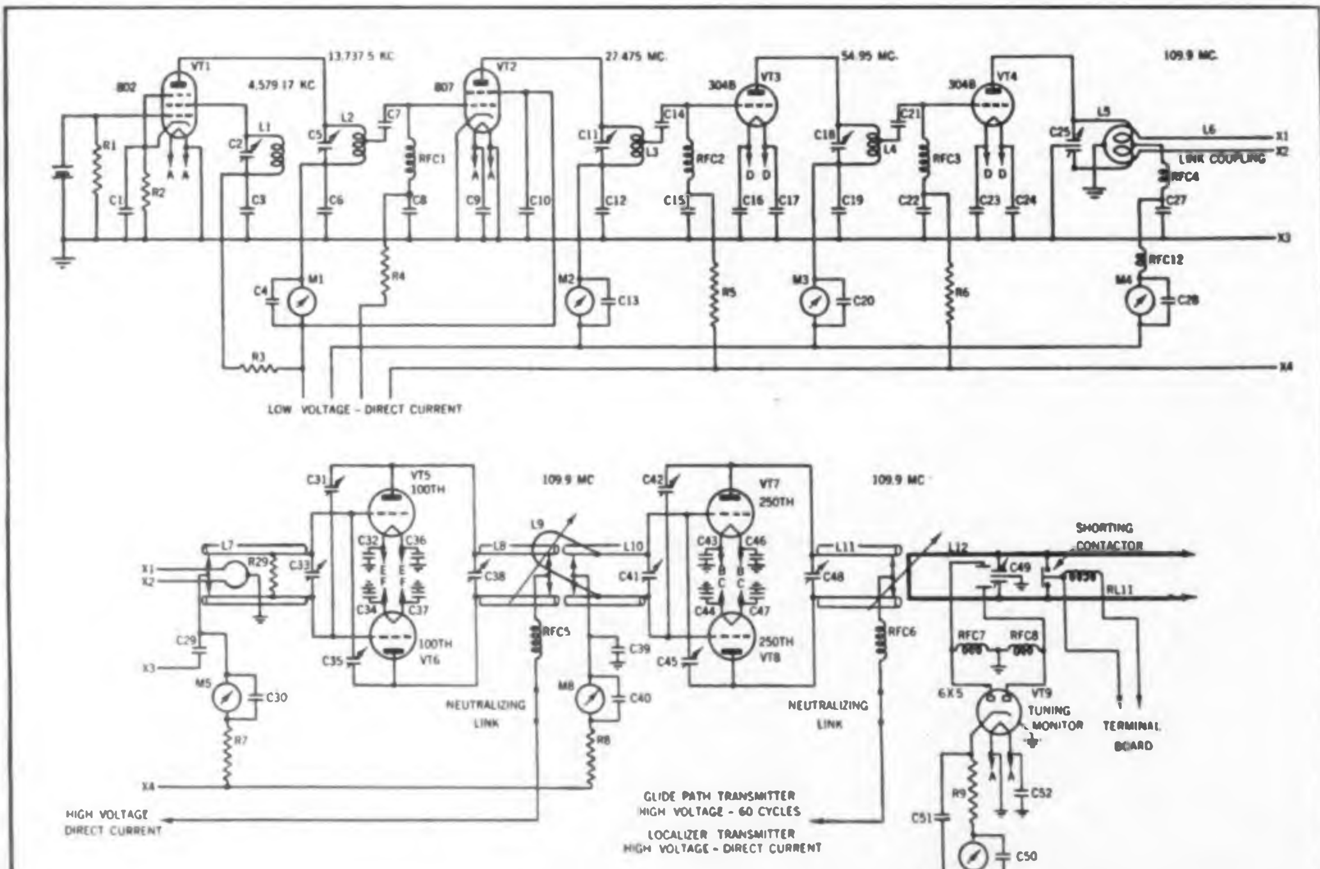
• Instrument landing systems, using a radio-electronic "glide path," are an improvement for the Federal Airways awaiting the end of the war. Ultimately such systems are slated to be installed at all of the busier airports of the nation. Improvements, brought about by the laboratories, for military uses remain shrouded in complete secrecy and may produce systems which are much more efficient than those in operation or known publicly now.

In any blind landing system it is essential to (1) know exactly where the runway is located, and (2) to determine the glide path so that it can be approached from exactly the right direction and contacted at a selected point near one end. Both problems must be solved precisely, since landing at a point parallel with the runway, but just aside of its boundaries, would be disastrous.

Taking up these elements in the order that they would be utilized by a pilot, in flying a course, he would be guided toward the airport by the regular beacon signals. However as he nears the airport he must be provided with continually increasing precision in the knowledge of his location.

Under the system which has been effected by the Civil Aeronautics Administration, as described in the CAA-RTCA report just prepared by Harry I. Metz of the Technical Development Division, the pilot establishes direction towards the airport on a "runway localizer" beam at a predetermined altitude some distance beyond an outer marker. This predetermined altitude is maintained until "a glide path" is intercepted. The vertical cross-pointer on the aircraft instrument gives an on-course indication and the horizontal cross-pointer shows the proper altitude at which to fly. The pilot establishes a glide, maintains direction by reference to the vertical cross-pointer. Outer and inner markers act as sign posts along the localizer beam to indicate the pilot's distance from the runway.

Fig. 1—Basic diagram for crystal controlled localizer and glide path transmitter units



LANDING INSTALLATION

These systems in conjunction with the vhf airway ranges will permit the airport traffic control tower to regulate the flow of arriving aircraft at instrument weather conditions with greatly increased efficiency.

On the basis of testing existing systems, particularly the operation of the Indianapolis instrument landing system (which is called the CAA-RTCA system) it has been found that the radio transmitting equipment, including localizer, glide path and marker transmitters, is especially well designed and fully reliable under widest fluctuation of ambient temperature and voltage conditions. The radiating systems, particularly the localizer antennas, are considered very reliable. Based on present technic, experience and results in work on uhf antennas, horizontally polarized waves are preferable to vertically polarized waves.

The method of mechanical modulation in the localizer system is of outstanding importance for four major reasons as compared to previous mechanical systems since it permits reduction of cross modulation, harmonic distortion, waste of power and stabilizes the localizer course against tube failure variation. The receivers have been very reliable in their operation and calibration, but a weight and space reduction of the localizer receiver would be desirable.

The method of controlling and monitoring the system, while sound and complete in principle, is not entirely satisfactory in service and requires simplification. The generally uniform horizontal pattern of the aircraft receiving antenna has been found to be a desirable requirement which has not been obtained with vertically polarized receiving antennas.

As installed at the Indianapolis Municipal Airport, the system provides for instrument landing in four directions, through the use of fixed ground stations. Three elements are involved: (1) a localizer of the equi-signal type, (2) a glide path using the constant intensity principle, and (3) inner and outer markers having vertically directed radiation.

There are four transmitters involved in each direction of approach. These are: inner marker, outer marker, localizer, and glide path. Each has the same basic crystal oscillator circuit and first multiplying stage, as shown in the localizer and glide path transmitter diagram, Fig. 1. The crystals are sealed in nitrogen and maintained at a temperature of plus 80 deg. by thermostatic control.

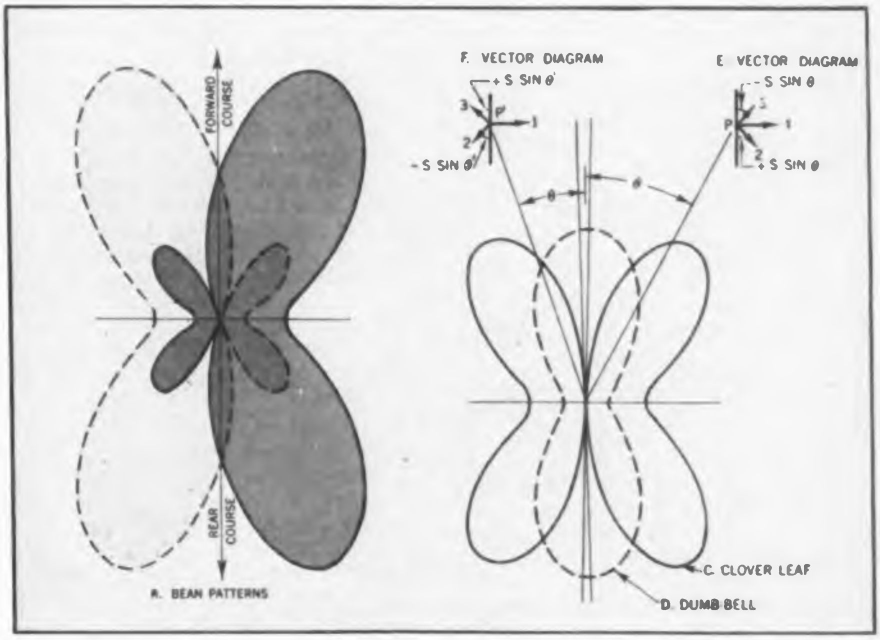


Fig. 2—Radiation pattern for localizer bean at left is composite of two patterns at right (Fig. 4). Course sharpness is 1.2 db per 1.5 deg. off-course. On-course signal approximately 2.75 db below maximum at 25 deg. off-course

The inner and outer marker transmitters are identical, except for their modulation frequency and rate of keying. These characteristics are included in the general tabulation shown:

Each transmitter contains a type 913 cathode ray tube on which the percentage of modulation can be determined. This tube operates only when the local "n" switch is operated at the transmitter.

The basic localizer pattern, frequently referred to as the "bean" pattern, is shown in Fig. 2. This is produced by three loop radiators of the design shown in Fig. 3. The

TABLE OF TRANSMITTER CHARACTERISTICS

	Marker	Glide Path	Localizer
F (Carrier)	75 mc	93.9 mc	109.9 mc
F (Modulation)	1300/400 cycles	60 cycles	90/150 cycles
F (Crystal)	4166.6 kc	3912.5 kc	4579.17 kc
Output (watts)	5	300	300
Input (watts)	290	—	—
High V. supply	300	Adj. (2250 max.)	3000
Low V. supply	None	1440	1500
Bias (volts)	100	100	100
Tubes:			
Oscillator	802 (3)**	802 (3)	802 (3)
No. 1 Multiplier	807 (3)	807 (2)	807 (2)
No. 2 Multiplier	807 (2)	304B (2)	304 (2)
No. 3 Multiplier	None	304B (2)	304B (2)
No. 1 Amplifier	807 (1)	100th (1)	100th (1)
No. 2 Amplifier	None	250th (1)	250th (1)
Line Monitor	6H6	6X5	6X5
Main Rectifier	5Z3	836	836
Aux. Rectifier	None	5Z3	5Z3
Bias Rectifier	Selenium	Selenium	Selenium

**Number in parenthesis indicates order of multiplication of frequency.

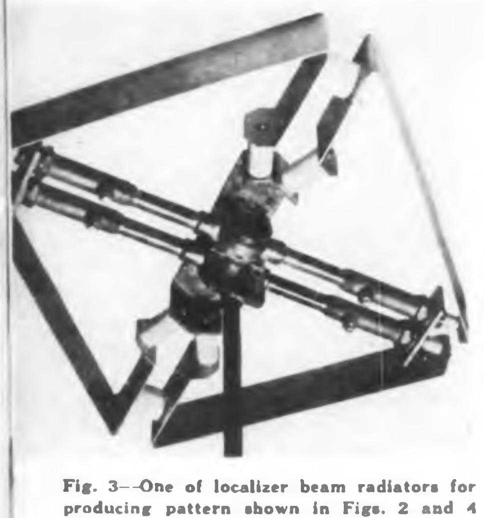


Fig. 3—One of localizer beam radiators for producing pattern shown in Figs. 2 and 4

bean pattern is actually the resultant of two other basic patterns generally referred to as the "clover-leaf" and "dumb-bell" patterns, respectively, as are illustrated in Fig. 2. The clover-leaf is produced by the two outside radiators (2 and 3 in Fig. 5) which are spaced 165 electrical degrees and excited 180 deg. out of phase. Both radiators are excited with equal amplitudes of 90-cycle and 150-cycle sideband energy. The orientation of the radiators is set so that the null of the clover-leaf is in exact alignment with the center line of the airport runway. This null is very sharp and defines the runway center line precisely after it is once established. However, since there is no signal along the runway center line from the clover-leaf, this pattern alone cannot serve for operation as the localizer. Further, since both 90-cycle and 150-cycle signals are present in equal ratio throughout, left-right sensing is therefore absent.

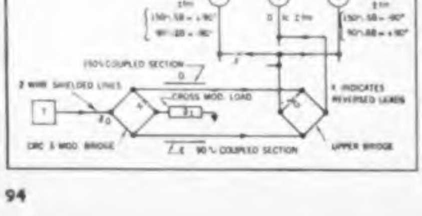
To establish an on-course signal with left-right sensing, the center radiator is excited with the carrier fully modulated with equal amounts of 90 and 150 cycles. Operating alone, the center radiator would produce a circular pattern. However, in the presence of the outside loops, which are free to operate parasitically with the center loop, the dumb-bell pattern is produced. The phase of the current in the center radiator is set at 90 deg. with respect to the excitation supplied to the outer radiators, so that in space (to either side of the clover-leaf null) the side band energy combines with the modulated carrier of the center loop to give left-right sensing. Since the outer radiators produce a null on-course, the only signal received on-course is the 100 per cent modulated carrier of the center radiator.

The patterns here described are capable of being altered slightly by adjustment of outer radiator spacing and phasing and center radiator phasing. These adjustments affect the sharpness of the course, the direction of the maximum radiation, the amount of signal on-course, and the ratio of maximum radiation to that at 90 deg. from the course.

It is evident that a spacing of outer radiators approaching 180 deg., which would give a minimum at 90 deg. to the course, cannot be used because this would cause radiation in this direction to be only that resulting from the dumb-bell pattern and would thereby permit the course indicating instrument in the aircraft to indicate on-course. The difference between the 90-cycle and 150-cycle bean patterns, often referred to as "clearance," must always be great enough to avoid a false course or, preferably, to keep the instrument pointer always off scale except when in the true on-course area.

The method of modulation is illustrated in Figs. 5 and 6. A photograph of the modulator unit is given in Figs. 7 and 8. From the diagrams it is seen that the output of the localizer transmitter, consisting of unmodulated carrier, is first passed through the "lower or cross-modulation bridge" where it is divided into two channels for modulation at 90 and 150 cycles. The

Fig. 5—Antenna feed system and phasing for localizer pattern



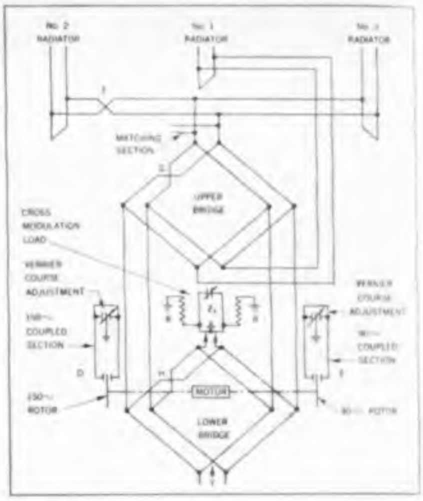


Fig. 6—Detail of Fig. 5 showing modulation system of detuning coupled sections

TABLE OF RECEIVER CHARACTERISTICS

	Glide Path Receiver	Localizer Receiver	Marker Receiver
Carrier (mc)	93.9	109.9	75.0
Crystal (kc)	7298	8325	7630.5
IF (kc)	6325	10,000	6325
Pass Filters (cycles)	60	150/90	3000/1300/400
Nominal Sensitivity	2500 μv.	50 μv.	150 μv.
Selectivity (60 kc)	3 db	3 db	6 db
Selectivity (300 kc)	60 db	60 db	60 db
Image Response	—60 db	—60 db	—60 db
IF Response	—60 db	—60 db	—60 db
Sig./noise	30 db	30 db	30 db
Output	0-600 μa. d.c.	Bal. d.c.	Sig. lamp & aural
Audio Selectivity*	15 db	15 db	20 db
Voltage Stability	±10 per cent	0.5°**	—
Temp. Stability (—40 to +60°C)	±10 per cent	3.5°**	—
Width***	5-3/16"	10-3/8"	5-3/16"
Weight	14 lbs.	27 lbs.	15 lbs.
Vibrator	Non-Sync.	Sync.	Non-Sync.
Tubes: Mod.	6C6G	6J7	6J7
IF.	6SJ7	6SK7	6J7
2nDet.	6SQ7	6SQ7	6Q7
Aud.	6R7	6J5	6V6G
OSC.	6C6G	6N7	6N7

* *Audio selectivity value at freq. 25 per cent below resonance.*
** *Localizer vertical pointer movement in degrees.*
*** *Std. aircraft length and height is 19-7/16 x 7-11/16 in.*

corner of the bridge opposite the entrance corner is loaded with a network Z_1 which reduces cross modulation. The circuit voltage at the point where Z_1 is connected is minimized by the reversal "H".

The current passing in the two vertical channels is modulated by closely coupled sections which are alternately tuned and detuned by specially shaped 150-cycle and 90-cycle rotors driven at 1800 rpm by a synchronous motor. The modulated current of the two channels enters opposite corners of the "upper bridge," which permits each carrier to add in-phase and pass with the respective side bands to the center radiator (1), while the carriers to the outer radiators (2 and 3) cancel (by virtue of the reversal G), thus allowing only side bands to excite these radiators. The lengths of all lines are equal from the transmitter to the output of the upper bridge. The lengths from the upper bridge to the radiators are chosen so as to provide correct relative phasing in the radiators.

The four glide path stations were installed 400 feet off to the side of the center lines of their respective runways. The radiation pattern intended for these stations was a broad beam, the axis of which is directed along the runway. In the use of the system, the airplane

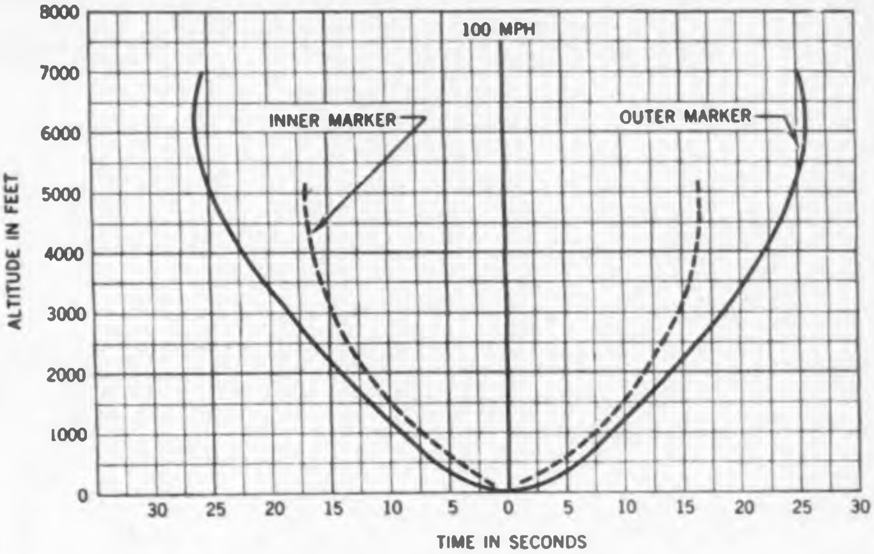
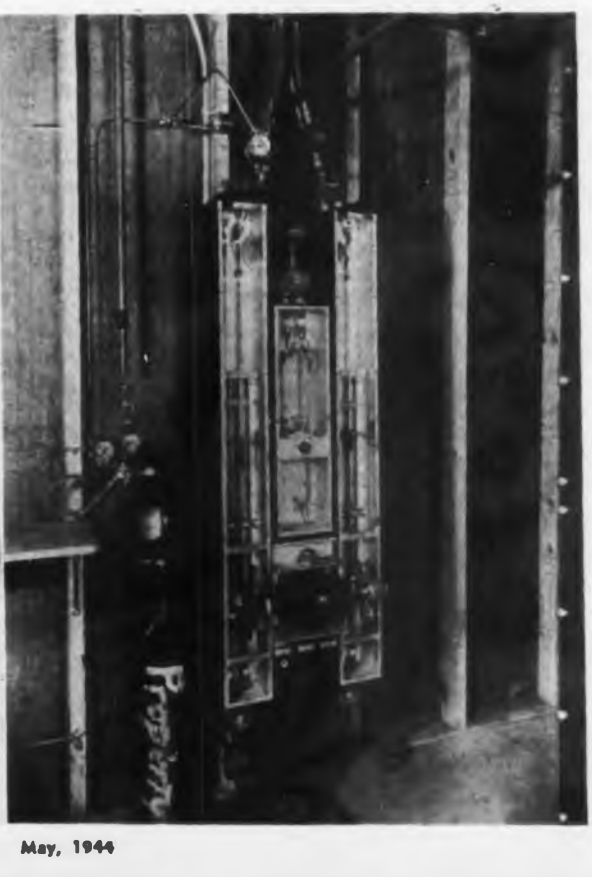


Fig. 9—Vertical pattern of outer and inner marker beams showing duration of indicator lamp glow at various elevations in feet for plane speed of 100 mph

would follow a parabolic curve of constant field intensity as defined by the output of the glide path receiver.

The power of each inner and outer marker was adjusted arbitrarily to give a marker light indication of 8 seconds duration when the aircraft was flying over the station at 600 ft. altitude at 100 mph. The marker receiver sensitivity was adjusted to give a 15-second marker light indication when the aircraft was flying at an altitude of 1,000 ft. over the Indianapolis "Z" marker. In normal use the inner marker indication is approximately 1½ seconds when the aircraft is passing over the marker at an altitude of approximately 45 ft. The duration of the outer and inner marker signals (8 and 1½ seconds, respectively) has been found satisfactory for instrument landing. Vertical patterns of the two markers, taken with increased power output, are shown in Fig. 9. There are no minor lobes. The pattern in the horizontal plane at 600 ft. altitude has a cross-course length to thickness ratio of approximately 4-1.

Fig. 7—(left) Transmission line modulator unit shown in Fig. 6. Fig. 8—(right) Modulator with cover removed showing motor and chopper wheels



Monitors

To immediately ascertain if circuit failure prevents any part of the service to be missing, a monitor and control system is installed in the airport control center desk, located in the Administration Building control tower, handles all functions. Each signal received at the control desk is individually adjusted for level, amplified, filtered, and rectified to operate the control desk indicating instruments. The localizer indicating instrument is a zero-center instrument and signals to operate it are derived from a balanced 90/150-cycle filter and special copper oxide rectifier units identical to those used in the localizer receivers. The other filters used are combination filter-saturable reactor units, similar to those used in Airline 27-A marker receivers. The saturable-reactors are operated by the rectified monitor signals which release 60-cycle alter-

(*Continued on page* 276)

Photoelectric Dimension Gage

by A. EDELMAN
Photobell Division, Liquidometer Corp.*

Production-line inspection unit makes eight measurements on 20 mm. shells, delivering one shell per second

• In a factory making ammunition, a surprisingly large number of persons are normally employed solely for inspection, to determine whether the critical dimensions are within the required tolerances. In wartime, with all types of labor at a premium, it is extremely difficult to obtain a sufficient number of persons capable of learning the inspection process properly, and willing to perform the work for long hours. The experience of all ammunition factories has been such that they require automatic devices for such work, wherever possible.

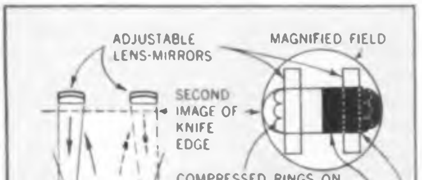


Fig. 1—Diagram of one of the 8 optical and photoelectric units. Knife edge takes a position determined by actual dimension being measured

The use of phototubes for the inspection of dimensions is not new, but previous attempts to employ phototubes for this service have all failed to include fully automatic features, and have not been economically attractive.

At the request of Matam Corporation, a photoelectric assembly was built into a conveying device, to determine the nature of such problems as might arise in high-speed, accurate sorting of ammunition shells into groups according to critical dimensions. With the experience gained from this first assembly, a complete machine was constructed, capable of measuring eight critical dimensions, sorting the shells according to these dimensions, and delivering one shell per second, or 36,000 per 10-hour day. This machine has successfully passed numerous tests for accuracy, sensitivity, reproducibility of results, etc., and will soon be in continuous use.

General description

The machine consists of a manual feeding device for feeding the shells into the conveyor; an oscillating, motor-driven conveying device that moves the shell through sixteen positions before finally removing it; eight photoelectric assemblies; sixteen air-blast ejecting devices for removing the shells from the conveyor; and eight mechanical assemblies for clamping and measuring the shell.

In operation, the motor operates the conveyor so that all of the shells in the sixteen positions on the conveyor are advanced one position each second, starting from the magazine feed at one end and finishing at the drop-off position at the other end. The first position and alternate ones thereafter are measuring positions, so that there are eight measuring positions in all.

In between the measuring positions, starting from the second position, there are eight ejecting positions. The shell which is measured in the first position may be ejected in the second position, or it may be permitted to pass to the third position and there be measured again for another dimension. A shell may spend a total of sixteen seconds in the machine, first being measured for dimension A; then being subjected to possible ejection for this measurement; then being measured for dimension B; then being subjected to possible ejection for this second measurement; and so on through a total of eight measurements.

For each measurement, the shell may be found oversize, within tolerance, or undersize. If oversize, it is ejected to the right side; if undersize, it is ejected to the left side; and if within tolerance, it is permitted to continue on to the next measurement position. Thus, each ejection position has two ejecting devices, one for oversize and one for undersize. At the completion of a run, there will be sixteen containers more or less filled with sorted-out rejects, and one container at the end of the conveyor, filled with perfect shells.

The shell is brought into the measurement position by the conveyor, and dropped onto a V-block which is part of the measuring system. Thereafter, the conveyor and all vibrating or shaking parts remain out of contact with the measuring system until it is time to remove the shell.

After the shell is in the V-block, an air cylinder moves pistons to grip the shell so that it may be held rigidly during the measurement. Each of the eight measuring stations has its own requirements as to how the shell must be gripped.

*36-16 Skillman Ave., Long Island City, N. Y.

For example, in measuring overall length of the shell, the clamping action is such as to bring one end of the shell solidly and squarely up to an anvil from which the measurements begin as reference.

In measuring outside diameter, the shell is again clamped to bring one end solidly up to a pre-determined position, but now the anvil is on the O.D. opposite to a point at which measurements are to be taken. To measure inside diameters, the anvil is inside, opposite to the point at which measurements are taken.

After clamping, a measuring bar is brought into contact with the shell, to position itself in accordance with the dimension to be measured. In general, this measuring bar is a sliding or a pivoted lever which has little or no backlash, and which moves accurately under spring pressure into contact with the shell. The arrangement of this measuring bar is different for each measuring station, being designed to permit the most reliable measurement.

Close-up of delivery end of Matam Corporation's shell inspection machine. Note final measuring and ejecting positions

Optical system

Attached to the measuring bar is a "knife edge," or thin steel body which appears in position within the field of a microscope when the measuring bar is properly seated on the shell. If the measured dimension is precisely on the mean, then this edge precisely divides the circular field of view of the microscope into equal dark and lighted semicircles. If the measured dimension is away from the mean, then the measuring bar will have a different position, and will bring the edge to a different position, away from the diameter of the field of view of the microscope.

The microscope is arranged vertically within a housing on top of the framework, as shown in Fig. 1. Below the objective lens of the microscope is mounted a condenser lens system. Below the condenser lens system is a light projector assembly which also contains a condenser lens.

A 32cp 6v prefocus type lamp is employed, operated at 5.7 volts for long life. A paraboloidal condensing lens close to the lamp focuses the light upward into the second condenser system. The second condenser system is a group of one or two lenses designed to bring the maximum light into the opening of the microscope objective. This set of lenses must be different for each strength of objective lens employed, in accordance with conventional microscope practice.

Between the second condenser lens set and the objective lens set is the knife edge, capable of horizontal movement only. The knife edge intercepts part of the light, according to the position of the measuring bar on the shell.

The light entering the microscope objective lens set is projected upward to form an image near the eyepiece lens set. The eyepiece lens set projects this image upward again; and if there were no more lenses employed, it would produce an image of the knife edge, highly magnified, approximately 10 in. above the top of the microscope.

In order to employ the light available at this position more efficiently, a cylindrical lens is placed above the eyepiece lens set, and so adjusted as to compress the round image of the field of the microscope into an oval one. This permits the maximum amount of light to strike into the mirrors placed at this level.

Two focusing-type lens-mirrors are used, one to receive light from the left half, and the other to receive light from the right half of the oval field. These mirrors may be adjusted as to position, thereby adjusting the tolerance of the measurement. For all adjustments of the mirrors, they reflect whatever light they receive into phototubes. The left mirror always focuses its light into a small rectangle which enters the left phototube and the right mirror does likewise for the right phototube.

The mirrors are long strips, 2-in. by ⅜-in., cut from a plano-convex lens which has been silvered on the convex side. The distance between the mirror and the eyepiece lens of the microscope is so related to the focal length of the mirror as to cause a small focused spot of light to come to the phototube window. This permits the phototube to be small and to be fully enclosed except for a small opening through which the light may enter. The result is a high grade of shielding

Shells are fed by hand into the dimension gage via an inclined chute. Cover removed from first photoelectric unit

against pickup of electric fields and stray light.

In order that the mirrors may be adjusted to vary the tolerance for which the system is set, and yet continue to focus their light accurately into the phototube for all possible adjustments, the phototubes are placed close to the eyepiece lens of the microscope, and the mirrors are mounted on arms which pivot from a position also close to the eyepiece lens. Thus, for all positions of the mirrors, they may be considered as being segments of a sphere whose center is the pivot point; and it is well known that light originating at the center of a sphere will always be returned to the center by any specular reflection from the walls of the sphere.

The adjustment of the mirrors is accomplished from outside, by means of a lead-screw which travels a nut back or forth as wanted. The mirror follows the movement of this nut, and a spring takes up backlash. The lead screw is turned several full revolutions to move the mirror an amount equivalent to one thousandth of an inch change in dimension. Each mirror is separately controlled by its lead screw.

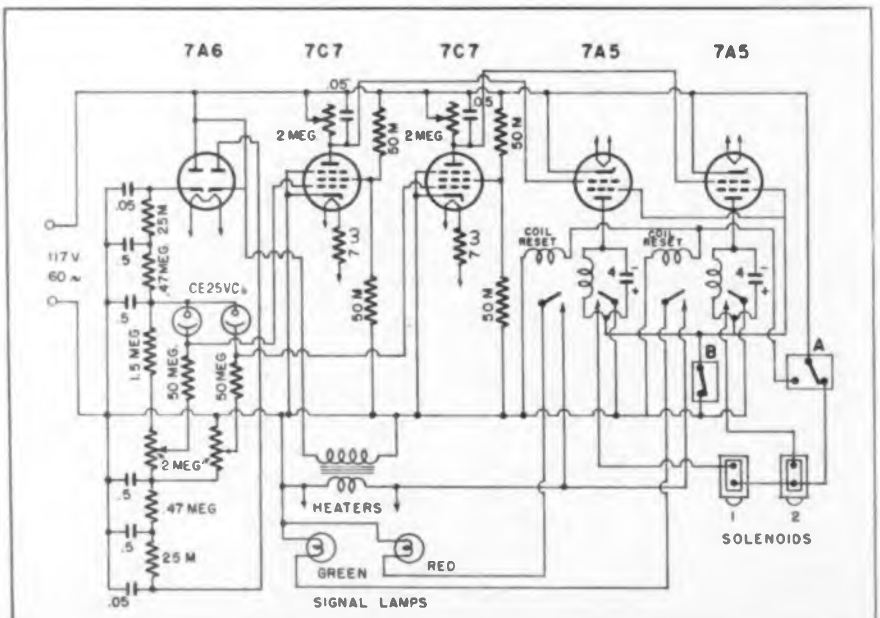
There are two phototubes per measuring station, one to receive the light from the left mirror, and the other to receive the light from the right mirror. Because the spot of light was small, and space constricted, a Continental CE-25-VC phototube was employed, this being an average-sensitivity, vacuum type, caesium-oxide phototube of small dimensions, in which the light-sensitive cathode is not interfered with by an anode rod directly in front of it. Each phototube is within a metal box for shielding against light and pick-up, and connects to the amplifier chassis by shielded cable.

The total amount of light actually reaching the phototube is quite small, and therefore a two-stage amplifier is employed for each phototube. The first tube is for voltage amplification primarily, and the second tube is for power amplification, so that the coil of a locking-type relay may be operated directly from it. Thus, there are two tubes for each phototube, employed as amplifiers, plus one rectifier tube which furnishes dc power, making five tubes in all, per measuring station.

An empty octal socket is also provided in a readily accessible position, as a test socket. Phone tins or a connector body may be employed to make connection to this socket, and furnish all essential voltage data. Two adjustment knobs are provided; one to adjust the voltage applied to the phototube, and the other to adjust the plate resistor coupling the two stages.

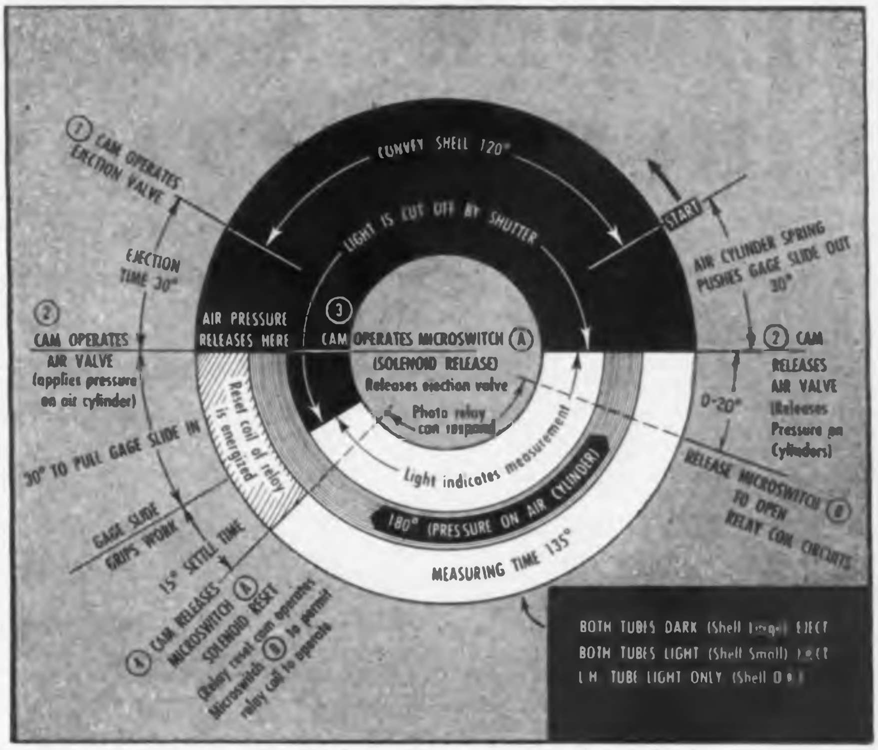
To reduce the grid current in the first amplifier tube, the heater is

Circuit diagram of photoelectric dimension gager unit. Microswitches A and B operated by cam on conveyor mechanism. Phototube signals operate solenoids 1 and 2 to reject off-size shells



operated at 4.5 volts instead of at 6.3 volts. This has been found to be helpful when phototubes deliver very little current, as in the present case.

A timing cam on the conveying device disconnects the coil of the relay in the plate circuit of the power amplifier tube, until after the phototube is receiving the desired amount of light as a result of the shell being in position, and the measuring bar in contact with it, and the knife edge in the field of the microscope. Then the coil of the lock-type relay may or may not energize, according to the light received at the phototube. Then the plate circuit is again disconnected, leaving the relays in position to indicate the result of the inspection by controlling ejecting devices.



Timing diagram of the automatic shell inspection machine. Microswitches and solenoids referred to are shown in circuit diagram on the opposite page

Sorting method

As a result of each inspection, any one of three things may happen:

(1) The shell dimension may be oversize, and this will cause the measuring bar to position the knife edge so that it covers up some light that would otherwise enter the microscope. If enough of this light is covered, so that the image of the knife edge obscures both mirrors, then the coils of both relays in the measuring set are energized, and this has the result of completing a circuit to one of the two ejecting devices for that station, so that the shell may be ejected into the "over-size" container. The ejecting operation does not take place, however, until the shell has been removed from the measuring position, and has arrived at the next or ejecting position.

(2) The shell dimension may be undersize, and in similar fashion, this positions the measuring bar and knife edge so that both mirrors and phototubes are receiving light. This causes the coils of the two relays to both remain unenergized, and this completes a circuit to the second of the two ejecting devices for that station, so that the shell is ejected into an "undersize" container.

(3) If the shell dimension is within tolerance, the knife edge will be so positioned that one mirror and phototube receive light while the other mirror and phototube do not; and this causes one relay coil to energize and the other to remain inoperative. This has the result of preventing either ejecting device from operating, so that the shell is not ejected, but is again picked up by the conveying device and brought to the next measuring station.

The same sorting operation may occur at each of the eight measuring stations, so that a shell may fall into any of eight "oversize" containers, any of eight "undersize" containers, or one "perfect" container at the end of the conveyor.

Ejecting devices

At each ejecting station, two copper tubes are aimed at the shell, one from the left and one from the right. Each is capable of blowing the shell off the conveyor, into a chute. Each has a solenoid-controlled air valve which is set to open the air path or to close it, according to the position of the lock-type relays.

If both relays operate, one of the solenoid valves will be operated to open the line on that side. If both relays are unoperated, the other solenoid valve will be operated to open its line. If only one relay is operated, the other being unoperated, then neither solenoid valve will operate, and both of the ejector lines will remain closed.

During a part of each cycle, at a time when the shell is at rest in the ejector station, a master air valve operated by the timing cam of the conveyor will fill the supply air lines with compressed air. Those of the valves which have opened their ejector tubes will then blast the shells off the conveyor. Thus, all ejections take place simultaneously for the eight ejecting positions.

After completion of this blasting part of the cycle, the timing cam continues around and resets the lock-type relays to their normal positions. Immediately following this resetting operation, the relays are required to operate for the next shell being measured.

The conveying device is a framework, about four feet long, which oscillates in a simple fashion while always remaining perfectly horizontal. A crank arm at each end supports this framework; and both crank arms rotate together. The result is to move the framework in circular fashion, oscillating back and forth.

Any and every part of the framework moves in a circular orbit of about 6 in. diameter. This permits the framework to pick up a shell by coming up from underneath it; lift it off and out of its V-block support; carry it 3 in. over to the next V-block; deposit it into the next V-block; and then move down and out of the way until it is time to move the shell again, a little later.

The timing is such that the shell is being transported during 1/3 of each 1-second cycle; and during the remaining 2/3 of each cycle, the conveying device is not in contact with the shell at all. This allows ample time for clamping the shell, positioning the measuring bar, operating the phototubes and relays. While these operations are taking place in a measuring position, ejection may be taking place in an ejecting position.

(Continued on page 256)

CLIPPER AND LIMITER CIRCUIT ACTION

by RALPH R. BATCHER and WILLIAM MOULIC

Circuits for voltage and current amplitude discrimination. From the new Electronic Engineering Handbook

● The great bulk of tube applications has been in the fields of rectification, amplification, and oscillation, but their use as an element in other types of circuits is also becoming of importance. In control circuits the problem of separating electrical effects according to their own peculiar characteristics finds many uses.

The field of application for amplitude limiting circuits is quite large, and many variations in the procedure are in use depending on the problem at hand. The most obvious method of limiting the voltage in a circuit is to connect across it some device whose resistance goes down as the voltage rises. Devices with this characteristic are sometimes known as Varistors. A special type of ceramic "insulator" impregnated with a special material known as Thyrite has the property of becoming a fairly good conductor at high voltages, although its insulating properties are maintained at low voltages. The ordinary "dry-disk" or barrier layer rectifiers (selenium-on-iron or copper oxide) are very effective in limiting the accidental voltages on a telephone line, which would otherwise cause damage to equipment. The "voice" voltages are not reduced or distorted seriously by this action because the rectifiers represent a high resistance at the small speech voltage. On the other hand, this simple limiter "takes hold" only gradually so that voltages considerably above the desired level (that is, above the speech-voltages) get through the line. In critical applications, the use of vacuum tubes makes it possible to set a much more definite ceiling.

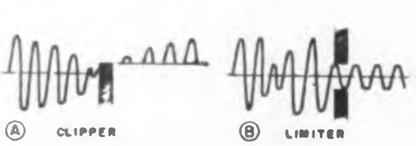
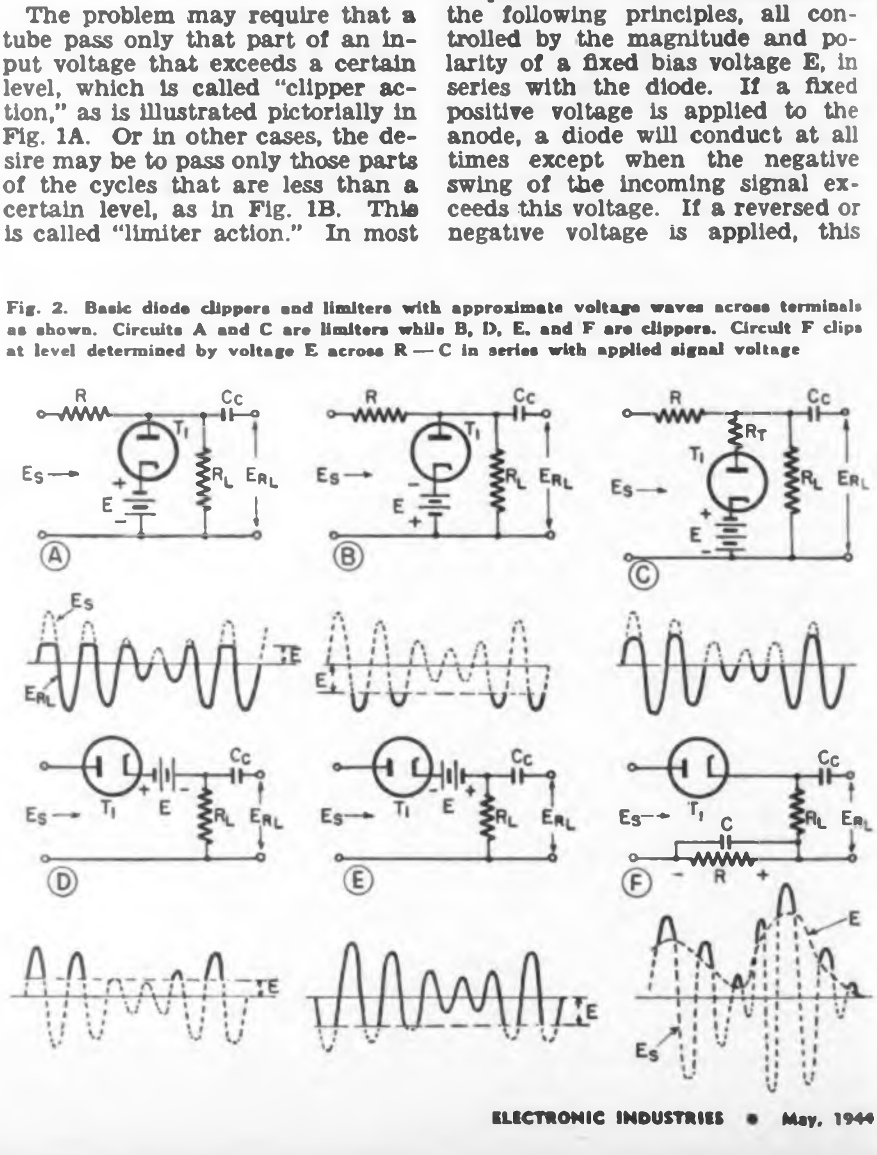


Fig. 1. Graphical representation of action of (A) clipping peaks of voltage wave and (B) limiting output to predetermined level

The problem may require that a tube pass only that part of an input voltage that exceeds a certain level, which is called "clipper action," as is illustrated pictorially in Fig. 1A. Or in other cases, the desire may be to pass only those parts of the cycles that are less than a certain level, as in Fig. 1B. This is called "limiter action." In most cases the need is to establish the level at which this division occurs within close limits, or at a point controlled by some other operating characteristic.

From among the numerous variations which can be worked out, there are four classes of circuits by which amplitude discrimination can be procured. These are based on the following principles, all controlled by the magnitude and polarity of a fixed bias voltage E, in series with the diode. If a fixed positive voltage is applied to the anode, a diode will conduct at all times except when the negative swing of the incoming signal exceeds this voltage. If a reversed or negative voltage is applied, this

Fig. 2. Basic diode clippers and limiters with approximate voltage waves across terminals as shown. Circuits A and C are limiters while B, D, E, and F are clippers. Circuit F clips at level determined by voltage E across R — C in series with applied signal voltage



* The entire edition of the Electronic Engineering Handbook has been purchased by Caldwell-Clements, Inc., for the benefit of the paid subscribers of Electronic Industries. At the present time the Handbook is not for sale separately but is being offered only with renewals and new subscriptions to Electronic Industries. For detailed information, address Subscription Manager, Electronic Industries, 480 Lexington Ave., New York 17, New York.

tube will conduct only when the positive swing of the incoming signal exceeds the negative voltage. Thus it is possible to control the threshold of action over wide limits.

Also it is possible to connect the tube as a short circuit across the load so that it dissipates the energy during the conductive intervals, or in series with the load so that it passes energy during those intervals, and cuts off the signal at other times. These connections, together with the different polarity factors are shown in Fig. 2.

Then again, it is possible to modify the effectiveness of the tube in either part of the circuit by adjusting its impedance up and down with respect to that of the load, or by placing an external resistance in series with its anode, as in Fig. 2C.

The transfer point with the various combinations shown here can be altered to any point on the wave by altering the bias voltage between the positive and negative extremes. Fig. 2 also shows the form of the output voltage during the typical operating interval when an input signal as shown is applied.

Limiter characteristics

Other variations come about when two diodes are used. For instance, one diode may act on positive swings and the other on negative swings, or else they may be used with different bias values so they will pass only those signals which are between two limits, or as a transfer "switch," which will connect voltage surges greater than a certain value to one circuit and lesser values to another. It will be evident that these diodes may be individually connected using any two of the combinations shown in Fig. 2. Of course in certain instances the resulting signal might add up to zero—that is, deliver no useful current. Even this latter connection can be used to advantage if the two tubes have different cut-off bias voltages. For example, such an arrangement was a very early system for reducing radio interference in communication receivers. The two diodes are connected in parallel, but series opposing. If both tubes had identical characteristics, the rectified currents cancel in the load. However, one diode is biased for high sensitivity on weak signals, and the other for low sensitivity so that it will function only on strong signals. There is, therefore, a certain operating range over which the balancing effect is ineffective.

A limiter is a device in which the signal level is reduced if the amplitude exceeds a certain datum. It has been mentioned that certain radio receivers and amplifiers may have an automatic volume control feature, where the gain in an amplifier is altered inversely as the signal level (as indicated by the rectified and averaged output) so that the resulting amplitude is relatively constant. These circuits generally derive their control voltage from the radio frequency carrier level, if used with a radio receiver, in which case the designation AVC applies. When the control factor depends upon the average volume level in the audio amplifier itself, the system is generally termed a limiter amplifier or as a compression-expansion amplifier. These systems do not alter the wave shape of the original signal as do the limiters described above.

These AVC circuits generally operate slowly and average the control action over a short interval so that a single cycle of excessive voltage will not affect the gain. A more rapid control effect is called a peak limiter. These limiters, operating on single cycles of excessive potentials are the same as described in Fig. 2, (A and C) for diodes, although in practical circuits a triode or pentode is often substituted. In many cases there is no basic difference in the limiter action in its various degrees between diodes and triodes, etc.

In an amplifier, limiting action may be accomplished in a variety of ways, as by connecting a diode limiter across the amplifier. This is not the easiest way that this action can be accomplished however. Limiters are of value when the desired signal is weaker than an unwanted strong one, and mixed with it on the same incoming circuit. Here the strong signal remains at the approximate level of the weak one, so that the ear has a better chance of distinguishing the latter than it would if the strong signal blanketed the whole.

For commoner applications of limiters, the circuit Fig. 3A is used. Here the pentode amplifier stage is operated with a low anode voltage, possibly only a few volts. It is evident that voltage variation across the load resistance is always less than the applied anode voltage so that all strong voltages applied to the grid can not be amplified above a certain level, and only signals of low intensity are transmitted through the stage without being affected. A limiter stage can be set up using normal plate voltages, by providing a large grid circuit resistance and no independent bias on the grid so that it can "go positive" momentarily during each cycle. As shown in the curve relation, Fig. 3B, negative swings are limited when the signal exceeds the grid cut-off point, while positive swings are limited due to a high bias appearing in the grid circuit when the grid is positive.

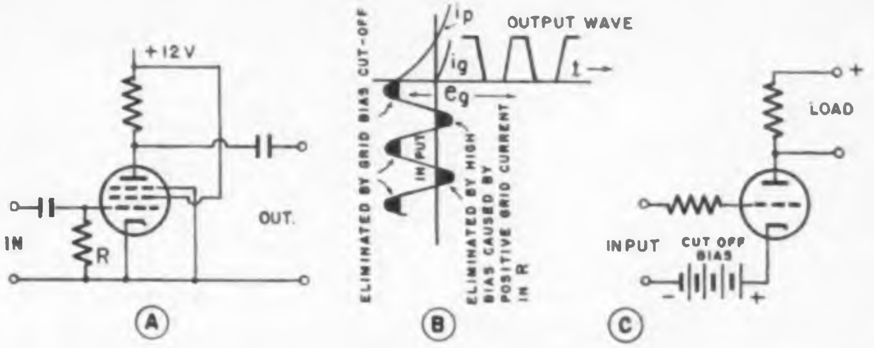


Fig. 3. Pentode limiter circuit at (A) uses low voltages and grid leak bias to limit response on positive and negative cycles as in (B). At (C) is clipper circuit to pass only part of positive half cycle of input voltage. Bias battery adjusts clipping level

Adjusting clipping

Various schemes have been devised to provide an automatically established bias that is always just above the wanted signal level. In one form, the circuit of Fig. 2F maintains a cut-off level a definite number of volts above the average voltage applied to the system. These circuits are found of interest in television circuits and some of the more elaborate communication circuits. The bias voltage is developed across R and C in Fig. 2F in such a manner as to prevent any output until a peak exceeds this bias. This circuit is used to sep-

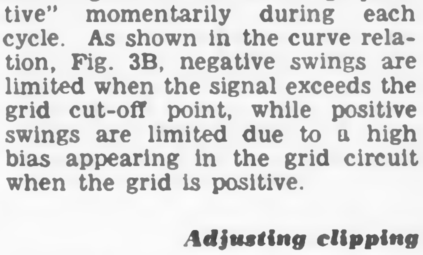


Fig. 4. Limiter circuit with increased control range uses separate amplifier tube (6SJ7) and rectifier (6H6) to control 6L7

arate the synchronizing signals from the video in television.

In this circuit the value of C must be large enough to store up a charge over the high frequency cycles. In one form of this circuit both R and C in the grid circuit are quite large. The grid current passing through the cathode-grid path in the tube is rectified and accumulates on the grid capacitor. This voltage is therefore equal to the average voltage of the signal and the tube which is biased at this value will transfer a signal only when the peaks of the signal exceed the average. A fixed bias is sometimes used here, as in Fig. 3C In this manner, the circuit acts as a clipper to select and pass only the positive peaks.

It is possible with this arrangement to take note of signals if they are greater than a certain value, or to pick a weak or strong signal out of a mixed strength combination. If the non-desired signal is weak. the basic principle, Fig. 3C, consists of a tube biased to a high enough value so that only an input greater than this value will affect the grid. In other words, this tube passes what the previously mentioned limiters block out.

Another circuit which has the reversed limiting effect, Fig. 4, passes weak signals but is more or less immune to strong ones. This action is due to an auxiliary pair of tubes (6SJ7 and 6H6) which take note of the incoming signal levels and produce a bias voltage that reduces the gain of the amplifier action in the 6L7 tube when the signal gets too strong. The level at which this occurs is adjustable. The resultant output can even show "voids" when strong overloads occur. An effect that must be considered when the use of this circuit is contemplated. It is a common form of "static" reducer in communication receivers, voids in a signal train being less obnoxious than blasting interference pulses.

Differentiating action

Discriminator circuits can be set up which take note of the rate of change of an effect of some circuit factor, so as to act as a "differentiating circuit." The circuit that will take note of rapidly changing waveform, and not of steady conditions is relatively simple. Mathematically speaking this is not a true differentiation however, although in certain cases the divergence is not great. A capacitance-resistance network is generally used (although an inductance-resistance combination would suffice) because a capacitance can be obtained that has lower internal losses than an inductance.

In Fig. 5 when a current, i, is passed through C and R, the rate of change of the voltage across C is proportional to i, and the instantaneous value of current is proportional to the instantaneous value of the voltage across R. While e_c is small compared to C, it is

(*Continued on page* 280)

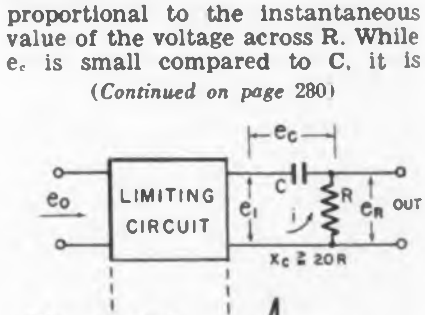


Fig. 5. Typical circuit for producing sharp pulses of short time duration. Sine wave input converted to square wave by limiter and differentiated by R-C to give pulse

Editors of new ELECTRONIC ENGINEERING HANDBOOK

RALPH R. BATCHER

WILLIAM MOULIC

The new "Electronic Engineering Handbook," published by Electronic Development Associates, 125 East 46th Street, New York 17, N. Y., represents the editorial work of Ralph R. Batcher and William Moulic, well-known among radio and electronic engineers for their many technical articles. Both are members of the editorial staff of "Electronic Industries".

Ralph R. Batcher, senior editor of the new Handbook, is an engineering consultant who has written many articles and text books on electronic subjects, including special works on cathode-ray tubes and electrotherapeutic apparatus.

Beginning as a radio amateur in Iowa in 1909, Batcher was graduated from Iowa State College in 1920. During World War I he served as instructor in radio theory at the Signal Corps School, CCNY, and also at the old Marconi Institute. From 1920-24 he was engineer with the Western Electric (now Bell) Laboratories at New York, then becoming research engineer with A. H. Grebe & Co. until 1928. In 1929-30 he entered the manufacture of loudspeakers, as vice-president of Decatur Manufacturing Co., resigning to do consulting engineering work until 1938 when he became chief engineer of Allen D. Cardwell Mfg. Co., a post in which he continued during the war period. until he became consulting editor of "Electronic Industries" magazine.

Mr. Batcher is a member of the Board of Editors of the I. R. E. Proceedings. He is also active in the New York Society of Measurement and Control.

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William Moulic, associate editor of "Electronic Industries", and technical editor of "Radio and Television Retailing", also published by Caldwell-Clements, Inc., began radio activities in Illinois as a "ham" operating W9LDY, and as radio servicer.

Graduated from Pratt Institute in electrical engineering, he became technical editor of "Radio Today" in 1939. During the war period he has taught ultra-high frequency technics and other courses to Signal Corps reservists at New York State Signal Corps Training School in 1942 and 1943.

—OHC

Rating Tube Performance

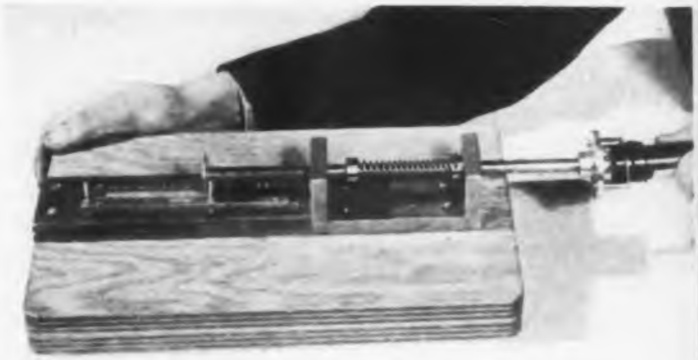
Capabilities of tubes are checked by simple set-ups that simulate practical hazards of military usage

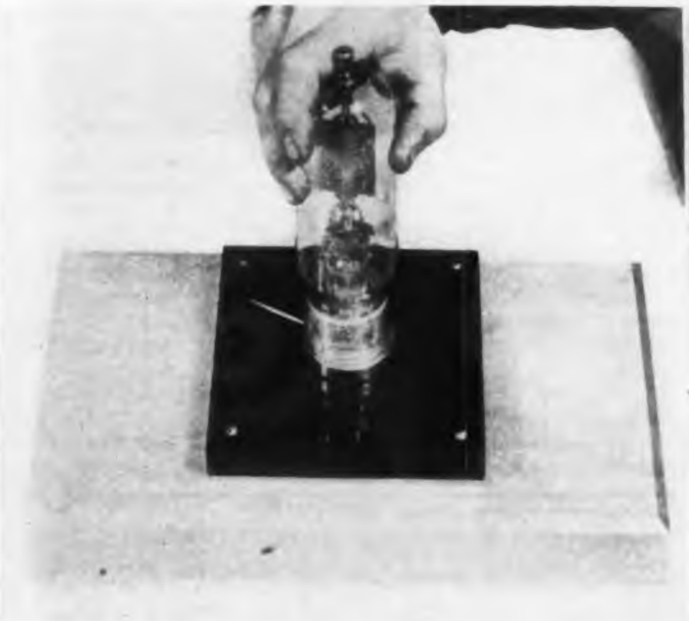
ELECTRON TUBE SOCKET TESTER—(right). For testing the serviceability, uniformity, and durability of electron tube sockets. It accurately measures the force required to insert and withdraw tube base pins

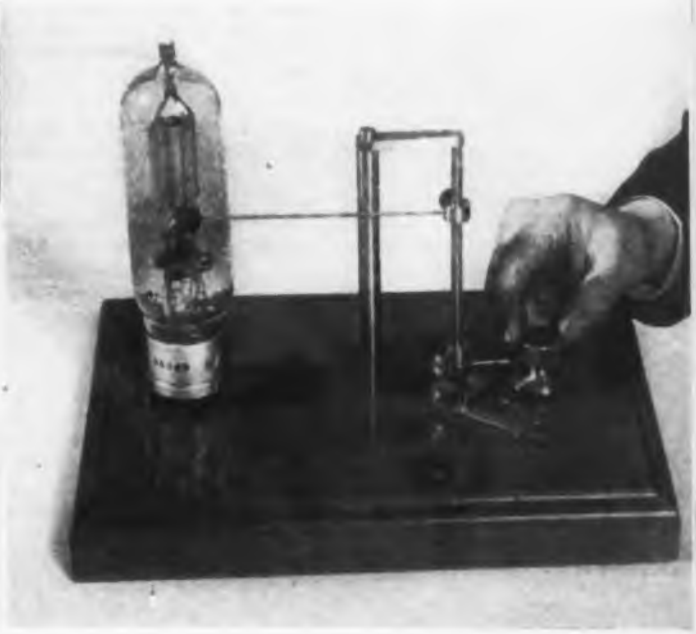
ELECTRONIC TUBE CEMENT IMMERSION TESTER—(below). This instrument measures in torque units, the force required to loosen or rupture the bond existing between the base and envelope of an electronic tube thereby providing a standard upon which a specification can be based

AUTOMATIC TAPPING DEVICE FOR TESTING TUBE NOISE—(below right). It strikes a uniform blow on the tube envelope for testing the background, harmonic and resonant noise components introduced in tube circuits when operated under the critical conditions of military operation

Details as to the construction of these devices and information as to their use may be obtained from the Signal Corps Standards Agency, Electronic Tubes Section, 12 Broad Street, Red Bank, N. J.



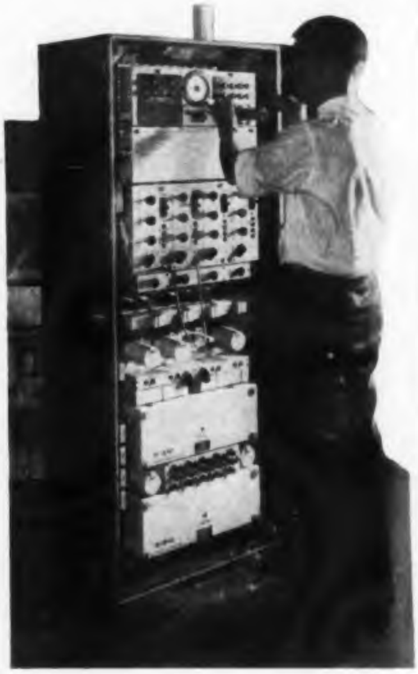




TUBE BUMP TESTER—(left). Spring-actuated bar is released to swing through a selected angle to strike a calibrated blow on the tube base in each direction relative to the plane of tube elements thereby measuring the intensity of the resultant impact, in standard units. It registers an accurate index of the tube structure in both electrical and mechanical terms. BUMP TEST CALIBRATOR—(right). The blow is calibrated by comparison with the maximum deflection of a pendulum-like device when struck by the bump lever, records the impact force used against the base of the tube. Center photo shows rebound of the pendulum after being struck by swinging stylus

SPIRAL-FOUR SYSTEM

by J. CLIFFORD JOHNSON
Western Electric Co., Inc.



