JUNE · 1943

electronics

DIRECTORY ISSUE

More tube hours are going into battle

Through a series of design and construction developments tending to prolong normal operating life, we have increased the length of actual service that is being derived from each AMPEREX tube. Basically, our facilities are of laboratory type. And any measure of our war production, computed solely on the number of tubes manufactured, would not be a true indication of our total effort.

We, at AMPEREX, have kept pace with numerical production increases being registered throughout the nation. But we are infinitely more proud of our attainments in building longer life into our transmitting and rectifying tube designs. Each AMPEREX radio and radar tube is bringing extra hours of performance to equipment at the front.

AMPEREX ELECTRONIC PRODUCTS

79 WASHINGTON STREET BROOKLYN, NEW YORK

Don't touch our original drawings

We PRESERVE them

as records only – use PHOTACT prints to take the abuse of frequent handling.

K+E
TRADE MARK

"We've learned our lesson. There was a time when our tracings would become blurry smudges within days after they left the drafting board. If they weren't being man-handled in the office, they were taking a beating in the blueprint room—and turning out mighty poor blueprints at the end.

"But not now. Now, just as soon as a pencil or ink tracing is completed, we make a Photact print of it. Then the original goes into the files for safe-keeping as a permanent record.

"Photact *preserves* our original, because the Photact print takes the place of that original as the 'master' for reference and reproduction.

"Photact also *restores* the old, worn-out drawings. We take one of these limp, over-age drawings—put it through the Photact process—and come out with a new 'master' with lines clearer, opaque and ink-like.

"And, of course, Photact *duplicates* our originals. From the negative, we make as many prints as we need—on Photact paper or cloth. They are ideal for government requirements. We also send them to subcontractors and branch plants, because each Photact print can be used for any number of top-quality black-line or blueprints."

* * *

For complete information about the Photact process and Photact papers and cloths, write: Photact Department, KEUFFEL & ESSER CO., Third & Adams Streets, Hoboken, New Jersey.

EST. 1867

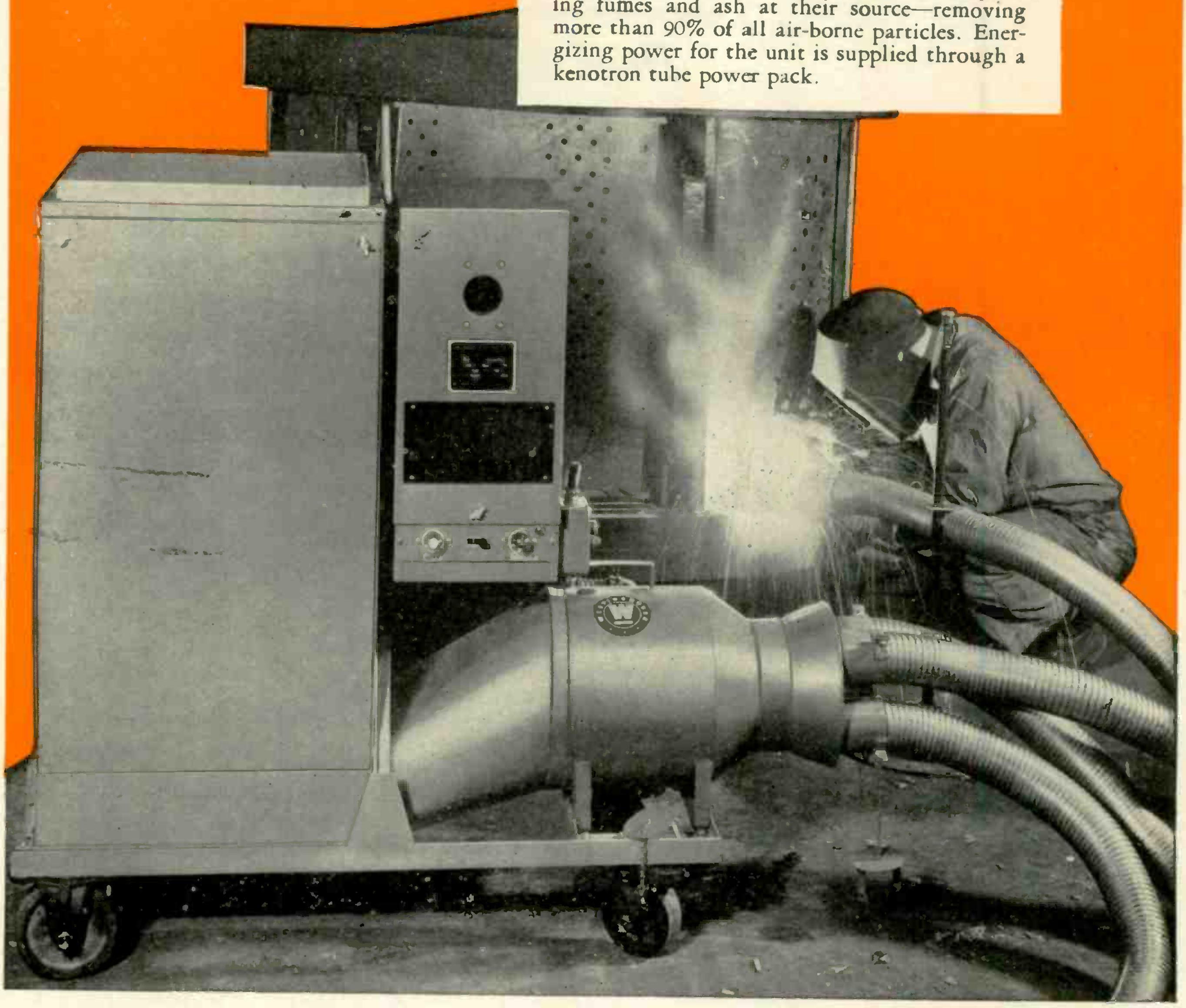
KEUFFEL & ESSER CO.

NEW YORK • HOBOKEN, N. J.

CHICAGO • ST. LOUIS • SAN FRANCISCO • LOS ANGELES
DETROIT • MONTREAL

Electronics

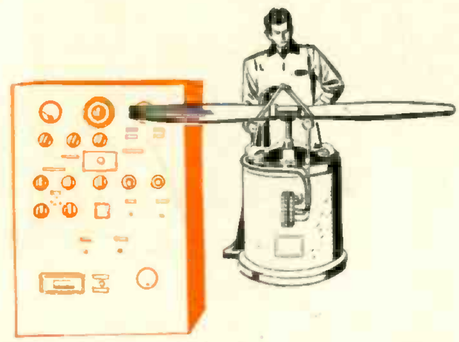
Illustrated here is probably the most recent application of electronic equipment. Precipitron—the Westinghouse electric air cleaner—is being used to remove injurious welding fumes and smoke. It has been found that toxic welding fumes can cause serious illness for operators, but available mechanical equipment is ineffective for cleaning the air. Small, portable Precipitron units are now doing the job efficiently—capturing fumes and ash at their source—removing more than 90% of all air-borne particles. Energizing power for the unit is supplied through a kenotron tube power pack.



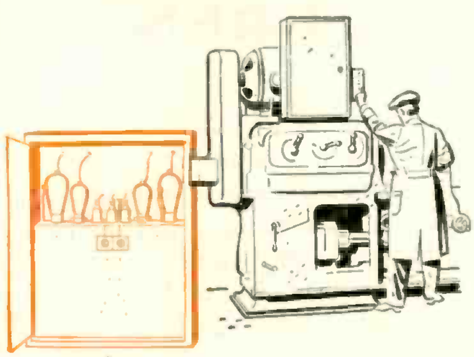
. . at Work

Industry has electronics to thank for many of the results now being secured on war production lines. It is saving time—cutting costs—improving products. Typical examples of Westinghouse Electronic Equipment at work, are:

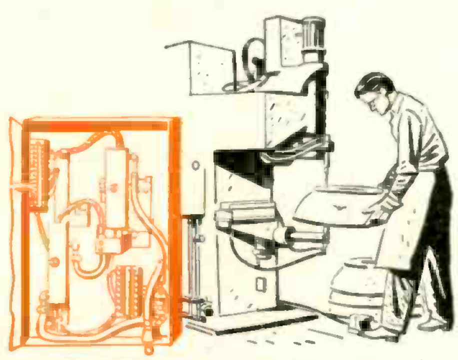
Carrier-Current Relaying—One of the most important electronic applications in the power transmission field. Carrier signals permit simultaneous high-speed tripping of both circuit breakers in from one to three cycles. This high-speed clearing of faults by electronic methods improves system stability and increases loads that can be carried safely.



Vibration Fatigue Tests—Only through electronics has it been possible to build vibration testing equipment that will deliver from 10 to 10,000 cycles per second. Employing the principle of the dynamic radio speaker, Westinghouse engineers have developed vibration fatigue equipment that has opened the way for tests that could not be made with existing mechanical methods.



Speed Control—By converting a-c power to direct current with thyratron tubes, Westinghouse has developed small, compact speed control units for d-c motors without using rotating equipment for current supply. Direct current is supplied by the tubes to the armature and field of the d-c motor. Both armature and field circuits are controlled by one dial on the Westinghouse Mot-O-Trol.



Accurate Welding Control—The use of small Ignitron tubes has practically eliminated mechanical contacts for resistance welding. In the Westinghouse powerswitch, Weld-O-Trol, action is instantaneous. Speed of current interruption is 600 or more times per minute. The two Ignitron tubes in each Weld-O-Trol are guaranteed for a year and have consistently held up for much longer periods.

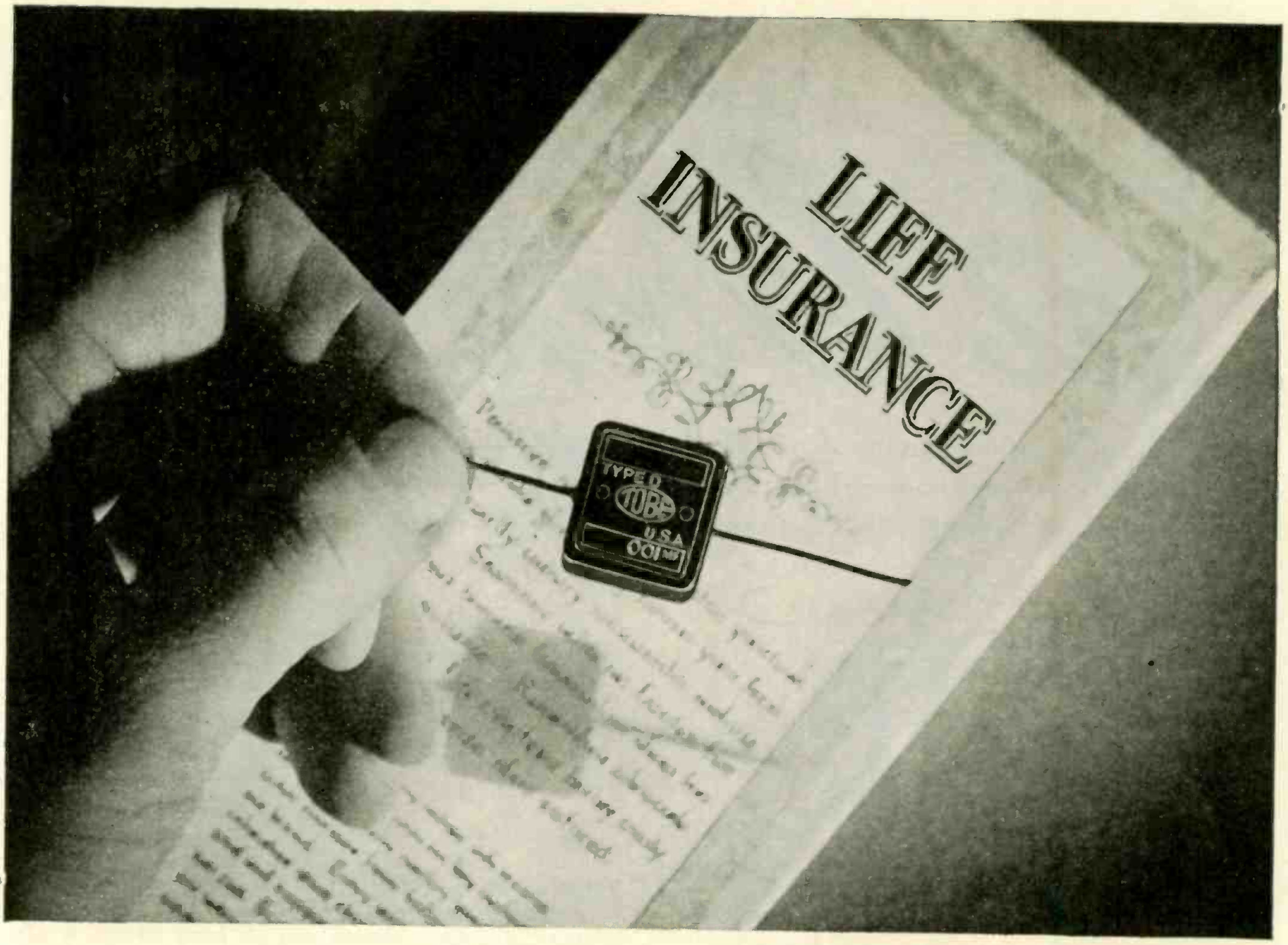
J-91031-A

For additional information about Westinghouse Electronic Equipment now available to industry, write for booklet B-3264. Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pennsylvania.

WESTINGHOUSE W

Westinghouse ELECTRONICS

PLANTS IN 25 CITIES . . . OFFICES EVERYWHERE



NOW AVAILABLE FOR YOUR PRODUCTION REQUIREMENTS!

The first oil-impregnated condenser to be found physically and electrically interchangeable with the majority of mica capacitors used in the by-pass and coupling circuits of radio and radar equipment.

The Tobe Type DP Molded Paper Capacitor has *long life built into it* through every step of manufacture. Rigid inspections maintain a standard that is exceptionally high—so high, in fact, that "returns" are almost completely unknown.

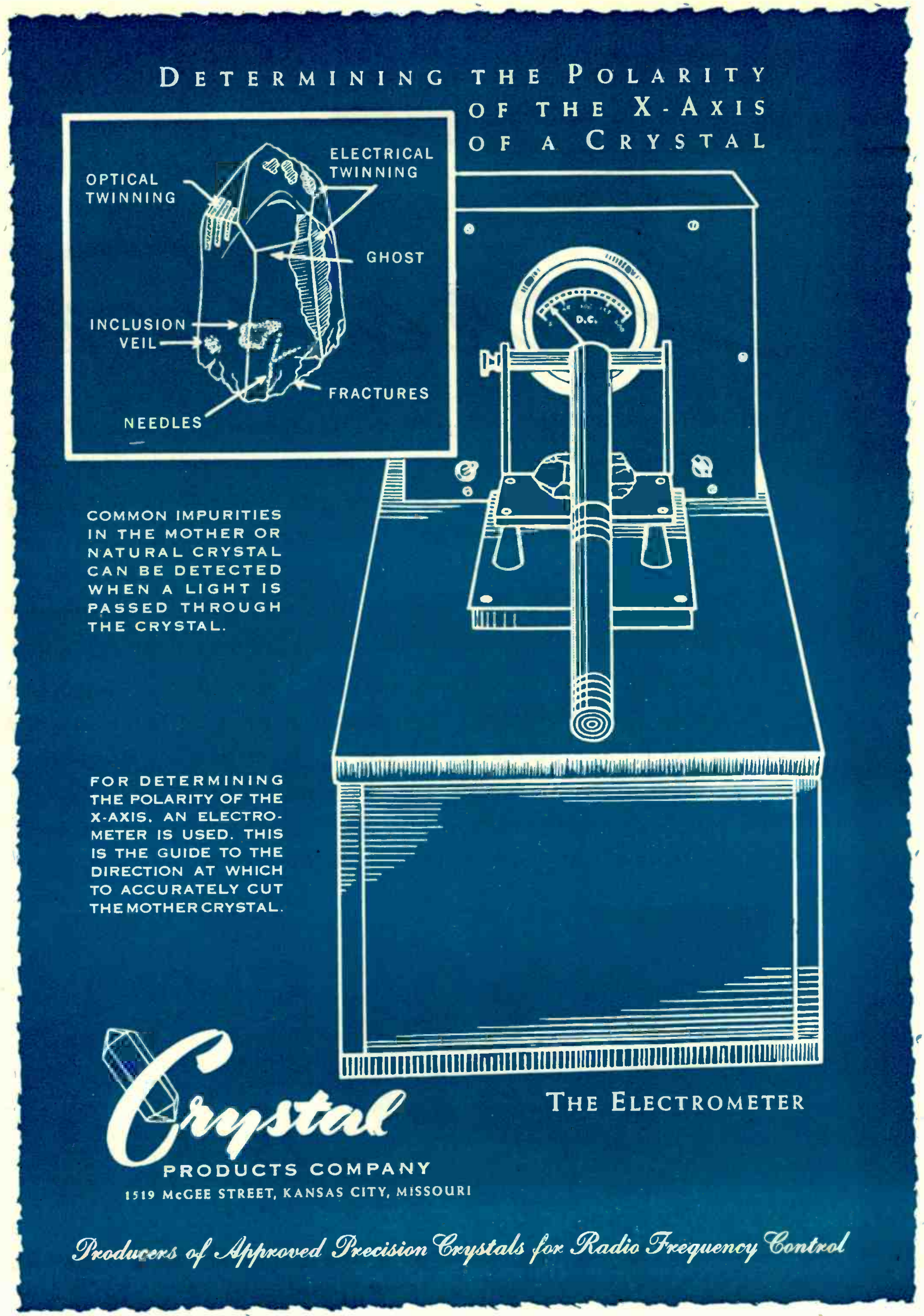
For the first time since its introduction we are *now* in a position to accept immediate orders for Type DP, with *prompt delivery assured.* They will be filled in order of receipt and we suggest you act promptly. For production samples or further information write TOBE DEUTSCHMANN CORP., CANTON, MASS.

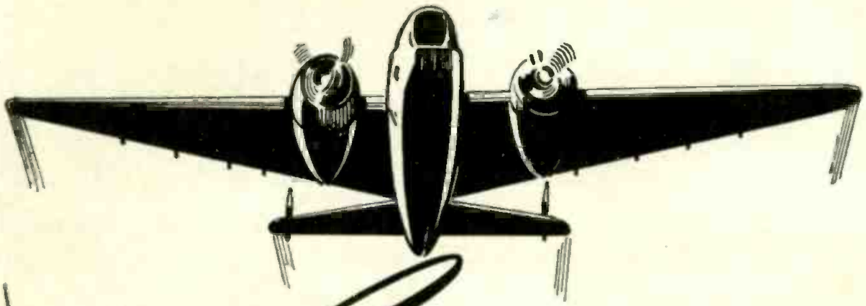
SPECIFICATIONS—TYPE DP CAPACITOR

CAPACITANCE	.001 to .01 mfd.
WORKING VOLTAGE	600 volts DC—flash test 1800 volts DC
SHUNT RESISTANCE	At 185° F.— 1000 megohms or greater At 72° F.—50000 megohms or greater
WORKING TEMPERATURE RANGE	Minus 50° F. to plus 185° F.
OPERATING FREQUENCY RANGE	Upper limit 40 megacycles Q at one megacycle—25 or better
POWER FACTOR	At 1000 cycles—.005 to .006

These capacitors meet Army and Navy requirements for immersion seal.

TOBE DEUTSCHMANN CORP. TOBE CANTON · MASSACHUSETTS


DETERMINING THE POLARITY OF THE X-AXIS OF A CRYSTAL
OPTICAL TWINNING
ELECTRICAL TWINNING
GHOST
INCLUSION
VEIL
FRACTURES
NEEDLES
COMMON IMPURITIES IN THE MOTHER OR NATURAL CRYSTAL CAN BE DETECTED WHEN A LIGHT IS PASSED THROUGH THE CRYSTAL.
D.C.
FOR DETERMINING THE POLARITY OF THE X-AXIS, AN ELECTROMETER IS USED. THIS IS THE GUIDE TO THE DIRECTION AT WHICH TO ACCURATELY CUT THE MOTHER CRYSTAL.
THE ELECTROMETER
Crystal
PRODUCTS COMPANY
1519 McGEE STREET, KANSAS CITY, MISSOURI
Producers of Approved Precision Crystals for Radio Frequency Control

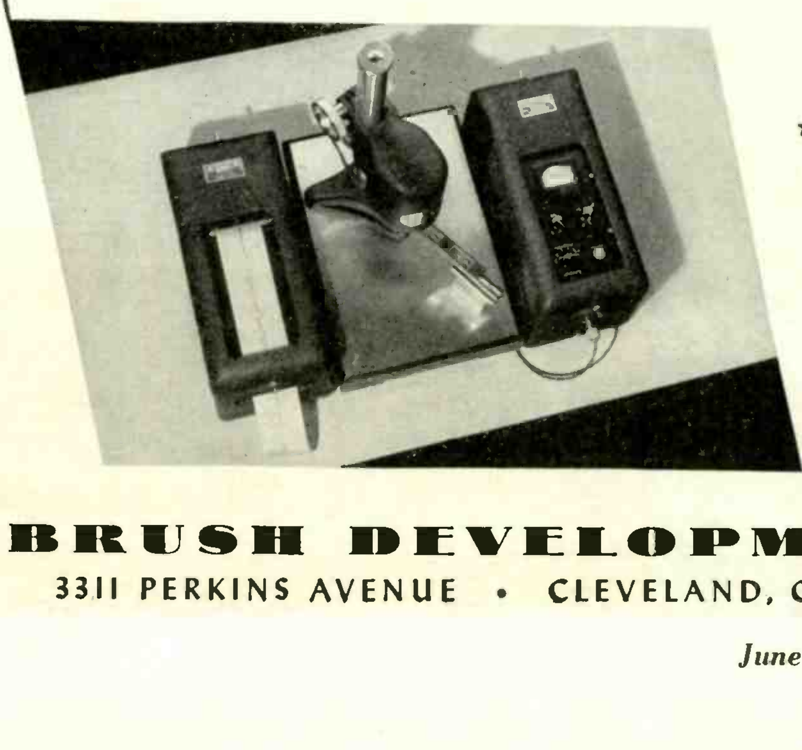


Correction-

● "American industry will produce 5000 planes a month in '43"—this was said in '42.

A correction is in order. It's May, the fifth month of '43, and already we've bettered this estimate by 500 planes a month. Every 7.8 minutes, night and day, a superbomber, transport, fighter or trainer rolls by, props spinning, bound for battle. This correction is proof enough that our Axis opponents are headed for trouble... Yankee trouble.

It takes tools to build this trouble ... tools that work fast and long, that probe into the vitals of engines to detect harmful vibrations, stresses and strains or reveal invisible irregularities in polished bearing surfaces. Such conditions as these are continually being studied from the chart recordings of the Brush Direct Inking Oscillograph and the Brush Surface Analyzer.



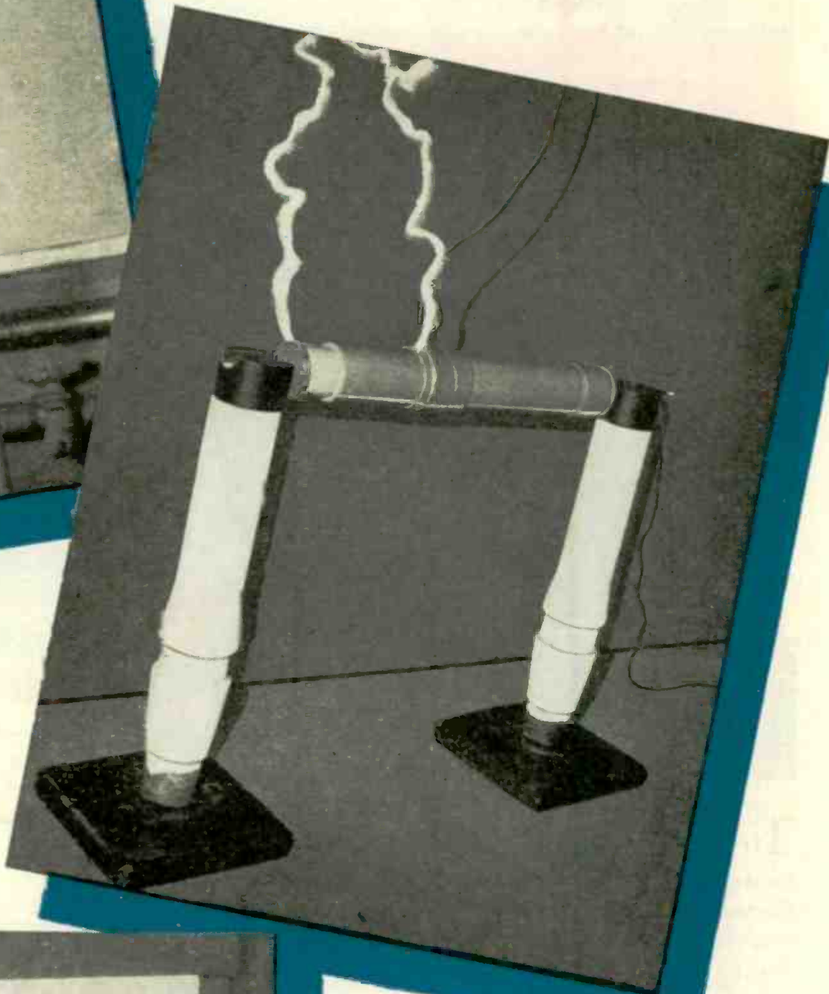
★ ★ ★ ★ ★

★ ★ ★ ★ ★

THE BRUSH DEVELOPMENT CO.

3311 PERKINS AVENUE • CLEVELAND, OHIO

. . . C-D's CUSTOMERS

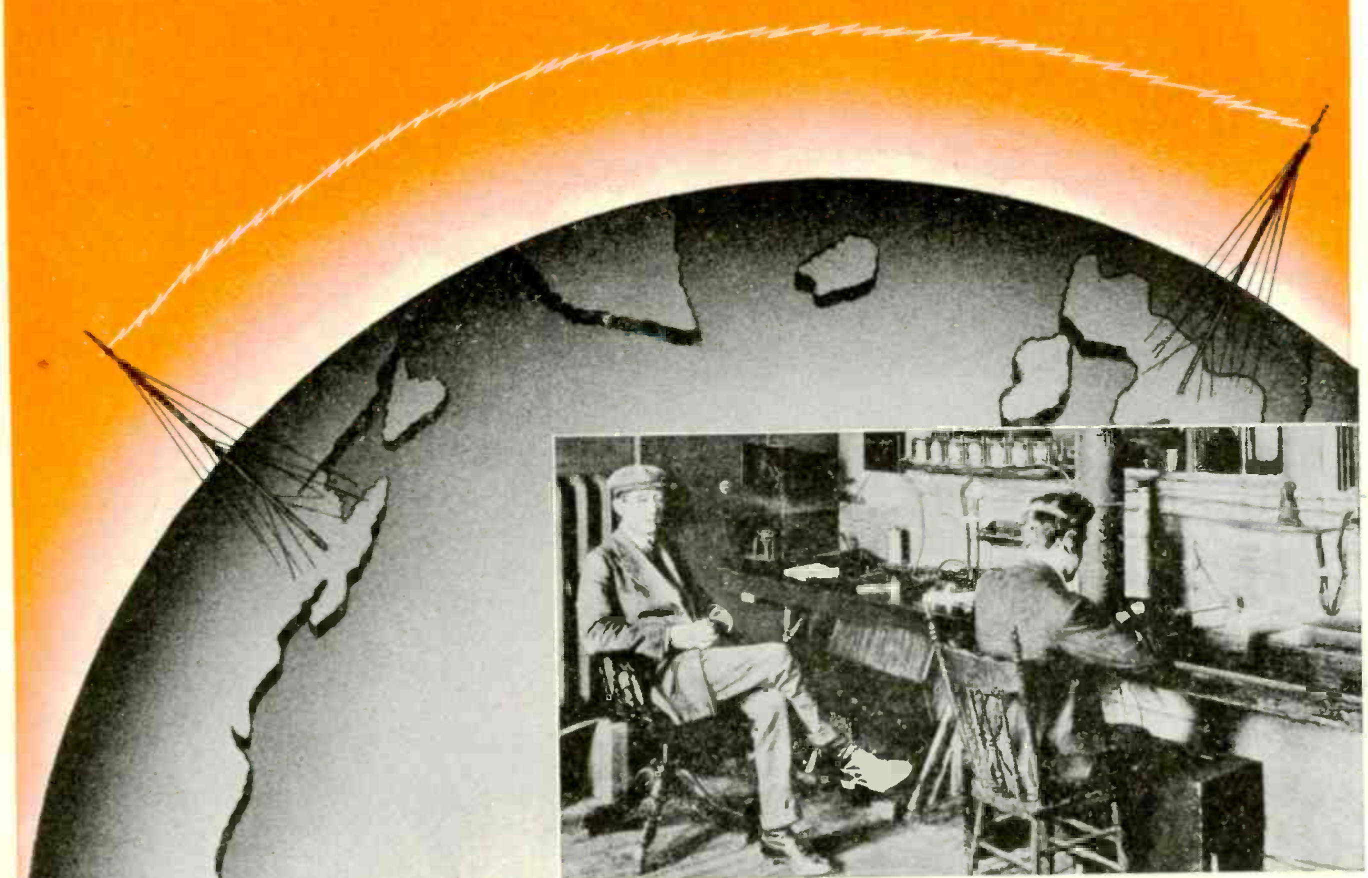


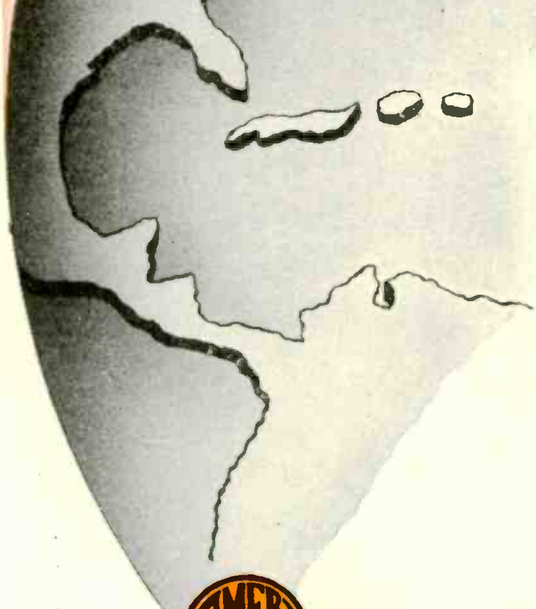
YES, DILECTO like all organic materials will BURN, BUT our Research Engineers can give you the exact time in seconds required to ignite this versatile insulating material. Complete details also may be found in the ASTM Standards.

DESIGNED for 15 KV . . . REQUIRES 52 KV to CAUSE FLASHOVER. Shown above is a Dilecto Oil Circuit Breaker Bushing for indoor use. While intended for a breaker of 15 KV, 1200 Amp. rating, specifications called for no flashover between mounting collar and terminals at a voltage under 50 KV. C-D Engineers made certain it took 52 KV to cause flashover.

At left is a precision instrument for measuring the power factor and dielectric constant of solid dielectrics. Every grade and thickness of Dilecto gets a control check on this device.

AMERTRAN helped Marconi send his first message across the Atlantic!





ONE of Marconi's headaches in the earlier development of long distance wireless communication was the lack of suitable transformers. It is, therefore, significant that he chose transformers manufactured by the AMERICAN TRANSFORMER COMPANY for the Nova Scotia station that sent his famous first message. Then only one year old, this Company had already acquired a reputation for solving the most difficult transformer problems. This is only one of the many historic applications of electric power in which AMERTRAN has been a participant.

Today, startling improvements are being incorporated in our products as a result of field reports of war service from the poles to the tropics. Many years of experience are being compressed into a few months. Details regarding these new economies, new characteristics, higher efficiencies with war-born ruggedness and ease of installation, will be revealed when peace comes. Meanwhile, the full production of our factories is being devoted to the war effort.

AMERICAN TRANSFORMER COMPANY
178 EMMET STREET · NEWARK, N. J.

PIONEER MANUFACTURER OF
TRANSFORMERS, REACTORS AND RECTIFIERS
FOR ELECTRONICS AND POWER TRANSMISSION

AMERTRAN
MANUFACTURING SINCE 1901 AT NEWARK, N. J.


THE Ability TO GO TO WAR!
In 1929, fourteen years ago, the first JENSEN Auditorium speaker was introduced. The first of its kind, it has during all the succeeding years faithfully served the public and professional need for a heavy duty, high quality loud speaker. We think it is undeniably the world's best known and respected loud speaker product. Now, this fourteen year old JENSEN product goes to war. Naturally it incorporates the refinements and improvements which have been steadily added, but the basic design and function remains the same. Many other JENSEN products are thus endowed with the ability to go straight to war.
Jensen
Jensen
RADIO MFG. CO.
6601 SOUTH LARAMIE AVENUE
CHICAGO, U. S. A.

Physicals FOR CAPACITORS!

X-Ray Photo of Solar Molded Domino Capacitor

There's an inside story of capacitors, too.

The genius of Roentgen is helping select the A-1's, not only in the field of medicine but also for quality inspection of molded capacitors.

Today, fluoroscopic inspection is an established procedure at Solar, assuring accurate centering of windings in Domino Molded Paper Capacitors. This "ounce of prevention" guarantees capacitors which truly reflect "Quality Above All"!

Solar Manufacturing Corporation, Bayonne, New Jersey.

SOLAR DOMINO TYPE MPW

3761

Solar SOLAR CAPACITORS

ARMY E NAVY

CAPACITORS: ELECTROLYTIC • MICA • PAPER • TRIMMER • TRANSMITTING

from Every Angle **THEY CAN DEPEND ON** *The Type 27*

SUPER AIRCRAFT RELAY

G-M

Originally designed for combat aerobatics . . . where strain and stress impose conditions unknown to pre-war relays . . . the Type 27 Super Aircraft Relay offers numerous advantages for a wide range of other uses.

Double trussed box frame construction provides rugged strength and rigidity . . . Measurements are 1½" x 1⅝" x 1⅞" and weight but 5 ounces. The type 27 SPDT double make—double break in 2 pole construction can withstand in excess of 15g without a flicker . . . has a 60 gram contact pressure (double make—double break) and a 20 ampere contact capacity at 30 volts d.c. (100 ampere inrush). Nominal coil voltage is 12 volts d.c. with a pickup of 6.5 volts (.61 watt) at 20° C. Coil wattage at 12 volts d.c. is 2.1 watts at 20° C. Temperature range is from −40 to +90° C.

Free samples of this relay are available to manufacturers on request if accompanied by a priority of AA-4 or better. Write or wire today requesting relay No. 12723.

VISITRON PHOTOTUBES

are available in quantity in numerous sizes. Made by G-M, pioneer in development and manufacture of quality phototubes.

G-M LABORATORIES INC.

4313 NORTH KNOX AVENUE, CHICAGO, ILLINOIS

Buy WAR BONDS & STAMPS

E·L IS OUT THERE, TOO...

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

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

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

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

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

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

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

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

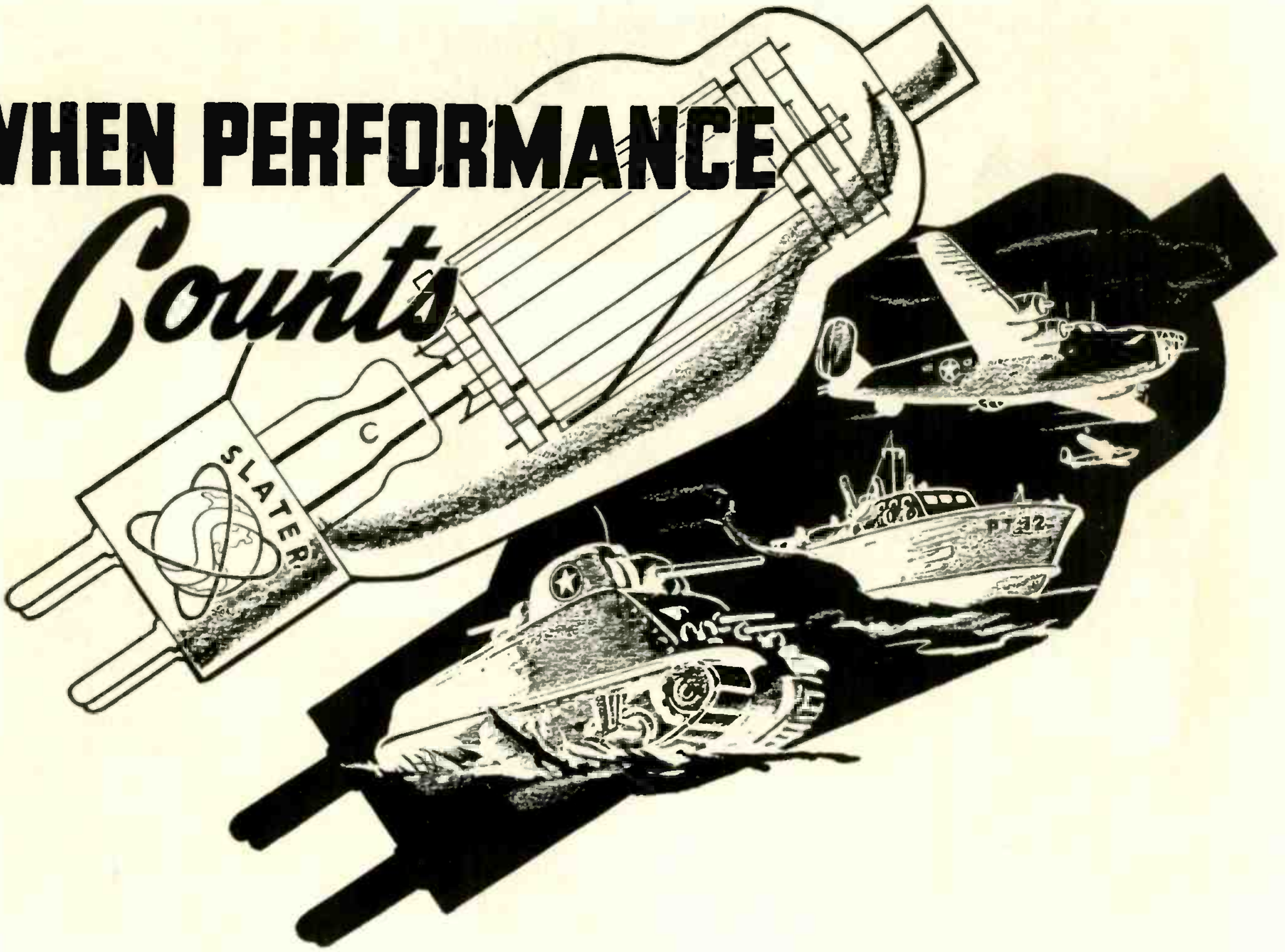
Electronic

LABORATORIES, INC.

INDIANAPOLIS

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

WHEN PERFORMANCE *Counts*



In this war . . . more than ever before . . . skill, courage and confidence permeate every fibre of our fighting men. For they know that the devices and equipment built into their airplanes, tanks, ships, and for the ground forces can be fully depended upon, in action. That is why . . . at Slater . . . all of our technical skill, ingenuity, and every measure of our resources are concentrated in making electronic tubes that will truly back up the men behind the guns . . . that will serve faithfully . . . *when performance counts.*

☆

FOR VICTORY BUY UNITED STATES WAR BONDS AND STAMPS

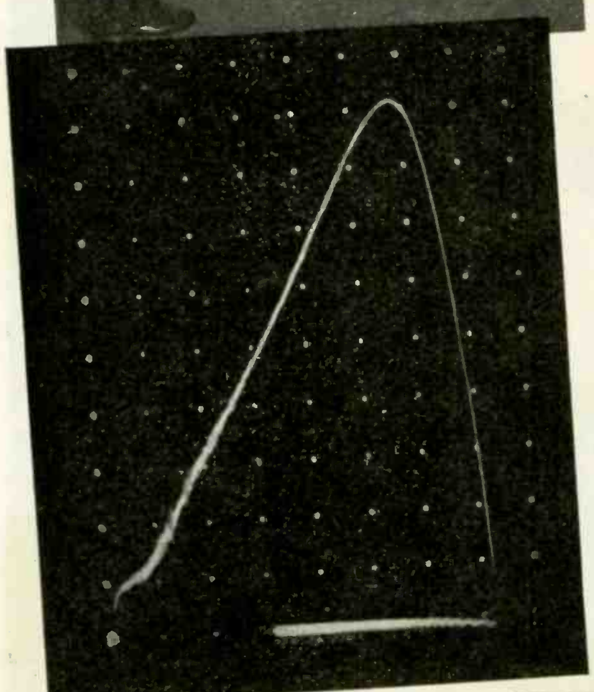
SLATER ELECTRIC & MFG. CO.

BROOKLYN, NEW YORK

MANUFACTURERS OF PRECISION ELECTRONIC TUBES AND INCANDESCENT STREET LIGHTING LAMPS


Specify
STEATITE
and stop worrying
There is
NO
Shortage!
Centralab
CRL
Division of Globe-Union Inc., Milwaukee, Wis.

So that our guns will SHOOT STRAIGHT



Above: DuMont Type 235 cathode-ray oscillograph. *Below:* Typical oscillogram for a given powder sample, showing matrix of dots providing an accurate reference or co-ordinate system for the burning powder graph, permanently photographed.

★ Knobs set. Camera ready. Firing circuit closed. BANG! Yet no sound, smoke, damage, to upset the serenity of the lab atmosphere. But . . .

Months later an American shell lands *smack* on the distant target. Precise powder charge has rounded out expert spotting, accurate calculations, fine gun-crew teamwork. To the growing consternation of our enemies, American marksmanship attains new heights of accuracy with its *electronically-checked* gunpowder. Specifically:

DuMont Type 235 cathode-ray oscillograph is being used in conjunction with the DuPont closed-bomb method of powder testing. Signals for the oscillograph are generated by the closed-powder-bomb. Potentials furnished by burning powder provide the horizontal and vertical deflection signals. Luminous dots electronically imposed on the short-persistence screen provide an accurate calibration means. The resultant combination oscillogram is photographed for a permanent record.

Thus each lot of powder, whether experimental or in production, is checked for vital burning qualities. Uniformity is assured. Our gun crews can be confident that their powder charges are *right*.

All of which is but another example of how DuMont specialists work with technicians in many different fields, in the application of cathode-ray technique.

★ *Submit your cathode-ray problem. Write for latest literature.*

DUMONT

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


CROLITE . . .
the STEATITE custom-built
to your precise needs
AGAIN AVAILABLE PROMPTLY
There's no bottleneck at Crowley's. Even before Pearl Harbor, but in anticipation, Crowley production facilities had been stepped up four-fold; since then, four-fold again. The giant plant is humming night and day. Skilled artisans long experienced in steatite fabrication guarantee you top quality along with quantity. A tremendous stock of raw materials backed by fully developed and controlled domestic sources insure against material shortages and shutdowns.
Crowley has met peak war demands. And there is still a surplus production capacity to be put to work.
Orders requiring months to fill a year ago are now handled in weeks. And by taking advantage of an outstanding inventory of dies and tools covering established designs and sizes, deliveries are reduced to days on standard pieces. Again we say, there's no bottleneck at Crowley's.
Other substitute materials are now critical. Switch back to Crolite steatite which is now available—and on time. Try the war-geared facilities of this pioneer steatite manufacturer. Engineering collaboration, specifications, quotations, samples cheerfully furnished.
NAVY
CROLITE
Custom-Built Steatite
HENRY L. CROWLEY & COMPANY, INC.
One Central Avenue
West Orange · New Jersey
PRESSED - EXTRUDED - MACHINED - WIDE CHOICE OF CHARACTERISTICS


HELPING AMERICA MEASURE UP
★ We can feel sure that the men who fight our battles are fully equal to the mighty task that faces them. ★ But the planes, tanks, ships, and guns they fight with must measure up, too. That's our job—those of us at home. How much? . . . How good? . . . are questions that only our hard work can answer. ★ Electrical instruments are a small but extremely vital part of America's war machine. Here at Simpson we are making *all* we can, the *best* we can, as *fast* as we can.
SIMPSON ELECTRIC COMPANY
5200-5218 W. Kinzie Street, Chicago, Illinois
DIRECT CURRENT
100
200
300
MILLIAMPERES
DIRECT CURRENT
.2
.4
.6
.8
MILLIAMPERES
Simpson
INSTRUMENTS THAT STAY ACCURATE
Buy War Bonds and Stamps for Victory

Important Notice

To All Users of

STEATITE INSULATORS

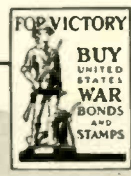
About a year ago—there was a drastic shortage of Steatite insulators and a serious lack of adequate manufacturing facilities. Consequently, there was a clamor for substitutes. Government officials took immediate steps to remedy the situation by urging those with years of engineering experience and a thorough knowledge of Steatite manufacturing processes to expand their production.

Today—there is no shortage of Steatite or of manufacturing facilities. Steatite insulators are available for prompt delivery in all sizes, shapes, and quantities. The production capacity of the industry as a whole has expanded far beyond the critical state, and now there is no longer reason to consider substitute materials.

Stupakoff engineers can help you solve your problems now. Stupakoff production facilities are available to fill your requirements now. Inquiries are given immediate attention.

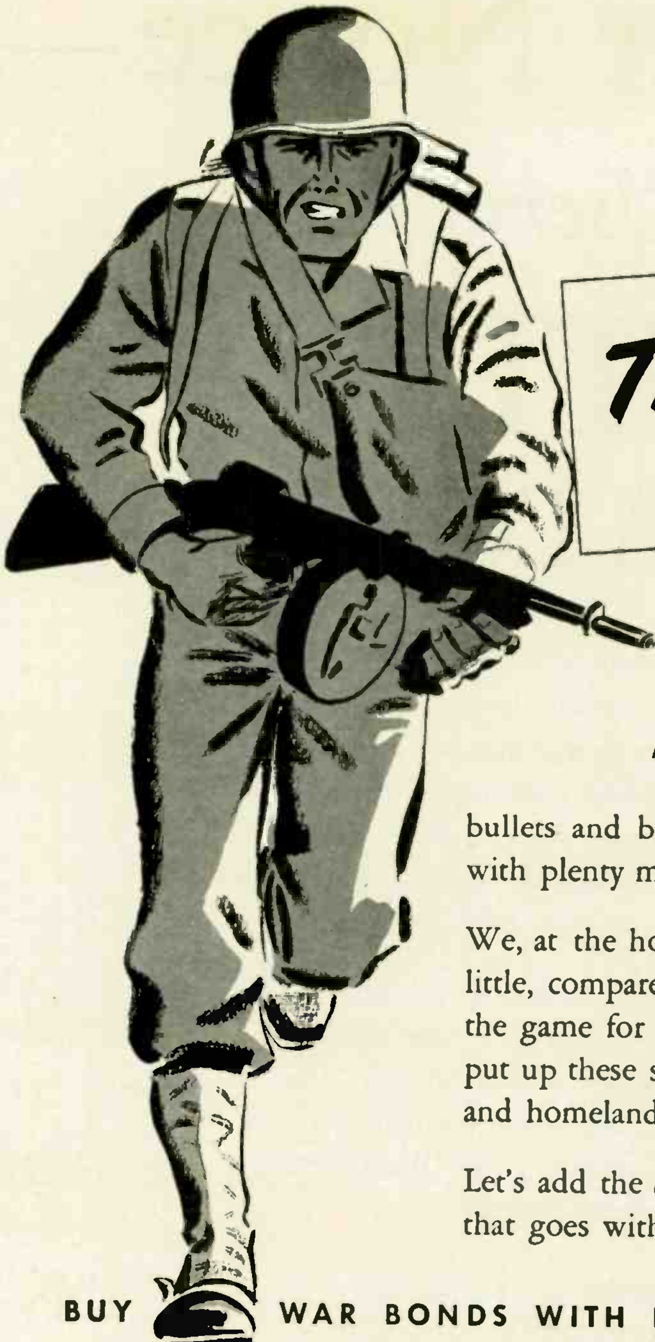
STUPAKOFF *Steatite* INSULATORS

The Army-Navy "E" Flag "for great achievement" flies over the Stupakoff plant.

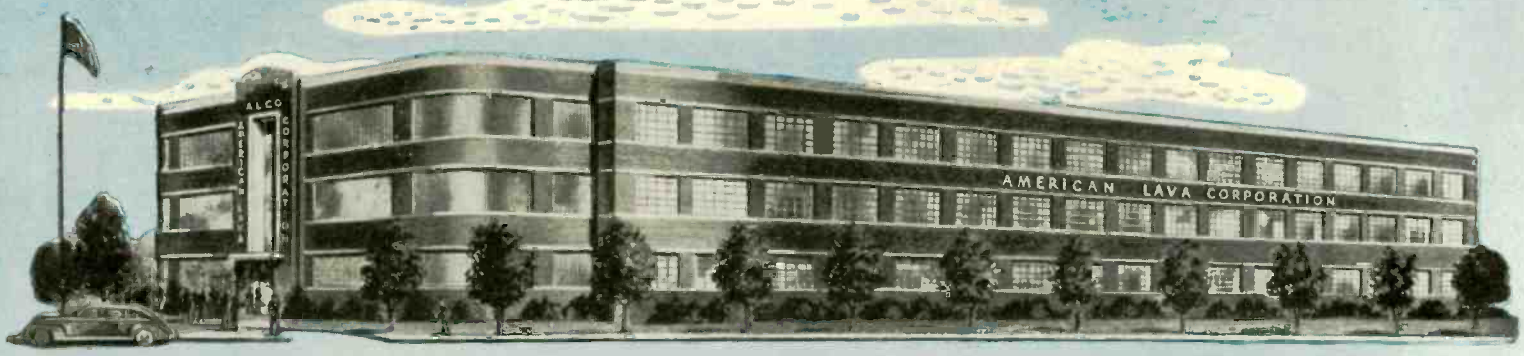


STUPAKOFF CERAMIC AND MANUFACTURING CO., LATROBE, PA.

Ceramics for the World of Electronics



OUT OF TODAY'S RESEARCH . . . TOMORROW IS ENGINEERED



ARMY E NAVY

AWARDED JULY 27, 1942

AN IMPORTANT ANNOUNCEMENT

FROM THE NATION'S LEADING PRODUCER OF STEATITE CERAMIC INSULATORS

DUE TO TREMENDOUS EXPANSION IN CAPACITY AND

PLENTIFUL RAW MATERIALS...THE STEATITE CERAMIC INDUSTRY

CAN SUPPLY STEATITE INSULATION FOR ALL NEEDS.

THE TRADE CAN RELY ON STEATITE

SUBSTITUTE MATERIALS ARE NOT NEEDED

ALSIMAG

TRADE MARK REGISTERED U. S. PATENT OFFICE

STEATITE CERAMIC INSULATION

AMERICAN LAVA CORPORATION

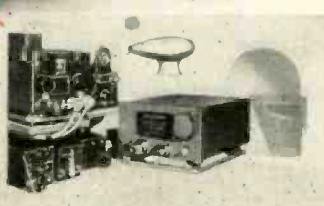
CHATTANOOGA • TENNESSEE

This might be your boy . . . or the kid next door. Yesterday he was a little shaver. Today, he's a full-fledged fighter on his own up there in the skies!

Yes, he's on his own . . . but never alone. For riding with him in his plane are the radiomen of "The Invisible Crew" of Bendix.

With these special aircraft radio devices, he talks with fellow pilots, and keeps in touch with comrades on the ground. He picks up distant radio stations to guide him on his course. He "sees" what lies ahead, even through impenetrable fog. Daily, as a matter of course, he uses new electronic devices far too confidential to talk about now.

Through these engineering marvels that guide and protect him, he senses secrets of the future . . . the future that he's fighting for.



RADIOMEN OF "THE INVISIBLE CREW"

These "Radiomen" have the ability to withstand extreme service conditions as a result of the painstaking efforts of the Bendix Radio Engineers. No detail is too small to escape the grueling tests that insure unfailing performance. Electronic research continually steps up already high performance to exceed every standard previously reached.

BENDIX RADIO

Back America's invincible crew . . . our fighters on every front. Buy War Bonds and Stamps regularly.

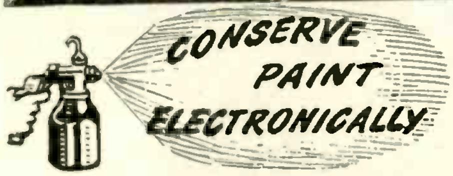
★

More than 25 Bendix plants are speeding "The Invisible Crew" to world battle fronts.

THE INVISIBLE CREW
Precision Equipment by
Bendix
AVIATION CORPORATION

B E N D I X R A D I O D I V I S I O N

FOR SALE—ELECTRONIC PRODUCTION AIDS



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

HOW BLUE IS SCARLET?

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

To Measure Actual Strain in Structural Parts

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

HOW TO SAVE ON A-C RESISTANCE-WELDER MAINTENANCE

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

DO YOUR WORKMEN SQUINT

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

Delicate Timing!

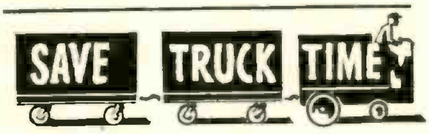
Standard G-E electronic timers go down to 0.045 second and up to two minutes; five ranges to choose from. Special ranges on request. Consistent. Stepless time range controlled by knob on front. Only one moving part. Only one tube. Used to time resistance welders, induction furnaces, conveyors, laboratory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

MACHINE-TOOL USERS!

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

IS YOUR METAL-STRIP PRODUCTION LEAKING OUT THRU PINHOLES?

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



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

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

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

THINKING ABOUT THE FUTURE?

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

Speed Production Electronically

GENERAL ELECTRIC

General Electric, Sec. P676-100
Schenectady, N. Y.

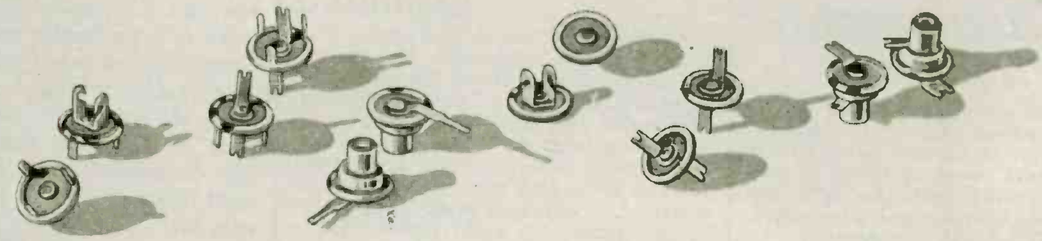
I want to know more about speeding production electronically. Please send me the bulletins checked;

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

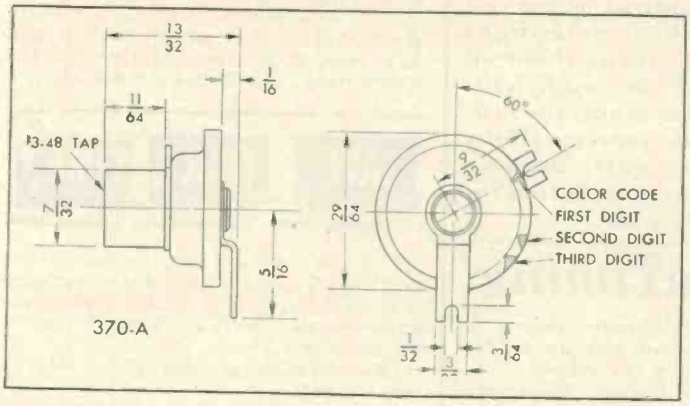
Name....................
Company....................
Address....................
City.................... State....................

8490

Erie Button Mica Condensers



Compact Silver Micas for U. H. F.



Characteristics

Capacity Range:	15 to 500 mmf.
Power Factor:	.08% max. for capacity tolerance of ± 5% or less .12% max. for capacity tolerance of over ± 5%
Max. Working Voltage:	500 Volts D. C.

FOR U.H.F. and V.H.F. applications where short leads, high resonant frequency, and compactness are essential, Type 370 Erie Button Mica Condensers are ideal.

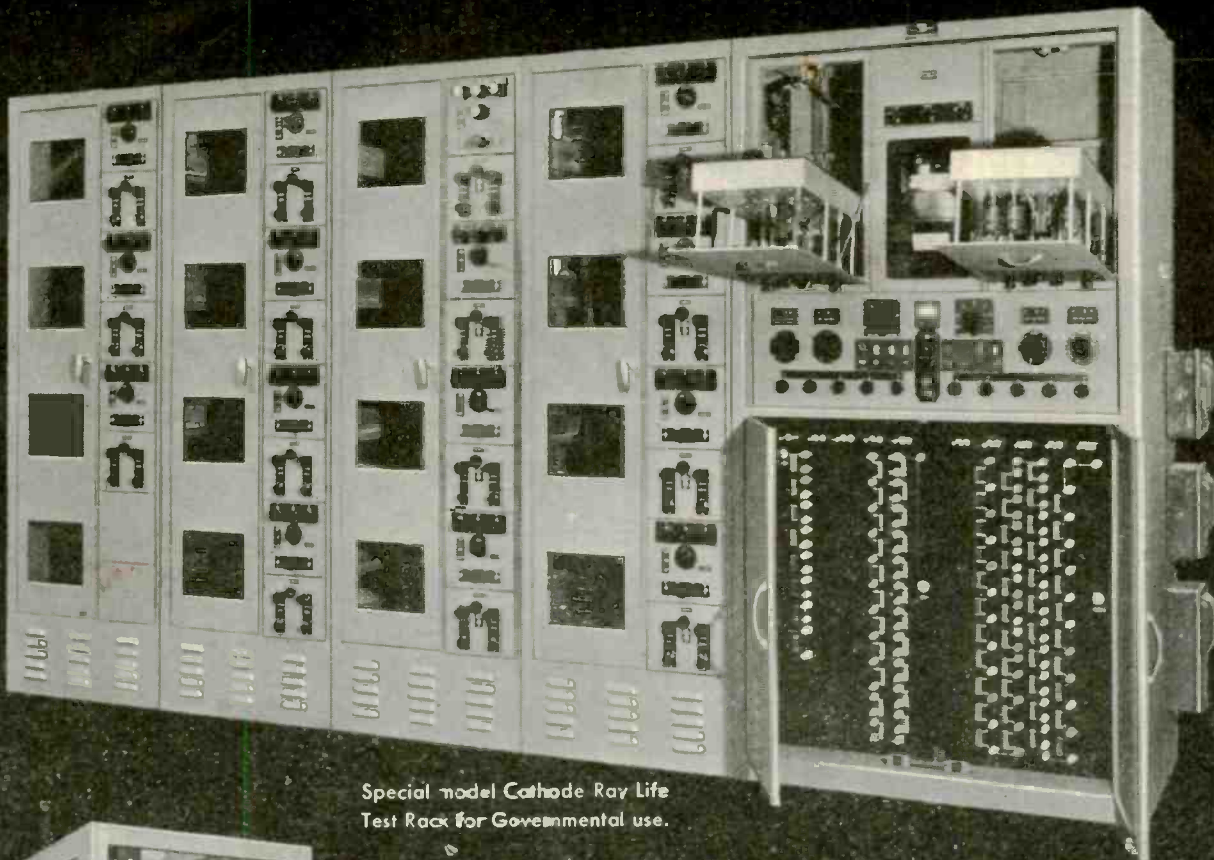
These small capacitors consist essentially of a stack of silvered mica sheets encased in a silver plated housing. The housing forms one terminal, the other terminal being connected at the center of the stack, thus providing the shortest possible electrical path to the capacitor. A wide selection of terminal and mounting designs is available to provide both feed-thru and by-pass connections.

Erie Button Mica Condensers have been thoroughly proven in large scale production quantities since 1941. Capacity ranges and electrical characteristics are given above.

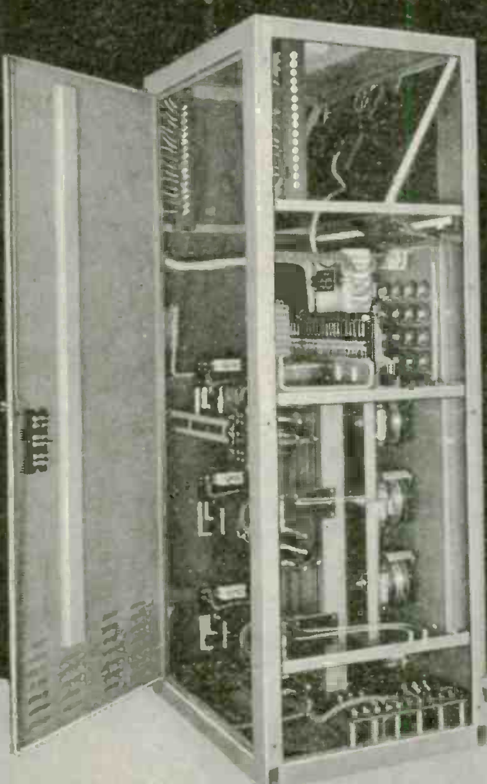
Samples of Erie Button Mica Condensers and complete technical information will be sent to interested engineers on request.

INVEST TODAY IN BONDS FOR VICTORY

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



Special model Cathode Ray Life Test Rack for Governmental use.



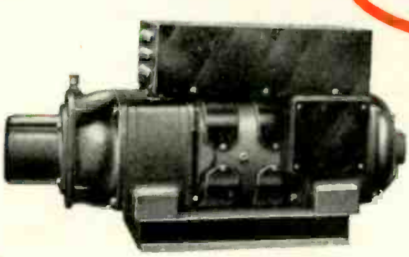
Rear view of filament and bias control of a TEMCO Life Test Rack installation, showing method of coupling and bus connections.

They sail with the Fleet

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

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

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



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

Leland

WAR DUTY MOTORS

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

THE LELAND ELECTRIC COMPANY ★ DAYTON, OHIO

A COMPLETE LINE OF LOW-LOSS CONNECTORS FOR SOLID DIELECTRIC COAX AND TWINAX CABLES

(To ARMY and NAVY Specifications)

EASY TO ASSEMBLE
Amphenol Low-Loss Connectors

1. Strip insulation as per diagram.
2. Unscrew coupling ring and slip over outer sheath of cable.
3. Insert conductor into hole in contact (B) and twist insulation into taper-threaded sleeve (C) until shielding passes solder holes (D) in sleeve.
4. Solder conductor to tip of contact, making sure no surplus solder extends beyond the diameter of the pin; (otherwise good contact with socket contact will not be made).
5. Solder shielding to connector by flowing solder into holes (D) after fluxing with non-corrosive flux.
6. Screw coupling ring in place.

UNIFIED ENGINEERING—Connectors and Cables

Approved by the Army and the Navy for use on standard coax and twinax cables. . . . Water-proof, small in size, rugged. . . . Easy to assemble anywhere with ordinary tools. . . . Electrical discontinuity is sufficiently small to permit operation at ultra-high frequencies and constant characteristics are maintained. . . . Cables are connected to the plug only—there is but one type of assembly operation for each size of cable.

Available now five types
for three cable sizes:

Solid Dielectric Coax Cables—
410" O. D.—290" Dielectric

Solid Dielectric Twinax Cable—
410" O. D.—290" Dielectric

Solid Dielectric Twinax Cable—
630" O. D.—475" Dielectric

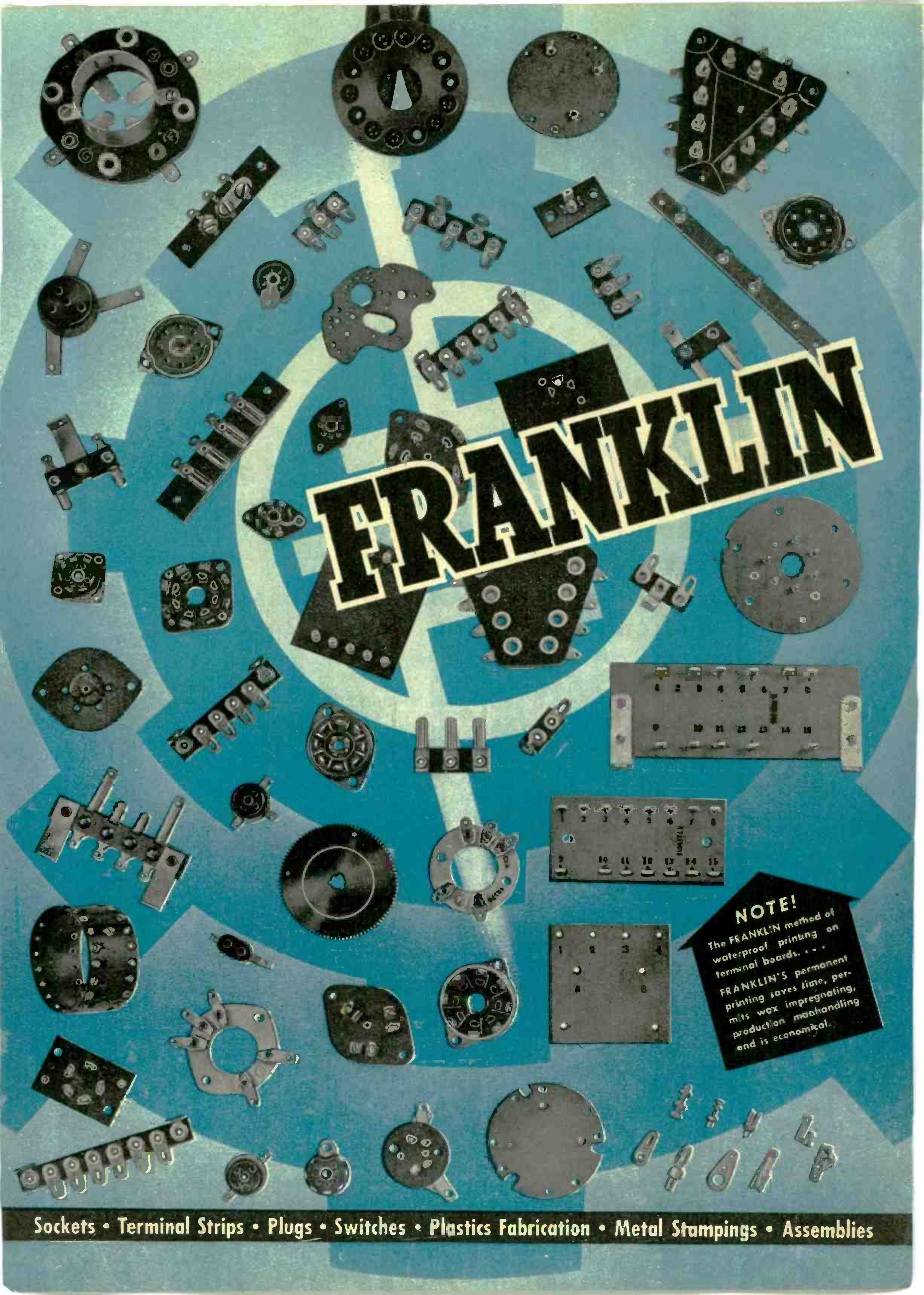
Write for information on these Cables and Connectors.

AMPHENOL

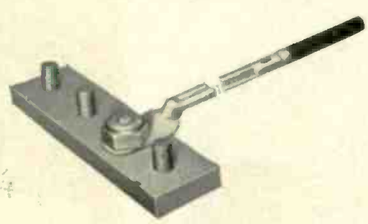
AMERICAN PHENOLIC CORPORATION • CHICAGO

IN CANADA—AMPHENOL LIMITED • TORONTO

THE COMPLETE LINE — ULTRA-HIGH FREQUENCY CONNECTORS AND CABLES


FRANKLIN
NOTE!
The FRANKLIN method of
waterproof printing on
terminal boards. . . .
FRANKLIN'S permanent
printing saves time, per-
mits wax impregnating,
production manhandling
and is economical.
Sockets • Terminal Strips • Plugs • Switches • Plastics Fabrication • Metal Stampings • Assemblies

The Burndy LINKIT
(closed position)



The LINKIT Lug

The LINKIT with Burndy VERSIFLEX insulating sleeve

Headquarters for Connectors

Again, Burndy solves a small wire connection problem in a simple, foolproof manner.

The LINKIT is a detachable connector, positive in its action, and without any troublesome, extra parts . . . parts which might loosen or become lost.

It simply z-i-p-s into position, yet establishes a sound, secure contact over its entire fork contact area. To disconnect, a firm pull releases the contact grip, and it zips apart. Either operation wipes contact surfaces *clean*.

And the LINKIT provides a *sound* connection, mechanically as well as electrically. For it's forged from pure copper. *Pure copper for high conductivity . . . forging for high strength.*

Another advantage . . . the LINKIT is a modern solderless connector, attached in the same speedy and secure manner as popular Burndy HYLUG terminals . . . *simply indented to the wire with a Burndy HYTOOL.*

Samples of LINKIT, and other Burndy solderless connectors for small wires, will gladly be sent on request.

BURNDY ENGINEERING CO., INC., 107 Eastern Boulevard, N.Y.C.

BURNDY

BEHIND THE GLAMOUR THAT IS ELECTRONICS

Hands on America's production lines insert more Superior seamless and patented Lockseam cathode sleeves into electronic equipment than those of any other manufacturer.

Superior works for the unglamorous engineer — the man who is posed with the problem of developing and producing the stuff that "tomorrow's dreams are made of."

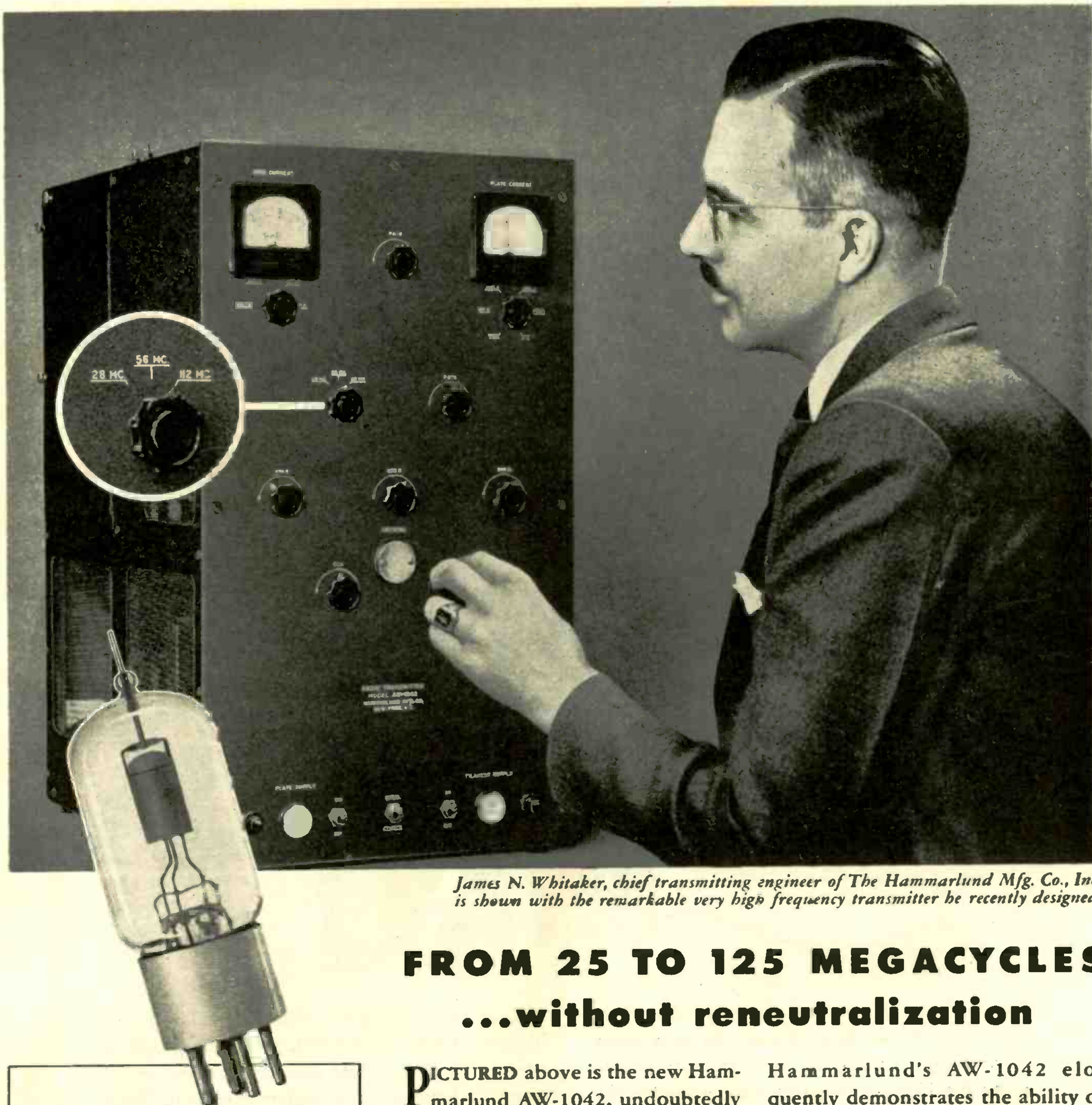
Superior cathode sleeves and anodes are unglamorous too, if you look at them as just millions of pieces of small metal tubing. But to the war on every front, and to the men and women on the production lines of the radio and electronic industry, these precision engineered sleeves are often the difference between top performance in the field and a dead tube—they are the engineers' blue-print come alive—these unglamorous Superior cathodes and anodes.

Our automatic production machinery spits cathodes out as fast as a machine gun; our smallest standard size to date is .010.

SUPERIOR — *the big name in cathodes and anodes today . . . and tomorrow.*

SUPERIOR TUBE CO.

NORRISTOWN, PENNSYLVANIA



James N. Whitaker, chief transmitting engineer of The Hammarlund Mfg. Co., Inc. is shown with the remarkable very high frequency transmitter he recently designed.

FROM 25 TO 125 MEGACYCLES
...without reneutralization

EFFICIENT VHF OPERATION WITH GAMMATRON HK-24's

The high efficiency of HK-24 Gammatrons at very high frequencies is the result of two things: the long, capped tantalum plate which confines the entire electron stream for useful output, and the fact that the grid is closely spaced to the filament for short electron time-flight.

The HK-24 triode is easy to neutralize, and parasitic oscillation is avoided, because the inter-electrode capacities are low and the grid and plate leads are short. The grid to plate capacity is only 1.7 micro-microfarads.

For maximum and typical ratings of the HK-24 as an r. f. power amplifier, audio amplifier, crystal oscillator, doubler, or tripler, write for data.

PICTURED above is the new Hammarlund AW-1042, undoubtedly the first neutralized power amplifier to operate on 28, 56, and 112 megacycles without reneutralization.

High stability is not the only news-worthy feature of this new transmitter. It has been engineered with such skill that it replaces an accepted transmitter of similar performance requiring twice the power input and weighing seven times as much!

The AW-1042 produces 50 watts of useful carrier power with either audio or narrow-band frequency modulation, both of which are crystal-controlled. It offers CW, tone telegraph, and phone performance.

Hammarlund's AW-1042 eloquently demonstrates the ability of their engineers to evaluate design; and Heintz and Kaufman, Ltd. is proud that HK-24's are used in the final, as well as in the three preceding doubler stages.

States Mr. Whitaker: "I chose HK-24 Gammatrons because their mechanical and electrical characteristics render them particularly suitable for high frequency operation with unusually high efficiency and stability."

HEINTZ AND KAUFMAN, LTD.

SOUTH SAN FRANCISCO, CALIFORNIA, U. S. A.

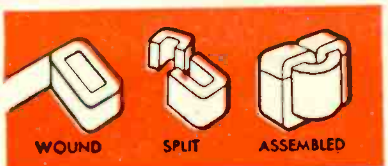
Gammatron Tubes

FOR MORE ELECTRONIC WEAPONS FASTER

Simplify Transformer Assembly

with HIPERSIL* two-piece cores

Hipersil cores eliminate hard-to-handle little transformer laminations. Made from a new magnetic steel that has ⅓ more flux-carrying capacity . . . they are wound from *one strip* and then split in two pieces.



This split-core construction saves valuable man-hours because there are only 2 or 4 pieces to assemble around the windings.

Hipersil cores offer hitherto unavailable improvements to manufacturers of radio transformers, relays, reactors, chokes and loading coils. For example:

SMALLER SIZE... ideal for airplanes, tanks, "walkie-talkie" sets, etc.

LIGHTER WEIGHT. Because of better magnetic properties, Hipersil saves 30 to 50% in weight . . . particularly important in aircraft and portable equipment.

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

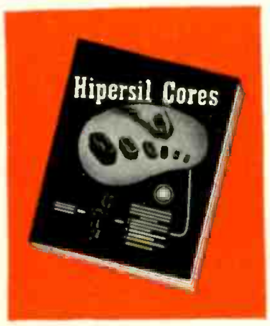
Ask your Westinghouse representative about standard Hipersil core sizes now available for war production.

*Registered Trade-mark, Westinghouse Electric & Mfg. Co., for HIgh PERmeability SILicon steel.

GET THE FACTS ABOUT HIPERSIL

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

J-70408

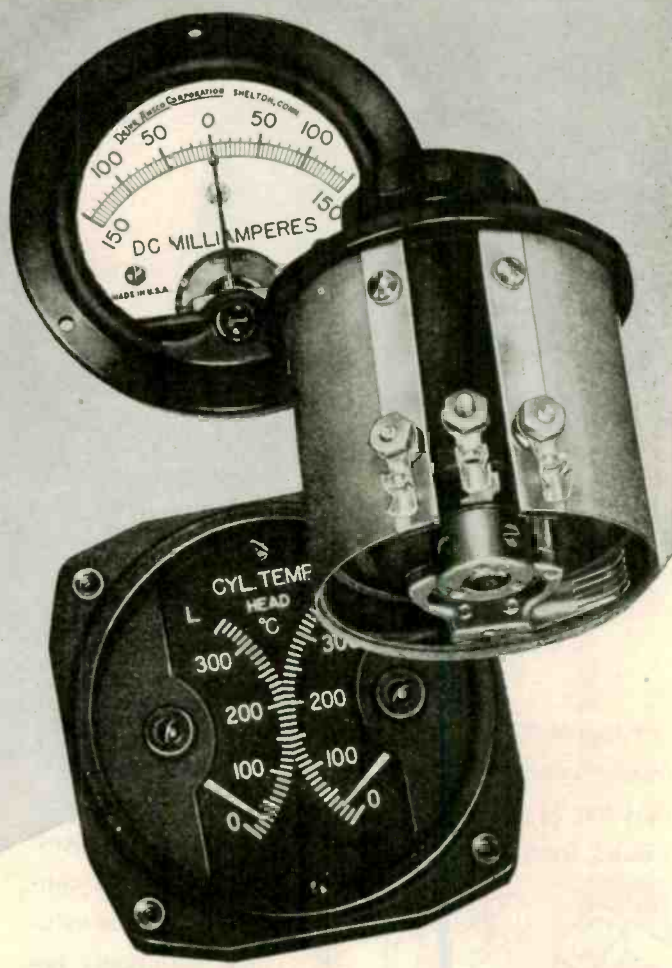


Westinghouse

PLANTS IN 25 CITIES... OFFICES EVERYWHERE

HIPERSIL

More than ever



With *the struggle* becoming increasingly fierce . . . now, more than ever . . . the quality of American men and equipment stand out in bold relief. We cannot tell you where . . . but we do know that somewhere on all the fronts . . . the quality of DeJur Aircraft and Electrical Instruments, Potentiometers and Rheostats is being subjected to the severest of tests. Thanks to 25 years of experience and research, our products will not be found wanting.

Awarded for Excellence in Production and Quality of Materiel

DeJur-Amsco Corporation

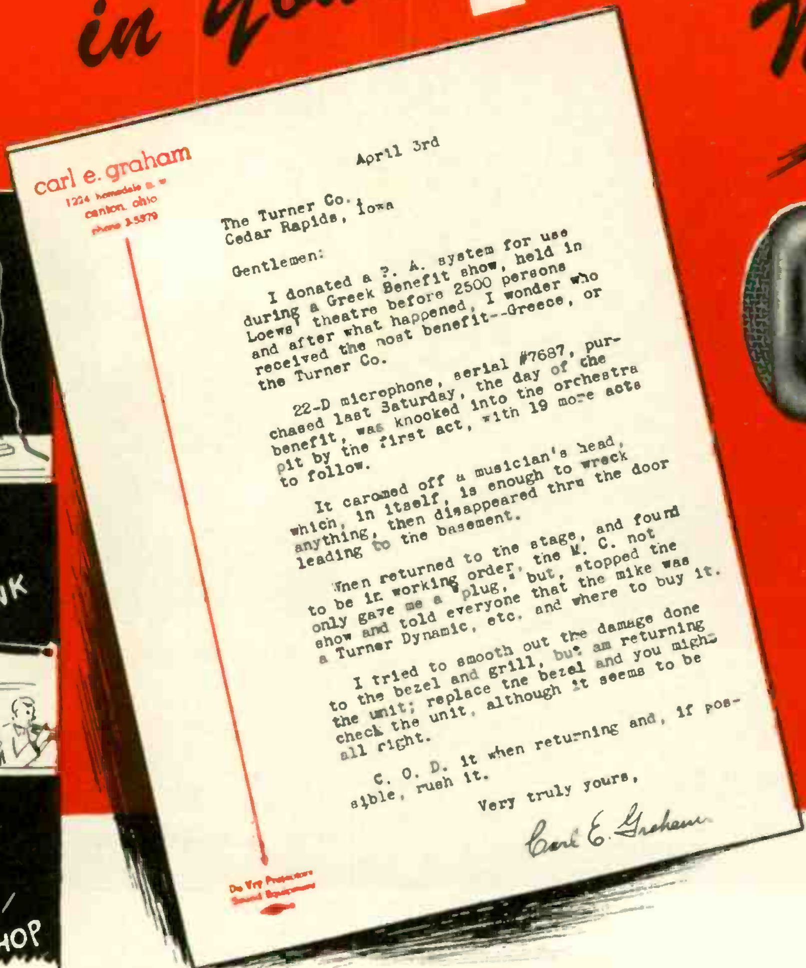
SHELTON, CONNECTICUT

NEW YORK PLANT:
99 Hudson Street, New York City

CANADIAN SALES OFFICE:
560 King Street West, Toronto

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

Keep that Fight in Your TURNER *Mike*



carl e. graham
1224 homedale n. w.
canton, ohio
phone 3-5379

April 3rd

The Turner Co.
Cedar Rapids, Iowa

Gentlemen:

I donated a P. A. system for use during a Greek Benefit show, held in Loews' theatre before 2500 persons and after what happened, I wonder who received the most benefit--Greece, or the Turner Co.

22-D microphone, serial #7687, purchased last Saturday, the day of the benefit, was knocked into the orchestra pit by the first act, with 19 more acts to follow.

It caromed off a musician's head, which, in itself, is enough to wreck anything, then disappeared thru the door leading to the basement.

When returned to the stage, and found to be in working order, the M. C. not only gave me a "plug," but, stopped the show and told everyone that the mike was a Turner Dynamic, etc. and where to buy it.

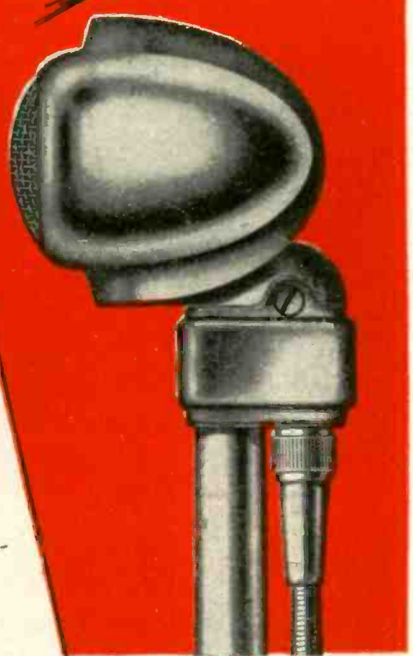
I tried to smooth out the damage done to the bezel and grill, but am returning the unit; replace the bezel and you might check the unit, although it seems to be all right.

C. O. D. it when returning and, if possible, rush it.

Very truly yours,

Carl E. Graham

De Vry Projectors
Sound Equipment



TURNER
Model **22-D**

Turn to Turner---for a Mike with "Built-In" Fight

Whatever your need for a Microphone, you can be sure of complete satisfaction under any acoustic or climatic condition when you specify Turner. Thousands of satisfied users can vouch for the rugged construction, the accurate response and superb performance of Turner Microphones under the toughest usage.

Today's Turner Microphones are being used for vital war communications, in War Plants, Airdromes, Ordnance Plants, Docks, Army Camps, Broadcasting Studios, Police Transmitters and other highly sensitive spots where accuracy is essential. IF YOU HAVE A HIGH PRIORITY RATING, you can still buy Turner Microphones. Write today, explaining your problem, and we will help you select the Turner unit best suited to your needs.

The **Turner** *Company*
CEDAR RAPIDS, IOWA

GET THIS *free* TURNER CATALOG

. . . Write now to obtain your Free copy of Turner's new 8-page, fully illustrated, colorful Microphone Catalog. Select the one you need, at the price you want to pay.

Turner Crystal Microphones licensed under patents of the Brush Development Co.

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

From a thousand feet up
The burning airdrome
Looks like
A "pushover"...

But
When you get
Right down to earth
It turns out to be
Anything but.

Suddenly the trees
To the right
Start throwing lead—
And your men
Are still hanging
Like clay pigeons
In their harnesses.

* * *

What a break
That you're equipped
With a
Two-way
Radio.

What a break
That you can tell your trouble
To a friendly
Fighter plane.

* * *

Today, communication equipment
Designed and manufactured
By I.T.&T. associate companies
Is helping Uncle Sam's fighting forces
Work together
On land, sea and in the air...

Tomorrow, the broad experience
Of I.T.&T.
In the field of communications
Will help build a better world
For every man.

INTERNATIONAL TELEPHONE AND TELEGRAPH CORPORATION *67 Broad St., New York, N. Y.*

I T&T

Manufacturing Associate:
FEDERAL TELEPHONE AND RADIO CORPORATION

SEA DOGS

Hats off to the Sea Dogs . . . those intrepid bluejackets who are making naval history! Tales of their courage, endurance and sacrifice will live long after the last gun is silenced and the sea is safe again for all free men.

They're the men who make possible the naval feats that are adding up to victory. They're the men who are at their posts when the cry of "*Battle Stations!*" is heard. They're the men who never lose hope or courage . . . who carry out orders unquestioningly. As one young seaman so aptly expressed it—"They give you a tough job to do, and you do it. That's all."

That's all.

Like the bluejackets on a United States battleship who shot down 32 attacking Jap planes and later sank three Jap cruisers and one destroyer.

Or the seamen on the little U. S. Destroyer Laffey who bravely tackled four Jap warships, and fought until their last gun was silenced.

Then there was the sailor who, lying on the blistering deck of the crippled aircraft carrier Hornet, with one leg broken and the other shattered, tried to climb off his stretcher to have another shot at the Japs.

And the sea dogs who stood unhesitatingly behind Admiral Callaghan as he led the cruiser San Francisco right into a hell of fire between two lines of Jap warships, and then finished off a battleship, a cruiser and a destroyer.

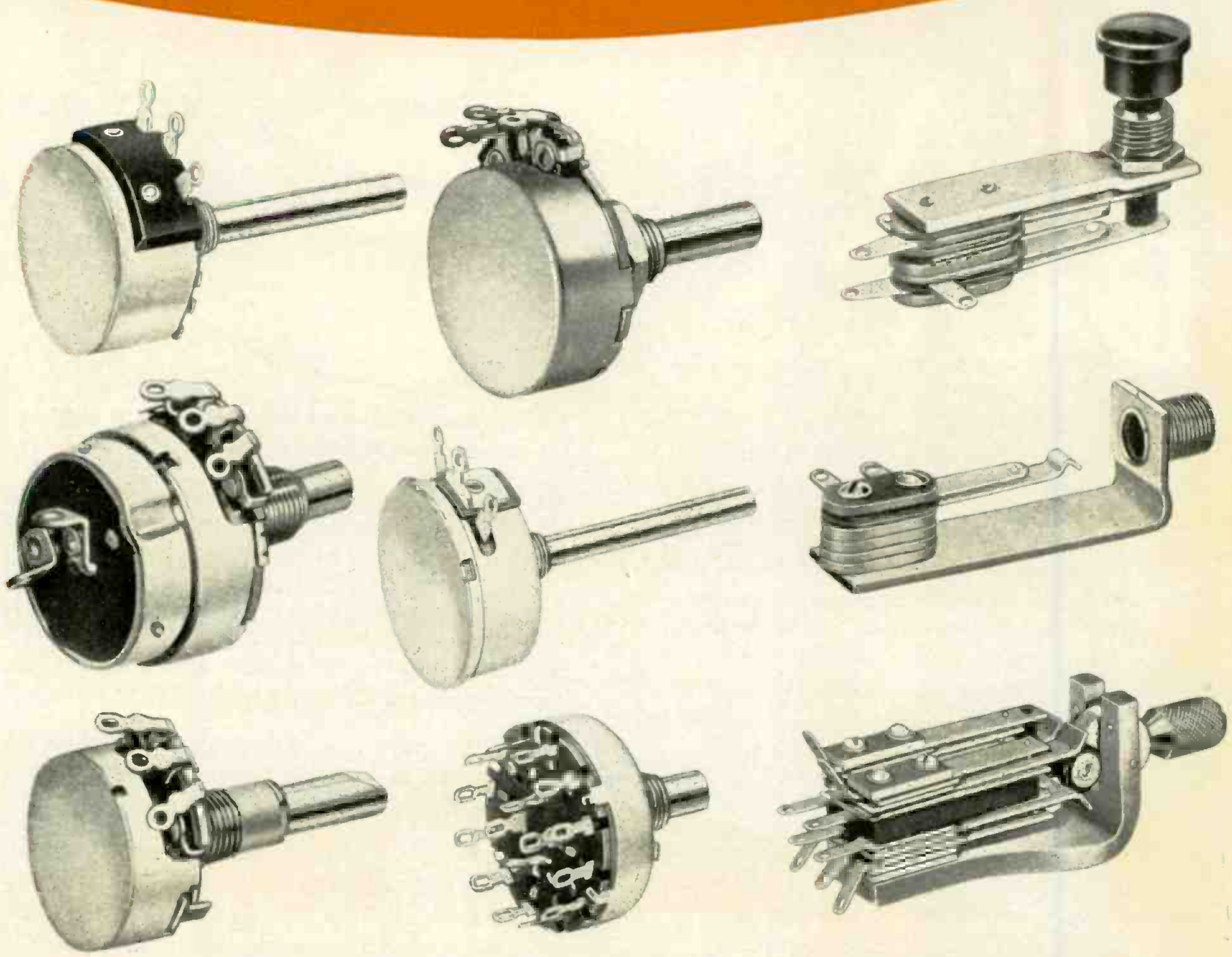
That's our Navy . . . youngsters, most of them . . . the generation the old fellows called "spoiled" and "soft."

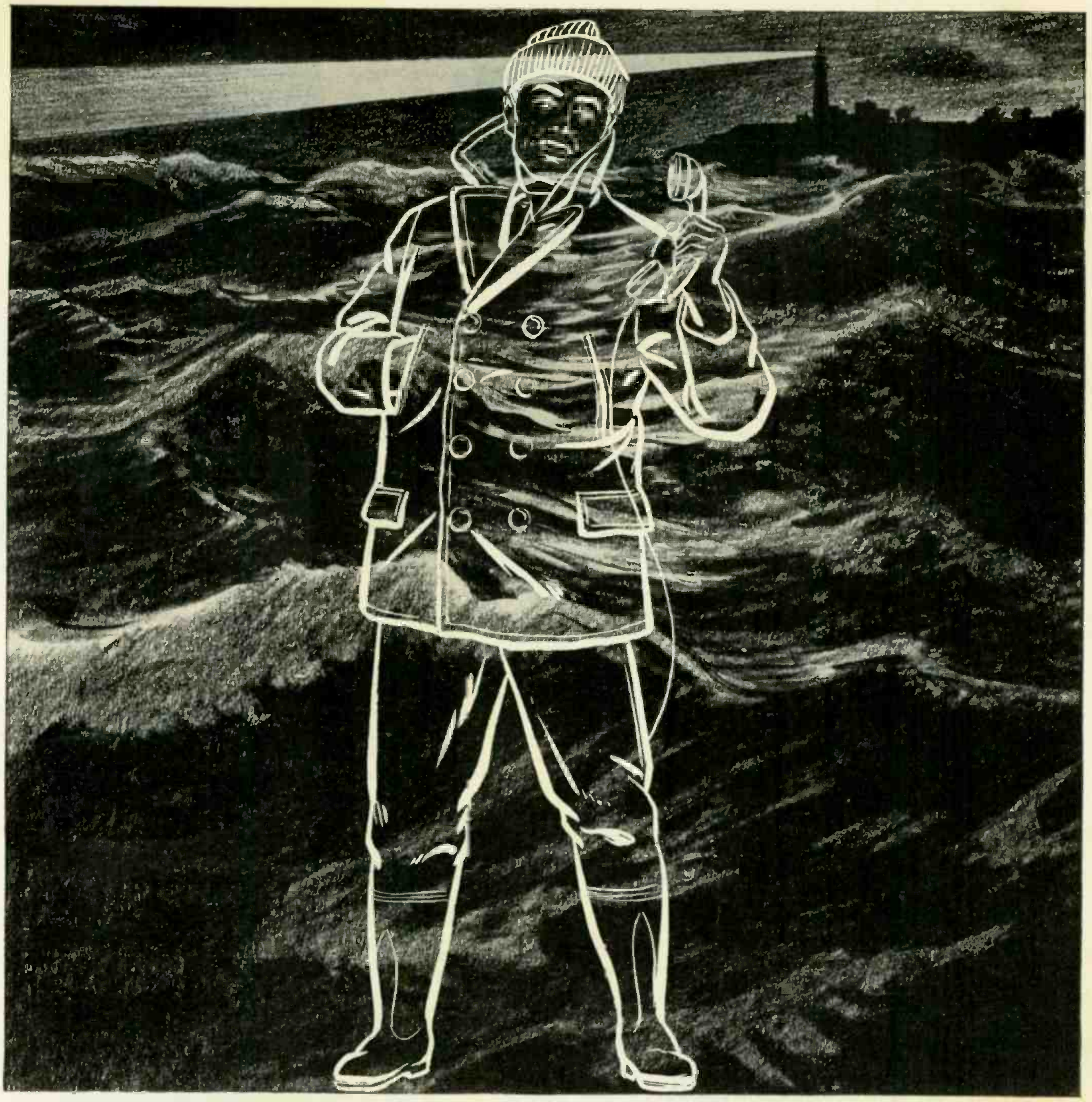
That's our Navy . . . every man-jack of them the finest example of American manhood this country has ever produced.

That we may not let them down, Cornell Dubilier is using every minute of its thirty-three years of experience and every facility at its disposal to build capacitors that are absolutely reliable—that can be depended upon to stand up under tough treatment and battle action. We are proud to think that C-D Capacitors, in all types of communication systems, are helping to guide the destinies of America's great fleets.

A Tribute to the American Sailor

CORNELL DUBILIER ELECTRIC CORPORATION, SOUTH PLAINFIELD, N. J.





WAR HAS MERELY SKIMMED THE USES FOR ELECTRONICS!

It seems almost to be a war of men and electronic devices. Wherever we engage the enemy, or guard against him, the electron has been put to work. Planes are spotted, gunfire controlled, even the course of our battleships is guided by means of electronics.

Yet in the light of *potential* uses for science's newest miracle, the surface has only been scratched. When the war is finally won, electronics will emerge in the new industrial era to perform countless wonders and open up new fields—in the food industry, for example, inspecting packaged merchandise for matter injurious to health but invisible to the eye . . . in construction, joining together metals formerly considered unweldable, such as aluminum and stainless steel . . . in a hundred-and-one peacetime pursuits, from refueling furnaces to matching colors.

The frequency range from 10 to 100 megacycles alone today includes application of the electronic theory to diathermy, to generate heat within the body—airport markers, for the guidance of pilots—frequency modulation, extended throughout commercial broadcasting. Here, in just one of many frequency bands, lie opportunities in Medicine, Aviation, Communication, for men with an electronic background.

While every day, out of the laboratories, are coming new developments that point to promising electronic careers yet undetermined in the peacetime world. Already scientists are talking about *interplanetary communication* through the magic of the science of electronics!

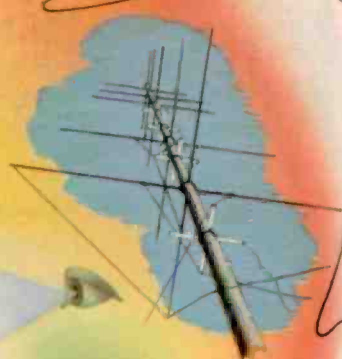
To Isolantite, there is encouragement in the scope and extent to which electronic devices are being used to meet the needs of war. For men are being trained who will be the mainspring of the new Electronic Age. These men—you may be one of them—are learning well the importance of high-grade insulation to the future of the electronic industry.

PHYSICAL THERAPY

In the medical field, diathermy is a fast growing market for electronic devices and engineers.

AVIATION INDUSTRY

Airport markers operated by electronics—another use for this amazing new science in aviation.



COMMERCIAL FM

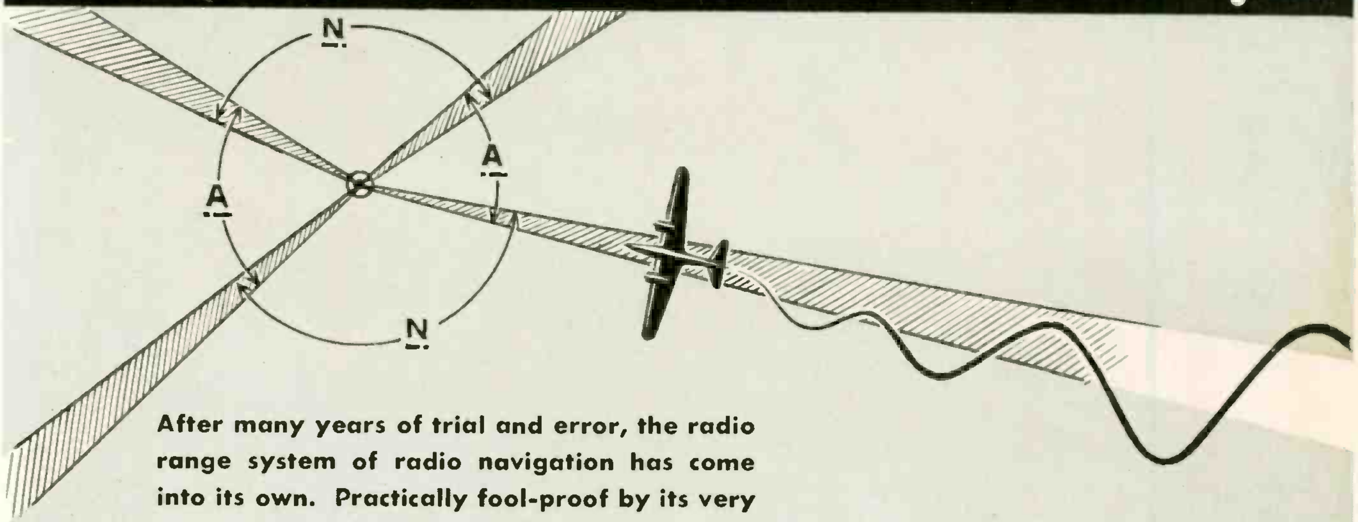
Electronics' playground, FM, waits only for peace to have wide application in radio broadcasting.

ISOLANTITE

CERAMIC INSULATORS

ISOLANTITE INC., BELLEVILLE, N. J.

RADIO RANGE QUADRANTS TAKE PILOTS OUT OF *Quandaries!*



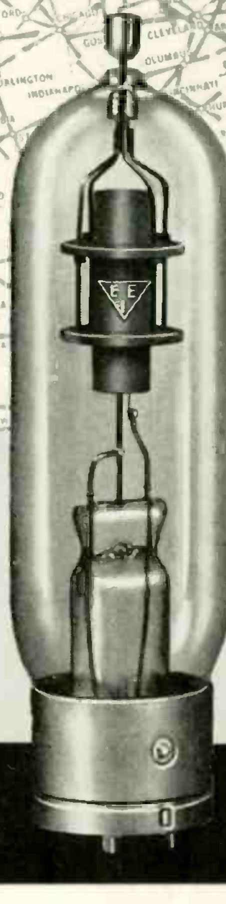
After many years of trial and error, the radio range system of radio navigation has come into its own. Practically fool-proof by its very simplicity, it eliminates—as obstacles of air travel—the darkness of night and "X" weather.

Each radio range station marks four courses, or equi-signal zones — each approximately 90° apart. The letter N (– ·) is transmitted in diagonally opposite quadrants; the letter A (· –) in the others.

Each quadrant overlaps the other slightly. Thus in this overlapping wedge, two interlocked signals are received . . . this is the beam!

If the plane deviates from this "chalked line" of the airways, the pilot hears—instead of the monotone—the letters of the quadrant he is entering in error.

Electronic Enterprises power and transmitter tubes—now vitally integrated in the communication systems of the Armed Forces—will serve in a similarly important role in future Air Commerce. Inquiries—for present military needs, or future plannings—are invited.



ELECTRONIC ENTERPRISES, INC.

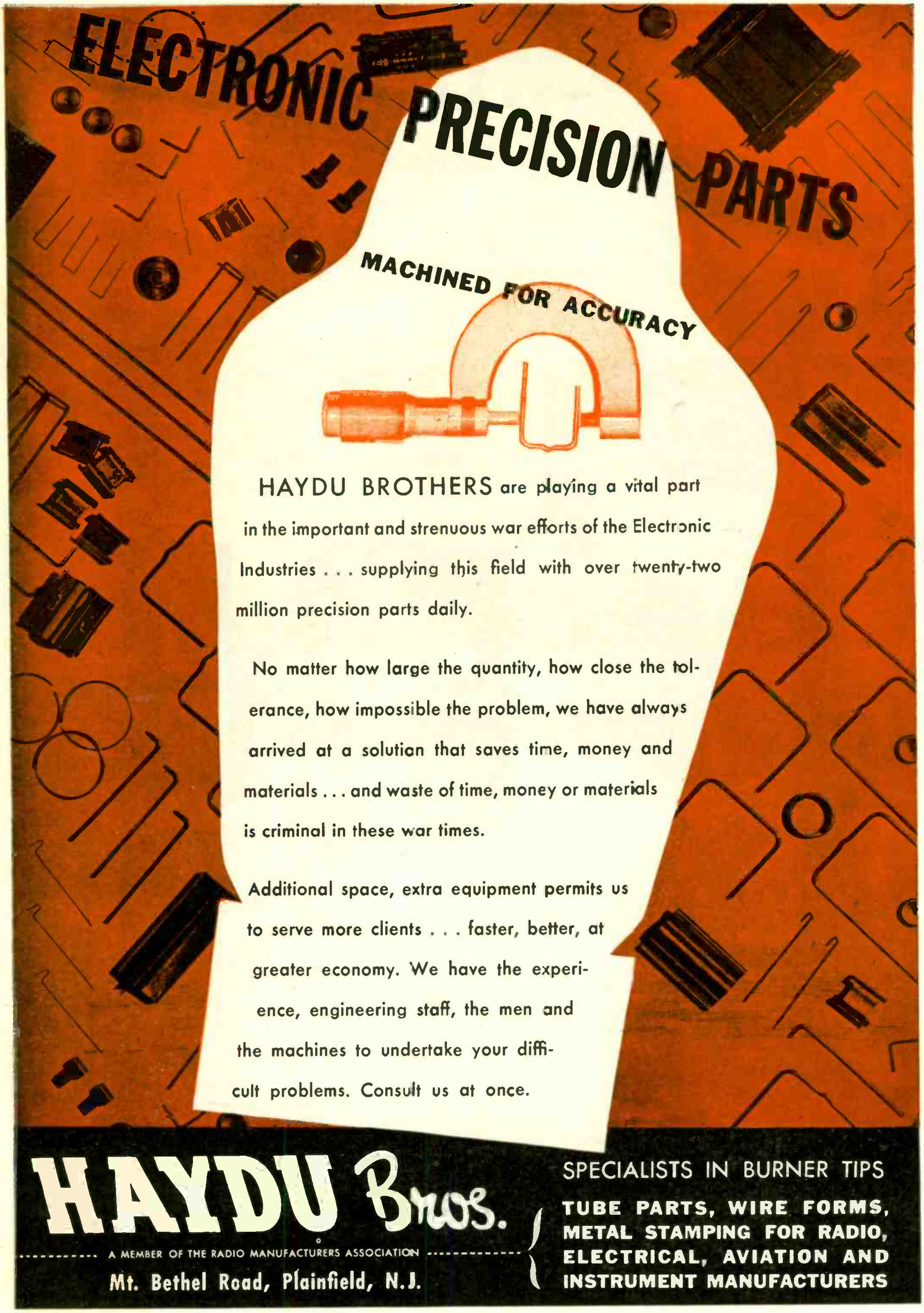
ELECTRONIC e ENTERPRISES

GENERAL OFFICES: 65-67 SEVENTH AVENUE, NEWARK NEW JERSEY

PRECISION *Fabricators* INC.

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

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


ELECTRONIC PRECISION PARTS
MACHINED FOR ACCURACY
HAYDU BROTHERS are playing a vital part in the important and strenuous war efforts of the Electronic Industries . . . supplying this field with over twenty-two million precision parts daily.
No matter how large the quantity, how close the tolerance, how impossible the problem, we have always arrived at a solution that saves time, money and materials . . . and waste of time, money or materials is criminal in these war times.
Additional space, extra equipment permits us to serve more clients . . . faster, better, at greater economy. We have the experience, engineering staff, the men and the machines to undertake your difficult problems. Consult us at once.
HAYDU Bros.
A MEMBER OF THE RADIO MANUFACTURERS ASSOCIATION
Mt. Bethel Road, Plainfield, N.J.
SPECIALISTS IN BURNER TIPS
TUBE PARTS, WIRE FORMS, METAL STAMPING FOR RADIO, ELECTRICAL, AVIATION AND INSTRUMENT MANUFACTURERS

AMCOIL

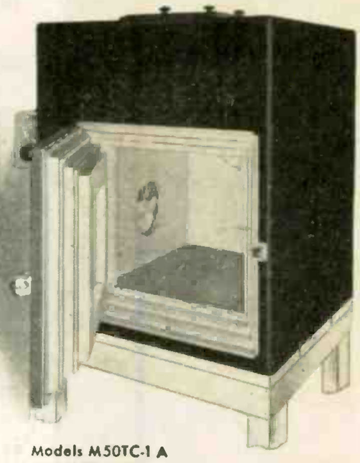
Quick, Sure Equipment Testing

For low temperature with altitude, and high temperature with humidity. The testing of aircraft equipment in Amcoil test chambers offers these outstanding advantages:

- Quicker Pull Down
- Completely Automatic
- Easier to Operate
- Long Trouble-Free Life
- More Tests per Hour
- More Tests per Dollar

Models RTC-1 and RTC-1A

Model RTC-3



Models M50TC-1 A and M50TC-2 A

MODEL NO.	TYPE OF REFRIGERATION (Quick Pull-Down)	PRESSURE	TEMPERATURE FAHRENHEIT	DIMENSIONS							
				EXTERIOR				USABLE INTERIOR			
				Height		Width	Depth	Height	Width	Depth	Cu. Ft.
				Cabinet	Stand						
RTC-1	Mechanical	Sea Level	−67° to +160°	56½″	35″	71″	42″	28½″	59″	30″	28.7
RTC-1A	Mechanical	Sea Level	−95° to +160°	56½″	35″	71″	42″	27½″	52″	30″	25
RTC-3	Mechanical	Sea Level	−67° to +160°	41″	34″	56″	38″	19″	27″	26″	7.7
M50TC-1A	Dry Ice	Sea Level	−67° to +160°	43″	X	48″	40″	21″	21″	28″	7
M50TC-2A	Dry Ice	Sea Level	−67° to +160°	53″	X	52″	43″	28″	25½″	28″	11
RAC-1	Mechanical	70,000 ft.	−67° to +160°	66½″	35″	84″	49″	24″	30″	18″	8
RAC-2	Mechanical	70,000 ft.	−67° to +160°	66½″	35″	100″	49″	24″	44″	18″	11

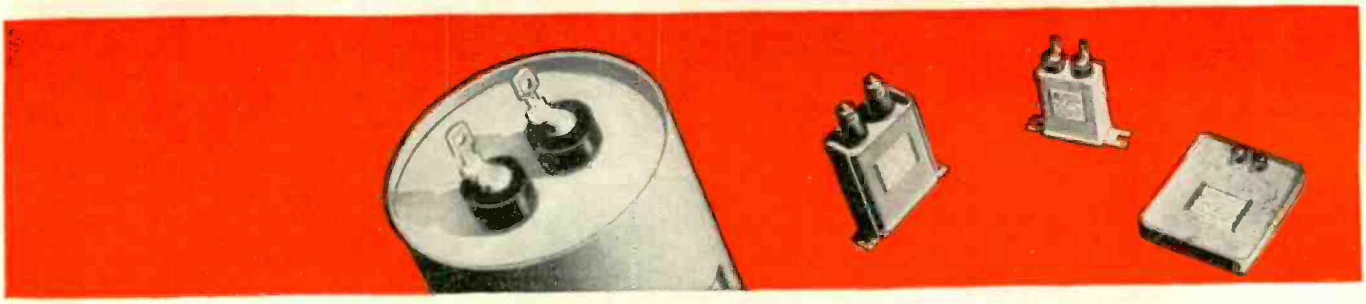
Further details will be furnished on request. Address Dept. 6E

AMCOIL

AMERICAN COILS CO.

25-27 LEXINGTON STREET • NEWARK, N. J.

3755



IT'S EASY FOR YOU TO DESIGN WITH

PYRANOL CAPACITORS

Because

YOU'LL find that G-E Pyranol* capacitors, especially because of their small size, are ideal for all built-in applications, such as in electronic devices, communications equipment, motors, control, transformers, and fluorescent-lamp ballasts.

The use of Pyranol as the treating material has made it possible to reduce physical size. Its use also makes these G-E capacitors far superior, in permanence and uniformity of characteristics, to those formerly available.

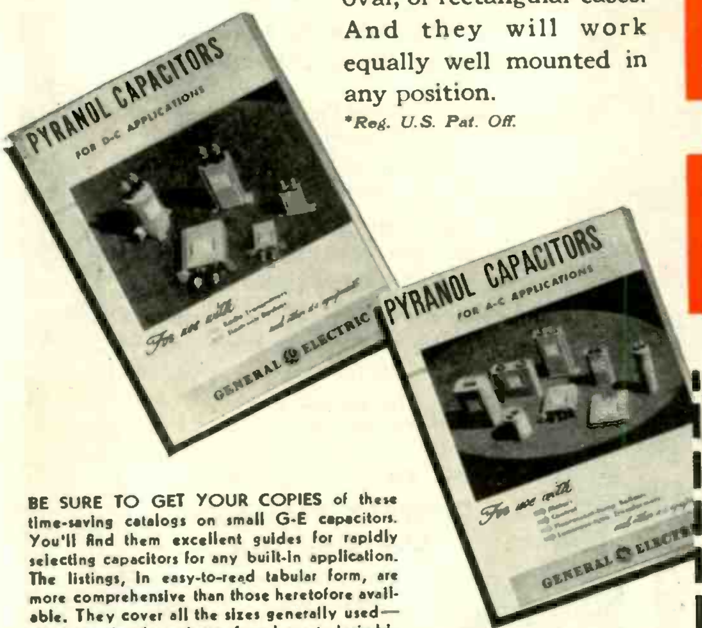
Many of the ratings are available in cylindrical, oval, or rectangular cases. And they will work equally well mounted in any position.

**Reg. U.S. Pat. Off.*

1. They are small and compact

2. They can be mounted in any position

3. They are available in many shapes and sizes



BE SURE TO GET YOUR COPIES of these time-saving catalogs on small G-E capacitors. You'll find them excellent guides for rapidly selecting capacitors for any built-in application. The listings, in easy-to-read tabular form, are more comprehensive than those heretofore available. They cover all the sizes generally used—all those that have been found most desirable with respect to ratings and dimensions.

GENERAL ELECTRIC

General Electric Company, Section A 407-52
Schenectady, N. Y.

Please send me complete information on small Pyranol capacitors for built-in applications.

- ☐ For D-c Applications (GEA-2621A)
- ☐ For A-c Applications (GEA-2027B)

Name..

Company..

Address..

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

5700


On Sea-
Land-
and Air-
Stewart
is "there"
TERMINALS, LUGS, BRACKETS, CLIPS
AUTOMATIC WIRE FORMING AND METAL STAMPING
Odd Shaped Pieces Stamped and Formed from Wire or Strip on High Speed Machines.
Hundreds of items in stock to meet practically every installation requirement.
Complete Hot Tinning and Plating facilities for handling large orders.
Send for samples and quotations. Let us have your prints and specifications.
QUICK RESPONSE TO INQUIRIES!
STEWART STAMPING CORPORATION
621 East 216th Street
New York
TERMINALS
by STEWART
Built to Highest Precision Standards

THERE IS ONLY ONE MYCALEX

A secret weapon stands guard. It keeps constant vigil along our shores, rides on the bridges of our battleships, watches faithfully over the skies and the seas. Darkness, rain, clouds, and storms cannot blind its sure stab for hostile aircraft and ships. RADAR locates enemy targets, measures the distances, points the swift annihilation of vandal raiders. Ultra-high frequency waves make possible this new miracle. The electronic age shrivels the forces of barbarism.

MYCALEX plays its part in making this secret weapon available to aid us—plays its part in this as faithfully, as dependably, as in all other applications. There is scarcely a phase of the entire war program in which MYCALEX is not performing, as reliably as it has for more than a quarter century of peace-time services. Navy and Army approval is the reward for years of dependability, and the Mycalex Corporation of America has been labouring night and day since before Pearl Harbor to meet the needs of our armed forces.

The return of peace will reveal new realities born of the blood and smoke of war, and MYCALEX will serve as always in these visions turned real.

MYCALEX is not the name of a class of materials. MYCALEX is the registered trade-name for low-loss insulation manufactured only by the Mycalex Corporation of America in the Western Hemisphere. MYCALEX is specified by engineers because MYCALEX is required. There is only one MYCALEX.

Trade Mark Reg. U. S. Pat Off.

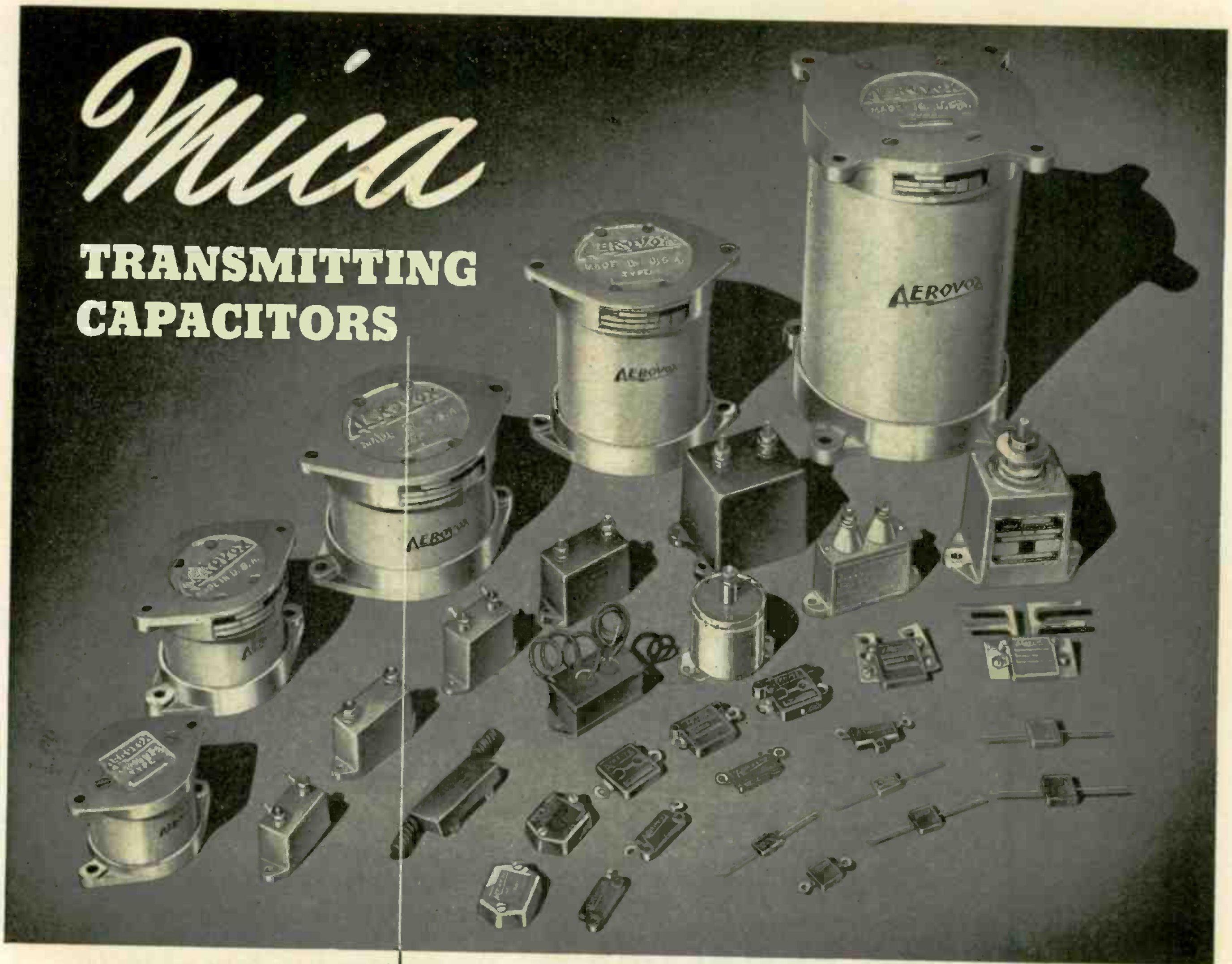
MYCALEX CORPORATION OF AMERICA

Exclusive Licensee under all patents of MYCALEX (PARENT) CO. Ltd.

60 CLIFTON BOULEVARD — CLIFTON, NEW JERSEY

Photo, Courtesy Mid-Continent Airlines showing current Wilcox installations

Mica
TRANSMITTING CAPACITORS



OUR WAR EFFORT

From January 1941 to December 1942, Aerovox . . .

• Stepped up production output 500% for our Armed Forces.

. . .

• Increased production floor space 300%.

. . .

• Sought, hired, trained, and put to work additional workers—a 300% increase in productive personnel.

. . .

• Opened second plant in Taunton, bringing work to available workers there.

. . .

• And—doing more and more; growing week by week!

• Be it tiny "postage-stamp" mica capacitor or large stack-mounting unit—regardless, it's a *precision* product when it bears the Aerovox name.

Only the finest ruby **mica** is used. Each piece is *individually gauged and inspected*. Uniform thickness means meeting still closer capacitance tolerances. Also, sections are of exceptionally uniform capacitance, vitally essential for those high-voltage series-stack capacitors. Meanwhile, the selection of perfect mica sheets accounts for that extra-generous safety factor so characteristic of ALL Aerovox capacitors.

Our new Transmitting Capacitor Catalog lists the outstanding choice of types. • Write on your business stationery for your registered copy.

AEROVOX *Capacitors*

INDIVIDUALLY TESTED

AEROVOX CORPORATION, NEW BEDFORD, MASS., U. S. A. • SALES OFFICES IN ALL PRINCIPAL CITIES
Export: 100 VARICK ST., N. Y. C. • Cable: 'ARLAB' • In Canada: AEROVOX CANADA LTD., HAMILTON, ONT.


A FIRST IN FM!
Hallicrafters are pioneers in FM! Producers of the first general coverage U. H. F. communications receiver to incorporate both FM and AM. Time and research have added much to the performance capabilities of Hallicrafters FM-AM communications receivers . . . wartime experience is adding invaluable engineering advantages . . . all of which will be available to you in your peacetime Hallicrafters communications receiver.
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CHICAGO, U.S.A
World's Largest Exclusive Manufacturer of Short Wave Radio Communications Equipment
ARMY NAVY


CRYSTALS
EVERY
KIND OF CRYSTAL
Any TYPE OF CUT AND FREQUENCY
Should you need special crystal types we are ready to produce them *now*—in small or large quantities. And the crystals we produce to your temperature coefficient and absolute frequency specifications, will *be exact!* If you are rushed:
PHONE CRYSTAL SERVICE DIVISION
PLYMOUTH THREE THREE
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PLYMOUTH, INDIANA
EXCELLENCE IN MUSIC AND VOICE REPEATING INSTRUMENTS
JOHN MECK INDUSTRIES
JOHN MECK

A HELPING HAND

for your electronic problems

The N-Y-T Service Department!

The multitude of highly specialized assignments now being undertaken by the N-Y-T Sample Department is indicative of the trend of electronics toward consumer applications.

After months of uninterrupted research, design and production of transformers for every branch of the Armed Forces, N-Y-T engineers and technicians are again formulating plans for postwar achievements. Advantages for richer, more healthful living that will make all previous efforts incongruous in comparison.

Our clients—leaders in their respective fields—utilize the N-Y-T Sample Department facilities as an integral part of their own companies. It is available to you, too. Inquiries are invited.

NEW YORK TRANSFORMER COMPANY

26 WAVERLY PLACE, NEW YORK, N. Y.

Dunco Sensitive

RELAYS FOR LOW-POWER USES

TWICE TESTED . . . BALANCED TO STAND VIBRATION

For vacuum tube circuits—for the protection of delicate instrument contacts—for alarm circuits—for exacting temperature control—wherever the need is for dependable relays to operate on very low coil circuit power, you will find Dunco Sensitive Relays unexcelled.

Each unit is specifically "tailored" to its specific job. Each has its moving parts carefully balanced, making it suitable for use where vibration is encountered. Each is twice-tested before leaving the factory.

Shown here are sensitive relays of the Dunco Series 28 (high-sensitivity), and Series 29 (medium-sensitivity) types available in various styles of mounting. Numerous sensitive Dunco Midget Types are likewise available for similar low-power uses where small size and light weight are important factors.

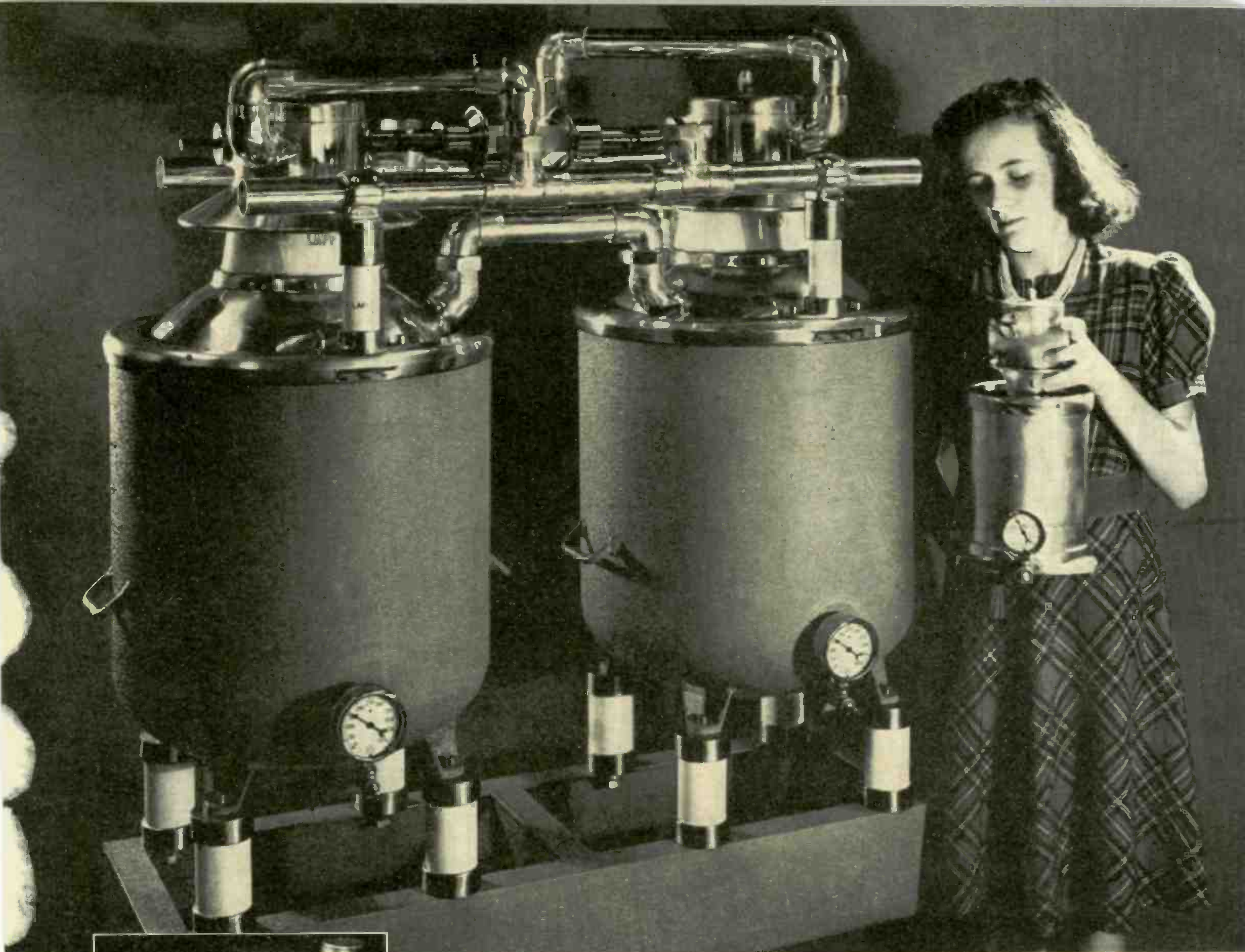
DUNCO CATALOG AND RELAY DATA BOOK

You can find the right relay for almost any application in the 48-page Dunco Catalog—also helpful engineering information and suggestions on relay selection and use. Copy upon request.

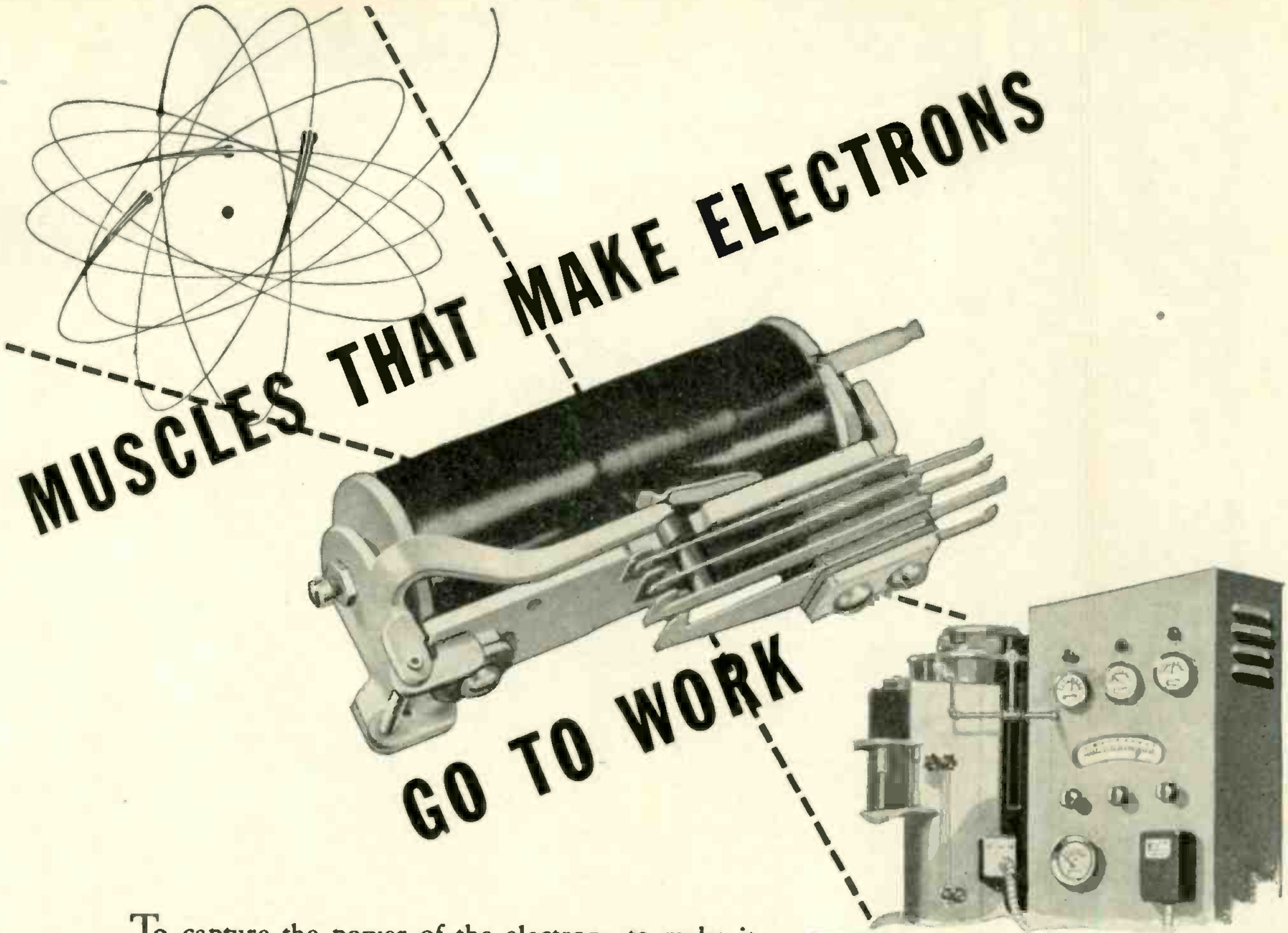
STRUTHERS DUNN, Inc.

1321 ARCH STREET **PHILADELPHIA, PA.**

LET DUNCO DISTRICT ENGINEERS IN 28 STRATEGICALLY LOCATED CENTERS HELP SOLVE YOUR RELAY PROBLEMS



MUSCLES THAT MAKE ELECTRONS GO TO WORK



To capture the power of the electron—to make it behave and do a specific job—often requires control devices which must be carefully selected and precisely engineered to fit the conditions of the problem.

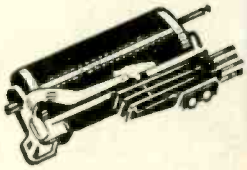
Automatic Electric relays and stepping switches, by bridging the gap between the electron tube and the job to be done, are helping to take new electronic ideas out of the laboratory and put them to practical use. They are the "muscles" that make electrons go to work.

Automatic Electric field engineers are today working with the makers of electronic devices of every kind, offering time-saving suggestions for the selection of the right control apparatus for each job—and extending the benefit of the technique which comes from fifty years of experience in electrical control applications. As a result, Automatic Electric controls are finding increasing use both in the implements of war, and in the plants where war products are made.

If you have an electrical control problem—whether electronic or not—first, be sure you get the Automatic Electric catalog. Then, if you would like competent help in selecting the right combination to meet your need, call in our field engineer. His recommendations will save time and money.

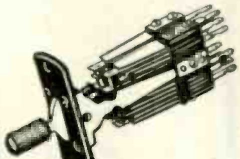
AMERICAN AUTOMATIC ELECTRIC SALES COMPANY
1033 West Van Buren St.
Chicago, Ill.

The Automatic Electric line of control devices includes:



RELAYS—A complete range of light and heavy duty types, for operation on a-c or d-c power, and with endless coil and contact combinations.

STEPPING SWITCHES—magnet driven selector switches for automatic or directed selection of circuit channels, in capacities of 10 to 100 circuits.

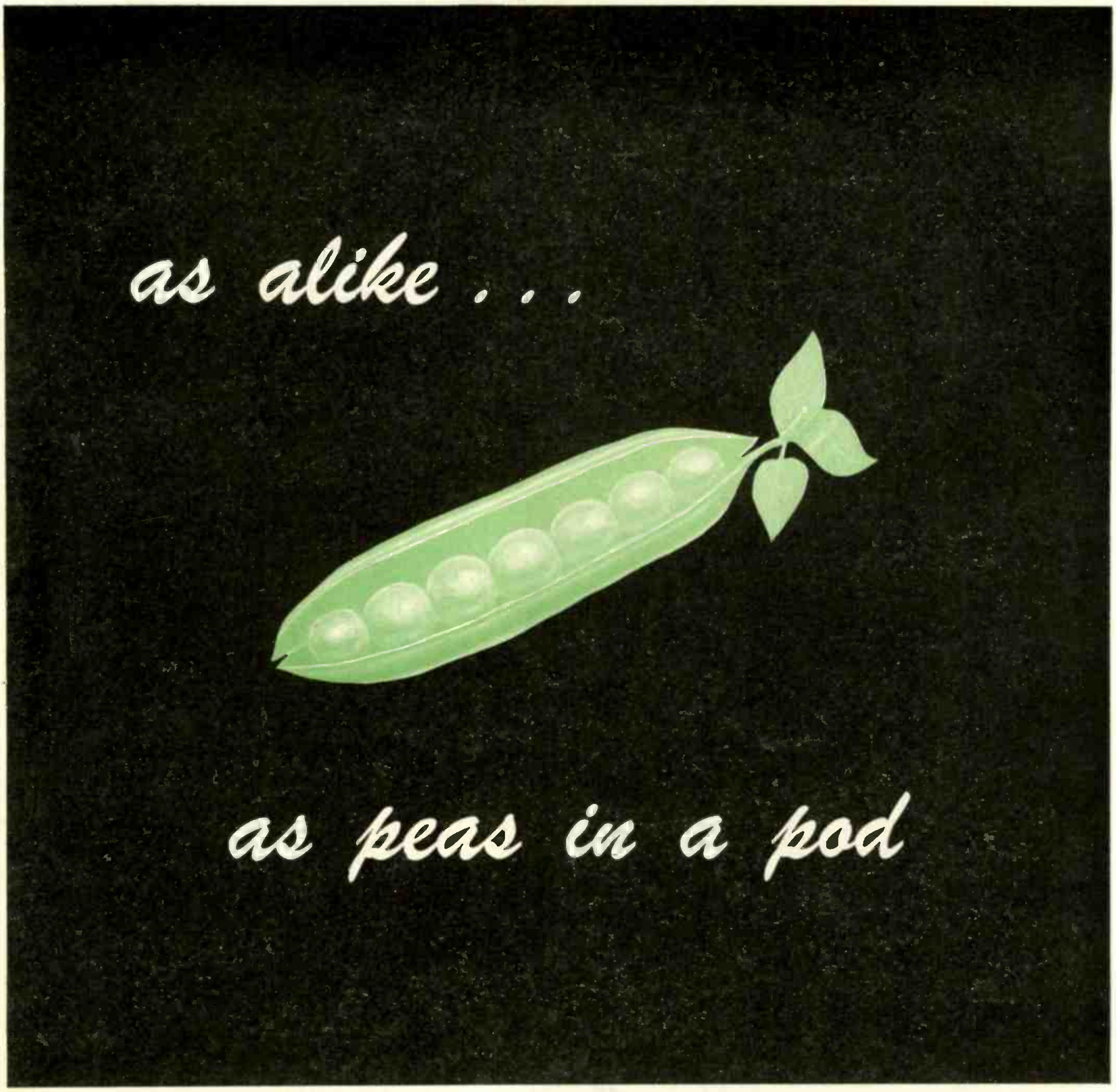


LEVER KEYS—Locking and non-locking types in any desired contact combination, for manual switching of control or communication circuits.

The Automatic Electric catalog of control apparatus includes also a complete listing of control accessories, such as solenoids, counters, jacks, plugs, impulse senders, lamp and target signals, etc. Write for your copy.

Relays AND OTHER CONTROL DEVICES by AUTOMATIC ELECTRIC

MUSCLES FOR THE MIRACLES OF ELECTRONICS



YOUR DETERMINATION AND OURS!

● We both have an identity of purpose—to produce dependable, first-class products on time—***thus help shorten the war!*** We know that you depend on us to fulfill our end of the bargain which is the production of uniform special alloys and their delivery on schedule. Our entire mental and physical resources are directed to this end.

• RIBBON • STRIP •
ROD
SPECIAL ALLOYS
WIRE

WILBUR B. DRIVER CO.
NEWARK • NEW JERSEY

EVERY MINUTE *Counts!*

PRODUCTION LINES MUST NOT SLOW DOWN!

Lafayette Radio is strategically located to give you *quick* deliveries on radio and electronic parts and equipment. Millions of items have been shipped from Chicago, the shipping hub of the nation, to industrials, training schools and all branches of the armed services. Lafayette's procurement and expediting service has helped to prevent work stoppages on many vital war production lines.

Many instances are on record wherein Lafayette has made immediate delivery on hard-to-find key items, eliminating costly delays in giant armament programs. This is because Lafayette handles the products of every nationally known manufacturer in the radio and electronic field. A single order to Lafayette, no matter how large or how small, will bring prompt delivery of *all* your requirements.

Free — 130 page Catalog — "Radio and Electronic Parts and Equipment." Write 901 W. Jackson, Chicago, Ill. Dept. 6G3

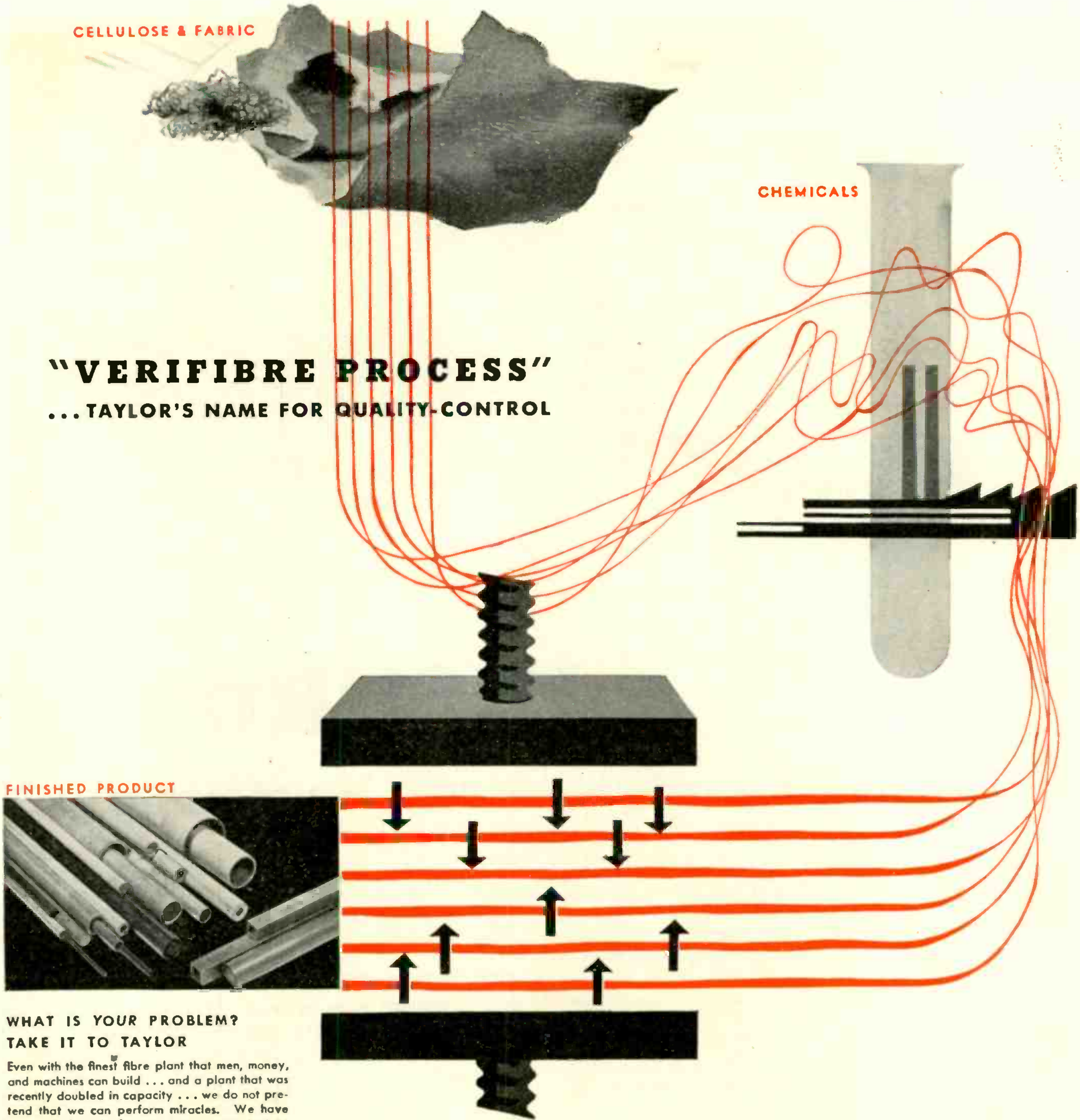
LAFAYETTE RADIO CORP.
CHICAGO

★ ★ ★ ★ ★ ★ ★

"Quick Delivery of Radio and Electronic Parts and Equipment"

"VERIFIBRE PROCESS"

...TAYLOR'S NAME FOR QUALITY-CONTROL



WHAT IS *YOUR* PROBLEM?
TAKE IT TO TAYLOR

Even with the finest fibre plant that men, money, and machines can build . . . and a plant that was recently doubled in capacity . . . we do not pretend that we can perform miracles. We have no magic formula for man-power, no patent on the impossible. But we invite your inquiries, suggest you "Take it to Taylor." We'll do as well as the next fellow, and sometimes a little better. With some blueprints on the table, want to talk it over anyhow?

By telescoping the words "verify" and "fibre," we get "*Verifibre*" . . . a quick way of saying that Taylor fibre products are verified and checked at every step of the way in laboratories as modern as this morning's newspaper.

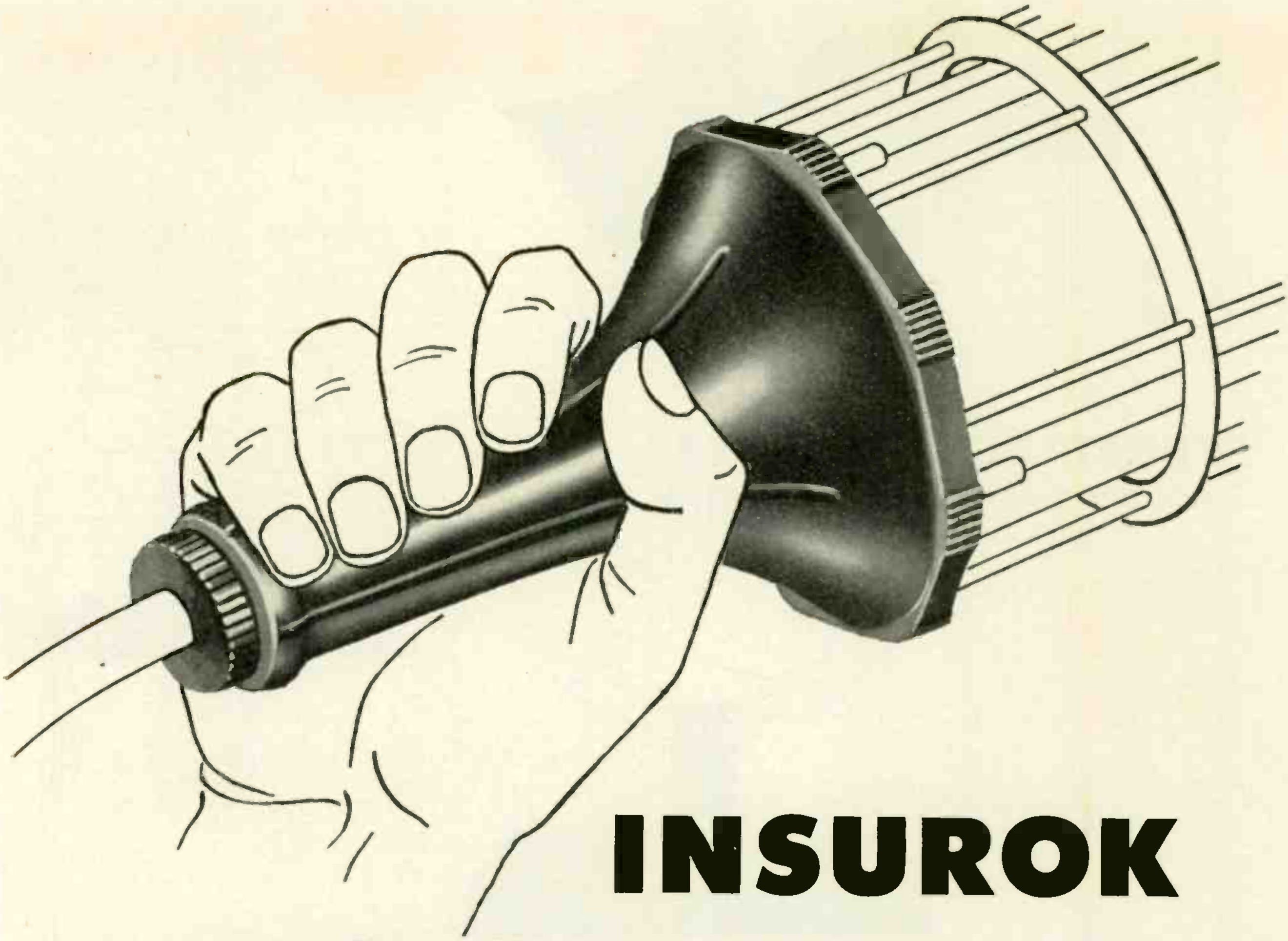
From blueprint to shipping platform, Taylor products are formed and fabricated under one roof. The plant is self-contained and self-sufficient . . . producing or refining its own materials—papers, resins, chemicals.

The result of this *Verifibre Process*? Materials and finished parts that meet and match your severest specifications. Products that are strictly quality in their make-up, strictly dependable in their use.

TAYLOR
FIBRE COMPANY
NORRISTOWN, PENNSYLVANIA

LAMINATED PLASTICS: VULCANIZED FIBRE • PHENOL FIBRE

SHEETS, RODS, TUBES, AND FABRICATED PARTS



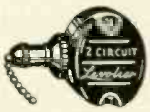
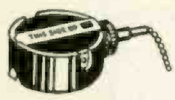
INSUROK

puts a handle on a 100-watt lamp

LIGHT is an important tool of war—in the camps—on board ship and in the vital war plants. Making light easy to move where needed most, putting a handle on it for greater convenience is but one of the many ways in which Molded INSUROK met problems before the war, is meeting them now.

Molded INSUROK was selected for this Vaporproof Lamp application because of its high impact strength, fire resistance and non-arcing qualities. Richardson precision molding enables the production of close tolerance parts, thus facilitating fast, economical assembly of interchangeable parts.

For Fluorescent and Incandescent Fixtures

In addition to the many spectacular war-born developments in the use of INSUROK, it is used effectively and economically for many commonplace articles—things that you see and use every day. Many electrical products, for example, are made wholly or in part of Molded or Laminated INSUROK.

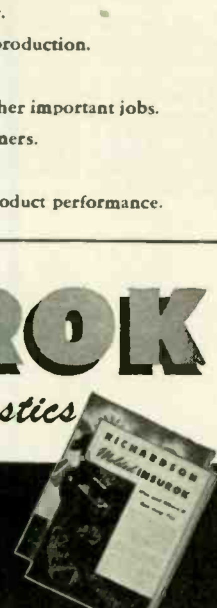
Richardson Plasticians are continually recommending the grade of Molded or Laminated INSUROK best suited for electrical, mechanical or chemical applications. Write for suggestions in connection with *your* present or plan-stage products.

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

1. Increasing output per machine-hour.
2. Shortening time from blueprint to production.
3. Facilitating sub-contracting.
4. Saving other critical materials for other important jobs.
5. Providing greater latitude for designers.
6. Doing things that "can't be done."
7. ✓ Aiding in improved machine and product performance.

INSUROK

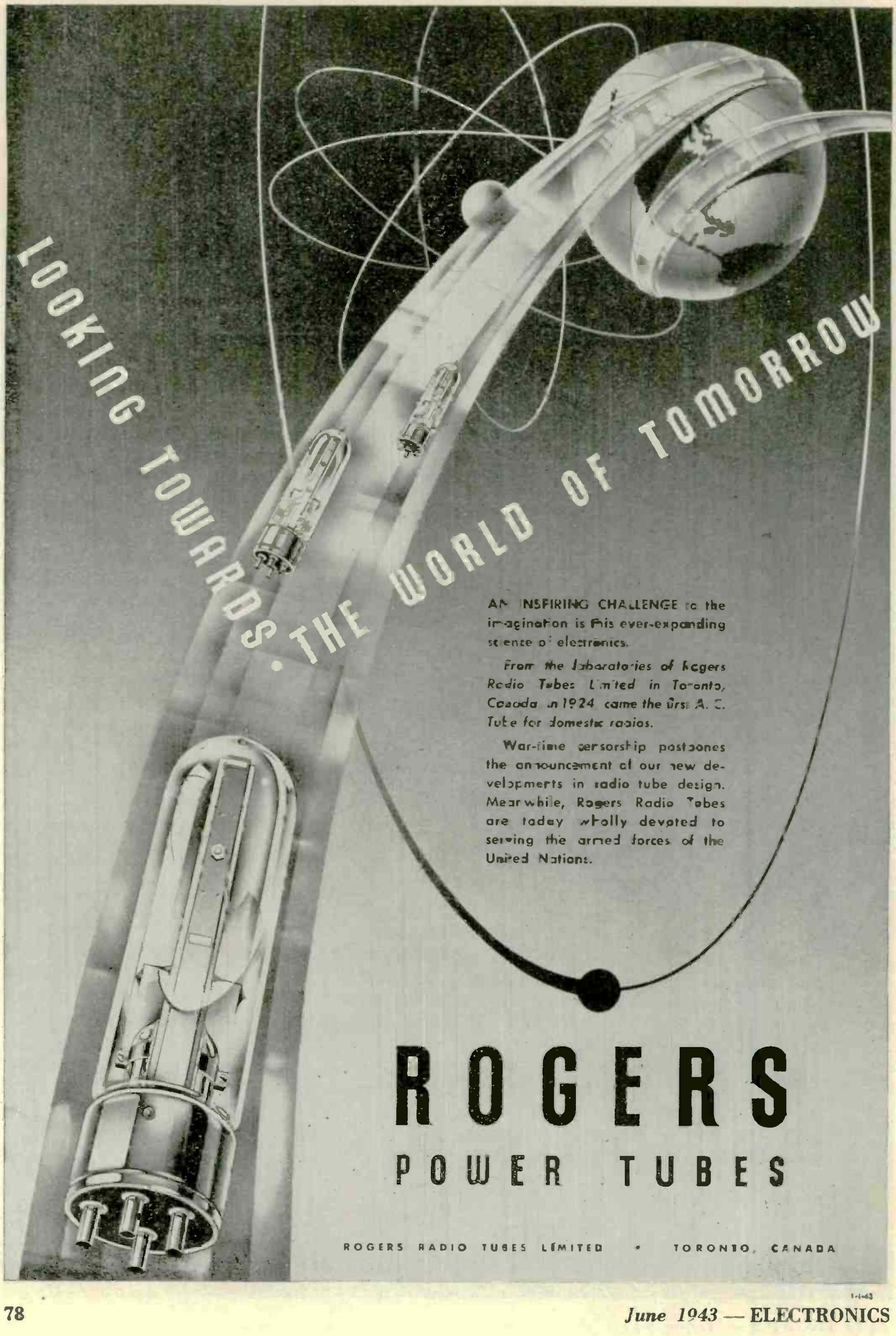
Precision Plastics



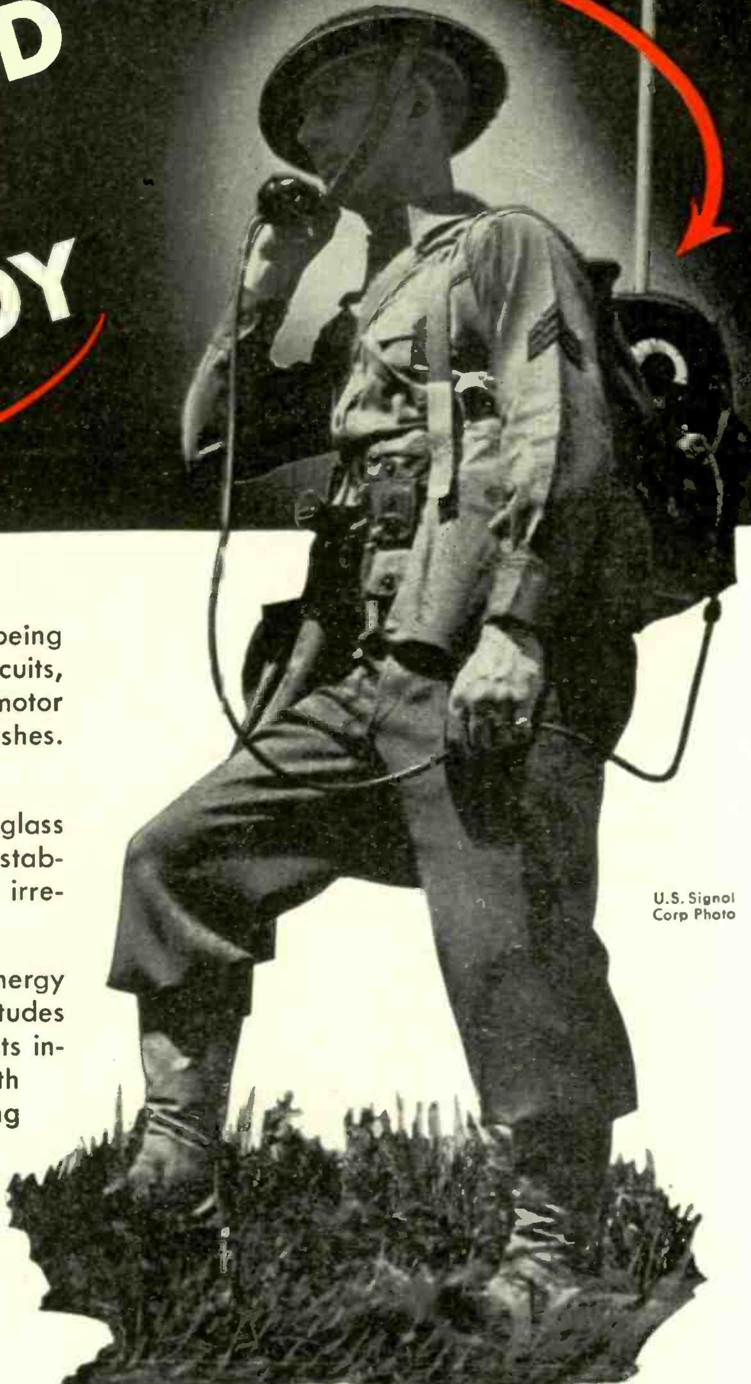
The RICHARDSON COMPANY

MELROSE PARK, ILL.   LOCKLAND, OHIO   FOUNDED 1858   NEW BRUNSWICK, N. J.   INDIANAPOLIS, IND.
SALES OFFICES: 75 WEST ST., NEW YORK CITY. G. M. BUILDING, DETROIT


So all the world will KNOW!
Because Audiodiscs have proven themselves the Number One recording disc in America, they are now selected for a vital role in the war. Today Audiodiscs are shipped and heard around the globe!
Built for greatest endurance, unaffected by temperature changes, they carry their messages safely, flying the seas, sailing in far-flung convoys — wherever perfection in recordings is a "must" in the war effort. Through recorded shows Audiodiscs bring a bit of home to our armed forces. And from lands untouched by aggression they bear messages beyond enemy lines, renewing hope and courage for oppressed millions.
It is this unfailing "quality first" which makes Audiodiscs the logical choice of broadcasting studios and transcription studios from coast to coast. For further information, write Audio Devices, Inc., 1600 Broadway, New York City.
world's finest recording blanks
audiodiscs
they speak for themselves


LOOKING TOWARDS • THE WORLD OF TOMORROW
AN INSPIRING CHALLENGE to the imagination is this ever-expanding science of electronics.
From the laboratories of Rogers Radio Tubes Limited in Toronto, Canada in 1924 came the first A. C. Tube for domestic radios.
War-time censorship postpones the announcement of our new developments in radio tube design. Meanwhile, Rogers Radio Tubes are today wholly devoted to serving the armed forces of the United Nations.
ROGERS
POWER TUBES
ROGERS RADIO TUBES LIMITED • TORONTO, CANADA

INSULATED WITH MYKROY



U.S. Signal Corp Photo

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

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

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

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

TYPICAL EXAMPLES OF MYKROY APPLICATIONS

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

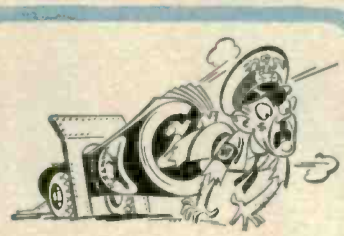
MYKROY is available in ample quantities and can be supplied for war and essential requirements.
For further information write us.

MYKROY
CERAMIC INSULATING MATERIAL

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

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

How to Trap Gremlins in Springs



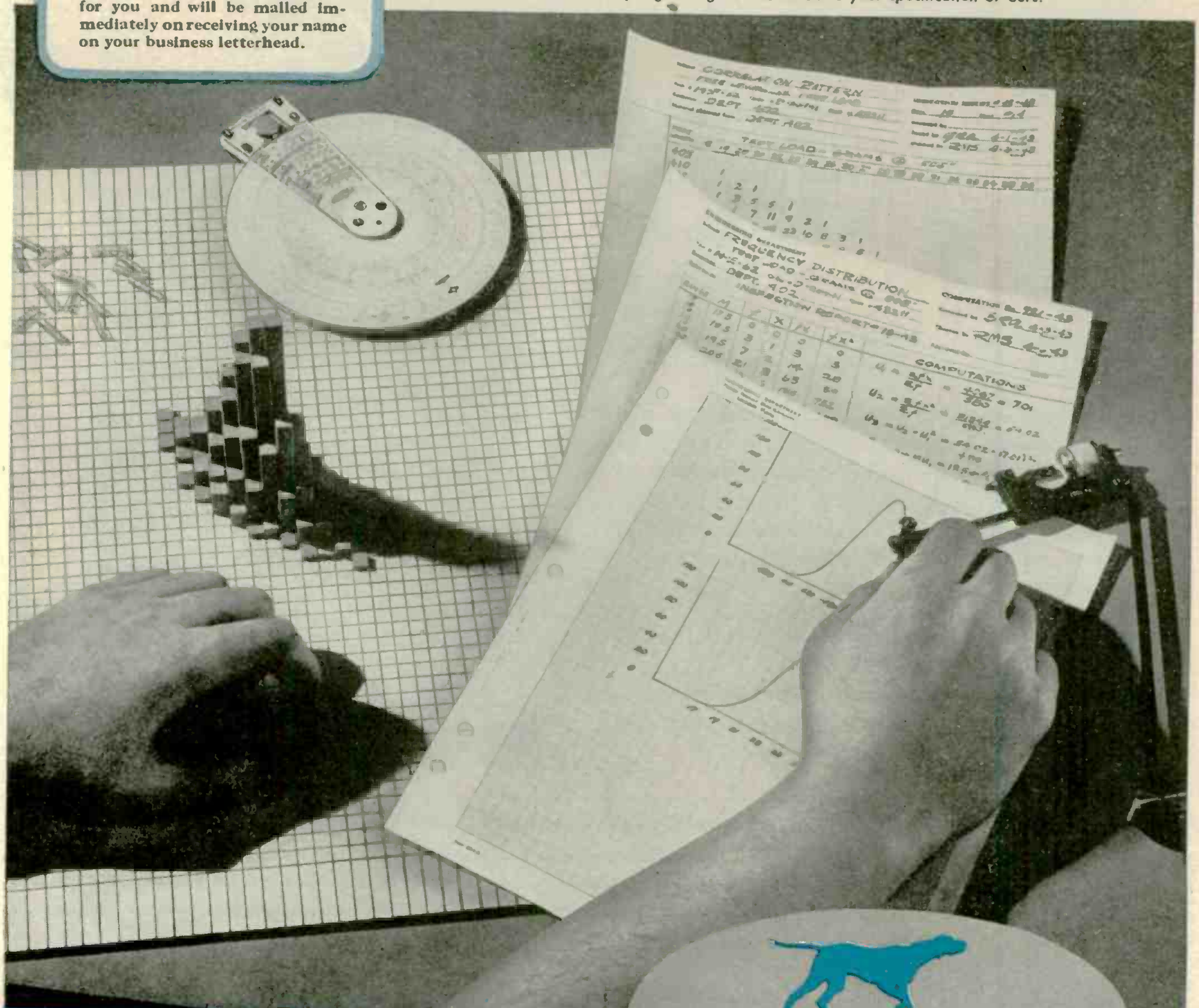
ALL OVER BUT THE SHOOTIN'

Is Hitler washed up? We don't know. But we do know that thousands of planes, ships, tanks and bombs are pointed his way, helped by springs. And that the design of many of these springs can be facilitated by reading "Science in Springs". Your copy is now ready for you and will be mailed immediately on receiving your name on your business letterhead.

IN a cluster of draftees, in a barrel of apples, in a clip of shells, in a batch of springs . . . in *every* quantity made by nature or man ... there are variations from any chosen standard. What those variations are and why they occur it is often important to know. When springs run into millions, *statistical control* must be exercised to bring the largest possible portion within the desired specifications. Statistical control of springs uncovers the gremlins of quality and production, detects underlying causes for variations, controls or eliminates them, anticipates changes in quality. In the example below, a sample lot of springs was tested for load and length and readings noted. From the results a frequency curve of variations and a "skyscraper" chart were prepared. The height and location of the "Skyscrapers" show how many, and how much springs vary from given specifications. Statistical control is everyday work at Hunter, a matter-of-fact part of insuring the ONE right spring for your job.

Varied and interesting answers to the problem presented in our last advertisement have been received. For those interested, the correct answer is R_1 4.58; R_2 2.92; R_3 .42; R_4 2.08.

AT YOUR COMMAND—*Send your orders, we'll produce them if they're for essential equipment. Write, wire or telephone. Springs designed and made to your specification or ours.*



HUNTER

Science in Springs

HUNTER PRESSED STEEL COMPANY, LANSDALE, PENNA.

HOW TO SAVE UP TO 47% ON ELECTRICAL COIL FORMS!

HERE'S ALL YOU DO TO MAKE ROCK BOTTOM SAVINGS!

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

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

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

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

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

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

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

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

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

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

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

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

Corning Glass Works
Insulation Division, Dept. E-62, Corning, N. Y.

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

Quantity ....

When Needed (date) ....

Electrical Characteristics ....

....

Acceptable Revisions ....

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Name ....

Company ....

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City .... State ....

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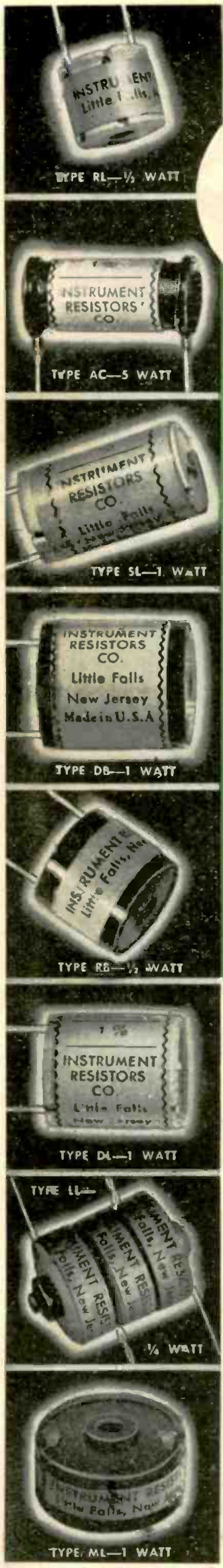

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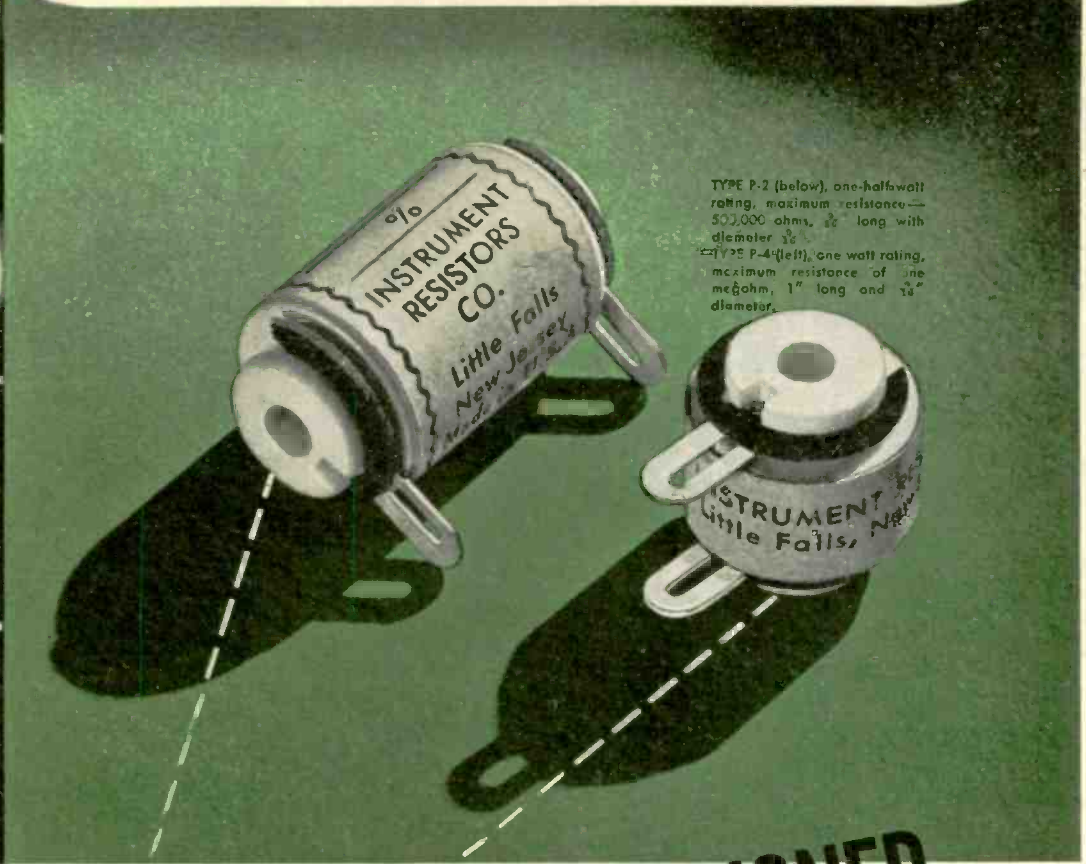

TYPE P-2 (below), one-half watt rating, maximum resistance—500,000 ohms, [illegible] long with diameter [illegible].
TYPE P-4 (left), one watt rating, maximum resistance of one megohm, 1" long and [illegible]" diameter.

IN-RES-CO APPLICATION-DESIGNED RESISTORS

Proof of the outstanding quality of these highly-accurate, precision-made electronic components is their wide specification in communication and control applications for every branch of the Armec Forces. The multiple electrical and dimensional advantages of IN-RES-CO fixed and adjustable resistors, meter shunts, choke coils, meter multipliers, solenoids and special coils—plus their mechanical ruggedness and ingenuity of design—assures the extra degree of dependability required for mili-ary successes.

IN-RES-CO precision units are ideally suited fcr pos-war plannings because each is application-designed for specific functioning. By specialization, IN-RES-CO resistors are offered without price premium for their extra quality . . . custom windings at stock prices. Inquiries—for present essential, or future industrial needs—are invited. Literature on request.

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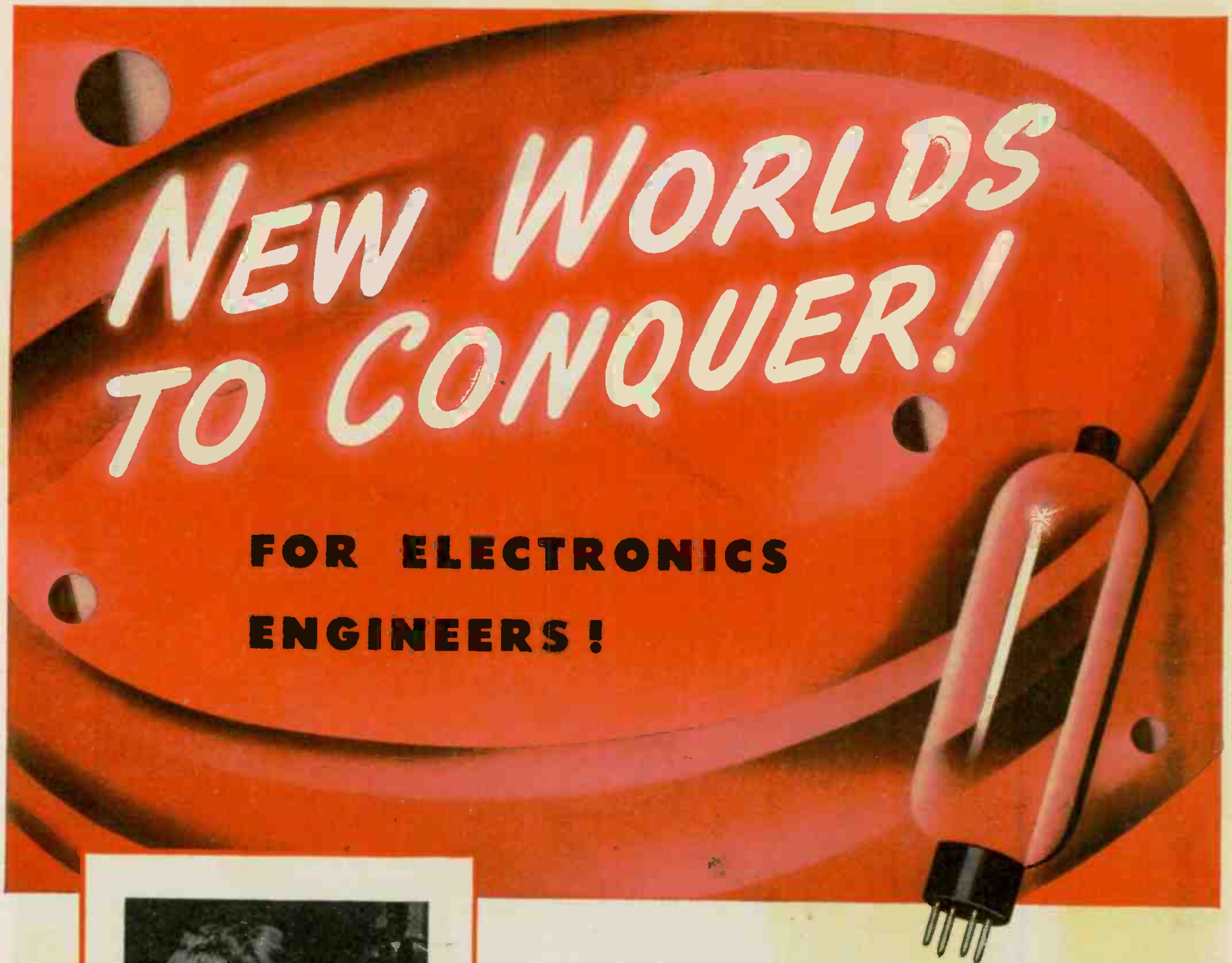

PRECISION

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

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

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

NATIONAL UNION RADIO CORPORATION

NEWARK, NEW JERSEY   LANSDALE, PENNSYLVANIA

NATIONAL UNION ELECTRONIC TUBES

Electrical Equipment—Weapons and Tools

From miniature motors to mammoth generators, from tiny detector tubes to great broadcasting stations—everything electrical is essential to our war effort

AS this editorial goes to press, newspapers and radio news commentators are telling the dramatic story of the blasting of two mighty Nazi power dams. Floods are sweeping down the Ruhr Valley, Germany's most vital munition production center. Two vast networks of industrial activity lie inert, for the great generators that had fed power to hundreds of plants producing war goods for Hitler, today stand idle. This daring raid will go down in history as one of the most, if not *the* most devastating of the entire war. It has destroyed two great sources of power, stopping the wheels in hundreds of plants and throwing into darkness thousands of factories and homes.

This epoch-making raid by the R.A.F. brings home to us the vital importance of our own power resources, those colossal generators from which flows the current that turns the wheels of our great industries, illuminates our factories and homes and runs our electric railways and subways. It makes us realize how dependent we are on electricity and how important is the part of those manufacturers who produce the electrical equipment that makes possible its generation and use.

Beginning with Thomas A. Edison, the inventive genius of electrical manufacturing men has devised more and more efficient ways of generating the current, better and better means of transmitting it and of applying it to do thousands of jobs quicker and better.

The products of electrical manufacturers have become so completely an essential component part of every industrial, business and domestic activity that our economy and our war effort could not go on without it.

In days of peace the laboratories of our electrical industry gave us radio, fluorescent lighting, infra-red drying, precision process-control, telemetering, split-second circuit breakers and many other things that border on the miraculous.

Today their facilities and their genius are devoted to an all-out war of wits with Axis scientists and production men.

Electricity plays a significant part in this war . . . from the "walkie-talkie" that brings support to hard-pressed outposts, to the mammoth motors on the battleships. While many electrical developments today are cloaked in secrecy, the nation will enthusiastically applaud these electrical manufacturers when the curtain is lifted.

The far-reaching importance of electrical instruments, apparatus and machines becomes evident when we consider that over 350 different electrical items go into combat vessels and that more than 170 go into a fighter plane. Most of these products are distinctly special in nature and are far removed from their civilian counterparts if, indeed, they have such counterparts.

To the civilian, a light bulb is something so standardized that every need can be filled by any nearby dealer. Our armed forces, by contrast, must have at their disposal more than 400 distinct types of lamps. Some no larger than the head of a match, are so brilliant that they flash signals under a tropical noon sky. Others are built to withstand extremely low temperatures, vibration, shock and many other abuses to which they are subjected.

On planes, for example, numerous fractional-horsepower motors are used but the standard industrial motor is not suitable for this service. New records in low weight-per-horsepower had to be achieved involving extensive changes in design and production.

To prevent the light from instrument panels from impairing the vision of night fighters, ultra-violet radiation which activates fluorescent instrument dials was developed. As a result, the pilot may look out into the darkness after reading his instruments without the least effect on his eyes. How many precious air victories can be credited to this one development alone?

But, in general, the story of this industry's war work is much too blurred by military censorship to afford an adequate picture of its contributions. The factories and shipyards that are turning out war matériel tell a more complete story. Many of these have been built during the past two years. Others have gone through a complete conversion process. In every case, large quantities of electrical materials were involved.

In the broadest sense, there are three major jobs which this industry has had to do, in addition to equipping our modern war machine. It has had to supply materials for the vast expansion of our industrial system, keep every plant fully maintained, and provide the necessary equipment for the vital power and communication fields.

More than $1,900,000,000 was spent for new industrial construction in 1942, and of this about 7% or $140,000,000 was for electrical materials. New machine tools and other production equipment required an additional $350,000,000 worth of electrical products. The conversion program called for another $145,000,000 of electrical apparatus and supplies.

This total of over $600,000,000 in itself would have staggered the electrical industry in a peace-time year. Yet, this record-breaking production was essential and had to be superimposed upon the direct requirements of the Army and Navy.

Industry depends upon electricity. Consider for a moment the effect of modern lighting upon war production. Industry enjoys levels of illumination and color quality that were undreamed of ten years ago. As a result, midnight shifts operate at daytime efficiency. As a matter of fact, many of the more modern plants have no windows at all.

Then there is maintenance. The failure of one single motor or feeder will stop a production line. Electrical manufacturers have had to stand at all times ready to supply the heavy demand for the maintenance and repair parts that keep our industrial machine operating at top speed. Excess loads, 24-hour schedules and inexperienced production hands combine to shorten the lives of electrical equipment.

Electrical manufacturers have had to supply the greatly expanded needs of our power and communication systems.

New construction of all sorts — war plants, cantonments, war housing — has created a formidable need for additional capacity. Every element in our domestic economy has called for increased communication and power services. All this had to be superimposed upon the vast demands of our armed forces. The magnitude of this task is obvious but it is being successfully accomplished. Every old installation is functioning smoothly and every new one has been ready to function on exact schedule. There has been no failure either in our power or in our communication. Part of the credit for this performance belongs to the hundreds of manufacturers who delivered their products when and where they were needed.

This was not merely a problem of increasing production. These manufacturers had been depending on rubber, copper, aluminum and steel — all highly critical materials. For much of their non-military production they suddenly had either to find substitutes or practice the utmost economy and ingenuity.

Solutions to many problems were quickly found. Lighting manufacturers greatly reduced their use of steel by designing efficient, non-metallic reflectors. Wire and cable manufacturers expanded their use of synthetic insulation in place of rubber and they promoted the use of higher distribution voltages so that every ounce of copper would work more efficiently.

Steel is essential in apparatus that operates magnetically. There is no known substitute. But marked economies in its use have been achieved through the development of new alloys that are of increased magnetic efficiency. As a result, motors and transformers now consume substantially less steel than did units of equal capacity a year or two ago.

Electrical manufacturers have given our industries numerous new production tools. Infra-red heating tunnels, for example, have drastically reduced the time involved in production drying . . . in some cases from hours to minutes. High-frequency induction-heating has been spectacularly successful in the forging, brazing, hardening and casting of ordnance. Modern welding equipment makes possible speedy production with inexperienced labor.

America's production lines are being patrolled by electrical devices which eliminate human error. One million volt X-ray equipment looks through castings and points an unfailing finger at defects. An electronic flaw detector tests nonferrous drawn-metal tubing for imperfections. Other electronic devices are counting and sorting the products of thousands of war plants. Precision controls regulate all sorts of processes, from aluminum production to armor plate annealing.

These are but a few of many examples of the way in which the magic power of electricity has been harnessed to the war effort. Back of every development there is at least one electrical manufacturer — more often many — who have pooled ideas and methods with no thought of royalties or dispute over cost allocation.

No story of the electrical industry would be complete that did not pay tribute to those manufacturers who have dropped their normal lines in order to produce special war products. Many appliance manufacturers fall in this group. When war came, they did not stop to argue that civilian morale and big pay checks would demand a continued supply of their products, instead they quickly shifted to the production of war matériel and today they are deep in the manufacture of machine gun parts, aircraft sub-assemblies, and even gas-mask fabric. They have had to abandon their hard-won markets for the duration; but they are contributing mightily to permanent peace and a more prosperous world to which they will return when the guns are silenced.

This great industry has increased its production threefold in two years — $2,500,000,000 in 1940 to $7,500,000,000 in 1942. It has done this with all the zest of youth, for this is a young and a pioneering industry. Few companies in this industry are fifty years old; the majority are much younger. Top management in general is young, too, and many outstanding technical developments have come from the brains of men just a few years out of college.

The results of all its intensive intelligent work can be found in every factory, on every battlefield and ocean, and even in the flak-spotted air over Berlin. In a sense, the electrical manufacturing industry stands beside every soldier and every sailor as he goes into action. It has a place of honor it richly deserves.

And when this war passes into history, as it surely will, our soldiers and sailors returning to peace-time jobs, will find a life greatly enriched by electrical developments that were undreamed of yesterday.

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

President, McGraw-Hill Publishing Company, Inc.


RADAR puts the finger on our enemies!
Hiding above the clouds there's a plane. Anti-aircraft guns let loose—down crashes the enemy bomber.
How can you hit enemies you can't see—through clouds, darkness and fog? The answer is Radar—radio detecting and ranging equipment.
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Radar sends out a wave which searches the sky or sea. When this beam hits a plane or ship, it bounces back to the Radar. Traveling with the speed of light, the beam makes this round trip in a few thousandths of a second and tells you . . . there he is!
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★ ★ ★
Radar is the result of the work of many research groups in this country and abroad. Bell Telephone Laboratories has played an important part in its development. Western Electric today is one of the world's largest manufacturers of Radar.
Western Electric
ARSENAL OF COMMUNICATIONS EQUIPMENT
ARMY E NAVY

WASHINGTON FEEDBACK

The program of standardization of components for military radio, the manufacturing problems arising therefrom, and the anticipated benefits came in for a comprehensive review at a recent meeting of the War Committee on Radio. Attending the meeting were top radio experts of the Army and Navy, leading manufacturers of radio and components as well as representatives of WPB who are doing the liaison job between the services and the industry.

The picture outlined at the meeting can be summarized thusly: Much of the work of developing standards has already been done. The job now is to apply to production the standards already agreed upon. Changing over will in some instances result in a temporary falling off in production but it is hoped that this can be minimized by careful timing of changes in components. The end result will augment production, promote straight line production.

Among those who took part in the meeting, were S. K. Wolf, Chief of Resources Branch, Radio and Radar Division, WPB, and Chairman of the Committee; Maj. Gen. Roger B. Colton, Chief Signal Supply Services, U. S. Army Signal Corps; Commander David R. Hull, Officer in charge, Radio Design Branch, Bureau of Ships, U. S. Navy; Donald D. Davis, Operations Vice Chairman, WPB; P. G. Agnew, ASA; Col. G. C. Irwin, Officer in charge, Signal Corps Standards Agency; Lt. P. M. Lion, Officer in Charge Standardization and Coordination Section, Design Br. Radio Div. Bureau of Ships; Marvin Hobbs, Head Radio Engineer for Radio and Radar Div. WPB; and Myron E. Whitney, Staff Assistant; H. N. Willetts, Western Electric Co.; H. P. Sparks, Westinghouse Electric and Manufacturing Co.; J. H. Fitch, Assistant Chief, Conservation Branch, Resources and Production Div. Headquarters, ASF, U. S. Army; Ray Ellis, Director Radio and Radar Div. WPB; and Frank McIntosh, Assistant Director in charge of Civilian Radio. (Editor's Note. For present status of the program see page 126.)

WPB—S. K. Wolf has been granted leave of absence from WPB for two or three months to take an important assignment. W. N. Anderson, Deputy Director in Charge of Operations, will act as head of the Resources Branch while Mr. Wolf is away.

Of special importance to the electronics industry are the recent revisions to Limitations Order L-183-A, which give the manufacturer of components greater freedom to schedule his deliveries in accord with the schedule for end products, based on Army-Navy precedence lists. It allows for urgency ratings. The revised order gives WPB power to schedule deliveries of components in accordance with precedence list designations.

The changes in the order were worked out through the closest cooperation of WPB and ANEPA (headed by B. F. R. Lack.) Mr. Lack returns to Western Electric from ANEPA after the accomplishment of this important work. (Details of the 183-A situation will be found in News of the Industry, this issue.)

Manufacturers of military radio components have been told by WPB that as their backlogs decline, their best chances for further business are from prime contractors who are well stocked with orders. The job now is to translate these orders to the prime contractors into orders for the components. During the winter, WPB's Vice Chairman Wilson put pressure on claimant agencies (Army, Navy, Maritime Commission) to speed their orders. Wilson clearly saw that if they were not placed and backlogs were kept at high levels manufacturers would "stretch" their production and take off shifts of workers. Since the orders have been placed, the danger of stretching is not great. Scheduling of backlogs and screening of new orders under M-293 will distinctly favor those with excess capacity or small backlogs.

Coaxial Cable Industry Advisory Committee with WPB has been told that the speed with which orders reach producers of high frequency cable now depends upon the rapidity with which prime contractors set up their requirements. The situation is general, applying to capacitors, resistors and components. While the volume of cable output this year on the average will hold to the peak levels of the final quarter of 1942 present business is declining. Some manufacturers are cutting output, either leaving their facilities idle or devoting them to other products.

Resistor manufacturers have been told that backlogs of orders for fine wire, used in resistor production, are rapidly declining, and that the present time is a good time to buy. However, deliveries are still slow in some sizes. Claimant agencies are urged to make early statements of requirements for resistors used in military radio and radar. Requirements should be stated in quantities broken down into broad classifications. Those having difficulty in the delivery of fine wire 0.002 inch or smaller should seek direct assistance from the Resources Branch.

M-293—Effective May 1, deliveries of radio and radar test equipment will be made in accordance with schedules determined under M-293 instead of preference ratings. Buyers of test equipment will fill in Form 556, on the basis of which the placement and delivery of new orders will be determined. The form, available at WPB regional offices, will be submitted to the Radio Div. and the approved forms will be attached to purchase orders.

GALLOP—Radio Div. of WPB is using a statistical method to locate factors that cause rejects or reduce output in various components. Take, for instance, coaxial cable. The assumption of manufacturers and the services has been that the most important factor influencing impedance was the outside diameter of the cable. Statistical checkup similar to that used by Gallop shows that its influence is much less than had been supposed. On the other hand, the symmetry with which the inside wire is placed in relation to the outer conductor is more important than was generally believed. Capacitance is also an important factor.—G.T.M.

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CROSS TALK

▶ **BREATHER** . . . Never again will the radio industry be presented with its present unparalleled opportunity to take stock of itself and to plan realistically for the future. Never again will the industry be able to say: "Stop the factories, we're going to set up a whole new system."

Complete cessation of building civilian radios has provided the industry with time out to think what it is going to do about the new frequencies now being actively used for other purposes; what to do with television, with facsimile, with FM, with broadcasting generally.

Are we going to start up where we left off or are we going to open up a whole new box of tricks? It is not too soon to begin thinking about such matters. Once the war ends and set manufacturers tool up for mass production of the pre-war variety of receivers, it will be too late. If they get raw materials to go back into production for the home before the end of the war, which is possible, it will be too late to project a new system, for then their inertia will be added to that of the transmission end of the business with its investment in stations and in audiences on present frequencies.

Predictions are freely offered by experts who should know what the war will offer the radio industry; that broadcasting as we have it now will be dead in 10 years; that we will have all of our entertainment services in adjacent bands in the spectrum—not spread all over the lot as at present. And there are other predictions that are equally startling.

Much better for the industry—engineers and manufacturers, government and private users of radio, broadcasters and listeners—to get together now and provide a new plan complete and ready to go.

▶ **WHO DONE IT** . . . Now that Army and Navy, in a rare joint statement, have let the public in on what has been an open secret for a long time, namely that there is such a thing as Radar and that it is playing a vital part in the war, it is to be hoped that there will be no big battle fought to determine who "invented" it.

Army, Navy, civilians, English, Americans, government and industrial laboratories—all have had a hand in the design of this remarkably effective defensive and offensive weapon. The word has been readied for the dictionary by providing a definition—"radio-detecting-and-ranging."

Full recognition is given the English for putting the reflection technique, already known throughout the world, to the very practical use of locating enemy aircraft. It is well known that many Americans learned the Radar technique in England; and that English engineers have been over here teaching us this technique. There has been a constant sharing of data and improvement.

If only a small percentage of the experience stories coming back from the front are true, or even partially true, praising the benefits of Radar will prove much more than arguing about "Who done it."

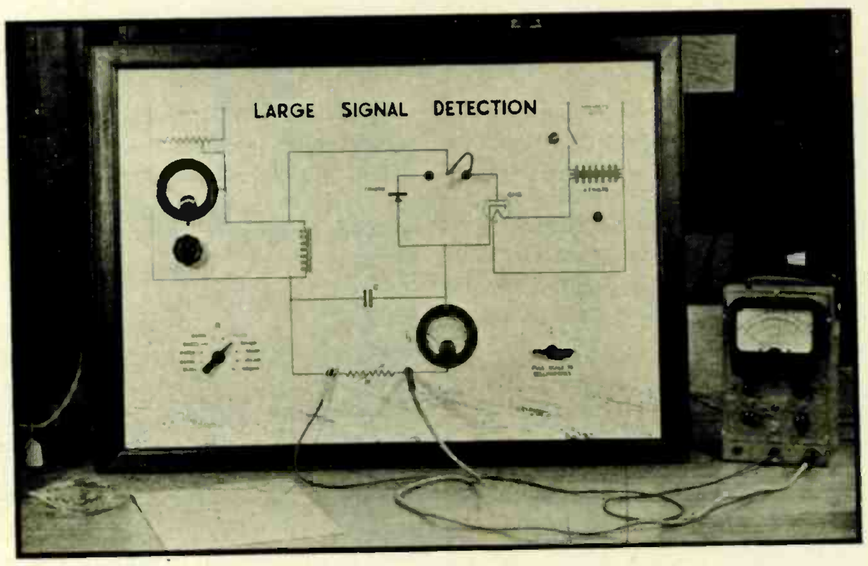
▶ **SYMBOLS** . . . It is an unfortunate fact that two branches of industry now interested in electronics use different symbols for certain of the components that are common to all electronic apparatus. Communications people use a zig-zag line to represent a resistor; a series of loops to indicate an inductor. Industrial engineers, however, use the zig-zag line to represent an inductor and a rectangle to represent a resistor. Other discrepancies occur, but none are so likely to cause trouble in reading diagrams as these two.

ELECTRONICS has so far used communications symbols only and has assumed that industrial men would understand. Lately, however, the wider spread of electronics among non-communication engineers has brought the symbol problem more seriously to the attention of everyone. ELECTRONICS will continue to use communication symbols in the interest of uniformity, which a technical publication must have. We hold no brief for either set of symbols, however, so we will also continue to hope most fervently that a single set of symbols will, soon, be acceptable to both communications and industrial electronic engineers.

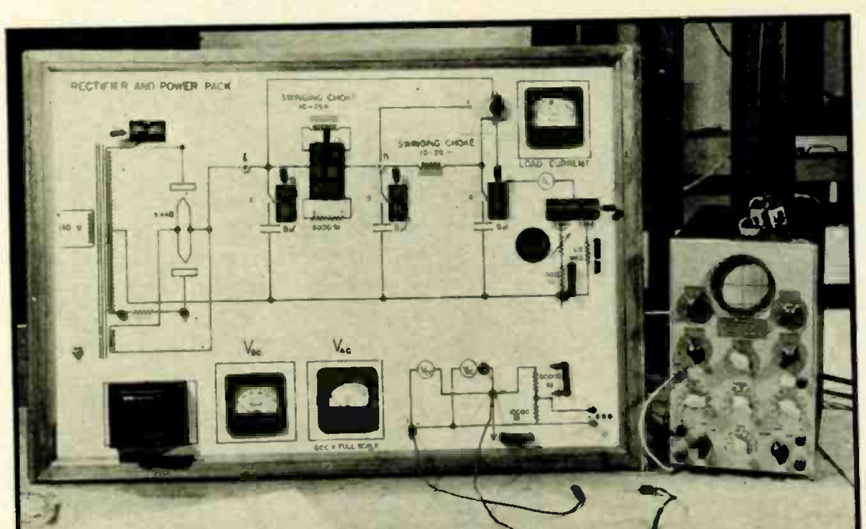
New Laboratory Techniques

EXPEDITE TRAINING IN

Harvard employs improved laboratory methods to accelerate training in electronics and radio. Pictorial demonstration boards have long, serviceable life, correlate equipment with schematic diagram, and provide flexibility while minimizing time for assembling apparatus. Method well adapted to use by institutions carrying out war training in science



A simple test panel with practically all wiring for the experiment completed. Crystal or diode rectifier characteristics can be studied for various load resistances whose value may be selected by means of the rotary switch at the lower left corner



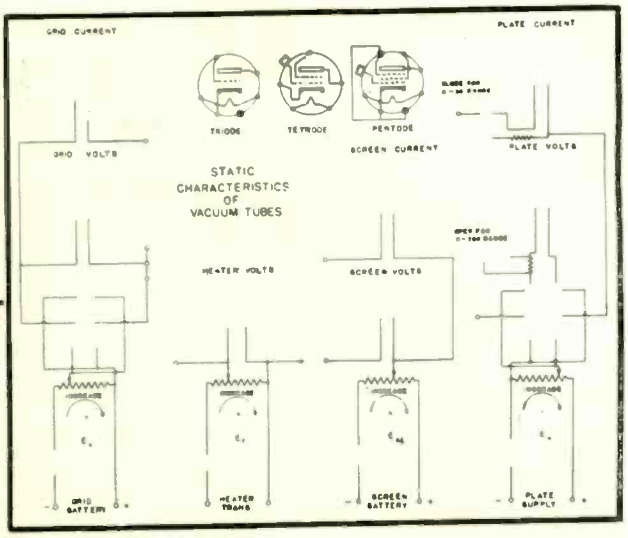
The effect of various capacitors and chokes on the completeness of filtering can be studied by means of the oscilloscope, while the meters give indication of the output voltage and current and regulation of a full-wave rectifier and power pack

THOROUGH and adequate instruction in the principles of radio and electronics—highly essential in any training program for modern warfare—necessitates the full utilization of all effective and rapid pedagogical implements. This is particularly true where large classes are involved, where speed of training is important, or where accelerated educational programs are in force.

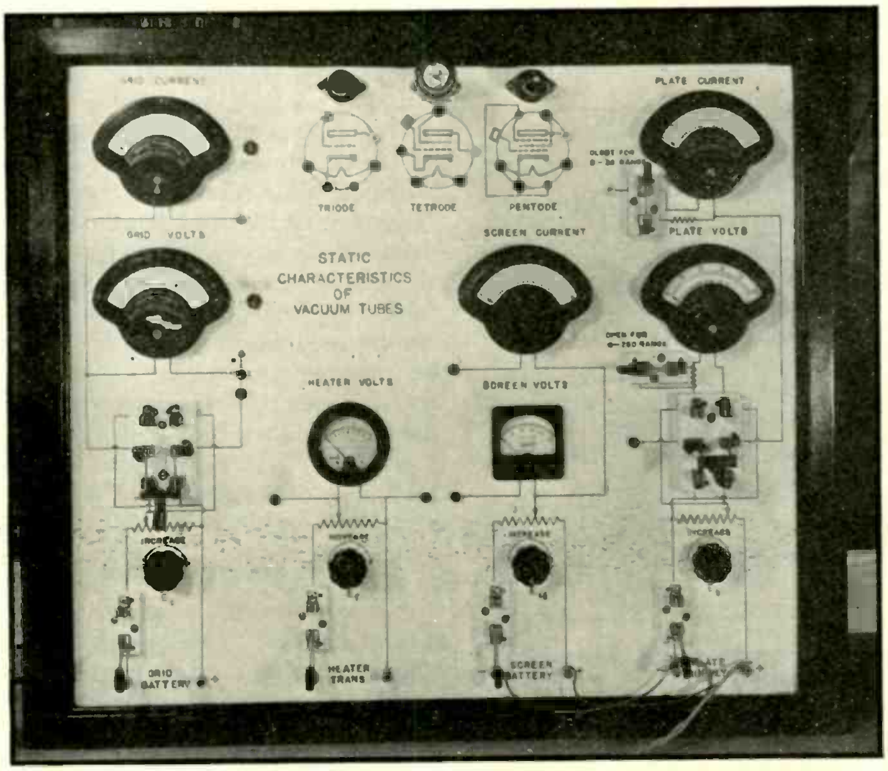
Motion picture films and slides have been used in various training programs, and frequently these pictorial presentations have been accompanied by appropriate sound effects. That these methods have been successful can hardly be doubted. But in instruction in science subjects, and particularly in electronics, no method yet developed has been so successful in application, nor so quickly convincing as the method of experimental laboratory investigations. The student may doubt the statements of the instructor, but meter readings, traces on the screen of an oscilloscope, or blown fuses offer incontestable factual evidence which cannot be lightly or thoughtlessly dismissed. Moreover, the students' interest is whetted through the process of "learning by doing" which laboratory experiments require.

Improvements in experimental laboratory techniques may, consequently, be expected to lead to better understanding and more rapid assimilation of the topic being studied. The demonstration triode, developed some years ago, uses a plate coated

ELECTRONICS



Drawing of circuit arrangements for demonstration board designed for the study of characteristics of vacuum tubes. The completed board is shown at the left



Test board for the determination of static characteristics of electron tubes. Connections are made to the tube selected for test by connecting the appropriate voltage supply to the desired electrode. Meter circuits are partly wired as shown

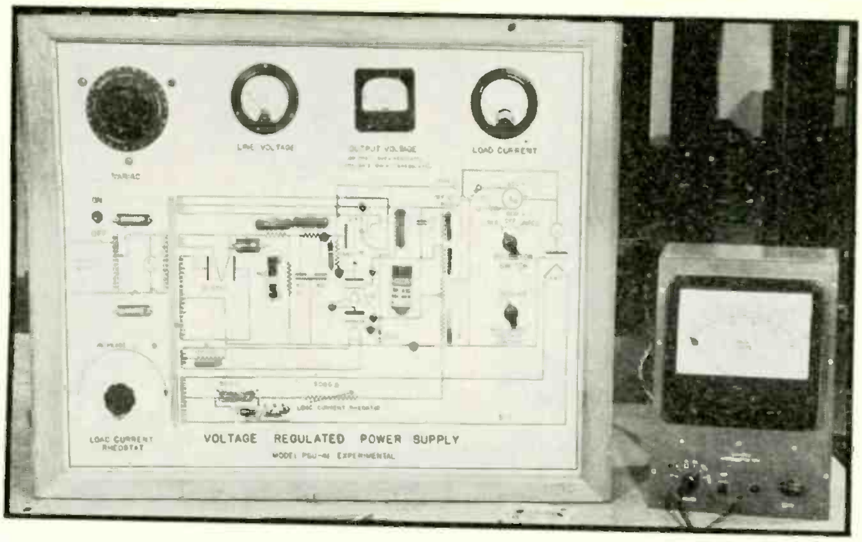
with fluorescent material to give visual evidence of flow of electrons. This device represents one effective means of teaching the fundamentals of electron tube operation.

Modifications of the conventional methods of carrying out laboratory experiments have been used at Cruft Laboratory, Harvard University. During nearly two years of operation with the laboratory experiments in operation approximately 48 hours per week, the method employing pictorial demonstration boards has proven signally successful in teaching fundamental principles of electronic communication. The method of handling laboratory experiments may be adapted by almost any educational institution engaged in accelerated training programs in the physical sciences; in fact the advantages of the system are in direct proportion to the number of men who must be trained in a specified time interval.

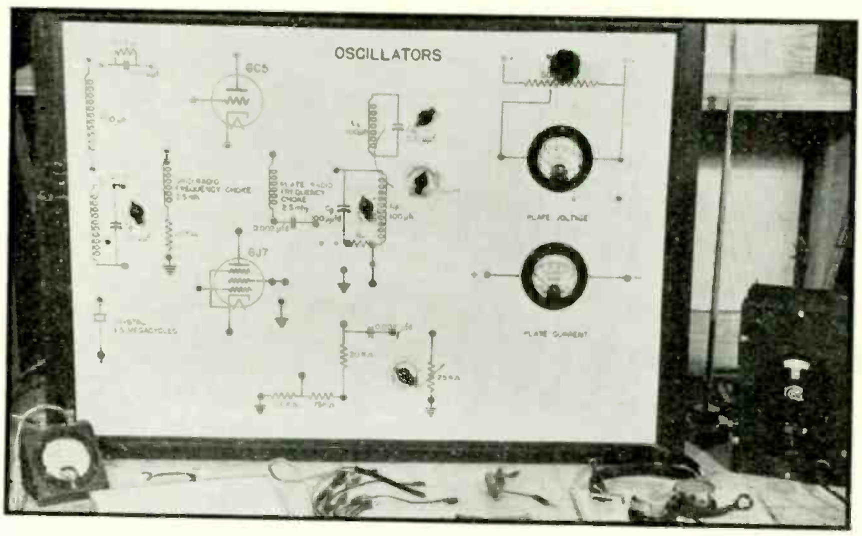
Class and Laboratory Coordination

The success of engineering training is, in large measure, the result of providing, simultaneously, the fundamental background or theory in regular lectures and class-room recitations, and the opportunity to verify (or disprove!) the principles enunciated by observation of apparatus in operation. The most effective training requires that the lecture and laboratory work be prepared as an integral unit, one activity supplementing the other.

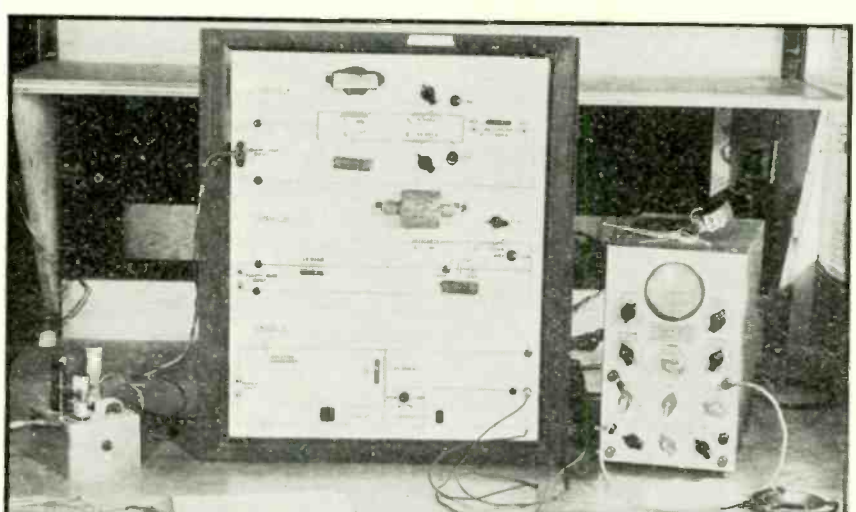
Both classroom and laboratory work in the Cruft Laboratory courses are carefully planned. The laboratory experiments are correlated with classroom lectures so as to supplement the lectures as much as possible. More than the usual amount of laboratory work is assigned to provide as great a background of experimental work as possible. To minimize waste time and motion on the part of students in carrying out laboratory demonstrations, practically all of the experiments are permanently set up and more or less completely wired on large wooden panels or pictorial demonstration boards. The student is thus enabled to spend his full time in the laboratory for carrying out those operations and making those observations and measurements which will make maximum contribution to his understanding of the experiment. At the same time he is relieved from time-consuming wiring of various pieces of apparatus, operations which do not contribute appreciably to comprehension of basic working principles. Of course it is important for the student to become acquainted with the construction and maintenance of electronic equipment, and



The load characteristics of a voltage-regulated power supply can be determined by the meters mounted at the top of the panel. The vacuum tube voltmeter at the right permits measurement of the voltages across the various components which are exposed



Basic elements for various types of oscillators are provided on this demonstration board, but the student must complete the connections, according to the oscillator to be studied, by flexible leads such as those shown in the center foreground



A non-sinusoidal oscillator (left) and oscilloscope (right) used with three simple circuits (center) consisting of *L*, *R*, and *C*, are used in studying the circuit response to non-sinusoidal waves. The backs of the boards are accessible for checking the wiring indicated on front

for this type of instruction the student is given shop practice, assembles and wires complete systems and services receivers and transmitters.

To carry out such a system of laboratory experimental work, several dozen pictorial demonstration boards have been designed, usually one for each experiment to be performed. Each demonstration board is made of half-inch or three-quarter-inch plywood, usually 20x30 inches in size, and mounted in a suitable frame and supporting stand. All of the apparatus needed in the experiment is mounted on the board, except for power supplies, oscilloscopes, oscillators, loud speakers, and similar accessory equipment. The front panel contains the meters, switches, controls, and wiring which are important in the carrying out of the experiment. The rear of the board contains routine wiring which is not necessarily required for an understanding of the principles which the experiment is to convey. Transformers, capacitors, chokes and similar equipment which need not be changed during the experiment are also mounted on the rear of the panel. The rear of the demonstration board is always accessible, so that the student may check the connections if he chooses.

Value of Demonstration Boards

A feature of these demonstration boards is the correlation of the schematic wiring diagram with the physical apparatus actually employed. There is always associated in the student's mind the close relationship between the actual physical electrical component and its schematic representation in a wiring diagram.

The photographic method of reproducing the essential connections for an experiment has worked out very well, since several students may be studying the same experiment at the same time, thereby requiring that several duplicate boards be made.

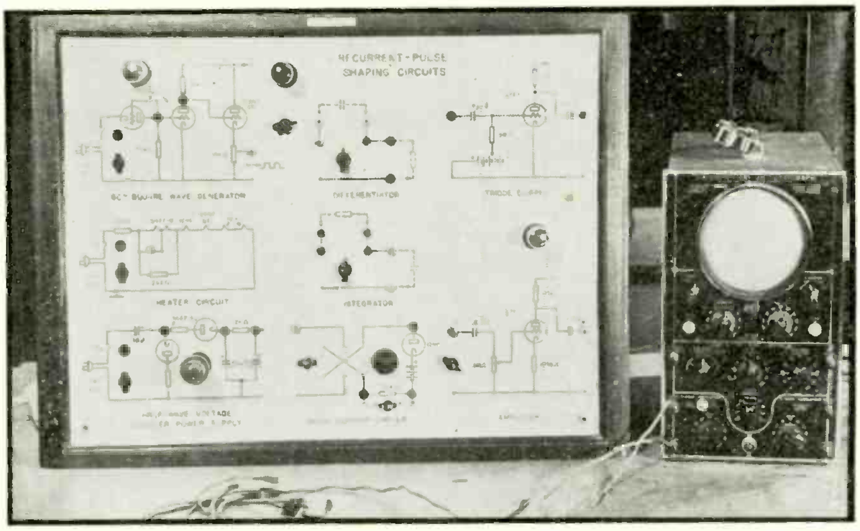
It has proved advantageous to prepare drawings of the proposed board from which photographs are made. The original drawing is half as large as the final photograph and demonstration board. The sizes of the boards vary, but most are 20x30 inches. A drawing for a typical board is shown in one of the illustrations, together with the completed board.

Technique of Making the Demonstration Boards

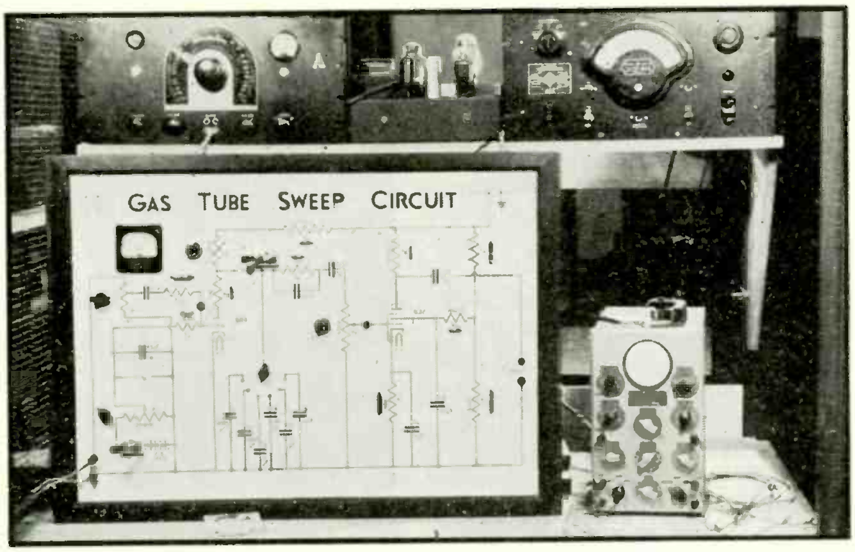
Full size photographic prints for the board are made in the usual manner. After washing and while still wet, the prints are glued to the plywood board, and allowed to dry under pressure. The surface of the photographic print is then given three coats of clear lacquer before the board is placed in its frame. The parts are then mounted and the necessary connections are made. Terminals are made available on the front of the board at those points where the student must complete connections. Ordinarily the plywood has sufficiently high insulation that wires can be passed through it without difficulty, although in some high voltage or high impedance circuits ceramic or plastic sleeves or cylinders are required to provide the desired insulation. Wood boards have the advantage of being easily worked in a carpentry shop.

The pictorial boards illustrated here are representative of several dozen which are in constant use. The experiments on "Rectifier and Power Pack" and "Voltage-Regulated Power Supply" are completely wired. On the other hand, the board designed for a study of "Oscillators" is arranged so that the student makes the desired connections by means of pin jacks and plugs. Various modifications of these two extremes are illustrated on the remaining boards.

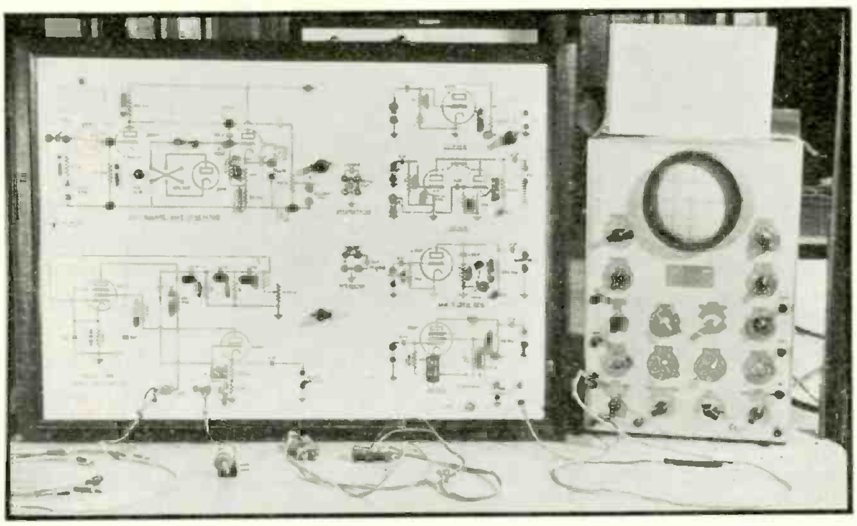
The photographs of the two power supply boards show that they are in good condition after having been in use for a year and a half for approximately 48 hours each week. Service and maintenance of these boards is not a problem. Damage to apparatus is kept to a minimum since meters and other sensitive equipment are permanently mounted and at least partially wired. However, any board can be quickly and easily modified or repaired if this should become necessary. Of course it is necessary to clean the surfaces of the boards periodically to remove dust, pencil marks, and finger prints, but this can be done easily with a damp cloth.—B.D.



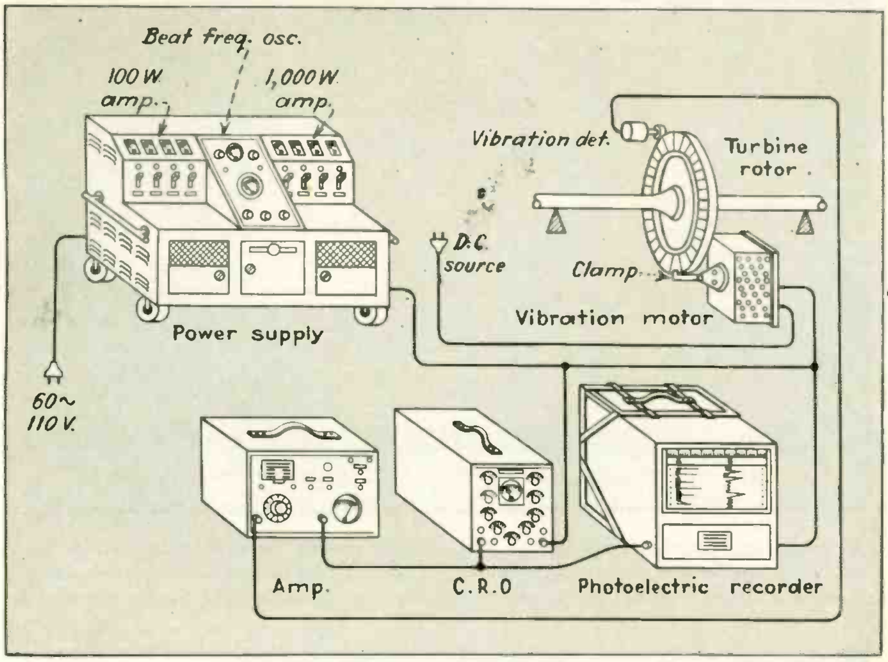
By connecting one side of equipment to a common ground, the connections which the student is required to make may be kept to a minimum, as illustrated in the recurrent-pulse shaping circuits above, employing integrating and differentiating circuits



Another panel for studying the effect of various simple circuits when the power supply may have any of several common wave shapes. Note the additional circuits and lettering pasted over the original photograph, indicating ease with which minor changes are made



The more complicated circuits are completely wired, so the student's full time is devoted to studying the operation of the circuit. The student obtains experience in construction of circuits, but not when studying the operation of a circuit as above



Electronic

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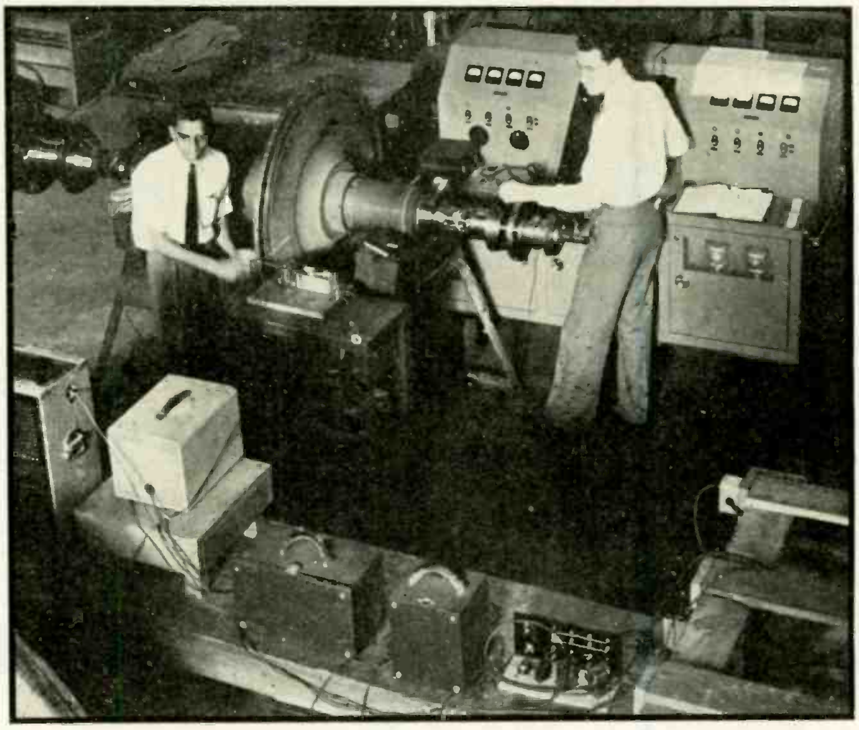


FIG. 1—Equipment setup for turbine wheel vibration test. One operator varies the power output and frequency of the driving unit while the other manipulates the detector. Both watch the cathode-ray oscilloscope

THE INTRODUCTION of electronic apparatus into the vibration testing field has widened the range of vibration measurements and the range in which vibrations can be excited.

A typical example of the successful application of electronic apparatus for vibration measurement as well as for vibration excitation, beyond the scope of conventional mechanical means, was the determination of the high resonant frequencies of a modern high-speed turbine wheel. This information was of great value to the turbine designers.

Testing Procedure

A vibrating force was applied to the turbine wheel while at rest and the vibration of the wheel was measured. The amplitude of the wheel vibration varied from low to high values and vice versa when the frequency of the vibrating force was changed over a wide range. The amplitude increased to a high value whenever the basic frequency of the vibratory force or its harmonics coincided with one of the many resonant frequencies of the turbine wheel.[1]

The vibratory force was supplied by a vibration-exciting motor. This vibration motor was energized by a 1000 va amplifier which was driven by an oscillator of adjustable frequency. The vibration amplitude was detected by a crystal vibration detector and its associated circuit comprising amplifier, cathode-ray oscillograph and photoelectric recorder.

The resonant frequencies of the turbine wheel were determined by observing the variations in amplitude of the vibration on the screen of the cathode-ray oscillograph or on the recorder while the frequency of the oscillator was being slowly changed. Figure 1 shows the arrangement of the different elements of the testing equipment in block diagram form and also pictorially.

Power Supply

The power supply, consisting of oscillator and amplifier, worked over the wide frequency range from 30 to 20,000 cps at a high rate of power output into the vibration motor. This made the driving force of the motor sufficient to excite well-defined nodal patterns in the wheel.

Apparatus for
VIBRATION TESTING

The frequencies at which high-speed turbines vibrate are determined, with the wheels at rest. 1000 volt-amperes of a-c, variable from 30 to 20,000 cps, is converted into mechanical power and applied by an electrodynamic driving motor. Resulting vibration is picked up by a crystal detector. Wave shape and amplitude is shown on an oscilloscope

FIG. 2—The electronic power supply unit. Push-buttons control filament and plate circuits. Dials at the extreme left control feedback and output impedance

Nodal patterns were very sensitive to small changes in frequency, especially in the range of higher frequencies, and it was therefore of great advantage to have the frequency easily adjustable and to be able to keep it constant over a long period of time. This virtually excluded rotating machines as a power supply even in the frequency range for which they were readily available.

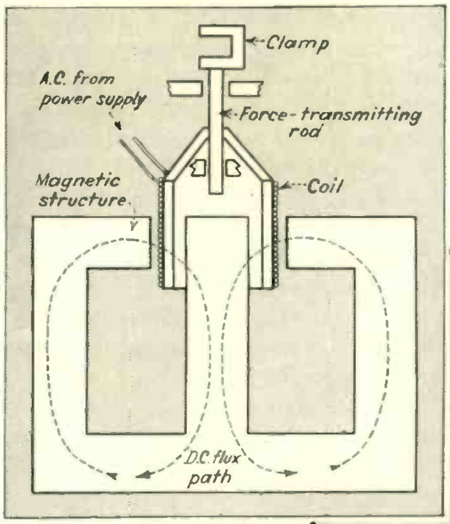
The electronic power supply used consisted of three sections built into one unit. The first section was a beat frequency oscillator, the second section was a 100 va amplifier, and the third section was a 1000 va amplifier. The output of the oscillator was amplified by the 100 va amplifier. The output of the 100 va amplifier was used to control the tubes of the 1000 va amplifier, or, for small power requirements, the 100 va amplifier output was directly connected into the vibration motor.

The photograph of the power supply, Fig. 2, shows the three different sections. The oscillator is located in the center. The left side contains the 100 va amplifier and the right side contains the 1000 va amplifier.

Vibration Motor

The vibration motor used to vibrate the turbine wheel was built like an overdimensioned electrodynamic loudspeaker, as shown diagrammatically and pictorially in Fig. 3.

The moving coil was energized by the output of the power amplifier. The frequency of the motor was, therefore, equal to the frequency of the oscillator voltage. The force of the moving coil was proportional to the current through the coil, hence proportional to the output voltage of the oscillator. Vibration frequency and vibration force could therefore be controlled by the set-



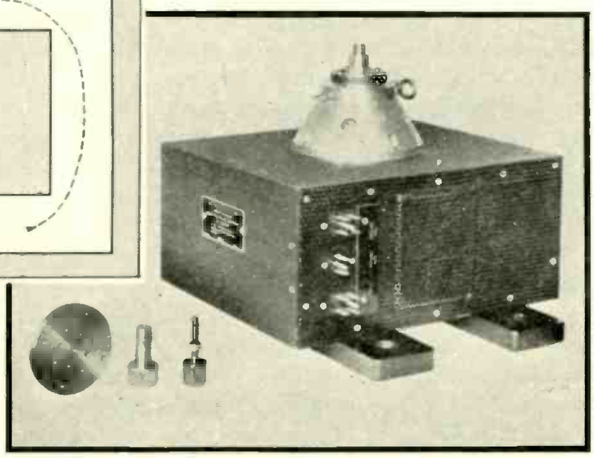


FIG. 3 — Elemental schematic and photograph of electrodynamic vibration motor

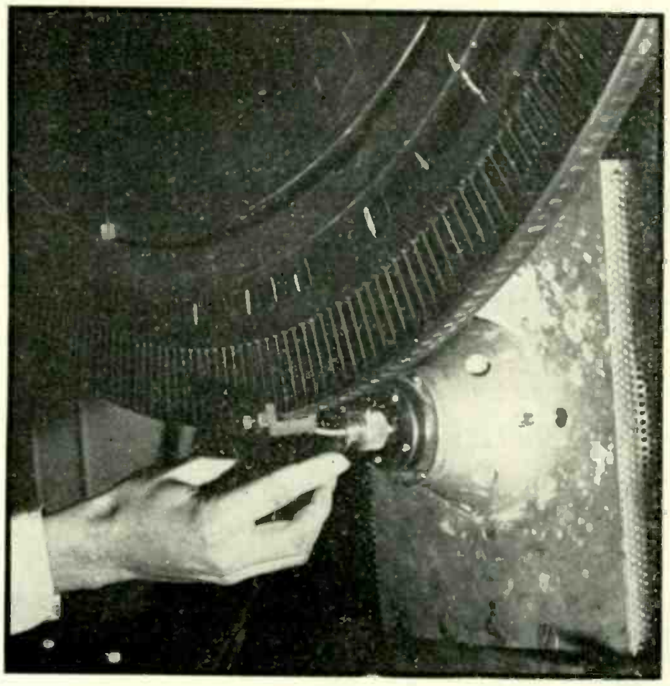


FIG. 4—The vibration motor in position for testing, showing the method of conveying power to the turbine wheel by means of a coupling rod and clamp

FIG. 5—The crystal vibration detector is moved along the wheel while the operator watches a nearby oscilloscope. Points of peak vibration are marked on the wheel

ting of the frequency and gain dials on the power supply.

The maximum vibration force was limited by the current value causing excessive heating of the coil.

The driving force was transmitted from the coil to the turbine wheel by a clamp carried by the coil and attached to the turbine wheel at a point on its circumference. This clamping arrangement is shown in the photograph in Fig. 4.

Vibration Detector

A crystal detector was selected for the measurement of the relative amplitude of the vibration. Its sensitivity was suitable in the frequency range above 1000 cps, which is considered the high-frequency range for mechanical vibrations. Its moving element, which was placed on the vibrating turbine wheel, did not add any considerable mass to the mass of the wheel. Finally, this particular detector could be moved along the circumference of the turbine wheel while its search prod was in continuous contact with the vibrating surface, as shown in Fig. 5.

The output of the crystal detector was amplified by a voltage amplifier having a gain of approximately 40 to 50 db. The output of this amplifier was connected into the vertical amplifier of a cathode-ray oscillograph and also into the rectifier of a photoelectric recording device.

The wave shape of the vibration and its instantaneous amplitude values were observed on the cathode-ray oscillograph. For this purpose the sawtooth-wave sweep circuit of the oscillograph was connected to the horizontal deflecting plates of the cathode-ray tube.

Measurement Interpretation

The frequency of the resonant vibration also had to be determined. This was accomplished by a comparison of the vibration frequency and the driving frequency, by observing Lissajou figures on the cathode-ray oscillograph.[2] These figures were obtained when the oscillator voltage was connected to the horizontal plates of the cathode-ray oscillograph. A circle was visible on the screen when the vibration frequency was equal to the driving frequency, a figure "8" was seen when the ratio of the two frequencies was 1:2, and so forth.

The average amplitude of the vibration was recorded for some tests by the two-element photoelectric recorder. One element recorded the vibration amplitude while the other element recorded the frequency. This was a convenient way to obtain a record of all frequencies at which resonance occurred.

The resonant frequencies of the turbine wheel which were determined by observing the vibration amplitudes, were in reality the resonant frequencies of the complete mechanical and electrical system. These resonant frequencies, however, were with very good approximation equal to the natural frequencies of the turbine wheel as the mass of the driving system was small compared to the mass of the turbine wheel and the driving system was rather stiff compared to the "flexible" turbine wheel.

This statement could be proven by analyzing the equivalent electrical circuit for the electrical and mechanical load of the vibration motor and the turbine wheel.[3] The details of this analysis have been omitted since it was felt that they were beyond the scope of this paper.

This method of testing is not necessarily restricted to the testing of turbine wheels. It seems likely that many other products, both large and small, might also be improved by information which has been obtained by electronic apparatus applied to vibration testing.

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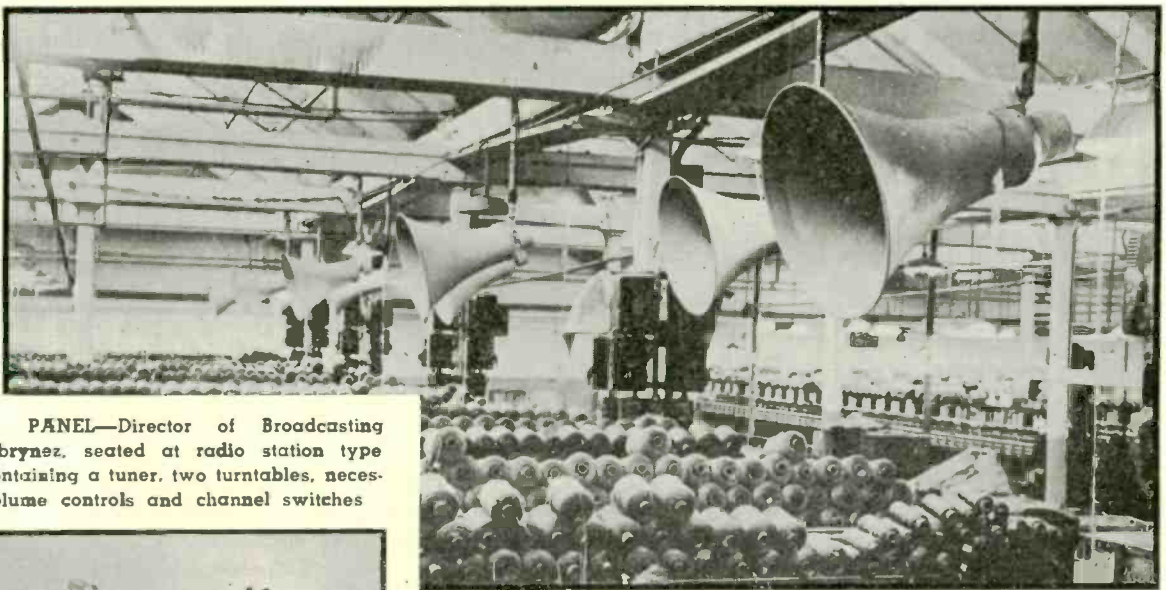
(2) Pender & McIlwain, *"Electrical Engineers' Handbook V,"* John Wiley and Sons, Inc., p. 10-07, 1936.

(3) Firestone, F. A., The Mobility Method of Computing the Vibration of Linear Mechanical and Accoustical Systems, *Jour. of Applied Physics*, 9, p. 373, June 1938.

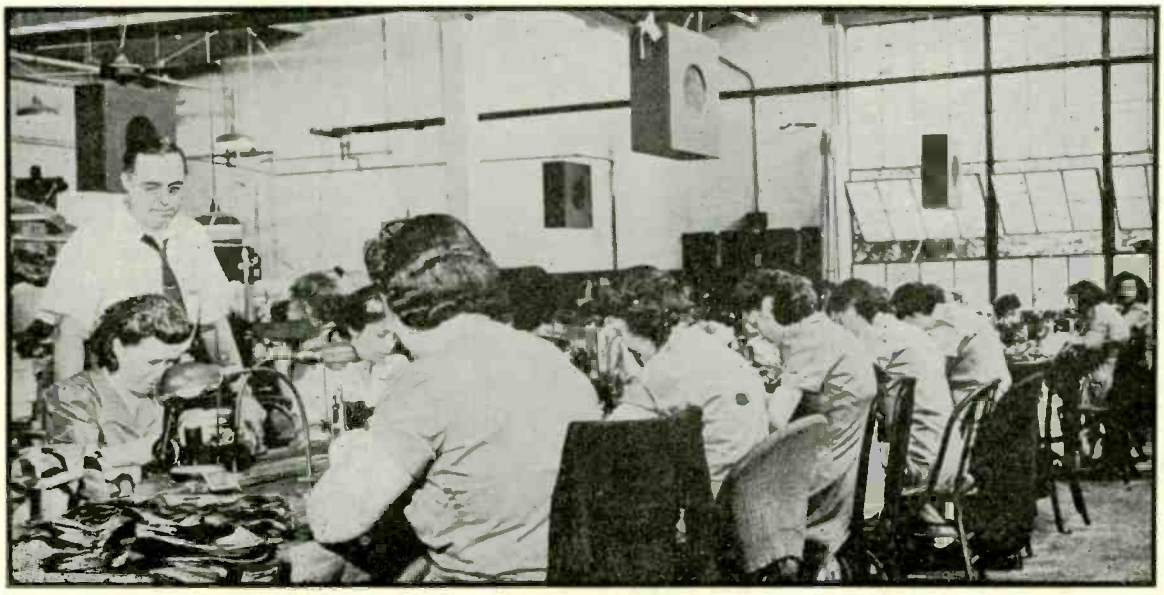
KNITTING MILL—Noise level throughout this building averages 94 db. Properly pitched amplifiers permit speech and music to be clearly heard over re-entrant type horns liberally used



CONTROL PANEL—Director of Broadcasting Marie Kabrynez, seated at radio station type console containing a tuner, two turntables, necessary volume controls and channel switches

SOUND Aids Production

Emergency messages, stimulating radio programs and musical recordings reach workers in the 765,000 sq. ft. plant of New Jersey's Botany Mills via RCA equipment. Efficiency is kept at wartime peak with the aid of a modern electronic equipment installation



SEWING ROOM—Fatigue and boredom are reduced by proper musical programs. Noise level of machines is 86 db at the ears of the operators, requiring special amplifier design and proper speaker placement

Automatic Transmitter Protection

Complete and reliable protection from overloads and underloads are features of this simple electronic relay system. Use of spare parts to provide full transmitter protection makes this a particularly timely article for radio station engineers. In use at WMCA

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AUTOMATIC production of broadcast transmitters has become increasingly important because of serious material shortages. Protective means to insure against dangerous loads on tubes or component parts can mean the difference between staying on or going off the air for the duration. It has been the general practice among the 50 kw stations and, to a lesser degree, the 5 kw stations, to provide complete automatic overload and underload protection from the crystal unit to and including the antenna system.

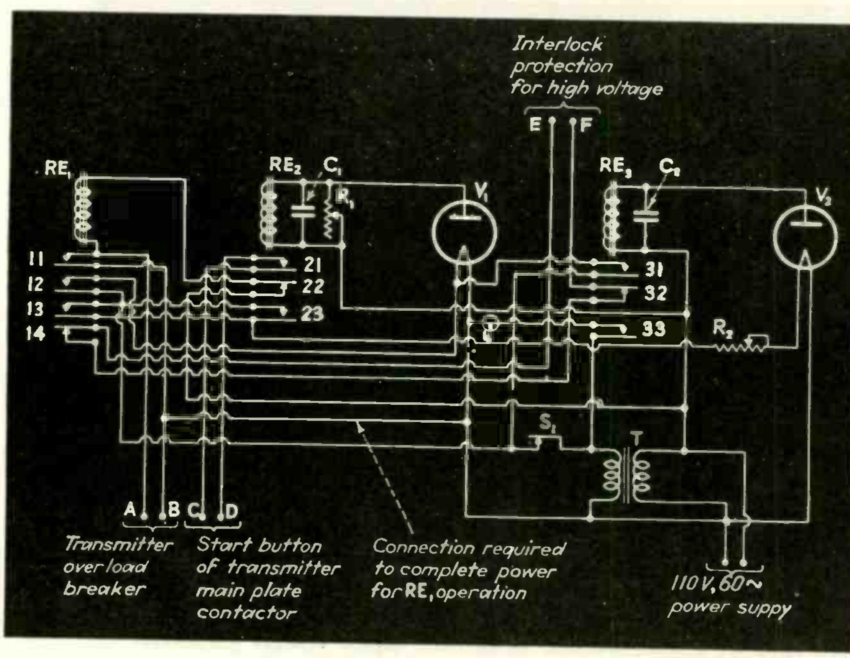
Numerous devices are used to provide this protection—namely, fuses, circuit breakers, step switches, relays and various electronic systems. The majority of high power transmitters have "three times and out" protection. That is, if an overload or underload occurs at any point in the system, the carrier goes off momentarily and if the trouble has cleared, it immediately returns to the air. However, if the cause is still present at the end of three tries, the device locks out to keep the transmitter off until the trouble has been cleared.

These systems in general are quite complicated, involving the use of sequence relays. Such relays, besides being rather expensive, are now very difficult if not altogether impossible to obtain. It is the purpose of this paper to describe a system which will provide the same protection as the more complicated systems, and which can be built up from parts usually found in the junk box of any broadcast station. In fact, a suggested source of supply for the necessary parts is the service or maintenance department of pin ball machine operators. It has been found in practice that almost any available relay can be made to work in the unit.

The essential operation of the unit depends on thermal action for the operation of the relays. Therefore, if desired, tubes V_1 and V_2 and relays RE_2 and RE_3 can be replaced by thermal operated relays similar to those used for preheating mercury vapor tubes before application of plate voltage. The circuit diagram of the control device is shown in Fig. 1. Its operation for transmitter overloads is as follows: Tripping of the overload breaker in the transmitter closes contacts *A-B*. It may be necessary in some transmitters to provide a set of make contacts on the overload breaker. This presents no problem and can readily be done if required.

The closing of contacts *A-B* energizes relay RE_1, which is subsequently kept closed by holding contacts 11. Contacts 14 in series with contacts 32 on relay RE_3 are made a part of the interlock system of the transmitter. Therefore, opening of contacts 14 removes the high voltage from the transmitter. Actuating relay RE_1 also applies filament voltage to tubes V_1 and V_2. As tube V_1 comes up to conducting temperature, its plate current closes relay RE_2. The variable resistor R_1 limits the current across relay RE_2, allowing it to close at different peak values of plate current. When relay RE_2 is actuated, contact 21, which is paralleled across the start button of transmitter main plate contactor, is closed. Closing of this relay also opens contacts 22, releasing relay RE_1. Contacts 23 are paralleled across contacts 13, so that constant filament current is supplied to tube V_2. This is necessary because of the

FIG. 1—Schematic wiring diagram of overload protective relay. Long tube life is assured since tubes are used only when overloads of transmitter occur. Standard relays with heavy contacts are used



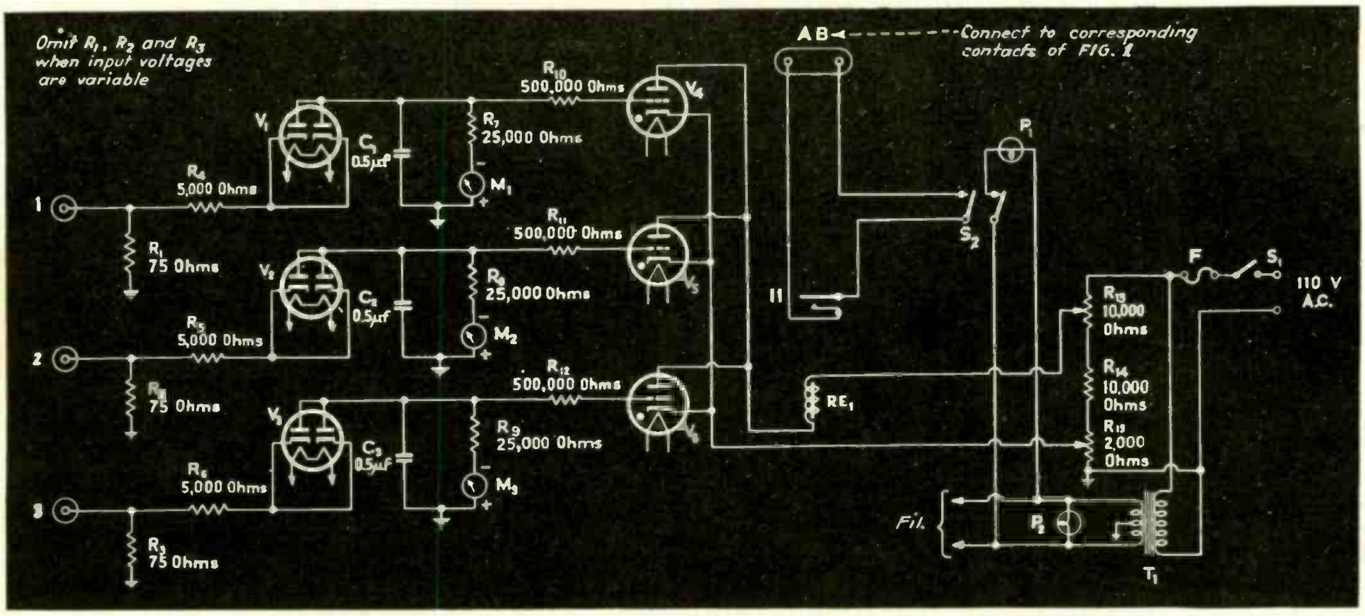


FIG. 2—Vacuum type diodes and gaseous triodes (or tetrodes) are used in the underload protective relay system. The relay is actuated from radio frequency power feeding the diodes

pulsating operation of relays RE_1 and RE_2 on a continuous overload in the transmitter. It is seen that if the overload has cleared on one cycle of operation of relays RE_1 and RE_2, the filament current is removed from tubes V_1 and V_2. However, if the overload is still present, relay RE_2 closes the plate contactor through contacts 21, but relay RE_1 immediately closes because of the operation of the transmitter overload breaker. While relays RE_1 and RE_2 are closed, tube V_2 is heating through contacts 13 and 23. The time required for this tube to reach operating temperature is controlled by rheostat R_2. When V_2 reaches operating temperature relay RE_3 closes operating contacts 31, 32, and 33. Contact 31 locks on the filaments of both tubes, thereby keeping relays RE_1 and RE_2 in their closed position. At the same time, contact 32, in series with the transmitter interlock system, is locked open. This makes it impossible to return the transmitter to the air until release button S_1 is operated, recycling the unit for another sequence of operations. If a visual indicator is desired, contacts 33 and pilot lamp, L, can be added.

The rectified output of the tubes receives additional filtering from the condensers across the relays. The necessity for these will be governed by the type relays used and whether chattering is encountered. The impulse control R_1 determines the off period of the transmitter and should be adjusted to operate relay RE_2 approximately ½ second after relay RE_1 closes. Rheostat R_2 controls the number of impulses or times the transmitter will try itself before locking out. It is suggested that this be set for three cycles of relays RE_1 and RE_2 before relay RE_3 locks out. The tubes used in the unit described are 80's, although if desired, different timing cycles can be obtained with other types.

Underload Protection

Although not generally used on broadcast transmitters, underload protection can be as important as overload protection under certain conditions. Electrical storms or heavy static charges in the vicinity of the antenna systems, cause the protective gaps to break down. Under certain conditions, this arc is maintained by the transmitter and can cause serious damage to the terminal equipment. Depending on the length of the transmission line, the arc may or may not overload the final transmitter stage. However, the radiated signal will drop sharply and if means are provided to momentarily break the carrier, the arc can be stopped. This type of protection also offers an instantaneous alarm to the operating staff in case of trouble which may develop ahead of the final stage. Anything that will reduce the carrier by a predetermined amount will operate the device to cut the carrier.

The underload section, as used at WMCA, was designed for a three-element antenna system and in addition to protection, it provides for remote metering. Circuit connections are shown in Fig. 2. Its operation requires that a small amount of radio frequency power be picked up at the base of the towers and be fed over ¼-inch transmission lines to terminals input 1, 2, and 3 of Fig. 2. This radio frequency power is rectified and used to bias the thyratrons to cutoff. It can be seen that any reduction of r-f input will cause the thyratron to fire closing actuating relay RE_1 and closing terminals 11 and 12. These terminals are paralleled across terminals *A-B* of Fig. 1 and their closing will, as explained before, remove the transmitter carrier from the air.

Where a single transmitting antenna is used, only one rectifier and thyratron are required. Radio frequency can be obtained with a short antenna coupled to the rectifier tube. With this method, it is suggested that a tuned circuit be incorporated in the rectifier circuit to increase the rectified voltage. When a tuned circuit is used, resistors R_1 to R_6 can be eliminated. It is not advisable to couple to the output stage of the transmitter, or attempt to use the

(Continued on page 313)

Operation of VAPOR TUBE RECTIFIER CIRCUITS With Opposing Direct Voltages

The behavior of full wave and half wave gaseous rectifiers with opposing direct voltage is analyzed graphically and analytically for various periods of conduction. Results given have been checked experimentally and good agreement between theory and practice exists

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THE application of rectifier tubes to the charging of batteries or to the energizing of d-c motors from an alternating current source differs from the usual application of rectifiers in that in both these applications an opposing direct voltage is present. It is the purpose of this paper to develop and present general equations and curves for such service descriptive of the various voltages and currents pertinent to the design of full and half wave rectifier circuits in which an opposing direct voltage equal to or greater than zero is present. These equations will apply to diode rectifiers and to grid-controlled rectifiers with full cycle grid excitation. For this latter case, the equations developed are sufficient in that the rating of the rectifier plate transformer and maximum d-c output are obtained when the grids are allowed to cause conduction over the entire time the rectifier plates are positive. The full wave rectifier will be considered first.

The following quantities are descriptive of the full wave rectifier circuit shown in Fig. 1. The tube drop E_t, initially is omitted. In mercury vapor tubes, its value is approximately 15 volts; it may be added to the value of E, defined below, to obtain the required voltage, E_{eff}, with no appreciable error after E has been determined. It is also assumed that the tube drop does not appreciably distort the sine wave voltage assumed to exist in the transformer secondary.

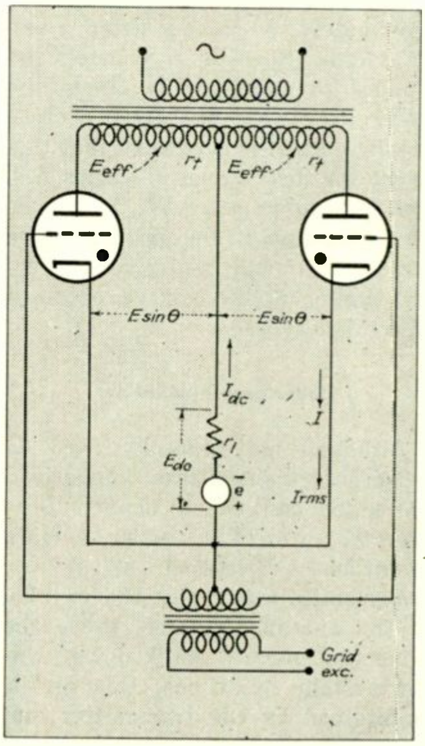

Fig. 1—Schematic wiring diagram of full wave rectifier using gas tubes

In the analysis given here, let

r_t = resistance of one half of the secondary winding in ohms
r_l = load resistance in ohms
e = the back emf (direct voltage) in the load circuit in volts
E = no load voltage across one half secondary for full wave rectifier;
E_{eff} = no load voltage across total secondary for half wave rectifier.
I_{dc} = the average current flowing through the load in amperes
E_{dc} = the average voltage across the load in volts
I = the peak value of rectifier plate current per tube in amperes
I_{rms} = root mean square value of I in amperes
W_s = total watts loss in the transformer secondary due to I
E_t = average tube drop in volts during the conducting period of the tube
W_t = tube plate loss in watts

These values are shown diagrammatically in Figs. 2(a) and 2(b).

Because of the presence of a back emf in the load circuit, the rectifier tubes conduct over only a portion of each half cycle. Label the point at which conduction begins ϕ, and the point at which conduction ceases $(\pi-\phi)$. This is a close approximation in the case of the voltage curve of Fig. 2(a) if applied to the rectifier drive of a d-c motor since the inductance in the armature circuit causes the voltage in the region of $(\pi-\phi)$ to drop below the value of e as shown in Fig. 2(c). However, for most cases, this dip may be neglected; the derivations herein are so based.

Consider first Fig. 2(a) for the derivation of an expression for E_{dc}. From 0 to ϕ radians the voltage across the load is e, from ϕ to $(\pi-\phi)$

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radians this voltage is $E \sin \theta]_{\phi}^{\pi-\phi}$ and from $(\pi-\phi)$ to π radians the voltage is again e. The average voltage over the period 0 to π is:

$$E_{dc} = \frac{1}{T}\int_0^T e dt \quad (1)$$

$$E_{dc} = \frac{E}{\pi}\left[\int_{\phi}^{\pi-\phi} \sin\theta \, d\theta + 2\phi \sin\phi\right] \quad (2)$$

$$= \frac{2E}{\pi}(\cos\phi + \phi\sin\phi) \quad (3)$$

Equation (3) is plotted in Fig. 3 for $E_{dc} = 120$ volts to illustrate the general shape of the curve relating ϕ to E for a specified direct voltage. The more general case of E/E_{dc} is also plotted from which curves may be plotted for various values of E_{dc}.

The derivation of an expression for power output to the load terminals is next considered

$$\text{Since } E_{dc} = I_{dc} r_l + e \quad (4)$$

$$\text{then } I_{dc} r_l = E_{dc} - e \quad (5)$$

$$\text{or } I_{dc} = \frac{E_{dc} - e}{r_l} \quad (6)$$

$$\text{then } W = E_{dc} I_{dc} = \frac{E_{dc}}{r_l}(E_{dc} - e) \quad (7)$$

$$\text{Also } e = E \sin\phi \quad (8)$$

Combining Eq. (3) (7) and (8)

$$W = \frac{4E^2}{r_l \pi^2}(\cos\phi + \phi\sin\phi)\left(\cos\phi + \phi\sin\phi - \frac{\pi}{2}\sin\phi\right) \quad (9)$$

Simplifying Eq. (9) by performing the indicated multiplication and then making trigonometric substitutions:

$$\frac{Wr_l}{E^2} = \frac{2}{\pi^2}\left[1 - \frac{\phi\pi}{2} + \phi^2 + \left(1 + \frac{\phi\pi}{2} - \phi^2\right)\cos 2\phi + \left(2\phi - \frac{\pi}{2}\right)\sin 2\phi\right] \quad (10)$$

Figure 4 is plotted for several values of E in terms of Wr_l and ϕ. The values of E chosen cover the range required for $E_{dc} = 120$ volts for any value of ϕ from 0 to 90 degrees for usual values of r_l. Figure 4 also displays the plot of Wr_l/E^2 in terms of ϕ from which other families of curves as a function of E may be plotted to suit specific applications.

It now remains to develop expressions for values of I_{dc} and I_{rms} in terms of I both as a function of ϕ. The values of I_{dc}, I and E will give sufficient information to choose rectifier tubes of the proper rating for a given application. During the half cycle or portion thereof that either rectifier tube is conducting the cur-

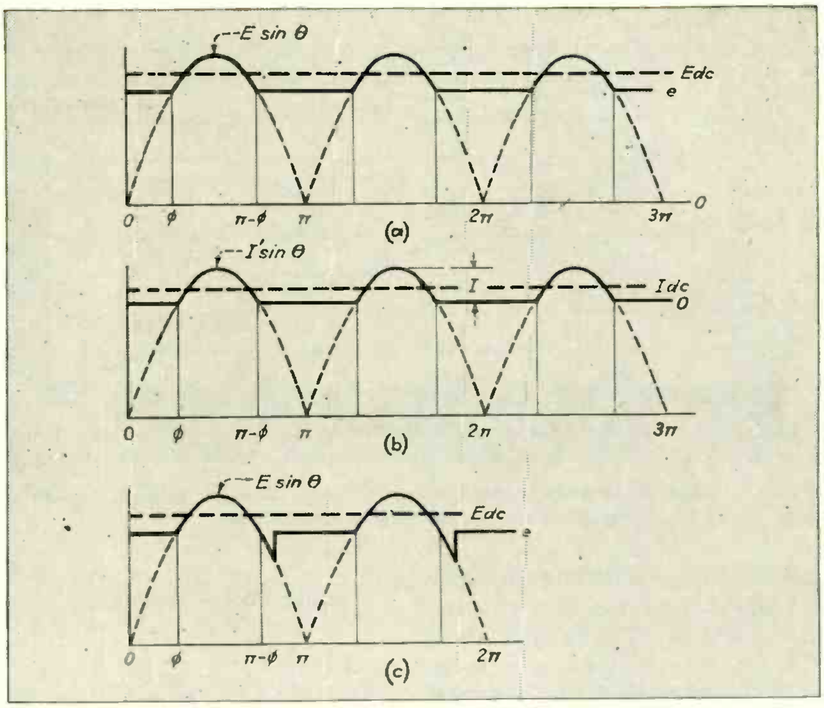


Fig. 2—At (a) is shown the applied voltage and back emf. Current flowing into a resistive load under this condition is shown at (b). At (c) is shown the drop in voltage, near end of conducting period, for inductive load

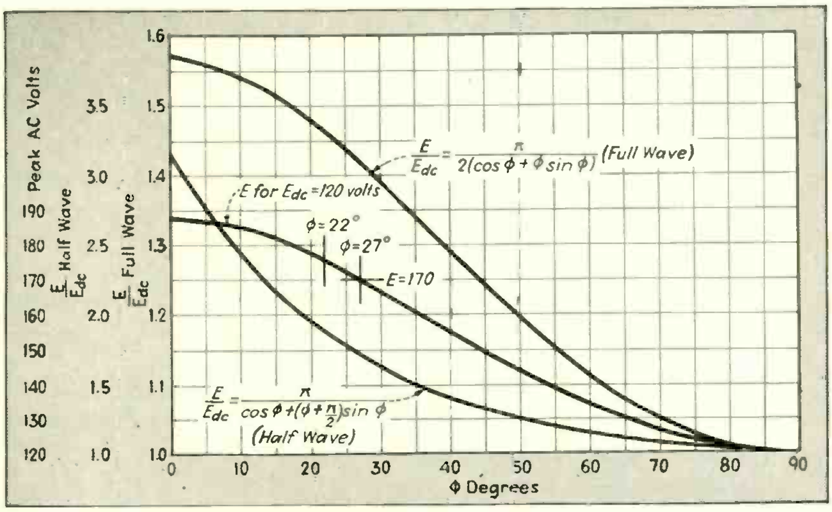


Fig. 3—Ratio of no-load voltage to average voltage across the load for two types of rectifier circuits

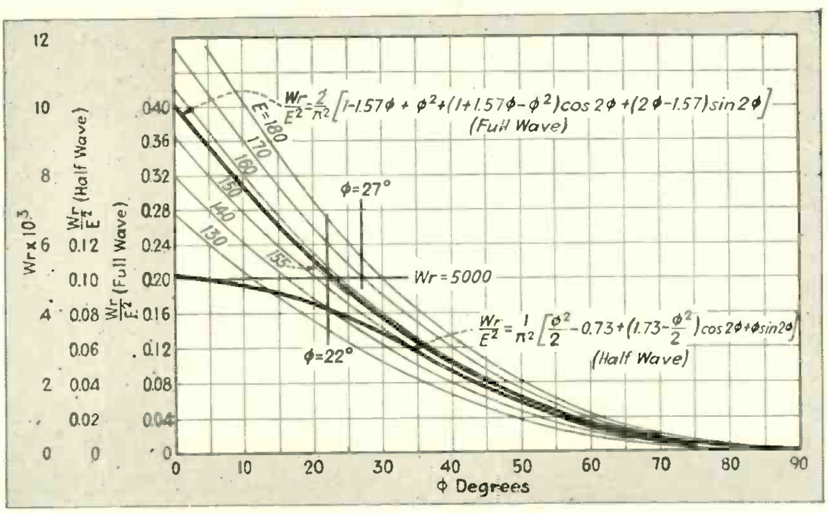


Fig. 4—Performance of half wave and full wave rectifiers for various values of applied voltage and conduction angle

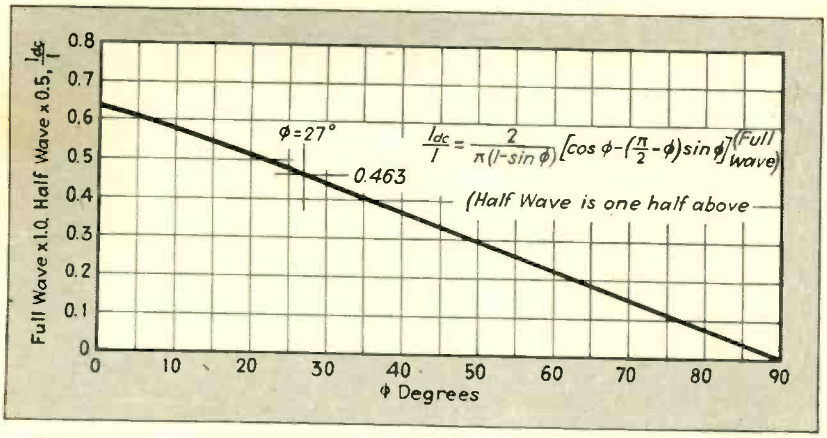


Fig. 5—Ratio of average current to peak value of plate current through rectifier for various angles of conduction

rent through the conducting tube and the voltage across the load are essentially portions of a sinusoid. During the period of time of 0 to ϕ radians, the current through the load is zero, from ϕ to $\pi-\phi$ radians the current is $(I' \sin\phi) - (I' - I)$ and from $(\pi-\phi)$ to π radians the current is again zero. The average direct current is, therefore,

$$I_{dc} = \frac{I'}{\pi}\left[\int_{\phi}^{\pi-\phi} \sin\theta \, d\theta - (\pi - 2\phi)\sin\phi\right] \quad (11)$$

$$= \frac{I'}{\pi}\left[2\cos\phi - (\pi - 2\phi)\sin\phi\right] \quad (12)$$

Since $I' - I = I'\sin\phi$ (13)

$$I' = \frac{I}{I - \sin\phi} \quad (14)$$

substituting Eq. (14) into Eq. (11)

$$\frac{I_{dc}}{I} = \frac{2}{\pi(1-\sin\phi)}\left[\cos\phi - \left(\frac{\pi}{2} - \phi\right)\sin\phi\right] \quad (15)$$

Equation (15) is plotted in Fig. 5 with I_{dc}/I as a function of the conduction angle ϕ.

The root mean square value of a periodic function i is defined by

$$I_{rms} = \sqrt{\frac{1}{T}\int_0^T i^2 dt} \quad (16)$$

In this case

$$i = I'(\sin\theta - \sin\phi)]\phi^{\pi-\phi} \quad (17)$$

Since each tube conducts only once per cycle each half of the secondary is required to carry current only once per cycle equal to a period of ϕ to $(\pi-\phi)$. The value of I_{rms} then may be derived on the basis of the heating produced per half secondary. This can be done by integrating i^2 over the period of ϕ to $(\pi-\phi)$ and setting $1/T = 1/2\pi$. Substituting Eqs. (14) and (17) in Eq. (16)

$$I^2_{rms} = \frac{I^2}{2\pi(1-\sin\phi)^2}\left[\int_{\phi}^{\pi-\phi}(\sin^2\theta - 2\sin\phi\sin\phi + \sin^2\phi)\, d\theta\right] \quad (18)$$

$$I^2_{rms} = \frac{I^2}{2\pi(1-\sin\phi)^2}\left[\frac{\pi}{2} - \frac{\phi}{2} - \frac{\sin 2(\pi-\phi)}{4} - \frac{\phi}{2} + \frac{\sin 2\phi}{4} + 2\sin\phi(\cos(\pi-\phi) - \cos\phi) + (\pi - 2\phi)\sin^2\phi\right] \quad (19)$$

Simplifying Eq. (19)

$$\frac{I^2_{rms}}{I^2} = \frac{1}{2\pi(1-\sin\phi)^2}\left[2\left(\frac{\pi}{2} - \phi\right) - \left(\frac{\pi}{2} - \phi\right)\cos 2\phi - \frac{3}{2}\sin 2\phi\right] \quad (20)$$

Figure 6 is a plot of I^2_{rms}/I^2 and I_{rms}/I as function of ϕ.