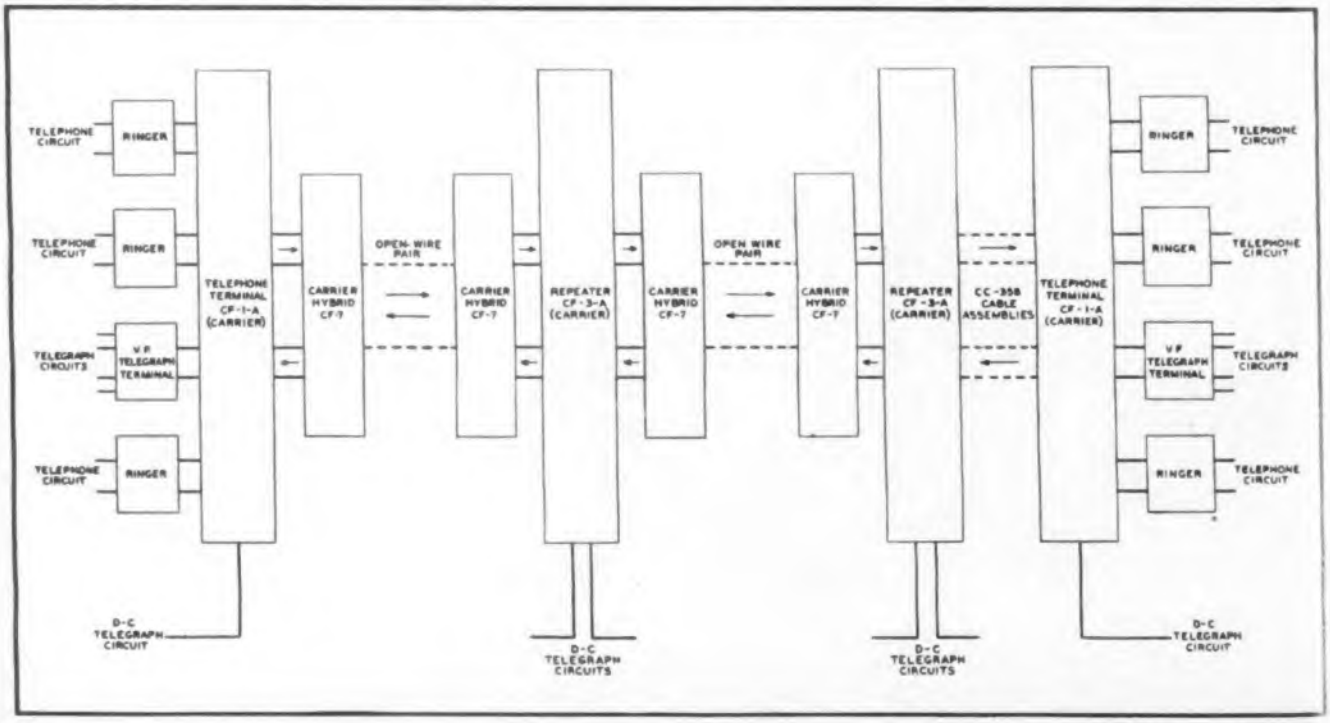
Carrier telegraph terminal unit for four duplex channels used on spiral-four system

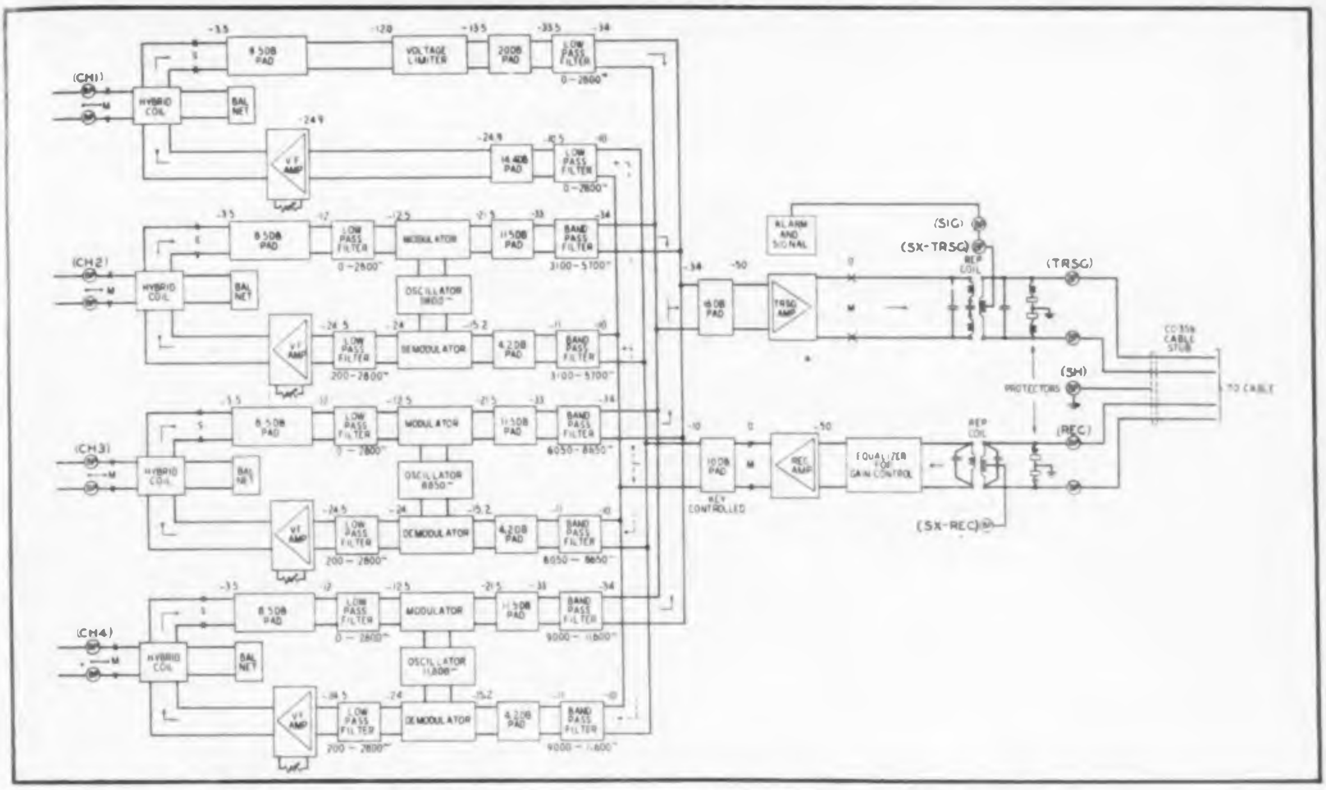
• In view of the fluid tactics used in modern warfare, caused primarily by the extreme mobility of our Armed Forces, advanced positions may be many miles ahead of the main body of the organization. This condition naturally precipitates a positive demand for some rapid and dependable means of communication. To meet this condition the Western Electric Company and Bell Telephone Laboratories in conjunction with the Signal Corps developed a carrier telephone system employing the new "spiral-four" cable assembly. The speed and simplicity of installation, and the ease of operation of this system are the principal achievements.

The system provides four telephone circuits of which one will be used for voice-frequency telegraph operation to obtain four full duplex telegraph circuits. In addition the system provides an alarm and signaling circuit, and a grounded dc telegraph circuit. Equipment used in the system comprises five types of units designated by the Signal Corps as Telephone Terminal CF-1-A (Carrier), Telegraph Terminal CF-2-B (Carrier), Repeater CF-3-A (Carrier), Ringing Equipment EE-101-A (Voice Frequency), and Carrier Hybrid CF-7. Various spare parts are supplied with the equipment, and the Signal Corps supplies such necessary auxiliary items as engine generator sets, storage batteries, telephone sets, tools, voltohmmeters and a limited quantity of replacement parts.

The spiral-four cable assembly is a four conductor type of cable with couplers at the junction points of the cable sections. The cable, which is manufactured in quarter-mile, 100 ft., and 12 ft. lengths, consists of four rubber or buna insulated

Block diagram of complete spiral-four carrier telephone and telegraph system showing equipment used to provide three telephone, four duplex telegraph, one alarm and one dc telegraph circuits on new four wire cable. Terminal repeater equipment housed in portable cases





Block diagram of circuit elements at each CF-1-A carrier terminal on equipment location spiral-four system. Channel 1 at top is straight voice frequency while remaining three channels have carriers of 5900 cps, 8850 cps, and 11,800 cps each with pass band of 2600 cps

stranded copper conductors twisted spirally to form a quad. The four conductors are wrapped with a shield of metalized paper, covered with a steel wire braid, and then encased in a heavy protective jacket of Neoprene. Each pair is made up of diagonally opposite wires of the quad: one pair of conductors serving to transmit in one direction, and the other pair in the opposite direction. Each end of the cable is equipped with couplers composed of a pair of male and female connectors, and a 6-millihenry loading coil which is connected to the pair of wires terminating in the female connectors. Thus, when two couplers are joined together, each pair has one loading coil at the junction point. The spiral-four cable is designed to withstand considerable abuse and can be laid on the ground, buried, or suspended aerially.

Carrier telephone terminals are required at both ends of the system, with intermediate repeaters at 25 mile intervals where the system exceeds a distance of 30 miles. There are four circuits provided by the carrier system with circuits designated as channels one, two, three and four. Each channel includes a transmitting and receiving branch which are combined at each terminal by means of a hybrid coil to form a two-wire circuit.

Channel one covers the voice-frequency band and channels two, three and four are shifted by modulation into the carrier-frequency range. Each circuit passes frequencies between 200 and 2800 cycles. The voice-frequency telegraph system will normally operate over channel three. Each telephone channel includes a low-pass filter in the voice-frequency circuit. For channel one the receiving and transmitting low-pass filters are the only ones employed, while in the three carrier channels, band-pass filters are required to select the required frequencies and suppress the others. An oscillator in each channel provides the carrier frequency supply for both the modulator and demodulator which are the copper oxide type arranged to suppress the carrier. In the modulator the carrier frequency combined with the voice-frequencies result in the production of upper and lower side-band frequencies. The upper side bands are suppressed by the band-pass filters while the lower side-bands enter the common transmitting circuit with channel one. Together with the voice-frequencies from channel one, the three lower side-bands from channels two, three and four are passed together through a two-stage feedback type amplifier having a gain over the band from 200 to 12,000 cycles of about 50 db. They then pass through a repeating coil, center tapped for the simplex, to the transmitting pair of the spiral-four cable.

In the receiving end of the system the common receiving circuit is associated with the incoming cable pair, and is provided with protection and repeating coil arrangements similar to those of the transmitting circuit. All four channel bands arriving at the receiving terminal are attenuated by the loss of the preceding cable and are amplified in the common circuit. The loss of the cable changes with frequency; therefore, the amount of gain required depends not only on the length of the cable section and the temperature, but also on the frequency. To provide a gain control which can be varied as required, a fixed gain single tube feedback type amplifier preceded by an equalizer consisting of four networks is employed. A dial control is provided for the adjustment of each network.

Repeater unit

Each carrier terminal is encased in a portable cabinet with removable front and rear covers. The terminal unit is approximately 5 ft. 6 in. high, 2 ft. 4 in. wide, and 1 ft. 7 in. deep, and weighs about 475 pounds.

The repeater unit, CF-3-A, has two amplifiers with associated gain-control equalizers, one for each direction of transmission. The amplifiers and equalizers are similar to those at the terminals and are adjustable in a similar manner. The repeater unit is mounted in a portable housing 2 ft. 10 in. high, 2 ft. 4 in. wide, and 1 ft. 2 in. deep, which weighs about 225 pounds.

Power supplies

The power requirements are supplied by 120 or 240-volt 50-60 cycle alternating current or 12-volt storage batteries for emergency operation in case of a failure of the regular ac supply or when no ac supply is available. The terminals require 60 watts of ac power; the repeater requirements are 30 watts. When the system is operating on storage batteries, the drain will be about 5 amperes at a terminal, and 2.5 amperes at a repeater.

Since a low frequency ringing current is not transmitted effectively by carrier systems, voice-frequency ringing equipment designated as EE-101-A is provided. This equipment is inserted in the telephone circuit between the switchboard or magneto set and the line. When the home end rings, the low frequency ringing current from the switchboard or magneto set causes the ringing equipment to transmit 1,000 cycle current, interrupted approximately 19 times a second, over the line. At the receiving end it causes low frequency ringing current to be sent toward the switchboard. Generally 60 cycle ac is used to ring bells or operate switchboard signals, however other low frequency ringing current can be used when available. The ringing equipment is a self-contained portable unit 21¼ in. wide, 14¾ in. deep, and 11⅝ in. high, and weighs about 95 pounds.

The voice-frequency telegraph equipment designated as CF-2-B was designed primarily for operation over a channel of the 4-channel telephone system, and usually is connected to the two-wire terminals of channel three. When necessary, voice - frequency telegraph may be operated over more than one channel.

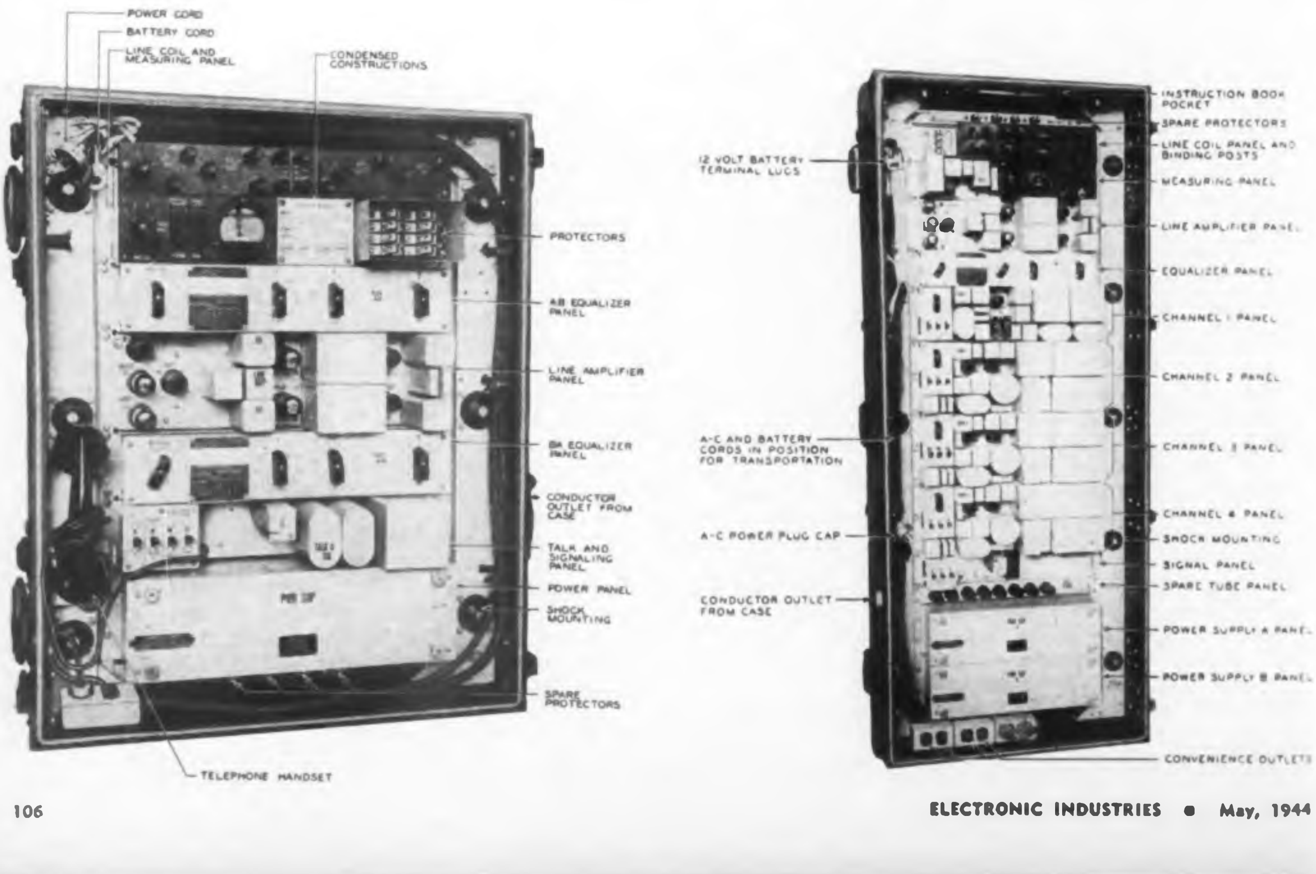
Telegraph methods

At the transmitting end of the telegraph system, the signals received from the four dc telegraph circuits connected to the telegraph terminals are converted to voice frequencies; while at the receiving end, these voice frequencies are reconverted to dc telegraph signals in the respective four connected circuits. Different carrier frequencies are employed in each direction of transmission for each telegraph channel. The terminals for the two ends of the telegraph channel are alike and are convertible by means of a switch to either direction. The terminals are housed in a portable cabinet with removable front and rear covers. The unit measures 5 ft. 6 in. high, 2 ft. 3½ in. wide, and 1 ft. 7 in. deep, and weighs approximately 560 pounds.

The carrier hybrid designated as CF-7 is a unit for connecting a two-wire line to either the telephone terminal CF-1-A or a repeater CF-3-A, both of which are designed for four-wire operation. The unit is used to particular advantage where telephone lines in battle areas are still intact. With this equipment four 2-way telephone circuits can be obtained over a single pair of wires. In addition, two grounded dc telegraph circuits or a dc signaling circuit and one dc telegraph circuit may be operated over the pair. In place of one of the telephone circuits four voice-frequency telegraph channels can be made available by applying telegraph terminals at the telephone terminals. The unit is suitable primarily for open-wire lines but has been adopted for use with the spiral-four cable assembly. The unit is housed in a portable case 18⅜ in. long, 9½ in. wide, and 7⅜ in. deep, and weighs approximately 48 pounds.

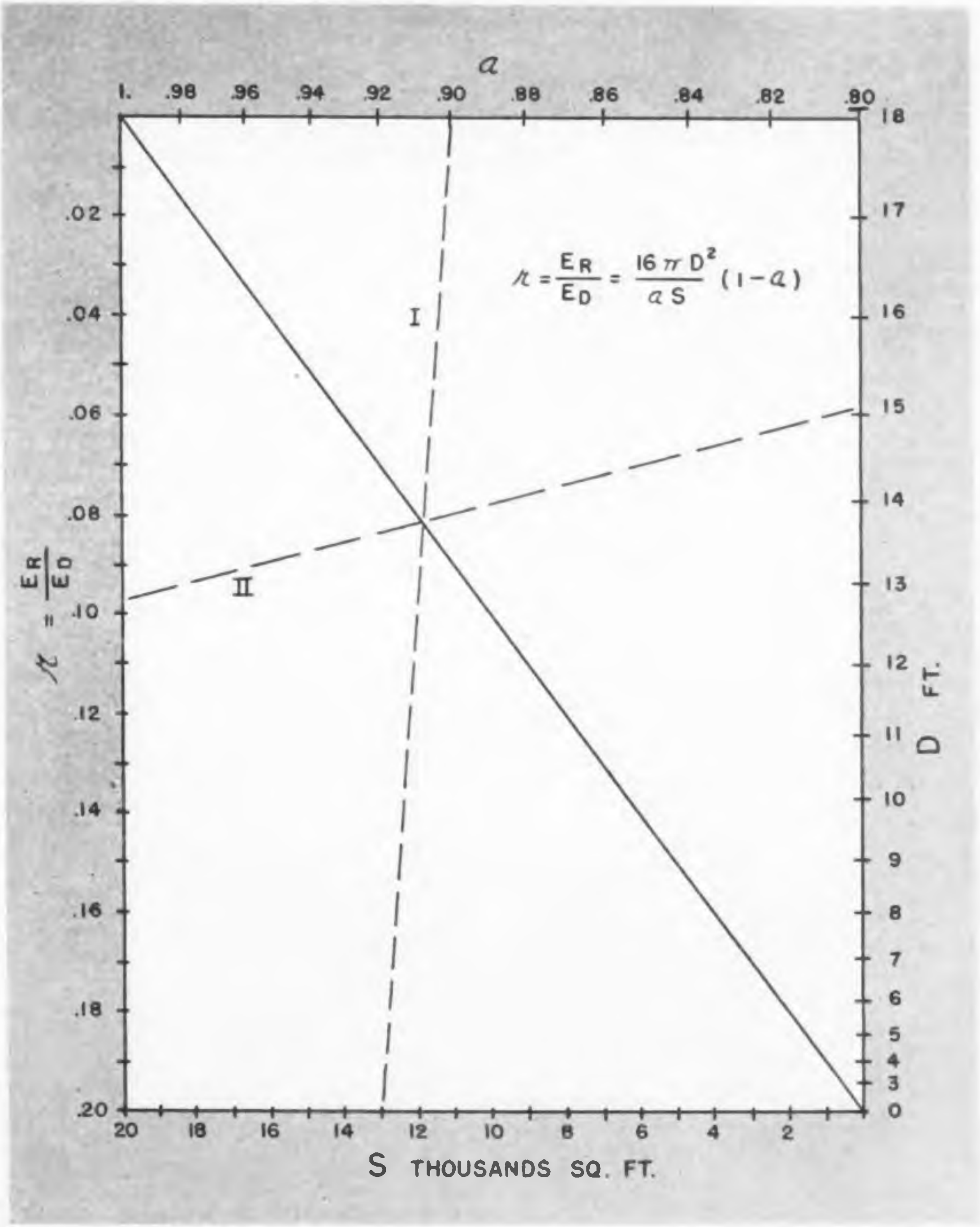
All of the equipment was designed to withstand critical climatic conditions and severe physical abuse. Field tests have proven conclusively that the system is dependable and meets the rigid trials of our present global war.

Spiral-four system repeater at left and carrier telephone terminal unit at right. Protective covers on both units removed. Note carrying handles



REFLECTION OF SOUND

by CARL P. NACHOD



A formula for the ratio (r) of the energy density E_R of reflected sound to E_D, that of the direct sound appears on the nomogram above.

The nomogram above is made for the graphical solution of this formula by drawing two intersecting lines upon it, connecting the factors involved in a particular problem. For example, if (a) the coefficient of sound absorption is taken as 0.9; (D) the distance from the source to the observation point, is 15 feet, and (S) the area of absorbing material, is 13,000 square feet, then (r) is .0967.

The four boundary scales of the nomogram are in parallel pairs, and originate at the ends of the ungraduated diagonal. If any three of the four quantities (r), (a), (D) and (S) are given, then the fourth may be found by drawing two lines intersecting at a common point on the diagonal.

Thus to find (r) computing secant I is first drawn, from (a) to (S) at their respective given values, which intersects the diagonal; and then secant II is drawn from (D) through this intersection and continued to the (r) scale, which it cuts at the required value.

Beryllium-Copper Springs

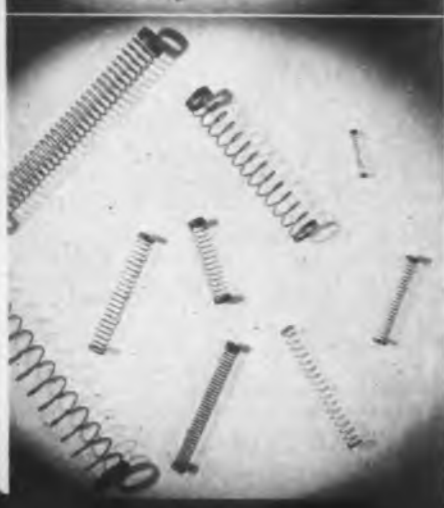
by SHELDON C. KLOCK
Field Engineer, Instrument Specialties Co., Inc.

Production control methods necessary in applications of beryllium-copper in electric equipment

● Heat-treatable beryllium-copper provides an entirely new combination of properties for important applications in electronic equipment. It is not only as non-magnetic and corrosion resistant as brass or phosphor bronze, but it is also nearly twice as strong. It has endurance strength nearly equal to steel, even higher under corrosive conditions. Its electrical conductivity is twice that of bronze, and it will maintain spring properties under temperatures 100 deg. F. higher than bronze. In addition, it has less tendency to drift or take a set than any other spring material, an important property in many electronic applications.

Since it is hardened by heat-treatment after forming, beryllium-copper springs can be made in forms and shapes impossible to duplicate in any other corrosion-resistant alloy. The use of heat-treating jigs or fixtures permits closer tolerance and greater uniformity of spring action than can be obtained with any other spring material.

Beryllium-copper flat springs are used for long life, high strength, better conductivity and corrosion resistance. Dynomotor brush springs, below, increase brush life



Control essential

In spite of its advantages, beryllium-copper made little headway in the field of electronic equipment for five or six years after its introduction in 1932. Designers tried to use the material, but many of these early attempts were not successful because they were made without a full understanding of its limitations. The early promotors did perhaps expect too much and it was introduced as a general purpose alloy which would become the designer's panacea. Its real potentialities for specific types of applications suffered because of insufficient knowledge of the relations which exist between mill control and fabricating practice. Certainly, it was not generally appreciated that special annealing in the mill, and carefully controlled time and temperature for hardening heat-treatment, were required to obtain peak properties; that special fabricating and coiling equipment was essential to avoid excessive distortion during the hardening heat-treatment.

Because of a better understanding of the foregoing factors, and the development of specialized processing methods, beryllium-copper has today become an important spring material for electronic equipment.

Designers were often stymied because of two major difficulties encountered. First, the response to heat-treatment varied from lot to lot. No single standardized or "compromise" heat-treatment could be relied upon to give uniform results. The answer to this problem was obvious and fortunately simple: heat-treatment of each lot for the time and temperature required to obtain best properties, on the basis of hardening response tests. The second problem encountered was distortion during hardening. Attempts to eliminate distortion by reducing the heat-treating temperature or time resulted in the loss of expected spring properties. Again, a simple answer was found in the use of jigs or fixtures to hold the parts during hardening.

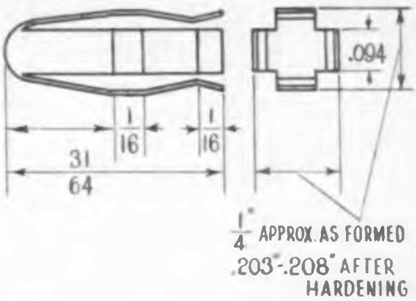
Although the answers to the above problems were simple, and relatively easy to accomplish, the manufacturers of beryllium-copper alloys may have originally felt that many potential customers would become discouraged and disinterested if they were told that this material required "special handling" if optimum properties were to be obtained. Consequently, the raw material suppliers recommended heat-treating temperatures in the range of 550 to 600 deg. F., for periods ranging from one to two hours. These temperatures are considerably below those usually required to obtain the best spring properties. These heat-treatments were recommended because the variation in hardening response between different lots of material was less noticeable than at higher temperatures and there was less danger of over heat-treating through inaccurate control. Higher temperatures are particularly desirable where precision heat-treatment is required, because at these temperatures heat-treat forming is more effective, proportional limit and endurance strength are higher, and drift is minimized. In addition, the required time at temperature is greatly reduced, with a lower resultant heat-treating cost.

The answer developed at Instrument Specialties for the solution of these problems in production is "Micro-processing" which involves four steps: (1) Each lot of raw material is tested for heat-treating response before fabrication; (2) Fabricated parts are hardened at the one combination of time and temperature which insures best properties for the lot of material from which they were formed; (3) Heat-treating jigs and fixtures are used to obtain closer tolerances; (4) Continuous inspection throughout the processing procedure insures parts meeting final specifications.

When drift testing was found to provide the most sensitive method of determining the proper heat-treating time and temperature, the electronic micrometer was developed for this service. From this instrument came the "Micro" in Micro-processing. Variations in the alloy as supplied today still offer some problems, but methods of testing the material are available which will predict accurately the spring performance obtainable from any lot of material. If the performance is not up to requirements, these tests will also identify the faulty mill procedure responsible for the deficiency.

So, today beryllium-copper is taking on vital jobs in electronic components that no other spring alloy can perform. Here are some typical examples:

The lowly "banana plug" contact spring is a good one. Note in the accompanying drawing that the nose of the spring is deeply drawn to provide the rounded end needed for easy insertion in the socket. To stand this deep draw the metal must be soft, too soft to permit its having good spring properties in the legs. With beryllium-copper the desired spring characteristics are obtained by heat-treatment after forming, using heat-treating jigs to hold the one critical dimension to a precise tolerance. Adjustment of heat-treating time and temperature to the exact needs of each lot of material results in uniform spring properties, and the short time cycle at the higher heat-treating temperatures reduces the tendency to drift or take a set and also cuts the cost of these advantages. The process results in freedom from service failure under extreme conditions which often include severe vibration and high temperatures, greater uniformity of pull-out tension, high electrical conductivity, and far longer life than could be obtained with any other alloy.



Beryllium-copper banana plug spring is formed from annealed strip and given desired spring properties by hardening after forming. Critical dimensions are held by fixture during the heat treating period

Numerous recent improvements in springs for other electronic applications include better operating characteristics plus simplified design made possible by the use of beryllium-copper. The high strength of this alloy together with its high electrical conductivity permit the design of smaller and lighter parts, an important factor in airborne equipment.

Brush springs for dynamotors offer another example of the intelligent use of beryllium-copper. These machines convert low-voltage dc power to high-voltage ac for operating electronic equipment. Since the failure of the brush spring will shut down the power supply, it is essential to have springs that will hold up under all service conditions. Phosphor-bronze was formerly the accepted material for brush springs, but high service temperatures, space limitations, and the necessity for longer brush life in modern high-performance light-weight dynamotors required a more efficient spring material. "Micro-processed" beryllium-copper safely withstands a temperature 100 deg. F. higher than bronze and offers several other important advantages.

Heat-treat forming holds the coil diameter to such close tolerances that the reduced diameter or "necked-down" end can be eliminated. This permits a larger diameter brush neck which is stronger and has more available room for at-

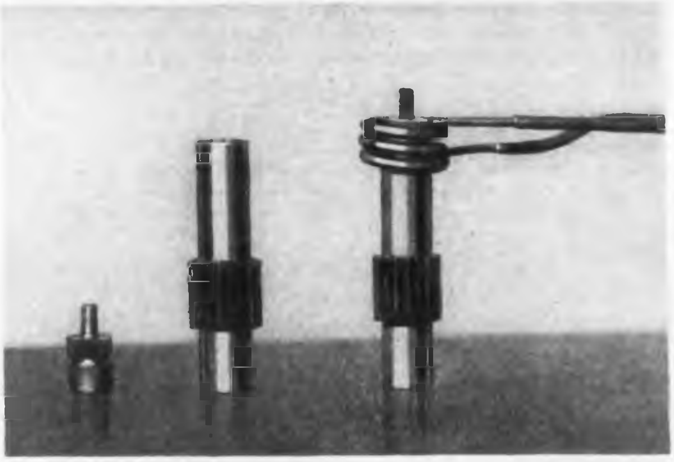
(Continued on page 282)

Automatic recording electronic micrometer, designed and built at Instrument Specialties Company, to study drift in beryllium-copper springs. Essentially a piece of electronic equipment, this laboratory instrument detects, measures and records drift effects in springs where such deviations may be as small as one-millionth of an inch

CASE-STUDIES OF TYPICAL

Survey of practical industrial problems point out methods and equipment requirements for satisfactory results

STEEL PIN BEING ZONE-HARDENED IN OIL BATH. (Top right). One end hardened to R 55 C. Top surface of collar is also hardened to a very slight depth but rest of collar and shank remain soft. Results excellent as proved by mounted etch. No distortion noted. Pins are hardened to 55 Rockwell C in two seconds by induction heating.



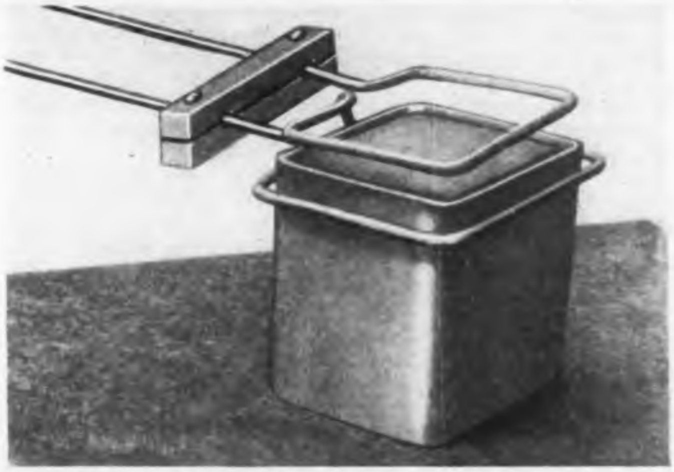
BRAZING PLUG TO SHAFT OF SCAVENGE OIL PUMP. (Center). Shaft: AMS 6250 steel 3/4 in. x 4 in. Plug: AMS 6335 steel 3/4 in. x 1/4 in. Test set-up: Induction heating used Handy-Flux and Easy-Flo silver soldering. Ring of solder placed around shaft. 3-turn coil of 1/8 in. tubing/ 1 in. O.D. form. 3/4 in. vertical length. Bottom of coil even with center of heated section. Power input: 1400 watts. Time: 30 seconds. Results: Satisfactory; brazing accomplished evenly and smoothly in minimum of time.

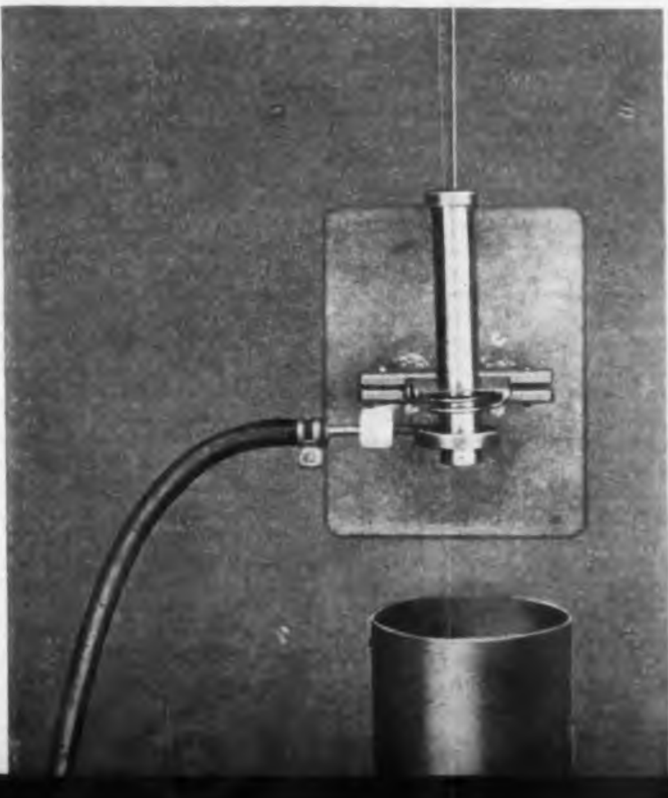
TO HARDEN CAM SURFACE BY INDUCTION HEATING. (Below right). Time: One second. Results: Cams were file tested and found a good wearing surface to a depth of .015 in.

BRAZING CAP TO STUD, LEAKTIGHT TO WITHSTAND 20 PSI PRESSURE. (Below left). Stud: 1½ in. x 3/32 in. Cap: ½ in. x ¼ in. Test set-up: Induction heating used Easy-Flo silver solder ring around stud. 3-turn coil of .06 in. tubing. Power input: 838 watts. Time: 22 seconds. Results: Satisfactory; smooth, even soldering able to withstand required pressure.

These solutions to typical production problems were prepared by the Industrial Electronics Division, Federal Telephone & Radio Corp. (IT&T associate), Newark, N. J., using Megatherm heating process.

INDUCTION HEATING JOBS



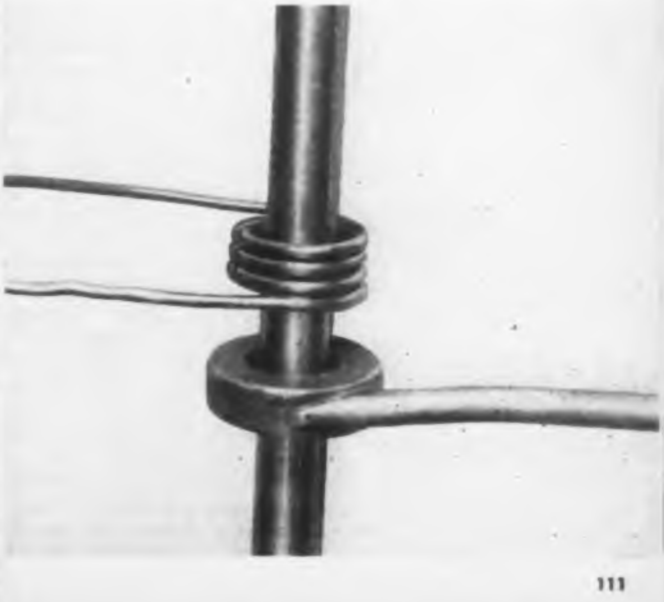


SURFACE HARDENING DIES WITH A CONTINUOUS SCANNING PROCESS. (Top left). Die moves at a rate of 9 in. per minute. Principal bending edges of the bending die are hardened to 55 Rockwell C and better. A water quench is applied to the heated steel immediately after passing under the coil.

SOFT SOLDERING LIDS TO CANS. (Center). Rectangular tin transformer cans and lids; $2\frac{7}{8}$ in. x $2\frac{1}{4}$ in. Test set-up: Induction heating 2-turn coil $\frac{3}{8}$ in. apart. Time: 7 seconds. Power input: 1640 watts. Results: Satisfactory; lids were soldered to cans smoothly and evenly.

TO CONTINUOUSLY CASE-HARDEN 1 in. DIAMETER STEEL RODS. (Below left). Hollow tail wheel bolt steel SAE 4140, core metal; 53-54 Rockwell 30N; 1 in. diameter. Test set-up: Induction heating using 25 kw standard unit. Rod travels through coil at rate of .625 in. per second. 2-turn coil of .125 in. tubing. Quench attached directly below coil sprayed water at rate of 1 ga. per minute. Power input: 47 kw. Results: Satisfactory; rod case-hardened to 77 Rockwell 30 N; .025 in. case depth.

CONTINUOUS SURFACE-HARDENING. (Below right). Procedure: $\frac{1}{2}$ in. rod case-hardened by continuously moving through an induction heating coil. Steel: Drill rod. Case depth: .010 in. Hardness case: 64-65 Rockwell C. Scanning speed: 3.2 in. per second. Power: 21 kw output. Quench: Continuous water spray as rod left coil.



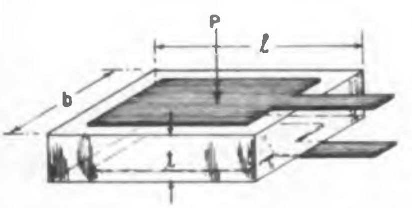
Process CONTROL METHODS

by RALPH R. BATCHER
Consulting Editor, Electronic Industries

Part IV—Basic transducer systems for conversion of mechanical effects into electronic control impulses

● In this survey of devices used in the conversion of physical movements into electrical quantities for industrial measuring purposes, one of the most frequently used methods utilizes the piezo-electric effect, such as is found in natural quartz and certain other crystals. Quartz occurs as a crystalline aggregate, as individual crystals of the hexagonal system, or as broken fragments from normal crystals. Although quartz occurs in regular many-faceted crystals, it has no definite lines of cleavage and breaks into irregular masses. When a crystal is strained, dielectric polarization occurs, depending on the magnitude and direction of the pressure with respect to the crystallographic axes. This results in electrical charges appearing on electrodes attached to the surface.

The direct piezo-electric effect results when the plate is compressed in a direction parallel to the X-axis as in Fig. 1, whereupon the resulting polarization induces equal and opposite potential charges on the faces. The converse effect results when the plate is polarized by an external electric field, whereupon an expansion in the X-axis direction results. Tension along the Y-axis produces the same polarities as pressure on the X-axis, and X-axis tension or Y-axis pressure will produce reverse polarities. Pressure or tension along the Z-axis (that extending lengthwise through crystal parallel with the normal hexagonal faces) produces no electrical effects. These effects are reversible—electrical potentials applied to the X- and Y-axes contract or expand the crystal.



Y = YOUNGS MODULUS = 7.85 10⁸ FOR X CUT.
E = CHARGE
P = PRESSURE IN DYNES
C = PIEZO-ELECTRIC CONSTANT = 6.36 X 10^{-8}
K = DIELECTRIC CONSTANT = 4.5 FOR QUARTZ

Fig. 1—Simple piezo-electric generator develops voltage across surface electrodes when force is applied

Voltage and pressure

In the measurement of small displacements the natural frequency of the crystal is not utilized, operations being conducted at a much lower frequency. However, it is not possible to compute, with accuracy, just how much voltage is developed per unit of force or per mil deflection, since the effectiveness of the charge generated is applied to the whole external capacitance of the circuit. Thus an actual calibration of any convertor unit is necessary.

Fig. 1 shows a piezo-electric generating system where electric charges are generated by the continuous changes in the deformation of the crystal. As in the case of crystals used as standards of frequency, the shape is in wafer form. The capacitance of the combination —the electrodes spaced by the quartz (with a dielectric constant of 4.5), and that of the cable and the attached circuits must be charged by the potentials generated by the crystal.

The output of a given crystal may be computed on either the basis of pressure applied to the face, or on the relative displacement of the faces. These two systems give equivalent results if Young's modulus for the crystal is known. Young's modulus is a number that represents the ratio between the force per unit cross-section of a material and the elongation per unit length. In each case the unit used is the centimeter, and the force is in dynes. However, as mentioned above the effect of shunt capacitance and the discharge path through the measuring circuit path prevents the computation of an output constant useful for measurement purposes. For comparison purposes, however, consider the crystal, Fig. 1, and let $b = l = 1$ in.; $t = 0.1$ in.; Pressure 1 kg. $= 9.81 \times 10^5$ dynes; C = piezo-electric constant, and k = the dielectric constant of the quartz.

$$E = \frac{4\pi t\,CP}{k\,b\,l}$$

$$= \frac{4\pi\ .1 \times 6.36\ 10^{-8} \times 9.81 \times 10^5}{4.5 \times 1 \times 1 \times 2.54}$$

$= 0.00685$ E in cgs units $= 2$ volts

It will be noted that in order to get a large potential, it is desirable to decrease the area and increase the thickness of the crystal. By using a quartz bar one-half inch square and 2 inches long would give a 4×20 or 80 fold increase in voltage or a 160 volt output.

Rochelle crystals

The greatest piezo-electric effect so far noted has been with crystals prepared from Rochelle salts (sodium potassium tartrate) $NaKC_4H_4O_6 — 4H_2O$. When this salt is crystallized, it forms a large hip-roof shaped slab, which is later sawed up into rectangular plates, not unlike quartz crystal plates, but generally with less area. The sawing, however, is much easier and can even be done by a fast-moving wet string! Thickness and orientation accuracy requirements are missing since these crystals are not used as standards.

Wafers are usually cut from Rochelle salt crystals with their edges at a 45 deg. angle from the

FOR INDUSTRIAL USES

axes along which the piezo-electric effect is most prominent, as in Fig. 2. Here the outline of a typical Rochelle crystal is shown, as it is "grown" for the purpose from a solution. These crystals usually weigh many* pounds. The plates may be cut from wafers with faces parallel to the floor of the prism or in a plane at right angles to this face. If they are of the same size, two crystals may be cemented together with their edge dimensions combined so as to reverse the axes with respect to each other. Plates cut as at (a) are most sensitive to pressure on the face; cut as at (b) to pressure on edges; cut (c) to pressure 45 deg. from its thickness dimension. The latter is used for torsional stresses. The other cuts are used for pressure or bending studies.

Both torsional and bending strains can be measured using 45 deg. crystals mounted 90 deg. to each other and 45 deg. to the direction of strain. Bending strains are obtained by connecting the electrodes so that the charges are parallel-aiding. For torsional strains they are connected so that bending effect charges are neutralized leaving the torsional effects.

Bimorph crystals can be produced by cementing two of the above crystals together so that a single bending, torsion or compressional force produces a single output potential. The results are sometimes easier understood by studying the crystal expansion with applied fields.

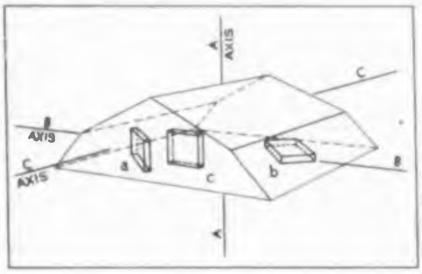


Fig. 2—Rochelle salt crystal exhibits greatest piezo-electric effect along axis 45 deg. from B and C perpendicular to A

When a "b" cut crystal is placed in an electrical field one diagonal expands and the other contracts. It is seen that although an altered shape occurs, the crystal remains flat.

In use two such crystals are cemented together, either back-to-back or else with each stated axis at right angles to the same axis on the opposing crystal. In either cases the effect is for the combination to warp, much like a bimetallic thermostatic plate does when heated, with this exception: the bimetallic plate becomes saucer-shaped with all corners turning up or down at the same time, whereas the Rochelle crystal plate has two corners (across a diagonal) which turn up and the alternate pair (across the other diagonal) which turn down. Thus crystals can be arranged to twist, bend, etc., as desired.

If a bimorph crystal is warped by force, an electrostatic charge appears across metallic foil electrodes placed on its surfaces. In many units, one electrode is the central "sandwiched" foil between crystals, and the other is the two outer surface foils connected together. This is the effect utilized in microphone and vibration pickup units, the force being applied by sound waves or by direct contact.

Depending on the application, considerable vibrations in the size of crystals have been used. For example, for use as a geophone for measuring earth noises and ground waves in mining operations, a bimorphic crystal 2½ in. long, ¾ in. wide and ¼ in. thick is mounted as a cantilever in a steel tube 1¼ in. in diameter. This form of mounting therefore is of the inertia type, giving an output proportional to acceleration. In the usual vibration pickup and microphone design, extremely thin crystals are used. They are cemented back-to-back and have only a fraction of an inch of area.

In making a vibration test or a measurement of a displacement, it has been seen that numerous operating principles can be utilized. Their principal characteristics have been summarized in the table, Fig. 3. It is not possible to make a direct comparison of these units, at least as to their relative output. However, all of them will operate an amplifier which makes the actual voltage output of less im-

Fig. 3—Comparison of control systems and pickup characteristics for conversion from mechanical to electrical effects

SYSTEM	PICKUP UNIT	OUTPUT	TEMPERATURE COEFFICIENT	DIRECTIVITY	TEST*	SENSITIVITY (TYPICAL UNITS)	COMMON USES
Oscillator	Capacitor	Freq. shift	Small	Good	Static, (Dynamic)†	10^{-6} in. to	Pressure, Temperature, Displacement, Stress, Torque, Thickness, etc.
Oscillator	Inductor	Freq. shift	Small	Good	Static, (Dynamic)†	several inches	
Magnetic	Reluctance	Phase shift	Small	Good	Static, Dynamic	-	Thickness gaging of metallic material
Magnetic	Reluctance	AC voltage	Small	Good	Static, Dynamic	For displacements of 0.0001 mil to 0.01 in.	Thickness gaging of material, Vibrations, Torque, Stress, Acceleration, Pressure, Temperature
Magnetic	Reluctance	DC voltage	Small	Good	Dynamic	For accelerations of 0.0001 G to 70 G	
Resistance	Strain Gage	Resistance	Small	Good	Static, Dynamic	$\Delta R/\Delta L$ = K (ohms/mil) value of K ranges from 0.1 to 30 or more.	Dynamic or fixed structural loads torque, thrust, tension, strains due to vibrational resonance.
Resistance	Strain Gage	Current	Small	Good	Static, Dynamic		
Resistance	Strain Gage	Voltage	Small	Good	Static, Dynamic		
Piezo-electric	Quartz	Voltage	Small	Good	Dynamic	-	Fluid and gaseous pressure, 1 to 15,000 psi.
Piezo-electric	Rochelle Salts (displacement)	Voltage	large	Fair	Dynamic	$E = 35 \times D \times F^2$ (volts, mils, kilocycles)	Vibrational displacements at rates greater than a few cycles/sec.
Piezo-electric	Rochelle Salts (Acceleration)	Voltage	large	Poor	Dynamic		Acceleration, and velocity of vibrations.
Electronic Micrometer	Contactor	Indicator	Small	Good	Static	10^{-6} in. or over.	Thickness gaging.

*Static tests will handle fixed displacement measurements. Dynamic tests involve vibratory movements only.
†Dynamic measurements involve conversion of frequency modulated signal.

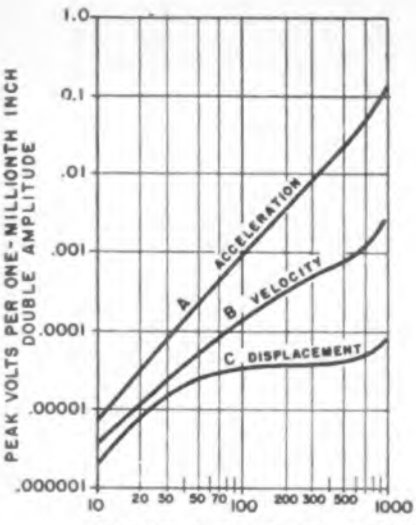


Fig. 4—Conversion curve for type 61B vibration unit (Shure). Curve A with 3 megohm load, B with a 3 megohm—.003 mf integrating stage, and C with two of these integrating stages in cascade

portance. The differences in output characteristics are of more moment, since conversion is less easily accomplished. While it is true that displacement and velocity indications can be derived from acceleration units, still there is but a limited frequency range over which such a conversion is linear (see Fig. 4). Normal frequency characteristics of several commercial piezo-electric pickup units are shown in Fig. 5.

From these curves it is evident that the increased sensitivity at the higher frequencies may give false impressions as to the magnitude and importance of vibrations that might occur in that range. If the only problem is to get rid of noise, it is probable that high pitched tones are more obnoxious and a simple acceleration unit might give fair qualitative evidence. On the other hand in order to reduce vibration for increasing efficiency and life, tests with such a unit may prove futile.

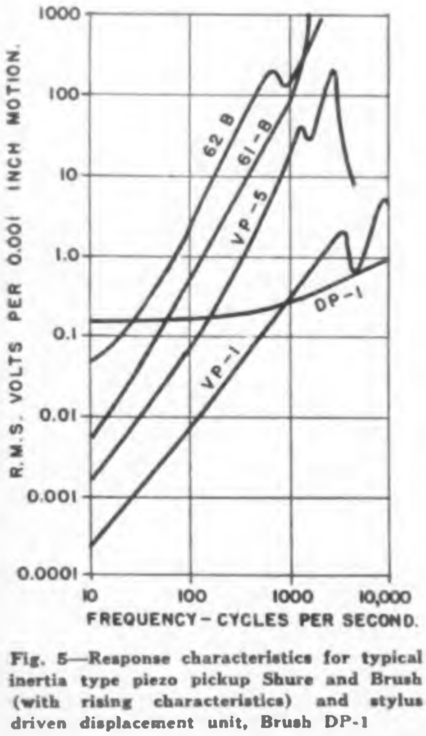


Fig. 5—Response characteristics for typical inertia type piezo pickup Shure and Brush (with rising characteristics) and stylus driven displacement unit, Brush DP-1

Crystal pickups of the inertia type are not directive, and vibration in any direction will generate a voltage. It will be found that it is possible to produce a voltage when the probe of such a unit is applied at any angle to a vibrating body, even when the latter is known to vibrate only in a single direction. This is not entirely true with many of the inertia-type magnetic units, since the latter have guiding springs which restrain the movement to a single direction, as in Fig. 6, which shows the type RA-355 Western Electric vibration pickup, with and without its case.

Here the moving coil is wound on a cylindrical drum which is supported by a double-spring assembly, highly flexible longitudinally to the coil and stiff to lateral or radial motion. The unit may be used in any plane without effect on the calibration. The structure carrying the coil is supported in the gap of a strong radial permanent magnet field. The lightweight coil assembly is caused, by inertia, to move with respect to the field assembly when the pickup is vibrated. The extreme lightness of the moving coil system permits damping by magnetic generation of eddy currents in the drum on which the coil is wound.

The light coil and spring assembly, together with the magnetic circuit which forms the base of the unit, have a total weight of only 6 ounces. Its size is approximately 2 in. by $2\frac{15}{32}$ in. by $1\frac{3}{32}$ in. It has a sensitivity of approximately 100 microvolts (open circuit) per mil per second velocity. Maximum exciting amplitude, 0.080 in. double amplitude.

As described in Part III, this unit is bolted to the part under study, which may be floors of a building, a wing of a plane, automobile body, or on a motor or engine. The whole unit thus vibrates except that the flexibly mounted coil which lags behind on account of its own inertia. The flux rate of change that induces the voltage in the coil is thus dependent on the velocity at which the field moves past the coil —expressed above as mils per second (a mil is 0.001 in.).

In vibration tests confused results are sometimes obtained when hand-held units are used, since the machine as a whole may move so the output voltage includes that caused by the instantaneous sum of the movement of a vibrating item (say the armature) with respect to the rest of the bulk, plus that due to the movement of the whole machine with respect to the outside fixed point. In vibration tests, either one effect or the other may be wanted, but not both.

Magnetic units are of low impedance, and they can be mounted at some distance from the amplifier, like any moving coil type microphone.

This is convenient in some cases, since a standard high-quality voice frequency amplifier can be effectively utilized in vibration tests. High impedance units must be protected from leakage and the capacitance of the connection leads

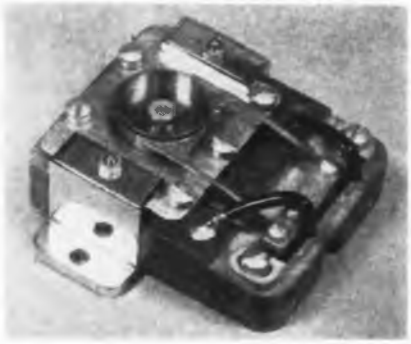


Fig. 6—Western Electric RA-355 vibration pickup with cover removed (above). Combines high-directional sensitivity and wide frequency range

must be considered. With the latter, the pickup of static effects is greater. It is sometimes found that a pseudo-piezo effect in rubber cable insulation, caused by movements of or pressure on the rubber cable's insulation, will show up.

When it comes to obtaining useful analytical and control results, the problem, of course, requires much more than the selection and application of a displacement converter or pickup. While an amplifier and a suitable indicating or recording instrument, calibrated to show absolute movements, may be all that is required in many cases, still the discriminating engineer

(*Continued on page* 294)

TUBES IN METALLURGY—II

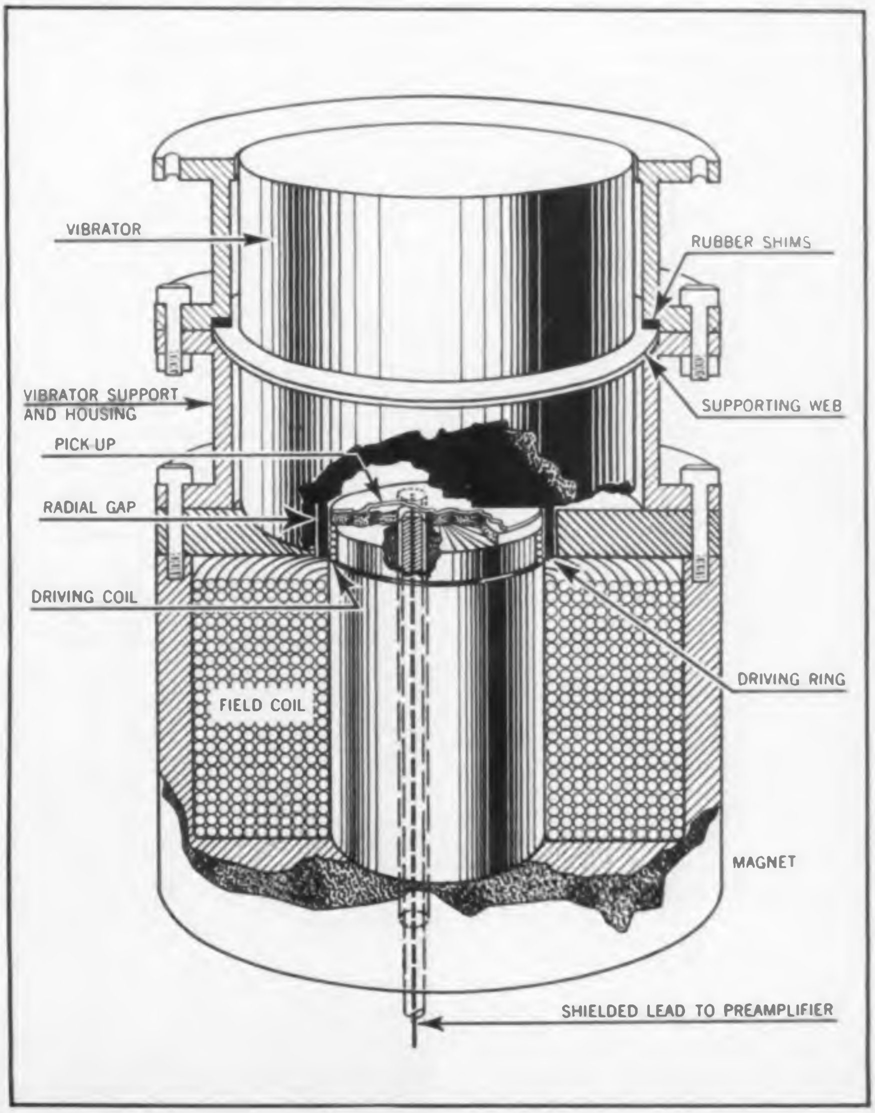
by E. V. POTTER
U. S. Bureau of Mines

Details of sonic flocculating apparatus, magnetic property analysis and chemical measuring equipment

• Sonic and ultrasonic waves of high intensity produce many peculiar effects, and their influence on the deposition of metals in electrolytic processes, and the degassing of metal melts has been the subject of much study. The fact that sonic waves will cause flocculation of solid materials suspended in gases was known many years ago, and the use of sonic waves for the recovery of suspended solid and liquid matter from smokes, fumes, and other aerosols has probably progressed further than the other applications. A special sound generator was developed for use in this work.

The sound generator[1] consists essentially of a vibrating member, an electromagnetic driving system, and an electrostatic pickup plate; a cross-section of the generator is shown in Fig. 1. The vibrating member of this generator is a solid duralumin cylinder supported at its midsection by a thin web which is an integral part of the cylinder. The cylinder is free to vibrate longitudinally as a free-free bar; the force producing the vibrations originates in a driving ring on one face of the cylinder. This ring is also an integral part of the cylinder. The driving mechanism consists of a pot magnet with a circular air gap, into which the driving ring fits, and a driving coil wound on the inner face of the air gap. The current to drive the vibrator passes through this coil and, by transformer action, induces a current in the driving ring. The interaction of this induced current with the radial magnetic field in the air gap of the pot magnet produces the force on the driving ring. The electrostatic pickup plate on the center pole of the pot magnet does not contribute directly to operation of the generator but provides a means for controlling the vibrations. It is insulated from the magnet structure, and a connection is brought out through a hole in the center pole piece. The capacitance between this plate and the vibrator will vary with the motion of the vibrator; by suitable means, this capacitance change can be made

Fig. 1—Sound generator consisting of vibrator piston driven by currents induced into driving ring by stationary driving coil located in annular gap. Pickup plates and vibrator form capacitor microphone for feedback



[1] St. Clair, Hillary W., Sonic Flocculator as a Fume Settler: Theory and Practice, Bureau of Mines R. I. 3400, 1938, pp. 51-64; An Electromagnetic Sound Generator for Producing Intense High-Frequency Sound, Rev. Sci. Inst., Vol. 12, May 1941, pp. 250-6.

to produce a voltage whose amplitude, frequency, and phase are determined by the motion of the vibrator.

The force on the driving ring will be proportional to the product of the current induced in the driving ring and the strength of the field in the air gap of the pot magnet; it will also be in phase with the current in the driving ring, which current will be essentially 180 deg. out of phase with the current in the driving coil. At its resonant frequency, the cylinder will have its maximum velocity of motion which will be in phase with the driving force. For frequencies above resonance the velocity will lag, and for lower frequencies the velocity will lead. The same relative condition is true of the amplitude, except that all are displaced in phase by a 90 deg. lag. The variation of velocity and amplitude with frequency is very great near resonance, and to maintain the amplitude of the vibrations near the maximum it is necessary to maintain the driving frequency within ± 0.2 cycle per second of the true resonant frequency. This is not as simple as it might seem because the dimensions and elastic constants of the vibrator change with temperature and the frequency may change as much as 100 cycles per second between its initial value and its value after operating for an hour.

Feedback circuit

The driving system devised for operating these vibrators is shown in a block diagram, Fig. 2. Here the capacitance change in the pickup plate is converted in amplifier (1) into a potential and amplified sufficiently to drive amplifier (2), which in turn supplies the power to drive the vibrator. The actual motion of the vibrator will vary with its acoustical load, and thus the voltage generated by the pickup will vary. It is necessary, however, to maintain a substantially constant power input to the vibrator driving coil. Also, the phase of the driving current must be correct relative to the vibrator motion to maintain the maximum amplitude of vibration. Thus, the phasing amplifier (1) was designed with an automatic gain control and a phase-shifting circuit so that a constant-output voltage could be maintained over a wide range of input voltages, and the phase of the output voltage can be changed through nearly 360 deg. relative to its input voltage. The diagram of this amplifier is shown in Fig. 3. The automatic gain-control circuit includes the 6C6 and 6H6 tubes which control the bias on the two 6D6 tubes. The phase-control circuit consists of the resistors

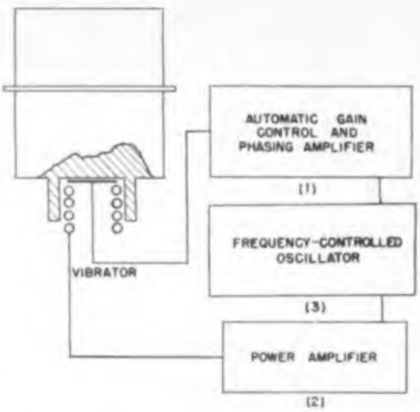


Fig. 2—Block diagram of self-controlled sonic generator using transducer in Fig. 1

and capacitors in the bridge circuit at the grid of the last 6D6.

With this driving arrangement the driving frequency always remains at its optimum value when the phase has been properly adjusted. It has several disadvantages in that the circuit either oscillates or is completely inoperative, in which case an external source of voltage must be used to drive it instead of the voltage from its own pickup.

Fig. 2 also shows an alternate driving system which has been used, containing an additional frequency-controlled oscillator circuit (3). The oscillations generated in this unit are amplified to drive the vibrator and do not depend on the

Fig. 3—Preamplifier with automatic gain control and phase-shifting network. Resistor values in kilohms. Output is coupled to frequency correction circuit at right

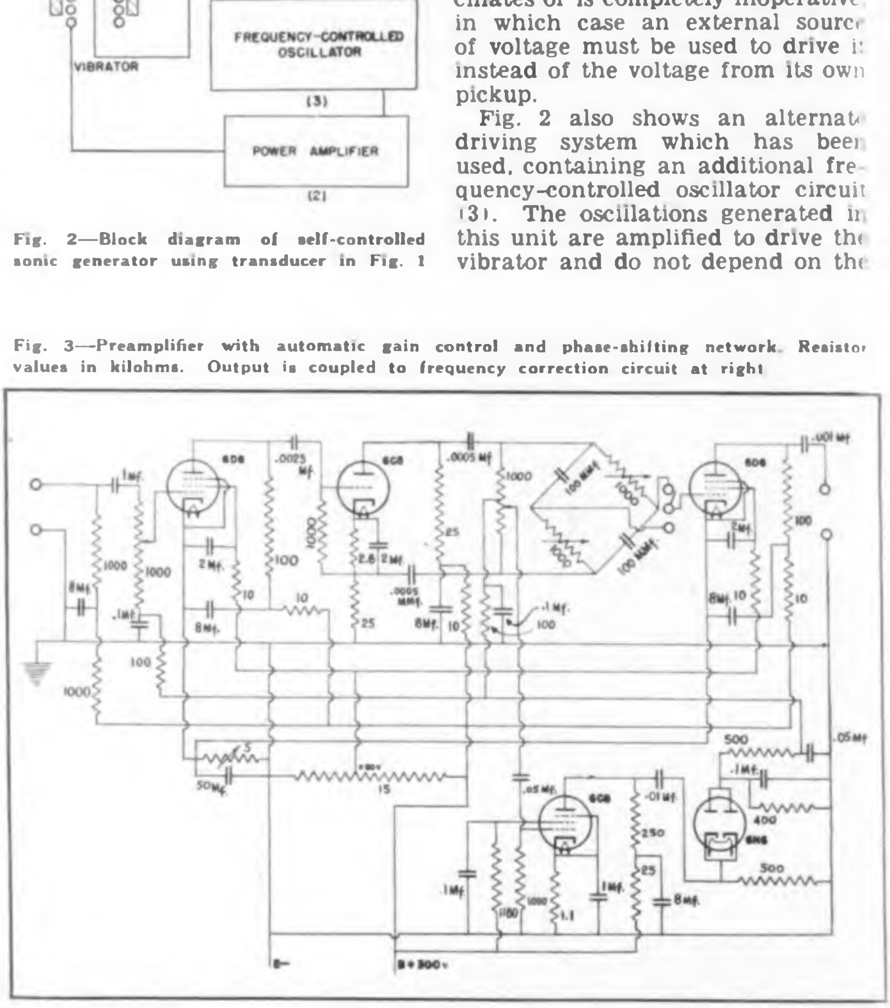
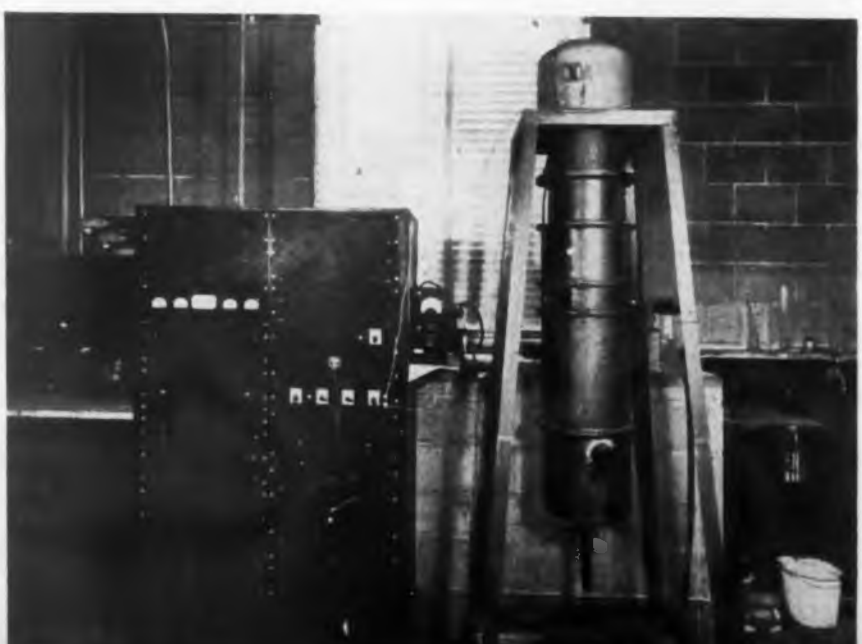


Fig. 5—Sonic flocculating unit capable of developing 2500 watts. Amplifiers at left



vibrator motion. However, the variation in phase of the pickup voltage with frequency is used to control the frequency delivered by the oscillator. The diagram of this oscillator and amplifier[3] is shown in Fig. 4. V_4 is the oscillator tube, and V_5, V_6, and V_7 are amplifier tubes to isolate V_4 from its load, and to supply sufficient power to drive the power amplifier. V_1 amplifies the output of the phasing amplifier (1) and supplies a voltage for the discriminator tube V_2, which varies in phase with the vibrator motions. V_2 delivers direct-current grid bias to reactor tube V_3. The latter, together with coil L_1 and capacitor C_g determines the oscillator frequency. When the automatic control is operating, the capacitance C_g can be varied by an amount ordinarily sufficient to change the frequency of the oscillator by 900 c.p.s. in 17 kilocycles, but the automatic control will compensate for this capacitance change and hold the actual frequency within about ± 0.2 cps. of the proper resonant value. This driving system will function under the heaviest acoustic loading of the vibrator and even when the vibrator motion is too small for the automatic control to operate, the oscillator will still drive the vibrator if the frequency is adjusted manually from time to time. In addition, this driving system supplies maximum driving power at all times and makes it easier to get the vibrator into motion. A large sonic flocculating unit with a driving circuit capable of developing 2,500 watts of energy is shown in Fig. 5.