Since Eq. (20) is for one half of the secondary the total heat required to be dissipated by the secondary is essentially

$$W_s = 2r_t I^2_{rms} \quad (21)$$

The total watts required by the transformer secondary from the primary (Fig. 1) considering tube drop is therefore closely approximated by:

$$W_s + W_t + W = 2r_t I^2_{rms} + \frac{(\pi - 2\phi)E_t I_{dc}}{\pi} + \frac{2E^2}{r_t\pi^2}\left[1 - \frac{\phi\pi}{2} + \phi^2 - \left(1 + \frac{\pi\phi}{2} - \phi^2\right)\cos 2\phi + \left(2\phi - \frac{\pi}{2}\right)\sin 2\phi\right] \quad (22)$$

The voltage induced in each half of the secondary is very nearly:

$$E_{s1/2} = \frac{E + E_t + Ir_t}{\sqrt{2}} \quad (23)$$

To illustrate the use of the foregoing equations and Figs. 3, 4, 5 and 6 suppose the following d-c load requirements:

$W = 500$ watts, $r_t = 10$ ohms
$E_{dc} = 120$ watts, $r_t = 3$ ohms
Then $Wr_t = (500)(10) = 5000$ watt ohms

Figures 3 and 4 are used essentially for simultaneously solving for E and ϕ. Solving for these quantities graphically is more easily done than attempting a simultaneous solution of Eqs. (3) and (1) for these quantities. Draw a line on Fig. 4 at $Wr_t = 5000$ then select values of E and ϕ that can also be located on the curve of $E_{dc} = 120$ in Fig. 3. A trial solution is first made. On Fig. 3 a value of ϕ of 22 degrees has been arbitrarily selected yielding the corresponding value of $E = 175.5$. Going to Fig. 4 and drawing a vertical line at $\phi = 22°$ it is noted that $E = 155$ at the intersection of this line with $Wr_t = 5000$. It,

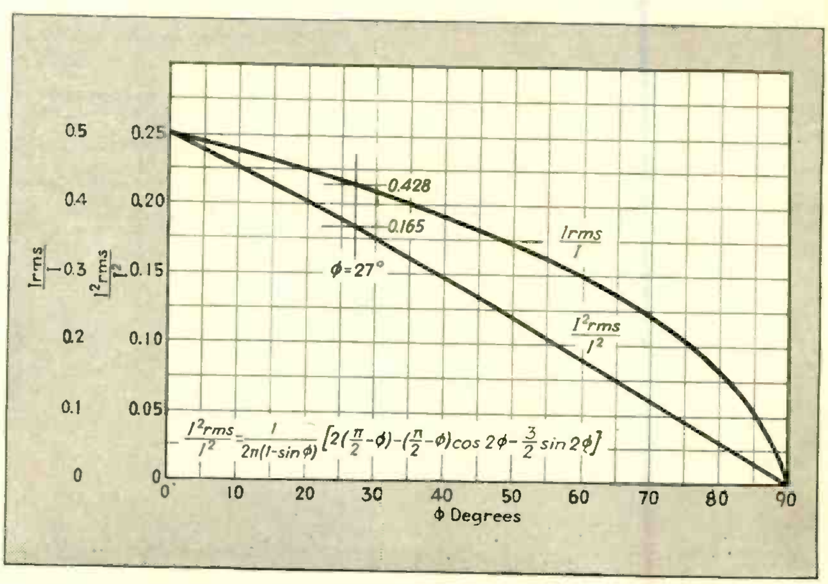


Fig. 6—Ratio of effective current to peak rectifier current for various angles of conduction

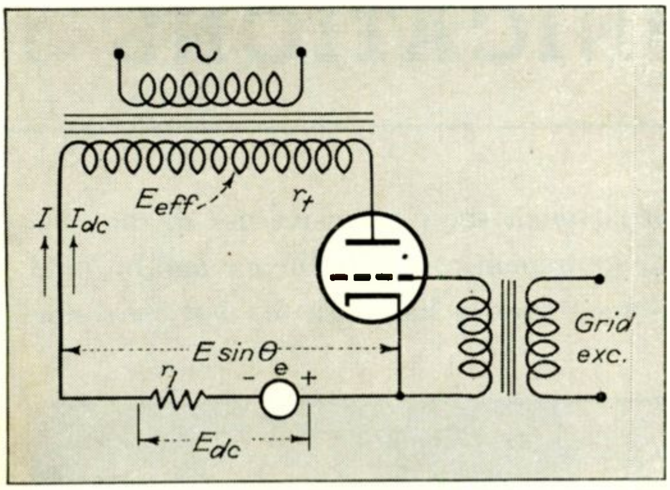


Fig. 7—Schematic wiring diagram of half wave grid controlled gaseous rectifier

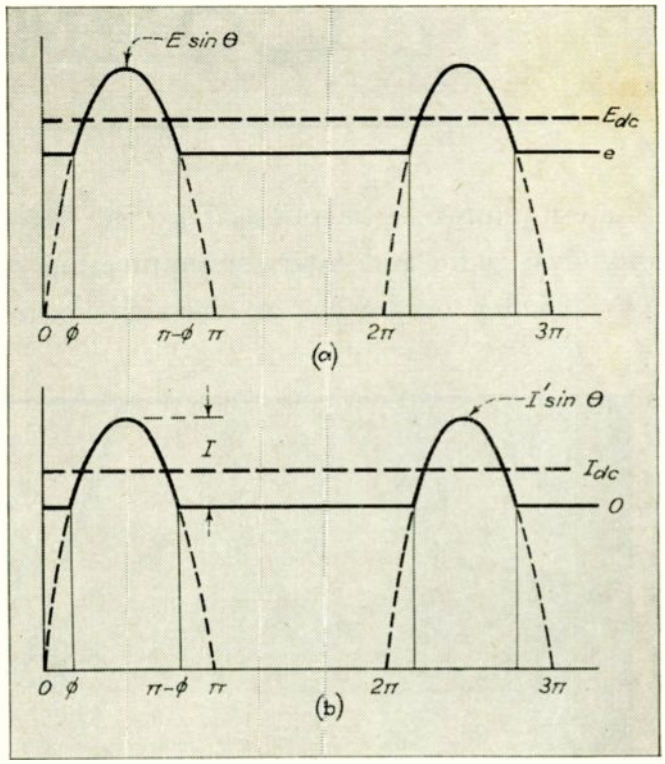


Fig. 8—Current and voltage relations for the half wave rectifier

therefore, is obvious that a value of $\phi = 22°$ is too small. Another value of ϕ is then selected. This is repeated until the value of E from Fig. 3 agrees with that of Fig. 4. For this example ϕ and E have been determined to be 27 deg. and 170 volts respectively.

Using the value of ϕ just determined I_{dc}/I is found to be 0.463, then

$$I = \frac{500}{(120)\,(0.463)} = 9 \text{ amps} \tag{24}$$

From Fig. (6) $I_{rms}/I = 0.428$ and $I^2_{rms}/I^2 = 0.165$ from which

$$I_{rms} = (0.428)\,(9) = 3.86 \text{ amps} \tag{25}$$

$$\text{and } I^2_{rms} = (0.165)\,(9)^2 = 13.41 \tag{26}$$

Equations (25) and (26) give rms values of current for each half of the transformer secondary of Fig. 1. The heat dissipation of the total secondary is then, from Eq. (21),

$$W_s = (2)\,(3)\,(13.41) = 80.46 \text{ watts} \tag{27}$$

Assuming a tube drop of 15 volts, the voltage required in each half of the secondary is, from Eq. (23),

$$E_{eff} = \frac{170 + 15 + (9)\,(3)}{\sqrt{2}}$$

$$= (0.707)\,(212) = 150 \text{ volts}$$

The power required by the transformer secondary of the primary is, from Eq. (22),

$$W + W_t + W_s = 80.46 + \frac{(0.944)\,(15)\,(4.17)}{\pi} + 500$$

$$= 80.46 + 18.7 + 500$$

$$= 599 \text{ watts} \tag{28}$$

For a half wave rectifier the same general considerations apply. Consider the circuit shown in Fig. 7 wherein the symbols of voltage and current are as defined for Fig. 1 and wherein the same assumptions hold as previously described.

The instantaneous values of voltage and current are as shown in Fig. 8(a) and 8(b)

Then

$$E_{dc} = \frac{E}{2\pi}\left[\int_{\phi}^{\pi-\phi} \sin\theta\, d\theta + (2\phi + \pi)\sin\phi\right] \tag{29}$$

$$E_{dc} = \frac{E}{\pi}\left[\cos\phi + \left(\phi + \frac{\pi}{2}\right)\sin\phi\right] \tag{30}$$

and

$$\frac{E}{E_{dc}} = \frac{\pi}{\cos\phi + \left(\phi + \frac{\pi}{2}\right)\sin\phi} \tag{31}$$

This relation is plotted in Fig. 3 and may be replotted for more convenient use in terms of E for any desired specific value of E_{dc}. Since, from Eq. (7) and (8)

$$W = \frac{E_{dc}}{r_l}\,(E_{dc} - E\sin\phi) \tag{32}$$

the power input to the load is:

$$W = \frac{E}{\pi r_l}\Big(\cos\phi + \left(\phi + \frac{\pi}{2}\right)\sin\phi\Big)\left[\frac{E}{\pi}\Big(\cos\phi + \left(\phi + \frac{\pi}{2}\right)\sin\phi\Big) - E\sin\phi\right] \tag{33}$$

$$= \frac{E^2}{\pi^2 r_l}\left[\cos^2\phi + 2\phi\sin\phi\cos\phi + \left(\phi^2 - \frac{\pi^2}{4}\right)\sin^2\phi\right] \tag{34}$$

$$= \frac{E^2}{\pi^2 r_l}\left[\frac{\phi^2}{2} - \frac{\pi^2}{8} + \frac{1}{2} + \left(\frac{-\phi^2}{2} + \frac{\pi^2}{8} + \frac{1}{2}\right)\cos 2\phi + \phi\sin 2\phi\right] \tag{35}$$

or

$$\frac{W r_l}{E^2} = \frac{1}{\pi^2}\left[\frac{\phi^2}{2}0.73 + \left(\frac{-\phi^2}{2} + 1.73\right)\cos 2\phi + \phi\sin 2\phi\right] \tag{36}$$

Equation (36) is plotted on Fig. 4.

The average or direct current is from Fig. 8(b) and equation (14).

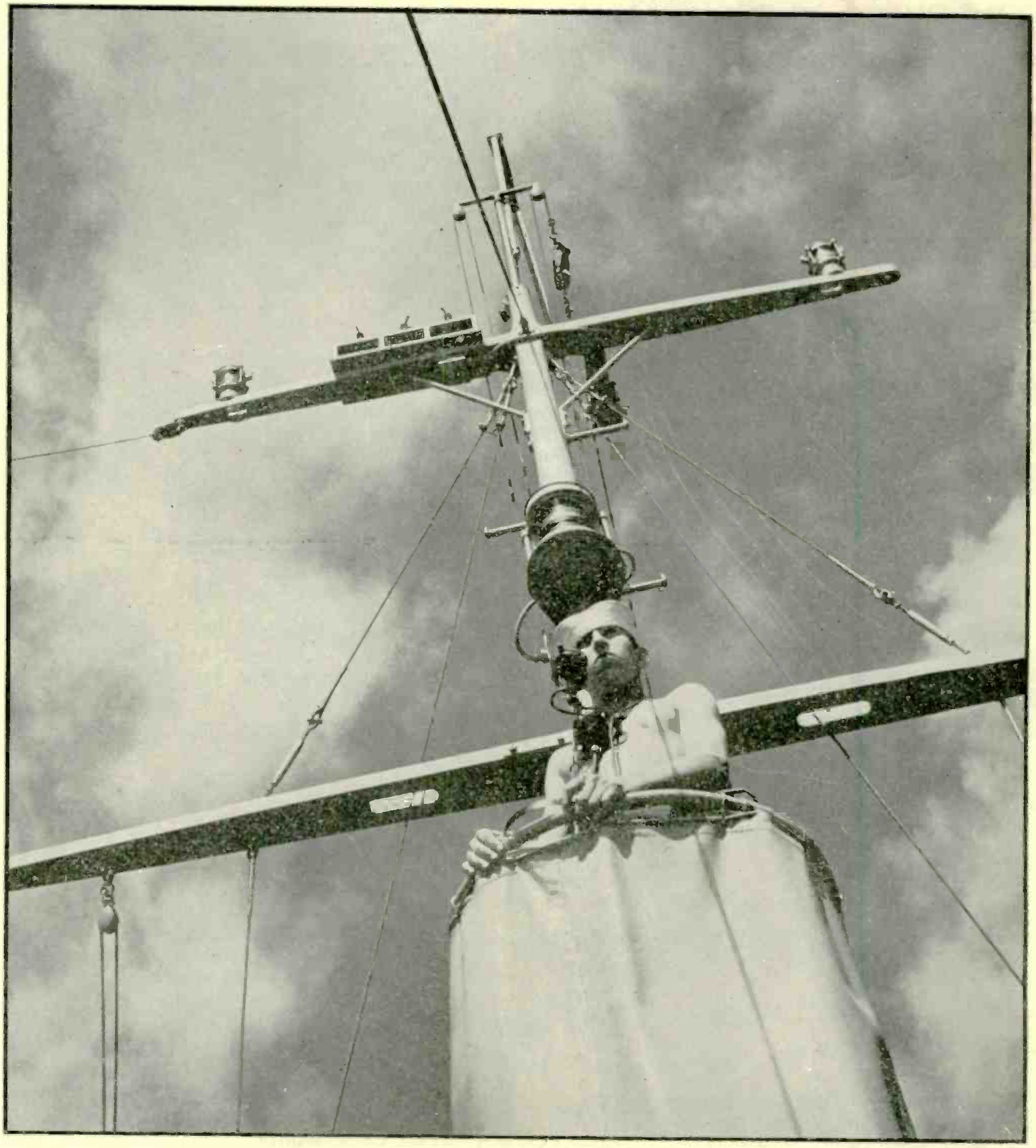
$$I_{dc} = \frac{I}{2\pi\,(1 - \sin\phi)}\left[\int_{\phi}^{\pi-\phi} \sin\theta\, d\theta - (\pi - 2\phi)\sin\phi\right] \tag{37}$$

$$\frac{I_{dc}}{I} = \frac{1}{\pi\,(1 - \sin\phi)}\left(\cos\phi - \left(\frac{\pi}{2} - \phi\right)\sin\phi\right) \tag{38}$$

Equation (38) is plotted in Fig. 5 and is, of course, one half the magnitude of Eq. (15). Since Eq. (2) was developed in the case of the full wave rectifier for each half of the secondary, it is applicable for the half wave rectifier directly. The curves and their equations which have just been derived for the half wave rectifier are applied in manner similar to that illustrated in the example for the full wave rectifier.

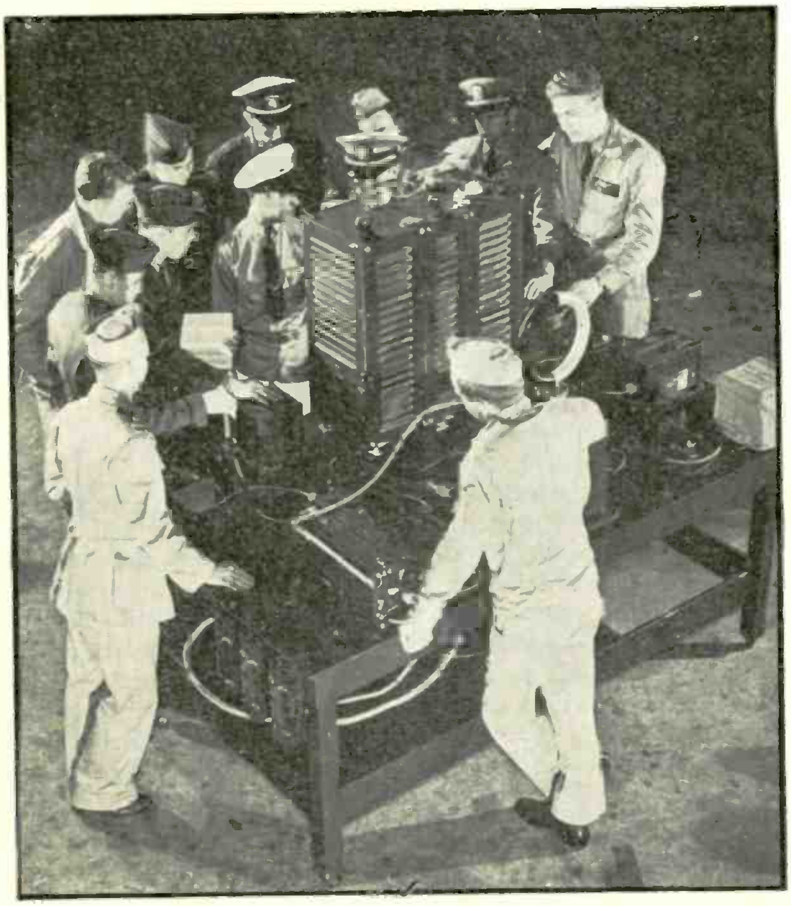
COMMUNICATIONS in

Latest photos to be released by the Navy Department show extensive use of the most modern radio and inter-communicating sound equipment at sea, in the air and on land. Proficiency in the use of electronic gear has long been a hallmark of alert personnel



The lookout in the crow's nest of a subchaser reports to the bridge via inter-phone

the NAVY

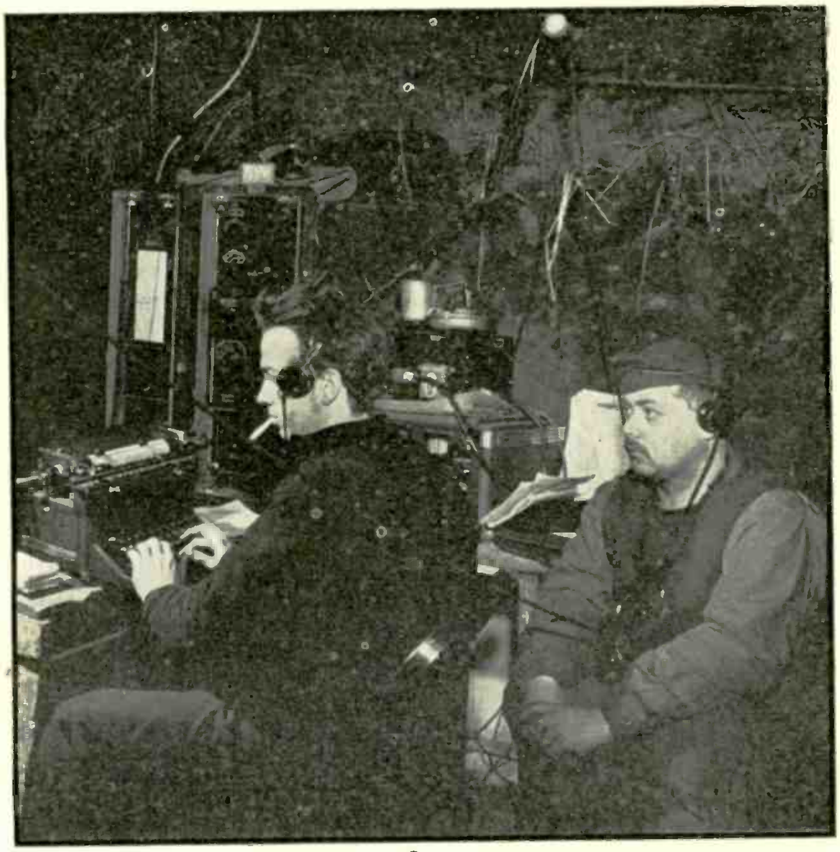


"Bread-board" layout of radio apparatus used in the PBY "Catalina" patrol plane

This "quanset" hut, in the Aleutians, is fully equipped with the most modern transmitters and receivers

Official U. S. Navy Photographs

Inter-phone equipped lookout in a PBY patrol bomber looks out over the broad Pacific in the vicinity of the Aleutians



Complete ground station equipment in use in an advanced dugout at an unnamed base

Low- and High-Pass

Treatment of electric wave filters on the basis of considering them as bisectable symmetrical circuits

In a previous treatment of symmetrical electrical circuits it has been shown that the sending current I_s and the received current I_r of Fig. 1, due to the driving force E can be evaluated from the currents I_o and I_c which would flow from E with the network opened and closed at the center of symmetry by using:—

$$I_s = \tfrac{1}{2}(I_o + I_c) \qquad (1)$$

$$I_r = \tfrac{1}{2}(I_o - I_c) \qquad (2)$$

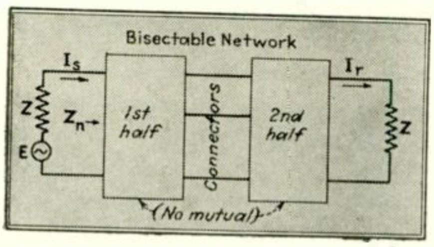


FIG. 1—Combination block and schematic diagram of symmetrical bisectable network

With the impedances looking into the network from the sending impedance Z (termed Z_o for the center opened condition, and Z_c for the center closed condition) the values of the terminal currents in terms of Z, Z_o and Z_c are:—

$$I_s = \frac{E}{2}\left[\frac{2Z + (Z_o + Z_c)}{(Z + Z_o)(Z + Z_c)}\right] \qquad (3)$$

$$I_r = \frac{E}{2}\left[\frac{(Z_o - Z_c)}{(Z + Z_o)(Z + Z_c)}\right] \qquad (4)$$

The effect of the presence of the network upon the sending termination may be expressed by the loading ratio, defined as the ratio of the impedance Z_n by which the sending arm is loaded with the network present to the impedance Z by which it is loaded with the network absent, given by,

$$\text{Load Ratio} = \frac{Z_n}{Z} = \frac{[Z_o Z_c/Z^2] + [(Z_o + Z_c)/2Z]}{1 + [(Z_o + Z_c)/2Z]} \qquad (5)$$

The effect of the presence of the network upon the receiving termination is expressed by the ratio of the current $E/2Z$ which would flow in the receiving termination if the network were absent, to the current I_r which flows with the network present. This is the insertion ratio given by,

$$\text{Insertion Ratio} = \frac{E/2Z}{I_r} = \frac{(Z + Z_o)(Z + Z_c)}{Z(Z_o - Z_c)} = M + jN \qquad (6)$$

In general the impedances Z, Z_o and Z_c involve resistor and reactor elements so that the insertion ratio is a complex imaginary, $M + jN$, which can be evaluated for any specific circuit under consideration. The loss in decibels and the phase shift of the received current due to the presence of the network are:—

$$\text{Loss} = 10 \log_{10}(M^2 + N^2) \qquad (7)$$

$$\text{Lag} = \tan^{-1}(N/M) \qquad (8)$$

Whenever the circuit is made up of a bisectable reactance network terminated with resistances R, the impedances Z_o and Z_c become reactive impedances jX_o and jX_c. Upon

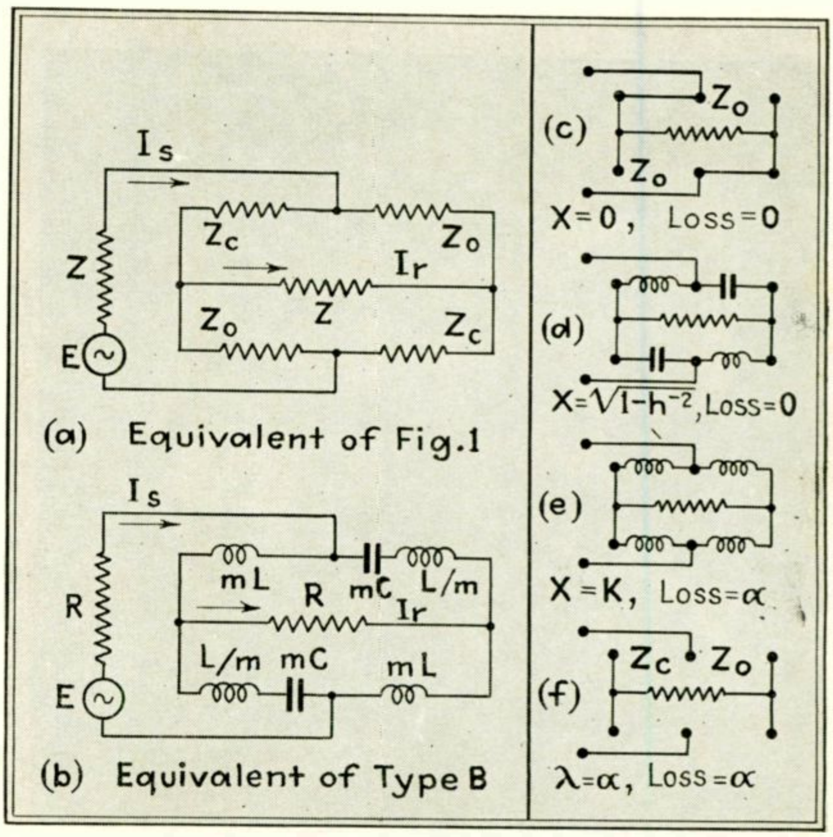


FIG 2 Schematic diagram of various types of bridge networks

Wave Filter Units

By E. S. Purington

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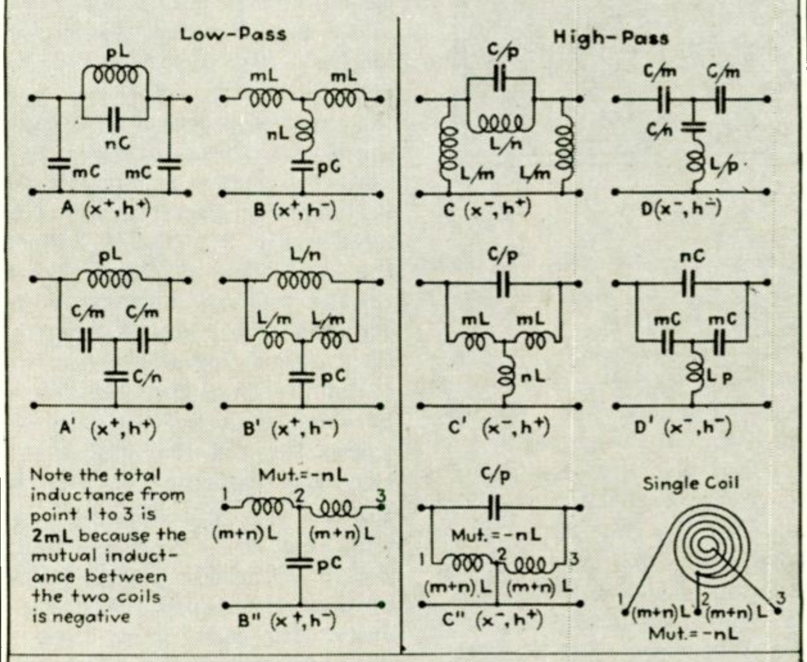
Gloucester, Mass.

Table I. Standard Low- and High-Pass Wave Filter Units



For terminations R, Loss $= 10 \log_{10} (1+F^2_{loss})$; Lag $= \tan^{-1} (F_{lag})$

$m=\sqrt{1-k^{-2}}$	$F_{loss}=m(h-h^{-1})\ x^{\pm 1}\left[\dfrac{(x^{\pm 1}/a)^2-1}{(x^{\pm 1}/k)^2-1}\right]$	$a=\sqrt{1-h^{\pm 2}}$
$n=\frac{1}{2}mk^2$		$b=\sqrt{1+h^{\pm 2}}$
$p=2m$	$F_{lag}=\pm m(h+h^{-1})\ x^{\pm 1}\left[\dfrac{(x^{\pm 1}/b)^2-1}{(x^{\pm 1}/c)^2-1}\right]$	$c=1/\sqrt{2-k^{-2}}$

Where required, choose exponents of x and h in accordance with the notation adjacent to networks. In the lag equation, use + sign before m for low-pass units, and − for high-pass units.

$L=0.1592\ hR/F_o$ (h, ohm, cps) or (mh, ohm, kcs) or (μh, ohm, mcs)

$C=159200/hRF_o$ (μf, ohm, cps) or (mμf, ohm, kcs) or (μμf, ohm, mcs)

abbreviating $X_o/R = q_o$ and $X_c/R = q_c$, the insertion ratio becomes more explicitly:—

$$\text{Insertion ratio} = \frac{E/2R}{I_r}$$

$$= \left[\frac{q_o + q_c}{q_o - q_c}\right] + j\left[\frac{q_o q_c - 1}{q_o - q_c}\right] \qquad (9)$$

and the loss and lag equations in terms of the q's become:—

$$\text{Loss} = 10 \log_{10} (1 + F^2_{loss}) \qquad (10)$$

where $F_{loss} \left[\dfrac{1 + q_o q_c}{q_o - q_c}\right]$ and

$$\text{Lag} = \tan^{-1} (F_{lag}) \qquad (11)$$

where $F_{lag} \left[\dfrac{q_o q_c - 1}{q_o + q_c}\right]$

For illustrating the operation of this complete theory of symmetrical circuits, a study was made of a four element network which under proper conditions is suitable for low-pass filter work. The performance of this network together with that of nine other related networks is summarized in Table I. It is understood that each network is terminated with resistances R. Listed are the four ladder networks A to D, most commonly used in low- and high-pass filter work, their bridged-T equivalents, A' to D', derived by making Δ to Y conversions of inductor and condenser combinations, and two mutual inductance type equivalents B'' and C''. The performances of all these ten networks when terminated by resistances R are expressed by a single loss and a single lag equation. When a choice is to be made of an exponent of h or x, it should be in accordance with the notation adjacent to the type designation. For the lag equation, the sign before m is to be plus for A and B types, but minus for C and D types. Parameter k which determines m, n and p applied to L and C to evaluate network elements, must universally be chosen greater than unity, but the sign of the exponent of x provides automatically that infinite loss occurs at $x = k$ for A and B types and at $x = 1/k$ for C and D types. Universal equations provide for computation of the circuit elements for use with a specified R, after a choice has been made of the value of F_o desired to correspond to unity value of the frequency ratio $x = f/F_o$, and of the curve shape parameters h and k. Simplicity of expression of performance and design results because the basic inductance and capacitance values L and C were selected to be of equal numerical impedance hR at F_o, which unfortunately is not the case with the usual terminologies.

Types A and B, likewise C and D may be termed impedance level complementaries. For a given set of values of x and k, the loss for one unit at impedance level h is the same as for its impedance level complementary at $1/h$. Correspondingly, types A and C, likewise B and D may be termed frequency complementaries. For a given set of values of h and k, the loss for one unit at frequency ratio x is the same as for its frequency complementary at $1/x$. All five A and B units therefore can give the same insertion performance suitable for low-pass work, and all

Type of Network	q_o	q_c	q_oq_c
A, A′	$-h/mx$	$-hmx/x^2-1)$	$h^2/(x^2-1)$
B, B′, B″	$h(x^2-1)/mx$	hmx	$h^2(x^{-2}-1)$
C, C′, C″	hx/m	$hm/x(x^{-2}-1)$	$h^2/(x^{-2}-1)$
D, D′	$-hx(x^{-2}-1)/m$	$-hm/x$	$h^2(x^{-2}-1)$

TABLE II. Network Parameters

five C and D units are similarly suitable for high-pass work. Performance information is most easily obtained for the B unit, and this is readily convertible into information for the other three units. Graphical information for impedance complementaries is the same, except that curves labeled with a given value of h, such as 5/3, when they represent type B should be relabeled h^{-1} such as 3/5 when they represent type A. Information for type A is convertible to information for C by plotting ordinate values at x for A and $1/x$ for C.

Network Parameters Tabulated

To assist in the understanding of the relations of the various type unit, functional values of the q's and their products are given in Table II.

Considering first the simpler related frequency complementaries such as units A and C, reactor elements involving like multiplicative and divisive factors such as pL of A and C/p of C are related elements, with the universal property that the related elements are of the same numerical impedance at frequency of reciprocation F_o, such as phR, but one represents an inductance and the other a capacitance. As a result the impedance of any element is the same function of x as its related element is of $-1/x$. This is true also of all similar combinations of elements, such as the parallel resonance impedance of elements involving p and n in the type A and C structures. As a result, the q functions of A and C are frequency reciprocally related and also the loss and lag functions. Because the loss function is to be squared, it is irrelevant as to whether the sign before m is plus or minus, but it is of importance in the determination of lag.

For the impedance level complementaries, the related elements are also one an inductor and the other a condenser, but the universal property is that under the conditions of equal network performance, the products of the impedances of related elements is R^2. Thus the impedance of pL of A at level h is $jphRx$, while the impedance of the related element pC of B at level h^{-1} is $-jR/phx$, and the product is R^2. This is also true of related network arms, with the product of the impedance of the series arm involving p and n in A and the impedance of the shunt arm involving p and n in B also equal R^2. As a result, q_o of A is $-1/q_c$ of B, and q_c of A is $-1/q_o$ of B, provided A and B are at reciprocal levels. By referring back to Eq. (9), the insertion ratio equation is unchanged upon substituting $-1/q_c$ for q_o and also $-1/q_o$ for q_c. Functionally expressed, insertion ratio (q_o, q_c) equals insertion ratio ($-1/_{qc}$, $-1/q_o$). Therefore the insertion ratio, loss and lag are the same for a set of values of x and k, provided h for the A unit is h^{-1} for the B unit.

Bridge and Lattice Networks

Less used types of networks for low-and high-pass purposes are the bridge or lattice types, and also what may be termed the reversed types. The bridge type, separately shown in Fig. 2(a), is not bisectable, but if the terminal currents I_s and I_r are determined in terms of Z, Z_o and Z_c by setting up the mesh equations, the solution will be found to be identical with I_s and I_r for Fig. 1 given in Eqs. (3) and (4). Therefore any bisectable network as in Fig. 1 may be replaced by setting up a bridge as in Fig. 2(a), with the arms of the bridge structurally identical with Z_o and Z_c produced by bisecting Fig. 1, then opening and closing at the center. The equivalent of the type B unit is shown for example in Fig. 2(b), but this would be little used in practice because of the superior practical advantages of the B unit. In the bridge form it is however somewhat simpler to visualize the network performance. Smaller figures (Fig. 2(c) to 2(f)) illustrate the impedances of the bridge arms for the value of x corresponding to zero and infinite loss. For $x = 0$, arm Z_c is of zero impedance and arm Z_o of infinite impedance, wherefore regardless of the circuit constants I_s passes through the network to become I_r without loss or phase shift. For $x = \sqrt{1-h^{-2}}$, a condition is met with $q_oq_c = -1$ corresponding to $Z_oZ_c = R^2$, which by Eq. (5) makes the load ratio upon the source arm unity. The same power flows from the source termination with the network present as would flow with the network absent, and since the network is not dissipative, all the power received by the network flows to the load termination, making the insertion loss zero. For the value $x = k$, all the bridge arms are of the same inductive impedance value and the bridge is balanced resulting in infinite insertion loss. It will be noted the bridge may be balanced if Z_o and Z_c are equally dissipative at the balance frequency, therefore infinite insertion loss at $x = k$ and $x = 1/k$ is possible for some units of Table I, even when the terminations are not pure resistors and the network elements are not pure reactors. This property of networks is the basis of using the type A' unit for checking the departure of an inductor pL

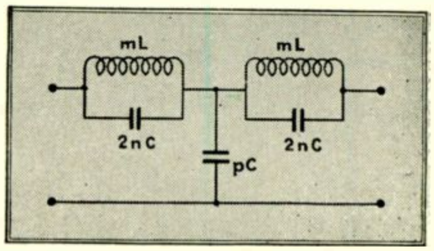


FIG. 3—Reversed A unit

from standard inductance and quality values, using a condenser C/n with variable capacity and loss properties. The final condition of interest at x = infinity makes all of the bridge arms of infinite impedance, thereby disconnecting the sending arm from the receiving arm completely and making the loss infinite.

Bridge networks are more flexible than the other types. Interchanging the arms Z_a and Z_c reverses the phase of the received current without changing the loss. A greater variety of choices of elements is possible. In Fig. 2(b), there is no restriction upon the value of m, so that element mL if desired could be of greater inductance than element L/m. This is not possible with the type B unit, because a real value of k, corresponding to the frequency of resonance of shunt arm nL in series with pC makes m less than unity. A bridge structure with m greater than unity corresponds to a circuit with k a pure imaginary such as $1.25\sqrt{-1}$, so that the bridge cannot be represented by a B or B' unit. Furthermore with m greater than unity, the factor n is a negative quantity. With m greater than unity, the bridge can however be replaced by the B'' unit, with the factor n negative instead of positive calling for a mutual inductance between the two inductors in an additive sense. The performance of the bridge structure or its mutual inductance equivalent is covered by the same loss and lag equations as given in Table I. All that is required is that k be assigned a value not in the real range 1 to infinity, but rather in the range of pure imaginaries. The equations will properly express the performance with k imaginary, just as they will for the value of $x = \sqrt{1 - h^{-2}}$ for zero loss for a B unit being a pure imaginary, when h is chosen less than unity. Therefore the particular bridge of Fig. 2(b) is seen to be no more general than the simpler networks of Table I except as to the possibility of changing the phase lag equation by 180 electrical degrees.

In contrast with the bridge types of low and high-pass filter units, the reversed types have a limited amount of practical value. If for example the π type A unit is bisected, the resulting half sections reversed and the unit reassembled, a five element T unit results as in Fig. 3. By inspection it yields zero loss at $x = 0$, and infinite loss at $x = k$ and x = infinity, and therefore qualifies as being potentially useful as a low-pass unit. Usually the unit of Fig. 3 is used at $h = 1$, $k = 1.25$, or else half of the unit is attached, at the beginning or end or both, to a chain otherwise made up of an integral number of type A units. The broad purpose is to make the loss for the range $x = 0$ to $x = 1$ more uniform than possible with the A unit also operating at level $h = 1$. It is interesting to compare the performance of Fig. 3 under the usual conditions $h = 1$, $k = 1.25$ with the performance of a type A unit, without restriction of the parameters that may be used. For the A reversed unit, as in Fig. 3, the loss function in general is:

$$F_{loss} = mx\left[h^{-1} + \frac{h\,(x^2 - 1)}{[(x/k)^2 - 1]^2}\right]$$

and for the parameters $h = 1$, $k = 1.25$,

$$F_{loss} = 0.168\,x^3\left\{\frac{(x/0.826)^2 - 1}{[(x/1.25)^2 - 1]^2}\right\}$$

In Fig. 4 is shown in heavy lines the loss in accordance with this equation, using two scales of ordinates to permit the loss for the range $x = 0$ to $x = 1.125$ to be shown with enlarged ordinates. For comparison. in dotted lines is shown the loss curve for a type A unit with $h = 0.6$, $k = 1.14$. The parameter h was chosen to give reasonably uniform loss in the low loss range, and parameter k was chosen to match the solid curve as to the 8db difference between maximum loss in the low loss range and minimum loss in the high loss range. The slopes of the curves in the transitional region are very closely the same. If a figure of merit could be established, based upon the uniformity of loss in the low loss range, the useful difference of losses in the two ranges, and the speed of transition from one range to the other, then presumably the five element unit would not receive a much higher rating than the four element unit.

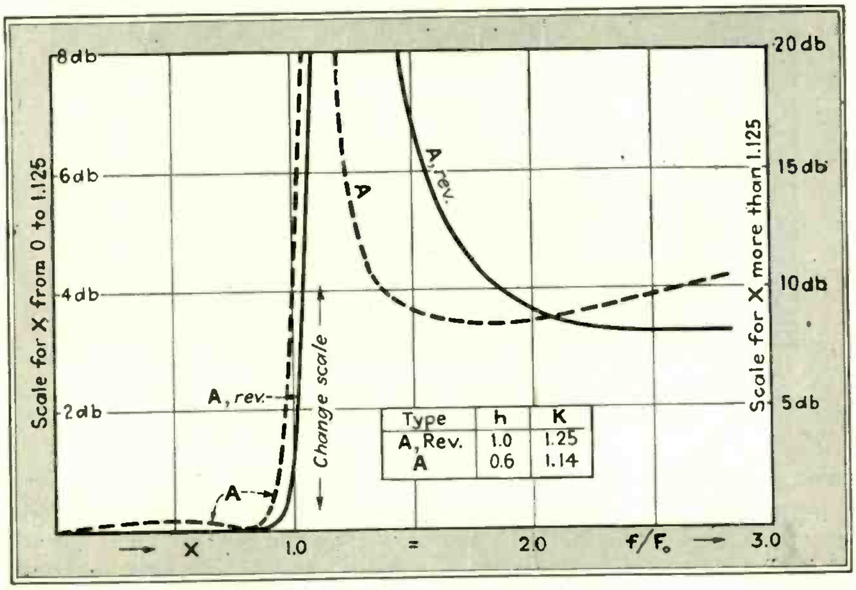


FIG. 4—Comparison of behavior of network A, and A reversed

While this method of treating low- and high-pass electric wave filter units is somewhat different from the conventional methods of analysis, it is hoped that the point of view which is expressed in this article may be found useful by the reader in the design and construction of his own filter elements. It is believed that the analysis on the basis of bisectible networks has certain advantages over those analytical approaches which are more frequently encountered in the technical literature and with which the average engineer is more familiar.

Rolled Steel

By C. C. Horstman

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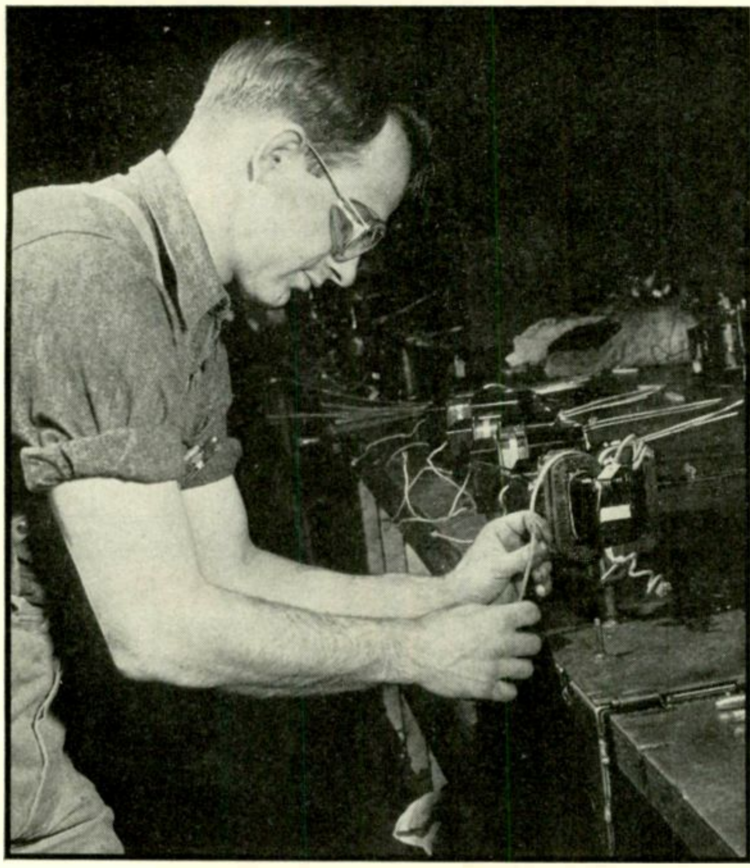

Applying the metal band which holds together the two sections of a rolled Hipersil core for a radio transformer

FOR several years Hipersil* cores have been used to great advantage for large distribution and power transformers. The result of research to develop an electrical steel with higher permeability, Hipersil permitted the redesign of transformers to take full advantage of the lower core losses.

A silicon steel like Hipersil, when processed to produce favorable orientation of the crystal lattice, is characterized by excellent magnetic properties in the direction of favorable orientation, which is the rolling direction. This crystal and domain orientation results in the material having a very high permeability at both high and low flux densities, a high incremental permeability and very low losses in the rolling direction. The actual permeability values are as good as some of the nickel steels, and approach the permeability of the best nickel alloys such as Hipernik and Permalloy.

With these properties it is possible in many cases to substitute Hipersil cores directly in applications now using nickel alloy laminations without lowering the performance. In some cases the designer may obtain advantage from the substitution because Hipersil cores combine the good low-density properties of the nickel alloys with the high saturation of silicon alloys, thus providing a very high permeability at high density.

The maximum permeability of the Hipersil core occurs at about 2 kilogausses higher density than that of nickel alloy steels, a property that may be used to advantage by the design engineer. Core losses are about 25 percent lower than for the best grade of high silicon steel heretofore available. With the low losses and increased permeability, smaller designs result, saving copper and core steel; this provides a transformer of reduced size and weight, a highly important factor in aircraft and portable equipment.

New Core Construction Method

To make full use of the directional properties of Hipersil core material it was necessary to develop a new type of construction in which the flux always travels in the direction of rolling of the steel. This type of core construction is shown in Fig. 1.

The core is made by winding strip on a rectangular mandrel of desired dimensions. After the core is wound it is annealed at high temperature and is impregnated with a plastic compound so as to provide a solid unit. The impregnated core is then cut into two parts and the cut surfaces machined and processed. This produces a very closely cooperating butt joint in the magnetic circuit, when reassembled with the coils.

It has been proven by many experiments throughout years of use in power transformers that this butt joint will not increase the core losses. So far as exciting current is concerned, each joint is equivalent magnetically to about a ½-mil air gap. The butt joint used in this type of construction has very definite advantages at high frequencies or at high induction.

As illustrated in Fig. 2, the conventional type of alternate butt and lap joint used with "E" and "I" punchings tends to distort the flux and causes poor results when used at high frequencies or at densities higher than 15 kilogausses.

Form-wound copper coils are used with Hipersil cores, thus retaining all the advantages of pre-wound and pre-tested coils. The cores are assembled on the coils as shown in Fig. 3 and are held together by metal bands and seals similar to those used for packing crates. The bands are put on with a specially developed tool which provides the correct tension.

For small radio transformers, this type of construction lends itself to easy and simplified end framing and mounting. The resultant saving in manpower is a direct contribution toward the gigantic task confront-

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* Registered Trade Mark, Westinghouse Electric & Mfg. Co., coined from "high permeability silicon steel."

Cores for Radio Transformers

Transformer cores can be made appreciably smaller and lighter in weight by means of a constructional method radically new in the radio field. The core is rolled from a single long strip of high-permeability silicon steel, cut to insert the coil, then clamped together

ing this country in building communication devices for war use.

Normally, 29 gauge Hipersil steel is used for cores. Because of its oriented structure, it is suitable for power units at frequencies up to 400 cycles. Actually, up to this frequency Hipersil cores will have lower losses and higher permeability than ordinary 5 mil "E" and "I" laminated cores. For applications at higher frequencies, a core made by the same method has been developed using a thinner silicon steel with the properties of 5 mil silicon steel. The space factor of this core is as high as 92 percent, which represents a great increase in space factor over that of the equivalent stacked core. In addition, the core takes advantage of directional properties and all of the material is active; there are no dead corners as in "E" and "I" stacked cores. The labor saved in the assembly of this type of core, involving either two or four pieces, is easily seen when compared with the assembly of conventional cores using thinner gauges of steel.

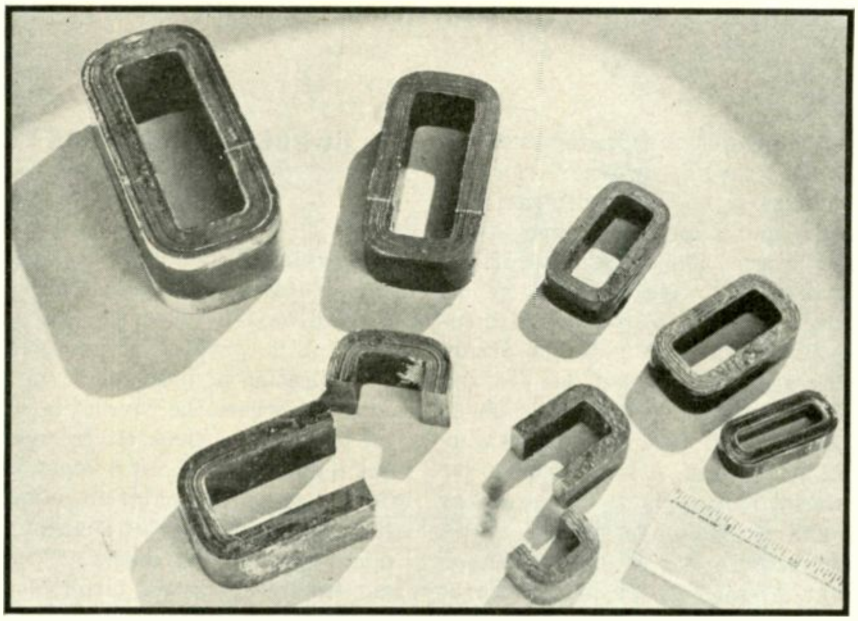

FIG. 1 (above)—Completed rolled Hipersil córes for radio use are smaller in size and lower in weight than comparable stacks of laminations

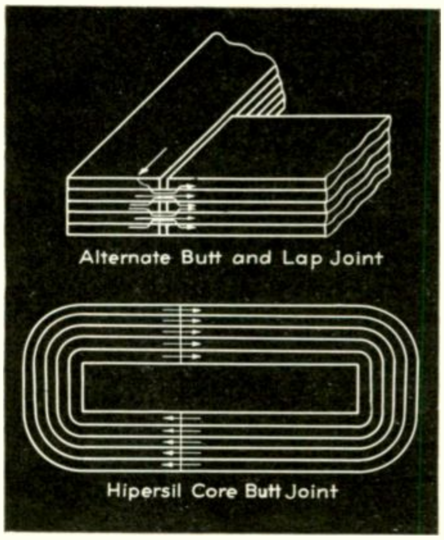

FIG. 2 (left)—The machined butt joint of a Hipersil core eliminates crowding of flux in every other lamination of a conventional alternate butt and lap joint

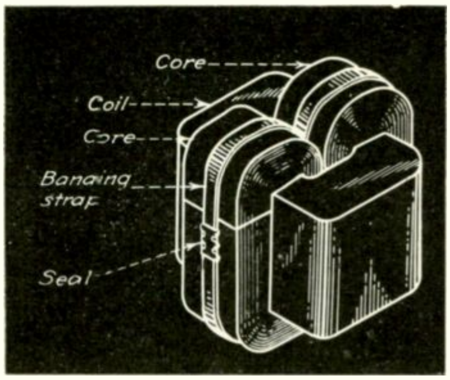

FIG. 3 (right)—Shell form of assembly using two Hipersil cores

For special applications involving high frequencies a new extra-thin steel has been developed which utilizes the same core construction and solves a knotty problem. It has outperformed every other available material and construction method in these applications. The space factor of these extra-thin-gauge cores is 89 percent and the assembly labor saving over punched laminations is tremendous. As previously explained, the butt joint is very advantageous for the high frequencies involved.

In general, Hipersil cores offer new freedom to the designer of iron-core communication devices such as power and audio transformers, relays, chokes, loading coils and kindred devices, by giving high permeability at both high and low flux densities, high incremental permeability and low losses. The cores using thinner-gauge materials offer great advantages in the whole series of applications from audio to ultra-high frequencies; how well they fit an individual application will be determined by its requirements.

The SWINGING FILTER

Engineering comments on the purpose, proper design and correct use of variable inductance chokes for filtering the output of rectifier systems. Optimum performance of swinging choke depends upon its use in circuits meeting specifications for which it was designed. Poor performance may result from misapplication of well designed unit

By ROBERT M. HANSON
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THE SO-CALLED swinging choke is often used by designers of rectifier-filters as the first element of a choke input filter. This type of reactor was so named because of the characteristic wide variation of inductance as the direct current component is varied. This discussion will cover the design principles and the application of this type of choke from both the theoretical and practical standpoint. A large part of the material will apply to the ordinary smoothing reactor as well.

Inductance may be defined as follows: A coil has an inductance of one henry when an electromotive force of one volt is induced by a uniform current-change of one ampere per second.

Any change of current through the winding will result in the generation of a voltage across the coil having a polarity opposing the voltage causing the current change. The definition of inductance gives the magnitude of this voltage as a measure of the inductance. This voltage will be zero when the current in the coil is constant. Consequently the application of inductance will be to circuits where the current is subject to change. The electromotive force induced in the coil is commonly referred to as its excitation voltage. Alternating current equipment is usually specified in terms of root-mean-square sine wave terminology, and a choke specification is not complete unless the excitation voltage and frequency are specified as well as the inductance and the average value of the direct current flowing through it.

A manufacturer's catalog will seldom list the rating of excitation voltage for an iron core filter reactor. In the normal application the maximum choke excitation voltage will be determined by the direct voltage of the power supply and the type of rectifier circuit chosen. The insulation test voltage of the choke is usually given and the unit recommended for operation in rectifier circuits where the direct voltage is from thirty to fifty percent of this rms test voltage. The unit will have been designed to withstand the excitation voltages encountered in this service. It would be bad practice to insulate the core of a low test voltage choke by mounting it on standoff insulators and to connect the coil in a high voltage rectifier filter, unless it had been determined that the permissible excitation voltage would not be exceeded. Such a condition would be characterized by the noisy operation, poor filtering, erratic rectifier tube operation (possibly with the load shifting from tube to tube), and early failure of internal coil insulation.

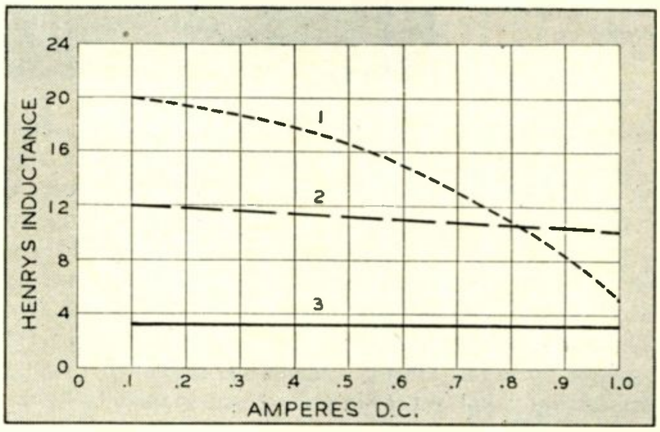

Fig. 1—Inductance of typical iron core coils intended for use in power supply filter circuits. Curve 1 represents desirable characteristics for one type of swinging choke. Curve 3 represents characteristics of coil whose inductance is independent of current through it. Curve 2 represents compromise between 1 and 3

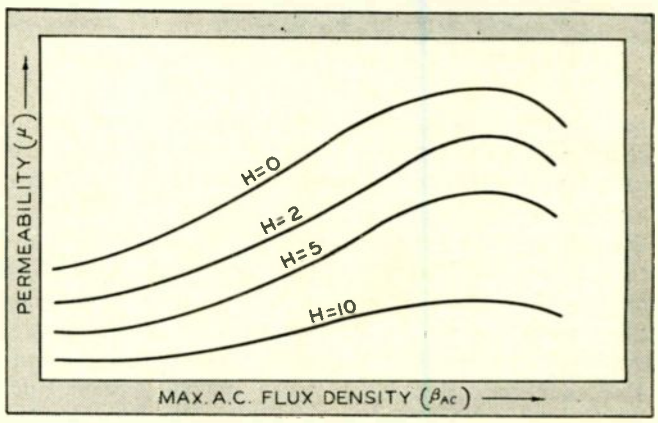

Fig. 2—Curves representing the variation of permeability plotted against maximum a-c flux density for iron core coils with varying degrees of magnetic intensity, *H*, resulting from direct current flowing through the coil. The relative values of *H* for each case is indicated on the individual curves of the family

CHOKE

TABLE OF RECTIFIER CIRCUIT CHARACTERISTICS	Type of Circuit			
	Single phase full wave		Three phase half-wave	
	Using 2 tubes	Bridge using 4 tubes	Using 3 tubes	Bridge using tubes
Ratio of ac voltage to dc output voltage				
1. Transformer secondary rms volts per leg	1.11	1.11	0.86	0.43
2. AC components of rectifier output, rms				
At ripple frequency	0.47	0.47	0.18	0.04
At ripple 2nd harmonic	0.10	0.10	0.04	0.01
At ripple 3rd harmonic	0.04	0.04	0.02	....
Ripple frequency, where f is supply frequency	$2f$	$2f$	$3f$	$6f$
Ratio of tube currents to direct current				
Peak anode current	1.00	1.00	1.00	1.00
Average anode current	0.50	0.50	0.33	0.33

The manufacturers of filter chokes usually catalog the swinging and smoothing reactors in sets rated according to the direct current capacity. As the requirements of different applications will vary, the ratings have been standardized by listing the inductance of the smoothing choke at maximum rated direct current, and giving the inductance of the swinging choke at both maximum and at 10 percent of the maximum rated direct current. Typical design values would be 10 henries for the smoothing choke and a swinging choke with 6 henries at rated current and 15 henries at 10 percent of rated current. An alternate set of values might be 12 henries for the smoothing choke and 5 to 20 henries for the swinging choke. The companion set of swinging and smoothing chokes will usually be found to be exactly the same overall size, and to have identical coil construction. Curve 1 of Fig. 1 shows a typical curve for a 1 ampere swinging choke.

Ratings of Filter Chokes

Curve 2 of Fig. 1 shows the inductance-current characteristic of the regular smoothing reactor where the unit is designed for optimum inductance at rated current. The inductance at maximum rated current is approximately twice that of the swinging choke but the increase of inductance is only about 20 percent at 10 percent rated current.

Curve 3 of Fig. 1 shows the inductance-current curve of a filter reactor designed for constant inductance. These three curves were plotted from measurements made on reactors having identical coil and core sizes. The only difference was in the design of the magnetic circuit of the three units. The swinging choke has a relatively small air-gap in series with the magnetic circuit compared to the gap in the unit set for optimum inductance.

The inductance of an iron core filter choke may be determined by the following expressions:

$$L = K N^2 \mu / b \qquad (1)$$

where, L is inductance in henries,
K is factor expressing core area, units, etc.,
N is number of turns in winding,
μ is permeability of core steel, and
b is equivalent length of magnetic circuit flux path including effect of air gap

All of these factors except the core permeability are essentially independent of the magnitude of the direct current in the winding. However the permeability factor is variable depending upon the direct current magnetization of the core, and also upon the a-c flux density in the core. An increase of the d-c magnetization tends to decrease the permeability, while an increase of the a-c flux density increases the permeability up to a certain value after which further increases of flux density results in rapid decrease of permeability. The silicon steel commercially used in filter chokes can give a permeability change of as much as 30 to 1 over the extremes of d-c magnetization, and a change of 10 to 1 with variations in a-c flux density.

The flux density in the core resulting from the direct current in the winding is expressed by the following formula:

$$B_{dc} = 0.4 \pi N I \mu / b \qquad (2)$$

where, B_{dc} is flux density in gauss,
π is 3.14,
N is number of turns in winding,
I is direct current in amperes,
μ is permeability of core under operating conditions,
b is equivalent length of magnetic path including effect of air-gap.

This flux represents energy stored in the magnetic field and once established, no additional energy is required to maintain it.

This filter reactor will have an alternating voltage applied to the winding that is dependent upon the amount of ripple voltage requiring filtering. The frequency of this voltage will depend upon the power line frequency and upon the type of rectifier circuit selected. With a 60 cps single phase, full wave, two tube rectifier, the principle component will be 120 cps with smaller 240 and 480 cps components.

The fundamental relation between magnetic flux ϕ and induced voltage E is:

$$E = 10^{-8} K N f \phi = K N f A B_{ac} \qquad (3)$$

where, E is effective voltage, in volts,
K is constant,
N is number of turns in winding,
f is frequency in cps,
ϕ is total flux in core,
A is area of core cross section, and
B_{ac} is flux density (maximum)

Rearranging Eq. (3) we find

$$B_{ac} = 10^{-8} E / K N f A \qquad (4)$$

The maximum instantaneous flux density in the core will be the sum of B_{ac} and B_{dc}. The design must be such that this total does not exceed the saturation value for the core material used. It is evident from Eq. (2) and (4) that the designer may set the values of a-c and d-c flux densities at any desired value within

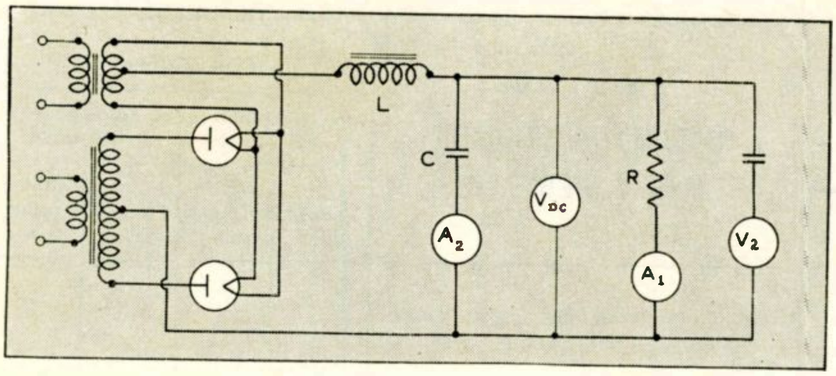

Fig. 3—Schematic wiring diagram of single-phase, full-wave rectifier, filter and load

limits by proper selection of the design elements of number of turns, core area, length of magnetic path in iron, length of magnetic path in air, grade of core material, and operating point of magnetic material.

The d-c magnetomotive force in gilberts per centimeter will be

$$H_0 = 0.4\pi N I / b \qquad (5)$$

where H_0 is the force establishing the flux in the magnetic material having a mean length of path b.

The relative effects of d-c magnetization, and of a-c flux density upon the permeability of a core material are shown in Fig. 2. The abscissa represents the range of a-c flux density from low values to the saturation point, the ordinate is proportional to permeability, and the family of curves shows the effect of various degrees of d-c magnetization. It can be seen that for any constant value of a-c flux density the permeability is a maximum for zero direct current, and decreases as the direct current is increased.

Design of Swinging Chokes

The problem in designing a swinging choke is to cause the inductance to increase when the direct current in the winding is decreased, and assuming the a-c excitation voltage to be kept constant. Reference to Eq. (1) shows that the change must be accomplished by a change in the permeability μ. From Eq. (4) we see that the a-c flux density will not change when the direct current is changed and the a-c voltage, E, is kept constant. However, Eq. (5) shows that the d-c magnetomotive force is directly proportional to the direct current in the winding. Therefore, when the direct current is decreased, the value of H from Eq. (5) will decrease, the resultant permeability shown on Fig. 2 will be increased, and consequently the inductance will increase as shown by Eq. (1).

If the magnetic path of the reactor consisted entirely of iron the change of inductance would be directly proportional to the change in permeability. This sets the absolute limit for the inductance ratios of a swinging choke at the permeability ratios resulting from the maximum and minimum values of magnetomotive force.

A reactor with no air gap in the magnetic circuit, and carrying direct current, would have a relatively large value of H and therefore a low permeability. Placing an air gap in the circuit would increase the effective length of path shown as b is Eq. (5) and result in greatly decreased H. This increased effective length of magnetic circuit, and the value of increased permeability due to decreased H, may be substituted in the inductance formula Eq. (1). It may be found that the increased permeability more than compensates for the increased magnetic path and the result is that the choke with the air gap will have a higher inductance when carrying direct current than the choke with a closed magnetic circuit. It will also be found that there is an optimum value of air gap giving a maximum inductance and this value will be different for each value of direct current. As the amount of direct current is increased the optimum air gap will also become larger.

Swing Choke Adjustments

The swinging choke is adjusted with an air gap that is at the optimum value giving high inductance at the lowest current and consequently the gap will be smaller than optimum at the high current and the inductance at high current will be low. Reference to Fig. 1 shows this effect clearly. Curve 1 shows a reactor with a small air gap giving 20 henries at 0.1 ampere d-c and only 5 henries at 1 ampere. Curve 2 shows the gap adjusted for the maximum inductance of 10 henries at 1 ampere. This large air gap minimizes the effect of permeability variations and the inductance only increases to 12 henries at 0.1 ampere dc. Curve 3 shows the effect of a very large air gap resulting in an inductance below the maximum at 1 ampere, but it is practically constant regardless of variations of direct current.

The engineer designing the swinging reactor will calculate the inductance at both the low and high currents. The design is modified until these two inductances are the values specified. Further investigation must then be made to be sure that the core material is not saturated at the high value of current. After the reactor is assembled the air gap may

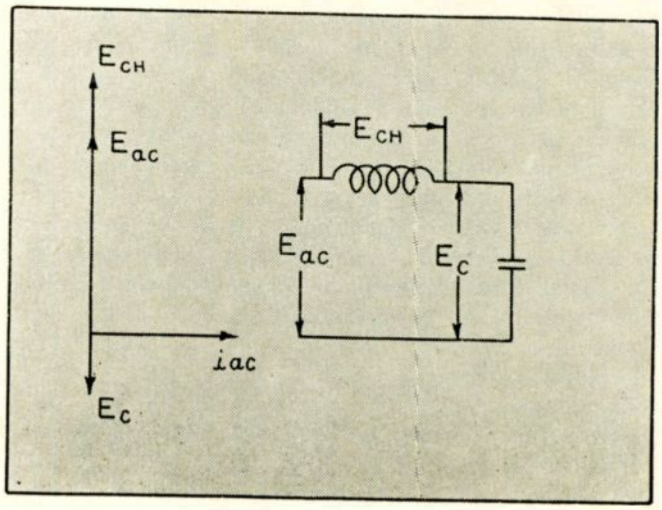

Fig. 4 — Vector diagram of voltages across elements of simple L-type filter, illustrating the possibility of attaining resonance

be adjusted until the inductance at the high current is the exact value specified. The inductance at the low current is then measured. If this value of inductance did not meet the specifications it would be necessary to correct the entire design as both inductances cannot be independently adjusted by means of the air gap.

Ripple Voltage Considerations

The value of the a-c excitation voltage is necessary in designing these reactors. Figure 2 shows the permeability change with flux density, and indicates how it drops to a very small value after the density exceeds a certain value. This means that a reactor might be designed and tested to give a specified inductance at an excitation of 10 volts r.m.s. 60 cps, and yet when the choke is installed in the filter where the excitation is 1500 volts 120 cps it could be unsatisfactory. However the practice of measuring the choke at such low excitation is perfectly satisfactory providing it has been designed for the operating conditions, and this measured inductance is considered as a figure of merit for the reactor rather than the actual operating inductance to be used in circuit design.

The references on the subject of filter design, given in the bibliography, explain in detail how to determine the size of reactor and condenser required for a specific ripple percentage, and for proper limitation of peak rectifier tube current. A portion of the standard table of rectifier design data will be given here for discussion purposes. The data of this chart was determined assuming choke-input filter with infinite inductance, zero voltage drop in tubes and choke, and perfect regulation in power transformer and supply line.

The chart shows that the rectifier output will have a fundamental ripple frequency that is dependent upon the supply frequency and the type of rectifier circuit used. With a 60 cps supply the regular full-wave circuit will have a principle ripple voltage at 120 cps and the magnitude of this ripple voltage is shown to be 47 percent of the direct voltage. The three-phase half-wave circuit would have a fundamental ripple voltage at 180 cps and have a root-mean-square value equal to approximately 18 percent of the direct voltage. The three-phase full-wave bridge rectifier would have a fundamental ripple voltage at 360 cps and an r-m-s value equal to 4 percent of the direct voltage.

The exact magnitude of the various ripple components will differ from the values given in the chart in actual practice because of non-sinusoidal waveform of supply voltage, reactance in the power transformer, resistance in filter reactor, voltage drop in rectifier tube, and an input reactor with an inductance that is not relatively infinite.

A single-phase full-wave rectifier circuit is shown in Fig. 3. The output of the rectifier is delivered to

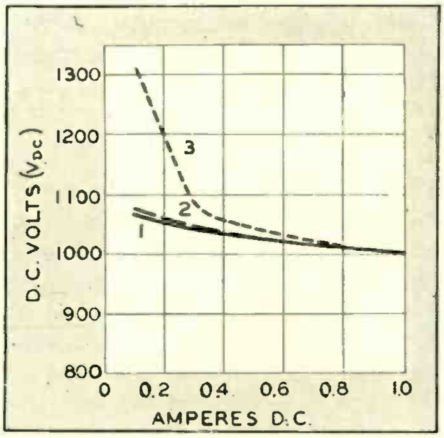

Fig. 5—D-C voltage regulation for the full wave rectifier circuit of Fig. 3, for the three chokes whose variation of inductance with saturation current is shown graphically in Fig 1

the load R through a single section choke input filter consisting of the reactor L and the condenser C. This 6-μf condenser will have a reactance of approximately 220 ohms at 120 cps. The load resistance R was adjusted from 1000 to 10,000 ohms to give a direct current range of 1 ampere to 0.1 ampere when $V_{dc}=1000$ volts. There will be a flow of direct current through the reactor and the load resistor R. There will also be a flow of alternating current through the reactor L and the parallel impedance of the condenser C and the resistance R. However the reactance of the condenser is so much smaller than the resistance of the load that the actual load resistance has little effect upon the magnitude of this alternating current.

The peak value of the excitation voltage of the filter reactor L will be equal to the product of its reactance and the alternating current flowing in the winding *i.e.*, $\sqrt{2}\,E_{ac} = 2\pi f L I_{ac}$ volts.

Avoiding Resonance Effects

If this current is to be calculated the circuit must be solved by the use of complex algebra as the reactor consists of an inductive reactance in series with a resistance depending upon the Q of the choke, and the condenser is in series with these two elements and consists of a capacitive reactance. As the inductive reactance of the choke becomes smaller with decreased inductance it will approach equality with the reactance of the condenser and the voltage across the reactor will increase. If the reactance of the choke and condenser become equal we have a condition of series resonance and the voltage across the reactor may become much greater than the actual ripple voltage from the rectifier. This condition of series resonance must be avoided as it will result in high peak current through the rectifier tubes, excessive voltage across the filter choke, and high ripple voltage at the load.

The vector relationships between the filter input voltage E_{ac}, the choke excitation voltage E_{ch}, and the output ripple voltage across the condenser E_c are shown in Fig. 4. If the choke is a pure reactance the voltage induced will lead the current by 90 deg. The voltage drop of the condenser will lag the current by 90 deg. The input voltage E_{ac} will be the vector sum of these two voltages. Examination of the vector diagram shows that the choke excitation voltage will tend to be greater than the filter input ripple voltage. It is also evident that a decrease of inductance will result in increased voltage drop across the choke as well as increased ripple voltage across the condenser.

Under operating conditions with the usual rectifier-filter combination, the excitation voltage for the input filter reactor will have an approximate root-mean-square value equal to 50 or 60 percent of the d-c output voltage. This means that the choke excitation voltage for a filter in a single-phase full-wave supply delivering 3000 volts d-c would be about 1500-1800 volts r.m.s., at 120 cps if the supply is 60 cps. The reactor for this service must be de-

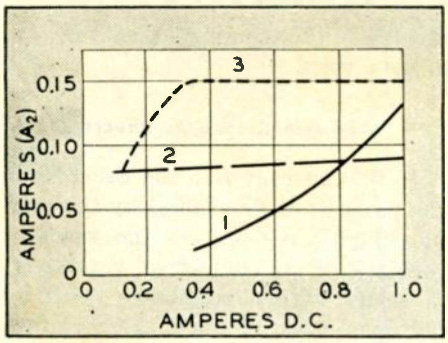

Fig. 6—Current through the filter condenser, C of Fig. 3, for choke coils whose characteristics are given in Fig. 1. The numbered curves have the corresponding significance in Figs. 1, 5, 6, and 7

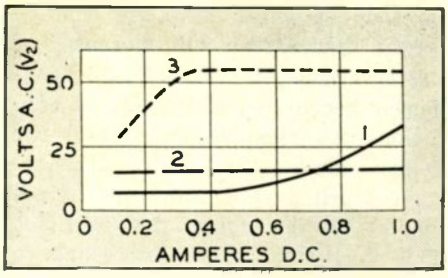

Fig. 7—Ripple voltage, measured by voltmeter V_2, across the load, R, for the three types of choke coils given in Fig. 1

signed with sufficient turns and adequate core area to avoid excessive flux density and saturation of the core. A 5-henry, 1-ampere reactor designed for service in a 400 volt d-c supply would not operate in place of a 5-henry, 1-ampere reactor designed for use in a 3000 volt d-c power supply. However the high voltage unit would be satisfactory in the low voltage supply providing the low excitation did not result in low inductance. It is also perfectly possible that both units might measure 5 henries at 1 ampere dc and an excitation of 10 volts 60 cps.

The actual current in the winding of the input filter reactor has been shown to consist of a steady current to the load with a superimposed alternating current flowing through the filter condenser. If the reactance of the condenser be considered negligible compared with the reactance of the reactor, this alternating current will be $E_{ac}/2\pi fL$, where E_{ac} is the ripple voltage at the filter input. The peak value of this current will be equal to $\sqrt{2}E_{ac}/2\pi fL$ amperes. Now as long as this peak value of current is less than the direct current flowing in the reactor there will never be a period of zero current in the choke. But if the direct current be reduced in value to less than this peak alternating current there will be a period of zero current for a part of each cycle. The rectifier tubes pass current in one direction only and prevent passage of the negative part of the alternating current. The action is somewhat similar to overmodulation of a high level class C radio frequency amplifier. During these periods of zero current through the reactor, the load current must be supplied by the filter condenser charge. At the beginning of the next conducting cycle the rectifier current will rise to a high value and restore the condenser charge. The limiting condition is obtained when the load has been removed entirely and then the filter condenser will become charged up to the peak value of the transformer secondary voltage.

Effects of Decreased Load Current

This analysis indicates that as the load current is decreased the rectifier will operate properly with good regulation until the point where the direct current has a magnitude equal to the peak alternating current flowing in the filter reactor, and then as the current is further removed the direct voltage will rise until it equals the crest value of the transformer voltage as a limit. As the direct current is reduced below this critical point part of the alternating current cycle will be cut off, consequently its r-m-s value will be decreased. This will result in decreased *IX* drop in the filter condenser and a lower value of measured ripple voltage.

Curves 3 of Figs. 5, 6 and 7 show measured values of these effects using the circuit of Fig. 3, and a 3-henry reactor shown on curve 3 of Fig. 1. The approximate formula for determining the critical direct current in amperes was given as follows:

$$I = \sqrt{2}\,E_{ac}/2\pi f L \qquad (6)$$

As this was a 1000-volt rectifier we take, from the table, 0.47 times 1000 to get the value of the 120 cps ripple voltage E_{ac}. Substituting in Eq. (6) gives us

$$I = \frac{\sqrt{2} \times 470}{6.28 \times 120 \times 3} = 0.3 \text{ ampere}$$

The measurements show this to be the critical current. Curve 3 of Fig. 5 shows a sudden rise in direct voltage as the direct current is reduced below 0.3 ampere. Curve 3 of Fig. 6 shows a sudden decrease in the condenser displacement current as the direct current is reduced below 0.3 ampere, while Fig. 7 also shows the corresponding sudden decrease in ripple voltage. It must be remembered that the current of Fig. 6 is an average value over the complete cycle and actually the peak value through the rectifier may be increasing seriously.

Equation (6) may be rewritten to give the minimum value of inductance in henries that is required for a given set of voltage and current operating conditions:

$$L = \frac{\sqrt{2}\,E_{ac}}{2\pi f I} \qquad (7)$$

The minimum inductance for our filter operating from 0.1 to 1 ampere d-c is determined from Eq. (7). At 1 ampere L must be more than 0.9 henry and, at 0.1 ampere L must be more than 9.0 henries.

Curve 2 of Figs. 5, 6 and 7 show the operation with choke 2 of Fig. 1. The inductance varies from 10 to 12 henries. The regulation is satisfactory, the condenser current decreases very slightly due to the 20 percent increase of inductance, and there is a corresponding slight decrease in ripple voltage as the direct current is decreased. The ripple voltage is approximately one fourth that obtained with the 3-henry reactor. This reactor would have adequate inductance at every current to permit proper operation of the filter.

Solution of Eq. (7) above showed that the inductance must be at least 0.9 henry at 1 ampere d-c and increase to 9.0 henries at 0.1 ampere. If filter reactors were to have a constant inductance that was independent of the magnitude of the direct current, it would be necessary to install a 9-henry reactor. But if a unit could be constructed to have 0.9 henry at 1 ampere, 9 henries at 0.1 ampere dc and be above the critical inductance for all intermediate current values, it would serve the purpose and quite possibly would be smaller and cheaper than the 9-henry constant inductance unit. The swinging choke is the answer to this problem.

The selection of the proper input filter reactor requires consideration

(Continued on page 335)

COURT DECISIONS
Affecting Broadcasting

A review of broadcasting cases on which decisions were made by higher courts in 1942. The rulings are definite and authentic interpretations of modern law as it pertains to broadcast stations, expressed here in language readily understood by technical readers

By LEO T. PARKER
Attorney at Law, Cincinnati, Ohio

PRESENT unusual and emergency conditions make for legal controversies. However, many modern higher courts recently have rendered interesting and informative decisions that will enable readers to avoid similar legal pitfalls. The purpose of this article is a review of decisions made during 1942.

Cancellation of Commercial Program

First, we shall consider an important point of law relating to broadcasting contracts. Considerable discussion has arisen from time to time over the legal question: When and under what circumstances may a broadcasting station cancel advertising and other contracted programs without any liability?

Briefly, the answer is: When it becomes impossible through no fault of the broadcasting station to complete the contract. Obviously, the legal interpretation of the word "impossible" is important when deciding a controversy of this nature. Any Government regulation that prevents completion of the contract satisfies the legal impossibility of fulfilling a broadcasting contract.

For example, in King v. Valley Broadcasting Company, 43 F. Supp. 137, the higher court held that a treaty between the United States and a foreign country by the terms of which a station's power was reduced constituted a valid reason to breach a broadcasting contract.

In this case it was shown that station XEAW was being operated from Reynosa, Mexico and had contracts to broadcast advertising programs. A treaty between Mexico and the United States contained provisions necessitating changing the location of station XEAW and reducing its operating power. In holding that this fact automatically cancelled all contracts for broadcasting over the station, the court said:

"A treaty effective and binding upon the contracting parties binds the courts and affects contracts theretofore entered. Courts have no right to annul or disregard any provisions. . . ."

The reason for this decision is that when because of "impossibility", not within control of either contracting party, a contract cannot be performed in accordance with the original intentions of the contracting parties, such contract is automatically and absolutely cancelled.

How Ceiling Prices Affect Legality of Sales Contracts

In the case of Kremer, 43 N.E. (2d) 492, decided by a New York higher court, the testimony disclosed that a contract for purchase of merchandise between a buyer and seller clearly stipulated that any controversy arising under or in relation to this contract shall be settled by arbitration.

Subsequently, the seller contended that the establishment of "ceiling" price automatically invalidated the contract and that he was not required to make delivery of the merchandise specified in the contract, because the "ceiling" price established by OPA was lower than the contract price.

However, the purchaser contended that the controversy must be arbitrated in accordance with the above-mentioned arbitration provision in the contract.

It is interesting to observe that the higher court held that the arbitrators could not enter into this discussion, and also held that the contract need *not* be fulfilled by the seller since the contract was automatically cancelled by the Federal "ceiling" price order which was less that the price the purchaser had agreed to pay for the merchandise.

Also, many late higher courts have gone so far as to hold that a lease on real property is automatically cancelled if through Government regulations the lessee is unable to continue operating his business. Such regulations may relate to "frozen" merchandise, or inability otherwise to perform usual and regular business transactions.

Wording and Intent Govern Legality of Contract after One Party Dies

Modern higher courts hold that the proper and legal interpretation of any contract must be based upon the "intended" obligations of the contracting parties at the time the contract was made or signed. Moreover, unless testimony is given explaining unusual wording or formulation of a contract the court will determine the rights of the parties by reference to the contract itself.

A PATENT . . .	**A COPYRIGHT . . .**	**A TRADEMARK . . .**
. . protects the production and use of the creative conception reduced to practical shape in various forms. . . is based upon evidence of priority in time. . . protects from the date the patent is allowed. Persons making, using or selling a patented article are guilty of infringing the letters patent even though they may have invented the same thing without knowledge of the existing patent. . . does not protect during the period a patent is pending or before an application is made, and hence gives no right to collect damages for anything done before the patent is allowed. The phrase "Patent Applied For" has no legal value; anyone may make a device so marked, up to the day the patent is issued.	. . protects the publication of copies in the form of substance of the particular creative conception in which it has been impressed by the author. Recomposition of material without copying is *not* an infringement of a copyright. . . is independent of priority in time. . . is non-exclusive in the sense that different persons may apply for and receive a copyright on exactly the same thing if they invented it or designed it independently of each other. . . is issued only *after* publication of the material. . . is absolutely forfeited unless all copies offered for sale or released on the market are properly marked so everybody knows that the author or composer either has or intends to obtain a copyright.	. . is a name, mark or other distinctive symbol which is attached to saleable products. . . is independent of priority in time of filing of application for registration. . . is adapted to obtain protection against infringement, and to establish in the minds of purchasers the quality of the product the mark represents. . . is not in any sense the name of a manufacturer or business, which is legally a trade-name. . . is infringed, with liability for damages, even though the owner of the trade-mark has not filed an application in Washington to register it. . . requires no notice on the product that trade-mark protection is desired.

For example, in Segar, 22 N.Y.S. 790, a contract provided that an employer or sponsor was to pay an employe a percentage of all money derived from his services for radio and other rights. The employe died and the question presented the court was whether the employer was obligated to pay the specified percentage on contracts taken after the employe's death.

Since the contract provided that the employer was to have full ownership in all drawings, manuscripts, etc., and the contract provided that the contract was effective so long as the employe performed satisfactory services, the higher court held that the employe's dependents and heirs were not entitled to further payments. This court said:

"The words used had a very definite meaning. They fixed the term of the contract to the date the employe might cease performance of his personal services. . . ."

Five-Year Restrictive Clauses Are Legal for Salesmen

Modern higher courts recognize the fact that trade secrets, confidential information, lists of customers names, and the like are valuable property. Furthermore, employment contracts are valid by which a salesman, or other employe, agrees not to accept employment with a competitor for a reasonable period in the territory in which the employer's customers or patrons are located. Generally, five years is considered by the courts as a reasonable period.

For illustration, in Briggs v. Butler, 45 N.E. (2d) 757, reported January, 1943, it was shown that a salesman was employed to solicit advertising under a contract which contained a clause that the salesman would not for a period of five years, from the date he left the employment, engage himself with another employer in the same or similar kind of business. The employer expended money in training the salesman who soon afterward resigned and took employment with a competitor. The record discloses that the new employer pursued substantially the same plan as that adopted and employed by the first employer, and in the performance and promotion of which contracts with business establishments as sponsors, had been procured and patrons thereof solicited. In fact, contracts with several business houses as sponsors were secured by the salesman for the new company within a few days after starting with the new employer.

The first employer filed suit against the salesman and asked the court to grant an injunction to prohibit him from continuing the new employment. The higher court granted the injunction, and said:

"It is to be observed that the restrictive provisions of the contract relate only to 'the same kind or similar business', in competition with the company, and do not undertake otherwise to prevent or limit the trade, occupation, profession, business or activities of the defendant (salesman). The clear purpose and effect of the contract is to prevent or at least to limit the appropriation of the benefits of information and experience secured in service with the plaintiff (first employer) and the employment thereof for his own personal advantage and to the disadvantage of the plaintiff by becoming a direct competitor, as in fact did occur in this instance. . . . For the reasons indicated, we are of opinion that under the facts disclosed by the record the restrictive covenants of the contract entered into, by and between the plaintiff and defendant do not impose a restraint beyond that reasonably required for the protection of the employer in his business . . . and are therefore valid and enforceable."

The reasons restrictive contracts of this nature are valid is first, because a business is built upon the confidence of its customers and the employe gains acquaintances and sells the customers by using the good will of the employer; and, second, the employer's dealings with his customers through the employe give the employe confidential knowledge that should not be divulged or used for his own benefit.

(Continued on page 268)

ELECTRONIC CONTROL of D-C Motors . . . Part II

Constant predetermined speed of d-c shunt motors is obtainable by operating them from a-c lines with thyratrons for controlling the armature voltage. Constant voltage reference system required for eliminating speed changes due to line-voltage variations

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To regulate the speed of a d-c shunt motor automatically by control of its armature voltage assumes a separate, constant source of field excitation and implies that some means is available to measure the speed of the motor and to automatically correct the armature voltage by the amount necessary to maintain the speed essentially constant at the pre-set value.

When thyratron tubes in grid-controlled rectifier circuits are used to supply the armature excitation to a d-c motor, the problem of speed regulation becomes one of varying the phase of the grid voltage on the thyratron tubes as a function of small deviations in speed.

Saturable Reactor Phase Shift Bridge

One means of obtaining a grid voltage which can be varied in a phase-lagging sense with respect to the anode voltage, is the inductance-resistance bridge network, or phase-splitter, wherein a saturable reactor is used as the variable inductive element. A typical bridge circuit is shown in Fig. 1, together with grid-voltage wave forms peculiar to this circuit when a saturable reactor is used as the inductive arm of the bridge.

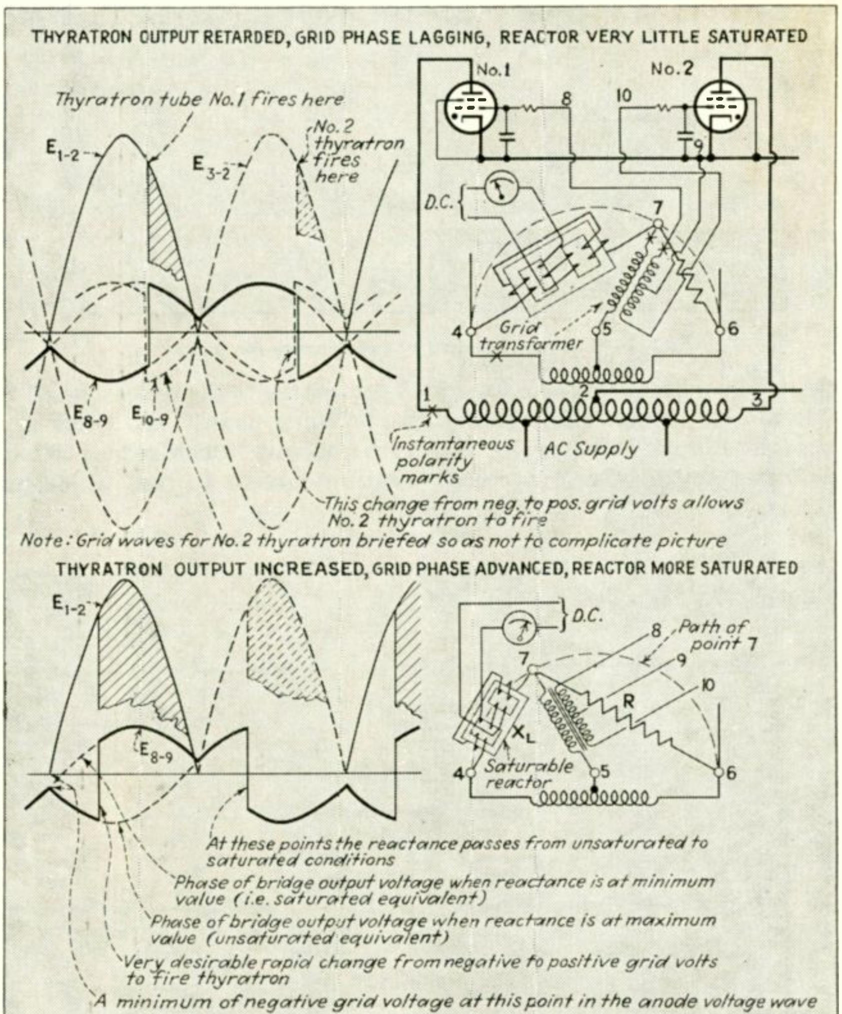

FIG. 1—Saturable reactor-resistor phase shift bridge for controlling the phase of grid voltage at which thyratrons conduct

A saturable reactor is merely an electromagnetic device without mechanically moving elements; in appearance it is similar to a transformer. The inductive reactance of the reactor can be varied by changing the amount of control current in its d-c saturating winding—accomplished by magnetic saturation of the iron core due to the presence of d-c flux from the saturating winding.

As shown in Fig. 1, the construction used for control purposes is that of a three-legged core having two a-c coils, series connected, one on each outside leg, and a d-c winding on the middle leg. This arrangement

For purposes of consistency, the symbols employed in this article are those commonly used in communication circuits.—Editor

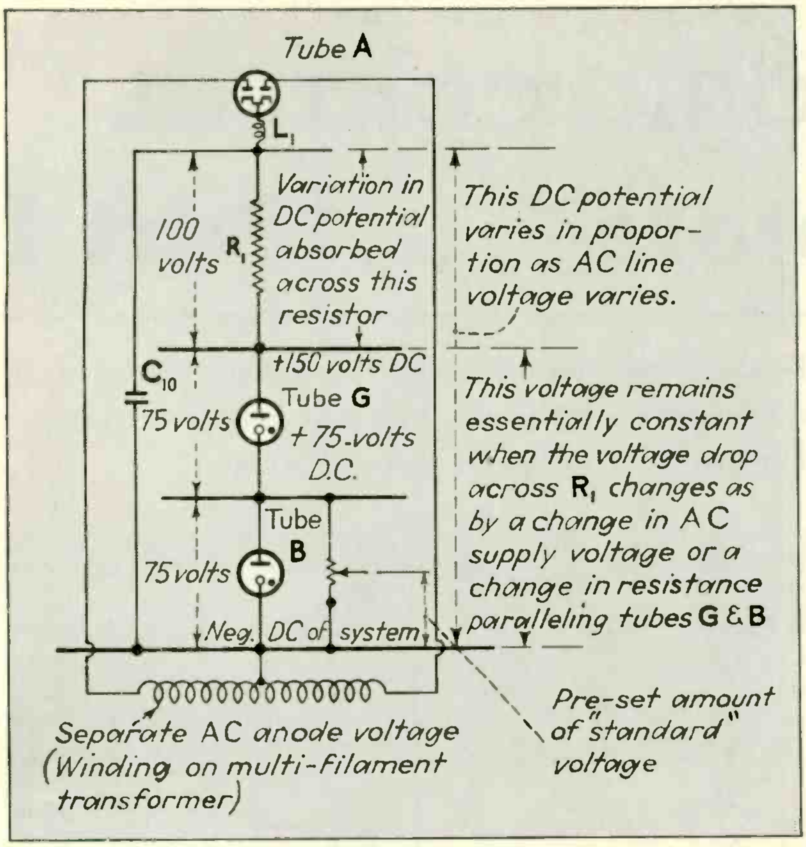

FIG. 2—Auxiliary constant voltage supply for reactor

of the coils results in cancellation of the alternating voltage tending to be induced in the d-c winding by the transformer action of each a-c coil.

As compared to the a-c windings, the d-c winding usually has many more turns of wire which reduce the saturating current to that which may be supplied through a small triode, but the many turns gives this winding considerable inductance. A typical saturable reactor having a core of high permeability iron is well saturated with 2.5 milliamperes d-c through its 3300-ohm saturating winding. The quick-saturating properties of this special core material tend to produce the sharp changes in the grid-voltage wave.

One advantage to be derived from the use of a saturable reactor is the fact that the d-c control circuit is electrically insulated from the a-c circuits. The very desirable, steeply rising grid voltage wave at the control point is offset, however, by the relatively small hold-off bias at the critical full-on point of the anode voltage wave.

The control sense of the saturable reactor bridge is such that when the d-c flow in the saturating winding is sufficient to saturate the reactor, its reactance is at a minimum and the grid voltage is almost fully in-phase with the anode voltage so that the thyratrons are fired early in their positive half-cycles of anode voltage and the direct voltage output to the armature is at a maximum. If the d-c saturating current is reduced, the output voltage of the bridge

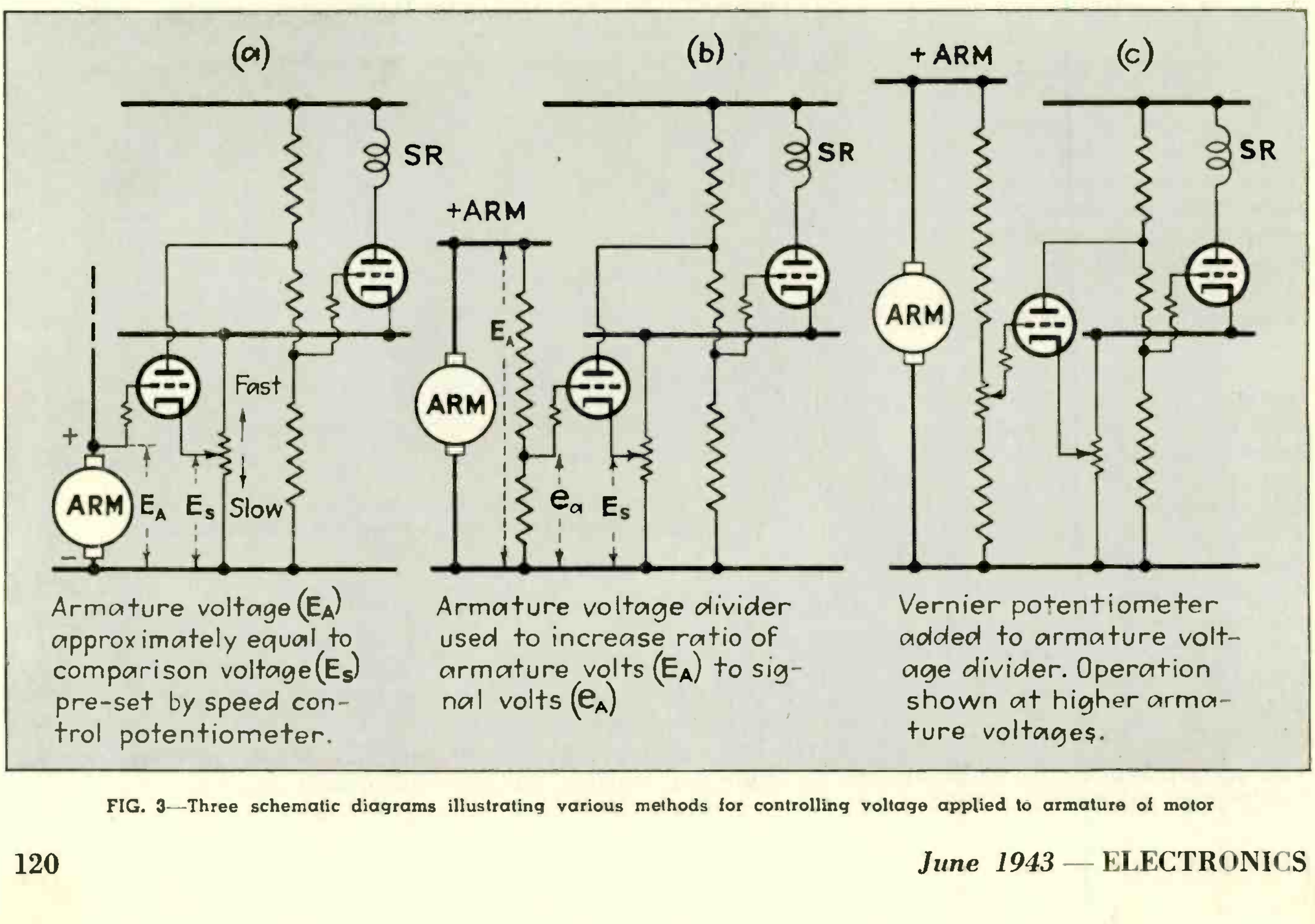

FIG. 3—Three schematic diagrams illustrating various methods for controlling voltage applied to armature of motor

shifts in a more lagging sense and delays the firing of the thyratron tubes so as to reduce the armature voltage. Finally, when the d-c saturating current is reduced to zero, the grid voltage is almost fully 180 deg. out-of-phase-lagging with respect to the anode voltage so that the thyratron tubes are never fired or are fired so late that the armature voltage is negligibly small. Intermediate values of d-c saturating current give corresponding grid phase relations and d-c output voltages so that the armature voltage can be varied smoothly and continuously by changing the amount of d-c excitation in the d-c winding of the saturable reactor.

Auxiliary Rectifier and Voltage Regulator Tubes

A source of d-c for the saturating winding of the saturable reactor is readily available from a small thermionic rectifier (tube *A*, Fig. 2) connected to the same voltage source as the anodes of the thyratron tubes. It is preferable, however, in the case of certain types of rectifier tubes and combinations of large kva anode transformers and reversing sequences, to supply tube *A* from a separate winding on one of the control power transformers. The direct voltage thus obtained is filtered by means of a d-c smoothing reactor, L_1, and a capacitor, C_{10}, before being applied through a ballast resistor, R_1, to the voltage regulator tubes and amplifier tubes.

The voltage regulator tubes (tubes *B* and *G* in Fig. 2) are used in order to minimize the variations in the d-c auxiliary voltage from rectifier tube *A* which varies in direct proportion to the a-c line voltage. The value of resistor R_1 is such that the current through the glow tubes is approximately the mean of the operating current range (approximately 20 ma for the VR 75-30 tubes) when the a-c supply voltage is at nominal rated value. Then, if the alternating voltage were to increase, say 10 percent, the auxiliary rectifier voltage would also increase approximately 10 percent, but practically all of the increase would be absorbed across resistor R_1 because it is an inherent characteristic of these glow tubes that their terminal voltage tends to remain essentially constant at rated value (75 volts for the VR 75-30 type) even though the current through the tube varies widely (5-30 ma for the VR 75-30 tube).

One of these tubes (*B*) is primarily used as a constant-voltage reference against which various signal voltages are compared. If such a tube, or its equivalent, were not used as a voltage standard, that portion of the d-c control voltage which is used for a reference voltage would change in proportion to a-c line voltage changes; hence, all signal voltages which were referred to this varying standard would in themselves vary in proportion to the variation in the a-c line voltage. This means, for example, that any pre-set value of speed would change every time the a-c line voltage changed. When the reference voltage is to be only a portion of the rated voltage across a glow tube, this portion can be obtained from a potentiometer voltage-divider connected across the tube, as shown in Fig. 2.

Voltage regulator tube *G* is used in series with tube *B* to provide a constant-potential, three-wire d-c system of 150/75 volts within whose limits the control tubes function. Because direct-coupled sense-inverting amplifiers are used, it is necessary to maintain the 150 volt source at an essentially constant voltage independent of a-c line voltage variations; otherwise these variations will be amplified and passed on as a false control signal. The constancy of the voltage drop across these tubes and the voltage level which a particular tube maintains will change gradually as the tube ages over a period of

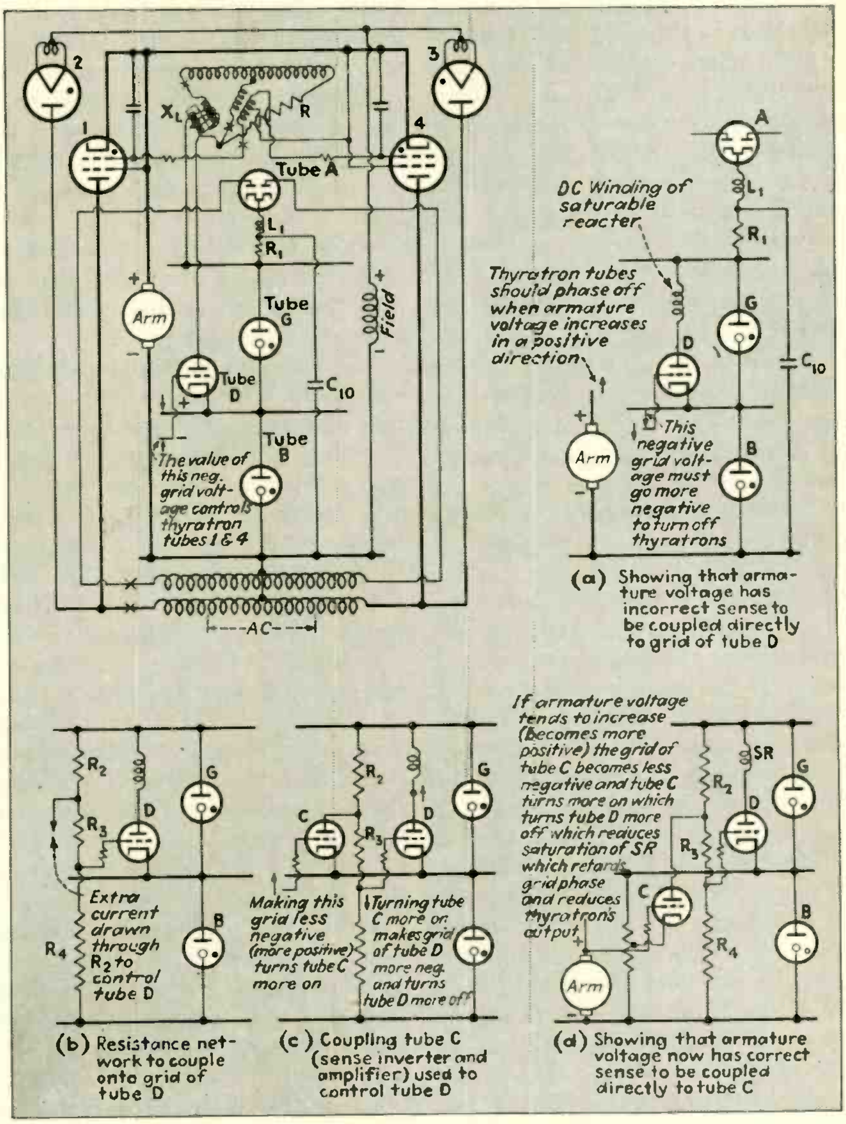

FIG. 4—Basic diagram for variable d-c source for saturable reactor, with supplementary diagrams showing development of means for providing proper directional changes of currents and voltages for proper control

time so that if an attempt is made to calibrate the speed control dial, the relation between dial setting and corresponding speed should be checked occasionally and readjusted by means of the vernier adjustment of armature voltage shown in Fig. 3B.

Control Sense at First Amplifier

The d-c winding of the saturable reactor is connected in series with a triode vacuum tube, *D*, and this combination connected across the 75-volt control bus of tube *G*. If the grid-to-cathode voltage of tube *D* is made negative (grid negative with respect to cathode) by only a few volts, tube *D* ceases to pass current and the saturable reactor is unsaturated and the thyratrons are phased off. If its grid is made less negative, tube *D* conducts a small amount of current and partially saturates the reactor which advances the grid phase control of the thyratron tubes so as to fire these tubes at some intermediate point in their positive anode voltage wave and produce a corresponding increase in armature voltage. As the grid voltage approaches zero value, tube *D* conducts sufficient current to fully saturate the reactor and phase the thyratron tubes full-on. Intermediate values of grid voltage on tube *D* produce intermediate degrees of phase control of the thyratron tubes and hence intermediate values of armature voltage. Thus, control of the armature voltage is centered around values of negative grid voltage on tube *D*.

The control scheme will now consist of comparing a portion of the armature voltage with a pre-selected portion of the voltage across voltage regulator tube *B*, of determining the sense and amount of the difference of these voltages, *i.e.*, whether the armature voltage signal is higher or lower than the glow tube reference voltage (sense) and how much higher or lower (amount), then amplifying this difference and inverting or reversing the sense before applying the voltage to the grid of triode tube *D*. The latter tube then saturates the reactor controlling the grid phase shift on the thyratron tubes which supply the armature of the motor.

To couple the armature voltage onto triode *D*, it is necessary to have a common point for the signal voltage from the armature and for the grid voltage applied to the triode. In addition, it is necessary that the sense relation of these voltages be correct, *i.e.*, an increase in armature voltage above a pre-set voltage level should make the grid of tube *D* more negative, reduce the saturation in the saturable reactor, and phase retard the thyratron grids so as to reduce the thyratron output voltage to the pre-set level. Conversely, a decrease in armature voltage below the pre-set level should make the grid of tube *D* less negative, increase the saturation in the saturable reactor, and phase advance the thyratron grids so as to increase the output from the thyratron tubes and raise the armature voltage to the pre-set level. As shown in Fig. 4A, an increase in armature voltage is an increase in a positive direction (upward) with reference to the negative voltage bus, whereas to decrease the current through tube *D* its grid must be decreased negatively (downward) in a direction away from its cathode and toward the negative bus. These two directions are counter to one another and hence cannot be directly inter-connected but rather must be coupled by a means which will reverse the sense, or electrical direction of travel, of the one voltage relative to the other.

The first step in this coupling procedure is to connect the grid of tube *D* to a slightly positive point on a voltage divider stretched across the 150-volt control bus (see Fig. 4B) so that the saturable reactor triode (tube *D*) will normally be fully conducting and hence cause the armature thyratrons to be phased full-on. The upper half of this voltage divider is made up of two equal resistors (R_2 and R_3) and by means of a control circuit, an additional current is caused to flow through R_2 so that the voltage drop across R_2 will increase and hence the voltage across the other two resistors (R_3 and R_4) must decrease because the total voltage across all three resistors is always 150 volts. A reduction in voltage across resistors R_3 and R_4 makes the point to which the grid of tube *D* is connected go negative relative to the stationary cathode point of tube *D*; this has the effect of reducing the current conduction through tube *D*. In other words, electrically "pulling down" on the junction point of resistors R_2 and R_3 has the effect of turning off tube *D* and reducing the armature voltage; "letting go" of the junction point of R_2 and R_3 has the effect of turning on tube *D* and increasing the armature voltage.

The extra current flow through resistor R_2 can be produced by connecting the anode of a second triode (tube *C*) to the lower end of resistor R_2 and connecting the cathode of this second triode *C* to, say, the mid-point of another voltage divider connected across regulator tube *B* which is used as the voltage standard or reference voltage against which the armature voltage is to be compared. The grid-to-cathode voltage of tube *C* determines the degree of turn-on of tube *D* which determines the saturation of the reactor. This in turn determines the grid phase shift of the thyratron tubes which determines the armature voltage. The control sense is such that if the grid of tube *C* is made negative this tube is turned off so that the grid of tube *D* is turned on. In other words, turning *on* tube *C* turns off the thyratrons, and turning *off* tube *C* turns *on* the thyratrons.

Control Sense of Second Amplifier Tube

As shown by Figs. 4C and 4D, the armature voltage may now be directly coupled to the grid circuit of tube *C* because an increase in armature voltage above a certain level will be in a positive direction (upward) such as to turn on tube *C*, turn off tube *D*, and reduce the thyratron output voltage. This tends to restore the armature voltage to the value it had before the increase took place. Conversely, a decrease in armature voltage will cause the grid of tube *C* to move in an electrically negative direction (downward), tending to turn off tube *C* and turn on tube *D* so as to increase the output from the thyratron tubes and tend to raise the armature voltage to the level at which it was operating before the reduction took place.

When the cathode of tube *C* is connected to the mid-point of a voltage divider across glow tube *B*, the cathode of tube *C* will be approximately 37½ volts positive with respect to the negative bus to which the negative end of the armature is connected. If the armature voltage is zero, as at starting, the grid of

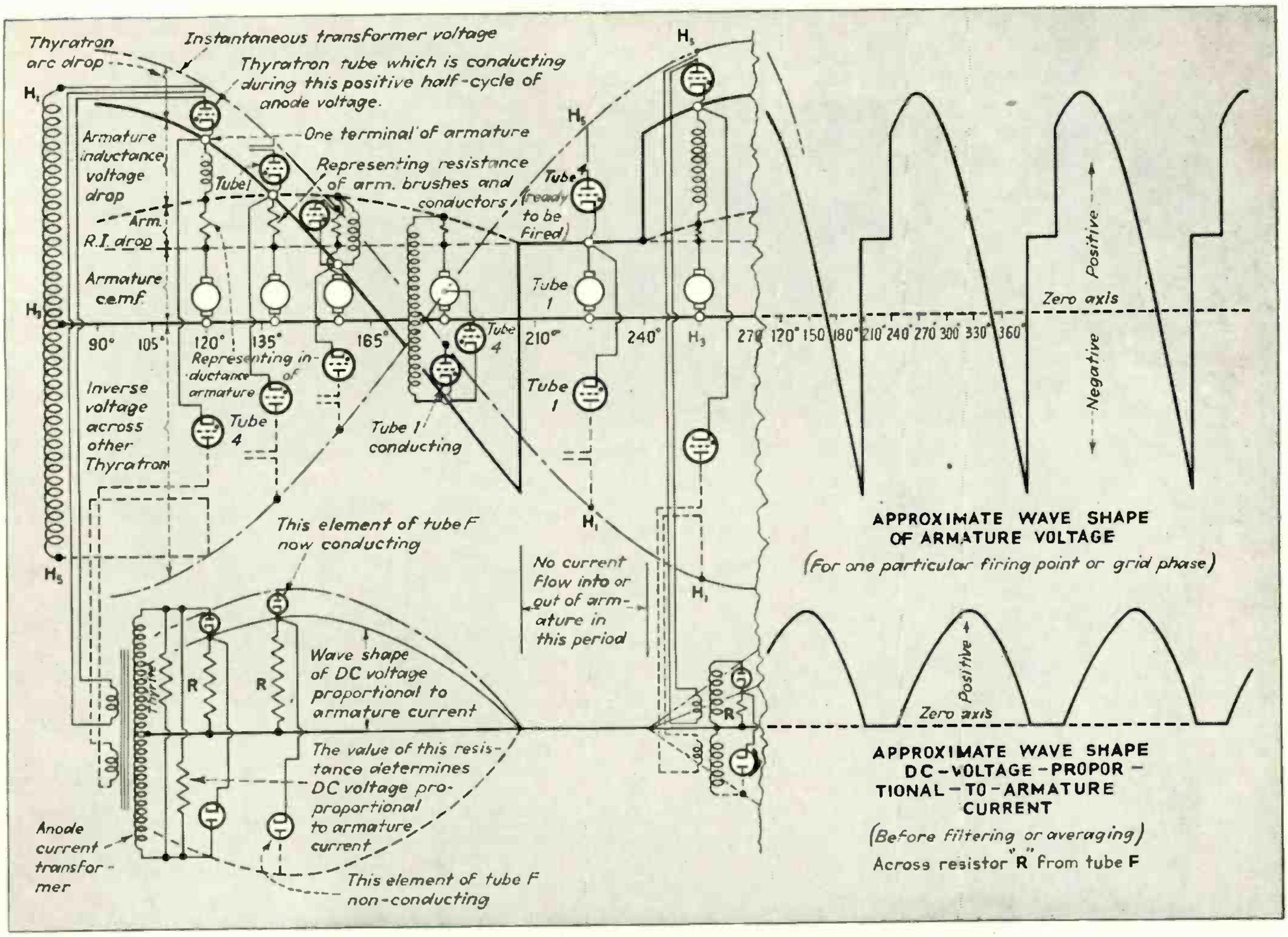

FIG. 5—Wave forms of armature voltage and armature-current signal-voltage

tube *C* will be 37½ volts negative and the thyratron tubes will be phased full-on. The thyratrons will remain full-on until the armature voltage builds up to within a few volts of the cathode level of tube *C*, at which point tube *C* will begin to conduct current and turn off tube *D*. This will decrease the saturation of the reactor and phase lag the firing of the thyratron tubes so as to reduce their output. Thus, the armature voltage will be held at a value of voltage which is but a few volts lower than the voltage between the negative bus and the cathode of tube *C*.

Speed Control Potentiometer

Replacing the fixed voltage divider by a potentiometer will enable the standard voltage (measured from slider of potentiometer to negative bus) to be changed to any value between 0 and 75 volts above the negative bus. Since the armature voltage tends to maintain itself within a few volts of the standard voltage which exists between the cathode connection of tube *C* and the negative bus, any changes made in the value of this standard voltage will cause a change in the armature voltage level at which the motor operates. If for the present, the armature voltage is assumed to be a measure of motor speed, then the speed at which the motor operates will follow the voltage position of the slider on the speed adjusting potentiometer.

When the slider of the speed adjusting potentiometer is at the extreme end of travel corresponding to the connection between glow tubes *B* and *G*, the maximum standard voltage is being used. Since the armature voltage tends to rise and maintain itself within a few volts of the pre-selected value of the standard voltage as determined by the position of the slider of the speed-control potentiometer, it is evident that the armature voltage cannot rise above the voltage level of tube *B* (approximately 75 volts for a VR 75-30 tube). In order that 230 volts across the armature will correspond to the maximum 75-volt setting of the speed-control potentiometer, only a portion of the armature voltage is used as a signal voltage. This portion is determined by the resistance ratios of a voltage divider connected across the armature. This is shown in Fig. 3B.

To allow for variations in glow tube voltage and for manufacturing tolerances in each of the component parts and to enable the user to adjust more closely the no-load motor voltage to its rated value of, say 230 volts, the voltage divider across the armature includes a potentiometer in the vicinity of the tapped section. By this adjusting means, it is possible to proportion exactly the signal-voltage to armature-voltage ratio. Once set, this adjustment need not be changed, except perhaps when new tubes, particularly glow tubes *B* and *G*, are substituted for the originals. This is shown in Fig. 3B.

The armature terminal voltage is

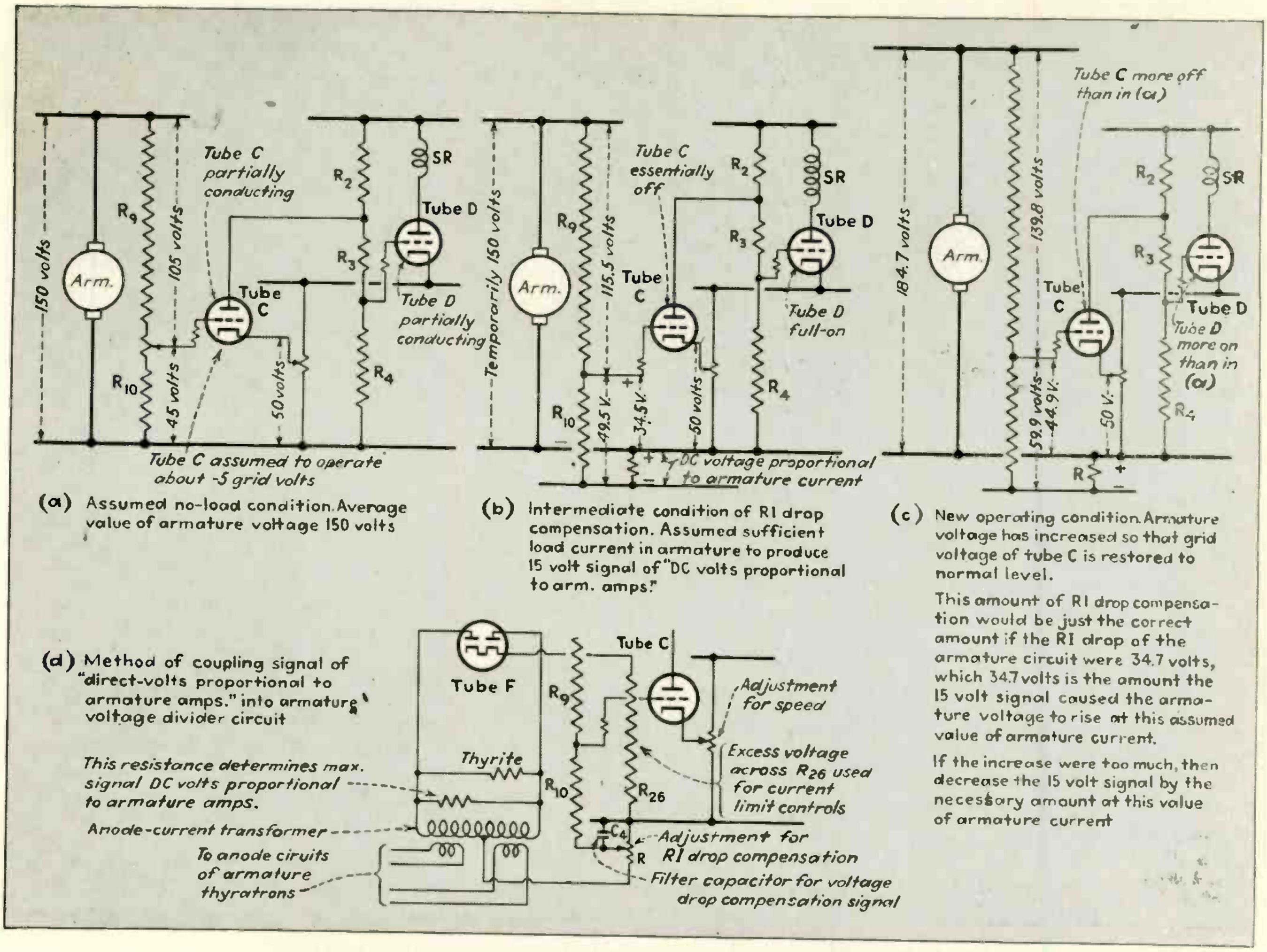

FIG. 6—Three stages in the circuit operation resulting from changes of load (a, b, and c, respectively) with schematic diagram illustrating method of coupling signal controlling voltage into armature voltage divider circuit (d)

proportional to the motor speed only when there is zero current in the armature circuit at a time when the armature is rotating in a constant magnetic field. Given these conditions, the armature voltage is the counter electro-motive force or induced (generated) voltage of the armature conductors and is directly proportional to the speed at which the armature conductors "cut" magnetic flux. If the field strength is changed, the flux being cut is changed; hence, the ratio of armature volts to speed is changed and a new proportionality between armature voltage and speed is established. When current does flow in the armature circuit, as when the motor is driving a load, the counter e.m.f. which is a measure of the true speed is less than the terminal voltage by an amount equal to the voltage drops in the resistance of the armature conductors, brushes, etc. If a constant motor speed were to be maintained, irrespective of load current, it would be necessary to raise the terminal voltage progressively as the load current increased by an amount just equal to the armature circuit resistance voltage drops at each successive value of armature current so as to maintain the counter e.m.f. constant. Under load, this counter e.m.f. is not a voltage which can be readily measured because each volt of counter e.m.f., so to speak, is sandwiched in between a fraction of a volt of armature resistance drop, and the one cannot be segregated from the other and each grouped together as all counter e.m.f. on one hand and all IR voltage drop on the other.

IR Drop Compensation

A control means which automatically increases the armature terminal voltage by the amount necessary to compensate for voltage drop due to armature current flowing through the various resistances in the armature circuit, must be capable of measuring this armature current, then converting it into a direct voltage signal which is adjustable in ratio of signal volts to armature current. The control must then couple this voltage-proportional-to-current signal into the armature control circuit in such a way that an increase in armature current causes an increase of a definite amount in the terminal voltage applied to the armature, thus allowing the counter e.m.f. of the armature to remain constant. Such a control means would also compensate for such secondary effects as armature reaction only in so much as the speed change due to armature reaction is directly proportional to armature current.

The signals required to actuate the control grids of these vacuum tube circuits are preferably of the order of volts rather than the 50 to 100 millivolts (0.050 to 0.100 volts) usually obtained from a meter shunt connected to read armature current. An amplifier system could be devised to amplify the voltage drop obtained from a shunt, but it would be more complex than the following method.

The current which flows in the armature circuit of the motor is the anode current which flows in successive pulses through each thyratron, first through one and then through the other and always in the same direction through each tube, i.e. from anode to cathode. If the current pulses of one anode are passed through one primary winding of a small transformer and the pulses from the other anode are passed through another primary winding of the same transformer but in such a direction as to produce flux in opposition to that of the other primary winding, then a resistance across the secondary winding of this small transformer will have across it an alternating voltage wave of a shape which is the image of the primary current pulses except that successive pulses are alternately positive and negative as in any alternating voltage wave. Since this small transformer is acting as a current transformer, the turns ratio between primary and secondary windings determines the secondary current. Each value of primary current must have a certain value of secondary current in this ratio (primary exciting current is assumed to be so low in comparison with load current as to be negligible), hence secondary voltage will be determined by the value of resistance through which this secondary current flows. Doubling the secondary resistance will double the secondary voltage corresponding to a given anode current (provided the transformer windings are designed for this voltage). Halving the secondary resistance will give only half the secondary voltage for the same anode current. Thus, the ratio of secondary voltage to primary current can be varied by merely changing the value of secondary resistance.

Protective Thyrite Resistor

A thyrite resistor is connected across the whole or part of the secondary winding to reduce the voltage surges which occur as a result of quick changes in armature current. Without some such surge arrester, voltages have been observed which were sufficiently high to arc-over socket connections between anodes of the current rectifier tube.

It is a direct voltage-proportional-to-anode-current, rather than an alternating voltage, which is needed for control signals. Therefore, the alternating voltage obtained from the secondary of the current transformer is rectified by a small two-anode diode rectifier (tube *F*) to produce a direct voltage-proportional-to-armature-current whose wave form is a succession of unidirectional pulses, each of which is the image of an anode current pulse. The negative terminal of this direct voltage signal is the mid-tap of the secondary winding of the current transformer; the positive terminal is the cathode of tube *F*. The load resistance in the d-c output circuit of this rectifier will, in effect, be paralleled with the resistor across the secondary of the current transformer and hence will play its part in determining the voltage across the secondary winding. But if the relative values of the two resistances are such that the one directly across the winding draws about ten times as much current as the load circuit, then small changes in load current will not materially alter the anode-current-to-dc-signal-voltage ratio. Then too, a high resistance, low-current d-c load circuit allows the use of the rectifier section of a dual-purpose tube such as the 7K7 double-diode-triode for the rectifying element. The sketches of Fig. 5 show in elementary form the connections of this anode current transformer and its rectifier element and the current and voltage wave forms corresponding to one particular phase control point of the thyratron tubes.

Methods of Producing Voltage Proportional to Armature Current

As shown by the sketches of Fig. 6, if the lower end of the armature voltage divider is disconnected from the negative bus and is connected instead to the negative end of the direct-voltage-proportional-to-armature-current, the positive end of which is connected to the negative bus, then, as the armature current increases, the lower end of the armature voltage divider becomes more negative and the tapped point of the voltage divider will become proportionately negative. The grid of tube *C* will then become more negative so as to increase the output of the thyratron tubes, until the armature terminal voltage increases sufficiently to bring the grid of tube *C* once again approximately to the voltage level of the slider of the speed-control potentiometer. In a typical control, a 0.2-volt change in the grid potential of tube *C* is sufficient to control the phase of the thyratron tubes from full-on to full-off, or vice versa, hence any tendency of the current signal to lower the grid potential of tube *C* will be compensated by an increase in armature terminal voltage tending to restore the grid voltage of tube *C* to practically its original value. Thus, with no change in the setting of the speed-control potentiometer, the armature voltage has been caused to increase automatically as the load current increased. If the volts-proportional-to-armature-current is adjusted to the correct value of volts per ampere of current, then the armature voltage will be increased by the correct amount, in proportion to the load current increases, so as to compensate exactly for the resistance drop in the armature conductors, brushes, feeder wires, etc., and cause the counter e.m.f. of the motor to remain practically constant irrespective of load. The amount of this direct-voltage-proportional-to - armature - current which is introduced into the lower end of the armature voltage divider circuit is adjusted by means of a potentiometer which taps off a pre-set portion of an excess amount of the voltage signal. This scheme can be made to overcompound if more than sufficient volts-per-ampere is cut into the circuit by this adjusting means. That portion of the direct voltage determined by the potentiometer setting is filtered by an electrolytic capacitor before it is added to the armature voltage divider circuit. Too much capacity will cause the control to be sluggish.

This has been a discussion of an electronic motor control applied only to the armature of a d-c shunt motor whose field was assumed to be separately excited at constant rated value. A further increase in speed and a different type of motor characteristic will result if the armature is maintained at constant rated counter e.m.f. and the field is weakened. How this is accomplished and its attendant interrelated control problems, particularly those concerning armature current limit and anti-hunting, will be discussed in a concluding article.

War Radio Components

Tables showing manufacturers' code numbers corresponding to fixed paper dielectric capacitors and electrical indicating instruments standardized by the American Standards Association War Committee on Radio. Data on other components is to follow

For months engineers of the radio industry have been working together with members of the War Production Board, technical societies and the armed services to standardize and simplify lines of radio components so necessary to the war program. From the program, Army and Navy expect more equipment and speedier delivery; more dollar value for the military radio budget; more equipment per man hour of labor; and much simplification of the supply and maintenance problem.

Thus far the War Committee on Radio of the American Standards Association has approved standards for certain electrical indicating instruments; ceramic radio insulating materials, Class L; fixed mica dielectric capacitors and ceramic radio dielectric capacitors. New subjects for standardization include coaxial cables and connectors, dials, finishes, fuses, head phones, hookup wire, loud speakers, microphones, nameplates, panels, racks, cabinets, power packs, relays, screws, nuts, and hardware, soldering, storage batteries and chargers, switches, telegraph keys, voltage regulators.

Code Number Tables

On these two pages are assembled the code numbers (used by the several manufacturers) which correspond to the models of certain radio components so far standardized by the ASA War Committee on Radio. They apply to fixed paper dielectric capacitors and to two sizes of the small round electrical meters so widely used. For example, Micamold 337-3 capacitor corresponds in physical dimensions to American War Standards capacitor CN35A302. In like manner the Western Electric capacitor 404B corresponds to the specifications of the same unit.

Inclusion of a manufacturer's code numbers in these tables does not imply that the manufacturer agrees with the standards described in the ASA bulletin describing them; or that he has the testing or other equipment necessary to completely follow the standard specifications. Inclusion indicates that the manufacturer makes, or is prepared to make, a capacitor or electrical instrument, corresponding in physical dimensions to the dimensions given in the ASA bulletins.

These data were collected by means of two questionnaires sent to lists of manufacturers supplied by the War Production Board, and by telephone calls and telegrams. There are probably other manufacturers whose code numbers could be added to these listings, but at the time of going to press they were not available.

As other components come under the standardization procedure, similar tables relating to them will be presented in ELECTRONICS.

The importance of this program was emphasized at a recent meeting of the War Committee by Major General Roger B. Colton, Chief, Signal Supply Services, U. S. Army Signal Corps, by stating the advantages mentioned above plus the obvious simplification of the field service problem of stocking and transporting replacement parts.

Fixed Molded Paper-Dielectric Capacitors
(Limited Sizes)

AWS Code Numbers	Coronet Elec. Co., Chicago, Ill.	Micamold Radio Corp., Brooklyn, N. Y.	Solar Mfg. Corp., Bayonne, N. J.	Sprague Specialties Co., North Adams, Mass.	Tobe Deutschmann Corp., Canton, Mass.	Western Electric Co., New York, N. Y.
CN35A302	SQ 3	337-3	(Same as AWS code)	(Same as AWS code)	D P	404B
CN35A602	SQ 6	337-6	"	"		404B
CN35A103	SQ 1	337-10	"	"	D P	404C
CN36B302	SR 3	336-3	"	"	D P	
CN36B602	SR 6	336-6	"	"	D P	
CN36B103	SR 1	336-10	"	"	D P	
CN40B302	SP 3	339-3	"	"		
CN40B602	SP 6	339-6	"	"		
CN40B103	SP 1	339-10	"	"		
CN41B302	SM 3	340-18	"	"		
CN41B602	SM 6	340-24	"	"		
CN41B103	SM 1	340-21	"	"		

(Also makes AWS Code Numbers CN21A and B, CN22A, CN23A)

STANDARDIZED

ELECTRICAL INDICATING INSTRUMENTS
2½- and 3½-Inch Round Flush-Mounting Panel-type

AWS Code Number*	Burlington Instrument Co., 316 Valley Street, Burlington, Iowa.	DeJur-Amsco Corp., Shelton, Conn.	Electric Products Service Co., 1322 S. Grand Avenue, Los Angeles, Cal.	General Electric Co., Instrument Dept., Schenectady, N. Y.	Hickok Electrical Instrument Co., 10514 Dupont Avenue, Cleveland, Ohio.	J. B. T. Instruments, Inc., 441 Chapel Street, New Haven, Conn.	Knickerbocker Development Corp., 116 Little Street, Belleville, N. J.	O. B. McClintock Co., Minneapolis, Minn.	Sun Mfg. Co., 6323 Avondale Avenue, Chicago, Ill.	Triplett Electrical Instrument Co., Bluffton, Ohio.	Western Electric Co., Instrument Dept., 195 Broadway, New York, N. Y.	Westinghouse Elec. & Mfg. Co., 95 Orange Street, Newark, N. J.	Weston Electrical Instrument Co., 614 Frelinghuysen Avenue, Newark, N. J.
MR25 2½-Inch													
D-C Voltmeters	42102	MR25	Production is to order only. Code numbers same as AWS, all models	DW-51	56		MR25	2002 [7] 2001	MR25	221		OX-33	506
D-C Microammeters	42121	"		DW-51 [1]	"		MR25 [6]	"	"	"		"	"
D-C Milliammeters	42111	"		DW-51	"		MR25	"	"	"		"	"
D-C Ammeters	42101	"					"	"	"	"		"	"
A-C Voltmeters	42202				57M					231		OA-33	517
A-C Milliammeters	42211				"					"		"	"
A-C Ammeters	42201				"					"		"	"
R-F Milliammeters	42311			DW-52 [2]	57T				MR25 [8]	241		OT-33	507
R-F Ammeters	42301			DW-52	"				MR25	"		"	"
MR35 3½-Inch													
D-C Voltmeters	43102	MR35	Production is to order only. Code numbers same as AWS, all models	DO-41	46		MR35	3002 [7] 3001	MR35	321	D163792	NX-35	301
D-C Microammeters	43121	"		"	"		MR35 [6]	"	"	"	D163791	"	"
D-C Milliammeters	43111	"		"	"	321 [3]	MR35	"	"	"	D163790	"	"
D-C Ammeters	43101	"					"	"	"	"	D163789	"	"
A-C Voltmeters	43202			AO-22	47M	332 [4]				331		NA-35	476
A-C Milliammeters	43211			"	"					"		"	"
A-C Ammeters	43201			"	"	332 [5]				"		"	"
R-F Milliammeters	43311			DO-44 [2]	57T				MR35 [8]	341		NT-35	425
R-F Ammeters	43301			DO-44	"				MR35	"		"	"

NOTES

Complete code number MR25‡10DCVV indicates 2½-inch d-c voltmeter 10 volts full scale,‡ to be filled in with one of four letters indicating scale color scheme.

DCVV = d-c voltmeter
DCUA = d-c microammeter
DCMA = d-c milliammeter
DCAA = d-c ammeter
ACVV = a-c voltmeter
ACMA = a-c milliammeter
ACAA = a-c ammeter
RCMA = r-f milliammeter
RFAA = r-f ammeter

[1] Except 20, 30, and 50μa.
[2] Conventional scale, all ratings. Minimum rating with expanded scale, 750 ma.
[3] 0-1 ma only.
[4] 100, 150, 300, 500 only; 3¼-inch metal case, rim mounted.
[5] 5, 30, 150, 300 only; 3¼-inch metal case, rim mounted.
[6] Not below 200μa.
[7] 2002, 3002 = metal; 2001, 3001 = Bakelite
[8] Except 100, 120, 150 ma.

Electronics Bibliography for WAR TRAINING

THE rapid advances which are being made in the radio and electronics fields necessitates that those designing, building or operating electronic control and communicating equipment have a thorough grounding in basic principles. The need for thorough understanding of fundamentals is as important in civilian as in military activities.

This bibliography has been prepared to meet the many requests which the editors of *Electronics* have received for a list of text and reference books suitable for self study or classroom instruction in physics, acoustics, electronics and radio. The list includes elementary as well as advanced texts; it includes books on the service and maintenance of equipment as well as texts dealing with theory.

The first part of this bibliography, with list of publishers, appeared in the May 1943 issue of *Electronics*. We regret that paper shortage makes it impossible for us to supply tear sheets of the material published in May.

VI COMMUNICATION ENGINEERING

General Texts

Communication Engineering—*By W. L. Everitt, McGraw-Hill Book Co., 567 p, $5.00, 1932.*

Treatment of fundamentals of communication systems for electrical engineering students.

Electrical Fundamentals of Communication—*By A. L. Albert, McGraw-Hill Book Co., 554 p, $3.50, 1942.*

An outline of the fundamentals of electricity from the point of view of the communications applications rather than the power field.

Electrical Communication—*By A. L. Albert, John Wiley and Sons, 398 p, $5.00, 1934.*

Theory and practice of wire and radio communication.

Ultra-high Frequency Technique—*By J. G. Brainerd, Glenn Koehler, H. J. Reich and L. F. Woodruff, D. Van Nostrand, 533 p, $4.50, 1942.*

Communication circuits with emphasis on methods and systems suitable for use at ultra-high frequencies, for those with a knowledge of radio.

Phenomena in High Frequency Systems—*By August Hund, McGraw-Hill Book Co., 641 p, $6.00, 1936.*

Thorough discussion of phenomena occurring at high frequencies with emphasis on basic principles.

Circuit Theory

Alternating Current Circuits—*By Earle M. Morecock, Harper & Bros., 175 p, $2.75, 1942.*

Communication Circuits—*By Lawrence A. Ware and H. R. Reed, John Wiley & Sons, 287 p, $3.50, 1942.*

Introduction to the basic principles of communication transmission lines and associated networks.

Electric Circuit Theory and Operational Calculus—*By J. R. Carson, McGraw-Hill Book Co., 197 p. $3.00, 1926.*

Introduction to electric circuit theory and systematic treatment of Heaviside calculus.

Electrical Circuits—*By E.E. Staff of M.I.T., John Wiley and Sons, 742 p, $7.50, 1940.*

A comprehensive treatment of linear and non-linear electrical circuits for students and engineers. For radio and communications engineers.

Communication Networks, Vol. I and II—*By E. A. Guillemin, John Wiley and Sons, Vol. I, 425 p, $5.00, 1931, Vol. II, 587 p, $7.50, 1935.*

Vol. I Classical theory of lumped constant networks. Vol II Classical theory of long lines, filters and related networks.

Electric Lines and Nets—*By A. E. Kennelly, McGraw-Hill Book Co., 426 p, $5.00, 1928, 2nd ed.*

Theory and electrical behavior of electrical lines and networks.

Transmission Networks and Wave Filters—*By T. E. Shea, D. Van Nostrand Co., 470 p, $6.50, 1929.*

Calculation and design of telephone networks and electrical wave filters.

Transmission Circuits for Telephone Communication—*By K. S. Johnson, D. Van Nostrand Co., 333 p, $5.00, 1927.*

General theory and principles applicable to development and design of telephone circuits.

Electromechanical Transducers and Wave Filters—*By Warren P. Mason, D. Van Nostrand Co., 333 p, $5.00, 1942.*

A mathematical treatment of electrical wave filters and electromechanical elements from point of view of communications engineer.

Electromagnetic Theory & Transmission

Elements of Electromagnetic Theory—*By Alexander Duff and S. J. Plimpton, Blakiston Co., 173 p, $2.75, 1940.*

Electromagnetic Theory—*By J. A. Stratton, McGraw-Hill Book Co., 615 p, $6.00, 1941.*

Mathematical treatment of variable electromagnetic fields and the theory of wave propagation. Knowledge of undergraduate physics and electrical engineering essential.

Electric Oscillations and Waves—*By G. W. Pierce, McGraw-Hill Book Co., 515 p, $5.00, 1920.*

Fundamentals of Electric Waves—*By Hugh H. Skilling, John Wiley & Sons, 186 p, $2.75, 1942.*

Principles of wave action with particular emphasis on basic ideas of Maxwell's equations.

Microwave Transmission—*By J. C. Slater, McGraw-Hill Bok Co., 309 p, $3.50, 1942.*

Intermediate text on transmission of electric energy over lines and wave guides, from the physicist's point of view.

Rhombic Antenna Design—*By A. E. Harper, Bell Labs., D. Van Nostrand Co., 111 p, $4.00, 1941.*

Radio Communication

Principles of Radio—*By Keith Henney (Fourth Edition), John Wiley and Sons, 539 p, $3.50, 1942.*

Elementary treatment of radio suitable for first course in subject. Can be used by those who must study without aid of a teacher.

Practical Radio Communication—*By Nilson and Hornung, McGraw-Hill Book Co., 754 p, $5.00, 1935.*

Radio school and home study material for prospective and experienced radio operators.

Introductory Study of Electrical Characteristics of Power and Telephone Transmission Lines—*By F. W. Norris and L. A. Bingham, International Textbook Co., 272 p, $2.50, 1937.*

Radio Fundamentals—*Technical Manual TM 1-455, War Department, Washington, D. C., Superintendent of Documents, Washington, D. C., 140 p, $0.25.*

Basic fundamentals of radio communication for radio operators and service men.

Understanding Radio—*By Watson, Welch and Eby, McGraw-Hill Book Co., 601 p, $2.80, 1940.*

A guide to practical operation and theory, for high school and home study.

Principles of Radio Communication—*By John H. Morecroft, John Wiley and Sons, 1001 p, $7.50, 1927, 2nd ed.*

Fundamentals of radio communication for electrical engineering students.

Principles of Radio Engineering—*By R. S. Glasgow, McGraw-Hill Book Co., 520 p, $4.00, 1936.*

Principles of radio engineering for communication engineering students.

Radio Engineering—*By F. E. Terman, McGraw-Hill Book Co., 813 p, $5.50, 2nd ed., 1937.*

A comprehensive treatment covering all phases of radio.

High Frequency Alternating Currents—*By Knox McIlwain and J. G. Brainerd, John Wiley and Sons, 508 p, $6.00, 1931.*

Communication text for senior or graduate electrical engineering students.

Ultrahigh Frequency Technique—*(Reprint of articles in* ELECTRONICS*) Electronics, 330 West 42nd Street, New York, N. Y., 64 p, $0.50, 1942.*

Treatment of electric concepts at u-h-f, antennas and radiation, tubes, receivers, generators and measurements at u-h-f with section on uses and applications of cathode-ray tubes.

Introduction to Frequency Modulation—*By John F. Rider, John F. Rider Publisher, 136 p, $1.00.*

An elementary description of the principles of f-m for service men, students, and others.

Frequency Modulation—*By August Hund, McGraw-Hill Book Co., 375 p, $4.00, 1942.*

Engineering text on frequency modulation covering both basic principles and design of commercial apparatus.

Foundations of Radio—*By R. L. Duncan, John Wiley and Sons, 247 p, $2.50, 1931.*

Simple treatment of fundamentals of electricity and allied subjects.

Radio Telegraphy and Telephony—*By R. L. Duncan and C. E. Drew, John Wiley and Sons, 1046 p, $7.50, 1931.*

Comprehensive instruction book explaining details of structure and control of apparatus, principles and methods of operation of radio equipment.

Practical Radio, Including Television—*By J. A. Moyer and J. F. Wostrel, McGraw-Hill Book Co., 410 p, $2.50, 4th ed., 1931.*

A practical discussion of radio principles.

Short Wave Wireless Communication—*By A. V. Ladner and C. R. Stoner, John Wiley and Sons, 453 p, $4.50, 4th ed., rev. 1942*

A self-contained treatise with principles common to both long and short waves.

Basic Radio—*By J. B. Hoag, D. Van Nostrand Co., 379 p, $3.25, 1942.*

An elementary treatment of the basic principles of radio.

Elements of Radio—*By A. Marcus and Wm. Marcus, Prentice-Hall, 699 p, $4.00, 1943.*

Elements of Radio Communication—*By O. F. Brown and E. L. Gardiner, Oxford University Press, 551 p, $6.00, 2nd ed. 1939.*

A general treatment of radio from the descriptive side. Not very mathematical.

Fundamentals of Radio—*By W. L. Everitt, editor, and E. C. Jordan, P. H. Nelson and W. C. Osterbrock, F. H. Pumphrey, and L. C. Smeby, Prentice-Hall, Inc., 400 p, $5.00, 1942.*

Basic material of radio for civil and military services, requiring knowledge only of elementary algebra.

Elements of Radio Communication—*By John H. Morecroft, John Wiley and Sons, 286 p, $3.00, 1931.*

Elementary treatment of radio theory with no knowledge beyond algebra required.

Telephony & Telegraphy

Telephone Theory and Practice—*By K. B. Miller, McGraw-Hill Book Co., Vol. I, 492 p, $5.00, Theory and Elements, 1930, Vol. II, 439 p, $5.00, Manual Switching, 1933, Vol. III, 490 p, $5.00, Automatic Switching, 1943.*

A comprehensive. authoritative treatise on practical telephony.

Telephone Communication—*By Wright and Puchstein, McGraw-Hill Book Co., 515 p, $5.00, 1925.*

A textbook on general telephone theory and practice.

American Telegraph Practice—*By D. McNichol.*

Automatic Telephony—*By A. B. Smith and W. L. Campbell.*

Automatic Telephony—*By H. H. Harrison, Longmans Green & Co.*

The Director System of Automatic Telephony—*By W. E. Hudson, Pitman Pub. Co., 156 p, $1.50, 1927.*

Elements of Telephone Transmission—*By H. H. Harrison, Longmans Green & Co., 147 p, $2, 1927.*

Handbook of Telephone Circuit Diagrams—*By J. M. Heath.*

Principles and Practice of Telephony—*By J. G. Mitchell, McGraw-Hill Book Co.*

Principles of Transmission in Telephony—*By M. P. Weinbach, Macmillan Co., 303 p, $4.00, 1924.*

Printing Telegraph Systems and Mechanisms—*By H. H. Harrison, Longmans Green & Co., $7.00, 1923.*

Telegraph Engineering—*By Erich Hausman, D. Van Nostrand Co., 2nd ed., $3.00, 1922.*

Telegraphy and Telephony—*By C. S. Rhoads, Simmons-Boardman, 518 p, $3.00, 1924.*

Telephone Communication Systems—*By R. G. Kloeffler, Macmillan Co., 284 p, $4.00, 1925.*

Telephonic Transmission—*By J. G. Hill.*

Telephony—*By S. G. McMeen and K. B. Miller.*

Telephony Including Automatic Switching—*By A. B. Smith, Frederick Drake & Co., 450 p, $2.50, 1924.*

Theory of The Submarine Telegraph and Telephone Cable—*By H. W. Malcolm, Benn Brothers.*

Submarine Telegraphy—*By Italo de Guilo, Pitman Publishing Co.*

Principles of Transmission in Telephony—*By M. P. Weinbach, Macmillan Co., 303 p, $4.50, 1924.*

Telephone Communication Systems—*By R. G. Kloeffler, Macmillan Co., 284 p, $4.40, 1925.*

VII ELECTRONICS & ELECTRON TUBES

Applied X-Rays—*By George L. Clark, McGraw-Hill Pub. Co., 674 p, $6.00, 2nd ed., 1940.*

Principles and applications of radiography with emphasis on x-ray analysis of structure of materials.

Applied Electronics—*By E. E. Staff of M. I. T., John Wiley and Sons, 772 p, $6.50, 1943.*

Radio Receiving and Television Tubes—*By J. A. Moyer and J. F. Wostrel, McGraw-Hill Book Co., 635 p, $4.00, 3rd ed., 1936.*

General non-mathematical discussion of electron tubes.

Engineering Electronics—*By G. D. Fink, McGraw-Hill Book Co., 358 p, $3.50, 1938.*

A general treatment of the electron tube and its communication and industrial applications.

The Electron + and −, *By R. A. Millikan, University of Chicago Press, $3.50.*

Electrons at Work—*By C. R. Underhill, McGraw-Hill Book Co., 354 p, $3.00, 1933.*

Electron and Nuclear Physics—*By J. B. Hoag, D. Van Nostrand Co., 502 p, $4.00, 1938.*

Gives complete account of experimental atomic physics.

Electron Emission and Adsorption Phenomenon—*By J. H. DeBoer, Macmillan Co., 398 p, $5.50, 1935.*

Electronics—*By J. Millman and S. Seeley, McGraw-Hill Book Co., 719 p, $5.00, 1941.*

Theoretical and practical aspects of electronics for those in the industrial or communications fields.

Experimental Electronisa—*By R. H. Muller, R. L. Garman, M. E. Droz, Prentice-Hall, Inc., 330 p, $4.65, 1942.*

Gaseous Conductors, Theory and Engineering Applications—*By J. D. Cobine, McGraw-Hill Book Co., 606 p, $5.50, 1941.*

Engineering applications of electrical discharges in gases including physical concept of kinetic theory of gases, study of gaseous discharges, and engineering applications of discharge phenomena.

Fundamentals of Engineering Electronics—*By W. G. Dow, John Wiley and Sons, 604 p, $5.00, 1937.*

Principles of electronics of importance in engineering work are treated in detail.

Kinetic Theory of Gases—*By L. B. Loeb, McGraw-Hill Book Co., 687 p, $6.00, 1934.*

A text and reference book whose purpose is to combine classical deductions with recent experimental advances in convenient form for student and investigator.

Kinetic Theory of Gases—*By Earle H. Kennard, McGraw-Hill Book Co., 483 p, $5.00, 1938.*

Classical kinetic theory of gases designed to serve as textbook for students and reference work, for experimental physicist.

Emission of Electricity from Hot Bodies—*By O. W. Richardson, Longmans, Green & Co., 304 p, $7.50, 1916.*

Thermionic Emission—*By A. L. Reiman, John Wiley & Sons, 324 p, $5.50, 1934.*

Electron Optics in Television—*By I. G. Maloff and D. W. Epstein, 299 p, $3.50, 1938.*

Develops theory of electron optics and illustrates its applications.

Principles of Electron Tubes—*By Herbert J. Reich, McGraw-Hill Book Co., 398 p, $3.50, 1941.*

Text primarily for students who do not intend to specialize in communications, but covering tubes and their applications quite well.

Principles of Electronics—*By R. G. Kloeffler, John Wiley and Sons, 175 p, $2.50, 1942.*

Action taking place within electron tube is discussed.

Theory of Thermionic Vacuum Tube Circuits—*By L. J. Peters, McGraw-Hill Book Co., 226 p, $3.00. 1927.*

Development of conventions and methods for use in treating electrical networks and systems containing three element tubes.

Theory of Gaseous Conduction and Electronics—*By F. A. Maxfield and R. R. Benedict, McGraw-Hill Book Co., 483 p, $4.50, 1941.*

Textbook covering the fundamentals of conduction in gases; suitable for undergraduate students in electrical engineering and applied physics.

Ions, Electrons and Ionizing Radiations—*By J. A. Crowther (7th ed.), Longmans, Green & Co., 348 p, $4.00, 1939.*

Electron Inertia Effects—*By F. B. Llewellyn, Macmillan Co., 104 p, $2.00, paper, 1941.*

Electronics and Electron Tubes—*By E. D. McArthur, John Wiley and Sons, 173 p, $2.50, 1936.*

Treatment of important phases of electron tube theory and applications.

Electron Tubes in Industry—*By K. Henney, 539 p, $5.00, 1937.*

Presentation of the practical aspects of electronics as applied to industrial operations.

Electron Tubes and Their Application—*By J. H. Morecroft, John Wiley and Sons, 458 p, $4.50, 1936.*

General treatment of tubes and their applications.

Fundamentals of Electronics and Vacuum Tubes—*By A. L. Albert, MacMillan Co., 421 p, $4.50, 1938.*

A text for college courses covering the fundamentals of electronics and electron tubes.

Fundamentals of Vacuum Tubes—*By A. V. Eastman, McGraw-Hill Book Co., 583 p, $4.50, 1941.*

Basic theory underlying all types of modern vacuum tubes, both radio and industrial, for senior electrical engineering students.

Industrial Electronics—*By F. H. Gulliksen and E. H. Vedder, John Wiley and Sons, 245 p, $3.50, 1935.*

For practicing engineers. Covers most important types of tubes and industrial applications of tubes.

Principles of Electron Tubes—*By H. J. Reich, McGraw-Hill Book Co., 398 p, $3.50, 1941.*

Introductory course on electron tubes for non-specialists; college level.

Physics of Electron Tubes—*By L. R. Koller, McGraw-Hill Book Co., 205 p, $3.00, 1937.*

Fundamental physical phenomena of operation of electron tube, with emphasis on what goes on inside tube rather than on use of tube as circuit element.

Theory of Thermionic Vacuum Tubes—*By E. L. Chaffee, McGraw-Hill Book Co., 652 p, $6.00, 1933.*

An advanced text and reference book dealing with the fundamentals of electronics, and the design and application of tubes as amplifiers and detectors for reception.

Theory and Applications of Electron Tube—*By H. J. Reich, McGraw-Hill Book Co., 670 p, $5.00, 1939.*

Fundamentals principles of electron tubes and associated circuits, for college students or reference work for practicing engineers.

Mercury Arc Rectifiers—*By O. K. Marti and H. Winograd, McGraw-Hill Book Co., 473 p, $6.00, 1931.*

Theory and practice of mercury arc rectifier operation.

Principles of Mercury Arc Rectifiers and Their Circuits—*By D. C. Prince and F. B. Vogdes, McGraw-Hill Book Co., 233 p, $3.00, 1927.*

Principles of mercury vapor rectifiers and their circuits.

Electron Optics—*By Otto Klemperer, Macmillan Co., 107 p, $1.75, 1939.*

Electron Optics, Theoretical and Practical—*By L. M. Myers, D. Van Nostrand Co., 618 p, $12.00, 1939.*

Thorough treatment of movement and behavior of electrons in various influencing fields.

Conduction of Electricity Through Gases—*By J. J. and G. P. Thomson, Macmillan Co., Vol. I 491½ p, $6.00, 1928, Vol. II, 608 p, $7.00, 1933.*

Photoelectricity

Photoelectric Phenomena—*By Hughes and Dubridge, McGraw-Hill Book Co., 531 p, $5.00, 1932.*

Critical survey of the entire field of photoelectric phenomena.

Photocells and Their Application—*By Zworykin and Wilson, John Wiley and Sons, 348 p, $3.00, 1934.*

Exposition of the art of photocells; what they are and what they do.

Photoelectric Cell Applications—*By R. C. Walker and T. M. C. Lance, Pitman Publishing Corp., 336 p, $4.00, 3rd ed., 1938.*

Photoelements and Their Application—*By Bruno Lange, Reinhold Publishing Co., New York, 297 p, $5.50, 1938.*

Cathode-ray Tubes

Cathode Ray Tubes and Allied Types—*RCA Mfg. Co.*

Cathode Ray Oscillography—*By MacGregor-Morris and Henley, Instruments Publishing Co., Pittsburgh, 249 p, $6.00, 1936.*

The Cathode Ray Oscillograph in Radio Research—*By Watson-Watt, Herd and Bainbridge, Bainbridge-Bell, His Majesty's Stationery Office, London, Price 10s net, 1933.*

Cathode Ray Tube at Work—*By J. F. Rider, Rider Publishing Co., New York, 326 p, $2.50, 1935.*

Cathode Ray Tubes—*By Manfred Von Ardenne, Sir Isaac Pitman & Sons Ltd., 530 p, $14.00, 1939.*

The Low Voltage Cathode Ray Tube and Its Applications—*By G. Parr, Chapman & Hall, Ltd., 177 p, 10s 6d, 1937.*

Guide to Cathode Ray Patterns—*By Merwyn Bly, John Wiley & Sons, 30 p, $1.50, 1943.*

VIII TELEVISION

The Electron Microscope—*By E. F. Burton and W. H. Kohl, Reinhold Publishing Co., New York, 233 p, $3.85, 1942.*

Television Standards and Practice—*edited by D. G. Fink, McGraw-Hill Book Co., 405 p, $5.00, 1943.*

Authoritative compilation of material on television from Proceedings of National Television Systems Committee.

Principles of Television Engineering—*By D. G. Fink, McGraw-Hill Book Co., 540 p, $5.00, 1940.*

Basic principles of television engineering design and practice.

Television, The Electronics of Image Transmission—*By V. K. Zworykin and G. A. Morton, John Wiley & Sons, 646 p, $6.00, 1940.*

A treatment of electronic television principles.

Television Broadcasting—*By Lenox R. Lohr, McGraw-Hill Book Co., 274 p, $3.00, 1940.*

Descriptions of operating techniques and equipment as well as discussions of fundamental television program considerations.

Television Engineering—*By J. C. Wilson, Pitman Pub. Co., 492 p, $10.00, 1937.*

Television Optics—*By L. M. Myers, Pitman Pub. Co., 364 p, $12.00, 2nd ed., 1938.*

Television Technical Terms—*By E. J. G. Lewis, Pitman Pub. Co., 95 p, $1.75, 1936.*

Radio Facsimile—*By RCA Institutes Technical Press, New York, V. I, 368 p, $3.00, paper $1.00, 1938.*

IX RADIO COMMUNICATIONS—MISCELLANEOUS

Service & Maintenance

Principles and Practice of Radio Servicing—*By H. J. Hicks, McGraw-Hill Book Co., 300 p, $3.00, new ed. in press.*

How to install, test, and repair radio receivers, with plain treatment of theory of radio and electricity.

Service by Signal Tracing—*By John F. Rider, John F. Rider Publisher, 360 p, $2.00, 1939.*

Radio Service Trade Kinks—*By Lewis S. Simon, McGraw-Hill Book Co., 254 p, $3.00 1939.*

Radio Field Service Data—*By A. A. Ghirardi, Radio and Technical Pub. Co., leaflette $2.50, 2nd rev., 1936.*

Radio Service Encyclopedia—*By P. R. Mallory Co., Indianapolis, Ind., 415 p, $1.50, 4th ed. 1943.*

Servicing Superheterodynes—*By John F. Rider Pub. Inc., 278 p, $1.00, 1934.*

Radio Troubleshooter's Handbook—*By A. A. Ghirardi, Radio & Technical Publishing Co., New York, 710 p, $5.00, 2nd ed. 1941.*

An Hour a Day With Rider on Automatic Volume Control—*By J. F. Rider Pub. Inc., 94 p, $0.60, 1936.*

Vacuum Tube Voltmeters—*By John F. Rider, John F. Rider Publisher, Inc., 179 p, $1.50, 1941.*

The Meter at Work—*By John F. Rider, John F. Rider Publisher, Inc., 152 p, $1.25, 1940.*

Radio Construction and Repairing—*By J. A. Moyer and J. F. Wostrel, McGraw-Hill Book Co., 386 p, $2.50, 4th ed., 444 p, $2.50, 4th ed. 1933.*

Essentials of practical radio servicing.

Radio Service Trade Kinks—*By Lewis S. Simon, McGraw-Hill Book Co., 269 p, $3.00, 1939.*

Useful manual for radio service and repair men, giving quick reference to common radio ailments and methods of correcting them.

Automatic Record Changers and Recorders—*By John F. Rider, John F. Rider Publisher, Inc., 744 p, $6.00.*

Automatic Volume Controls—*John F. Rider, Publisher, Inc., 96 p, $0.90.*

Resonance and Alignment—*John F. Rider, Publisher, Inc., 96 p, $0.90.*

Alternating Currents in Radio Receivers—*John F. Rider Publisher Inc., 96 p, $0.90.*

D-C Voltage Distribution in Radio Receivers—*John F. Rider Publisher, 96 p, $0.90.*

Automatic Frequency Control Systems—*By John F. Rider, John F. Rider Publisher, 144 p, $1.00, 1937.*

Servicing Receivers by Means of Resistance Measurement—*By John F. Rider, John F. Rider Publisher, 203 p, $1.00, 1932.*

Servicing Superheterodynes—*By John F. Rider, John F. Rider Publisher, Inc., 278 p, $1.00, 1934.*

The Cathode Ray Tube at Work—*By John F. Rider, John F. Rider, Publisher, Inc., 326 p, $2.50, 1935.*

Perpetual Trouble Shooter's Manual—*By John F. Rider, John F. Rider Publisher, Inc., Volumes I to V, abridged, 2000 p, $12.50, Vol. III, 1070 p, $8.25, Vol IV, 1060 p, $8.25, Vol. V, 1200 p, $8.25, Vol. VI, 1240 p, $8.25, Vol. VII, 1600 p, $11.00, Vol. VIII, 1650 p, $11.00, Vol. IX, 1672 p, $11.00, Vol. X, 1664 p, $11.00, Vol. XI, 1652 p, $11.00, Vol. XII, 1648 p, $11.00, Vol. XIII, 1672 p, $11.00, 1933-1942.*

Aligning Philco Receivers—*By John F. Rider, John F. Rider Publisher, Inc., Vol. I, 1929 to 1936, 176 p, $1.50. Vol II, 1937 to 1941, 200 p, $1.75.*

Abridged Manual (Trouble Shooter's Manual)—*By John F. Rider, John F. Rider Publisher, Inc., 2,000 p, $12.50.*

Oscillator at Work—*By John F. Rider, John F. Rider Publisher, Inc., 243 p, $1.50, 1940.*

Discussion of oscillators and their uses in radio servicing; a practical manual of instruction.

Servicing by Signal Tracing—*By John F. Rider, John F. Rider Publisher, Inc., 360 p, $2.00, Spanish edition, $3.50, 1939.*

Modern Radio Servicing—*By Alfred A. Ghirardi, Radio and Technical Publishing Co., New York, 1300 p, $5.00, 1936.*

Radio Troubleshooter's Handbook—*By A. A. Ghirardi, Radio & Technical Publishing Co., New York, 710 p, $5.00, 2nd ed. 1941.*

Operators Examinations

How to Pass Radio License Examinations—*By Chas E. Drew, John Wiley & Sons, new ed. in press this year, old ed. 201 p, $2.00, 1938.*

Guide to radiomen in preparation for FCC licenses.

Learning the Radio Telegraph Code—*By John Huntoon, American Radio Relay League, Inc., 534 p, $0.25, 1942.*

Radio Code Manual—*By Arthur R. Nilson, McGraw-Hill Book Co., 174 p, $2.00, 1942.*

Complete course in learning to send and receive the International Morse code, for FCC examinations.

Radio Operating Questions and Answers—*By Arthur R. Nilson and J. L. Hornung, McGraw-Hill Publishing Co., 415 p, $2.50, 7th ed. 1940.*

A study text for those preparing to take radio operator's license examinations, and covering the theory, practice, circuits, laws, and regulations of radio.

Radio Traffic Manual and Operating Regulations—*By R. L. Duncan and C. E. Drew, John Wiley and Sons, 187 p, $2.00, 1929.*

A manual for radio operators and those training to handle radio traffic.

Aeronautic Radio

Aircraft Radio and Electrical Equipment—*By H. K. Morgan, Pitman Publishing Corp., 384 p, $4.50, 2nd ed. 1939.*

Radio Navigation for Pilots—*By C. H. McIntosh, McGraw-Hill Book Co., 175 p, $2.00, 1942.*

Aeronautic Radio for Operators, Pilots, Mechanics—*By Myron F. Eddy, Ronald Press Co., New York, 502 p, $4.50, 1939.*

Aeronautic Radio—*By Myron F. Eddy, Ronald Press, 502 p, $4.50, 1939.*

Aircraft Radio and Electrical Equipment—*By Howard K. Morgan, Pitman Publishing Co., 384 p, $4.50, rev. ed. 1940.*

Instrument and Radio Flying—*By Karl S. Day, Air Associates, Inc., 284 p, $3.50, 1938.*

Principles of Aeronautical Radio Engineering—*By P. C. Sandretto, McGraw-Hill Book Co., 414 p, $3.50, 1942.*

Engineering treatment of radio as used in aeronautical navigation and communication.

X RECENT ARRIVALS

High Frequency Thermionic Tubes—*By A. F. Harvey, John Wiley and Sons.*

Behavior of tubes and their associated circuits, with indication of practical application to high frequency problems.

Magnetic Circuits and Transformers—*By E. E. Staff of M. I. T., John Wiley and Sons.*

A text for engineering students and practicing engineers.

Laboratory Manual in Radio—*By F. E. Almstead, K. E. Davis and G. K. Stone, McGraw-Hill Book Co.*

A laboratory work manual on fundamental principles and practices.

Electromagnetic Waves—*By S. A. Schelkunoff, D. Van Nostrand Co.*

A treatment of the properties of electromagnetic waves in space and along conductors.

Vector and Tensor Analysis—*By Thomas V. Craig, McGraw-Hill Book Co.*

An introduction to the subject.

XI FORTHCOMING VOLUMES

Electronic Control of Resistance Welding—*By G. M. Chute, McGraw-Hill Book Co.*

A practical manual.

Mathematics for Technical Students—*By M. S. Corrington, Harper and Brothers.*

A full course in arithmetic, algebra, logarithms and trigonometry, including the essential tables.

Elements of Radio—*By Charles I. Hellman, D. Van Nostrand Co.*

An exposition of the principles upon which radio operates.

X-Rays in Research and Industry—*By H. Hirst, Chemical Publishing Co.*

How science and industry benefit from radiography.

Introduction to Circuit Analysis—*By A. R. Knight and G. H. Fett, Harper and Brothers.*

A textbook in the analysis of electric circuits.

Hyper and Ultrahigh Frequency Engineering—*By R. I. Sarbacher and W. A. Edson, John Wiley and Sons.*

Introduction to Fundamentals of Electrical Engineering—*By E. M. Strong, John Wiley and Sons.*

A book for beginners.

Basic Principles of Radio—*By M. G. Suffern, McGraw-Hill Book Co.*

A manual to aid in the training of repair men.

Basic Electricity for Communications—*By W. H. Timbie, John Wiley and Sons.*

Electrical principles underlying telegraphy, telephone and radio communication.

Radio—*By V. Zeluff, John Wiley and Sons.*

A volume in the Wiley Pre-Service Series.

Graphical Constructions for Vacuum Tube Circuits—*By Albert Preisman, McGraw-Hill Book Co.*

A text in the Radio Communication Series dealing with graphical methods of analysis of electron tube circuits.

Mathematics of Physics and Chemistry—*By H. Margenau and G. M. Murphy, D. Van Nostrand Co.*

A handbook for physicists and chemists.

Radio Maintenance and Repair—*By R. Muniz and S. D. Prensky, D. Van Nostrand Co.*

How to keep radio receivers in operating order.

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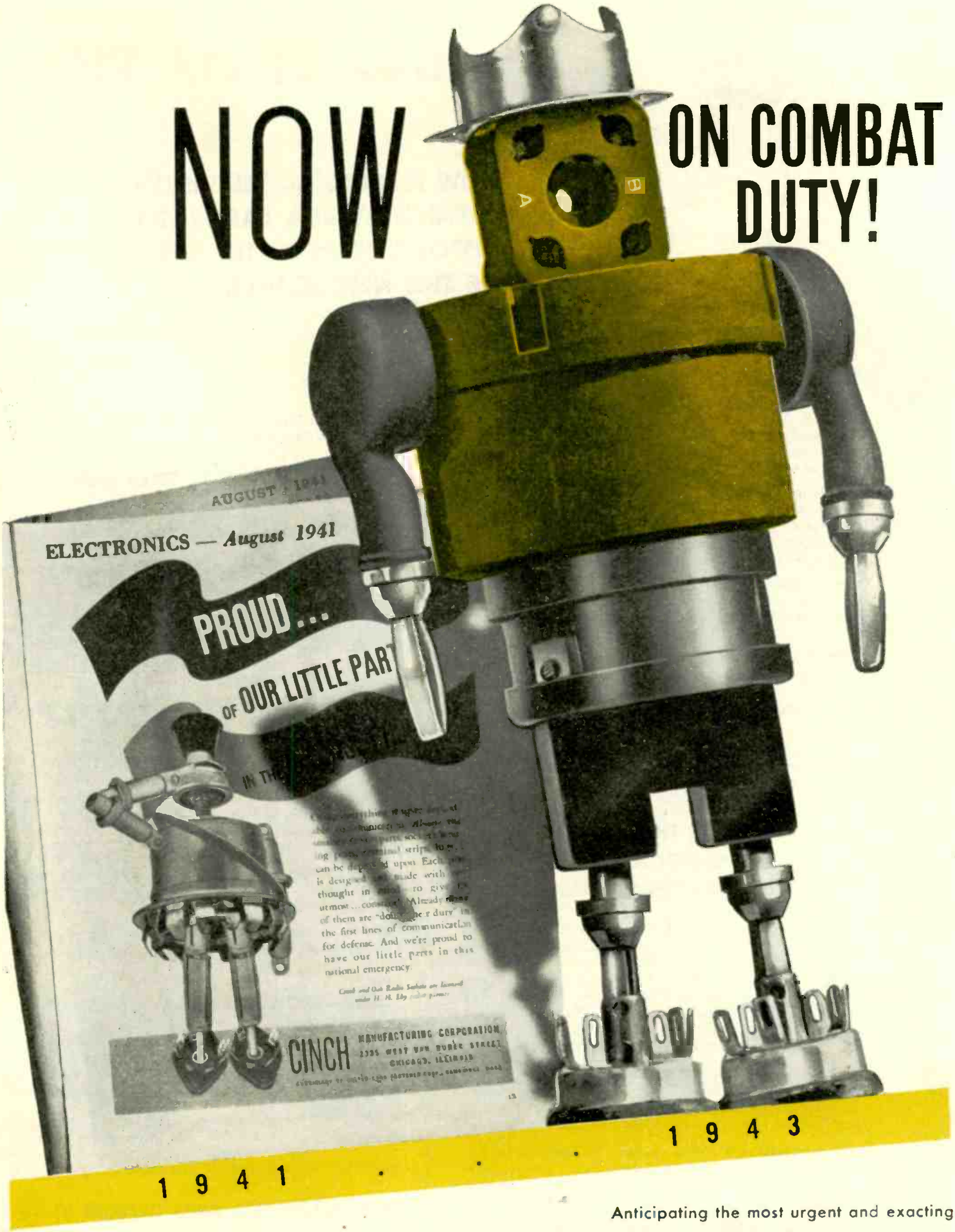

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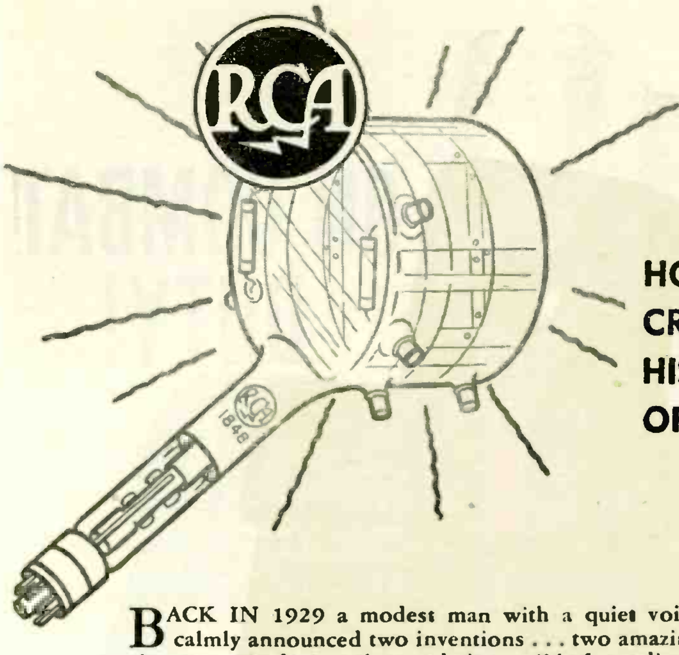


BLAZING THE

HOW ELECTRONIC TELEVISION WAS CREATED BY RCA LABORATORIES... HISTORIC STEPS IN THE EVOLUTION OF THIS NEW SCIENCE

BACK IN 1929 a modest man with a quiet voice calmly announced two inventions . . . two amazing almost magic devices that made it possible for radio to "see" as well as to "hear."

This man was Dr. V. K. Zworykin of RCA Laboratories. And his research in electronics gave radio its electronic "eyes" known as the Iconoscope and the Kinescope. The former is the radio "eye" behind the camera lens; the latter is the receiver's screen.

Since that red-letter day in television history, ceaseless research in the science of radio and electron optics has established RCA Laboratories as the guiding light of television.

The decade of the thirties saw television's coming-of-age. It brought new scientific instruments and discoveries; it developed new techniques of showmanship; it even created new words—televise, telecast, teleview, and telegenic.

In the evolution of television there have been "high spots"; historic milestones of progress; definite "firsts" —made possible by the services of RCA.

1928—1932—FROM THE FIRST EXPERIMENTAL STATION TO ALL-ELECTRONIC TELEVISION

Station W2XBS, New York, was licensed to RCA in 1928 to conduct television experiments. Transmitter located at laboratory in Van Courtlandt Park, was later moved to Photophone Building, 411 Fifth Avenue; then to New Amsterdam Theatre until 1931, when operations were transferred to Empire State Building.

On Jan. 16, 1930, Television pictures were transmitted by RCA from W2XBS at 411 Fifth Avenue and shown on 6-foot screen at RKO-Proctor's 59th Street Theatre, New York.

Television station W2XBS, operated by National Broadcasting Company, atop New Amsterdam Theatre, New York, opened for tests July 7, 1930, with the images whirled into space by a mechanical scanner.

Empire State Building, the world's loftiest skyscraper, was selected by RCA as the transmitter and aerial site for ultra-short-wave television experiments using both mechanical and electrical scanners. Operation began October 30, 1931.

Field tests of 240-line, all-electronic television were made by RCA at Camden, N. J., with television signals relayed by radio from New York through Mt. Arney, N. J., for the first time, May 25, 1932.

1936—OUTDOOR TELEVISION

Television outdoors was demonstrated by RCA at Camden, N. J., on April 24, 1936, with local firemen participating in the program broadcast on the 6-meter wave.

All-electronic television field tests of RCA began June 29, 1936, from ultra-short-wave transmitter in Empire State Building and aerial on the pinnacle releasing 343-line pictures.

Radio manufacturers saw television demonstrated by RCA on July 7, 1936, with radio artists and films used to entertain.

1937—ELECTRON "GUN"

Electron projection "gun" of RCA was demonstrated on May 12, 1937, to Institute of Radio Engineers, with pictures projected on 8 x 10-foot screen.

Television on 3 x 4-foot screen was demonstrated by RCA to Society of Motion Picture Engineers on October 14, 1937; pictures were transmitted from Empire State Building to Radio City.

Mobile television vans operated by RCA-NBC appeared on the streets of New York for first time, December 12, 1937.

1938—BROADWAY PLAY TELEVISED

Scenes from a current Broadway play, "Susan and God," starring Gertrude Lawrence, were telecast on June 7, 1938, from NBC studios at Radio City.

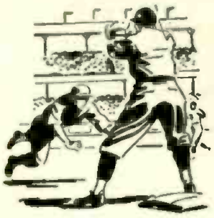
RCA announced on October 20, 1938, that public television program service would be inaugurated and commercial receiving sets offered to the public in April, 1939.

1939—BASEBALL—KING GEORGE VI—FOOTBALL

Opening ceremonies of the New York World's Fair televised by NBC on April 30, 1939, included President Roosevelt as first Chief Executive to be seen by television.

"A first from the diamond." Columbia vs. Princeton, May 17, 1939, televised by NBC.

TELEVISION TRAIL



Improved television "eye" named the "Orthicon," introduced by RCA on June 8, 1939, added greater clarity and depth to the picture.

Television spectators in New York area on June 10, 1939, saw King George VI and Queen Elizabeth at the World's Fair, telecast by NBC.

Brooklyn Dodgers-Cincinnati game telecast by NBC on August 26, 1939, was the first major-league baseball game seen on the air.

First college football game—Fordham-Waynesburg—televised by NBC, September 30, 1939.

Television from NBC station in New York was picked up by RCA receiver in plane 20,000 feet over Washington, D. C., 200 miles away, October 17, 1939.

Television cameras of NBC scanned the scene in front of Capitol Theatre and in lobby at premiere of motion picture "Gone With The Wind," December 19, 1939.

1940—HOCKEY—COLOR—TRACK BIRD'S-EYE TELEVISION

Color television was demonstrated on February 6, 1940, to Federal Communications Commission by RCA at Camden, N. J.

First hockey game was televised by NBC camera in Madison Square Garden, February 25, 1940.

Basketball: Pittsburgh-Fordham, also NYU-Georgetown at Madison Square Garden were televised by NBC, February 28, 1940, as first basketball games seen on the air.

First Intercollegiate track meet at Madison Square Garden telecast on March 2, 1940.

Using RCA's new, compact and portable television transmitter, a panoramic view of New York was televised for the first time from an airplane on March 6, 1940. Television sightseers as far away as Schenectady saw the bird's-eye view of the metropolis.

Premiere of television opera on March 10, 1940, featured Metropolitan Opera stars in tabloid version of "Pagliacci."

First telecast of religious services on March 24, 1940, from NBC Radio City studios, were seen as far away as Lake Placid.

Ringling Brothers-Barnum and Bailey circus viewed on the air, April 25, 1940, through NBC electric camera in Madison Square Garden.

Television pictures on 4½ x 6-foot screen were demonstrated at RCA annual stockholders meeting May 7, 1940, at Radio City.

Republican National Convention was televised on June 24, 1940, through NBC's New York station via coaxial cable from Philadelphia.

Democratic National Convention films rushed by plane from Chicago for NBC were telecast in New York, July 15, 1940.

President Roosevelt was seen by television throughout the Metropolitan areas as he addressed Democratic rally, October 28, 1940, at Madison Square Garden.

Election returns on November 5, 1940, televised for first time by NBC, showed teletypes of press associations reporting the news.

1941—COMMERCIAL TELEVISION

Television progress demonstrated to FCC on January 24, 1941, included: home-television receiver with 13½ x 18-inch translucent screen; television pictures 15 x 20 feet on New Yorker Theatre screen; pictures relayed by radio from Camp Upton, Long Island, to New York; also facsimile multiplexed with frequency modulation sound broadcast.

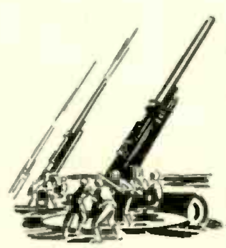
Television pictures in color were first put on the air by NBC from Empire State Building Transmitter on February 20, 1941.

Large-screen television featuring Overlin-Soose prize fight on May 9, 1941, at Madison Square Garden was demonstrated by RCA at New Yorker Theatre; also, on following days, baseball games from Ebbets Field, Brooklyn.

Commercial operation of television began July 1, 1941, on a minimum schedule of 15 hours a week. NBC's station WNBT, New York, the first commercially licensed transmitter to go on the air, issued the first television rate card for advertisers, and instituted commercial service with four commercial sponsors.

Entry of the United States in World War II, enlisted NBC television in New York to aid in illustrating civilian defense in air-raid instructions in the New York area.

1943—AMERICA AT WAR!



Today RCA Laboratories, pioneer in the science of electronics, is devoting all its efforts to the war.

Yet, from the discoveries, developments and inventions made under the urgency of war, will come greater wonders for the Better Tomorrow of a peacetime world.

RADIO CORPORATION OF AMERICA

RCA BUILDING, NEW YORK

CREATOR OF ELECTRONIC TELEVISION


We lose them, too...
that's why we are making
TURBO
☆ MORE EFFICIENT
☆ MORE DEPENDABLE
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...than ever before!
No incentive could be devised to induce greater effort in the design of electrical insulation than that which is now reflected in the production of TURBO electrical insulation.
Our military machines and equipment—just as it has been in industrial applications heretofore—suffices to emphasize "this job that must be done well".
The complete and diversified TURBO line includes a specific insulation for every requirement—electrical and mechanical. Inquiries pertaining to insulation problems are invited.
VARNISHED GLASS TUBING
Resistant to extremely high heat, is perfectly suited for heavy duty operating conditions, confined areas where ventilation is at a minimum, and other similar applications.
WIRE IDENTIFICATION MARKERS
To meet rigid ordnance specifications, are available in any size, length or color, with any marking. Made of standard TURBO tubing, thereby conserving the use of critical materials such as rubber, metal, vinylite, etc. Non-projecting, snug-fitting.
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Resistant to deteriorating influences and meeting the diversity of requirements essential to withstand general breakdowns, moisture absorption, acids, alkalis, etc.
EXTRUDED PLASTIC TUBING
Incorporating the most advanced developments of the plastic art as applied to electrical insulation. Especially applicable to conditions wherein embrittlement from the effects of sub-zero temperatures must be met.
Specimen boards, with samples of each TURBO product, together with a list of standard sizes, will be sent promptly on request. Write now
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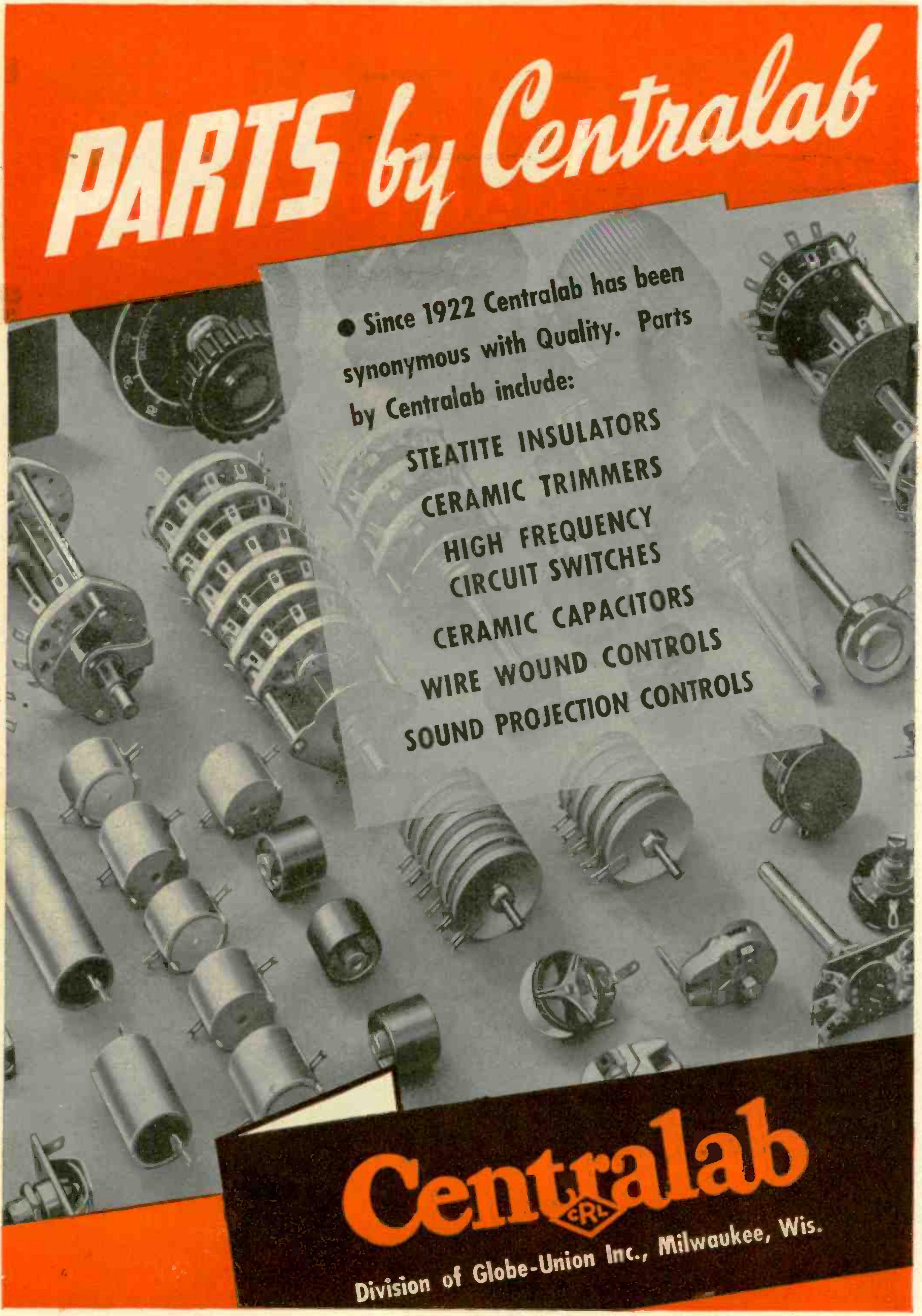
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Smallest CAPACITOR
.... Yet
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A proud achievement .... after years of research for a small moisture-proof paper capacitor .... Dumont engineers have scored a signal victory by perfecting a water-tight seal that is definitely moisture-proof. Conclusive tests of many samples show LESS THAN 1% CHANGE IN LEAKAGE RESISTANCE after 150 hours in water.
• Dumont moisture-proof capacitors, in all types of radio construction, are being used in radio equipment serving our armed forces and governmental agencies here and over there.
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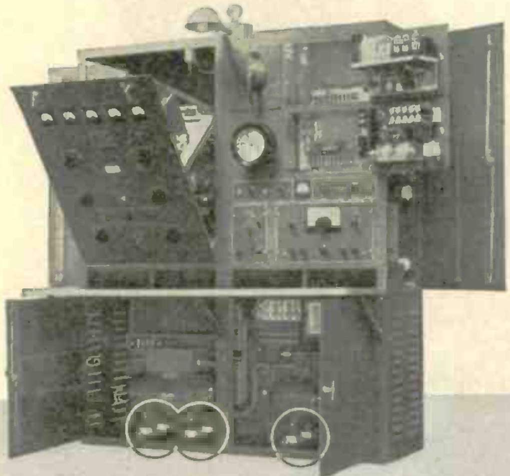
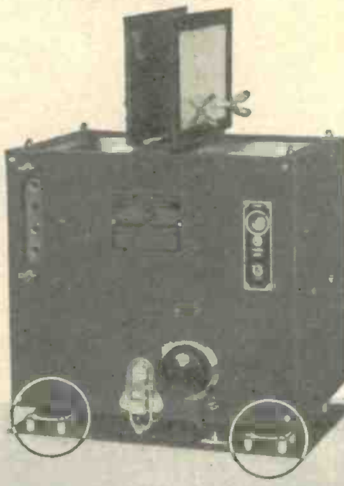
BONDED RUBBER

TYPICAL INSTALLATIONS OF LORD PLATE FORM MOUNTINGS



Radio Transmitter and Receiver



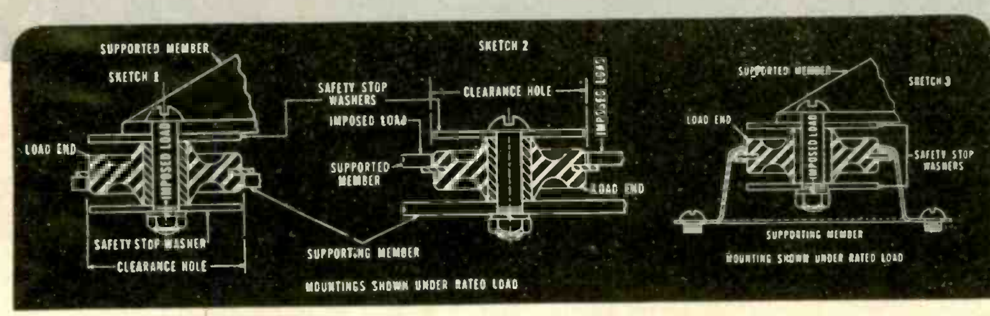
Police Car Radio Telephone Transmitter

PLATE FORM

HOLDER TYPE

Diameter of Rubber Section	Normal Load Rating
1"	1 to 4 lbs.
1½"	2 to 12 lbs.
2"	10 to 45 lbs.
2⅞"	120 to 310 lbs.

Maximum load capacities range from 100% to 200% higher than normal rating.



STANDARD Lord Shear Type Bonded Rubber Plate Form Mountings are made in four sizes, and in the following shapes; round, square, diamond, and holder type. Load capacities range from a few ounces up to 300 pounds. Lord Mountings absorb shock, isolate vibration and minimize all noise translated through solid conduction.

Illustrations show typical methods of installation and application. To install Plate Form Mountings as shown in sketches 1 and 2, provide recessed hole 1/32" larger than rubber diameter for clearance. Drilled, punched or tapped holes should be provided for fastening square or diamond shaped mountings.

Sketch 1 shows a Plate Form Mounting fastened to the *supporting* member and the *supported* member is attached to the center sleeve of mounting.

Sketch 2 shows the fastening made to the *supported* member, the *supporting* member being fastened to the center sleeve of the mounting. Stop washers at each end of the mounting form an interlocking system of metal, providing safety and preventing undue movement under shock loads.

Sketch 3 illustrates the general method of application and installation for the Holder Type Mounting. To install this mounting, it is necessary only to provide means of attachment to supporting member and in some cases, clearance for the center bolt in the supporting base.

The center sleeve of *all* Lord Plate Form Mountings can be tapped to any standard tapping specifications, where it is found to be inconvenient to use bolts, as shown in illustrations. The selected method of attachment depends entirely upon individual assemblies, those shown in sketches being indicative only. Lord Shear Type Mountings can be used in either a supporting or a suspension position with equally satisfactory results.

Complete information on dimensions, load ratings and methods of installation are contained in our Bulletin 104. Send for your copy.

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

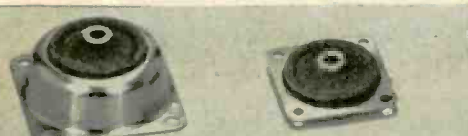


PLATE FORM MOUNTINGS

LORD BONDED RUBBER

TUBE FORM MOUNTINGS

FRACTIONAL H. P. FLEXIBLE COUPLINGS

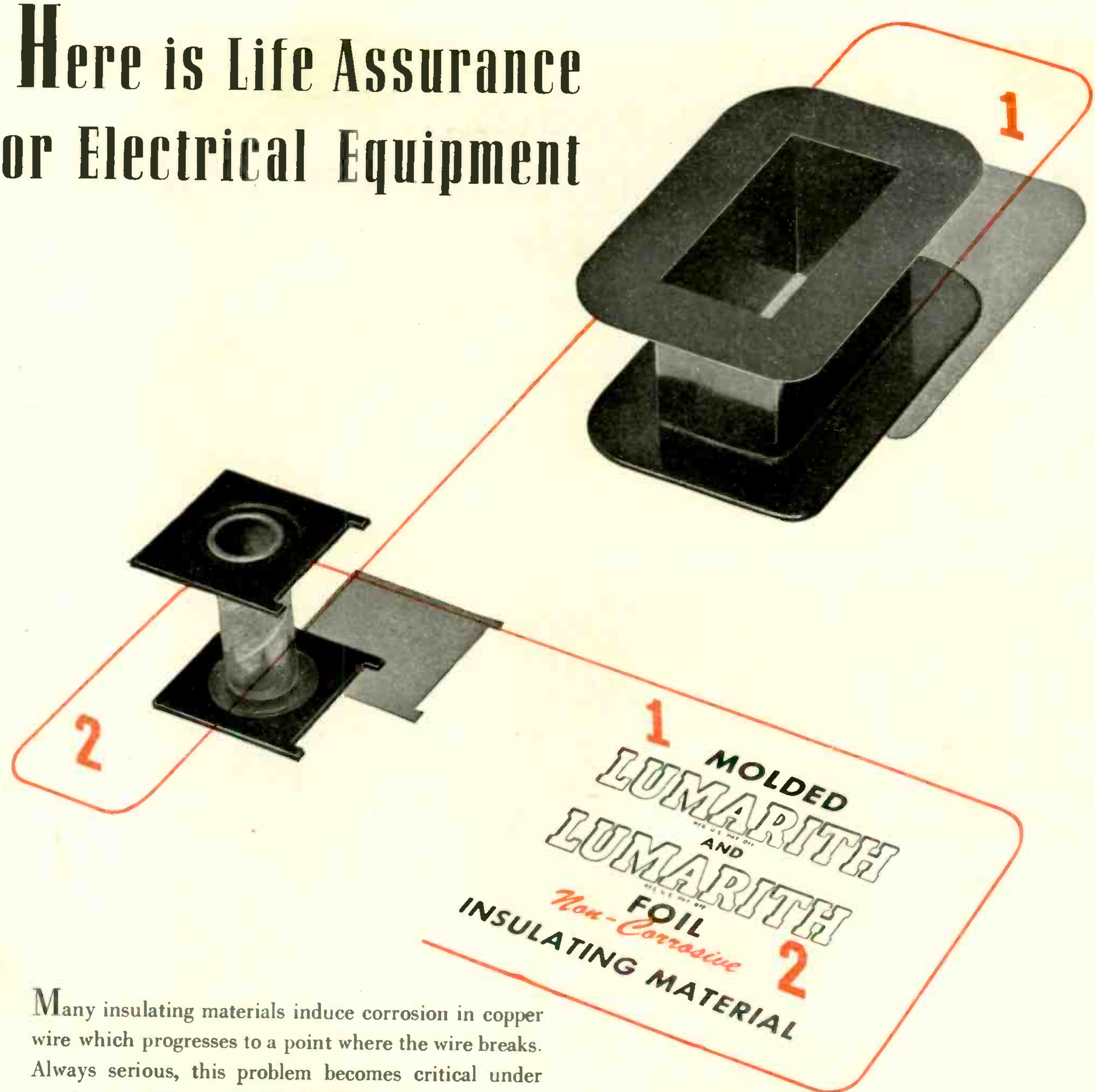
LORD MANUFACTURING COMPANY . . . ERIE, PENNSYLVANIA

Originators of Shear Type Bonded Rubber Mountings

SALES REPRESENTATIVES • NEW YORK, 280 Madison Ave. • CHICAGO, 520 N. Michigan Ave. • DETROIT, 7310 Woodward Ave. • BURBANK, CAL., 245 E. Olive Ave.


They make things HOT

Here is Life Assurance For Electrical Equipment



Many insulating materials induce corrosion in copper wire which progresses to a point where the wire breaks. Always serious, this problem becomes critical under wartime conditions . . . a "built-in" hazard that must be eliminated from military (and industrial) equipment.

LUMARITH does not promote corrosion and is resistant to electrochemical oxidation which causes corrosion in copper wire.

Coil forms and bobbins made entirely of LUMARITH —or of other materials covered with LUMARITH foil— eliminate the source of copper wire corrosion in many electrical devices. An extremely important application . . . but a mere scratch on the surface of the possibilities of LUMARITH as insulation in electrical equipment. For LUMARITH has excellent electrical properties; high dielectric strength; high resistivity.

The First Name in Plastics

Celanese Celluloid Corporation, a division of Celanese Corporation of America, 180 Madison Ave., New York City. *Representatives:* Cleveland, Dayton, Chicago, St. Louis, Detroit, Los Angeles, Washington, D. C., Leominster, Montreal, Toronto, Ottawa.

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NAME YOUR ELECTRICAL INSULATION REQUIREMENTS
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WE'LL MEET THEM!
Mitchell-Rand the "Insulation Headquarters" is a title well earned . . . the result of 54 years service to the Electrical and Electronic Industries during which time countless formulas for Waxes and Compounds, Varnished Tubings, Insulating Varnishes, etc., were developed for the expanding services required of electrical insulations.
Today as always M-R Electrical Insulations take the cares out of your insulation problems . . . You name your requirements and M-R will meet them.
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Write today for your Free Card of Varnished Tubing with samples ranging from size 0 to 20 to fit wires from .032 to .325 inches . . . other valuable aids, are the M-R Guide Book of Electrical Insulation . . . the Wall Chart with reference tables, electrical symbols, allowable capacities of conductors, dielectric averages, thicknesses of insulating materials and tap drill sizes . . . and the M-R Wax and Compound Guide Book . . . they are full of valuable information . . .
WRITE TODAY ON YOUR COMPANY LETTERHEAD!
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MITCHELL-RAND INSULATION COMPANY, INC.
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NEW YORK, N. Y.
A PARTIAL LIST OF M-R PRODUCTS
Fiberglas Varnished Tape and Cloth
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Asbestos Sleeving and Tape
Extruded Plastic Tubing
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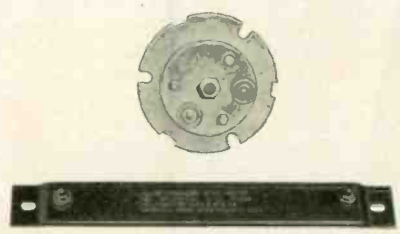
Here's design help on

HIGH HUMIDITY PROBLEMS

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

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



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

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

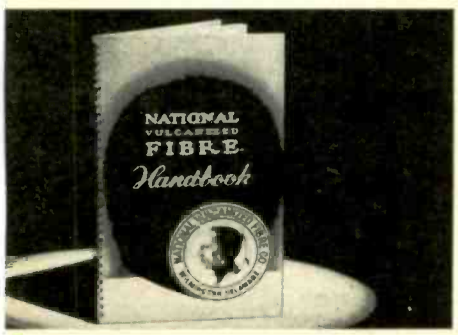
WESTINGHOUSE **Westinghouse**

PLANTS IN 25 CITIES . . . OFFICES EVERYWHERE

Deliveries of National Vulcanized Fibre and Phenolite are confined to products necessary to the War Effort. However, it is our sincere desire to meet the demands of all of our customers and to serve them to the full extent of the limitations placed upon us. You can depend on our doing this.

NATIONAL Provides Its Customers with Fabricating Data They Can Use

can profitably use these technical Books. Write for free copies on your company letterhead.



WAR production demands and shortages of skilled manpower have necessitated the use of inexperienced hands. In the training of these workers, valuable time can be saved if you are provided with easy-to-understand technical data.

We are in a position to provide you with technical bulletins which show in a clear and practical way the correct fabrication methods for National Fibre and Phenolite. Further, our engineers will be glad to work with your production men on any National Fibre or Phenolite fabricating problem. Write or call us.

NATIONAL VULCANIZED FIBRE CO.

WILMINGTON DELAWARE

Offices in Principal Cities


Where Sustained Power is Vital...
Depend on
TAYLOR TUBES
Wherever our boys are fighting, Taylor Tubes are daily proving their reliability, efficiency and extra stamina. In many battle positions they operate twenty-four hours a day — providing the power to help keep essential communications going through — delivering the same dependable service that established and maintained Taylor's peacetime reputation for high quality tube performance.
Taylor factories are turning out more tubes than ever before — supplying them where needed for the all out Victory program. After V Day, the same quality Taylor Tubes that are meeting today's urgent demands will provide "More Watts Per Dollar" service for all.
√TRANSMITTING √ELECTRONIC
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TAYLOR TUBES INC., 2312-18 WABANSIA AVE., CHICAGO, ILLINOIS

EBY *Components*

MANUFACTURED TO SIGNAL CORPS SPECIFICATIONS

(as of May 15, 1943)

This list is necessarily incomplete. It does, however, represent those typical components which the Eby organization is supplying to leading manufacturers of electrical and communications equipment.

Major and Sub-Assemblies

Eby has a thoroughly organized production department capable of turning out any desired quantity of complete or partial assemblies to rigid specifications. Our facilities have been integrated to meet the demand for basic engineering and production control, so that full responsibility is carried through in every detail. We will be pleased to discuss specific problems with you.

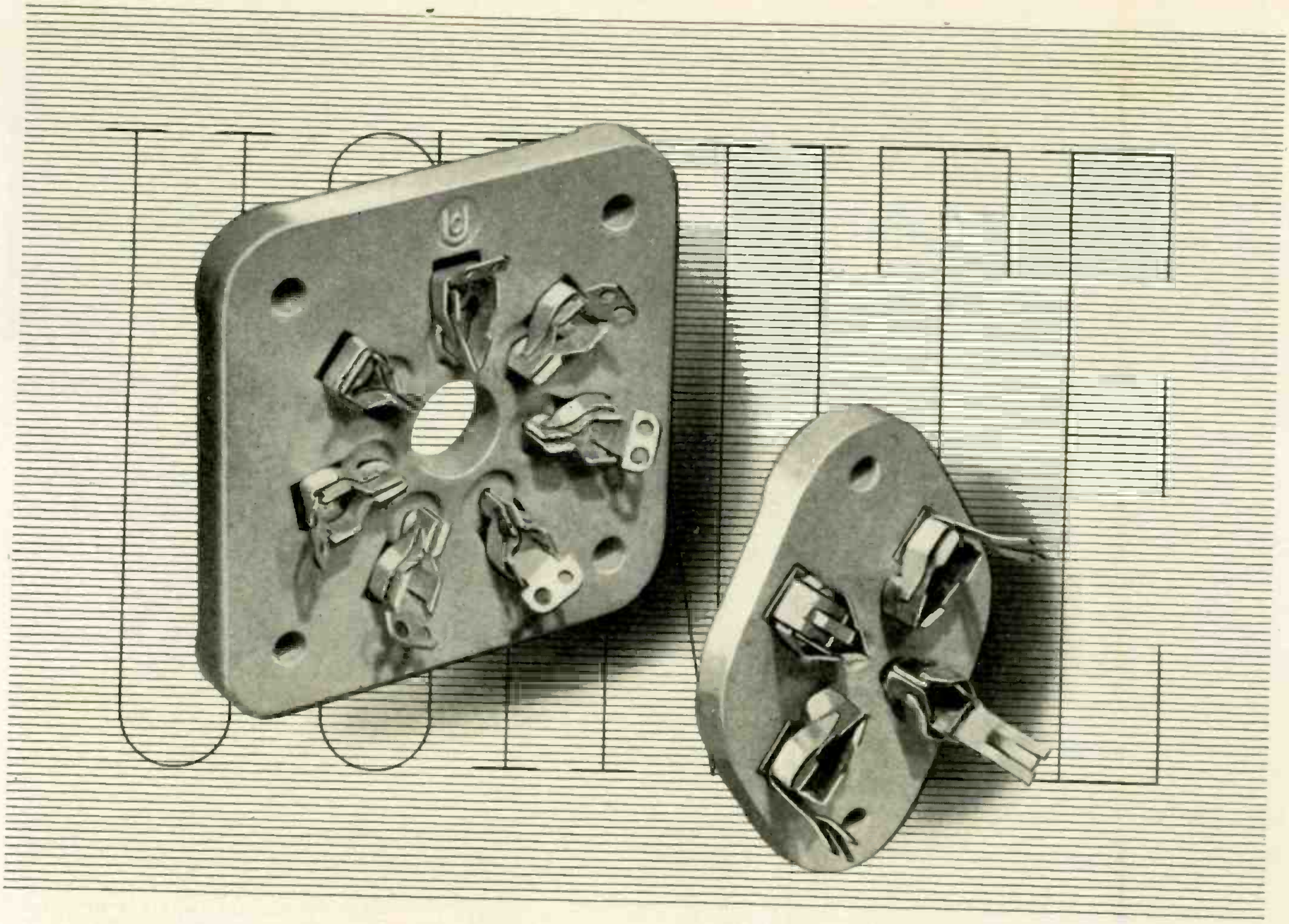
Additional copies of this sheet will be sent upon request.

HUGH H. EBY INCORPORATED
18 W. CHELTEN AVE.
PHILADELPHIA, PA.

This is only a partial list of Eby products and services:

Signal Corps Part No.	EBY Part No.	Name or Description
TM-109	45	Admiral Binding Post
TM-139	45-Spec.	Admiral Binding Post 1 1/8 Stud
TM-144	11	Corporal Binding Post
TM-145	13	Sergeant Binding Post
TM-145-A	13D	Sergeant Binding Post
TM-146	14	Sergeant Binding Post
TM-146-A	14D	Sergeant Binding Post
TM-149	14-Spec.	Sergeant Binding Post 7/8 Stud
TM-150	12	Buddy Binding Post
TM-152	32	Junior Binding Post
TM-175	75V	Teleposts
TM-176	TM-176	Special Binding Post
TM-186	14RC	Sergeant Post with Rubber Cap
TM-195	95V	Telepost
TM-196	14HB	Hex Base Sergeant Binding Post
TM-197	97	Panel Post
TM-198	98	Special Hex Base Sergeant Post
TM-214	14GD	Sergeant
TM-215	12E	Buddy Binding Post
TM-89	6513	Metal Terminals
TM-161	6549	Metal Terminals
TM-163	6550	Metal Terminals
TM-184	TM-184	Terminal Board
TS-565		Terminal Board
TS-562		Terminal Board
MC-162	MC-162	Earphone Cushions
MC-163	MC-163	Connector Clamp
JK-24	JK-24	Jack
SO-92	SO-92	9 prong Plug
PL-P59	PL-P59	Plug
PL-P61	PL-P61	Plug
PL-P64	PL-P64	Plug
PL-50A	PL-50A	Plug
PL-177	PL-177	Plug
PL-181	PL-181	Plug
PL-182	PL-182	Plug
P-20	P-20	Headset
BD-57A	BD-57A	Switchboard
M-221	M-221	Connector
BX-13	BX-13	Junction Box
HS-33	HS-33	Headsets
HS-38	HS-38	Headsets
T-44	T-44	Microphone

Write today for prices and delivery schedules.



No. 115047

No. 115002

Soup to nuts

Ucinite offers you all the advantages of dealing with a completely self-contained unit. We do our own fabricating, plating, heat-treating and assembling. If we need a new tool for a job we can make it ourselves. Or, if you should say, "I want a part to do so and so," we have the engineering talent to start from there to develop and produce it.

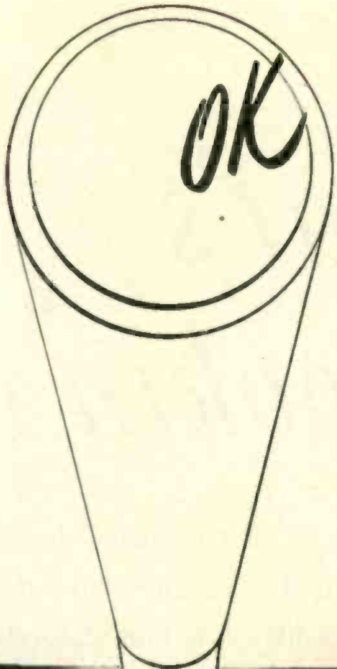
Ceramic sockets are a Ucinite specialty. We make octal mounts, ring mounts, flat types (as illustrated) and many special kinds for various purposes.

The UCINITE CO.

Newtonville, Mass.

Division of United-Carr Fastener Corp.

Specialists in **RADIO & ELECTRONICS**
LAMINATED BAKELITE ASSEMBLIES
CERAMIC SOCKETS · BANANA PINS & JACKS · PLUGS · CONNECTORS · ETC.



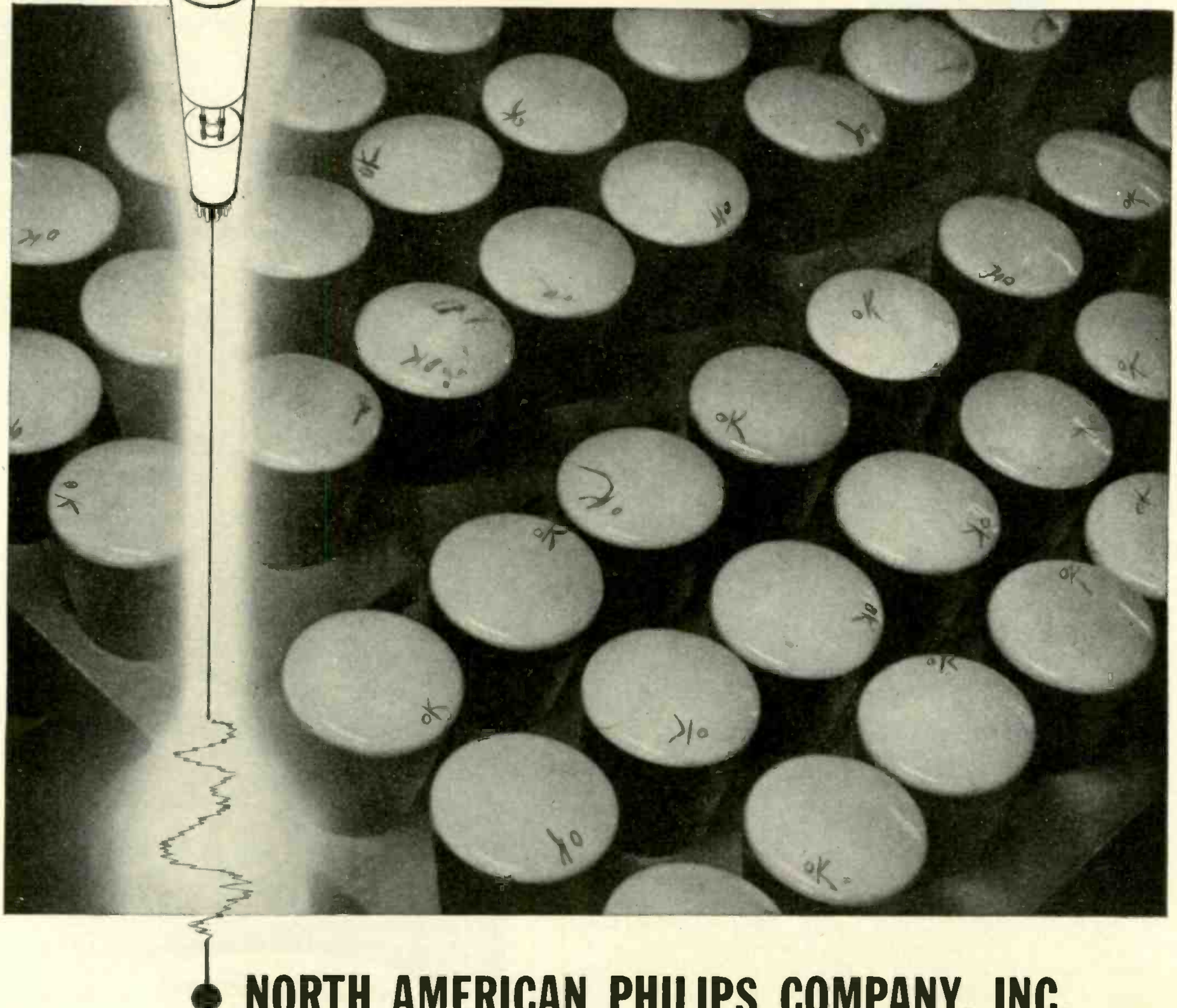
FOR THE BIGGEST JOB IN THE WORLD!

WHETHER it's a simple strand of wire or a cathode ray tube, we at Philips have only one standard that merits the O. K. of our electronics engineering experts. That standard is perfection.

Today, our O. K.'s contribute towards the biggest job in the world. Today, Victory is our primary and exclusive concern.

Manufacturers for Victory — Cathode Ray Tubes; Amplifier Tubes; Rectifier Tubes; Transmitting Tubes; Electronic Test Equipment; Oscillator Plates; Tungsten and Molybdenum in powder, rod, wire and sheet form; Tungsten Alloys; Fine Wire of all drawable metals: bare, plated and enameled; Diamond Dies.

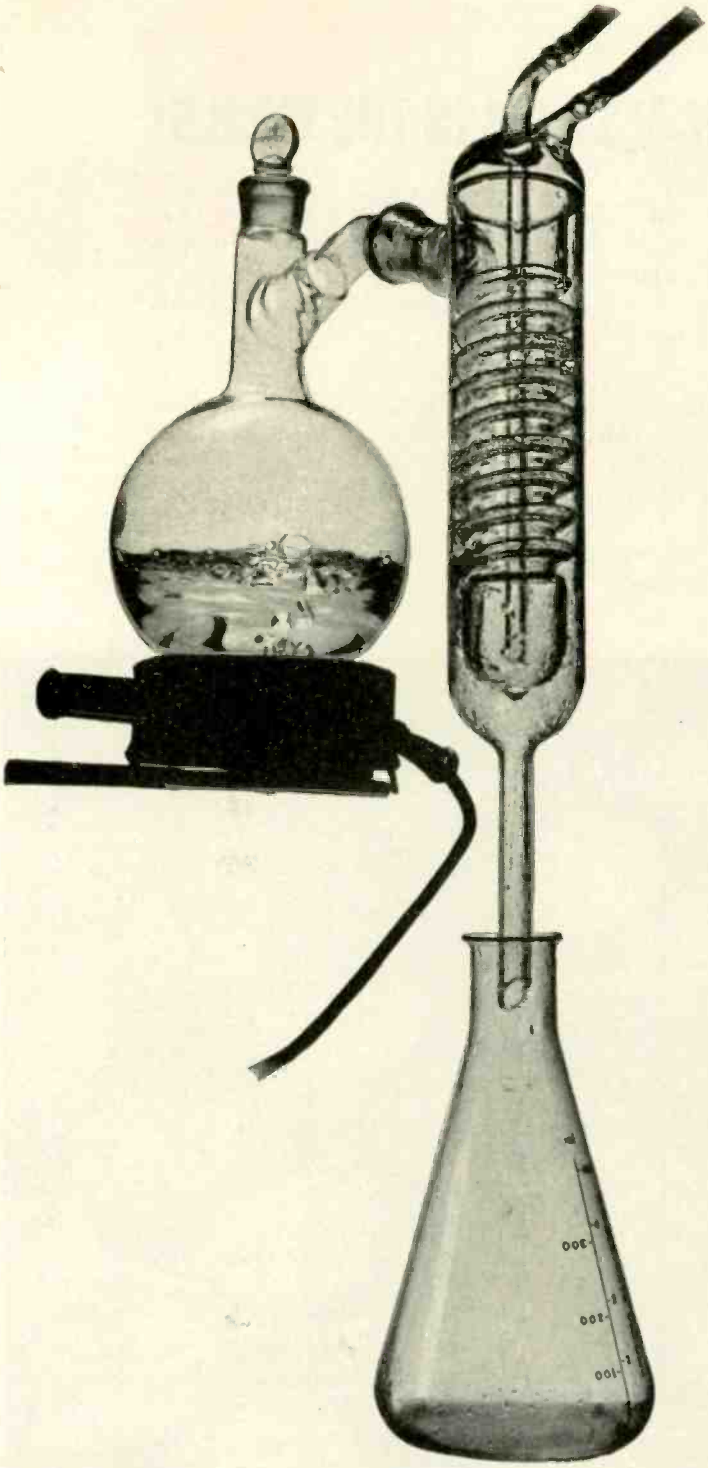
X-Ray Apparatus for industrial, research and medical applications. (Philips Metalix Corporation.)



NORTH AMERICAN PHILIPS COMPANY, INC.

Electronic Research and Development

Factories in Dobbs Ferry, N.Y.; Mount Vernon, N.Y. (Philips Metalix Corp.); Lewiston, Maine (Elmet Division)



What's Cookin'?

Americans have an inexhaustible desire to know what's "on the fire" and how it will affect them. This fifth freedom of foretasting the future has of necessity been curbed by war restrictions. But it's sufficient to say that interesting developments which will affect scores of industries have been and are being produced in the Foote laboratories.

Every day, with a broad scope of experience behind them, Foote researchers are finding or helping others to find newer, better ways to put ores, minerals, metals and chemicals to work.

It is definitely possible that Foote products, processes, or research can benefit you. We are anxious to put our experience and our facilities at your disposal — if you'll write.

ZIRCONIUM IS A "GETTER" AND A "GIVER"

In the clutch of an emergency, Zirconium convincingly proved its efficiency as a "getter" or absorbent for gases in radio tubes. But it also gave to these tubes benefits not entirely hoped for. Zirconium metal powder, sprayed on molybdenum plates, approaches the long-sought perfect "black body" with resultant high heat radiation. Thus Zirconium makes possible smaller transmitting tubes and longer tube life. Now, in addition to Zirconium metal powder, Foote offers Ductile Zirconium for tube elements. Ductile Zirconium is not only an active "getter" but it also reduces secondary electron emission. It may be formed, welded or machined from rod, sheet, wire, or woven screen. You are invited to write for information on experimental quantities.

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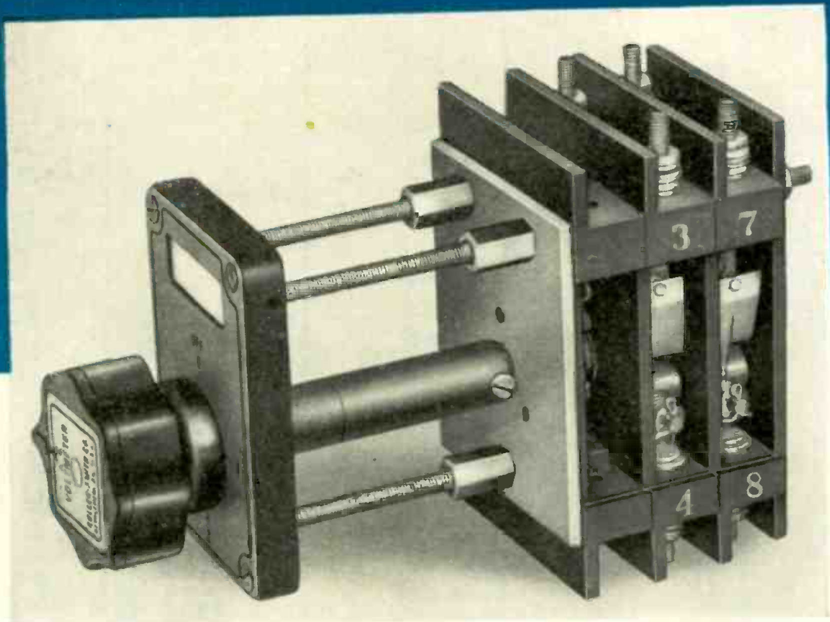
OW TO MAKE NSTRUMENTS DO

DOUBLE DUTY

with the



A.C. VCLTMETER SWITCH WITH COVERS REMOVED AND HANDLE IN NO. 3 POSITION

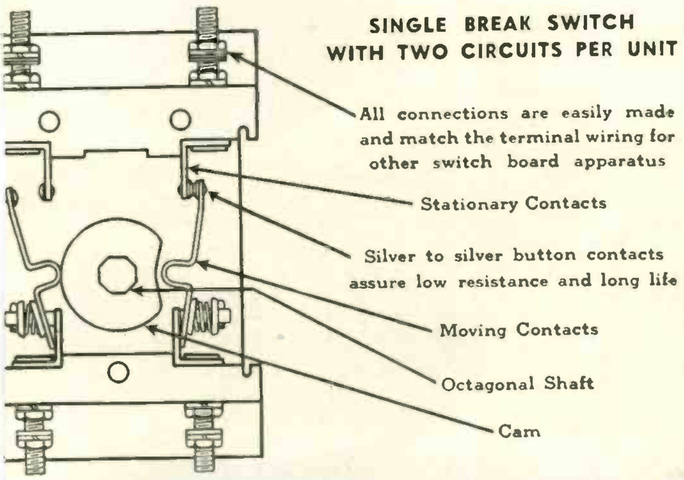
YPE R-2 ROTARY INSTRUMENT SWITCH

ler-Smith's Type R-2 instrument switches multiply the rtime usefulness of scarce electrical instruments. For ımple—One meter can be used to read a multitude of ·ious voltages merely by turning a Type R-2 rotary itch to the proper position. These single break, direct-ing type switches are used on all types of instrument nsfer for voltage and current coils, with each unit of switch taking care of 2 circuits.

e body of each switch is of unit construction and uses ulded bakelite as a housing for the contacts. Moving d stationary contacts are brass, silver-plated. Contact faces are silver buttons, riveted to contact arms. Com-ession springs assure good contact pressure.

selection of suitable cams, switches can be built up any number of applications. Both poles in the same it can be open, closed, or one open and one closed in y position. This minimizes the number of units re-ired and reduces the cost of switches for special plications.

SINGLE BREAK SWITCH WITH TWO CIRCUITS PER UNIT



APPLICATIONS

AMMETER SWITCHES

The ammeter switches are arranged to connect instruments to any phase without opening the secondary circuit of the current trans-formers. The arrangement is such that cne set of contacts are com-pletely closed before the second set are opened. This is to insure that the current circuit is not interrupted.

VOLTMETER SWITCHES

These switches are arranged to connect the voltmeter to the individual circuit of which the voltage is to be read. For potential coil transfer one set of contacts are completely opened before the second set close in order to prevent a short betwen circuits. Since the contacts are held open by the cams there is no danger of accidental short circuits.

FREQUENCY METER SWITCH

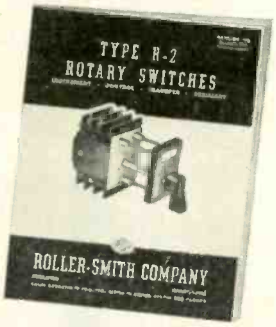
This switch connects the frequency meter to one circuit only. In order to use one frequency meter on several circuits a separate switch is required for each circuit.

WATTMETER, POWER FACTOR METER AND REACTIVE FACTOR METER SWITCHES

These switches connect the Instrument transformers of any one poly-phase circuit to the proper instrument by means of a suitable com-bination of voltage and current contacts. A separate switch is required for each polyphase circuit. Power factor meter switches can be used for reactive factor meters by using a suitable marked nameplate.

Write for Bulletin No. 7140

This bulletin is virtually a textbook on instrument and control switches. It includes complete technical data for all Type R-2 rotary switches; 38 diagrams of connections and switch developments and many application recommendations. Send for your copy today!

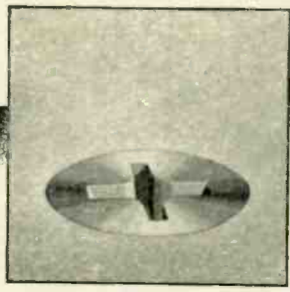


Electrical Measuring and Protective Apparatus

ROLLER-SMITH COMPANY BETHLEHEM, PENNA.

Switchboards • Metal Enclosed Switchgear • Electrical Instruments
Indoor and Outdoor Oil Circuit Breakers • Air Circuit Breakers

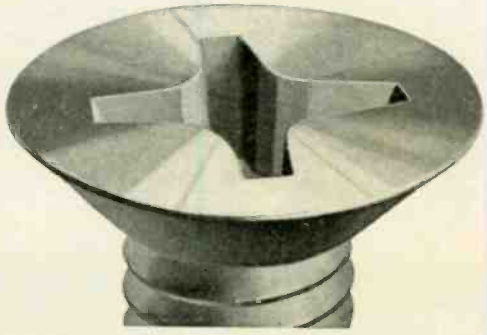
She always has a LEVEL HEAD on every American Phillips Screw



She's only been on the job a short time, but she's already *doubled* the output of the man she replaced . . . the big bruiser who struggled with slotted-head screws and had the scars to prove it (both on himself and his work). All because her department chief had changed to American Phillips on all screw assemblies when he began to hire women workers. Now, with a Phillips driver and American Phillips screws . . . which fit together in a straight-line unit that can't twist apart in driving . . . she sets *every* screw-head up tight and *plumb level* with the work-surface, without a burr on the screw-head or a mark on the work.

Apart from the ease and rapidity of upgrading women workers, this department chief had other good reasons for changing to American Phillips Screws: He can readily get any type and size. He knows that every shipment runs uniformly true to American's high quality standard. And he knows he can get the industry's most advanced engineering and research service to help him on any fastening problem. So he . . . like all others who once try American Phillips Screws . . . *will always use them from now on.*

4-winged driver and tapered recess cut assembly time and costs 50% . . . give cleaner, stronger fastenings



AMERICAN SCREW COMPANY

Providence, Rhode Island

CHICAGO
589 E. Illinois Street

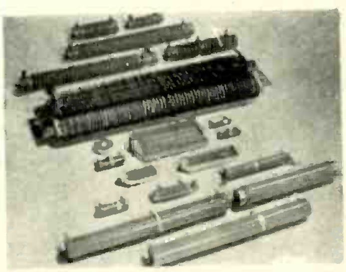
DETROIT
5-267 General Motors Bldg.

RESISTORS IN THE AIR

In the new Bendix RTA-1B two-way telephone for aircraft and ground station service, WARD LEONARD, wire wound vitreous enamel resistors are used.

To quote from an article in March 1943 FM Magazine by Mr. R. B. Edwards, Bendix radio engineer, "Aircraft radio apparatus design might be described as the radio engineer's delight, for no restrictions are put upon the designers ingenuity in using the best he can find in materials and methods to assure absolute dependability."

WARD LEONARD RESISTORS are built to withstand heat, moisture, vibration and other adverse operating conditions. The line covers a wide range of types, sizes, ratings, terminals, mountings and enclosures. Let us send you bulletins describing resistors of interest to you.



But the use of Ward Leonard Resistors is not confined to communications. You find them used by the Army, Navy and by industry for every purpose where dependable resistors are required to operate under most difficult conditions.

Ward Leonard Engineers are at the service of every manufacturer of equipment using resistors. They will gladly suggest the resistor from the Ward Leonard line that will not only give you the best possible service but will be best adapted to the conditions of assembly.

WARD LEONARD

RELAYS • RESISTORS • RHEOSTATS

Electric control (WL) devices since 1892.

WARD LEONARD ELECTRIC COMPANY, 32 SOUTH ST., MOUNT VERNON, NEW YORK

G-E ELECTRONIC TUBES FOR INDUSTRIAL USE

PHANOTRONS—gaseous-discharge rectifier tubes

Type No.	No. of Electrodes	CATHODE Volts	CATHODE Amp.	PLATE Peak Volts	PLATE Peak Amp.	Avg. Amp.	Temp. Range Condensed Mercury, C	Shipping Weight in Lb.	Ask for This Bulletin
GL-866A/866	2	2.5	5	10000	1	0.25	40— ±5	3	GET-966
FG-190	3	2.5	12	175	5	1.25	—20— +60*	6	GET-982
GL-872	2	5.0	10	7500	5	1.25	40— ±5	3	GET-917
GL-872A	2	5.0	6.75	10000	5	1.25	40— ±5	3	GET-745
FG-32	2	5.0	4.5	1000	15	2.5	30—80	6	GET-981
GL-869B	2	5.0	18	20000 15000‡	15	2.5 5.0‡	35— ±5	6	GET-964
FG-280	2	5.0	10	1000	40	6.4	40—80	3	
FG-104	2	5.0	10	3000	40	6.4	40—80	9	GET-733
GL-857B	2	5.0	30	22000	40	5.0 10.0‡	30—40	9½	GET-745
FG-166	2	2.5	100	1500	75	20	20—60	9	GET-735

‡ Quadrature operation.

THYRATRONS—grid-controlled gaseous-discharge rectifier tubes

Type No.	No. of Electrodes	CATHODE Volts	CATHODE Amp.	PLATE Peak Volts	PLATE Peak Amp.	Avg. Amp.	Starting Grid Voltage	Temp. Range Condensed Mercury, C	Shipping Weight in Lb.	Ask for This Bulletin
GL-2051	4	6.3	0.6	700	0.375	0.075	Neg.		3	GET-984
GL-2050	4	6.3	0.6	1300	0.500	0.100	Neg.		3	GET-984
FG-178-A	3	2.5	2.25	500	0.500	0.125	Neg.	—20— +50*	3	GET-618
FG-81-A	3	2.5	5.0	500	2.0	0.5	Neg.	—20— +50*	3	GET-465
FG-98-A	4	2.5	5.0	500	2.0	0.5	Neg.	—20— +50*	3	GET-743
FG-97	4	2.5	5.0	1000	2.0	0.5	Var.	40—80	3	GET-743
FG-17	3	2.5	5.0	2500	2.0	0.5	Neg.	40—80	3	GET-428
FG-154	4	5.0	7.0	500	10.0	2.5	Neg.	—20— +50*	6	GET-743
FG-27-A	3	5.0	4.5	1000	10.0	2.5	Neg.	40—80	6	GET-428
FG-33	3	5.0	4.5	1000	15.0	2.5	Pos.	35—80	6	GET-435
FG-57	3	5.0	4.5	1000	15.0	2.5	Neg.	40—80	6	GET-425
FG-67	3	5.0	4.5	1000	15.0	2.5	Var.	40—80	6	GET-438
FG-95	4	5.0 †5.5	4.5 5.0	1000 1000	15.0 40.0	2.5 0.5	Var. Var.	40—80 40—80	6	GET-743
GL-429	4	5.0	10.0	1000	40.0	3.0	Var.	50—70	9	GET-962
FG-105	4	5.0	10.0	1000	40.0	6.4	Var.	40—80	9	GET-994
FG-172	4	5.0	10.0	1000	40.0	6.4	Var.	40—80	9	GET-619
FG-41	3	5.0	20.0	10000	75.0	12.5	Neg.	40—65	9	GET-436
GL-414	4	5.0	20.0	2000	100.0	12.5	Neg.	40—80	9	

* These tubes are inert-gas-filled, and the temperature ratings are expressed in terms of the ambient temperature range over which the tubes will operate. † These ratings apply only when the tube is used for ignitor firing.

PLIOTRONS—grid-controlled high-vacuum tubes

Control Types	No. of Electrodes	CATHODE Volts	CATHODE Amp.	PLATE Max. Volts	PLATE Max. Amp.	Max. Dis. Watts	Mu	Shipping Weight in Lb.	Ask for This Bulletin
PJ-21	3	4.5	1.1	350		7.5	3	3	GET-496
PJ-7	3	4.5	1.1	350	0.040	10	30	3	GET-492
PJ-8	3	4.5	1.1	350	0.040	10	8.5	3	GET-493
Special Purpose									
FP-54	4	2.5	0.09	6	0.0060	Low grid-current measurement tube		9	GET-484
FP-62	3	4.5	1.48	112.5	0.010	For gas-pressure measurements		9	GET-485

Therapy Types	No. of Electrodes	CATHODE Volts	CATHODE Amp.	PLATE Max. Volts	PLATE Max. Amp.	Max. Input	Max. Dis. Watts	Mu	Shipping Wt. in Lb.	Ask for This Bulletin
FP-285	3	10	3.25	1350	0.200	270	100	12	6	GET-738
FP-265	3	10	5.20	1500	0.200	300	160	75	6	GET-990

Power Triodes for high-frequency heating.	No. of Electrodes	CATHODE Volts	CATHODE Amp.	PLATE Max. Volts	PLATE Max. Amp.	Max. Dissip. Watts	Mu	Type of Cooling	Shipping Weight in Lb.	Ask for This Bulletin
GL-851	3	11	15.5	2500	1.00	750	20.5	.....	9	GET-504D
GL-8002	3	16	39.0	3500	1.00	1200	20.5	Water		GET-960
GL-8002R	3	16	39.0	3500	1.00	1200	20.5	Air	15	GET-961
GL-891R	3	22	60.0	10000	2.00	4000	8	Air	90	GET-914
GL-889	3	11	125.0	8500	2.00	5000	21	Water	9	GET-765
GL-889R	3	11	125.0	8500	2.00	5000	21	Air	52	GET-958
GL-891	3	22	60.0	12000	2.00	6000	8	Water	9	GET-913
GL-207	3	22	52.0	15000	2.00	10000	20	Water	9	GET-763
GL-892	3	22	60.0	15000	2.00	10000	50	Water	9	GET-916
GL-893	3	20	183.0	20000	4.00	20000	36	Water	27	GET-766
GL-893R	3	20	183.0	20000	4.00	20000	36	Air	290	GET-959
GL-862	3	33	207.0	20000	10.00	100000	45	Water	175	GET-919
GL-898	3	33	207.00	20000	10.00	100000	45	Water	175	GET-767

KENOTRONS—high-vacuum rectifier tubes

Type No.	No. of Electrodes	CATHODE Volts	CATHODE Amp.	PLATE Peak Volts	PLATE Peak Amp.	Shipping Weight in Lb.	Ask for This Bulletin
FP-400	2	4.0	2.25	100	0.025	6	GET-746
GL-411	2	10	14.5	100000	0.3	9	GET-734
KC-4	2	20	24.5	150000	1.0	9	GET-734

IGNITRONS—high-peak-current, pool-cathode tubes

Welding Control Types*	MAXIMUM RATINGS Kva. Demand	Corresponding Average Anode Current Amperes	Maximum Average Anode Current Amperes	Corresponding Kva. Demand	Type of Cooling	Shipping Weight in Lb.	Ask for This Bulletin
GL-415	300	12.1	22.4	100	Water	6	GET-968
FG-271	600	30.2	56.0	200	Water	12	GET-967
FG-235-A	1200	75.6	140	400	Water	16	GET-967
FG-258-A	2400	192.0	355	800	Water	45	GET-967

* Ratings are for voltages of 600 volts rms. and below. Ignitor requirements for all welding-control types are 200 volts and 40 amperes.

Power Rectifier Types†	D-c Volts	MAXIMUM CURRENT Peak Amp.	Average Amp.	Average Amp. 1 Minute	Type of Cooling	Shipping Weight in Lb.	Ask for This Bulletin
GL-427	125	30	5	....	......	3	
FG-238-B	300	1800	300	400	Water	35	GEA-3565
	600	1200	225	300			
FG-259-B	300	900	150	200	Water	22	GEA-3565
	600	600	100	133			

† Typical ignitor requirements for power-rectifier ignitrons are 75-125 volts, 15-20 amperes. Maximum requirements are 150 volts, 40 amperes.

PHOTOTUBES—light-sensitive tubes

Type No.	Gas or Vacuum	Cathode Surface Material	Anode Volts	Sensitivity in Microamperes per Lumen	Window Area Sq. In.	Max. Amb. Temp., C	Shipping Weight in Lb.	Ask for This Bulletin
PJ-22	Vacuum	Caesium	200	14	0.9	50	3	GET-742
PJ-23	Gas	Caesium	90	50	0.9	50	3	GET-742
FJ-401	Gas	Rubidium	90		0.9	50	3	GET-742
FJ-405	Vacuum	Sodium	200		0.75	50	6	GET-742
GL-441	Vacuum	Caesium	200	45	0.9	100	3	GET-742
GL-917	Vacuum	Caesium	500	20	0.9	50	3	
GL-919	Vacuum	Caesium	500	20	0.9	50	3	
GL-921	Gas	Caesium	90	100	0.38	50	3	
GL-922	Vacuum	Caesium	500	20	0.38	50	3	
GL-923	Gas	Caesium	90	100	0.43	50	3	GET-983
GL-927	Gas	Caesium	90	75	0.4	50	3	
GL-929	Vacuum	Caesium	250	45	0.6	100	3	GET-983
GL-930	Gas	Caesium	90	100	0.6	100	3	GET-983
GL-931	Vacuum	Caesium	1250	2.3×10^6	0.25	50	3	

LOW TUBES—cold-cathode tubes for use as voltage regulators

Type No.	Starting Supply Voltage, D-c, Min.	Operating Voltage Maintained, D-c, Approx.	OPERATING CURRENT, MILLIAMPERES Min.	Max.	Shipping Wt. in Lb.	Ask for This Bulletin
GL-75-30	105	75	5	30	3	GET-985
GL-874	125	90	10	50	3	GET-985
GL-105-30	137	105	5	30	3	GET-985
GL-150-30	180	150	5	30	3	GET-985

ALLAST TUBES—resistor-type tubes used to maintain a constant average current

Type No.	VOLTS Min.	Max.	AMPERES Min.	Max.	Shipping Wt. in Lb.	Ask for This Bulletin
FB-50	5	8	0.225	0.275	3	GEH-1000
B-25	7	16	1.07	1.16	3	GEH-1000
B-47	8	18	2.05	2.35	3	GEH-1000
B-46	8	18	2.70	3.25	3	GEH-1000
B-6	15	21	0.95	1.01	3	GEH-1000
B-4	105	125	1.24	1.36	3	GEH-1000

ACUUM SWITCHES

Type No.	Description	A-c	D-c	Amp.	Shipping Wt. in Lb.	Ask for This Bulletin
FA-6	Single-pole double-throw	440	500	10	3	GET-609
FA-15	Single-pole double-throw	3000	3000	8	3	GET-729

ACUUM GAGES—to measure gas pressure

Type No.	Volts	Range in Microns	Shipping Wt. in Lb.	Ask for This Bulletin
FA-13	6	0-600	3	GEI-8695
FA-14	6	‡	3	GEI-8695

‡ Used with FA-13 to compensate for temperature and voltage changes.

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THERE'S A G-E ELECTRONIC TUBE FOR EVERY ELECTRONIC PURP

GENERAL ELECTRI

BUYERS' GUIDE

A Directory of

ELECTRONIC and ALLIED PRODUCTS

In preparing this war-year Directory we have endeavored to list companies by products as an immediate buyers' guide for war materials. Moreover, we have listed products which companies have indicated that they will continue to manufacture after the war. Thus, this Directory should be useful as a buyers' guide for the present emergency as well as for post-war planning.

SECTION 1 . . . *Parts, Accessories, Materials*

Basic products used in the fabrication and assembly of electronic devices.

SECTION 2 . . . *Instruments*

Test and measurement devices used in the design, production and adjustment of electronic equipment.

SECTION 3 . . . *Electronic Equipment*

Devices having electronic operating principles . . . Essential equipment used by engineers.

In each of these sections products are listed under the noun or principal word. Certain products not readily classifiable have been included in the third section. The index on the following two pages serves as a key to all three sections.

PUBLISHED 1943 By ELECTRONICS

A McGraw-Hill Publication *330 West 42nd St., New York City*

GENERAL

INDEX

PARTS, ACCESSORIES and MATERIALS

Aluminum

See Metals

Anodes

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Dixon Crucible Co., Joseph, Jersey City, N. J.
Keystone Carbon Co., 1935 State St., St. Mary's, Pa.
National Carbon Co., Inc., Cleveland, Ohio
Ohio Carbon Co., 12508 Berea Rd., Cleveland, Ohio
Pure Carbon Co., St. Mary's, Pa.
Speer Carbon Co., St. Mary's, Pa.
Stackpole Carbon Co., Tannery St., St. Mary's, Pa.
United States Graphite Co., 1621 Holland Ave., Saginaw, Mich.

METAL ANODES

Bishop & Co., Platinum Works, J., 12 Channing Ave., Malvern, Pa.
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Climax Molybdenum Co., 500 Fifth Ave., New York, N. Y.
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Rice's Sons, Inc., Bernard, 325 5th Ave., New York, N. Y.
Superior Tube Co., Norristown, Pa.

Antennas

RECEIVING ANTENNAS

Aeronautical Radio Mfg. Co., 155 First St., Mineola, N. Y.
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Amplex Engineering, Inc., 1620 Grand Ave., New Castle, Ind.
Amy, Aceves & King, Inc., 11 W. 42nd St., New York, N. Y.
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Birnbach Radio Co., 145 Hudson St., New York, N. Y.
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Okonite Co., Passaic, N. J.
Philco Corp., Tioga & C Sts., Philadelphia, Pa.
Philson Mfg. Co., Inc., 156 Chambers St., New York, N. Y.
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Stromberg-Carlson Telephone Mfg. Co., 100 Carlson Rd., Rochester, N. Y.
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Trebor Radio Co., Pasadena, Calif.
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Whisk Laboratories, 145 West 45th St., New York, N. Y.

TRANSMITTING ANTENNAS

Airplane & Marine Instruments, Inc., Clearfield, Pa.
American Bridge Co., Frick Bldg., Pittsburgh, Pa.
Blaw-Knox Co., Farmers Bank Bldg., Pittsburgh, Pa.
Erco Radio Laboratories, Inc., Fenimore Avenue, Hempstead, N. Y.
General Electric Co., Schenectady, N. Y.
General Electronic Industries, Div. of Auto Ordnance Corp., 342 Putnam, Greenwich, Conn.
Hoke Vertical Radiator Co., 135 S. Market St., Petersburg, Va.
Isolantite, Inc., 343 Cortland St., Belleville, N. J.
Johnson Co., E. F., Waseca, Minn.
Lehigh Structural Steel Co., 17 Battery Pl., New York, N. Y.
Lingo & Son, John E., 28th St. & Buren Ave., Camden, N. J.
Link, Fred M., 125 W. 17th St., New York, N. Y.
Okonite Co., Passaic, N. J.
Truscon Steel Co., Albert St., Youngstown, Ohio
Western Electric Co., Inc., 195 Broadway, New York, N. Y.
Wincharger Corp., 7th & Division Sts., Sioux City, Iowa

Attenuators

see Controls

Ballasts

see Tubes

Batteries

DRY BATTERIES

Acme Battery Corp., 59 Pearl St., Brooklyn, N. Y.
Bright Star Battery Co., 200 Crooks Ave., Clifton, N. J.
Burgess Battery Co., Foot of Exchange St., Freeport, Ill.
General Dry Batteries, Inc., 13000 Athens Ave., Cleveland, Ohio
National Carbon Co., 30 E. 42d St., New York, N. Y.
National Union Radio Corp., 15 Washington St., Newark, N. J.
Philco (Battery Division), Philadelphia, Pa.
Ray-O-Vac Co., Madison, Wis.
Southern Battery Co., Appomattox, Va.
United States Electric Mfg. Corp., 222 W. 14th St., New York, N. Y.
Western Cable Battery Co., Inc., 395 Sibley St., St. Paul, Minn.
Winchester Repeating Arms Co., New Haven, Conn.

STORAGE BATTERIES

American Battery Co., 17 E. Jefferson St., Chicago, Ill.
Am-plus Storage Battery Co., 425 W. Superior St., Chicago, Ill.
Auto Lite Battery Corp., 3215 Highland Ave., Niagara Falls, N. Y.
Bowers Battery & Spark Plug Co., Reading, Pa.
Edison Storage Battery Div., Thomas A. Edison, Inc., Main St. at Lakeside Ave., West Orange, N. J.
Electric Storage Battery Co., Allegheny Ave. & 19th St., Philadelphia, Pa.
General Lead Batteries Co., 196 West Railway Ave., Paterson, N. J.
General Storage Battery Co., 2005 Locust St., St. Louis, Mo.
Globe Union, Inc., 900 E. Keefe Ave., Milwaukee, Wis.
Gould Storage Battery Corp., 35 Neoga St., Depew, N. Y.
Ideal Commutator Dresser Co., 1631 Park Ave., Sycamore, Ill.
K. W. Battery Co., 3705 N. Lincoln Ave., Chicago, Ill.
Koehler Mfg. Co., Marlboro, Mass.
National Battery Co., E. 1201 First National Bank Bldg., St. Paul, Minn.
Philco Corp., (Storage Battery Division), Philadelphia, Pa.
Prest-O-Lite Battery Co., 4500 W. 16th St., Indianapolis, Ind.
Solar Corp., 944 W. Bruce St., Milwaukee, Wis.
Universal Battery Co., 3410 S. La Salle St., Chicago, Ill.
Western Cable Battery Co. Inc., 395 Sibley St., St. Paul, Minn.
Willard Storage Battery Co., 246 E. 131st St., Cleveland, Ohio.

Breakers

CIRCUIT BREAKERS (for electronic applications)

Burlington Instrument Co., Burlington, Iowa.
Federal Electric Products Co. Inc., 50 Paris St., Newark, N. J.
General Electric Co., Bridgeport, Conn.
General Electronic Industries, Div. of Auto Ordnance Corp., 342 Putnam, Greenwich, Conn.
Heinemann Circuit Breaker Co., 97 Plum St., Trenton, N. J.
Littelfuse, Inc., 4755 Ravenswood Ave., Chicago, Ill.
Penn Electric Switch Co., Goshen, Ind.
Roller-Smith Co., Bethelehem, Pa.
Spencer Thermostat Co., Attleboro, Mass.
Stangard Products Co., 4111 Fort Hamilton Pkwy., Brooklyn, N. Y.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Cabinets

CABINETS, CHASSIS AND PANELS

Altec Lansing Corp., 1680 N. Vine St., Los Angeles, Calif.
Aluminum Goods Mfg. Co., Manitowoc, Wisc.
American Radio Hardware Co., Inc., 476 Broadway, New York, N. Y.
Boes Co., W. W., 3001 Salem Ave., Dayton, Ohio
Bud Radio, Inc., 2118 E. 55th St., Cleveland, Ohio
Caswell-Runyon Co., Huntington, Ind.
Columbia Metal Box Co., 260 E. 143rd St., New York, N. Y.
Controls Inc., Hillcrest Rd., Towaco, N. J.
Creative Plastics Corp., 975 Kent Ave., Brooklyn, N. Y.
Crowe Nameplate & Mfg. Co., 3701 Ravenswood Ave., Chicago, Ill.
Dahlstrom Metallic Door Co., Buffalo St., Jamestown, N. Y.
Erie Art Metal Co., 1602 East 18th St., Erie, Pa.
Erie Can Co., 816 W. Erie St., Chicago, Ill.
Falstrom Co., 7 Falstrom Court, Passaic, N. J.
Federal Electric Products Co., Inc., 50 Paris St., Newark, N. J.
Hadley Co., Robert M., 711 E. 61st St., Los Angeles, Calif.
Insuline Corp. of America, 36-02 35th Ave., Long Island City, N. Y.

Karp Metal Products Co., 129 30th St., Brooklyn, N. Y.
Lewyt Corp., 60 Broadway, Brooklyn, N. Y.
Millen Mfg. Co., James, 150 Exchange St., Malden, Mass.
Miller Co., J. W., 5917 S. Main St., Los Angeles, Calif.
National Co., 61 Sherman St., Malden, Mass.
Olsen Illuminating Co., Ltd., Otto K., 1560 Vine St., Hollywood, Calif.
Par Metal Products Corp., 32-62 49th St., Long Island City, N. Y.
Paramount Radio Corp., 967 32nd St., Oakland, Calif.
Richardson-Allen Corp., 15 W. 20th St., New York, N. Y.
Sherron Metallic Corp., 1201 Flushing Ave., Brooklyn, N. Y.
Syracuse Ornamental Co., 581 So. Clinton St., Syracuse, N. Y.
Trebor Radio Co., Pasadena, Calif.
Union Aircraft Products Corp., 380 Second Ave., New York, N. Y.
Wallace Mfg. Co., Wm. T., Chili & Madison Aves., Peru, Ind.

PLASTICS CABINETS—see Plastics

Cable

see also Wire

COAXIAL CABLE

Alpha Wire Corp., 50 Howard St., New York, N. Y.
American Phenolic Corp., 1830 S. 54th Ave., Chicago, Ill.
Anaconda Wire & Cable Co., 25 Broadway, New York, N. Y.
Andrew Co., Victor J., 363 East 75th St., Chicago, Ill.
Belden Mfg. Co., 4673 W. Van Buren St., Chicago, Ill.
Boston Insulated Wire & Cable Co., 65 Bay St. (Dorchester), Boston, Mass.
Brach Mfg. Corp., L. S., 55 Dickerson St., Newark, N. J.
Chicago Metal Hose Corp., 1315 S. 3rd Ave., Maywood, Ill.
Communications Products Co., 363 Cator Ave., Jersey City, N. J.
Cornish Wire Co., 15 Park Row, New York, N. Y.
Doolittle Radio, Inc., 7421 S. Loomis Blvd., Chicago, Ill.
Eby, Inc., Hugh H., 18 W. Chelton Ave., Philadelphia, Pa.
Essex Wire Corp., 1601 Wall St., Fort Wayne, Ind.,
General Cable Corp., 420 Lexington Ave., New York, N. Y.
General Insulated Wire Corp., 53 Park Pl., New York, N. Y.
Isolantite, Inc., 343 Cortlandt St., Belleville, N. J.
E. F. Johnson Co., Waseca, Minn.
Okonite Co., Passaic, N. J.
Phelps Dodge Copper Products Corp., 40 Wall St., New York, N. Y.
Precision Tube Co., 3828 Terrace St., Philadelphia, Pa.
Radex Corp., 1322 Elston Ave., Chicago, Ill.
Radio Receptor Co., 251 W. 19th St., New York, N. Y.
Schott Co., Walter L., 9306 Santa Monica Blvd., Beverly Hills, Cal.
Simplex Wire & Cable Corp., 79 Sidney St., Cambridge, Mass.
Uniform Tubes, Shurs Lane & Lauriston St., Roxborough, Philadelphia, Pa.
Western Electric Co., Inc., 195 Broadway, New York, N. Y.
Wood Electric Co., Inc., C. D., 826 Broadway, New York, N. Y.

Capacitors

FIXED CAPACITORS

Aerovox Corp., 740 Belleville Ave., New Bedford, Mass.
American Condenser Corp., 2508 S. Michigan Ave., Chicago, Ill.
Atlas Condenser Products Co., 548 Westchester Ave., Bronx, N. Y.
Automatic Electric Co., 1033 W. Van Buren St., Chicago, Ill.
Bud Radio, Inc., 2118 E. 55th St., Cleveland, Ohio
Cardwell Mfg. Corp., Allen D., 81 Prospect St., Brooklyn, N. Y.
Centralab, 900 E. Keefe Ave., Milwaukee, Wis.
Condenser Corp. of America, 1000 Hamilton Blvd., South Plainfield, N. J.
Condenser Products Co., 1375 N. Branch St., Chicago, Ill.
Cornell-Dubilier Electric Corp., 1000 Hamilton Blvd., South Plainfield, N. J.
Cosmic Radio Co., 699 E. 135th St., New York, N. Y.
Crowley & Co., Henry L., 1 Central Ave., West Orange, N. J.
Deutschmann Corp., Tobe, Canton, Mass.
Dumont Electric Co., 34 Hubert St., New York, N. Y.
Eitel-McCullough, Inc., San Bruno, Cal.
Electro-Motive Mfg. Co., S. Park & John Sts., Willimantic, Conn.
Erie Resistor Corp., 640 W. 12th St., Erie, Pa.
Fast & Co., John E., 312 N. Pulaski Ave., Chicago, Ill.
General Electric Co., Schenectady, N. Y.
General Radio Co., 30 State St., Cambridge, Mass.
Girard-Hopkins, 1000 40th Ave., Oakland, Cal.
H. R. S. Products, 5707 W. Lake St., Chicago, Ill.
Illinois Condenser Co., 3252 W. North Ave., Chicago, Ill.
Industrial Condenser Corp., 1725 W. North Ave., Chicago, Ill.
Jennings Radio Mfg. Co., R 3 Box 22, San Jose, Calif.
Johnson Co., E. F., Waseca, Minn.
Kellogg Switchboard & Supply Co., 6650 S. Cicero Ave., Chicago, Ill.
Magnavox Co., 2131 Bueter Rd., Fort Wayne, Ind.
Mallory & Co., P. R., 3029 E. Washington St., Indianapolis, Ind.
Micamold Radio Corp., 1087 Flushing Ave., Brooklyn, N. Y.
Muter Co., 1255 S. Michigan Ave., Chicago, Ill.
National Union Radio Corp., 15 Washington St., Newark, N. J.
Noma Electric Corp., 55 West 13th St., New York, N. Y.
Polymet Condenser Co., 699 East 135 St., New York, N. Y.
Potter Co., 1950 Sheridan Rd., North Chicago, Ill.
Radio Corp. of America, Camden, N. J.
Sangamo Electric Co., Springfield, Ill.
Sevison Magneto Engrg. Co., 379 Phillips Ave., Toledo, Ohio.
Sickles Co., F. W., 165 Forest St., Chicopee, Mass.
Solar Mfg. Corp., Bayonne, N. J.
Sound Equipment Corp. of California, 6245 Lexington Ave., Hollywood, Cal.
Sprague Specialties Co., 189 Beaver St., North Adams, Mass.
Teleradio Engineering Corp., 484 Broome St., New York, N. Y.
Telex Products Co., Telex Park, Minneapolis, Minn.

COMPRESSED GAS CAPACITORS

Lapp Insulator Co., 31 Gilbert St., Le Roy, N. Y.

VARIABLE RECEIVER TUNING CAPACITORS

Alden Products Co., 117 Main St., Brockton, Mass.
American Steel Package Co., Squire Ave., Defiance, Ohio
Barker & Williamson, Upper Darby, Pa.
Bud Radio, Inc., 2118 E. 55th St., Cleveland, Ohio.
Cardwell Mfg. Corp., Allen D., 81 Prospect St., Brooklyn, N. Y.
General Electronic Industries, Div. of Auto Ordnance Corp., 342 Putnam, Greenwich, Conn.
General Instrument Corp., 829 Newark Ave., Elizabeth, N. J.
Hammarlund Mfg. Co., 460 W. 34 St., New York, N. Y.
Kaar Engineering Co., 619 Emerson St., Palo Alto, Calif.
Meissner Mfg. Co., Mt. Carmel, Ill.
Millen Mfg. Co., James, 150 Exchange St., Malden, Mass.
National Co., 61 Sherman St., Malden, Mass.
Pacific Electronics, W. 1130 Sprague Ave., Spokane, Wash.
Radio Condenser Co., Camden, N. J.

VARIABLE TRANSMITTER TUNING CAPACITORS

Barker & Williamson, 235 Fairfield Ave., Upper Darby, Pa.
Bud Radio, Inc., 2118 E. 55th St., Cleveland, Ohio
Cardwell Mfg. Corp., Allen D., 81 Prospect St., Brooklyn, N. Y.
General Electronic Industries, Div. of Auto Ordnance Corp., 342 Putnam, Greenwich, Conn.
General Instrument Corp., 829 Newark Ave., Elizabeth, N. J.
Hammarlund Mfg. Co., 460 W. 34 St., New York, N. Y.
Insuline Corp. of America, 36-02 35th Ave., Long Island City, N. Y.
Johnson, E. F., Waseca, Minn.
Millen Mfg. Co., James, 150 Exchange St., Malden, Mass.
National Co., 61 Sherman St., Malden, Mass.

VARIABLE TRIMMER CAPACITORS

Aerovox Corp., 740 Belleville Ave., New Bedford, Mass.
Alden Products Co., 117 Main St., Brockton, Mass.
American Steel Package Co., Squire Ave., Defiance, Ohio
Automatic Winding Co., 900 Passaic Ave., East Newark, N. J.
Bud Radio, Inc., 2118 E. 55th St., Cleveland, Ohio
Cardwell Mfg. Corp., Allen D., 81 Prospect St., Brooklyn, N. Y.
Centralab, 900 E. Keefe Ave., Milwaukee, Wis.
D-X Crystal Co., 1841 W. Carroll Ave., Chicago, Ill.
Erie Resistor Corp., 640 W. 12th St., Erie, Pa.
General Electric Co., Bridgeport, Conn.
General Electronic Industries, Div. of Auto Ordnance Corp., 342 Putnam, Greenwich, Conn.
General Radio Co., 30 State St., Cambridge, Mass.
Guthman, Inc., E. I., 15 S. Throop St., Chicago, Ill.
Hammarlund Mfg. Co., 460 W. 34 St., New York, N. Y.
Insuline Corp. of America, 36-02 35th Ave., Long Island City, N. Y.
Johnson Co., E. F., Waseca, Minn.
Leeds & Northrup Co., 4970 Stenton Ave., Philadelphia, Pa.
Meissner Mfg. Co., Mt. Carmel, Ill.
Millen Mfg. Co., James, 150 Exchange St., Malden, Mass.
Miller Co., J. W., 5917 S. Main St., Los Angeles, Cal.
Muter Co., 1255 S. Michigan Ave., Chicago, Ill.
National Co., 61 Sherman St., Malden, Mass.
Sickles Co., F. W., 165 Front St., Chicopee, Mass.
Standard Coil Products Co., 2329 N. Pulaski Rd., Chicago, Ill.
Teleradio Engineering Corp., 484 Broome St., New York, N. Y.

Cells

Photo-Electric Cells—see Tubes

Cements

RADIO CEMENTS

Alden Products Co., 117 Main St., Brockton, Mass.
American Products Mfg. Co., 8127 Oleander St., New Orleans, La.
Crowley & Co., Henry L., 1 Central Ave., West Orange, N. J.
D-X Crystal Co., 1841 W. Carroll Ave., Chicago, Ill.
General Cement Mfg. Co., 919 Taylor Ave., Rockford, Ill.
General Electric Co., Bridgeport, Conn.
Maas & Waldstein Co., 438 Riverside Ave., Newark, N. J.
Schott Co., Walter L., 9306 Santa Monica Blvd., Beverly Hills, Cal.
Stangard Products Co., 4111 Ft. Hamilton Pkwy, Brooklyn, N. Y.
Zophar Mills, Inc., 112 26th St., Brooklyn, N. Y.

Ceramics

see Insulation

Changers

AUTOMATIC RECORD CHANGERS

Autocrat Radio Co., 3855 N. Hamilton Ave., Chicago, Ill.
Farnsworth Television & Radio Corp., 3700 Pontiac St., Fort Wayne, Ind.
Garrard Sales Corp., 296 Broadway, New York, N. Y.
General Industries Co., Taylor & Olive Sts., Elyria, Ohio
General Instrument Corp., 829 Newark Ave., Elizabeth, N. J.
Radio Corp. of America, Camden, N. J.
Rock-Ola Mfg. Corp., 867 N. Kedzie Ave., Chicago, Ill.
Sillcox Radio & Television Corp., 70 Pine St., New York, N. Y.
Talking Devices Co., 4451 W. Irving Park Rd., Chicago, Ill.

Chokes

POWER and AUDIO CHOKES

American Communications Corp., 306 Broadway, New York, N. Y.
American Transformer Co., 178 Emmet St., Newark, N. J.
Arlavox Mfg. Co., 5042 Cottage Grove Ave., Chicago, Ill.
Automatic Products Co., 2450 North 32nd St., Milwaukee, Wisc.
Chicago Transformer Corp., 3501 W. Addison St., Chicago, Ill.
Coto-Coil Co., 71 Willard Ave., Providence, R. I.
Electrical Transformer Co., 421 Canal St., New York, N. Y.
Electronic Transformer Co., 515 West 29th St., New York, N. Y.
Ferranti Electric, Inc., 30 Rockefeller Plaza, New York, N. Y.
Freed Transformer Co., 72 Spring St., New York, N. Y.
Hadley Co., Robert M., 711 E. 61st St., Los Angeles, Cal.
Halldorson Co., 4500 Ravenswood Ave., Chicago, Ill.
Hardwick, Hindle, Inc., 40 Hermon St., Newark, N. J.
Hollywood Transformer Co., 645 N. Martel Ave., Los Angeles, Cal.
International Transformer Co., 17 W. 20th St., New York, N. Y.
Jefferson Electric Co., Bellwood, Ill.
Johnson Co., E. F., Waseca, Minn.
Kenyon Transformer Co., 840 Barry St., New York, N. Y.
Lectrohm, Inc., 5133 W. 25th Pl. (Cicero), Chicago, Ill.
Merit Coil & Transformer Corp., 311 N. Desplaines St., Chicago, Ill.
Miller Co., J. W., 5917 S. Main St., Los Angeles, Cal.
National Co., 61 Sherman St., Malden, Mass.
New York Transformer Co., 26 Waverly Place, New York, N. Y.
Norwalk Transformer Corp., South Norwalk, Conn.
Red Arrow Electric Corp., 100 Coit St., Irvington, N. J.
Sonotone Corp. P. O. Box 200, Sawmill River Rd., Elmsford, N. Y.
Sound Equipment Corp. of California, 6245 Lexington Ave., Hollywood, Calif.
Standard Transformer Corp., 1500 N. Halsted St., Chicago, Ill.
Thordarson Electric Mfg. Co., 500 W. Huron St., Chicago, Ill.
Transformer Products, Inc., 143 W. 51 St., New York, N. Y.
Triumph Mfg. Co., 4017 W. Lake St., Chicago, Ill.
United Transformer Co., 150 Varick St., New York, N. Y.
Utah Radio Products Co., 820 Orleans St., Chicago, Ill.

R.F. CHOKES

Aladdin Radio Industries, Inc., 501 W. 35th St., Chicago, Ill.
Anaconda Wire & Cable Co., 25 Broadway, New York, N. Y.
Bud Radio, Inc., 2118 E. 55th St., Cleveland, Ohio
D-X Crystal Co., 1841 W. Carroll Ave., Chicago, Ill.
Erwood Co., 223 W. Erie St., Chicago, Ill.
Essex Specialty Co., Inc., 1060 Broad St., Newark, N. J.
Fast & Co., John E., 3101 N. Pulaski Ave., Chicago, Ill.
General Radio Co., 30 State St., Cambridge, Mass.
General Winding Co., 420 West 45th St., New York, N. Y.
Guthman & Co., E. I., 15 S. Throop St., Chicago, Ill.
Hammarlund Mfg. Co., 460 W. 34th St., New York, N. Y.
Insuline Corp. of America, 36-02 35th Ave., Long Island City, N. Y.
Lectrohm, Inc., 5133 W. 25th Pl. (Cicero), Chicago, Ill.
Merit Coil & Transformer Corp., 311 N. Desplaines St., Chicago, Ill.
Millen Mfg. Co., James, 150 Exchange St., Malden, Mass.
Miller Co., J. W., 5917 S. Main St., Los Angeles, Cal.
Muter Co., 1255 S. Michigan Ave., Chicago, Ill.
National Co., 61 Sherman St., Malden, Mass.
Ohmite Mfg. Co., 4835 W. Flournoy St., Chicago, Ill.
Sickles Co., F. W., 165 Front St., Chicopee, Mass.
Standard Coil Products Co., 2329 N. Pulaski Rd., Chicago, Ill.
Teleradio Engineering Corp., 484 Broome St., New York, N. Y.

Clips

TEST and TUBE CLIPS

Alden Products Co., 117 Main St., Brockton, Mass.
American Phenolic Corp., 1830 S. 54th Ave., Chicago, Ill.
American Radio Hardware Co., Inc., 476 Broadway, New York, N. Y.
Birtcher Corp., 5087 Huntington Drive, Los Angeles, Calif.
Bud Radio, Inc., 2118 E. 55th St., Cleveland, Ohio
Chase Brass & Copper Co., Waterbury, Conn.
Dante Electric Mfg. Co., Bantam, Conn.
Fahnestock Electric Co., 46-44 11th St., Long Island City, N. Y.
Insuline Corp. of America, 36-02 35th Ave., Long Island City, N. Y.
Kulka Electric Mfg. Co., Inc., 30 South St., Mt. Vernon, N. Y.
Micarta Fabricators, Inc., 4619 Ravenswood Ave., Chicago, Ill.
Mueller Electric Co., 1583 E. 31st St., Cleveland, Ohio
National Co., 61 Sherman St., Malden, Mass.
Penn Union Electric Corp., 315 State St., Erie, Pa.
Zierick Mfg. Corp., 385 Gerard Ave., New York, N. Y.

Coils

POWER and A. F. COILS and WINDINGS

Anaconda Wire & Cable Co., 25 Broadway, New York, N. Y.
Apex Industry, 1035 Lake St., Chicago, Ill.
Arlavox Mfg. Co., 5042 Cottage Grove Ave., Chicago, Ill.
Barker & Williamson, 235 Fairfield Ave., Upper Darby, Pa.
Bud Radio, Inc., 2118 E. 55th St., Cleveland, Ohio
Carron Mfg. Co., 415 S. Aberdeen St., Chicago, Ill.
Coto-Coil Co., 71 Willard Ave., Providence, R. I.
Dano Electric Co., 93 Main St., Winsted, Conn.
Davis & Co., Dean W., 549 W. Fulton St., Chicago, Ill.
Dinion Coil Co., 1 North St., Caledonia, N. Y.
Doyle, Inc., James W., 2734 N. Pulaski Rd., Chicago, Ill.
Electrical Coil Winding Co., 2734 Saunders St., Camden, N. J.
Electricoil Co., 6 Varick St., New York, N. Y.
Electro Units Supply Co., 4203 W. Fullerton Ave., Chicago, Ill.
Electronic Transformer Co., 515 West 29th St., New York, N. Y.
Freed Transformer Co., 72 Spring St., New York, N. Y.
General Electric Co., Schenectady, N. Y.
General Winding Co., 420 West 45th St., New York, N. Y.
Guthman & Co., Edwin I., 15 S. Throop St., Chicago, Ill.
Hadley Co., Robert M., 711 East 61st St., Los Angeles, Calif.
Halldorson Co., 4500 Ravenswood Ave., Chicago, Ill.
Industrial Transformer Corp., 2540 Belmont Ave., New York, N. Y.
Instrument Resistors, Inc., Little Falls, N. J.
International Transformer Co., 17 W. 20th St., New York, N. Y.
Magnetic Windings Co., 16th & Butler Sts., Easton, Pa.
Merit Coil & Transformer Corp., 311 N. Desplaines St., Chicago, Ill.
Merwin-Wilson Co., New Milford, Conn.
Muter Co., 1255 S. Michigan Ave., Chicago, Ill.
Northelfer Winding Labs., 111 Albermarle Ave., Trenton, N. J.
Phelps Dodge Copper Products Corp., American Copper Products Div., 40 Wall St., New York, N. Y.
Premier Crystal Laboratories, Inc., 55 Park Row, New York, N. Y.
Presto Electric Co., 4511 New York Ave., Union City, N. J.
Radex Corp., 1322 Elston Ave., Chicago, Ill.
Standard Coil Products, 2329 N. Pulaski Rd., Chicago, Ill.
Standard Transformer Corp., 1500 N. Halsted St., Chicago, Ill.
Teleradio Engineering Corp., 484 Broome St., New York, N. Y.
Transformer Products, Inc., 143 W. 51st St., New York, N. Y.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
Wheeler Insulated Wire Co., 378 Washington Ave., Bridgeport, Conn.

R.F. RECEIVING or TRANSMITTING COILS

Alden Products Co., 117 Main St., Brockton, Mass.
Alladin Radio Industries, Inc., 501 W. 35th St., Chicago, Ill.
American Communications Corp., 306 Broadway, New York, N. Y.
Anaconda Wire & Cable Co., 25 Broadway, New York, N. Y.
Andrew Co., Victor J., 363 E. 75th St., Chicago, Ill.
Barber & Howard Co., East Ave., Westerly, R. I.
Barker & Williamson, 235 Fairfield Ave., Upper Darby, Pa.
Carron Mfg. Co., 415 S. Aberdeen St., Chicago, Ill.
Coto-Coil Co., 71 Willard Ave., Providence, R. I.
D-X Crystal Co., 841 W. Carroll Ave., Chicago, Ill.
Erco Radio Labs, Inc., Fenimore Ave., Hempstead, N. Y.
Essex Specialty Co., Inc., 1060 Broad St., Newark, N. J.
General Winding Co., 420 W. 45th St., New York, N. Y.
E. I. Guthman & Co., 15 So. Throop St., Chicago, Ill.
Hammarlund Mfg. Co., 460 W. 34th St., New York, N. Y.
Johnson Co., E. F., Waseca, Minn.
Meissner Mfg. Co., Mount Carmel, Ill.
Miller Co., J. W., 5917 S. Main St., Los Angeles, Cal.
Muter Co., 1255 S. Michigan Ave., Chicago, Ill.
National Co., 61 Sherman St., Malden, Mass.
S-W Inductor Co., 1056-58 N. Woods St., Chicago, Ill.
Sickles Co., F. W., 165 Front St., Chicopee, Mass.
Sound Equipment Corp. of California, 6245 Lexington Ave., Hollywood, Calif.
Standard Windings Corp., 2-4 Johnes St., Newburgh, N. Y.
Super Electric Products Corp., 1057 Summit Ave., Jersey City, N. J.
Teleradio Engineering Corp., 484 Broome St., New York, N. Y.
Webber Co., Earl, 4358 W. Roosevelt Rd., Chicago, Ill.