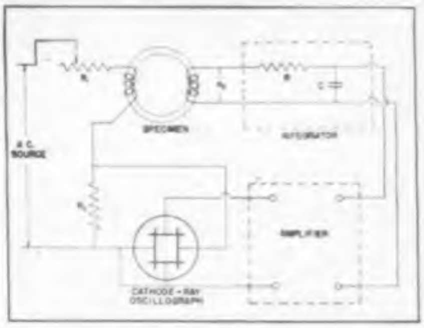
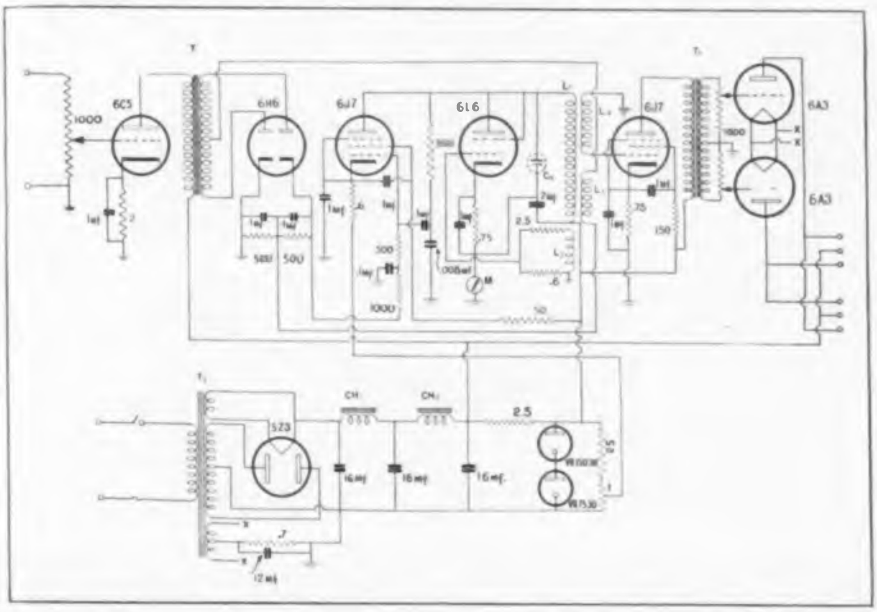


Fig. 6—Circuit for tracing B-H curves for magnetic samples using cathode ray oscillograph. Low frequency ac is used

Fig. 4—Frequency-controlled oscillator and amplifier (unit 3 of Fig. 2). V_1 is 6C5; V_2, 6H6; V_3, 6J7; V_4, 6L6; V_5, 6J7; V_6 and V_7, 6A3's. Input is from Fig. 3 at left



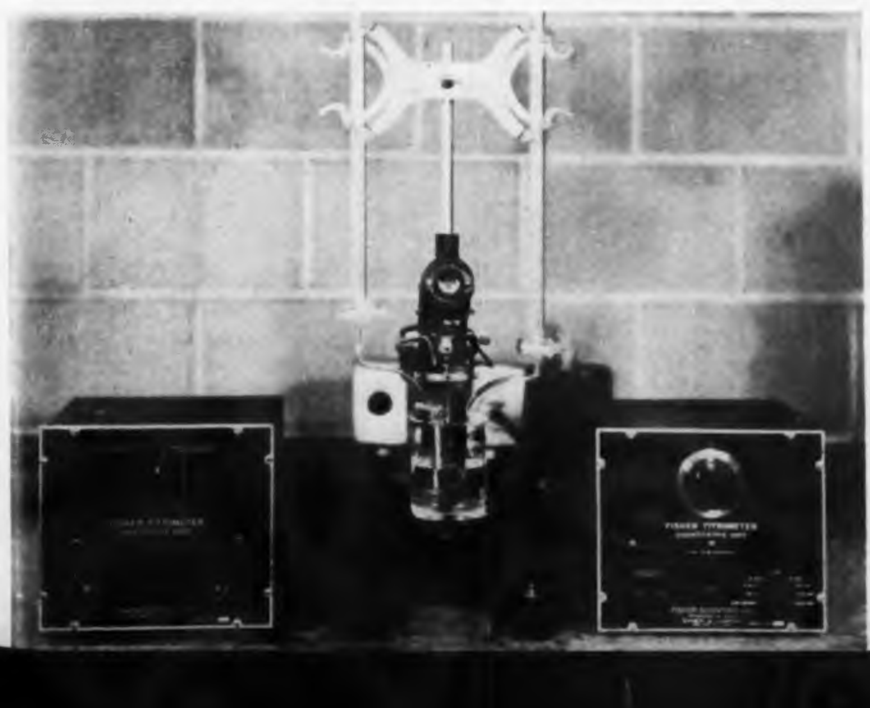
Although the best method for determining the magnetic properties of metals is by regular permeameter measurements, in many cases, the accuracy of the permeameter methods may not be required and the time required for making them will not be warranted. In such cases, it is possible to trace B-H curves directly on a cathode-ray oscillograph. A circuit for accomplishing this is shown in Fig. 6.

The specimen is excited by an alternating current of low frequency, 20 to 60 cycles per second. The secondary voltage e_s is applied to an integrator circuit R, C. The voltage across capacitor C will represent the value of B in both phase and magnitude with very little error if the impedance of R is large compared with that of C at the operating frequency. The voltage across C will be small and must be amplified by a vacuum-tube amplifier having negligible phase shift over a frequency band (which includes the operating frequency and a number of its harmonics). If the apparatus is properly designed and the frequency is low enough to eliminate skin effects, the curves thus obtained are sufficiently accurate for many purposes.

Where only the coercive force of a material need be determined, a coercimeter is used. This instrument does not involve electronic apparatus directly but with magnetically weak materials, direct-current amplifiers[4] or resistance-capacitance-coupled amplifiers with good response at low frequencies have greatly increased the accuracy

(*Continued on page 288*)

Fig. 7—Electronic equipment for determining titration end-points in chemical solutions



[3] Potter, E. V., An Automatic Frequency-Controlled Oscillator and Amplifier for Driving Mechanical Vibrators, Bureau of Mines R. I. 3702, 1943, 10 pp.; Rev. Sci. Inst., Vol. 14, No. 7, July 1943, pp. 207-15.

[4] Potter, E. V., and Coleman, E. F., Coercimeter for Magnetically Weak Samples, Rev. Sci. Inst., Dec. 1936, Vol. 7, pp. 299-501.

SIX RADIO-ELECTRONIC

1. LIGHT on the subject, even if it's in the out-of-the-way category, can be provided by "piping" the illumination through a bent lucite rod. Unit shown below is a neon-strobo rpm counter devised by researchers at Cities Service Co., Hillside, N. J.

2. THREE DECKER Lazy-Sue table variation speeds assembly at New York plant of Electronic Corp. of America. "Handi-Tray," made by Handi Equipment Co., Jamaica, N. Y., is three tiers of trays for small parts

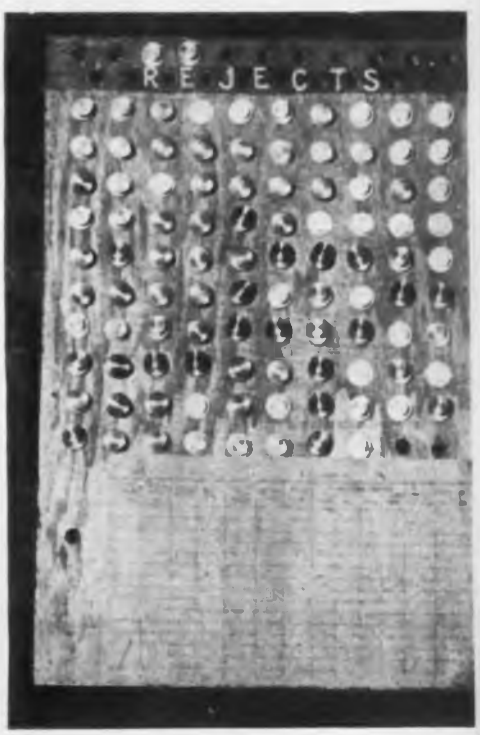
3. SHAKER TABLE, at right, designed at Tung-Sol, Newark, N. J., for tube tests consists of spring-suspended shelves agitated by unbalanced flywheels on small motors, providing adequate vibration if not many G's are needed

WAR PRODUCTION IDEAS

4. TUBE-CHECKER built by Pacific Electronics, Spokane, Washington, speeds pre-installation tube testing 3000 per cent over one-man method, checking shorts, leakage, emission, etc., with unskilled help

5. FLUX METER developed by J. Thos. Rhamstine, Detroit, is permeability comparator for meter and other magnets

6. CLOCK-WATCHING helps production at Strauss Co., Buffalo, N. Y., subcontracting small precision part for Colonial Radio Corp. One hand on each of four top "clocks" points to scheduled production, while other indicates actual state of affairs. Lower dials show total performance of two shifts. Routing board (below) carries parts from one operation to next



SAW-TOOTH GENERATOR

by **W. MULLER**

Stevenson, Jordan & Harrison, Inc.*

Time base generator using high vacuum tube has linear saw-tooth output over frequency range of 1 cycle to 1 mc

● Wave form analysis of the visual type, that is by the use of an oscilloscope, has become of greater importance than ever in the electronic and industrial field. Until a few years ago, oscilloscope amplifiers and sweep generators had a limited range. The overall amplifier response was fairly flat from about 20 cycles to 100 kilocycles and the sweep generator, of the gaseous triode type, covered about half this range or roughly from 5 cycles to 30,000 cycles. In one particular model the sweep generator operated as high as 50,000 cycles, but erratic operation and distortion was very noticeable. Of course, since most measurements were made in the audio range of waves of sinusoidal character, the units served the purpose well.

The advent of television brought a demand for extended amplifier response and thus the range was increased to 500 kc. But new developments and uses, especially through war equipment, demanded still greater ranges of the amplifiers. Square wave and pulse wave measurements first in the low frequency bracket, gradually increasing in frequency, brought out designs of amplifiers that had a response up to 10 megacycles. But, as mentioned, these improvements were chiefly in the amplifier sections only, that is, the "vertical" amplifier (usually) of the oscilloscope.

Sweep requirements

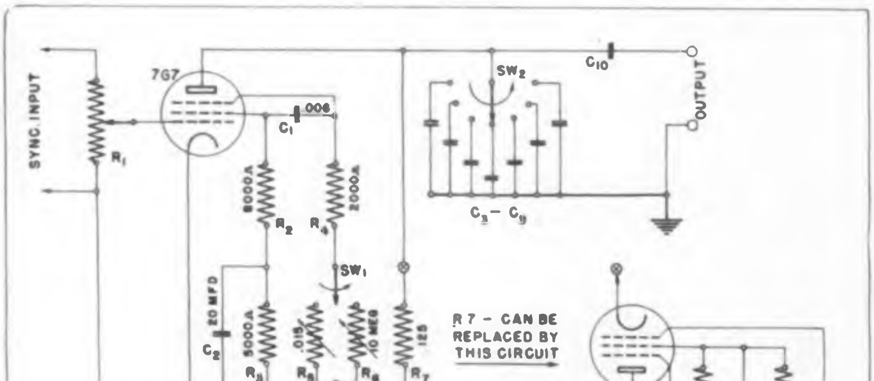
The sweep generator remained in its old form, that is, using the gaseous triode discharge tube, and thus providing for observations only up to approximately 50 kc. Since some of the applications of pulse modulation are making use of frequencies running from 10 kc to 200 kc or more, the importance of observing the wave form in respect to sides, top, etc., becomes obvious.

Consider the observation of a pulse, a single wave of a frequency of 20 kc. For the proper reproduction of this pulse the "vertical" amplifier must be uniform to at least 500 kc and the sweep generator amplifier must be uniform to at least 200 kc if operated with a sweep of 20 kc. The reason of course for this wide band response is that square wave and pulse waves are composed of $F + F^n$, where F^n are harmonics of the fundamental. The more uniform the amplifier, the better the reproduction of the harmonics, and it follows, the greater the accuracy of the reproduced wave on the cathode ray screen. The writer has encountered instances where it seemed imperative to observe a pulse from 5 to 10 microseconds at a frequency ranging from 5000 to 10,000 cycles. But the then existing equipment gave only a very poor picture of what really occurred and from this observation the balance of the true picture had to be calculated or guessed at.

It was with these problems on hand, efforts were made to investigate the possibility of extending the usefulness of the oscilloscope by incorporating a high frequency sweep circuit plus its associate necessary amplifier, in the hope of finding a solution for the beforementioned shortcomings. Searches on the subject of wide frequency sweep circuits disclosed a number of possibilities. The multivibrator using hi-mu triodes, van der Pohl negative resistance oscillator, dynatron, transitron, multivibrators with special feedback circuits, blocking oscillators and a host of others. Some forms showed great promise, but in general all those tried had the bad feature of increasing cost and being complicated in adjustment.

Among all the numerous circuits investigated the final circuit most likely to be used was the negative resistance type or transitron type, providing certain modifications could be incorporated to simplify all around control and cost. The

Fig. 1—Basic circuit of saw-tooth generator. Synchronization control R_1 should be 2000 ohms. Pentode circuit shown at right can be substituted for R_7 when necessary to give greater linearity at high output levels. R_5 and R_6 are fine frequency controls



*19 West 44th St., New York City

FOR HF OSCILLOSCOPES

main aim was to have as few parts or at least not more than used in the conventional gas triode discharge type of circuit. This was finally accomplished by utilizing some of the features of both, plus a rather unorthodox way of operating some of the elements in respect to applied voltage. Experiments with 15 different types of tubes brought about the selection of the 7G7 loctal type of tube. This tube performed consistently well over a period of months without failure and was thusly selected for the final adaptation in the circuit. Most other types showed failures usually after a short period of operation.

Fig. 1 shows the complete circuit as evolved. The B + supply needed is about 400 to 425 volts. Good regulation is essential but electronic voltage regulation is not advised. Shielding should be as complete as possible. Wiring should be as short as possible. All values of parts are given and the components can be of commercial tolerances. With the given circuit Fig. 1, the following results were obtained.

Frequency range is covered in seven steps from 1 cycle to 1 megacycle, continuously variable. Synchronizing control action will extend the range almost to 2 megacycles, that is, at 1 to 2 megacycles, one single sine wave is apparent on the screen of the oscilloscope. The reason for the extended range is, that at the high frequency end, the oscillator will readily lock-in with any synchronizing signal from 500 kc to 2 megacycles.

Stability is good in that with little synchronizing voltage (0.03 volts min.) the pattern will remain stationary. During 8 hours' continuous operation, no drift was experienced. Linearity is excellent over the entire frequency range.

The discharge time varies with frequency slightly, from 1 cycle to 180 kc the discharge time to charge time is about 9 per cent, see Fig. 2B. From 180 kc up to 1 megacycle the discharge rate increases slightly so as to reach about 15 per cent of the charge time, see Fig. 2B. Although the time of discharge has increased slightly on the high frequency end, it will be found that it is not objectionable. The fact that 4 to 6 megacycle wave trains in sets of 4, 6 or 8 single waves can be readily observed without wandering should in itself be considered an improvement.

The saw-tooth output voltage ranges from 45 volts to 1 volt.

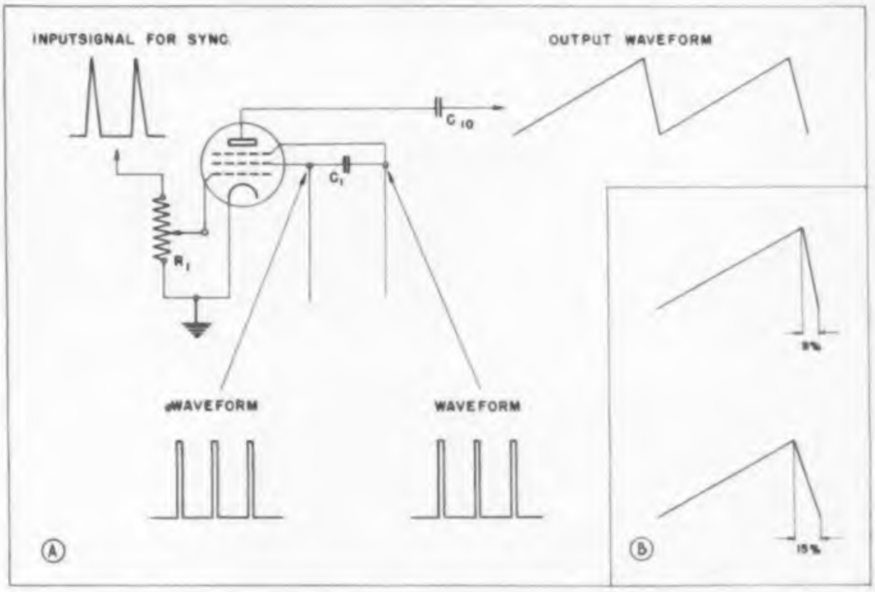


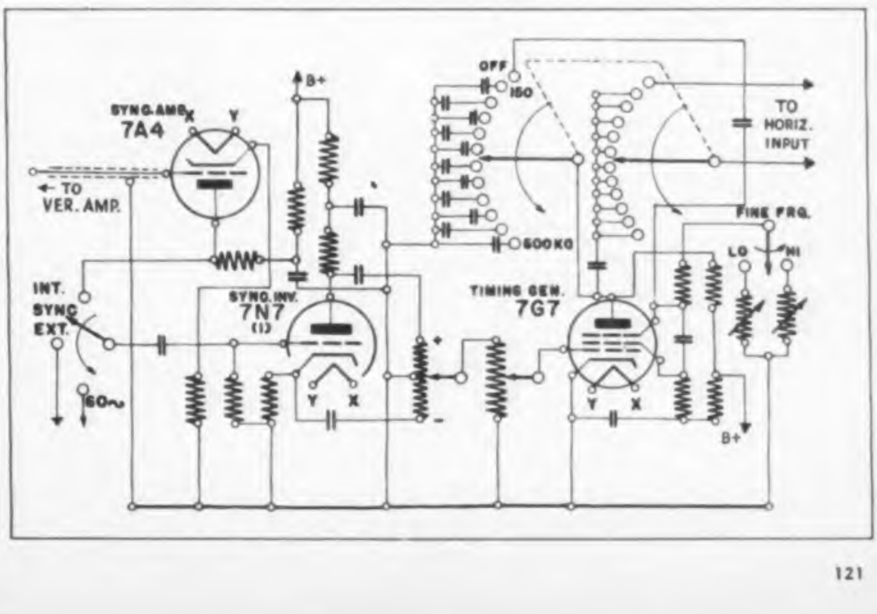
Fig. 2—Waveforms generated at screen and suppressor grids, and at output of circuit in Fig. 1. Synchronizing signal should be short duration pulse as shown. In B, the return trace time is 9 per cent up to approximately 180 kc and 15 per cent at 1 mc

From the given data the main point of objection seems to be the large change in voltage amplitude. This large change in output voltage could be reduced somewhat, by juggling the circuit constants so as to obtain a more average point or range of operation, but this would be only necessary in extreme cases of accuracy requirements. Resistance R_7 could be replaced by the constant current circuit given in Fig. 1, thus improving the output somewhat by making it more constant, but difficulty will be encountered at the low frequency end, where linearity distortion will be noticed. Improvements might be made, so as to overcome this fault, but at present the control tube circuit doesn't show enough improvement to warrant its use.

The following effects are to be noted: The frequency of the device is determined by the components

(*Continued on page 290*)

Fig. 3—Typical synchronization amplifier and inverter circuit for timing generator. Potentiometer in output circuit of 7N7 phase inverter permits positive or negative synchronizing pulses to be applied to saw-tooth oscillator



ENEMY

More views of captured

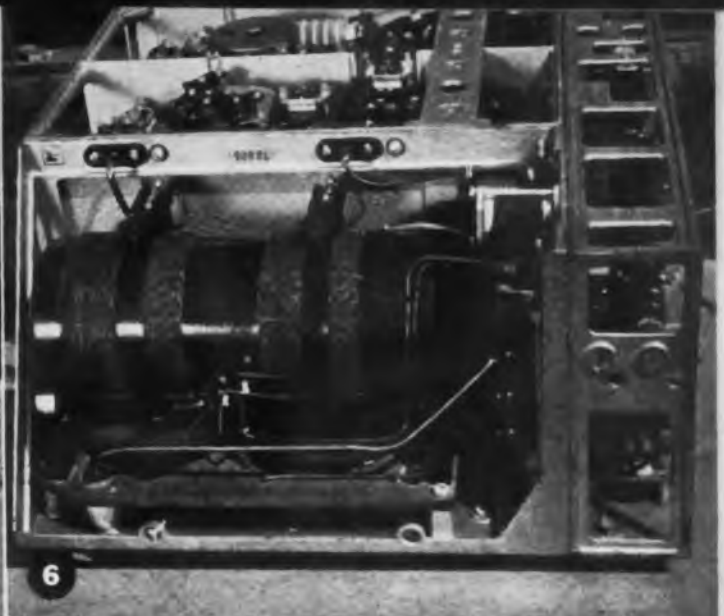
(*Photographs, descriptions, and analyses of other November,* 1942; *July,* 1943; *September,* 1943;

1. Front view of Ukw.E.e., 27.2 to 33.4 mc AM tank receiver, a conventional superhet with temperature-compensating condensers. Receiver has own dynamotor, drawing 4 amps from 12 volt battery

2. Another tank receiver, the Telefunken Ukw.E.h., with knobs and front panel removed. All tubes are RV 12 P-2,000's

3. Rear view of Ukw.E.h., minus case. Covers 24 to 27 mc with several "flick" tuning positions

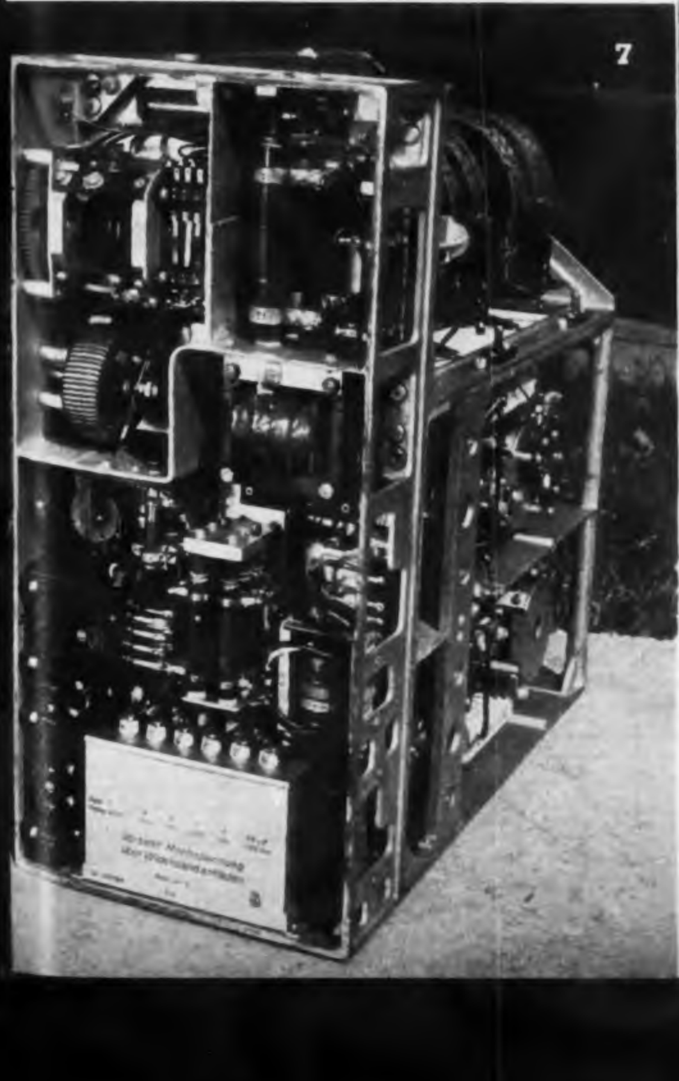
4. WRI Commercial allwave receiver, 150 kc to 15 mc



RADIO

German radio equipment

enemy apparatus in "Electronic Industries" for and February, 1944)



5. 100 WS division-command set transmitter; this outfit often carried on armored car or truck

6. Close up, showing variometer tuning method used in 100 WS

7. Another view of 100 WS, 200 to 1200 kc armored car transmitter

8. FUD 2, 33 to 38 mc pack transceiver removed from case. Typical example of standardized, die-cast, compact German construction technic

Discontinuities in UHF Lines

Determination of effect of discontinuities in characteristics of transmission lines

● It is extremely difficult to calculate the transmission characteristics of discontinuities in centimeter-wave circuits, e.g., those caused by ceramic disks, or by transition from concentric transmission lines to hollow wave guides, but it is possible to find these characteristics by measurements, and the transformer theorem to be derived permits the ready evaluation of the experimental data. The theorem applies to lossless four-terminal networks obeying the reciprocity theorem (no rectification, linear elements) and whose input and output are connected to uniform transmission lines, which is the case in most actual circuits.

It will be shown that any complicated, lossless, four-terminal circuit element, that meets the requirements of the reciprocity theorem, can be made to simulate a four-terminal network, having the characteristics of an ideal transformer, by the addition of uniform transmission lines of suitable lengths at its input and output. A simple measuring arrangement will be described that has been used to determine the transformer ratio of these equivalent transformers and the input and output points to be selected on the uniform lines. The most complicated disturbing elements may be handled by this procedure.

Experimental procedure

In general, the formula

$$Z_1 = (jaZ_2 + b)/(Z_2 + jc) \qquad (1)$$

will give the effective impedance at the arbitrarily chosen point D (Z_1) as a function of the terminal impedance referred to the arbitrarily chosen point C (Z_2), provided the circuit between D and C is considered as a lossless, nonrectifying, linear, four-terminal network. Measurement of Z_1 for three different terminal impedances Z_2 are required to determine a, b, and c.

If the transmission characteristics for pure reactances only are investigated (X_1, X_2 instead of Z_1, Z_2), different lengths of the terminating transmission line may be used at point C as load reactances,

$$X_2 = jZ_{02} \tan(2\pi x/\lambda),$$

where Z_{02} is the characteristic impedance of the terminating line. A movable short circuit stub may be used to adjust for different values of X_2. The corresponding sending end reactance at point D, X_1, is determined by locating the voltage minimum. If its distance from D is y, the sending end reactance X_1 at D will be equal to

$$jZ_{01} \tan(2\pi y/\lambda),$$

where Z_{01} is the characteristic impedance of the input line.

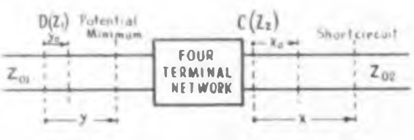


Fig. 1—Arrangement for measuring transformer characteristics of lossless four terminal networks

The transmission lines must be long enough so that at the points of measurement and where the reactance X_2 is assumed to be connected, the electromagnetic field is only that in the transmission lines and all disturbing waves are sufficiently attenuated.

The experimental determination of four terminal network characteristics consists of finding the dependence of the position of the voltage minimum (y) at the sending end, on the position of the short circuit stub (x) at the receiving end, at a constant frequency.

Fig. 2 shows a graphical representation of a measured curve which may be described by the equation:

$$jZ_{01} \tan[2\pi(y-y_0)/\lambda] = jkZ_{02} \tan[2\pi(x-x_0)/\lambda], \qquad (2)$$

where kZ_{02}/Z_{01} is the slope of the curve at inflection point x_0, y_0. It will be seen that

$$Z_{02} \tan 2\pi(x-x_0)/\lambda$$

is the terminal line reactance $X_{2(x_0)}$ referred to point x_0, and that

$$Z_{01} \tan 2\pi(y-y_0)/\lambda$$

is the sending line reactance $X_{1(y_0)}$ referred to point y_0. The experimentally established relationship indicates that if the terminating line reactance is referred to point x_0, the equivalent sending line reactance referred to point y_0 will be k times the terminating line reactance, k being a real number. In other words, if transmission line sections are added or taken away to make the four-terminal network extend from x_0 to y_0, it will be equivalent to a transformer having a real transformer ratio k, i.e.

$$X_{1(y_0)} = kX_{2(x_0)} \qquad (3)$$

which will take the place of general equation 1.

If this relation is valid for reactances, it must be valid for any impedances to satisfy the four-terminal network relations.

The following theorem has been proved: Any complicated and cumbersome lossless four-terminal network, satisfying the premises of the reciprocity theorem and connected at both ends to uniform transmission lines, may be made the equivalent of a four-terminal network obeying the conventional transformer rules and having a real transformer ratio k, by the addition or elimination of suitable lengths of the transmission lines

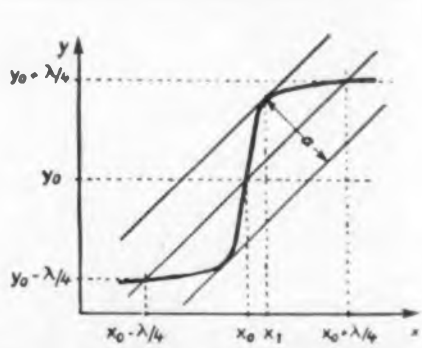


Fig. 2—Dependence of position of potential minimum (y) on position short of (x)

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*From an article by Albert Weissfloch, Hochfrequenztechnik und Elektroakustik, Berlin, September, 1943. Translated and adapted by Josepha Zentner, Ph.D., Associate Editor, Electronic Industries.

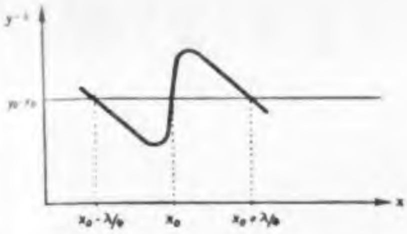


Fig. 3—Same dependence as in Fig. 2 if network is moved

(to points x_o and y_o). Any impedance $Z_{2(x_o)}$ connected at x_o (i.e. any impedance having the value Z_2 with reference to point x_o) appears at y_o as impedance

$$Z_{1(y_o)} = kZ_{2(x_o)}$$

Similarly, in a reversed network, any impedance $Z_{2(y_o)}$ at y_o will appear as

$$Z_{1(x_o)} = Z_{2(y_o)}/k$$

at the point x_o. x_o, y_o, and k are for most practical purposes independent of frequency and are available from measured curves like the one shown in Fig. 3. The theorem can also be proved mathematically.

Measurement considerations

The direct determination of the slope of the curve

$$m = kZ_{02}/Z_{01}$$

is not very accurate for steep curves. The slope may then be computed from the distance (a) between the two tangents inclined at 45 deg. The formula is

$$m = \left[\cot \frac{\pi}{\lambda} \left(\frac{\lambda}{4} - \frac{a\sqrt{2}}{2}\right)\right]^2 \quad (4)$$

In some instances it is more convenient to move the four-terminal network instead of the short circuit, as for instance when the four-terminal network consists of a ceramic disk. The resulting curve (Fig. 4) is obtained from Fig. 3 if y-x is substituted for the ordinate x.

As the transformer characteristics of a four-terminal network are determined by three measurements, equation (2) contains three variables (x_o, y_o, k), and the curves corresponding to Figs. 3 and 4 are determined by three points. If frequent measurements are intended, it is advisable to prepare a graph of a family of computed curves for

$$\tan 2\pi y/\lambda = m \tan 2\pi x/\lambda,$$

with λ as unit length. The measured curve is traced on transparent paper and identified with one of the curves on the chart. Deviations of the measured curve from the ideal one can then be readily estimated; they may be due to losses and indicate when the losses may not be neglected.

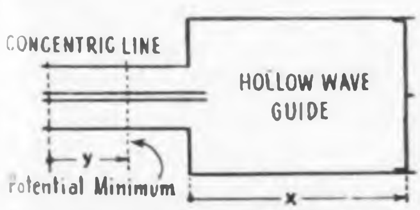


Fig. 4—Arrangement for measuring transfer characteristics at transition from concentric line to hollow wave guide

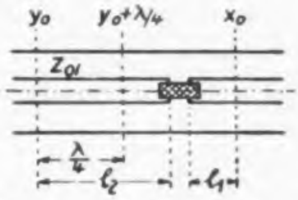


Fig. 5a—Concentric line with inner conductor partly replaced with ceramic piece

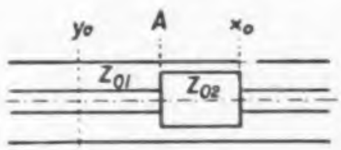


Fig. 5b—Quarter wave length transformer

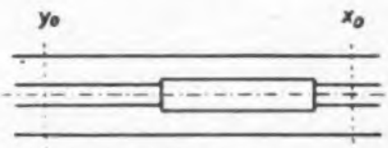


Fig. 5c—Half wave length line with disturbing corners

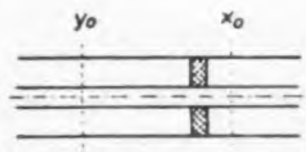


Fig. 5d—Concentric line with dielectric disk

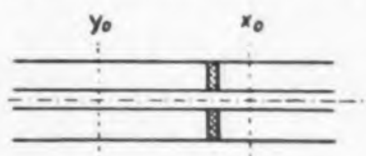


Fig. 5e—Concentric line with ceramic bolt

General applications

A shorted uniform line is frequently used for tuning which is effected by moving a short. At the desired adjustment, a short circuit is established at a certain point on the line. Fig. 3 indicates how, with a fixed short the position of the voltage minimum in front of a ceramic disk may be varied by moving the disk. From this it may be inferred that movable four-terminable networks of any shape may be used for tuning, avoiding movable metal contacts. A previous determination of the curve in Fig. 3 makes it possible to find the correct dimensions of the tuning device. It is more advantageous to use the part of the curve where the slope is less steep, because at the steeper part there is a higher attenuation.

The curve in Fig. 2 suggests that the four-terminal network concept applies also to hollow wave guides without an inner conductor, provided only one wave type is transmitted. Fig. 4 shows an arrangement to investigate the transfer characteristics from a concentric transmission line to a hollow wave guide. A diagram similar to Fig. 2 with x/λ^1 and y/λ instead of x and y, (λ^1=wavelength in hollow wave guide), may be obtained. The less the curve deviates from a straight line having a 45 deg. slope, the less reflection takes place at the transition from the concentric line to the wave guide.

Particular applications

First Example: A concentric transmission line section (Fig. 5a) with a short length of the inner conductor replaced by a ceramic piece, was investigated for wavelengths between 13.9 cm and 14.8 cm. The results for k, l_1 and l_2 (which correspond to k, x_o and y_o) shown in Fig. 6, were found. At a wavelength of 14.0 cm for instance, the length between x_o and $(y_o+\lambda/4)$ can be considered as a quarter wave transformer section with an impedance

$$Z_2 = Z_{01}/\sqrt{k} = Z_{01}/\sqrt{6.8},$$

where Z_{01} is the characteristic impedance of the line when no ceramic piece is present.

Second Example: In the computation of the transformer ratio k of a quarter wave transformer section (Fig. 5b), the effects of the corners of the quarter wave piece on the electromagnetic field are

(Continued on page 286)

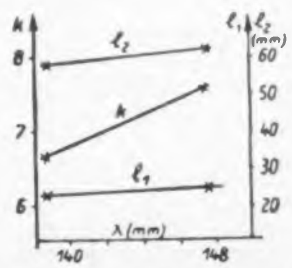


Fig. 6—Transformer characteristics corresponding to arrangement shown in Fig. 5a

TUBES

Artillery Detecting and Ranging

The Army puts its ear to the ground. The soldier with the shovel is planting an outpost microphone in the area northwest of Mt. Lungo, Italy. Purpose of these buried mikes and self-contained two-stage amplifiers is the locating of enemy artillery pieces by the sound of their firing. Even war goes in for specialization; the sergeant digging the microphone emplacement belongs to an artillery observation battalion.

Signal Corps photo from OWI.

Tubes in Motor-Tests

A miniature 400 cycle ac induction motor undergoing complete tests, including the brake test shown, at the laboratory of Eastern Air Devices, Brooklyn, N. Y. On such small motors an ordinary tachometer would be a partial load on the motor, so that speed is checked stroboscopically, while an oscillograph checks motor-current waveform. Line and phase ammeters, wattometers and voltmeters all play their part in providing the operating data, and even the humble scale does its bit in supplying torque readings.

Noticeable under the bench are the battery supply for dc motor testing, and the little oven in which single check tests on parts, or even motors, can be run at high ambients.

Electronic Supercharger Control

Called the electronic turbo regulator, an instrument developed by the Minneapolis-Honeywell Regulator Company, controls the "breathing" of four-engined AAF bombers.

Developed at the request of the Materiel Command at Wright Field, Dayton, Ohio, the electronic mechanism controls turbo supercharger speeds and automatically provides maximum safe power output and efficiency at all altitudes. It also prevents superchargers from blowing up—sometimes the cause of serious accidents and crashes. The device has been on Army heavy bombers in combat service for some months.

Principle of the turbo supercharger is to compress the rarified air of the upper atmosphere and feed this to the carburetor under a pressure sufficient to maintain the power output at normal. One engine of a Flying Fortress consumes five tons of air an hour at cruising speed, and many times as much at top speeds. Supercharger speeds, depending upon compression requirements, range up to 28,000 revolutions a minute, but any speed over this will blow up the turbine, endangering the crew as well as causing a drop in manifold pressure which renders the engine practically useless at high altitudes.

The turbo regulator operates from a single knob control mounted on the cockpit throttle column. This adjustment controls all four engines at the same time, assuring equal manifold pressures on all engines and providing a simplified control of airspeed on bombing runs. From this point on the pilot need no longer bother with supercharger control problems unless, at some time during the flight, he desires to alter manifold pressures.

The control system itself operates continuously, making minute adjustments in waste gate position as the airplane gains or loses altitude, moves into hot or cold fronts where air pressures vary, or as airplane speed is changed through altered throttle positions.

The turbo boost selector knob controls a reference signal fed to the amplifier. This signal combines with another signal generated by a device operated by carburetor air pressures. The amplifier interprets these signals and repositions the waste gate motor to maintain the selected carburetor air pressures regardless of altitude.

ON THE JOB

Suitcase Electron Microscope

As part of a discussion of electron microscopy before the Radio Club of America meeting at Columbia University, New York City, on March 9, General Electric engineers demonstrated the "suitcase" model electron microscope illustrated. The unit is not a production model but is used for demonstration purposes only. It is ten times more powerful than the best light microscope and operates on 110-volt ac power.

The unit is a step nearer the day when a small, compact, and easily operated electron microscope will be available for widespread use by doctors and research men. The microscope proper weighs 78 pounds. A vacuum pump used with the instrument and also of average suitcase size comprises a second unit. It weighs 55 pounds. Weight of the microscope can be reduced still further when certain lightweight alloys can be used to replace steel and other heavy metals now used.

Left to right: Igor Bensen, General Electric Development engineer; F. A. Klingenschmitt, president of the Radio Club of America; and Dr. C. H. Bachman of General Electric's electronics laboratory.

Phototube Follows Cutting Pattern

One of the most important considerations in the design and operation of gas-cutting machines is that of guiding the machine smoothly, uniformly, and accurately to follow a drawing, contour, or template. The electronic control described is designed to guide the machine automatically completely around a template, which consists of a pencil drawing on white paper, independent of the operator once the cut has been started.

The template is a piece of paper or white cardboard, upon which is drawn the shape to be reproduced. This may be drawn in heavy pencil, or in ink. Blueprints or black-and-white prints may be used if the errors due to shrinkage of the paper, and slippage when passing through the blueprint machine, are not objectionable. The reduction of labor and machinery required in making the template, the savings in template material, and the ease with which these templates may be stored, all tend to reduce the overall cost of machine gas-cutting.*

Fig. 1 shows a standard gas-cutting machine to which has been added a steering motor, geared so that it may rotate the plane of the tracing wheel about a vertical axis, by turning its spindle. This motor simply performs the function formerly accomplished by the operator. Another gear has been added to the steering motor shaft, and a drum (B) is geared so that it rotates with a ratio of 1:1 with the driving spindle.

Signal produced

Fig. 2 shows a close-up of this drum which has a lens (D) mounted a short distance away from its center of rotation. The drum is supported in bearings so that it may rotate about centerline XY. The light source and lens (c) flood the entire bottom end of this cylinder with light. Lens (D) collects some of this light and projects it in the form of a small spot on the paper template at point E. One or more phototubes are mounted so as to receive the light reflected back from the template. This reflected light causes an electrical signal to be produced, proportional to the amount of light reaching the phototubes.

Since the amount of light which reaches the paper at point E is constant, the amount of light which reaches the phototube depends upon the surface of the paper at point E. If this is plain white paper, considerable light will reach the phototube and its electrical signal will be fairly large in magnitude. If a black line is drawn on the paper at point E, much of the light received from the optical system will be absorbed by this black line. Therefore, the amount of light reaching the phototube, and the phototube's electrical signal in turn, will be small.

The position of this small spot of light (E), when the control is following along a straight line is shown in Fig. 3. The control is adjusted so that the steering motor is at rest when the spot of light is half on the black line and half on the white surface of the template adjacent to the line. If the spot of light moves in either direction away from its correct position a signal is given to the steering motor to return it to its proper position.

The circuit is arranged so that if the spot should approach closer to the line, as shown in Fig. 4, both the optical system and the driving spindle will be rotated in a counterclockwise direction. If the spot should tend to leave the line and,

*The photoelectric principle utilized was described by R. D. McComb, General Electric Co., at the American Welding Society's Chicago Convention.

therefore, strike the white paper surface, the optical system and driving spindle will move in a clockwise direction.

As shown in Fig. 5, this response is not limited to merely one position of this spot; the control can continue to follow around a circle, or other such figure, as many times as required. When following a curved line the steering motor is continually given a slight signal, due to the fact that the spot will always be traveling in the direction indicated by the driving wheel, and would therefore tend to leave the edge of the curved line if the steering motor did not turn the driving spindle clockwise.

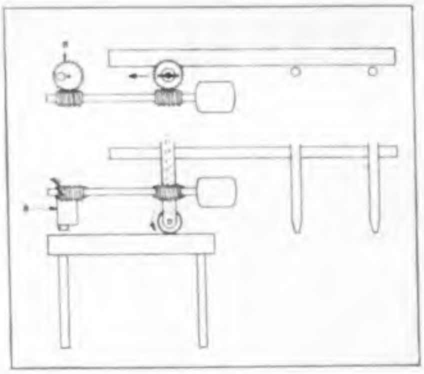


Fig. 1

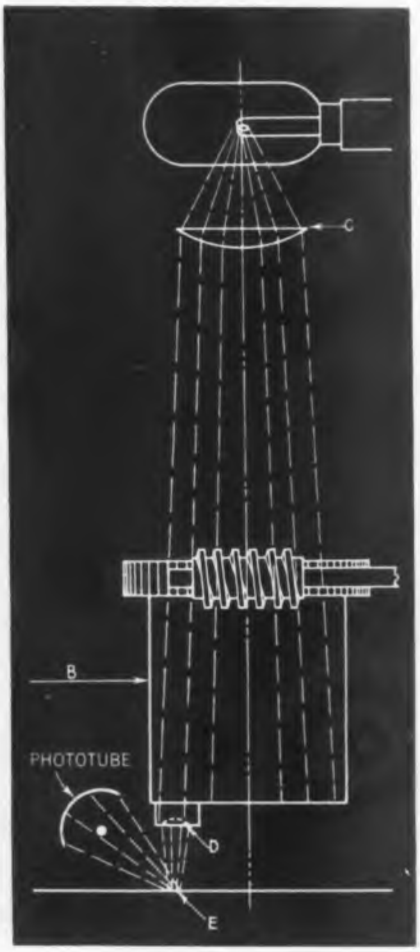


Fig. 2

Therefore, the spot will not quite be centered on the line, but will follow in such a manner that slightly more of its area is on the white paper template than is on the black line. In that way, a slight signal is continually given to the steering motor so that the control is smoothly turned around the circle and produces a smooth, clean cut.

The action of the control when steering the machine around the square corner is shown in Fig. 6. The spot approaches the corner as shown in a and b. In b, it is just beginning to leave the straight portion of the vertical line, and therefore, the phototube is beginning to receive more light than it received in a. By the time the driving wheel has advanced the carriage to the position shown in c, the steering motor has begun to rotate the optical system and the driving head, and will continue to do so while the spot advances through the position shown in d. As shown in e, the control will position itself, with the spot approximately half on and half off of the black line of the template, and, due to the inertia of the machine carriage, the true position of the torches may pass slightly beyond the new line of motion as shown in f.

The true position of the torch does not correspond with the true position of the spot when going around a sharp curve or corner. If the machine is traveling quite slowly, as would be the case when cutting heavy material, the tendency of the driving wheel to skid after the control has turned the spindle through 90 deg. will be very small, and the cut obtained will be somewhat as shown in Fig. 7. If, however, the machine is operated at high speed, it might tend to skid beyond its proper position, and the cut obtained would be somewhat as shown in Fig. 8.

Most normal cuts will fall somewhere between the two extremes and will, therefore, produce the

(Continued on page 262)

P-E Furnace Door Opener

A new job for photoelectric door openers enables unskilled labor to do a good job in the plant of Burgess-Norton Mfg. Co., Geneva, Ill. The installation was made on a new-type, triple action, automatically controlled furnace which brazes, heat-treats, and quenches tank-track parts. The photo is a close-up of the furnace feed. A timer sets the feed-rollers in motion, carrying a tray of parts toward furnace door. The tray interrupts a light beam and causes the latter to open. A second P-E unit closes the door and stops the feed-in rollers when the tray has passed its beam. Only after the tray has cleared the second beam can the feed-rollers start again, insuring proper spacing of the trays within the furnace. Both photoelectric units are visible at left center in the photograph, made by Electrified Industry, Chicago.

ENGINEER AS EXECUTIVE

Wider usefulness and opportunities for technically - trained business leaders

• "Engineers," someone has said, "are the fellows who went right home after school to wind No. 14 wire around Quaker Oats boxes". They left football to the more gregarious. They put all their mental eggs in one basket. We all know the results now. Technical pursuits attracted most of the best minds. Technology forged ahead of society, of business, of economics, and (regrettably) of international relations.

What the world of tomorrow needs most, therefore it can be reasoned, is to borrow some of the research laboratory's Scientific Method. The proper practitioner must, of course, be the engineer. One of the proper places for him to practice will be in industrial management,—all the way through production, distribution and application as charted below. Engineering leadership in all the functions of management will pay big dividends to the engineer, to the individual firm, and to society.

Present limits

The accompanying chart arbitrarily divides the industrial problem into nine steps. The first three are shaded to represent the present customary scope and limits of the engineer's activities. It is his job (and perhaps not always a very well paid one, at that) to carry on research, OBSERVATION of experiments,—to make discoveries. He, or his slightly more worldly brethren, next must consider how these observed results might satisfy some human need, make CONCLUSIONS, and visualize a product. Finally, in CREATION, the engineer nearest the pulse of the public invents and designs the new devices to be marketed.

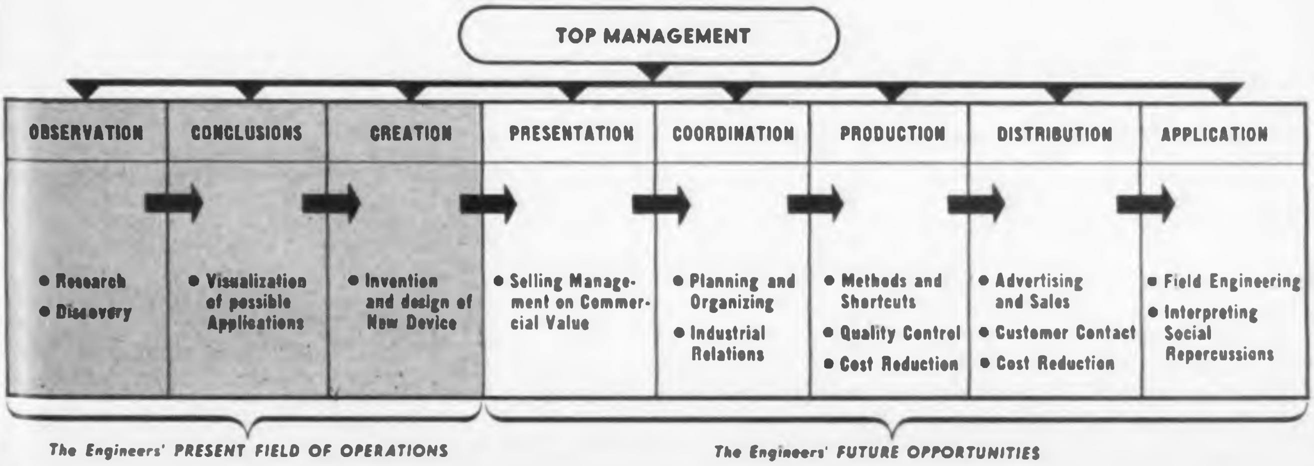
The only thing wrong with this picture is that word "finally." With step three, CREATION, the rights and duties of the average engineer cease. His company can (and often does) go bankrupt, precisely through a lack of "scientific method" on the part of management. Small wonder, when one considers the pitfalls in those other six divisions of our picture!

Must "sell" ideas

Who is to say how many good ideas, new inventions (brainchildren of the introverted engineers) never see the light of day because the engineers have not learned the technics of PRESENTATION, of "Selling" management on the commercial value of their ideas? How many firms have failed outright, or settled down into an industrial "smog", for lack of COORDINATION? The engineer of tomorrow must learn to plan, to organize for production, to oil the cogs in the machinery of industrial relations. Any truly great industrialist will tell you organization is the foundation of financial success. The manufacturing company must function as a team. The logic and common sense of the trained engineer are badly needed in the captains' positions on these industrial teams of tomorrow. Stop to think what America has done with PRODUCTION. Necessity married engineering brains to beget it.

Look into sales, too

Have a look also at DISTRIBUTION, Mr. Engineer-reader. Distribution looms so important on the postwar horizon that more than one major electric company has set up extensive machinery to study the whole problem. However big or little a firm may be, advertising and sales promotion and customer contact are among the most pertinent and realistic problems! The field of APPLICATION is perhaps the universal blot on the engineer's escutcheon. Interpreting social repercussions should be one of the most nourishing foods for thought, in the postwar adjustment. We should have more Peace Prizes and less Dynamite. We should never again fail to plead and argue the practical applications of tools like radar. There are crying needs in TOP MANAGEMENT for top engineers who have learned their lessons in human psychology as well as lessons on slide-rules.



SURVEY of WIDE READING

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

Intercoupled Transmission Lines

M. Fuchs (Electrical Communication, Vol. 21, No. 4)

When one pair of transmission lines, line A, is placed in proximity to another pair, line B, interactions take place, and it is the purpose of the paper to formulate a system of equations applicable to the practical problems of intercoupling encountered by radio engineers.

A system of 2N differential equations relating voltages and currents in N parallel conductors of circular cross-section is derived. Only steady state conditions are considered, and the conductors are assumed to have zero resistance; spacing between conductors is small compared to the wavelength, but large compared to the radii of the conductors. At radio frequencies, the above conditions are usually very well satisfied by physical lines.

The general equations are then simplified to describe a system of two similar and symmetrical pairs of transmission lines (first figure). In the reduced form, the equations read:

$$V_A = C_A e^{j\theta} + D_A e^{-j\theta},$$

$$V_B = C_B e^{j\theta} + D_B e^{-j\theta},$$

$$I_A = \left[\frac{Z_0 C_A - Z_m C_B}{Z_0^2 - Z_m^2}\right] e^{j\theta} - \left[\frac{Z_0 D_A - Z_m D_B}{Z_0^2 - Z_m^2}\right] e^{-j\theta},$$

$$I_B = \left[\frac{Z_0 C_B - Z_m C_A}{Z_0^2 - Z_m^2}\right] e^{j\theta} - \left[\frac{Z_0 D_B - Z_m D_A}{Z_0^2 - Z_m^2}\right] e^{-j\theta},$$

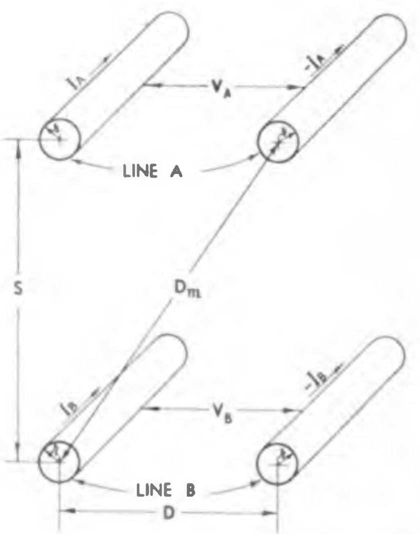
where

$$Z_0 = 120 \log_e \left(\frac{D}{r}\right),$$

$$Z_m = 120 \log_e \sqrt{1 + \left(\frac{D}{s}\right)^2},$$

$$\theta = 2\pi\left(\frac{x}{\lambda}\right),$$

and C_A, C_B, D_A, D_B are constants which depend on the boundary



conditions, i.e., the impedances and voltages at the terminals of the lines.

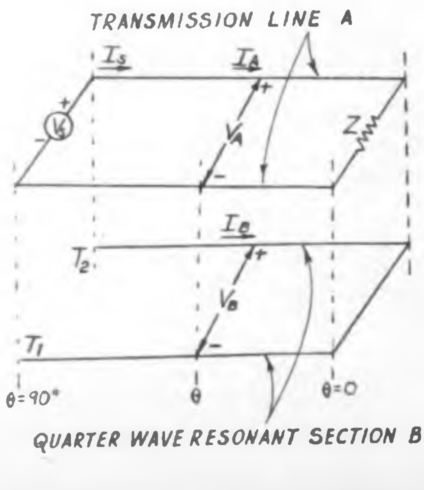
If, by introducing suitable boundary conditions, these expressions are applied to a quarter wave resonant section B coupled into a line A transmitting power to a load (second figure), the voltages and currents are given by:

$$V_A = V_s \sin\theta,$$

$$I_A = 0,$$

$$V_B = V_s\left[\frac{Z_0}{Z_m}\right] \sin\theta,$$

$$I_B = \frac{-jV_s}{Z_m} \cos\theta.$$



The coupled section blocks line A and power transfer at the frequency for which section B is a quarter wave length long is prevented.

Formulas for a similar arrangement with a variable capacitor inserted between terminals T_1 and T_2 show that the voltage on line A will be amplitude modulated by variation of the capacitor reactance; by the use of properly shaped rotor and stator plates, sinusoidal modulation is readily obtainable.

Transmission line couplings for the tank circuits of transmitting power amplifiers and the conventional quarter wave coupling loop are also treated in some detail.

Graphical Fourier Analysis

H. P. Williams (Wireless Engineer, London, March, 1944)

A graphical method to evaluate the Fourier coefficients

$$a_n = \frac{1}{\pi}\int_0^{2\pi} f(wt) \sin nwt \; d(wt)$$

$$b_n = \frac{1}{\pi}\int_0^{2\pi} f(wt) \cos nwt \; d(wt)$$

is developed.

The definite integral for a_n represents summation of triple products of the type

$$\sin nwt_1 \times f(wt_1) \times d(wt).$$

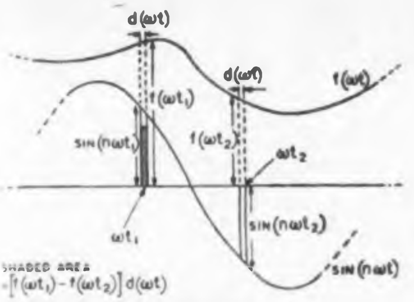
As for every positive value of $\sin nwt_1$, there will be a corresponding negative value $\sin nwt_2$, two triple products may be combined to

$$\sin nwt_1 \, [f(wt_1) - f(wt_2)] d(wt).$$

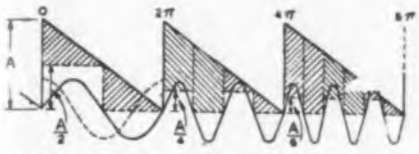
To find a_n all these products are summed up over the positive cycles of sin nwt and the result divided by π. In the first figure, the shaded area represents

$$[f(wt_1) - f(wt_2)] d(wt).$$

By performing the subtractions $f(\omega t_1) - f(\omega t_2)$ in such a way as to make the difference constant, the integration is very easily performed. Suppose the constant difference is A, then the sum of all products will be equal to A times the width of the



Finding Fourier coefficients



Dividing triangular pulses

strip times the mean value of sin $n\omega t$ over the positive half cycles, i. e., it will be equal to 2A, and a_n will be equal to $2A/\pi$.

Exactly the same argument may be used for the cosine coefficients b_n for a suitable subdivision of the cycles.

A simple example is shown in the second figure.

The coefficient a_1 is found by sketching in a complete sine wave between o and 2π. The whole of the negative portion may be subtracted from the positive half in the manner shown. This leaves the unshaded area which has the constant height $A/2$. Multiplying this by $2/\pi$ we obtain A/π, which is therefore the amplitude of the fundamental sine component. The fundamental cosine component will be seen to be zero, since by adding in an appropriate manner the area from o to $\pi/2$ with that from $3\pi/2$ to 2π we find that the result will cancel out with the negative area between $\pi/2$ and $3\pi/2$. In a similar manner it will be found that all the harmonics of this cosine wave will also be zero.

The coefficient a_2 is found by sketching in two complete sine waves. The shaded areas cancel out, leaving a constant height of $A/4$. Hence the amplitude of a_2 is $A/2\pi$.

The third harmonic is shown sketched in between 4π and 6π and shows us that a_3 is equal to $A/3\pi$. Proceeding in this manner we soon see that the amplitude of the nth harmonic will be $1/n$th of the fundamental.

Rectangular and triangular pulses are very easily analyzed by this method because suitable intervals can be readily found; the results will be accurate. Pulses of short duration may also be treated without difficulty by an approximation method which is explained in detail.

HF Capacitors

R. E. Morbury (Westinghouse Engineer, March, 1944)

An experimental porcelain-encased capacitor has been developed for induction heating purposes requiring the handling of large kva per unit of volume at high frequency ranges. There is no metal case in the high frequency field and all current-carrying parts can be effectively cooled.

The foil structure consists of two coils of opposite polarity separated by suitable working insulation. The foil is bonded directly to the cooling arrangement that forms the closures and terminals. This makes a non-inductive assembly and one that permits transferring more than 95 per cent of the heat generated in the dielectric to the cooling water.

Single units have been rated at 500 kva, even for relatively low voltage, which results in ratings that involve very large currents through the terminals.

Equivalent Circuits of the Electromagnetic Field

J. F. McAllister, Jr. (General Electric Review, March, 1944)

The article reports a new approach to the approximate solution of Maxwell's equations for mathematically complicated problems. It is shown that difference equations corresponding to the differential equations may be represented by electrical networks, i.e., an electrical network approximately equivalent to the electromagnetic field in space can be constructed, voltages and currents measured in a network analyzer and the E and H value throughout the entire region computed in a very simple way. The method is suitable for wave guide or cavity resonator computations.

The diagram shows a cylindrical wave guide with an abrupt change in diameter and a network whose behavior is equivalent to that of the guide. The actual magnetic field strengths are obtained by dividing the appropriate board voltages by the radius r.

Experimental work and actual difference equation analysis indicated that about twenty network elements or less per wavelength should be sufficient for accuracy within a few per cent. Of course, for the same accuracy, more elements would be required in regions of sharp discontinuities than in more uniform ones.

AC Potentiometer

R. B. Marshall (Electrical Engineering, February, 1944)

An ac potentiometer to reduce the power required for indicating instruments and the consequent errors has been constructed. Readings on a wattmeter, an ammeter, a voltmeter and the potentiometer setting are necessary for the computation of current, voltage, impedance and power factor, whatever the unknown quantity may be. A switch to change from low-impedance to high-impedance measurements is provided.

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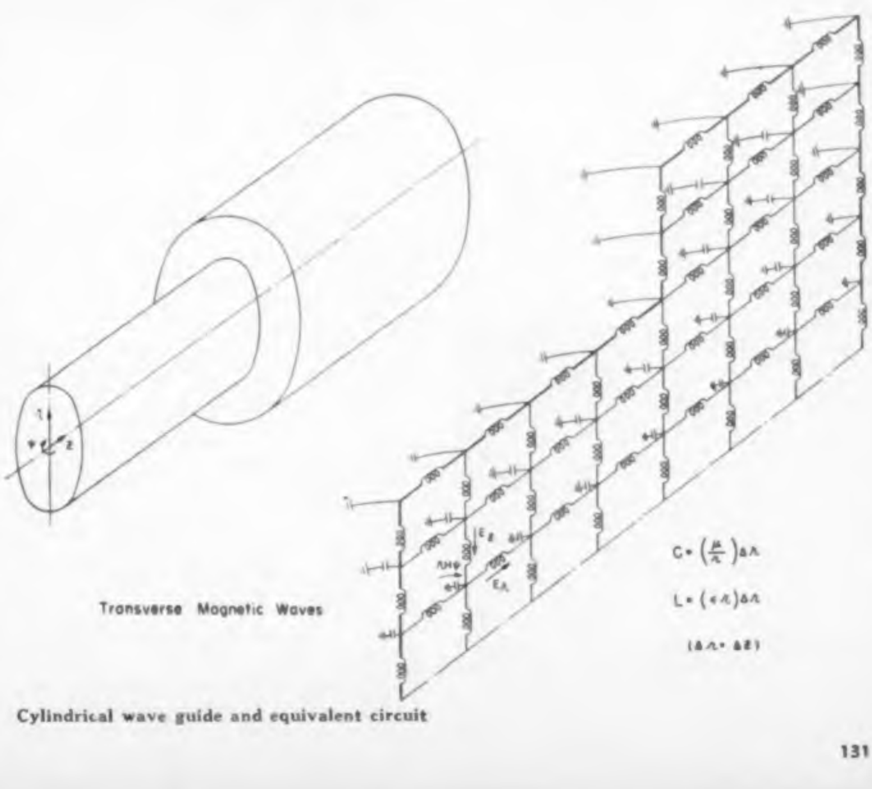


Cylindrical wave guide and equivalent circuit

WHAT'S NEW

Devices, products and materials the manufacturers offer

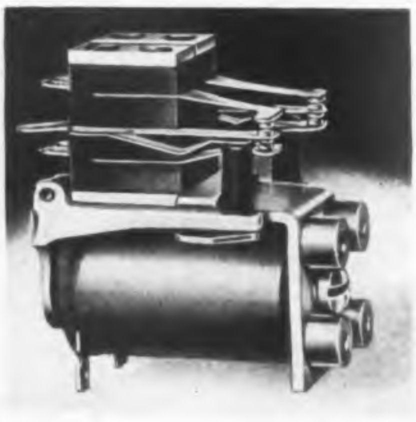
Gage Blocks

An economy set of 37 gage blocks is now available in two qualities from Continental Machines, Inc., 1301 Washington Avenue So., Minneapolis 4, Minn., packaged in a newly designed pocket carrying case, which holds the blocks on end for ease in handling and identifying. The set includes two .050 wear blocks in addition to the five standard series of gage blocks regularly offered. The addition of the .050 in. size makes the complete set more versatile. The series consists of 9 blocks: .1001 in. to .1009 in. in increments of .0001 in.; 9 blocks: .101 in. to .109 in. in increments of .001 in.; 9 blocks: .110 in. to .190 in. in increments of .010 in.; 5 blocks: .100 in. to .500 in. in increments of .100; and 3 blocks: 1.0 in., 2.0 in., and 4.0 in.

These blocks when wrung altogether give any measurement from .050 in. to 11.7995 in. in increments of .0001 in. and can be made with high accuracy, using various size blocks in combination. At 68 deg. F. the A quality blocks have an accuracy within ± 0.000004 in., and B quality within ± 0.000008 in.

Telephone Type Relay

Model TKL, a new telephone type relay, has been developed for maximum magnetic efficiency with resultant sensitive operation at minimum power input. This relay was designed for high frequency use and incorporates the use of Mycalex insulation. However, it can be supplied with approved bakelite insulation for standard switching service. The coil is cellulose acetate sealed for resistance to humidity and the relay will meet all standard salt spray specifications. It will withstand shock and vibration to 10 Gs. Normally the contacts are of palladium for maximum sensitivity but fine silver or special alloy contacts are available on request. Double pile-ups of contacts can be supplied from a single "A" (SPSTNO), "B" (SPSTNC) or "C" (SPDT) arrangement to a maximum of four "C" combinations. Weight and dimensions, less contact pile-ups, are 1½ ounces and 1 7/16 in. long by 15/16 in. wide by 1 1/16 in. high. Special tapped studs, brazed to the frame, permit easy mounting and prevent short circuiting of the coil. Manufacturer is Allied Control Co., Inc., 2 East End Ave., New York 21, N. Y.



Silver Micas

A capacity range of 6 to 2,000 mmf measured at 1 megacycle is now available in silver mica capacitors manufactured by Centralab, Division of Globe Union, Inc., 900 E. Keefe Ave., Milwaukee, Wis. Several new types with many terminal arrangements have also been added to the 830 and 831 types first manufactured. The basic construction of the silver mica capacitor is stacked mica disks individually silvered.

They are especially useful for high frequency applications. Type 830 has a metal cup holding the mica capacitor and is assembled to a tapped brass mounting with or without ground terminal. Mounting terminal and shell are all electrically connected. The same type capacitor without tapped mounting is available for applications where it is preferable to solder the cup directly to another component. Capacities range from 6 to 650 mmf, terminal types available include light right angle, heavy right angle, long tongue, U-shaped and post terminals. 830 capacitors can be supplied with or without a terminal between the stud and the shell.

Type A831 is of "feed thru" construction available with one or two terminals riveted to the center capacitor plate.

Chronograph Interval Timer

Great accuracy hitherto impossible in direct-reading instruments has been achieved in a new interval counter developed by the Potter Instrument Company, 135-56 Roosevelt Ave., Flushing, N. Y. It is called a Counter Chronograph Interval Timer, and patent has been applied for. Using electronic counters in the timer, with 100-kc crystal controlled oscillator to generate the initial counting rate, an electronic switch or "gate" is first actuated by a pulse from the initiation of the time interval. The 100-kc frequency is divided by four decades down to an output of 0.1 second. The pulse generated by the termination of the time interval turns the electronic gate off, leaving a count on the panel indicators. The resulting count is the number of cycles of the 100 kc source that have elapsed in that time interval. So accurate is this reading that it gives fractions of a second of +0 and —1 cycle of the 100 kc source or 0.00001 second for any reading. The full capacity reading of the panel is 0.09999 second. In addition, the counter can "run over" this reading if desired. Only four

tubes are used for counting and indicating a scale of ten. The answers are indicated for each decade on four neon lamps designated 1-2-4-8. Combinations of these lamps indicate 0 to 9. The instrument operates from a line voltage of 100-125 v 60 cycles ac. The tube complement is 27 tubes. Plug-in construction of the units is used throughout. The counter chronograph interval timer's dimensions are 15 in. x 10 in. x 10 in., and the weight is approximately 39 pounds.

Vacuum Tube Volt-Meter

Televiso Products, Inc., 6533 N. Olmstead, Chicago 31, Ill., is now offering a new vacuum-tube volt-meter for rf-af applications. Its special features include: high sensitivity, stabilized zero, and a built-in standard cell for calibration checks. Voltage ranges: .5-5-50-200 ac full scale. Frequency range from 2 CPS to 150 megacycles. It is accurate to 2 per cent of full scale on voltage, 2 per cent on frequency to 150 mc. Resonant frequency: 350 mc. This new volt-meter has automatic zero adjustment on all ranges. Readings vary 1 per cent with 10 per cent line voltage fluctuation. It is used for rf-af production and laboratory measurements by communications and electronic equipment manufacturers. Model 201 (illustrated), with built-in probe, input capacity 10 mmf $125. Model 200, same as 201, but with separate probe, input capacity, 5 mmf $135.

Moisture-proofing Compound

Salt-spray resistance and moisture proofness of lacquers and varnishes can be greatly increased by the addition of small percentages of Acrawax C powdered, a synthetic wax, declares Glyco Products Co., Inc., 26 Court St., Brooklyn 2, N. Y. Unlike natural waxes, Acrawax C does not retard the drying process of the lacquer or varnish. The use of Acrawax C is also said to improve the flow-out and helps pigment suspension. One-half of one per cent Acrawax C powdered, incorporated into a 28 per cent solids urea formaldehyde alkyd modified clear baking varnish, gave a film on a steel panel which after baking at 300 deg. F for 30 minutes resisted a concentrated salt spray (20 per cent) at 100 deg. F for 144 hours. The Acrawax C powdered should be treated as a pigment and ground into the resin with part of the solvent. Clarity of the varnish is unaffected.

Safety Flux

Experts in the art of soldering, brazing and welding are fully acquainted with the precautions that should be taken to guard workers from toxic action due to the ingredients of fluxes. The toxic action in ordinary fluxes now in use is injurious to the workers' eyes, skin, and respiratory mucous membranes. A new development, Kwikflux, safeguards the worker from harmful toxic action. This safety feature safeguards the workers' health and brings about greater efficiency, better work and an increased rate of production. Kwikflux is thoroughly tested for uniformity and dependability, and is manufactured by Special Chemicals Corp., 30 Irving Place, New York, N. Y.

Tube-Cap Terminals

The solderless tube-cap terminals shown are designed for heavy-load, high-temperature operation on power tubes in confined areas. These terminals, which can be furnished complete with leads, are practically independent of operation temperature. Caps and leads are made in various metals for operation in any range of temperature. Hot-electro tinning assures highest corrosion resistance for all types of caps and leads available. The Diamond Grip tube-cap units are for use on insulated wire where an insulation-support type of terminal is required. The standard Type B units may be used in either insulated or non-insulated wire.

Each type of tube-cap terminal is available as an individual item or may be ordered as an integral part of a complete lead built to users' specifications, from Aircraft-Marine Products Inc., 1591D No. Fourth St., Harrisburg, Pa.

Snap-Action Relay

The Struthers-Dunn Type 79XAX snap-action relay is designed so that its armature practically completes its travel before the contacts snap with a positive action to the corresponding position. Contacts remain closed with full pressure up to the instant of transfer to the other position; this permits the unit to be used in a number of new applications; i.e., overcurrent protection, particularly in the range of 1 to 100 milliamperes; overcurrent protection in connection with shunts furnishing potentials in the range of 1 to 100 millivolts; pulsing circuits where the relay must "pump" or "scratch its own back"; numerous sensitive vacuum tube circuits; and many others. Normal sensitivity is 0.01 watt, although a greater degree of sensitivity may be obtained by means of various circuit arrangements. The contact arrangement is S.P.D.T. and contact rating 10 amps. 110-volt ac and 10 amps. 24-volt dc. Balanced construction withstands 10G vibration and shock. Coil resistance available from ¼ to approximately 30,000 ohms. Weight is 10 ounces and the size 2¾ in. x 3 in. x 1¾ in. Manufactured by Struthers-Dunn, Inc., 1321 Arch St., Philadelphia 7, Pa.

Regulated Power Supply

A new regulated power supply has been developed by Radio-Television Institute, Inc., 480 Lexington Ave., New York 17, N. Y. The unit is designated as Model 44 and its dc output is continuously variable from 0 to 300 volts. At settings toward the upper end of this range the voltage changes less than 0.2 volts when 100 milliamperes load is applied. At low voltages the voltage variation with 100 milliamperes load is less than 0.1 volt. Maximum output voltage change with line variations of 105 to 125 volts varies from 0.15 volt at the low end to 0.5 volt at the high end. The hum content is less than 12 millivolts *rms* at any output voltage and with full load. Output voltage is set by a single knob in addition to the 3-position range-changing switch. A voltmeter is incorporated in the instrument.

Zinc-plated Steel

American Nickeloid Co., Peru, Ill., are makers of zinc-plated steel which can be furnished in a wide range of gages and sheet sizes, and in plating thicknesses ranging from .00015 in. to .0005 in. Laboratory tests indicate that a plating thickness of .0003 in. per side will withstand at least 50 hours of salt spray; .0005 in. per side, at least 100 hours. The galvanic action between the zinc coating and the steel base of zinc-plated steel sheet makes the metal highly corrosion-resistant. The sheared edges are also rust-resistant due to the galvanic action, plus the coating that flows over the edges from a shearing or blanking operation.

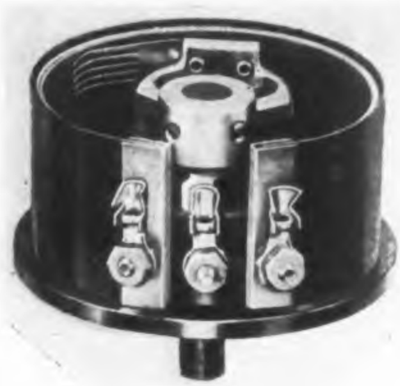
Miniature Tube Socket

Hugh H. Eby, Inc., 18 W. Chelton Ave., Philadelphia 44, Pa., announces a miniature tube socket developed at the Signal Corps Laboratories at Fort Monmouth, N. J. The socket, which was designed to give long service life under rigorous conditions, meets required specifications and withstands the humidity cycle immersion, shock, vibration, and thermal shock tests. The socket includes an especially designed "Micro-Processed" beryllium-copper contact which is heavily silver-plated, to give low contact resistance between the socket and the tube pin. The Eby miniature tube socket is available in two types: (1) The low-loss type with Navy grade G Steatite casting having loss factor of 0.016 or less when tested in accordance with ASTM D 150-42 T. Its capacity is 1.5 mmf or less at 10 mc. (2) General purpose type with mica filled plastic casting having a loss factor of 0.05 or less when tested in accordance with ASTM D 150-42T. Its capacity is 5 mmf or less at 10 mc.

Industrial Electronic Timers

This Series II timer contactor, manufactured by Electronic Products Co., Geneva, Ill., is an electronic timer with time control from ½ cycle to 45 cycles range. It is also an electronic contactor for loads up to 15 demand kva. Heat control, from 1 to 100 per cent in stepless variation, allows accurate control of welding temperature. This method has no power loss as is the case with rheostat or auto transformer power control. Xenon-filled power tubes assure quick start and perfect operation under all temperature conditions. Low internal drop gives greater power and efficiency. 20½ in. high, 12½ in. wide, 7 in. deep. Weight: 30 lbs.

TIMER		CONTACTS		
Volts	Cycles	Volts	Peak rms I.	Demand kva
110	60	110	54	15
220	60	220	54	15
		440	54	15



Precision Pots

Precision potentiometers which can operate for 2,500,000 revolutions at 360 deg. continuous rotation in both directions for 24 hours a day are among types developed by DeJur-Amsco Corp., Shelton, Conn. Feature is the close tolerance, which requires winding equipment built especially for DeJur. Resistance wire is space wound on a strip of fabric base bakelite. The strips are then coated with a bonding agent and a protective bakelite band is placed externally over the strip, securing the wire against mechanical damage. It is next bent around and fastened to the bakelite supporting form. Constant contact resistance and low noise level are maintained through the use of separate wiping fingers.

Portable DC Power Source

The Mallory Rectostarter, available in both portable and stationary types, is designed for aircraft engine starting, as a dc power source for operating plane lights, radio and instruments while grounded and for testing electronic equipment. It supplies 12 or 24 volts dc with a high surge rating for starting. In continuous operation, it has a rating of 100 amperes at 24 volts or 200 amperes at 12 volts. The unit can also be used for charging 12 and 24 volt aircraft batteries without removing them from the plane. Rectostarters are available to operate from 208-230 volts ac 3 phase circuits, or 460 volts ac 3 phase circuits. Portable unit is rubber-tired and carefully balanced for easy handling. Caster-type front wheel has locking device for holding unit in place when operating. A primary tap changing switch is provided to compensate for variations in ac line voltage and to increase dc output for heavier loads. Manufactured by P. R. Mallory & Co., Inc., Indianapolis 6, Ind.

Ceramic Coatings

General Ceramics and Steatite Corp., Keasbey, N. J., have developed a technic for applying metal coatings to steatite insulator surfaces. These metal coatings are composed of a layer of silver fixed at a high temperature to the surface of the steatite, plus an electro-copper plate on top of the silver to increase the thickness of the metallic plate. This method of application assures a strong and permanent bond between the steatite and the metal. The combination provides a method of solder sealing metal parts to ceramic over limited temperature ranges. The metallic surface being in ultimate contact with the insulating surface provides a convenient method of adding shields to reduce corona effect in high frequency circuits at high altitudes.

Capacity Meter

Providing accurate measurement of vacuum tube interelectrode capacities on a production basis, Model 37 interelectrode capacity meter may be used by unskilled personnel. Micromicrofarads are read directly from a large meter when a tube is plugged into the shielded measuring circuit. Range is from .001 to 100.0 mmfd. with accuracy of 5 per cent or better on all the five steps in which this range is pro-

vided. On the lowest range, increments as low as .00001 mmfd. may be used. Measurement is made at radio frequency in a crystal-controlled circuit having both primary and secondary voltages automatically regulated for maximum operating stability. The connector base accepts adapters for tubes up to 8-pin and provides for connection of coaxial cables to any pair of elements whose capacity is to be measured. The universal shield furnished with the instrument accommodates tubes up to 2-5/8 in. in diameter and 4¾ in. high; standard RMA shields, as specified for various tube types, may also be used. Special adapters, constructed to suit the application, may be attached to the connector base for measurements not involving vacuum tubes. Manufacturer is Technical Apparatus Co., 1171 Tremont St., Boston, Mass.

Regulated Power Supply

Supplying dc loads up to 40 watts at 200 to 400 volts, with voltage variation of less than 1 per cent from zero to full load, the Model 1218 voltage regulated power supply is a useful tool for general use in experimental development laboratories. A single operating control allows the output to be set at the desired value, where it remains regardless of load variation; current may be drawn up to 100 milliamperes at 400 volts and increasing to 200 milliamperes at 200 volts with voltage regulation electronically maintained in a circuit using standard tubes. The built-in voltmeter and milliammeter permit direct reading of output delivered at the safety jack conveniently located on the front panel. Another feature is the provision of a second output jack at which is available 4 amperes ac at 6.3 volts (unregulated). The power supply is housed in a well ventilated steel cabinet, 13 in. wide, 9 in. high, and 9 in. deep, finished in grey. Manufacturer is Technical Apparatus Co., 1171 Tremont St., Boston, Mass.

Wire Stripper

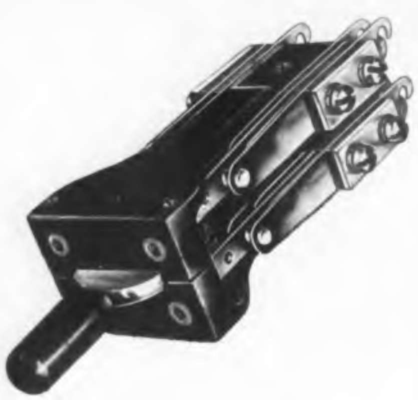
A new model of the Speedex Wire Stripper incorporating an improved automatic "stay open" feature provides a time-saving advantage when stripping the insulation from very fine stranded wires. The mechanism of the new tool is designed to hold the jaws of the stripper open until the wire is removed. A new handle design makes easier operation possible when the stripper is used as a production tool by girls with small hands. The stripper removes insulation from all types of solid or stranded wire without crushing over a wide range of sizes from No. 8 to No. 30. It can be used to cut wire when desired. Manufactured by General Cement Mfg. Co., Rockford, Ill.

Voltage Regulators

Data on a new, high-wattage voltage regulator has just been released by Webster Products, 3825 W. Armitage Ave., Chicago 47, Ill. Known a the VR-2200 series, these carbon pile voltage regulators were developed for airborne applications. They dissipate 300 to 400 per cent more power than previous conventional designs, yet occupy the same chassis space, with 8 per cent less cubic volume and are only 6 per cent heavier. The VR-2200 series units will handle 100 watts in the pile with an air flow through the fins of approximately 25 cu. ft. per minute, and up to 50-75 watts without air blast. Piles can be provided with a resistance range of the order of 20 to 1.

Electric Furnace

A line of high temperature electric furnaces for sintering powdered metal at temperatures between 1800 deg. F. and 2750 deg. F., is made by the Harper Electric Furnace Corp., Niagara Falls, N. Y. They are equipped with a preheat tunnel leading to the high temperature chamber and a water-jacketed cooling chamber. The entrance to the preheat tunnel and the exit on the cooling tunnel are equipped with automatic flame curtains. Gas-tight construction permits the use of protective atmospheres, such as hydrogen, dissociated ammonia and carbon monoxide.

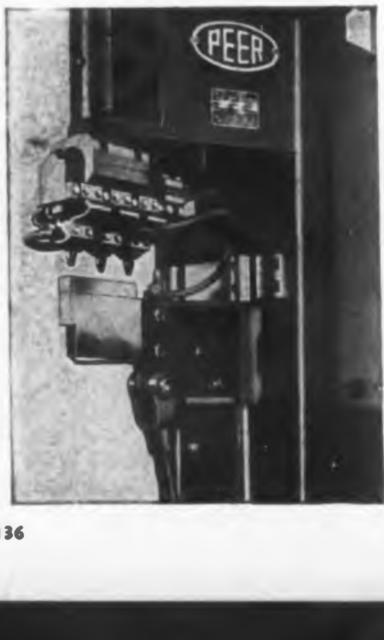


Featherweight Switch

Satisfying the demand for a multi-circuit switch with decreased weight at no sacrifice of desirable operating characteristics, the Maco featherweight switch is now available in an advanced design that meets present requirements for economy of critical materials. The frame is molded of high-impact phenolic (Navy Spec. 17P4 CFI-20). An advantage, derived from the molded frame, is increased rigidity and complete uniformity of switch elements. For added mounting security, knurled inserts with full quarter-inch depth of thread are provided on ⅝ x 1¼ in. centers and are locked in place so they cannot twist or pull out. Newly designed hook-type solder terminals, tinned all over, speed the wiring of assemblies incorporating this switch. Coin silver contacts, securely fastened in phosphor-bronze spring leaves, carry 10 amperes ac or 2 amperes dc at 115 volts. Contacts may be ganged in any desired number and combination and for locking or spring-return in either lever position. Manufacturer is Metallic Arts Co., 243 Broadway, Cambridge, Mass.

Multiple Welder

During the last few years there have been many cases of assemblies requiring a number of spot welds within close proximity. For such work fabrication has been speeded up and greater economy attained through the use of hydraulically equalized multiple spot welding electrode units. One of these heads, a 3-point unit, is shown on a Peer press type welder. This head made it possible to reduce the number of operations on a metal box requiring 52 spot welds to 14 operations. Accuracy of spacing was easily accomplished and the pressures held uniform by the hydraulic equalization provided in the head. Maker is the Pier Equipment Mfg. Co., 2000 Milton St., Benton Harbor, Mich.



VR Power Supply

Identical in performance, Communication Measurements Laboratory (116 Greenwich St., New York) 1100 series power supplies differ only in construction. Model 1100 is a table model for use in the laboratory, while the Model 1110 is designed for rack mounting. Both units use the familiar series regulator circuit. To insure low noise level and better regulation, a high gain two stage control circuit is used, instead of the conventional single stage circuit. The high voltage output can be shifted through a range of 225 to 325 volts by means of the potentiometer control on the front panel. The maximum current drain is 200 milliamperes from 225 to 300 volts and 180 milliamperes from 300 to 325 volts. Under these conditions the sum of all ac components present in the output is less than 5 millivolts. The change in voltage output from no load to full load is less than one volt. The primary of the power transformer is tapped for use at 105 volts, 115 volts and 125 volts on a 50-60 cycle source. An unregulated heater supply winding of 6.3 volts at 5 amperes is furnished.

Hermetic Sealing

Kovar, an iron-nickel-cobalt alloy, has been used for years to meet the exacting demands in tubes for a metal making a perfect vacuum and pressure tight seal with glass, and is now available to meet the demands for wide application in other fields. Typical Kovar-glass seal applications, in addition to electron tubes, are transformers, resistors, capacitors, switches, relays, instruments, heating elements, compressors, etc. The patented alloy, Kovar, is a development of Westinghouse Electric & Mfg. Co., and marketed by the Stupakoff Ceramic and Mfg. Co., Latrobe, Pa. Kovar is supplied as rod, wire, tubing, sheet and special shapes; and for those not equipped for glass working, Stupakoff makes Kovar sealed terminals and other assemblies, ready for soldering, welding or brazing to metal containers.

Vacuum Capacitors

Four new vacuum capacitors, designed for circuits where the peak voltages range from 7,500 to 16,000 volts, have been made available by the Tube Division of the General Electric Co.'s Electronics Department, Schenectady. The capacitors are designed as GL-1L 36/GL-36 which has a peak voltage of 7,500, 25 mmf capacitance; GL-1I 38/GL-38 with a peak voltage of 7500, 50 mmf capacitance; GL-1L 22/GL-492 with a peak voltage of 16,000, 25 mmf capacitance; and GL-1L 23 with a peak voltage of 16,000, 50 mmf capacitance.

The new capacitors are small and comparatively loss-free since there are no losses in the vacuum dielectric and because the total capacitance is lumped into a volume of about one (1) cu. in. internal voltage breakdown is constant and is independent of altitude, temperature, humidity, and other factors because of the vacuum construction.

Wire-Wound Resistors

Elco Resistors Co., 112-116 West 18th St., New York 11, N. Y., has developed a precision type A resistor, designed for use in electrical indicating instruments, electrical test equipment, radar, radio, etc. It is compact in size and it is arranged so that it can be mounted by means of a 6-32 screw, through its center, or mounted by soldering directly to the leads. The resistance wire is wound in pies, on a steatite spool, and the ends of the wire are soldered to the lead wire in a way that any bending or handling of the leads will not damage the soldered connections. The steatite spool is countersunk on one end and flat on the other, so that it can be mounted with either flat heads or filester head screws.

The completed resistor is finished with a baked-on varnish that provides a high degree of insulation against moisture. Normal accuracy is ½ per cent but they can be supplied with accuracies of ¼ per cent or 1 per cent.

Copper Oxide Rectifiers

A group of copper oxide rectifiers, styled "Coprox", has been developed by Bradley Laboratories, Inc., 82 Meadow Street, New Haven, Conn. Gold contacts on the copper oxide pellets, highly adaptable mountings, and pre-soldered lead wires, or other arrangements to prevent overheating during assembly of equipment using these rectifiers, are innovations. BX-100, a center tap, full wave rectifier is enclosed in Bakelite and rectifies high frequency current, operating in special circuits up to 8 megacycles. BX-22.8 is a double bridge rectifier, with excellent temperature and temperature-current characteristics. BX-22.5 is a single half wave rectifier, BX-22.2 a full wave, and BX-22.4 a double half wave. Conservative ratings show low forward resistance, combined with high leakage resistance.

BX-22.3

BX-100

BX-22.4

Photoelectric Colorimeter

Two models of Lumetron photoelectric colorimeters, both operating from 110 volt, 60 cycle source, have been developed by Photovolt Corp., 95 Madison Ave., New York. They are direct reading, portable and designed for use with full-length test tubes. In model 400-A, the voltage stabilizer unit is external; model 400-G has the unit integral. Both are supplied with a dozen matched Pyrex test tubes and a set of 6 filters mounted in two holders.

Prefabricated Housings

Lindsay Structure, manufactured by Lindsay & Lindsay, 2225 Adams St., Chicago, is completely prefabricated to exact requirements and shipped in convenient knocked down form; the accurately die-formed parts can be assembled with wrenches requiring no welding, riveting or cutting. Lindsay Structure consists

of four basic parts: channels, tensioners, panel sheets, and screws. The basic principle is as follows: A 24 or 26-gage panel sheet with specially drawn flanged edges is fitted over the flanges of the channel framing. Tensioner channels are then applied over the edges of the sheets and are pulled down into the flanged frame by means of socket lock screws. This automatically draws the sheet into minutely uniform tension between the framing members and creates a union which approximates the full strength in the sheet. Lindsay Structure is being used as housings for radio and electrical war equipment, for auxiliary combat bodies for the Armed Forces, for refrigerator food storage buildings at tropical military and naval bases, and for many other fighting uses.

Kelvin Bridge

Several unusual features are incorporated in the Model K-1 Kelvin Bridge produced by Industrial Instruments, Inc., 156 Culver Ave., Jersey City, N. J. The bridge source voltage is 60 cycles ac. An electron-ray null indicator has been substituted for the conventional galvanometer. The instrument can be operated by unskilled personnel at high-speeds—up to several hundred tests per hour with suitable test fixtures. The entire equipment is completely self-contained in a single cabinet. Operation is simplified, since measurements are obtained by the rotation of a single dial directly calibrated in resistance, the dial readings being multiplied by a factor determined from the setting of the standard resistance switch. The instrument is characterized by a source voltage of only .05, which means no appreciable heating of any resistor under test. The overall accuracy is within plus-minus 2 per cent except for resistance values below .0005 ohm.

Recessed Indicating Light

H. R. Kirkland Co., Morristown, N. J., has a new pilot light for either panel or switchplate mounting, the S11 unit. It is for use with the standard S11 lamp bulb,

10 watt, available in all colors. The bulb is recessed into the unit from the front of the panel so that the tip assumes the appearance of a lens. With single-hole mounting it can be mounted on a single-gang switchplate.

Coaxial Feeders

Feeding the four bays of the Zenith FM turnstile antenna are eight Andrew 1⅝ in. diameter coaxial cables. These lines, as well as the 4⅛ in. diameter cables feeding power from the transmitter, are used in a "back-to-back" connection to provide a balanced 140 ohm transmission line. All cables are equipped with gas tight terminals and the entire system is constantly maintained under gas pressure.

(*Continued on page* 200)

Compounders and Extruders of Specific Materials for Specific Uses

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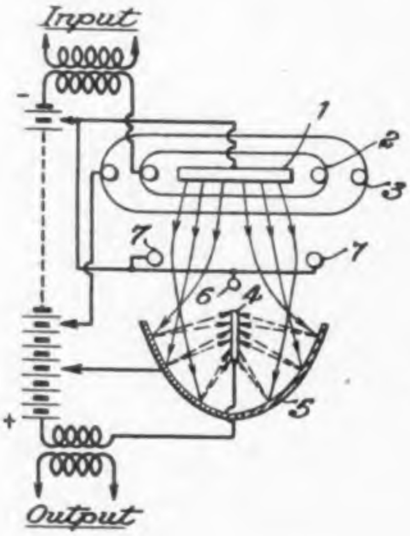
NEW PATENTS ISSUED

ELECTRON TUBES

Secondary Electron Amplifier

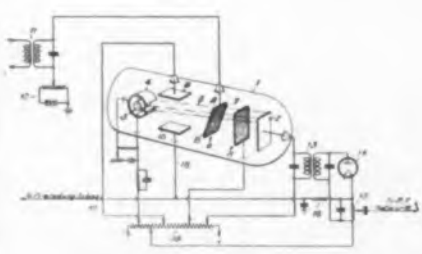
It is intended to provide a secondary electron emission tube which has low inter-electrode capacitance and in which the internal resistance does not change materially, even when the tube is used for short waves. Anode 4 is shaped as rod or strip and so placed that as viewed from the cathode 2 it is behind a shield member 6, preferably a rod parallel to and in front of the edge of the anode 4. The secondary emission electrode 5 is concave or recessed, facing the cathode 1 and surrounding the greater



part of the anode 4, so that the secondary electrons go directly to the flat sides of the anode. The electron beams impinge on the inner surfaces of the secondary emission electrode 5 in such a way that substantially all secondary electrons pass directly to the anode without oscillating around or near it, and practically none of them return to the vicinity of the control grid 2. A. J. W. M. van Overbeek, Alien Property Custodian, (F) June 6, 1941, (I) Feb. 1, 1944, No. 2,340,631.

Variable Mu Tube

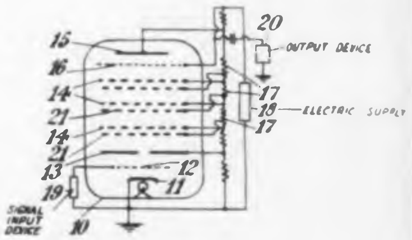
The principal object is to provide a tube with a continuous and uniform variation in the amplification factor at constant control



grid bias so that the plate current does not depend on the value of the amplification factor. To this end the electron discharge is concentrated into an electron beam 5 which is shifted between positions A and B by voltages impressed on deflecting plate 10. Because of the inclined position of control grid 6, the amplification factor is high when the beam is at position A, and low when the beam is at position B. In the example shown, the tube is used for automatic volume control, the regulating potential being taken off the cathode resistor of diode 14, filtered, and applied to deflecting plate 10 so as to determine the amplification factor of the tube. J. L. H. Jonker, Alien Property Custodian, (F) Aug. 21, 1941, (I) Feb. 1, 1944, No. 2,340,594.

Electron Multiplier

In front of each of the secondary cathodes 14 is an additional electrode 21 which, like the cathode 14, is sensitized for secondary emission and is in the form of a grid or perforated plate. Each electrode 21 is connected to the potential divider 17 so as to have a potential somewhat higher than the secondary cathode 14 immediately following it but substantially lower than the potential of the next secondary cathode 14. Alternatively, each secondary cathode may be electrically connected to its associated additional electrode within the multiplier and consequently have the same potential. Some of



the approaching electrons will pass through the apertures in the electrode 21 and impinge on the electrode 14 to liberate secondary electrons. The remaining approaching electrons will impinge on the electrode 21 and liberate secondary electrons. The accelerating field of the next following electrode penetrates the apertures in the electrode 14 for collecting or accelerating the secondary electrons emitted by this electrode and at least the secondary electrons emitted at high velocity by the associated electrode 21. F. J. G. van den Bosch, Vacuum-Science Products Limited, (F) June 16, 1941, (I) Feb. 1, 1944, No. 2,340,407.

HF AND UHF CIRCUITS

UHF Amplifier

It is proposed to use a converted-oscillator as the radio frequency amplifier in an uhf receiver to obtain an input conductance of desired value; the input conductance may be made negative. Gain and selectivity can be increased by this method. The oscillator portion of the tube need not be tuned and may be at some frequency sufficiently removed from the signal and i.f. frequencies so as not to introduce spurious responses. J. A. Rankin, RCA, (F) April 4, 1942, (I) Feb. 22, 1944, No. 2,342,492.

Reducing Capacitance at UHF

To reduce the large capacitances formed by the connecting leads in uhf circuits, each tube or pair of tubes is arranged as a separate amplifier having its own grid tank, plate tank, and preferably at least partially separate biasing means and by-pass condensers. These amplifiers are connected through lengths of tie-lines equal electrically to one-half wave length; this arrangement provides parallel inputs and additive power output. The diagram shows a push-

(Continued on page 144)

ASSOCIATION NEWS

Motion-Picture Engineers' N. Y. Convention

A symposium on television highlighted the 55th semi-annual technical conference of the Society of Motion Picture Engineers held at the Hotel Pennsylvania, New York, April 17-19.

With Dr. A. N. Goldsmith, past-president of the Society, serving as chairman of the opening session, William H. Sayer of Allen B. Du-Mont Laboratories, discussed "Recent Technical Advances in Television," and Sherman Price of Filmedia Corporation, New York, spoke on "The Scientific Approach to Television Program Production."

In all, thirty-six papers on motion-picture topics were presented during the three-day sessions, by military men, motion-picture engineers, and representatives of industries allied with the film business, as enumerated by W. H. Offenhauser, Jr., chairman of the papers committee. Papers and features of special electronic interest are listed as follows:

Monday afternoon:

"A Re-Recording Console, Associated Circuits and Constant B Equalizers," by Harry R. Kimball, Sound Dept., Metro-Goldwyn-Mayer Studios, Culver City, Calif. (See abstract following.)

"Direct Reading Audio-Frequency Meter," by W. R. Strauss, North American Philips Co., New York. (See abstract following.)

Tuesday morning:

"The PH-346A Recording Equipment," by Wesley C. Miller, Sound Dept., Metro-Goldwyn-Mayer Studios, Culver City, Calif. (See abstract following.)

"An Army Air Forces Portable Recording Unit," by Lt. F. T. Dyke, Hdq. 1st Motion Picture

(Continued on page 295)

RMA at Chicago, June 6, 7

The Radio Manufacturers Association's second annual War Conference and 20th annual convention is scheduled for the Hotel Stevens, Chicago, June 6 and 7. A general membership luncheon on June 7 will be the only social feature of the gathering.

These June conference plans were set during the RMA directors' meeting at New York, April 13, which also voted to add seven new directors to the board, in recognition of RMA's recent doubling of membership. Three of the new directors will represent the Parts Division. The sum of $25,000 was also voted to Chairman John S. Garceau of the advertising committee, to carry out the committee's publicity project to promote the radio industry to the general public.

Conventions and Meetings Ahead

Institute of Radio Engineers (330 West 42nd Street, New York), May 3, New York.

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

Society of Plastic Industry, May 11, 12, Edgewater Beach Hotel, Chicago.

Acoustical Society of America (Wallace Waterfall, 120 South LaSalle Street, Chicago), May 12-13, New York.

Society for Measurement and Control (New York Section Meeting), May 23, New York.

American Society of Mechanical Engineers (Ernest Hartford, 29 West 39th Street, New York), Semi-Annual Meeting, June 19-20, Pittsburgh.

American Society for Testing Materials (260 S. Broad Street, Philadelphia), June 26-30, New York City.

American Institute of Electrical Engineers (H. H. Henline, 29 West 39th Street, New York); Summer Technical Meeting, June 26-30, St. Louis, Mo.; Pacific Coast Technical Meeting, Aug. 29-Sept. 1, Los Angeles.

West Coast Electronic Manufacturers Active

The executive council of the West Coast Electronic Manufacturers Association has elected the following permanent officers: H. L. Hoffman, president; Jack Kaufman, vice-president; Herb Becker, secretary; Howard Thomas, treasurer.

The executive committee also adopted an Association insignia for use by the membership in their own advertisements.

According to statistics gathered by WCEM the rapid growth in the past few years has resulted in virtually a complete, self-sufficient industry on the Pacific Coast engaged in the manufacture of electronic components and complete equipments.

West Coast electronic manufacturers are now producing yearly

(Continued on page 150)

Officers of Pacific Coast Electronic Mfrs. Group

Top row, left to right, Lew Howard, Peerless Electrical Products Co.; E. Danielson, Remler Co., Ltd.; Leslie Howell, Gilfillan Bros., Inc.; James L. Fouch, Universal Microphone Co.; Clayton Bane, Technical Radio Co.; E. P. Gertsch, Air Associates, Inc.
Bottom row, left to right, Herb Becker, Eitel-McCullough, Inc.; H. L. Hoffman, Hoffman Radio Corp.; Jack Kaufman, Heintz & Kaufman, Ltd.; Howard Thomas, Packard-Bell Co.

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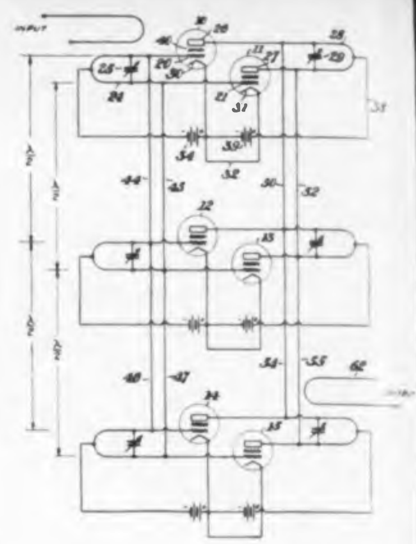

pull amplifier connected according to the invention. A system of two push-pull units, four tubes, may be arranged as a modulator by symmetrically applying the modulation frequency to the tank circuits of the units, and by transposing either tie-lines 44,45 or 50,52 so that the two units operate in phase opposition. The modulation is of the carrier-suppressed type giving only side bands. C. B. Watts, Jr., Federal Telephone and Radio Corp., (F) May 18, 1942, (I) Feb. 1, 1944, No. 2,340,352.

AMPLIFIER CIRCUITS

Audiphone Amplifier

Variable negative feedback is introduced so that for the lower sensitivities the feedback is greater and better quality of reproduction is obtained for those who have only slightly impaired hearing and who are more likely to appreciate the better quality. Further, a positive feedback proportional to the internal resistance of the battery is provided so that the gain of the amplifier is substantially independent of the internal resistance of the battery which increases as the battery becomes discharged. According to another feature of the invention, the pickup microphone is connected to the amplifier through an adjustable network which gives the user a choice of several low frequency characteristics. In noisy locations, this network may be set to give a large amount of low frequency attenuation, thereby discriminating against low pitched noises and the lower sound frequencies of the voice which contribute but little to intelligibility. This procedure permits of greater amplification of the higher frequencies without overloading. C. H. Rumpel, Bell Telephone Labs., (F) Dec. 24, 1940, (I) Feb. 29, 1944, No. 2,342,822.

Wide Range Amplifier

Several design features to compensate for distortion and provide constant gain in wide range amplifiers are described. By placing two amplifier stages after volume control 36 and by using an electrolytic condenser 35, constant harmonic balance conditions are maintained. Further, the impedance of resistance 18 in series with inductance 19 rises with frequency, compensating partially the shunting effect of the plate capacity of tube 1. The signal voltage applied to grid 25 is resonated at the high end of the desired frequency band by means of inductance 22 which forms a series resonant circuit with the input capacity of tube 2. This resonance lifts the upper end of the frequency response as much as ten times in a practical case. The resulting response peak may be too sharp to comple-

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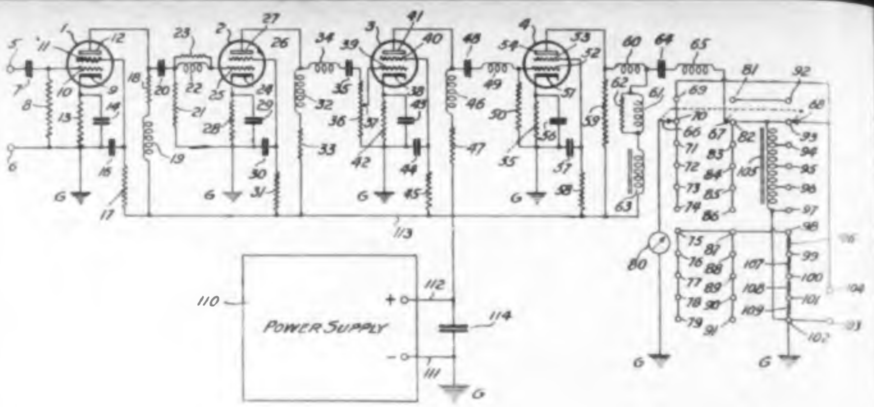
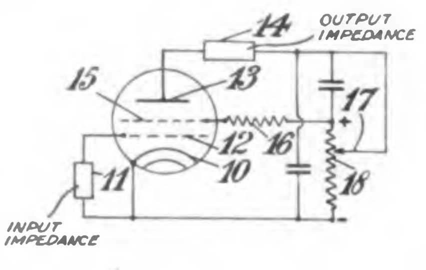


ment exactly the rest of the amplifier response in which case it may be made broader by shunting inductance 22 with damping resistor 23. The other stages have similar design. If the cathode resistor of tube 4 is by-passed by a small condenser 56 the stage will degenerate at low frequencies, thereby compensating an otherwise falling gain-frequency characteristic. The output may be taken either directly, from auto-transformer 105 or across resistance-type attenuator 106. A. W. Barber, Boonton Radio Corp., (F) Nov. 10, 1939, (I) Aug. 3, 1943, No. 2,325,933.

MISCELLANEOUS

Electron Tube

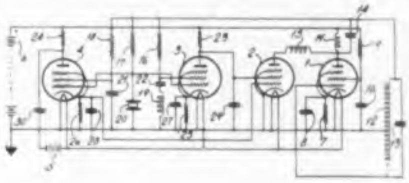
It is intended to reduce the dc component of the space current. A positive controlling electrode 15 is inserted in the electron path between the cathode and the plate. Impedance 16 is so dimensioned that the space current flowing through it produces a potential drop such that electrode 15 has the same potential as the plate. By diverting a portion of the space current in this manner, the cathode emission may be increased so that, with a given grid control, the slope of the grid voltage-plate current characteristic may be increased without increasing the dissipation at the plate. A frequency selective circuit having a high impedance at the signal frequency may be introduced in the lead to electrode 15 so



that it acts as by-pass for dc and no-signal-frequency space currents. Application to electron multipliers, amplifiers, and superheterodyne receivers is illustrated and described. F. J. G. van den Bosch, Vacuum-Science Products Limited, (F) June 16, 1941, (I) Feb. 29, 1944, No. 2,342,986.

Crystal Oscillator

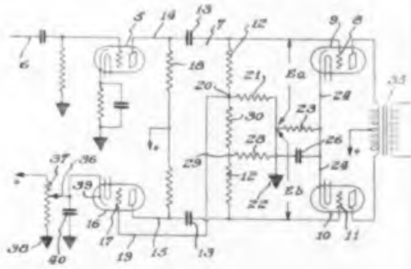
To stabilize the oscillator frequency, tank circuit 12, 13 is shunted in part by the impedance of coil 15 and tube 2; the effective inductance of this shunt circuit is determined by the grid and screen grid voltages of tube 2 which depend on the frequency deviation of the generated frequency from the resonant frequency of the crystal. If the frequency of the vacuum tube oscillator is above the resonant frequency of the quartz crystal 20, the grid voltage of vacuum tube 3 will be leading with respect to the oscillator tank voltage and will be in phase with the screen voltage of the tube which will start to conduct. The resulting voltage drop across resistor 23 decreases the current through tube 2 and coil 15 and lowers the oscillation frequency. If the oscillation frequency is below the crystal frequency, tube 3 will be blocked but tube 4 will conduct current, raising the potential



applied to the grid of tube 2 and thereby cause an increase in oscillation frequency. A simplified embodiment where tubes 3 and 4 are replaced by a double diode and tube 3 by a triode is shown and explained. G. T. Royden, Federal Telephone and Radio Corp., (F) May 4, 1942, (I) Feb. 22, 1944, No. 2,342,169.

Phase-Inverter Circuit

In the self-balancing phase-inverter circuit, a degenerative feedback is provided by the resistor network 21, 30, 28. Since the signal voltage from the inverter stage 16 is developed across the network as its load resistance, the voltage fed back by the network to the inverter grid 17 is less than the voltage across the resistor 28. Accord-



ingly there is less cancellation of the voltage on the inverter grid than in conventional circuits of the self-balancing type, and, for any given value of the gain of the inverter, the resistances 21, 30, 28 may assume values such that the voltages at the output grids 8 and 11 are substantially equal and 180 deg. out of phase under all conditions of operation. R. C. Sanford, RCA, (F) June 28, 1941, (I) Feb. 1, 1944, No. 2,340,617.

Signal Transmission

The symmetrical voice frequency current is to effect a signal response, while the unsymmetrical voice frequency current, corresponding to speech, is not to operate the signal receiver. The receiver comprises an asymmetry or differential

A NEW *Erie Ceramicon*

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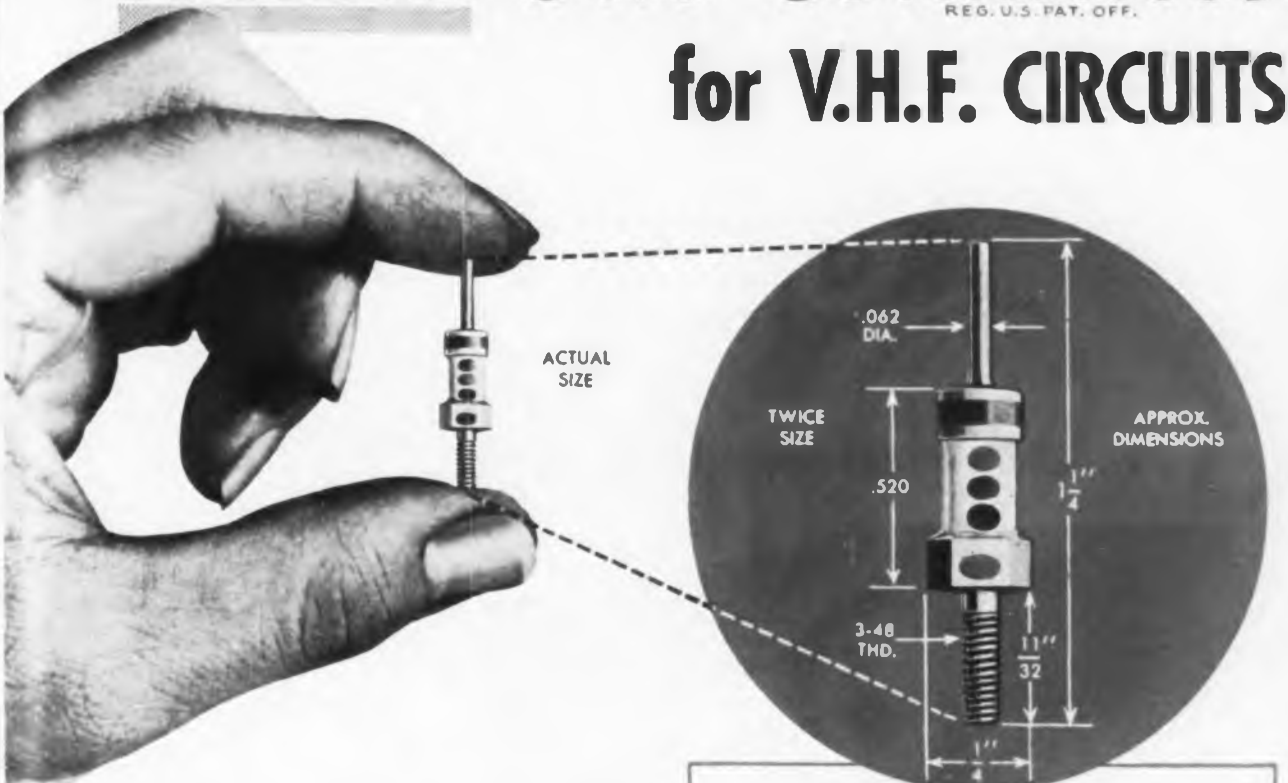

Developed for Important War Application—Ideal for Peacetime F.M. and Television

HIGH Frequency applications have a way of throwing existing component designs into the discard. Short, heavy leads, low series inductance, and other design factors assume greater importance.

Erie Resistor had already had considerable experience in designing tubular and disc ceramic capacitors, and button type silver mica condensers for V.H.F. and U.H.F. equipment. Thus, when engineers from one of the country's foremost research and development laboratories came to Erie Resistor with a new capacitor design problem, the answer was quickly forthcoming, in the form of a basically new style of Erie Ceramicon, pictured above. Approximately 60 days later, finished units were being delivered for the extremely urgent communications equipment for which they were designed.

ERIE STAND-OFF CERAMICON

Maximum Capacity

17 MMF.—zero temperature coefficient
30 MMF.—330 P/M/°C " "
75 MMF.—750 P/M/°C " "

Minimum Capacity, 2 MMF.

Minimum Capacity Tolerance ±0.5 MMF.

Available Temperature Coefficients +100 to —750 P/M/°C.

This compact, stand-off Ceramicon has mechanical advantages that permit it to be rigidly mounted, and support other circuit elements. Electrically, this Erie stand-off Ceramicon has a high resonant frequency, and short electrical path to both silvered plates. The stability and retrace characteristics of Erie temperature compensating Ceramicons are inherent in this new unit.

Is there a place for this new component in your designs for war or peacetime communications equipment? Or if you have any other design problems involving resistors or condensers, our engineers will be glad to discuss them with you.

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Electronics Division

ERIE RESISTOR CORP., ERIE, PA.

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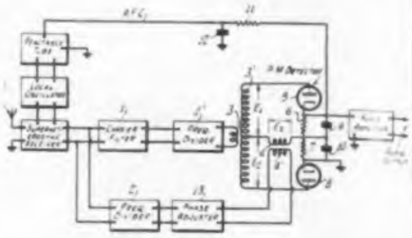
detector which prevents the closing of the signal detector circuit upon reception of asymmetrical currents. Further a delay network is included which permits closing of the signal detector circuit only if the symmetrical signal current of voice frequency persists for about 0.02 second. S. M. Babcock, A. W. Horton, and M. A. Logan, Bell Telephone Labs., Inc., (F) April 23, 1942, (I) Oct. 26, 1943, No. 2,332,494.



Phase Modulation Receiver

Similar frequency dividers 1' and 2 are inserted in the paths of the carrier and of the modulated carrier to reduce the relative phase shift to 90 deg. or less, which limit is required for the satisfactory operation of the automatic frequency control circuit. The undesirable phase shift is introduced by the carrier filter and is a function of the frequency deviation from the mid-band frequency. It is also proposed to provide two demodulators, one including frequency dividers and feeding the automatic frequency control reactance tube, the other without the frequency dividers and providing the audio signal. R. E. Schock, RCA, (F) May 23, 1942, (I) Feb. 1, 1944, No. 2,340,432.

Heroism in Tube Laboratory

Recognizing acts of heroism at the time of the Western Electric tube-shop explosion in New York City, the Vail Medal in bronze has been awarded to Louis G. DeLyon (posthumously), Alfred H. Gerlach, Alexander Mikolasy, William Mohrhoff and Louis J. Rom.

At fifteen minutes past midnight on the morning of November 30th, 1943, an explosion rocked the Western Electric Vacuum Tube Shop at 395 Hudson St., New York City. Heavy steel doors were ripped from their fastenings, walls were crushed, and broken glass and debris littered the streets for blocks around. Gas leaking from hydrogen tanks on a ground-floor loading platform had ignited and caused the disaster.

Mr. DeLyon, supervisor of the hydrogen equipment, with three fellow employes, Messrs. Gerlach, Mohrhoff and Rom, entered the gas room immediately upon learning of the initial trouble. Again and again the escaping gas drove them out. But with full knowledge of the extreme hazard involved they persisted in an attempt to avert the tragedy. All were injured by the resulting explosion and Mr. DeLyon lost his life.

Mr. Mikolasy, hearing the blast and guessing its probable location, proceeded from the third floor of the building to the scene where he

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MALLORY Vibrapack*

Is Setting New Records of Dependability and Efficiency

Modern war, with its rigorous demands on communications equipment, requires vibrator power supplies that can operate under great extremes of heat, cold and humidity, and are able to withstand terrific jolts and jars.

The Vibrapack meets these conditions unfailingly in its use with our armed forces. Military restrictions prevent our showing the latest Vibrapack units, but here are some of their features:

Hermetically-sealed vibrators and other components . . . rigid anchorage of parts to withstand abnormal vibration . . . special mechanical designs and mountings, including duplicate mountings for replacement of other equipment . . . wide band and special band RF "hash" filtering . . . multiple input and/or output voltages, including independent bias supplies and AC or DC filament power in addition to plate and screen potential.

With these and other Mallory improvements, the Vibrapack carries tremendous implications for new-born products of today and tomorrow. If you are looking for a method of obtaining high voltage DC current from a low voltage source, we shall be glad to send you further information.

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Hermetically-Sealed MALLORY Vibrators

Fully protected against corrosive fumes, extremes of atmospheric pressure and moisture-laden air, Mallory hermetically-sealed vibrators operate under ideal conditions for economy and long life.

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MALLORY VIBRATORS AND VIBRATOR POWER SUPPLIES

discovered a fellow employe whose clothing was on fire. After extinguishing the fire and removing the victim to safety with the help of a bystander, Mr. Mikolasy entered the gas room where a violent flame from the tanks threatened at any moment to touch off further disaster. In disregard for his own safety he persisted for more than fifteen minutes closing the operating and cylinder valves until the fire was extinguished. His unusual courage is credited with preventing further explosions.

WCEM ACTIVE

(Continued from page 142)

more than was produced by the entire radio industry in the United States in certain years prior to the war. The manufacturers represented by the Association comprise producers of virtually all types of electronic equipments and components. Component manufacturers have done an excellent job in supplying not only the needs of West Coast industries, but have achieved an excellent reputation in the radio industry nationally.

Forty-five manufacturers

Representing some forty-five electronic manufacturers, WCEM has been active in disseminating information to its membership through monthly meetings. Heads of government agencies have covered subjects including renegotiation, wage and bonus incentives, contract terminations, etc. Also through these meetings, the Association membership has learned first-hand of the workings of government agencies, whose supervisors have explained the scope and purpose of each of their respective agencies. Problems, affecting all electronic manufacturers, have been discussed and the association has moved to accomplish unanimous action on problems of selective service, renegotiation, procurement, contract terminations, etc.

Recently, General Harrison, of the Army Signal Corps, and Captain Shea of the Navy made inspection visits to plants of various members of the Association.

Frank S. Horning, WPB, also made an official visit to the California area and conferred with the heads of WCEM. A survey was made of the facilities and plants operated by members in order to determine how many new contracts could be awarded to the West Coast.

According to the Association, there is no shortage of "woman power" on the Coast. Inasmuch as approximately 60 per cent of the total employes of Association members are women, and because these women, in the main, have preferred work in the electronic

industry to jobs in shipbuilding or aircraft, Association members have experienced no difficulty in recruiting necessary production personnel.

"Representatives" at Chicago, June 6, 7

National Secretary David Sonkin of the Representatives of Radio Parts Manufacturers has announced that the organization is planning to hold its annual convention in Chicago on June 6 and 7. The Board of Governors, of which Dan Bittan is chairman, will convene on Tuesday afternoon, June 6, in Room 10 of the Hotel Stevens. The Delegates' meeting will follow on June 7 in Room 15. Final arrangements will be posted in the lobby of the hotel.

The Chicagoland Chapter recently added to its roster, Alfred Crossley of 549 W. Randolph St., Chicago, Ill. Jules Bencke has just been accepted as a member of the Missouri Valley Chapter. His address is 578 Arcade Bldg., St. Louis, Mo. L. D. Marsh of 110 Battery St., Seattle, Wash., has been elected a member-at-large.

Weiller on Electronic Controls

Speaking on the subject "Electronics—Servant or Fad", Dr. Paul G. Weiller, research director of Square D's Kollsman Instrument Division, Elmhurst, L. I., N. Y., addressed a record group at the seventeenth meeting of the New York Society for Measurement and Control on March 28th.

Dr. Weiller, himself a designer of tubes and tube-operated equipment, said electronics is both a fad and a servant. Electronic control for photoelectric opening of doors marked the beginning of the fad, and electronic timing and switching of resistance welder operation marked the significant beginnings of the tube as a servant, Dr. Weiller told the society.

In designing or using electronic control equipment, he urged engineers to consider that electronic devices lacked the positive action of mechanical devices. He likened mechanical control to a pair of gears, emphasizing the unalterable nature of the turns-ratio existing between them.

Rubber gears!

But an electronic control, he asserted, is a "gear system with rubber teeth"—put on a momentary overload and you may slip a cog or two and not even know it. He cited the automobile as an example of the dependability of mechanical devices and claimed that a cylinder's occasional misfiring was due

NEW VISIONS for Tomorrow's World

● IT DOESN'T MATTER NOW whether clouds hide the sun, or whether evening shadows fall on the baseball diamond. If the fans in the grandstand see the game so can the modern television camera.

That was not always so; the pre-war television "eye" needed as much sunshine as it could get to illuminate the scene. The same was true of football—final quarters were occasionally "washed out" on the television screen.

But thanks to research, conducted at the RCA Laboratories, a new super-sensitive television camera, rivaling the human eye in its ability to see under conditions of poor light is in prospect for the post-war world. Then, by television you will see every last-minute play of the ball game as clearly as if you were in the stands. Entertainment, sports, news events will pass before your eyes with every detail, every shadow faithfully reproduced.

Today, RCA's research facilities are devoted to providing the fighting forces of the United Nations with the best radio and electronic equipment available. Tomorrow, these same skills will continue to serve America in developing and creating new and finer peacetime products.

RADIO CORPORATION OF AMERICA

RCA LABORATORIES · PRINCETON · NEW JERSEY

RCA leads the way in radio—television—electronics

RCA

TUNE IN! . . . RCA's great new show, 7:30-8:00 P.M. EWT, over the Blue Network, every Saturday ★ BUY WAR BONDS EVERY PAY DAY ★

to unreliability of the spark—a phenomenon in the realm of electronics. Dr. Weiller pointed out that to be dependable, electronic control instruments must be designed with components rated for large factors of safety,—quite unlike the $9.95 commercial radio set.

The talk was followed by discussion and demonstration of a number of electronic control and research devices designed and constructed at the Kollsman laboratory.

Dr. Weiller is a metallurgical engineer graduated at Charlottenburg, Berlin, in 1908, and has had long experience in steel mills, copper smelters, and in explosives. From designing vacuum tubes and tube-making machinery for Westinghouse after World War I, he turned to the manufacture of welding and other electronic controls in 1928.

Maintaining Electronic Heat Equipment

Special installation and maintenance requirements for electronic heat-processing equipment were outlined by S. Walden Shaw, RCA field engineer, at the March meeting of the Electrical Maintenance Engineers Association of Philadelphia. Members of the Power Maintenance Association of South Jersey also met.

While installation of electronic power generators is relatively simple, Shaw said, the high voltages and high frequencies employed must be taken into account in selecting equipment and installing coupling circuits and applicator assemblies.

One factor is that high-frequency currents travel only on the surface of a conductor, he pointed out. Coupling circuits, therefore, must be made from tubing or pipe with a relatively large surface area. The surface of a pipe 2½ in. in diameter might be required, for example, to carry high-frequency currents of an amperage which, at low frequency, could be carried by a ¼-inch solid conductor.

Avoid sharp edges

Another consideration is the avoidance of points or sharp edges in the design of electrodes, in order to minimize the tendency of high voltages (often from 10 to 20 thousand volts) to form an arc from the edge of one electrode to the other. To avoid such short-circuiting of the material which has been placed between the electrodes for heating, voltages must be limited by the thickness of the load assembly.

Once installation is completed, Shaw said, the most serious responsibility of the plant maintenance man is to see that dust accumula-

tions are prevented by periodic cleaning of all parts of the set-up, and to check meter readings for any substantial deviation from standard.

Dust troubles

Dust containing either metallic particles or moisture may cause arcing if permitted to accumulate, he explained, while off-standard readings appearing on any of the meters on the generator may indicate the need for suspending operation of the equipment until adjustments are made.

The excitation, filament voltage, and high-frequency output power control settings are normally determined at the time of installation, he said, and there is little occasion to employ others except when setting up for an entirely different work load. Efficient operation, he pointed out, demands that the best control settings be determined for each new load.

Newspaper Men Study FM

Growing interest among newspaper publishers in the development of frequency modulation broadcasting prompted the American Newspaper Publishers Association to set aside an entire session of its annual membership meeting in New York April 27 to a discussion of the subject.

Dr. W. R. G. Baker, chairman RTPB, and Walter J. Damm, president of FM Broadcasters, Inc., and vice-president of the Journal Company, Milwaukee, Wis., accepted invitations to address the session of the convention. An FM educational film was also scheduled to be shown and a part of the session was to be devoted to general question-and-answer discussion.

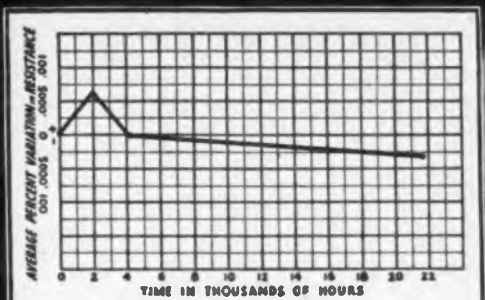
Newspapers have taken an active part in the development of FM to date. After the establishment of some fifty stations—many by newspapers—the war virtually stopped new construction. Now 125 applications for permission to build new stations are pending before the FCC. More than half of these have been filed by newspapers or companies having newspaper affiliation.

Noise Abatement Week

The first week of May has been set aside as Noise Abatement Week by the National Noise Abatement Council, 9 Rockefeller Plaza, New York, N. Y. Many cities are cooperating to reduce needless noise as a means of speeding up workers' efficiency and the war effort.

Prof. H. E. Reilley, of McGill University, Montreal, declares the cam-

CAN YOU MATCH THIS RESISTANCE STABILITY *in any other "commercial" meter multiplier?*



Here is the result of a 2½-YEAR CONTINUOUS LIFE TEST

About two and one-half years ago, some of the first Sprague Koolohm Meter Multipliers taken from production were put on continuous life test. These were measured periodically, and were just recently taken off test at the end of 21,747 hours. The above curve shows a typical result achieved on two standard Type MFB 1.5 megohm ±0.5% units tested at their rating of 1500 volts, 60 cycle A.C.—*a practically negligible change in resistance value after two and one-half years of continuous operation.*

Although this particular data is based on the operation of Type MFB units, it is entirely characteristic of all Sprague Koolohm Meter Multipliers. All are wound with the exclusive Koolohm ceramic insulated wire, and all receive our special voltage and thermal aging process.

All show resistance stability comparable to that illustrated here for the Type MFB.

WRITE FOR CATALOG

Other Sprague Koolohm Resistor types include both standard and hermetically sealed power wire wound types up to 120 watts; 10- and 15-watt voltage divider sections; bobbin-type resistors; and Megomax high-voltage, high-temperature resistors.

SPRAGUE SPECIALTIES CO.
Resistor Division
NORTH ADAMS • MASS.

SPRAGUE KOOLOHM RESISTORS AND CAPACITORS

paign has been found necessary because most people do not realize that prolonged exposure to noise of high intensity can ruin health. "Your digestive system, your hearing, your blood pressure, your whole nervous system can be deranged," he said. "Exposure to noise when you are working causes accelerated fatigue and abnormal absorption of energy. These facts have been proven over and over again by medical research and are accepted without question."

In Chicago, a window sticker—"Quiet Please, war worker sleeps here"—has been made available for the homes of all war workers. Night workers who sleep during the day are expected to be the principal beneficiaries of this window card.

Physical Society Electronic Discussions

The program of the Pittsburgh meeting of the American Physical Society on April 28 and 29, was scheduled to include several topics of interest to electronic engineers:

Amplifier with logarithmic response; J. A. Hipple and D. J. Grove, Westinghouse Research Laboratories.

Magnetic permeability at very rapid rates of change of induction; H. L. Glick and Sidney Siegel, Westinghouse Research Laboratories.

A resonant cavity method for measuring dielectric properties at ultra-high frequencies (50-1000 megacycles); C. N. Works, T. W. Dakin, and F. W. Boggs, Westinghouse Research Laboratories.

Apparatus for the determination of dispersion at supersonic frequencies; L. N. Liebermann, University of Kansas.

Precision measurement of the velocity of sound at supersonic frequencies using a microphone.

Paths of electrons and ions in non-uniform magnetic fields; N. D. Coggeshall and M. Muskat, Gulf Research and Development Company.