SOLENOID COILS

Acme Wire Co., 1255 Dixwell Ave., New Haven, Conn.
Allen-Bradley Co., 136 W. Greenfield Ave., Milwaukee, Wis.
Automatic Electric Co., 1033 W. Van Buren St., Chicago, Ill.
Automatic Switch Co., 41 E. 11th St., New York, N. Y.
Coto-Coil Co., 71 Willard Ave., Providence, R. I.
Davis & Co., Dean W., 549 W. Fulton St., Chicago, Ill.
Doyle, Inc., James W., 2734 N. Pulaski Rd., Chicago, Ill.

Eclipse Aviation Div. of Bendix Aviation, Bendix, N. J.
Electrical Coil Winding Co., 2734 Saunders St., Camden, N. J.
Electrical Transformer Co., 417 Canal St., New York, N. Y.
Electronic Transformer Co., 515 West 29th St., New York, N. Y.
Ferranti Electric, Inc., 30 Rockefeller Plaza, New York, N. Y.
General Electric Co., Schenectady, New York
Guardian Electric Mfg. Co., 1621 W. Walnut St., Chicago, Ill.
Industrial Transformer Corp., 2540 Belmont Ave., New York, N. Y.
Instrument Resistors, Inc., Little Falls, N. J.
Jefferson Electric Co., Bellwood, Ill.
Leotone Radio Co., 63 Dey St., New York, N. Y.
Magnavox Co., 2131 Bueter Rd., Fort Wayne, Ind.
Newton Co., 244 W. 23rd St., New York, N. Y.
R. B. M. Mfg. Co., Div. of Essex Wire Corp., 1601 Wall St., Fort Wayne, Ind.
Richardson-Allen Corp., 15 W. 20th St., New York, N. Y.
Smith Mfg. Co., Nathan R., 105 Pasadena Ave., S. Pasadena, Calif.
Standard Coil Products Co., 2329 N. Pulaski Rd., Chicago, Ill.
Standard Winding Co., 2-4 Johnes St., Newburgh, N. Y.
Trebor Radio Co., Pasadena, Calif.
Webber Co., Earl, 4358 W. Roosevelt Rd., Chicago, Ill.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Condensers

see Capacitors

Connectors

CABLE CONNECTORS AND COUPLINGS

Airadio, Inc., Melrose Ave. & Battery Pl., Stamford, Conn.
Aircraft-Marine Prods. Co., Inc., 286 N. Broad St., Elizabeth, N. J.
Alden Products Co., 117 Main St., Brockton, Mass.
American Insulator Corp., New Freedom, Pa.
American Phenolic Corp., 1830 S. 54th Ave., Chicago, Ill.
American Radio Hardware Co., 476 Broadway, New York, N. Y.
Astatic Corp., 830 Market St., Youngstown, Ohio
Atlas Sound Corp., 1443 39th St., Brooklyn, N. Y.
Bead Chain Mfg. Co., 110 Mountain Grove St., Bridgeport, Conn.
Birnbach Radio Co., 145 Hudson St., New York, N. Y.
Brush Development Co., 3311 Perkins Ave., Cleveland, Ohio
Bud Radio, Inc., 2118 E. 55th St., Cleveland, Ohio
Burndy Engineering Co., Inc., 107 Eastern Blvd., New York, N. Y.
Cannon Electric Development Co., 3209 Humboldt St., Los Angeles, Calif.
Chase Brass & Copper Co., Waterbury, Conn.
Cole-Hersee Co., 54 Old Colony Ave., South Boston, Mass.
Dante Elec. Mfg. Co., Bantam, Conn.
Dossert & Co., 242 W. 41st St., New York, N. Y.
Eby, Inc., Hugh H., 18 W. Chelton Ave., Philadelphia, Pa.
Federal Mfg. & Engrg. Corp., 199-217 Steuben St., Brooklyn, N. Y.
General Electronic Industries, Div. of Auto Ordnance Corp., 342 Putnam, Greenwich, Conn.
Harwood Co., 540 N. La Brea, Los Angeles, Calif.
Ideal Commutator Dresser Co., 1631 Park Ave., Sycamore, Ill.
Insuline Corp. of America, 36-02 35th Ave., Long Island City, N. Y.
Mallory & Co., P. R., 3029 E. Washington St., Indianapolis, Ind.
Monowatt Electric Corp., 66 Bissell St., Providence, R. I.
O. Z. Electrical Mfg. Co., 262 Bond St., Brooklyn, N. Y.
Paranite Wire & Cable, Div. of Essex Wire Corp., 1601 Wall St., Fort Wayne, Ind.
Penn-Union Electric Corp., 315 State St., Erie, Pa.
Precision Specialties, 220 North Western Ave., Los Angeles, Calif.
Pyle-National Co., 1334 N. Kostner Ave., Chicago, Ill.
Remler Co., Ltd., 2101 Bryant St., San Francisco, Calif.
Richards Co., Inc., Arklay S., 72 Winchester St., Newton Highlands, Mass.
Selectar Mfg. Corp., 21-10 49th Ave., Long Island City, N. Y.
Sheldon Service Corp., 24-15 43rd Ave., Long Island City, N. Y.
Sherman Mfg Co., H. B., 22 Barney St., Battle Creek, Mich.
Thomas & Betts Co., Inc., 36 Butler St., Elizabeth, N. J.
Ucinite Co., 459 Watertown St., Newtonville, Mass.
Zierick Mfg. Corp., 385 Gerard Ave., New York, N. Y.

Contacts

see Points

Contactors

Allen-Bradley Co., 136 W. Greenfield Ave., Milwaukee, Wisc.
Arrow-Hart & Hegeman Elec. Co., 103 Hawthorn St., Hartford, Conn.
Automatic Electric Mfg. Co., 10 State St., Mankato, Minn.
Colt's Patent Fire Arms Mfg. Co., 1429 Park St., Hartford, Conn.
Eisler Engineering Co., 751 South 13th St., Newark, N. J.
Guardian Electric Mfg. Co., 1621 Walnut St., Chicago, Ill.
Ward Leonard Electric Co., 31 South St., Mt. Vernon, N. Y.
Warrick, Charles F., 16251 Hamilton Ave., Detroit, Mich.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
Zenith Electric Co., 152 W. Walton St., Chicago, Ill.

Controls

ATTENUATORS

Allen-Bradley Co., 136 W. Greenfield Ave., Milwaukee, Wisc.
Cinema Engineering Co., 1508 S. Verdugo Ave., Burbank, Cal.
Clarostat Mfg. Co., 287 N. Sixth St., Brooklyn, N. Y.
Daven Co., 158 Summit St., Newark, N. J.
General Radio Co., 30 State St., Cambridge, Mass.
International Resistance Co., 401 N. Broad St., Philadelphia, Pa.
Mallory & Co., P. R., 3029 E. Washington St., Indianapolis, Ind.
Ohmite Mfg. Co., 4835 W. Flournoy St., Chicago, Ill.
Remler Co., 2101 Bryant St., San Francisco, Cal.
Rowe Radio Research Laboratory Co., 2422 N. Pulaski Rd., Chicago, Ill.
Shallcross Mfg. Co., 10 Jackson Ave., Collingdale, Pa.
Tech Laboratories, 7 Lincoln St., Jersey City, N. J.
Utah Radio Products Co., 820 Orleans St., Chicago, Ill.

VOLUME and TONE CONTROLS

Centralab, 900 E. Keefe Ave., Milwaukee, Wis.
Chicago Telephone Supply Co., 1142 W. Beardsley Ave., Elkhart, Ind.
Clarostat Mfg. Co., 287 N. Sixth St., Brooklyn, N. Y.
Daven Co., 158 Summit St., Newark, N. J.
General Radio Co., 30 State St., Cambridge, Mass.
Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio
International Resistance Co., 401 N. Broad St., Philadelphia, Pa.
Mallory & Co., P. R., 3029 E. Washington St., Indianapolis, Ind.
National Union Radio Corp., 15 Washington St., Newark, N. J.
Ohmite Mfg. Co., 4835 W. Flournoy St., Chicago, Ill.
Precision Resistor Co., 334 Badger Ave., Newark, N. J.
Remler Co., 2101 Bryant St., San Francisco, Cal.
Stackpole Carbon Co., St. Mary's, Pa.
Tech Laboratories, 7 Lincoln St., Jersey City, N. J.
Utah Radio Products Co., 820 Orleans St., Chicago, Ill.
Wirt Co., 5521 Greene St., Philadelphia, Pa.

Converters

ROTARY CONVERTERS—see Generators

Cores

POWDERED IRON CORES

Advance Solvents & Chemical Corp., 245 Fifth Ave., New York, N. Y.
Aladdin Radio Industries, Inc., 501 W. 35th St., Chicago, Ill.
Crowley & Co., H. L., 1 Central Ave., West Orange, N. J.
Electro Products Laboratories, 549 W. Randolph St., Chicago, Ill.
Ferrocart Corp. of America, P. O. Box 126, Hastings-on-Hudson, N. Y.
General Aniline Works, Div. of General Aniline & Film Corp., 435 Hudson St., New York, N. Y.
Mepham Corp., G. S., 2001 Lynch Ave., East St. Louis, Ill.
Pyroferric Corp., 175 Varick St., New York, N. Y.
Stackpole Carbon Co., Tannery St., St. Mary's, Pa.

Couplings

COAXIAL CABLE COUPLINGS—see Connectors

Crystals

CRYSTAL FINISHING EQUIPMENT

Capian & Sons, Oscar, Industrial Diamond Tool Div., 207 W. Saratoga St., Baltimore, Md.
Diamond Drill Carbon Co., 63 Park Row, New York, N. Y.
Felker Mfg. Co., Torrence, Calif.
Martindale Electric Co., Box 617 Edgewater Br., Cleveland, Ohio
Vreeland Lapidary Mfg. Co., 2020 Southwest Jefferson St., Portland, Oregon

QUARTZ CRYSTALS and HOLDERS

Aircraft Accessories Corp., Fairfax & Funston Rds., Kansas City, Kansas
American Insulator Corp., New Freedom, Pa.
American Jewels Corp., Attleboro, Mass.
Rex Bassett, Inc., 500 S. E. Second St., Fort Lauderdale, Fla.
Beaumont Elec., 1304 S. Indiana Ave., Chicago, Ill.
Bendix Radio Div., Bendix Aviation Corp., 920 E. Fort St., Baltimore, Md.
Bliley Electric Co., Erie, Pa.
Bodner, Inc., Charles J., 58 Marbledale Rd., Tuckahoe, N. Y.
Breon Laboratories, Williamsport, Pa.
Brush Development Co., 3311 Perkins Ave., Cleveland, Ohio
Wm. W. L. Burnett Radio Lab., 4814 Idaho St., San Diego, Calif.
Cambridge Thermionic Corp., 447 Concord Ave., Cambridge, Mass.
Carlisle Crystal Corp., 132 N. Hanover St., Carlisle, Pa.
Collins Radio Co., 855 35th St., N. E., Cedar Rapids, Iowa
Commercial Crystal Co., 112 N. Water St., Lancaster, Pa.
Commercial Equipment Co., 1416 McGee St., Kansas City, Mo.
Commercial Radio Equip. Co., 7134 Main St., Kansas City, Mo.
Connecticut Telephone & Electric Corp., 70 Britannia St., Meriden, Conn.
Corning Glass Works, Corning, N. Y.
Crystal Lab., Inc., 801 W. Maple St., Wichita, Kansas

Crystal Products Co., 1519 McGee St., Kansas City, Mo.
Crystal Research Lab., Inc., 29 Allyn St., Hartford, Conn.
C. W. Mfg., 3800 Brooklyn Ave., Los Angeles, Calif.
Daughetee Mfg., 228 N. Clinton St., Chicago, Ill.
Dallons Laboratories, 5066 Santa Monica Blvd., Los Angeles, Calif.
Diamond Drill Carbon Co., 63 Park Row, New York, N. Y.
L. A. Dow, 2208 4th Ave., Seattle, Wash.
DX Crystal Co., 1841 West Carrol Ave., Chicago, Ill.
Eidson's, 1309 N. 2nd St., Temple, Texas
Electric Appliances Corp., 120 W. North St., Indianapolis, Ind.
Electrical Prod. Corp., 950-30th St., Oakland, Calif.
Electronic Ind. (Ill.), Sandwich, Ill.
Electronic Ind. (Iowa), 517 Fourth Ave., S. E., Cedar Rapids, Iowa
Electronics Products Mfg. Corp., 7300 Huron River Drive, Dexter, Mich.
Elkay Radio Products, 319 E. Walnut St., Oglesby, Ill.
Etched Products Corp., 39-01 Queens Blvd., Long Island City, N. Y.
Federal Engineering Co., 37 Murray St., New York, N. Y.
Federal Telephone and Radio Corp., 591 Broad St., Newark, N. J.
Florida Aircraft, 522 N. E. 1st Ave., Fort Lauderdale, Fla.
Foote Mineral Co., 1609 Summer St., Philadelphia, Pa.
Franklin Transformer, 607-609 22nd Ave., N. E., Minneapolis, Minn.
Frequency Measuring, 601 West Pennway, Kansas City, Mo.
General Crystal Corp., 1775 Foster Ave., Schenectady, N. Y.
General Electric Co., 1 River Road, Schenectady, N. Y.
General Piezo Co., 2614 State Ave., Kansas City, Kans.
General Quartz Lab., Cosmopolitan Bldg., Irvington on Hudson, N. Y.
General Radio Co., 30 State St., Cambridge, Mass.
Gibbs & Co., Thomas B., Div. of George W. Borg Corp., 814 Michigan St., Delavan, Wis.
Good-All Electric, 320 N. Spruce St., Ogalala, Neb.
Harvey Radio Lab., Inc., 445 Concord Ave., Cambridge, Mass.
Harvey-Wells Communications, Inc., North St., Southbridge, Mass.
Hatcher & Fisk, 125 Kansas Ave., Topeka, Kan.
Hearing Aid Lab., 1404 Franklin St., Michigan City, Ind.
Henney Motor Co., Gentleman Products Div., Freeport, Ill.
Henry Mfg. Co., 2213 Westward Blvd., Los Angeles, Calif.
Higgins Industries, Inc., 2221 Warwick Ave., Santa Monica, Calif.
Highpower Crystal Co., 2035 W. Charleston St., Chicago, Ill.
P. R. Hoffman Co., 321 Cherry St., Carlisle, Pa.
Hollister Crystal Co., Boulder, Colo.
G. C. Hunt & Sons, 544 Hanover, Carlisle, Pa.
Hi-Power Crystal Co., 2035 W. Charleston St., Chicago, Ill.
Howard Mfg. Co., 15 4th St., Council Bluffs, Iowa
Kaar Engineering Co., 619 Emerson St., Palo Alto, Calif.
Katz & Ogush, Inc., 33 W. 60th St., New York, N. Y.
Kemlite Laboratories, 1809 N. Ashland Ave., Chicago, Ill.
Keystone Piezo Co., 943 Liberty Ave., Pittsburgh, Pa.
James Knights Co., 131 S. Wells St., Sandwich, Ill.
Leuck Crystal Lab., 245 S. 11th St., Lincoln, Neb.
Majestic Radio & Tel. Corp., 2600 W. 51st St., Chicago, Ill.
John Meck Industries, Liberty St., Plymouth, Ind.
August E. Miller, 9226 Hudson Blvd., North Bergen, N. J.
Monitor Piezo Prod., 1500 Mission St., South Pasadena, Cal.
Monowatt Elec., 66 Bissel St., Providence, R. I.
National Scientific Products Co., 2701 W. Belmont Ave., Chicago, Ill.
National Tile Co., Anderson, Ind.
North Amer. Phillips Co., Inc., 145 Palisade Ave., Dobbs Ferry, N. Y.
Pacific Radio Crystal Co., 1035 Post St., San Francisco, Cal.
Parisian Novelty Co., 3510 S. Western Ave., Chicago, Ill.
Petersen Radio Co., 2800 W. Broadway, Council Bluffs, Iowa
Philco Corp., Tioga & C Sts., Philadelphia, Pa.
Philmore Mfg. Co., 113 University Pl., New York, N. Y.
Precision Instrument Mfg. Co., Inc., Crystals, 57-02 Hoffman Dr., Elmhurst, L. I., N. Y.
Precision Piezo Service, 427 Mayflower St., Baton Rouge, La.
Premier Crystal Labs., Inc., 63 Park Row, New York, N. Y.
Quartz Lab., Inc., 1513 Oak St., Kansas City, Mo.
Radell Corp., 6327 Guilford Ave., Indianapolis, Ind.
Radio Specialty Mfg. Co., 403 N. W. 9th Ave., Portland, Oregon
Radio Corp. of America, Camden, N. J.
Reeves Sound Lab., Inc., 62 W. 47th St., New York, N. Y.
R-9 Crystals, 909 Penn Ave., Pittsburgh, Pa.
Ross Mfg. Co., 2241 S. Indiana Ave., Chicago, Ill.
Scientific Radio Products, 738 W. Broadway, Council Bluffs, Iowa
Scientific Radio Service, 4301 Sheridan St., University Park, Md.
Sentry Crystal Co., 206 S. W. Washington St., Portland, Ore.
Sipp-Eastwood Corp., 39 Keen St., Paterson, N. J.
M. L. Smith Lab., 16 Field St., Kane, Pa.
Somerset Laboratories, 124 Valleybrook Ave., Lyndhurst, N. J.
Standard Coil Products Co., 2329 N. Pulaski Rd., Chicago, Ill.
Standard Piezo Co., Comerford Bldg., Carlisle, Pa.
Telephonics Corp., 350 West 31st St., New York, N. Y.
Tellcon Corp., 305 East 63rd St., New York, N. Y.
Turner Company, 909 17th St., Cedar Rapids, Iowa
Union Piezo Co., 701 McCarter Highway, Newark, N. J.
Universal Dob Co., 347 West 36th St., New York, N. Y.
Universal Television System, 112 W. 18th St., Kansas City, Mo.
Urbach Dev. Co., 15 W. 47th St., New York, N. Y.
Valpey Crystals, Highland St., Holliston, Mass.
Vreeland Lapidary Mfg. Co., Portland, Ore.
V. Precision Instruments, 57-02 Hoffman Drive, Elmhurst, N. Y.
Wm. T. Wallace Mfg. Co., Chili & Madison Aves., Peru, Indiana
Wenkstern Halsey Co., 305 1st St., SW., Cedar Rapids, Iowa
Western Electric Co., 195 Broadway, New York, N. Y.
Wilcox Elec. Co., Inc., 14th & Chestnut, Kansas City, Mo.
Wynne Precision Co., 114½ N. Hill St., Griffin, Ga.

ROCHELLE SALT CRYSTALS

Tibbetts Laboratories, 12 Norfolk St., Cambridge, Mass.

Dials

see also Knobs, Pointers

Alden Products Co., 117 Main St., Brockton, Mass.
American Emblem Co., Utica, N. Y.
American Radio Hardware Co., Inc., 476 Broadway, New York, N. Y.
Austin Co., O., 42 Greene St., New York, N. Y.
Bastian Bros. Co., 1600 N. Clinton Ave., Rochester, N. Y.
Bud Radio, Inc., 2118 E. 55th St., Cleveland, Ohio
Continental-Diamond Fibre Co., 13 Chapel St., Newark, Del.
Crowe Name Plate & Mfg. Co., 3701 Ravenswood Ave., Chicago, Ill.
Dearborn Glass Co., 2414 W. 21st St., Chicago, Ill.
Daven Co., 158 Summit St., Newark, N. J.
Eastern Etching & Mfg. Co., Chicopee, Mass.
Emeloid Co., 291 Laurel Ave., Arlington, N. J.
Flock Process Corp., 17 W. 31st St., New York, N. Y.
General Radio Co., 30 State St., Cambridge, Mass.
Grammes & Sons, Inc., L. F., 366 Union St., Allentown, Pa.
Insuline Corp. of America, 36-02 35th Ave., Long Island City, N. Y.
Mica Insulator Co., 200 Varick St., New York, N. Y.
Millen Mfg. Co., James, 150 Exchange St., Malden, Mass.
National Co., 61 Sherman St., Malden, Mass.
New England Radiocrafters, 1156 Commonwealth Ave., Brookline, Mass.
Parisian Novelty Co., 3510 S. Western Ave., Chicago, Ill.
Premier Crystal Laboratories, Inc., 55 Park Row, New York, N. Y.
Premier Metal Etching Co., 21-03 44th Ave., Long Island City, N. Y.
Richardson Co., Lockland, Ohio
Sillcocks-Miller Co., 10 Parker Ave., W. South Orange, N. J.

Discs

BLANK RECORDING DISCS

Advance Recording Products Co., 36-12 34th St., Long Island City, N. Y.
Allied Recording Products Co., 21-09 43d Ave., Long Island City, N. Y.
Audio Devices, Inc., 1600 Broadway, New York, N. Y.
Dearborn Glass Co., 2414 W. 21st St., Chicago, Ill.
Duotone Co., 799 Broadway, New York, N. Y.
Emerson Radio & Phonograph Corp., 111 Eighth Ave., New York, N. Y.
Galvin Mfg. Corp., 4545 W. Augusta Blvd., Chicago, Ill.
General Electric Co., Schenectady, N. Y.
Gould-Moody Co., 395 Broadway, New York, N. Y.
Hammermill Paper Co., Erie, Pa.
Home Recording Co., 9 E. 19th St., New York, N. Y.
Howard Radio Co., 1735 Belmont Ave., Chicago, Ill.
Mirror Record Corp., 58 W. 25th St., New York, N. Y.
Presto Recording Corp., 242 W. 55th St., New York, N. Y.
Rangertone, Inc., 201 Verona Ave., Newark, N. J.
Scranton Record Co., 300 Brook St., Scranton, Pa.
Sound Devices Co., 160 East 116th St., New York, N. Y.
Talking Devices Co., 4447 Irving Park Rd., Chicago, Ill.

Dividers

VOLTAGE DIVIDERS—see Resistors

Dynamotors

see Generators

Enamels

see Finishes

Equalizers

see Filters

Escutcheons

see also Dials, Scales

American Emblem Co., Utica, N. Y.
American Radio Hardware Co., Inc., 476 Broadway, New York, N. Y.
Ansonia Clock Co., Inc., 103 Lafayette St., New York, N. Y.
Austin Co., O., 42 Greene St., New York, N. Y.
Bud Radio, Inc., 2118 E. 55th St., Cleveland, Ohio
Crowe Name Plate & Mfg. Co., 3701 Ravenswood Ave., Chicago, Ill.
Daven Co., 158 Summit St., Newark, N. J.
Eastern Etching & Mfg. Co., Chicopee, Mass.
Emeloid Co., Inc., 287 Laurel Ave., Arlington, N. J.

Gemloid Corp., 79-10 Albion Ave., Elmhurst, N. Y.
Grammes & Sons, Inc., L. F., 366 Union St., Allentown, Pa.
Hopp Press, Inc., 460 West 34th St., New York, N. Y.
Insuline Corp. of America, 36-02 35th Ave., Long Island City, N. Y.
Liberty Engraving & Mfg. Co., 2911 S. Central Ave., Los Angeles, Cal.
Plastic Fabricators, Inc., 440 Sansome St., San Francisco, Calif.
Premier Metal Etching Co., 21-03 44th Ave., Long Island City, N. Y.
Stewart Mfg. Corp., F. W., 4311 Ravenswood Ave., Chicago, Ill.
Syracuse Ornamental Co., 581 So. Clinton St., Syracuse, N. Y.

Fibre

see Insulation

Filters

ELECTRIC WAVE SECTION FILTERS

Audio Development Co., 2833 13th Ave., S., Minneapolis, Minn.
Bendix Aviation, Ltd., North Hollywood, Calif.
Ferranti Electric, Inc., 30 Rockefeller Plaza, New York, N. Y.
Electronic Transformer Co., 515 West 29th St., New York, N. Y.
Freed Transformer Co., 72 Spring St., New York, N. Y.
General Electric Co., Schenectady, N. Y.
General Radio Co., 30 State St., Cambridge, Mass.
Hollywood Transformer Co., 645 N. Martel Ave., Los Angeles, Calif.
Miller Co., J. W., 5917 S. Main St., Los Angeles, Calif.
Transformer Products, Inc., 143 W. 51st St., New York, N. Y.
United Transformer Co., 150 Varick St., New York, N. Y.

EQUALIZER FILTERS

Altec Lansing Corp., 1680 N. Vine St., Los Angeles, Calif.
American Transformer Co., 178 Emmet St., Newark, N. J.
Amplifier Co. of America, 17 West 20th St., New York, N. Y.
Electronic Transformer Co., 515 West 29th St., New York, N. Y.
Hollywood Transformer Co., 645 N. Martel Ave., Los Angeles, Calif.
Thordarson Electric Mfg. Co., 500 W. Huron St., Chicago, Ill.
Transformer Products, Inc., 143 W. 51st St., New York, N. Y.
United Transformer Co., 150 Varick St., New York, N. Y.

NOISE FILTERS

Aerovox Corp., 740 Belleville Ave., New Bedford, Mass.
Aeronautical Radio Mfg. Co., 155 First St., Mineola, N. Y.
Amplifier Co. of America, 17 W. 20th St., New York, N. Y.
Avia Products Co., 749 N. Highland, Los Angeles, Calif.
Bendix Aviation, Ltd., North Hollywood, Cal.
Cornell-Dubilier Electric Corp., 1000 Hamilton Blvd., South Plainfield, N. J.
Deutschmann Corp., Tobe, Canton, Mass.
Electronic Transformer Co., 515 W. 29th St., New York, N. Y.
Erie Resistor Corp., 640 West 12th St., Erie, Pa.
Ferranti Electric, Inc., 30 Rockefeller Plaza, New York, N. Y.
General Winding Co., 420 West 45th St., New York, N. Y.
Girard-Hopkins, 1000 40th Ave., Oakland, Cal.
Halldorson Co., 4500 Ravenswood Ave., Chicago, Ill.
Industrial Condenser Corp., 1725 W. North Ave., Chicago, Ill.
Mallory & Co., P. R., 3029 E. Washington St., Indianapolis, Ind.
Measurements Corp., Boonton, N. J.
Philmore Mfg. Co., 113 University Pl., New York, N. Y.
Slayter Electronic Div., Owens-Corning Fiberglas Corp., 26 W. Market St., Newark, Ohio

Solar Mfg. Corp., Bayonne, N. J.
Sprague Specialties Co., 189 Beaver St., North Adams, Mass.
Whisk Laboratories, 145 W. 45th St., New York, N. Y.

Finishes

INSULATING ENAMELS

Alden Products Co., 117 Main St., Brockton, Mass.
Franklin Paint & Varnish Co., Benjamin, 4820 Langdon St., Philadelphia, Pa.
Irvington Varnish & Insulator Co., 10 Argyle Terrace, Irvington, N. J.
Maas & Waldstein Co., 438 Riverside Ave., Newark, N. J.
New Wrinkle, Inc., 314 W. First St., Dayton, Ohio
Pittsburgh Plate Glass Co., 2000 Grant Bldg., Pittsburgh, Pa.
Roxalin Flexible Lacquer Co., Elizabeth, N. J.
Sherwin-Williams Co., 101 Park Ave., N. W., Cleveland, Ohio
Stangard Products Co., 4111 Ft. Hamilton Pkwy., Brooklyn, N. Y.

INSULATING VARNISH

Alrose Chemical Co., 180 Mill St., Cranston, R. I.
American Products Mfg. Co., 8127 Oleander St., New Orleans, La.
Arco Co., 7301 Bessemer Ave., Cleveland, Ohio
Ault & Wiborg Corp., 75 Varick St., New York, N. Y.
B & C Insulation Products, Inc., 261 Fifth Ave., New York, N. Y.
Bakelite Corp., 30 E. 42d St., New York, N. Y.
Day & Co., James B., 1872 Clybourn Ave., Chicago, Ill.
Dolph Co., John C., 168 Emmett St., Newark, N. J.
General Electric Co., Bridgeport, Conn.
George Co., P. D., 5201 N. Second St., St. Louis, Mo.
Haynes Laboratories Inc., C. W., 61 Chandler St., Springfield, Mass.
Hilo Varnish Corp., 42 Stewart Ave., Brooklyn, N. Y.
Impervious Varnish Co., Rochester, Pa.
Insulation Manufacturers Corp., 565 W. Washington Blvd., Chicago, Ill.
Irvington Varnish & Insulator Co., 10 Argyle Terrace, Irvington, N. J.
Kay & Ess Co., Box 968, Dayton, Ohio
Lastik Products Co., American Bank Bldg., Pittsburgh, Pa.
Maas & Waldstein Co., 438 Riverside Ave., Newark, N. J.
Makalot Corp., 262 Washington St., Boston, Mass.
Mitchell-Rand Insulation Co., 51 Murray St., New York, N. Y.
Murphy Varnish Co., 224 McWhorter St., Newark, N. J.
New Wrinkle, Inc., 314 W. First St., Dayton, Ohio
Ohmlac Paint & Refining Co., 6540 S. Central St., Chicago, Ill.
Pratt & Lambert, Inc., 75 Tonawanda St., Buffalo, N. Y.
Robertson Chemical Co., 9808 Meech Ave., Cleveland, Ohio
Schenectady Varnish Co., Congress St., Schenectady, N. Y.
Sherwin-Williams Co., 101 Prospect Ave., N. W., Cleveland, Ohio
Standard Insulation Co., 74 Paterson Ave., East Rutherford, N. J.
Standard Varnish Works, 2600 Richmond Terrace, Staten Island, N. Y.
Sterling Varnish Co., Haysville, Pa.
Synar Corp., Wilmington, Del.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
Zapon Div., Atlas Powder Co., Ludlow St., Stamford Conn.
Zophar Mills, Inc., 118-26th St., Brooklyn, N. Y.

LACQUER FINISHES

Alrose Chemical Co., Cranston, R. I.
American Products Mfg. Co., 8127 Oleander St., New Orleans, La.
Arco Co., 7301 Bessemer Ave., Cleveland Ohio
Ault & Wiborg Corp., 75 Varick St., New York, N. Y.
Bakelite Corp., 30 E. 42d St., New York, N. Y.
Berry Bros., Inc., 211 Leib St., Detroit, Mich.

Day & Co., James B., 1872 Clybourn Ave., Chicago, Ill.
Dolph Co., John C., 168 Emmett St., Newark, N. J.
du Pont de Nemours & Co., E. I., 626 Schuyler Ave., Arlington, N. J.
Durez Plastics & Chemicals, Inc., 1922 Walck Road, North Tonawanda, N. Y.
Egyptian Lacquer Mfg. Co., 1270 Sixth Ave., New York, N. Y.
Ferro Enamel Corp., 4150 E. 56th St., Cleveland, Ohio
Franklin Paint & Varnish Co., Benjamin, 4820 Langdon St., Philadelphia, Pa.
General Cement Mfg. Co., 919 Taylor Ave., Rockford, Ill.
Glidden Co., 11100 Glidden Ave., Cleveland, Ohio
Haynes Laboratories, Inc., C. W., 61 Chandler St., Springfield, Mass.
Hilo Varnish Corp., 42 Stewart Ave., Brooklyn, N. Y.
Jones-Dabney Co., Smith & Proback Sts., Louisville, Ky.
Kay & Ess Co., Box 968, Dayton, Ohio
Lily Varnish Co., 670 S. California St., Indianapolis, Ind.
Lowe Brothers Co., 436 E. Third St., Dayton, Ohio
Maas & Waldstein Co., 438 Riverside Ave., Newark, N. J.
Makalot Corp., 262 Washington St., Boston, Mass.
Masury & Son, John W., 50 Jay St., Brooklyn, N. Y.
Monsanto Chemical Co., Plastics Div., Springfield, Mass.
Murphy Varnish Co., 224 McWhorter St., Newark, N. J.
New Wrinkle, Inc., 314 W. First St., Dayton, Ohio
Pierce & Stevens, Inc., 710 Ohio St., Buffalo, N. Y.
Pittsburgh Plate Glass Co., Grant Bldg., Pittsburgh, Pa.
Pratt & Lambert, Inc., 92 Tonawanda St., Buffalo, N. Y.
Roxalin Flexible Lacquer Co., 802 Magnolia Ave., Elizabeth, N. J.
Sherwin-Williams Co., 101 Prospect Ave., N. W., Cleveland, Ohio
Stanley Chemical Co., East Berlin, Conn.
Walker Co., H. V., 714 Division St., Elizabeth, N. J.
Watson-Standard Co., 225 Galveston St., Pittsburgh, Pa.
Zapon Div., Atlas Powder Co., Ludlow St., Stamford, Conn.

Forms

COIL FORMS

Alden Products Co., 117 Main St., Brockton, Mass.
American Lava Corp., Kruesi Bldg., Chattanooga, Tenn.
Corning Glass Works, Corning, N. Y.
Creative Plastics Corp., 963 Kent Ave., Brooklyn, N. Y.
Crowley & Co., Inc., Henry L., 1 Central Ave., W. Orange, N. J.
D-X Crystal Co., 1841 W. Carroll Ave., Chicago, Ill.
General Ceramics & Steatite Corp., Keasbey, N. J.
General Winding Co., 420 W. 45th St., New York, N. Y.
Guthman & Co., E. I., 15 S. Throop St., Chicago, Ill.
Hammarlund Mfg. Co., 460 W. 34th St., New York, N. Y.
Haydu Bros., Mt. Bethel Rd., Plainfield, N. J.
Isolantite, Inc., 343 Cortland St., Belleville, N. J.
Lenoxite Div., Lenox, Inc., 65 Prince St., Trenton, N. J.
Millen Mfg. Co., James, 150 Exchange St., Malden, Mass.
National Co., 61 Sherman St., Malden, Mass.
National Tile Co., Anderson, Ind.
New England Radiocrafters, 1156 Commonwealth Ave., Brookline, Mass.
Ohio Brass Co., Mansfield, Ohio
Precision Paper Tube Co., 2033 W. Charleston St., Chicago, Ill.
Thomas & Sons Co., R., Lisbon, Ohio
Ucinite Corp., 459 Watertown Ave., Newtonville, Mass.

Fuses

Bussmann Mfg. Co., University at Jefferson, St. Louis, Mo.
Chase-Shawmut Co., Newburyport, Mass.

Littelfuse, Inc., 4755 Ravenswood Ave., Chicago, Ill.
Monarch Fuse Co., Ltd., Jamestown, N. Y.
Royal Electric Co., Inc., 95 Grand Ave., Pawtucket, R. I.

Generators

DYNAMOTORS, ROTARY CONVERTERS

A B C Radio Laboratories, 3334 N. New Jersey St., Indianapolis, Ind.
Alliance Mfg. Co., Alliance, Ohio
American Bosch Corp., Springfield, Mass.
Bendix Aviation, Ltd., North Hollywood, Calif.
Brown-Brockmeyer Corp., 1000 S. Smithville Rd., Dayton, Ohio
Burke Electric Co., 12th & Cranberry St., Erie, Pa.
Carter Motor Co., 1608 Milwaukee Ave., Chicago, Ill.
Century Electric Co., 1806 Pine St., St. Louis, Mo.
Controls, Inc., Hillcrest Rd., Towaco, N. J.
Crocker-Wheeler Elec. Mfg. Co., Ampere, N. J.
Diehl Mfg. Co., Somerville, N. J.
Eclipse Aviation Div. of Bendix Aviation Corp., Bendix, N. J.
Elcor, Inc., 1501 W. Congress St., Chicago, Ill.
Electric Indicator Co., 21 Parker Ave., Stamford, Conn.
Electric Specialty Co., 211 South St., Stamford, Conn.
Electronic Laboratories, Inc., Indianapolis, Ind.
Fidelity Electric Co., 322 No. Arch St., Lancaster, Pa.
General Electric Co., Schenectady, N. Y.
Janette Mfg. Co., 556 W. Monroe St., Chicago, Ill.
Jersey Mfg. Co., No. 4th at 1st Ave., Columbus, Ohio
Kato Engineering Co., 530 N. Front St., Mankato, Minn.
L. A. B. Corp., P. O. Box 162, Summit, N. J.
Leland Electric Co., 1501 Webster St., Dayton, Ohio
Midco Mfg. & Distr. Co., Sheboygan, Wisc.
Pioneer Gen-E-Motor Corp., 5841 W. Dickens Ave., Chicago, Ill.
Radex Corp., 1322 Elston Ave., Chicago, Ill.
Redmond Co., A. G., 201 Monroe St., Owosso, Mich.
Reliance Electric & Engrg. Co., 1084 Ivanhoe Rd., Cleveland, Ohio
Trav-ler Karenola Radio & Television Corp., 1028-36 W. Van Buren St., Chicago, Ill.
United Engineering Co., 655 N. May St., Chicago, Ill.
Wincharger Corp., 7th & Division, Sioux City, Iowa

GAS AND HAND-DRIVEN GENERATORS

Delco Appliance Div., General Motors Corp., 391 Lyell Ave., Rochester, N. Y.
Electric Specialty Co., 211 South St., Stamford, Conn.
General Electronic Industries, Div. of Auto Ordnance Corp., 342 Putnam, Greenwich, Conn.
Homelite Corp., Port Chester, N. Y.
Janette Mfg. Co., 556 W. Monroe St., Chicago, Ill.
Kato Engineering Co., 530 N. Front St., Mankato, Minn.
Midco Mfg. & Distributing Co., S. 13th & Kentucky Ave., Sheboygan, Wis.
Onan & Sons, D. W., 43 Royalston Ave., Minneapolis, Minn.
Pioneer Gen-E-Motor Corp., 5841 W. Dickens Ave., Chicago, Ill.
Wincharger Corp., 7th & Division, Sioux City, Iowa

Graphite

COLLOIDAL GRAPHITE

Acheson Colloids Corp., Port Huron, Mich.
Asbury Graphite Mills, Asbury, N. J.
Grafo Colloids Corp., Sharon, Pa.

Harnesses

WIRE HARNESSES

Aircraft-Marine Products, Inc., 286 No. Broad St., Elizabeth, N. J.
Alden Products Co., 117 Main St., Brockton, Mass.
Belden Mfg. Co., 4647 W. Van Buren St., Chicago, Ill.
Eby, Inc., Hugh, H., 18 W. Chelton Ave., Philadelphia, Pa.
Electric Auto-Lite Co., Wire Div., 3529 24th St., Port Huron, Mich.
Gavitt Mfg. Co., Inc., Brookfield, Mass.
Insuline Corp. of America, 36-02 35th Ave., Long Island City, N. Y.
Lewyt Corp., 60 Broadway, Brooklyn, N. Y.
Paranite Wire & Cable, Div. Essex Wire Corp., Fort Wayne, Ind.
Radiotechnic Laboratory, 1328 Sherman Ave., Evanston, Ill.
Rockbestos Products Corp., 308 Nicoll St., New Haven, Conn.
Royal Electric Co., Inc., 95 Grand Ave., Pawtucket, R. I.
Sherron Metallic Corp., 1201 Flushing Ave., Brooklyn, N. Y.
Wood Electric Co., Inc., C. D., 826 Broadway, New York, N. Y.

Headphones

Automatic Electric Co., 1033 W. Van Buren St., Chicago, Ill.
Autocrat Radio Co., 3855 N. Hamilton Ave., Chicago, Ill.
Aviometer Corp., 370 West 35th St., New York, N. Y.
Best Mfg. Co., Inc., 1200 Grove St., Irvington, N. J.
Brush Development Co., 3311 Perkins Ave., Cleveland, Ohio
Cannon Co., C. F., Springwater, N. Y.
Connecticut Telephone & Electric Div. of Great American Industries, 70 Britannia St., Meriden, Conn.
Consolidated Radio Co., 350 W. Erie St., Chicago, Ill.
Eby Co., Hugh H., 18 W. Chelton Ave., Philadelphia, Pa.
Electrical Industries Mfg. Co., Red Bank, N. J.
Kellogg Switchboard & Supply Co., 6650 S. Cicero Ave., Chicago, Ill.
Murdock Mfg. Co., William J., Chelsea, Mass.
Permoflux Corp., 4916 W. Grand Ave., Chicago, Ill.
Philmore Mfg. Co., 113 University Pl., New York, N. Y.
Quam-Nichols Co., 526 East 33rd Place, Chicago, Ill.
Rola Co., Inc., 2350 Superior Ave., Cleveland, Ohio
Shure Bros., 225 W. Huron St., Chicago, Ill.
Telephonics Corp., 350 West 31st St., New York, N. Y.
Telex Products Co., Telex Park, Minneapolis, Minn.
Tibbets Laboratories, 12 Norfolk St., Cambridge, Mass.
Trimm Radio Mfg. Co., 1770 W. Berteau Ave., Chicago, Ill.
Universal Microphone Co., 424 Warren Lane, Inglewood, Calif.
Utah Radio Products Co., 820 Orleans St., Chicago, Ill.
Warwick Mfg. Corp., 4640 W. Harrison St., Chicago, Ill.
Winslow Co., 9 Liberty St., Newark, N. J.

Holders

CRYSTAL HOLDERS—see Crystals

Horns

SPEAKER PROJECTOR HORNS

Atlas Sound Corp., 1443 39th St., Brooklyn, N. Y.
Erwood Co., 223 W. Erie St., Chicago, Ill.
Hawley Products Co., St. Charles, Ill.
Jensen Radio Mfg. Co., 6601 S. Laramie Ave., Chicago, Ill.
Operadio Mfg. Co., St. Charles, Ill.
Oxford Tartak Radio Corp., 3911 S. Michigan Ave., Chicago, Ill.

Racon Electric Co., 52 E. 19th St., New York, N. Y.
Radio Corp. of America, Camden, N. J.
Sherron Metallic Corp., 1201 Flushing Ave., Brooklyn, N. Y.
Simpson Mfg. Co. Inc., Mark, 188 W. Fourth St., New York, N. Y.
University Laboratories, 225 Varick St., New York, N. Y.
Western Electric Co. Inc., 195 Broadway, New York, N. Y.
Wright-Decoster, Inc., 2233 University Ave., St. Paul, Minn.

Insulation

see also Tubing, Finishes

BEAD INSULATION

American Lava Corp., Kruesi Bldg., Chattanooga, Tenn.
American Phenolic Corp., 1830 S. 54th Ave., Chicago, Ill.
Corning Glass Works, Corning, N. Y.
Dunn, Inc., Struthers, 1321 Arch St., Philadelphia, Pa.
Isolantite, Inc., 343 Cortlandt St., Belleville, N. J.
Martindale Electric Co., Box 617, Edgewater Br., Cleveland, Ohio
Star Porcelain Co., 61 Muirhead Ave., Trenton, N. J.
Steward Mfg. Co., D. M., E. 36th St., Chattanooga, Tenn.

CERAMIC INSULATION

Akron Porcelain Co., Cory Ave. & Belt Line, Akron, Ohio
American Lava Corp., Kruesi Bldg., Chattanooga, Tenn.
Centralab, Div. of Globe Union, Inc., 900 E. Keefe Ave., Milwaukee, Wisc.
Colonial Insulator Co., 931 Grant St., Akron, Ohio
Cook Ceramic Mfg. Co., 500 Prospect St., Trenton, N. J.
Crowley Co., Henry L., 1 Central Ave., West Orange, N. J.
Electronic Mechanics, Inc., 70 Clifton Blvd., Clifton, N. J.
General Ceramics & Steatite Corp., Keasbey, N. J.
General Porcelain Co., 951 Pennsylvania Ave., Trenton, N. J.
Hartford Faience Co., 271 Hamilton St., Hartford, Conn.
Illinois Electric Porcelain Co., Macomb, Ill.
Imperial Porcelain Works, Inc., Mulberry St. & New York Ave., Trenton, N. J.
Isolantite, Inc., 343 Cortlandt St., Belleville, N. J.
Knox Porcelain Corp., 200 Mynderse Ave., Knoxville, Tenn.
Lapp Insulator Co., 31 Gilbert St., Le Roy, N. Y.
Lenoxite Div., Lenox, Inc., 65 Prince St., Trenton, N. J.
Locke Insulator Corp., S. Charles & Cromwell Sts., Baltimore, Md.
Louthan Mfg. Co., 2000 Harvey Ave., East Liverpool, Ohio
McDanel Refractory Porcelain Co., 510 Ninth Avenue, Beaver Falls, Pa.
Metsch Refractories Co., East Liverpool, Ohio
Mica Products Mfg. Co., 69 Wooster St., New York, N. Y.
Mycalex Corp. of America, 60 Clifton Blvd., Clifton, N. J.
National Porcelain Co., 400 Southard St., Trenton, N. J.
National Tile Co., Anderson, Ind.
Ohio Brass Co., Mansfield, Ohio
Pacific Clay Products, 306 West Ave., 26, P. O. Box 145, Sta. A., Los Angeles, Calif.
Porcelain Insulator Corp., 447 E. Main St., Lima, N. Y.
Porcelain Products, Inc., 124 Front St., Findlay, Ohio
Porcelier Mfg. Co., Greensburg, Pa.
Saxonburg Potteries, Saxonburg, Pa.
Square D Co., 6060 Rivard St., Detroit, Mich.
Star Porcelain Co., 61 Muirhead Ave., Trenton, N. J.
Steward Mfg. Co., D. M., East 36th St., Chattanooga, Tenn.
Stupakoff Ceramic & Mfg. Co., Latrobe, Pa.
Thomas & Sons Co., R., Lisbon, Ohio
Union Electrical Porcelain Works, Trenton, N. J.
Universal Clay Products Co., 1505 E. First St., Sandusky, Ohio

Washington Porcelain Co., Washington, N. J.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

FABRIC INSULATION

Acme Wire Co., New Haven, Conn.
B & C Insulation Products, Inc., 22 W. 21st St., New York, N. Y.
Baer Co., N. S., 9 Montgomery St., Hillside, N. J.
Dobeckman Co., 3300 Monroe Ave., Cleveland, Ohio.
Endurette Corp. of Am., Cliffwood, N. J.
General Electric Co., Bridgeport, Conn.
Holliston Mills, Inc., Norwood, Mass.
Insulation Manufacturers Corp., 565 W. Washington Blvd., Chicago, Ill.
Irvington Varnish & Insulator Co., 10 Argyle Terrace, Irvington, N. J.
Mica Insulator Co., 200 Varick St., New York, N. Y.
New Jersey Wood Finishing Co., Electrical Insulation Dept., Woodbridge, N. J.
Standard Insulation Co., 74 Paterson Ave., East Rutherford, N. J.
Wright & Sons Co., Wm. E., West Warren, Mass.

FIBRE INSULATION

American Felt Co., Glenville, Conn.
Brandywine Fibre Products Co., 14th & Walnut Sts., Wilmington, Del.
Continental-Diamond Fibre Co., 13 Chapel St., Newark, Del.
Felters Co., 210 South St., Boston, Mass.
Franklin Fibre-Lamitex Corp., 12th & French Sts., Wilmington, Del.
Halowax Products Div., Union Carbide & Carbon Corp., 30 E. 42nd St., New York, N. Y.
Insulation Manufacturers Corp., 565 W. Washington Blvd., Chicago, Ill.
Lincoln Fibre & Specialty Co., Newport, Del.
National Vulcanized Fibre Co., Maryland Ave., Wilmington, Del.
Penn Fibre & Specialty Co., 2030 E. Westmoreland St., Philadelphia, Pa.
Precision Fabricators, Inc., 120 N. Fitzhugh St., Rochester, N. Y.
Spaulding Fibre Co., 310 Wheeler St., Tonawanda, N. Y.
Stevens Paper Mills, Inc., Windsor, Conn.
Taylor Fibre Co., Norristown, Pa.
West Virginia Pulp & Paper Co., 230 Park Ave., New York, N. Y.
Wilmington Fibre Specialty Co., Wilmington, Del.

GLASS INSULATION

Bentley, Harris Mfg. Co., Hector & Lime Sts., Conshohocken, Pa.
Brand & Co., William, 276 Fourth Ave., New York, N. Y.
Corning Glass Works, Corning, N. Y.
Hope Webbing Co., Providence, R. I.
Insulation Manufacturers Corp., 565 W. Washington Blvd., Chicago, Ill.
Kilburn Glass Co., 22 S. Worcester St., Chartley, Mass.
New Jersey Wood Finishing Co., Electrical Insulation Dept., Woodbridge, N. J.
Owens-Corning Fiberglas Corp., Nicholas Bldg., Toledo, Ohio

PAPER INSULATION

Acme Wire Co., 1255 Dixwell Ave., New Haven, Conn.
Case Bros., Manchester, Conn.
Continental-Diamond Fibre Co., 13 Chapel St., Newark, Del.
Cottrell Paper Co., 19 Purchase St., Fall River, Mass.
Federal Telephone and Radio Corp., 591 Broad St., Newark, N. J.
General Electric Co., Bridgeport, Conn.
Hartford City Paper Co., Hartford City, Ind.
Insulation Manufacturers Corp., 565 W. Washington Blvd., Chicago, Ill.
Irvington Varnish & Insulator Co., 10 Argyle Terrace, Irvington, N. J.
Lincoln Fibre & Specialty Co., Newport, Del.
Manning Paper Co., John A., Troy, N. Y.
Mica Insulator Co., 200 Varick St., New York, N. Y.
Mitchell-Rand Insulation Co., 51 Murray St., New York, N. Y.
National Varnished Products Corp., 211 Randolph Ave., Woodbridge, N. J.
National Vulcanized Fibre Co., Maryland Ave., Wilmington, Del.
New Jersey Wood Finishing Co., Electrical Insulation Dept., Woodbridge, N. J.
Precision Fabricators, Inc., 120 N. Fitzhugh St., Rochester, N. Y.
Riegel Paper Corp., 342 Madison Ave., New York, N. Y.
Smith Paper Co., Inc., Lee, Mass.
Spaulding Fibre Co., 310 Wheeler St., Tonawanda, N. Y.
Standard Insulation Co., 74 Paterson Ave., East Rutherford, N. J.
Stevens Paper Mills, Inc., Windsor, Conn.
Taylor Fibre Co., Norristown, Pa.
West Virginia Pulp & Paper Co., 230 Park Ave., New York, N. Y.
Wilmington Fibre Specialty Co., P. O. Box 944, Wilmington, Del.

PLASTIC INSULATION

American Phenolic Corp., 1830 S. 54th St., Chicago, Ill.
B & C Insulation Products, Inc., 261 Fifth Ave., New York, N. Y.
Brand & Co., 276 Fourth Ave., New York, N. Y.
Burndy Engrg. Co., Inc., 107 Eastern Blvd., New York, N. Y.
Continental-Diamond Fibre Co., 13 Chapel St., Newark, Del.
Dow Chemical Co., Midland, Mich.
Electrical Insulation Co., Inc., 12 Vestry St., New York, N. Y.
Extruded Plastics, Inc., Norwalk, Conn.
Farley & Loetscher Mfg. Co., Dubuque, Iowa
Federal Telephone and Radio Corp., 591 Broad St., Newark, N. J.
Formica Insulation Co., 4662 Spring Grove Ave., Cincinnati, Ohio
Franklin Fibre-Lamitex Corp., 12th & French St., Wilmington, Del.
Gemloid Corp., 79-10 Albion Ave., Elmhurst, N. Y.
General Electric Co., Plastics Dept., 1 Plastics Ave., Pittsfield, Mass.
Gering Products, Inc., 7th & Monroe Ave., Kenilworth, N. J.
Goodyear Tire & Rubber Co., 1144 E. Market St., Akron, Ohio.
Halowax Products Div., Union Carbide & Carbon Corp., 30 East 42nd St., New York, N. Y.
Hodgman Rubber Co., Framingham, Mass.
Industrial Synthetics Corp., 60 Woolsey St., Irvington, N. J.
Insel Co., Arlington, N. J.
Insulation Manufacturers Corp., 565 W. Washington Blvd., Chicago, Ill.
McInerney Plastics Co., 655 Godfrey Ave., S. W., Grand Rapids, Mich.
Mica Insulator Co., 200 Varick St., New York, N. Y.
Mica Products Mfg. Co., 69 Wooster St., New York, N. Y.
Mills Corp., Elmer E., 812 W. Van Buren St., Chicago, Ill.
Mitchell-Rand Insulation Co., 51 Murray St., New York, N. Y.
Monsanto Chemical Co., Plastics Div., Springfield, Mass.
National Varnished Products Corp., 211 Randolph Ave., Woodbridge, N. J.
National Vulvanized Fibre Co., Maryland Ave., Wilmington, Del.
Panelyte Div., St. Regis Paper Co., 230 Park Ave., New York, N. Y.
Penn Fibre & Specialty Co., 2030 E. Westmoreland St., Philadelphia, Pa.
Plax Corp., 133 Walnut St., Hartford, Conn.
Precision Fabricators, Inc., 120 N. Fitzhugh St., Rochester, N. Y.
Respro, Inc., Wellington Ave., Cranston, N. J.
Richardson Co., Lockland, Ohio
Spaulding Fibre Co., 310 Wheeler St., Tonawanda, N. Y.
Suprenant Electrical Insulation Co., 84 Purchase St., Boston, Mass.
Synthane Corp., Oaks, Pa.
Taylor Fibre Co., Norristown, Pa.
Ucinite Co., 459 Watertown Ave., Newtonville, Mass.
Werner Co., Inc., R. D., 380 Second Ave., New York, N. Y.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
Wilmington, Fibre Specialty Co., Wilmington, Del.

STEATITE INSULATION

American Lava Corp., Chattanooga, Tenn.
Architectural Tiling Co., Inc., Case & Jackson Sts., Keyport, N. J.
Centralab Div. of the Globe Union, Inc., 900 E. Keefe Ave., Milwaukee, Wisc.
Cook Ceramic Co., Trenton, N. J.
Crowley & Co., Inc., Henry, 1 Central Ave., W. Orange, N. J.
Gem Clay Products, Sebring, Ohio
General Ceramics and Steatite Corp., Keasbey, N. J.
Isolantite, Inc., 343 Cortlandt St., Belleville, N. J.
Lapp Insulator Co., Leroy, N. Y.
Lenox China Co., Trenton, N. J.
Locke Insulator Co., Baltimore, Md.
Louthan Mfg. Co., The, 2000 Harvey Avenue, E. Liverpool, Ohio
National Poreclain Co., 400 Southard St., Trenton, N. J.
National Tile Co., Anderson, Indiana
Pacific Clay Products, Los Angeles, Calif.
Pass & Seymour Inc., Solvay, New York
Saxonburg Potteries, Saxonburg, Pa.
Star Porcelain Co., The, Trenton, N. J.
Stupakoff Ceramic & Mfg. Co., Latrobe, Pa.
Wisconsin Porcelain Co., Sun Prairies, Wisc.

Insulators

Alden Products Co., 117 Main St., Brockton, Mass.
American Lava Corp., Kruesi Bldg., Chattanooga, Tenn.
American Phenolic Corp., 1830 S. 54th Ave., Chicago, Ill.
Burndy Engrg. Co., 107 Eastern Blvd., New York, N. Y.
Creative Plastics Corp., 963 Kent Ave., Brooklyn, N. Y.
Fleron & Son, Inc., M. M., 113 N. Broad St., Trenton, N. J.
General Electric Co., Schenectady, N. Y.
Isolantite, Inc., 343 Cortlandt St., Belleville, N. J.
Johnson Co., E. F., Waseca, Minn.
Katz & Ogush, Inc., 33 West 60th St., New York, N. Y.
Lapp Insulator Co., 31 Gilbert St., LeRoy, N. Y.
Locke Insulator Corp., S. Charles & Cromwell Sts., Baltimore, Md.
McDanel Refractory Porcelain Co., 510 9th Ave., Beaver Falls, Pa.
National Co., 61 Sherman St., Malden, Mass.
Parisian Novelty Co., 3510 S. Western Ave., Chicago, Ill.
Porcelain Products, Inc., 124 W. Front St., Findlay, Ohio
Richards Co., Inc., Arklay S., 72 Winchester St., Newton Highlands, Mass.
Stupakoff Ceramic & Mfg. Co., Latrobe, Pa.
Thomas & Sons Co., R., Lisbon, Ohio
Universal Clay Products Co., Sandusky, Ohio
Victor Insulators, Inc., Victor, N. Y.

MAST FOOTING and TOWER INSULATORS

Lapp Insulator Co., 31 Gilbert St., Le Roy, N. Y.
Locke Insulator Corp., S. Charles & Cromwell Sts., Baltimore, Md.

Inverters

Allis-Chalmers Mfg. Co., Milwaukee, Wisc.
American Television & Radio Corp., 300 E. Fourth St., St. Paul, Minn.
Benwood Linze Co., 1815 Locust St., St. Louis, Mo.
Eclipse Aviation, Div. of Bendix Aviation, Bendix, N. J.
Electrical Products Co., 6535 Russell St., Detroit, Mich.
Electron Equipment Corp., Palm Springs, Calif.
Electronic Laboratories, Inc., Indianapolis, Ind.
Gibbs & Co., Thomas B., Div. of George W. Borg Corp., 814 Michigan St., Delavan, Wisc.

Jacks

see also Plugs

American Phenolic Corp., 1830 S. 54th Ave., Chicago, Ill.
American Radio Hardware Co., Inc., 476 Broadway, New York, N. Y.

Audio Development Co., 2833 13th Ave., S., Minneapolis, Minn.
Automatic Electric Co., 1033 W. Van Buren St., Chicago, Ill.
Birnbach Radio Co., 145 Hudson St., New York, N. Y.
Bud Radio, Inc., 2118 E. 55th St., Cleveland, Ohio
Cinema Engineering Co., 1508 S. Verdugo Ave., Burbank, Calif.
Connecticut Telephone & Elec. Div. of Great American Industries, Inc., 70 Brittania St., Meriden, Conn.
Eby, Inc., Hugh H., 18 W. Chelton Ave., Philadelphia, Pa.
Electronic Products Mfg. Corp., 7300 Huron River Drive, Dexter, Mich.
Federal Mfg. & Engrg. Corp., 199 Steuben St., Brooklyn, N. Y.
General Radio Co., 30 State St., Cambridge, Mass.
Guardian Electric Mfg. Co., 1621 W. Walnut St., Chicago, Ill.
Insuline Corp. of America, 36-02 35th Ave., Long Island City, N. Y.
Johnson Co., E. F., Waseca, Minn.
Kellogg Switchboard & Supply Co., 6650 S. Cicero Ave., Chicago, Ill.
Mallory & Co., P. R., 3029 E. Washington St., Indianapolis, Ind.
Monowatt Electric Corp., 66 Bissell St., Providence, R. I.
Mossman, Inc., Donald P., 6133 Northwest Highway, Chicago, Ill.
Standard Electric Mfg. Co., 925 Wrightwood Ave., Chicago, Ill.
Telephonics Corp., 350 West 31st St., New York, N. Y.
Trav-ler Karenola Radio & Television Corp., 1028 W. Van Buren St., Chicago, Ill.
Ucinite Co., 459 Watertown Ave., Newtonville, Mass.
Universal Microphone Co., 424 Warren Lane, Inglewood, Calif.
Wood Electric Co., C. D., 826 Broadway, New York, N. Y.

Knobs

see Dials
also Pointers

Alden Products Co., 117 Main St., Brockton, Mass.
American Insulator Corp., New Freedom, Pa.
American Radio Hardware Co., Inc., 476 Broadway, New York, N. Y.
Bud Radio, Inc., 2118 E. 55th St., Cleveland, Ohio
Continental-Diamond Fibre Co., 13 Chapel St., Newark, Del.
Creative Plastics Corp., 975 Kent Ave., Brooklyn, N. Y.
Crowe Name Plate & Mfg. Co., 3701 Ravenswood Ave., Chicago, Ill.
Daven Co., 158 Summit St., Newark, N. J.
Davies Molding Co., Harry, 1428 N. Wells St., Chicago, Ill.
Eby, Inc., Hugh H., 18 W. Chelton Ave., Philadelphia, Pa.
Emeloid Co., 291 Laurel Ave., Arlington, N. J.
Gemloid Corp., 79-10 Albion Ave., Elmhurst, N. Y.
General Cement Mfg. Co., 919 Taylor Ave., Rockford, Ill.
General Radio Co., 30 State St., Cambridge, Mass.
Imperial Molded Products Corp., 2925 W. Harrison St., Chicago, Ill.
Kurz Kasch, Inc., 1415 S. Bway, Dayton, Ohio
Mallory & Co., P. R., 3029 E. Washington St., Indianapolis, Ind.
Millen Mfg. Co., James, 150 Exchange St., Malden, Mass.
Miller Co., J. W., 5917 S. Main St., Los Angeles, Cal.
National Co., 61 Sherman St., Malden, Mass.
New England Radiocrafters, 1156 Commonwealth Ave., Brookline, Mass.
Radio City Products Co., 127 West 26th St., New York, N. Y.
Richardson Co., Lockland, Ohio
Rogan Brothers, 2001 S. Michigan Ave., Chicago, Ill.
Sillcocks-Miller Co., 10 Parker Ave., W., South Orange, N. J.
Syracuse Ornamental Co., 581 So. Clinton St., Syracuse, N. Y.

Lacquer

see Finishes

Lamps

DIAL LAMPS

Alden Products Co., 117 Main St., Brockton, Mass.
Bud Radio, Inc., 2118 E. 55th St., Cleveland, Ohio
Carlton Lamp Corp., 730 South 13th St., Newark, N. J.
Cinch Mfg. Corp., 2335 W. Van Buren St., Chicago, Ill.
Cole-Hersee Co., 54 Old Colony Ave., S., Boston, Mass.
Dial Light Co. of America, 90 West St., New York, N. Y.
Drake Mfg. Co., 1713 Hubbard St., Chicago, Ill.
Mallory & Co., P. R., 3029 E. Washington St., Indianapolis, Ind.
National Union Radio Corp., 15 Washington St., Newark, N. J.
Signal Indicator Corp., 140 Cedar St., New York, N. Y.
Tung-Sol Lamp Works, Inc., 95 Eighth Ave., Newark, N. J.

PILOT LIGHTS

Alden Products Co., 117 Main St., Brockton, Mass.
Automatic Electric Co., 1033 W. Van Buren St., Chicago, Ill.
Bryant Electric Co., 1421 State St., Bridgeport, Conn.
Carlton Lamp Corp., 730 South 13th St., Newark, N. J.
Dial Light Co. of America, Inc., 92 West St., New York, N. Y.
Drake Mfg. Co., 1713 W. Hubbard St., Chicago, Ill.
General Electric Co., Bridgeport, Conn.
Gothard Mfg. Co., 1300 North 9th St., Springfield, Ill.
Hart Mfg. Co., 110 Bartholomew Ave., Hartford, Conn.
Hubbell, Inc., Harvey, State St. & Bostwick Ave., Bridgeport, Conn.
Kellogg Switchboard & Supply Co., 6650 S. Cicero Ave., Chicago, Ill.
Kirkland Co., H. R., 8-10 King St., Morristown, N. J.
Mallory & Co., Inc., 3029 E. Washington St., Indianapolis, Ind.
Pass & Seymour, Inc., Solvay Station, Syracuse, N. Y.
Signal Indicator Corp., 140 Cedar St., New York, N. Y.
Tingstol Corp., 1461 W. Grand Ave., Chicago, Ill.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Lines

COAXIAL LINES

see Cable

Locknuts

see Nuts

Loudspeakers

Altec Lansing Corp., 1680 N. Vine St., Los Angeles, Cal.
American Communications Corp., 306 Broadway, New York, N. Y.
American Amplifier & Telephone Co., Inc., 1220 Glendon Ave., Los Angeles, Calif.
Atlas Sound Corp., 1443 39th St., Brooklyn, N. Y.
Austin Electronic Mfg. Co., Warren, Pa.
Best Mfg. Co., 1200 Grove St., Irvington, N. J.
Bud Radio, Inc., 2118 E. 55th St., Cleveland, Ohio
Cinaudagraph Speakers, Inc., 3911 S. Michigan Ave., Chicago, Ill.
Dilk's Acoustic Co., 540 West Ave., Norwalk, Conn.
Fibre Form, Inc., Ellsworth & Washington Sts., Columbia City, Ind.
Gates Radio Co., 220 Hampshire St., Quincy, Ill.
Jensen Radio Mfg. Co., 6601 S. Laramie Ave., Chicago, Ill.
Leotone Radio Co., 63 Dey St., New York, N. Y.
Magnavox Co., 2131 Bueter Rd., Fort Wayne, Ind.
Miles Reproducer Co., 812 Broadway, New York, N. Y.
National Co., 61 Sherman St., Malden, Mass.
Operadio Mfg. Co., 13th & Indiana Sts., St. Charles, Ill.
Oxford Tartak Radio Corp., 3911 S. Michigan Ave., Chicago, Ill.
Permoflux Corp., 4916 W. Grand Ave., Chicago, Ill.
Philmore Mfg. Co., 113 University Pl., New York, N. Y.
Quam-Nichols Co., 526 East 33rd Place, Chicago, Ill.
Racon Electric Co., 52 E. 19th St., New York, N. Y.
Radio Speakers, Inc., 221 E. Cullerton St., Chicago, Ill.
Radio Corp. of America, Camden, N. J.
Rola Co., Inc., 2530 Superior Ave., Cleveland, Ohio
Simpson Mfg. Co., Mark, 188 West Fourth St., New York, N. Y.
University Laboratories, 225 Varick St., New York, N. Y.
Utah Radio Products Co., 820 Orleans St., Chicago, Ill.
Western Electric Co., Inc., 195 Broadway, New York, N. Y.

Lugs

TERMINAL LUGS

Aircraft-Marine Products Co., 286 N. Broad St., Elizabeth, N. J.
Belden Mfg. Co., 4647 W. Van Buren St., Chicago, Ill.
Burndy Engineering Co., 459 E. 133d St., Bronx, N. Y.
Cinch Mfg. Corp., 2335 W. Van Buren St., Chicago, Ill.
Cole-Hersee Co., 54 Old Colony Ave., South Boston, Mass.
Dante Electric Mfg. Co., Bantam, Conn.
Dossert & Co., 242 W. 41st St., New York, N. Y.
Eastern Specialty Co., 3617-19 N. Eighth St., Philadelphia, Pa.
Franklin Mfg. Corp., A. W., 175 Varick St., New York, N. Y.
Grammes & Sons, Inc., L. F., 344 Union St., Allentown, Pa.
Ideal Clamp Mfg. Co., 202 Bradford St., Brooklyn, N. Y.
Ideal Commutator Dresser Co., 1631 Park Ave., Sycamore, Ill.
Ilsco Copper Tube & Products, Inc., Mariemont Ave., Mariemont, Ohio
Industrial Screw & Supply Co., 713 W. Lake St., Chicago, Ill.
Insuline Corp. of America, 36-02 35th Ave., Long Island City, N. Y.
Jones, Howard B., 2300 Wabansia Ave., Chicago, Ill.
Krueger & Hudepohl, 232-8 Vine St., Cincinnati, Ohio
Manufacturers Screw Products, 216 W. Hubbard St., Chicago, Ill.
Morse Co., Frank W., 301 Congress St., Boston, Mass.
Multi Electrical Mfg. Co., 1840 W. 14th St., Chicago, Ill.
Penn-Union Electric Corp., 315 State St., Erie, Pa.
Rajah Co., Locust Ave., Bloomfield, N. J.
Richards Co., Inc., Arklay S., 72 Winchester St., Newton Highlands, Mass.
Shakeproof, Inc., 2501 N. Keeler Ave., Chicago, Ill.
Sherman Mfg. Co., H. B., Battle Creek, Mich.
Stewart Stamping Corp., 621 East 216th St., New York, N. Y.
Stimpson Co., Edwin B., 74 Franklin Ave., Brooklyn, N. Y.
Thomas & Betts Co., 36 Butler St., Elizabeth, N. J.
Thompson-Bremer & Co., 1640 W. Hubbard St., Chicago, Ill.
Zierick Mfg. Co., 385 Gerard Ave., New York, N. Y.

Magnesium

see Metals

Magnets

PERMANENT MAGNETS

Arnold Engrg. Co., 147 E. Ontario St., Chicago, Ill.

Cinaudagraph Corp., 2 Sellech St., Stamford, Conn.
Crucible Steel Co. of America, 405 Lexington Ave., New York, N. Y.
General Electric Co., Schenectady, N. Y.
Indiana Steel Products Co., 6 N. Michigan Ave., Chicago, Ill.
Taylor-Wharton Iron & Steel Co., Highbridge, N. J.
Thomas & Skinner Steel Products Co., 1120 E. 23d St., Indianapolis, Ind.

Metals

ALUMINUM

Aluminum Co. of America, Gulf Bldg., Pittsburgh, Pa.
Reynolds Metal Co., Federal Reserve Bldg., Richmond, Va.

MAGNESIUM

American Magnesium Corp., 2210 Harvard Ave., Cleveland, Ohio
Belmont Smelting & Refining Works, Inc., 330 Belmont Ave., Brooklyn, N. Y.
Bohn Aluminum & Brass Corp., Lafayette Bldg., Detroit, Mich.
Dow Chemical Co., Midland, Mich.

NICKEL

General Plate Div., Metals & Controls Corp., 34 Forest St., Attleboro, Mass.
Ingersoll Steel & Disc Co., New Castle, Ind.
International Nickel Co., 67 Wall St., New York, N. Y.
Lukens Steel Co., Coatesville, Pa.
Riverside Metal Co., Riverside, N. J.
Superior Metal Corp., Clearing, Ill.

POWDERED METALS

American Sintell Corp., Yonkers, N. Y.
Bound Brook Oilless Bearing Co., Bound Brook, N. J.
Chrysler Corp. Aplex Div., Detroit, Mich.
Cleveland Tungsten, Inc., 10200 Meech Ave., Cleveland, Ohio
Crowley, Inc., Henry, West Orange, N. J.
Foote Mineral Co., 1609 Summer St., Philadelphia, Pa.
General Aniline & Film Corp., 435 Hudson St., New York, N. Y.
General Laminated Products, Inc., 175 Varick St., New York, N. Y.
Johnson Bronze Co., Newcastle, Pa.
Mallory & Co., P. R., Indianapolis, Ind.
Mepham Corp., G. S., 2001 Lynch Ave., East St. Louis, Ill.
Moraine Products Div., General Motors Corp., Dayton, Ohio
Powder Metallurgy, Inc., Long Island City, N. Y.
Stackpole Carbon Co., St. Mary's, Pa.
United States Graphite Co., Saginaw, Mich.

SPECIAL METALS

American Electro Metal Corp., 165 Broadway, New York, N. Y.
American Platinum Works, New Jersey, R. R. Ave., at Oliver St., Newark, N. J.
Arnold Engrg. Co., 147 E. Ontario St., Chicago, Ill.
Baker & Co., 113 Astor St., Newark, N. J.
Belmont Smelting & Refining Works, Inc., 330 Belmont Ave., Brooklyn, N. Y.
Bishop & Co., Platinum Works, J., 12 Channing Ave., Malvern, Pa.
Brainin Co., C. S., 233 Spring St., New York, N. Y.
Callite Tungsten Corp., 544 39th St., Union City, N. J.
Chase Co., W. M., 1600 Beard Ave., Detroit, Mich.
Cleveland Tungsten, Inc., 10200 Meech Ave., Cleveland, Ohio
Cohn & Co., Sigmund, 44 Gold St., New York, N. Y.
Cross, H., 15 Beekman St., New York, N. Y.
Driver Co., William B., Newark, N. J.
Fansteel Metallurgical Corp., 2200 Sheridan Rd., No. Chicago, Ill.
Foote Mineral Co., 1609 Superior St., Philadelphia, Pa.
General Plate Div. Metals & Controls Corp., 34 Forest St., Attleboro, Mass.
Handy & Harman, 82 Fulton St., New York, N. Y.
Haydu Bros., Mt. Bethel Rd., Plainfield, N. J.
International Nickel Co., 67 Wall St., New York, N. Y.
King Laboratories, Inc., 205 Oneida St., Syracuse, N. Y.
Makepeace Co., D. E., Attleboro, Mass.
Ney Co., J. M., Hartford, Conn.
Noble Co., F. H., 535 West 59th St., Chicago, Ill.
North American Philips Co., Inc., Elmet Div., 145 Palisade St., Dobbs Ferry, N. Y.
Precision Products Co., 26 Bedford St., Waltham, Mass.
Seymour Mfg. Co., Seymour, Conn.
Simonds Saw & Steel Co., Lockport, N. Y.
Sirian Wire & Contact Co., 260 Sherman St., Newark, N. J.
Wilson Co., H. A., 105 Chestnut St., Newark, N. J.

STEEL, ELECTRICAL

Allegheny-Ludlum Steel Corp., Oliver Bldg., Pittsburgh, Pa.
American Rolling Mill Co., Curtis St., Middletown, Ohio
American Steel & Wire Co., Rockefeller Plaza, Cleveland, Ohio
Carnegie-Illinois Steel Corp., Carnegie Bldg., Pittsburgh, Pa.
Empire Sheet & Tin Plate Co., N. Bowman St., Mansfield, Ohio
Follansbee Steel Corp., Third & Liberty Sts., Pittsburgh, Pa.
Granite City Steel Co., Granite City, Ill.
Newport Rolling Mill Co., Ninth & Lowell Sts., Newport, Ky.
Republic Steel Corp., Alloy Steel Div., Massillon, Ohio
Thomas Steel Co., Delaware Ave., Warren, Ohio
Union Drawn Steel Div., Republic Steel Corp., Harsh Ave., S. E. Massillon, Ohio
Wheeling Steel Corp., Wheeling Steel Corp. Bldg., Wheeling, W. Va.
Youngstown Sheet & Tube Co., Stambaugh Bldg., Youngstown, Ohio

THERMOSTATIC METALS

Baker & Co., 113 Astor St., Newark, N. J.
Brainin Co., C. S., 233 Spring St., New York, N. Y.
Callite Tungsten Corp., 544 39th st., Union City, N. J.
General Plate Div., Metals & Controls Corp., 34 Forest St., Attleboro, Mass.
Wilson Co., H. A., 105 Chestnut St., Newark, N. J.

Mica

Asheville Mica Co., 5 River Rd., Biltmore, N. C.
Brand & Co., William, 276 Fourth Ave., New York, N. Y.
Continental-Diamond Fibre Co., 13 Chapel St., Newark, Del.
Cornell-Dubilier Electric Corp., 1000 Hamilton Blvd., South Plainfield, N. J.
English Mica Co., 220 E. 42d St., New York, N. Y.
Ford Radio & Mica Corp., 538 63rd St., Brooklyn, N. Y.
General Electric Co., Bridgeport, Conn.
Huse-Liberty Mica Co., 171 Camden St., Boston, Mass.
Insulation Manufacturers Corp., 565 W. Washington Blvd., Chicago, Ill.
International Product Corp., 2554 Greenmount Ave., Baltimore, Md.
Macallen Co., 25 Macallen St., Boston, Mass.
Mica Insulator Co., 200 Varick St., New York, N. Y.
Mica Products Mfg. Co., 69 Wooster St., New York, N. Y.
Munsell & Co., Eugene, 200 Varick St., New York, N. Y.
New England Mica Co., Waltham, Mass.
New Hampshire Mica & Mining Co., Washington St., Keene, N. H.
Schoonmaker Insulation Co., A. O., 635 Greenwich St., New York, N. Y.
Southern Mica Co., Johnson City, Tenn.
Spruce Pine Mica Co., Spruce Pine, N. C.
Tar Heel Mica Co., Plumtree, N. C.
U. S. Mica Mfg. Co., 1521 Circle Ave., Forest Park, Ill.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Microphones

American Amplifier & Telephone Co., Inc., 1220 Glendon Ave., Los Angeles, Calif.
American Microphone Co., 1915 S. Western Ave., Los Angeles, Calif.
Amperite Co., 561 Broadway, New York, N. Y.
Astatic Corp., 830 Market St., Youngstown, Ohio
Aurex Corp., 115 N. Franklin St., Chicago, Ill.
Austin Electronic Mfg. Co., Warren, Pa.
Automatic Electric Co., 1033 W. Van Buren St., Chicago, Ill.
Aviometer Corp., 370 West 35th St., New York, N. Y.
Best Mfg. Co., Inc., 1200 Grove St., Irvington, N. J.
Brush Development Co., 3311 Perkins Ave., Cleveland, Ohio
Eby, Inc., Hugh H., 18 W. Chelton Ave., Philadelphia, Pa.
Electro Voice Mfg. Co., 1239 South Bend Ave., South Bend, Ind.
Federal Mfg. & Engineering Corp., 199 Steuben St., Brooklyn, N. Y.
Federal Telephone & Radio Corp., 591 Broad St., Newark, N. J.
Galvin Mfg. Corp., 4545 W. Augusta Blvd., Chicago, Ill.
Gates Radio Co., Quincy, Ill.
General Electric Co., Schenectady, N. Y.
Kaar Engineering Co., 619 Emerson St., Palo Alto, Calif.
Kellogg Switchboard & Supply Co., 6650 S. Cicero Ave., Chicago, Ill.
Lektra Labs., Inc., 30 East 10th St., New York, N. Y.
Magnavox Co., 2131 Bueter Rd., Fort Wayne, Ind.
Miles Reproducer Co., Inc., 812 Broadway, New York, N. Y.
Myers & Sons, E. A., Radioear Bldg., Mt. Lebanon, Pittsburgh, Pa.
Permoflux Corp., 4916 W. Grand Ave., Chicago, Ill.
Philmore Mfg. Co., 113 University Pl., New York, N. Y.
Quam-Nichols Co., 526 East 33rd Place, Chicago, Ill.
Radio Corp. of America, Camden, N. J.
Radio Speakers, Inc., 221 E. Cullerton St., Chicago, Ill.
Rauland Corp., 4245 N. Knox Ave., Chicago, Ill.
Shure Bros., 225 W. Huron St., Chicago, Ill.
Sonotone Corp., Saw Mill River Road, Elmsford, N. Y.
Telephonics Corporation, 350 West 31st St., New York, N. Y.
Tibbetts Laboratories, 12 Norfolk St., Cambridge, Mass.
Turner Co., 909 17th St., N.E., Cedar Rapids, Iowa
Universal Microphone Co., 424 Warren Lane, Inglewood, Calif.
Western Electric Co., Inc., 195 Broadway, New York, N. Y.

Motor-Generators

see Generators

Motors

FRACTIONAL HORSEPOWER and MINIATURE MOTORS

Air-Way Electric Appliance Corp., 2101 Auburn Ave., Toledo, Ohio
Alliance Mfg. Co., Lake Park Blvd., Alliance, Ohio
Baldor Electric Co., 4353 Duncan Ave., St. Louis, Mo.
Barber-Colman Co., River & Loomis Sts., Rockford, Ill.
Black & Decker Electric Co., Kent, Ohio
Bodine Electric Co., 2262 W. Ohio St., Chicago, Ill.
Brown-Brockmeyer Co., 1000 S. Smithville Rd., Dayton, Ohio
Burke Electric Co., 12th & Cranberry Sts., Erie, Pa.
Century Electric Co., 1806 Pine St., St. Louis, Mo.
Crocker-Wheeler Electric Mfg. Co., Ampere, N. J.
Delco Appliance Division, General Motors Corp., 391 Lyell Ave., Rochester, N. Y.
Delco Products Div., General Motors Corp., 329 E. First St., Dayton, Ohio
Diehl Mfg. Co., Somerville, N. J.
Dumore Co., 14th & Racine Sts., Racine, Wis.
Eicor, Inc., 1501 W. Congress St., Chicago, Ill.
Electric Indicator Co., 21 Parker Ave., Stamford, Conn.
Electric Motor Corp., Racine, Wis.
Electric Specialty Co., 211 South St., Stamford, Conn.
Electro Dynamic Works of Electric Boat Co., Ave. A & North St., Bayonne, N. J.

Emerson Electric Mfg. Co., 1824 Washington Ave., St. Louis, Mo.
Fidelity Electric Co., 332 N. Arch St., Lancaster, Pa.
Franklin Transformer Mfg. Co., 607 22d Ave., N. E., Minneapolis, Minn.
General Electric Co., Schenectady, N. Y.
General Instrument Co., 829 Newark Ave., Elizabeth, N. J.
Globe Industries, Inc., 125 Sunrise Place, Dayton, Ohio
Hansen Mfg. Co., Inc., Princeton, Ind.
Haydon Mfg. Co., Forestville, Conn.
Heinze Electric Corp., Lowell, Mass.
Holtzer-Cabot Electric Co., 125 Amory St., Boston, Mass.
Janette Mfg. Co., 556 W. Monroe St., Chicago, Ill.
Kendrick & Davis Co., Lebanon, N. H.
Kimble Electric Co., 2011 W. Hastings St., Chicago, Ill.
Kingston-Conley Electric Co., 68 Brook Ave., North Plainfield, N. J.
L. A. B. Corp., P. O. Box 162, Summit, N. J.
Leich Electric Co., River Rd., Prairie View, Ill.
Leland Electric Co., 1501 Webster St., Dayton, Ohio
Marathon Electric Mfg. Corp., Randolph & Cherry Sts., Wausau, Wis.
Master Electric Co., 126 Davis Ave., Dayton, Ohio
Ohio Electric Mfg. Co., 5900 Maurice Ave., Cleveland, Ohio
Oster Mfg. Co. of Illinois, John, Genoa, Ill.
Peerless Electric Co., 740 W. Market St., Warren, Ohio
Pioneer Gen-E-Motor Corp., 581 N. Dickens St., Chicago, Ill.
Radex Corp., 1322 Elston Ave., Chicago, Ill.
Redmond Co., A. G., Owosso, Mich.
Reliance Electric & Engineering Co., 1084 Ivanhoe Rd., Cleveland, Ohio
Reynolds Electric Co., 2650 W. Congress St., Chicago, Ill.
Robbins & Myers, 1345 Lagonda Ave., Springfield, Ohio
Rowe Radio Research Laboratory Co., 2422 N. Pulaski Rd., Chicago, Ill.
Signal Electric Mfg. Co., 1915 Broadway, Menominee, Mich.
Small Electric Motors, Ltd., Seaside, Toronto 12, Canada
Smith Mfg. Co., F. A., P. O. Box 509, Rochester, N. Y.
Speedway Mfg. Co., 1834 S. 52d Ave., Cicero, Ill.
Star Electric Motor Co., Bloomfield Ave. & Grove St., Bloomfield, N. J.
Sterling Electric Motors, Inc., 5401 Telegraph Rd., Los Angeles, Cal.
Sunlight Electrical Div., General Motors Corp., 523 Dana Ave., Warren, Ohio
U. S. Electrical Motors, Inc., 200 E. Slauson Ave., Los Angeles, Cal.
Victor Electric Products, Inc., 2950 Robertson Ave., Cincinnati, Ohio
Wagner Electric Corp., 6400 Plymouth Ave., St. Louis, Mo.
Warren Telechron Co., Homer Ave., Ashland, Mass.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
Wincharger Corp., 7th & Division, Sioux City, Ia.

PHONOGRAPH MOTORS

Alliance Mfg. Co., Lake Park Blvd., Alliance, Ohio
Diehl Mfg. Co., Somerville, N. J.
General Electric Co., Schenectady, N. Y.
General Industries Co., Taylor & Olive Sts., Elyria, Ohio
Rotor Corp. of America, 10 Norwood St., Dayton, Ohio

TIMING MOTORS

Alliance Mfg. Co., Alliance, Ohio
Barber-Colman Co., Rockford, Ill.
Bodine Electric Co., 2262 W. Ohio St., Chicago, Ill.
Esterline Angus Co., P. O. Box 596, Indianapolis, Ind.
General Electric Co., Schenectady, N. Y.
Hansen Mfg. Co., Princeton, Ind.
Haydon Mfg. Co., Forestville, Conn.
James Research Laboratories, 2018 Addison St., Chicago, Ill.
Merkle-Korff Gear Co., 213 N. Morgan St., Chicago, Ill.
Lux Clock Co., 95 Johnson St., Waterbury, Conn.
Motorstat Electric Corp., 5005 Euclid Ave., Cleveland, Ohio
New Haven Clock Co., New Haven, Conn.
Ohio Electric Mfg. Co., 5900 Maurice Ave., Cleveland, Ohio
Oster Mfg. Co., of Illinois, Genoa, Ill.
Reynolds Electric Co., 2650 W. Congress St., Chicago, Ill.
Seth Thomas Clock Co., Div. of General Time Instruments Corp., Thomaston, Conn.
Speedway Mfg. Co., 1834 S. 52nd Ave., Cicero, Chicago, Ill.
Victor Electric Products, Inc., 2950 Robertson Ave., Cincinnati, Ohio
Warren Telechron Co., Ashland, Mass.

Mountings

VIBRATION INSULATING MOUNTINGS

Firestone Tire & Rubber Co., 12 S. Main St., Akron, Ohio
Goodrich Co., B. F., 500 S. Main St., Akron, Ohio
Johns-Manville, 22 E. 40th St., New York, N. Y.
Korfund Co., 48-15 32d Pl., Long Island City, N. Y.
Lord Mfg. Co., 1635 W. 12th St., Erie, Pa.
United States Rubber, 1230 6th Ave., New York, N. Y.
Vibration Eliminator Co., 8-22 Astoria Blvd., Astoria, Long Island, N. Y.

Needles

CUTTING NEEDLES

Acton Co., H. W., 370 Seventh Ave., New York, N. Y.
Audio Devices Inc., 1600 Broadway, New York, N. Y.
Capps Co., Frank L., 244 W. 49th St., New York, N. Y.
Duotone Co., 799 Broadway, New York, N. Y.
Eldeen Co., 504 N. Water St., Milwaukee, Wis.
Electrical Industries Mfg. Co., Red Bank, N. J.
Electrovox Co., 169 Maplewood Ave., Maplewood, N. J.
Federal Recorder Co., Elkhart, Ind.
General Phonograph Co., Putnam, Conn.
Gould-Moody Co., 395 Broadway, New York, N. Y.
Howard Radio Co., 1735 Belmont Ave., Chicago, Ill.
Jensen Industries, Inc., 737 N. Michigan Ave., Chicago, Ill.
Montgomery Bros., 61 Fremont St., San Francisco, Calif.
Paraloy Co., 600 S. Michigan Ave., Chicago, Ill.
Permo Products Corp., 6415 Ravenswood Ave., Chicago, Ill.
Phonograph Needle Mfg. Co., 42 Dudley St., Providence, R. I.
Presto Recording Corp., 242 W. 55th St., New York, N. Y.
Rangertone, Inc., 73 Winthrop St., Newark, N. J.
Recordisc Corp., 395 Broadway, New York, N. Y.

PLAY BACK NEEDLES

Acton Co., H. W., 370 Seventh Ave., New York, N. Y.
Audio Devices Inc., 1600 Broadway, New York, N. Y.
Duotone Co., 799 Broadway, New York, N. Y.
Eldeen Co., 504 N. Water St., Milwaukee, Wis.
Electrovox Co., 169 Maplewood Ave., Maplewood, N. J.
General Phonograph Co., Putnam, Conn.
Gerett Corp., M. A., 724 W. Winnebago St., Milwaukee, Wis.
Gould-Moody Co., 395 Broadway, New York, N. Y.
Harris Mfg. Co., 2422 W. Seventh St., Los Angeles, Cal.
Howard Radio Co., 1735 Belmont Ave., Chicago, Ill.
Jensen Industries, Inc., 737 N. Michigan Ave., Chicago, Ill.
Lowell Needle Co., Putnam, Conn.
Mirror Record Corp., 58 W. 25th St., New York, N. Y.
Montgomery Bros., 61 Fremont St., San Francisco, Calif.
Musicraft Records, Inc., 242 W. 55th St., New York, N. Y.
Paraloy Co., 600 S. Michigan Ave., Chicago, Ill.
Permo Products Corp., 6415 Ravenswood Ave., Chicago, Ill.
Pfanstiehl Chemical Co., 105 Lakeview Ave., Waukegan, Ill.
Phonograph Needle Mfg. Co., 42 Dudley St., Providence, R. I.
Presto Recording Corp., 242 W. 55th St., New York, N. Y.
Rangertone, Inc., 703 Winthrop St., Newark, N. J.
Recotone Corp., 21-10 49th St., Long Island City, N. Y.

Nickel

see Metals

Nuts

SELF LOCKING NUTS

An-cor-lox Div., Laminated Shim Co., Union St., Glenbrook, Conn.
Automatic Nut Co., Lebanon, Pa.
Bardwell & McAlister, 7636 Santa Monica Blvd., Hollywood, Calif.
Boots Aircraft Nut Corp., New Canaan, Conn.
Camloc Fastener Co., 420 Lexington Ave., New York, N. Y.
Clark Bros. Bolt Co., Milldale, Conn.
Columbia Nut & Bolt Co., 945 Main St., Bridgeport, Conn.
Drake Lock-Nut Co., 2440 E. 75th St., Cleveland, Ohio
Elastic Stop Nut Corp., 2371 Vauxhall Rd., Union, N. J.
Federal Screw Products Co., 224 W. Huron St., Chicago, Ill.
Industrial Lock Nut Co., South Hanover, Mass.
Palnut Co., 61 Cordier St., Irvington, N. J.
Pittsburgh Screw & Bolt Corp., 2719 Preble Ave., N. S., Pittsburgh, Pa.
Standard Pressed Steel Co., Jenkintown, Pa.
Thompson-Brewer & Co., 1640 W. Hubbard St., Chicago, Ill.
Tinnerman Products, Inc., 2106 Fulton Rd., Cleveland, Ohio
United Carr Fastener, 31 Ames St., Cambridge, Mass.

Optical Equipment

Bausch & Lomb, Rochester, N. Y.
Eastman Kodak Co., Rochester, N. Y.
Mogey & Sons, Inc., William, 76 Interhaven Ave., Plainfield, N. J.
Perkin-Elmer Corp., Glenbrook, Conn.

Photocells

see Tubes

Phototubes

see Tubes

Pickups

INDUSTRIAL PICKUPS

Brush Development Co., 3311 Perkins Ave., Cleveland, Ohio
General Electronic Industries, Div. of Auto Ordnance Corp., 342 Putnam, Greenwich, Conn.

PHONOGRAPH PICKUPS

Astatic Corp., 830 Market St., Youngstown, Ohio
Audak Co., 500 Fifth Ave., New York, N. Y.
Brush Development Co., 3311 Perkins Ave., Cleveland, Ohio
Garrard Sales Corp., 296 Broadway, New York, N. Y.
Presto Recording Corp., 242 W. 55th St., New York, N. Y.
Radio Corp. of America, Camden, N. J.
Webster Electric Co., 1900 Clark St., Racine, Wis.

Plastics

MANUFACTURERS of PLASTICS

American Cyanamid Co., Plastics Div., 30 Rockefeller Plaza, New York, N. Y.
Bakelite Corp., 30 E. 42nd St., New York, N. Y.

Carbide & Carbon Chemicals Corp., 30 E. 42nd St., New York, N. Y.
Catalin Corp., 1 Park Ave., New York, N. Y.
Celanese Celluloid Corp., 180 Madison Ave., New York, N. Y.
Ciba Co., Inc., 627 Greenwich St., New York, N. Y.
Continental-Diamond Fibre Co., 13 Chapel St., Newark, Del.
Dow Chemical Co., Midland, Mich.
DuPont de Nemours & Co., E. I., 626 Schuyler Ave., Arlington, N. J.
Durez Plastics & Chemicals, Inc., 1922 Walck Rd., North Tonawanda, N. Y.
Durite Plastics, Inc., 5010 Summerdale Ave., Philadelphia, Pa.
Federal Telephone & Radio Corp., 591 Broad St., Newark, N. J.
General Electric Co., Plastics Dept., 1 Plastics Ave., Pittsfield, Mass.
Hercules Powder Co., 916 Market St., Wilmington, Del.
Keasby & Mattison Co., Butler Ave., Ambler, Pa.
Makalot Corp., 262 Washington St., Boston, Mass.
Manufacturers Chemical Corp., Berkeley Heights, N. J.
Monsanto Chemical Co., Plastics Div., Springfield, Mass.
Mott-Smith Corp., 1041 M. Esperson Bldg., Houston, Texas
Nixon Nitration Works, Nixon, N. J.
Norton Laboratories, Inc., 520 Mill St., Lockport, N. Y.
Plaskon Co., 2112 Sylvan Ave., Toledo, Ohio
Plax Corp., 133 Walnut St., Hartford, Conn.
Reilly Tar & Chemical Corp., Merchants Bank Bldg., Indianapolis, Ind.
Richardson Co., Lockland, Ohio
Rohm & Haas, 222 Washington Sq., Philadelphia, Pa.
Synthane Corp., Oaks, Pa.
Tennessee Eastman Corp., Kingsport, Tenn.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

MOLDERS of PLASTICS

Accurate Molding Corp., 116 Nassau St., Brooklyn, N. Y.
Alden Products Co., 117 Main St., Brockton, Mass.
American Cyanamid Co., 30 Rockefeller Plaza, New York, N. Y.
American Insulator Corp., New Freedom, Pa.
American Molded Products Co., 1751 N. Honore St., Chicago, Ill.
American Phenolic Corp., 1830 S. 54th Ave., Chicago, Ill.
Auburn Button Works, Inc., 48 Canoga St., Auburn, N. Y.
Blum & Co. Inc., Julius, 532 West 22nd St., New York, N. Y.
Boonton Molding Co., Boonton, N. J.
Brach Mfg. Corp. L. S., 55 Dickerson St., Newark, N. J.
Breeze Corp., 41 S. Sixth St., Newark, N. J.
Bridgeport Molded Products, Inc., 303 Myrtle Ave., Bridgeport, Conn.
Celluplastic Corp., 50 Avenue L, Newark, N. J.
Chicago Molded Products Corp., 1020 N. Kolmar Ave., Chicago, Ill.
Cincinnati Moulding Co., 2037 Florence Ave., Cincinnati, Ohio
Cleveland Plastics, Inc., 1611 East 21st St., Cleveland, Ohio
Colt's Patent Fire Arms Mfg. Co., Plastics Div., Hartford, Conn.
Consolidated Molded Products Corp., 409 Cherry St., Scranton, Pa.
Continental-Diamond Fibre Co., 13 Chapel St., Newark, Del.
Creative Plastics Corp., 975 Kent Ave., Brooklyn, N. Y.
Davies Molding Co., Harry, 1428 N. Wells St., Chicago, Ill.
Dayton Insulating Molding Co., 418 E. First St., Dayton, Ohio
Diemolding Corp., Rasbach St., Canastota, N. Y.
Dimco Plastics, 207 E. 6th St., Dayton, Ohio
Eagle Plastics Corp., 23-10 Bridge Plaza So., Long Island City, N. Y.
Emeloid Co., 291 Laurel Ave., Arlington, N. J.
Erie Resistor Corp., 640 W. 12th St., Erie, Pa.
Formica Insulation Co., 4620 Spring Grove Ave., Cincinnati, Ohio
Franklin Fibre-Lamitex Corp., 12th & French Sts., Wilmington, Del.
Franklin Mfg. Corp., A. W., 175 Varick St., New York, N. Y.
Gemloid Corp., 79-10 Albion Ave., Elmhurst, N. Y.
General Electric Co., Plastics Dept., 1 Plastics Ave., Pittsfield, Mass.
General Laminated Products, Inc., 175 Varick St., New York, N. Y.
Gits Molding Corp., 4600 Huron St., Chicago, Ill.
Imperial Molded Products Corp., 2925 W. Harrison St., Chicago, Ill.
Industrial Synthetics Corp., 60 Woolsey St., Irvington, N. J.
Insel Co., Arlington, N. J.
Insulation Mfg. Co., 11 New York Ave., Brooklyn, N. Y.
Insulation Manufacturers Corp., 565 W. Washington Blvd., Chicago, Ill.
Insulation Products Co., 504 Richland St., Pittsburgh, Pa.
Johns-Manville, 22 E. 40th St., New York, N. Y.
Keasby & Mattison Co., Butler Ave., Ambler, Pa.
Keystone Specialty Co., 1372½ Cove Ave., Cleveland, Ohio
Kuhn & Jacob Moulding & Tool Co., 1200 Southard St., Trenton, N. J.
Kurz-Kasch Co., 1415 S. Broadway, Dayton, Ohio
Mack Molding Co., Wayne, N. J.
Maico Co., Inc., 2632 Nicollet Ave., Minneapolis, Minn.
Meissner Mfg. Co., Mt. Carmel, Ill.
Mica Insulator Co., 200 Varick St., New York, N. Y.
Molded Insulation Co., Aircraft Control Div., 335 E. Price St., Philadelphia, Pa.
Monowatt Electric Corp., 66 Bissell St., Providence, R. I.
Northern Industrial Chemical Co., 11 Elkins St., Boston, Mass.
Oris Mfg. Co., Thomaston, Conn.
Poinsetta Inc., 95 Cedar Ave., Pitman, N. J.
Precision Fabricators, Inc., Rochester, N. Y.
Printloid, Inc., 95 Mercer St., New York, N. Y.
Recto Molded Products, Appleton St. & B. & O. R. R., Cincinnati, Ohio
Remler Co., 2101 Bryant St., San Francisco, Calif.
Resinous Products & Chemical Co., 222 W. Washington Sq., Philadelphia, Pa.
Resistoflex Corp., 39 Plansden St., Belleville, N. J.
Reynolds Spring Co., Molded Plastics Div., Reynolds Bldg., Jackson, Mich.
Richardson Co., Lockland, Ohio
Rogan Brothers, 2001 S. Michigan Ave., Chicago, Ill.
Rohn & Haas, 222 W. Washington Sq., Philadelphia, Pa.
Royal Moulding Co., 69 Gordon Ave., Providence, R. I.
Specialty Insulation Mfg. Co., Center St., Hoosick Falls, N. Y.
Standard Molding Corp., Dayton, Ohio
Stokes Rubber Co., Jos., Taylor & Webster Sts., Trenton, N. J.
Syracuse Ornamental Co., 581 So. Clinton St., Syracuse, N. Y.
Taylor Fibre Co., Norristown, Pa.
Tech-Art Plastics Co., 41-01 36th Ave., Long Island City, N. Y.
Telex Products Co., Telex Park, Minneapolis, Minn.
Terkelsen Machine Co., 326 A St., Boston, Mass.
Universal Plastics Corp., 235 Jersey Ave., New Brunswick, N. J.
Varflex Corp., N. Jay St., Rome, N. Y.
Waterbury Button Co., 835 S. Main St., Waterbury, Conn.
Watertown Mfg. Co., 3 Porter St., Watertown, Conn.
Western Felt Works, 4029 Ogden Ave., Chicago, Ill.
Western Lithograph Co., 2nd St., Los Angeles, Calif.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

Plastics Marking and Metal Machines

Ansonia Clock Co., Inc., 103 Lafayette St., New York, N. Y.
Becker Bros. Engraving Co., 103 Lafayette St., New York, N. Y.
Eastern Etching & Mfg. Co., Chicopee, Mass.
Markem Machine Co., Keene, N. H.
Mico Instrument Co., 10 Arrow St., Cambridge, Mass.
Rogan Bros., 2003 S. Michigan Ave., Chicago, Ill.
Rohden Mfg. Co., 1753 N. Honore St., Chicago, Ill.

Plugs

TERMINAL PLUGS

see also Jacks

Alradio, Inc., Melrose Ave. & Battery Place, Stamford, Conn.
Alden Products Co., 117 Main St., Brockton, Mass.
American Phenolic Corp., 1830 S. 54th Ave., Chicago, Ill.
American Radio Hardware Co., Inc., 476 Broadway, New York, N. Y.
Audio Development Co., 2833 13th Ave. S., Minneapolis, Minn.
Automatic Electric Co., 1033 W. Van Buren St., Chicago, Ill.
Birnbach Radio Co., 145 Hudson St., New York, N. Y.
Bud Radio, Inc., 2118 E. 55th St., Cleveland, Ohio
Cannon Electric Development Co., 3209 Humboldt St., Los Angeles, Cal.
Cinch Mfg. Corp., 2335 W. Van Buren St., Chicago, Ill.
Connecticut Telephone & Electric Div., Great American Industries, Inc., 70 Brittania St., Meriden, Conn.
Eby, Inc., Hugh H., 18 W. Chelton Ave., Philadelphia, Pa.
Federal Mfg. & Engrg. Corp., 199 Steuben St., Brooklyn, N. Y.
Franklin Mfg. Corp., A. W., 175 Varick St., New York, N. Y.
General Radio Co., 30 State St., Cambridge, Mass.
Insuline Corp. of America, 36-02 35th Ave., Long Island City, N. Y.
Johnson Co., E. F., Waseca, Minn.
J. F. D. Mfg. Co., 4111 Fort Hamilton Pkway, Brooklyn, N. Y.
Jones, Howard B., 2300 Wabansia Ave., Chicago, Ill.
Kellogg Switchboard & Supply Co., 6650 S. Cicero Ave., Chicago, Ill.
Mallory & Co., P. R., 3029 E. Washington St., Indianapolis, Ind.
Monowatt Electric Corp., 66 Bissell St., Providence, R. I.
National Co., 61 Sherman St., Malden, Mass.
Philmore Mfg. Co., 113 University Place, New York, N. Y.
Precision Specialties, 220 No. Western Ave., Los Angeles, Calif.
Pyle-National Co., 1334 N. Kostner Ave., Chicago, Ill.
Remler Co., Ltd., 2101 Bryant St., San Francisco, Calif.
Telephonics Corporation, 350 West 31st St., New York, N. Y.
Trav-Ler Karenola Radio & Television Corp., 1028 W. Van Buren St., Chicago, Ill.
Ucinite Co., 459 Watertown St., Newtonville, Mass.
Universal Microphone Co., 424 Warren Lane, Inglewood, Calif.
Utah Radio Products Co., 820 Orleans St., Chicago, Ill.
Wood Electric Co., C. D., 826 Broadway, New York, N. Y.

Pointers

DIAL POINTERS

see also Knobs
also Dials

American Emblem Co., Utica, N. Y.
American Radio Hardware Co., Inc., 476 Broadway, New York, N. Y.
Bud Radio, Inc., 2118 E. 55th St., Cleveland, Ohio
Crowe Name Plate & Mfg. Co., 3701 Ravenswood Ave., Chicago, Ill.
Grammes & Sons, Inc., L. F., 366 Union St., Allentown, Pa.
Insuline Corp. of America, 36-02 35th Ave., Long Island City, N. Y.
Liberty Engraving & Mfg. Co., 2911 S. Central Ave., Los Angeles, Cal.
Radio City Products Co., 127 W. 26th St., New York, N. Y.

Points

CONTACT POINTS and ASSEMBLIES

American Platinum Works, New Jersey R. R. Ave. at Oliver St., Newark, N. J.

Baker & Co., 113 Astor St., Newark, N. J.
Bishop & Co., Platinum Works, J., 12 Channing Ave., Malvern, Pa.
Brainin Co., C. S., 233 Spring St., New York, N. Y.
Callite Tungsten Corp., 544 39th St., Union City, N. J.
Cleveland Tungsten, Inc., 10200 Meech Ave., Cleveland, Ohio
Fansteel Metallurgical Corp., 2200 Sheridan Rd., North Chicago, Ill.
General Plate Div., Metals & Controls Corp., 34 Forest St., Attleboro, Mass.
General Tungsten Mfg. Co., 502 23d St., Union City, N. J.
Gibson Electric Co., 8350 Frankstown Ave., Pittsburgh, Pa.
Independent Contact Mfg. Co., 540 39th St., Union City, N. J.
Mallory & Co., P. R., 3029 E. Washington St., Indianapolis, Ind.
Metroloy Co., 57 E. Alpine St., Newark, N. J.
Noble Co., F. H., 535 West 59th St., Chicago, Ill.
Speer Carbon Co., St. Mary's, Pa.
Tungsten Contact Mfg. Co., North Bergen, N. J.
Wilson Co., H. A., 105 Chestnut St., Newark, N. J.

Porcelain

see Insulation—Ceramic

Posts

BINDING POSTS and TERMINALS

Accurate Molding Corp., 116 Nassau St., Brooklyn, N. Y.
Alden Products Co., 117 Main St., Brockton, Mass.
American Brass Co., Waterbury, Conn.
American Radio Hardware Co., Inc., 476 Broadway, New York, N. Y.
Automatic Electric Co., 1033 W. Van Buren St., Chicago, Ill.
Birnbach Radio Co., 145 Hudson St., New York, N. Y.
Bud Radio, Inc., 2118 E. 55th St., Cleveland, Ohio
Burke Electric Co., 12th & Cranberry St., Erie, Pa.
Burndy Engineering Co., Inc., 107 Eastern Blvd., New York, N. Y.
Cannon Electric Development Co., 3209 Humboldt St., Los Angeles, Calif.
Chase Brass & Copper Co., Waterbury, Conn.
Cinch Mfg. Corp., 2335 W. Van Buren St., Chicago, Ill.
Cinema Engineering Co., 1508 S. Verdugo Ave., Burbank, Calif.
Creative Plastics Corp., 975 Kent Ave., Brooklyn, N. Y.
Curtis Development & Mfg. Co., 1 N. Crawford Ave., Chicago, Ill.
Doran & Sons, James C., 150 Chestnut St., Providence, R. I.
Eby, Inc., Hugh H., 18 W. Chelton Ave., Philadelphia, Pa.
Fahnestock Electric Co., 46-44 11th St., Long Island City, N. Y.
Franklin Mfg. Corp., A. W., 175 Varick St., New York, N. Y.
Industrial Screw & Supply Co., 713 W. Lake St., Chicago, Ill.
Insuline Corp. of America, 36-02 35th Ave., Long Island City, N. Y.
Jones, Howard B., 2300 Wabansia Ave., Chicago, Ill.
Kellogg Switchboard & Supply Co., 6650 S. Cicero Ave., Chicago, Ill.
Kulka Electric Mfg. Co., Inc., 30 South St., Mt. Vernon, N. Y.
Mallory & Co., P. R., 3029 E. Washington St., Indianapolis, Ind.
Manufacturers Screw Products, 216 W. Hubbard St., Chicago, Ill.
Meter Devices Co., 1001 Prospect Ave., S. W., Canton, Ohio
Millen Mfg. Co., James, 150 Exchange St., Malden. Mass.
Northern Industrial Chemical Co., 7-11 Elkins St., Boston, Mass.
Patton-MacGuyer Co., 17 Virginia Ave., Providence, R. I.
Precision Specialties, 220 No. Western Ave., Los Angeles, Calif.
Radex Corp., 1322 Elston Ave., Chicago, Ill.
Rice's Sons, Inc., Bernard, 325 5th Ave., New York, N. Y.
Richards Co., Inc., Arklay S., 72 Winchester St., Newton Highland, Mass.
Rohden Mfg. Co., 1753 N. Honore St., Chicago, Ill.
States Co., 19 New Park Ave., Hartford, Conn.

Potentiometers

see Variable Resistors

Power Supplies

Altec Lansing Corp., 1680 N. Vine St., Los Angeles, Calif.
American Instrument Co., 8030 Georgia Ave., Silver Spring, Md.
American Television & Radio Co., 300 E. Fourth St., St. Paul, Minn.
American Transformer Co., 178 Emmet St., Newark, N. J.
Amplifier Co. of America, 17 West 20th St., New York, N. Y.
Automatic Electric Co., 1033 W. Van Buren St., Chicago, Ill.
Barber Labs, Alfred W., 34-04 Francis Lewis Blvd., Flushing, Long Island, N. Y.
Benwood Linze Co., 1815 Locust St., St. Louis, Mo.
Communication Equipment Co., 134 Colorado St., Pasadena, Calif.
Communication Measurements Laboratory, 120 Greenwich St., New York, N. Y.
Consolidated Engineering Corp., 1255 E. Green St., Pasadena, Calif.
Electronic Laboratories, Inc., Indianapolis, Ind.
Electronic Products Co., 19 North First St., Geneva, Ill.
Espey Mfg. Co., 305 East 63rd St., New York, N. Y.
Fisher Research Laboratory, 1961 University Ave., Palo Alto, Calif.
Gates Radio Co., 220 Hampshire St., Quincy, Ill.
General Electric Co., Bridgeport, Conn.
General Transformer Corp., 1250 Van Buren St., Chicago, Ill.
Hamilton Radio Corp., 510 Sixth Ave., New York, N. Y.
Harvey-Wells Communications, Inc., North St., Southbridge, Mass.
Herbach & Rademan Co., 522 Market St., Philadelphia, Pa.
Mellaphone Corp., 714 University Ave., Rochester, N. Y.
Metron Instrument Co., 432 Lincoln St., Denver, Colo.
Radiotechnic Laboratory, 1328 Sherman Ave., Evanston, Ill.
Ward Leonard Electric Co., Mount Vernon, N. Y.

Rectifiers

see also Tubes

DRY DISC RECTIFIERS

American Battery Co., 17 S. Jefferson St., Chicago, Ill.
Arlavox Mfg. Co., 5042 Cottage Grove, Chicago, Ill.
Automatic Electric Co., 1033 W. Van Buren St., Chicago, Ill.
Benwood Linze Co., 1815 Locust St., St. Louis, Mo.
Bradley Labs, Inc., 82 Meadow St., New Haven, Conn.
Bunnell & Co., J. H., 215 Fulton St., New York, N. Y.
Electrical Transformer Co., 417 Canal St., New York, N. Y.
Electron Equipment Corp., Palm Springs, Calif.
Fansteel Metallurgical Corp., 2200 Sheridan Rd., North Chicago, Ill.
Federal Telephone and Radio Corp., 591 Broad St., Newark, N. J.
Ferranti Electric Co., 30 Rockefeller Plaza, New York, N. Y.
General Electric Co., Bridgeport, Conn.
General Radio Co., 30 State St., Cambridge, Mass.
Gould Storage Battery Corp., 35 Neoga St., Depew, N. Y.
Jeffrey Mfg. Co., 4th at 1st Ave., Columbus, Ohio
Mallory & Co., P. R., 3029 E. Washington St., Indianapolis, Ind.
Selenium Corp. of America, 1800 W. Pico Blvd., Los Angeles, Calif.
Standard Transformer Corp., 1500 N. Halsted St., Chicago, Ill.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J.

Rectifiers, Tube

Acme Electric & Mfg. Co., 1444 Hamilton Ave., Cleveland, Ohio
Allis Chalmers Mfg. Co., Milwaukee, Wisc.
American Battery Co., 17 S. Jefferson St., Chicago, Ill.
Automatic Electric Co., 1033 W. Van Buren St., Chicago, Ill.
Baldor Electric Co., St. Louis, Mo.
Eitel-McCullough, Inc., San Bruno, Calif.
Electric Heat Control Co., 9123 Inman Ave., Cleveland, Ohio
Electro Product Laboratories, 549 W. Randolph St., Chicago, Ill.
Electrons, Inc., 127 Sussex Ave., Newark, N. J.
Eureka X-Ray Tube Corp., 3250 N. Kilpatric Ave., Chicago, Ill.
Federal Telephone and Radio Corp., 591 Broad St., Newark, N. J.
France Mfg. Co., 10325 Berea Rd., Cleveland, Ohio
General Electric Co., Bridgeport, Conn.
Kalb Electric Co., 2711 Big Bend Blvd., St. Louis, Mo.
Mellaphone Corp., 65 Atlantic Ave., Rochester, N. Y.
Mohawk Electric Mfg. Co., 62 Howard St., Irvington, N. J.
Pier Equipment Mfg. Co., Benton Harbor, Mich.
Radio Corp. of America, Camden, N. J.
Raytheon Mfg. Co., 190 Willow St., Waltham, Mass.
Schuttig & Co., 9th & Kearney Sts. N. E., Washington, D. C.
Selenium Corp. of America, 1800 West Pico Blvd., Los Angeles, Calif.
Valley Electric Corp., 4221 Forest Park Blvd., St. Louis, Mo.
Weltronic Co., 20735 Grand River Ave., Detroit, Mich.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Regulators

see also Transformers
also Tubes

VOLTAGE REGULATORS and STABILIZERS

Acme Electric & Mfg. Co., 31 Water St., Cuba, N. Y.
Aerolux Light Corp., 653 Eleventh Ave., New York, N. Y.
American Transformer Co., 178 Emmet St., Newark, N. J.
Avia Products Co., 749 N. Highland, Los Angeles, Cal.
Burlington Instrument Corp., 316 Valley St., Burlington, Iowa
Clark Controller Co., 1146 E. 152d St., Cleveland, Ohio
Clarostat Mfg. Co., 287 N. Sixth St., Brooklyn, N. Y.
Control Corp., 600 Stinson Blvd., Minneapolis, Minn.
Eclipse Aviation Div. of Bendix Aviation Corp., Bendix, N. J.
Electric Sorting Machine Co., 802 Michigan Trust Bldg., Grand Rapids, Mich.
Electron Equipment Corp., Palm Springs, Calif.
Electronic Products Co., 19 North 1st St., Geneva, Ill.
Ferranti Electric, 30 Rockefeller Plaza, New York, N. Y.
Freed Transformer Co., 72 Spring St., New York, N. Y.
General Electric Co., Schenectady, N. Y.
General Electronic Industries, Div. of Auto Ordnance Corp., 342 Putnam, Greenwich, Conn.
Halldorson Co., 4500 Ravenswood Ave., Chicago, Ill.
Leland Electric Co., 1501 Webster St., Dayton, Ohio
Miller Co., Bertrand F., Trenton, N. J.
Raytheon Mfg. Co., 190 Willow St., Waltham, Mass
Radio Corp. of America, Camden, N. J.
Skaggs Transformer Co., 5894 Broadway, Los Angeles, Cal.
Sola Electric Co., 2525 Clybourn Ave., Chicago, Ill.
Standard Transformer Corp., 1500 N. Halsted St., Chicago, Ill.

Sundt Engrg. Co., 4757 Ravenswood Ave., Chicago, Ill.
Superior Electric Co., 83 Laurel St., Bristol, Conn.
Thordarson Electric Mfg. Co., 500 W. Huron St., Chicago, Ill.
United Transformer Co., 150 Varick St., New York, N. Y.
Ward Leonard Electric Co., 31 South St., Mount Vernon, N. Y.
Wirt Co., 5221 Greene St., Philadelphia, Pa.

Relays

HEAVY DUTY RELAYS

Adams & Westlake Co., Michigan St., Elkhart, Ind.
Advance Electric Co., 1260 W. 2nd St. Los Angeles, Calif.
Allied Control Co., Inc., 2 East End Ave., New York, N. Y.
American Instrument Co., 8010 Georgia Ave., Silver Spring, Md.
Automatic Electric Co., 1033 W. Van Buren St., Chicago, Ill.
Arrow-Hart & Hegeman Electric Co., 103 Hawthorne St., Hartford, Conn.
Autocall Co., 1142 Tucker Ave., Shelby, Ohio
Automatic Switch Co., 41 E. 11th St., New York, N. Y.
Dunn, Inc., Struthers, 1321 Arch St., Philadelphia, Pa.
General Controls Co., 801 Allen Ave., Glendale, Cal.
General Electric Co., Schenectady, N. Y.
General Electronic Industries, Div. of Auto Ordnance Corp., 342 Putnam, Greenwich, Conn.
Hagan Corp., George J., 2400 E. Carson St., Pittsburgh, Pa.
H-B Electric Co., 6122 North 21st St., Philadelphia, Pa.
Kurman Electric Co., 3030 Northern Blvd., Long Island City, N. Y.
Miller Co., Bertrand F., Trenton, N. J.
Monitor Controller Co., 51 S. Gay St., Baltimore, Md.
Penn Electric Switch Co., Goshen, Ind.
Philadelphia Thermometer Co., 6th & Cayuga Sts., Philadelphia, Pa.
Signal Engrg. & Mfg. Co., 154 W. 14th St., New York, N. Y.
Ward Leonard Electric Co., 31 South St., Mount Vernon, N. Y.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J.
Zenith Electric Co., 152 W. Walton St., Chicago, Ill.

MERCURY RELAYS

American Instrument Co., 8010 Georgia Ave., Silver Spring, Md.
Autocall Co., 1142 Tucker Ave., Shelby, Ohio
Automatic Electric Co., 1033 W. Van Buren St., Chicago, Ill.
Brown Instrument Co., 4428 Wayne Ave., Philadelphia, Pa.
Dunn, Inc., Struthers, 1321 Arch St., Philadelphia, Pa.
Durakool, Inc., 1010 N. Main St., Elkhart, Ind.
Guardian Electric Mfg. Co., 1621 W. Walnut St., Chicago, Ill.
H-B Electric Co., Inc., 6122 N. 21st St., Philadelphia, Pa.
Littelfuse, Inc., 4755 Ravenswood Ave., Chicago, Ill.
Mercoid Corp., 4201 Belmont Ave., Chicago, Ill.
Minneapolis-Honeywell Regulator Co., 2753 Fourth Ave., S., Minneapolis, Minn.
Philadelphia Thermometer Co., 6th & Cayuga Sts., Philadelphia, Pa.
Precision Thermometer & Instrument Co., 1434 Brandywine St., Philadelphia, Pa.
Presto Electric Co., 4511 New York Ave., Union City, N. J.
Ward-Leonard Electric Co., 31 South St., Mount Vernon, N. Y.

POLARIZED RELAYS

Automatic Electric Co., 1033 W. Van Buren St., Chicago, Ill.
Autocall Co., 1142 Tucker Ave., Shelby, Ohio
Dunn, Inc., Struthers, 1321 Arch St., Philadelphia, Pa.
Edison, Inc., Thomas A., Instrument Div., 51 Lakeside Ave., West Orange, N. J.
Kellogg Switchboard & Supply Co., 6650 S. Cicero Ave., Chicago Ill.
L A B Corp., Summit, N. J.
Precision Thermometer & Instrument Co., 1434 Brandywine St., Philadelphia, Pa.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

SENSITIVE CONTROL RELAYS

Adams & Westlake Co., Michigan St., Elkhart, Ind.
Advance Electric Co., 1260 W. Second St., Los Angeles, Cal.
Allen-Bradley Co., 136 W. Greenfield Ave., Milwaukee, Wisc.
Allied Control Co., Inc., 2 East End Ave., New York, N. Y.
American Instrument Co., Silver Spring, Md.
Apex Industry, 1035 Lake St., Chicago, Ill.
Arrow-Hart & Hegeman Elec. Co., Hartford, Conn.
Autocall Co., 1142 Tucker Ave., Shelby, Ohio
Automatic Electric Co., 1033 W. Van Buren St., Chicago, Ill.
Automatic Temperature Co. Inc., 34 E. Logan St., Chicago, Ill.
Bank's Mfg. Co., 1105 W. Lawrence Ave., Chicago, Ill.
Birtcher Corp., 5087 Huntington Drive, Los Angeles, Cal.
Bunnell & Co., J. H., 215 Fulton St., New York, N. Y.
Clare & Co., C. P., 4719 Sunnyside Ave., Chicago, Ill.
Colt's Patent Fire Arms Mfg. Co., 1429 Park St., Hartford, Conn.
Davis & Co., Inc., Dean W., 549 Fulton St., Chicago, Ill.
Dunn, Inc., Struthers, 1321 Arch St., Philadelphia, Pa.
Electro Units Supply Co., 4203 W. Fullerton Ave., Chicago, Ill.
Etna Electric Works, 410 East 15th St., New York, N. Y.
G-M Laboratories, Inc., 4313 N. Knox Ave., Chicago, Ill.
General Controls Co., 801 Allen Ave., Glendale, Calif.
General Electric Co., Schenectady, New York.
General Electronic Industries, Div. Auto Ordnance Corp., 342 Putnam, Greenwich, Conn.
Guardian Electric Mfg. Co., 1621 W. Walnut St., Chicago, Ill.
H-B Electric Co. Inc., 6122 North 21st St., Philadelphia, Pa.
Hart Mfg. Co., 110 Bartholomew Ave., Hartford, Conn.
Jennings Radio Mfg. Co., San Jose, Cal.
Kurman Electric Co., 241 Lafayette St., New York, N. Y.
Leach Relay Company, 5915 Avalon Blvd., Los Angeles, Calif.
Mossman, Inc., Donald P., 6133 Northwest Highway, Chicago, Ill.
Muter Co., 1255 S. Michigan Ave., Chicago, Ill.
Potter & Brumfield Mfg. Co., Princeton, Ind.
Precision Thermometer & Instrument Co., 1434 Brandywine St., Philadelphia, Pa.
R.B.M. Mfg. Co., Div. of Essex Wire Corp., 1601 Wall St., Fort Wayne, Ind.
Sigma Instruments, Inc., 78 Freeport St., Dorchester, Mass.
Signal Engrg. & Mfg. Co., 154 W. 14th St., New York, N. Y.
Smith Mfg. Co., Inc., Nathan R., 105 Pasadena Ave., Pasadena, Cal.
Standard Electrical Products Co., 300 East 4th St., St. Paul, Minn.
Warwick Co., Chas F., 16251 Hamilton Ave., Detroit, Mich.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J.

STEPPING RELAYS

Advance Electric Co., 1260 W. Second St., Los Angeles, Cal.
Automatic Electric Co., 1033 W. Van Buren St., Chicago, Ill.
Autocall Co., 1142 Tucker Ave., Shelby, Ohio
Dunn, Inc., Struthers, 1321 Arch St., Philadelphia, Pa.
Guardian Electric Mfg. Co., 1621 W. Walnut St., Chicago, Ill.
Presto Electric Co., 4511 New York Ave., Union City, N. J.

TELEPHONE RELAYS

Autocall Co., 1142 Tucker Ave., Shelby, Ohio
Automatic Electric Co., 1033 W. Van Buren St., Chicago, Ill.
Clare & Co., C. P., Lawrence & Lamon Aves., Chicago, Ill.
Dunn, Inc., Struthers, 1321 Arch St., Philadelphia, Pa.
Kellogg Switchboard & Supply Co., 6650 S. Cicero Ave., Chicago, Ill.
Kurman Electric Co., 3030 Northern Blvd., Long Island City, N. Y.
Leach Relay Co., 5915 Avalon Blvd., Los Angeles, Cal.
Presto Electric Co., 4511 New York Ave., Union City, N. J.
Western Electro-Mechanical Co., 300 Broadway, Oakland, Cal.

TIME DELAY RELAYS

Adams & Westlake Co., Michigan St., Elkhart, Ind.
Advance Electric Co., 1260 W. Second St., Los Angeles, Calif.
Allen-Bradley Co., 136 W. Greenfield Ave., Milwaukee, Wisc.
American Gas Accumulator Co., 1029 Newark Ave., Elizabeth, N. J.
Amperite Co., 561 Broadway, New York, N. Y.
Autocall Co., 1142 Tucker Ave., Shelby, Ohio
Automatic Electric Co., 1033 W. Van Buren St., Chicago, Ill.
Automatic Temperature Control Co., 34 E. Logan St., Philadelphia, Pa.
Betts & Betts Corp., 551 W. 52nd St., New York, N. Y.
Clare & Co., C. P., 4719 Sunnyside Ave., Chicago, Ill.
Clark Controller Co., 1146 E. 152nd St., Cleveland, Ohio
Controls, Inc., Towaco, N. J.
Cramer Co., R. W., Centerbrook, Conn.
Dayton Acme Co., 930 York St., Cincinnati, Ohio
Dunn, Inc., Struthers, 1321 Arch St., Philadelphia, Pa.
Eagle Signal Corp., Moline, Ill.
Edison, Inc., Thomas A., Instrument Div., 51 Lakeside Ave., West Orange, N. J.
Electronic Products Co., 19 North 1st St., Geneva, Ill.
General Electric Co., Schenectady, N. Y.
General Electronic Industries, 342 Putnam, Greenwich, Conn.
Gibbs & Co., Thomas B., Div. of George W. Borg Corp., 814 Michigan St., Delavan, Wisc.
Guardian Electric Mfg. Co., 1621 W. Walnut St., Chicago, Ill.
Hayden Mfg. Co., Forestville, Conn.
Kurman Electric Co., 3030 Northern Blvd., Long Island City, N. Y.
Magnetic Gauge Co., 63 E. Bartges St., Akron, Ohio
Monitor Controller Co., 51 S. Gay St., Baltimore, Md.
Paragon Electric Co., 37 W. Van Buren St., Chicago, Ill.
Partlow Corp., New Hartford, N. Y.
Photobell Corp., 116 Nassau St., New York, N. Y.
Photovolt, 95 Madison Ave., New York, N. Y.
Precision Thermometer & Instrument Co., 1434 Brandywine St., Philadelphia, Pa.
Presto Electric Co., 4511 New York Ave., Union City, N. J.
Rehtron Corp., 2159 Magnolia Ave., Chicago, Ill.
Signal Engrg. & Mfg. Co., 154 W. 14th St., New York, N. Y.
Spencer Thermostat Co., 34 Forest St., Attleboro, Mass.
Ward Leonard Electric Co., 31 South St., Mount Vernon, N. Y.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
White-Rodgers Electric Co., 1209 Cass Ave., St. Louis, Mo.
Zenith Electric Co., 152 W. Walton St., Chicago, Ill.

VACUUM CONTACT RELAYS

Automatic Electric Co., 1033 W. Van Buren St., Chicago, Ill.

Bendix Aviation, Ltd., North Hollywood, Cal.
Edison, Inc., Thomas A., Instrument Div., 51 Lakeside Ave., West Orange, N. J.
General Electric Co., Schenectady, N. Y.
General Electronic Industries, 342 Putnam, Greenwich, Conn.

Resistors

COMPOSITION FIXED RESISTORS

Acme Electric Heating Co., 1217 Washington St., Boston, Mass.
Aerovox Corp., 740 Belleville Ave., New Bedford, Mass.
Allen-Bradley Co., 136 W. Greenfield Ave., Milwaukee, Wisc.
Atlas Resistor Co., 423 Broome St., New York, N. Y.
Automatic Electric Co., 1033 W. Van Buren St., Chicago, Ill.
Centralab, 900 E. Keefe Ave., Milwaukee, Wisc.
Clarostat Mfg. Co., 287 N. Sixth St., Brooklyn, N. Y.
Continental Carbon Inc., 13900 Lorain Ave., Cleveland, Ohio
Cutler-Hammer, Inc., 1401 W. St. Paul Ave., Milwaukee, Wisc.
Daven Co., 158 Summit St., Newark, N. J.
Erie Resistor, 640 W. 12 St., Erie, Pa.
General Electric Co., Schenectady, N. Y.
Globar Div. Carborundum Co., Buffalo Ave., Niagara Falls, N. Y.
Hardwick Hindle Inc., 40 Hermon St., Newark, N. J.
Instrument Resistors Co., Little Falls, N. J.
International Resistance Co., 401 N. Broad St., Philadelphia, Pa.
Keystone Carbon Co., Inc., 1935 State St., St. Mary's, Pa.
Lectrohm, Inc., 5127 West 25th St., Cicero, Ill.
Mallory & Co., Inc., 3029 E. Washington St., Philadelphia, Pa.
Monitor Controller Co., 51 S. Gay St., Baltimore, Md.
Muter Co., 1255 S. Michigan St., Chicago, Ill.
Ohio Carbon Co., 12508 Berea Rd., Cleveland, Ohio
Ohmite Manufacturing Co., 4835 W. Flournoy St., Chicago, Ill.
Precision Resistor Co., 334 Badger Ave., Newark, N. J.
Rex Rheostat Co., 3 Foxhurst Rd., Baldwin, N. Y.
Schaefer Bros. Co., 1059 W. 11th St., Chicago, Ill.
Sensitive Research Instrument Corp., 9-11 Elm Ave., Mt. Vernon, N. Y.
Shallcross Mfg. Co., 10 Jackson Ave., Collingdale, Pa.
Speer Resistor Corp., St. Mary's, Pa.
Sprague Specialties Co., North Adams, Mass.
Stackpole Carbon Co., Tannery St., St. Mary's, Pa.
States Co., 19 New Park Ave., Hartford, Conn.
Tuttle & Co., H. W., 261 W. Maumee St., Adrian, Mich.
Ward Leonard Electric Co., 31 South St., Mt. Vernon, N. Y.
White Dental Manufacturing Co., S. S. (Industrial Div.) 10 E. 40th St., New York, N. Y.
Wirt Co., 5221 Greene St., Philadelphia, Pa.