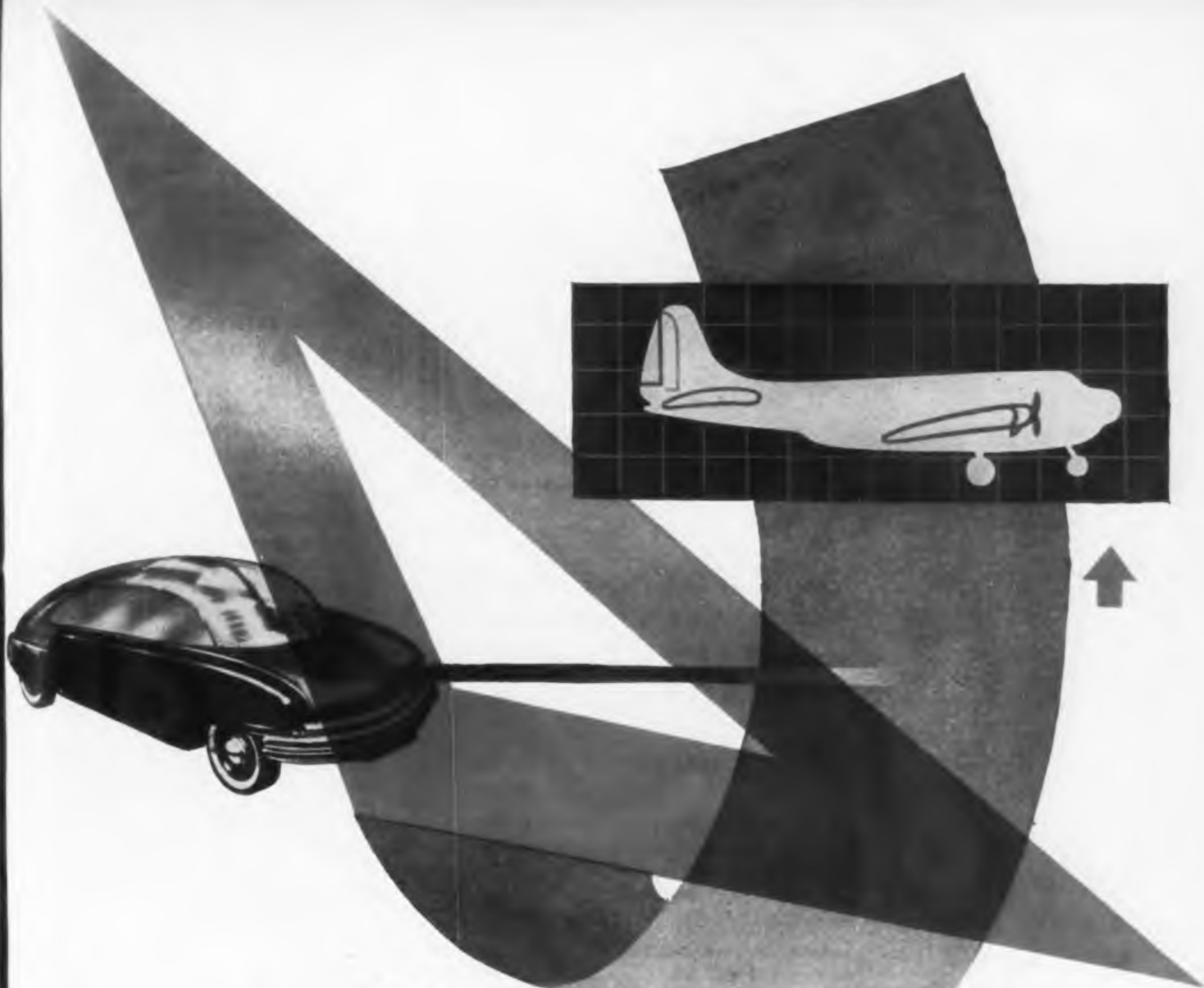
Energy distribution of electrons within dense electron beams; C. J. Calbick, Bell Telephone Laboratories.

Limiting stable current in electron beams in the presence of ions, J. R. Pierce, Bell Telephone Laboratories.

Mass spectrometer with a small magnet; R. E. Fox, J. A. Hipple, and T. W. Williams, Westinghouse Research Laboratories.

The reversed cyclotron; Laurence Ellsworth Dodd, University of California at Los Angeles.

Portable demonstration electron microscope; Igor Bensen, General Electric Company.



PLASTICS for post-war planning

"Cat's head," they call it. The core is Phenol Fibre—to eliminate moisture absorption and to increase dielectric strength. But because an electric arc will not carbonize Vulcanized Fibre, the front and back of the Cat's head are made of Vulcanized Fibre.

While there is still a war to be won, your principal concern, as well as ours, is to produce products that will speed victory. We are all giving our maximum attention and production-capacity to that vitally important objective.

But even the most pessimistic will agree that it is not too soon to *plan* and *think* for the post-war reconstruction period. Peace will dawn with the suddenness of a raised curtain and only those who are prepared for it will be able to swing into profitable, peace-time production with the minimum delay.

Figuring prominently in many a *profitable*, peace-time venture will be the intelligent use of Vulcanized Fibre and Phenol Fibre. In the design, application, and production of such products, Taylor Fibre is unsurpassed, thanks to Taylor's Verifibre Process in which quality is controlled step by step, from raw materials to finished product, in the industry's most modern plant.

Now—before the curtain goes up on a bright, new world, discuss your post-war plans with our engineers. *Now* is the time to Take it to Taylor.

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Dr. A. H. Taylor Gets Medal for Radar

Dr. Albert Hoyt Taylor, chief physicist of the Naval Research Laboratory, Washington, D. C., is the recipient of one of the two first awards of the Medal of Merit in recognition of exceptionally outstanding services in his discovery and development of radar. Secretary of State Hull presented the medal.

"Rock Island" RR Testing UHF

Communication between the front and rear ends of trains, and between train crews by use of radar and other electronic devices is being tested on the Chicago, Rock Island & Pacific Railway, reports the Associated Press.

The railway company is planning to develop a radio communication system in the micro-wave region. Many bands are available for use in channels for communication.

The railroad has appointed Ernest A. Dahl, electronic engineer, to direct the investigation and experiments. Immediate plans are for the development of radio communication between front and rear ends of trains, in yards between office and switching crews, and ultimately between dispatcher and train crews. Experiments in the use of radar for safety devices will be made.

FM Communications Highly Successful During Landings

The role of radio in military field communications during the Sicilian campaign was of a high order and formed the nerve centers of the fast-moving army that swept the Axis forces from Sicily in 38 days. This was revealed in reports by signal and communications officers of units of the Seventh Army which were transmitted to Major General H. C. Ingles, Chief Signal Officer of the U. S. Army.

"When radio silence was lifted" after the sea invasion forces got off shore, a report from the Seventh Army Headquarters stated, "all radio sets were quickly established and communications remained excellent during the landing phase of the operation." (These reports from Sicily were deemed especially significant in view of the impending operations in Europe.)

"Frequency-modulated sets provided to the divisions and lower units worked very successfully during the landing phase," the Seventh Army Headquarters report declared. "Radio Sets SCR-299 were used successfully in the operation. They provided the most reliable high-

All-Purpose Pocket Size Volt-Ohm-Milliammeter

A new modernistic styled, compact unit that provides an answer to all Volt-Ohm-Milliammeter requirements. Incorporates all the testing facilities of larger, more costly equipment. A.C. and D.C. Volts 0–2.5–10–50–250–1000–5000 (D.C. at 10,000 ohms per volt; A.C. 1000 ohms per volt); 0–.1–1–10–100–1000 D.C. Milliamperes, at 100 millivolts; 0–10 D.C. amperes at 100 millivolts; Resistance 0–400 Ohms (10 ohm center scale); 0–40,000 ohms (500 ohms center scale) 0–4 Megohms (50,000 ohm center scale). Self contained batteries. Selector switch control for all ranges.

Completely insulated black molded case and panel, attractive streamlined design. (Leather carrying case also available to hold tester and accessories.)

The Triplett Line—more comprehensive than ever—goes today for war needs but its exacting services in war assure you the final answer for post-war equipment requirements.

Battery slides into place. Easily inserted or removed.

Triplett

ELECTRICAL INSTRUMENT CO.
STANDARDS ARE SET BY TRIPLETT
BLUFFTON OHIO ★ ★ ★

Twenty position selector switch control for all ranges.

powered radio communications."

The report contained other details as follows:

Interference required CW

"The Division Commander's net utilized an SCR-188 and SCR-193's in quarter-ton trucks. This net linked up the Division Commander, the Deputy Commanders, the Assistant Commander for staff intelligence officers, and three Regimental Commanders. These vehicle-mounted sets were all landed without loss of a single set. Although this net was maintained for personal voice contact between the Division Commanders and for staff officers, radio interference conditions made it necessary to operate on cw (continuous wave) most of the time."

In describing another phase of the use of radio, a Signal officer of the Seventh Army declared in his report that "High-powered radios in amphibious vehicles were tried and used successfully in this operation. They provided the most reliable early communications that we had. The most useful vehicle we have found equipped with radio has been the quarter-ton truck on land. The set used was the SCR-193."

Amphibious equipment

"Amphibious envelopments by a battalion landing team were executed at San Agata and Brole," said a report from a Division Commander. "Radio contact with these landing forces was maintained on shipboard and established and maintained ashore within one hour after landing. Two SCR-193's in quarter-ton trucks served admirably for this purpose. They were able to follow the battalion from the beach to its objectives on high ground where larger vehicles could not go. On one occasion when the Infantry operated at a hill position where no vehicle could follow, the officer and operator with the set displayed extraordinary courage in continuing to operate the set from an exposed position on the flat ground outside the main lines."

The commanding officer of a Signal Company, reporting the activities during the middle of August, told how "a radio set SCR-193 mounted in a quarter-ton jeep and a radio set SCR-284 were assigned to a unit operating in mountainous terrain where it was necessary to hand-carry the SCR-284 to some points where vehicular transport was an impossibility. In these instances radio communications were maintained by relay through the SCR-193 located somewhere in the rear."

A Third CITATION

FOR THE INSTRUMENT LEADER

. . . FOR MERITORIOUS WAR PRODUCTION

This third citation for meritorious war production . . climaxing a long record of war service . . . is a source of justifiable pride to the men and women of WESTON.

The record began back in the earliest days of our defense period, when a large segment of WESTONS' capacity was assigned to the production of instruments vital to military needs. Thus, when we finally were forced into this world struggle, WESTON was ready for *full-scale war production.*

This new star which adorns our "E" pennant marks the *third* time WESTON has been *first* in this highly specialized field to receive each successive war citation. Weston Electrical Instrument Corporation, Newark 5, New Jersey.

Laboratory Standards . . . Precision DC and AC Portables . . . Instrument Transfomers . . . Sensitive Relays . . . DC, AC, and Thermo Switchboard and Panel Instruments.

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Specialized Test Equipment . . . Light Measurement and Control Devices . . . Exposure Meters...Aircraft Instruments... Electric Tachometers...Dial Thermometers.

FOR OVER 55 YEARS LEADERS IN ELECTRICAL MEASURING INSTRUMENTS

"Conveyor-Belt" Radio System

Government radio engineers continue to launch "trial balloons" from Washington to get public reactions on their proposal for a "radio trunk line" or "radio conveyor belt" for international communication. The system would be made up of eight powerful relay stations girdling the globe at a latitude about 20 degrees north of the equator. This would be theoretically far enough from the equator to get away from the tropical dampness which raises hob with electrical equipment, yet far enough south to avoid polar magnetic disturbances, the bane of radio transmission. (See also page 192, our January, 1944, issue.)

Tentative station locations are: San Juan, Puerto Rico; Tenerife, Canary Islands; Alexandria, Egypt; Bombay, India; Hong Kong, China; Guam; Honolulu, H. I., and Mexico City, Mexico.

How it would work

Overseas phone calls and radiograms from the eastern sections of the U.S. and Canada for London or Paris would go via high-powered stations in New York, Miami, or New Orleans, through Puerto Rico and the Canaries to destination. Calls from the western sections would be beamed via San Francisco to Mexico City, or via New Orleans to Puerto Rico; calls from Santiago, Chile, would go via Mexico City; those from Rio de Janiero, via the Canaries; calls for Berlin or Moscow would go via Egypt.

Experts of the FCC declare the plan to be technically possible in the present state of the radio art. Still to be heard from are the international diplomats and financiers whose services would have to be called upon before the "conveyor belt" system could become a postwar actuality.

Sees Peril in Nazi Radio Bombs

John Hays Hammond, Jr., internationally known inventor and holder of patents on radio-controlled bombs similar to those being used by the Germans, was quoted recently as saying in Boston he believed the Nazis have only been practicing with the projectiles and that their full force would be felt later, the AP reports.

"My feeling is," he said, "that perfection of this device by Germany would imperil the British fleet. The fleet versus glider bombs could be the next phase of this war —it could be glider bombs against the combined Allied fleets.

"No shipping will be safe if the Germans perfect this type of warfare, excepting those ships which can stay out of reach."

Hammond's prediction was described in London as "visionary and exaggerated out of all proportions", by one British expert.

Use of Quartz Crystals Relaxed

The number of permitted uses of quartz crystals, previously only available in the manufacture of radio oscillators and filters for war purposes and a few other military items, has been increased by the War Production Board through an amendment to General Conservation Order M-146 as the result of an easier supply-demand situation.

The new permitted uses are the utilization of quartz crystals for manufacture of radio oscillators and filters for governmental activities, directly connected with defense, public health, welfare or security and for commercial broadcasting stations and other commercial communication systems. The production of radio oscillators and filters for governmental activities will permit the police, forestry services and similar activities in which radio plays an important communications role to get the quartz radio parts they need. The manufacture of optical or electrical parts using quartz crystals for use in research of production instruments manufactured to fill orders rated AA-2X or better, also is permitted.

Made in Japan!

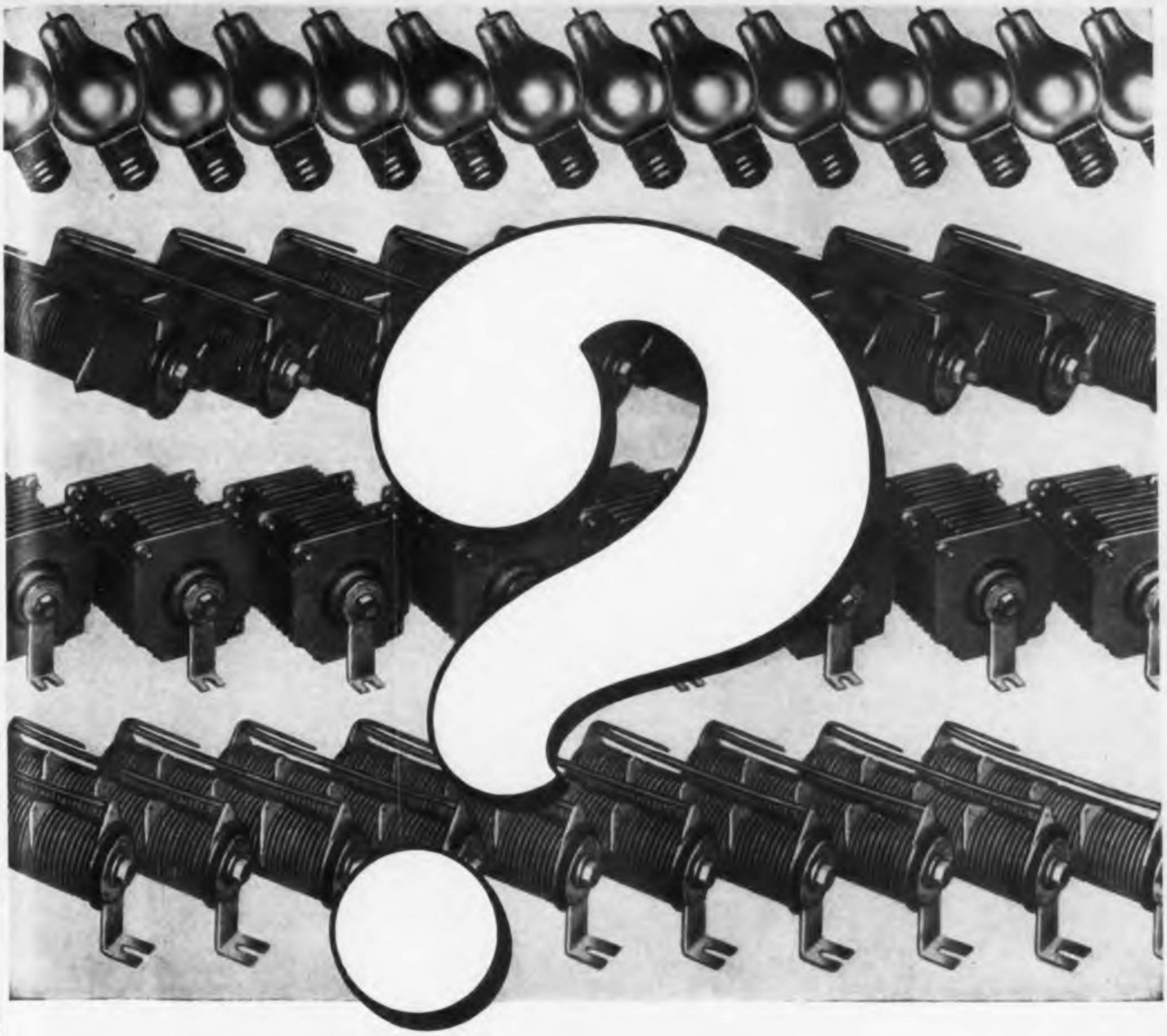
Mr. Tojo and his children are certainly proving the greatest imitators in the world.

This is a story brought back from the Southwest Pacific by Major General Ingles, Chief Signal Officer. The American troops were incensed at one time when they captured a Japanese radio station with tubes having the RCA trademark. But the tubes and the entire set, they soon found, had actually been made in Japan.

The little Nipponese were not merely content with copying the American design. They even reproduced the RCA markings.

Electron Micrographs of Mine Dust

Drilling and blasting operations produce silica dust in the air of a mine. If this dust is breathed into the lungs over a long period of time, the condition known as silicosis, which is a serious disease among miners, is set up. The drilling dust appears to be more harmful in its effect than the blasting



Are You Keeping Up-to-Date

ON LOW-VOLTAGE RECTIFIERS?

1. Name the three most commonly used types of low-voltage rectifiers.

2. In what respects do they differ?

3. What is the best way to decide which type to use for a specific job?

4. Name the only designer-manufacturer of all three types.

5. What engineering-service benefit does the rectifier user get when he consults a company that offers him all three types of rectifiers?

(Turn to page 313 for the answers.)

GENERAL ELECTRIC

dust, but no significant difference between the two could be discovered by ordinary methods.

In the November, 1943, issue of the Canadian Journal of Research, John H. L. Watson reports electron microscopic investigation of the particle size in mine dust. The distribution of particle sizes in the two types of dust was studied and from electron micrographs it could be concluded that the percentage of particles with diameters less than 0.20μ is much greater in the drilling than in the blasting dust.

AT&T to Try UHF Repeater Links

Plans for experimental operation of a series of ultra-high-frequency radio relay links between New York and Boston, for conveying both television programs and multiple telephone conversations, are revealed in applications just made by AT&T to FCC for the necessary frequencies.

Three groups of frequencies are requested: 2000 megacycles; 4000 megacycles, and 15,000 megacycles. Four bands in each group are applied for. Actual frequency group to be finally used is not yet determined, but will be fixed by experiments made with the several bands. Carrier power is specified as 2 watts for each transmitter. Highly directional radiating and receiving antenna systems will make this low power practical.

The new system will be operated by radio relays of a type which was under development by the Bell Telephone Laboratories prior to the war. This system applies to communication by radio many of the techniques which have played an important part in the development of long-distance wire telephone circuits. Directed radio beams at ultra-high frequencies will operate simultaneously in both directions and these will be relayed at stations spaced at an average of about 30 miles throughout the route. It is hoped that, ultimately, each radio beam will carry up to 100 telephone communications channels.

First commercial service

This is the first plan for a system of this type to handle regular commercial long-distance telephone messages over land within the United States and it is believed that it will be the first to handle commercial communications services anywhere in the world.

This project also represents another step in the march of radio telephony to utilize shorter and shorter wave lengths. Overseas commercial radio telephony to England was initiated by the Bell System in 1927 using very long waves. Soon afterward "short waves" were developed for trans-ocean telephony and today, except for the war, it is possible to talk from any telephone in the United

"Connecticut Tel." Host to Celebrities

When the War Manpower Commission hailed Meriden, Conn., as "the nation's ideal war community" this group visited the Meriden plant of Connecticut Telephone & Electric Division of Great American Industries, producers of radio and electronic devices for the armed forces. Left to right: Gov. Raymond Baldwin of Connecticut; WMC Chairman Paul V. McNutt; Luise Rainer, film star; Francis T. Maloney, U. S. Senator from Connecticut; Harold W. Harwell, president of Great American Industries, and Walter F. Skillen, vice-president. Probable cause of broad smiles—antics by radio comedian Jimmie Durante who accompanied party

How to Outflank a Future Flaw

BOOBY TRAPPED!

Have you read the Hunter Data Book? Copies of this book—crammed with helpful engineering data on the design and performance of springs—are at the elbow of engineers working on war products. Much of this information can't be found elsewhere. Your signature on your company letterhead will start a copy your way—at no cost to you.

MAYBE you're not thinking about the future as you read this ad. But suppose you are—and you have a world-beater of an idea cooked up for post war release. Into it you've poured midnight oil, imagination, and just plain sweat. To make it work let's say you need one or more springs. Now, springs are usually inconspicuous little parts, so there is a temptation to underrate them. We hope you won't make that mistake because guesswork and luck don't make the kind of springs you can depend on. No, the springs you want should be as meticulously designed as your product or machine. Hunter (and other good springmakers) brings to focus on your spring a thorough understanding of the mathematics and metallurgy of springs, years of experience and research, ingenious methods of testing and inspection . . . and often specially devised instruments and exhaustive reports diagnosing or predicting spring performance. In a critical spring the scientific springmaker never guesses. That's why we can say confidently you can stake your reputation on a Hunter Spring.

QUALITY CONTROL OF SPRINGS AT VARIOUS STEPS IN MANUFACTURE. *At Hunter—all precision springs are subjected—throughout the various manufacturing stages—to quality controls based on statistical methods. The normal distribution curves (below) illustrate the progressive decrease in deviation and corresponding increase in precision in these manufacturing steps. The quality control chart (ASA standards), used in conjunction with larger scale periodic sampling during manufacture, detects or predicts manufacturing variations, eliminates waste, assures you springs which are okay for your application.*

HUNTER PRESSED STEEL COMPANY, LANSDALE, PENNA.

States to more than 70 foreign countries and to any of more than 95 per cent of all the telephones in the world.

Using still shorter waves, only two or three meters long, which do not travel much beyond the horizon, radiotelephone service was established just before the war across Chesapeake Bay between Norfolk and Cape Charles, across Massachusetts Bay between Boston and Provincetown, and between the mainland and Smith and Tangier Islands in Chesapeake Bay.

The new project proposes to use microwaves which are shorter than have heretofore been used for commercial telephony.

Radio vs. coaxial

The principal purpose of the trial is to determine by practical operation in commercial service the relative advantages and disadvantages of radio relays in the transmission of long-distance messages and television programs, compared with transmission by the familiar wires and cables and coaxial cables. Relative costs represent only one of the factors to be determined; others include the relative quality of transmission, flexibility under actual operating conditions, and dependability.

Postwar plans were recently announced for a country-wide extension by the Bell System, by about 7,000 miles, of its coaxial cables suitable for telephone service and the transmission of television programs. According to telephone officials, it is hoped that the new radio system will prove to be valuable as an additional means of meeting the nation's telephone and television communications requirements. Plans will be worked out to tie together the new Boston-New York radio system, with the New York-Washington coaxial-cable line, to give a continuous wide-band channel for television from Washington to Boston.

Wright Succeeds Thomson At Western Electric

Philip L. Thomson, director of public relations of the Western Electric Company, retired under the Company's pension plan on April 1, after 41 years of service. He is succeeded by Fred B. Wright, an executive of the company's nation-wide distributing organization.

Mr. Thomson joined Western Electric in 1903 after receiving degrees from Union College and from Harvard. He rose through the ranks, becoming manager of the company's distributing house at Pittsburgh in 1905 and, in 1911, advertising manager at New York head-

ADLAKE *Plunger-type* MERCURY RELAYS

Snap Action

That Stays "Snappy"!

MERCURY moves *fast.* You know that because you've seen it in action. Due to this inherent characteristic of mercury, Adlake plunger-type *mercury* relays provide the *snap action* so desirable in a relay when contact is made—or broken.

There is positively no tendency toward "molasses in January" operation in these relays. Their action is "snappy" and it *stays "snappy"!*

Adlake Model 1040

For panel mounting. This relay can be supplied with either quick or time delay action; normally open or closed; and for a.c. or d.c. energization. Contact ratings up to 100 amperes a.c. with proportional d.c. ratings.

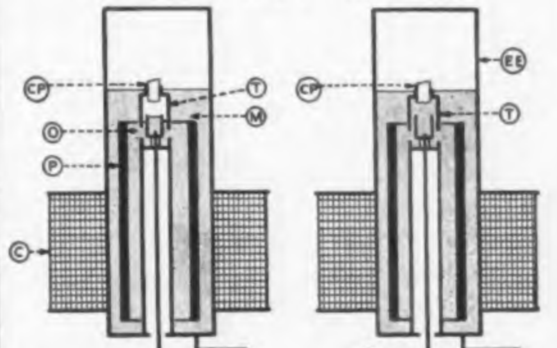
Hermetically Sealed Contact Mechanism

Contact mechanism of Adlake plunger-type mercury relays is hermetically sealed in an *armored* glass or metal cylinder. Dirt, dust, moisture, or oxidation cannot interfere with operation—*in any way or at any time.*

The *liquid* metal mercury contact is positive in action, chatterless, silent, and impervious to burning, pitting, and sticking.

For many kinds of service, no other type of relay provides equal *stamina* and *dependability.* Request complete bulletin.

HOW THEY WORK



ENERGIZED—*Coil C pulls plunger P down into mercury. Mercury thus displaced enters thimble T through orifice O. Inert gas in thimble gradually escapes through ceramic plug CP—thus producing time delay.*

ENERGIZED—*Mercury now fills thimble T, is completely leveled off and mercury-to-mercury contact established between electrodes E and EE. Degree of porosity of ceramic plug CP determines length of time delay.*

"BACK THE ATTACK—BUY BONDS"

Adlake TRADE MARK

THE ADAMS & WESTLAKE COMPANY

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

MANUFACTURERS OF ADLAKE SPECIALTIES AND EQUIPMENT FOR RAILWAY, AIRWAY, HIGHWAY, AND WATERWAY

quarters. In this capacity, he directed all of the company's public relations activities, a responsibility he continued to discharge during the ensuing 33 years.

Thomson heads ABC

Since 1925 Mr. Thomson has been a director and since 1927 president of the Audit Bureau of Circulations, the organization devoted to the self-regulation of the publishing and advertising business. Its membership embraces the principal operators in both fields. Following several years as a director, Mr. Thomson was president of the Association of National Advertisers in 1923 and 1924. He was also active in the affairs of the Advertising Federation of America.

Mr. Wright takes up his new responsibility with a long background in the field of distribution and sales. After graduating from the University of Vermont he entered the General Electric Co. for a short period and then returned to the University for three years as instructor.

Wright entered WE in 1910

In 1910 Wright entered the Western Electric Co. and later served six years with the Western Union Telegraph Co. In 1916 he went to St. Albans, Vt., becoming president of the Foundry Motor Car & Manufacturing Co. and of the Missiquoi Lime Works. He had charge of manufacturing supplies at the U. S. Government Arensal at Watervliet, N. Y., in 1918.

Mr. Wright reentered Western Electric to make special studies of its contract sales in 1922. This led to his appointment as head of one of the company's distributing houses, at Baltimore, Md. Subsequently, he successively became manager of the Washington and Chicago houses. In 1928 Mr. Wright came to headquarters in New York as program planning manager, becoming general manager of distribution in the East in 1935 and eastern zone manager in 1942.

C. S. Powell Graybar VP

Charles S. Powell has become a vice-president and director of the Graybar Electric Company, with headquarters at New York. Mr. Powell was an officer and pilot in the U. S. Air Service during World War I. His 30-year experience with Graybar covered assignments including: telephone, radio and appliance specialist at Omaha and St. Louis, manager at Nashville, Tenn. branch, manager at Louisville, Ky., telephone sales manager at New York, New England district manager at Boston and, returning to

The Black Hand of Corrosion Can Come from the Skies!

Humidity, which settles on and in electrical equipment, is the forerunner of corrosion that disrupts communications and impairs the operation of electrical instruments and services.

That is why it is so important to use an insulation material which is resistant to electro-chemical oxidation when in the presence of current-carrying copper wire and moisture.

Lumarith (cellulose acetate) is big in the news today because it is resistant to the corrosive influence of moisture. In foil, film, molded and other forms, it is the ideal insulator for coils, tubes, bobbins and other electrical parts.

The Celanese Celluloid Corporation's research department has prepared a booklet outlining the properties of Lumarith dielectrics. The information you will need: dielectric strength, resistivity, power factors, etc. is readily available within its pages. Write for your copy. Celanese Celluloid Corporation, *The First Name in Plastics*, 180 Madison Avenue, New York City 16, a division of Celanese Corporation of America, sole producer of Lumarith and Celluloid plastics. *Representatives:* Dayton, Philadelphia, Cleveland, Chicago, St. Louis, Detroit, Los Angeles, Washington, D. C., Leominster, Montreal, Toronto.

*Reg. U. S. Pat. Off.

LUMARITH PLASTICS . . IN FILM . . FOIL . . MOLDING MATERIAL AND OTHER FORMS

A CELANESE PLASTIC

TUNE IN The Celanese* Hour—*"Great Moments in Music"**—Columbia Network, Wednesdays, 10 P. M., E. W. T.

headquarters at New York in September, 1943, as manager of the communications and merchandising departments. Mr. Powell will continue to head up all Graybar sales activities in communications and merchandising lines.

General Radio's New Officers

Melville Eastham, who in 1915 founded General Radio Co., Cambridge, Mass., has just retired as president but will continue temporarily in charge of research and development with the title of chief engineer.

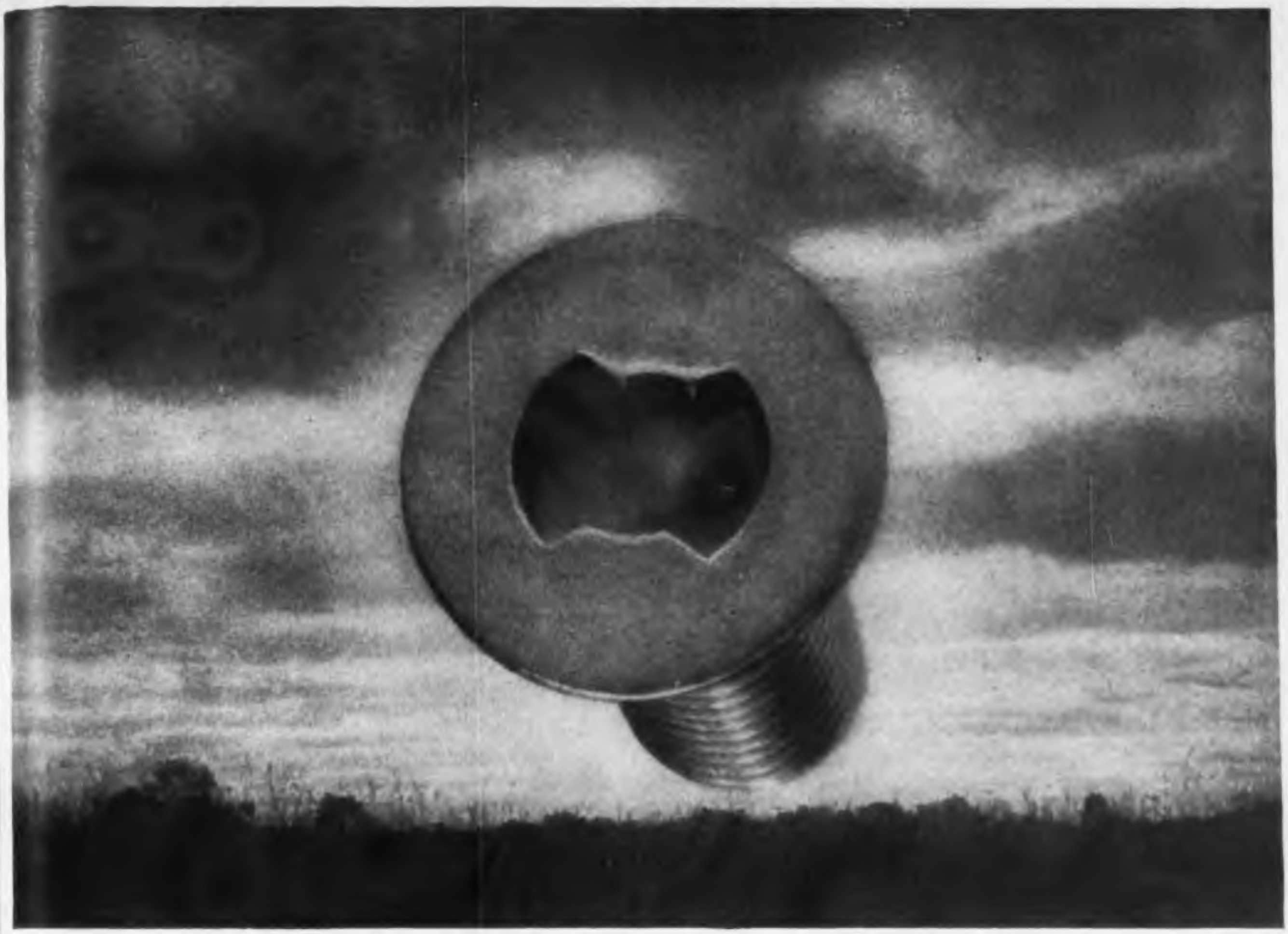
Henry S. Shaw is retiring as chairman of the board, and is succeeded by H. B. Richmond, who also becomes chairman of the management committee.

Errol H. Locke is the new president. Mr. Locke is a graduate of Harvard and before joining General Radio during World War I, was in the investment banking business.

Frank L. Tucker, the new treasurer, received his B.S. degree in electrical engineering from the University of Texas in 1927, and his M.B.A. degree from the Harvard Graduate School of Business Administration in 1930. He came to the General Radio Company as statistician in 1934 and was appointed comptroller in 1937.

Arthur E. Thiessen, vice-president in charge of sales, graduated in engineering from John Hopkins University in 1926. For a time with Bell Telephone Laboratories, he left there in 1928 to join the engineering staff of General Radio. For the next several years he was engaged

H. B. Richmond, who has been elected chairman of the board of directors of General Radio Co., Cambridge, Mass., following the retirement of Henry S. Shaw and Melville Eastham as officers of the company



New Horizons in assembly line production have been brought into focus by the advent of CLUTCH HEAD Screws . . . opening the way to new degrees of speed, safety, simplicity, and economy.

What other screw invites operator confidence and speed with a recess bull's-eye target so wide and so easy to hit?

What other screw has a straight-walled recess engineered to reduce end pressure for a safe effortless drive home?

What other screw matches the CLUTCH HEAD Lock-On feature which unites screw and bit as a unit for free one-handed reaching to hard-to-get-at spots?

What other driver approaches the economy of the rugged CLUTCH HEAD Type "A" Bit for long continuous service and simplified 60-second "on-the-spot" reconditioning to original efficiency?

In field service too . . . What other recess has the logical design that makes it operative with the ordinary type screwdriver: even with a piece of flattened steel rod in emergency? And what other than the Type "A" Bit makes it possible to withdraw screws undamaged and saved by the Lock-On for re-use?

That you may personally examine and test these exclusive features, United invites you to send for package assortment of CLUTCH HEAD Screws and sample Type "A" Bit; also fully illustrated Brochure.

CLUTCH HEAD SCREWS

UNITED SCREW AND BOLT CORPORATION

CHICAGO CLEVELAND NEW YORK

in both development engineering and sales activities, becoming commercial engineering manager in 1937.

Charles C. Carey, vice-president in charge of manufacturing, joined the General Radio organization as a winder in 1927. In 1935 he was appointed production superintendent, holding that post until recently elected vice-president.

Charles T. Burke, engineering manager, received his B.S. and M.S. degrees from the Massachusetts Institute of Technology in 1924. After graduation, he joined the engineering staff of General Radio. Since that time his activities have included engineering, publicity, sales, and export. He was editor of the "Experimenter" from 1927 to 1929, and was appointed engineering manager in 1933. He has been a member of the management committee since 1939, and was appointed chairman of the scheduling committee in 1943.

Army-Navy "E" for Superior Tube

Under Secretary of War Robert P. Patterson has notified S. L. Gabel, general manager of Superior Tube Company, Norristown, Pa., of the award to the company April 1 of the Army-Navy "E" for production excellence.

Batteries for Armed Forces

The Signal Battery Company, new Ray-O-Vac subsidiary in Milwaukee, Wis., announces the appointment of J. C. Ryan as vice-president and general manager. Mr. Ryan was formerly associated with Ball Bros., Muncie, Ind., and is thoroughly acquainted with manufacturing methods of the battery industry.

The Signal Battery Company will make batteries for the U. S. Army Signal Corps, particularly multiple cells used in portable radio equipment. The other officers and directors of the new company are executives in the Ray-O-Vac organization, which also operates plants in Clinton, Mass., Lancaster, Ohio, and Sioux City, Ia.

Dr. Goldsmith's New Offices

Dr. Alfred N. Goldsmith, consulting engineer, has announced the new location of his offices for technical consultation and the practice of engineering relative to research, development, patents, and commercialization of radio, motion picture, electrical, and optical devices and processes at 597 Fifth Ave., New York 17, N. Y., suite 804.

CONTROL...

COMPRISE MANY DIFFERENT TYPES . . .
WITH A WIDE VARIETY OF APPLICATIONS

There are many commercial and industrial fields to which control devices may be applied. These may be electrical, electronic or mechanical, depending upon the specific problem. The exact type of control is determined by our engineers after thorough study of the particular application. The devices may be made sensitive to changes in position, direction, pressure, temperature, time, voltage, current, humidity, light intensity or color. EAD not only builds control equipment to fulfill existing requirements but also builds special-purpose devices for which no previous specifications exist. EAD makes components such as motors, relays, generators, switches, instruments, electrical parts, as well as complete equipment. EAD specializes in working with manufacturers of equipment to develop and supply special components with particular emphasis on light weight and compactness. EAD has the ability and facilities to design and manufacture precision control devices and components.

Inquiries Invited

EAD

EASTERN AIR DEVICES, INC.

An Affiliate of* THE FRED GOAT CO. INC., *Special Machinery Specialists Since 1893

589 DEAN STREET BROOKLYN 17, N. Y.

Rahm in New York

The offices and industrial division of Rahm Instruments, Inc., now occupy new quarters at 47 West Fifty-sixth St., New York. Later all other manufacturing facilities of this company will be moved to the new address.

Utah Engineers Head Sales Also

Fred R. Tuerk, president of the Utah Radio Products Company, announces that W. A. Ellmore, vice-president in charge of engineering, assumes the additional duties of heading the sales department owing to the resignation of Oden F. Jester, vice-president in charge of sales, who becomes vice-president of Meissner Manufacturing Co. Well known in the radio industry, Mr. Ellmore has been with the Utah Radio Products Company for fifteen years.

Chester L. Walker, formerly chief engineer of Utah, has been promoted to sales manager in charge of manufacturing and equipment division. Robert M. Karet continues as sales manager of the wholesale and sound division and Frank E. Ellithorpe continues as sales manager of the Carter division.

Marion S. Danisch will become chief engineer. Danisch is well known in radio engineering circles, and has been identified with the industry for sixteen years. His experience includes a number of years as chief engineer of Ucoa Radio Sociedad Anonima, South American affiliate of the Utah Radio Products Co.

Gordon S. Carbonneau, who has been Production Engineer of the Utah Radio Products Co. for many years, has been appointed to new duties as engineer in charge of the quality control division.

W. A. ELLMORE

Utah Radio Product Company's vice-president in charge of engineering who now takes over general sales responsibility as well


Hidden Improvements
There's Engineering History Behind Every TAYLOR TUBE!
When transmitting tubes go into action, there is little to be seen of the forces that make it possible to carry out the vital commands of America's Fighting Men. Like other weapons of war, their efficiency and dependability is a direct reflection of engineering improvements—advanced technical developments that provide our Armed Forces with the world's finest communications. Taylor improved custom-built tubes are today helping defeat the enemy in every battle area. After Victory, these Taylor improvements will be ready for peacetime applications.
Buy More WAR BONDS For Victory!
810
Taylor
HEAVY
CUSTOM BUILT
DUTY
Tubes
TAYLOR TUBES, INC., 2312-18 WABANSIA AVE., CHICAGO, ILLINOIS

Meck Plans Radio Receivers

Following design and development work on postwar radio receivers, John Meck Industries, Plymouth, Ind., has recently been issued an RCA license to manufacture the sets, according to a statement from Mr. Meck. For the past several months, an internationally famous firm of industrial designing engineers has been working closely with Meck draftsmen in the preparation of streamlined models with popular eye-appeal for modern tastes.

Ralph Glover, Consulting Engineer

Ralph P. Glover has announced his resignation from Webster Products Co., Chicago, where he was in charge of engineering-sales coordination, as well as manager of the voltage-regulator division, to devote himself to consulting engineering, with offices at 1024 Superior St., Oak Park, Ill. He will specialize in product development and product management counsel in the electronic, electroacoustic and radio fields.

Upon graduation from the electrical engineering course at the University of Cincinnati, he joined Crosley Radio Corp. He was active in the formation of the Cincinnati Section of the I.R.E. and served as its secretary. Later he became assistant chief engineer of Silver-Marshall, Inc., and was placed in charge of public-address and parts development and manufacturing. From 1933 to 1935 he managed engineering and sales for the E. F. Johnson Co., manufacturers of transmitter components and antenna devices. From 1933 to 1940 he served as chief engineer of Shure Brothers, manufacturers of microphones and acoustic devices. He then joined the Jensen Radio

RALPH GLOVER

ONE PHASE
TWO PHASE
THREE PHASE

Mfg. Co., makers of loud speakers and sound-reproducing equipment, to coordinate engineering and sales activities on new products.

Mr. Glover is a member of the Acoustical Society of America, Institute of Radio Engineers, and the Radio Engineers Club of Chicago and is the author of a number of published technical papers.

Army-Navy "E" Awards

Aircraft Accessories Corp., Power Controls Division, Burbank, Cal. (white star added).

Electro Motive Mfg. Co., Williamtic, Conn. (white star added).

National Union Radio Corp., Newark & Maplewood, N. J. (white star added).

Rola Company, Inc., 2530 Superior Ave., Cleveland, Ohio. (star added).

Superior Tube Co., Norristown, Pa.

The Thomas & Betts Co., Elizabeth, N. J. (second star added).

Elmer Crane to Lear Avia

Elmer P. Crane, former head of the products and facilities branch of WPB's Radio and Radar Division, has been appointed general manager of radio for Lear Avia, Inc., manufacturer of radio and aircraft equipment of Piqua, O., and Grand Rapids, Mich. Mr. Crane, who previously had been with Western Electric for 18 years, will make his headquarters in Grand Rapids, where the Lear Avia organization's radio production is being centralized.

John Smith to P. R. Mallory

John M. Smith, who has been general manager of manufacturing for RCA Victor, Camden, N. J., has joined P. R. Mallory & Co., Inc., Indianapolis, Ind., as vice-president in charge of manufacturing

LAPP-DESIGNED, LAPP-BUILT—TO DO A SPECIFIC JOB

This is an antenna base insulator for use on a communications center transmitter. It is one of several Lapp designs for transmitter and receiver mast bases for military vehicular radio—on jeeps, halftracks, tanks and other rolling equipment.

Whether or not this special-purpose gadget has application to anything you build or propose to build, there's a moral in it for you. In this case, as in hundreds of others, an original and impractical design was modified by Lapp engineers—to provide a part that meets all electrical and mechanical requirements, and that Lapp can build economically and efficiently.

Lapp engineering talent and Lapp production methods are such that we can say, "If it's an assembly that can be made of porcelain or steatite and metal parts, tell us what the requirements are and how you think it might be made; Lapp will tell you how it can best be made—and will make it." Our right to that claim has been proved over and over in military electronic production; it's going to be a competitive advantage to smart post-war electronic producers. *Lapp Insulator Co., Inc., LeRoy, N. Y.*

Lapp

Transformers and Reactors

Postwar national distribution is now being programmed by Peerless Electrical Products Co., 6920 McKinley Ave., Los Angeles 1, Calif. Exclusive sales territories are being opened up in principal cities, except in California and Texas. Largest manufacturer of transformers on the Pacific Coast, Peerless produces small transformers and reactors.

Hazeltine License to Meck Industries

A Hazeltine license to manufacture radio-receiver sets has been issued to John Meck Industries, Plymouth, Ind.

"This is a constructive step in our planning for postwar production," declares John Meck, president. "We are immensely gratified to have received in recent weeks both RCA and Hazeltine set licenses.

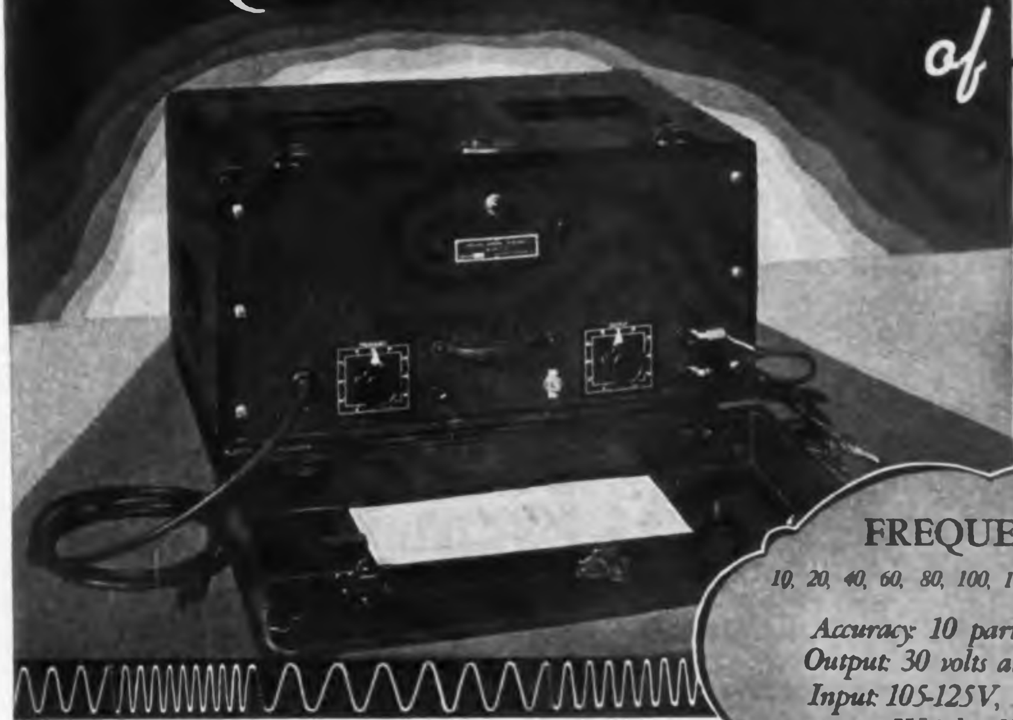
"To us, they represent a challenge and a promise—the challenge to press our war production with renewed vigor until Uncle Sam no longer needs us, and the promise, which we must later fulfill, of finer products and full employment in the peacetime future."

ANEPA to Cardwell

JOSEPH K. FABEL

Elected by the directors of the Allen D. Cardwell Mfg. Corp., Brooklyn, N. Y., to fill the newly-created office of vice-president in charge of sales, J. K. Fabel has resigned the post of assistant district manager, New York section, of the Army-Navy Electronics Production Agency. Mr. Fabel began serving in the expediting division of the U. S. Army Signal Corps in February of 1942, before Army and Navy electronics expediting activities were integrated through the creation of the ANEPA agency.

STANDARD FREQUENCIES—*Octaves of them*



FREQUENCIES

10, 20, 40, 60, 80, 100, 120, 140, 160, 180, 190

Accuracy: 10 parts in 1,000,000
Output: 30 volts at 500,000 ohms
Input: 105-125V, 50-60c., 40 watts
Weight: 50 pounds

Impossible? Well, here it is—

This Multi-frequency generator furnishes the frequencies shown above at the turn of a switch. All frequencies are obtained from a temperature-compensated tuning fork and voltage-stabilized circuit.

With this unit it is possible to calibrate oscillators at many selected points without encountering complex oscilloscope patterns. One of the uncertainties involved in development work on tuned circuits, filters, reeds—and in time measurement can be minimized with the aid of this instrument.

Developed primarily to check frequency meters for precision war work, this Multi-frequency generator possesses a rugged durability and dependability in service that will prove an extra value to many laboratories.

Additional information available on request.

Manufacturer of the

Watch Master

and distributor of Western Electric Watch-rate Recorders

American Time Products, INC.

580 Fifth Avenue New York 19, N. Y.

An Error is like two rabbits!

UNLESS you want a lot of rabbits it's safest to have only one. Two rabbits are like an error. The longer you keep them the more your troubles multiply.

Because errors can so greatly multiply themselves there are key points in the sciences, in production, and in the professions where measuring, metering, and testing instruments of absolute accuracy are required. Furthermore, so that these instruments can be relied upon to provide errorless information at all times and under all conditions, they must have the quality of *sustained accuracy*.*

It is for uses of this kind that Boes instruments are built. Frequently, they are specially designed for special work. Without exception, they are built to eliminate error and to provide information on which complete reliance may be placed.

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

Boes *instruments*

for Measuring, Metering & Testing Equipment

THE W. W. BOES COMPANY, DAYTON 1, OHIO

To Insure Best Varnish Insulation

John C. Dolph Company has prepared a poster to aid the War Production Board in counteracting inefficient methods of insulating electrical units with varnish.

If the seven simple rules which are outlined are adhered to, there will be less rejections and this in turn will aid the War Effort. A benzine solvent chart appears on this poster. This is great assistance in maintaining proper consistency of benzine solvent varnishes. Copies of chart may be obtained from John C. Dolph Co., Dept. 44, 168 Emmet St., Newark 5, N. J.

Goldstrohm, Muschamp to Brown Instrument Board

Paul L. Goldstrohm and George M. Muschamp have been elected members of the board of directors of the Brown Instrument Co., Philadelphia, manufacturer of precision industrial instruments. Mr. Muschamp is vice-president in charge of engineering of the Brown Company, a division of Minneapolis-Honeywell Regulator Co., and Mr. Goldstrohm is vice-president in charge of production.

Meck Opens N. Y. Field Office

William W. Montgomery, executive engineer of John Meck Industries, Plymouth, Ind., announces that a New York City office has been opened at 500 Fifth Ave. for expediting materials and as a field office for Meck engineers.

In charge is Chester A. Cole. eastern district manager, for many years associated with leading radio and automotive manufacturers.

Jobber and distributor sales to the Atlantic Coastal Area will be coordinated from the new office, and postwar eastern area sales activities will be directed from these quarters, since a long term lease has been executed for the premises.

D. B. McKey Heads WKY, KLZ, KVOR

Dixie B. McKey resigned his position as general communications engineer of the Graybar Electric Co., with which he has been associated since 1923, to join the Oklahoma Publishing Co., which operates WKY, Oklahoma City; KVOR, Colorado Springs, Colo.; and KLZ, Denver.

His first 10 years of radio training began in the U. S. Navy, in 1914, graduating from the Naval Sound Radio School.

(Continued on page 186)

In 1923 McKey joined Graybar as a member of A.T.&T.'s technical staff attached to Station WEAF. Three years later he was transferred to transoceanic radio telephone development and was made resident engineer of the station at Lawrenceville, N. J. By 1930 he was a member of the technical staff of Bell Telephone Laboratories in charge of development and design of aircraft radio telephone systems.

In 1936 he was made sales manager of broadcasting equipment for Graybar's Atlanta branch, and later manager.

Since 1942 Dixie McKey has been general communications engineer for Graybar, which position he leaves to join the Oklahoma Publishing Co.

Haines Making Wire-Wound Resistors

The Haines Mfg. Co., 248-274 McKibbin St., Brooklyn, N. Y., has entered the wirewound resistor field, according to an announcement by S. H. Harper, chief engineer. A complete line will be offered to the industry. At present the company is building the resistors for Army and Navy use. Catalogs on the new product are now available.

For Plant Protection

Two radio manufacturing companies—the Radio and X-Ray Division of Westinghouse Electric & Manufacturing Co. and the Philco Corp. — were among 34 companies which have just been awarded the National Security Award by the Office of Civilian Defense, Washington, D. C., for superior organization in the protection of plant property against air raids, fire and sabotage.

Laminated Plastics Film

"The Formica Story," a five-reel film depicting the history of the laminated plastics industry, produced for the Formica Insulation Co., Cincinnati, Ohio, is now being shown in various parts of the country before engineering societies, technical groups and others interested in the laminated field. The film may be booked by writing directly to the company.

If one builds a wall about himself which keeps valuable knowledge from getting out, that same wall keeps valuable information from coming in.— *A. F. Dixon, Bell Telephone Laboratories*

MILESTONES TOWARD THE ELECTRONIC ERA

*Elihu Thomson's Wireless Experiments of 1871-5**

by DAVID O. WOODBURY

Joseph Henry's experiments in electromagnetic induction, begun in 1832, had established the fact that an unknown form of electric energy could be transmitted through space for short distances. Henry was well aware that this amounted to instantaneous communication without wires. But he believed that it had no practical value. Telegraphy with wires, which he had also accomplished, gave no promise of commercial usefulness, and so naturally a wireless system failed to impress him.

For nearly forty years the scientific world continued to ignore the possibilities of signaling through space. Maxwell, enlarging upon Faraday's concept of electro-magnetic waves, showed mathematically that "etheric" communication would be possible if practical sending and receiving apparatus could be devised. But up to 1875 no one took the matter seriously.

In 1871, eighteen-year-old Elihu Thomson suddenly came upon the first element of the solution in experiments with Professor Houston at the Central High School [Philadelphia]. But he, too, failed to realize their practical significance.

Leyden jars and sparks

Thomson had been diligently at work in his basement laboratory building various forms of apparatus to demonstrate "static" electricity to his classes. Among these were a huge battery of Leyden jars, kept in a box which the students affectionately termed "the coffin," and a large induction coil which would throw a spark 6 inches through the air. This last, the so-called Ruhmkorff coil, was the descendant of the early Faraday and Henry experiments and was to be found in every school and college science cabinet of the period. It gave a continuous shower of noisy sparks when connected to a voltaic battery and was much favored for demonstrations though it had no practical value.

Thomson had been using the Leyden jars as a condenser across the spark gap of the coil, and he and Houston had been speculating as to why the jars shortened and fattened the sparks and turned them a vivid blue. The action of the

*From the newly-published book "Beloved Scientist" by David O. Woodbury, issued by Whittlesey House, McGraw-Hill Book Co., New York. Being a biography of Elihu Thomson, "a guiding spirit of the electrical age." With a foreword by Owen D. Young. 358 pages. Price $3.50.

condenser in storing electricity and discharging it as oscillations of high frequency was just beginning to be understood.

Wireless signals

One day Elihu disconnected the "coffin" from the spark coil and substituted a water pipe and metallic table top as the condenser plates. As he had expected the effect on the spark was the same as with Leyden jars. But now he made a startling discovery. When the Ruhmkorff coil was running, electric sparks seemed to be everywhere in the room. He found that he could draw them with a knife blade from the table top, from water pipes across the room—in fact, from the frame of a steam engine fully 30 feet away from the coil. He could even light a gas burner by touching it with his knife.

Here was the practical apparatus for demonstrating Maxwell's electromagnetic theory of wave propagation. Indeed, here was wireless signaling actually going on at the Central High School in 1871. But Thomson was too inexperienced to realize what he had found. Nor did Houston appreciate the discovery himself. In the paper which he wrote up on the experiments (and in which he took sole credit for the observations) he recorded what Thomson had seen, without comment or analysis. When it was published by the Franklin Institute it passed into oblivion without making the slightest stir.

"Etheric force"

During the fall of 1875, Edison, experimenting with a large electromagnet, came upon the same mysterious little sparks, jumping between metallic objects around the room. It being his habit never to leave a mystery unsolved, he dropped what he was doing and plunged into a series of tests on the phenomenon. But Edison was not a trained scientific investigator. Often he jumped at conclusions, on the strength of experiments that were superficially right but did not go deep enough. He did so now. When he found that the sparks induced by his electromagnet did not have any effect upon a gold-leaf electroscope, he assumed at once that they were not electrical in nature. He rushed into print immediately, claiming to have discovered a new "etheric force."

"The phenomena observed," he wrote, "attests new principles until now buried in the depths of human ignorance."

The statement annoyed Elihu Thomson exceedingly. Already knowing that a spark discharge was an alternating current which could not possibly influence an electro-

scope, he saw that Edison had been fooled. His proof of the supposed etheric force was no proof at all. Such a force could not exist except as a complete denial of the theories of Faraday and Maxwell. So he went to Houston with Edison's Scientific American article and proposed that they jump into the controversy.

"It is the same electrical effect that we discovered four years ago," he insisted. "I want to repeat those experiments and prove that Mr. Edison is wrong."

Houston readily agreed. "If Thomson is right," he said to himself, "there will be considerable advantage to us in stirring up an argument."

Proving Maxwell's theory

Thomson was already at work setting up apparatus for the experiment. He was quite certain that the so-called "etheric force" was a train of electromagnetic waves sent through space by the rapidly oscillating sparks from the induction coil, an action analogous to sound waves set in motion by the vibrating cords of the human voice. The energy, he believed, was supplied by the coil, transformed at the surface of the condenser plates into electromagnetic waves which traveled out in all directions, and, upon passing through a "receiver" composed of metallic objects almost touching, transformed back again into minute electric sparks. If he was right, the experiments would be valuable laboratory proof of Maxwell's theory, so far existing only on paper. Thomson was, in fact, after bigger game than Edison. He hoped to make a basic contribution to physical science.

Edwin Houston lent little to the occasion except the table top in his ground-floor classroom, where Thomson had set up a large Ruhmkorff induction coil. But Elihu was too sure of his procedure to need his superior's help. The connections were very simple. One terminal of the coil he fastened to a water pipe, the other to a large tin still mounted on a glass jar near by. The coil was supplied with current from a powerful battery of bichromate cells under the table. Any modern schoolboy will recognize that he had made the classical set-up for a transmitter of wireless signals.

Rudimentary receiver

For a receiver Thomson rigged up a black box, open at one side and provided with two graphite pencil points nearly touching within. One of the pencils carried a large brass knob outside to absorb more of the waves. Again, the rudimentary radio receiver. From our twentieth century knowledge of electrophysics it seems certain that

This will take a man higher even than a P-51.

THIS scientific apparatus looks quite earth-bound.

But, for experimental purposes at least, it can take a man higher than any aircraft ever built.

It is Sperry's new High Altitude Laboratory, constructed through the co-operation and assistance of our Government, and dedicated to the service of our Country in memory of Frederic Blin Vose, a Sperry engineer who lost his life in the performance of his duties in the war effort.

This laboratory helps find the answers to questions like these:

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The laboratory can mechanically simulate atmospheric pressures equivalent to those met at altitudes over 45,000 feet. It duplicates temperatures as low as 87 degrees below zero Fahrenheit.

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Testing the *combination* of man and instrument in this laboratory will result in better protection for the lives of our military and naval flyers, and makes possible improved instrument design and more efficient operation.

Experienced engineers and a medical staff, trained in the technique of the physiology of high-altitude flying developed by the Mayo Clinic and the Medical Departments of the Armed Forces, direct the Sperry laboratory. This laboratory serves other war manufacturers as well as our Armed Forces.

It is Sperry's hope that the tests and studies of man and his instruments in this laboratory will make possible the development of the perfect man-instrument team that will function in complete harmony in the frigid blue of the stratosphere.

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GYROSCOPICS • ELECTRONICS • AUTOMATIC COMPUTATION • SERVO-MECHANISMS

Elihu Thomson, with the basic apparatus in his hands, must have gone on to discover the whole great principle of wireless signaling forthwith. But he did not. For the second time in four years he missed the practical implications fairly staring him in the face and stuck to his theoretical investigation.

Thomson, the pure scientist, was to the fore that day. He was only the first of that long line of laboratory men—Hertz, Crookes, Helmholtz, Lodge and many more—who must complete their work before the youthful Marconi would see the enormous practical value of electromagnetic telegraphy and at last make it work.

A great invention is a notorious insult to the men who make it. Though a thousand minds labor, it refuses to be born till it pleases and then it turns to mock them all for their stupidity.

Sparks everywhere

No doubt if some prophetic person had told Thomson just then that he had the secret of a priceless system of communication in his grasp, he would have been unmoved. All that he wanted to do was to refute Edison's idea of an "etheric force" and establish experimental proof of Maxwell's waves. Turning on the Ruhmkorff coil and setting the gap to give the brightest and fattest sparks, he began a systematic search for the electromagnetic waves he hoped to find. Everywhere in Houston's classroom sparks flashed brilliantly in the black box. Thomson took it into the next room; the sparks were just as strong. Down in the cellar they were as good, even to the farthest corner. He found that it was unnecessary to use the box at all. There was runaway energy enough to produce the sparks by holding a sharp pencil against the brass knobs of the doors.

Elihu hurried from room to room, trying every metallic object that was insulated from ground. On the second floor he got the same results, and on the third. Finally climbing five flights of stairs to the observatory on the roof he made the pencil test again and found the wave energy still abundant.

A 90-ft. transmission

Astronomy Professor Snyder, working quietly in his observatory, was considerably surprised when his visitor burst in. But as the young chemistry instructor panted out an explanation of his experiment Snyder dropped what he was doing and took a decided interest. With growing attention he watched as Thomson drew sparks, first from the doorknob, then from the eyepiece of the telescope, and finally

even from a group of small metallic objects in a glass case.

Thomson invited him to try the pencil for himself. Snyder did so, growing more excited every minute. At a time like this the most sedate scientist acts like a child with a shiny new toy. The professor of astronomy knew Maxwell's work well—knew too that he had predicted the passage of electromagnetic waves through space or "ether" between the atoms of all known substances. This was certainly the proof. The spark coil was operating 90 feet below them, and the energy was coming up through five floors loaded with mortar and bricks and heavy beams.

Resonators tried out

They moved along the hallway to the door of the library, which had a particularly splendid brass knob. Here the sparks were so intense as almost to be audible. Thomson stopped suddenly and grinned inquiringly at Snyder. The older man nodded. "There's no doubt about it," he said. "Electric energy transmitted through space!"

But science is never spectacular all the time. Other very different tests were necessary. If the sparks really were generated by electromagnetic waves instead of by some unexplained "etheric force," they would be absent when the waves were absent, even though the induction coil was still in operation. Thomson devised an ingenious apparatus to suppress the waves without stopping the coil. It consisted of two "resonators" or tuned circuits, each sending out a wave of its own. The two could be adjusted so that their waves would add up and go out together, or so that they would oppose and neutralize each other.

Wave "interference"

This principle of "interference" was a very old one in the field of light waves, having been discovered centuries before by Newton. Elihu Thomson reasoned that if Maxwell were right in saying that light and electromagnetic waves were of the same nature, then the interference principle should work now.

He was delighted to find that it did work. The two resonators could be adjusted "in phase" to send out powerful waves, giving their sparks all over the building. Or they could be set in opposition, so that no waves went out at all, and consequently no sparks appeared. The induction coil was operating steadily all the while. Thus Edison's "etheric force" had been shown unnecessary to explain the facts.

But Thomson had done more than to refute Edison. Not only was this the pioneer use of tuned electric circuits on which radio would

come to depend, but it was also the definite demonstration of the truth of the electromagnetic theory.

Houston now sat down to write the matter up. The paper, as usual, was presented to the Franklin Institute, and signed by him alone. This time Thomson's name appeared once in an inside paragraph. "Immediately on reading the first published account of Mr. Edison's experiments," wrote Professor Houston, "I repeated my original experiments in connection with my friend, Professor Elihu Thomson of Philadelphia." The rest of the paper was sprinkled with "I's" so that the reader was bound to get the impression that Houston alone had done the work.

Subsequent generations of readers did get this impression, for Houston's name is sometimes mentioned independently of Thomson's in historical accounts of the wireless art. It is high time that the record be set straight. The discovery was made almost wholly by Elihu Thomson, with Houston only looking on, and later making the report.

Houston's paper, published on December 11, 1875, was reprinted in the Scientific American and elsewhere, and both he and Thomson did much further writing on the subject. Some of Edison's engineers took exception to their claims and the expected controversy ensued. But it did not last long, for the "etheric force" could not stand out against positive corroboration of the electromagnetic theory. Edison himself soon lost interest. He was in the midst of inventing the phonograph—a contribution so important that the "etheric force" and his connection with it were soon forgotten.

Manpower Solutions

When Electronic Mechanics, Inc., Clifton, N. J., discovered that seven day weeks were weary, promoted staleness and were unprofitable for labor and management alike, an unusual appeal was made to the U. S. Employment Service. How would male school teachers, lawyers, and other white collar people like to work in a war plant during vacations and during other spare time? The U.S.E.S. and the white collars responded in no uncertain terms. Even a high school principal rolled up his white cuffs and went to work alongside the Joe Krapowczies.

At last report the plan was doing fine. Investigation of this happy family of brothers under the skin revealed some of the reasons for successful labor relations at the Mykroy plant. With the help of physical education teaching specialists, baseball teams in spring and bowlers in winter were organized.

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WHAT'S NEW

(*Continued from page 138*)

"Temco" Turret

The turret assembly of the 1000 AC-CW transmitter consists of six pre-tuned channels employing six individual coil and condenser combinations. These channels may be selected by means of a motor-driven switch. The function of this switch is to place the desired parallel resonant circuit across the plates of the amplifier tubes, as well as open all parallel resonant circuits not in use so that, in the event the operating frequencies are close, self resonance will not take place in the unused channel. The purpose of the design of this rf assembly is primarily to maintain a low and evenly distributed capacity, irrespective of which channel may be in operation. The frequency range of this turret assembly is from two to sixteen megacycles, although not necessarily continuous. All coils are of the plug-in type so that, if a new frequency is desired, adapting this unit to it is a simple and speedy operation. Manufactured by Transmitter Equipment Mfg. Co., 345 Hudson St., New York City.

Electronic Micrometer

The Carson electronic micrometer has been developed to eliminate the unpredictable element of touch in making measurements, such for example as radio tube parts, to within .00005 in. The micrometer functions without pressure, an electronic circuit being used to indicate both visually and audibly, when the measuring point comes in contact with the

part being measured. The complete equipment, which operates on 110 v. 60 cycle power, weighs about 20 lb., requires no levelling or calibration. There are three models: 4½ in. dial with .00005 in. divisions; 3½ in. dial with .0001 in. divisions; and 2½ in. dial with .0001 in. divisions. Manufacturer is Carson Micrometer Corp., Little Falls, N. J.

Oil Capacitrons

The new "EC" oil type capacitrons are designed as standard components to replace many similar types of special capacitors used in the production of war equipment. They are being manufactured in several capacity ranges with dc working voltage ratings from 600 to 1,500 to meet U. S. Signal Corps and Navy specifications. The new units are locked on the chassis by means of a solid nut and lockwasher through a single hole to clear the ¾ x 16 threaded bakelite neck. The bakelite neck is lock-spun into the extruded insulated metal container, making possible

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Official U. S. Navy Photo

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a 100 per cent hermetic seal. Grounding of either insulated terminal is readily accomplished with a special lug. Dimensions of the 3 mfd. and 4 mfd. size units are 1¼ in. in diameter by 4½ in. in height. Manufacturer is Capacitrons, Inc., 318 W. Schiller St., Chicago 10, Ill.

Test Chamber

American Coils, Inc., Newark, N. J., has developed an improved type Model RTC-1 test chamber for high and low temperatures. When specially ordered, the improved machines which embodies all the features of the standard Amcoil cabinet may be obtained with four individually operated plugs in the lower panel of the door which permit ready access to the interior of the testing chamber. A turn of the handle opens the plug. The hand may be inserted through an insulated passage and the position of the part being tested can be adjusted. The machine is automatic. It can produce whatever temperature is desired between minus 70 deg. C. to 158.8 deg. C. It can maintain the temperature at any level so that actual service conditions may be created.

Cutting Head

A new Van-Eps-Duotone cutting head, designed for giving a clean and undistorted cut on complex waves, is being manufactured by Duotone Co., 799 Broadway, New York 3, N. Y. It has but a single resonant point which is easy to equalize. The output of this head is constant under all temperatures and humidity conditions. It has a reed armature which acts as its own damper, eliminating deteriorating materials which cause change. Measured distortion is 1.8 per cent at 400 cps. Requires only +20 db level (6 milliwatts in 500 ohms) for normal amplitude. Hermetically sealed, the cutting head is available in 15 and 500 ohm impedances, designed for 9/16 in. stylus.

Pilot Light

Known as the Gothard Series No. 1110 Pilot Light, this new unit is available in several variations. Primarily for ungrounded panels, all variations of this new light are equipped with two solder terminals. Models No. 1110 (faceted jewel) and No. 1111 (plain jewel) take long bulbs—Models No. 1112 (faceted jewel) and No. 1113 (plain jewel) take round bulbs. The preceding models are available with bayonet sockets only. This new light is also available as a shutter type light, for such applications that require variable intensities to satisfy varying conditions. 90 deg. turn of the shutter provides gradation from

bright light, through intermediate glows to a dim glow, or total blackout. In the shutter type—Models No. 1114 (faceted jewel) and No. 1115 (plain jewel) provide for round bulbs. They can also be furnished with polarized lens. All models mount in an 11/16 in. hole and have ½ in. jewels. Lamps are removed from front of panel. This new series of pilot lights is manufactured by the Gothard Manufacturing Co., Springfield, Illinois.

Sealed Transformer

A new method of attaching transformer cases which eliminate any strain on the solder seal has been developed by the Thermador Electrical Manufacturing Co. of 5119 South Riverside Drive, Los Angeles, Calif. The case is rigid, rustproof steel. The terminals may be of molded bakelite or glass and soldered sealed to the case. The mounting bolts are welded gas tight. It is also potted with a rubber seal compound.

Inlay Process Replacing Nameplates

A new inlay process for placing durable characters on metal panels, chasses, etc., eliminates the use of nameplates on front panels. The process is perfected in either a flat or a wrinkled background, on finished metal or on metal in the bare state. Backgrounds can be black, olive drab, brown—in fact any shade desired. Characters, inlay-baked, are white, red, yellow, green or any wanted color. The background finish so protects the inlaid characters as to make them completely resistant to abrasions and salt spray. All such new-inlay process characters are guaranteed to pass a 50-hour salt-spray test. Several large-scale radio and communication manufacturers, holding prime contracts with the Army and Navy, have already used this new inlay process in lieu of name plates, particularly since it enables them to match the finish of the front panels to the rest of the cabinet. Two weeks' delivery is guaranteed from receipt of fabricated steel to finished job. Perfected and supplied by Screenmakers, 64 Fulton St., New York 7, N. Y.

S P Relay

The S P Relay is a small compact relay designed to withstand shock and vibration. The armature is balanced so that the relay will operate in any position. Unit construction of bakelite molded base and stationary contact support eliminates the use of many screws and rivets. S. P. relays are made in both ac and dc types. All contact combinations are available up to and including double pole double throws. The relays have

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3/16 in. diameter fine silver contacts and will carry a non-inductive load of 5 amperes at 110 volts 60 cycles. For light loads of ½ ampere or less the use of ⅛ in. diameter ball points is recommended. Two sizes are manufactured: 2⅜ in. long, 1⅝ in. high and ½ in. wide; and 2⅜ in. long, 1⅝ in. high and 1-11/16 in. wide. The overall width of the above relays can be reduced by bending up the coil and movable contact solder lugs.

Coils are wound on insulating bobbins and thoroughly impregnated. 3 to 4 volt amperes for operation on ac and 2 to 2½ watts on dc are required. Standard coil voltages are: 6, 12, 24, 110, 220 volts 50-60 cycles; 6, 12, 24, 110 volt dc. Manufactured by Potter & Brumfield, Princeton, Ind.

Insulation Tester

The V. T. volt ohmegger Insulation Tester Model 665 provides insulation testing at 500 volts up to 10,000,000,000 ohms (10,000 megohms), a comprehensive electronic multitester not included in other similar types of insulation testers and a capacity meter measuring as low as 0.0000025 mfd. (2.5 micromicrofarads), and up to 2,000 microfarads. It includes VR 105-30 voltage regulator tube and its associated circuits, decreasing error due to line voltage fluctuations. 18 ac and dc voltage scales, measuring from a fraction of a volt to 6,000 volts, at very high sensitivity—with 29

ranges. Direct reading; high voltage test leads rf lead; signal tracing probe; input resistance 16 megohms maximum. Wide scale on 8 in. D'Arsonval microammeter with accuracy of 2 per cent of full scale; linear meter movement; maximum protection against burnout; meter cannot be damaged by checking a live resistor or using too low a range for making a measurement. Manufactured by Radio City Products Co., Inc., 127 West 26th St., New York 1, N. Y.

Dielectric Test Set

Providing a convenient dc source for voltage breakdown tests up to 4000 volts, the Model 1081-F dielectric test set manufactured by the Technical Apparatus Co., Boston, Mass., is a useful laboratory tool. Its half wave rectifier circuit, utilizing a 2 x 2 tube, delivers up to 18 ma and is provided with a resistive guard circuit so that momentary shorts on the output do not damage the instrument. The high voltage output is delivered at safety connectors to which 24 in. flexible cables, heavily insulated and terminated in high voltage test prods, may be readily connected. The ground terminal is provided with a heavy duty clip. Charge and discharge of capacitive test specimens, as well as breakdown of the insulation under test, are indicated by a neon glow lamp. An output indicating meter shows the voltage being applied to the specimen and a primary Variac provides continuous control of output voltage. No extended warm-up period is required—the test voltage is available practically as soon as the instrument is turned on. The unit is self-contained in a well-ventilated steel cabinet only 8 x 10 x 8 in.

Dial Lock

A tuning-dial lock, originally engineered and manufactured for use as a tuning control for the frequency tuning unit of the Hallicrafters SCR-299 mobile unit, is now available.

This product of The Radio Craftsmen, 1341 South Michigan Ave., Chicago, performs a dual function as a dial lock that will accommodate a wide range of dial thicknesses, and a precision tuning indicator that maintains a fixed position on the dial simply by snapping the lock.

Bobbin-Type Resistor

One of the latest developments in the application of Sprague Koolohm ceramic-insulated wire construction to the solution of resistor problems is the new Koolohm Bobbin-Type resistor. Instrument resistor stability for these resistors by a current and temperature ageing process, is a feature. Standard resistance tolerance for Koolohm bobbin-type resistors is ± 5 per cent for full wattage rating, although closer tolerances as low as ± ½ per cent, can be provided at lower wattage ratings. Maximum power rating is 2.5 watts and maximum resistance 250,000 ohms in a section ⅝ in. wide and having a diameter of 13/16 in. The maximum recommended operating temperature (ambient plus rise) is 150 deg. C. These resistors are wound with flexible ceramic-insulated resistance wire on molded high-temperature plastic forms, fitted with lug terminals molded integrally into the forms. Units are varnish-impregnated to provide protection against tropical humidity conditions. They are recommended for use as meter multipliers, as resistance standards in control instruments, as resistance elements of RC oscillators, as power resistors of medium wattage ratings in values to ½ megohm, and where stability is required. Manufactured by Sprague Specialties Co., Resistor Division, North Adams, Mass.

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NEW BOOKS

The Technique of Radio Design

By E. E. Zepler, Ph.D., Lecturer in Physics at the University College, Southampton, and Technical Consultant, published by John Wiley & Sons, Inc., New York, 1943, 312 pages, $3.50.

"This book is an attempt to convey to the reader some of the experiences of a radio designer oblarge work laboratory. The technic tained over a number of years in a of design consists in foreseeing complications and in being able to work out on paper the electrical circuit and the mechanical construction so that serious trouble is not likely to occur. To develop qualities necessary for such work, i.e. a feeling for the right order of magnitude, a quick grasp of essential facts and common sense in approaching the problems, is the principal aim of this book."

The first chapters deal with antenna, amplifiers, detectors and frequency converters, selectivity, noise, and gain control. Screening, feedback, distortion, undesired resonance effects, and power supply are also treated. Special sections on routine measurements and fault finding are included.

The text is well written; numerical examples are frequently used to illustrate application to practical problems. It can be recommended for self study or as a text book.

A Primer of Electronics

By Don Caverly, Commercial Engineer, Sylvania Electric Products, Inc. Published by McGraw-Hill Book Co., 330 W. 42nd St., New York City. 234 pages, 10 chapters, 200 illustrations, $2.00.

While admittedly not a book for engineers engaged in the electronic field, this new "Primer" is likely to find its greatest sale among executives and business men who wish to understand possible applications for electronics in their own enterprises. It will also appeal to high school and college students as a foundation for advanced studies.

In the second half the author explains specifically, yet simply, the actual operation of the most common electronic devices in use today, as well as those which will become more common within the next few years. These include radio and radio tubes, fluorescent and related light sources, television and the tubes which make it possible, and a number of other electronic tubes some of which are employed in fighting the war today. Within


15 YEARS...

the next few years many of these tubes in wartime use will find peacetime uses to assure greater comfort and happiness for mankind.

Practical Radio and Electronics Course

Prepared under direction of M. N. Beitman. Three volumes, approximately 350 pages. Price $3.95. Published by Supreme Publications, Chicago, Ill.

Intended for home study, these three books are addressed to "progressive mechanically inclined persons". Fifty-three lessons present basic fundamentals of radio, television, uhf., facsimile, X-Rays, FM, servicing, welding, etc. Covering as it does so much electronic territory, the course of study is necessarily brief and oversimplified, especially in its treatment of underlying principles, but is undoubtedly adequate as introductory material. The lessons are well illustrated, and special comments printed adjacent to the text offer suggestions, give references, and in general are intended to take the place of a teacher.

Slide Rule Simplified

By Charles O. Harris, B.S., M.S., Sc.D, Assistant Professor of Mechanics, Illinois Institute of Technology, published by the American Technical Society, Chicago, 1944, 258 pages, $3.15.

The basic slide rule operations (multiplication, division, square, square root, cube, cube root, sines, cosines, tangents, and logarithms) are extensively explained so as to be understood by anyone who has studied arithmetic and can multiply two numbers and divide one number by another, even though he has never before seen a slide rule. A ten inch Dietzgen slide rule comes with the book.

Practical Radio Communication

By A. R. Nilson and J. L. Hornung. Published by McGraw-Hill Book Co., New York. 1943. Second edition, 927 pages, price $6.00.

This manual of radio operating procedures presents a well-rounded-out plan of study and reference to the commercial operating side of radio communication. In this second edition about 2/3 of the text is new, and all of it is revised and brought up to date. It should continue to be the standard manual of instruction for courses in radio operating, and preparation for operator's license examinations.

NEW BULLETINS

Spot Welders

Manual and automatic spot welders made by Pier Equipment Mfg. Co., Benton Harbor, Mich., are illustrated and described in their Catalog 42. Details of important parts, regulator controls and automatic weld timer for controlling timing periods are given. Also includes welding capacity charts for all welder sizes and for different throat depths.

Tensile Tester

W. C. Dillon & Co., Inc., 5410 West Harrison St., Chicago 44, Ill., has issued a new bulletin No. 144 on its Model K Tensile Tester. Shows special gripping jaws available, and also special models.

Complete Line of Ovens

All the electrically heated ovens available from the Harold E. Trent Co., Leverington Ave. and Wilde St., Manayunk, Philadelphia 27, Pa., are included in their new leaflet 71-T. Includes diagrams, illustrations and specifications of laboratory, constant temperature, convection, industrial, processing, conveyor and special ovens.

Spring-life Bellows

The Cook Electric Co., 2700 Southport Ave., Chicago 14, Ill., has issued a manual on its "Spring-life" bellows. This manual includes pictures and tells about the engineering, manufacturing and development facilities of the company. Also gives characteristics and engineering advantages of the "Spring-life" principle, its applications, and other data on Cook bellows, pressure-detector switches, and products.

Tube Substitutions

A comprehensive tube substitution directory, designed to help radio dealers and service men use available tubes in place of hard-to-get types in servicing civilian radio receivers, has just been published by the Radio Corporation of America, through its Commercial Engineering Section, 596 South Fifth St., Harrison, N. J.

More than 2,000 substitutions are suggested by RCA in this 16-page guide.

Features of the directory include: A listing, in numerical-alphabetical order of 304 RCA Receiving Tube types—and in most cases one or more substitution types which can be used as replacements; notations, with detailed explanations, of the space limitations and the wiring, filament-circuit or heater-circuit, and socket changes involved in making the substitutions; sample calculations of series and shunt resistors in heater strings; suggested substitutions cross-indexed and keyed to cathode voltages.

Disconnect Electrical Fittings

Bulletin 522 gives engineering details on all phases of the T&B Sta-Kon disconnect way of wiring. This system is based on a tip which is applied to ends of wires by standard Sta-Kon pressure tools. No solder required. Two identical tips meet in a beryllium-copper spring coupler. Varieties of quickly disconnectable electrical devices can be designed around these basic parts. Many of these devices, including disconnectable two-way splices, three and four way splices, disconnect terminals, disconnect strips, blocks, and others are pictured and described in this new booklet of Thomas & Betts Co., Inc., 36 Butler St., Elizabeth 1, N. J.

High-Frequency Current

Lepel High Frequency Laboratories, Inc., 39 W. 60th St., New York City, manufacturers of induction heating units have assembled in folder form authentic information concerning the most modern source of heat for the heat treatment of ferrous and non-ferrous metals — high-frequency current. Lepel equipment is designed to reduce the time required for hardening, annealing, stress relieving, brazing, soldering and melting from minutes to seconds. The catalog illustrates many ways to do heat-treating jobs faster.

Saran

A new booklet containing information on the handling of Saran, a co-polymer of Vinyl and Vinylidene Chloride, its physical, chemical and electrical qualities and the forms in which it is available has been published by Acadia Synthetic Products Div., Western Felt Works, 4029 Ogden Ave., Chicago 23, Ill. This firm also issued a data-sheet on compression-molded Polystyrene.

Thermocouple Manual

Wheelco Thermocouple Data Book and Catalog gives descriptions, prices and recommendations for applications. Specifications, illustrations and milli-volt tables are all included in the 36-page book. Its number is 52-4 and it is issued by the Wheelco Instruments Co., Harrison and Peoria Sts., Chicago 7, Ill.

Uses of Formica

A new data book that gives information on how, where and why Formica is used, is offered by the Formica Insulation Company of Cincinnati, Ohio. Profusely illustrated, it shows and describes the new uses discovered and the new grades and variants developed in the Formica laboratories which adapt the material to special purposes and emphasize some of its many characteristics to meet specific requirements. Contains also some tables on average and dielectric properties, special grades for specific applications, and average values of properties and applications.

Brush Crystal Products

Brush Development Co., 3311 Perkins Ave., Cleveland, Ohio, have issued a catalog entitled "Brush Crystal Products of Quality" dealing with some crystal-actuated mechanisms—direct inking oscillographs and surface analyzers.

File This For Reference...

USEFUL INFORMATION ABOUT PRESENT-DAY AND FUTURE APPLICATIONS OF QUARTZ OSCILLATOR PLATES

Here is common-sense, understandable data about the characteristics, production, and adaptation of quartz crystals. Graphically illustrated, these papers are combined in a convenient file for instant accessability. Write for your copy today.

Crystal
PRODUCTS COMPANY
1519 McGEE STREET, KANSAS CITY, MO.

Producers of Approved Precision Crystals for Radio Frequency Control

Diamond Abrasive Wheels

Felker Mfg. Co., Torrance, Calif., announce their new Di-Met catalog of Resinoid bonded diamond abrasive wheels. In order to obtain maximum benefits and long life from these wheels, a part of the catalog is devoted to some recommendations concerning applications, minimum wear, grit sizes, and concentration, together with operating instructions. The remaining pages contain list prices, specifications and diagrams of the available types.

Power and Transmitting Tubes

Electronic Enterprises, Inc., 65-57 7th Ave., Newark, N. J., describe some of their high power transmitting and rectifier tubes in a bulletin called "E-E Electronic Tubes". Each type is illustrated and its features, specifications, view of socket connections, and maximum circuit conditions and ratings are given.

Jaeger Speed Indicator

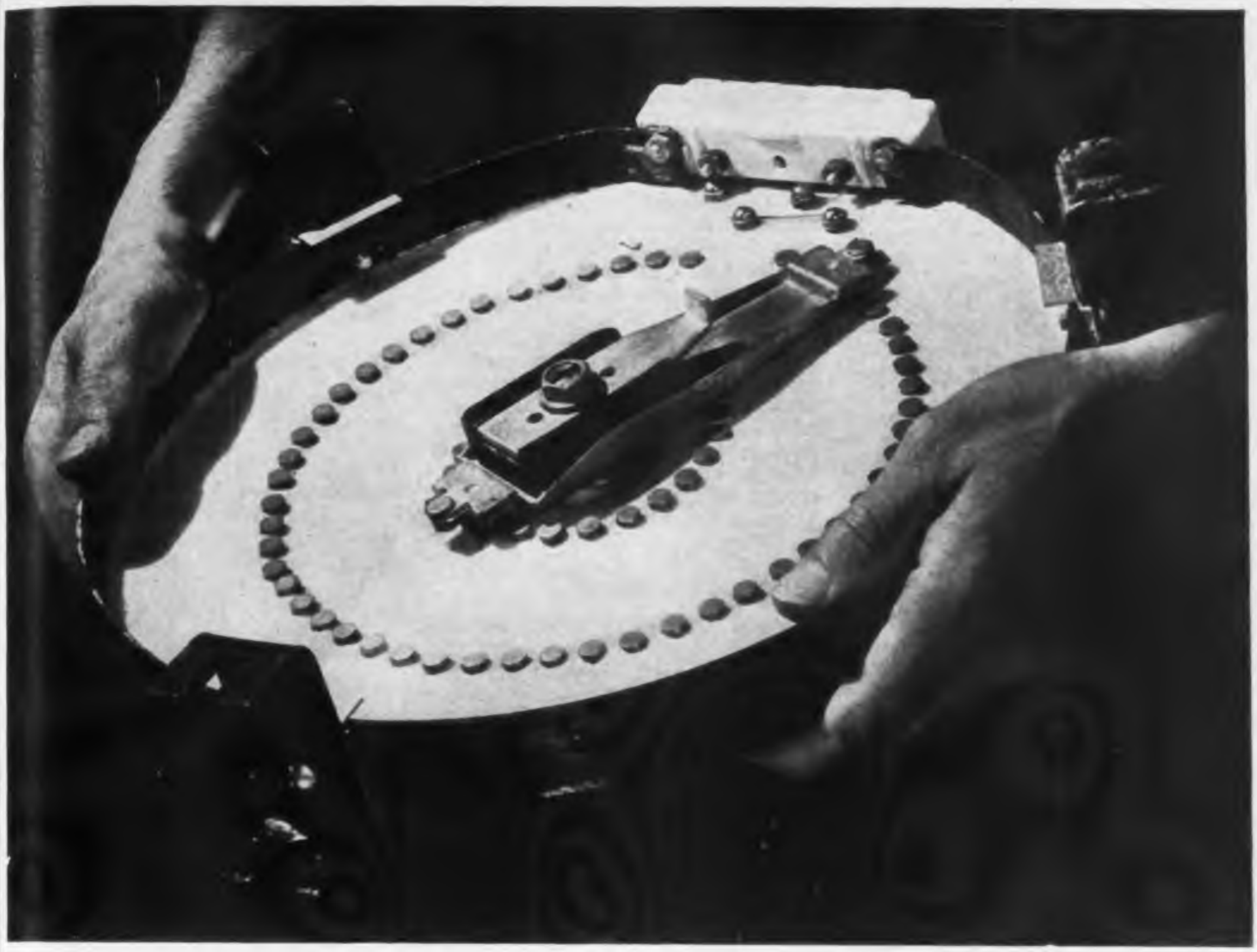
New bulletin No. 1750 has just been released by the James G. Biddle Co., 1211 Arch St., Philadelphia 7, Pa., on their new "Jaeger" speed indicator for measuring locational and surface speeds of various kinds of mechanical equipment. It describes the instrument and its operation and lists its price.

Norton Electrical Instruments

Ammeters, voltmeters and wattmeters, listed in this catalog comprise three different systems—(1) moving coil, (2) electromagnetic, and (3) electro-dynamometer. The book is illustrated and gives specifications and prices of the line of instruments manufactured by Norton Electrical Instr. Co., Manchester, Conn.

Fasteners

This is the title of the initial issue of a publication of the American Institute of Bolt, Nut and Rivet Manufacturers, 1550 Hanna Building, Cleveland 15, Ohio, designed to provide the factual engineering data, users of fasteners need to keep abreast of the new developments of the industry. Some articles in this first issue are: The Rollwed Screw Thread Process, Cold Driving of Large Rivets, How Tight Should a Bolt Be?, etc., also a feature giving current information on bolts, nuts, rivets, screws, etc.



IT'S SUBSTANTIAL

A Rheostat is a piece of equipment where substance and quality spell real economy. A good Rheostat properly installed and used will outlast the machine it controls. It is wise therefore to use the best Rheostat obtainable.

Ward Leonard Pressed Steel Rheostats are built on that premise. They are absolutely smooth in operation due to proper design and fine machining. They dissipate heat from both sides keeping temperatures low. Contacts are round or rectangular solid metal ground for perfect fit. These are but a few of their many advantages.

Ward Leonard Rheostats are made in a wide range of sizes in single and multiple mounting for manual or motor drive. Bulletin 60 gives full particulars. Send for a copy.

Pressed Steel Rheostats are made in 4" to 18", Ring types from 1½" to 4", incl.

WARD LEONARD

RELAYS • RESISTORS • RHEOSTATS

Electric control (WL) devices since 1892.

WARD LEONARD ELECTRIC COMPANY, 61 SOUTH STREET, MOUNT VERNON, NEW YORK

Allegheny Ludlum Bulletins

Three new technical manuals have been issued by Allegheny Ludlum Steel Corp., Brackenridge, Pa. One, numbered EM3, on transformer laminations, gives the magnetic and mechanical dimensions and diagrams of various types. EM-11 includes data on electrical sheets and coiled electrical steels, residual magnetism and hysteresis losses, relay steels, and high permeability alloys, and a number of pages of magnetization permeability curves. Bulletin EM-2 covers magnetic core materials for audio transformers, giving diagrams, dimensions and permeability curves.

Kolton Bulletin PB2

This catalog lists and describes the tumbler-switch and fuse-type lighting panelboards and dead-front distribution panelboards, manufactured by Kolton Elec. Mfg. Co., 123 New Jersey Railroad Ave., Newark 5, N. J. It is illustrated with photographs and wiring diagrams and contains other information as box sizes, list prices for special features, etc.

Band Filing

The Doall continuous band filing machine is described and pictured in a four-page, file size bulletin by Continental Machines, Inc., 1301 Washington Ave. S., Minneapolis 4, Minn.

The bulletin shows how continuous band filing may be used in broaching operations, many times faster than former methods. Illustrations of the machine in operation show various internal as well as external file broaching jobs. Included is a display of the various kinds of file bands available.

Mica Capacitors

"Mica Capacitors by El Menco" is the title of the new catalog put out by the ElectroMotive Mfg. Co., Willimantic, Conn. Compiled to assist in placing orders, it gives the type designation, capacity value, voltage ratings and color code of the various kinds of El Menco capacitors.

Insulation Tester

The Herman H. Sticht Co., Inc., of 27 Park Place, New York City, has recently issued a new bulletin No. 445 describing its new model C-2 Megohmer or insulation tester, which uses a new spillproof lightweight storage battery as a power supply.

Hopp Plastics

"Hopp plastics—today and tomorrow" is the name of a new illustrated book issued by The Hopp Press, Inc., Plastics Div., 460 W. 34th St., New York 1, N. Y. It is a brochure detailing Hopp service, facilities, and progress in the field of plastics in the past 51 years.

Turner Mikes

The various types of microphones of the Turner Company, Cedar Rapids, Iowa, are shown in a new illustrated catalog, giving specifications, characteristics and prices of models available.

SMC Catalog

The purpose of the catalog is to acquaint the reader with the accomplishments of the Standard Molding Corp., Dayton, Ohio, in the development of thermoplastics and injection molding technics. Shows pictures of the executives and general staff and describes and illustrates its products and their applications.

Thermostatic Bi-Metals

Callite Tungsten Corp., 540 39th St., Union City, N. J., has issued a new technical folder on its Calliflex Bi-Metal, which is available in five types according to temperature requirements. This bulletin No. 155 contains information on the deflection and power of the various types in strip and coil, also thicknesses, sizes, etc.

Hole Punching Units

Catalog E illustrates and describes Wales type E hole-punching units, which punch a series of holes simultaneously in extruded and shaped sections. Diagrams, prices of complete units and parts prices are given for different models. Wales-Stripit Corp., North Tonawanda, N. Y.

Motorola Engineers Hear About Electron Microscope

"Rapid progress is being made in finding commercial uses for the electron microscope," stated Dr. Paul L. Copeland, professor in the physics department of the Illinois Institute of Technology, in a paper delivered before the last regular monthly meeting of the Motorola Engineering Club, at Chicago. Dr. Copeland went on to explain the theory behind the use of this microscope and the electronic circuits used in its operation.

A high degree of control is necessary for the operation of the magnetic lens system, he pointed out. As an example he mentioned that although an accelerating potential of 60,000 volts is used, a control of 2000th of one per cent is maintained.

At present actively engaged in research at the Institute in finding commercial applications, Dr. Copeland accompanied his lecture with actual enlarged photographs of some of his work. The club members viewed photographs of bacteria, virus molecules and micromolecules of synthetic organic compounds. All photographs showed a magnifying power of 50,000 diameters and above, and had good resolving power and definition.

The Motorola Engineering Club is the professional organization of technical men of the Galvin Manufacturing Corporation of Chicago.

WASHINGTON

★ ★ ★ ★ **Latest Electronic News Developments Summarized by *Electronic Industries'* Washington Bureau** ★ ★ ★

MEN UP TO 30, NEXT!—Selective Service System is now really tough as the draft deferment developments during April exhibited. And it is going to be even harder going! Now that the men under 26 have been inducted, except the special highly qualified "irreplaceables", the electronic-radio industry must comb over most carefully its employees under 30—they are slated to be inducted in from 2 to 6 weeks. Intensive training of replacements must be under way, the Army and Navy and WPB authorities urge. The treatment of the "under-26" employees showed the criteria that is being followed.

ONLY HIGHLY QUALIFIED—Employees of the engineering level with educational and technical training, who are indispensable, are those up to 30 years who will probably be rated for deferments. Production-line workers, even though supervisors, are not being considered for deferment in the "screening" by the governmental claimant agencies of the Inter-Agency for Occupational Deferments. No matter how key a post they occupy in the assembly and production lines. Probably foremen will be given deferment weight. Component manufacturers in radar can submit deferment cases to WPB Regional Offices just the same as to WPB in Washington.

EXPANSION OF ESSENTIAL WAR ACTIVITIES—Outlook at this writing was favorable for enlargement of electronic production activities beyond radar in the essential classification. It was felt that the Army and Navy in only specifying radar must recognize that other vital electronic-radio equipment goes into their "essential end-products" of aircraft, battleships, landing craft, submarines and aircraft carriers and without the electronic-radio components of these war items, the latter lose their combat value. Same is true for Maritime Commission's combat transports and cargo vessels and tankers. Likewise bottleneck components cut across radar into other highly important electronic-radio equipment.

ANEPA INTEGRATION—By May 15 the functions and personnel of ANEPA will be distributed and integrated among the Army Signal Corps, Navy radio procurement branches and WPB Radio and Radar Division. ANEPA has been in process of drastic shrinking during the past half-dozen months; its present staff of 500-600 men and women represent less than one-third of its 1943 peak strength when its efforts in production expediting, materials and labor searching, etc. were of huge benefit to contractors and component producers. In fact, a great deal of credit in the industry's achievement of production goals is due to ANEPA and its two leaders, Western Electric's Fred Lack and later Bell System's Doug Tellwright. The Congressional criticism of ANEPA has been unwarranted as, like other Army and Navy activities, it had started to curtail its staff previously when its expediting and other functions were diminishing in utility to manufacturers who had begun to get the "know-how" of Army-Navy production.

COMPONENT RECOVERY — Section, launched by Radio and Radar Division Director Ray Ellis, is paying dividends for electronic-radio-radar industry. More than 100 prime contractors and component producers have so far responded to the machinery of the Section which is headed by Wesley Smith, formerly of ANEPA —and an ever-increasing number of manufacturers are now coming into this fold. During the past 30 days approximately $1,000,000 worth of small component items have been flowing into the military production stream between prime contractors, the armed services and component makers with list prices being paid. Components of no military value, which were idle on manufacturers' shelves, are going into the civilian production field for maintenance, repair and operating construction of civilian equipment.

NAVY'S ELECTRONIC-RADIO NEEDS—More than a quarter of a billion dollars to the already massive allotments of the armed services for communications-radio-radar equipment was added in the 1945 Navy Department Appropriation Bill. The Bureau of Ships provided the largest amount with over $145,000,000 of which $84,718,000 was for Marine Corps radio and radar, including "loran", the latest advance in electronic apparatus; for advanced Navy bases, $42,154,000 is to procure 5,481 transmitters of various sizes and types and 7,008 receivers. For replacement of radio equipment of obsolete categories with the newest electronic types, the Bureau of Aeronautics received $79,-500,000, while from another fund $66,500,000 was transferred for the replacement of radar equipment. Naval Communications is building 5 new shore stations.

FREQUENCY ALLOCATION — In accordance with the custom of rotating the chairmanship, the Interdepartment Radio Advisory Committee has elected Commander Paul D. Miles, head of the Frequency Section of Naval Communications, as its 1944-45 chieftain. Commander Miles is a specialist in frequency matters and his appointment is important because of the role IRAC (which designates government wavelengths) may play in postwar allocations. He formerly headed the Frequency Bureau of Mackay Radio. Incidentally, Commander Arps, Assistant Director of Naval Communications reported the Navy had used its last available frequency about Dec. 15 and that radio has reached a point where the number of frequencies available does not even begin to permit the total number of circuits required for world communications.

MISCELLANY—WPB and other government agencies are now probing "black market" in radio sets and tubes, said to extend over seven or eight states . . . WPB Office of War Utilities ordered electric power companies to protect capacity required for manufacture of radio and radar transformers for military use, now 50% above 1943 requirements . . . Relaxed use of quartz crystals in radio oscillators and filters permitted for commercial broadcasting stations and communications and non-military police, forestry, etc. services.

National Press Building
Washington, D. C.

ROLAND C. DAVIES
Washington Editor

NBC PLANS NATIONWIDE TELEVISION SYSTEM; AT&T SCHEDULES COAST-TO-COAST COAXIAL

That the future of television is bright, not to say brilliant, is the opinion of more than one engineering executive in a position to judge from experience, and no one is more optimistic regarding postwar possibilities than is President Niles Trammel of National Broadcasting Co. That organization, he has made plain, has very definite plans, already laid, and they go even so far as to include a network set up that will cover the country. Says Mr. Trammel:

"The economic basis for television broadcasting on a national scale must eventually depend upon the interconnection of stations. The networking of stations will be effected either by coaxial cable lines or radio relays which must be established. NBC has experimented with both and the ultimate determination of which is to be used will be governed by the relative efficiency of the service they render and their comparative costs."

In the meantime, though, it is significant that American Telephone and Telegraph Co., according to Vice-President Keith McHugh, "is planning to construct within the next few years a large amount of coaxial cable. The extent of this construction, when and where it will be undertaken, will depend upon the requirements of the armed forces, general business conditions, the volume and distribution of long distance telephone messages, the availability of the necessary manufactured cable and equipment, and other factors. Tentatively, however, our plans call for between six and seven thousand route miles of coaxial cable in the next five or six years.

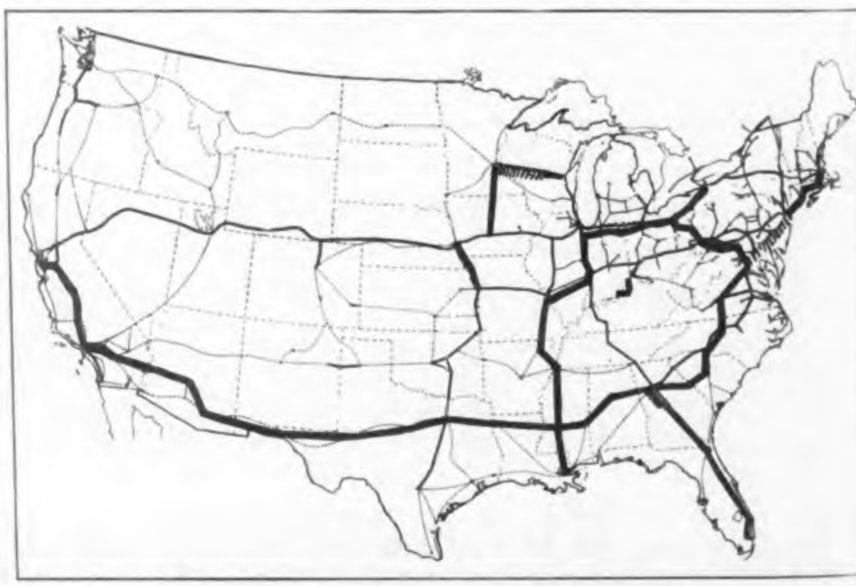
"The equipment now developed will give a one-way television channel of 2.7 megacycles in width. Future technical developments will increase this to 4.0 megacycles and also provide for simultaneous use of a single coaxial unit to transmit a television channel and a large number of telephone channels. Consequently, the ultimate number of television facilities which could be provided over these cables will be considerably greater than the initial number.

Tentative program

"The approximate dates at which television transmission facilities might be made available, if demand justifies their provision and manufactured cable and equipment can be secured, in accordance with present tentative program for extension of principal coaxial cable or equivalent routes for telephone purposes, follows:

1945	New York-Washington
1946	New York-Boston Washington-Charlotte Chicago-Terre Haute-St. Louis Los Angeles-Phoenix
1947	Chicago-Toledo-Cleveland-Buffalo Southern Transcontinental Route (a large part)

(*Continued on page 226*)



Heavy line indicates proposed coaxial cable routes. Shaded line shows existent coaxial lines

Will include Charlotte-Columbia - Atlanta - Birmingham - Jackson - Dallas - El Paso-Tucson-Phoenix

1948-1950 Southern Transcontinental (complete)
- Washington - Pittsburgh-Cleveland
- St. Louis - Memphis - New Orleans
- Kansas City-Omaha
- Des Moines-Minneapolis
- Atlanta - Jacksonville-Miami
- Los Angeles-San Francisco

"As soon after the war as materials become available," reports Mr. Trammel, "NBC will construct a television station in Washington, D. C., so that a service of sight-and-sound may be available in the nation's capital, and from the nation's capital to other cities when interconnection between stations is made available.

"To establish the anchor points of television system, NBC has filed additional applications with the Federal Communications Commission for construction permits for television stations in Chicago, Cleveland, Denver, San Francisco and Los Angeles, where NBC already maintains a programming organization and studio facilities.

Nationwide network

"A nationwide network will not spring up overnight, but must proceed as an orderly, logical development. Such a development, as we see it, would establish television networks in the following possible ways.

"1. An Eastern Network that will extend from Boston to Washington, with stations located at such intervening points as Worcester, Providence, Hartford, Schenectady, New York, Philadelphia, Wilmington and Baltimore, with perhaps an extension to Syracuse, Rochester and Buffalo.

"2. A Mid-West Network that will develop with Chicago as its hub, spreading out to Milwaukee, Minneapolis, St. Paul, Des Moines, St. Louis, Indianapolis, Detroit and Cleveland.

"3. A Pacific Coast Network between the great talent center of Hollywood connecting with San Francisco and gradually extending to other important points.

"These regional networks will gradually stretch out over wider areas, and will themselves become linked together. Thus, city after city, across the continent will be brought into network operation, until finally complete nationwide networks will become a reality."

What we had to learn to help him

Manufacture of dry batteries for war has shown us how to make better batteries for peace.

. . . the "know how" we gained furnishing dry batteries in ever-increasing millions to our armed forces will help you if batteries are used in your post war products.

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ELECTRONIC TOMORROWS

How Mail Might Be Automatically Distributed by Photoelectric Robots, Saving Millions of Postal Man-Hours

by W. C. WHITE

Director, Electronic Laboratory, General Electric Co., Schenectady, N. Y.

"Routine saving" by electronic methods is only just starting and one can think of many cases where it might function to advantage, and probably will, as time goes on. Here's an imaginary example of what I have in mind. At the present time, what I am going to describe is technically possible, but much administrative work covering a good many years would be required to put it into wide application.

Consider all the routine that takes place in connection with the delivering of a letter by our postal system. The letter is first picked up and brought to the post office in the city from which it is being sent. There it must be looked at and consigned to a certain large city or district of the country. When it arrives at this destination, it is again looked at to be forwarded to some sub-division or postal sub-station. Here again it must be examined to route it to the particular mailcarrier district in which the addressee is located. In all of these cases, much routine work is involved and, when we consider the millions of letters in transit all the time, a tremendous amount of human effort is piled up.

Code for PE tubes

Now it would be perfectly possible to place along the lower edge of the envelope a sort of black and white checker-board design which would code the address. In other words, a row or rows of black and white squares in certain order would designate the first main subdivision. A second row would identify the postal sub-station and a third row the city postal carrier district. A form of rubber stamp with movable inserts would be used by the sender or at the first post office to imprint this design on the letter, utilizing a key sheet to prepare the design from the elements of the address to which the letter is to be sent.

The great majority of mail which consists of letter envelopes could then be run through a machine that lines up a photoelectric scanner, or what is popularly termed the electric-eye, along the bottom edge of the envelope and, as the

Breakdown Tests Give New slants on Insulation

In special test rooms like this, Automatic Electric relays undergo insulation breakdown tests under extremely high voltage. From long study of such tests, Automatic Electric engineers have developed effective safeguards against high potentials in actual service.

* * *

When war uses of electrical control equipment focused attention on the need for improved insulation, Automatic Electric engineers were well prepared. For insulation technique is a factor in relay design to which they had already given long study. Today, improved methods to meet wartime needs have not only improved the performance of war equipment, but also will add to dependability of peacetime designs.

Similar studies are constantly being made of spring design, contact materials and pressures, magnetic circuits, finishes and coil designs. The resulting experience is one basic reason why Automatic Electric relays perform so dependably under tough conditions.

You can take advantage of this background by calling in the Automatic Electric field engineer. A specialist in electrical control, he works daily with designers of war products, and will be glad to work with *you* in selecting the apparatus best suited to your needs.

AUTOMATIC ELECTRIC SALES CORPORATION
1033 West Van Buren St., Chicago 7, Illinois
In Canada: Automatic Electric (Canada) Limited, Toronto

Relays AND OTHER CONTROL DEVICES by AUTOMATIC ELECTRIC

PARTS AND ASSEMBLIES FOR EVERY ELECTRICAL CONTROL NEED letter whisked by the electric-eye it would do the equivalent of reading the address in the coded squares and automatically route the letter to the proper mail bag or container. This would be repeated again for the second row and again for the third row when it arrives in the final postal subdistrict.

Thus it would actually have to be looked at only by the carrier who was to make the final delivery at the place of business or residence of the recipient. One can well imagine the magnitude of routine saving that would result from the universal use of such a method. Of course, one might well raise the question of technological unemployment which would result from the widespread use of such devices. However, there is reason to believe that changes of this sort always come more or less gradually and would not present a serious social problem.

Remember that this is just an imaginary case and would take years to perfect and introduce, but technically it is practical.

Additions to Electronic Engineering Directory

The following companies should be included under the associated headings in the March, 1944, Electronic Engineering Directory. Page numbers are those of classification in March issue.

Antennas & Accessories P. 127

Snyder Mfg. Co., 22nd & Ontario Sts., Philadelphia 40, Pa. Auto antennas, ground clamps, towers (home)

Cabinets, Racks & Panels P. 130

Columbia Metal Box Co., 260 E. 143rd St., New York, N. Y.—Chassis, metal cabinets, panels, racks

Communication Equipment P. 132

Espey Mfg. Co., 305 E. 63rd St., New York 21, N. Y.—"Espey"

Dials, Name Plates & Knobs P. 135

Kopp Glass Co., 1 E. 42nd St., New York 17, N. Y. —Pilot light jewels.

Ton-Tex Corp., 247 Pearl St., N. W., Grand Rapids 2, Mich.—Dial belts

Drafting Room Equip. P. 136

Arkwright Finishing Co., 76 Westminster St., Providence, R. I.—Tracing cloth

Hardware, Connectors, Miscell. P. 140

Bead Chain Mfg. Co., Bridgeport 5, Conn.—Binding posts, contact points, terminals

Aircraft Marine Products, Inc., Harrisburg, Pa.

Laboratory Equipment P. 143

Rascher & Betzold, Inc., 730 N. Franklin St., Chicago 10, Ill.—Chemical and glassware specialties

Machinery & Production Equip. P. 145

E. W. Bliss Co., 53rd St. & 2nd Ave., Brooklyn 32, N. Y.—Metal forming equipment, molding presses, powdered metal presses

(*Continued on page* 232)

Measuring Instruments P. 146

Rascher & Betzold, Inc., 730 N. Franklin St., Chicago 10, Ill.—Thermometers, hygrometers, PH meters
Waugh Laboratories, 420 Lexington Ave., New York 17, N. Y.—Magnetic measuring equipment

Metal for Radio P. 148

Allegheny-Ludlum Steel Corp., Pittsburgh 22, Pa.—Laminations, electrical alloys
Callite Tungsten Corp., 558 39th St., Union City, N. J.—Tungsten
Follansbee Steel Corp., 3rd & Liberty Ave., Pittsburgh 30, Pa.—Laminations
Great Metal Mfg. Corp., 9 Wyckoff Ave., Brooklyn, N. Y.—Metal stampings

Motors & Generators P. 150

Small Motors, Inc., 1308-22 Elston Ave., Chicago 22, Ill.—Miniature control and blower motors
Universal Electric Co., 300 E. Main St., Owosso, Mich.—Miniature control motors

Sound Systems P. 158

Springfield Sound Co., 12 Cass St., Springfield 4, Mass.—Sound systems

Tube Parts P. 164

Bead Chain Mfg. Co., Bridgeport 5, Conn.—Base pins, tube seal leads

Wire & Cable P. 164

Columbia Wire & Supply Co., 4106 N. Pulaski Rd., Chicago 41, Ill.—Cord sets, cables, radio harness

Corrections to Alphabetical Index Page 166

Aircraft Marine Products, Inc., Harrisburg, Pa.—Cable connectors
Thomas & Betts Co., Inc., Elizabeth, N. J.—Connectors
Callite Tungsten Corp., Union City, N. J.—Contact points, tungsten
Waugh Laboratories, New York, N. Y.—Measuring instruments

On Ehrenhaft's Magnetic Current

J. T. Kendall of the Research Department, Metropolitan-Vickers Co., repeated the experiments on which Prof. Ehrenhaft bases his claim: establishment of the existence of magnetic current. The following report of Mr. Kendall's findings and conclusions, which he again verified by further investigations, have been reported in Nature, London:

"The account of Ehrenhaft's claim to have discovered a magnetic current which appeared in the daily Press of January 17, is very brief and possibly inexact. However, it appeared to be so completely contrary to the fundamental conceptions of electricity and magnetism, that thoughtful readers must search their minds for other interpretations of the experimental phenomena he is reported to have observed. Accordingly, we at once set up apparatus to repeat the experiments which the Press had described.

"The soft iron pole-pieces of a powerful electro-magnet were immersed in dilute hydrochloric acid. The pole-pieces were soldered to a brass block to ensure that the experiments could not be vitiated by the passage of unsuspected leakage currents through the liquid.

"A fine stream of bubbles was given off at each pole, and when the magnetising current was switched on, the streams of bubbles tended to be deflected into the space between the poles, which was 1.5 mm. wide. Some of the bubbles were deflected downwards, against their buoyancy. Close observation showed that the motion of the bubbles was apparently caused by the motion of the liquid as a whole. Small inequalities of concentration, which are shown up as refractive index striations, permit any motion of the liquid to be recognized. Under the influence of the magnetic field, a steady streaming of the liquid from the pole faces into the centre of the gap and the consequent setting up of rotary currents in the liquid were observed. The streams of bubbles were entrained and carried along with this movement, and their motion was mainly controlled by it.

"Confirmation of this motion of the liquid was obtained by repeating the experiment with the pole-pieces covered with a film of paraffin wax, and immersed in a solution of ferrous chloride. Under these conditions no bubbles were formed and no movement of the liquid in the magnetic field took place. However, if water was slowly poured into the solution, thus providing an non-uniform concentration of ferrous chloride, movement of the liquid in the magnetic field did occur. If the addition of water was stopped, the motion gradually died away as the concentration of ferrous chloride regained uniformity.

Explanation and control experiments

"The movement of the liquid under the conditions above described can be explained very easily. It is due to the action of the strong, non-uniform magnetic field on the non-uniform concentration of para-magnetic ferrous ions. The parts of the liquid containing a high concentration of ferrous ions will tend to move in the strongest parts of the field. In confirmation of this, a number of other electrolytes were tried, both with waxed and unwaxed pole-pieces. No movement was observed with potassium chloride or cadmium sulphate under any conditions. Movement was observed with ferrous sulphate, ferric chloride, and nickel sulphate under conditions of non-uniform concentrations.

These experiments demonstrate conclusively that the general movement of the liquid, disclosed by refractive index striations, depends essentially on the presence of ferrous or other ions of high magnetic susceptibility. We wished to be sure that the movement of the bubbles formed at the unprotected ion pole-pieces was also due to the move-

ment of the liquid, caused by the presence of the ferrous ions, which are provided by the solution of the pole-pieces in the acid. Accordingly the pole-pieces were heavily plated with cadmium and were then immersed in dilute hydrochloric acid. Bubbles of gas were liberated as before, but their motion in the liquid was entirely unaffected by the magnetic field: it was impossible to tell from their motion whether the magnetising current was switched on or not.

Gases evolved

"In addition to the motion of the bubbles in the magnetic field, Ehrenhaft is also reported to have claimed that oxygen is evolved at the north pole and hydrogen at the south pole. Accordingly we immersed the bare iron pole-pieces in dilute hydrochloric acid and collected the gas from each pole separately. To facilitate this, a thin strip of mica was placed between the poles. The oxygen content of the gas was determined by heating a platinum filament to redness in it.

As light contraction in volume took place, corresponding to 0.54 and 0.49 per cent of oxygen in the gas from the north and south poles respectively. As the probable error in analysis was ±0.03 per cent of oxygen, no difference in the gases collected at the north and south poles was detected. The presence of a small amount of oxygen was expected for two reasons. First, the pole-pieces became warm during the course of the experiment (due to the current in the magnetising coils), and air dissolved in the acid would then be evolved. Secondly, there will be a non-equilibrium interchange of gas at the bubble-solution interface. When a bubble of hydrogen is formed in a solution saturated with air but containing no dissolved hydrogen, air (and water-vapour) must pass through this interface inwards in an attempt to establish partial pressures equal to those existent over the solution, and hydrogen must pass outwards into solution in the liquid phase.

Theoretically, if the bubble rose slowly that equilibrium was attained by the time it reached the surface, it would then consist entirely of air (and water-vapour) and would have a hydrogen content of zero! Practically, of course, the interchange is not sufficiently rapid to induce more than a small oxygen-nitrogen content in the bubble. It would seem to be rather difficult to prevent the presence of a little oxygen (due to these causes) in the collected gas, and perhaps Ehrenhaft's reported observation may be accounted for in this way.

"A third reported observation—that the pole strength of a permanent magnet decreases when immersed in dilute acid—we have not attempted to confirm. If sufficient of the permanent magnet were dissolved away, there would, of course, be a measurable decrease in its pole strength.

Conclusions

"Our interpretation of the experiments we have made here may perhaps explain the effects attributed in the Press to Ehrenhaft. These may turn out to be no more valid than his previous claims of the existence of charges smaller than the electron (see Phys. Z., 21, 675, 683; 1920). However, we must reserve final judgment until a fuller account of his experiments is available."

Disclaims Kendall's tests

Speaking before the American Institute of Electrical Engineers at New York in March, Professor Ehrenhaft disclaimed the Kendall experiments performed in England, as being entirely different from his own experiments. Dr. Kendall, he insisted, merely repeated experiments performed more than 100 years ago.

Dr. Kendall, Professor Ehrenhaft declared, performed his experiments only on the basis of newspaper reports, "in which the details of my experiments could naturally not be described." No scientific publication of his latest work had appeared so far, he added.

Augustin Fresnel, great French physicist who died in 1827 at the age of 39, and Heinrich Hertz, discoverer of radio waves, both believed that there "must be magnetic current," Professor Ehrenhaft said. Hertz, shortly before his death, was quoted by Dr. Ehrenhaft as saying: "Something in the electromagnetic equation is wrong; perhaps there is a magnetic current."

Protecting Permanent Magnets Against Losses

Every precaution has to be taken to prevent contact of steel tools or other ferro-magnetic pieces with precision magnets intended for use in measuring instruments or other devices where the exact degree of magnetism is important. Momentary contact, especially in the areas midway between the poles and the magnetic neutral point, can permanently drain off an appreciable part of the magnet's energy content. The most common protection used by firms assembling magnets has been to mold covers or shields of aluminum or other non-magnetic material to fit over the magnet. Such covers provided suitable pro-

tection but entailed considerable cost not only in materials but in the necessary dies. Also, the time lag between the design of the cover and the completion of the die was considerable.

Cinaudagraph engineers at Stamford, Conn., recognizing the wartime problems confronting the users of these magnets, have developed two entirely different types of covers which practically eliminate this time lag and obviate the use of critical material. Even now, with the crisis in aluminum passed, the Cinaudagraph methods of covering magnets continue to offer a greater economy, efficiency and saving in time.

Temps. up to 350 deg. F.

The first of these developments is a "low-temperature" cover; that is, a cover which will give full protection up to about 350 deg. F. This cover is formed by molding a dry, flexible plastic material saturated with a special solvent, around the magnet by hand. The soaking gives it a "stretchability," enabling the operator to cover all parts no matter what shape or size or curvature of contours. When the magnet is suitably covered—a matter of only 2 to 4 minutes—it is placed in an infra-red or drying oven for a few hours. The tacky covering becomes thoroughly dry and firmly bonded to the magnet, forming a hard protective surface which no ordinary blow will crack and which is of sufficient thickness to prevent loss of energy content should a steel tool accidentally touch it.

Some war requirements, however, have called for a cover which would withstand considerably higher temperatures without either sloughing off or disintegrating.

Protection to 700 deg. F.

The Cinaudagraph engineers, after investigating available materials in the organic field, turned to the inorganic. After testing numerous fabrics as well as other coating materials, they found a fabric which when soaked with a special inorganic solution, could be molded readily around the magnet to give it protection. This operation, as with the plastic covers, takes only a minute or two. After the cover is smoothed into shape, it is usually given a second coating of the solution with a brush. The covered magnets are then dried in an infrared ray oven. The covers on these magnets will withstand temperatures well above 700 deg. F. They fully protect the magnet against contact with assembly tools.

Summarizing, the advantages provided by these two methods of applying covers to permanent magnets are: (1) Elimination of the use of critical materials together

with the time lag and expense required for making the necessary dies; (2) speed of application; (3) ease of application even with the most intricate of magnet design; (4) toughness of cover.

Senate Studies Radio Train Control

Considerable impetus to the use of radio communications by railroads for dispatching and safety purposes was viewed as a likely result from testimony before the Senate Military Affairs Subcommittee on War Mobilization, headed by Senator Kilgore (D., W. Va.). It was generally felt, however, that the railways need to program their communications operations with a greater degree of coordination and cooperation between the carriers in order to achieve improved operating methods and equipment, both in their wire facilities, telephone and telegraph, which are now in use, and in any projected expansion of radio communications, especially using the radiotelephone on FM bands.

Two experts gave their views on the potentialities of radio communication's use by the railroads. One was the new FCC Commissioner, E. K. Jett, who was making his final appearance before a Congressional committee in his previous capacity of Chief Engineer, and in an executive session of the Senate body was understood to have pointed out that the FCC would be most sympathetic towards the consideration of a general and coordinated plan for frequency assignment to railroads in this service. The other was William S. Halstead, president of the Halstead Traffic Communication Corp. of New York, who stated Feb. 11 that radio communication equipment is available now for use in railroad freight yards and within 3 to 6 months should be ready for installation along railroad main lines.

Mr. Jett, who was accompanied by FCC Safety Services Division Chief William Krebs, Assistant General Counsel Harry Plotkin and FCC Engineer Glenn West, was understood to have given a complete historical background of the experiments in radio communications by railroads. Mr. Jett also gave his views on the frequency situation in the postwar period.

Increased safety factor

Senator Kilgore indicated also that his own subcommittee would prepare in the near future a report to the Senate recommending the feasibility of radio communications in the railroad field.

In his testimony before the Senate subcommittee, Mr. Halstead emphasized that the wartime applica-

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

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tion of radio inter-communicating systems for railroads would be a great help in speeding up the handling and movement of vital war materials especially in freight yards. He outlined a program of using radio-telephone in two-way communication between the engineers and conductors on moving trains and dispatchers in freight yards or terminals. He felt that this method of communication would aid in eliminating most of the "lost time" in freight yards and would be a definite "increased safety factor" which might have prevented some of the recent serious railroad wrecks.

Mr. Halstead felt that radio was even more dependable than telephone or telegraph, but he admitted that the telephone and telegraph people viewed their facilities as superior and more stable than radio. Commenting that there are no radio systems installed at present on railroad main lines, he declared that the apparent slowness of the adoption of radio communication by the railroads is because railroad communications officials "are trained in telephone and telegraph techniques." But he stressed as an advantage of radiotelephone installations on trains that messages to and from passengers, as well as dispatching orders, could be transmitted while the trains were in motion.

Previous experiments

For the past 20 years the use of radio on trains has been tested only "in a sporadic manner," Mr. Halstead stated, and there has been no sustained program of experimentation. However, he did mention that a number of leading companies, including RCA, General Electric, Westinghouse, the Galvin Mfg. Co. and the two leading railroad signaling concerns, the General Railway Signal Co. and the Union Switch and Signal Co., had conducted experiments in this field.

To a question of Senator Kilgore about the "reaction" of railroad management and labor to the use of radio, Mr. Halstead replied that "management seems much interested in the possibilities of radio," although there is a difference of opinion among the executives as to where to use it best, along the main lines or in the freight yards. The union attitude will be cooperative, he said, because unions are interested in "anything that will increase the efficiency and safety of operations and safeguard the lives of their members."

ICC acts

Afterwards, Senator Wheeler, Chairman of the Senate Interstate Commerce Committee, made public a letter to FCC Chairman Fly and Interstate Commerce Commission

NC-100XA

The NC-100XA has gone to war. Under the pressure of the emergency following Pearl Harbor, many stock receivers of the NC-100 series went into action, and served brilliantly. Since then, growing experience has led to a long series of minor changes and improvements, culminating in the superb receiver shown in the photograph above. We cannot show what is inside the cabinet until after the war, but a glance at the front panel will make any amateur recognize an old friend. It is stripped for action and in battle dress, but it is still the old reliable NC-100XA. And like its amateur prototype, this new Navy model is winning an impressive reputation for brilliant performance and absolute reliability.

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Chairman Patterson on the subject of train communication.

Senator Wheeler pointed out that during the past several years there have been "an alarming number of major accidents on the railroads of the country" with some of them amounting to catastrophies in deaths and injuries. Citing that the causes of these accidents have varied, Chairman Wheeler wrote, "it has been suggested to me, however, that some of them might have been prevented if the railroads had been equipped with more efficient signaling devices."

"Will you kindly advise me whether or not the FCC has made any study as to the feasibility and desirability of using short wave radio communications systems on the railroads, and whether or not radio frequencies are now available for the purpose or will be available in the postwar period? If the Commission has not made a study and investigation of this matter, it occurs to me that it would be a very desirable thing, in the interest of national safety, that such a study be made by the FCC Engineering Department, working in cooperation with the Safety Division of the ICC.

"I realize, of course, that aside from the question of the feasibility and practicability of inaugurating such a system of radio communications there are technical difficulties that would have to be solved, particularly in view of the very definite limits on the number of radio frequencies now available. It does seem to me, however, that this is a matter that could well receive some attention and study by the FCC and the ICC."

Patterson not sold on radio

On the other side of the Capitol, Chairman Patterson of the ICC wrote on practically the same date to Chairman Lea of the House Interstate Commerce Committee on the subject of communications as related to railroad wrecks, particularly the recent Atlantic Coast Line smash-up. Chairman Patterson emphasized that radio communications developments for use on trains "have not proceeded far enough to warrent requiring the adoption of such devices to promote safety." He added that the ICC's Safety Division has had these developments under study for many years.

Meanwhile, the Telephone and Telegraph Section of the Association of American Railroads in a lengthy memorandum brought out that railroads, in cooperation with communications manufacturing companies such as RCA, Western Electric, American Telephone & Telegraph Co., Westinghouse Electric & Manufacturing Co., General Electric and Union Switch & Signal Co. have been developing two types

of systems—wired wireless, or carrier current circuits, and "pure radio."

Difficulties with ultra-highs

The memorandum stressed that carrier equipment was more expensive than radio and, as a safety measure alone, the cost of its installation would not be justified, since the money could be used for other safety measures, such as the elimination of grade crossings, "which would undoubtedly produce a greater saving of life and limb."

The memorandum pointed out that in both pure radio and wired wireless tremendous difficulties and operating problems "are still to be solved" before either or both systems can be adopted for wide use by the railroads. One difficulty in the use of ultra-high frequencies, the Association noted, is a tendency toward line of sight transmission, where the signals are not efficiently read except in cases where the antenna is high enough to be seen from the point of reception. The elevation of antennas on railroad equipment is limited to about 30 inches above the roof of the train's caboose, by the height of bridges, tunnels and other factors, which makes the use of ultra-high frequencies over considerable distances almost an impossibility now, the memorandum stated.

Discussing carrier systems, the Association emphasized that "the carrier circuit system requires a track with bonded joints and a wire adjacent to the track—conditions not always available."

The Association of American Railroads, in its memorandum, reviewed the historical development of communications in the railroad field.

Cosy KOZY

Whether or not you're from Missouri, one look at this photo of FM station KOZY will convince you that this two-room Kansas City outfit really lives up to its call-letters.

Facing the cozy corner which serves as KOZY's reception room, is the office, slightly separated by a small partition. The station's other room is likewise divided, by a glass window, into a studio and a transmitter and speech input room. The transmitter itself is composite—designed and built by engineers of Commercial Radio Equipment Co., Kansas City, Mo., owner of the station. The final stage is designed for 2,000-watt output, although at present the antenna is being excited by the last buffer stage with input between five and six hundred watts.

The speech input is a Collins console. RCA turntables are equipped with Western Electric combination vertical and horizontal pick-up heads. A seven-eighths inch coaxial cable leads from the transmitter on the tenth floor to the top

FM Station KOZY, Kansas City, Mo.

Looking from girl "manned" KOZY's studio into transmitter room

Fighting Words Flash Through!

PHOTO COURTESY U. S. ARMY SIGNAL CORPS

RUMBLING over the treacherous roads in Italy and lunging ashore on Jap island-fortresses, this "rolling radio station" of the U. S. Signal Corps has won high praise for its splendid performance in the battle of communications.

Built by the Hallicrafters Co., and designated "SCR-299", it also illustrates a number of the constantly growing uses for which *permanent magnets* are employed today. In the 299's loud speakers, headsets, microphones, telephones, instruments and magnetos, permanent magnets are extremely vital parts.

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of the building five floors up, where the coaxial type antenna is located atop a penthouse.

All-girl staff

Another factor contributing not a little to KOZY's coziness is its all-girl staff. Three attractive young ladies serve as program manager, announcer, and engineer, keeping the station on the air six hours every weekday with a program consisting 100 per cent of vertical transcriptions, most of them furnished by the World Recording Co.