WIRE WOUND RESISTORS

Aerovox Corp., 740 Belleville Ave., New Bedford, Mass.
Atlas Resistor Co., 423 Broome St., New York, N. Y.
Automatic Electric Co., 1033 W. Van Buren St., Chicago, Ill.
Beck Bros., 421 Sedgley Ave., Philadelphia, Pa.
Cinema Engineering Co., 1508 S. Verdugo Ave., Burbank, Calif.
Continental Carbon, Inc., 13900 Lorain Ave., Cleveland, Ohio
Cutler-Hammer, Inc., 1401 W. St. Paul Ave., Milwaukee, Wisc.
Daven Co., 158 Summit St., Newark, N. J.
General Radio Co., 30 State St., Cambridge, Mass.
Gray Instrument Co., 64 W. Johnson St., Philadelphia, Pa.
Hardwick Hindle, Inc., 40 Hermon St., Newark, N. J.
Instrument Resistors, Inc., 25 Amity St., Little Falls, N. J.
International Resistance Co., 401 N. Broad St., Philadelphia, Pa.
Lectrohm, Inc., 5133 W. 25th Pl., (Cicero) Chicago, Ill.
Leeds & Northrup Co., 4970 Stenton Ave., Philadelphia, Pa.
Micamold Radio Corp., 1087 Flushing Ave., Brooklyn, N. Y.
Muter Co., 1255 S. Michigan Ave., Chicago, Ill.
National Electric Controller Co., 5307 Ravenswood Ave., Chicago, Ill.
Ohio Carbon Co., 12508 Berea Rd., Cleveland, Ohio
Ohmite Mfg. Co., 4835 W. Flournoy St., Chicago, Ill.
Precision Resistor Co., 334 Badger Ave., Newark, N. J.
Presto Electric Co., 4511 New York Ave., Union City, N. J.
Rex Rheostat Co., 3 Foxhurst Rd., Baldwin, N. Y.
Shallcross Mfg. Co., 10 Jackson Ave., Collingdale, Pa.
Sprague Specialties Co., 189 Beaver St., North Adams, Mass.
Triplett Electrical Instrument Co., 286 Harmon Rd., Bluffton, Ohio
Utah Radio Products Co., 820 Orleans St., Chicago, Ill.
Vasco Electrical Mfg. Co., 4116 Avalon Blvd., Los Angeles, Calif.
Ward Leonard Electric Co., 31 South St., Mount Vernon, N. Y.
White Dental Mfg. Co., S. S. 10 E. 40th St., New York, N. Y.
Wirt Co., 5221 Greene St., Philadelphia, Pa.

VARIABLE RESISTORS.

Potentiometers and Rheostats

Acme Electric Heating Co., 1217 Washington St., Boston, Mass.
Aerovox Corp., 740 Belleville Ave., New Bedford, Mass.
Allen-Bradley Co., 136 W. Greenfield Ave., Milwaukee, Wisc.
American Instrument Co., 8030 Georgia Ave., Silver Springs, Md.
Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland, Ohio
Beck Bros., 421 Sedgley Ave., Philadelphia, Pa.
Biddle Co., James G., 1213 Arch St., Philadelphia, Pa.
Bristol Co., Waterbury, Conn.
Brown Instrument Co., 4428 Wayne Ave., Philadelphia, Pa.
Centralab, 900 E. Keefe Ave., Milwaukee, Wisc.
Central Scientific Co., 1700 Irving Park Rd., Chicago, Ill.
Chicago Apparatus Co., 1735 N. Ashland Ave., Chicago, Ill.
Chicago Telephone Supply Co., 1142 W. Beardsley Ave., Elkhart, Ind.
Clarostat Mfg. Co., 285 N. 6th St., Brooklyn, N. Y.
Continental Carbon, Inc., 13900 Lorain Ave., Cleveland, Ohio
DeJur-Amsco Corp., 6 Bridge St., Sheldon, Conn.
Eastern Specialty Co., 3619 N. Eighth St., Philadelphia, Pa.
Foxboro Co., Neponset Ave., Foxboro, Mass.
G-M Laboratories, Inc., 4313 N. Knox Ave., Chicago, Ill.
General Electric Co., Schenectady, New York
General Radio Co., 30 State St., Cambridge, Mass.
Gray Instrument Co., 64½ W. Johnson St., Philadelphia, Pa.
Hardwick, Hindle, Inc., 40 Hermon St., Newark, N. J.
International Resistance Co., 401 N. Broad St., Philadelphia, Pa.
J-B-T Instruments, Inc., 441 Chapel St., New Haven, Conn.
Leeds & Northrup Co., 4970 Stenton Ave., Philadelphia, Pa.
Lewis Engineering Co., Naugatuck, Conn.
Mallory & Co., P. R., 3029 E. Washington St., Indianapolis, Ind.
Mossman, Inc., Donald P., 6133 Northwest Highway, Chicago, Ill.
National Electric Controller Co., 5307 Ravenswood Ave., Chicago, Ill.
National Technical Laboratories, 820 Mission St., South Pasadena, Calif.
Ohio Carbon Co., 12508 Berea Rd., Cleveland, Ohio
Ohmite Manufacturing Co., 4835 W. Flournoy St., Chicago, Ill.
Mason-Neilan Regulator Co., 1190 Adams St., Boston, Mass.
Rex Rheostat Co., 3 Foxhurst Rd., Baldwin, N. Y.
Rowe Radio Research Laboratory Co., 2422 N. Pulaski Rd., Chicago, Ill.
Rubicon Co., 3751 Ridge Ave., Philadelphia, Pa.
Schaefer Bros. Co., 1059 W. 11th St., Chicago, Ill.
Shallcross Mfg. Co., 10 Jackson Ave., Collingdale, Pa.
Stackpole Carbon Co., Tannery St., St. Mary's, Pa.
Sticht Co., Inc., Herman H., 27 Park Row, New York, N. Y.
Tagliabue Mfg. Co., C. J., 540 Park Ave., Brooklyn, N. Y.
Tech Laboratories, 7 Lincoln St., Jersey City, N. J.
Thwing-Albert Instrument Co., Penn St., & Pulaski Ave., Philadelphia, Pa.
Utah Radio Products Co., 820 Orleans St., Chicago, Ill.
Vasco Electrical Mfg. Co., 4116 Avalon Blvd., Los Angeles, Calif.
Ward Leonard Electric Co., 31 South St., Mount Vernon, N. Y.
Wheelco Instruments Co., 847 W. Harrison St., Chicago, Ill.
Wirt Co., 5221 Greene St., Philadelphia, Pa.

Rheostats

see Variable Resistors

Scales

DIAL SCALES

see also Dials
also Escutcheons

American Emblem Co., Utica, N. Y.
Austin Co., O., 42 Greene St., New York, N. Y.
Bud Radio, Inc., 2118 E. 55th St., Cleveland, Ohio
Crowe Name Plate & Mfg Co., 3701 Ravenswood Ave., Chicago, Ill.
The Emeloid Co., Inc., 287 Laurel Ave., Arlington, N. J.
Gemloid Corp., 79-10 Albion Ave., Elmhurst, N. Y.
Grammes & Sons, Inc., L. F., 366 Union St., Allentown, Pa.
Insuline Corp. of America, 36-02 35th Ave., Long Island City, N. Y.
Parisian Novelty Co., 3510 S. Western Ave., Chicago, Ill.
Syracuse Ornamental Co., 581 So. Clinton St., Syracuse, N. Y.

Screws

RECESSED HEAD SCREWS

American Screw Co., 21 Stevens St., Providence, R. I.
The Bristol Co., Waterbury, Conn.
Central Screw Co., Chicago, Ill.
Chandler Products Co., Cleveland, Ohio
Continental Screw Co., New Bedford, Mass.
Corbin Screw Corp., High, Myrtle & Grove Sts., New Britain, Conn.
Federal Screw Products Co., 224 W. Huron St., Chicago, Ill.
Harper Co., H. M., 2646 Fletcher St., Chicago, Ill.
Industrial Screw & Supply Co., 713 W. Lake St., Chicago, Ill.
International Screw Co., 9444 Roselawn Ave., Detroit, Mich.
Lamson & Sessions Co., Cleveland, Ohio
National Screw & Mfg. Co., 2440 E. 75th St., Cleveland, Ohio
New England Screw Co., 109 Emerald St., Keene, N. H.
Parker Co., Chas., Meriden, Conn.
Parker-Kalon Corp., 200 Varick St., New York, N. Y.
Pawtucket Screw Co., Pawtucket, R. I.
Pheoll Mfg. Co., 5700 Roosevelt Rd., Chicago, Ill.
Reading Screw Co., Norristown, Pa.
Russell, Burdsall & Ward Bolt & Nut Co., Midland Ave., Port Chester, N. Y.
Scovill Mfg. Co., Waterville, Conn.
Shakeproof, Inc., 2565 N. Keeler Ave., Chicago, Ill.
Southington Hdwe. Mfg. Co., Southington, Conn.
Whitney Screw Co., Nashua, N. H.

SET and CAP SCREWS

Bristol Co., Waterbury, Conn.
Chandler Products Corp., 1475 Chardon Rd., Cleveland, Ohio
Continental Screw Co., New Bedford, Mass.
Corbin Screw Corp., High, Myrtle & Grove Sts., New Britain, Conn.
Federal Screw Products Co., 224 W. Huron St., Chicago, Ill.
Harper Co., H. M., 2646 Fletcher St., Chicago, Ill.
Industrial Screw & Supply Co., 713 W. Lake St., Chicago, Ill.
Lamson & Sessions Co., 1971 W. 85th St., Cleveland, Ohio
National Screw & Mfg. Co., 2440 E. 75th St., Cleveland, Ohio
Parker-Kalon Corp., 200 Varick St., New York, N. Y.
Pheoll Mfg. Co., 5700 Roosevelt Rd., Chicago, Ill.
Russell, Burdsall & Ward Bolt & Nut Co., Midland Ave., Port Chester, N. Y.
Scovill Mfg. Co., Waterville, Conn.
Standard Pressed Steel Co., Jenkintown, Pa.

Shafts

FLEXIBLE SHAFTS

Breeze Corps., 41 S. Sixth St., Newark, N. J.
Chicago Flexible Shaft Co., 5600 Roosevelt Rd., Chicago, Ill.
Coates Clipper & Mfg. Co., 237 Chandler St., Worcester, Mass.
Fischer Spring Co., Chas., 248 Kent Ave., Brooklyn, N. Y.
Haskins Co., R. G., 615 S. California St., Chicago, Ill.
J. F. D. Mfg. Co., 4111 Ft. Hamilton Pkwy., Brooklyn, N. Y.
Jarvis Co., Charles L., Middletown, Conn.
Linick, Green & Reed, 29 E. Madison St., Chicago, Ill.
Martindale Electric Co., 1371 Hird Ave., Cleveland, Ohio
Stewart Mfg. Corp., F. W., 4311 Ravenswood Ave., Chicago, Ill.
Stow Mfg. Co., 445 State St., Binghamton, N. Y.
Strand & Co., N. A., 5001 N. Wolcott Ave., Chicago, Ill.
Walker-Turner Co., 1463 Berckman St., Plainfield, N. J.
White Dental Mfg. Co., S. S. (Industrial Div.), 10 E. 40th St., New York, N. Y.
Wyzenbeck & Staff, 838 W. Hubbard St., Chicago, Ill.

Shields

TUBE SHIELDS

Aluminum Goods Mfg. Co., Manitowoc, Wisc.
American Radio Hardware Co., Inc., 476 Broadway, New York, N. Y.
Bud Radio, Inc., 5205 Cedar Ave., Cleveland, Ohio
Erie Can Co., 816 W. Erie St., Chicago, Ill.
Goat Metal Stampings, Inc., 314 Dean St., Brooklyn, N. Y.
Guthman & Co., Edwin I., 15 S. Throop St., Chicago, Ill.
Hegeler Zinc Co., Danville, Ill.
National Co., 61 Sherman St., Malden, Mass.
Paul & Beekman, 18th & Cortland Sts., Philadelphia, Pa.

Sockets

DIAL LIGHT SOCKETS

Dial Light Co. of America, 90 West St., New York, N. Y.
Pass & Seymour, Inc., Solvay Station, Syracuse, N. Y.
Ucinite Co., 459 Watertown St., Newtonville, Mass.

TUBE SOCKETS

Airadio, Inc., Melrose Ave. & Battery Place, Stamford, Conn.
Aladdin Radio Industries, Inc., 501 W. 35th St., Chicago, Ill.
Alden Products Co., 117 Main St., Brockton, Mass.
American Phenolic Corp., 1830 S. 54th Ave., Chicago, Ill.
American Radio Hardware Co., Inc., 476 Broadway, New York, N. Y.
Astatic Corp., 830 Market St., Youngstown, Ohio
Bead Chain Mfg. Co., 110 Mountain Grove St., Bridgeport, Conn.
Birtcher Corp., 5087 Huntington Drive, Los Angeles, Calif.
Bud Radio, Inc., 2118 E. 55th St., Cleveland, Ohio
Cinch Mfg. Co., 2335 W. Van Buren St., Chicago, Ill.
Eagle Electric Mfg. Co., 59 Hall St., Brooklyn, N. Y.
Eby, Inc., H. H., 18 W. Chelton Ave., Philadelphia, Penn.
Federal Manufacturing & Engrg. Corp., 199 Steuben St., Brooklyn, N. Y.
Franklin Mfg. Corp., A. W., 175 Varick St., New York, N. Y.
General Cement Mfg. Co., 919 Taylor Ave., Rockford, Ill.
Hammarlund Mfg. Co., 460 West 34th St., New York, N. Y.
Insuline Corp. of America, 36-02 35th Ave., Long Island City, N. Y.
Johnson Co., E. F., Waseca, Minn.
Jones, Howard B., 2300 Wabansia Ave., Chicago, Ill.
Micarta Fabricators, Inc., 4619 Ravenswood Ave., Chicago, Ill.
Millen Mfg. Co., James, 150 Exchange St., Malden, Mass.
National Co., 61 Sherman St., Malden, Mass.
National Tile Co., Anderson, Ind.
Precision Specialties, 220 No. Western Ave., Los Angeles, Calif.
Remler Co., 2101 Bryant St., San Francisco, Cal.
Rohden Mfg. Co., 1753 N. Honore St., Chicago, Ill.
Smith Co., Maxwell, 1027 N. Highland Ave., Hollywood, Cal.
Standard Winding Corp., 2-4 Johnes St., Newburgh, N. Y.
Ucinite Co., 459 Watertown St., Newtonville, Mass.

Solder

Allen Co., L. B., 6730 Bryn Mawr Ave., Chicago, Ill.
Alpha Metal & Rolling Mills, Inc., 363 Hudson Ave., Brooklyn, N. Y.
Belmont Smelting & Refining Works, Inc., 330 Belmont Ave., Brooklyn, N. Y.
Chase Brass & Copper Co., Waterbury, Conn.
Division Lead Co., 836 W. Kinzie St., Chicago, Ill.
Dunton Co., M. W., 670 Eddy St., Providence, R. I.
Eutetic Welding Alloys Co., 40 Worth St., New York, N. Y.
Gardiner Metal Co., 4820 S. Campbell Ave., Chicago, Ill.
Glaser Lead Co., 31 Wycoff Ave., Brooklyn, N. Y.
Goldsmith Bros. Smelting & Refining Co., Washington St., Chicago, Ill.
Handy & Harmon, 82 Fulton St., New York, N. Y.
Industrial Screw & Supply Co., 745 W. Lake St., Chicago, Ill.
Kester Solder Co., 4212 Wrightwood Ave., Chicago, Ill.
Lenk Mfg. Co., Newton Lower Falls, Mass.
National Lead Co., 111 Broadway, New York, N. Y.
New York Solder Co., 15 Crosby St., New York, N. Y.
Ruby Chemical Co., 68 McDowell St., Columbus, Ohio

Speakers

see Loudspeakers

Springs

Accurate Spring Mfg. Co., 3811 W. Lake St., Chicago, Ill.
Aeronautical Radio Mfg. Co., 155 First St., Mineola, N. Y.
American Coil Spring Co., 2034 Keating Ave., Muskegon, Mich.
American Spiral Spring & Mfg. Co., 5528 Harrison St., Pittsburgh, Pa.
American Spring & Wire Specialty Co., 816 N. Spaulding St., Chicago, Ill.
American Steel & Wire Co., Rockefeller Bldg., Cleveland, Ohio
Barnes Co., Wallace, Div. of Associated Spring Corp., Bristol, Conn.
Barnes-Gibson-Raymond Div. of Associated Spring Corp., 6400 Miller Ave., Detroit, Mich.
Cary Spring Works, Inc., 240 W. 29th St., New York, N. Y.
Cleveland Wire Spring Co., Cuyahoga Heights, Cleveland, Ohio
Cuyahoga Spring Co., 10272 Berea Rd., Cleveland, Ohio
Dunbar Bros. Co., Div. of Associated Spring Corp., 76 South St., Bristol, Conn.
Gibson Co., Wm. D., Div. of Associated Spring Corp., 1800 Clybourn Ave., Chicago, Ill.
Hubbard Spring Co., M. D., Central Ave., Pontiac, Mich.
Hunter Pressed Steel Co., Lansdale, Pa.
Instrument Specialties Co., 246 Bergen Blvd., Little Falls, N. J.
Jones Spring Co., W. B., 124 E. Seventh St., Cincinnati, Ohio
Lee Spring Co., 30 Main St., Brooklyn, N. Y.
Manross & Sons, F. N., Div. of Associated Spring Corp., Bristol, Conn.
Mid-West Spring Mfg. Co., 4634 S. Western Ave., Chicago, Ill.
Muehlhausen Spring Corp., 255 Michigan Ave., Logansport, Ind.
Newcomb Spring Corp., 238 40th St., Brooklyn, N. Y.
Peck Spring Co., Plainville, Conn.
Precision Products Co., 26 Bedford St., Waltham, Mass.
Raymond Mfg. Co., Div. of Associated Spring Corp., 226 S. Center St., Corry, Pa.
Reliance Spring & Wire Forms Co., 3167 Fulton Rd., Cleveland, Ohio
Reynolds Spring Co., 955 Water St., Jackson, Mich.
Tuck Mfg. Co., Brockton, Mass.
Union Spring & Mfg. Co., New Kensington, Pa.
Wickwire Spencer Steel Co., 500 Fifth Ave., New York, N. Y.
Yost Superior Co., Springfield, Ohio

Stabilizers

VOLTAGE STABILIZERS—see Regulators

Stampings

METAL STAMPINGS, Small

Ace Manufacturing Co., 1255 East Erie Ave., Philadelphia, Pa.
Crowe Name Plate & Mfg. Co., 1752 Waverly Ave., Chicago, Ill.
Franklin Mfg. Corp., A. W., 175 Varick St., New York, N. Y.
Goat Metal Stampings, Inc., 314 Dean St., Brooklyn, N. Y.
Grammes & Sons, L. F., 344 Union St., Allentown, Pa.
Hubbard Spring Co., M. D., 573 Central Ave., Pontiac, Mich.
Hunter Pressed Steel Co., Lansdale, Pa.
Insuline Corp. of America, Long Island City, N. Y.
O'Neil-Irwin Mfg. Co., 316 8th Ave., S., Minneapolis, Minn.
Precision Fabricators, Inc., 120 N. Fitzhugh St., Rochester, N. Y.
Scovill Mfg. Co., 99 Mill St., Waterbury, Conn.
Sherron Metallic Corp., 1201 Flushing Ave., Brooklyn, N. Y.
Standard Pressed Steel Co., Jenkintown, Pa.
Stewart Stamping Corp., 621 East 216th St., Bronx, N. Y.
Thomas & Skinner Steel Prod., Co., 1120 E. 23rd St., Indianapolis, Ind.
United Carr Fastener Corp., Cambridge, Mass.
Webster-Chicago Corp., 5622 Bloomingdale Ave., Chicago, Ill.

NON-METALLIC STAMPINGS, Small

Continental Diamond Fibre Co., 13 Chapel St., Newark, Del.
Franklin Fibre Lamitex Corp., Wilmington, Del.
General Electric Co., Plastics Dept., Pittsfield, Mass.
Insulation Mfgrs. Corp., 565 W. Washington Blvd., Chicago, Ill.
Mica Insulator Co., 196 Varick St., New York, N. Y.

Richardson Co., Lockland, Ohio
Synthane Corp., Oaks, Pa.
Taylor Fibre Co., Norristown, Pa.

Stands

MICROPHONE STANDS

American Microphone Co., 1915 S. Western Ave., Los Angeles, Cal.
Amperite Co., 561 Broadway, New York, N. Y.
Art Specialty Co., 3245 Lake St., Chicago, Ill.
Astatic Corp., 830 Market St., Youngstown, Ohio
Atlas Sound Corp., 1443 39th St., Brooklyn, N. Y.
Braun, Inc., W. C., 601 W. Randolph St., Chicago, Ill.
Bud Radio, Inc., 2118 E. 55th St., Cleveland, Ohio
Eastern Mike-Stand Co., 56 Christopher Ave., Brooklyn, N. Y.
Halldorson Co., 4500 Ravenswood Ave., Chicago, Ill.
Newcomb Audio Products Co., 2815 S. Hill St., Los Angeles, Cal.
Oleson Illuminating Co., Ltd., Otto, 1560 Vine St., Hollywood, Calif.
Radio Corp. of America, Camden, N. J.
Simpson Mfg. Co., Mark, 188 W. Fourth St., New York, N. Y.
Turner Co., Cedar Rapids, Iowa
Universal Microphone Co., 424 Warren Lane, Inglewood, Cal.

SPEAKER STANDS

Art Specialty Co., 3245 Lake St., Chicago, Ill.
Atlas Sound Corp., 1443 39th St., Brooklyn, N. Y.
Erwood Co., 223 W. Erie St., Chicago, Ill.
Radio Corp. of America, Camden, N. J.

Steel

ELECTRICAL STEEL—see Metals

Strips

TERMINAL STRIPS—see Posts

Switches

MERCURY SWITCHES

Arrow-Hart & Hegeman Electric Co., 103 Hawthorne St., Hartford, Conn.
Bacon Electric Timer Corp., 4513 Brooklyn Ave., Cleveland, Ohio
Durakool, Inc., 1010 N. Main St., Elkhart, Ind.
General Electric Co., Bridgeport, Conn.
H. B. Electric Co. Inc., 6122 North 21st St., Philadelphia, Pa.
Hart Mfg. Co., Hartford, Conn.
Jefferson Electric Co., Bellwood, Ill.
Littelfuse, Inc., 4753 Ravenswood Ave., Chicago, Ill.
Mercoid Corp., 4201 Belmont Ave., Chicago, Ill.
Minneapolis-Honeywell Regulator Co., 2753 Fourth Ave., S., Minneapolis, Minn.
Powrex Switch Co., Watertown, Mass.

LIMIT SWITCHES

Allen-Bradley Co., 136 W. Greenfield Ave., Milwaukee, Wis.
Automatic Electric Co., 1033 W. Van Buren St., Chicago, Ill.
Burling Instrument Co., 253 Springfield Ave., Newark, N. J.
Clare & Co., C. P., 4719 Sunnyside Ave., Chicago, Ill.
Electronic Control Corp., 626 Harper Ave., Detroit, Mich.
Federal Mfg. & Engrg. Corp., 199 Steuben St., Brooklyn, N. Y.
General Electronic Industries, Div. Auto Ordnance Corp., 342 Putnam, Greenwich, Conn.
Micro Switch Corp., 7 Spring St., Freeport, Ill.
Photoswitch, Inc., 77 Broadway, Cambridge, Mass.
United Cinephone Corp., 65 New Litchfield St., Torrington, Conn.

ROTARY and BAND CHANGE SWITCHES

Autocall Co., 1142 Tucker Ave., Shelby, Ohio
Automatic Electric Co., 1033 W. Van Buren St., Chicago, Ill.
Barker & Williamson, 235 Garfield Ave., Upper Darby, Pa.
Centralab, 900 E. Keefe Ave., Milwaukee, Wisc.
Chicago Telephone Supply Co., 1142 W. Beardsley Ave., Elkhart, Ind.
Daven Co., 158 Summit St., Newark, N. J.
General Control Co., 243 Broadway, Cambridge, Mass.
General Electric Co., Bridgeport, Conn.
Guardian Electric Mfg. Co., 1621 W. Walnut St., Chicago, Ill.
JBL Instrument Co., 420 E. Providence Rd., Aldan, Pa.
J. B. T. Instruments, Inc., 441 Chapel St., New Haven, Conn.
Lewis Engineering Co., 52 Rubber Avenue, Naugatuck, Conn.
Mallory & Co., P. R., 3029 E. Washington St., Indianapolis, Ind.
Mossman, Inc., Donald P., 6133 Northwest Highway, Chicago, Ill.
Ohmite Mfg. Co., 4835 W. Flournoy St., Chicago, Ill.
Peerless Labs, Inc., 115 East 23rd St., New York, N. Y.
Philmore Mfg. Co., 113 University Place, New York, N. Y.
Richardson-Allen Corp., 15 West 20th St., New York, N. Y.
Sensitive Research Instrument Corp., 9–11 Elm Ave., Mt. Vernon, N. Y.
Shallcross Mfg. Co., 10 Jackson Ave., Collingdale, Pa.
Super Electric Products Corp., 1057 Summit Ave., Jersey City, N. J.
Triplett Electrical Instrument Co., 135 E. College Ave., Bluffton, Ohio
Wirt Co., 5221 Green St., Philadelphia, Pa.

TOGGLE, PUSHBUTTON and MICRO SWITCHES

Acro Electric Co., 3167 Fulton Rd., Cleveland, Ohio
Allen-Bradley Co., 136 W. Greenfield Ave., Milwaukee, Wisc.
Arrow-Hart & Hegeman Electric Co., 103 Hawthorne St., Hartford, Conn.
Aviometer Corp., 370 West 35th St., New York, N. Y.
Boes Co., W. W., 3001 Salem Ave., Dayton, Ohio
Clare & Co., C. P., 4719 Sunnyside Ave., Chicago, Ill.
Cole-Hersee Co., 54 Old Colony Ave., So., Boston, Mass.
General Control Co., Cambridge, Mass.
General Electric Co., Bridgeport, Conn.
Hart Mfg. Co., 110 Bartholomew Ave., Hartford, Conn.
Kulka Electric Mfg. Co., Inc., 30 South St., Mt. Vernon, N. Y.
Mallory & Co., P. R., 3029 E. Washington St., Indianapolis, Ind.
McDonnell & Miller, Wrigley Bldg, Chicago, Ill.
Micro Switch Corp., 7 W. Spring St., Freeport, Ill.
Minneapolis-Honeywell Regulator Co., 2753 Fourth Ave., S. Minneapolis, Minn.
Mu-Switch Corp., 38 Pequit St., Canton, Mass.
Philmore Mfg. Co., 113 University Place, New York, N. Y.
Stackpole Carbon Co., Tannery St., St. Mary's, Pa.
Tech Laboratories, 7 Lincoln St., Jersey City, N. J.
Ucinite Co., 459 Watertown Ave., Newtonville, Mass.
Warwick Co., Chas. F., 16251 Hamilton Ave., Detroit, Mich.
Wirt Co., 5221 Greene St., Philadelphia, Pa.

TIME SWITCHES

Automatic Electric Mfg. Co., 10 State St., Mankato, Minn.
Bacon Electric Timer Corp., 4513 Brooklyn Ave., Cleveland, Ohio
Cleveland Time Clock & Service Co., Superior Ave. at E. 27th St., Cleveland, Ohio
Cramer Co., R. W., Centerbrook, Conn.
Eagle Signal Corp., Moline, Ill.
Electric Controls Corp., 68 Murray St., New York, N. Y.
General Electric Co., Schenectady, N. Y.
General Electronic Industries, 342 Putnam, Greenwich, Conn.
Industrial Instrument Co., 2249 14th St., S. W., Akron, Ohio
Leich Electric Co., River Rd., Prairie View, Ill.
Mercoid Corp., 4201 Belmont Ave., Chicago, Ill.
Minneapolis-Honeywell Regulator Co., 2753 Fourth Ave., S., Minneapolis, Minn.
Paragon Electric Co., 37 W. Van Buren St., Chicago, Ill.
Penn Electric Switch Co., Goshen, Ind.
Presto Electric Co., 4511 New York Ave., Union City, N. J.
Reliance Automatic Lighting Co., 1927 Mead St., Racine, Wis.
Rhodes, Inc., M. H., 30 Bartholomew Ave., Hartford, Conn.
Richardson-Allen Corp., 15 West 20th St., New York, N. Y.
States Co., 19 New Park Ave., Hartford, Conn.
Thompson Clock Co., H. C., 38 Federal St., Bristol, Conn.
Tork Clock Co., 1 Grove St., Mount Vernon, N. Y.
Wadsworth Electric Mfg. Co., Inc., 20 W. 11th St., Covington, Ky.
Walser Automatic Timer Co., 420 Lexington Ave., New York, N. Y.
Ward Leonard Electric Co., 31 South St., Mount Vernon, N. Y.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
Wheelco Instruments Corp., 847 W. Harrison St., Chicago, Ill.
Zenith Electric Co., 152 W. Walton St., Chicago, Ill.

Tape

CELLULOSE TAPE

Dobeckman Co., 3300 Monroe Ave., Cleveland, Ohio
Insulation Manufacturers Corp., 565 W. Washington Blvd., Chicago, Ill.
Minnesota Mining & Mfg. Co., 900 Fauquier Ave., St. Paul, Minn.
Wright & Sons Co., Wm. E., West Warren, Mass.

COTTON or SILK TAPE

Anchor Webbing Co., 1005 Main St., Pawtucket, R. I.
Carolina Narrow Fabric Co., 1036 N. Chestnut St., Winston-Salem, N. C.
Elizabeth Webbing Mills, Pawtucket, R. I.
General Electric Co., Schenectady, N. Y.
Hope Webbing Co., Providence, R. I.
Insulation Manufacturers Corp., 565 W. Washington Blvd., Chicago, Ill.
Linton & Bro., Horace, 3081 Ruth St., Philadelphia, Pa.
Mica Insulator Co., 200 Varick St., New York, N. Y.
Mitchell Rand Insulation Co., 51 Murray St., New York, N. Y.
Priscilla Braid Co., 1461 High St., Central Falls, R. I.
Sidebotham, Inc., John, 4317 Griscom St., Philadelphia, Pa.

VARNISHED TAPE

Acme Wire Co., 1255 Dixwell Ave., New Haven, Conn.
B & C Insulation Products, Inc., 261 Fifth Ave., New York, N. Y.
Electro-Technical Products, Inc., Nutley, N. J.
General Electric Co., Bridgeport, Conn.
Insulation Manufacturers Corp., 565 W. Washington Blvd., Chicago, Ill.
Irvington Varnish & Insulator Co., 10 Argyle Terrace, Irvington, N. J.
Mica Insulator Co., 200 Varick St., New York, N. Y.
New Jersey Wood Finishing Co., Electrical Insulation Dept., Woodbridge, N. J.
Owens-Corning Fiberglas Corp., Nicholas Bldg., Toledo, Ohio
Respro, Inc., Wellington Ave., Cranston, R. I.
Standard Insulation Co., 74 Paterson Ave., East Rutherford, N. J.
Sullivan & Sons Mfg. Co., J., 2224 N. Ninth St., Philadelphia, Pa.

Terminals

see Posts

Transformers

CURRENT TRANSFORMERS

American Transformer Co., 178 Emmet St., Newark, N. J.
Annis Co., R. B., 1101 N. Delaware St., Indianapolis, Ind.
Apex Industry, 1035 Lake St., Chicago, Ill.
Arlavox Mfg. Co., 430 S. Green St., Chicago, Ill.
Chicago Transformer Corp., 3501 W. Addison St., Chicago, Ill.
Davis & Co., Dean W., 549 W. Fulton St., Chicago, Ill.
Dinion Coil Co., North St., Caledonia, N. Y.
Doyle, Inc., James W., 2734 N. Pulaski Rd., Chicago, Ill.
Eastern Specialty Co., 3619 N. Eighth St., Philadelphia, Pa.
Elsler Engineering Co., 751 So. 13th St., Newark, N. J.
Electrical Transformer Co., 417 Canal St., New York, N. Y.
Electron Equipment Corp., Palm Springs, Calif.
Esterline Angus Co., P. O. Box 596, Indianapolis, Ind.
Ferranti Electric, Inc., 30 Rockefeller Plaza, New York, N. Y.
Freed Transformer Co., 72 Spring St., New York, N. Y.
General Controls Co., 801 Allen Ave., Glendale, Calif.
General Radio Co., 30 State St., Cambridge, Mass.
General Transformer Corp., 1250 W. Van Buren St., Chicago, Ill.
Hadley Co., Robert M., 711 E. 61st St., Los Angeles, Calif.
Halldorson Co., 4500 Ravenswood Ave., Chicago, Ill.
Industrial Transformer Corp., 2540 Belmont Ave., New York, N. Y.
Jefferson Electric Co., Bellwood, Ill.
Kenyon Transformer Co., 840 Barry St., New York, N. Y.
Langevin Co., Inc., 37 West 65th St., New York, N. Y.
Magnetic Windings Co., 16th & Butler Sts., Easton, Pa.
Merwin-Wilson Co., New Milford, Conn.
New York Transformer Co., 26 Waverly Place, New York, N. Y.
Newark Transformer Co., 17 Frelinghuysen Ave., Newark, N. J.
Northelfer Winding Labs., 111 Albermarle Ave., Trenton, N. J.
Oxford Tartak Radio Corp., 3911 S. Michigan Ave., Chicago, Ill.
Presto Electric Co., 4511 New York Ave., Union City, N. J.
Radio Corp. of America, Camden, N. J.
Red Arrow Electric Corp., 100 Coit St., Irvington, N. J.
Sola Electric Co., 2525 Clybourn Ave., Chicago, Ill.
Standard Transformer Corp., 1500 N. Halsted St., Chicago, Ill.
Superior Electric Co., 83 Laurel St., Bristol, Conn.
Superior Electric Products Corp., 1057 Summit Ave., Jersey City, N. J.
Thordarson Electric Mfg. Co., 500 W. Huron St., Chicago, Ill.
Transformer Products, Inc., 143 W. 51st St., New York, N. Y.
United Transformer Co., 150 Varick St., New York, N. Y.
Utah Radio Products Co., 820 Orleans St., Chicago, Ill.
Western Electro-Mechanical Co., 300 Broadway, Oakland, Calif.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J.

INSTRUMENT TRANSFORMERS

American Transformer Co., 178 Emmet St., Newark, N. J.
Erie Electric Co., 120 Church St., Buffalo, N. Y.
Esterline-Angus Co., P.O. Box 596, Indianapolis, Ind.
General Electric Co., Schenectady, N. Y.
Hollywood Transformer Co., 645 N. Martel Ave., Los Angeles, Cal.
New York Transformer Co., 26 Waverly Place, New York, N. Y.
Newark Transformer Co., 17 Frelinghuysen Ave., Newark, N. J.
Newton Co., 244 West 23rd St., New York, N. Y.
Niagara Electric Improvement Corp., 122 E. 42d St., New York, N. Y.
Presto Electric Co., 4511 New York Ave., Union City, N. J.
Roller-Smith Co., Bethlehem, Pa.
Sparkes Mfg. Co., 318 Jefferson St., Newark, N. J.
Standard Transformer Co., 1500 N. Halsted St., Chicago, Ill.
States Co., 19 New Park Ave., Hartford, Conn.
Surges Electric Co., 101 E. Seeboth St., Milwaukee, Wis.
Transformer Corp. of America, 69 Wooster St., New York, N. Y.
Uptegraff Mfg. Co., R. E., Scottdale, Pa.
Wagner Electric Corp., 6400 Plymouth Ave., St. Louis, Mo.
Webber Co., Earl, 4358 W. Roosevelt Rd., Chicago, Ill.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J.

RF AND IF TRANSFORMERS

Aladdin Radio Industries, Inc., 501 W. 35th St., Chicago, Ill.
American Transformer Co., 178 Emmet St., Newark, N. J.
Automatic Windings Co., 900 Passaic Ave., East Passaic, N. J.
Best Mfg. Co., Inc., 1200 Grove St., Irvington, N. J.
Cambridge Thermionic Corp., Cambridge, Mass.
Carron Mfg. Co., 415 S. Aberdeen St., Chicago, Ill.
D-X Crystal Co., 1841 W. Carroll Ave., Chicago, Ill.
Essex Specialty Co., Inc., 1060 Broad St., Newark, N. J.
General Winding Co., 420 West 45th St., New York, N. Y.
Guthman & Co., E. I., 15 S. Throop St., Chicago, Ill.
Hammarlund Mfg. Co., 460 W. 34th St., New York, N. Y.
Industrial Transformer Corp., 2540 Belmont Ave., New York, N. Y.
Millen Mfg. Co., James, 150 Exchange St., Malden, Mass.
National Co., 61 Sherman St., Malden, Mass.
Red Arrow Electric Corp., 100 Coit St., Irvington, N. J.
Sickles Co., F. W., 165 Front St., Chicopee, Mass.
Sound Equipment Corp. of California, 6245 Lexington Ave., Hollywood, Calif.
Standard Coil Products Co., 2329 N. Pulaski Rd., Chicago, Ill.
Teleradio Engineering Corp., 484 Broome St., New York, N. Y.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

AUDIO & POWER TRANSFORMERS

Acme Electric & Mfg. Co., 31 Water St., Cuba, N. Y.
Altec Lansing Corp., 1680 N. Vine St., Los Angeles, Calif.
American Transformer Co., 178 Emmet St., Newark, N. J.
Amplifier Co. of America, 17 W. 20th St., New York, N. Y.
Arlavox Mfg. Co., 5042 Cottage Grove Ave., Chicago, Ill.
Audio Development Co., 2833 13th Ave. S., Minneapolis, Minn.
Bendix Radio Div., Bendix Aviation Corp., Baltimore, Md.
Best Mfg. Co., Inc., 1200 Grove St., Irvington, N. J.
Cole Radio Works, 86 Westville Ave., Caldwell, N. J.
Dinion Coil Co., 1 North St., Caledonia, N. Y.
Dongan Electric Mfg. Co., 2987 Franklin St., Detroit, Mich.
Doyle, Inc., James W., 2734 N. Pulaski Rd., Chicago, Ill.
D-X Crystal Co., 1841 W. Carroll Ave., Chicago, Ill.
Electric Power Construction, Inc., 569 S. Main St., Akron, Ohio
Ferranti Electric, Inc., 30 Rockefeller Plaza, New York, N. Y.
Freed Transformer Co., 72 Spring St., New York, N. Y.
General Transformer Corp., 1250 W. Van Buren St., Chicago, Ill.
Hadley Co., Robert M., 711 E. 61st St., Los Angeles, Calif.
Halldorson Co., 4500 Ravenswood Ave., Chicago, Ill.
Hollywood Transformer Co., 645 N. Martel Ave., Los Angeles, Calif.
Industrial Transformer Corp., 2540 Belmont Ave., New York, N. Y.
Jefferson Electric Co., Bellwood, Ill.
Jensen Radio Mfg. Co., 6601 S. Laramie Ave., Chicago, Ill.
Kenyon Transformer Co., 840 Barry St., New York, N. Y.
Langevin Co., Inc., 37 West 65th St., New York, N. Y.
Magnetic Windings Co., 16th & Butler Sts., Easton, Pa.
Merwin-Wilson Co., New Milford, Conn.
New York Transformer Co., 26 Waverly Place, New York, N. Y.
Newark Transformer Co., 17 Frelinghuysen Ave., Newark, N. J.
Raytheon Mfg. Co., 190 Willow St., Waltham, Mass.
Rola Co., Inc., 2530 Superior Ave., Cleveland, Ohio
Skaggs Transformer Co., 5894 Broadway, Los Angeles, Calif.
Sonotone Corp., P. O. Box 200, Sawmill River Rd., Elmsford, N. Y.
Standard Transformer Corp., 1500 N. Halsted St., Chicago, Ill.
Super Electronic Products Corp., 1057 Summit Ave., Jersey City, N. J.
Superior Electric Co., 83 Laurel St., Bristol, Conn.
Thermador Elec. Mfg. Co., 5119 S. Riverside Drive, Los Angeles, Calif.
Thordarson Electric Mfg. Co., 500 W. Huron St., Chicago, Ill.
Transformer Products, Inc., 143 W. 51st St., New York, N. Y.
Utah Radio Products Co., 820 Orleans St., Chicago, Ill.
Walsh Engineering Co., 34 DeHart Place, Elizabeth, N. J.

TRANSMITTER TRANSFORMERS

American Transformer Co., 178 Emmet St., Newark, N. J.
Apex Industry, 1035 Lake St., Chicago, Ill.
Bendix Radio Div., Bendix Aviation Corp., Baltimore, Md.
Doyle, Inc., James W., 311 N. Desplaines St., Chicago, Ill.
Electricoil Transformer Co., 421 Canal St., New York, N. Y.
Ferranti Electric, Inc., 30 Rockefeller Plaza, New York, N. Y.
Freed Transformer Co., 72 Spring St., New York, N. Y.
Hadley Co., Robert M., 711 E. 61st St., Los Angeles, Calif.
Halldorson Co., 4500 Ravenswood Ave., Chicago, Ill.
Industrial Transformer Corp., 2540 Belmont Ave., New York, N. Y.
Jefferson Electric Co., Bellwood, Ill.
Kenyon Transformer Co., 840 Barry St., New York, N. Y.
Langevin Co., Inc., 37 West 65th St., New York, N. Y.
Magnetic Windings Co., 16th & Butler Sts., Easton, Pa.
Merwin-Wilson Co., New Milford, Conn.
New York Transformer Co., 26 Waverly Place, New York, N. Y.
Newark Transformer Co., 17 Frelinghuysen Ave., Newark, N. J.
Radio Corp. of America, Camden, N. J.
Raytheon Mfg. Co., 190 Willow St., Waltham, Mass.
Rola Co., Inc., 2530 Superior Ave., Cleveland, Ohio
Skaggs Transformer Co., 5894 Broadway, Los Angeles, Calif.
Sola Electric Co., 2525 Clybourn Ave., Chicago, Ill.
Standard Transformer Corp., 1500 N. Halsted St., Chicago, Ill.
Thordarson Electric Mfg. Co., 500 W. Huron St., Chicago, Ill.
Transformer Products, Inc., 143 W. 51st St., New York, N. Y.
United Transformer Co., 150 Varick St., New York, N. Y.
Utah Radio Products Co., 820 Orleans St., Chicago, Ill.

VOLTAGE REGULATING TRANSFORMERS

American Transformer Co., 178 Emmet St., Newark, N. J.
Amplifier Co. of America, 17 W. 20th St., New York, N. Y.
Clark Controller Co., 1146 E. 152d St., Cleveland, Ohio

Freed Transformer Co., 72 Spring St., New York, N. Y.
General Transformer Corp., 1250 W. Van Buren St., Chicago, Ill.
Halldorson Co., 4500 Ravenswood Ave., Chicago. Ill.
Industrial Transformer Corp., 2540 Belmont Ave., New York, N. Y.
International Transformer Co., 17 W. 20th St., New York, N. Y.
Raytheon Mfg. Co., 190 Willow St., Waltham, Mass.
Radio Corp. of America, Camden, N. J.
Skaggs Transformer Co., 5894 Broadway, Los Angeles, Cal.
Sola Electric Co., 2525 Clybourn Ave., Chicago, Ill.
Standard Transformer Corp., 1500 N. Halsted St., Chicago, Ill.
Stevens Arnold Co., 22 Elkins St., South Boston, Mass.
Superior Electric Co., 83 Laurel St., Bristol, Conn.
Thordarson Electric Mfg. Co., 500 W. Hurson St., Chicago, Ill.
Transformer Products Inc., 143 W. 51st St., New York, N. Y.
United Transformer Co., 150 Varick St., New York, N. Y.

Tubes

CATHODE RAY TUBES

Du Mont Laboratories, Inc., Allen B., 2 Main Ave., Passaic, N. J.
Farnsworth Television & Radio Corp., 3700 Pontiac St., Ft. Wayne, Ind.
General Electric Co., Schenectady, New York
General Electronics Industries, Div. Auto Ordnance Corp., 342 Putnam, Greenwich, Conn.
Ken-Rad Tube & Lamp Corp., 227 E. 9th St., Owensboro, Ky.
National Union Radio Corp., 15 Washington St., Newark, N. J.
North American Philips Co., Inc., Elmet Div., 145 Palisade St., Dobbs Ferry, N. Y.
Northern Mfg. Co., Inc., 36 Spring St., Newark, N. J.
Radio Corp. of America, Camden, N. J.
Radio Electronics Laboratory, Inc., 120 Freeman St., Brooklyn, N. Y.
Rauland Corp., 4245 N. Knox Ave., Chicago, Ill.
Sylvania Electric Products, Inc., 60 Boston St., Salem, Mass.
Western Electric Co., Inc., 195 Broadway, New York, N. Y.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

CURRENT REGULATING TUBES (Ballast)

Amperite Co., 561 Broadway, New York, N. Y.
General Electric Co., Schenectady, N. Y.
Hytron Corp., 76 Lafayette St., Salem, Mass.
Radio Corp. of America, Camden, N. J.
Sylvania Electric Products, Inc., 60 Boston St., Salem, Mass.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

GEIGER-MUELLER TUBES and EQUIPMENT

Cyclotron Specialties Co., Moraga, Calif.
Distillation Products Co., Rochester, N. Y.
Herbach & Rademan Co., 522 Market St., Philadelphia, Pa.

HEARING AID TUBES

Hytron Corp., 76 Lafayette St., Salem, Mass.
Ken-Rad Tube & Lamp Corp., 227 E. 9th St., Owensboro, Ky.
Raytheon Production Corp., 55 Chapel St., Newton, Mass.
Radio Corp. of America, Camden, N. J.
Sonotone Corp., P. O. Box 200, Saw Mill River Rd., Elmsford, N. Y.

INDUSTRIAL TUBES

Continental Electric Co., 903 Merchandise Mart, Chicago, Ill.
Electronic Enterprises, Inc., 65-67 Seventh Ave., Newark, N. J.
Electronics, Inc., 127 Sussex Ave., Newark, N. J.
Federal Telephone and Radio Corp., 591 Broad St., Newark, N. J.
General Electric Co., Schenectady, N. Y.
General Electronics Industries, Div. Auto Ordnance Corp., 342 Putnam, Greenwich, Conn.
Heintz & Kaufman, Ltd., South San Francisco, Calif.
Hytron Corp., 76 Lafayette St., Salem, Mass.
Ken-Rad Tube & Lamp Corp., Owensboro, Ky.
Machlett Laboratories, Springdale, Conn.
Raytheon Production Corp., 55 Chapel St., Newton, Mass.
Radio Corp. of America, Camden, N. J.
Slater Elec. & Mfg. Co., Inc., 728 Atlantic Ave., Brooklyn, N. Y.
Taylor Tubes, Inc., 2312-18 Wabansia Ave., Chicago, Ill.
Translite Inc., 647 Kent Ave., Brooklyn, N. Y.
United Electronics Co., 42 Spring St., Newark, N. J.
Westinghouse Lamp Div., Westinghouse Electric & Mfg. Co., Bloomfield, N. J.

PHOTOTUBES

Bradley Laboratories, 82 Meadow St., New Haven, Conn.
Continental Electric Co., 903 Merchandise Mart, Chicago, Ill.
Eby, Inc., Hugh H., 18 W. Chelton Ave., Philadelphia, Pa.
Electronic Laboratory, 306 S. Edinburgh Ave., Los Angeles, Calif.
General Electric Co., Schenectady, New York
General Electronic Industries, Div. Auto Ordnance Corp., 342 Putnam, Greenwich, Conn.
General Scientific Corp., 4829 S. Kedzie Ave., Chicago, Ill.
G-M Laboratories, Inc., 4313 N. Knox Ave., Chicago, Ill.
National Union Radio Corp., 15 Washington St., Newark, N. J.
Photobell Corp., 116 Nassau St., New York, N. Y.
Radio Corp. of America, Camden, N. J.
Rehtron Corp., 2159 Magnolia Ave., Chicago, Ill.
Selenium Corp. of America, 1800 W. Pico Blvd., Los Angeles, Calif.
Western Electric Co., Inc., 195 Broadway, New York, N. Y.
Westinghouse Lamp Div., Westinghouse Electric & Mfg. Co., Bloomfield, N. J.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J.

RECEIVING TUBES

Emerson Radio & Phonograph Corp., 111 Eighth Ave., New York, N. Y.
General Electric Co., Schenectady, New York
General Electronic Industries, 342 Putnam, Greenwich, Conn.
Hytron Corp., 76 Lafayette St., Salem, Mass.
Ken-Rad Tube & Lamp Corp., 227 E. Ninth St., Owensboro, Ky.
National Union Radio Corp., 15 Washington St., Newark, N. J.
North American Philips Co., Inc., Elmet Div., 145 Palisade St., Dobbs Ferry, N. Y.
Raytheon Production Corp., 55 Chapel St., Newton, Mass.
Radio Corp. of America, Camden, N. J.
Slater Electric & Mfg. Co., Inc., 728 Atlantic Ave., Brooklyn, N. Y.
Sperry Gyroscope Co., Inc., Manhattan Bridge Plaza, Brooklyn, N. Y.
Sylvania Electric Products, Inc., 60 Boston St., Salem, Mass.
Tung-Sol Lamp Works Inc., 95 Eighth Ave., Newark, N. J.
Western Electric Co., Inc., 195 Broadway, New York, N. Y.

RECTIFYING TUBES

Allis-Chalmers Mfg. Co., Milwaukee, Wisc.
Continental Electric Co., 903 Merchandise Mart, Chicago, Ill.
Eitel-McCullough, Inc., San Bruno, Calif.
Electrons, Inc., 127 Sussex Ave., Newark, N. J.
Federal Telephone and Radio Corp., 591 Broad St., Newark, N. J.
General Electric Co., Schenectady, New York
Heintz & Kaufman, Ltd., South San Francisco, Calif.
Jennings Radio Mfg. Co., R3, Box 22, San Jose, Calif.
National Co., Inc., 61 Sherman St., Malden, Mass.
North American Philips Co., Inc., Dobbs Ferry, N. Y.
Raytheon Mfg. Co., 190 Willow St., Waltham, Mass.
Taylor Tubes, Inc., 2312 Wabansia Ave., Chicago, Ill.
Translite, Inc., 647 Kent Ave., Brooklyn, N. Y.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

TRANSMITTING and POWER TUBES

Amperex Electronic Products, 79 Washington St., Brooklyn, N. Y.
de Forest Laboratories, Lee, 5106 Wilshire Blvd., Los Angeles, Calif.
Eitel-McCullough, Inc., San Bruno, Cal.
Electronic Enterprises, Inc., 65-67 Seventh Ave., Newark, N. J.
Federal Telephone and Radio Corp., 591 Broad St., Newark, N. J.
General Electric Co., Schenectady, New York
General Electronic Industries, 342 Putnam, Greenwich, Conn.
Heintz & Kaufman, Ltd., South San Francisco, Calif.
Hytron Corp., 76 Lafayette St., Salem, Mass.
Ken-Rad Tube & Lamp Corp., Owensboro, Ky.
Machlett Laboratories, Springdale, Conn.
National Union Radio Corp., 15 Washington St., Newark, N. J.
North American Philips Co., Inc., Elmet Div., 145 Palisade St., Dobbs Ferry, N. Y.
Raytheon Mfg. Co., 190 Willow St., Waltham, Mass.
Radio Corp. of Aemrica, Camden, N. J.
Slater Electric & Mfg. Co., Inc., 728 Atlantic Ave., Brooklyn, N. Y.
Sperry Gyroscope Co., Inc., Manhattan Bridge Plaza, Brooklyn, N. Y.
Taylor Tubes, Inc., 2312 Wabansia Ave., Chicago, Ill.
Translite, Inc., 647 Kent Ave., Brooklyn, N. Y.
Tung-Sol Lamp Works, Inc., 95 Eighth Ave., Newark, N. J.
United Electronics Co., 42 Spring St., Newark, N. J.
Western Electric Co., Inc., 195 Broadway, New York, N. Y.
Westinghouse Lamp Div., Westinghouse Electric & Mfg. Co., Bloomfield, N. J.

X-RAY TUBES and EQUIPMENT

Eureka X-Ray Corp., 3250 N. Kilpatrick St., Chicago, Ill.
Fischer & Co., H. G., 2323 Wabansia Ave., Chicago, Ill.
General Electric X-Ray Corp., 2012 Jackson Blvd., Chicago, Ill.
Machlett Laboratories, Springdale, Conn.
North American Philips Co., Inc., Dobbs Ferry, N. Y.
Phillips Metalix Corp., 419 Fourth Ave., New York, N. Y.
Picker X-Ray Corp., 300 Fourth Ave., New York, N. Y.
Standard X-Ray Co., 1930 N. Burling St., Chicago, Ill.
Universal X-Ray Products, Inc., 1800 N. Francisco Ave., Chicago, Ill.
Westinghouse Electric & Mfg. Co., Radio & X-Ray Div., Baltimore, Md.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.
Westinghouse Lamp Div., Westinghouse Electric & Mfg. Co., Bloomfield, N. J.

TUBES, PARTS

Admak Manufacturing Co., 46 Cordier St., Irvington, N. J.
Bead Chain Mfg. Co., 110 Mt. Grove St., Bridgeport, Conn.
Birtcher Corp., 5087 Huntington Drive., Los Angeles, Calif.
Engineering Co., 27 Wright St., Newark, N. J.
Ford Radio & Mica Corp., 538 63rd St., Brooklyn, N. Y.
General Electric Co., Schenectady, N. Y.
Goat Metal Stampings, Inc., 314 Dean St., Brooklyn, N. Y.
Haydu Bros., Mt. Bethel Rd., Plainfield, N. J.
King Laboratories, Inc., 205 Oneida Street, Syracuse, N. Y.
Lewis Electronics, Inc., Rte. 3, Los Gatos, Calif.

Rice's Sons, Inc., Bernard, 325 Fifth Ave., New York, N. Y.
Sherron Metallic Corp., 1201 Flushing Ave., Brooklyn, N. Y.
Superior Tube Co., Norristown, Pa.
Worcester Pressed Steel Co., 100 Barber Ave., Worcester, Mass.

Tube Repairs

Lewis Electronics, Inc., Los Gatos, Calif.
Freeland & Olschner, Inc., 611 Baronne St., New Orleans, La.
West Shore Laboratories, Box 117, Marblehead, Mass.

Tubing

BRASS and COPPER TUBING

American Brass Co., Waterbury, Conn.
Bridgeport Brass Co., E. Main St., Bridgeport, Conn.
Chase Brass & Copper Co., Waterbury, Conn.
Mueller Brass Co., 1925 Lapeer Ave., Port Huron, Mich.
Precision Tube Co., 3828 Terrace St., Philadelphia, Pa.
Revere Copper & Brass, Inc., 230 Park Ave., New York, N. Y.
Scovill Mfg. Co., 99 Mill St., Waterbury, Conn.
Wolverine Tube Co., 1411 Central Ave., Detroit, Mich.

CERAMIC TUBING—see Insulation

FABRIC TUBES and TUBING

Anchor Webbing Co., 1005 Main St., Pawtucket, R. I.
B & C Insulation Products, Inc., 261 Fifth Ave., New York, N. Y.
Bentley, Harris Mfg. Co., Hector & Lime Sts., Conshohocken, Pa.
Brand & Co., William, 276 Fourth Ave., New York, N. Y.
Electro-Technical Products, Inc., Nutley, N. J.
General Electric Co., Bridgeport, Conn.
Insulation Manufacturers Corp., 565 W. Washington Blvd., Chicago, Ill.
Irvington Varnish & Insulator Co., 10 Argyle Terrace, Irvington, N. J.
Mica Insulator Co., 200 Varick St., New York, N. Y.
Mitchell-Rand Insulation Co., 51 Murray St., New York, N. Y.
Pearce Co., R. T., 235 Scott Blvd., Covington, Ky.
Surprenant Electrical Insulation Co., 84 Purchase St., Boston, Mass.
Varflex Corp., Cor. N. Jay St., Rome, N. Y.

FIBRE TUBING—see Insulation

GLASS TUBES and TUBING

Bentley, Harris Mfg. Co., Hector & Lime Sts., Conshohocken, Pa.
Corning Glass Works, Corning, N. Y.
Duro-Test Corp., North Bergen, N. J.
Electro-Technical Products, Inc., Nutley, N. J.
Hygrade Sylvania Corp., 60 Boston St., Salem, Mass.
Insulation Manufacturers Corp., 565 W. Washington Blvd., Chicago, Ill.
Libbey Glass Co., Ohio Bldg., Toledo, Ohio
Luminous Laboratories, Inc., 6 E. Lake St., Chicago, Ill.
Owens-Corning Fiberglas Corp., Nicholas Bldg., Toledo, Ohio
St. Charles Technical Laboratories, Inc., 10 State Ave., St. Charles, Ill.

KNITTED WIRE TUBES and TUBING

Alden Products Co., 117 Main St., Brockton, Mass.
Anaconda Wire & Cable Co., 25 Broadway, New York, N. Y.
Camden Wire Co., Camden, N. Y.
Chicago Metal Hose Corp., 1315 S. 3rd Ave., Maywood, Ill.
Columbia Cable & Electric Co., 45-45 30th Place, Long Island City, N. Y.
Essex Wire Corp., 1601 Wall St., Fort Wayne, Ind.
General Electric Co., Bridgeport, Conn.
Hope Webbing Co., Providence, R. I.

METAL and ALLOY TUBING

General Plate Div., Metals & Controls Corp., 34 Forest St., Attleboro, Mass.
International Nickel Co., 67 Wall St., New York, N. Y.
Steel & Tubes Div., Republic Steel Corp., 224 E. 131st St., Cleveland, Ohio.
Summerill Tubing Co., Bridgeport, Pa.
Superior Tube Co., Norristown, Pa.

PAPER TUBES and TUBING

American Paper Tube Co., Hazel St., Woonsocket, R. I.
B & C Insulation Products Inc., 261 Fifth Ave., New York, N. Y.
Cleveland Container Co., 10630 Berea Rd., Cleveland, Ohio
Cross Paper Products Corp., 2595 Third Ave., New York, N. Y.
Electro-Technical Products, Inc., Nutley, N. J.
Franklin Fibre-Lamitex Corp., 12th & French Sts., Wilmington, Del.
General Paper Tube Co., 430 E. Chelton Ave., Philadelphia, Pa.
National Varnished Products Corp., 211 Randolph Ave., Woodbridge, N. J.
Paramount Paper Tube Co., 801 Glasgow Ave., Fort Wayne, Ind.
Precision Paper Tube Co., 2033 W. Charleston St., Chicago, Ill.
Stone Paper Tube Co., 900 Franklin St., N. E. Washington, D. C.
Uniform Tubes, Shurs Lane & Lauriston St., Roxborough, Phila., Pa.

PLASTIC TUBING—see Insulation

Turntables

PHONOGRAPH and TRANSCRIPTION TURNTABLES

Alliance Mfg. Co., Lake Park Blvd., Alliance, Ohio
Bateman Sound Systems, 680 Johnston St., Akron, Ohio
Electro Acoustic Co., 2131 Bueter Rd., Fort Wayne, Ind.
Gates Radio Co., 200 Hampshire St., Quincy, Ill.
General Industries Co., Taylor & Olive St., Elyria, Ohio
Harris Mfg. Co., 2422 W. Seventh St., Los Angeles, Cal.
Pacent Engineering Corp., 79 Madison Ave., New York, N. Y.
Presto Recording Corp., 242 W. 55th St., New York, N. Y.
Proctor Co., B. A., 2 W. 45th St., New York, N. Y.
Radio Engineering Laboratories, Inc., 35-54 36th St., Long Island City, N. Y.
Radio Corp. of America, Camden, N. J.
Rek-O-Kut Corp., 173 Lafayette St., New York, N. Y.
Robinson Recording Laboratories, 35 S. Ninth St., Philadelphia, Pa.
Smith Co., Maxwell, 1027 N. Highland Ave., Hollywood, Cal.
Talking Devices Co., 4447 W. Irving Park Rd., Chicago, Ill.
Transformer Corp. of America, 69 Wooster St., New York, N. Y.
Waters-Conley Co., Rochester, Minn.

Varnish

see Finishes

Vibrators

American Television & Radio Corp., 300 E. 4th St., St. Paul, Minn.
Kurman Electric Co., 3030 Northern Blvd., L. I. City, N. Y.
Mallory & Co., P. R., 3029 E. Washington St., Indianapolis, Ind.
Oak Mfg. Co., 1260 Clybourn Ave., Chicago, Ill.
Radiart Corp., 3571 W. 62 St., Cleveland, Ohio
Utah Radio Products Co., 820 Orleans St., Chicago, Ill.
Vibrapower Co., James, 1551 Thomas St., Chicago, Ill.

Washers

LOCK WASHERS

American Nut & Bolt Fastener Co., 2045 Doerr St., Pittsburgh, Pa.
Clark Bros. Bolt Co., Milldale, Conn.
Eaton Mfg. Co., Reliance Spring Washer Div., Massillon, Ohio
Federal Screw Products Co., 224 W. Huron St., Chicago, Ill.
Garrett Co., Geo. K., D & Tioga Sts., Philadelphia, Pa.
Harper Co., H. M., 2630 Fletcher St., Chicago, Ill.
Hobbs Mfg. Co., 26 Salisbury St., Worcester, Mass.
Hubbard Spring Co., M. D., 7 Central Ave., Pontiac, Mich.
Industrial Screw & Supply Co., 713 W. Lake St., Chicago, Ill.
Lewis Bolt & Nut Co., 504 Malcolm Ave., S. E., Minneapolis, Minn.
Manufacturers Screw Products, 216 W. Hubbard St., Chicago, Ill.
National Lock Washer Co., 40 Hermon St., Newark, N. J.
Palnut Co., 61 Cordier St., Irvington, N. J.
Philadelphia Steel & Wire Corp., Penn St. & Belfield Ave., Philadelphia, Pa.
Positive Lock Washer Co., 181 Miller St., Newark, N. J.
Shakeproof, Inc., 2501 N. Keeler Ave., Chicago, Ill.
St Louis Screw & Bolt Co., 6900 N. B'way, St. Louis, Mo.
Thompson-Bremer & Co., 1640 W. Hubbard St., Chicago, Ill.
Wrought Washer Mfg. Co., 2223 S. Bay St., Milwaukee, Wis.

Waxes

WAXES and COMPOUNDS

Allied Asphalt & Mineral Corp., 217 Broadway, New York, N. Y.
American Products Mfg. Co., 8127 Oleander St., New Orleans, La.
Anaconda Wire & Cable Co., 25 Broadway, New York, N. Y.
Bakelite Corp., 30 E. 42d St., New York, N. Y.
Biddle Co., James G., 1213 Arch St., Philadelphia, Pa.
Biwax Corp., 1017 S. Kolmar Ave., Chicago, Ill.
Bosin Products Co., George, Lathrop Ave., Savannah, Ga.
Cantol Wax Co., 211 N. Washington St., Bloomington, Ind.
Cochrane Chemical Co., 432 Danforth Ave., Jersey City, N. J.
Federal Telephone and Radio Corp., 591 Broad St., Newark, N. J.
General Electric Co., Bridgeport, Conn.
Glyco Products Co., Inc., 26 Court St., Brooklyn, N. Y.
Halowax Products Div., Union Carbide & Carbon Corp., 30 East 42nd St., New York, N. Y.
Insl-X Co., Inc., 857 Meeker Ave., Brooklyn, N. Y.
Insulatine Co., 1 Broadway, New York, N. Y.
Johns-Manville, 22 E. 40th St., New York, N. Y.
Maas and Waldstein Co., 438 Riverside Ave., Newark, N. J.
Mineralіac Electric Co., 25 N. Peoria St., Chicago, Ill.
Mitchell-Rand Insulation Co., 51 Murray St., New York, N. Y.
Okonite Co., Canal St., Passaic, N. J.
Petroleum Specialties, Inc., 570 Lexington Ave., New York, N. Y.
Pioneer Asphalt Co., 435 N. Michigan Ave., Chicago, Ill.
Roebling's Sons Co., John A., 640 S. Broad St., Trenton, N. J.
Sterling Varnish Co., Haysville, Pa.
Trotter & Co., E. T., 594 Johnson Ave., Brooklyn, N. Y.
Zophar Mills, Inc., 112–26th St., Brooklyn, N. Y.

WINDINGS—see Coils

Wire

POWER CORDS

Alden Products Co., 117 Main St., Brockton, Mass.

Alpha Wire Corp., 50 Howard St., New York, N. Y.
American Electric Cable Co., Holyoke, Mass.
American Steel & Wire Co., Rockefeller Bldg., Cleveland, Ohio
Anaconda Wire & Cable Co., 25 Broadway, New York, N. Y.
Ansonia Electrical Co., Ansonia, Conn.
Belden Mfg. Co., 4647 W. Van Buren St., Chicago, Ill.
Birnbach Radio Co., 145 Hudson St., New York, N. Y.
Boston Insulated Wire & Cable Co., 65 Bay St., (Dorchester), Boston, Mass.
Camden Wire Co., Camden, N. Y.
Circle Wire & Cable Corp., 5500 Maspeth Ave., Maspeth, N. Y.
Clarostat Mfg. Co., 285 N. Sixth St., Brooklyn, N. Y.
Collyer Insulated Wire Co., 249 N. Main St., Pawtucket, R. I.
Columbia Cable & Electric Co., 45-45 30th Place, Long Island City, N. Y.
Consolidated Wire & Associated Corps., Peoria & Harrison Sts., Chicago, Ill.
Cornish Wire Co., 15 Park Row, New York, N. Y.
Crescent Co., Front & Central Ave., Pawtucket, R. I.
Crescent Insulated Wire & Cable Co., N. Olden Ave., Trenton, N. J.
Electric Auto-Lite Co., Wire Div., 3529-24th St., Port Huron, Mich.
Essex Wire Corp., 1601 Wall St., Fort Wayne, Ind.
General Cable Corp., 420 Lexington Ave., New York, N. Y.
General Electric Co., Schenectady, N. Y.
Guthman Co., Edwin I., 15 S. Throop, Chicago, Ill.
Hatfield Wire & Cable Co., Hillside, N. J.
Hazard Insulated Wire Works, Div. of The Okonite Co., Wilkes-Barre, Pa.
Kellogg Switchboard & Supply Co., 6650 S. Cicero Ave., Chicago, Ill.
Kennecott Wire & Cable Co., Phillipsdale, R. I.
Kerite Insulated Wire & Cable Co., Seymour, Conn.
Lenz Electric Mfg. Co., 1751 N. Western Ave., Chicago, Ill.
Lowell Insulated Wire Co., 171 Lincoln St., Lowell, Mass.
National Electric Products Corp., Fulton Bldg., Pittsburgh, Pa.
New England Cable Co., Concord, N. H.
Okonite Co., Passaic, N. J.
Paranite Wire & Cable Div., Essex Wire Corp., 1601 Wall St., Fort Wayne, Ind.
Phelps Dodge Copper Products Corp., American Copper Products Div., 40 Wall St., New York, N. Y.
Rockbestos Products Corp., 308 Nicoll St., New Haven, Conn.
Roebling's Sons Co., John A., 640 S. Broad St., Trenton, N. J.
Rome Cable Corp., Rome, N. Y.
Runzel Cord & Wire Co., 4731 W. Montrose Ave., Chicago, Ill.
Simplex Wire & Cable Corp., 79 Sidney St., Cambridge, Mass.
Triangle Conduit & Cable Co., New Brunswick, N. J.
Walker Bros., Conshohocken, Pa.
Wheeler Insulated Wire Co., 378 Washington Ave., Bridgeport, Conn.
Whitney Blake Co., New Haven, Conn.
York Insulated Wire Works Div. of General Electric Co., York, Pa.

ANTENNA WIRE

Alpha Wire Corp., 50 Howard St., New York, N. Y.
American Brass Co., Waterbury, Conn.
American Steel & Wire Co., Rockefeller Bldg., Cleveland, Ohio
Anaconda Wire & Cable Co., 25 Broadway, New York, N. Y.
Ansonia Electrical Co., Ansonia, Conn.
Boston Insulated Wire & Cable Co., 65 Bay St., (Dorchester), Boston, Mass.
Chase Brass & Copper Co., 236 Grand St., Waterbury, Conn.
Circle Wire & Cable Corp., 5500 Maspeth Ave., Maspeth, L. I., N. Y.
Crescent Insulated Wire and Cable Co., N. Olden Ave., Trenton, N. J.
Electric Auto-Lite Co., Wire Div., 3529-24 St., Port Huron, Mich.
General Cable Corp., 420 Lexington Ave., New York, N. Y.
General Electric Co., Schenectady, N. Y.
E. F. Johnson Co., Waseca, Minn.
New England Electrical Works, 365 Main St., Lisbon, N. H.
Roebling's Sons Co., John A., 640 S. Broad St., Trenton, N. J.
Sherman & Reilly, Inc., Chattanooga, Tenn.

HIGH VOLTAGE WIRE

Alden Products Co., 117 Main St., Brockton, Mass.
Alpha Wire Corp., 50 Howard St., New York, N. Y.
American Steel & Wire Co., Rockefeller Bldg., Cleveland, Ohio
Anaconda Wire & Cable Co., 25 Broadway, New York, N. Y.
Boston Insulated Wire & Cable Co., 65 Bay St., (Dorchester), Boston, Mass.
Crescent Co., Front & Central Ave., Ave., Pawtucket, R. I.
Crescent Insulated Wire & Cable Co., North Olden Ave., Trenton, N. J.
Diamond Wire & Cable Co., 128 E. 16th St., Chicago Heights, Ill.
Driver Co., Wilbur B., Riverside Ave., Newark, N. J.
General Cable Corp., 420 Lexington Ave., New York, N. Y.
General Electric Co., Schenectady, N. Y.
Goldmark Wire Co., James, 116 West St., New York, N. Y.
Jeliff Mfg. Corp., C. O., 200 Pequot Ave., Southport, Conn.
National Electric Products Corp., Fulton Bldg., Pittsburgh, Pa.
Okonite Co., Canal St., Passaic, N. J.
Phelps Dodge Copper Products Corp., 40 Wall St., New York, N. Y.
Rhode Island Insulated Wire Co., 50 Burnham Ave., Providence, R. I.
Rockbestos Products Corp., 309 Nicoll St., New Haven, Conn.
Roebling's Sons Co., John A., 640 S. Broad St., Trenton, N. J.
Rome Cable Corp., 330 Ridge St., Rome, N. Y.
Whitney Blake Co., New Haven, Conn.
York Insulated Wire Works Div., General Electric Co., York, Pa.

HOOKUP WIRE

Aircraft-Marine Products, Inc., 286 No. Broad St., Elizabeth, N. J.
Acorn Insulated Wire Co., 225 King St., Brooklyn, N. Y.
Alden Products Co., 117 Main St., Brockton, Mass.
Alpha Wire Corp., 50 Howard St., New York, N. Y.
American Electric Cable Co., Holyoke, Mass.
Anaconda Wire & Cable Co., 25 Broadway, New York, N. Y.
Ansonia Electrical Co., Ansonia, Conn.
Belden Mfg. Co., 4647 W. Van Buren St., Chicago, Ill.
Birnbach Radio Co., 145 Hudson St., New York, N. Y.
Boston Insulated Wire & Cable Co., 65 Bay St., (Dorchester) Boston, Mass.
Consolidated Wire & Associated Corps., Peoria & Harrison Sts., Chicago, Ill.
Cornish Wire Co., 15 Park Row, New York, N. Y.
Crescent Co., Front & Central Ave., Pawtucket, R. I.
Crescent Insulated Wire & Cable Co., Trenton, N. J.
Diamond Wire & Cable Co., 128 East 16th St., Chicago Heights, Ill.
Electric Auto-Lite Co., Wire Div., 3529-24 St., Port Huron, Mich.
Essex Wire Corp., 1601 Wall St., Fort Wayne, Ind.
Gavitt Mfg. Co., Inc., Brookfield, Mass.
General Cable Corp., 420 Lexington Ave., New York, N. Y.
General Electric Co., Bridgeport, Conn.
Lenz Electric Mfg. Co., 1751 N. Western Ave., Chicago, Ill.
Lowell Insulated Wire Co., 171 Lincoln St., Lowell, Mass.
Paranite Wire & Cable Corp., 1601 Wall St., Fort Wayne, Ind.
Packard Electric Div., General Motors Corp., Warren, Ohio
Phelps Dodge Copper Products Corp., 40 Wall St., New York, N. Y.
Precision Tube Co., 3828 Terrace St., Philadelphia, Pa.
Rockbestos Products Corp., 308 Nicoll St., New Haven, Conn.
Western Insulated Wire, Inc., 1001 East 62nd St., Los Angeles, Calif.

MAGNET WIRE

Acme Wire Co., 1255 Dixwell Ave., New Haven, Conn.
American Steel & Wire Co., Rockefeller Bldg., Cleveland, Ohio
Anaconda Wire & Cable Co., 25 Broadway, New York, N. Y.
Ansonia Electrical Co., Ansonia, Conn.
Belden Mfg. Co., 4647 W. Van Buren St., Chicago, Ill.
Cornish Wire Co., 15 Park Row, New York, N. Y.
Crescent Insulated Wire & Cable Co., Olden & Taylor Aves., Trenton, N. J.
Electric Auto-Lite Co., Wire Div., 3529-24 St., Port Huron, Mich.
Essex Wire Corp., 1601 Wall St., Fort Wayne, Ind.
General Cable Corp., 420 Lexington Ave., New York, N. Y.
General Electric Co., Schenectady, N. Y.
Goldmark Wire Co., James, 116 West St., New York, N. Y.
Guthman & Co., Edwin I., 15 S. Throop St., Chicago, Ill.
Hudson Wire Co., Winsted Div., Winsted, Conn.
Massachusetts Electric Mfg. Co., 11 Margin St., West Lynn, Mass.
Meisner Mfg. Co., Mt. Carmel, Ill.
New England Electrical Works, Lisbon, N. H.
Paranite Wire & Cable Corp., Div., Essex Wire Co., 1601 Wall St., Fort Wayne, Ind.
Phelps Dodge Copper Products Corp., 40 Wall St., New York, N. Y.
Philadelphia Insulated Wire Co., 200 N. Third St., Philadelphia, Pa.
Rea Magnet Wire Co., Inc., E. Pontiac St., Fort Wayne, Ind.
Rockbestos Products Corp., 308 Nicoll St., New Haven, Conn.
Roebling's Sons Co., John A., 640 S. Broad St., Trenton, N. J.
Rome Cable Corp., 330 Ridge St., Rome, N. Y.
Wheeler Insulated Wire Co., 378 Washington Ave., Bridgeport, Conn.

RESISTANCE and FILAMENT WIRE

Alloy Metal Wire Co., Prospect Park, Pa.
American Brass Co., Waterbury, Conn.
American Steel & Wire Co., Rockefeller Bldg., Cleveland, Ohio
Callite Tungsten Corp., 544 39th St., Union City, N. J.
Cohn & Co., Sigmund, 44 Gold St., New York, N. Y.
Driver Co., Wilbur B., 150 Riverside Ave., Newark, N. J.
Driver-Harris Co., 201 Middlesex St., Harrison, N. J.
Gibbs & Co., Thomas B., Div. of George W. Borg Corp., 814 Michigan St., Delavan, Wisc.
Goldmark Wire Co., James, 116 West St., New York, N. Y.
Haydu Bros., Mt. Bethel Rd., Plainfield, N. J.
Hoskins Mfg. Co., 4445 Lawton Ave., Detroit, Mich.
Jelliff Mfg. Corp., C. O., 200 Pequot Ave., Southport, Conn.
Rockbestos Products Corp., 308 Nicoll St., New Haven, Conn.

SHIELDED WIRE

Alden Products Co., 117 Main St., Brockton, Mass.
Belden Mfg. Co., 4673 W. Van Buren St., Chicago, Ill.
Crescent Ins. Wire & Cable Co., N. Olden Ave., Trenton, N. J.
Chase Brass & Copper Co., Waterbury, Conn.
Cornish Wire Co., Inc., 15 Park Row, New York, N. Y.
General Cable Corp., 420 Lexington Ave., New York, N. Y.
Packard Electric Division, General Motors Corp., Warren, Ohio
Precision Tube Co., 3828 Terrace St., Philadelphia, Pa.
Roebling's Son's Co., John A., 640 Broad St., Trenton, N. J.
Uniform Tubes, Shurs Lane & Lauriston St., Roxborough, Philadelphia, Pa.

COMPILING THIS DIRECTORY

Nearly three thousand company names were questionnaired in order to prepare this Directory. A second and third follow-up was sent out to those who were slow in answering. Although the response was high, it was not complete, and there may be a few omissions. However, we believe this is the most complete and authentic Directory we have ever published—certainly the most useful of any in the field.

ELECTRICAL INSTRUMENTS

Adapters

TEST ADAPTERS

Alden Products Co., 117 Main St., Brockton, Mass.
American Radio Hardware Co., Inc., 476 Broadway, New York, N. Y.
Bud Radio, Inc., 2118 E. 55th St., Cleveland, Ohio
Radio City Products Co., 127 W. 26th St., New York, N. Y.
Radio Corp. of America, Camden, N. J.
Readrite Meter Works, College Ave., Bluffton, Ohio
Rola Co., Inc., 2530 Superior Ave., Cleveland, Ohio
Triplett Electrical Instrument Corp., 286 Hermon Rd., Bluffton, Ohio

Ammeters

see Meters

Analyzers

CIRCUIT ANALYZERS

Aerovox Corp., 740 Belleville Ave., New Bedford, Mass.
Clough-Brengle Co., 5501 N. Broadway, Chicago, Ill.
General Electric Co., Schenectady, N. Y.
General Radio Co., 30 State St., Cambridge, Mass.
Hewlett-Packard Co., 395 Page Mill Rd., Palo Alto, Cal.
Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio
H-W Mfg. Co., 3124 Larga Ave., Los Angeles, Cal.
J. B. T. Instruments, Inc., 441 Chapel St., New Haven, Conn.
Mallory & Co., P. R., 3029 E. Washington St., Indianapolis, Ind.
Philco Corp., Tioga & C Sts., Philadelphia, Pa.
Precision Apparatus Co., 92-27 Horace Harding Blvd., Elmhurst, N. Y.
Radio City Products Co., 127 W. 26th St., New York, N. Y.
Radio Corp. of America, Camden, N. J.
Readrite Meter Works, College Ave., Bluffton, Ohio
Roller-Smith Co., Bethlehem, Pa.
Simpson Electric Co., 5218 W. Kinzie St., Chicago, Ill.
Supreme Instrument Corp., Greenwood, Miss.
Televiso Products, Inc., 6533 N. Olmsted Ave., Chicago, Ill.
Triplett Electrical Instrument Co., 286 Harmon Rd., Bluffton, Ohio
Triumph Mfg. Co., 913 W. Van Buren St., Chicago, Ill.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J.

HARMONIC ANALYZERS

Gaertner Scientific Corp., 1201 Wrightwood Ave., Chicago, Ill.
Hewlett-Packard Co., 395 Page Mill Rd., Palo Alto, Cal.
Mico Instrument Co., 10 Arrow St., Cambridge, Mass.
United Transformer Co., 150 Varick St., New York, N. Y.

NOISE ANALYZERS

Aerovox Corp., 740 Belleville Ave., New Bedford, Mass.
Deutschmann Corp., Tobe, Canton, Mass.
Ferris Instrument Corp., 110-112 Cornelia St., Boonton, N. J.
General Electric Co., Schenectady, N. Y.
General Radio Co., 30 State St., Cambridge, Mass.
Radio Corp. of America, Camden, N. J.
Sprague Specialties Co., 189 Beaver St., North Adams, Mass.
Televiso Products, Inc., 6533 N. Olmsted Ave., Chicago, Ill.

TRANSMISSION ANALYZERS

Daven Co., 158 Summit St., Newark, N. J.
General Electronics Industries, 342 Putnam, Greenwich, Conn.

Bridges

ELECTRICAL MEASUREMENT BRIDGES

see also Analyzers
also Testers

Aerovox Corp., 740 Belleville Ave., New Bedford, Mass.
Biddle Co., James G., 1213 Arch St., Philadelphia, Pa.
Central Scientific Co., 1700 Irving Park Rd., Chicago, Ill.
Clough-Brengle Co., 5501 N. Broadway, Chicago, Ill.
Communication Measurements Laboratory, 120 Greenwich St., New York, N. Y.
Cornell-Dubilier Electric Corp., 1000 Hamilton Blvd., South Plainfield, N. J.
Foxboro Co., Foxboro, Mass.
General Electric Co., Schenectady, N. Y.
General Radio Co., 30 State St., Cambridge, Mass.
Gray Instrument Co., 64½ W. Johnson St., Philadelphia, Pa.
Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio
Hollywood Electronics Co., 800 Sunset Blvd., Los Angeles, Calif.
Industrial Instruments, Inc., 156 Culver Ave., Jersey City, N. J.
Leeds & Northrup Co., 4970 Stenton Ave., Philadelphia, Pa.
Photobell Corp., 116 Nassau St., New York, N. Y.
Radio Corp. of America, Camden, N. J.
Radio City Products Co., Inc., 127 West 26th St., New York, N. Y.
Roller-Smith Co., Bethlehem, Pa.
Rubicon Co., 3751 Ridge Ave., Philadelphia, Pa.
Shallcross Mfg. Co., 10 Jackson Ave., Collingdale, Pa.
Supreme Instruments Corp., Greenwood, Miss.
Tagliabue Mfg. Co., C. J., 540 Park Ave., Brooklyn, N. Y.
Thwing-Albert Instrument Co., Penn St. & Pulaski Ave., Philadelphia, Pa.
Triplett Electrical Instrument Co., 286 Harmon Rd., Bluffton, Ohio
United Transformer Co., 150 Varick St., New York, N. Y.
Welch Scientific Co., W. M., 1515 Sedgwick St., Chicago, Ill.

Forks

ELECTRICALLY DRIVEN TUNING FORKS

Cambridge Instrument Co., Grand Central Terminal, New York, N. Y.
Central Scientific Co., 1700 Irving Park Blvd., Chicago, Ill.
Chicago Apparatus Co., 1735 N. Ashland Ave., Chicago, Ill.
Electric Tachometer Corp., 1354 Spring Garden St., Philadelphia, Pa.
Gaertner Scientific Corp., 1201 Wrightwood Ave., Chicago, Ill.
General Radio Co., 30 State St., Cambridge, Mass.
Gibbs & Co., Thomas B., Div. of George W. Borg Corp., 814 Michigan St., Delavan, Wisc.
Riverbank Laboratories, Geneva, Ill.
Welch Scientific Co., W. M., 1515 Sedgwick St., Chicago, Ill.

Galvanometers

see Meters

Generators

see also Generators, Dynamotors

SIGNAL GENERATORS

B. C. Equipment Co., 32 N. Washington St., Battle Creek, Mich.
Bendix Aviation Corp., Bendix Radio Division, Baltimore, Md.
Bendix Aviation Corp., Marine Div., 1 Hanson Place, Brooklyn, N. Y.
Boonton Radio Corp., Boonton, N. J.
Carron Mfg. Co., 415 S. Aberdeen St., Chicago, Ill.
Clough-Brengle Co., 5501 N. Broadway, Chicago, Ill.
Dayco Radio Corp., 915 Valley St., Dayton, Ohio
Espey Mfg. Co., Inc., 305 East 63rd St., New York, N. Y.
Fada Radio & Electric Co., Inc., 30-20 Thomson Ave., Long Island City, N. Y.
Federal Mfg. & Engineering Corp., 199-217 Steuben St., Brooklyn, N. Y.
Ferris Instrument Corp., 110-112 Cornelia St., Boonton, N. J.
General Electric Co., Schenectady, N. Y.
General Radio Co., 30 State St., Cambridge, Mass.
Hewlett-Packard Co., 395 Page Mill Rd., Palo Alto, Cal.
Measurements Corp., Boonton, N. J.
Meissner Mfg. Co., Mt. Carmel, Ill.
Monarch Mfg. Co., 2014 N. Major Ave., Chicago, Ill.
Packard Bell Co., 1115 So. Hope St., Los Angeles, Calif.
Precision Apparatus Co., 92-27 Horace Harding Blvd., Elmhurst, N. Y.
Radex Corp., 1322 Elston Ave., Chicago, Ill.
Radio City Products Co., 127 W. 26th St., New York, N. Y.
Radio Corp. of America, Camden, N. J.
Radio Design Co., 1353 Sterling Place, Brooklyn, N. Y.
Reiner Electronics Co., 152 West 25th St., New York, N. Y.
Remler Co., Ltd., 2101 Bryant St., San Francisco, Cal.
Hickok Electrical Instrument Co., 10514 DuPont Ave., Cleveland, Ohio
Superior Instruments Co., 227 Fulton St., New York, N. Y.
Transmitter Equipment Mfg. Co., Inc., 345 Hudson St., New York, N. Y.
Triplett Electrical Instrument Co., 286 Harmon Rd., Bluffton, Ohio
Triumph Mfg. Co., 913 W. Van Buren St., Chicago, Ill.

SQUARE WAVE GENERATORS

Audio-Tone Oscillator Co., 60 Walter St., Bridgeport, Conn.
General Electric Co., Schenectady, N. Y.
General Electronic Industries, 342 Putnam, Greenwich, Conn.
General Radio Co., 30 State St., Cambridge, Mass.
Hewlett-Packard Co., 395 Page Mill Rd., Palo Alto, Cal.
Hollywood Electronics Co., 800 Sunset Blvd., Los Angeles, Calif.
Measurements Corp., Boonton, N. J.
Radio Corp. of America, Camden, N. J.
Reiner Electronics Co., 152 West 25th St., New York, N. Y.

Indicators

CAPACITOR LEAKAGE INDICATORS

Cornell-Dubilier Electric Corp., 1000 Hamilton Blvd., South Plainfield, N. J.
Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio
Industrial Instruments, Inc., 156 Culver Ave., Jersey City, N. J.
Leeds & Northup Co., 4970 Stenton Ave., Philadelphia, Pa.

POWER LEVEL INDICATORS and RECORDERS

see Meters

Daven Co., 158 Summit St., Newark, N. J.
General Electric Co., Schenectady, N. Y.
Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio
Monarch Mfg. Co., 2014 N. Major Ave., Chicago, Ill.
Radio Corp. of America, Camden, N. J.
Sound Apparatus Co., 150 W. 46th St., New York, N. Y.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

VOLUME INDICATORS—see Meters

Meters

AMMETERS

Boes Co., W. W., 3001 Salem Ave., Dayton, Ohio
Bristol Co., Waterbury, Conn.
Burlington Instrument Co., 316 Valley St., Burlington, Ia.
Columbia Electric Mfg. Co., 4519 Hamilton Ave., Cleveland, Ohio
De Jur-Amsco Corp., 6 Bridge St., Shelton, Conn.
Engelhard, Inc., Charles, 233 N. J. R. R. Ave., Newark, N. J.
Esterline-Angus Co., P. O. Box 597, Indianapolis, Ind.
Ferranti Electric, Inc., 30 Rockefeller Plaza, New York, N. Y.
General Electric Co., Schenectady, N. Y.
Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio
Hoyt Electrical Instrument Works, Boston, Mass.
Jackson Electrical Instrument Co., 131 Wayne Ave., Dayton, Ohio
J. B. T. Instruments, Inc., 441 Chapel St., New Haven, Conn.
Martindale Elec. Co., Box 617 Edgewater Br., Cleveland, Ohio
Norton Electrical Instrument Corp., 79 Hilliard St., Manchester Conn.
Precision Apparatus Co., 92-27 Horace Harding Blvd., Elmhurst, L. I., N. Y.
Rawson Electrical Instrument Co., 110 Potter St., Cambridge, Mass.
Readrite Meter Works, College Ave., Bluffton, Ohio
Reliance Instrument Co., 715 N. Kedzie Ave., Chicago, Ill.
Rhamstine, J. Thos., 301 Beaubien St., Detroit, Mich.
Rieber, Inc., Frank, 11916 W. Pico Blvd., Los Angeles, Calif.
Roller-Smith Co., Bethlehem, Pa.
Sensitive Research Instrument Corp., 9-11 Elm Ave., Mt. Vernon, N. Y.
Simpson Electric Co., 5200-16 W. Kinzie St., Chicago, Ill.
Sun Mfg. Co., 6323 Avondale Ave., Chicago, Ill.
Superior Instruments Co., 227 Fulton St., New York, N. Y.
Supreme Instruments Corp., Greenwood, Miss.
Triplett Electrical Instrument Co., 286 Harmon Rd., Bluffton, Ohio
Welch Scientific Co., W. M., 1515 Sedgwick St., Chicago, Ill.
Western Electro-Mechanical Co., Inc., 300 Broadway, New York, N. Y.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J.

FREQUENCY METERS

Bendix Radio, Div. of Bendix Aviation Corp., Baltimore, Md.
Biddle Co., James G., 1213 Arch St., Philadelphia, Pa.
Browning Laboratories, Inc., 750 Main St., Winchester, Mass.
Burnett, Wm. W. L., 4814 Idaho St., San Diego, Cal.
Doolittle Radio, Inc., 7421 Loomis Blvd., Chicago, Ill.
Erco Radio Laboratories, Inc., Fenimore Ave., Hempstead, N. Y.
Espey Mfg. Co., Inc., 305 East 63rd St., New York, N. Y.
Esterline-Angus Co., P. O. Box 596, Indianapolis, Ind.
Ferris Instrument Corp., Boonton, N. J.
Garner Co., Fred E., 41 E. Ohio St., Chicago, Ill.
General Electric Co., Schenectady, N. Y.
General Electronic Industries, 342 Putnam, Greenwich, Conn.
General Radio Co., 30 State St., Cambridge, Mass.
Gurley, W. & L. E., 514 Fulton St., Troy, N. Y.
Harvey Radio Laboratories, Inc., 447 Concord Ave., Cambridge, Mass.
Herbach & Rademan Co., 522 Market St., Philadelphia, Pa.
Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio
Higgins Industries, Inc., 2221 Warwick Ave., Santa Monica, Calif.
Lampkin Laboratories, Bradenton, Fla.
Leeds & Northrup Co., 4970 Stenton Ave., Philadelphia, Pa.
Lavoie Laboratories, Mattawan-Freehold Rd., Morganville, N. J.
Millen Mfg. Co., 150 Exchange St., Malden, Mass.
Radio Corp. of America, Camden, N. J.
Rieber, Inc., Frank, 11916 W. Pico Blvd., Los Angeles, Calif.
Roller-Smith Co., Bethlehem, Pa.
Sonotone Corp., P. O. Box 200, Sawmill River Rd., Elmsford, N. Y.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J.

GALVANOMETERS

Brown Instrument Co., 4428 Wayne Ave., Philadelphia, Pa.
Brush Development Co., 3311 Perkins Ave., Cleveland, Ohio
Cambridge Instrument Co., Grand Central Terminal, New York, N. Y.
Central Scientific Co., 1700 Irving Park Blvd., Chicago, Ill.
Chicago Apparatus Co., 1735 N. Ashland Ave., Chicago, Ill.
General Electric Co., Schenectady, N. Y.
Hathaway Instrument Co., 1315 S. Clarkson St., Denver, Colo.
Heiland Research Corp., 130 East Fifth St., Denver, Col.
Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio
Leeds & Northrup Co., 4970 Stenton Ave., Philadelphia, Pa.
Miller Corp., Wm., 362 W. Colorado St., Pasadena, Calif.
Pfaltz & Bauer, Inc., 350 Fifth Ave., New York, N. Y.
Rawson Electrical Instrument Co., 110 Potter St., Cambridge, Mass.
Roller-Smith Co., Bethlehem, Pa.
Rubicon Co., 3751 Ridge Ave., Philadelphia, Pa.
Sensitive Research Instrument Corp., 9-11 Elm Ave., Mt. Vernon, N. Y.
Tagliabue Mfg. Co., C. J., 540 Park Ave., Brooklyn, N. Y.
Thwing-Albert Instrument Co., Penn St. & Pulaski Ave., Philadelphia, Pa.
Triplett Electrical Instrument Co., 286 Harmon Rd., Bluffton, Ohio
Welch Scientific Co., W. M., 1515 Sedgwick St., Chicago, Ill.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J.

MODULATION METERS

General Radio Co., 30 State St., Cambridge, Mass.
Radio Corp. of America, Camden, N. J.
Sundt Engineering Co., 4757 Ravenswood Ave., Chicago, Ill.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J.

OHMMETERS

Biddle Co., James G., 1213 Arch St., Philadelphia, Pa.
Borden Electric Co., Summit, N. J.
Esterline-Angus Co., P. O. Box 596, Indianapolis, Ind.
General Electric Co., Schenectady, N. Y.
General Radio Co., 30 State St., Cambridge, Mass.
Gray Instrument Co., 64 W. Johnson St., (Germantown) Philadelphia, Pa.
Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio
Hoyt Electrical Instrument Works, Boston, Mass.
Industrial Instrument Co., 2249 14th St., S. W., Akron, Ohio
Leeds & Northrup Co., 4970 Stenton Ave., Philadelphia, Pa.
Martindale Electric Co., Box 617, Edgewater Br., Cleveland, Ohio
Norton Electric Instrument Co., 79 Hilliard St., Manchester, Conn.
Precision Apparatus Co., 92-27 Horace Harding Blvd., Elmhurst, N. Y.
Radio City Products Co., 127 W. 26th St., New York, N. Y.
Radio Design Co., 1353 Sterling Place, Brooklyn, N. Y.
Rawson Electrical Instrument Co., 110 Potter St., Cambridge, Mass.
Roller-Smith Co., Bethlehem, Pa.
Rubicon Co., 3751 Ridge Ave., Philadelphia, Pa.
Sensitive Research Instrument Corp., 9-11 Elm Ave., Mt. Vernon, N. Y.
Shallcross Mfg. Co., 10 Jackson Ave., Collingdale, Pa.
Simpson Electric Co., 5218 W. Kinzie St., Chicago, Ill.
Sticht Co., Inc., Herman H., 27 Park Row, New York, N. Y.
Triplett Electrical Instrument Co., 286 Harmon Rd., Bluffton, Ohio
Triumph Mfg. Co., 913 W. Van Buren St. Chicago, Ill.
Welch Scientific Co., W. M., 1515 Sedgwick St., Chicago, Ill.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J.

PHASE ANGLE METERS

Andrew Co., Victor J., 363 East 75th St., Chicago, Ill.
General Electric Co., Schenectady, N. Y.
Johnson Co., E. F., Waseca, Minn.
Leeds & Northrup Co., 4970 Stenton Ave., Philadelphia, Pa.
Radio Corp. of America, Camden, N. J.

POWER LEVEL METERS—see Indicators

"Q" METERS

Boonton Radio Corp., Boonton, N. J.

THERMOCOUPLE METERS

General Electric Co., Schenectady, N. Y.
Rawson Electrical Instrument Co., 110 Potter St., Cambridge, Mass.
Reliance Instrument Co., 715 N. Kedzie Ave., Chicago, Ill.
Roller-Smith Co., Bethlehem, Pa.
Sensitive Research Instrument Co., 9-11 Elm Ave., Mt. Vernon, N. Y.
Triplett Electrical Instrument Co., 286 Harmon Rd., Bluffton, Ohio
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

VACUUM TUBE VOLTMETERS

Ballantine Laboratories, Inc., Boonton, N. J.
Espey Mfg. Co., Inc., 305 East 63rd St., New York, N. Y.
Fada Radio & Electric Co., 30-20 Thomson Ave., Long Island City, N. Y.
Ferris Instrument Corp., 110-112 Cornelia St., Boonton, N. J.
Fisher Scientific Co., 711 Forbes St., Pittsburgh, Pa.
General Electric Co., Schenectady, N. Y.
General Radio Co., 30 State St., Cambridge, Mass.
Hewlett-Packard Co., 395 Page Mill Rd., Palo Alto, Cal.
J-B-T Instruments, Inc., 441 Chapel St., New Haven, Conn.
Jackson Electrical Instrument Co., 131 Wayne Ave., Dayton, Ohio
Measurements Corp., Boonton, N. J.
National Technical Laboratories, 820 Mission St., S. Pasadena, Calif.
Precision Apparatus Co., 647 Kent Ave., Brooklyn, N. Y.
Radio Design Co., 1353 Sterling Place, Brooklyn, N. Y.
Reiner Electronics Co., 152 West 25th St., New York, N. Y.
Reliance Instrument Co., 1135 W. Van Buren St., Chicago, Ill.
Shallcross Mfg. Co., 10 Jackson Ave., Collingdale, Pa.
Sound Apparatus Co., 150 West 46th St., New York, N. Y.
Televiso Products, Inc., 6553 N. Olmsted Ave., Chicago, Ill.
Triplett Electrical Instrument Co., 286 Harmon Rd., Bluffton, Ohio
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J.

VOLTMETERS

Boes Co., W. W., 3001 Salem Ave., Dayton, Ohio
Ballantine Laboratories, Inc., Boonton, N. J.
Barber Labs, Alfred W., 34-04 Francis Lewis Blvd., Flushing, N. Y.
Burlington Instrument Co., 316 Valley St., Burlington, Iowa
De Jur-Amsco Corp., 6 Bridge St., Shelton, Conn.

Englehard, Inc., Charles, 233 N. J. R. R. Ave., Newark, N. J.
Esterline-Angus Co., P. O. Box 596, Indianapolis, Ind.
Ferranti Electric, Inc., 30 Rockefeller Plaza, New York, N. Y.
Ferris Instrument Corp., 110-112 Cornelia St., Boonton, N. J.
General Electric Co., Schenectady, N. Y.
General Radio Co., 30 State St., Cambridge, Mass.
Hatry & Young, 203 Ann St., Hartford, Conn.
Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio
Hollywood Electronics Co., 800 Sunset Blvd., Los Angeles, Calif.
Hoyt Electrical Instrument Works, Boston, Mass.
J-B-T Instruments, Inc., 441 Chapel St., New Haven, Conn.
Norton Electrical Instrument Co., 79 Hilliard St., Manchester, Conn.
Radio City Products Co., 127 W. 26th St., New York, N. Y.
Rawson Electrical Instrument Co., 110 Potter St., Cambridge, Mass.
Reliance Instrument Co., 715 N. Kedzie Ave., Chicago, Ill.
Rhamstine, J. Thos., 301 Beaubien St., Detroit, Mich.
Rieber, Inc., Frank, 11916 W. Pico Blvd., Los Angeles, Calif.
Roller-Smith Co., Bethlehem, Pa.
Rowe Radio Research Laboratory Co., 2422 N. Pulaski Rd., Chicago, Ill.
Sensitive Research Instrument Corp., 9-11 Elm St., Mt. Vernon, N. Y.
Shallcross Mfg. Co., 10 Jackson Ave., Collingdale, Pa.
Simpson Electric Co., 5200-16 W. Kinzie St., Chicago, Ill.
Sun Mfg. Co., 6323 Avondale Ave., Chicago, Ill.
Supreme Instruments Corp., Greenwood, Miss.
Televiso Products, Inc., 6553 N. Olmsted Ave., Chicago, Ill.
Triplett Electrical Instrument Co., 286 Harmon Rd., Bluffton, Ohio
Triumph Mfg. Co., 4017 W. Lake St., Chicago, Ill.
Welch Scientific Co., W. M., 1515 Sedgwick St., Chicago, Ill.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J.

VOLUME INDICATOR METERS

Amplifier Co. of America, 17 W. 20th St., New York, N. Y.
Daven Co., 158 Summit St., Newark, N. J.
General Electric Co., Schenectady, N. Y.

WATTMETERS

Audi-Tone Oscillator Co., 60 Walter St., Bridgeport, Conn.
Bristol Co., Waterbury, Conn.
Esterline-Angus Co., P. O. Box 596, Indianapolis, Ind.
General Electric Co., Schenectady, N. Y.
Leeds & Northrup Co., 4970 Stenton Ave., Philadelphia, Pa.
Reliance Instrument Co., 715 N. Kedzie Ave., Chicago, Ill.
Roller-Smith Co., Bethlehem, Pa.
Sensitive Research Instrument Corp., 9-11 Elm Ave., Mt. Vernon, N. Y.
Welch Scientific Co., W. M., 1515 Sedgwick St., Chicago, Ill.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J.

Microammeters

see Ammeters

Microfaradmeters

see Bridges

Milliammeters

see Ammeters

Multipliers

VOLTMETER MULTIPLIERS

Associated Research, Inc., 231 S. Green St., Chicago, Ill.
Farnsworth Television & Radio Corp., Fort Wayne, Ind.
General Electric Co., Schenectady, N. Y.
Instrument Resistors, Inc., 25 Amity St., Little Falls, N. J.
Precision Resistor Co., 334 Badger Ave., Newark, N. J.
Shallcross Mfg. Co., 10 Jackson Ave., Collingdale, Pa.

Ohmmeters

see Meters

Oscillators

AUDIO-FREQUENCY OSCILLATORS

American Communications Corp., 306 Broadway, New York, N. Y.
American Instrument Co., 8030 Georgia Ave., Silver Spring, Md.
Amplifier Co. of America, 17 W. 20th St., New York, N. Y.
Audio-Tone Oscillator Co., 60 Walter St., Bridgeport, Conn.
Boonton Radio Corp., Boonton, N. J.
Carron Mfg. Co., 415 S. Aberdeen St., Chicago, Ill.
Clough-Brengle Co., 5501 N. Broadway, Chicago, Ill.
Espey Mfg. Co., Inc., 305 East 63rd St., New York, N. Y.
Dayco Radio Corp., 915 Valley St., Dayton, Ohio
Fada Radio & Electric Co., 30-20 Thomson Ave., Long Island City, N. Y.
General Electronic Industries, 342 Putnam, Greenwich, Conn.
General Radio Co., 30 State St., Cambridge, Mass.
Hewlett-Packard Co., 395 Page Mill Rd., Palo Alto, Cal.
Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio
Hollywood Electronics Co., 800 Sunset Blvd., Los Angeles, Calif.
Jackson Electrical Instrument Co., 123 Wayne Ave., Dayton, Ohio
Leeds & Northrup Co., 4970 Stenton Ave., Philadelphia, Pa.
Lepel High Frequency Laboratory, Inc., 39 W. 60th St., New York, N. Y.
Maico Co., Inc., 2632 Nicollet Ave., Minneapolis, Minn.
Millen Mfg. Co., Inc., 150 Exchange St., Malden, Mass.
Photobell Corp., 116 Nassau St., New York, N. Y.
Radio Corp. of America, Camden, N. J.
Radio Design Co., 1353 Sterling Place, Brooklyn, N. Y.
Simpson Mfg. Co., Inc., Mark, 188 W. 4th St., New York, N. Y.
Supreme Instruments Corp., Greenwood, Miss.
Televiso Products, Inc., 6553 N. Olmsted Ave., Chicago, Ill.
Triplett Electrical Instrument Co., 286 Harmon Rd., Bluffton, Ohio

RADIO-FREQUENCY OSCILLATORS

Clough-Brengle Co., 5501 N. Broadway, Chicago, Ill.
Espey Mfg. Co., Inc., 305 East 63rd St., New York, N. Y.
Ferris Instrument Corp., Boonton, N. J.
General Electronic Industries, 342 Putnam, Greenwich, Conn.
General Radio Co., 30 State St., Cambridge, Mass.
Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio
Hoyt Electrical Instrument Works, Boston, Mass.
Jackson Electrical Instrument Co., 123 Wayne Ave., Dayton, Ohio
McFarlin Co., 29 W. Marion Ave., Youngstown, Ohio
Millen Mfg. Co., Inc., James, 150 Exchange St., Malden, Mass.
Philharmonic Radio Corp., 216 William St., New York, N. Y.
Premier Crystal Laboratories, Inc., 63 Park Row, New York, N. Y.
Radio Corp. of America, Camden, N. J.
Simpson Electric Co., 5218 W. Kinzie St., Chicago, Ill.

Supreme Instruments Corp., Greenwood, Miss.
Televiso Products, Inc., 6533 N. Olmsted Ave., Chicago, Ill.
Triplett Electrical Instrument Co., 286 Harmon Rd., Bluffton, Ohio
Triumph Mfg. Co., 913 W. Van Buren St., Chicago, Ill.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J.

Oscilloscopes

CATHODE-RAY INSTRUMENTS

American Instrument Co., 8030 Georgia Ave., Silver Spring, Md.
Clough-Brengle Co., 5501 N. Broadway, Chicago, Ill.
Consolidated Engineering Corp., 1255 E. Green St., Pasadena, Calif.
Dayco Radio Corp., 915 Valley St., Dayton, Ohio
Du Mont Laboratories, Inc., Allen B., 2 Main Ave., Passaic, N. J.
Electro-Medical Laboratory, Inc., Holliston, Mass.
General Electric Co., Schenectady, N. Y.
General Electronic Industries, Div. Auto Ordnance Corp., 342 Putnam, Greenwich, Conn.
General Radio Co., 30 State St., Cambridge, Mass.
Heiland Research Corp., 130 East Fifth St., Denver, Col.
Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio
Jackson Electrical Instrument Co., 131 Wayne Ave., Dayton, Ohio
Metron Instrument Co., 432 Lincoln St., Denver, Col.
Millen Mfg. Co., James, 150 Exchange St., Malden, Mass.
Miller Corp., Wm., 362 W. Colorado St., Pasadena, Calif.
Radio City Products Co., Inc., 127 West 26th St., New York, N. Y.
Radio Corp. of America, Camden, N. J.
Reiner Electronics Co., 152 West 25th St., New York, N. Y.
Supreme Instrument Corp., Greenwood, Miss.
Thordarson Electric Mfg. Co., 500 W. Huron St., Chicago, Ill.
Triplett Electrical Instrument Co., 286 Harmon Rd., Bufton, Ohio
Triumph Mfg. Co., 913 W. Van Buren St., Chicago, Ill.
United Transformer Co., 150 Varick St., New York, N. Y.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

MOVING-CONDUCTOR OSCILLOGRAPHS

Cambridge Instrument Co., Grand Central Terminal, New York, N. Y.
Consolidated Engineering Corp., 1255 E. Green St., Pasadena, Calif.
General Electronic Industries, 342 Putnam, Greenwich, Conn.
Hathaway Instrument Co., 1315 S. Clarkson St., Denver, Colo.

MULTI-ELEMENT OSCILLOGRAPHS

Cambridge Instrument Co., Grand Central Terminal, New York, N. Y.
Electro-Medical Laboratory, Inc., Holliston, Mass.
Engineering Laboratories, Inc., 624 E. Fourth St., Tulsa, Okla.
General Electric Co., Schenectady, N. Y.

PIEZOELECTRIC OSCILLOGRAPHS

Brush Development Co., 3311 Perkins Ave., Cleveland, Ohio
Electro-Medical Laboratory, Inc., Holliston, Mass.
Heiland Research Corp., 130 East Fifth St., Denver, Col.
McFarlin Co., 29 W. Marion Ave., Youngstown, Ohio
Tibbetts Laboratories, 12 Norfolk St., Cambridge, Mass.

"Q" Meters

see Meters

Recorders

see Indicators

CAPACITOR LEAKAGE RECORDERS

Cornell-Dubilier Electric Corp., 1000 Hamilton Blvd., South Plainfield, N. J.
Esterline-Angus Co., P. O. Box 596, Indianapolis, Ind.

FREQUENCY RECORDERS

Esterline-Angus Co., P. O. Box 596, Indianapolis, Ind.
Sound Apparatus Co., 150 W. 46th St., New York, N. Y.

Shunts

AMMETER SHUNTS

Associated Research, Inc., 231 S. Green St., Chicago, Ill.
Esterline-Angus Co., P. O. Box 596, Indianapolis, Ind.
General Electric Co., Schenectady, N. Y.
Gray Instrument Co., 64 W. Johnson St., (Germantown), Philadelphia, Pa.
Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio
Instrument Resistors, Inc., 25 Amity St., Little Falls, N. J.
International Resistance Co., 401 N. Broad St., Philadelphia, Pa.
Leeds & Northrup Co., 4970 Stenton Ave., Philadelphia, Pa.
Roller-Smith Co., Bethlehem, Pa.
Sensitive Research Instrument Corp., 9-11 Elm Ave., Mt. Vernon, N. Y.
Triplett Electrical Instrument Co., 286 Harmon Rd., Bluffton, Ohio
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J.

Standards

CAPACITANCE STANDARDS

Cornell-Dubilier Electric Corp., 1000 Hamilton Blvd., South Plainfield, N. J.
General Radio Co., 30 State St., Cambridge, Mass.
Industrial Instruments, Inc., 156 Culver Ave., Jersey City, N. J.
Leeds & Northrup Co., 4970 Stenton Ave., Philadelphia, Pa.

FREQUENCY STANDARDS

Aircraft Accessories Corp., Fairfax & Funston Rds., Kansas City, Kansas
Andrew Co., Victor J., 363 East 75th St., Chicago, Ill.
Bendix Radio Div., Bendix Aviation Corp., Baltimore, Md.
Carlisle Crystal Corp., Carlisle, Pa.
Electro Products Labs, 549 W. Randolph St., Chicago, Ill.
Erco Radio Labs, Inc., Fenimore Ave., Hempstead, N. Y.
Ferris Instrument Corp., 110-112 Cornelia St., Boonton, N. J.
General Electric Co., Schenectady, N. Y.
General Radio Co., 30 State St., Cambridge, Mass.
Gibbs & Co., Thomas B., Division of George W. Borg Corp., 814 Michigan St., Delavan, Wisc.
Hallicrafters Co., 2611 S. Indiana Ave., Chicago, Ill.
Hewlett-Packard Co., 395 Page Mill Rd., Palo Alto, Calif.
Meissner Mfg. Co., Mt. Carmel, Ill.
Millen Mfg. Co., James, 150 Exchange St., Malden, Mass.
Rosen & Co., Raymond, 32nd & Walnut Sts., Philadelphia, Pa.

INDUCTANCE STANDARDS

General Radio Co., 30 State St., Cambridge, Mass.
Leeds & Northrup Co., 4970 Stenton Ave., Philadelphia, Pa.
New York Transformer Co., 26 Waverly Place, New York, N. Y.

RESISTANCE STANDARDS

General Electric Co., Schenectady, N. Y.
General Radio Co., 30 State St., Cambridge, Mass.
Instrument Resistors, Inc., 25 Amity St., Little Falls, N. J.
Leeds & Northrup Co., 4970 Stenton Ave., Philadelphia, Pa.
Sensitive Research Instrument Corp., 9-11 Elm Ave., Mt. Vernon, N. Y.
Shallcross Mfg. Co., 10 Jackson Ave., Collingdale, Pa.
Ward Leonard Electric Co., 31 South St., Mount Vernon, N. Y.

Testers

BATTERY TESTERS

Chaslyn Co., 1906 Irving Park Rd., Chicago, Ill.
Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio
Hoyt Electrical Instrument Works, Boston, Mass.
Knickerbocker Development Co., 116 Little St., Belleville, N. J.
Philco Corp., Tioga & C Sts., Philadelphia, Pa.
Radio Design Co., 1353 Sterling Place Brooklyn, N. Y.
Rascher & Betzold, 835 Orleans St., Chicago, Ill.
Sterling Mfg. Co., 9205 Detroit Ave., Cleveland, Ohio

CAPACITOR TESTERS

Aerovox Corp., 740 Belleville Ave., New Bedford, Mass.
Clough-Brengle Co., 5501 Broadway, Chicago, Ill.
Cornell-Dubilier Electric Corp., 1000 Hamilton Blvd., South Plainfield, N. J.
Deutschmann Corp., Tobe, Canton, Mass.
Industrial Instruments, Inc., 156 Culver Ave., Jersey City, N. J.
Jackson Electrical Instrument Co., 131 Wayne Ave., Dayton, Ohio
Music Master Mfg. Co., 542 S. Dearborn St., Chicago, Ill.
Philco Corp., Tioga & C Sts., Philadelphia, Pa.
Radio Corp. of America, Camden, N. J.
Radio Design Co., 1353 Sterling Place, Brooklyn, N. Y.
States Co., 19 New Park Ave., Hartford, Conn.
Triplett Electrical Instrument Co., 286 Harmon Rd., Bluffton, Ohio

HIGH VOLTAGE TESTERS

American Transformer Co., 178 Emmet St., Newark, N. J.
General Electric Co., Schenectady, N. Y.
Ideal Commutator Dresser Co., 1631 Park Ave., Sycamore, Ill.
Industrial Transformer Corp., 2540 Belmont Ave., New York, N. Y.
Knickerbocker Development Corp., 116 Little St., Belleville, N. J.
Miller Co., Bertrand F., Trenton, N. J.
Raytheon Mfg. Co., Waltham, Mass.
Slayter Electronic Div., Owens-Corning Fiberglas Corp., 26 W. Market St., Newark, Ohio
States Co., 19 New Park Ave., Hartford, Conn.

TUBE TESTERS

Clough-Brengle Co., 5501 N. Broadway, Chicago, Ill.
Dayco Radio Corp., 915 Valley St., Dayton, Ohio
Dayton Acme Co., 930 York St., Cincinnati, Ohio.
Espey Mfg. Co., Inc., 305 East 63rd St., New York, N. Y.
General Electric Co., Bridgeport, Conn.
Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio
Jackson Electrical Instrument Co., 131 Wayne Ave., Dayton, Ohio
Philco Corp., Tioga & C Sts., Philadelphia, Pa.
Philharmonic Radio Corp., 216 William St., New York, N. Y.
Precision Apparatus Co., 92-27 Horace Harding Blvd., Elmhurst, N. Y.
Radio City Products Co., 127 W. 26th St., New York, N. Y.
Radio Corp. of America, Camden, N. J.
Readrite Meter Works, College Ave., Bluffton, Ohio
Simpson Electric Co., 5200-16 W. Kinzie St., Chicago, Ill.
Superior Instruments Co., 227 Fulton St., New York, N. Y.
Supreme Instruments Corp., Greenwood, Miss.
Triplett Electrical Instrument Co., 286 Harmon Rd., Bluffton, Ohio
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J.

INSULATION TESTERS

Associated Research, Inc., 231 S. Green St., Chicago, Ill.
American Transformer Co., 178 Emmet St., Newark, N. J.
Biddle Co., James G., 1213 Arch St., Philadelphia, Pa.
Communication Measurements Laboratory, 120 Greenwich St., New York, N. Y.
Electric Service Supplies Co., 17th & Cambria Sts., Philadelphia, Pa.
Ferranti Electric, Inc., 30 Rockefeller Plaza, New York, N. Y.
General Electric Co., Schenectady, N. Y.
General Radio Co., 30 State St., Cambridge, Mass.
Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio
Ideal Commutator Dresser Co., 1631 Park Ave., Sycamore, Ill.
Industrial Instruments, Inc., 156 Culver Ave., Jersey City, N. J.
Leeds & Northrup Co., 4970 Stenton Ave., Philadelphia, Pa.
Miller Co., Bertrand F., Trenton, N. J.
Rubicon Co., 3751 Ridge Ave., Philadelphia, Pa.
Sticht Co. Inc., Herman, 27 Park Place, New York, N. Y.
Superior Instruments Co., 227 Fulton St., New York, N. Y.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
Winslow Co., 9 Liberty St., Newark, N. J.

Thermocouples

VACUUM THERMOCOUPLES

American Electrical Sales Co., 67 E. 8th St., New York, N. Y.
American Thermo-Electric Co., 67 East 8th St., New York, N. Y.
Bristol Co., Waterbury, Conn.
Burlington Instrument Co., 316 Valley St., Burlington, Ia.
De-Jur Amsco Corp., Shelton, Conn.
Field Electric Instrument Co., 2432 Grand Concourse, New York, N. Y.
General Electric Co., Schenectady, N. Y.
General Electronic Industries, 342 Putnam, Greenwich, Conn.
General Radio Co., 30 State St., Cambridge, Mass.
Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio
Illinois Testing Laboratories, Inc., 420 N. LaSalle St., Chicago, Ill.
J. B. T. Instruments, Inc., 441 Chapel St., New Haven, Conn.
Rawson Electrical Instrument Co., 102 Potter St., Cambridge, Mass.
Richards Co., Inc., Arklay S., 72 Winchester St., Newton Highlands, Mass.
Rowe Radio Research Laboratory Co., 2422 N. Pulaski Rd., Chicago, Ill.
Sensitive Research Instrument Corp., 9-11 Elm Ave., Mt. Vernon, N. Y.
Western Electric Co., Inc., 195 Broadway, New York, N. Y.
Wheelco Instruments Corp., 847 W. Harrison St., Chicago, Ill.
Xervac Instrument Co., 9 New Park Ave., Hartford, Conn.

Voltmeters

see Meters

Wattmeters

see Meters

Compiling This Directory

Nearly three thousand company names were questionnaired in order to prepare this Directory. A second and third follow-up were sent out to those who were slow in answering. Although the response was high, it was not complete, and there may be a few omissions. However, we believe this is the most complete and authentic Directory we have ever published—certainly the most useful of any in the field.

ELECTRONIC EQUIPMENT

Amplifiers

AUDIO FREQUENCY AMPLIFIERS

Altec Lansing Corp., 1680 North Vine St., Los Angeles, Calif.
American Communications Corp., 306 Broadway, New York, N. Y.
Amplifier Co. of America, 17 West 20th St., New York, N. Y.
Arrow Radio Co., 900 W. Jackson Blvd., Chicago, Ill.
Audio Tone Oscillator Co., 60 Walter St., Bridgeport, Conn.
Autocrat Radio Co., 3855 N. Hamilton Ave., Chicago, Ill.
Ballantine Laboratories, Inc., Boonton, N. J.
Bogen Co., David, 663 Broadway, New York, N. Y.
Braun, Inc., W. C., 601 W. Randolph St., Chicago, Ill.
Bunnell & Co., J. H., 215 Fulton St., New York, N. Y.
Chicago Sound System Co., 2124 S. Michigan Blvd., Chicago, Ill.
Cincinnati Time Recorder Co., 1733 Central Ave., Cincinnati, Ohio
Consolidated Enginnering Corp., 1255 E. Green St., Pasadena, Calif.
Eastern Amplifier Corp., 794 E. 140th St., Bronx, N. Y.
Electronic Corp. of America, 45 West 18th St., New York, N. Y.
Espey Mfg. Co., Inc., 305 E. 63rd St., New York, N. Y.
Erwood Co., 223 W. Erie St., Chicago, Ill.
Federal Telephone and Radio Corp., 591 Broad St., Newark, N. J.
Ferranti Electric, Inc., 30 Rockefeller Plaza, New York, N. Y.
Gabel Mfg. Co., John, 1200 W. Lake St., Chicago, Ill.
Gates Radio Co., 220 Hampshire St., Quincy, Ill.
General Communication Co., 681 Beacon St., Boston, Mass.
General Electric Co., Bridgeport, Conn.
General Electronic Industries, 342 Putnam, Greenwich, Conn.
General Radio Co., 30 State St., Cambridge, Mass.
Gibbs & Co., Thomas B., Div. of Borg. Corp., George W., 814 Michigan St., Delavan, Wisc.
Gray Mfg. Co., 16-30 Arbor St., Hartford, Conn.
Guided Radio Corp., 161 Sixth Ave., New York, N. Y.
Herbach & Rademan Co., 522 Market St., Philadelphia, Pa.
Harvey-Wells Communication, Inc., North St., Southbridge, Mass.
Hatry & Young, 203 Ann St., Hartford, Conn.
Hollywood Electronics Co., 800 Sunset Blvd., Los Angeles, Calif.
Hollywood Transformer Co., 645 N. Martel Ave., Los Angeles, Calif.
Howard Radio Co., 1735 Belmont Ave., Chicago, Ill.
Jack Mfg. Co., 30 No. Penn St., York, Pa.
Knickerbocker Development Co., 116 Little St., Belleville, N. J.
Lincrophone Co., 1661 Howard Ave., Utica, N. Y.
Malco Co., Inc., 2632 Nicollet Ave., Minneapolis, Minn.
Meck Industries, John, Liberty St., Plymouth, Ind.
Metron Instrument Co., 432 Lincoln St., Denver, Colo.
Miles Reproducer Co., 812 Broadway, New York, N. Y.
Miller Corp., Wm., 362 W. Colorado St., Pasadena, Calif.
National Co., 61 Sherman St., Malden, Mass.
National Union Radio Corp., 15 Washington St., Newark, N. J.
Newcomb Audio Products Co., 2815 S. Hill St., Los Angeles, Calif.
Operadio Mfg. Co., St. Charles, Ill.
Oxford Tartak Radio Corp., 3911 S. Michigan Ave., Chicago, Ill.
Photobell Corp., 116 Nassau St., New York, N. Y.
Powers Electronic & Communication Co., New Street, Glen Cove, L. I., N. Y.
Rauland Corp., 4245 N. Knox Ave., Chicago, Ill.
Rieber, Inc., Frank, 11916 W. Pico Blvd., Los Angeles, Calif.
Rowe Radio Research Laboratory, 2422 N. Pulaski Rd., Chicago, Ill.
Setchell Carlson, Inc., 2233 University Ave., St. Paul, Minn.
Sherron Metallic Corp., 1201 Flushing Ave., Brooklyn, N. Y.
Simpson Mfg. Co., Inc., Mark, 188 W. 48th St., New York, N. Y.
Skaggs Transformer Co., 5894 Broadway, Los Angeles, Calif.
Sound Equipment Corp. of California, 6245 Lexington Ave., Hollywood, Calif.
Stevens-Arnold Co., 22 Elkins St., South Boston, Mass.
Talking Devices Co., 4451 W. Irving Park Rd., Chicago, Ill.
Televiso Products Inc., 6533 N. Olmsted Ave., Chicago, Ill.
Terminal Radio Corp., 85 Cortlandt St., New York, N. Y.
Thordarson Electric Mfg. Co., 500 W. Huron St., Chicago, Ill.
Valco Mfg. Co., 400 S. Peoria St., Chicago, Ill.
Warwick Mfg. Corp., 4640 W. Harrison St., Chicago, Ill.
Webster Electric Co., 1900 Clark Ave., Racine, Wis.
Western Electric Co. Inc., 195 Broadway, New York, N. Y.

Analyzers

COLOR ANALYZERS

Bausch & Lomb Optical Co., 635 St. Paul St., Rochester, N. Y.
Gaertner Scientific Corp., 1201 Wrightwood Ave., Chicago, Ill.
General Electric Co., Schenectady, N. Y.
Photobell Corp., 116 Nassau St., New York, N. Y.
Photovolt Corp., 95 Madison Ave., New York, N. Y.
Pho-Tron Instrument Co., 5713 Euclid Ave., Cleveland, Ohio
Rubicon Co., 3751 Ridge Ave., Philadelphia, Pa.
Saxl Instrument Co., 38 James St., East Providence, R. I.

SURFACE ANALYZERS

Brush Development Co., 3311 Perkins Ave., Cleveland, O.
General Electronic Industries, 342 Putnam, Greenwich, Conn.
Physicists Research Co., 343 S. Main St., Ann Arbor, Mich.

Apparatus

GEOPHYSICAL APPARATUS

Associated Research, Inc., 231 S. Green St., Chicago, Ill.
Cambridge Instrument Co., Grand Central Terminal, New York, N. Y.
Consolidated Engineering Corp., 1255 E. Green St., Pasadena, Calif.
Engineering Laboratories, Inc., 624 E. Fourth St., Tulsa, Okla.
Ferranti Electric, Inc., 30 Rockefeller Plaza, New York, N. Y.
Fisher Research Lab, 1961 University Ave., Palo Alto, Calif.
Geophysical Instrument Co., 1315 Half St., S. E., Washington, D. C.
Heiland Research Corp., 130 East Fifth St., Denver, Colo.
Illinois Testing Laboratories, Inc., 420 N. La Salle St., Chicago, Ill.
Metron Instrument Co., 432 Lincoln St., Denver, Colo.
Mico Instrument Co., 10 Arrow St., Cambridge, Mass.
Miller Corp., Wm., 362 W. Colorado St., Pasadena, Calif.
Western Geophysical Co., 711 Edison Bldg., Los Angeles, Calif.

Bearings, Miniature

Miniature Precision Bearings, Keene, N. H.

Blowers, Small

L-R Manufacturing Co., 65 New Litchfield St., Torrington, Conn.

Chambers, Test

HUMIDITY, PRESSURE, TEMPERATURE

All American Tool & Machine Co., 1014 Fullerton Ave., Chicago, Ill.
American Coils, Inc., 27 Lexington St., Newark, N. J.
American Instrument Co., 8010 Georgia Ave., Silver Spring, Md.
Deepfreeze Division, Motor Products Corp., 2301 Davis St., N. Chicago, Ill.
Industrial Filter & Pump Mfg. Co., 3017 W. Carroll Ave., Chicago, Ill.
Kold-Hold Mfg. Co., 446 North Grand Ave., Lansing, Mich.
Mobile Refrigeration, Inc., 630 Fifth Ave., New York, N. Y.
Northern Engineering Labs., 50 Church St., New York, N. Y.
Revco Inc., Deerfield, Mich.
Scharr & Co., 754 W. Lexington St., Chicago, Ill.
Syntron Co., Homer City, Pa.
Tenney Engineering, Inc., 8 Elm Street, Montclair, N. J.
Young Bros. Co., 6500 Mack Ave., Detroit, Mich.

Colorimeters

PHOTO-ELECTRIC COLORIMETERS

Central Scientific Co., 1700 Irving Park Blvd., Chicago, Ill.
Coleman Electric Co., 310 Madison St., Maywood, Ill.
Electronic Products Co., 19 North First St., Geneva, Ill.
Fisher Scientific Co., 711 Forbes St., Pittsburgh, Pa.
Frober-Faybor Co., Chagrin Falls, Ohio
National Technical Laboratories, 820 Mission St., South Pasadena, Calif.
Pfaltz & Bauer, Inc., 350 Fifth Ave., New York, N. Y.
Photovolt Corp., 95 Madison Ave., New York, N. Y.
Pho-Tron Instrument Co., 5713 Euclid Ave., Cleveland, Ohio
Rubicon Co., 3751 Ridge Ave., Philadelphia, Pa.
Saxl Instrument Co., 38 James St., East Providence, R. I.
Schaar & Co., 754 W. Lexington St., Chicago, Ill.
Scientific Glass Apparatus Co., Bloomfield, N. J.

Equipment

DRAFTING ROOM EQUIPMENT

Alteneder Co., Theo., 1217 Spring Garden St., Philadelphia, Pa.
American Pencil Co., 504 Willow Ave., Hoboken, N. J.
American Photocopy Equipment Co., 2849 N. Clark St., Chicago, Ill.
Arkwright Finishing Co., Turks Head Bldg., Providence, R. I.
Bruning Co., Charles, 4700 Montrose Ave., Chicago, Ill.
Carter's Ink Co., Cambridge, Mass.
Dietzgen Co., Eugene, 2425 Sheffield Ave., Chicago, Ill.

Dixon Crucible Co., Joseph, Jersey City, N. J.
Eagle Pencil Co., 703 East 13th St., New York, N. Y.
Emmert Mfg. Co., Waynesboro, Pa.
Eraser Co., 231 W. Water St., Syracuse, N. Y.
Faber Co., A. W., 41 Dickerson St., Newark, N. J.
Faber Pencil Co., Eberhard, 37 Greenpoint Ave., Brooklyn, N. Y.
Higgins Ink Co., Inc., 271 Ninth St., Brooklyn, N. Y.
Holliston Mills, Inc., Norwood, Mass.
Hunter Electro Copyist, Inc., 430 S. Warren St., Syracuse, N. Y.
Keuffel & Esser Co., 303 Adams St., Hoboken, N. J.
Koh-I-Noor Pencil Co., 373 Fourth Ave., New York, N. Y.
Ozalid Products Div., General Aniline & Film Corp., 25 Ansco Rd., Johnson City, N. Y.
Paragon-Revolute Corp., 77 South Ave., Rochester, N. Y.
Pease Co., C. F., 2601 W. Irving Park Rd., Chicago, Ill.
Post Co., Frederick, 3650 Avondale Ave., Chicago, Ill.
J. S. Staedtler, Inc., 53-55 Worth St., New York, N. Y.
Starrett Co., L. S., 165 Crescent St., Athol, Mass.
United States Blue Print Paper Co., 207 S. Wabash Ave., Chicago, Ill.
Universal Drafting Machine Co., 1426 W. Third St., Cleveland, Ohio
Weber Co., F., 1220 Buttonwood St., Philadelphia, Pa.
White Dental Mfg. Co., S. S., 10 E. 40th St., New York, N. Y.
Wickes Bros., 515 N. Washington St., Saginaw, Mich.
Williams, Brown & Earle, Inc., 918 Chestnut St., Philadelphia, Pa.

Gases

GASES, RARE

Air Reduction Sales Co., 60 East 42nd St., New York, N. Y.
Linde Air Products Co., 30 E. 42nd St., New York, N. Y.

Gears, Precision

Quaker City Gear Works, 1910-32 N. Front St., Philadelphia, Pa.