Commercial Radio Equipment Co. has been manufacturing quartz crystals since the late 'twenties and now operates in Silver Springs, Md., Kansas City, and Hollywood, Calif. The company is approved by the F.C.C. to manufacture high quality crystals for broadcast station use, but has been mass-producing war radio crystals since February, 1942.

Nazis Using Continental Radio as Air-Raid Warning

A London dispatch to the New York Herald Tribune April 1 called attention to the Nazi's new network of air-raid warnings, employing a continent-wide radio broadcasting network to announce current Allied bombing attacks. The new system requires Deutschlandsender and all Reich broadcasting stations to report Allied air activity over Nazi-occupied Europe every hour on the hour, with bulletins interrupting programs "in the event of any change."

The system is basically regarded as an aircraft warning network, plus its propaganda value to the Nazis in that the German listeners stay tuned to their own stations, instead of listening to Allied propaganda emissions. According to the article, "the development has jolted Allied authorities, who are busy now trying to devise some means of winning back that audience." The warnings are also regarded as a "Strength Through Fear" propaganda campaign of the Nazis.

Yale MD's Detect Pregnancy Electronically

Using a new supersentitive electrocardiograph, with a special intermediate electronic amplifier, research physicians at the Yale School of Medicine at New Haven, Conn., have succeeded in recording the heartbeats of embryos as early as the fourth month of pregnancy.

In the Yale Journal of Biology and Medicine, Drs. A. V. N. Goodyer, A. J. Geiger, and W. M. Monroe report that their technic worked in 87 per cent of the 181 examina-

tions made to date, and promises to solve many hitherto baffling obstetrical problems.

The Yale men's innovation was a special amplifier, placed in the electrical circuit between the pregnant woman and a portable electrocardiograph. They set up three contacts with the patient's body, one high and one low on her abdomen, the third on her left leg—this last to minimize interference. The amplifier boosted the power of the electric currents produced by the fetal heart muscles and produced electrocardiograph tracings strong enough to be analyzed with precision.

Fetal deaths

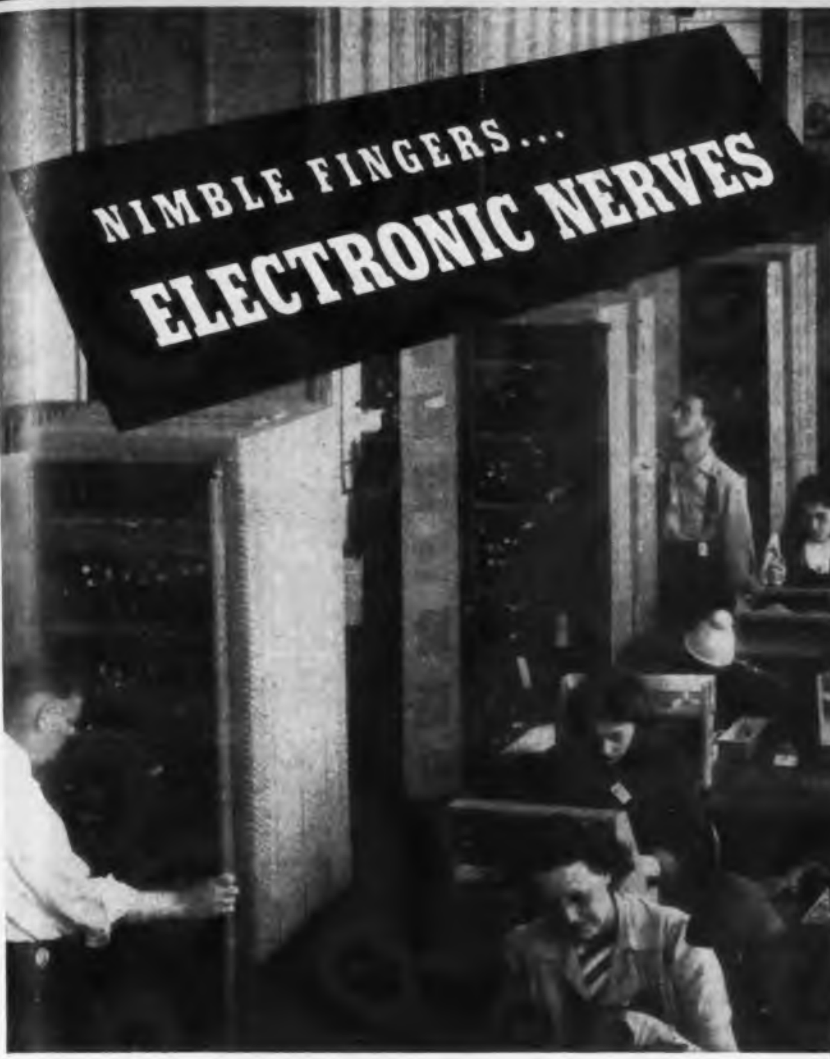
The researchers cited eleven case histories as proof that electrocardiograms (tracings) often tell more about the baby's condition than the X-ray, stethoscope, and other methods. In some cases, it reassured women who had felt no movement for a few days and feared that their babies might be dead. In others, early discovery that the babies actually were dead probably saved the mothers' lives.

The electrocardiograph also proved more accurate in differentiating between pregnancy and certain tumors. One woman had been diagnosed as pregnant after a positive urine test. When she developed serious disease symptoms, doctors considered an abortion to save her life. The electrocardiograph, however, detected no fetal heart waves. Soon it was discovered that the patient wasn't pregnant at all. Instead she was suffering from a growth of cysts.

Twins revealed

X-rays or the stethoscope can detect twins no earlier than the sixth month. Because the electrocardiograph makes recordings from the fourth month, it should now make a diagnosis possible some two months earlier, the investigators indicate. Further refinement of the method is also expected to give more definite answers to the important questions of how drugs and anesthetics administered to mothers affect babies' hearts.

The Yale researchers blasted at least two popular obstetrical beliefs. One is the theory that the sex of a child can be determined from its heartbeats, since girls' fetal pulses supposedly beat faster in the womb than those of boys. The electrocardiograms revealed that the average rate for males and females is 145 and 143 beats per minute, respectively, or too close to be worth while in sex determination. Also exposed as a myth was the belief that the heart rate declines as birth approaches and thus indicates the time of labor.



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59	67	109	127		212938-1
60	68	112	149		

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

OTHER DESIGNS TO ORDER

RTPB Panel Wants More FM Channels

Widening of the present FM band from its existing 40-channel limit to 80 or 100 channels, retention of the 200-kc channel width, and continued occupancy of the existing portion of the spectrum for FM, were recommendations adopted by Panel 5 of the Radio Technical Planning Board at Chicago, April 11. C. M. Jansky, Jr., presided at the session which was attended by some 30 members and observers.

The panel, part of the RTPB created to develop proposed allocations and standards for radio services for FCC consideration, concluded that there are no systems of modulation which show any indication of being either as good or better than FM. Moreover, it held that, despite contentions of interference in the present FM range (42-50 mc) the present position should not be changed.

Minimum of 80 to 100

The panel advocated a minimum of 80 to 100 channels for FM, both commercial and non-commercial, in a continuous band. Television channel No. 1 occupies the range from 50 to 56 mc and the amateurs have the range from 56 to 60 mc, which are the additional bands sought for FM.

The proposal for expansion of the band, to cover 80 to 100 mc in lieu of the present 40-channel range, was advanced by Walter J. Damm, Milwaukee, president of FM Broadcasters, Inc., Milwaukee.

Text of resolution

(I) Type of Modulation: The Panel at its first meeting had referred to its "Committee on the State of the Art," composed of men having access to classified radio information, the question whether or not there have been any new undisclosed developments in the art which would offer advantages for VHF broadcasting superior to the system of frequency modulation now provided for in the present rules of the FCC governing Frequency Broadcasting. This committee reported to the Panel that there are no systems of modulation classified or otherwise which show any indication of being either as good as or better than the FM system now in use;

(II) Position of VHF Broadcast Band in the Spectrum: (Adopted subject to evidence from Dr. J. H. Dellinger, Radio Chief, National Bureau of Standards, concerning the effect in the present part of the spectrum of erratic interference when used for FM broadcasting systems.) The fact that the technical evidence has now shown by practical operating experience that FM

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can provide a satisfactory service in its present position in the frequency spectrum, and the fact that there is no technical evidence to indicate that certain erratic propagation characteristics of the presently assigned portion of the spectrum would be improved by any shift in the present allocation, or that there would be any other advantages accruing through the use of other locations of the spectrum, and the fact that there is already a substantial public investment in FM equipment and a highly organized public service already being rendered by existing FM stations in this position of the spectrum;

Be it hereby resolved that it is the consensus of this Committee that the present position of FM Broadcasting in the spectrum should not be changed;

200-kw channels

(III) (Approved by an 18 to 6 vote). Width of Channel: It was the general thought of the Panel that they saw no reason to discuss changing the present FM channel width of 200 kc and that there was no need at this time for reconsideration;

(IV) (Approved by a 23 to 1 vote). Number of Channels Required for an Adequate VHF Broadcast Structure:

It is the consensus of the Committee that a minimum of 80 to 100 channels for commercial and noncommercial broadcasting stations is necessary for the development of an adequate nationwide FM Broadcast structure, and the Committee recommends that these 80 to 100 channels, comprising a band of 16 to 20 megacycles, be so assigned that they shall be continuous.

May 24 Is Morse Centennial

Congress has approved with the greatest of speed the Bulwinkle-Wheeler Resolution to launch on May 24 the commemoration of the Centennial of the first telegram of Professor Samuel F. B. Morse over a telegraph line from the old Supreme Court room in the Capitol to Baltimore. The House enacted the Resolution with Rep. Bulwinkle paying tribute to Dr. Morse and his contributions to the communications industry. An identical Resolution was passed by the Senate after Senator Wheeler had brought it up.

The Centennial is to be held May 24 and Congress will place an appropriate plaque or other suitable memorial in commemoration of the historic event which took place May 24, 1844, with exercises in which Congressional leaders, high government officials and Western

Union and all other communications companies will take part.

In his address, Rep. Bulwinkle who handled the telegraph-merger legislation through the House, reviewed the history of the sending of the first telegraphic message by Professor Morse and how Congress had initiated the step by appropriating $30,000 for the construction of the first experimental line from Washington to Baltimore. He quoted extensively from the Congressional Globe (the Record of that day) and from the Washington newspaper reports when the famous first message—"What Hath God Wrought?"—was transmitted. The North Carolina Representative declared that Congress will deem it fitting to recognize the outstanding achievement of Professor Morse in giving to the world a new system of communications which was the forerunner of the present-day telegraph, cable, telephone, teletype, radio and television.

WPB Holds Radio Cabinets Electronic Equipment

In an interpretation of Limitation Order L-265, the WPB holds that radio cabinets, regardless of the material from which they are made, are included within the definition of "electronic equipment," and are subject to all provisions of the order. The interpretation also noted that provisions of the order do not apply to the transfer of "radio receiving sets" which were produced and designed for home use, and which were completely manufactured on or before April 24, 1943. An impression had existed, the WPB pointed out, that sets partly assembled or almost complete on that date could be finished and transferred free of the restrictions of the order.

At the same time, the WPB interpreted procedures under Order L-183-a to clarify its relation to General Scheduling Order M-293 and Priorities Regulation 1. While representing no change in the scope or operation of the order, the interpretation outlines procedures for scheduling electronic equipment and components in accordance with Army and Navy precedence.

The WPB also noted that methods of speeding up delivery of components to increase production of test instruments was discussed at a recent meeting of the Test Instrument Manufacturers' Industry Advisory Committee. Lack of certain critical components has retarded production by as much as 30 to 50 per cent. It was recommended that procurement of critical components be placed on AAA priority basis to meet estimated 1944 needs, which are expected to exceed those of 1943 by 60 per cent.

COIL FORMS OF

Steatite BODY (302)

and *Centradite BODY (400)

An almost endless variety of coil forms (up to 5 inches in diameter) are available processed to your specifications within reasonable tolerances. We are also able to furnish pressed pieces to approximately 6 inches square. • The facilities of Centralab's engineering and laboratory experience are at your disposal.

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Division of GLOBE-UNION INC., Milwaukee

★ Centradite is especially indicated where Low Thermal Expansion, High Resistance to Heat Shock, Low Porosity and Low Loss Factor are requisites.

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

Represents Astatic at Memphis

R. T. Schottenberg, sales manager, Astatic Corporation, Youngstown, Ohio, announces the appointment of J. M. Cartwright, 1276 Peabody Avenue, Memphis, Tenn., as Astatic representative for Louisiana, Mississippi, Arkansas and western Tennessee. Mr. Cartwright, long familiar with radio and sound products, is well known in this territory.

DIMENSION GAGE

(Continued from page 99)

The conveying device is quite heavy and bulky; but to prevent it from imparting a shaking movement to adjacent parts, it is fully counterbalanced.

The conveyor drive is a motor of conventional type, connected by belt and pulley to a countershaft. A worm drive on the countershaft operates a worm gear at considerably reduced speed; this gear drives the crank arms which move the conveyor, and the timing cams.

In the event of a shell falling off the conveyor into a position in which it may jam against the conveyor, the belt is intended to slip and thereby prevent breakage.

Calibration

The operator is provided with a set of gages which are accurately ground to size. Four shell gages are required to fully adjust one measuring station, making a total of thirty-two shell gages in all.

For a typical measuring station, the requirement is to inspect the shell for an external diameter of 0.875 in. $\pm$ 0.004 in. That is, all shells passing through this measuring station require to be sorted into three groups:

Undersize: smaller than 0.871 in.
Within tolerance:
between 0.871 and 0.879 in.
Oversize: larger than 0.879 in.

To allow for possible small errors in the adjustment, it is well to adjust these limits slightly to make the machine sort as follows:

Undersize: smaller than 0.8711 in.
Within tolerance:
between 0.8711 and 0.8789 in.
Oversize: larger than 0.8789 in.

It is quite impossible to make any machine sort shells with such precision as is indicated by the above tabulation; shells in the vicinity of 0.8711 in. will sometimes be called undersize, and sometimes within the tolerance.

Similarly, shells in the vicinity of 0.8789 in. will be called oversize or within tolerance, according to unpredictable changes. Consequently, the following tabulation is used to represent what actually is being

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RECEIVING TUBES
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done in this or any other gaging machine:

Definitely undersize:
smaller than 0.8711 in.
Possibly undersize:
between 0.8711 in. and 0.8715 in.
Definitely within tolerance:
between 0.8715 in. and 0.8785 in.
Possibly oversize:
between 0.8785 in. and 0.8789 in.
Definitely oversize:
larger than 0.8789 in.

It should be noted that absolutely no shells which are 0.004 in. off the mean dimension can be called within tolerance, but that some shells close to the tolerance limits and within tolerance, may be called bad. This conservative practice is necessary and desirable, and involves only a small loss of good shells, since only the shells which are within 0.005 in. of the maximum tolerance limit are likely to be rejected.

Readjusting the calibration

There are numerous adjustments necessary to initially bring the individual measuring stations into proper operation; but after this is once accomplished, a simple procedure is available for maintaining it.

The operator places the gages into the magazine feed of the machine, and allows the gages to pass through all measurements as best they may. A gage for the fourth station, for example, is required to pass through the first three stations without being rejected. Four gages are required to have dimensions precisely right for readjusting the calibration of each measuring station. Using the figures of the previous example, these gages would be dimensioned as follows:

0.8711 in. must be rejected undersize;
0.8715 in. must be passed as within tolerance;
0.8785 in. must be passed as within tolerance;
0.8789 in. must be rejected oversize.

If the undersize and oversize shells are rejected, and the other two are passed, then this clearly proves that the adjustment of that measuring station is properly made. Since the gages may be passed through the machine at any time, it is obvious that the adjustment may be checked whenever desired.

It is convenient and economical to arrange the gages so that those which pass through one station are rejected at the next station. That is, the gages which pass through station 3 are the ones which should be rejected at station 4. Then, only 18 gages instead of 32 are required in all, and the gages may all be found in the reject containers, after passing through the machine, except for the last two.

If a gage does not come into the proper reject pocket, a simple table

tells the operator how to readjust the machine. For example, suppose that the 0.8711 in. gage was not rejected as undersize, but passed through to the next station, and was there rejected with the 0.8715 in. gage.

The operator, upon finding the shell in the wrong container, refers to his table of instructions. There he is instructed to turn the screw which controls the position of the mirror for the undersize adjustment of that measuring station, one quarter turn, anti-clockwise. This changes the adjustment of that mirror by an amount corresponding to 0.0001 in., in the desired direction. The gage is then placed in the magazine again, and allowed to pass through the machine a second time. After one or several such adjustments, the shell will be required to appear in the desired reject container.

The operator is continually checking and rechecking the adjustment of each station by procedures similar to the above, and thereby maintains the adjustment in spite of wear on the gaging surfaces, loosening of mechanical parts, changes in sensitivity, etc.

If trouble should arise on some station, whereby readjustment is not possible, the operator will become aware of it instantly because that station will reject all shells, or because it will not properly differentiate between the gages. For such emergency service, the entire measuring assembly is replaceable with a spare. The electrical assembly which is part of the measuring assembly is also removable from it, and arranged with plug-in connectors for quick change.

Range and sensitivity of measurements

The measurements taken on the present machine include outside diameters, inside diameters, overall lengths, and depth of counterbore. The outside diameter must be measured at several locations, since it is not of the same diameter all over, but has a band, a bulge, and a groove to be measured.

Some of the measurements are ± 0.001 in. tolerance, while others are less close, up to ± 0.008 in. For those measurements which have closer tolerance, the optical magnification is increased. The magnifications actually used vary from 100 diameters to 660 diameters. No mechanical leverage magnification is used, except such as cannot be avoided because of the arrangement of the measuring bar.

The limit of sensitivity is not reached for inspections which have a tolerance of ± 0.001 in.; but for this and closer tolerances, some changes in design are clearly indicated as being desirable, to make

Do you recognize these insulators?

They are the first radio tower insulators made in this country. They were designed and built by Locke for the original wireless telegraph stations.

That was a long time ago and every day since has added to our skill and experience. Research facilities available nowhere else in the industry have been in constant use finding better, simpler, lower cost methods of producing the finest in radio insulators.

Whether your requirements are standard or special, we think you will find them better filled by Locke.

A COMPLETE "CLAY"RAMIC SERVICE

For every electrical, chemical and mechanical application, Locke has unrivalled facilities for the production of fired clay pieces by every known method.

(1) Dry Process — Porcelain and Steatite

A process ideally suited to the production of certain pieces with reasonable tolerances and adequate mechanical and electrical strength.

(2) Vacutite Process—Porcelain and Steatite

A process developed by Locke for forming intricate pieces. Close tolerances. Mechanical and electrical strength almost equal to wet process.

(3) Wet Process — Porcelain and Steatite

The standard process for the production of high voltage insulators, and porcelain for mechanical and chemical applications. Exceptionally strong mechanically and electrically.

Locke Wet Process porcelain and Locketite is produced by the following methods, the selection of method depending upon the piece.

(1) Pugging	(5) Jiggering
(2) RamExtrusion	(6) Plastic Press
(3) Wet and Dry Turning	(7) Core Casting
	(8) Drain Casting
(4) Plunging	(9) Throwing

and certain other methods which at the present have only limited application.

Other clayramic products will be available in the future to meet special conditions. Whatever your problem, our experienced electrical, mechanical and ceramic engineers will be glad to help. Their services have resulted in material savings in money, time and critical materials to other manufacturers. Perhaps they can help you.

Locke INSULATOR CORPORATION

BALTIMORE, MARYLAND *"Leaders in Clayramics"* the initial setting up easier, and to permit a more precise readjustment from time to time.

In all of the measurements, the indecisive or doubtful region, for which the machine is permitted to call the shell good or bad, is less than 10 per cent of the tolerance range. For those measurements which have wide tolerances, it is far less than 10 per cent while for the 0.001 in. tolerance, it was found to be possible to use the 10 per cent figure, and perhaps improve upon it.

Design principles

After many experimental runs with production shells, it has been found possible to consider the machine successful and usable in its present form. However, the following general design considerations are worth noting:

(1) The surrounding atmosphere must be dust free, because dust on the anvils or measuring bars, or on the lenses of the microscopes, causes errors. The more precise the measurements, the more important this requirement.

(2) The shell handling design must be such as will permit a shell to fall off and get into unexpected positions without damage to the machine. All delicate regions of the machine must be covered to prevent the flying entrance of a shell thrown off the conveying device, so that the shell may not jam between moving members.

(3) The gages must be of such design as will pass through the stations of the machine successfully to reach their critical measurement station; and they must be so designed as to be undamaged by continuous use and readily recognized and identified by the operator. They must be rechecked frequently.

(4) Certain minor structural and electrical changes are indicated, which will improve the maintenance of the adjustment over long periods of time.

(5) The temperature of the machine as a whole must not be subject to wide changes. Trouble with this was not experienced as yet, but it is known that on long runs, the changes in the temperature of some structural members will require continuous readjustment as a means of compensating.

TUBES ON THE JOB

(Continued from page 128)

effect shown in Fig. 9, which consists of a slight rounding-off of the corner, plus a slight raised spot on the top surface of the cut. It should be noted that these drawings are enlarged and the error is exaggerated in order to show the result more clearly.

(Continued on page 264)

NEW LETTER CONTEST for SERVICEMEN!

ELEVEN 1st PRIZE WINNERS IN 5 MONTHS IN CONTEST #1!

Yes sir, guys, the hundreds of letters received were so swell that *double* first prize winners had to be awarded each of the first four months and there were *triple* first prize winners the fifth and last month . . .

SO—HERE WE GO AGAIN!

Get in on this NEW letter contest—write and tell us your *first hand* experiences with *all* types of Radio Communications equipment built by Hallicrafters including the famous SCR-299!

RULES FOR THE CONTEST

Hallicrafters will give $100.00 for the best letter received during each of the five months of April, May, June, July and August. (Deadline: Received by midnight, the last day of each month.) . . . For every serious letter received Hallicrafters will send $1.00 so even if you do not win a big prize your time will not be in vain. . . . Your letter will become the property of Hallicrafters and they will have the right to reproduce it in a Hallicrafters advertisement. Write as many letters as you wish. V-mail letters will do. . . . Military regulations prohibit the publication of winners' names and photos at present . . . monthly winners will be notified immediately upon judging.

BUY MORE BONDS!

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THE HALLICRAFTERS CO., MANUFACTURERS OF RADIO AND ELECTRONIC EQUIPME the initial setting up easier, and to permit a more precise readjustment from time to time.

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(*Continued from page* 128)

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BUY MORE BONDS!

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

However, the effect of these two errors is negligible. The distance from the center of rotation of the spot to the spot, is never more than approximately 1/8 in. In many cases, this distance may be as small as 1/16 or 1/32 in. and therefore this error will be correspondingly reduced.

If the distance between these two points were the maximum value (1/8 in.), then the error as shown in Fig. 9 would be 1/32 in. or less. However, in most cases it will be found that the small projection, which is located on the top flat surface of the cut, will be partially burned off, due to the fact that the torch heats this material on the trip up along one side of the template and, as it turns to follow the new path along the top of the template, this material (which has already been heated to quite a high temperature) is burned off easily. Therefore, the error involved will be usually even less than this 1/32 in.

Theoretically, it would be possible to change the radius of rotation of the spot, so that for high-speed cutting this radius would be fairly large, and for cutting on heavy stock at low speed, it would be very small. In actual practice, it has been found that an intermediate adjustment will be satisfactory for almost all work. If it is necessary to secure more precise operation, the template may be modified slightly, as shown in Fig. 10, so that a very nearly square corner may be obtained.

Sixty-fourth-in. accuracy

The diameter of the small spot of light on the paper is about 1/16 in. Therefore, by the time the spot has moved 1/64 in. away from its correct position, well over half of the maximum available signal has already been applied to the motor. This means that when following a

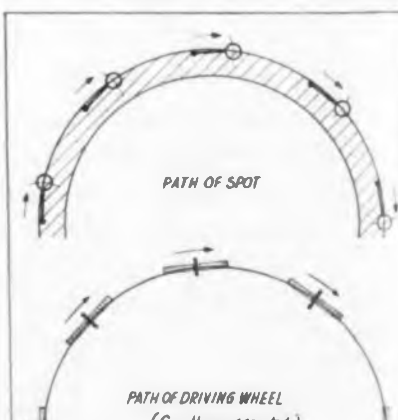


Fig. 3

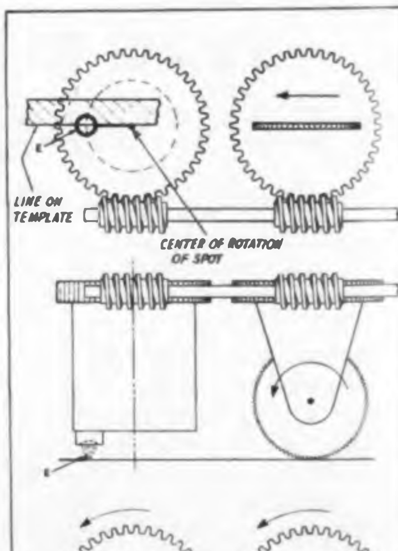
straight or slightly curved line the error will usually not exceed 1/64 in. at most.

Since a full sized template is used, the accuracy with which templates can be drawn is well within the permissible tolerance. Due to the fact that the machine constantly compares the torch position directly with the templates, cumulative errors due to the driving wheel slipping are not present.

Smooth control signals

One feature which contributes materially to the accuracy and speed of response is the smoothness of operation of the control. The control does not provide an "off-on" signal, but instead provides a signal which varies smoothly as the spot is moved from its correct position to a position on either the black line or the white paper. Therefore, it provides a correction which is approximately proportional to the amount of error.

This type of control, together with an anti-hunt circuit which is included in the electrical circuit of the equipment, combine to provide a control which rotates the spindle around a corner much more rapidly than could be done by hand, and yet maintains better accuracy than that obtained under manual control. The speed of rotation of the driving spindle when allowed to rotate freely is approximately 100 rpm, or almost two complete revolutions every second. Therefore, when the driving wheel approaches a corner, it is turned to its new position very rapidly. This makes



Figs. 4, 5, 6

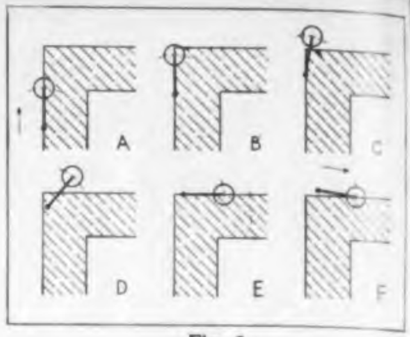


Fig. 6

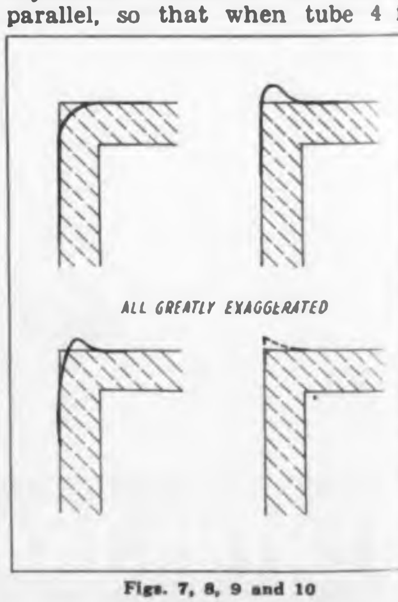
it possible to follow intricate shapes with very good accuracy.

The electronic control circuit is shown in Fig. 11. Tube 1 is a rectifier tube which supplies dc power for the phototube and for amplifier tubes 2 and 3. A separate rectifier supplies dc power for the motor field.

The phototube is connected in a bridge circuit which is made up of resistors R1, R2, R3 and the phototube. The resistance of the phototube varies as a function of the amount of light which it receives. Therefore, the circuit is adjusted so that when the spot of light is half on the white paper of the template and half on the black line, the signal applied to the left grid of tube 2, is equal to the signal applied to the right grid of this tube. In other words, the voltages across R1 and R2 are equal. Under these conditions the output of both plates of tube 2 will be equal. Therefore, the signals applied to the grids of tube 3 will be equal.

Since an equal signal appears on each grid of tube 3, the currents which flow in the windings of saturable reactors SR1 and SR2, which are connected in the plate circuit of tube 3, will be equal.

The ac windings of saturable reactors SR1 and SR2 are connected in the grid circuits of tubes 4 and 5 respectively. These tubes are thyratrons connected in inverse parallel, so that when tube 4 is



Figs. 7, 8, 9 and 10

allowed to conduct current, the current flows from the ac line up through the motor armature circuit and back into the top ac line. If only tube 5 is allowed to conduct, the current flows in the opposite direction and therefore, flows downward through the motor armature. In that way, dc may be obtained from the ac line and the motor may be driven in either direction by turning on either tube 4 or 5.

If both tubes 4 and 5 are turned on by the same amount, the current through the armature of the motor will be ac and the motor will not rotate. If tube 4 is allowed to pass slightly more current than tube 5, the result will be a slight dc component of current in the armature circuit. Therefore, the motor will revolve slowly in one direction.

The amount of current which is allowed to pass by the thyratron tube is a function of the dc current in the windings of saturable reactors SR1 and SR2. When the

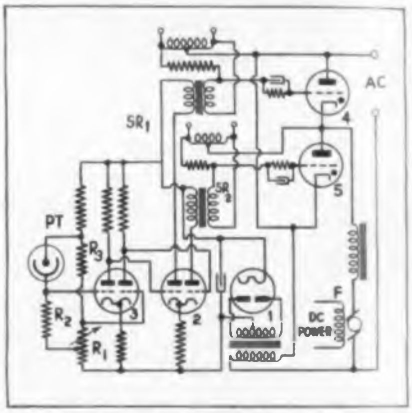


Fig. 11—Circuit diagram

current in the dc winding of SR1 (which is in the plate circuit of tube 3) is increased, the amount of current which tube 4 is allowed to pass is increased by phase-shifting of the thyratron. If the dc through SR1 and SR2 is the same, then thyratron tubes 4 and 5 will both conduct the same amount of current and the steering motor will not rotate.

The net result is that if the voltage across R1 is equal to the voltage across R2, (that is, the spot is centered on the edge of the line), then thyratron 4 will conduct the same amount of current as thyratron 5. Under these conditions the motor will not rotate and the control will continue to follow along the line in the same direction.

If the spot should tend to move towards the white paper, the resistance of the phototube will tend to decrease. This will increase the voltage across resistor R2 and consequently will cause SR2 to pass more dc, and tube 5 to pass more current through the motor armature. This will result in rotating

YOU CAN'T BUY A NEW TUBE IN A FOX HOLE

When a signal corpsman goes into action, the tubes his unit must depend upon for communications are the tubes that were issued to him back at the base. They have been jerked on trains, handled in and out of ships and tumbled in trucks before they even get to him. Then he gives them a long rough ride in the set on his back. Tubes have to be good to stand up under this kind of treatment.

Little did TUNG-SOL Engineers realize that the many design and construction features they incorporated in TUNG-SOL Tubes long before there was any thought of war, would assume a new importance in our nation's battles. Then TUNG-SOL Tubes were built to withstand the synthetic abuse we called "Vibration-Testing". Now they are called upon and do withstand the real thing.

Manufacturers and users of radio and other electronic devices and controls may be assured that the TUNG-SOL Tubes they buy for initial equipment and replacement have been "War-Tested" far beyond any requirement of civilian use. TUNG-SOL Research and Development Division will be glad to assist manufacturers in planning circuits and selecting TUNG-SOL Electronic Tubes for present and future devices.

THE SPRING DAMPER BAR developed by TUNG-SOL

The TUNG-SOL Damper Bar construction is positioned to hold the filament tension spring to one side, thus taking the whip out of the filament above the mica disc. This whip would allow the filament to vibrate, the cause of low frequency pitch known as "howl".

TUNG-SOL

vibration-tested

ELECTRONIC TUBES

ARMY E NAVY

TUNG-SOL LAMP WORKS INC., NEWARK 4, NEW JERSEY

ALSO MANUFACTURERS OF MINIATURE INCANDESCENT LAMPS, ALL-GLASS SEALED BEAM HEADLIGHT LAMPS AND CURRENT INTERMITTORS the steering motor in such a direction that the spot returns to the position where it is centered on the edge of the line.

The action of this control is such that it provides a smooth signal which produces only as much correction as is required. That is, if the spot is only slightly away from its correct position, the amount of torque which is delivered by the steering motor is small and therefore the spot moves smoothly to its correct position. If, on the other hand a corner is reached and the amount of light on the phototube suddenly becomes considerably greater than it should be, then full voltage will be applied to the correcting motor and the steering spindle will be rapidly rotated until the correct position is reached.

WIDE READING

(*Continued from page* 131)

UHF Impedance Measurement

G. Williams (Proceedings of the Physical Society, London, January, 1944)

A method using Lecher wires has been developed to determine impedances at uhf frequencies; the method eliminates errors due to fluctuations in the oscillator power output.

The unknown impedance Z is connected across the end of the Lecher wires, and the ratios of the currents I_1 and I_2, as a function of the distance s, are used to calculate the value of Z. It is proved that, for a certain adjustment of s_1, the absolute value ρ of this complex ratio, which is the quantity measured in the experiments, is given by the expression

$$\rho^2 = K_1 + \frac{K_2}{\sinh^2 a + \sin^2(b+\beta s)}$$
$$= K_1 + \frac{2K_2}{\cosh 2a - \cos 2(b+\beta s)}$$

and that the unknown impedance Z is given by the expression

$$Z = Z_0 \tanh(a + jb),$$

where β is the propagation constant of the wires, which is purely imaginary, and Z_0 is the characteristic impedance of the wires. Constant K_1 is found experimentally; the values of a and b and the wavelength are determined graphically from suitably plotted curves.

The method has been used to measure the impedances of carbon

TODAY . . .

Aerovox Capacitors Go to War

TOMORROW . . .

Aerovox Capacitors Help Build Peacetime Progress

Aerovox oil-filled capacitors for war and for peace – a giant 15,000 volt unit with side terminal and grounded case, to reduce head room; a small "bathtub" unit for use in better-grade radio and electronic assemblies.

● In countless ways Aerovox capacitors are speeding up the winning of the war. Thousands of skilled workers, carrying out the designs and specifications of engineers long specializing in capacitors, are meeting a large portion of the wartime requirements.

Indeed, Aerovox personnel has expanded threefold since Pearl Harbor. Close to half a million square feet, in two plants, are now devoted exclusively to capacitor production.

Today Aerovox is all-out for the war effort. Winning the war comes first. But tomorrow, when victory shall have been achieved, Aerovox once more will be ready as never before to rebuild for peacetime progress—to meet the requirements of the expanding radio industry and the booming electronic era. Special types of yesterday shall be the commonplace types of tomorrow. New standards of life and performance for your assemblies can be taken for granted.

Let us help you now with your wartime needs. And it isn't too early now to be discussing your post-war plans and problems. Submit your capacitance problems or needs.

AEROVOX Capacitors

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resistors and to investigate the properties of liquids, especially the dielectric constant of a transformer oil, at frequencies of the order of 150 megacycles. It has also been used to measure the capacitances between the electrodes of tubes.

Pulse Generation

J. M. A. Lehihan (Electronic Engineering, London, March, 1944)

The basic circuits used for the generation of pulses and for the sharpening and shortening of pulses are summarized. Thyratron circuits, squegging and blocking oscillators, squaring circuits, rc circuits and multivibrators are treated.

High-Power HF Magnetron Oscillator

N. F. Alekseev (IRE Proceedings, March, 1944)

Experimental magnetrons for high power output were designed and tested in the centimeter range. Details of tube construction are given and suggestions for further developments based on the experimental results are made.

Mass Spectrometer

James E. Taylor (Review of Scientific Instruments, January, 1944)

A mass spectrometer suitable for routine isotope abundance measurements was constructed to analyze mixtures of carbon isotope compounds. The apparatus is described in detail.

On Permanent Magnet Alloys

M. S. Wilson and J. M. Whittenton (Electrical Engineering, March, 1944)

In an article on the influence of improved magnetic alloys on the design trends of electrical instruments, the electrical and mechanical properties of these alloys are compared, production methods discussed and applications mentioned. The table shows the essential characteristics of various magnetic alloys.

Effect of Feedback on Impedance

R. B. Blackman (Bell System Technical Journal, October, 1943)

By considering the equations for the network shown, the following general relationship between feedback and impedance is derived:

$$\frac{Z_A}{Z_P} = \frac{1 - F_{sh}}{1 - F_{op}},$$

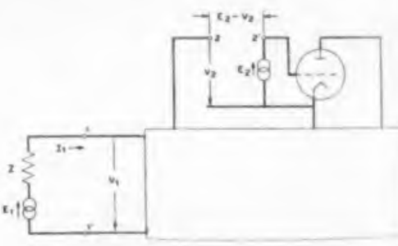
where
$$Z_A = \left(\frac{V_1}{I_1}\right)_{E_2 = V_2}$$

$$Z_P = \left(\frac{V_1}{I_1}\right)_{E_2 = 0}$$

$$F_{sh} = \left(\frac{V_2}{E_2}\right)_{V_1 = 0}$$

and
$$F_{op} = \left(\frac{V_2}{E_2}\right)_{I_1 = 0}$$

Z_A is the impedance which will be seen at the terminals 1,1′ when terminals 2,2′ are connected together and the only source of emf acting on the network is the external circuit connected to the terminals 1,1′. Z_P is the impedance which will be seen at the terminals 1,1′ when terminals 2,2′ are connected together and the amplification factor of the tube is nullified. F_{sh} is the feedback to the tube with the terminals 1,1′ connected together, and F_{op} is the feedback to the tube with the terminals 1,1′ left open.



Schematic feedback network

To use the equation for the determination of feedback by impedance measurements, it is essential to choose a pair of terminals for which either F_{sh} or F_{op} is equal to zero so that the other is identical with the normal feedback which

Permanent magnet alloys

Alloy	Typical Composition (Per Cent)	Coercive Force (Hc)	Residual Induction (Br)	B×H (Maximum)	Mechanical Properties	Commercial Methods of Fabrication
1. Chromium magnet steel	3.5 Cr; 1 C; remainder, Fe	65	9,000	295,000	Hard and strong	Hot forge, punch and machine
2. Tungsten magnet steel	5 W; 1 C; remainder, Fe	70	10,300	320,000	Hard and strong	Hot forge, punch cast, machine
3. Cobalt (36 per cent) magnet steel	36 Co; 3.5 Cr; 1 C; remainder, Fe	210	9,000	930,000	Hard and strong	Hot forge, punch cast, machine
4. Cobalt-nickel-copper alloy	41 Co; 24 Ni; 35 Cu	440	5,300	993,000	Ductile	Cold-roll, machine, punch cast
5. Iron-nickel-copper alloy	20 Fe; 20 Ni; 60 Cu	450	5,300	1,070,000	Ductile	Cold-roll, machine punch
6. Comol magnet alloy	12 Co; 17 Mo; remainder, Fe	245	10,300	1,100,000	Hard and strong	Hot forge, punch machine, cast
7. Alnico IV	12 Al; 28 Ni; 5 Cu; remainder, Fe	700	5,200	1,250,000	Hard and brittle	Cast, sinter, or grind
8. Alnico III	12 Al; 25 Ni; remainder, Fe	400	7,100	1,330,000	Hard and brittle	Cast, sinter, or grind
9. Alnico I	12 Al; 20 Ni; 5 Co; remainder, Fe	400	7,100	1,330,000	Hard and brittle	Cast, sinter, or grind
10. Alnico II	10 Al; 17 Ni; 12.5 Co; 6 Cu; remainder, Fe	540	7,200	1,650,000	Hard and brittle	Cast, sinter, or grind
11. Alnico V	8 Al; 14 Ni; 24 Co; 3 Cu; remainder, Fe	525	12,000	4,000,000	Hard and brittle	Cast, grind

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may then be determined by measuring Z_A and Z_P. Choice of suitable terminals and experimental methods are described in detail.

Another application of the equation is the study of impedance control by feedback. Three examples are given to illustrate the mathematical procedure.

Trailer Radio Station for Emergencies

To provide mobility for the Bell System emergency radio telephone sets, engineers of the American Telephone and Telegraph Company have developed the 140-RT radio telephone trailer. This is a two-wheel vehicle designed to house the equipment and to shelter the operator. When fully loaded with radio and other apparatus, the trailer weighs about 2,000 pounds. Fittings on the trailer permit towing by passenger car or truck.

It takes only a few minutes after the trailer is uncoupled to establish an operating radio terminal. At its location the trailer is steadied by adjustable pipe supports at its four corners; and its doors are thrown open. Using the materials it carries, a fifty-foot mast is quickly erected and the proper connections are made to the radio equipment.

Following this the normal ground connections are made and the gasoline engine-driven generator, which is located in the rear compartment of the trailer, is started to provide the necessary power supply. Immediately the radio operator calls the distant station and makes known the availability of the radio terminal. Connections from the trailer station to the nearest telephone line are made and the central office is advised that communication over the emergency radio channel is available for service.

CAA-RTCA

(*Continued from page* 95)

nating current to indicator lamps located above the indicating instruments to indicate the presence of monitoring signals. Similar indicating lamps, also operated by the monitor signals, are located in appropriate positions on the miniature diagram of the airport on the surface of the control desk. The lamps indicate the locations of the stations operating.

To provide a permanent record of operating intervals, each of the amplified monitor signals is connected to a commutating device on the drive shaft of an Esterline-Angus recording milliammeter. Through this commutating device the signals are connected in sequence to an amplifier and rectifier and thence to the recorder. The individual levels are adjusted so that each causes the recorder pen

Fig. 10—Glide path receiver, type RUJ

to deflect to mid scale and provide uniform recorder amplitude for normal operation except for the runway identifying signal.

Time markings in minutes and hours are continuously made on the margin of the chart by two impulse pens operated from a dry-cell battery through a precision clock. The signals applied to the recorder are also applied to the control grid of an 884 tube, the plate current of which normally holds an alarm circuit relay open. Failure of any of the signals received by this tube from the commutator causes the relay to close and an audible alarm to sound in the control tower. A red signal also lights on the control desk.

Localizer, glide path, and marker receivers for the instrument landing system were designed, constructed, and tested under conditions equivalent to those for airline ATC equipment. The glide path and localizer receivers are shown in Figs. 10 and 11. Each receiver is a crystal controlled superheterodyne, the crystal being hermetically sealed and less than 9 megacycles in frequency.

Each receiver is designed for operation from a 70-ohm concentric transmission line. Power supplies are designed to operate from 12 volts direct current.

Special features were incorporated in both localizer and glide path

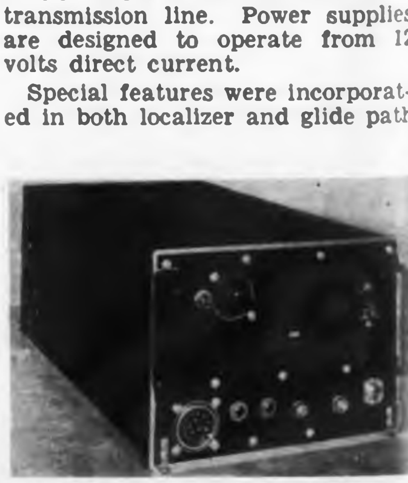

Fig. 11—Localizer receiver, type RUK

WHERE THE GOING IS TOUGHEST is where the men of the U. S. Signal Corps do business

Behind the front, at the front — yes, and ahead of the front lines, they are laying wire, directing artillery fire, spotting enemy movements and putting their superb technical training into practice with calmness and efficiency in the thick of battle. They don't get as many headlines as they deserve, but they rate and get the thanks of every soldier, from General to buck private.

Many of our own men, now in the service, have been assigned to Signal Corps duty, and are frequently using the very equipment they once helped to build. Their experience in our plant is being put to good use at fighting fronts all around the world. Signal Corps training will in turn make them all the more valuable to us when they return. Thus, important forward strides in communications engineered by the Signal Corps, manufactured by the communications industry, and put to the acid test by superbly trained technicians will be available to serve you in the postwar world.

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receivers to meet the specification requirements. For example, temperature compensation of receiver sensitivity was necessary. In the glide path receiver this was especially important. Compensation had to be applied, in the glide path receiver, for momentary and prolonged change of battery voltage such as usually results from the starting of the airplane radio transmitter or the operating of landing lights. For a prolonged drop in battery voltage, two types of compensation are employed, one to correct for the immediate change caused by reduction of receiver plate voltage and the other to compensate for the gradual change in emission of the filaments. In the localizer receiver, careful consideration in the design of the 90/150-cycle filter and its associated circuit was required to avoid variation of the indicated course for signal levels below that at which the receiver automatic volume control was in operation. The rectifiers operating on the output of the 90/150-cycle filter had to be of special design and, as supplied, were balanced with respect to signal volume and temperature. Under test at prolonged high relative humidity, difficulty of leakage in certain parts of the wiring and in the IF transformers were overcome.

Although instrument landing systems, using a radio-electronic "localizer" are at present being installed for military use only and general applications for civilian operation await the end of the war, this improvement for the Federal Airways which is being done by the Civil Aeronautic Administration is slated eventually to be installed in all the busier airports of the nation. The equipment for postwar installation is being manufactured by eight or ten electronic manufacturing companies.

Jungle Troubles Solved by Radio Men

No critical shortage of communications and radio equipment has occurred in the Pacific theaters of war. All three commanding officers —Admirals Nimitz and Halsey and General MacArthur — report that they had never been delayed in their operations by the lack of signal apparatus and facilities.

This was related at a War Department press conference by Major General Harry C. Ingles, Chief Signal Officer of the Army, who returned after an inspection tour of five weeks of Signal Corps installations in the Central Pacific, Southwest Pacific and South Pacific Theaters of Operation, as briefly reported in our Washington News for April.

General Ingles paid the highest tribute to the great ingenuity which the Signal Corps troops in the Pacific combat zones display in their work of installing and operating communications, both radio and wire, under the most difficult fighting conditions in the world—the jungles of the Southwest Pacific Islands. He declared that despite these difficult conditions, the American soldiers preserve their humor and throughout his trip he saw many illustrations of the latter attribute.

The Chief Signal Officer emphasized that the relations between the Army and Navy in the Pacific theaters of war are "just splendid" and, although this has been a goal which has been preached by the military leadership since the beginning of the war, "I do not see how they could be improved upon." General Ingles related that the Signal Centers in every case throughout these theaters are combined and one sometimes sees an Army radio channel manned by a sailor and a Navy circuit operated by a Signal Corps soldier. The whole relationship is excellent, he stressed.

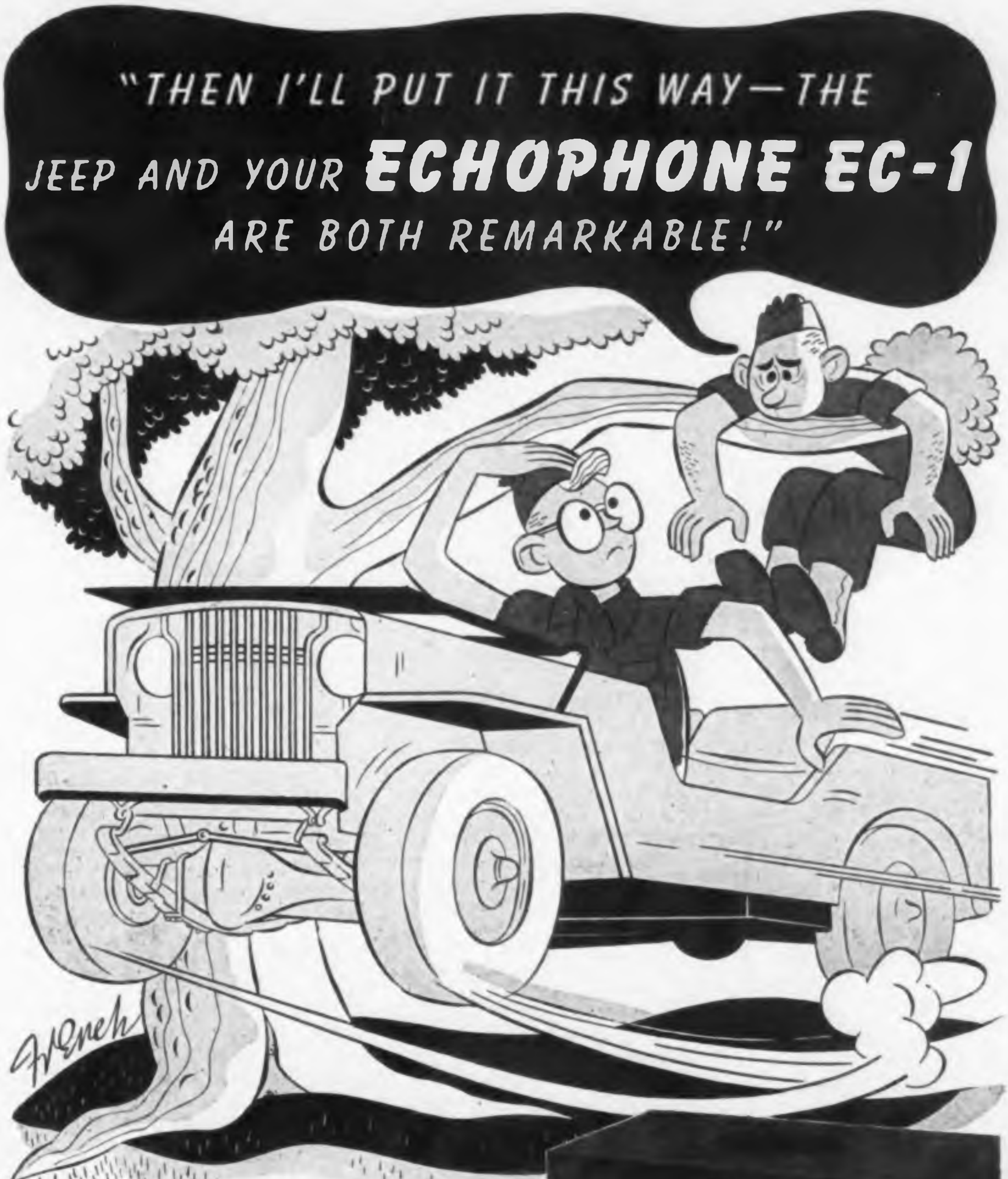
The enormous distances of the Pacific theaters where a couple of thousand miles are just a normal distance throws a great burden on communications, General Ingles stated.

Procurement now satisfactory

Declaring that in the other theaters of operations such as Europe, Africa, Mediterranean and Caribbean the primary communications medium is wire with radio regarded as auxiliary but valuable. General Ingles pointed out that in the Pacific theaters radio is not only the primary means but in most cases the only method of communications because of the huge spaces of water.

In discussing the procurement problems of the Signal Corps, General Ingles brought out that the Corps' procurement and distribution now is quite satisfactory and that this phase of its activities had come up in improvement a great deal, by over 75 per cent, during the past year. He told the newspapermen that the Signal Corps procures 96,000 different items of communications equipment, including a great many parts.

Relating that the jungles in the Solomons and New Guinea were the worst that he had ever seen—much more difficult than those of Central and South America—the Chief Signal Officer described how the jungle affects both the operations and the equipment of the radio apparatus. The jungle has a blanketing effect on radio so that walkie-talkies don't transmit with their normal range, particularly if the jungle is wet, he said. Sets with normal range of five or ten miles can't get more



Echophone Model EC-1

(Illustrated) a compact communications receiver with every necessary feature for good reception. Covers from 550 kc. to 30 mc. on three bands. Electrical band-spread on all bands. Beat frequency oscillator. Six tubes. Self-contained speaker. Operates on 115-125 volts AC or DC.

Echophone Radio Co., 540 N. Michigan Ave., Chicago 11, Illinois than two or three miles, he noted. Therefore, the Signal Corps as soon as it is possible lays telephone wire networks on shore.

Equipment takes awful beating

Communications equipment also takes an awful beating in the Pacific theaters both in use and being unloaded in nets from the ocean-going vessels to the unloading barges. They often lie on the beaches, too, in the rain without any protection.

The jungle weather is also extremely hard on the radio sets and they have to be treated especially with protective chemicals for water-proofing and to prevent fungus growth. The equipment, General Ingles stated, is treated for the tropics with the best methods available. It is especially important that the containers be made water-proof. It is a bad country for dry batteries, he added, and in order to keep them in a good condition the batteries have to be placed in cold storage. He related that the troops build refrigerating structures out of sawdust from the lumber that they have used in making Army buildings and then put the refrigerating apparatus inside the sawdust housings. The Signal Corps is now trying to develop a special battery for the tropical climate which it is hoped will be an improvement. The heavy radio station equipment does not need to have such extensive water-proofing protection since they are housed practically entirely in buildings.

Signal Corps in thick of fighting

The Signal Corps troops' ingenuity is remarkable, according to the Chief Signal Officer. The sergeants and enlisted men in their small "teams" or units often do not perform their installation and maintenance and repair operations according to the book but try out different methods of their own invention. He related that he had never seen so many different ways of putting up field wire and told about a young lieutenant at Bougainville who made cross-arms with little notches instead of the usual insulators and tied the wire into these notches with basket-weave knots in a very good method. He noted that the field wire (which weighed 185 pounds per mile in World War I) is lighter in this war, weighing only 125 pounds.

The Signal Corps soldiers are combat troops, taking part in the fighting a great deal and engaging in all actions, General Ingles stressed. They are trained in this country in infantry methods because of their being right in the combat operations. He added that this applies to all service troops in this war and cited how the Army Engineers at Milne Bay left their bulldozers and took up their machine guns and rifles and mowed down an attack wave of Japanese. He also paid special tribute to the Signal Corps photographers who go with the Infantry in the first waves, although not armed.

New Research Lab Completed

Geophysical Instrument Company has announced the occupancy of its new research laboratories and scientific instrument plant at Key Blvd. and Nash St., Arlington, Va.

This company manufactures electronic medical and industrial equipment, such as metal locators, X-ray intensity meters, optical equipment, etc.

CIRCUIT ACTION

(*Continued from page* 102)

closely proportional to de_r/dt when e_r is small. This principle can be used to alter the waveform of an applied signal, as from a sine wave to a peaked wave. A sine wave is first "clipped" in a limiter circuit and applied to a series RC combination with a capacitor of a small value (X large for the frequency involved, preferably many times the value of R).

Differentiation circuits are often used to discriminate between pulse varieties as to wave shape, as for example the separation of a pulse with a sharp front, from one with a gradual wave front and an abrupt falling off. A combination of these pulses which might be used in some remote control system, is shown in the e_g curve in the oscillogram, Fig. 6.

The first derivative of this waveform has a sharp positive and negative pulses, curve (e_p). These pulses can be separated by the use of diodes so as to operate the respective relays. A circuit is shown

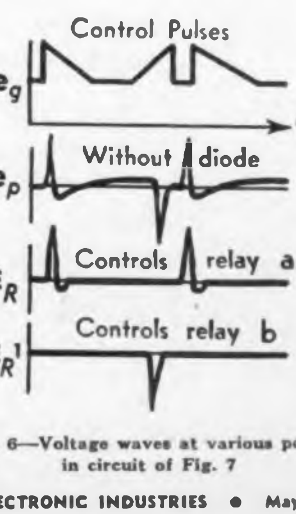


Fig. 6—Voltage waves at various points in circuit of Fig. 7

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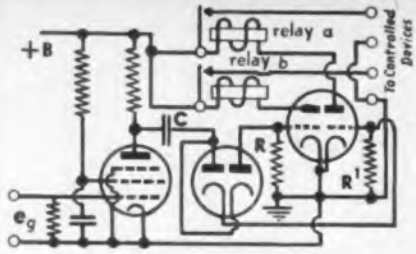

Fig. 7—Circuit to operate relays on positive and negative rates of change of applied voltage e.g. See Fig. 6

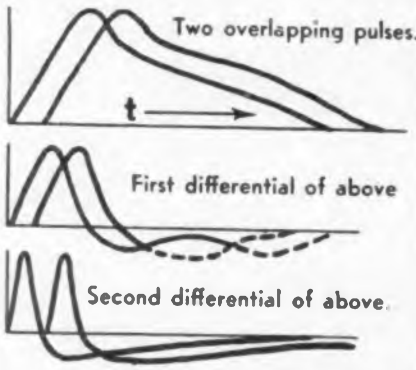

Fig. 8—Effect of multiple differentiator on overlapping pulses. Permits separation for control purposes

in Fig. 7 that will do this. This arrangement can be used to provide greater discrimination in recording or counting random effects. It may happen that two pulses take place close together, so as to overlap as in the oscillogram, Fig. 8. The first derivative of this wave, shown here, has a somewhat greater time separation between the peaks, while the second derivative shows a distinct separation between them.

BERYLLIUM-COPPER

(*Continued from page* 109)

taching the shunt. Both ends of the spring can be made alike which increases the speed of the assembly operation thereby reducing its cost. Closer tolerances also result in more uniform brush pressure, a better interference fit between the spring and the brush neck, as well as a better fit in the brush holder. Since beryllium-copper can be safely used at much high working stresses, a spring can be designed with more initial compression. This results in a decrease in the loss of brush pressure with brush wear, and often doubles brush life.

A third example shown in the accompanying drawing is a beryllium-copper frame for the moving element of an electrical indicating instrument used on electronic equipment. A non-magnetic material is essential. Because of the intricate shape die castings have been generally used in the past. The fact that die castings have a tendency to grow or distort during normal aging resulted in dimensional changes which threw the

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PHYSICAL CONSTANTS

Density, lb. per cu. in.	.297
Elastic modulus, maximum	19,000,000*
Torsional modulus, maximum	7,500,000*
Electrical conductivity (Copper = 100%)	25 to 30%*
Thermal conductivity (BTU/sq. ft./in./sec./deg. F.)	16 to 20*
Coefficient of thermal expansion	1.7×10^{-5}
Coefficient of elastic modulus	33×10^{-5}

*Values depend on heat-treatment

Physical properties when fully heat-treated

Ultimate tensile strength, over	190,000 lb./sq. in.
Proportional limit	100,000
Endurance strength (bending)	65,000
Hardness, Rockwell 15N	80 to 82

Typical Spring Design Stresses Compression Coil Springs

Occasional load	65,000—80,000
Rapidly repeated load	50,000—60,000
Calibrated spring	40,000—55,000

Flat Springs in Bending

Occasional load	80,000—100,000
Rapidly repeated load	50,000— 65,000
Calibrated spring	60,000— 80,000

jeweled pivot bearings out of line. In making this part of beryllium-copper, it is formed from material in the soft and ductile state, then hardened in fixtures to tolerances as close as those obtainable in a die casting. Because of the higher tensile strength a thinner cross section can be used which results in a frame of lighter weight. This frame has dimensional stability, requires no machining or reaming of holes, and because of its greater strength is less subject to damage in handling.

Instrument frame of beryllium-copper outperforms a die casting, costs less and requires no finish machining. Formed while soft and hardened in fixture to hold important dimensions

and the costs of tools and parts are less.

There are, of course, many other applications in the electronic field, a few of which are shown in the group illustration. The story behind the design and fabrication of each of these parts is essentially the same as one or more of the several examples already described in detail. The higher strength, corrosion resistance, freedom from set or drift, ability to withstand higher temperatures, greater endurance strength, higher electrical conductivity, and closer tolerances obtainable with heat-treat forming, add up to important overall advantages in nearly every instance where springs are required in electronic equipment. With intelligent engineering and "know how" on the part of the spring maker, beryllium-copper springs can be made to do things which can not be accomplished with any other spring material.

For those who want basic data helpful in design, the following information is offered. The constants, design stresses and tolerances are based on "Micro-processed" beryllium-copper material of good quality, heat-treated at temperatures between 680 and 700 deg. F. for the time giving best properties, with parts held in heat-treating fixtures to obtain precision tolerances.

When service conditions involve temperatures about 300 deg. F., or when the material is annealed prior to hardening or with material thickness greater than ⅛ in., conservative design should allow for some reduction from these values.

Electrons in the Solid State of Matter

Recent developments in the theory of constitution of materials in the solid state may lead to great strides in fields previously quite dependent on trial-and-error methods. These include such problems as the action of light on photographic plates, fluorescent lighting, action of television tubes, and the reduction of iron ore. Although the general nature of the phenomena involved was appreciated, it has appeared too complicated for complete understanding. Now, however, it seems that suich phenomena can be largely explained by a mechanism fairly simple from the viewpoint of quantum mechanics.

Solids are made of atoms, and atoms consist of electrons which revolve around a nucleus. According to modern physics, only certain orbits are permitted for these revolutions. The energy of the electron's motion within the orbit rather than the shape of the orbit is important. Thus, an atom is

considered as a scale of actual and potential energy levels. When two atoms combine to form a molecule, the number of levels stays constant, giving the combination a double energy-level system. The interaction of the atoms on each other causes the energy levels to shift slightly to give pairs of different, rather than identical, levels. When a large number of atoms form a solid, such as a crystal, each original atomic energy level is split into a number of levels which are separate but so close together that they are considered as a band.

The energy-level scheme of an atom could be pictured as a tall house with many stories, but only one room in each story. These houses are populated by electrons, which prefer to inhabit the lower levels. No more than two electrons occupy the same room. The more complicated atoms can be considered as houses whose lower rooms are entirely filled, but whose upper rooms generally are only partially occupied by tenants.

Electrons "on the loose"

The formation of a solid can be visualized as the grouping of the single-room houses to form an apartment house, with many rooms on the same floor. If the original houses had each room occupied by a pair of electrons, there would not be much intermingling in the apartment house. This is why inert gases, like helium, with all levels filled, do not condense to solids except at very low temperatures. Many simple molecules behave similarly, and form soft solids like paraffin wax. If, however, the individual houses had upper floors only partly filled, as in the reactive elements, the interaction is very curious. In the community of electrons morals are quite free. There is a tendency of single occupants to double up, sharing the lowest room available as an electron pair. The pair will always live on a lower floor than before the union, which in our analogy means a lower energy level, which gives the system stability. This phenomenon of electron coupling binds the ninety-two elements into compounds and crystals.

When metallic elements form a solid, a simple population count shows the upper floors are only partially filled. If there is any attraction on one side of the house, such as a passing fire-engine, some of the inhabitants of the upper floors will rush to that side. This is typical of the migration of electrons under the influence of an external electric field, the motion producing an electric current. In the heat of summer some inhabitants will vacate their rooms and move to the top floor. This is the case of an electron in a photocell exposed to radiation. Some will leave altogether, showing the phenomenon of electron emission of the alkali metals used in phototubes.

In more elaborate structures, exposure to light may cause an electron to move to another wing of the apartment, where it may find a single inhabitant to join. The formation of an image on a photographic plate is supposed to follow such a mechanism. Light falling on an electron causes it to migrate and eventually encounter a silver atom with a missing electron, which it joins, thereby producing the metallic silver of the image. Thus by simply taking a count of the rooms available and the number of electrons to be accommodated, it is possible to predict which elements form weak crystals, metals, or semiconductors, and to arrive at a consistent explanation of the various phenomena observed in solids.

Quantitative investigations of the relative positions of the energy levels and widths of the bands has led to further advances in the understanding of the constitution of many substances and of the mechanism of the more fascinating phenomena and reactions of the solid state. The green color of a radio's "magic-eye" is caused by bombardment of a screen of tiny crystals by electrons. Brighter and more permanent screens have been made as a result of the understanding of the energy bands in the crystals. Similarly three-dimensional X-ray views of the interior of a patient's body have been made possible by the discovery of more responsive crystals. Television screens can be thought of as numerous minute magic-eyes blinking under a stream of continually changing radio signals. The materials of these screens, in particular those for color television, are being developed by research guided by the band theory of solids. Much the same considerations can be applied to research in photocells, photographic materials, and fluorescent lights. Other fruitful fields where the theory of the solid state would lead to practical developments are rectification, reduction of ores, corrosion, scaling of iron, sintering, soldering, and powder metallurgy.—**Industrial Bulletin of Arthur D. Little, Inc., Massachusetts Institute of Technology, Cambridge, Mass.**

DISCONTINUITIES

(*Continued from page* 125)

neglected. To give an idea of these effects, the measured results on a quarter wave piece of 3.50 cm length are: $Z_{01}=76.7$ ohms and $Z_{02}=17.3$ ohms. Then $k=Z^2_{01}/Z^2_{02}=19.7$ for the section x y_o, by computation; $k=18.9\pm1\%$ for $\lambda=14.0$

. . . BUT AS FOR ME . . .