Heating, High Frequency

Ajax Electrothermic Corp., Ajax Park, Trenton, N. J.
Ecco High Frequency Electric Corp., 7020 Hudson Blvd., North Bergen, N. J.
Electron Equipment Corp., Palm Springs, Calif.
Fairchild Eng. & Airplane Co., 30 Rockefeller Plaza, New York, N. Y.
Federal Telephone and Radio Corp., 591 Broad St., Newark, N. J.
General Electric Co., Schenectady, N. Y.
Girdler Corp., Thermex Div., 224 E. B'way, Louisville, Ky.
Gorhen Co., Inc., 1841 Broadway, New York, N. Y.
Induction Heating Corp., 389 Lafayette St., New York, N. Y.
Johnson Co., E. F., Waseca, Minn.
Kahle Engineering Corp., 1307 Seventh St., North Bergen, N. J.
Kurman Electric Co., 3030 Northern Blvd., Long Island City, N. Y.
Lepel High Frequency Laboratories, 39 West 60th St., New York, N. Y.
Radio Corp. of America, Camden, N. J.
Radio Frequency Laboratories, Inc., Boonton, N. J.
Stratosearch, Inc., 699 Madison Ave., New York, N. Y.
Westinghouse Electric & Mfg. Co., Radio & X-Ray Div., Baltimore, Md.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Intercommunicators

Airadio, Inc., Melrose Ave. & Battery Place, Stamford, Conn.
Altec Lansing Corp., 1680 N. Vine St., Los Angeles, Calif.
American Amplifier & Telephone Co., Inc., 1220 Glencon Ave., Los Angeles, Calif.
Ansley Radio Corp., 21-10 49th Ave., Long Island City, N. Y.
Austin Electronic Mfg. Co., Warren, Pa.
Autocrat Radio Co., 3855 N. Hamilton Ave., Chicago, Ill.
Automatic Electric Co., 1033 W. Van Buren St., Chicago, Ill.
Banks Mfg. Co., 1105 W. Lawrence Ave., Chicago, Ill.
Bell Sound Systems, Inc., 1183 Essex Ave., Columbus, Ohio
Bendix Aviation Ltd., North Hollywood, Calif.
Bogen Co., David, 663 Broadway, New York, N. Y.
Bond Products Co., 13139 Hamilton Ave., Detroit, Mich.
Cannon Electric Development Co., 3209 Humboldt, Los Angeles, Calif.
Communication Equipment & Engineering Co., 504 N. Parkside Ave., Chicago, Ill.
De Wald Radio Mfg. Corp., 440 Lafayette St., New York, N. Y.
Electronic Corp. of America, 45 West 18th St., New York, N. Y.
Executone, Inc., 415 Lexington Ave., New York, N. Y.
Federal Mfg. & Engineering Corp., 199 Steuben St., Brooklyn, N. Y.
Garner Co., 43 East Ohio St., Chicago, Ill.
Hollywood Electronics Co., 800 Sunset Blvd., Los Angeles, Calif.
Industrial Sound Products Co., 3597 Mission St., San Francisco, Calif.
Intercall Systems, Inc., 610 Linden Ave., Dayton, Ohio
Karadio Corp., 2233 University Ave., St. Paul, Minn.
Lake Mfg. Co., 2323 Chestnut St., Oakland, Calif.
Magnavox Co., 2131 Bueter Rd., Fort Wayne, Ind.
Miles Reproducer Co., Inc., 812 Broadway, New York, N. Y.
Newcomb Audio Products Co., 2815 S. Hills St., Los Angeles, Calif.
Operadio Mfg. Co., St. Charles, Ill.
Oxford Tartak Radio Corp., 3911 S. Michigan Ave., Chicago, Ill.
Philco Corp., Philadelphia, Pa.
Powers Electronic & Communication Co., Glencove, L. I., N. Y.
Remler Co., Ltd., 2101 Bryant St., San Francisco, Calif.
Radio Corporation of America, Camden, N. J.
Rauland Corp., 4245 N. Knox Ave., Chicago, Ill.
Regal Amplifier Mfg. Corp., 20 West 20th St., New York, N. Y.
Select-O-Phone Co., 1012 Eddy St., Providence, R. I.
Setchell Carlson, Inc., 2233 University Ave., St. Paul, Minn.
Simpson Mfg. Co., Inc., 188 West Fourth St., New York, N. Y.
Sound Equipment Corp., of California, 6245 Lexington Ave., Hollywood, Calif.
Talk-A-Phone Mfg. Co., 1219 W. Van Buren St., Chicago, Ill.
Telemotor Corp., 260 Fifth Ave., New York, N. Y.
Trav-Ler Karenola Radio & Television Corp., 1028 W. Van Buren St., Chicago, Ill.
Triebor Radio Co., Pasadena, Calif.
Webster Electric Co., 1900 Clark St., Racine, Wisc.
Western Sound & Electric Laboratories, Inc., 3512 W. St. Paul Ave., Milwaukee, Wisc.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.
Zenith Radio Corp., 6001 Dickens Ave., Chicago, Ill.

Irons

ELECTRIC SOLDERING IRONS

Acme Electric Heating Co., 1217 Washington St., Boston, Mass.
American Electrical Heater Co., 6110 Cass Ave., Detroit, Mich.
Brach Mfg. Corp., L. S., 55 Dickerson St., Newark, N. J.
Cole Radio Works, 86 Westville Ave., Caldwell, N. J.
Dominion Electrical Mfg. Inc., 120 Elm St., Mansfield, Ohio
Drake Electric Works, 3656 Lincoln Ave., Chicago, Ill.
Dual Remote Control Co., 31776 Cowan Rd., Wayne, Mich.
Electric Soldering Iron Co., 205 W. Elm St., Deep River, Conn.
General Electric Co., Schenectady, N. Y.
Hexacon Electric Appliance Corp., 161 W. Clay Ave., Roselle Park, N. J.
Ideal Commutator Dresser Co., 1631 Park Ave., Sycamore, Ill.
Jackson Electro Corp., 124 Bleeker St., New York, N. Y.
Kay Co., J. H., 121 Second St., San Francisco, Cal.
Landers, Frary & Clark, 47 Center St., New Britain, Conn.
Lenk Mfg. Co., Newton Lower Falls, Mass.
Sta-Warm Electric Co., 565 N. Chestnut St., Ravenna, Ohio
Trent Co., Harold E., 55th St. & Wyalusing Ave., Philadelphia, Pa.
Vasco Electrical Mfg. Co., 4116 Avalon Blvd., Los Angeles, Cal.
Vulcan Electric Co., 600 Broad St., Lynn, Mass.
Wellmade Electric Mfg. Co., Railroad Sq. & Church St., Torrington, Conn.

Keys and Coding Equipment

Alden Products Co., 117 Main St., Brockton, Mass.
American Communications Corp., 306 Broadway, New York, N. Y.
American Radio Hardware Co., Inc., 476 Broadway, New York, N. Y.
Bunnell & Co., J. H., 215 Fulton St., New York, N. Y.
Clare & Co., C. P., 4719 Sunnyside Ave., Chicago, Ill.
Electro-Medical Laboratory, Inc., Holliston, Mass.
Federal Manufacturing & Engineering Corp., 199-217 Steuben St., Brooklyn, N. Y.
Gray Manufacturing Co., 16-30 Arbor St., Hartford, Conn.
Kay Electric, J. H., 664 Howard St., San Francisco, Calif.
McElroy Manufacturing Corp., 82 Brookline Ave., Boston, Mass.
Reynolds Electric Co., 2650 W. Congress St., Chicago, Ill.
Teleplex Co., 107 Hudson St., Jersey City, N. J.
Vibroplex Co., Inc., 833 Broadway, New York, N. Y.
Wallace & Tiernan Products, Inc., Belleville, N. J.
Winslow Co., Inc., 9 Liberty St., Newark, N. J.

Machines

COIL WINDING MACHINES

Armature Coil Equipment, Inc., 2605 Vega Ave., Cleveland, Ohio
Chapman Electrical Works, P. E., 1820 Chouteau Ave., St. Louis, Mo.
Eisler Engrg. Co., 770 S. 13th St., Newark, N. J.
Electric Service Supplies Co., 17th & Cambria Sts., Philadelphia, Pa.
General Electronic Industries, 342 Putnam, Greenwich, Conn.
Guthman & Co., Edwin I., 15 S. Throop St., Chicago, Ill.
Ideal Commutator Dresser Co., 1631 Park Ave., Sycamore, Ill.
Meissner Mfg. Co., Mt. Carmel, Ill.
Potter & Rayfield, Inc., Hemphill Ave., Atlanta, Ga.
Stevens Machinery Co., 1461 W. Grand Ave., Chicago, Ill.
Universal Winding Co., 1655 Elmwood Ave., Cranston, R. I.

TUBE MANUFACTURING MACHINES

Eisler Engineering Co., 751 S. 13th St., Newark, N. J.
Engineering Co., 27 Wright St., Newark, N. J.
Kahle Engineering Corp., 1307 Seventh St., North Bergen, N. J.

Meters

FIELD INTENSITY METERS

Fada Radio & Electric Co., Inc., 30-20 Thomson Ave., Long Island City, N. Y.
Measurements Corp., Boonton, N. J.
Radio Corp. of America, Camden, N. J.

LIGHT METERS

DeJur-Amsco Corp., 6 Bridge St., Shelton, Conn.
Gaertner Scientific Corp., 1201 Wrightwood Ave., Chicago, Ill.
General Electric Co., Schenectady, N. Y.
Leeds & Northrup Co., 4970 Stenton Ave., Philadelphia, Pa.
Pfaltz & Bauer, Inc., 350 Fifth Ave., New York, N. Y.
Phipps & Bird, Inc., Richmond, Va.
Photovolt Corp., 95 Madison Ave., New York, N. Y.
Pho-Tron Instrument Co., 5713 Euclid Ave., Cleveland, Ohio
Rubicon Co., 3751 Ridge Ave., Philadelphia, Pa.
Welch Scientific Co., W. M., 1515 Sedgwick St., Chicago, Ill.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J.

TIME METERS

American Time Products, Inc., 580 Fifth Ave., New York, N. Y.
Cramer Co., R. W., Centerbrook, Conn.
Electric Tachometer Corp., Broad & Spring Garden Sts., Philadelphia, Pa.
Esterline- Angus Co., P. O. Box 596, Indianapolis, Ind.
General Electric Co., Schenectady, N. Y.
National Instrument Co., 44 School St., Boston, Mass.
Rowe Radio Research Laboratory Co., 2422 N. Pulaski Rd., Chicago, Ill.
Warren Telechron Co., Homer Ave., Ashland, Mass.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Micrometers

ELECTRONIC MICROMETERS

Sensitive Research Instrument Corp., 9-11 Elm Ave., Mt. Vernon, N. Y.
Televiso Products, Inc., 6533 N. Olmsted Ave., Chicago, Ill.

Microscopes

ELECTRON MICROSCOPES

General Electric Co., Schenectady, N. Y.
Radio Corp. of America, Camden, N. J.

Moisture Proofing Equipment

Production Engineering Corp., 666 Van Houten Ave., Clifton, N. J.

Monitors

Doolittle Radio, Inc., 7421 S. Loomis Blvd., Chicago, Ill.
General Electric Co., Schenectady, N. Y.
General Radio Co., 30 State St., Cambridge, Mass.
Howard Radio Co., 1735 Belmont Ave., Chicago, Ill.
Link, Fred M., 125 West 17th St., New York, N. Y.
Radio Engineering Laboratories, Inc., 35-54 36th St., Long Island City, N. Y.
Radio Corp. of America, Camden, N. J.
Schuttig & Co., 9th & Kearney, N. E. Washington, D. C.

Phonographs

ELECTRIC PHONOGRAPHS and RECORD PLAYERS

Ansley Radio Corp., 21-10 49th Ave., Long Island City, N. Y.
Autocrat Radio Co., 3855 N. Hamilton Ave., Chicago, Ill.
Continental Radio & Television Corp., 3800 Cortlandt St., Chicago, Ill.
D-X Crystal Co., 1841 W. Carroll Ave., Chicago, Ill.
Electro Acoustic Co., 2131 Bueter Rd., Fort Wayne, Ind.
Electronic Corp. of America, 45 West 18th St., New York, N. Y.
Emerson Radio & Phonograph Corp., 111 Eighth Ave., New York, N. Y.
Espey Mfg. Co., 305 E. 63d St., New York, N. Y.
Farnsworth Television & Radio Corp., 3700 Pontiac St., Fort Wayne, Ind.
Garrard Sales Corp., 296 Broadway, New York, N. Y.
Harris Mfg. Co., 2422 W. Seventh St., Los Angeles, Cal.
Magnavox Co., 2131 Bueter Rd., Fort Wayne, Ind.
Marconiphone, Inc., 679 Madison Ave., New York, N. Y.
Midwest Radio Corp., 909 Broadway, Cincinnati, Ohio
Mills Novelty Co., 4100 Fullerton Ave., Chicago, Ill.
Pacific Sound Equipment Co., 1534 Cahuenga Blvd., Hollywood Calif.
Philco Corp., Tioga & C Sts., Philadelphia, Pa.
Presto Recording Corp., 242 W. 55th St., New York, N. Y.
Radiad Service, 720 W. Schubert Ave., Chicago, Ill.
Radio Corp. of America, Camden, N. J.
Regal Amplifier Mfg. Corp., 20 West 20th St., New York, N. Y.
Rock-Ola Mfg. Corp., 867 N. Kedzie Ave., Chicago, Ill.
Seeburg Corp., J. P., 1510 N. Dayton St., Chicago, Ill.
Sentinel Radio Corp., 2020 Ridge Ave., Evanston, Ill.
Simpson Mfg. Co., Inc., Mark, 188 West Fourth St., New York, N. Y.
Sonora Radio & Television Corp., 2626 W. Washington St., Chicago, Ill.
Stromberg-Carlson Telephone Mfg. Co., 100 Carlson Rd., Rochester, N. Y.
Talk-A-Phone Mfg. Co., 1219 W. Van Buren St., Chicago, Ill.
Waters-Conley Co., 501 First St., N.W., Rochester, Minn.
Wurlitzer Mfg. Co., Rudolph, North Tonawanda, N. Y.

Pumps

VACUUM PUMPS

Beach-Russ Co., 50 Church St., New York, N. Y.
Buffalo Foundry & Machine Co., 1635 Fillmore Ave., Buffalo, N. Y.
Central Scientific Co., 1700 Irving Park Rd., Chicago, Ill.
Distillation Products, Inc., 755 Ridge Rd. W., Rochester, N. Y.
Eisler Engrg. Co., 751 S. 13th St., Newark, N. J.
General Electric Co., Schenectady, N. Y.
General Electronic Industries, 342 Putnam, Greenwich, Conn.
Haydu Bros., Mt. Bethel Rd., Plainfield, N. J.
Ingersoll-Rand Co., 11 Broadway, New York, N. Y.
International Machine Works, 2207 46th St., North Bergen, N. J.
Kahle Engineering Corp., 1307 Seventh St., North Bergen, N. J.
Kinney Mfg. Co., 3529 Washington St., Boston, Mass.
Kraissl Co., 303 Williams Ave., Hackensack, N. J.
Leiman Bros., 156 Christie St., Newark, N. J.
Nelson Vacuum Pump Co., Geo. F., 2133 Fourth St., Berkeley, Calif.
Pennsylvania Pump & Compressor Co., Easton, Pa.
Robbins & Myers, Inc., 1345 Lagonda Ave., Springfield, Ohio
Stokes Machine Co., F. J. 5850 Tabor Rd., Olney P. O., Philadelphia, Pa.
Sullivan Machinery Co., 929 Woodland Ave., Michigan City, Ind.
Welch Scientific Co., W. M., 1515 Sedgwick St., Chicago, Ill.
Worthington Pump & Machinery Corp., Harrison, N. J.
Yeomans Bros. Co., 1433 N. Dayton St., Chicago, Ill.
Zenith Products Co., West Newton, Mass.

Receivers

Because of the fact that all receiver manufacturers are on a 100 percent war basis, we are listing them in this directory without type classification. In our first Directory after conclusion of hostilities we will again classify receiver manufacturers by the kind they make.

Abbott Instrument Inc., 8 W. 18th St., New York, N. Y.
Air King Products Co., Inc., 1523 63rd St., Brooklyn, N. Y.
Aircraft Accessories Corp., Fairfax & Funston Rds., Kansas City, Kans.
Airplane & Marine Instruments, Inc., Clearfield, Pa.
American Communications Corp., 306 Broadway, New York, N. Y.
Andrea Radio Corp., 43-20 34th St., Long Island City, N. Y.
Ansley Radio Corp., 21-10 49th Ave., Long Island City, N. Y.
Austin Electronic Mfg. Co., Warren, Pa.
Autocrat Radio Co., 3855 N. Hamilton Ave., Chicago, Ill.
Automatic Radio & Mfg. Co., 122 Brookline Ave., Boston, Mass.
Bassett, Inc. Rex, 500 S. E. Second St., Fort Lauderdale, Fla.
Bell Radio & Television, 125 East 46th St., New York, N. Y.
Belmont Radio Corp., 5921 W. Dickens Ave., Chicago, Ill.
Bendix Aviation, Ltd., North Hollywood, Calif.
Bendix Radio, Div. of Bendix Aviation Corp., Baltimore, Md.
Bodner Co., Inc., Charles, 58 Marbledale Rd., Tuckahoe, N. Y.
Bunnell & Co., J. H., 215 Fulton St., New York, N. Y.
Cinaudagraph Speakers, Inc., 3911 S. Michigan Ave., Chicago, Ill.
Collins Radio Co., 2920 First Ave., Cedar Rapids, Iowa
Colonial Radio Corp., 254 Rano St., Buffalo, N. Y.
Communications Co., Coral Gables, Fla.
Communications Equipment Co., 134 W. Colorado St., Pasadena, Calif.
Continental Radio & Television Corp., 3800 Cortlandt St., Chicago, Ill.
Crosley Corp., 1329 Arlington St., Cincinnati, Ohio
Delco Radio Div., General Motors Corp., Kokomo, Ind.
Detrola Corp., 1501 Beard Ave., Detroit, Mich.
DeWald Radio Mfg. Corp., 440 Lafayette St., New York, N. Y.
Doolittle Radio, Inc., 7421 S. Loomis Blvd., Chicago, Ill.
Dumont Laboratories, Inc., 2 Main Ave., Passaic, N. J.
Echophone Radio Co., 201 East 26th St., Chicago, Ill.
Eckstein Radio & Television Co., 1400 Harmon Place, Minneapolis, Minn.
Electronic Corp. of America, 45 W. 18th St., New York, N. Y.
Electronic Specialty Co., 3456 Glendale Blvd., Los Angeles, Calif.
Emerson Radio & Phonograph Corp., 111 Eighth Ave., New York, N. Y.
Federal Telephone and Radio Corp., 591 Broad St., Newark, N. J.
Espey Manufacturing Co., 305 E. 63rd St., New York, N. Y.
Fada Radio & Electric Co., 30-20 Thomson Ave., Long Island City, N. Y.
Farnsworth Television & Radio Corp., 3700 Pontiac St., Fort Wayne, Ind.
Freed Radio Corp., 200 Hudson St., New York, N. Y.
Galvin Mfg. Corp., 4545 Augusta Blvd., Chicago, Ill.
Garod Radio Corp., 70 Washington St., Brooklyn, N. Y.
General Electric Co., Bridgeport, Conn.
Gilfillan Bros., Inc., 1815 Venice Blvd., Los Angeles, Calif.
Hallicrafters Co., 2611 S. Indiana Ave., Chicago, Ill.
Hamilton Radio Corp., 510 Sixth Ave., New York, N. Y.
Hammarlund Mfg. Co., 460 W. 34 St., New York, N. Y.
Harvey Machine Co., Inc., 6200 Avalon Blvd., Los Angeles, Calif.
Harvey Radio Laboratories, Inc., 447 Concord Ave., Cambridge, Mass.
Harvey-Wells Communications, Inc., North St., Southbridge, Mass.
Hazeltine Electronics Corp., 1775 Broadway, New York, N. Y.
Herbach & Rademan, 522 Market St., Philadelphia, Pa.
Higgins Industries, Inc., 2221 Warwick Ave., Santa Monica, Calif.
Howard Radio Co., 1735 Belmont Ave., Chicago, Ill.
Hudson American Corp., 36 West 47th St., New York, N. Y.
Islip Radio Mfg. Corp., Foot of Beacon St., Islip, N. Y.
Jefferson-Travis Radio Mfg. Corp., 380 Second Ave., New York, N. Y.
Kaar Engineering Co., 619 Emerson St., Palo Alto, Calif.
Karadio Corp., 2233 University Ave., St. Paul, Minn.

Lear-Avia, Inc., 1718 Broadway, Piqua, Ohio
Link, Fred M., 125 West 17th St., New York, N. Y.
Magnavox Co., 2131 Bueter Rd., Fort Wayne, Ind.
Majestic Radio & Television Corp., 2600 W. 51st St., Chicago, Ill.
Meissner Mfg. Co., Mt. Carmel, Ill.
Midwest Radio Corp., 909 Broadway, Cincinnati, Ohio
Millen Mfg. Co., James, 150 Exchange St., Malden, Mass.
National Co., 61 Sherman St., Malden, Mass.
Noblitt-Sparks Industries, E. 17th St., Columbus, Ind.
Oxford Tartak Radio Corp., 3911 S. Michigan Ave., Chicago, Ill.
Pacific Electronics, W. 1130 Sprague Ave., Spokane, Wash.
Packard Bell Co., 1115 South Hope St., Los Angeles, Calif.
Philco Corporation, Philadelphia, Pa.
Philharmonic Radio Corp., 216 William St., New York, N. Y.
Philmore Mfg. Co., 113 University Pl., New York, N. Y.
Pilot Radio Corp., 37-06 36th St., Long Island City, N. Y.
Precision Specialties, 220 North Western Ave., Los Angeles, Calif.
Press Wireless, Inc., 1917 Tribune Tower, Chicago, Ill.
Presto Recording Corp., 242 W. 55th St., New York, N. Y.
Radio Corp. of America, Camden, N. J.
Radio Engineering Laboratories, Inc., 35-54 36th St., Long Island City, N. Y.
Radio Mfg. Engineers, Inc., 304 First Ave., Peoria, Ill.
Radio Navigational Instrument Corp., 500 Fifth Ave., New York, N. Y.
Radio Receptor Co., 251 West 19th St., New York, N. Y.
Radio Transceiver Laboratories, Inc., 8717 117th St., Richmond Hill, N. Y.
Radiomarine Corp. of America, 75 Varick St., New York, N. Y.
Scott Labs, Inc., E. H., 4450 Ravenswood Ave., Chicago, Ill.
Sentinel Radio Corp., 2020 Ridge Ave., Evanston, Ill.
Setchell Carlson, Inc., 2233 University Ave., St. Paul, Minn.
Sherron Metallic Corp., 1201 Flushing Ave., Brooklyn, N. Y.
Signal Electronic & Mfg. Co., 439 Lafayette St., New York, N. Y.
Sonora Radio & Television Corp., 2926 W. Washington St., Chicago, Ill.
Sparks-Withington Co., North St., Jackson, Mich.
Stewart-Warner Corp., 1826 Diversey Pkwy., Chicago, Ill.
Stromberg Carlson Telephone Mfg. Co., 100 Carlson Rd., Rochester, N. Y.
Templeton Radio Co., Mystic, Conn.
Transmitting Equipment Mfg. Co., Inc., 345 Hudson St., New York, N. Y.
Trav-Ler Karenola Radio & Television Corp., 1036 W. Van Buren St., Chicago, Ill.
Trebor Radio Co., Pasadena, Calif.
Warwick Mfg. Co., 4640 W. Harrison St., Chicago, Ill.
Wells-Gardner & Co., 2701 N. Kildare Ave., Chicago, Ill.
Western Electric Co., Inc., 195 Broadway, New York, N. Y.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
Westinghouse Electric & Mfg. Co., Radio X-Ray Div., Baltimore, Md.
Wilcox Electric Co., 1400 Chestnut St., Kansas City, Mo.
Wilcox-Gay Corp., Charlotte, Mich.
Zenith Radio Corp., 6001 Dickens Ave., Chicago, Ill.

RADIO COMPASS RECEIVERS

Airguide, Inc., Islip, N. Y.
Air Radio & Instrument Co., 5214 W. 63d St., Chicago, Ill.
Aircraft Accessories Corp., Fairfax & Funston Rds., Kansas City, Kansas
Airplane & Marine Instruments, Inc., Clearfield, Pa.
American Aircraft Radio Div., Searle Aero Industries, Inc., 226 N. Hawthorne Blvd., Hawthorne, Cal.
Ansley Radio Corp., 21-10 49th Ave., Long Island City, N. Y.
Bendix Radio Div. of Bendix Aviation Corp., Baltimore, Md.
Erie Art Metal Co., 1602 East 18th St., Erie, Pa.
Federal Telephone and Radio Corp., 591 Broad St., Newark, N. J.
Finch Telecommunications, Inc., Passaic, N. J.
Fisher Research Laboratory, 1961 University Ave., Palo Alto, Cal.
Gray Radio Co., 730 Okeeshobee Rd., West Palm Beach, Fla.
Hallicrafters Co., 2611 S. Indiana Ave., Chicago, Ill.
Harvey Radio Laboratories, Inc., 447 Concord Ave., Cambridge, Mass.
Jefferson Inc., Ray, 182 Millburn Ave., Baldwin, N. Y.
Jefferson-Travis Radio Mfg. Corp., 380 Second Ave., New York, N. Y.
Lear-Avia, Inc., 1718 Broadway, Piqua, Ohio
Magnavox Co., 2131 Bueter Rd., Fort Wayne, Ind.
Panoramic Radio Corp., 242 W. 55 St., New York, N. Y.
Press Wireless, Inc., 1917 Tribune Tower, Chicago, Ill.
Radiomarine Corp. of America, 75 Varick St., New York, N. Y.
Radio Navigational Instrument Corp., 500 Fifth Ave., New York, N. Y.
Radio Corp. of America, Camden, N. J.
Sperry Gyroscope Co., Inc., Manhattan Bridge Plaza, Brooklyn, N. Y.
Stratosearch, Inc., 699 Madison Ave., New York, N. Y.
Western Electric Co., Inc., 195 Broadway, New York, N. Y.

FACSIMILE RECEIVERS

Alden Products Co., 117 Main St., Brockton, Mass.
Finch Telecommunications, Inc., Passaic, N. J.
Press Wireless, Inc., 1917 Tribune Tower, Chicago, Ill.
Radio Corp. of America, Camden, N. J.

Recorders, Sound

RECORDERS and CUTTING HEADS

Allied Recording Products Co., 21-09 43rd Ave., Long Island City, N. Y.
Annis Co., R. B., 1101 N. Delaware St., Indianapolis, Ind.
Audak Co., Inc., 500 Fifth Ave., New York, N. Y.
Audio-Tone Oscillator Co., 60 Walter St., Bridgeport, Conn.
Austin Electronic Mfg. Co., Warren, Pa.
Autocraft Radio Co., 3855 N. Hamilton Ave., Chicago, Ill.
Brush Development Co., 3311 Perkins Ave., Cleveland, Ohio
Bunnell & Co., 215 Fulton St., New York, N. Y.
Chicago Sound Systems Co., 2124 S. Michigan Ave., Chicago, Ill.
Dictaphone Corp., 420 Lexington Ave., New York, N. Y.
Fairchild Aviation Corp., 88-06 Van Wyck Blvd., Jamaica, L. I., N. Y.
Federal Recorder Co., Elkhart, Ind.
Garod Radio Corp., 70 Washington St., Brooklyn, N. Y.
Gates Radio Co., 220 Hampshire St., Quincy, Ill.
Gray Mfg. Co., 16-30 Arbor St., Hartford, Conn.
Howard Radio Co., 1735 Belmont Ave., Chicago, Ill.
Memovox, Inc., 9242 Beverly Blvd., Beverly Hills, Calif.
Miles Reproducer Co., 812 Broadway, New York, N. Y.
Montgomery Bros., 61 Fremont St., San Francisco, Calif.
Pacific Sound Equipment Co., 1534 Cahuenga Blvd., Hollywood, Calif.
Presto Recording Corp., 242 W. 55th St., New York, N. Y.
Proctor Co., B. A., 2 W. 45th St., New York, N. Y.
Radio Corp. of America, Camden, N. J.
Radiotechnic Laboratory, 1328 Sherman Ave., Evanston, Ill.
Radiotone, Inc., 7356 Melrose Ave., Los Angeles, Calif.
Rek-O-Kut Corp., 173 Lafayette St., New York, N. Y.
Rieber, Inc., Frank, 11916 W. Pico Blvd., Los Angeles, Calif.
Robinson Recording Laboratories, 35 S. Ninth St., Philadelphia, Pa.
Scully Machine Co., 62 Walter St., Bridgeport, Conn.
Seeburg Corp., J. P., 1510 N. Dayton St., Chicago, Ill.
Simpson Mfg. Co., Inc., 188 W. 4th St., New York, N. Y.
Sound Apparatus Co., 150 W. 46th St., New York, N. Y.
Sound Scriber Corp., 82 Audubon St., New Haven, Conn.
Speak-O-Phone Recording & Equipment Co., 23 W. 60th St., New York, N. Y.
Talk-A-Phone Mfg. Co., 1219 W. Van Buren St., Chicago, Ill.
Talking Devices Co., 4447 W. Irving Park Rd., Chicago, Ill.
United Sound Engrg. Co., 6642 Santa Monica Blvd., Hollywood, Calif.
Western Sound & Electric Laboratories, Inc., 3512 W. St. Paul Ave., Milwaukee, Wisc.
Wilcox-Gay Corp., Charlotte, Mich.

NOISE RECORDERS

Brush Development Co., 3311 Perkins Ave., Cleveland, Ohio
General Radio Co., 30 State St., Cambridge, Mass.

Records

PHONOGRAPH RECORDS

Classic Record Co., 2 W. 46th St., New York, N. Y.
Columbia Recording Corp., 1473 Barnum Ave., Bridgeport, Conn.
Decca Records, Inc., 50 W. 57th St., New York, N. Y.
Jack Mfg. Corp., Charles, 30 No. Penn St., York, Pa.
Radio Corp. of America, Camden, N. J.
Sonora Radio & Television Corp., 2626 W. Washington St., Chicago, Ill.

Relays

CAPACITY OPERATED RELAYS

General Electric Co., Schenectady, N. Y.

PHOTOELECTRIC RELAYS

Advance Electric Co., 1260 W. Second St., Los Angeles, Cal.
Allied Control Co., Inc., 2 East End Ave., New York, N. Y.
American Instrument Co., 8010 Georgia Ave., Silver Spring, Md.
Automatic Electric Co., 1033 W. Van Buren St., Chicago, Ill.
Clare & Co., C. P., 4719 Sunnyside Ave., Chicago, Ill.
Dickson Co., 7420 Woodlawn Ave., Chicago, Ill.
Eby, Inc., Hugh H., 18 W. Chelton Ave., Philadelphia, Pa.
Electronic Control Corp., 625 Harper Ave., Detroit, Mich.
Electronic Laboratory, 306 S. Edinburgh Ave., Los Angeles, Cal.
Electronic Products Co., 19 N. 1st St., Geneva, Ill.
General Electric Co., Schenectady, N. Y.
G-M Laboratories, Inc., 4313 N. Knox Ave., Chicago, Ill.
Leach Relay Co., 5915 Avalon Blvd., Los Angeles, Cal.
Lipman Eng. Co., 415 Van Braam St., Pittsburgh, Pa.
Lumenite Electric Co., 407 S. Dearborn St., Chicago, Ill.
Philharmonic Radio Corp., 216 William St., New York, N. Y.
Photobell Corp., 116 Nassau St., New York, N. Y.
Photoswitch, Inc., 77 Broadway, Cambridge, Mass.
Rehtron Corp., 2159 Magnolia Ave., Chicago, Ill.
United Cinephone Corp., 65 New Litchfield St., Torrington, Conn.
Ward Leonard Electric Co., 31 South St., Mount Vernon, N. Y.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J.
Worner Products Corp., 1019 W. Lake St., Chicago, Ill.

PHOTOTUBE RELAYS

Brown Instrument Co., 4536 Wayne Ave., Philadelphia, Pa.
Electronic Control Corp., 626 Harper Ave., Detroit, Mich.
Electronic Products Co., 19 N. 1st St., Geneva, Ill.
General Control Co., 243 Broadway, Cambridge, Mass.
General Electric Co., Schenectady, N. Y.

G-M Laboratories, Inc., 4313 N. Knox Ave., Chicago, Ill.
Leach Relay Co., 5915 Avalon Blvd., Los Angeles, Cal.
Potter & Brumfield Mfg. Co., 617-621 No. Gibson St., Princeton, Ind.
United Cinephone Corp., 65 New Litchfield St., Torrington, Conn.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J.

Sound

COMPLETE SOUND SYSTEMS

Altec Lansing Corp., 1680 N. Vine St., Los Angeles, Cal.
American Communications Corp., 306 Broadway, New York, N. Y.
Amplifier Co. of America, 17 W. 20th St., New York, N. Y.
Atlas Sound Corp., 1443 39th Brooklyn, N. Y.
Austin Electronic Mfg. Co., Warren, Pa.
Bell Sound Systems, Inc., 1183 Essex Ave., Columbus, Ohio
Bogen Co., David, 663 Broadway, New York, N. Y.
Bond Products Co., 13139 Hamilton Ave., Detroit, Mich.
Boom Electric Amplifier Corp., 1227 W. Washington Blvd., Chicago, Ill.
Braun, Inc., W. C., 601 W. Randolph St., Chicago, Ill.
Cincinnati Time Recorder Co., 1733 Central Ave., Cincinnati, Ohio
Dilks Acoustic Co., 540 West Ave., Norwalk, Conn.
Eastern Amplifier Corp., 794 East 140th St., Bronx, N. Y.
Electronic Corp. of America, 45 W. 18th St., New York, N. Y.
Executone, Inc., 415 Lexington Ave., New York, N. Y.
Forest Electronic Co., 320 E. 65th St., New York, N. Y.
Gates Radio Co., 220 Hampshire St., Quincy, Ill.
General Electric Co., Schenectady, N. Y.
General Electronic Industries, Div. Auto Ordnance Corp., 342 Putnam, Greenwich, Conn.
Gibson, Inc., 225 Parsons St., Kalamazoo, Mich.
Globe Phone Mfg. Corp., 2 Linden St., Reading, Mass.
Godfrey Mfg. Corp., 2140 North 27th St., Milwaukee, Wisc.
Harris Mfg. Co., 2422 W. 7th St., Los Angeles, Calif.
Herbach & Rademan, 522 Market St., Philadelphia, Pa.
Industrial Sound Products Co., 3597 Mission St., San Francisco, Calif.
Jack Mfg. Corp., 30 N. Penn St., York, Pa.
Laurehk Radio Mfg. Co., 3918 Monroe Ave., Wayne, Mich.
Lincrophone Co., 1661 Howard Ave., Utica, N. Y.
Meck Industries, John, Liberty St., Plymouth, Ind.
National Union Radio Corp., 15 Washington St., Newark, N. J.
Newcomb Audio Products Co., 2815 S. Hill St., Los Angeles, Calif.
Operadio Mfg. Co., 13th & Indiana Sts., St. Charles, Ill.
Pacific Sound Equipment Co., 1534 Cahuenga Blvd., Hollywood, Calif.
Philco Corp., Philadelphia, Pa.
Radiad Service, 720 W. Schubert Ave., Chicago, Ill.
Radio Corp. of America, Camden, N. J.
Radio Receptor Co., 251 West 19th St., New York, N. Y.
Rauland Corp., 4245 N. Knox Ave., Chicago, Ill.
Regal Amplifier Mfg. Corp., 20 W. 20th St., New York, N. Y.
Setchell Carlson, Inc., 2233 University Ave., St. Paul, Minn.
Simpson Mfg. Co., Mark, 188 W. Fourth St., New York, N. Y.
Sound Equipment Corp. of California, 6245 Lexington Ave., Hollywood, Calif.
Sound Scriber Corp., 82 Audubon St., New Haven, Conn.
Stromberg-Carlson Telephone Mfg. Co., 100 Carlson Rd., Rochester, N. Y.
United Sound Engrg. Co., 6642 Santa Monica Blvd., Hollywood, Calif.
Webster Electric Co., 1900 Clark St., Racine, Wisc.
Western Electric Co., Inc., 195 Broadway, New York, N. Y.
Western Sound & Electric Laboratories, Inc., 3512 W. St. Paul Ave., Milwaukee, Wisc.

Stroboscopes

General Electric Co., Schenectady, N. Y.
General Electronic Industries, Div. Auto Ordnance Corp., 342 Putnam, Greenwich, Conn.
General Radio Co., 30 State St., Cambridge, Mass.
L. A. B. Corp., Summit, N. J.
Pioneer Instrument Div. of Bendix Aviation, Bendix, N. J.
Welch Scientific Co., W. M., 1515 Sedgwick St., Chicago, Ill.

ELECTRICAL METER TESTERS

Biddle Co., James G., 1213 Arch St., Philadelphia, Pa.
Communication Measurements Laboratory, 120 Greenwich St., New York, N. Y.
Eastern Specialty Co., 3619 N. Eighth St., Philadelphia, Pa.
General Electric Co., Schenectady, N. Y.
McFarlin Co., 29 W. Marion Ave., Youngstown, Ohio
Radio Corp. of America, Camden, N. J.
Rubicon Co., 3751 Ridge Ave., Philadelphia, Pa.
Sensitive Research Instrument Corp., 9-11 Elm Ave., Mt. Vernon, N. Y.
States Co., 19 New Park Ave., Hartford, Conn.
Superior Instruments Co., 227 Fulton St., New York, N. Y.

Timers

AUTOMATIC CYCLE TIMERS

American Gas Accumulator Co., 1029 Newark Ave., Elizabeth, N. J.
Betts & Betts Corp., 551 W. 52d St., New York, N. Y.
Bristol Co., Waterbury, Conn.
Brown Instrument Co., 4428 Wayne Ave., Philadelphia, Pa.
Controls, Inc., Towaco, N. J.
Cramer Co., R. W., Centerbrook, Conn.
Cyclotron Specialties Co., Moraga, Calif.
Eisler Engineering Co., 751 South 13th St., Newark, N. J.
Electric Switch Corp., 14th at Union St., Columbus, Ind.
Foxboro Co., Neponset Ave., Foxboro, Mass.
General Electric Co., Schenectady, N. Y.
General Electronic Industries, Div. Auto Ordnance Corp., 342 Putnam, Greenwich, Conn.
Industrial Instrument Co., 2249 14th St., S. W., Akron, Ohio
Industrial Timer Corp., 117 Edison Pl., Newark, N. J.
Minneapolis-Honeywell Regulator Co., 2753 Fourth Ave., S., Minneapolis, Minn.
Paragon Electric Co., 37 W. Van Buren St., Chicago, Ill.
Penn Electric Switch Co., Goshen, Ind.
Richardson-Allen Corp., 15 W. 20th St., New York, N. Y.
Stromberg Time Corp., 109 Lafayette St., New York, N. Y.
Tagliabue Mfg. Co., C. J., 540 Park Ave., Brooklyn, N. Y.
Thompson Clock Co., H. C., 38 Federal St., Bristol, Conn.
Walser Automatic Timer Co., 420 Lexington Ave., New York, N. Y.
Zenith Electric Co., 152 W. Walton St., Chicago, Ill.

AUTOMATIC INTERVAL TIMERS

American Gas Accumulator Co., 1029 Newark Ave., Elizabeth, N. J.
Automatic Electric Mfg. Co., 10 State St., Mankato, Minn.
Betts & Betts Corp., 551 W. 52d St., New York, N. Y.
Bristol Co., Waterbury, Conn.
Controls, Inc., Towaco, N. J.
Cramer Co., R. W., Centerbrook, Conn.
Dunn, Inc., Struthers, 1321 Arch St., Philadelphia, Pa.
Eisler Engineering Co., 751 South 13th St., Newark, N. J.
Electric Switch Corp., 14th at Union St., Columbus, Ind.
General Electronic Industries, Div. Auto Ordnance Corp., 342 Putnam, Greenwich, Conn.
Glogau & Co., 1722 Rand McNally Bldg., Chicago, Ill.
Guardian Electric Mfg. Co., 1621 W. Walnut St., Chicago, Ill.
Industrial Engineering Corp., Evansville, Ind.
Industrial Timer Corp., 117 Edison Pl., Newark, N. J.
Lektra Laboratories, Inc., 30 E. Tenth St., New York, N. Y.
Minneapolis-Honeywell Regulator Co., 2753 Fourth Ave., S., Minneapolis, Minn.
Northwestern Clock Co., 514-15 Brown Bldg., Omaha, Neb.
Paragon Electric Co., 37 W. Van Buren St., Chicago, Ill.
Photovolt Corp., 95 Madison Ave., New York, N. Y.
Rawson Electrical Instrument Co., 110 Potter St., Cambridge, Mass.
Reliance Automatic Lighting Co., 1927 Mead St., Racine, Wisc.
Rowe Radio Research Laboratory, 2422 N. Pulaski Rd., Chicago, Ill.
Standard Electric Time Co., 89 Logan St., Springfield, Mass.
Stromberg Time Corp., 109 Lafayette St., New York, N. Y.
Thompson Clock Co., H. C., 38 Federal St., Bristol, Conn.
Walser Automatic Timer Co., 420 Lexington Ave., New York, N. Y.
Zenith Electric Co., 152 W. Walnut St., Chicago, Ill.

AUTOMATIC RESET TIMERS

American Gas Accumulator Co., 1029 Newark Ave., Elizabeth, N. J.
Automatic Electric Mfg. Co., 10 State St., Mankato, Minn.
Betts & Betts Corp., 551 52d St., New York, N. Y.
Bristol Co., Waterbury, Conn.
Cramer Co., R. W., Centerbrook, Conn.
Dunn, Inc., Struthers, 1321 Arch St., Philadelphia, Pa.
General Electronic Industries, Div. Auto Ordnance Corp., 342 Putnam, Greenwich, Conn.
Paragon Electric Co., 37 W. Van Buren St., Chicago, Ill.
Stromberg Time Corp., 109 Lafayette St., New York, N. Y.
Tagliabue Mfg. Co., C. J., 540 Park Ave., Brooklyn, N. Y.
Zenith Electric Co., 152 W. Walton St., Chicago, Ill.

PHOTO-ELECTRIC TIMERS

General Control Co., 243 Broadway, Cambridge, Mass.
General Electric Co., Schenectady, N. Y.
General Electronic Industries, Div. Auto Ordnance Corp., 342 Putnam, Greenwich, Conn.
Intercontinental Marketing Corp., 95 Madison Ave., New York, N. Y.
Reynolds Electric Co., 2650 Congress St., Chicago, Ill.
United Cinephone Corp., 65 New Litchfield St., Torrington, Conn.

Tools

SCREWDRIVERS and SMALL INSULATED TOOLS

Bonney Forge & Tool Works, Allentown Pa.
Bridgeport Hardware Mfg. Corp., Iranistan Ave., Bridgeport, Conn.
Crescent Tool Co., 200 Harrison St., Jamestown, N. Y.
Eastern Specialty Co., 3617-19 N. Eighth St., Philadelphia, Pa.
Forsberg Mfg. Co., 125 Seaview Ave., Bridgeport, Conn.
Hoosick Falls Radio & Electrical Parts Mfg. Co., First St., Hoosick Falls, N. Y.
O'Neil-Irwin Mfg. Co., 316 Eighth Ave., So., Minneapolis, Minn.
Park Metalware Co., 28 Bank St., Orchard Park, N. Y.
Schollhorn Co., William, 414 Chapel St., New Haven, Conn.
Stanley Tools, Div. of Stanley Works, New Britain, Conn.
Stevens Walden, Inc., 459 Shrewsbury St., Worcester, Mass.
Utica Drop Forge & Tool Corp., 2800 Whitesboro St., Utica, N. Y.

Transmitters

Because of the fact that all transmitter manufacturers are on a 100 per cent war basis, we are listing them in this directory without type classification. In our first Directory after conclusion of hostilities we will again classify transmitter manufacturers by the kind they make.

Abbott Instrument Inc., 8 W. 18th St., New York, N. Y.
Air Communications, Inc., 2233 Grand Ave., Kansas City, Mo.
Airadio, Inc., Melrose Ave. & Battery Pl., Stamford, Conn.
Aircraft Accessories Corp., Fairfax & Funston Rds., Kansas City, Kansas
Aircraft Radio Corp., Boonton, N. J.
Airplane & Marine Instruments Inc., Clearfield, Pa.
American Communications Corp., 306 Broadway, New York, N. Y.
Arnessen Electric Co., 116 Broad St., New York, N. Y.
Austin Electronic Mfg. Co., Warren, Pa.
Barber Labs, Alfred W., 34-04 Francis Lewis Blvd., Flushing, N. Y.
Bassett, Inc., Rex., 500 S. E. Second St., Lauderdale, Fla.
Bendix Aviation, Ltd., North Hollywood, Calif.
Bendix Radio, Div. of Bendix Aviation Corp., Baltimore, Md.
H. O. Boehme, Inc., 915 Broadway, New York City
Bunnell & Co., J. H., 215 Fulton St., New York, N. Y.
Cinaudagraph Speakers, Inc., 3911 S. Michigan Ave., Chicago, Ill.
Collins Radio Co., 2920 First Ave., Cedar Rapids, Iowa
Communications Co., Inc., Coral Gables, Fla.
Communications Equipment Co., 134 West Colorado St., Pasadena, Calif.
Delco Radio Div., General Motors Corp., Kokomo, Ind.
Doolittle Radio, Inc., 7421 S. Loomis Blvd., Chicago, Ill.
Du Mont Laboratories, Inc., Allen B., 2 Main Ave., Passaic, N. J.
Electronic Corp. of America, 45 East 18th St., New York, N. Y.
Electronic Specialty Co., 3456 Glendale Blvd., Los Angeles, Calif.
Erco Radio Labs Inc., Fenimore Ave., Hempstead, N. Y.
Fada Radio & Electric Co., 30-20 Thomson Ave., Long Island City, N. Y.
Farnsworth Television & Radio Corp., 3700 Pontiac St., Fort Wayne, Ind.
Federal Telephone and Radio Corp., 591 Broad St., Newark, N. J.
Galvin Mfg. Corp., 4545 Augusta Blvd., Chicago, Ill.
Gates Radio Co., 220 Hampshire St., Quincy, Ill.
General Electric Co., 1 River Rd., Schenectady, New York
General Electronic Industries, 342 Putnam, Greenwich, Conn.
Hallicrafters Co., 2611 S. Indiana Ave., Chicago, Ill.
Hamilton Radio Corp., 510 South Ave., New York, N. Y.
Hammarlund Mfg. Co., Inc., 460 W. 34 St., New York, N. Y.
Harvey Radio Laboratories, Inc., 447 Concord Ave., Cambridge, Mass.
Harvey-Wells Communications, Inc., North St., Southbridge, Mass.
Hazeltine Electronics Corp., 1775 Broadway, New York, N. Y.
Herbach & Rademan, 522 Market St., Philadelphia, Pa.
Higgins Industries Inc., 2221 Warwick Ave., Santa Monica, Calif.
Hudson American Corp., 36 W. 47th St., New York, N. Y.
Islip Radio Mfg. Corp., Foot of Beech St., Islip, New York
Jefferson-Travis Radio Mfg. Corp., 380 Second Ave., New York, N. Y.
Jennings Radio Mfg. Co., R 3 Box 22, San Jose, Calif.
Kaar Engineering Co., 619 Emerson St., Palo Alto, Calif.
Lear-Avia, Inc., 1718 Broadway, Piqua, Ohio
Link, Fred M., 125 W. 17th St., New York, N. Y.
Majestic Radio & Television Corp., 2600 W. 51st Street, Chicago, Ill.
Maritime Radio Corp., 24 Whitehall St., New York City
Meissner Mfg. Co., Mt. Carmel, Ill.
Millen Co., James, 150 Exchange St., Malden, Mass.
Oxford Tartak Radio Corp., 3911 S. Michigan Ave., Chicago, Ill.
Pacific Electronics, W. 1130 Sprague Ave., Spokane, Wash.
Packard Bell Co., 1115 So. Hope St., Los Angeles, Calif.
Press Wireless, Inc., 1917 Tribune Tower, Chicago, Ill.
Radio Corp. of America, Camden, N. J.
Radio Engineering Laboratories, Inc., 35-54 36th St., Long Island City, N. Y.
Radio Navigational Instrument Corp., 500 Fifth Avenue, New York, N. Y.
Radio Receptor Co., 251 W. 19th St., New York, N. Y.
Radio Transceiver Laboratories, 120-03 Jamaica Ave., Richmond Hill, N. Y.
Radiomarine Corp. of America, 75 Varick St., New York, N. Y.
Sherron Metallic Corp., 1201 Flushing Ave., Brooklyn, N. Y.
Sparks-Withington Co., North St., Jackson, Mich.
Standard Transformer Corp., 1500 N. Halsted St., Chicago, Ill.
Televiso Products Co., 6533 N. Olmsted Ave., Chicago, Ill.
Templetone Radio Co., Mystic, Conn.
Transmitter Equipment Co., 345 Hudson St., New York, N. Y.
Western Electric Co., Inc., 195 Broadway, New York, N. Y.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
Westinghouse Electric & Mfg. Co., Radio & X-Ray Division, Baltimore, Md.
Wilcox Electric Co., 1400 Chestnut St., Kansas City, Mo.
Wilcox Gay Corp., Charlotte, Mich.

FACSIMILE TRANSMITTERS

Alden Products Co., 117 Main St., Brockton, Mass.
Finch Telecommunications, Inc., Passaic, N. J.
Press Wireless, Inc., 1917 Tribune Tower, Chicago, Ill.
Radio Corp. of America, Camden, N. J.

Winders

COIL WINDERS—see Machines

HOW TO USE THIS BUYERS GUIDE

IN THIS DIRECTORY of suppliers, products are alphabetically listed in three separate sections:

1—PARTS, ACCESSORIES, MATERIALS

Basic commodities used in the fabrication, assembly and maintenance of electronic devices

2—ELECTRICAL INSTRUMENTS

Test and measurement items used in the design, production and adjustment of electronic devices

3—ELECTRONIC EQUIPMENT

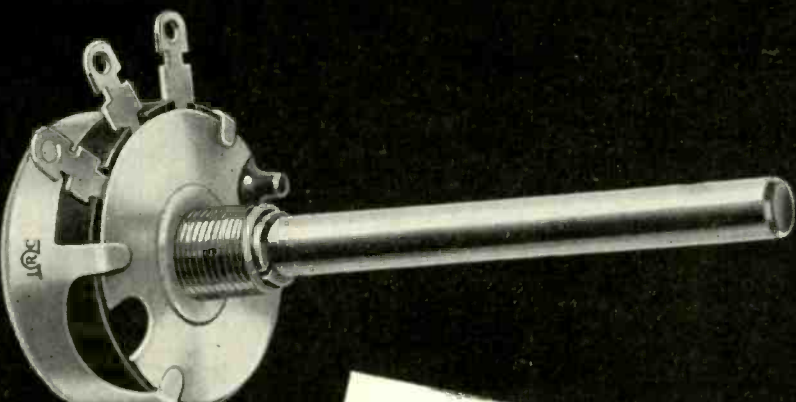
Devices having electronic operating principles, used by other fields as well as by the electronic industry itself

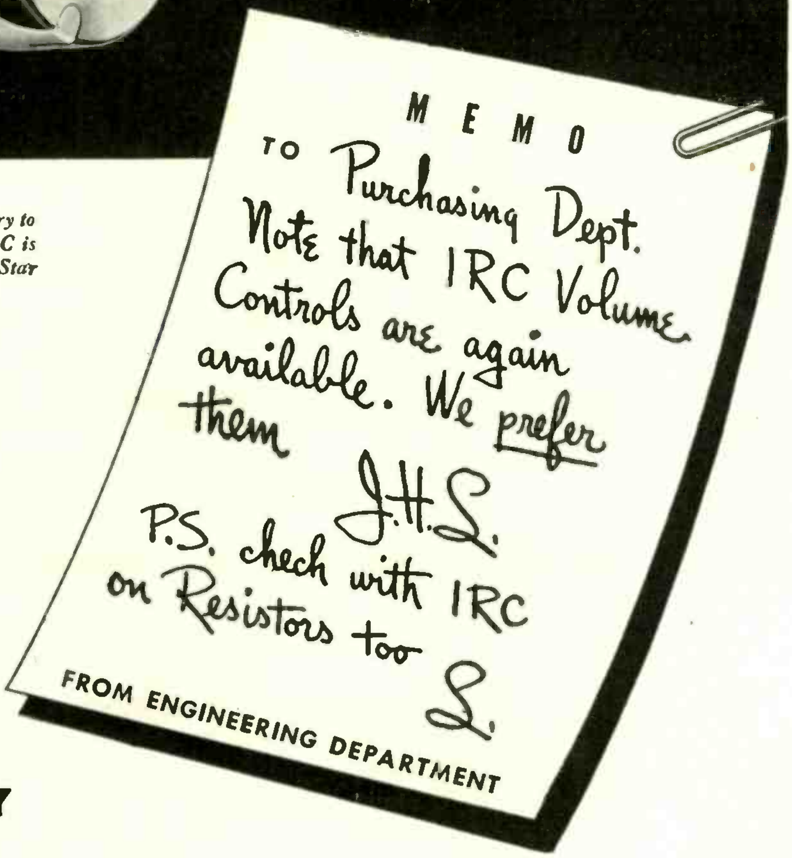
In each of these three sections products are listed under the noun or principal word. Certain products, not readily classified, have been arbitrarily included in the third section. The index on pages D-2 and D-3 serves as a general key to all three sections.

IRC VOLUME CONTROLS HAVE *All* THE FEATURES

No single attribute is responsible for the definite preference so often expressed by electronic engineers for IRC Volume Controls. Rather the fact that each unit embodies *all* the important factors which make for dependable operation has earned the regard of many of the largest users of potentiometers. . . . For preferred performance under severe conditions, for accuracy, stability and long life—specify IRC Volume Controls.

1—Metallized Element
2—Spiral Spring Connector
3—5 Finger Positive Contact
4—2 Sizes—1⅛" and 1¼" diam.
5—2 Ratings—½ and 1½ Watts
6—Available for Salt Spray, Sealed, and High Altitude Performance.





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TUBES AT WORK

R-F Heating of Plastics

A RAPIDLY INCREASING interest in the possibilities of high-frequency heating was indicated at the well-attended symposium of the Society of Plastics Engineers held in Chicago April 6, 1943. The purpose of the symposium was to familiarize the plastics engineer with the basic principles and the possible applications of high-frequency heating in his own field.

The first two speakers, J. A. Boyajian, Chief Engineer of the General Television and Radio Corporation, and Alfred Crossley of Electroproducts Laboratories, gave a short survey of the history of r-f heating in general and discussed the fundamental electric laws governing this new procedure.

Heating in plastics, as in all dielectric materials, is due to the losses in the dielectric itself. These losses are proportional to the frequency of the current, to the power factor of the material, and to the square of the voltage across the sample to be heated.

The advantage of using as high a frequency as economically possible is evident; with all other factors remaining constant, the power absorption increases proportionally with the frequency. Economic considerations will determine the maximum frequency, mainly for the reason that the tube efficiency decreases, and in some cases, initial tube costs increase when approaching the higher frequencies.

The power factor itself is a very important factor, determining whether the material can or cannot be heated within reasonable limits of the necessary voltage across the electrodes.[1]

Fortunately, the raw materials in the plastics field for most commercial purposes have sufficiently high power factor. Insulating materials with low power factor are not suitable for high-frequency heating.

Electrode Design Considerations

The influence of the shape of the electrodes and the relative spacing between object and electrodes was discussed by Eugene Mittelmann, Consulting Engineer, Illinois Tool Works, in connection with the importance of sufficiently accurate power absorption measurements. The amount of power which a particular object of given electrical properties may absorb in the electric field is determined by the size of the electrodes and the spacing between object and electrodes. In general, the following rules are true for all applications: Large electrode surface areas and small spacings mean high power absorption. Small surface areas and large spacings mean lower power absorption for a given constant voltage across the electrodes.

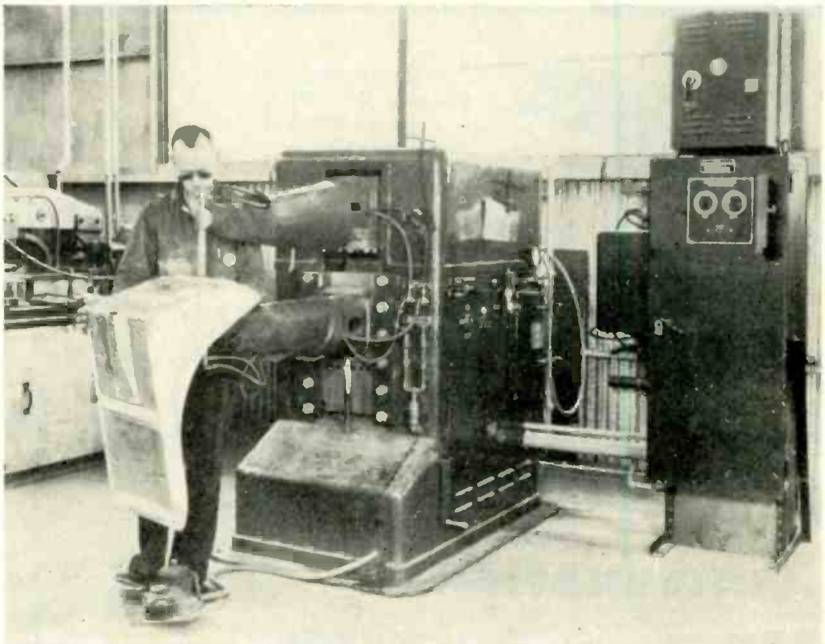
A 2.5 kw unit equipped with a high-frequency voltmeter indicating the amount of r-f power actually converted into heat within the sample was discussed with the aid of slides.

R-F Preheating of Plastics

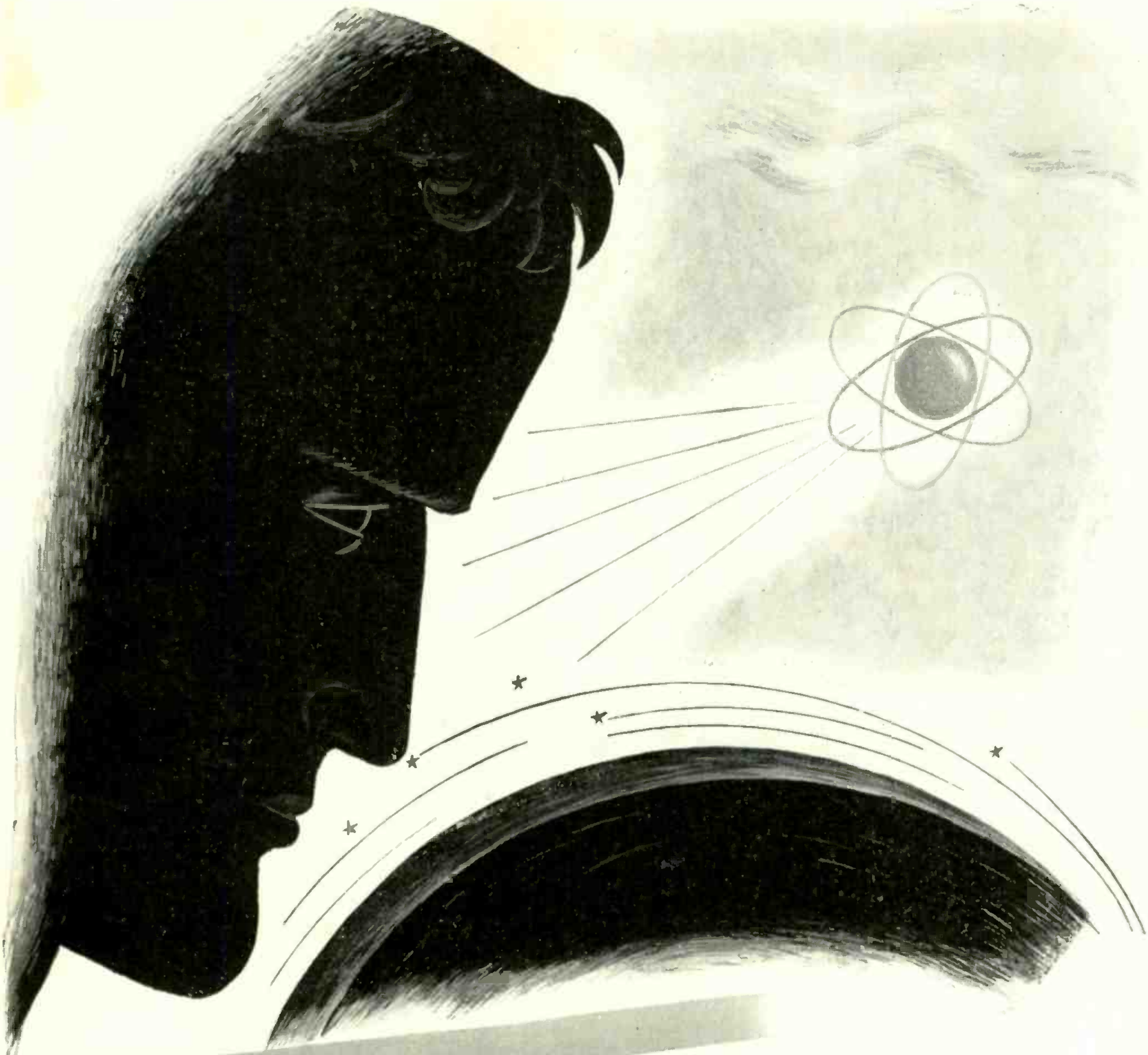
A number of commercial applications, including the use of high-frequency heating in the aeroplane industry in the manufacture of laminated propellers, was discussed by W. M. Witty of the Electronic Division of RCA Mfg. Co. Some quantitative relations between the required power and the volume of the material to be heated were given.

There are two main fields in the heating of plastic materials. One

Electronics In An Aircraft Plant



G-E thyratron unit (right) controlling a spot welding machine in a large aircraft plant. Tubes here insure satisfactory war work and speed up production



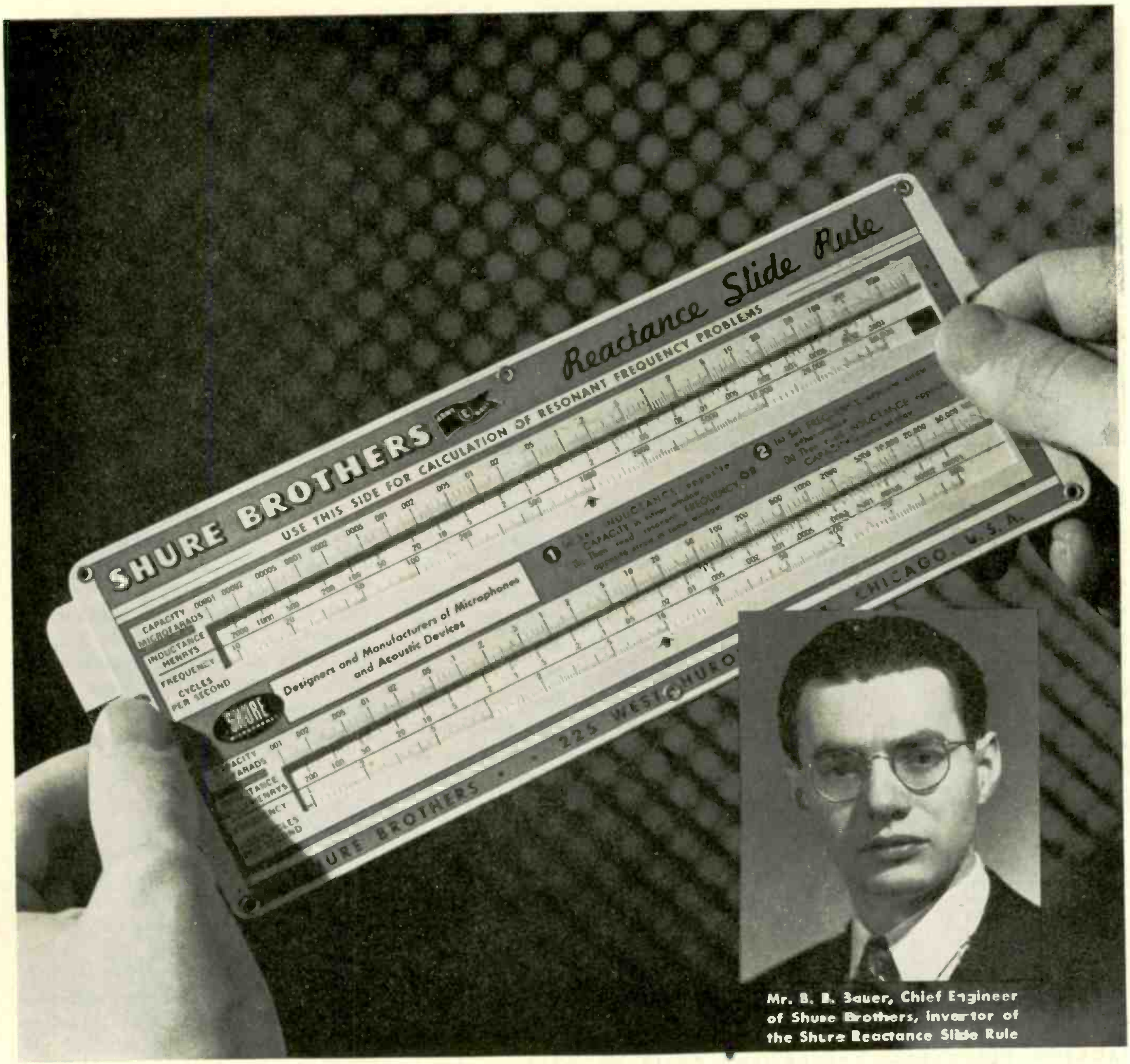
Example of typical r-f heating unit used in plastics manufacturing processes

applies to the molding of plastics by compression, in which case so-called pre-forms are used. The other involves heat treatment of impregnated wood for the purpose of manufacturing Compregwood articles.

In the molding processes using pre-forms and orthodox methods of heating, the maximum temperature to which the pre-forms can be brought depends on the limiting time factor. This is due to the fact that irrespective of the actual value of the temperature, overcuring takes place if the curing time exceeds a certain limit.

In the ordinary heating processes, heat is transferred to the center of the piece by heat conduction alone; hence the maximum uniform temperature which may be arrived at in a given time is rather limited. In the normal process the pre-forms are heated to a temperature of about 140 deg. F, then transferred to a molding press where the forms are raised to a temperature of about 300 to 325 deg. F. The difference in temperature has to be supplied by the properly heated press. Here again, if uniform temperature throughout the mold is required, a certain minimum time must elapse before the press can be closed.

The advantage of high-frequency heating is primarily due to the fact that uniform and high temperatures throughout the pre-forms can be arrived at in relatively short time. This high temperature of the pre-forms allows far shorter molding times in the press proper. This means more economical utilization of the press,



Mr. B. B. Bauer, Chief Engineer of Shure Brothers, inventor of the Shure Reactance Slide Rule

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ARMY E NAVY

SHURE MICROPHONES

SHURE BROTHERS, Dept. 174M, 225 West Huron St., Chicago, U. S. A.

Designers and Manufacturers of Microphones and Acoustic Devices with the possibility of reducing both pressure and molding time considerably. As for the power requirements, practical experience seems to indicate that two kw per pound and per minute are required for satisfactory heatings. The temperature so achieved is in the neighborhood of 300 deg. F.

The main application of high frequency in the manufacture of laminated Compregwood is in pre-heating of the bulk material to a stage where the wood becomes plastic and is duly impregnated with the bonding resin. The pre-heated samples are then transferred to the press, where the proper forming operation takes place.

When dealing with objects of different cross-section and density, the procedure includes the shaping of the high-frequency heat-treating electrode to follow the contours of the sample. To compensate for the difference in volume, sufficient air space is introduced between object and electrodes. The frequencies used range from 3½ to 30 megacycles.

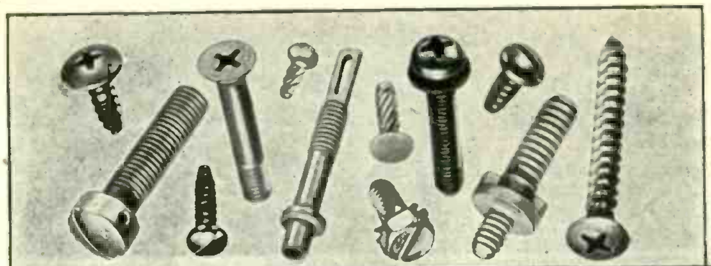
Report on R-F Heating Experiments

Mr. W. T. Cooper of the Bakelite Corporation reported on a number of practical experiments on a commercial scale with high-frequency heating. Although these experiments were carried out only for a relatively short time, the results seem to warrant the statement that the product obtained by high-frequency heating is at least equal to if not superior to the product obtained by the methods used up to date.

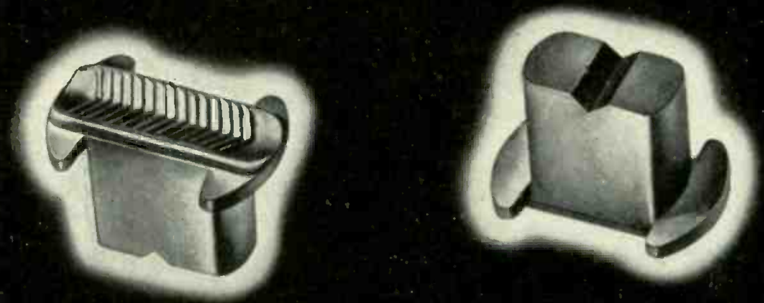
The plastics industry looks forward to the time when the electronic engineer will be in a position to offer relatively simple equipment which allows the arbitrary distribution of high-frequency energy to a number of simultaneously operated molding presses. Today's practice is limited to the use of a single apparatus for each press.

The transfer of the radio-frequency heat-treated pre-forms to the press is done manually today, but it is entirely conceivable that automatic fixtures will be developed which allow the immediate transfer of the pre-forms to the press.

Electronic heating of the material within the press itself presents difficulties, due to the fact that both the upper and lower die are at ground potential. This would require either



SCOVILL CAN LICK YOUR FASTENINGS PROBLEMS WITH LESS MONEY-METALS-MOTIONS



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"Know how" is a phrase so common nowadays as to be often treated with *un*deserved contempt. Yet it will always remain the essential element in first-class fastenings at fair prices. Without it men are merely hands, machines simply metal, and laboratory controls wasted motions.

Scovill has "know how" born of 141 years of experience in metal-working, enough to give it the edge over all in standard and special fastenings. We do not ask you to take our word for it—the problems we have solved tell their own story.

For example: the electrical part illustrated (a necessity in both war and peace) was made from flat wire (gilding metal) by a single cold forging operation plus clipping. Just another of many instances where Scovill "know how" meant minimum money—metals—motions.

We want to help you on your war production and post-war fastenings needs. Each office listed below has a Fastenings Expert at your call. He'll give you a prompt, frank answer as to when and where our part in the War Effort will let us serve you. It will pay you to give Scovill first call.

To the Reader: **Please pass this on wherever it can be of service. Thanks!**

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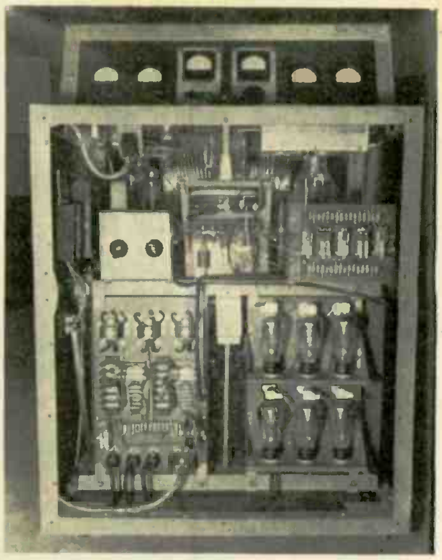


Same unit with front cover removed to show tubes and associated equipment

the introduction of some method of insulating either the lower or upper die, or special types of presses. The main advantage of the new method appears to lie in greater utilization of existing equipment by cutting down molding pressure and molding time.—E. M.

REFERENCE

(1) Mittelman, Eugene, Design Chart for Radio Frequency Heat Treatment Generators, ELECTRONICS, Sept. 1941.

• • •

Checking Cables in Aircraft With Rotobridge Tester

By D. A. GRIFFIN

Communication Measurements Laboratory

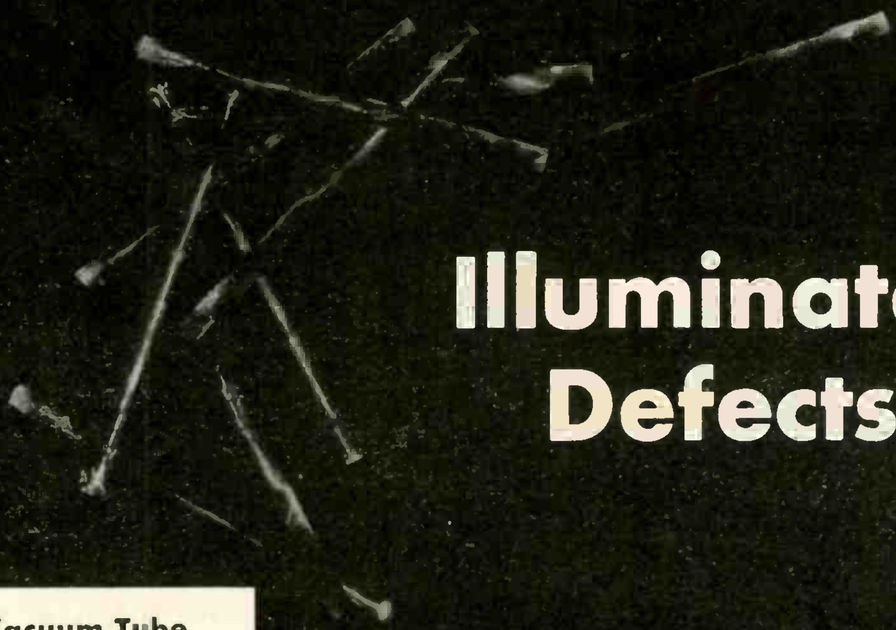
THE PROBLEM of testing multiple-wire cable harnesses installed in aircraft can be solved with a simple adaptation of the Rotobridge automatic production tester described in the February 1943 issue of ELECTRONICS. In brief, this motor-operated rotary switch permits an unskilled operator to check 120 different circuits in a few minutes after connections have been made. The machine compares resistance, capacitance and inductance values of newly-assembled apparatus with corresponding standard values.

In most aircraft, the wiring from the wings, tail, etc., is brought to a junction box. While some terminals in this box may have only one wire connected to them, others may have a plurality of wires. In addition to

Zyglo

Reg. U. S. Pat. Off.

The Newest Inspection Technique for the World's Newest Industry



Illuminates Defects

Reveals Vacuum Tube Defects

One example of Zyglo's practical application is the inspection of vacuum tubes for quality of vacuum seal. The finished tube is dipped in Zyglo fluorescent penetrant liquid. After a standing period and a rinse, inspection under black light shows bright indications at remarkably small leaking areas. Such defects include cracks and pin holes in the glass, particularly around the seals and lack of bond between the glass seals and the lead wire. Leaks through seamy tungsten are also well shown.

Tungsten wire and rod, subject to defects in drawing and swaging operations are more easily and quickly inspected by Zyglo than by microscopic examination. Cracks and undue porosity in ceramic and plastic insulators are also being successfully detected.

Standard practice in Zyglo inspection may be varied but consists basically of dipping, rinsing, drying, powdering (with a developing powder which draws penetrant to form accurate pattern indications on the surface) — and finally examination under black light. A complete line of equipment to speed these steps in the tempo of the production line is being manufactured.

MAGNAFLUX CORPORATION

● Following recent general announcement of the Zyglo Method by the originators of Magnaflux Inspection, important applications have been made in the field of electronics. The new method has all the background of enormous manhour and material savings made by Magnaflux inspections of magnetic parts.

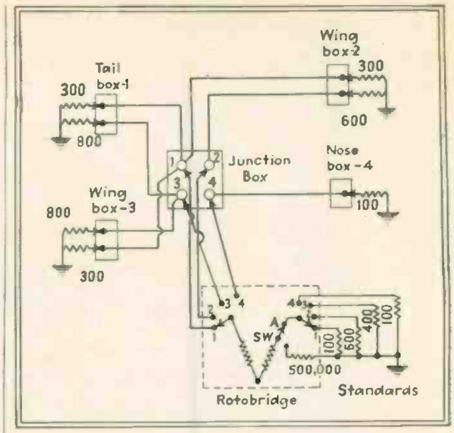
Zyglo now by means of fluorescent indications under black light makes possible similar flaw detection in *non-magnetics*—not only aluminum, stellite, austenitic steels and magnesium, but tungsten, ceramics, plastics and glass.

Operating executives and engineers in the electronic industry are invited to write. We will then send descriptive data on Zyglo and data covering similar applications or laboratory findings.

MAGNAFLUX CORPORATION

5914 Northwest Highway, Chicago

NEW YORK DETROIT LOS ANGELES DALLAS



Method of using the Rotobridge for checking an aircraft cabling system

the electrical problems involved, it is impractical to clear the plane of other workmen during construction and introduce test equipment and test men to make a conventional analysis.

The diagram shows these difficulties are overcome with the Rotobridge tester. One adapter is made to connect the terminals in the junction box to Rotobridge terminals. A separate adapter is made for the *AN* connector or box at the remote end of each cable. These adapters can be passed over the heads of the workers and plugged into the *AN* connectors, and the ground clip of each can be fastened to the metal frame of the aircraft. As shown in the diagram, each remote adapter connects a particular value of resistance between its cable wire and ground.

The net resistance of the three wires connecting to terminal 1 is 100 ohms, which balances against a similar standard resistor in the other variable bridge arm. If one wire is open, the resistance rises to 150 ohms, and if two are open, to 300 ohms. If any of the other wires are accidentally connected in parallel, the summation will not equal 100 ohms. Opens, shorts, or transpositions are therefore easily detected.

In general, the number of wires that can be tested by this "resistance selectivity" method is limited by the number of resistance values that can be set up within the range of the bridge independently of each other. An exception to this is shown at terminal 4 of the junction box, where the resistor value is the same as that used for the total of the three wires connecting to terminal 1. In actual

A NEW DI-MET DEVELOPMENT THAT *Improves* DIAMOND BLADE PERFORMANCE

A new exclusive process is now being applied to all DI-MET blades for obtaining DYNAMIC FLATNESS—a process which produces and sets a predetermined balanced, radial tension that keeps blades flat under normal operating conditions of heat, pressure and high r.p.m.

IN THE PAST, blade manufacturers depended upon static flatness to eliminate wobble . . . flatness that was proved by testing on surface plates but which was not necessarily permanent. Tests show that entirely new conditions appear after blades are put in operation. Unequalized strains in an apparently flat blade are released by high speed rotation, pressure and heat. These strains reassert themselves throughout the blade and destroy its original shape by warping. *So a blade which tests flat on the bench will not necessarily remain flat after being put in service!* To overcome these problems DI-MET engineers have succeeded in relieving blades of unequal internal strains, thus acquiring perfect flatness and introducing the correct balanced, radial tension. This "set" keeps the rim slightly contracted until relieved by the heat of normal operation. In effect, balanced tension neutralizes expansion of the rim under actual operating conditions and produces a stiffer, more rigid blade for any given thickness.

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Dynamic flatness is exclusive with DI-MET blades and is materially aiding in the production of more crystals per pound of quartz by cutting thinner wafers of excellent surface finish, with less wafer breakage.

LOOK FOR THIS DI-MET SYMBOL ➡ WHICH GUARANTEES DYNAMIC FLATNESS

FELKER MANUFACTURING COMPANY
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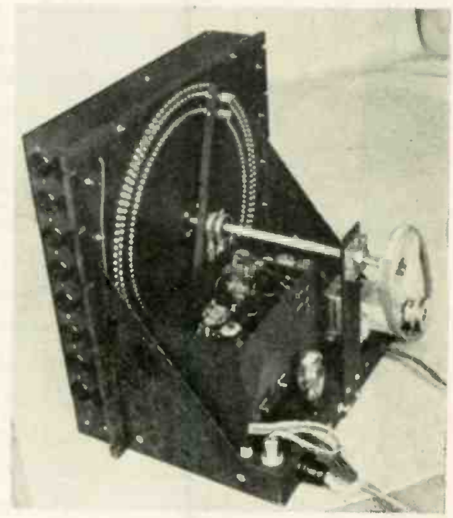
MANUFACTURERS OF DIAMOND ABRASIVE WHEELS

practice it would be extremely unlikely that all three wires would be shifted from 1 to 4 and the single wire from 4 shifted to 1. Analysis of each job will indicate where such repetitions are practical.

The Rotobridge itself is capable of handling connections to a junction box with 120 terminals, and will make a complete resistance test in 2 minutes. The number of wires that can be tested depends on the accuracy of the resistors that are used. If 1 percent tolerance resistors are used, it is possible to get over 400 useful resistor values. This makes it possible to test 400 wires without the use of repetitions.



Interior view of the Rotobridge, showing the two banks of contacts and the motor-driven rotating contact arm

After continuity checks are completed, a high-voltage test is made between each cable wire and the frame, to check leakage. To accomplish this, another set of adapters is plugged into the remote ends of the cables, connecting each terminal to ground through 500,000 ohms. A relay in the Rotobridge then switches *SW* from *A* to *B*, to an internal 500,000 ohm resistor.

The Rotobridge can be adjusted to indicate up to a 50-megohm leakage path from each wire to every other wire and to ground as well. This test also takes only two minutes for 120 circuits. Thus, in four minutes operating time the cabling is tested for opens, shorts to ground, incorrect wiring, improper strapping, and leakage between all wires and from each wire to ground.

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offers You *THESE SERVICES*

'Round the corner from your plant is a man whose chief stock in trade these days is his ability to help busy war industries get needed Radio and Electronic materials faster and use them to better advantage.

That man is your local RCA Tube and Equipment Distributor. Behind him is an organization which has been dealing with things Electronic since the "knee pants" days of Radio.

They know how to get the materials you need. They know how to use these properly once they've been obtained. You'll find their technical advice and recommendations as big a help as their personalized expediting service which assures fast, accurate deliveries.

Whether it's one RCA Tube or a hundred—they're ready and geared to help you. They'll help you, too, in obtaining condensers, resistors, rheostats, controls, potentiometers, coils, transformers, wire, and numerous other Radio and Electronic components produced by many manufacturers.

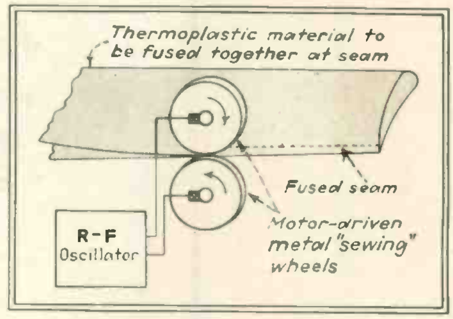
RCA

RCA RADIO-ELECTRONIC TUBES

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

Induction Heating Unit "Sews" Thermoplastic Sheets

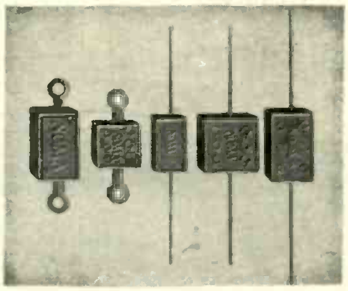
THERMOPLASTIC MATERIALS like vinylite, koroseal and pliofilm, used in thin sheets for making raincoats, caps, weather balloons and packages for foods and oils, can be fused together with heat to give seams which are air and water tight. Externally applied heat creates problems of maintaining uniform heat and preventing equipment from getting gummy. A special induction heating machine developed in RCA Laboratories eliminates these difficulties and provides a highly satisfactory mass-production method of putting to-



This induction heating machine, developed by RCA for use by the plastics industry, is popularly known as a radio sewing machine. The diagram shows how the two wheels act as electrodes

NOMA
MICA CAPACITORS
DEPENDABLE AS THE NAME BEHIND THEM

In this global war, *communication* . . . the vital link between our fighting forces . . . must not fail whenever courageous lives are at stake. For in the heat of battle . . . when co-ordination is so important . . . whether on land, on the sea, or in the air . . . each component part of the communication equipment must perform efficiently. That is why every NOMA mica capacitor is built toughly for endurance . . . built to stand the gaff of war . . . to function faithfully under the severest conditions . . . to be as *dependable as the name behind them.* Each capacitor is carefully tested for accuracy of capacity, voltage breakdown, and insulation resistance.



The same broad background of experience, engineering skill, and expert craftsmanship which made NOMA the most outstanding name in decorative lighting is now utilized in the manufacture of high quality mica capacitors. We are in a position to make prompt deliveries on types illustrated, in all capacities and tolerances shown in American War Standard C75.3 specification. Your inquiry invited on other types.

When planning for post-war production, a NOMA capacitor engineer will gladly confer with you.

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MANUFACTURERS OF FIXED MICA DIELECTRIC CAPACITORS

gether sections of thermoplastic sheets.

The material to be sealed is fed through two small roller wheels which are connected to the output terminals of a low-power r-f oscillator. Heat is generated in the material by dielectric loss, causing the sheets to fuse together in a tight bond. The roller wheels are driven by a small electric motor, so as to pull the material through at a uniform rate.

• • •

Tube-Making is Clean Job

MANY OF THE CLEANLINESS standards of a hospital have been adopted by Westinghouse in their new laboratory devoted to the manufacture of high-power electronic tubes. Workers on certain operations are assigned clean white cotton gloves daily, and special precautions are taken to keep grease off electrodes during assembly.

High-power radio transmitter tube being lowered into an annealing pot where strains in the glass will be relieved by a temperature of approximately 1000 degrees F. White gloves are worn to protect tube parts from moisture and grease

with Design Changes

Rapid changes in aircraft designs are promptly met with new SPEED NUTS engineered to fit the needs of the hour. The Speed Nut principle lends itself to a flexibility of design possessed by no other fastening.

For example: To meet the need for better and faster fastenings on beaded extrusions, up comes SPEED NUT No. 6320. No more holes to drill—no structural weakening. Just snap it on and turn the screw. For attaching conduit, piping, and wire harnesses, it's a record breaker! Again, with the present rapid conversion to rolled sections, SPEED NUT No. 6337 is doing the same record job on "Z" stringers. Hundreds of different Speed Nut designs already have saved millions of man-hours. Calling out SPEED NUTS for MORE of your non-structural attachments will do the same for you. First step is to send us your details today.

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Speed Nut System (PATENTED)

—*FASTEST THING IN FASTENINGS*

Phototube Checks Oxygen In Blood of Flyers

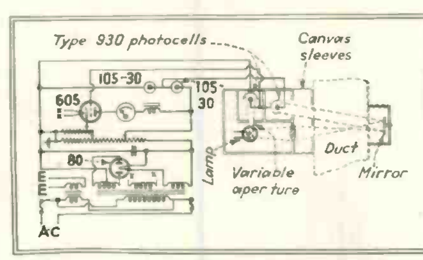
A PHOTOELECTRIC instrument under development at Westinghouse monitors the color of the blood in a flyer's ear, and indicates when additional oxygen is needed during high-altitude flying. The arrangement is based upon the change in the color of the blood with changes in oxygen content. A tiny light and midget phototube are supported on opposite sides of the ear lobe by a spring clip, and the output of the phototube is amplified and fed to an indicating instrument.

• • •

Smoke Detector for Ducts

THE ARRANGEMENT shown is being used in air conditioning ducts, ventilating systems and other locations where it is desired to detect the presence of smoke and operate an alarm or stop a blower motor automatically.

All necessary electronic apparatus is mounted in a single compact unit mounted on one side of the duct, while a mirror is mounted on the opposite side. A 50-candlepower bulb operating at reduced voltage for longer life projects a beam of light through the duct to the mirror, which in turn reflects the light back to a phototube. Smoke passing through the duct decreases the intensity of the light reaching the phototube, changing the amount of current passing through the tube. Amplification of this change with ordinary radio tubes actuates a relay which controls the alarm or blower circuit.



Electronic method of detecting smoke in an air-conditioning duct

Compensation for normal fluctuations in voltage and for gradual decrease in emitted light is made by means of a second phototube which is illuminated directly by the lamp, independently of light-transmitting

Tomorrow's pictures were made possible in 1928!

Recent development in television techniques lends weight to the belief that within due time after the war's end telecasting stations will be erected throughout the nation and television will become a revolutionary force for the betterment of humanity.

To us at Farnsworth, the magic of tomorrow is the reward for more than 15 years of research and development work.

It was 1928 when Farnsworth first picked up a picture electronically with the then newly developed "Image Dissector" tube, and reproduced the image on the end of a special electronic tube, proving that the Farnsworth revolutionary theory of *electronic television* was the answer to television of the future.

Continued Farnsworth research has produced many additional basic inventions. Research on electronic tubes and circuits has been carried on simultaneously with the knowledge that the full potentialities of this science are to be achieved by the correlated development of both.

Farnsworth created electronic television and will continue as a pioneer in this field. Perfected television has been the primary objective of our research . . . our production facilities are eminently fitted to produce the precision devices that will be the television apparatus of the future.

Today, all of our resources are devoted to the needs of our Armed Forces. But, in the peacetime world of the future, Farnsworth will be ready with the answers to your television problems.

FARNSWORTH TELEVISION

• Farnsworth Television & Radio Corporation, Fort Wayne, Indiana. Manufacturers of Radio and Television Transmitters and Receivers; Aircraft Radio Equipment; the Farnsworth Dissector Tube; the Capehart, the Capehart-Panamuse, and the Farnsworth Phonograph-Radios.

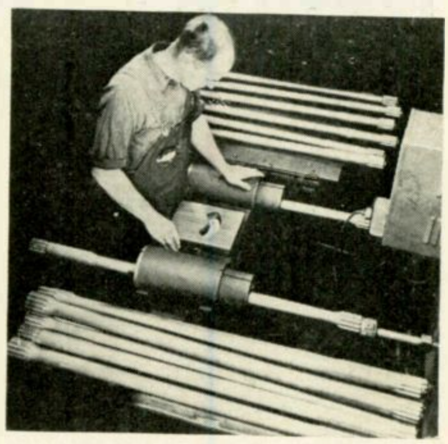
conditions in the duct. To make the smoke detector "fail safe" an arrangement of three relays is used so as to give an alarm when the lamp is burned out or when phototubes or amplifiers fail.

Since many ventilating ducts are not sufficiently rigid for direct mounting of this smoke detector unit as used by Electronic Control Corp. of Detroit, separate rigid supports are generally used, with canvas collars between the units and the ducts.

• • •

Magnetic Comparator Checks Hardness of Axle Shafts

A MAGNETIC COMPARATOR consisting simply of four coils and a voltmeter has been successfully utilized for approximately 15 years at the New Brunswick, N. J. plant of Mack-International Motor Truck Corp. as a check on the accuracy of heat treatment of axle shafts. The complete absence of electronic tubes in the unit emphasizes the fact that simple mechanical or electrical methods should not be overlooked by electronic engineers when confronted with industrial problems.



Magnetic comparator being used to check hardness of axle shafts for trucks. The a-c voltage regulator is on the wall in front of the operator

The comparator is based upon the relation between the magnetic permeability and the hardness of steel. A predetermined standard axle shaft having the desired characteristics is inserted in one set of primary and secondary coils. The shaft to be checked is inserted in the other set of coils, with stops being provided to

FOR MAGNET WIRE THAT MUST MEET SPECIFICATIONS

ALL THE WAY—

When you specify WINCO magnet wire, there's one thing of which you can be certain:

Every spool of the delivered product will be found uniformly accurate and free from variation. It will have the required electrical properties, flexibility, tensile strength, laying speed, etc.

Modern wire making methods, mercury process tests and exacting WINCO supervision, guarantee that any order for magnet wire products, whether it be for a single spool or a million pounds, must meet specifications all the way.

If you have a magnet wire problem of any nature our engineers and complete facilities are at your disposal. Send product blue prints or specifications for our recommendations. Or if you wish samples for test, we will be glad to cooperate.

ENAMELED COPPER
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TWISTED MULTIPLES
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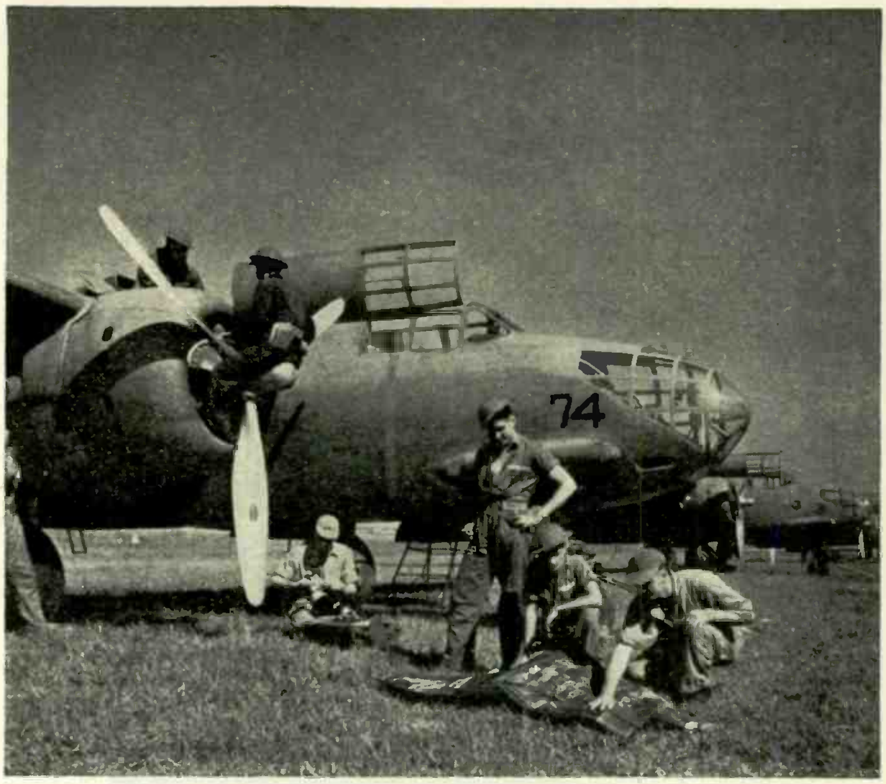

insure that both shafts have the same positions with respect to the coils.

The primary coils are energized directly from a 60-cycle power line, while the secondary coils are connected in series opposition. An a-c voltmeter is connected across the two secondary coils to read the difference between the voltages induced in the two coils. If the two shafts have identical permeability, the meter reads zero. When permeabilities differ, the magnitude of the meter reading is a measure of the difference in the physical characteristics of the two shafts.

To eliminate inaccuracies due to fluctuations in a-c line voltage, a voltage regulator is used to stabilize the voltage acting on the primary coils. This can well be an electronic voltage regulator.

The magnetic test has proven even more sensitive than a standard Brinell test. It gives a quick test throughout the length of the shaft, whereas the Brinell test is ordinarily made at only one point.

• • •

New Bass-Boosting Circuit

By L. M. BARCUS

ON PAGE 44 of the June 1940 issue of ELECTRONICS the author described a two-tube circuit for achieving bass boost in the region below 200 cycles. This was accomplished by screen grid injection. The interest in this circuit was considerable and quite a bit of correspondence with readers of ELECTRONICS resulted, indicating a desire for a simpler circuit with some other advantages to be described below. Work was undertaken on the project and the following material is the result.

A modification of the original circuit appears in Fig. 1. It has been demonstrated that the performance of this circuit is due to regeneration due to the negative resistance char-

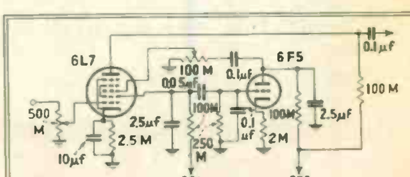

Fig. 1—Original two-tube bass-boosting circuit, slightly modified, with typical parts values

WE *Can* DO MORE!

With sleeves rolled up, Americans are determined to do the utmost to back up the boys at the fighting fronts. There seems to be almost no limit to American ingenuity, engineering know-how and mass production methods. Electronic Corporation of America is now in full production on 100% war work . . . but we *can* do more! ECA is pledged to do all in its power . . . and then a little more . . . to help win the war quicker!

To Manufacturers and Government Agencies

The Electronic Corporation of America factory is perfectly set up for the manufacture and assembly of electronic devices and equipment. ECA invites inquiries from manufacturers and government agencies who can make use of our facilities and experience to help win the war sooner.

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"Let's Win the War Now! . . . with the Utmost in Production"

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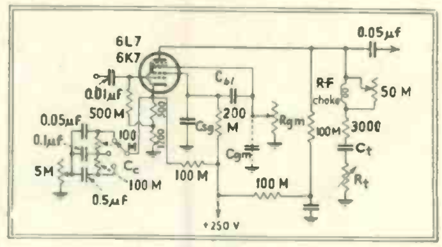
acteristic of the tube when operated according to this schematic.

Attempts to simplify the circuit to a single-tube method at first resulted in insufficient gain on the one hand and response curves lacking clear-cut attenuation characteristics on the other hand. Additional development, however, showed that the gain of the simplified circuit could be vastly increased by proper manipulation of the load resistance and applied voltages while, at the same time, proper control was exercised over the phase shift in the system. Stable voltage gains in excess of 10,000 have been recorded. The new circuit in Fig. 2 showed less variance than the former circuit in overall performance as a function of differences among tubes.



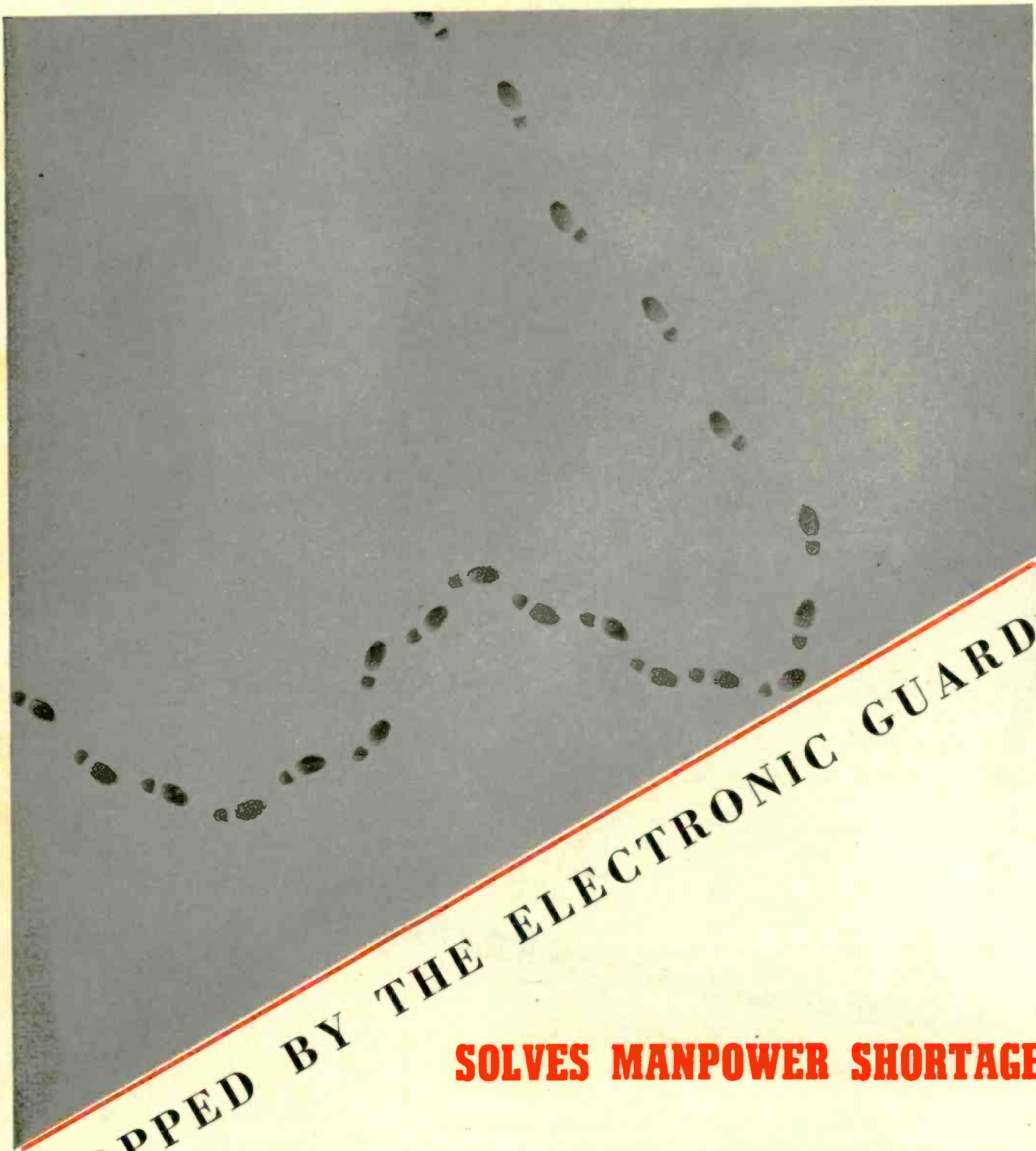
Curve	C_{sg} μf	C_{bl} μf	C_{gm} μf	C_t μf	R_{gm} ohms	R_t ohms
A	0.45	0.1	.....	0.1	100M	7M
B	"	"	.....	"	"	100M
C	"	"	.....	0.2	"	7M
D	0.25	0.02	.....	"	"	"
E	"	0.1	0.05	"	40M	"
F	"	0.02	"	"	100M	"
G	0.45	0.1	.....	0.1	"	"
H	"	0.02	.....	"	"	"
J	0.25	0.1	0.05	"	"	"

Fig. 2—Single-tube bass-boosting circuit. Values required with a 6K7 tube to obtain the various curves in Figs. 3 and 4 are given in the accompanying table

Study of the various response curves given will reveal the several basic functions of the capacitances employed. The frequency of the peak response is determined largely by the value of C_{sg} and C_{gm} and an increase in their effective value will lower this peak. Accordingly, the response may be made to peak at practically any point below 100 cycles, below which the gain will tend to fall off.

The greater the value of capacitor C_t, the sharper will be the bend of the knee of the response curve and the lower will be the gain between 100 and 500 cycles.

Coupling condenser C_{bl} may be considered basically as regulating the amount of coupling between C_{sg} and C_{gm}, with some effect upon the



STOPPED BY THE ELECTRONIC GUARD

SOLVES MANPOWER SHORTAGE

The Browning Signal System lays down a protective wall, is on the job night and day, reduces guarding personnel, cuts guarding costs.

BROWNING SIGNAL SYSTEM

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shape of the lower end of the curve. In those cases where considerable values of by-passing are used and the coupling is well below unity, an increase in the size of C_{b2} will naturally increase the gain. In those cases where a peak below 25 cycles is desired, the value of C_{b2} is generally large and the coupling held to below unity by a lower value of R_{gm}.

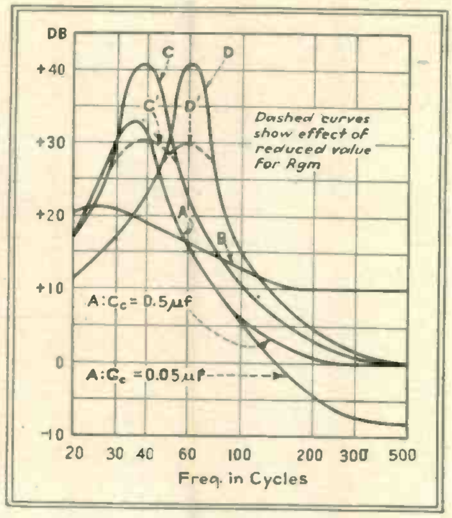


Fig. 3—Response curves obtained with various values in the circuit of Fig. 2

While the high-frequency choke is not essential, sole dependence being made upon C_c for sufficient gain in the upper frequencies, it is highly recommended. Since noticeable harmonic distortion attends the use of an iron-core choke, the air-wound unit is advised. In this respect, it has been found that the field winding of a midget speaker is most satisfactory and easily obtained. It should be of the 1200-ohm type.

If several types of curves are desired, it is suggested that leakage resistances be placed between the several capacitances of any one group as demonstrated at C_c in Fig. 2. This

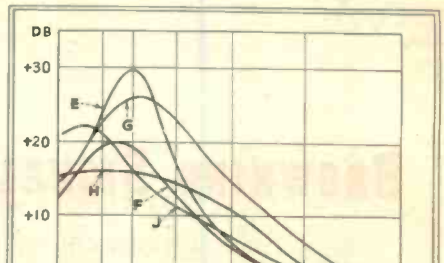


Fig. 4—Response curves obtained with various values in the circuit of Fig. 2

LOOKING *into the Future* NOW

3 to 6 Kw.
Converter with 3P4 Furnace and Truck

20 to 40 Kw.
Converter with 17 pound Furnace

15 to 60 Kw.
Tube Converter

If the history of metals in this war is ever written in full, the contribution of laboratory technicians will be revealed.

Most of the alloys now in use were first melted in a small AJAX-NORTHRUP furnace. The fast melts, perfect control, ability to vary or duplicate and the comfortable working conditions are known to most of the university and industrial metallurgical laboratories in the country.

But as these men now work to solve war problems they get glimpses of the future too. The tremendous increase in the use of high frequency for testing, pilot plants, large scale melting, heating and brazing, are like handwriting on the wall.

They see the vision of duplicating laboratory discoveries in future quantity peace time production with a certainty as to results, timing and cost.

Only a few of the smaller AJAX-NORTHRUP furnaces are shown on this page.

AJAX furnaces range from 1 oz. to 8 tons and from 60 to 1,000,000 cycles. Oscillators, tube converters, and motor generators provide the power. AJAX also provides the experience that has successfully solved hundreds of unusual problems from brazing fuse-seat liners to hardening razor blades or melting special alloys at the rate of 44 tons in 24 hours.

Catalogs on heating, melting, or laboratory units will be sent on request. Inquiries from manufacturers desiring to incorporate electronic heating in their post-war products are particularly welcome.

AJAX HIGH FREQUENCY FURNACES

NORTHRUP AJAX ELECTROTHERMIC CORPORATION, AJAX PARK, TRENTON, N.J.

ASSOCIATE COMPANIES: THE AJAX METAL CO. *Non-Ferrous Ingot Metal for foundry use.*
AJAX ELECTRIC FURNACE CORPORATION. *Ajax-Wyatt Induction Furnaces for melting.*
AJAX ELECTRIC CO., INC. *Ajax-Hultgren Salt Bath Furnace and Resistance Type Electric Furnaces.*
AJAX ENGINEERING CORPORATION. *Aluminum Melting Furnaces.*

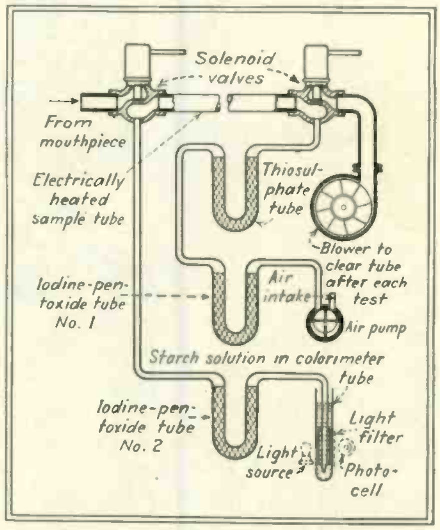
maintains an equal potential on each and allows switching without objectionable noise.

Finally, it must be pointed out that much of the expected performance of any system using this method of tonal correction depends upon the amplifier and speaker system. Among essential requirements are good voltage regulation for the power tubes, a large amount of feedback which permits an increase in the amount of low-frequency bass which the system can handle, and low distortion.

• • •

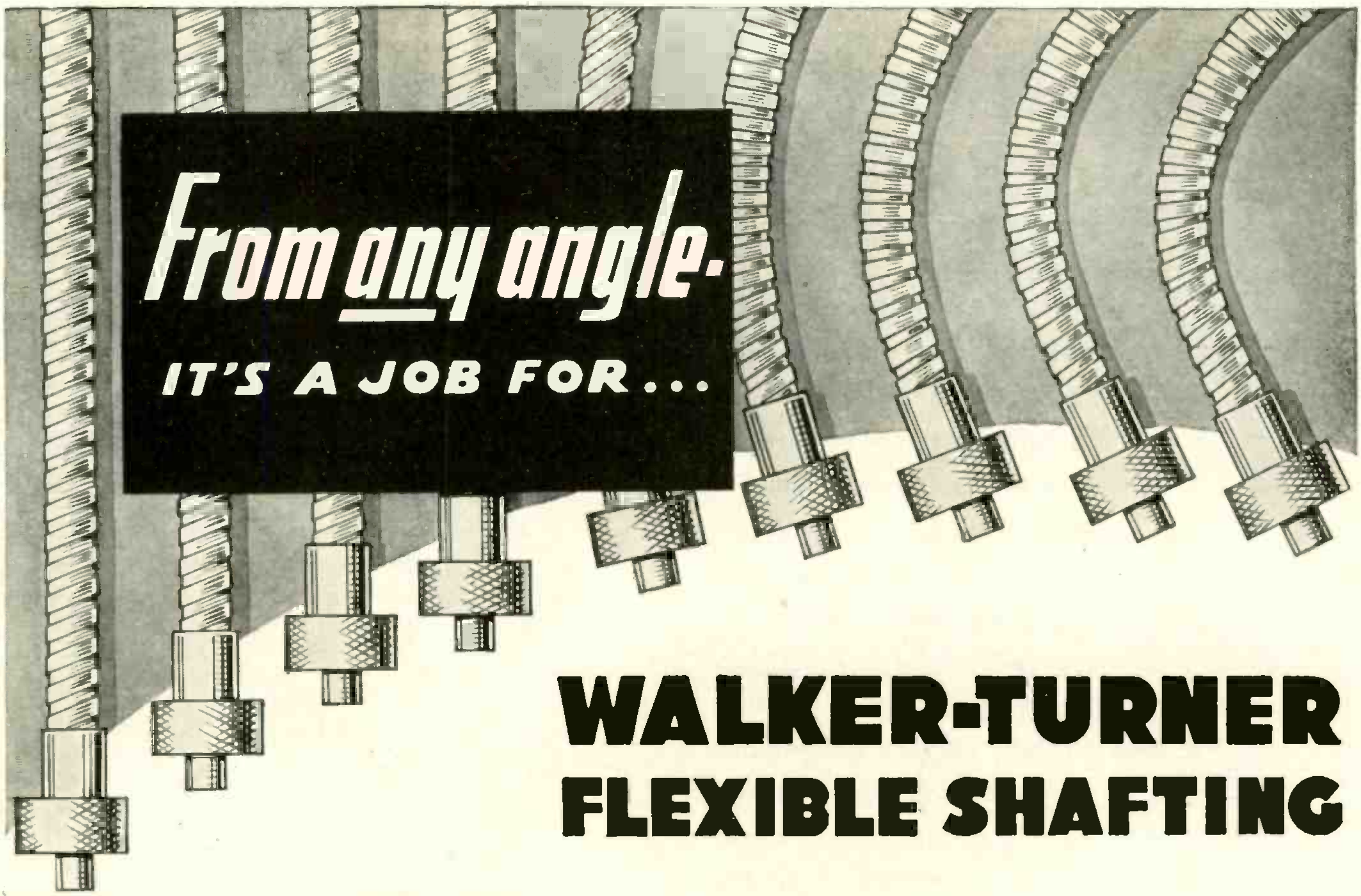
Photoelectric Colorimeter Detects Alcohol in Breath

AN ELECTRONIC METHOD of diagnosing moderate intoxication at the time of an accident or arrest has been developed at Yale University. As described by Prof. Leon A. Greenberg in the *Yale Scientific Magazine* for Feb. 1943, the apparatus is fully portable, requires only a sample of expired air, and gives a result in terms of alcohol concentration in a few minutes.

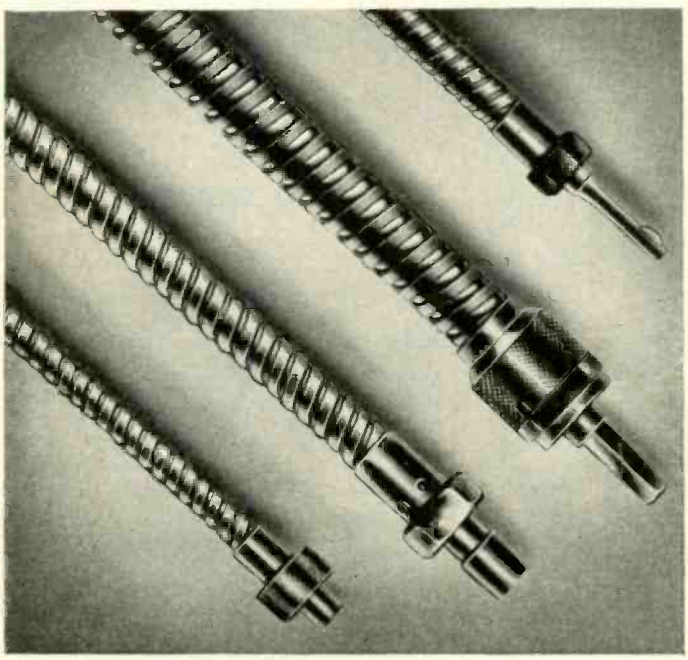


This combination of electronic and chemical apparatus determines scientifically whether or not a person involved in an automobile accident or other incident has had "just one little drink"

The essential features are shown in the diagram. An exactly measured sample of the suspect's breath is collected in a sample tube which is electrically heated to prevent condensation of moisture which might contain alcohol. The exhaled breath automatically passes through a tube



WALKER-TURNER FLEXIBLE SHAFTING



Is your problem the transmission of a small amount of power at an angle, or between two points not in a straight line? Or is it the matter of control of some mechanical or electrical impulse from a point relatively remote?

In either case, the chances are that Walker-Turner Flexible Shafting can do the job more effectively than any other means. For many years Walker-Turner has manufactured flexible shaft machines, which are today used by the thousands throughout industry. The specialized knowledge of the design of flexible shafting which we have gained in this work, has been applied to many war applications of power transmission and remote control, under the most exacting conditions.

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FLEXIBLE SHAFTING

FOR REMOTE CONTROL AND POWER TRANSMISSION

of iodine pentoxide which oxidizes the alcohol and liberates iodine in proportion to the amount of alcohol oxidized. The iodine is carried in a stream of warm air to a glass tube containing a solution of starch. This starch turns blue in proportion to the amount of iodine present, and a photoelectric cell indicates the intensity of the blue color on a meter in terms of percent of alcohol in the blood.

The various operations are timed and kept in proper sequence by a synchronous motor, hence the test is automatic once the motor is started. In use, the operator presses the starting button. When a green light appears, the suspect blows his breath into a mouthpiece. The operator then inserts a small glass tube of solution into a holder and waits five minutes for the meter reading. If anything goes wrong, the apparatus fails completely, an essential requirement if the test is to have legal status. It cannot give an erroneous reading. The tube of final solution can be taken into court as evidence, and can be reinserted in the apparatus at any time to verify the concentration of alcohol.

• • •

RADIO MECHANICS

The personnel of the Women's Royal Naval Service are expert radio mechanics. This photo, taken at a Royal Naval Air Station in south England, shows a transmitting instrument being fitted into a plane. The girls are taught to tune in radio instruments

Tubes Drive Relay in Telegraph Repeater Circuit

BY ALDER F. CONNERY
Chief Engineer, Postal Telegraph Co.

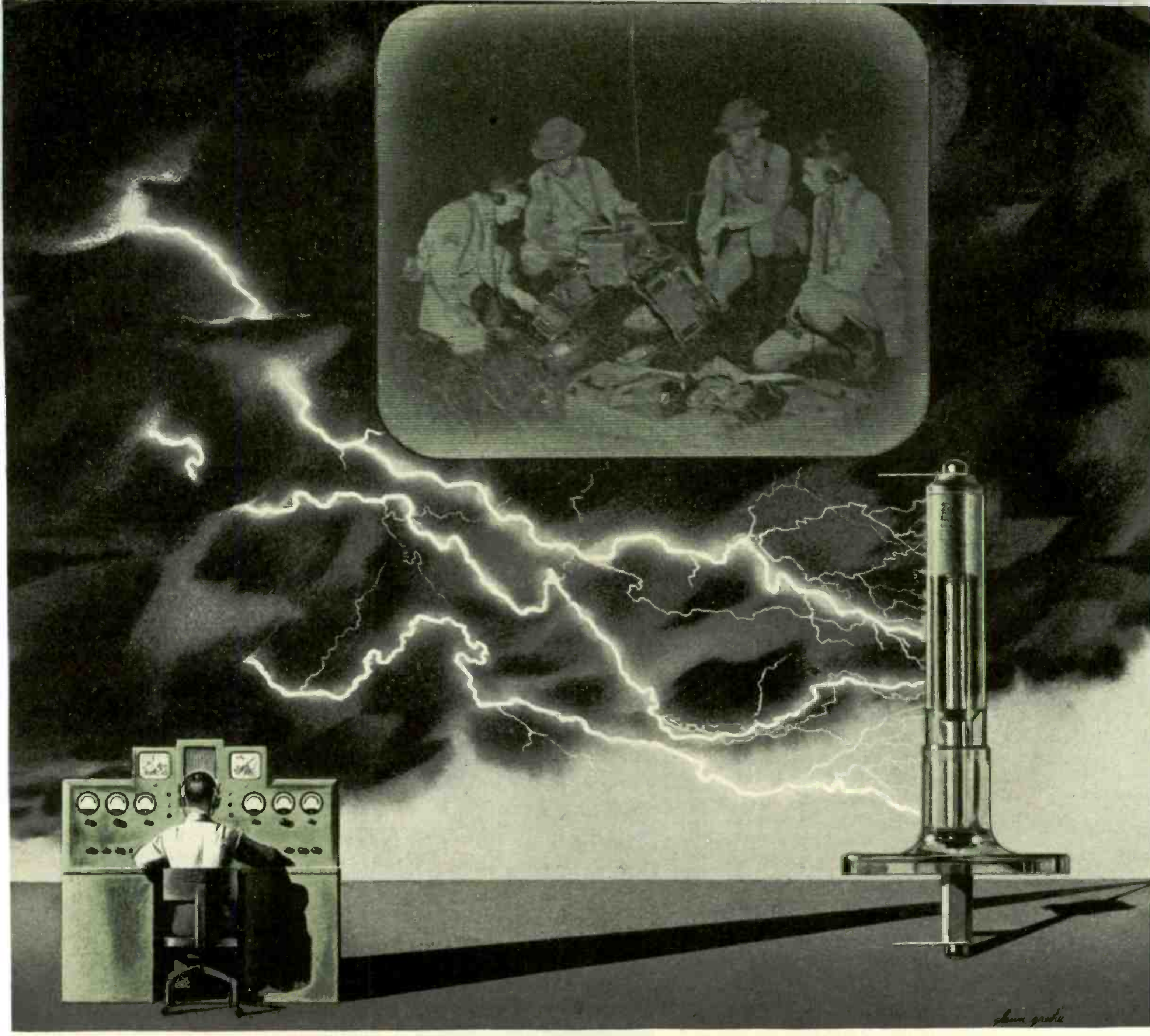
A PAIR OF VACUUM TUBES arranged in push-pull to drive a receiving polarized relay has proved a satisfactory solution to the problem of designing an efficient metallic telegraph circuit. The duplex line is arranged in bridge fashion with 250-ohm ratio arms, and the driving circuit for the tubes is connected across the pair of ratio arms.

The characteristics of the tube circuit are such that the relay will be operated by a current of the proper value for efficient operation regardless of the value of the current in the loop circuit. A very small line loop current will result in practically full value of current through the relay windings. A further increase in the line current will but slightly increase the relay current. The effect of this is that the electromechanical relay operates on a "square" sharply defined signal even though the shape of the signal through the line loop may be

• • •

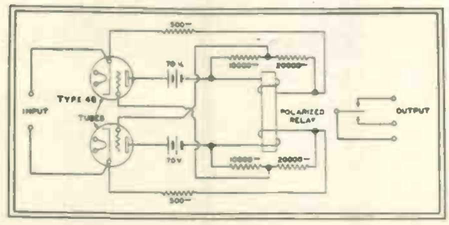
RADIO AIDS CIVILIAN DEFENSE

Many amateur operators are back on the air again as war emergency workers. They are supplementing regular communications facilities in the event of air raids and aiding in case of other disasters. The new service enables communities throughout the country to set up, at their own expense, mobile, portable and fixed short-wave communications on a two-way basis. Shown here is a WERS radio set in operation in a Civilian Defense emergency repair truck



"rounded" and therefore not sharply defined.

A further and very important advantage gained by driving the relay by vacuum tubes is that the reactance of the relay windings does not appear in the loop circuit and therefore does not complicate the process of obtaining a duplex balance. The balancing network need only contain the adjustable resistance element and two or three timed adjustable capacitor elements. It is not necessary to have any lumped inductance in the artificial line network to simulate the effect of the distant receiving relay.



Relay driving circuit used to make weak telegraph signals operate a polarized relay

The accompanying drawing shows the tube circuit for driving the relay. The circuit is symmetrically arranged so that no bias can result from variations in the supply voltage. The two 70-volt "insulated" plate voltages are obtained from two small selenium rectifier stacks each provided with a simple filter.

It will be noted that each tube has its cathode connected to an input terminal. When the voltage across the input terminals is zero there will be a small plate current in each tube. The two currents of equal intensity flowing through the two windings of the differentially wound polarized relay will balance out and have no effect on the relay. A small voltage, however, across the input terminals will result in an increase in the plate current in one tube and reduction in the plate current in the other tube. The net effect on the relay will be to make it "mark" or "space" as the case may be.

The control grids of the two tubes are connected in the circuit in such a way that an increase in the plate current in one tube and reduction of plate current in the other tube will alter the IR drops in the two 500-ohm plate circuit resistors. The change in the IR drops will result in an additional effect on the control grids which augments or exaggerates the grid control resulting from the voltage applied across the input terminals. In this manner a very small value of input voltage will bring one plate circuit to practically full current value and the other plate circuit to practically zero current. Further increase in the voltage applied across the input terminals will have but little effect on the relay current.

When the grid of one tube is sufficiently negative to bring the plate current to zero an increase in the negative potential on the grid will still maintain the plate current at zero. The grid of the other tube can never be driven so that it is more than slightly positive with respect to the cathode because of the limiting effect of the resistors in the grid circuit.

Effect of Self-Inductance

The self-inductance of the windings of the polarized relay naturally tends to prevent a quick build-up of current through its windings, and thus will limit the maximum speed at which the metallic circuits may be operated. The effect will be most pronounced in wet weather when the received signals are weak.

The relay driving circuit is arranged in a novel manner so that the self-induced voltage of the relay windings (which resists a change in value of the relay current) is caused to react on the tube grids and thus tends to neutralize the relay self-inductance. Each winding of the polarized relay is shunted by 10,000 and 20,000-ohm resistors in series, and control grids are connected to

• • •

RADIO SCHOOL

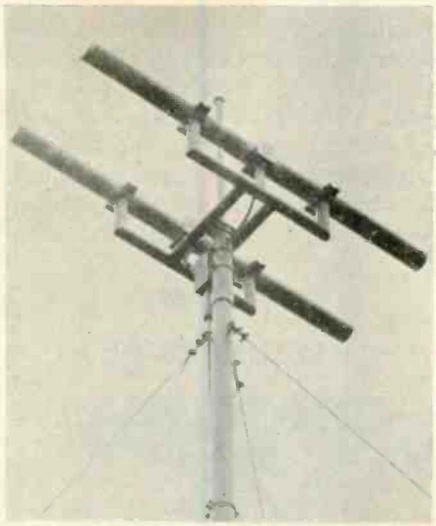
The American Women's Volunteer Service has established a radio school for training their members. Some of the members are shown here examining an old type radio with separated power unit, speaker and chassis the junction points of the resistors. By means of these voltage dividers two-thirds of the self-induced voltage is applied to the grids. The full amount of the induced voltage is not used because it would be excessive and the relay would oscillate when the input voltage was small.

When the grounded types of telegraph circuits are used a common source of transmitting potential can supply all the circuits working in the office. Each metallic circuit, however, requires its individual "insulated" source of positive and negative potential. A pair of small power packs supplies the necessary 160 volts positive and negative potentials for each metallic circuit. Full-wave mercury-vapor tubes are used for rectifiers.

• • •

New FM Radio Relay Antenna

A MULTI-DIPOLE FM antenna for studio-to-transmitter service in one of the 23 assigned channels centering on 337 Mc has been developed by G-E engineers at Schenectady. The antenna concentrates its radiation in a narrow beam in the desired direction only, in accordance with FCC



New G-E antenna for 337-mc channels assigned for FM relay service

specifications for this class of service. The dipoles are positioned and electrically connected to achieve the necessary uni-directional radiation pattern. The entire electrical system is mounted in a nonmetallic housing for protection from rain, snow and ice, and is arranged for mounting on a single pole.

Pioneers in the development of Portable and Mobile F-M and A-M Radiotelephone Equipment, Motorola engineers are today applying their accumulated skills and scientific knowledge to solving problems which confront our country, its states, counties, cities and towns. Housed in a new Engineering Building, with expanded facilities for research and engineering, the Motorola capacity for vital service is greater than ever. Electronic knowledge thus gained will one day soon be applied to the normal peacetime demands of a nation eager for better things in all phases of its living.

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THE ELECTRON ART

Graphic Solutions of Ohm's Law for A.C. Networks

By Robert C. Paine

VECTOR DIAGRAMS showing voltages, impedances, and current are numerous in electrical text books, but they seldom show all these elements integrated in complete solutions. Several such complete graphic solutions are presented here. They involve methods similar to "Some Graphic Solutions of Parallel Circuits" presented by the same author in the December 1942 issue of ELECTRONICS.

The following figures show network schematics, each element of which is designated by a capital letter and by lower case letters for each terminal. The same lower case letters are used as far as possible to designate lines used to represent the impedance between these points. Heavy lines indicate impedance values, dashed lines indicate voltage, and dotted lines current. Each of these functions is laid out to its own appropriate scale. Light lines are used for construction. Voltage and current lines are lettered in this manner: E_{ab}, I_{ac}, or I_x, which means voltage between points of the network *a* and *b*, current through the network between points *a* and *c*, or current through the element *X* respectively.

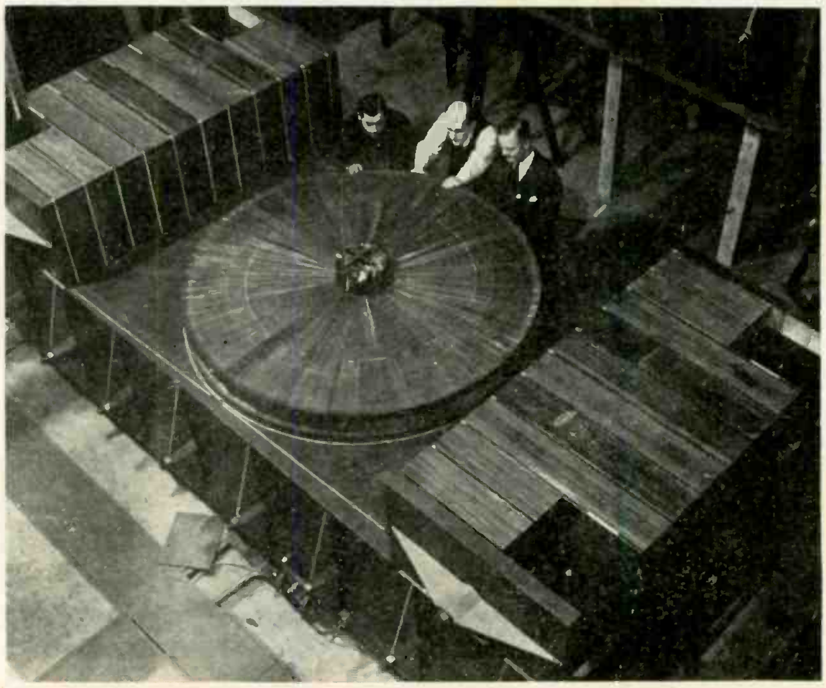
Certain definite values of impedance and voltage have been used in the example given, resulting in certain values of current in the graphic solutions. These values have been given in the text in parentheses in order to correlate the graphic solutions with mathematical solutions. Any reasonable degree of accuracy can be accomplished graphically, depending on the size of drawing, accuracy of scaling, etc., but of course mathematical solutions are more precise, if extreme accuracy is required.

The solution of a simple resistance circuit is shown in Fig. 1. The values of the resistor R_{ad} (2 ohms) and the voltage E_R (3 volts) are laid out to any convenient scale on the line *am*, and represented by the segments *ad* and *am*, respectively. The perpendicular *ac* is erected at *a* and the line *bp* drawn parallel to *am*. To some suitable scale for current, a line of unit length *bu* is marked and a line from *d* is drawn through *u* intersecting the perpendicular at *c*. A line from *m* to *c* will then intersect *bp* at the point *p* and *bp* will be the required value of current I_{ad} (1.5 amp.).

Proof: It is shown in books on geometry that "If three or more lines pass through a common point and intersect two parallel lines, they intercept proportional segments on the parallel lines." Therefore $bp/bu = am/ad$, or $bp/i = E/R = I_{ad}$, the required current.

The value of the unit length *bu* will depend on the scales used. For example, the voltage line could represent 3 volts and the resistance 200 ohms; then the value *bu* would be taken as 10 on the current line and the answer would be 15 milliamperes.