169 years ago this month a man arose in the 2nd Virginia Convention and into just nineteen crystal-clear words compressed a question and an answer which will never pass from men's memories. Said Patrick Henry, "I know not what course others may take, but as for me, give me liberty or give me death."

Patrick Henry's speech carried the convention, and ultimately a young nation was committed to fight for its life—and its freedom, which it valued more. That nation has never since hesitated in the pursuit and defense of freedom, and never will. Today, in freedom's name, America and her allies are fighting a war greater than all the wars of history put together, a war in which the amount of weapons and materials needed surpasses the imagination of most men. But they *are* being provided and will continue to be provided, with the aid of your War Bonds. It's the *extra* punch that wins battles—provide it by buying *extra* War Bonds.

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FINE MUSICAL INSTRUMENTS SINCE 1902

J. P. SEEBURG CORPORATION • CHICAGO, ILLINOIS cm and $k=19.5\pm1\%$ for $\lambda=14.5$ by measurement. An accuracy of ±1 per cent is easily obtained with suitable precision of the measuring line and frequency constancy of the transmitter.* The experimentally found points x_o and y_o deviate very little from the computed ones, which were derived without taking the disturbing effects of the corners into account.

Third Example: The disturbances caused by the corners are more striking with a half wave section (Fig. 5c). In the example measured, the line with the smaller characteristic impedance was 7.0 cm long and it was to be expected that the four-terminal network would give a transformer ratio of k equal to unity for a wavelength of 14.0 cm. Actually a k equal to 1.10 was measured, and only for a wavelength of 14.5 cm was k equal to unit. Because of the corners, the piece appears to be 2.5 mm longer.

Fourth Example: On a concentric line having a characteristic impedance of 76.8 ohms a dielectric disk of 6 mm thickness (Fig. 5d) at $\lambda=14$ cm gave $k=1.45$. From this value a dielectric constant of 2.47 can be computed. $k=1.45$ also means that a 100 per cent matching behind the disk results in a ratio of $E_{min}:E_{max}=1:1.45=69$ per cent in front of the disk.

Fifth Example: A ceramic bolt of 4 mm width in a concentric line (Fig. 5e) gives a $k=1.07$ for a wavelength of 14 cm. 100 per cent matching behind the bolt results in a 93 per cent matching in front of it.

METALLURGY

(*Continued from page* 117)

of the determination and extended the scope of its usefulness.

In making chemical and spectrographic analyses, a number of electronic devices are used: such as the photoelectric densitometer (for measuring the density of the lines on spectrographic plates and recording the values on a continuous chart) determinations of the pH of solutions, electronic titrimeters, and conductivity bridges. An instrument for making titrations in cases where the end-points cannot be observed accurately by the eye is shown in Fig. 7. Polarographs are used for analyzing dilute solutions. In these instruments the variation of current through the solution with applied potential is determined, and sudden changes in current at critical values of potential are used to identify the elements in the solution. The magnitude of the changes can be used to determine the amount of an element present. Some of these instruments record the current voltage curve automatically.

Other electronic devices, including vacuum gages, vacuum-tube

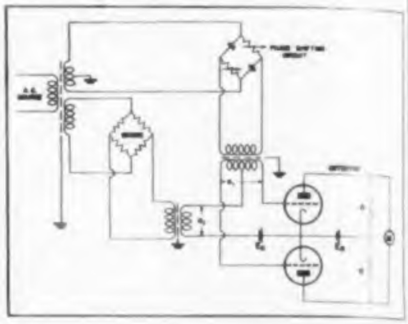


Fig. 8—Bridge detector using balanced modulator action

voltmeters, rectifiers for electrostatic separators, and bridge detectors, are used extensively in a metallurgical laboratory. A special type of bridge detector, shown in Fig. 8, was developed for use in making ac bridge measurements at frequencies where regular ac galvanometers will not function. The current M in the detector output circuit is proportional to $e_1e_2 \cos \theta$, where θ is the phase angle between e_1 and e_2. Thus, by properly adjusting the phase of e_1, the current in M can be made to depend on one component of e_2 only and by proper choice, the reactive and resistance components of the bridge can be balanced independently of each other.

This paper has been mainly concerned with devices that have been found useful in the metallurgical work of the Bureau of Mines. The cases discussed indicate the wide range encompassed at the present time, and many more uses will certainly be found in the future.

"Why Are Electrons All Alike?"—Condon

Atomic "universes" so tiny that many billions of them may exist in a speck of dust, will provide fruitful fields for exploration by postwar scientists, young and old, declared Dr. Edward U. Condon, associate director of the Westinghouse Research Laboratories.

"These universes which hold such immense promise for the future well-being of man are the concern of the atomic physicist. Just now the nation's physicists are engaged in the vitally important task of developing new weapons of war and so they have had to neglect the basic problems of their science. But when the war ends, they will again turn to the task of improving our under-

*Methods used for the exact determination of the voltage distribution along transmission lines and an accurately adjustable short-circuit stub are described in an article on precision frequency measurements by the same author, Zeitschrift fuer technische Physik, 1943, issue No. 2.

T-30

T-45

UNIVERSAL MICROPHONES IN MILITARY APPLICATION

T-17

Universal takes pride in producing these three types of Microphones at the request of the U. S. Army Signal Corps. These units represent but a small part of the skill and experience which has produced over 250 different types and models made available to our customers. From Submarine Detectors to High Altitude Acoustic units, Universal's Engineering experience has covered World War II.

These Microphones built without peace time glamour have every essential of military utility. When peace comes, Universal Microphones, with many innovations of design and accoutrements, will enter upon the post-war scene. Universal includes among its electronic communication components, in addition to microphones: Plugs, Jacks, Switches, and Cord Assemblies.

UNIVERSAL MICROPHONE COMPANY

INGLEWOOD, CALIFORNIA

standing of the fundamental constitution of all matter.

"During a war we must live on our scientific 'capital,' because fundamental research does not yield results rapidly enough to help win battles. But in the postwar period, atomic physicists will return to their real task, building new foundations for advances which may result in a world so different from the present one as to be almost unrecognizable."

There are many things still unknown about the tiny universes that are called atoms and the electrons, protons and neutrons which are found in each atom, Dr. Condon said.

"Why are all electrons, particles of negative electricity, identically alike instead of differing slightly one from the other, as do peas in a pod?" he asked. "We know that bits with like electrical charges repel each other, so what holds together the different parts of an electron? Does it make sense to talk of the parts of anything so fundamental as the electron? If you are looking for places to contribute to physics, I will tell you that there are no answers known as yet to these questions."

The atom of hydrogen is the simplest of all the 92 elements which form all the matter known to scientists today, Dr. Condon said. It consists of a proton charged with positive electricity, and an electron whose negative charge is equal to the proton's positive charge but whose "weight" or mass is 1800 times smaller than the proton's mass. Other atoms are more complicated but they follow the same pattern; there is a nucleus, a tightly constructed center composed of protons and neutrons, which have no electrical charge and around this nucleus are electrons.

"For the physicist," Dr. Condon said, "the primary problem is the discovery of the mechanics of the nucleus—the laws of motion of its particles and the nature of the forces which hold them together.

"In any nucleus except hydrogen we are confronted with protons stuck together at distances 10,000 times smaller than the distances between atoms in a molecule. Since the energy between electrically charged particles increases as the particles get closer together, this means that the electrical energy tending it blow up any nucleus is some 10,000 times greater than usual chemical energies like the fuel value of coal.

"Nevertheless, most atoms are quite stable so there must be strongly attractive forces of a new kind operating between the particles of the nucleus to hold it together in spite of the explosive tendencies of the electrical forces. These new forces are presumably non-electrical in character for they act between proton and neutron in much the same way as between proton and proton."

Sell Phono Surplus

Approximately 40,000 hand-winding portable phonographs, which the United States Government will sell as surplus commodities, were given specific dollars-and-cents prices at wholesale and retail levels by the Office of Price Administration. The personnel of the armed services and export customers, it is understood, will get all instruments.

For the sale of a Model No. 64 Special (with Swiss motor) a consumer may be charged a maximum price of $14.25, and for the sale of Model R (rebuilt with American motor), $12.75. At wholesale the maximum prices are set at $8.50 f.o.b. sellers point of shipment for a Model No. 64 Special, and $7.00 f.o.b. sellers point of shipment for a Model R.

SAW-TOOTH GENERATOR

(*Continued from page* 121)

R_4, R_5, R_6. C_3—C_9. R_4 is the limiting resistor for the highest frequency to be generated, in this case 2000 ohms, where F = 1 megacycle. C_1 to C_9 is the "rough" frequency control and R_2 covers the "fine" control from 1 cycle to 1000 cycles. Above 1000 cycles a switch is thrown so as to cut R_2 out and R_3 in, which is a 15,000 ohm control which will serve to cover the balance of the required frequency spectrum from 1000 cycles to 1 mc.

R_5 located in the screen circut of the tube must handle 4 watts. Under operating conditions the screen current will reach 20 milliamperes. Considering normal tube functions, this would seem excessive, and has proven so for any tubes not having certain characteristics pertinent to the grid structure. Of all the varieties tried the 7G7 tube definitely proved its worth in operating without one single failure. The screen in this tube seems to remain in the cool region, that is, judging by sight, while in others the screen grid became quite red after a few minutes of operation. The screen operating voltage is about 250 volts at the tube socket terminal. The 400 to 425 volt supply is dropped through R_5 and R_6. C_3 is an isolation capacitor. In some cases C_4 should be shunted by 0.006 mfd. to isolate high frequencies. The plate voltage at the tube socket runs from +14 volts minimum to about +55 volts maximum. The plate load resistor R_7 must be kept at this value ±10 per cent. Any change of this resistor will result in linearity distortion.

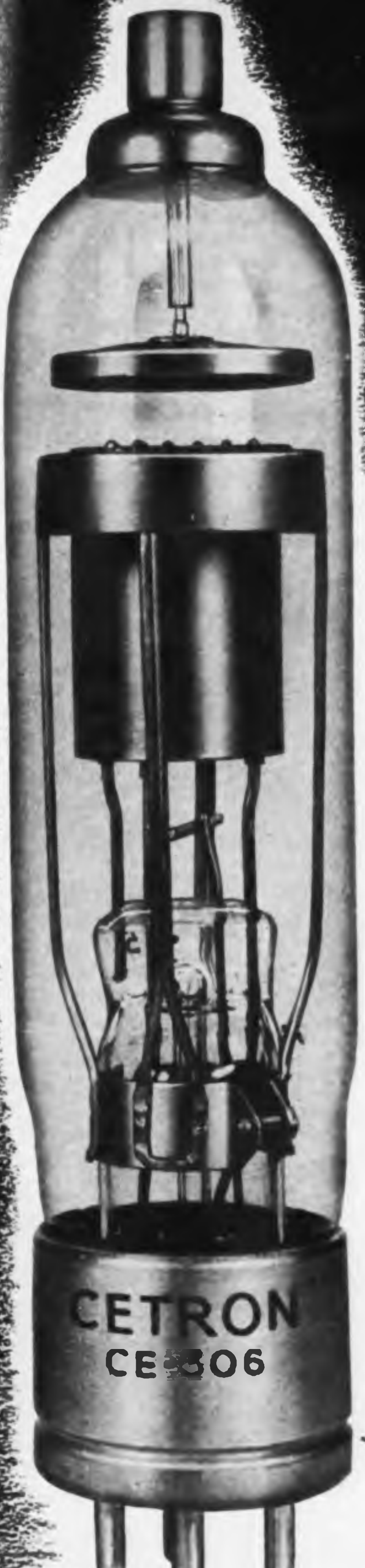
C_1 is the feedback capacitor. Its size (0.006 mfd.) should preferably not be changed. An increase in

CETRON

GRID CONTROL RECTIFIER

(Thyratron)

CE-306



This tube is ideally suited for many industrial applications. . . . Among them, handling primary currents of many small resistance welders, light control, arc welding control, etc. Also, serves capably in motor control applications and other industrial equipment such as control rectifiers.

Minimum internal heating with maximum rectifier efficiency. A long-life product built especially for standing the gaff of all industrial requirements. Bulletin 118 gladly sent on request.

This is only one of the great variety of Cetron Rectifiers, Phototubes and Electronic Tubes. Ask for catalog. If you need a special tube, let us explain how our engineers can serve you in this regard.

LET THIS CARTON
BE YOUR
GUIDE TO QUALITY

The familiar orange and blue package guarantees the tube therein will give long-life, dependable service.

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capacity has degenerative effects on low frequencies. Its function and size have been well established and best results are obtained with the present set-up.

Studying the circuit we would feel that it is either a transitron or negative resistance or dynatron type of oscillator, but another few points will show that actually it has a little of all three.

Circuit waveforms

In Fig. 2A, the wave forms developed at the screen grid and the suppressor of the tube are shown. The steeper or higher, these wave forms (which are of a negative character) the more linear the output will be. This wave form holds true for all frequencies above 500 cycles. On the ranges above 100 kc it changes in that the wave forms lose their flat-top characteristic, but are still steep enough to give the desired effects. The oscilloscope used for observing these high frenquency pulses had apparently insufficient response characteristic to permit true observation. Observation on an oscilloscope will show one readily the wave form on these points. We now come to the synchronizing input control R_1. This resistor is of a rather low value about 2,000 ohms. With a large enough synchronizing input signal, this value was found to be adequate. Large values of grid resistors have a disastrous effect, in erratic operation and also distortion of the output wave. For good synchronization, a pulse signal seems to be the best wave form, especially at low frequencies. Sinusoidal waves do not cause proper lock in, but tend to cause wandering of the generated frequencies. Conversion of any synchronizing signal of any wave form into a pulse appears to be the best solution. C_{10} is a 1 mfd. output capacitor. A smaller value will cause low frequency distortion. The values for C_3 to C_9 are about as follows: $C_3 = 1$ mfd, $C_4 = .1$, $C_5 = .05$, $C_6 = .01$, $C_7 = .005$, $C_8 = .001$, $C_9 = 50$ mmfd. Circuit construction might cause the last two values to be changed slightly.

No doubt improvements can and will be made. It is hoped that the data given will be helpful in promoting an improvement in oscilloscopes for the laboratories and industry.

In Fig. 3, the synchronizing amplifier and inverter for the timing generator of a conventional oscilloscope are shown. For internal synchronization, the output of the first vertical amplifier stage is connected through a shielded cable to the 7A4 grid. The amplified output is connected through a selector switch to the grid of one section of the 7N7 inverter. The plate load of this tube is divided into the equal sections and either positive or negative pulses may be applied to the timing generator grid circuit for synchronization.

The component values in the synchronizing amplifier and inverter stages are so chosen as to produce a desirable steep-wave front essential to accurate synchronization. This can be accomplished by supplying the 7A4 with an excessive signal so as to drive the tube to saturation and also beyond cut-off in order to produce an approximate square wave. This square wave is passed through a C-R coupling network which acts as a differentiator to produce the peaked waves shown in Fig. 2A.

Photocell Control for Bessemer Steelmaking

In a recent paper given before the American Institute of Mining and Metallurgical Engineers, by Dr. H. K. Work, manager of research and development, Jones & Laughlin Steel Corporation, Pittsburgh, Pa., fundamental principles of operation underlying the Bessemer electronic flame-control process were discussed, along with considerable background material concerning the Bessemer process.

A great deal of work has been done in the past aiming toward more precise control of Bessemer steel-making, but to a large extent this work has failed to contribute anything definite. The course of the reactions is so rapid that the usual chemical control methods cannot be applied, and the quality of the Bessemer "blow," therefore, in the past depended upon human observation and judgment.

In the development of the new photocell control it was considered desirable that the human element be eliminated as far as possible, and that in addition the following conditions be fulfilled to have a successful control:

Conditions of control

(1) Speed—The rapidity with which the reaction takes place makes speed a prime requisite of methods for control of the blow.

(2) Quantitative accuracy — Because of inability to meet the speed requirements, qualitative methods have been resorted to in the past and undoubtedly this has contributed to the lack of uniformity of Bessemer steel.

(3) Reference points — Reference points must be known if the control is to be successful.

(4) Records—Records allow scientific comparisons and subsequent improvements.

The success of the photocell method of control is due to the fact that it adequately fulfills these conditions.

The basic control equipment consists of (1) a photoelectric viewing

element, containing suitable filters, that receive radiation from substantially the whole flame, (2) an electronic amplifier to amplify the current received from the viewing element so that it can be recorded on (3) a strip chart recorder.

The active element for picking up radiation from the Bessemer flame is a group of three PJ-22 tubes. This arrangement of cells is set up about 60 feet from the converter, in a position controlled primarily by such mechanical conditions in the mill as: (1) convenience of mountings on parts of buildings; (2) possible interference by cranes or smoke; (3) exclusion of other Bessemer flames, sun, and sky from field of view; (4) ease of servicing; and, (5) a variety of other considerations related to physical surroundings and peculiar to the individual application. The response of the cells is amplified and recorded, so that there is available a recorded history of the blow. This written record, or autograph, makes it possible to scientifically study the best blowing conditions.

In operation, a continuous record is obtained throughout the blow. During the first few minutes of the blow the indication remains very low on the chart but as soon as most of the silicon is burned out and the flame begins to increase in brilliance the indication rises. The magnitude of the indication is used to determine the approximate finishing temperature of the blow. As the finish of the carbon elimination approaches, the indication drops rapidly to a low value.

The resultant curve traced on the record during the decrease in indication has reproducible characteristics that are used as reference points to guide in the finish of the blow. It has been found that the amount of time that the heat is blown after this reference point is reached affects the quality of the blow. The chart is, therefore, automatically marked at the point of the finish of the blow so that the interval between the reference point and the finish of the blow (afterblow) can be determined.

Variation factors

In applying the control to the Bessemer converter, it has been found that variations of several factors affect the course of the blow, and these factors must be considered to obtain the proper afterblow for the particular type of steel being made. The factors for which corrections are normally applied are (1) the silicon content of the iron, (2) the rate of air flow in the converter, and (3) the weight of iron charged.

The use of the photocell control has favorably affected the quality of the Bessemer steel produced, and suggests a way by which Bessemer steel may return to greater prominence as a method of steelmaking. Heats not meeting specifications have been reduced materially, and both internal soundness and surface of Bessemer steel have shown marked improvement because of the more accurate control of the end-point of the blow. Nitrogen, now considered an important variable in Bessemer steel, can also be controlled more closely by the use of photocells.

CONTROL METHODS

(*Continued from page* 114)

may desire more specific arrangements.

Displacements that are relative to other effects or with respect to the time during an operating cycle may be more important. Other effects such as the product of two effects, the quotient (or ratio), the sum, the difference, or the phase difference.

As long as the two effects are in phase, the first named effects are obtainable with means well known in measuring technic. A dynamometer instrument with armature and field operated by the two effects will indicate their product, various null or bridge circuits will indicate quotients or ratios, and the sum or difference, values can be obtained by simple series connections in the grid circuit of an amplifier stage.

Double winding indicating instruments, with split or tapped rotor windings are useful with electromagnetic pickup units, of the type described in Part III (April, 1944).

Here alternating current is applied both to the pickup unit and to the field of the instrument or relay. The output of the pickup—which might be considered as an amplitude modulated version of that "carrier" frequency—is applied to the rotor of the same meter or relay, whereupon mutual reaction takes place in accordance with the per cent modulation of the carrier, caused by the vibration, the inertia of the instrument being enough to average the more rapid fluctuations.

These conversions are all right for low frequency vibrational studies of a simple nature, but when one tries to combine waves with a harmonic content, no completely satisfactory method is known, in view of errors caused by different natural resonances in the pickup converters, or by the mechanical phase delay introduced by the travel time of the pressure waves through the metal. This is particularly true of the inertia operated piezo-electrical system, operating on acceleration values, which, as mentioned before, permit the upper frequencies to be emphasized.

SMPE CONVENTION

(*Continued from page* 142)

Unit, Army Air Forces, Culver City, Calif.

"Noise Reduction Anticipation Circuits," by John G. Frayne, Electrical Research Products Division, Western Electric Co., Hollywood, Calif.

"Western Electric Recording Equipment—U. S. Naval Photographic Science Laboratory," by Reeve O. Strock and E. A. Dickinson, Electrical Research Products Division, Western Electric Co., New York.

Wednesday morning:

"Functional Design Considerations of Amplifier Equipment for Military Use," by S. L. Chertok, American Standards Association, New York.

Status Reports by Chairman of ASA Z52: Subcommittee B on 16-MM Sound, J. A. Maurer; Subcommittee C on 16-MM Laboratory Practice, by M. R. Boyer; Subcommittee D on 16-MM Projection, by A. G. Zimmerman.

Wednesday afternoon:

"ABC of Photographic Sound Recording," by Edward W. Kellogg, RCA Victor Division, Radio Corporation of America, Indianapolis, Ind.

"Commercial Processing of 16-MM Variable Area," by Robert V. McKie, RCA Victor Division, Radio Corporation of America, Hollywood, Calif.

"Re-Recording 35-MM Entertainment Films for 16-MM Armed Forces Release," by P. E. Brigandi, RKO Radio Pictures Corp., and W. M. Dalgleish, RCA Victor Division, Radio Corporation of America, Hollywood, Calif.

ABSTRACTS OF SMPE PAPERS

Re-recording Console

by Harry R. Kimball

The equipment described is a modern, two-position console designed for the utmost in flexibility for handling the many re-recording problems entailed in motion-picture production. Signals from as many as 20 previously recorded soundtracks can be combined in the final print at any desired level or with whatever equalization characteristics may be necessary. Sliding instead of rotating volume controls are used, providing the operators with better control over the mixing. The mixing circuits and constant B equalizers are arranged to provide uniform output and input impedances regardless of the number of signal circuits (in pairs) being mixed.

Direct-reading Audio Frequency Meter

by W. R. Strauss

Mr. Strauss announced an instrument capable of indicating audio frequencies of 10 to 50,000 cycles to accuracies limited only by the panel meter or pen-and-ink-chart recording meter employed, regardless of audio voltage variations.

The source of audio-frequency voltage is fed into a high-impedance grid circuit and, due to plate saturation of the input tube, the incoming frequency wave shape is changed to a square wave, which retains the original frequency but is not affected by variations in signal voltage amplitudes. Only one volt is necessary to trigger the grid circuit.

The output of the first tube is amplified by a direct-coupled multivibrator or flip-flop circuit, consisting of two tubes whose circuit constants have no resonant effects on the frequencies ordinarily under test. Wave shape remains unchanged and amplification is constant. Appropriately chosen capacitive and resistive networks then permit the integrated pulses to collect on the grid of the countertube circuit.

To produce a linear frequency calibration, the grid circuit of the countertube is biased to plate current cut-off with zero signal input. A 0 to 5 ma milliammeter in the plate circuit serves as a pulse counting device, and provisions are made to use an external recorder.

A means of recalibrating the instrument when tube replacement is necessary is incorporated to use the ac line frequency or its second harmonic.

Gas-discharge tubes employed in the B voltage supply serve to stabilize operation from 105 to 125 volts with less than 3 per cent full scale change in frequency indication.

A plate overload relay is used to protect the panel meter, should frequencies applied to input circuit be greater than those for which the selector switch is set.

PH 346A Recording Equipment

by Wesley C. Miller

The paper described a superportable double system film recording equipment designed under the auspices of the Research Council of the Academy of Motion Picture Arts and Sciences, at the request of the Army Pictorial Service, to provide a type of equipment not ordinarily available to the armed forces.

The equipment fills the immediate wartime need for completely portable, relatively high-quality field or studio work. Moreover, the practicability of extensions and adaptations to postwar requirements have been kept in mind so that its flexibility and value may later be enhanced by arranging it to handle more refined work if desired. It also will probably find a place in studio work when supply conditions are such as to make it commercially available. The entire equipment operates from a 24 volt portable-type storage battery, the camera and recorder being driven by interlocked dc motors.

Noise-Reduction Anticipation Circuits

by John G. Frayne

In recording sound-on-film, it is common practice to reduce the clear or unexposed area of the soundtrack during periods of silence or low modulation in order to minimize "grain" or background noise from the projected print. This process is controlled by a dc voltage derived by rectification of a portion of the signal, the dc bias being applied to the recording galvanometer or an auxiliary shutter admitting light to the film. A universal problem involved with such a system is "clipping" of the

(*Continued on page* 297)

first few cycles of signal after a period of silence or low level modulation, resulting from the fact that some signal must be rectified before the noise-reducing exposure can be stopped.

The method described in the paper wholly eliminates this problem while retaining the desirable features of noise-reduction. The system entails the use of one extra amplifier channel with its own microphone placed a few feet closer to the subject than the mike for the signal to be recorded. The control microphone picks up the signal a few milliseconds early, and its amplified impulse opens up the noise-reduction shutter in time to enable faithful recording of the first cycle of signal input without clipping.

Col. Firth Heads British Procurement

Colonel C. R. H. Firth is in charge of procurement, research and development of all types of radio and communications equipment and small power units, in Supply Directorate IX of the British Supply Mission at Washington, D. C. On his staff are R. P. Ross dealing with research and development, and Lt.-Colonel R. V. Coles dealing with procurement. Also attached to the department is A. E. Barrett of the British Broadcasting Corporation.

Electronic "Oscar" to Match Women's Clothes

Through the work of Virginia Granville, assistant color technologist at the Interchemical Corporation in New York City, milady of 1950 may be sure that her shoes match her suit, and that they will stay matched under any lighting condition. And she will have learned to say to the sales department, "Yes, to my eye, they look like they match, but I want to be sure they match spectrophotometrically!"

Mrs. Granville is not matching up fabrics and leathers now. Her laboratory is largely concerned with color work for defense purposes. After the war, she says, all they have learned will be useful for many pleasant peaceful purposes.

She and Mr. Granville, who direct the laboratory, are using a G-E photoelectric spectrophotometer in their work. This electronic device sees more accurately than any human eye, utilizing electronic determinations to measure color wavelengths, and then recording its findings in the shape of a curve on a piece of graph paper. Using this curve as a guide, the scientist can match colors exactly.

Mrs. Granville, who calls the electronic machine "Oscar," explains that it already is being used for cosmetics. "You can see how it would help match up lipstick and nailpolish and how it keeps different batches of powder the same shade." She is looking forward to the day when she can tell the house painters just what color curve number she wants to use, for then she will be sure of the right shade on the living room walls.

Industrial X-raying of Ceramics

Some interesting developments on the application of X-ray to ceramic materials and products were presented by John P. Nielson, application engineer, North American Philips Company, Inc., at the annual convention of the American Ceramic Society, held in Pittsburgh on April 5.

Radiographs show defects

In cooperation with approximately twenty ceramic companies, North American Philips investigated problems involving refractories, glass, insulators, crucibles and chinaware. Radiographs, made with Searchray equipment during the laboratory tests, showed that plate glass and lead glass—which look the same to the naked eye—are radically different when photographed by X-ray. Since lead greatly affects ray absorption, it is possible to detect any small differences in lead content.

Several radiographs were shown covering voids, cracks and laminations that occur in fire brick and refractory furnace orifice rings. In all instances, the X-ray revealed hidden defects, not visible on the exterior.

Bread plates which were radiographed before and after glazing showed the uneven distribution of the glaze after firing. Glaze mixtures usually contain compounds having high atomic weights (high ray absorption) and though applied in thin layers, differences in thickness showed up remarkably.

The First Wave-Filter

Filters, to a photographer, are optical systems selective in their transmission of light waves that can be interposed between lens and scene to favor certain colors. By analogy, the name "filter" was applied to the networks which G. A. Campbell patented in 1917, to select electric currents on the basis of wavelengths.

Campbell's wave filters take many forms, for his invention was broad and basic. In general, they are artificial transmission lines formed by a succession of sections, each a network of inductances and capacitances. In general, also, they are of three types: high-pass, which discriminate against all components of current with frequencies below a designed "cut-off"; low-pass, which transmit only currents below a specified frequency; and, most important, band filters which pass only frequencies between assigned values.

Finds many uses

Campbell's invention made possible many important advances in all the arts where complex currents carry signals or speech. Carrier-current transmission, for example, depends upon band-pass filters to select desired bands of frequencies from a complex current involving several simultaneous messages.

Throughout the years since Campbell's epoch-making invention Bell Laboratories has made many important contributions to filter theory and to its analytical methods; also, many new types of filters have been invented and perfected.

Much of the advance has come from intensive development studies and ingenious designs of the coils and condensers which form the filter sections. That work was profitable because the more closely a filter's circuit elements can approximate the ideal of pure inductance and pure capacitance, the more sharply can it discriminate between wanted and unwanted frequencies.

Great discrimination

Near its cut-off point, for example, a one per cent change in frequency can cause a hundred-fold difference in transmitted power. (For comparison: a human ear listening to a pure tone of concert pitch A cannot perceive a pitch change much smaller than one per cent.) In the high-frequency range, when quartz crystals are used as resonant elements, a precision of discrimination can be reached such that a 10,000-fold change in power follows a 0.1 per cent change in frequency. Filters of this type are used in coaxial cable systems. — **Bell Laboratories Record.**

Wire Basic Communication Medium in Sicily

While radio was used extensively during military operations in Sicily, wire remained the basic medium of combat communications, the War Department announces, in an analysis of reports from commanders of Signal Corps field units. This has also been true in the case of the Fifth Army in Italy.

The Signal Corps commanders emphasized the ability of wire-laying units in Sicily to maintain communications at a pace which matched that of the advancing In-

Sylvania Radio Tube "Firsts"

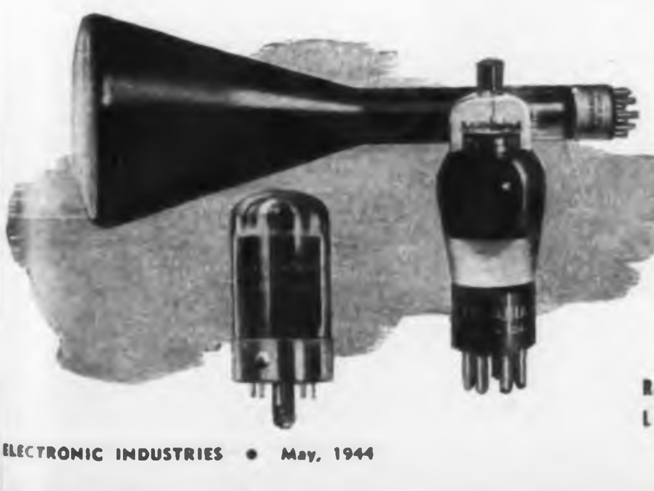
Sylvania was first to introduce a line of 1.4-volt tubes, which made the camera-type portable radio the rage of 1938 and later contributed to our military radio service.

Prior to this Sylvania development, the standard filament voltage for battery receivers was 2.0. This meant that two dry cells had to be connected in series to provide 3 volts. This power was reduced to 2.0 volts by means of a resistor, which dissipated one-third of the expensive voltage.

Sylvania 1.4-volt tubes operated, without resistor, on a single dry cell. Their low filament drain made it possible to build combination receivers that took their power from either a 110-volt power line or a single dry cell.

This development, which is typical of Sylvania's leadership in engineering of economical standardization, went to war in portable radio equipment for close-range military communication. On every front 1.4-volt tubes reduced by half, the battery weight that our boys have to carry.

Quality that Serves the War Shall Serve the Peace



RADIO DIVISION EMPORIUM, PENNSYLVANIA

SYLVANIA

ELECTRIC PRODUCTS INC.

RADIO TUBES, CATHODE RAY TUBES, ELECTRONIC DEVICES, FLUORESCENT LAMPS, FIXTURES AND ACCESSORIES, INCANDESCENT LAMPS fantry, and cited the security and accuracy with which a large volume of traffic was carried through wire communications lines.

The War Department estimated that communications units in Sicily rehabilitated 950 pole line miles, a total of 49,176 wire miles, and 24,588 circuit miles of communications. In addition, more than 1,800 miles of spiral cable was laid.

One report stated that "during the battle of San Fratello, it was found necessary to lay a five-mile line of wire over a rocky, trackless mountainside where a man could only move by frequent use of his hands, and for 15 miles where wire could be transported only by pack animals and laid only by hand. In another instance, on a march of the Infantry from San Marco to Mirto to Naso, a 20-mile line was laid entirely by hand. In another, two lines were laid for 15 miles completely clear of the trails used by the men and pack animals. This line was laid at the rate of advance of the pack train carrying the wire. One six-mile line from the coast road to San Marco required 24 hours to put in operation because the mountain road on which it was laid was under constant shell-fire."

Another report explained that "the wire in the landing operation was brought ashore and laid from quarter-ton trucks. Additional wire was brought ashore and transported inland in two-wheeled quarter-ton trailers, six miles of wire being carried with each of the teams landed. Wire to all regiments was put in operation as soon as physical contact with the regiments was established."

An Infantry commander added his commendation to the work of the Signal Corps in Sicily: "During the operation, wire communication was desirable down to rifle companies and battalion observation posts."

Joins Meissner Company

Oden F. Jester, veteran sales executive, has been named a vice-president of Meissner Mfg. Co., Mt. Carmel, Ill. Mr. Jester recently resigned as sales manager of Utah Radio Products Co., Chicago.

Instruments Easier

The panel indicating instrument industry is now in a position to fill orders for any known requirements for these instruments, representatives of the War Production Board announced at a recent meeting of the Panel Instrument Industry Advisory Committee.

The Electrical Instrument Section of the Radio and Radar Division, WPB, has made a thorough study of 1944 requirements, and these data, taken with statistics on current operation (shipments, backlog of unfilled orders, etc.) present an encouraging picture, the industry committee was told. Quotations on delivery time for panel indicating instruments have been reduced within the past six months, WPB said. While quotations formerly were for delivery from six to eight months after receipt of an order by an instrument manufacturer, the average delivery time is now four months.

However, requirements have been known to change suddenly and to such an extent that products become critical overnight, WPB officials pointed out. But if this does not occur in the panel instrument industry in the next six months, total shipments are expected to exceed actual requirements, they said.

Air Traffic Problems Reviewed by L. Arnson

Speaking before the International Municipal Signal Association meeting at New York April 19, Ludwig Arnson, president of Radio Receptor Co., Inc., declared that operation of airports will be an important municipal function in the coming air age and that effective study of airport traffic control in all its branches must be started immediately.

"The communications problem of the airport with its planes in flight is tied up with the regulations issued by Federal Communications. The airport itself, although in the past built and maintained by municipal funds, is only part of a system of air highways—it may be either a port of call so to speak, or a terminal on this system, or both. It has been stipulated by the CAA that airport traffic control in the air should commence at a distance of 30 miles from the airport, or ten minutes flight. This gives the airport not more than ten minutes to clear the runways. As traffic at an airport increases, this time will have to be reduced and the tempo of operations increased.

"The CAA controls the airway traffic between airports both inter- and intra-state. This comprises a complete inter-communication and ground-to-air navigational and

meteorological reporting system. The situation is somewhat confused today because some of these airports are either wholly or partially controlled by the Air Forces. In normal times, however, all principal airports are on communications networks prescribed by the FCC. They are the red, blue, brown, green, purple, yellow and orange. The red network, for instance, is called the Northern Trans-Continental Chain and Feeders, and the principal airline using it is the United. There are twenty-two frequencies assigned to this network, ranging from 3147.5 kc to 141.22 kc. The control tower should be prepared to receive on at least three of these frequencies, any one of which may be required if the other two channels are occupied. It should be pointed out that there are any number of frequencies used by planes of all nations for aircraft on sea flight, distress signals, scheduled and off-schedule routes, etc. Thus it will be seen how the airport is tied down to the airways system and functions as part of it.

"Like the airplane itself, the airport and its traffic control will have to accommodate itself to changing conditions in the postwar world. For instance, it is said that at the new Idlewild Airport there will be 13½ miles of runways. Hangar lines for airplanes will be six miles long, and for sea planes one mile long—altogether making it possible to handle 900 planes every 15 hours or one per minute. Three or four control points may become necessary. Tying these together, using all receivers and transmitters, will become a problem unless properly worked out. That, however, is for the future. Our job now is to study each project on a long-range viewpoint. Lots of experience has been gained—a number of helpful devices have been developed and progress is continuously going on."

Place Joins RCA

Edward R. Place, former assistant to the director general of the War Production Drive, has joined the staff of the Department of Information of the Radio Corporation of America. Mr. Place has had wide experience in the newspaper, advertising and publicity fields. He formerly was radio editor of "The Providence Journal," managing editor of "Labor Management News," editor and publisher of "Playtime" magazine, and columnist on the old "Boston Transcript." In 1935, he was publicity director in New England for N. W. Ayer & Son, Inc.

SF Office for Sylvania

Opening of a West coast headquarters office at 111 Sutter Street, San Francisco, in charge of B. K. Wickstrum, Pacific coast sales manager for the company's lighting products, has been completed by Sylvania Electric Products, Inc. Heavily engaged in war production, Sylvania will serve the many industrial establishments on the Pacific coast through the new office and will deal with export matters after the war. Sylvania recently opened offices in Los Angeles and Seattle, with G. W. "Chick" Field as manager of the California Division which includes Nevada, Utah and Arizona, and C. W. Dickinson as manager of the Northwest Division, assisting Mr. Wickstrum.

Airtronics Adds Two

Airtronics Mfg. Co., Los Angeles, maker of high-frequency generators for heating molding compounds in the plastics industry, has appointed two regional representatives for sales and service. L. R. Liljequist will take over the middle-Western States, with offices at 121 West Wacker Drive, Chicago; Edward K Kellogg will be in charge of the Atlantic seaboard and other Eastern States. His offices are at 31-28 Queens Blvd., Long Island City, N. Y.

IRE Sponsors Industrial Electronics Demonstration

The Institute of Radio Engineers has scheduled the first of a group of meetings of special interest to the industrial electronic engineers on May 24, at 7:30 P.M. in the auditorium of the Western Union Building, 60 Hudson St., New York City. At this meeting several papers will be delivered on the subject of industrial electronics, with demonstrations.

Since activity in this field is increasing, there has been need for more frequent meetings devoted to the non-communication uses of radio principles and the IRE is making great progress in promoting interest in this subject. All persons interested in this subject are invited to attend.

Schott in Chicago

In order to give quicker and better delivery service to their nationwide customers, the Walter L. Schott Co. has discontinued the New York warehouse and has occupied large space in the Terminal Bldg., 537 South Dearborn Street, Chicago. The main office of the Walter L. Schott Co., 9306 Santa Monica Blvd., Beverly Hills, Calif., continues to be the regular mailing address.

Ken-Rad Protests Army's Occupation of Plant

The Ken-Rad Tube and Lamp Corporation, which employs approximately 4,000 persons at its Owensboro, Ky., plant, was taken over by the War Department April 14 under the order of President

FASTER FABRICATION OF LAMINATED PLASTIC PARTS

Our expanded fabrication facilities permit us to offer rapid production and prompt delivery of laminated plastic parts for all kinds of mechanical, electrical, electronic and graphic applications. We have the equipment needed to meet the most exacting Army and Navy "specs" . . . and an ability to use it which is based upon ten years of production-crammed experience. We've learned the practical limitations and the broad, useful scope of fabricated plastic parts . . . and we're ready to put them all . . . facilities, equipment, personnel and experience . . . to work on your job . . . NOW!

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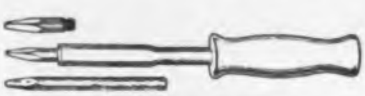

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are widely used in industrial plants throughout the country. They are designed to withstand the strain of continuous service required of factory tools.

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designed for treadle operation for advancement of iron and solder, leaving operator's hands free for handling of product.

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prevent overheating of soldering irons between soldering operations. Irons do not deteriorate when being used. The idle period causes oxidation and shortens life.

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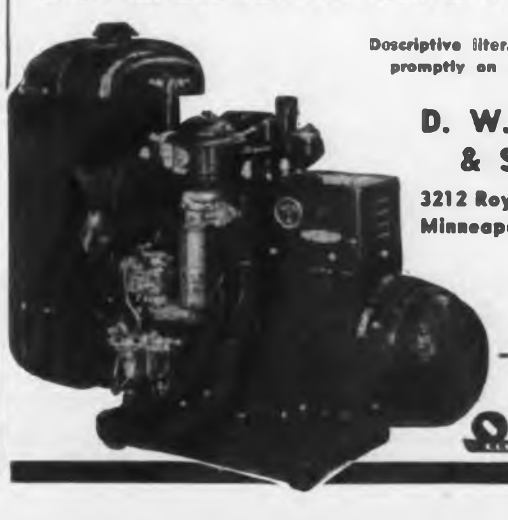

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ONAN
ELECTRIC PLANTS

Roosevelt after its management had declined to obey wage-increase directives of the War Labor Board. Col. Carroll Badeau, commanding officer of the Lexington, Ky., Signal Depot, was assigned to take charge of the plant.

The Ken-Rad management, headed by Roy Burlew, president, announced that it will bring suit to dispute the occupancy by the Army of the plant. The company had insisted it could not afford a general wage increase of 3 cents an hour, retroactive to Sept. 4, 1942, which the WLB had ordered last July because it had held the wage levels were sub-standard.

New Electron Microscopes

Two improved electron microscopes representing the culmination of four years of intensive research and engineering by the Radio Corporation of America were demonstrated for the first time at the national wartime conference of the Society of American Bacteriologists at Hotel Pennsylvania, New York, May 3 to May 5, and at the meeting of the New York State Medical Society the following week.

Meade Brunet, manager of the Engineering Products Department, RCA Victor Division, revealed that one of the new instruments is an advanced model of the instrument that was introduced in 1940, and which is now being utilized in important wartime research by many medical, industrial and university laboratories.

The other new instrument is in compact console form and is expected to have wide application in smaller industrial laboratories, hospitals, schools and other institutions and agencies who might not ordinarily be able to utilize the "super-eye" because of limited budgets and space.

In conjunction with the showing of the new instruments, Dr. V. K. Zworykin, Dr. James Hillier of RCA Laboratories, Princeton, N. J., and Perry Smith, of the RCA Victor Engineering Department, Camden, N. J., presented a joint paper before the Society of American Bacteriologists. Dr. Zworykin, under whose direction the RCA electron microscope was developed in association with Dr. Hillier, presented a number of important electron micrographs of bacteria, viruses, and other minute matter. Mr. Smith described the engineering and construction features of the new instruments.

Both instruments embody advances in design developed as a result of extensive experience with the first electron microscope in some of the country's leading research laboratories. They also incorporate many ideas offered by scientists and research workers who have had experience with the electron microscope.

Three-Bagger "E"

F. A. Poor, founder of Sylvania Electric Products, Inc., with an employee, receiving pennant from Maj. Gen. Wm. H. Harrison, when each of 3 plants won coveted award

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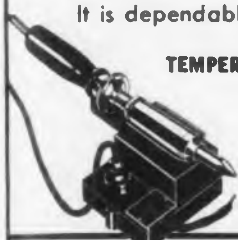
Not only the superior construction of the heating element, but the sturdy quality of the other units, makes this the preferred iron for all industrial uses . . . . It is dependable, durable and efficient.



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NEW KURMAN *Ideas*

This instrument was originally developed for our own use in testing the Relays which we manufacture. We are now making it available to other manufacturers who are likewise desirous of making their products immune to the effects of vibration.

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NEW, SIMPLE

POWER FORK for VIBRATION TEST

Features: Simple harmonic motion with variable amplitude. • Variable frequency from 20 to 70 C.P.S. • Vibration testing can be made in any direction through 360°. • Capacity up to 5 lbs. • Vibration acceleration is provided to 30 G. plus. • Only 75 watts are required for maximum test conditions. • Can be mounted on any bench without transmitting extraneous vibration. • Variable frequency direction provided. • No moving cranks, gears, or bearings in the vibration system.

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NATIONAL INDUSTRIAL EMERGENCY SERVICE

Motion-Picture Amplifier Design

Arousing considerable interest at the 55th technical conference of the Society of Motion Picture Engineers in New York, a paper "Functional Design Considerations of Amplifier Equipment for Military Use" was presented by S. L. Chertok of the American Standards Association.

Mr. Chertok emphasized the fact already well known in the radio industry, that amplifiers for military use are invariably subjected to extreme conditions of vibration, shock, humidity, low or high temperatures and salt and dust-laden atmosphere. Designers should keep in mind that the equipment may not always be used by carefully trained sound men and should, therefore, be simple to operate and service. It is not only possible to forget "eye appeal" but it is wisest to shun symmetrical placement of controls in order to prevent accidental incorrect operation. Controls always must be placed far enough apart so that they can be operated with a gloved hand, and equipment must be drip and splash proof in order to meet Navy specifications and actual conditions often encountered in use or transportation. Parts such as volume controls which protrude through the projector case must have special neoprene gaskets to keep moisture from entering through the small clearance between shaft and bearing. A common occurrence with commercial equipment was to have various parts attacked by fungi. Voice coils were particularly susceptible; tropical insects frequently ate all of the cloth insulation from wiring. Glass insulation is, therefore, imperative in certain locations.

The basic requirement of any military motion-picture or other equipment is that it render long and consistent service under really tough conditions and the most common cause for failure in amplifier equipment is humidity. Many parts in the future must be hermetically sealed using gasketed terminals, solder sealed to glass or porcelain or metal to glass seals with special alloys.

Mr. Chertok stressed the fact that electrolytic capacitors are considered a necessary evil to be avoided when possible. Special electrolytics designed for the particular ambients are used but since electrolytics designed for low temperature operation are not the best for high temperature applications each problem must be studied in the light of the fact that equipment may be stored for long periods outdoors under sheds in sub-arctic temperatures or in a ship's hold at 185 degrees F. Various wax impregnating compounds are another problem which the manufacturers of motion-picture equipment must face as the manufacturers of radio equipment have had to do.

Mr. Chertok pointed out that transformers should now be potted and hermetically sealed. Where dc must pass through the windings it is considered good practice today to use acetate winding cores, layer insulation, inter-layer insulation and cross-strip insulation. Both carbon and wire wound resistors must withstand severe thermal shock and salt water emersion and cycling tests as a guarantee of reasonable life, Mr. Chertok told the motion-picture engineers. Here again impregnating or over-all molding compounds are a problem which must be considered in the light of almost-certain sudden changes in temperature encountered in military service.

Television Opportunities and Problems

Discussed by Dr. A. N. Goldsmith

The present state of the television art, its problems, and its future, were outlined from the viewpoint of the expert, in an address by Dr. A. N. Goldsmith to the April 6th

(*Continued on page 309*)

Short of Help?

Here's one good way to hold those you still have!

(to say nothing of doing your duty to your country)

Just organize *all* your employees as active War Bond and Stamp sales solicitors! Put your *whole* establishment in the War Bond effort!

You'll be astonished at the results. Astonished—and gratified!

Once "Betty, the Bond Seller" comes to realize that she's just as vital a part of the war effort as Rosie, the Riveter—*or even more so*—that restless urge to "do something for the war" will fade away. And Betty will regard her present job in an entirely new light.

Don't take our word for it! Check up against the experience of a national 5¢-10¢ chain which, through its hundreds of outlets, sold a total of $53,464,389 in War Bonds and Stamps in 1943.

This chain reports that—entirely aside from doing its duty to our country—it has gained immeasurably in the regard of its employees, and of the communities it serves. Both of these have become convinced that this concern is wholeheartedly playing an important part in the war effort. And employee morale has been sharply increased through the pride and satisfaction its workers take in their War Bond work.

So why not put in effect at once this simple means by which you can help yourself, help your employees, and help your country?

War Bonds To Have And To Hold!

HOW MANY BONDS ARE YOU SELLING?

If your bond sales approach, or exceed, 250 pieces a month, and you are not already an Issuing Agent for United States War Bonds, we suggest that you discuss this matter with your Federal Reserve Bank. If your bond sales are running at a lower figure, your own bank of deposit can probably arrange to have you appointed as a sub-issuing agent.

LET'S ALL BACK THE ATTACK WITH WAR BONDS!

The Treasury Department acknowledges with appreciation the publication of this message by

ELECTRONIC INDUSTRIES

This is an official U. S. Treasury advertisement—prepared under auspices of Treasury Department and War Advertising Council meeting of the Radio Executives Club in New York.

Dr. Goldsmith said, "A matter of natural interest is the appearance of the television pictures. Actually these pictures, at their best rather closely resemble fairly small-size pictures of the type projected by a 16-mm. film projector. If you imagine such pictures between 5 x 7 inches in dimensions and perhaps 18 x 24 inches in size, you will have a fairly accurate idea of what television pictures look like. They are bright enough to be seen clearly in a room having soft artificial illumination. And they are sufficiently clear and sharp to give an acceptable dramatic, comic, or educational effect.

DR. A. N. GOLDSMITH

Cost considerations

"Television receivers will depend for their cost on a number of factors. Accurate figures cannot be given because no one can say at this time what will be the cost of labor and materials after the war. But the price of a receiver will be based primarily on the picture size and clarity, the sound quality, the perfection of the circuits, and the appearance and size of the cabinet. Broadly speaking, television receivers, even for small pictures, are hardly likely to fall below $100 per unit for many years to come. Most television-receiver lines will probably start somewhere between $150 and $250 and extend upward to $400 or more. But it must be emphasized that these are merely rough estimates in terms of 1942 dollars."

In answer to the question, Shall we have to wait until after the war for practical technical development in television? Dr. Goldsmith said: "The present shortages of men and materials prevent or limit the installation and operation of new transmitting stations and the manufacture and sale of new receiving sets or parts. Until after the allied invasion of Europe seems well advanced or until some other highly favorable aspect of the war develops, any major relaxation of present governmental restrictions is unlikely, and full-swing operation in the television manufacturing field is not likely to start before six to twelve months after Victory Day."

To a third question, Is television ready now with a wide-angle theater-size screen? Dr. Goldsmith's answer was, "There are at least two types of equipment for theater projection that have already been demonstrated publicly in New York and London. Pictures have been produced ranging in size from 9 x 12 ft. to 12 x 20 ft. At their best, these pictures are clear, of acceptable brightness, and capable of telling a story in interesting fashion. The performances were well greeted by the audience, particularly in the case of horse-racing and boxing events. Two or more other types of theater television projection equipment are under study or development, and some of these seem promising."

The next question submitted was: What is the situation as far as the use of higher frequencies for television is concerned?

"The present television frequencies assigned by the Federal Communications Commission lie in the general range between 50 and 200 megacycles. One group of television experts have suggested that television should have 30 assignments or channels, each 6 megacycles wide, beginning at or near 40 megacycles. This would require a continuous band from 40 to 220 megacycles. Frequency modulation broadcasting, which at present sends out sound programs directly below the lowest-frequency television channel, has asked through some of its representatives for twice its present number of channels, these to be obtained by transferring the first television channel to frequency modulation broadcasting. Recommendations in this regard will be made by the recently organized Radio Technical Planning Board.

Higher frequencies

"It has been suggested, as indicated in the question, that television might go to higher frequencies, for example and purely illustratively, somewhere between 200 and 2,000 megacycles. But grave problems would then at once face this young and promising field of television broadcasting—and these problems might well take years to solve. For example, transmitting tubes giving high power output in the new range of frequencies are not available and will require considerable time for their development. The circuits, antennas, and operating methods will similarly need thought and time. Accordingly, if we go to these high frequencies for television, we may face locked factory doors and inactivity at the television broadcasting stations. And this is utterly inacceptable since America must offer the returning service men wide opportunities for employment such as can come by the rapid commercialization of new and existing fields."

The next question proposed was: Is color television practical on an electronic basis?

"Electronic color television was under development before the war. It has not been fully worked out in practice but will doubtless be effectively accomplished in the years following the war. The problems of electronic color television are numerous and substantial, and it will undoubtedly require a number of years to work them out. On the other hand, a number of television engineers believe that mechanical color television of the type now available is unlikely to be the ultimate answer in the color-television field, any more than mechanical black-and-white television methods were the answers in that field. Our present black-and-white television pictures are produced altogether electronically in receivers which have no mechanical moving parts. There seems little reason to doubt that color television will ultimately take the same course.

Color television

"It has been proposed by some that television broadcasting should not be commercially exploited until color television was ready for public use and offered for that purpose. It is generally admitted that this would mean a delay of a number of years before commercial television could be used. For reasons which have been mentioned earlier in this discussion, it seems undesirable that television shall be held back for any reason other than the war needs of our country."

Removable Fibre Washers Make Lamp Equally Accessible on 1/4 inch or 1/16 inch Panels!

Thickness of panel is no barrier to quick, easy installation of the new DRAKE No. 85 Jewel Light Assembly. Whether it's a 1/4" or a 1/16" panel, or practically any thickness in between, all can be accommodated by simply removing the fibre washers.

The locking, vibration-proof, slip-it bezel (jewel holder) can be removed and lamp replaced with the fingers! No wrench or tools needed. 90° turns to right and left bring total black-out or complete even illumination over entire surface of the jewel. Partial turns produce any density of light desired. Check up on these and other superior features of DRAKE Patented Assemblies. Have you sent for our newest catalog?

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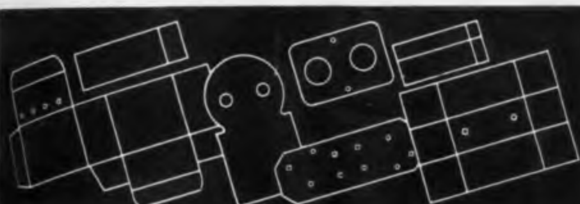

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Excellent working conditions and post-war opportunities with long-established manufacturer.

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12" x 6" x 6"

Made as per specification —42 B 9 (Int) for shipboard use, Electrical and Mechanical. Navy grey finish. Immediate Delivery.

24 STOCK SIZES

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1025-7	18	12	9
1025-8	18	6	6
1025-9	18	15	9
1025-10	18	12	6
1025-11	18	15	12
1025-12	18	12	12
1025-13	18	18	12
1025-15	24	15	12
1025-16	24	15	15
1025-17	24	18	12
1025-18	24	18	15
1025-19	24	18	18
1025-20	24	12	9
1025-23	30	15	9
1025-14	30	15	12
1025-22	36	12	9
1025-21	42	9	9
1025-24	42	12	9

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18" x 15" x 12"
(Partitions extra)

Cole Steel office equipment
will again be available after the war

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349 Broadway, New York 13, N. Y. Factory: Brooklyn

Television Licenses and Applications

Because of the tremendous amount of publicity now being given to television, television station applications at the Federal Communications Commission are growing in number.

Latest check with the FCC shows that the following have applied for commercial television station licenses:

Earle C. Anthony, Inc., Los Angeles, C 1, (Held CP under call KSEE), 96000-102000, Channel 6; Bamberger Broadcasting Service, Inc., New York City, Channel 6, Washington, D. C., Channel 4, Philadelphia, Channel 7, all 96000-102000 kc.; Broadcasting Corp. of America, Riverside, Calif., Channel 3, 66000-72000 kc.; Allen B. DuMont Laboratories, Inc., Washington, D. C., Channel 3, 660000-72000 kc.; Havens & Martin, Inc., Richmond, Va., Channel 3; Hughes Productions, Division of Hughes Tool Co., Los Angeles, also San Mateo County, California, Channel 2; KLZ Broadcasting Co., Denver, Colo., Channel 3; Don Lee Broadcasting System, San Francisco, Calif., Channel 1; Loyola University, New Orleans, La., not specified; Metropolitan Television, Inc., New York City, Channel 8;

60000—66000 kc.: NBC, Washington, D. C., NBC, Denver, Channel 2, Cleveland and Chicago, Channel 1, Los Angeles, Channel 3 and San Francisco, Channel 4; News Syndicate Co., Inc., New York City, Channel 1; Philco Radio & Television Corp., Washington, D. C., Channel 4; WCAU Broadcasting Co., Philadelphia, Pa., Channel 5.

78000-84000: WGN, Inc., Chicago, Ill., Channel 4; WKY Radiophone Co., Oklahoma City, Okla., Channel 1; Louis Wasmer, Spokane, Wash., Channel 1; Westinghouse Radio Stations, Inc., Boston, Channel 5, Philadelphia, Channel 7 and Pittsburgh, Channel 1. Stromberg-Carlson Co., Rochester, N. Y., Channel not listed.

Experimental license applications

The applications for experimental television licenses are:

Albuquerque Broadcasting Co., Albuquerque, N. Mex.: 50,000-56,000 kc, Channel 1, V*-3 kw, A*-3 kw, (4 kw peak).
CBS (Held CP under call W9XCB): 78,000-84,000 kc, Channel 4, V-1 kw, A-1 kw.
Industrial Tool & Die Works, Inc., Minneapolis, Minn.: 78,000-84,000 kc, Channel 4, V-3 kw, A-3 kw, (5 kw peak).
Intermountain Broadcasting Corp., Salt Lake City, Utah: 50,000-56,000 kc, Channel 1, V-100 w, A-200 w.
Wm. B. Still, Jamaica Radio & Tele. Co., Jamaica, L. I.: 66,000-72,000 kc, Channel 3, V-250 w, A-250 w, (1 kw peak).
Guz Zaharis, Charleston, W. Va.: 50,000-56,000 kc, Channel 1, V-50 w, A-110 w (200 w peak).
RCA, Camden, N. J. (Reinstatement W3XEB): Channel 5.

Experimental relay stations

Pending applications for experimental television relay stations include:

Albuquerque Broadcasting Co., Area of Albuquerque: 282,000-294,000, 25 w (peak
The Journal Co. (Milwaukee Journal), Area of Milwaukee, Wis., (Had CP under W9XCV): 200,000-202,000, 25 w, (output power not in excess of 6.5 watts).
Philco Radio & Tele. Corp., Area of New York City: 204,000-216,000, 15 w, Channels 11 and 12.
RCA, Area of Camden, N. J., (reinstatement of W3XAD): 321,000-327,000.

Commercial stations on air

The following commercial television stations are now on the air:

60,000-66,000 kc: Balaban and Katz, Chicago, Ill., KBKB, Channel 2; CBS, New York City, WCBW, Channel 2.
50,000-56,000 kc: Don Lee Broadcasting System, Hollywood, Calif., KTSL; National Broadcasting Co., Inc., New York City, WNBT, Channel 1.
66,000-72,000 kc: General Electric Co., Schenectady, N. Y., WRGB, Channel 3; The Journal Co., (Milwaukee Journal), Milwaukee, Wis., WMJT, Channel 3; Philco Radio & Tele. Corp., Philadelphia, Pa., WPTZ; Zenith Radio & Tele. Corp., Chicago, Ill., WTZR, Channel 1.

DuMont's experimental station W2XWG is now on the air in the channel 78,000-84,000 kc.

* V=Visual Power; A=Aural Power


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★ # TELEVISION TODAY* ★

News Developments in the Video Field

G-E Discloses Big Video Plans

General Electric's elaborate postwar plans for television were announced at New York April 6 by Dr. W. R. G. Baker, vice-president in charge of the electronic division who introduced J. D. McLean, R. S. Peare, and A. A. Brandt.

Future GE tele receivers will include both tube and projection models, these speakers revealed. Plans are also underway for a New York-Schenectady relay network, and for systems of master and satellite transmitter stations which will distribute television programs to cities and towns throughout the country.

A new transmitting tube exhibiter, is reported by GE engineers to be especially applicable to television relay stations. Designed for operation up to 1000 mc, the new tube uses a disc electrode construction to reduce lead inductance. The glass bulb is divided into sections and sealed to both sides of the disk. An air-cooled radiator is used for plate heat dissipation.

*Title registered U.S. Patent Office

Farnsworth's Cummings Predicts Projection Sets

Postwar television sets will employ projected pictures, promises B. Ray Cummings, vice-president in charge of engineering of the Farnsworth Television & Radio Corp., Fort Wayne, Ind. Addressing the Television Press Club in New York City, Mr. Cummings predicted that the tube-end television picture will become obsolete in the near future. The speaker, who has been in television development for 20 years, declared that striking improvements in picture quality will also be evident postwar.

Fly Sees "Nationwide Service"

"A permanent and indeed better nationwide television service to which we all may look forward" was promised by James Lawrence Fly, FCC chairman in a talk delivered over a "network" of television stations WNBT, WPTZ and WRGB, April 10. He addressed television set owners in the metropolitan New York, New Jersey and Connecticut areas serviced by NBC's WNBT, as well as thousands of others in the Troy-Albany-Schenectady area covered by GE's WRGB, and in the Philadelphia-Camden territory serviced by Philco's WPTZ.

The FCC chairman came to New York to participate in the world premiere, via television, of the two-reel motion picture "Patrolling the Ether," filmed by Metro-Goldwyn Mayer as part of its "Crime Does Not Pay" series. The movie dramatizes methods used by the FCC in combatting enemy espionage.

On the same evening similar showings of the film were being offered over the air by television stations W9XZV, operated by Zenith in Chicago, and W6XAO, operated by Don Lee in Hollywood.

DuMont on "TNT" or "Tele. Now and Tomorrow!"

Outlining a complete picture of the present status of television, Allen B. DuMont, president of Allen B. DuMont Laboratories, Passaic, N. J., told the American Marketing Society how his own station in New

Austin Company Proposes All-Steel Television Studios

Here is one of the postwar all-steel video master studios designed by nation's largest builder of war plants in collaboration with G-E television engineers. Note four-part rotating stage, audience auditoriums, prop storage spaces, and special studios

York City is serving as an experimental laboratory or "Television Kindergarten."

Turning to future television operations, Mr. DuMont suggested motion-picture films as a third important method of joining up television networks, in addition to radio relays and coaxial cable.

Regarding future contests between the new visual art and the older aural broadcasting, said Mr. DuMont, "there seems to be a definite place for broadcasting and a definite place for television. In fact, the relationship is pretty much the same as that between the daily newspaper and the Sunday magazine section. One is the news, the meat of the matter, the plain facts. The other is the embellished presentation, the pictures, the more complete story. Both have their place.

Television 7 to 11

"Likewise between television and broadcasting. In many localities the broadcast station and the television station will be operated side by side. the one supplementing the other. Either the broadcaster will sooner or later be operating a television supplementary service, or someone else will step in and do that essential job. Television — the complete home entertainment — will reign supreme from 7 to 11 at night when the family can concentrate on a real show.

"And in terms of marketing, television will open up brand new possibilities. Merchandise can be actually shown—hats, garments, styles, pretty models. That new-model car can be presented in all its attractiveness and in the ideal outdoor setting. Recipes can be worked out on the television screen, creating a desire that no verbal description can possibly equal. The shop or store can be virtually brought right to the home, with a full display of wares. By comparison, broadcasting is like a plain type advertisement as against a beautifully illustrated and appeal-packed display advertisement.

"Television will set new standards in marketing," declared Mr. DuMont, "fully in keeping with the coming age of super-marketing if America is to provide jobs and prosperity and the better life for its millions of workers."

When we re-establish ourselves after this war, we must get the idea that we cannot have a continuity of sameness, that we are going to have a continuity of change. We need to go into the new era convinced that if there is one thing eternal, it is change.—*Charles F. Kettering.*

Advertisers . . May, 1944

While every precaution is taken to insure accuracy, we cannot guarantee against the possibility of an occasional change or omission in the preparation of this index.

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On every front, Solar Elim-O-Stat Filters are keeping speech channels clear . . . absorbing local interference where it starts . . . at motors, generators, contacts.

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THERE have been many dramatic moments when radio history was made.

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June, 1940: The curtain slowly rises. Suddenly a spotlight flashes on, sweeps across the dark stage, picks out an unbelievably tiny radio set — less than 3 inches high, 3½ inches wide, 8⅞ inches long. Radio's newest marvel is unveiled—the "Personal Radio"—made possible because of 4 entirely new-type RCA tubes, called *Miniatures*.

War — today: A paratrooper lands behind enemy lines. Something else has arrived seconds ahead of him — dropped, as *he* was, from the sky. The tiny beam of his flashlight flicks on — probes the dark — and he finds it: his victory-vital "Handie-Talkie," made possible again through *Miniature* tubes.

Tomorrow, too, the spotlight will be on Miniatures, for once Victory is won, *Miniatures* will play an increasingly important part in the many new radio and other electr devices you designers will create.

RCA, eager to help, will gladly advise you now wh Miniatures will be among the tube types most likely to included in RCA's post-war "Preferred Type Tube" li If you want this information, simply write to RC Commercial Engineering Section, 703 South 5th Stre Harrison, New Jersey.

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