130 TON X-RAY MACHINE



This large electron accelerator, when finished, will generate x-rays at voltages up to a hundred million. It will make possible the utilization of x-rays for the examination of thicker metal sections than can now be studied by means of x-rays. The photo shows the lower part of the huge alternating current magnet. The magnet is made of slabs of steel spaced apart for cooling and consisting of thin sheets cemented together. Dr. Ernest E. Charlton and W. F. Westendorp of the laboratory's x-ray section and Rudolph Wroblewski are shown examining one of the circular magnet pole faces, between which the electrons will be whirled around in a six foot doughnut shaped vacuum tube

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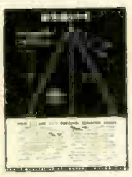

Parallel Resistor Chart

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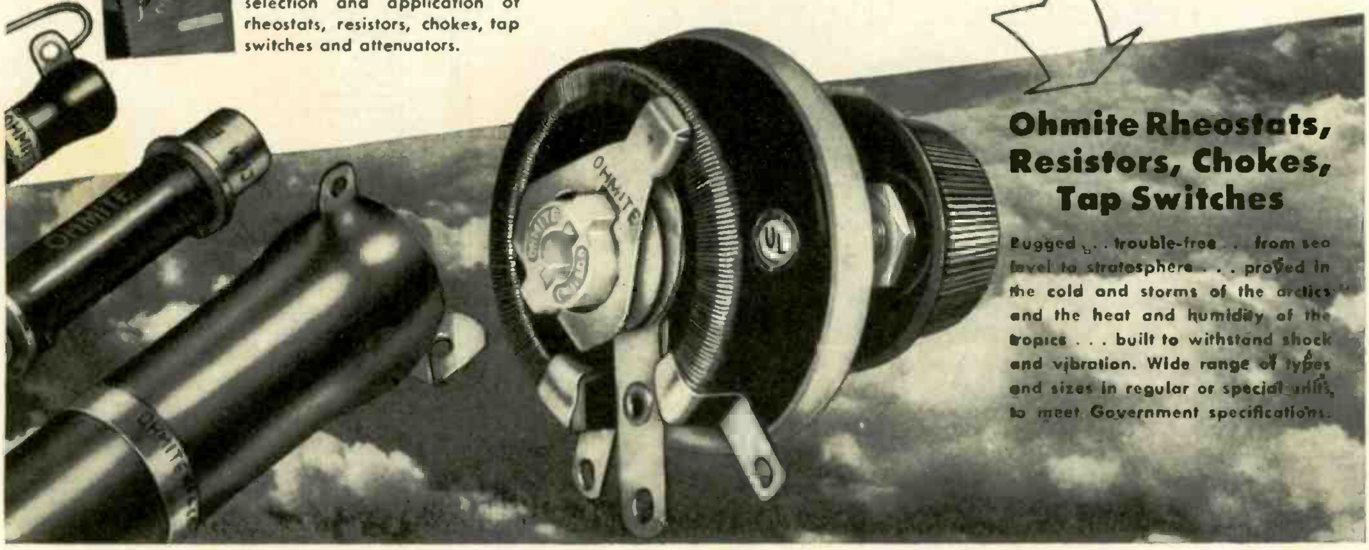

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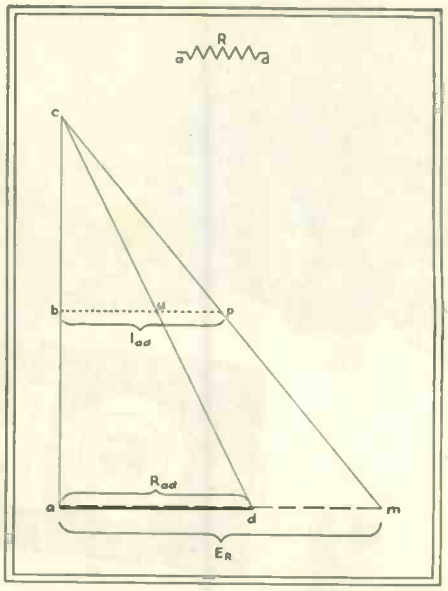

Fig. 1—Graphical solution for simple resistance. The voltage E_R across resistor R_{ad}, results in the current I_{ad} if bu represents unit current

A solution for two resistances in parallel is shown in Fig. 2. The values of the resistances, $R_1 = cf$ (4 ohms) and $R_2 = fg$ (3 ohms), are laid out on the line cg and the perpendicular ci and parallel f_1m are drawn as in Fig. 2. The line f_1g_1 is made equal to fg and a line from g is drawn through g_1 intersecting ci at b. A line from f to b will then

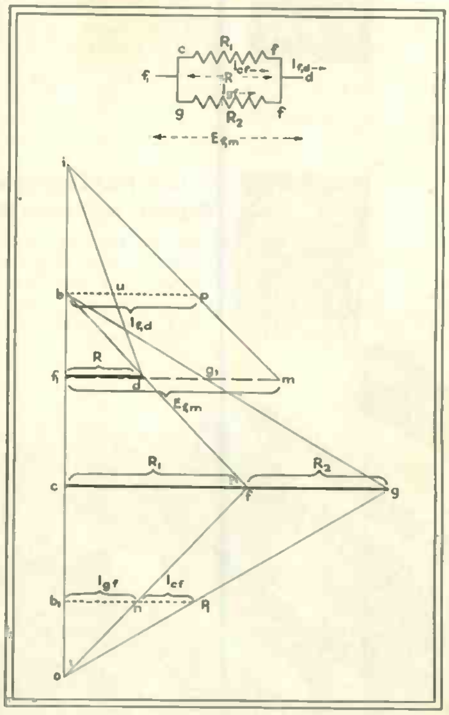

Fig. 2—Diagram for calculation of two resistances in parallel. The net resistance is R, measured by line f_1d

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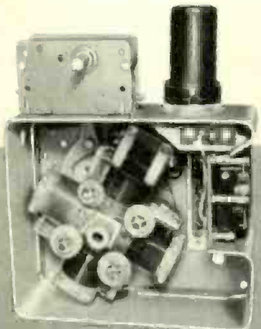
From three basic Harvey cells—each a compact, complete self-contained circuit—many types of electronic equipment can be produced. Individual cells or groups of cells can be used in such electronic equipment as: follow-up devices . . . remote control units . . . radio transmitters and receivers . . . intercommunication systems . . . public address equipment . . . automatic electronic control devices . . . temperature controls . . . alarm systems . . . recording and actuating humidistats . . . laboratory test equipment . . . etc.

For example, practically any type of radio receiver, from a small four-cell scout car model to a nine-cell highly selective, multi-band aircraft receiver, can be assembled from the same basic "Unitized" cells. These receivers need only one tuning condenser type, *two* capacitance of by-pass condensers, a resistor and tube type list that is cut to the minimum. Only 75% of the usual hook-up wire is used.

This Harvey development permits mass production methods that speed output while improving performance of electronic devices.



★ At left, an R.F. cell unit for use in radio equipment, with variable tuning condenser and remote cut-off high-mu pentode tube. The rotary turret coil assembly is mounted on a hollow trunnion, and coils are rotated by band change control, which connects the desired coil to the fixed components of the circuit. Use of low-loss coil forms, minimum contact resistance and short leads contributes to the high efficiency of the Harvey R.F. cell.

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For over a Quarter of a Century Geared for Flying Production intersect f_1m at d, and f_1d then equals the combined value of the two resistors (1.7 ohms).

Proof: $f_1d/cf = f_{1g1}/cg$, or $f_1d = f_{1g1}(cf/cg)$. But $f_{1g1} = f_g = R_2$ by construction, and $cf = R_1$ while $cg = R_1 + R_2$. Therefore, when plotted to scale as directed, the line f_1d represents the combined resistance of R_1 and R_2 in parallel, or $f_1d = R_1R_2/(R_1 + R_2) = R$.

The voltage E_{f1m} applied across the two resistances in parallel (4 volts) is laid out on line f_1d, extended. For the scale used, the voltage E_{f1m} is represented by line f_1m. The total current is determined in terms of E_{f1m} and R in the same manner as in Fig. 1. This gives the solution for current in terms of length of line bp. Thus, to the scale used, $I_{f1d} = bp = 2.35$ amp.

The total current will divide between the resistors R_1 and R_2 in a ratio inversely proportional to their resistance values. For convenience this division is worked out below the line cg, although it could be done above this reference axis. The line b_1p_1 parallel to cg and equal in length to bp is divided as shown, giving $b_1n/np_1 = cf/fg = R_1/R_2 = \left(\frac{E}{I_1}\right)\left(\frac{I_2}{E}\right) = \frac{I_2}{I_1}$. Since the currents are in inverse proportion, the current in R_1 is represented by the line np_1 (1.01 amp) and in R_2 it is represented by b_1n (1.34 amp).

The solution for a more complex series-parallel circuit composed of resistance elements is shown in Fig. 3. The values of the resistors R_1 (4 ohms) and R_2 (3 ohms) are laid out on cg, and their combined value represented by f_1d is found as in Fig. 2 to obtain the resultant resistance R. This value is added directly to R_3 (1 ohm) which is laid out to the left of f_1 and is represented by af_1. The net resistance of this series-parallel combination is $R_o = R_3 + \left(\frac{R_1 R_2}{R_1 + R_2}\right) = R_3 + R$. Since af_1 represents R_3 and f_1d represents R, the net resistance is given by the length of line ad.

The applied voltage E_{ad} (5 volts) is laid out from a to d and is divided by the total of the combined resistors $R_o = ad$ (2.71 ohms) to give the resultant current I_{ad} represented by line bp (1.84 amp). This current could be divided as in the lower half of Fig. 2 if desired to give the current through each branch.

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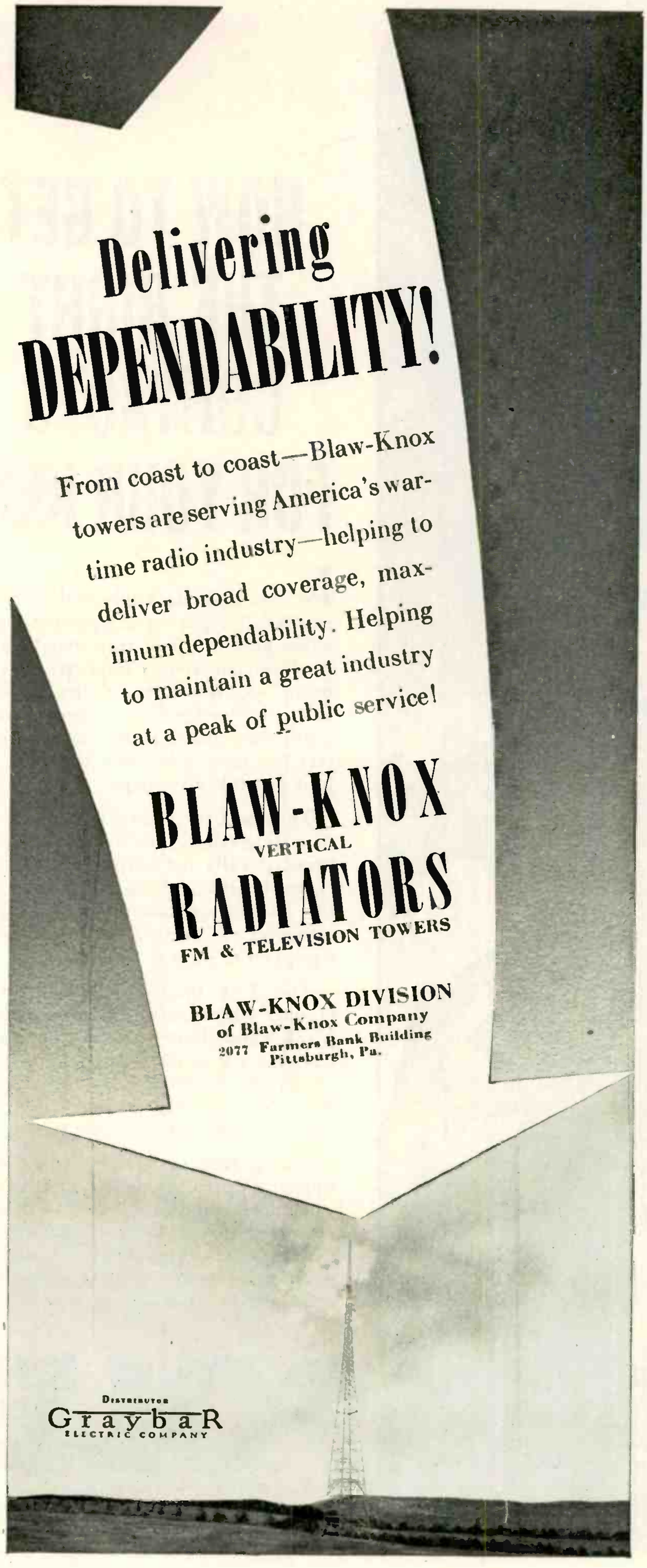


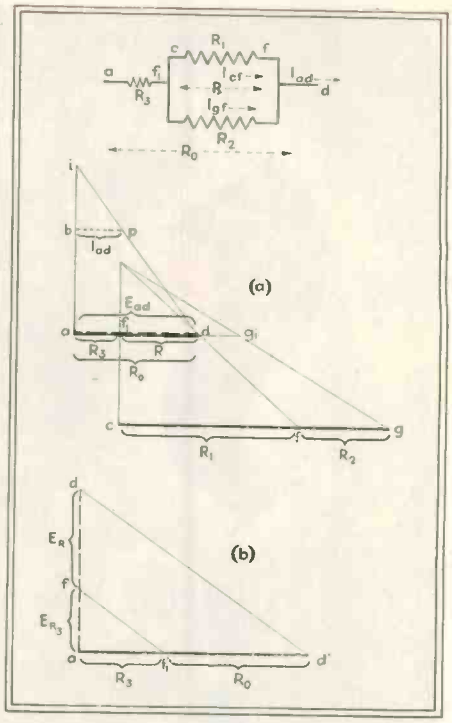


Fig. 3—By combining diagrams of the type shown in Fig. 1 with that shown in Fig. 2, a diagram, as above, represents series-parallel combination of resistors

The voltage across each section is found in Fig. 3 (b) in which *ad* has been redrawn with the resistance line *ad* perpendicular to the voltage line *ad'* for convenience only; (the angle of the resistance line is not significant in this case). A line is drawn from *d* to *d'* and a line through f_1 is drawn parallel to *dd'*, cutting *ad* at *f*. The voltage across R_3 (1.84 volts) is given by line *af* and that across R_o (3.16 volts) is given by line *fd*.

Proof: Since f_1f_1' is parallel to one side of the triangle *add'*, we have $af_1/f_1d = af/fd$ or $E_{R3}/E_R = R_3/R_o = R_3/[R_1R_2/(R_1 + R_2)]$.

Solutions for pure resistance circuits have been shown in Figs. 1, 2, and 3. The same solutions can be used for either direct or alternating voltages. More complicated resistance networks can be solved by similar methods, by extending the principles given here.

In a-c problems involving inductances and capacities, account has to be taken of the fact that current is not in phase with the voltage. This condition is taken care of in the well-known manner by representing the impedance as a vector having magnitude and direction at some angle with respect to the reference axis. If the angle is negative (counter-


14
475

clockwise) as in a capacitive reactance, the division of voltage by the impedance will result in a positive angle for the current, meaning that the current reaches a maximum sooner than the voltage does. An inductive reactance will have a positive angle and division of voltage will result in a negative angle for the current. Only capacitive reactances are shown in the following figures, but similar methods can be used with inductive reactances. Impedance of parallel circuits not composed of pure resistances or reactances can be found graphically by methods given in the article in the December 1942 issue of ELECTRONICS.

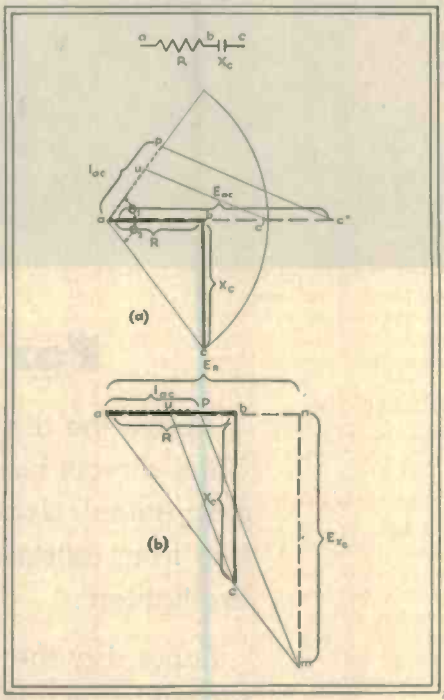


Fig. 4—Construction for R and C in series. The voltage across these components is E_R and E_C respectively, and current is I_{ac}

A resistance R in series with a capacitive reactance X_c is shown in Fig. 4(a). Line ab is drawn to scale to represent the resistance R (3 ohms) and bc to represent the capacitative reactance X_c (4 ohms). The line ac then represents the combined series impedance $Z = R - j\,X_c$. The line ac is the vector addition of ab and bc and represents the quantities R and X_c in the well-known series impedance diagram. Line ac'' is drawn equal to the applied voltage E_{ac} (7 volts) and the impedance is laid off along the same line, being represented by ac'.

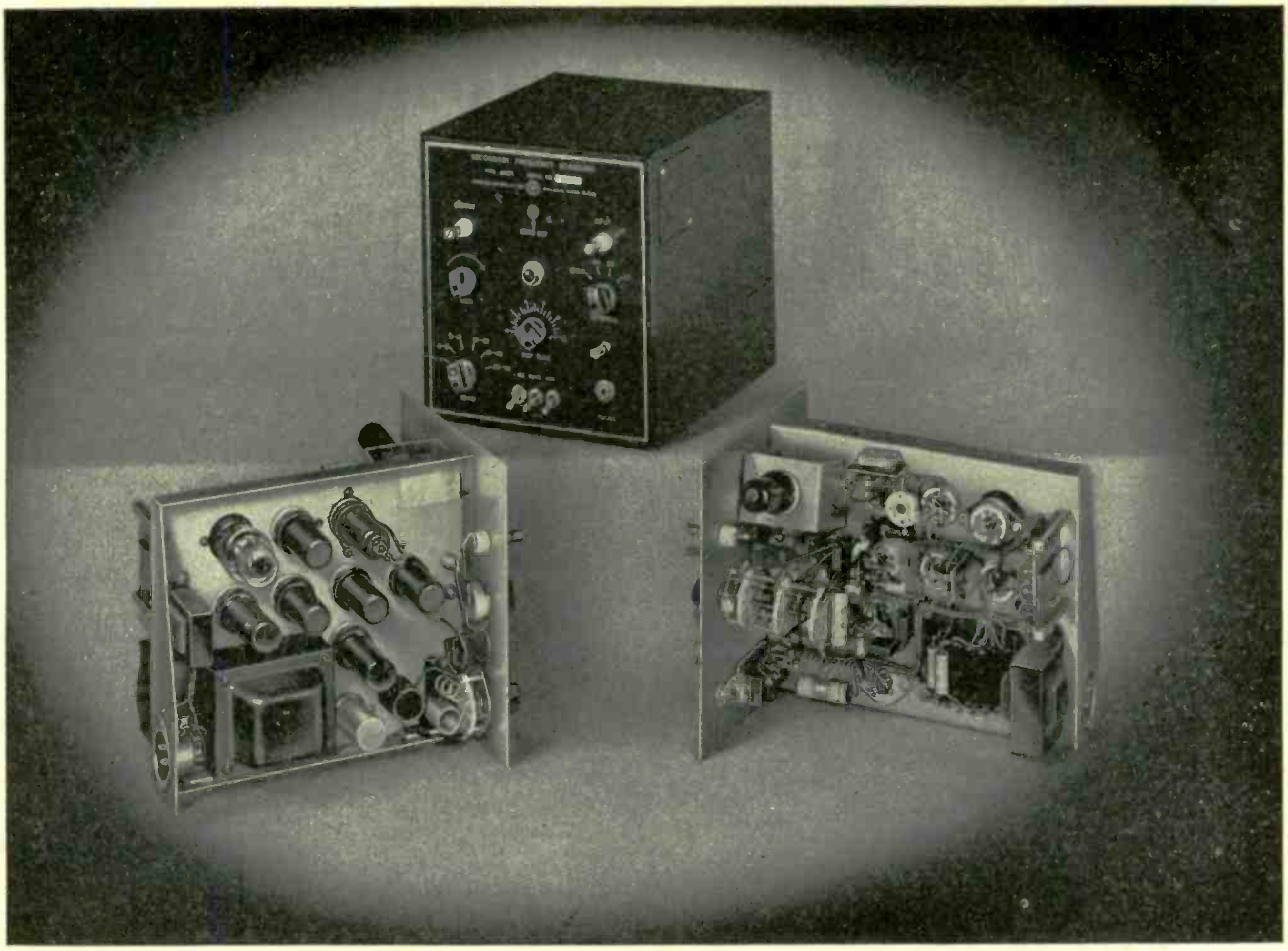
The line for the current ap is

drawn, making the two angles at a equal ($\theta_1 = \theta_2$), since the division of the voltage by the negative angle of impedance results in an equal positive angle for the current. The line au is laid out equal to a unit of the current scale and a line is drawn from c' to u. Then a line $c''p$ parallel to $c'u$ intersects ap at p and ap represents the required value of current I_{ac} (1.4 amp). Since $c''p$ is parallel to $c'u$, we have this relation $ac''/ac' = ap/au$. But $ac'' = E_{ac}$ and $ac' = Z$ while $au = 1$ represents unit current and the total current is therefore $ap = (ac'')\ (au)/(ac') = ac''/ac' = E_{ac}/Z = I_{ac}$. As the circuit is capacitative, the current leads the voltage by the angle θ_1.

The diagram of Fig. 4(b) has been drawn with the voltage line ac'' coinciding with the impedance line ac. The resulting current is still shown in the correct relation to the voltage but the work of Fig. 4(a) has been simplified. This arrangement has been used in succeeding figures. The voltages across R and X_c are also shown; they are found by drawing mn parallel to bc. Then an represents the voltage across R, and mn designates the voltage across X_c.

Proof: From the construction in which uc and mp are drawn parallel to each other, we have $ap/au = am/ac = an/ab$. Therefore $ap/au = an/ab$, or $an = (ap)(ab)$. Since ap represents I_{ac} and ab represents R, the physical interpretation of line an is $an = I_{ac}\ R = E_R$ so the segment an measures the voltage across R, or E_R. In a similar manner it can be shown that mn represents the voltage across X_c. The voltage across R is in phase with the current and the voltage across X_c lags 90 electrical degrees behind the current.

The vector diagram for a resistance and capacitative reactance in parallel is shown in Fig. 5. The resistance R and reactance X_c are shown as the lines cf (6 ohms) and cg (8 ohms) respectively. The combined impedance Z, represented by the line cd (4.8 ohms) in the reactance diagram, is in a manner similar to that given for Fig. 5 in the article referred to in the December 1942 issue of ELECTRONICS. The voltage E_{cd} is shown as the line cd' (7 volts) and the current I_{cp} represented by cp (1.45 amp) is found as in Fig. 4(b). The current I_{cp} is the vector sum of two currents, I_R and



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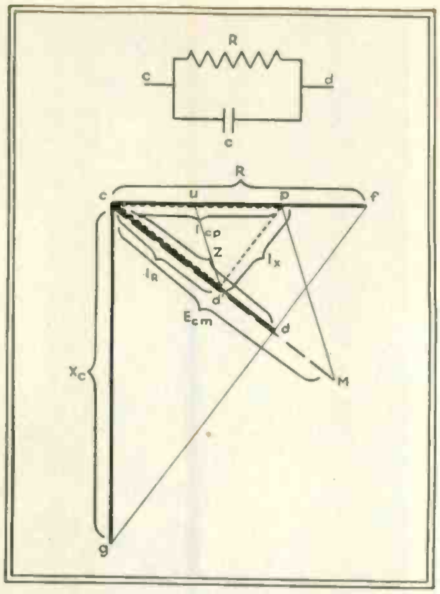

Fig. 5—For R and C in parallel, the combined impedance is Z, measured by the line cd

I_x, and is found by dropping a line ps from p perpendicular to the line cd. The current through the resistor R is given by line cs (1.116 amp) and ps (0.87 amp) is the current through the capacitance X_c.

Proof that the current through R is represented by cs: The current I_R will be in phase with the voltage E_{cm} and therefore geometric constructions representing these quantities will lie on the same line. Construct du parallel to mp so that the line cu represents a unit current; i.e., to the scale used, $cu = 1$. Since du is parallel to mp, we have the relation $cu/cp = cd/cm$ or $cd = (cu)(cm)/cp$. In the two similar right triangles csp and dcf, $cs/cp = cd/cf$, and we may now substitute the value for cd from the previous equation. Thus we obtain $cs/cp = (cu)(cm)/(cf)(cp)$, or $cs = (cu)(cm)/(cf) = cm/cf = E_{cm}/R = I_R$, current through R. Proof that the current through X_c is represented by ps: This current will be 90 electrical degrees in advance of the applied voltage and so will be represented by a line at right angles to cm. In the two similar right triangles dcg and psc, proportionalities exist given by $ps/co = cd/cg$, or $ps = (cd)(cp)/cg$. As shown above, $cu/cp = cd/cm$, or $(cp)(cd)/1 = cm$. Substitute this in the above equation and we have $ps = cm/cg = E_{cm}/X_c = I_x$. It will be noted that in Fig. 5, a more suitable scale for the current which is different from that for the voltage has been chosen and this gives a

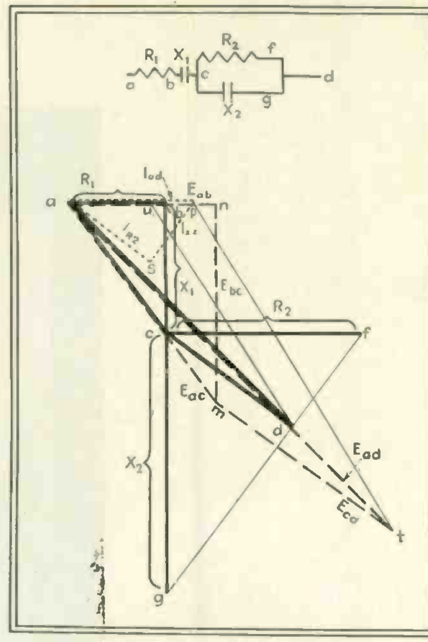

Fig. 6—By combining the constructions of Fig. 4 and 5, as above, the graphical construction for a series-parallel R-C circuit is obtained

more accurate solution than in Fig. 4.

A solution for a more complex circuit is shown in Fig. 6 which is a combination of Figs. 4 and 5. The impedance of the parallel elements between *c* and *d* in the network is added to the impedance of the series elements between *a* and *c* by drawing the impedance triangle *gcf* for the parallel elements adjacent to the impedance triangle *abc* for the series elements. The line *ad* represents the total or net impedance. Line *ad* is extended to *t* for the value of the applied voltage represented by line *at*. Then the total current given by *ap* is found by drawing the parallel lines *du* and *tp* similar to lines *du* and *mp* of Fig. 5. The division of current between R_2 and X_2 is found by drawing line *as* parallel to the line *cd* representing the impedance of R_2 and X_2 in parallel. Since the current in resistor R_2 will be in phase with the voltage dropping the perpendicular from *p* to *s* will divide the current I_{ad} into its real and quadrative components, I_{R2} and I_{X2}, respectively. The voltages across the impedances Z_1 represented by *ac* and Z_2 represented by *cd* will be proportional to these impedances. With respect to the reference current, I_{ad}, these voltages will be at the same angles to the voltage across the combined impedance (line *at*) as they are to the impedance *ad*. To

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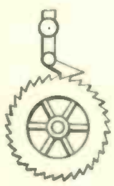

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find these voltages draw the line *tm* parallel to *cd* and extend the line *ac* to meet *tm* at *m*. Then *am* will represent the voltage E_{ac} across R_1 and X_1 in series and *mt* designates the voltage E_{cd} across R_2 and X_2 in parallel. The voltage E_{am} can be divided into the voltages E_{an} and E_{nm} across R_1 and X_1 respectively, as in Fig. 4 (b).

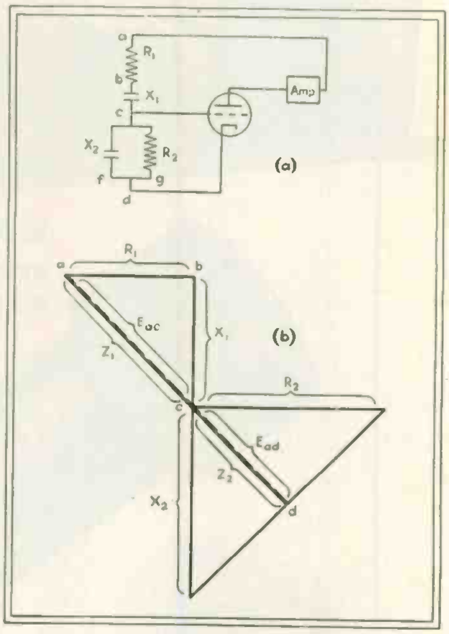

Fig. 7—Series-parallel R-C circuit of Fig. 6 applied to feedback amplifier

The network shown in upper part of Fig. 6 has been used as a feedback arrangement in some simple audio oscillator circuits, as in the block diagram of Fig. 7(a). The audio frequency at which the oscillator operates will be the frequency at which the component of the voltage across *cd* in phase with the feedback voltage is maximum. This will occur at the frequency for which R_1 equals X_1 and R_2 equals X_2. Then the impedances Z_1 represented by *ac* and Z_2 given by *cd* will have the same phase angle as shown in Fig. 7(b). In this figure the feedback voltage given by *at*, is taken equal in scale to the voltage across the total impedance, represented by *ad*, and the in phase component of this voltage, applied to the grid of the tube, is E_{cd} (represented by *cd*) or half of the total voltage E_{ad}.

A network used in the Wien bridge for frequency measurement is represented in Fig. 8(a). The rheostats R_2 and R_4 are mechanically coupled and calibrated in terms of

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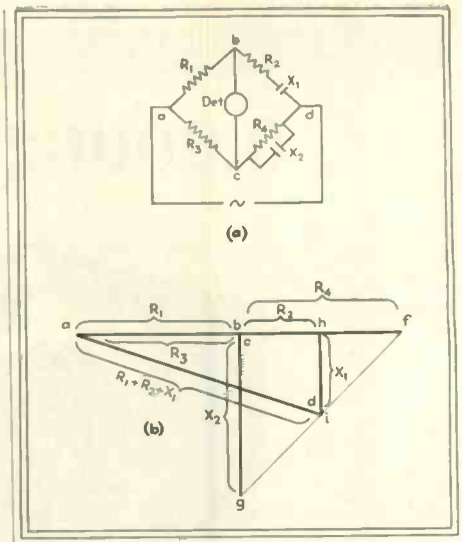
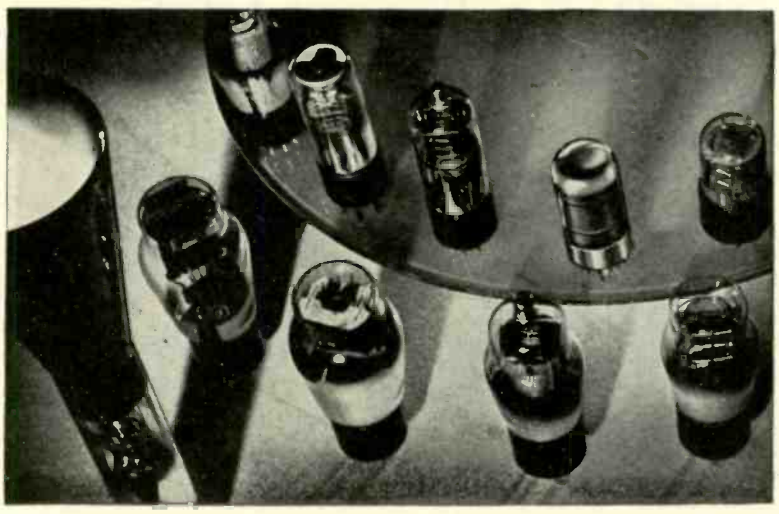


Fig. 8—Graphical analysis of Wien bridge circuit

frequency. At any given setting the corresponding frequency will balance the bridge and result in zero voltage across the detector. At other frequencies an unbalance voltage will exist across the detector. The unbalanced voltage can easily be found, if it is assumed that the detector has infinite impedance. Such a solution will be sufficiently accurate if the actual detector has relatively high impedance as will be true if a vacuum detector is employed. If the detector impedance is low the solution becomes more complicated.

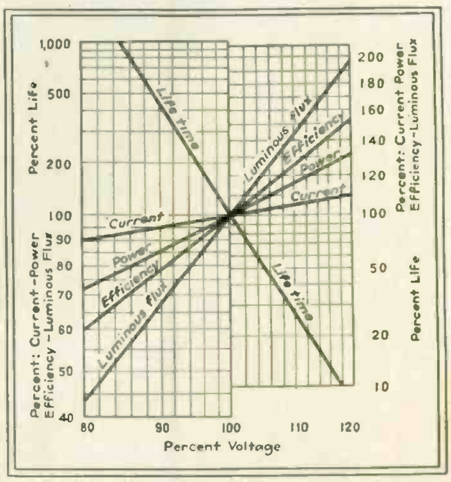
Figure 8(b) shows the voltage conditions at balance. The resistance R_1 (say 2000 ohms) is represented by the line *ab*, R_2 (1000 ohms at a given setting for example) is represented by *bh* and the reactance X_1 (1000 ohms), by *hi*. The combined impedance of the upper branch *abhi* then equals *ai*. Resistor R_3 (2000 ohms) is represented by *ac* coinciding with *ab*, R_4 (2000 ohms) by *cf* and the reactance X_2 (2000 ohms) by *cg*, resulting in a combined impedance for the lower banch given by *ad*. The scale of voltage can be so taken that the voltages coincide with the impedances. In this case the voltage diagram *abi* of the upper branch coincides with that of the lower branch *acd* and there is no voltage between *b* and *c*.

These few examples have shown how graphic methods can be used to solve fairly complex problems. While the accuracy is not as great as in the corresponding mathematical solutions, the chances of making a serious error in computation is not as great.



How Line Voltage Affects Incandescent Lamps

THE CHARACTERISTICS of gas-filled incandescent lamps are plotted with respect to operating voltage on the accompanying chart taken from the catalog of North American Philips Co. of Dobbs Ferry, N. Y. Values are expressed as percentages of what would be obtained with normal (100 percent) voltage. Each of the four quadrants of the chart have different vertical scales, to permit plotting each curve as a straight line despite different rates of change above and below normal voltage.



Effect of operating voltage on the characteristics of gas-filled incandescent lamps

As an example, a lamp operated at 90 percent of normal rated voltage would have 450 percent of its designed life, draw 95 percent of its designed current, consume 86 percent of its designed wattage, have 78 percent of its designed efficiency and give 68 percent of its designed light output.

• • •

Capacitance Manometer Checks Arterial Blood Pressure

AN ELECTRICAL CAPACITANCE diaphragm manometer designed to measure and record pressure curves directly from the arterial blood stream is described by Dr. John C. Lilly of the Physiology Dept., Univ. of Penn. in *The Review of Scientific Instruments*, p. 34–37, 13, 1942. The pressure is applied to a stiff nickel diaphragm 0.005 in. thick and ¼ in. in diameter. This diaphragm is connected to the ground side of the tank coil of a crystal oscillator. A flat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electrode connected to the plate end of the tank coil is placed 0.0005 in. from the diaphragm. Pressure applied to the diaphragm causes a change in this capacitance across the tank circuit, which causes a detuning of the crystal oscillator and a resulting change in its plate current. The plate current flows through a 100,000-ohm wire-wound resistor, so that a small current change will produce a large change in voltage drop.

In order to obtain extreme sensitivity, a 14-megacycle crystal is used, with the tank capacitance adjusted to the sharply sloping part of the resonance curve. The sensitivity may be increased to 1 mm per inch deflection of the cathode-ray spot, but is ordinarily considerably lower.

The connection to the blood stream is by means of a needle. The top frequency response of a membrane manometer of this type is dependent on the amount of liquid which must be forced through the needle in order to move the diaphragm with each change in pressure. Because of the stiffness of the nickel diaphragm, an increase in pressure produces little

• • •

FATHER OF ELECTRON TUBES

Lee de Forest, who is now 69, is now busy manufacturing short-wave diathermy machines for the United States Navy. He is shown here in his Los Angeles laboratory assembling the parts for the inside of one of his radio tubes. In his left-hand is the plate, which he is spot-welding to supporting metal structure. At the left is a rackful of grids. The grid is the third element which de Forest added to the radio tube in 1906.

movement of the diaphragm and thus little movement of the fluid through the needle. Therefore smaller needles may be used with this manometer than with most others, which is of considerable advantage when pressure records are to be made from a human subject.

The device is apparently highly stable after a one hour warm-up period. Satisfactory pressure curves are reproduced, but nothing is said about linearity of response.

The principle of operation has been used previously for physiological pressure recording, but the instrument described represents a great advance in mechanical design and circuit refinement.—W.E.G.

• • •

Distortion in Loudspeakers Caused by Doppler Effect

FREQUENCY MODULATION distortion in a loudspeaker, due to the fact that the diaphragm may be moving at a low audio frequency while it is producing a high-frequency sound, is analyzed by G. L. Beers and H. Belar in the April 1943 *Journal of the Society of Motion Picture Engineers*. This distortion is a result of the Doppler effect, in which movement of the source causes the frequency at a distant point to vary. It becomes

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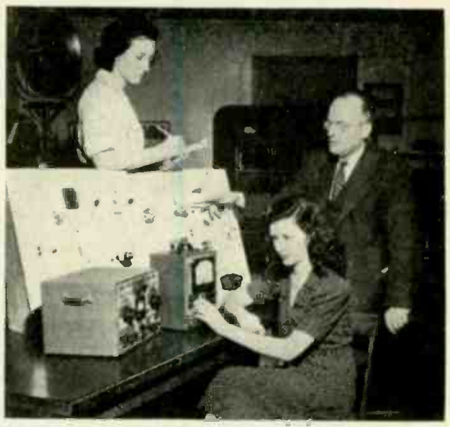
ASSEMBLERS



At the Case School of Applied Science, Cleveland, Prof. John Martin explains the mysteries of electricity and radio to Evelyn Killelea (left) and Margaret Marsh. The course takes twenty-four weeks, after which they'll be graduated to jobs with U. S. Army Signal Corps in the Aircraft Radio Lab., Wright Field, Ohio. There they will test, supervise, put together and install radio equipment for airplanes

A typical United industrial type tube

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Today, thanks to the miracle of electronics, automatic machines perform intricate tasks which only human hands, eyes and brains could once perform.

One of these remarkable machines is the ELECTRIC SORTING MACHINE, pictured above, made by the company of the same name at Grand Rapids, Michigan. This sensitive device sorts and grades dried beans, peas or peanuts according to size or color . . . separates the perfect from the defective. With unerring "skill" it rejects foreign objects, such as pebbles, shells, sticks, etc.

The electronic "heart" of this intricate industrial machine is the modern vacuum tube, as perfected by the advanced engineering skill of UNITED. We are proud that the makers of the ELECTRIC SORTING MACHINE are among hundreds of manufacturers who insure maximum efficiency, long service and economy of operation by standardizing on UNITED tubes.

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more and more important to high-fidelity reproduction as the response of a sound-reproducing system is extended.

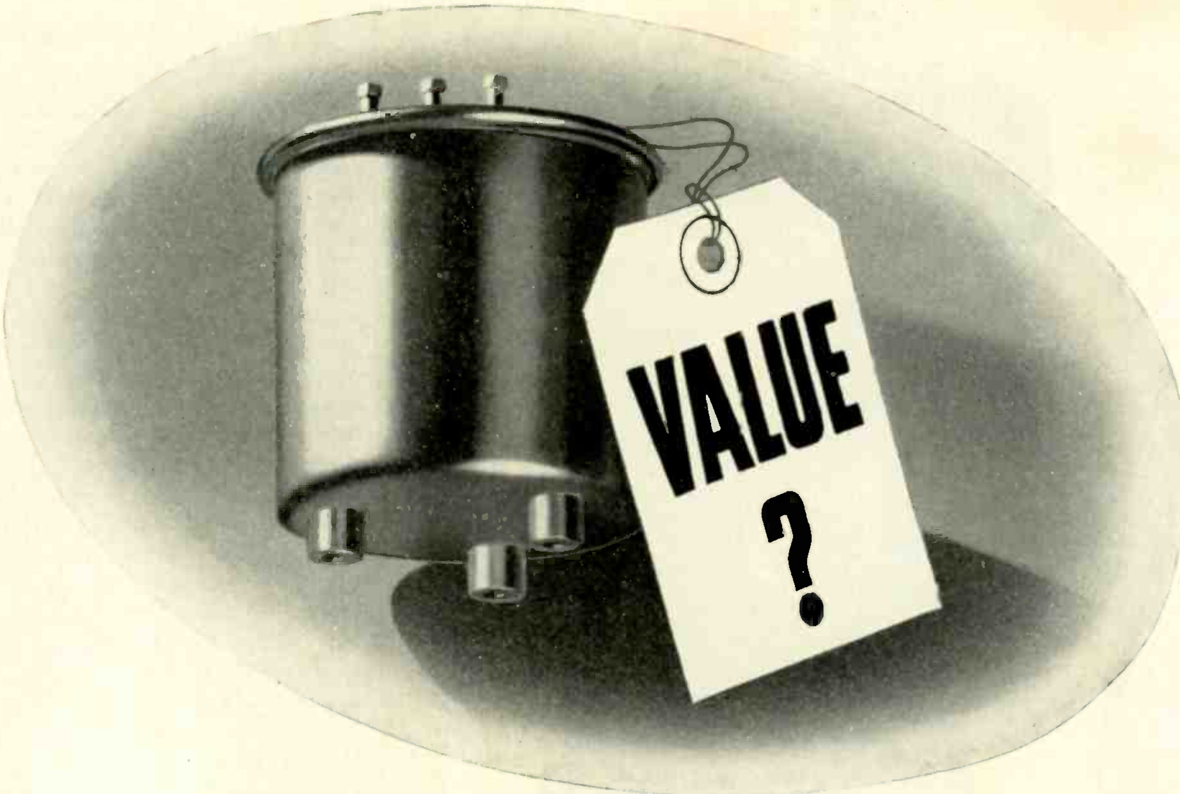
The paper gives basic equations for calculating this type of distortion, and presents measurements confirming the calculated results. Preliminary listening tests have indicated that the distortion can be noticeable as a hard-to-describe change in quality when it reaches about 2 or 3 percent, but conclusive data is not yet available.

The distortion can be reduced by loading the loudspeaker with a horn to reduce the amplitude of cone traverse, by increasing the cone diameter and thereby reducing the amplitude of motion, by limiting the power input at low frequencies to reduce low-frequency amplitudes, and by using separate loudspeakers for the low and high frequencies.

• • •

A DEGREE WITH INTERRUPTIONS

Russell Gustafson learned to fly at Denver University in a civilian pilot training program in 1939 and joined United Air Lines in 1940. He trained further in multimotored flight in August 1941 and became a co-pilot the next October. He is shown in the electrical engineering laboratory at Denver University where he expects to get his degree this spring, between monthly trips to Australia for the Army's Air Transport Command



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Reactance Tube Circuits

FUNDAMENTAL EQUATIONS applying to the design of reactance tube circuits for controlling oscillator frequency are given in a paper by H. A. Ross and B. Sandel in *A.W.A. Technical Review* (published by Amalgamated Wireless of Australia), Vol. 6, No. 2, 1943.

An expression is derived for connecting the resistance and reactance values of the reactance tube to the specified frequency deviation and the sensitivity of the device. Step-by-step instructions for designing a reactance control system are given, based upon utilization of the maximum linear change in mutual conductance. Stray circuit capacitances should of course be kept to an absolute minimum. It is pointed out also that electronic reactance circuits are prone to frequency instabliity with respect to changes in grid bias on the reactance tube, making it advisable to use a stabliized grid voltage source when operating from an a-c power pack.

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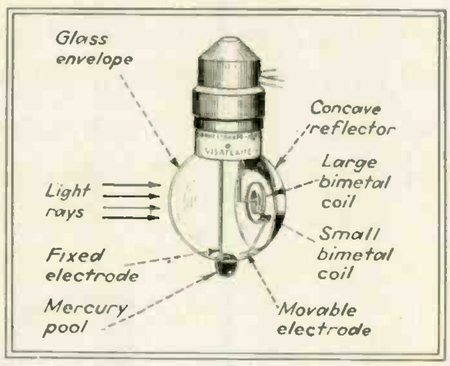
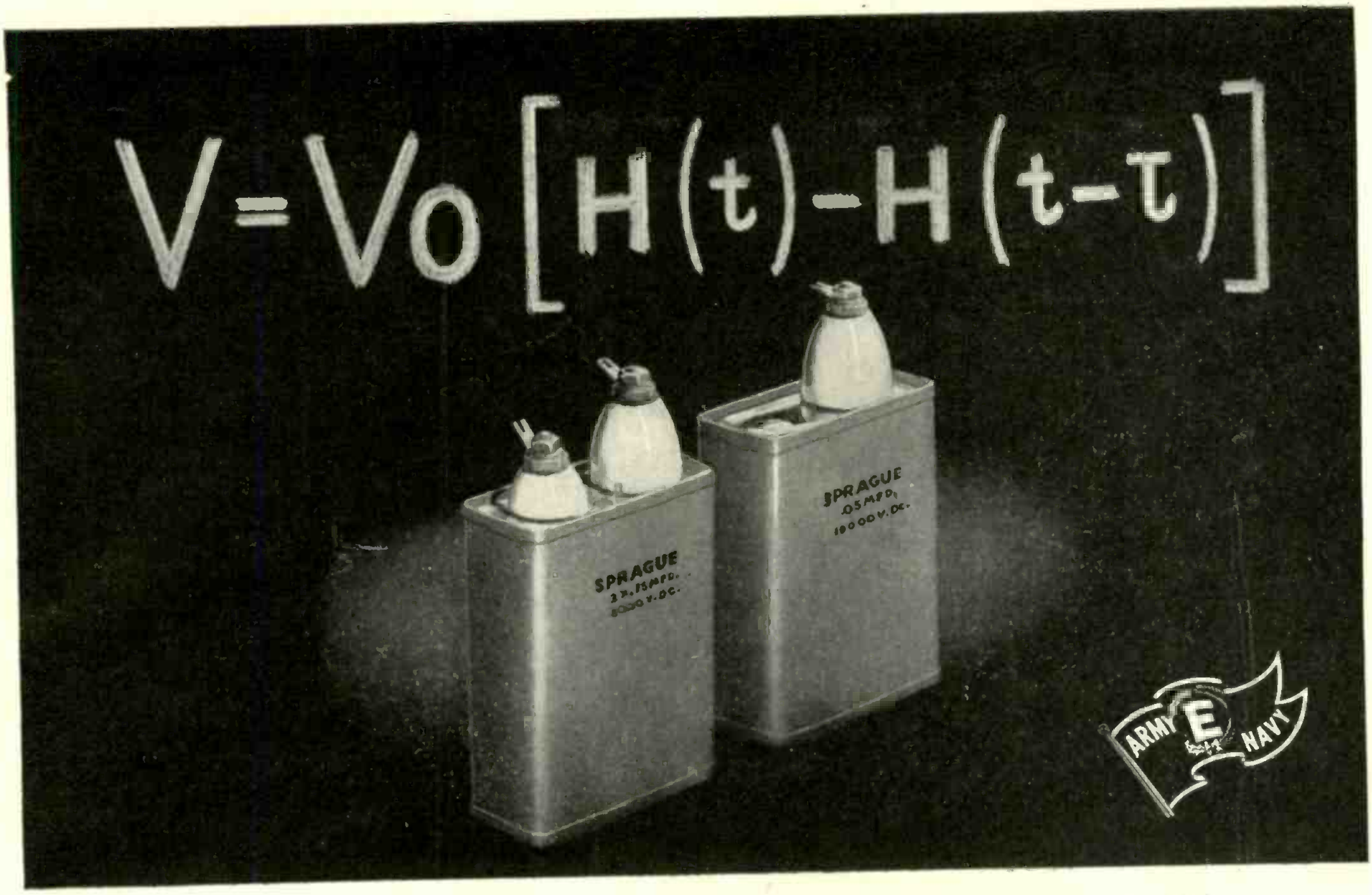
Light-Actuated Mercury Switch

RELIABLE PROTECTION against flame failure in an oil burner is provided by a simple mercury switch which operates directly from the light produced by burning oil.



Construction of light-actuated switch

The glass-enclosed switch is mounted just outside the furnace in such a way that light from the flame reaches the concave inside-silvered mirror, as shown in the diagram. This mirror focuses the light on a small bimetal coil, which is opaque



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On the other hand, more often than not, eminently suitable components have been forthcoming. A typical illustration is the Sprague Type PX-25 "VITAMIN Q" Paper Capacitor that reads "off scale" on megohm bridges at more than 200,000 megohms.

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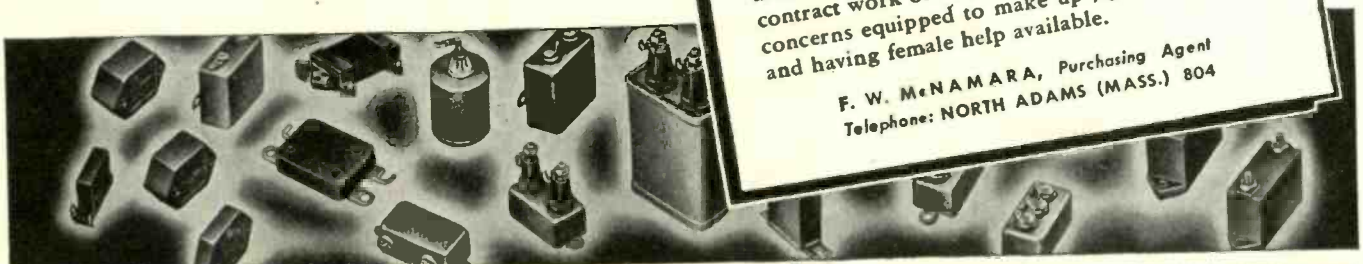


MANUFACTURERS OF A COMPLETE LINE OF RADIO and INDUSTRIAL CAPACITORS and KOOLOHM RESISTORS

and hence converts the light into heat. This heat expands the coil, causing an electrode to move into a pool of mercury and close the circuit. Failure of the flame during normal burner operation allows the bimetal coil to cool and open the circuit, initiating conventional flame-failure operating sequences.

A large bimetal coil surrounds the small coil but is wound in the opposite direction and is outside the range of the focussed light. Ambient temperature changes act equally on both coils, hence their movements cancel and the movable electrode is not affected by changes in room temperature.

The switches are known commercially as Visaflame bulbs. They are made by The Mercoid Corp. and are intended chiefly for installation by manufacturers as integral parts of oil burners. They eliminate conventional phototube and amplifier units in applications having a sufficiently high-intensity source of light.

• • •

TRAINING RADIO MEN

The Norwegian Government has taken over several large houses and transformed them into businesslike workshops in England. The houses are equipped with ships' engines and radio equipment. Norwegian seamen who arrive in England are trained to be radio operators and engineers. The training courses last from three to eight months. This photo shows trainees experimenting on a Marconi transmitter, at one of the schools in London

British Electrocardiograph Uses Smoked Glass Discs

FROM *Wireless World* comes a short description of the Cox-Both Electrocardiograph which produces cardiogram records without an intermediate photographic process. The instrument contains only three tubes, operates from dry batteries and is fully portable. The heart action voltage is collected by electrodes in the normal manner, and after amplification is fed to a moving-coil device suspended in a permanent-magnet field. Attached to this coil is a diamond-pointed stylus which traces the desired pattern on a carbon-surfaced glass disc driven at constant speed by a spring motor.

The resulting trace is one-fortieth conventional size, but can be viewed in standard size while the recording is being made, by means of a microscope having an accurately adjusted magnification factor. Light is projected through the glass disc up into the microscope to make the trace visible.

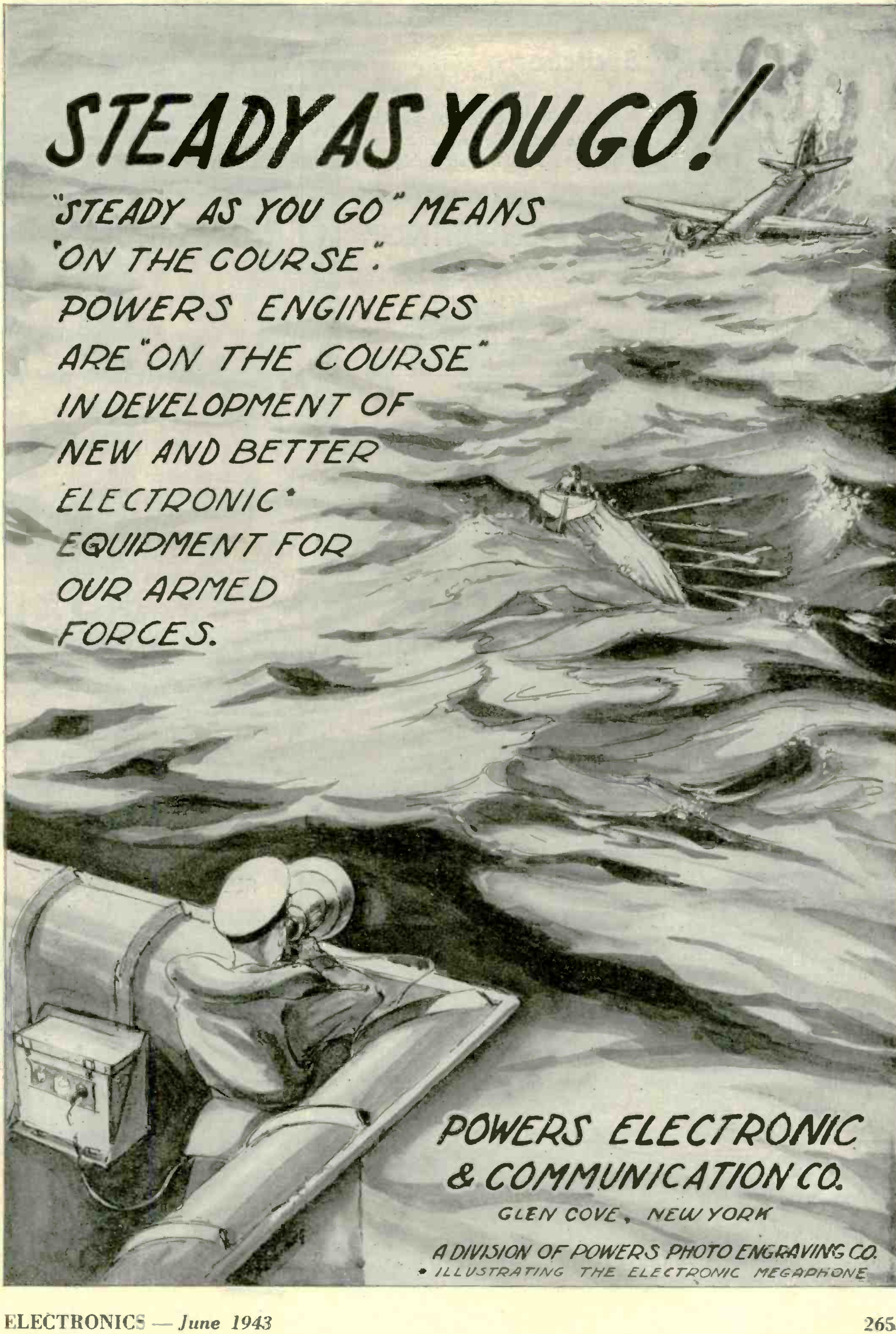
• • •

Essentials of Walking Are Studied with Oscillograph

A 12-ELEMENT oscillograph is being used at the University of Rochester School of Medicine to record the factors considered essential to the process of walking. Pressure-responsive resistance discs each about the size of a dime are applied to six points on the bottom of each foot and connected to the 12 high-sensitivity G-E mirror galvanometer elements. The current passed by each disc varies in proportion to the pressure exerted on it during walking. The light beams from all 12 galvanometer mirrors are directed on a moving strip of photographic paper, producing 12 curves similar to those shown in the accompanying diagram.

By comparing and analyzing nearly 4000 charts of normal and abnormal walking, time and pressure values for normal walking have been formulated. Comparison of these norms with values obtained from patients under treatment provides a positive check on the effectiveness of therapy.

The same oscillograph has also been applied to the recording of muscle action current curves, useful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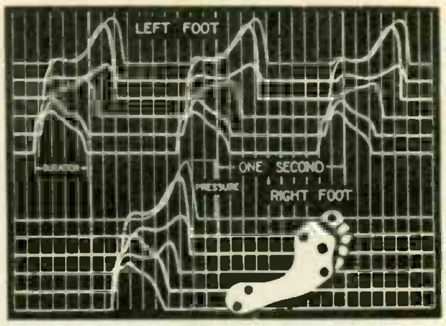
A DIVISION OF POWERS PHOTO ENGRAVING CO.
* ILLUSTRATING THE ELECTRONIC MEGAPHONE



Sample walking record made with 12-element oscillograph. Pressure point locations are shown on the foot tracing

in the study of neuromuscular pathology. These records make it possible to demonstrate the presence of spasm in muscles formerly considered to be unaffected by diseases like infantile paralysis.

• • •

Measuring Coils

H. D. BRAILSFORD, author of "Measuring Coil Characteristics Without an Impedance Bridge" in the May 1943 issue of ELECTRONICS, has submitted additional data pertaining to the illustrations in his article.

In connection with the caption for Fig. 2, at the proper value of R the horizontal deflection equals the vertical deflection, but an ellipse will appear on the screen because of the inductive reactance of the coil under measurement.

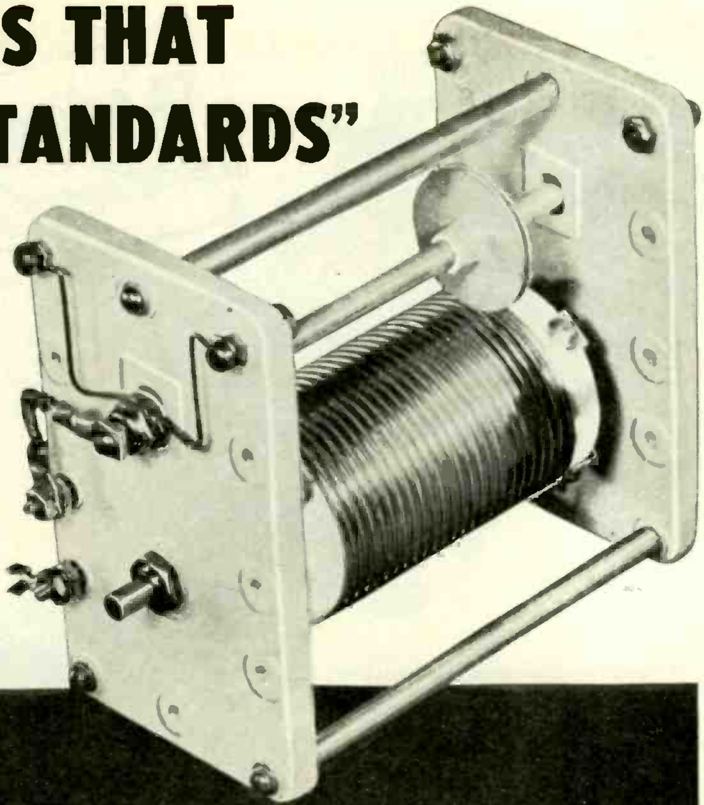
In connection with Fig. 6, this straight-line pattern indicates the fundamental resonant frequency of the LC circuit formed by the coil and the series capacitance.

• • •

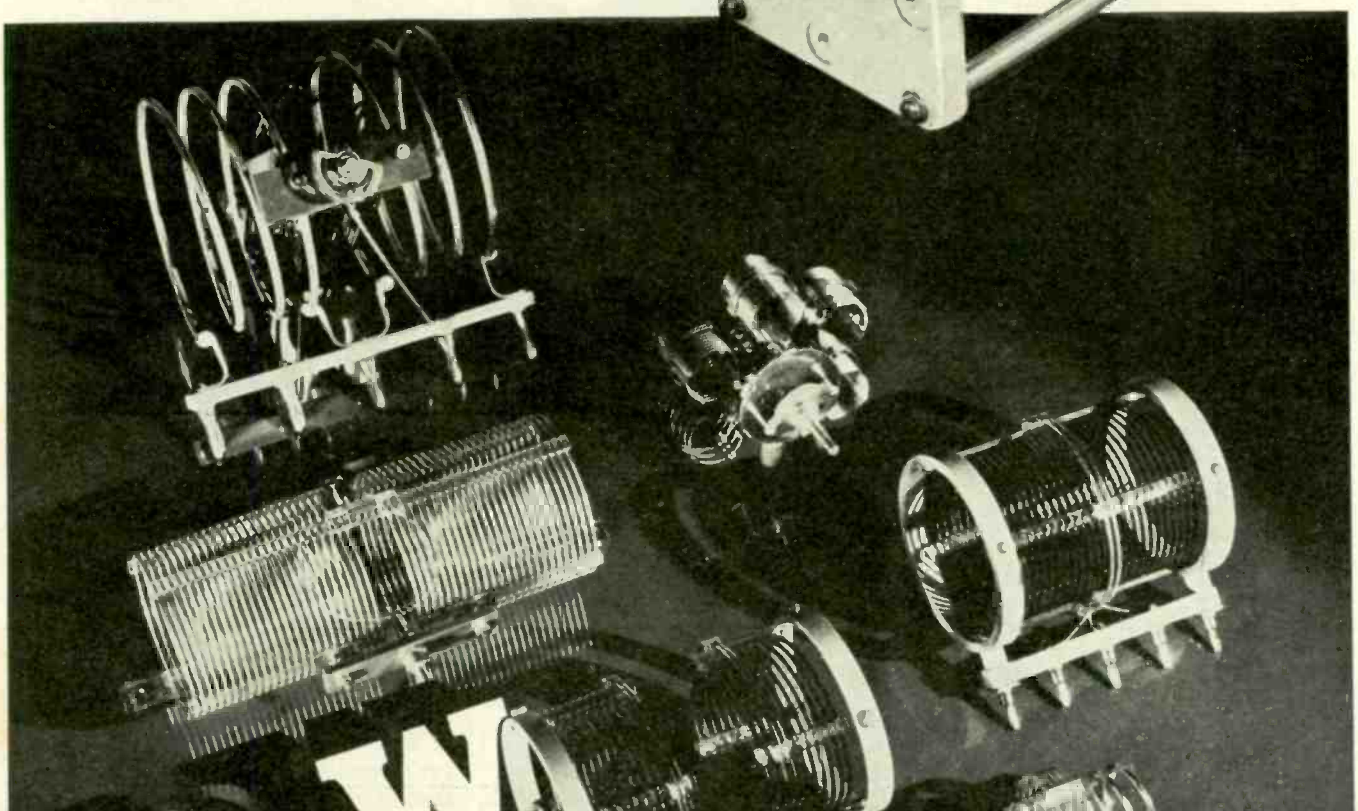
P.A. SYSTEM AIDS SURRENDER OF JAPS

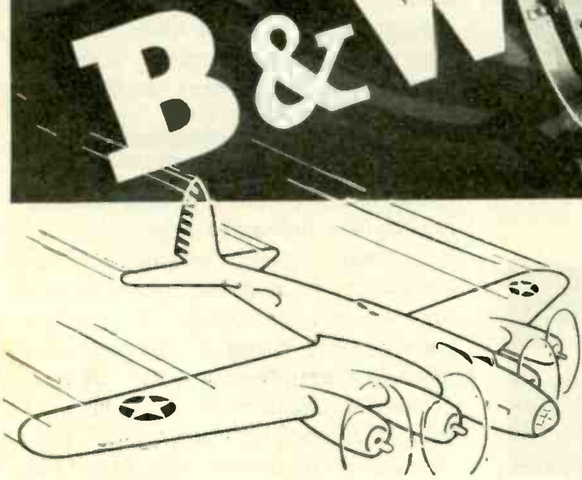
This loud-speaker was set up in the jungle on Guadalcanal, facing the enemy lines. Lt. Col. Fred Munson, Jr., told the Japs within hearing distance of the amplifier to surrender or be killed. Some surrendered, the Jap code of "bushido" to the contrary notwithstanding

"THE AIR INDUCTORS THAT SET THE QUALITY STANDARDS"



PERHAPS no radio components have seen greater engineering advances in recent years than Air Inductor coils—and B&W engineering has consistently led the field at every turn. Built to exacting tolerances, durably constructed for the most strenuous wartime uses, and available in a wide variety of types and assemblies, B&W Air Inductors have established new, higher standards of quality wherever coils are used. That's because they're produced by men to whom quality coil-making is not only a specialized business, but a matter of intense personal pride as well.





In the group photo, are shown five standard B&W "fixed for fightin'" Air Inductors and one of the famous B&W turret assemblies. At top is a special rotary coil unit.

Bring your problems to Air Inductor headquarters! Fast deliveries on both standard models and wartime adaptations!

BARKER & WILLIAMSON

Manufacturers of Quality Electronic Components for 10 Years

235 Fairfield Avenue, Upper Darby, Pa.

Court Decisions Affecting Radio

(Continued from page 118)

Therefore, contracts to protect the employer by restriction of subsequent employment within reasonable limits of time and territory, are permitted and sanctioned, and the court will enjoin the employe from competing in violation of his contract.

How Statute of Limitation Laws Apply to Broadcast Stations

Each state has Statute of Limitation Laws. All officials connected with the business of broadcasting should familiarize themselves with these laws.

For illustration, in Hanley v. Oil Capital Broadcasting Ass'n, 167 S.W. (2d) 631, reported December, 1942, it was shown that a lawyer was employed by a broadcasting company for five years, beginning 1935. During this period the value of the services rendered amounted to $2,213.60, and in 1940 there remained a balance due of $1,763.60. The broadcasting company refused to pay the account and the lawyer filed suit to collect this amount. However, in this state, Texas, a state law provides that debts of this class are outlawed after two years. The higher court held the lawyer entitled to recover only $663.60, the fees earned during the last two years. This court said:

"In response to special issues the jury found that the value of the services for which plaintiff sued defendants amounted to $1,763.60. The court adjudged that to the extent of $1,100 recovery by plaintiff (lawyer) was barred by the two-year statute of limitations, and rendered judgment for plaintiff upon the verdict for the remaining sum of $663.60. . . . Judgment is affirmed."

Profit Governs Infringement of Copyrighted Phonograph Records

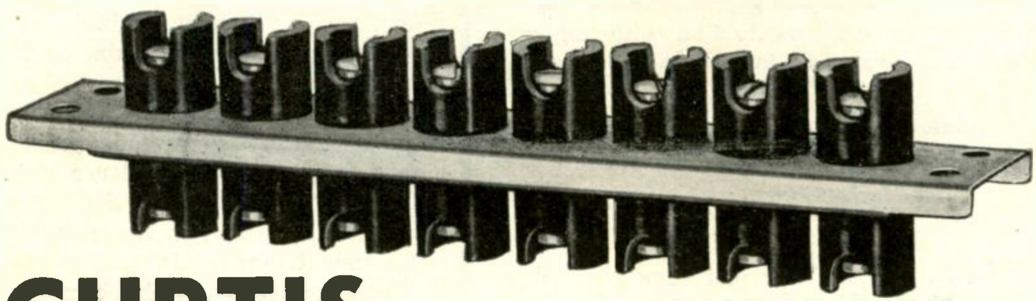
The law provides that a broadcasting station infringes a copyright if it is used without consent of the composer "in a public performance for profit". Recently a modern higher court adopted the law that when determining whether an unlicensed broadcast of a copyrighted musical composition is a "public performance for profit", the fact that

Here is another New

CURTIS TERMINAL BLOCK

—FACTORY BUILT IN 1 TO 10 TERMINALS—

for SUB-PANEL and CHASSIS CONNECTIONS



CURTIS...

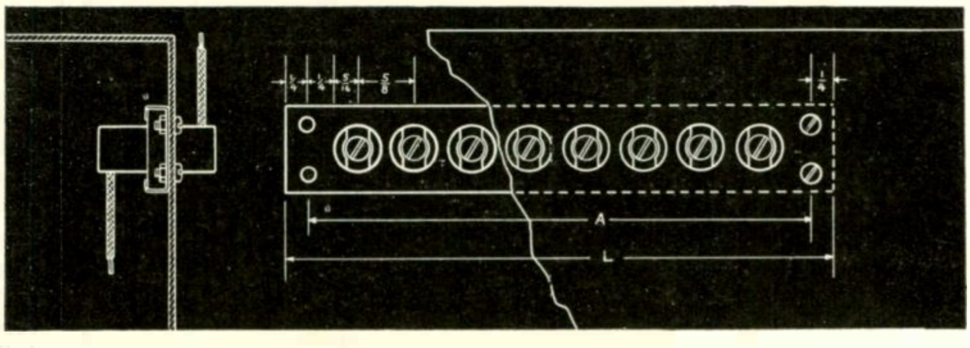
FEED-THRU TERMINAL BLOCKS

—were designed to meet the demand for sub-panel and chassis construction with external terminals. Electronic and modern electrical design necessitate the use of Feed-Thru Terminals with their obvious wiring simplicity and other advantages.

Individual Feed-Thru Terminals, mounted in bakelite, are permanently held in metal strip in any combination desired. Factory production now includes blocks having any number of terminals between 1 and 10, but because of their unique sectional design, Curtis Feed-Thru Terminal Blocks can be supplied with the exact number of terminals needed to meet your specifications.

Curtis Feed-Thru Terminals have ample clearances and leakage distances for use in circuits carrying up to 300 volts, 20 amperes. Center to center distance between terminals is 5/8". No. 8 screws are used on each side of terminals for connecting wires. The two mounting holes on each end of the terminal base take No. 8 machine screws.

When ordering — specify number of terminals required per unit.



CURTIS DEVELOPMENT & MANUFACTURING CO.

FACTORY: MILWAUKEE, WISCONSIN • SALES OFFICE: 5 NORTH CRAWFORD AVE., CHICAGO, ILL.

the program is made on a sustaining program which brings in no revenue is *not* important, since both sustaining and commercial programs must be considered in ascertaining the character and status of the station.

For example, in Associated Music v. Debs Memorial Radio Fund, 46 Fed. Supp. 829, it was disclosed that suit was filed against a radio station to recover damages for broadcasting a copyrighted phonograph record. This record was a part of the station's regular program featured as "Symphonic Hour". The broadcast lasted only six minutes. The station counsel contended that no infringement existed because the Copyright Act provides that an infringing act must be a public performance for profit.

However, although in the operation of the station revenue was derived from a very limited use of its facilities by advertisers, the higher court held the station liable for infringement, and said:

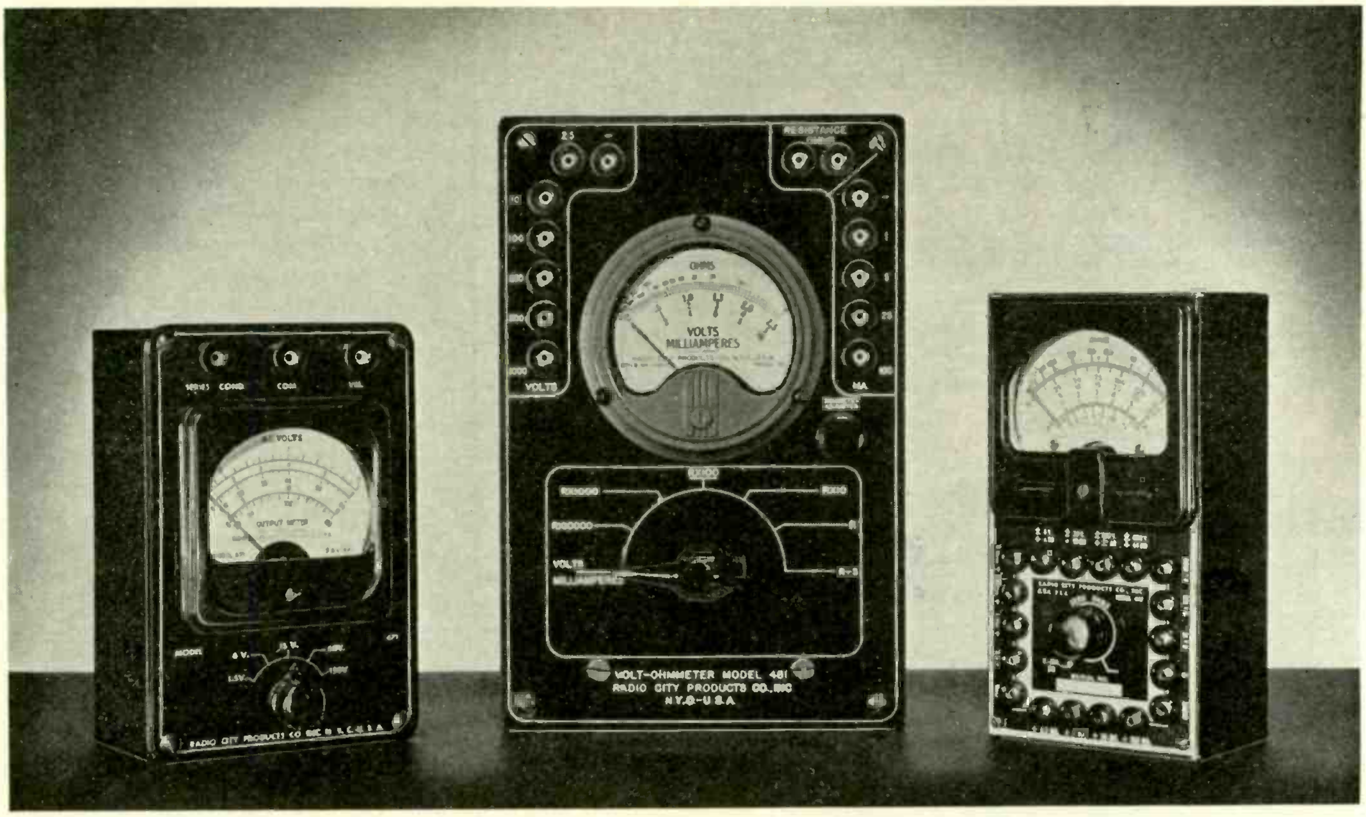
"It is settled that such a broadcast on a sustaining program of a commercial station is an infringement. I do not think that sustaining programs can be separated from the commercial programs in determining whether infringement exists. . . . "

Patents, Copyrights and Trade-Marks

The law relating to patent, trademark, label or copyright varies considerably. The law on these usual protective methods is briefly reviewed in the accompanying tabulation based in part on Supreme Court ruling 210 U. S. 239. It will be seen that the protection afforded by the patent laws is considerably broader in the case of copyrights.

Song in Public Domain Cannot Later Be Copyrighted

In Egner v. E. C. Schirer Music Company, 48 Fed. Supp. 187, reported January, 1943, it was disclosed that a person wrote the music and words of a song and took no action toward having the song copyrighted for 13 years during which time the song enjoyed great popularity in army cantonments and with civilians. Also, radio stations and a famous composer of marches used the song without objection by the composer. The composer, after al-



Test Equipment for

WARTIME PRODUCTION REQUIREMENTS

Designed for the wartime production needs of government agencies and contractors, these instruments are typical of the R.C.P. line of quality test equipment. Compact, efficient and accurate, they meet today's requirements for test units that are simple to use and have the required degree of test flexibility. The units illustrated are:

Model 471 Output Meter. This instrument has a constant impedance of 4,000 ohms with 5 voltage ranges. All resistors are precision wire wound and accurate within 1%. Self contained condenser for blocking any D.C. component is connected to separate terminals. Ready for operation, Net: $26.50.

Model 481 Volt-Ohmmeter. A practical high quality tester with a meter sensitivity of 50 microamperes. Equipped throughout with precision wire wound resistors accurate to 1%. D.C. voltmeter readings from 0.1 to 1,000 volts. D.C. milliammeter readings from 0.1 to 100 ma. Resistance measurements from 0.1 ohms to 10 megohms.

Energy for ohmmeter readings supplied by self-contained batteries. Complete, ready for operation with test leads, Net: $64.50.

Model 442 Multimeter with sensitivity of 5,000 ohms per volt. A compact pocket meter with a 200 microampere movement and a sensitivity of 5,000 ohms per volt. Four D.C. milliammeter ranges with first scale division 5 microamperes. Four A.C. and D.C. voltmeter ranges with first scale division 0.1 volt. Four output voltmeter ranges and four decibel ranges. db meter from minus 6 to plus 50 db. Complete, ready for operation, Net: $21.00.

Other instruments in the complete line of R.C.P. electronic and electrical test equipment are described in catalog material, available on request.

And now a word about deliveries. Naturally, like other manufacturers in the instrument field, we are devoting our every effort and all of our facilities to the needs of war production. Although we have considerably expanded our manufacturing and engineering facilities, wartime instrument requirements have kept pace with this expansion. Therefore, we urge you to schedule your instrument needs sufficiently in advance so that you will be better assured of getting R.C.P. instruments when you require them. Your cooperation will enable us to service your needs efficiently.

RADIO CITY PRODUCTS COMPANY, INC.

127 WEST 26th STREET — RCP — NEW YORK CITY

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

lowing free use of the song and giving permission to the compilers of a book of songs to include the song in their compilation, which book was copyrighted, did not himself apply for a copyright until nine years later. In the meantime the compiler of the book assigned the copyright to the composer of the song.

The question presented the court was whether this assignment was valid and whether the composer could use his copyright to legally prevent unlicensed stations, bands and others from using the song. The court held the copyright void, and said:

"The conduct of Gruber (composer) is consistent with a general publication of his work without a reservation of a right to copyright. . . . I find and rule that the copyright issued to Gruber (composer) in 1930 was invalid by reason of the song being then in the public domain by his own abandonment. I find and rule that the assignment by Gruber passed no right, title, or interest in the song."

Trade-Mark Laws Apply to Call Letters of Station WOR

As previously explained, a trademark is a broad and dependable protection against interferences and other business infringements.

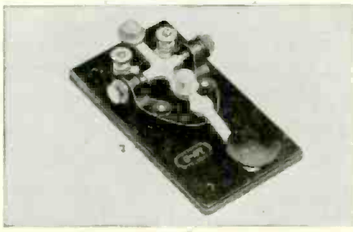
For example, take the late and leading case of Bamberger Broadcasting Co., 44 Fed. Supp. 904. In this case it was shown that a radio broadcasting company operated under the call letters WOR. A printing company that was engaged in the business of printing letter-heads, bill-heads, circulars, etc., began distribution of its business cards under the name of "W.O.R. Printing Company". The owner of the printing company contended that he had a legal right to use this name because his own name is William W. Orloff.

Notwithstanding this contention the higher court promptly granted an injunction against further use of the name used by the printing company, and said:

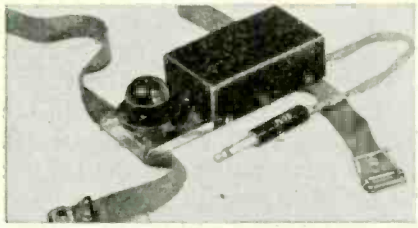
"So long as the licensee (radio station) conducts any business its property rights are entitled to protection. . . . It is entitled to protection from trade practices which do or are likely to infringe unfairly upon use of the letters WOR."

DIRECTORY of ALDEN PRODUCTS

The following parts are made to Government Specifications:



J-47

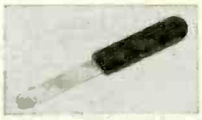


B-19

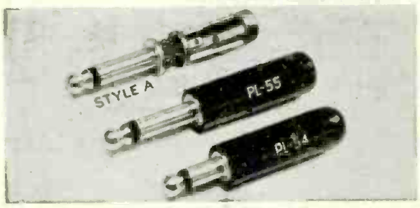
TELEGRAPH KEYS

built to Signal Corps Specifications. Continuous production on J-37, J-41A, J-44, J-45, J-47, J-48 and B-19. Excellent facilities for making all the parts of these keys. Consequently prompt delivery on most numbers. Check your requirements with us.

1A BURNISHER

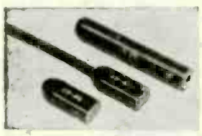


Signal Corps Type 1A relay contact burnisher.



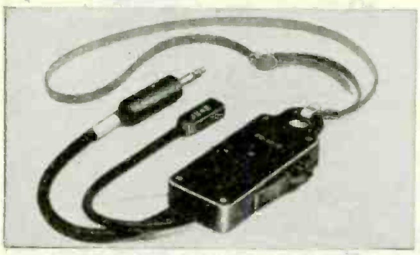
TELEPHONE PLUGS

Signal Corps Types Style A, PL-55 (Navy Type NAF-310572) and PL-54. Style A for molded rubber plug assemblies.



TELEPHONE JACKS

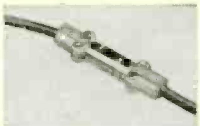
JK-26 and JK-48. Supplied with cords attached if desired.



CORDS WITH PLUGS ATTACHED

A complete line of all Signal Corps and Navy Types including 307A, CD-318, CD-264, CD-366 and CD-125.

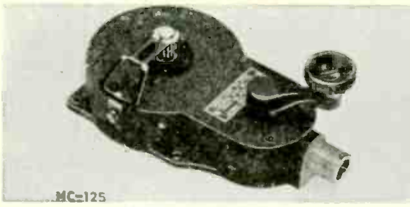
SINGLE CONTACT CONNECTOR



Models PL-202 and JK-50 for use with single conductor shielded cables. Designed to fill the need for a compact, quickly detachable, quality connector.

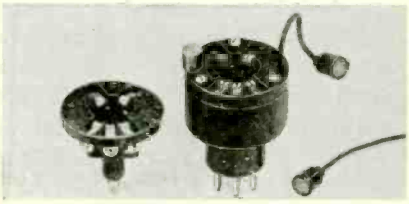
OTHER TYPES OF PLUGS

PL-50A, PL-58, PL-114, PL-P-103, PL-Q-103, SO-104 and SO-143.



TUNING UNITS

MC-125 and MC-127 illustrate a close tolerance, precision assembly in which our quality record was excellent.

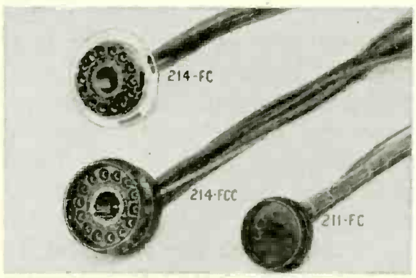


ACORN SOCKETS and ADAPTORS

Socket 455-V2 and Adaptor 966. Quality designed to handle the wide variations in these tubes. New contact tooling assures prompt delivery.

ANALYZER and ADAPTOR KITS

for all Government Test Sets. Prompt delivery.

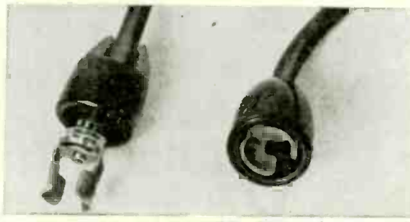


CATHODE RAY CONNECTORS and SOCKETS

A magnal type socket assembly with leads prepared to your specifications. Two new di-heptal connectors for panel mounting or for straight connector use. All sockets have individually insulated terminals and leads, providing a large safety factor at high altitudes and over a wide temperature range. Magnal 211-FC; Di-heptals 214-FC and 214-FCC.

FUSE HOLDER

designed to rivet direct to the panel to preclude any loosening under vibration. Made with ejector spring.



92-RL

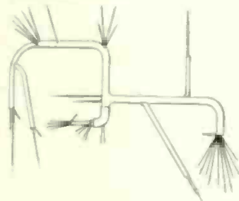
TUBE CAP CONNECTORS

furnished with leads attached for every possible application from receiving tubes to high current radio frequency applications.

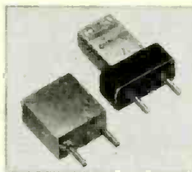
SPECIAL MOLDINGS

Knobs, condenser and relay bases, commutator and brush assemblies for RADAR applications. Special magazine method of phenolic molding for both large and small quantities. A single mold starts your order, additional molds step up production to any daily requirements. This method also permits any required changes and is particularly well-suited for government requirements.

CABLE ASSEMBLIES



Any type of cable assembly such as formed, laced, braided or shielded to your print, with wire of your choice, can be handled efficiently in large or small quantities.



CRYSTAL HOLDERS and ADAPTORS

made to government specifications and to meet special requirements.

SPECIAL QUALITY WIRE

Immediately available capacity for serving, braiding, lacquering and shielding.

MULTI-WIRE CONNECTORS

for every purpose from miniature hearing aids up. Particular attention given to compactness and complete insulation around each lead. Government and commercial types.

COIL FORMS, HOUSINGS and CASINGS

RF coil forms for iron core tuning. Molded from low loss material. Available in plain, ribbed, molded thread types.

Coil housings for iron pot and core applications designed for positive hermetical sealing.

Plug-in coil cases for moistureproof sealing of small transformers.

SPECIAL ASSEMBLIES

Facsimile and picture transmission equipment.

For complete information, cost and delivery estimates or samples on any Alden products write to Department A.

ALDEN PRODUCTS COMPANY, INC.

117 NORTH MAIN STREET — MAKERS OF NA-ALD PRODUCTS — BROCKTON • MASS.

NEWS OF THE INDUSTRY

First news about radar; UHF summer courses; ERSA supplies parts to labs; WPB electronic rulings; Dr. Jewett re-elected; cable secrecy is questioned; more tantalum discovered; personnel changes; E awards

Radar Stories Are Released By U. S. and Great Britain

IN LINE WITH the policy of giving the American people as much information as possible without endangering our own forces or helping the enemy, the early development of radar was described in a joint Army-Navy release dated April 25, 1943. At about the same time, the British Information Services released information on the development of radiolocation, British equivalent of radar. The two releases are given here essentially in their entirety for purposes of reference.

Joint Army-Navy Radar Release

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

"It is one of the marvels made possible by the electron tube. Ultra-high frequency waves traveling with the speed of light can be focussed and made to scan the air and sea. When they strike an enemy ship or airplane, they bounce back. Radio waves travel at a constant speed of 186,000 miles per second. Thus a small space of time is required for such signals to travel to a reflecting surface and return to a receiver, so that, with means provided for measuring this time interval, it is possible to determine the distance to a given target. Radars operate through fog, storms, and darkness, as well as through cloudless skies. They are, therefore, superior to both telescopes and acoustic listening devices.

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

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

"So far, it had been necessary to have the moving object pass *between* the radio transmitter and the receiver. This obviously limited the possible fields of application. In 1925 it was found that the surface of an object, or target, would act as a reflector of high-frequency radio waves. In other words, the radio signals sent out by a transmitter could be made to strike a target, and then bounce back to a receiver. This made it possible to have both the transmitter and the receiver at the same location.

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

"In order to prevent information which might facilitate development of radar from reaching the enemy through publicity originating in the United States, it has been decided that no further items on the subject will be released until the Army and Navy are convinced that the enemy already has the information from some other source."

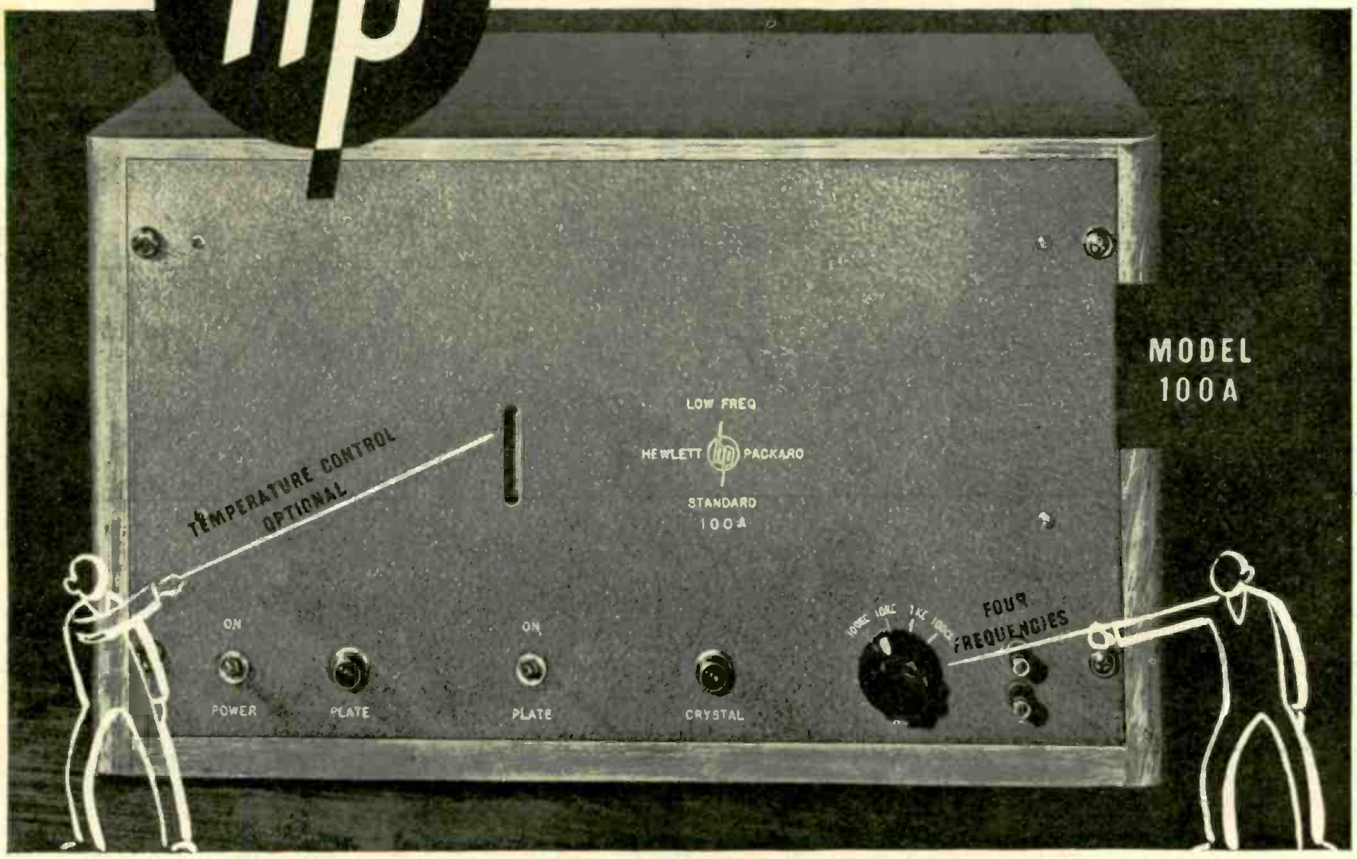
British Information Services Release

"Sir Robert A. Watson-Watt, C.B,. F.R.S., the inventor and developer of radiolocations, visited America in 1941–42 to advise Army and Air Force chiefs on its principles and practice, of which he gave them full details.

"Reduced to the simplest terms of definition, radiolocation is the system of sending ether waves which are unaffected by cold or darkness. Any

Sir Robert Armstrong Watson-Watt, inventor of the British system of radiolocation. He was knighted by King George VI in 1942 for his pioneer work on this British equivalent of radar

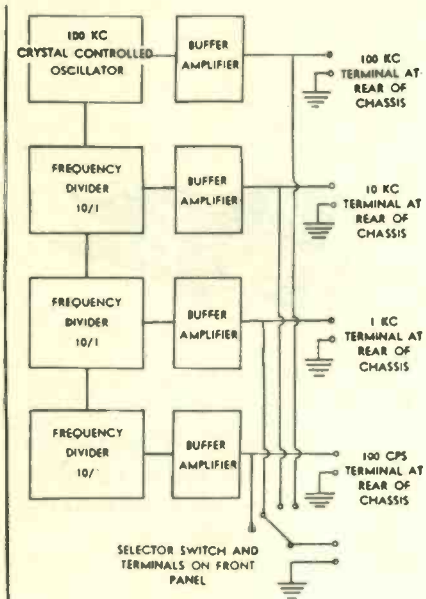
NEW -hp- LOW FREQUENCY STANDARD



Four Standard Frequencies Available Simultaneously

Standard frequencies of 100cps, 1 KC, 10 KC and 100 KC are supplied through a crystal controlled oscillator and a series of frequency dividers of the regenerative modulator type. The output of each of these frequency dividers is made available separately through a low impedence output system. Thus the *-hp-* Model 100A becomes extremely valuable for production test work because the single instrument will provide standard frequencies at a number of test positions. The output impedence is low enough that long lengths of shielded cable can be used for distribution in the laboratory or test department. Separate terminals are provided as shown in the block diagram.

Make accurate interpolation measurements and standardize such measurements to a high degree, calibrate audio equipment accurately and make many other useful tests and measurements with this Model 100A Frequency Standard. Get the complete details on this new *-hp-* instrument today. Also ask for the fully illustrated *-hp-* Catalog which gives you much valuable information about electronic instruments and how to use them. Write today for yours . . . there is no obligation whatsoever.



HEWLETT-PACKARD COMPANY

662 BOX 1135E. STATION A, PALO ALTO, CALIFORNIA

For 32 years Magnavox has been serving the radio industry. Now our engineering skills and factory facilities, which have made such important contributions to radio, are concentrating on winning the war.

Magnavox

TAKE OUR WORD FOR IT—the new Magnavox factory is an excellent plant . . . six acres under one roof . . . facilities, talent and resources to handle anything in the communication and electronic field.

With engineering skill amplified and production capacity increased we are able to exceed the enviable achievements already made by our organization in war work.

As prime and sub-contractor Magnavox has set many new records. Some facilities are again available for additional contracts. Write, phone or wire. The Magnavox Company, Fort Wayne, Indiana.

The skill and craftsmanship which won for Magnavox the first Navy "E" award (and White Star Renewals) among radio receiver manufacturers, has served the radio industry capably for 32 years.

MAGNAVOX IS NOW WORKING FOR THESE BRANCHES OF SERVICE:

ARMY—Air Corps . . . Signal Corps . . . Ordnance

NAVY—Aeronautics . . . Ordnance . . . Ships

COAST GUARD

MARINE CORPS

MARITIME COMMISSION

solid substance, such as aircraft, in the path of the waves sends a reflection to a detecting station, thus revealing its presence or approach. Waves go out continuously, thereby obviating the need for maintaining standing patrols of fighter aircraft, and releasing men and machines for attacking raiders. Radiolocation installation would have rendered the Pearl Harbor attack impossible.

"Watson-Watt is the scientific adviser to the Air Ministry on telecommunications, under Sir Robert Renwick, chairman of the radiolocation committee and controller of communications equipment. A sturdy, dark-haired Scot of 51, Watson-Watt works seven days a week. He has been experimenting in radiolocation since 1935, beginning with headquarters in a hut and truck on a lonely country road near the Daventry headquarters of the B.B.C. His wife was his first assistant.

"His idea was that girls should undertake radiolocation work, and he trained three of his typists as a crew. He is a great believer in women workers, finding that Waafs frequently do better work than the men in the R.A.F., showing greater initiative and application, though frequently less mechanical-minded.

"The enterprise steadily expanded to the point of employing scientists, engineers and manufacturers. The organization, with its staffs, now covers the whole country and serves the R.A.F., the Army and the Navy. Watson-Watt, as president of the Association of Scientific Workers, pointed out that even now greater use could be made of scientific workers in the war effort.

"Watson-Watt was born in Brechin, Scotland in 1892, was educated at University College in Dundee and has distinguished himself in electrical engineering.

"He began his civil service career in the Meteorological Office, subsequently holding responsible posts for applying physics, meteorology and radio engineering to aeronautics, and has visited Egypt and traversed the Indian Ocean in pursuit of his investigations.

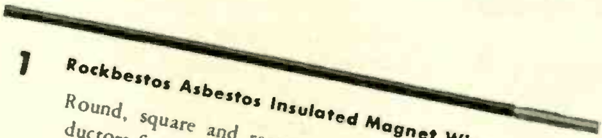
"The entire ether is his domain—he has dealt with echoes of wireless signals reflected back to earth after going beyond the moon.

"He married Margaret Robertson, a Dundee teacher, in 1907, when he was a lecturer in physics at Uni-

ROCKBESTOS

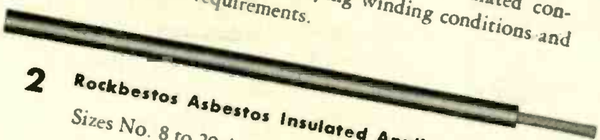
Permanently Insulated Wires, Cables and Cords

FOR ELECTRONIC APPLICATIONS



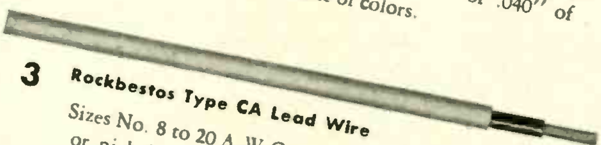
1 Rockbestos Asbestos Insulated Magnet Wire

Round, square and rectangular asbestos insulated conductors finished to meet varying winding conditions and coil treatment requirements.



2 Rockbestos Asbestos Insulated Appliance Lead Wire

Sizes No. 8 to 20 A.W.G. solid or stranded copper, monel or nickel conductors insulated with .031″ or .040″ of felted asbestos in black, white or colors.



3 Rockbestos Type CA Lead Wire

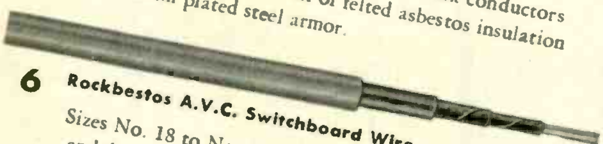
Sizes No. 8 to 20 A.W.G. solid or stranded copper, monel or nickel conductors insulated with synthetic tape and varying wall thicknesses of felted asbestos in black, white or colors.

4 Rockbestos Firewall Radio Hookup Wire

Sizes No. 4 to 22 A.W.G. stranded tinned copper conductors insulated with synthetic tapes, felted asbestos, and covered with lacquer-finished color-coded glass braid. Heat, flame and moisture resistant, light weight, small diameter construction.

5 Rockbestos Thermostat Control Wire

Sizes No. 14, 16 and 18 A.W.G. in two to six conductors with 12½, 25 or 32 mil wall of felted asbestos insulation and cadmium plated steel armor.



6 Rockbestos A.V.C. Switchboard Wire

Sizes No. 18 to No. 4/0 A.W.G. with varnished cambric and felted asbestos insulation and gray, black, white or colored flameproof cotton braid.

Have you been looking for a wire high in dielectric strength, small in diameter, light in weight, resistant to heat, flame, moisture, oil, grease, corrosive fumes, alkalies, caustics and other trouble-making agents? Rockbestos designed the first one of that type in 1937. This wire, Rockbestos Firewall Radio Hookup Wire, is but one of 122 standard constructions, and numerous specials, designed in answer to demands for wires for unusual applications requiring a high degree of electrical performance under severe operating conditions.

1 Protect your coils against heat-induced failure with Class B windings of Rockbestos Asbestos Insulated Magnet Wire. Use Rockbestos A.V.C. Motor Lead Cable for your motor leads.

2 This Rockbestos All-Asbestos Insulated Lead Wire will not dry out and crack under heat and vibration, won't rot, swell or flow as a result of contact with oil or grease, and has ample moisture resistance for most applications. It's the type used in waffle irons, hot plates, ranges, etc.

3 Rockbestos Type CA Lead Wire has the same general characteristics as mentioned above, plus additional moisture resistance and higher dielectric strength provided by the thin, tough, moisture-resistant synthetic tape next to the conductor. Good for humid locations and localities.

4 As mentioned in the leading paragraph, Rockbestos Firewall Radio Hookup Wire is exceptionally high in dielectric strength even though its synthetic tapes, felted asbestos and lacquered color-coded glass braid combine to make a small diameter, light weight construction. Resistant to heat, cold, flame, oil, grease, gasoline, etc. Has broad use in instruments and aircraft radio and ground installations.

5 This Rockbestos Multi-conductor Thermostat Control Wire is widely used in heat control devices and low voltage signal and intercommunicating systems. Its lifetime insulation and rugged armor will give you troubleproof control circuits.

6 Rockbestos A.V.C. Switchboard Wire is not only fireproof but will not dry out or flow under heat. Takes right-angle bends without cracking as the felted asbestos wall gives like a cushion under the braid. Rockbestos A.V.C. Hinge Cable and Switchboard Bus Cable have the same characteristics.

On this page we show but a few of our 122 *permanently insulated* standard constructions. Send for a catalog to learn about the others — and feel free to ask Rockbestos Research for recommendations and engineering advice. Write to the nearest branch office or:

Rockbestos Products Corp., 400 Nicoll Street, New Haven, Conn.

ROCKBESTOS RESEARCH

Solves Difficult Wiring Problems

NEW YORK, BUFFALO, CLEVELAND, CHICAGO, PITTSBURGH, ST. LOUIS, LOS ANGELES, SAN FRANCISCO, SEATTLE, PORTLAND, ORE.

INVEST IN WAR BONDS • MAKE EVERY PAYDAY A LAY-AWAY DAY

versity College and she was a student there. The scientific technique they worked out in the early years of their married life has been extended over the whole field of radio research."

Conclusions

The release of an official account involving the word radar apparently implies approval of general use of this word from now on. The term had been banned since before Pearl Harbor for reasons of military secrecy.

It is likewise apparent that the statement "It was first discovered in the United States in 1922" refers only to the basic principles underlying radar, and is not intended as a claim to prior discovery. The principles could probably be traced even further back, to the very birth of radio itself and to the first experiments with electromagnetic waves. In this country, the principles of radar were further uncovered by the Naval Research Laboratory. Development and refinement of the equipment was carried out in the Army Signal Corps Laboratories at Fort Monmouth in cooperation with the Navy. Developmental work was thus progressing simultaneously in both countries. The British can, of course, be given full credit for first applying the invention to modern warfare, in the dramatic defense of Britain against the Luftwaffe in 1940 and 1941.

The Signal Corps and Army Air Forces have concentrated on the use of radar offensively and defensively in connection with aircraft, while the Navy has centered its efforts on application of radar to its warships and undersea craft.

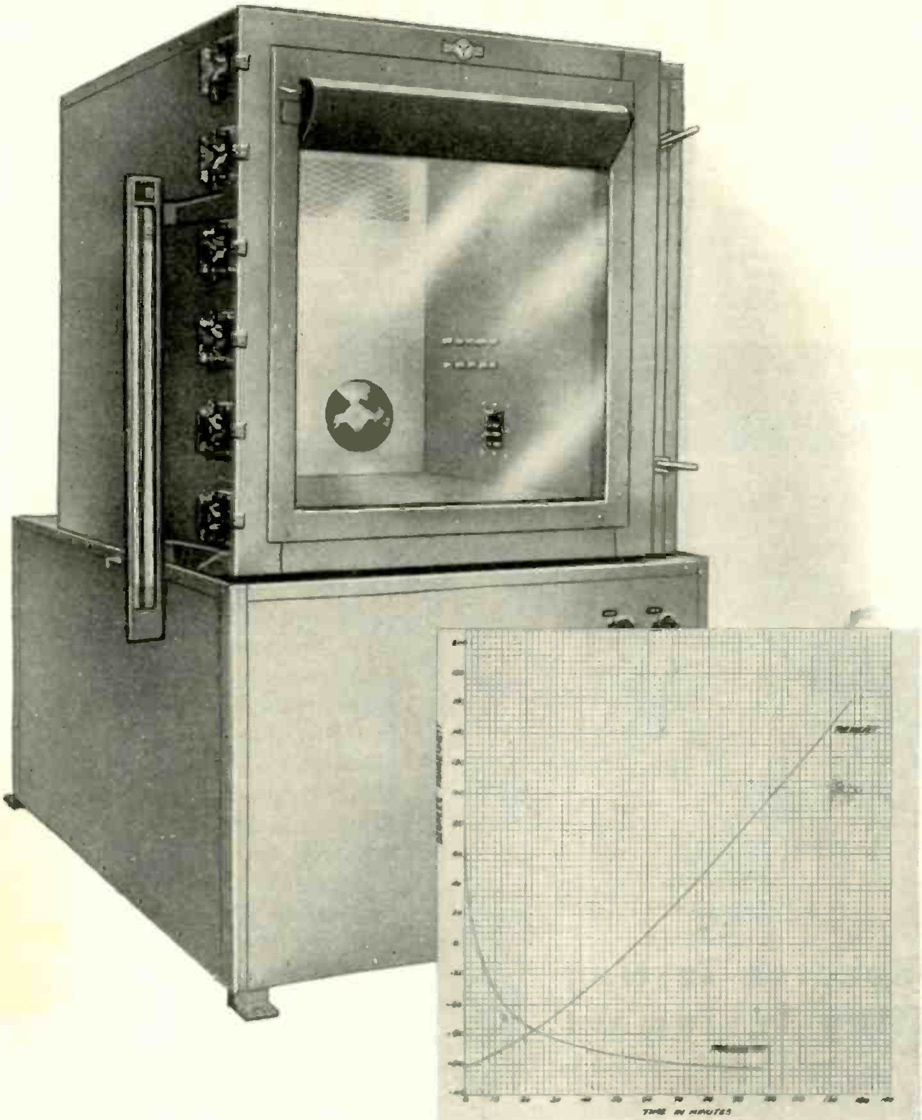
Commentary

Frank McIntosh of Radio and Division, WPB: "Radar is a godsend to this war, and we in the electronic field believe it will be a tremendous factor in the winning of the war". Speaking at the NAB War Conference in Chicago, he also predicted commercial use of radar after the war in connection with vehicles, ships and airplanes, and indicated that this detecting and ranging equipment would eliminate the hazards of plane crashes in mountainous areas which have been responsible for some of the major accidents in the past.

Dr. W.R.G. Baker, in charge of

EXPERTS . . . REFUSE TO BE STUMPED

When a possibility seems an improbability, call in a MOBILE engineer. Over the wide range of requirements for high altitude test and calibration chambers, our men have overcome many of the difficulties which gave instrument manufacturers a headache. Unusual specifications have been successfully met, production test times substantially lowered, greater efficiency effected. All MOBILE units incorporate positive means of refrigeration and control, with an indicating recording controller. Where-ever standard models are not suitable, we will build to individual needs.



★

HIGH ALTITUDE DEVELOPMENT CHAMBERS

Temperature: —125° F to +180° F, accuracy ±2° F of setting.
Vacuum: to .15" Hg absolute.
Time: complete cycle within 90 minutes.
Size: minimum of 12"x12"x12" to any greater capacity.
Humidity: 20% to 95% R. H. manual or automatic control.

★

COLD CHAMBERS

Specifications are identical with those listed above for altitude chambers, except that cold chambers have no vacuum provision.

★

HOT AND COLD BATH CALIBRATION STANDS

Temperature: —85° F to +600° F.
Control: constant temperature control ±1° F.
Size: 1 pint to 50 gallons; also available with multiple vat units.
Automatic mechanical refrigeration (no dry ice).

★

FLIGHT CHAMBERS

Temperature: to —100° F. or without refrigeration.
Vacuum: to 80,000 ft. with automatic control of temperature compared to pressure for dive and climb similitude.
Size: 6'x4'x4' to as large as 10'x10'x50'.
Humidity: manual or automatic control in range between 20% and 95% R.H.

★

ACCESSORY INSTRUMENTS

Special Recording Pyrometers
Manometers and Altimeters
Vertical Speed Indicators
Oximeters
Instrument panels and switchboards

May we work with you?

MOBILE REFRIGERATION, INC.

630 FIFTH AVENUE NEW YORK, N. Y.

G-E Electronics Dept.: "As early as the twenties, General Electric engineers and scientists were actively engaged in the development of tubes, circuits and apparatus for the very high frequencies which form the basis for present-day radar—the electronic device which locates planes and ships far beyond man's vision. With such experience added to manufacturing skill, G-E was able to start building radars long before Pearl Harbor. They are being made today in our factories for installations on ships and on the ground."

David Sarnoff, president of RCA: "American inventive genius contributed much to the creation and perfection of the great offensive and defensive weapon known in the United States as radar. I am happy to report that RCA Laboratories have been in the forefront of radar research and development. The radio-electron tube was the key to its application. By the use of radio and especially radar, the United Nations have been able to avert many disasters, save precious lives, and inflict severe damage upon enemies."

UHF Summer Courses

TUITION-FREE summer courses in ultrahigh-frequency theory and practice, cathode-ray circuits, and various other phases of electronics and radio are being offered by colleges and universities throughout the country as part of the Engineering, Science and Management War Training Program. Information and application blanks can be obtained from the individual colleges. Most classes are scheduled to start about June 1, and meet one evening per week.

All courses are college grade, with admission requirements varying with the level, scope and intensity of the course. Special courses can be set up to suit the requirements of individual plants.

Seven ESMWT summer courses of particular interest to electronic engineers are being given by the Polytechnic Institute of Brooklyn: Introduction to Microwave Theory; Introductory Experiments in Microwaves; Theory of Cathode-ray Circuits; Experiments in Cathode-ray Circuits; Experiments in Ultrahigh-Frequency Generators and Receivers; Measurements at Ultrahigh Frequency; Advanced Theory of Ultra-Short Electromagnetic Waves.


GIUSTI

New Agency Will Supply Labs With Hard-To-Find Parts

FROM CHARLES E. WILSON, executive vice chairman of the War Production Board, late in April, came word of the formation of the Electronic Research Supply Agency, with offices at 460 Fourth Avenue, New York City (Tel: Murray Hill 5-8229), under the direction of Maurice S. Despres.

The new agency, said Mr. Wilson, will procure and stock critical electronic equipment component parts needed by government, institutional and industrial laboratories for completion of Army-Navy research and development contracts. It will ship from its own stocks to wholesalers serving such laboratories, or direct to the laboratories, where the required parts are not readily avaliable through regular distribution channels. The agency, it was further indicated, will accept and endeavor to fill by every possible means at its command, emergency orders from properly accredited laboratories even during the period in which its stock is being built up.

Interviewed by ELECTRONICS early in May, ERSA managing director Despres supplied the following details:

The new agency was formed at the request of WPB and at the instance of the Army, Navy and the Office of Scientific Research and Development. It is a subsidiary of the government's Defense Supplies Corporation, which will receive any profits which may accrue from its operation and will, similarly, defray any losses. It will have access to data covering research and development projects placed in the hands of laboratories by the Army and Navy and so will be able to anticipate in many instances their component parts needs. It will, where possible, place advance orders with manufactures on the basis of this knowledge, the quantities ordered being subject to approval by a committee comprising representatives of the Army, the Navy, the OSRD and the WPB. John Timmons, deputy director of WPB's Radio-Radar Division, is chairman of this committee.

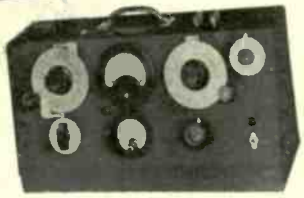
The agency expects to have sufficient stock on hand by June 10 to handle a majority of laboratory orders without delay. Priorities need not be submitted by the 250-odd laboratories having government re-

INSTRUMENTS *for Precision Measuring*

In DEVELOPMENT
RESEARCH
DESIGN
and PRODUCTION
of radio and allied equipment

Choose your test apparatus from these DEPENDABLE and DIRECT READING instruments

CATALOGUE B UPON REQUEST



Q-METER
TYPE 160-A

Frequency Range: 50kc. to 75mc. may be extended with external oscillator down to 1 kc.
Range of Q Measurements, Coils: 50 to 625.
Accuracy: In general ± 5%
Range of Q Tuning Condenser: 30-450 mmf. (Vernier Condenser: ± 3 mmf.)

Q-METER
TYPE 170-A

Frequency Range: 30 mc. to 200 mc.
Range of Q Measurements, Coils: 100-1200
Accuracy: In general ± 10%
Range of Q Tuning Condenser: 10-60 mmf.

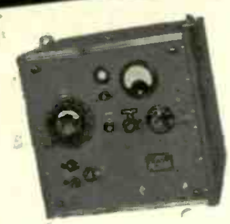
QX CHECKER
TYPE 110-A

The factory counterpart of the Q-Meter. Compares fundamental characteristics of inductance or capacitance and Q under production line conditions with a high degree of accuracy, yet quickly and simply. Insures uniform parts held within close tolerances. Frequency range 100 kc. to 25 mc.

FREQUENCY MODULATED SIGNAL GENERATOR
TYPE 150 SERIES

Type	Frequency.
150 A	41-50 mc. and 1-10 mc.
151 A	30-40 mc. and 1-9 mc.
152 A	20-28 mc. and 0.5-5 mc.
154 A	27-39 mc. and 1-7 mc.

Developed specifically for use in design of F. M. equipment. Frequency and Amplitude Modulation available separately or simultaneously.



BEAT FREQUENCY GENERATOR
TYPE 140-A

A single compact instrument which provides wide frequency and voltage coverage of generated signals.
Frequency Range: 20 cycles to 5 mc. in two frequency ranges.
Output Voltage Range: 1 millivolt to 32 volts.
Accuracy: ± 3%.
Output Power: One watt into external load.

BOONTON RADIO CORPORATION BOONTON, NEW JERSEY, U.S.A.

search and development contracts. It will, however, be necessary for such laboratories to include with purchase orders statements certifying that the parts requested from the agency are to be used exclusively for such projects. Parts ordered direct from the agency will be billed at established wholesalers' resale prices.

Laboratories are expected to explore the stocks of local wholesalers before placing orders direct with the agency. It is believed that wholesalers can fill at least part of most orders out of existing stocks, and attempts to by-pass such normal distribution will be frowned upon. Wholesalers finding it necessary to round out a laboratory order through the agency may do so by accompanying their purchase order with the customer's certification, as described above, plus their own certification stating that the order is for the identified customer's use. Where orders are placed by laboratories through wholesalers the wholesalers will be billed by the agency at prices representing the cost of parts to the agency plus a handling charge. Price lists are already available to wholesalers on request.

Major objectives of the agency, according to Mr. Despres, include:

(1) Speeding up of delivery of critical component parts to laboratories engaged in research and development work for the Army and Navy and OSRD, without upsetting normal manufacturer production runs, as is frequently the case when laboratories having high priority ratings order small quantities of parts direct. This objective, it is hoped, will be reached by placing orders with manufacturers at times when production runs will not be upset. The agency's knowledge of what parts are likely to be needed by laboratories will permit anticipation of many needs.

(2) More rapid standardization of parts used in Army-Navy gear. It is pointed out that parts used in laboratory models frequently carry over into production runs in order to avoid the possibility that substitutions in production might alter equipment performance. Stocking of standard parts only by the agency will insure their use right from the laboratory stage.

(3) Reduction of laboratory stockpiles, one agency rather than many laboratories building up the reserve

needed for safety with resultant centralization and quantity savings.

The agency, its managing director emphasized, will positively confine its activities to the procurement of parts needed by laboratories having Army-Navy research and development contracts, as distinguished from manufacturers having production contracts. The agency's stock will be widely diversified but, in view of its purpose, would not stand tapping for production purposes from the standpoint of quantities of individual items on hand.

Mr. Despres has been associated with WPB and OPA radio divisions for the past two years. Prior to his association with these government agencies he was widely known in the electronics field as president of the Dale Radio Company, Inc., of New York and a director of the Continental Radio & Television Corporation of Chicago. Associated with him as the new agency's purchasing agent is Adolph Gross, formerly affiliated with the Terminal Radio Corporation of New York.

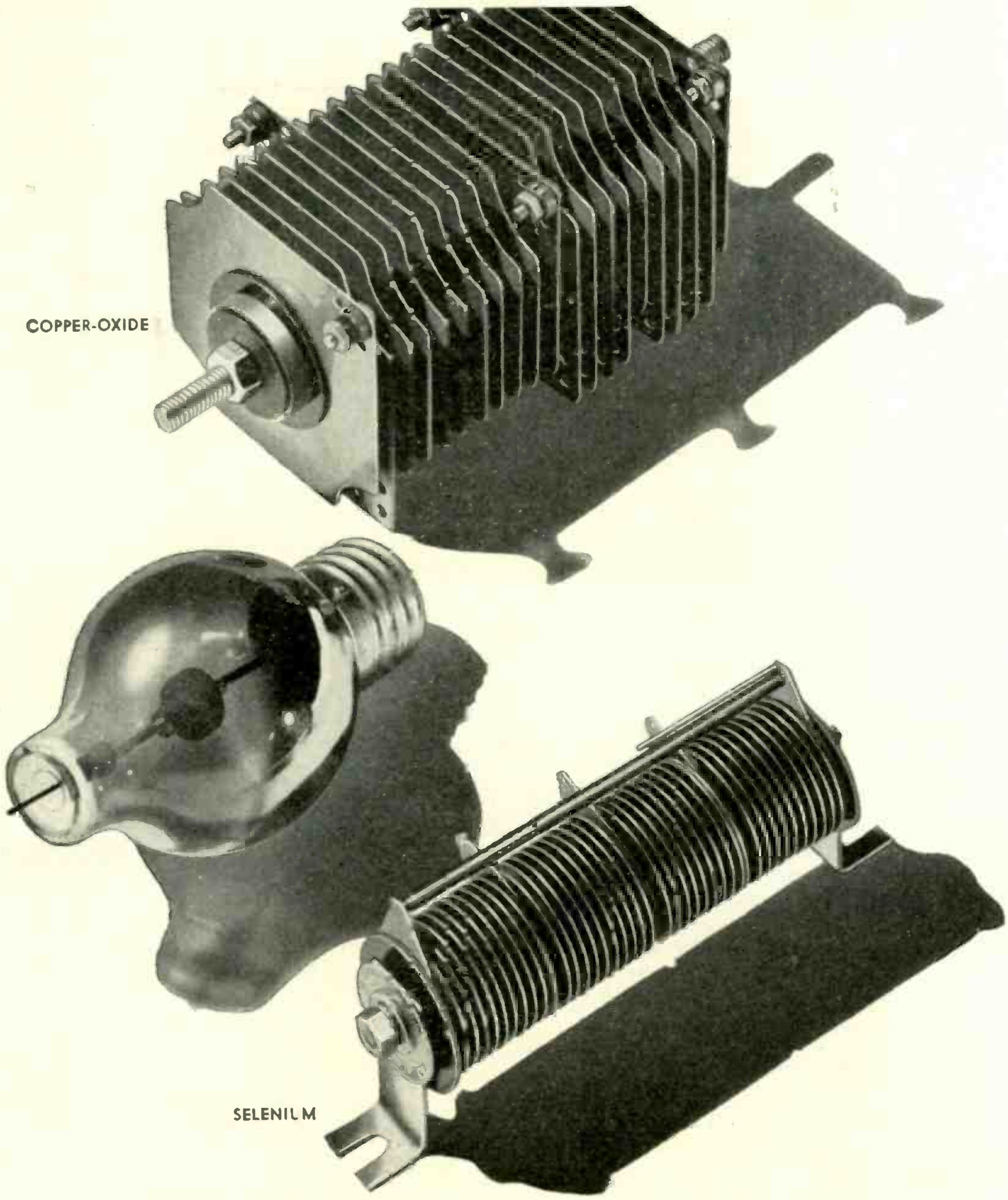
Picatinny Arsenal Will Test Fence Protection Devices

THE PICATINNY Arsenal at Dover, N. J. has been designated by the War Dept. as official test station for all fence protection devices, electronic and otherwise. Manufacturers are invited to install their equipment on sample sections of the fences around the Arsenal. Interested Ordnance establishments will send representatives to the Arsenal to determine from impartial tests and their own observations which type of fence intrusion-detecting equipment is best suited to their needs.

WPB Electronic Rulings

Electronic Parts. Newly revised order L-183-A gives WPB the power to change the scheduling of deliveries of condensers, resistors, meters and about 2000 other electronic components in order to meet production schedules for completed equipment. WPB may freeze schedules, reallocate unfilled orders, divert deliveries or establish earmarked stocks of components, all of which will make it easier for ANEPA expediters to help manufacturers meet their schedules.

Test Equipment. Deliveries of



Need a Rectifier?

Then you will want to know which type is best for your specific requirements—Copper Oxide, Selenium or Tungar.

General Electric can give you an impartial answer because General Electric manufactures all three.

When next you need a rectifier you can get a valuable consulting service (no obligation, of course) through G-E Tungar and Metallic Rectifier Engineers. Address inquiries to Section A636-119, Appliance and Merchandise Department, General Electric Company, Bridgeport, Connecticut.

GENERAL ELECTRIC

radio and radar test equipment are no longer subject to the competition of priority ratings, and a triple A rating can therefore no longer be used to trump another buyer's bid for equipment. Buyers will fill in Form 556, on the basis of which the precedence list for test equipment sales will be made up. Only when equipment is urgently needed will it be possible to secure a directive authorizing prompt delivery. Manufacturers receiving purchase orders without WPB approval on Form 556 are directed to return the orders to their customers unfilled.

Resistor Wire. Backlogs of orders for fine wire used in resistor production are rapidly declining, according to WPB, and hence the present is a good time to buy both wire and resistors. Early placement of resistor orders for military radio and radar equipment is urged, to permit effective scheduling of future production.

Mica. Although newly developed substitutes may eventually serve satisfactorily for 10 to 15 percent of total mica requirements, WPB cautions that there is still urgent need for high-quality natural mica. According to the WPB Mica-Graphite Division, little of the substitute material is in actual production on any scale beyond laboratory work, and few component parts containing the new materials have been adopted by prime contractors or the Armed Services.

New Parts Can Be Bought If Old Parts Are Turned In

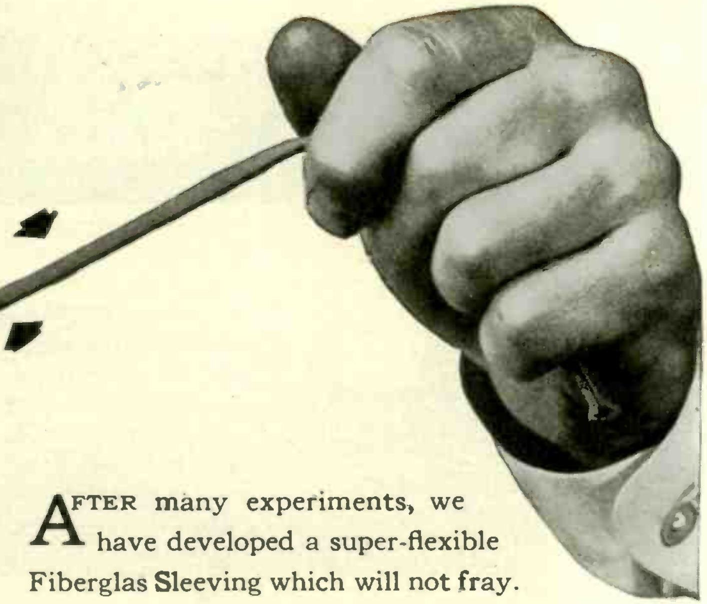
ALTHOUGH SET OWNERS will not need priority ratings to replace defective tubes or parts in their radio receivers, they must from now on abide by the "tube for tube" and "part for part" rules set forth in WPB Limitation Order L-265.

Exceptions are permissible only when the order is rated A-1-A or higher, or when formal certification is made that return of the defective tube or part is impractical, as when the old part has been lost or in the case of a rural set owner who can buy only by mail. Such a buyer must state in writing "I hereby certify that the part specified on this order is essential for presently needed repair of electronic equipment which I own or operate."

The radio serviceman must collect either a part or certificate when he

AT LAST!

A New Sleeving—Flexible as String and Non-Fraying



AFTER many experiments, we have developed a super-flexible Fiberglas Sleeving which will not fray.

This sleeving is made by an entirely new, recently-discovered process. Formerly, to prevent excessive fraying, it was necessary to saturate the sleeving, sometimes to a degree where stiffness became objectionable. The new BH Fiberglas Sleeving is as limp and flexible as string—you could tie any kind of a knot with it—yet the severest handling will produce only the merest fuzz at the end.

THIS – NOT THIS

NON-FRAYING • FLEXIBLE • HEAT-RESISTANT
NON-INFLAMMABLE • WATER-RESISTANT
NON-CRYSTALLIZING at LOW TEMPERATURES

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

All sizes, from No. 20 to 5/8″, inclusive, are available. Write for samples of this radically new and different sleeving today—in the sizes you desire. Seeing is believing! Bentley, Harris Manufacturing Co., Dept. E, Conshohocken, Pa.

BH PRODUCTS

NON-BURNING IMPREGNATED MAGNETO TUBING • NON-BURNING FLEXIBLE VARNISHED TUBING • SATURATED AND NON-SATURATED SLEEVING

BENTLEY, HARRIS MANUFACTURING CO.
Conshohocken, Penna.

sells a part or repairs a set, but need not pass the used parts along to his suppliers. Instead, he must certify that he has collected parts or certificates covering the parts he is ordering, and must take the used parts to scrap heaps or salvage stations within 60 days after receiving them.

L-265 applies also to complete radio sets, phonographs and electronic units, with exceptions to permit the sale of equipment completed before April 24. It does not apply to hearing aid devices, batteries, power and light equipment. It incorporates provisions of previous orders against the manufacture of new radio sets and phonographs, and prohibits the manufacture of electronic equipment except to fill orders of the Services, orders rated AA-4 or higher, or to the extent that the manufacturer has received materials under CMP.

New U. S. Propaganda Stations

WITH 22 NEW SHORT-WAVE transmitters now planned or under construction, the United States will by next March have a total of 36 stations bringing the facts of America's war aims and gains to the people of all enemy and enemy-occupied countries and to the rest of the world, according to Roy C. Corderman, Assistant Chief of the OWI Bureau of Communication Facilities, speaking at the NAB convention. Each program will be broadcast on two frequencies to minimize danger of jamming by the Axis.

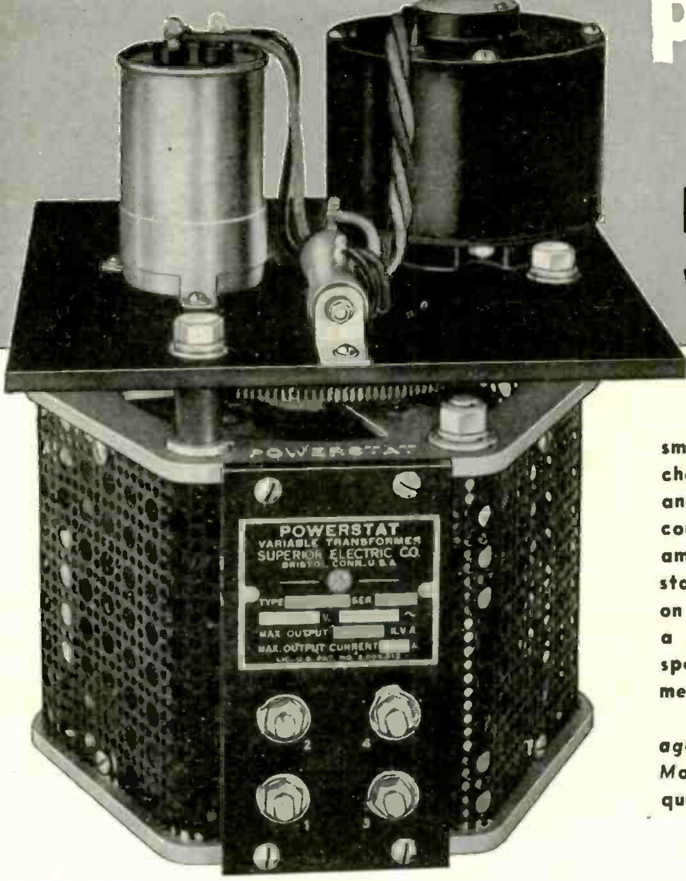
Sixteen of the new stations will have 50 kw power, and the others will range from 25 to 200 kw. When all are in operation, the combined propaganda power of America will have been boosted from the present 706 kw to 2475 kw.

Thirteen of the new transmitters are being built along the Atlantic coast, giving the East a total of 25 international short-wave stations. The remaining nine new stations will supplement the two transmitters now in use on the west coast.

A central master control center including sixteen individual studios is just about completed in New York City. With it and the combined facilities of all the transmitters, it will be possible to broadcast 18 programs simultaneously to reach all parts of the world at their best listening hours.

New! A MOTOR DRIVEN POWERSTAT

Now you can control large amounts of power with a simple push button

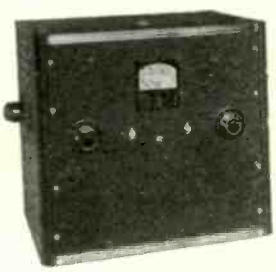


No longer is it necessary to sacrifice range and smoothness of control by using antiquated, inflexible tap changing devices and heavy wiring to control A.C. voltage and power. SECO has solved the problem of obtaining a continuous, distortionless and simple control of large amounts of power. A standard line of Motor Driven Powerstats in sizes up to 75 KVA for single or polyphase operation on 115, 230 or 440 volt circuits is available. You can select a standard unit for your application or where necessary, special designs can be manufactured to meet your requirements.

Engineered combinations of *Powerstat Variable Voltage Transformers and a Highly Damped Synchronous Driving Motor of low fundamental speed* are the answer to efficient, quick, convenient and continuous control of power.

STANDARD AIR COOLED POWERSTAT

For more than five years **Superior Electric Company** has specialized in **Continuously Variable Voltage Transformers** and has won the confidence of **The Armed Forces** and **Industry**. Investigate **Powerstat Variable Transformers** for your control problem. Standard types are manufactured for single or polyphase operation on 115, 230 or 440 volts.



SECO AUTOMATIC VOLTAGE REGULATOR

Incorporating a Synchronous Motor Drive, **SECO Distortionless Automatic Voltage Regulators** deliver constant output voltage with variations of applied voltage and frequency. The output is unaffected by changes in power factor or magnitude of load.

Available in sizes up to 75 KVA.

SEND FOR BULLETINS 149LE (POWERSTAT) AND 163LE (REGULATOR)

SUPERIOR ELECTRIC COMPANY

38 LAUREL STREET BRISTOL, CONNECTICUT

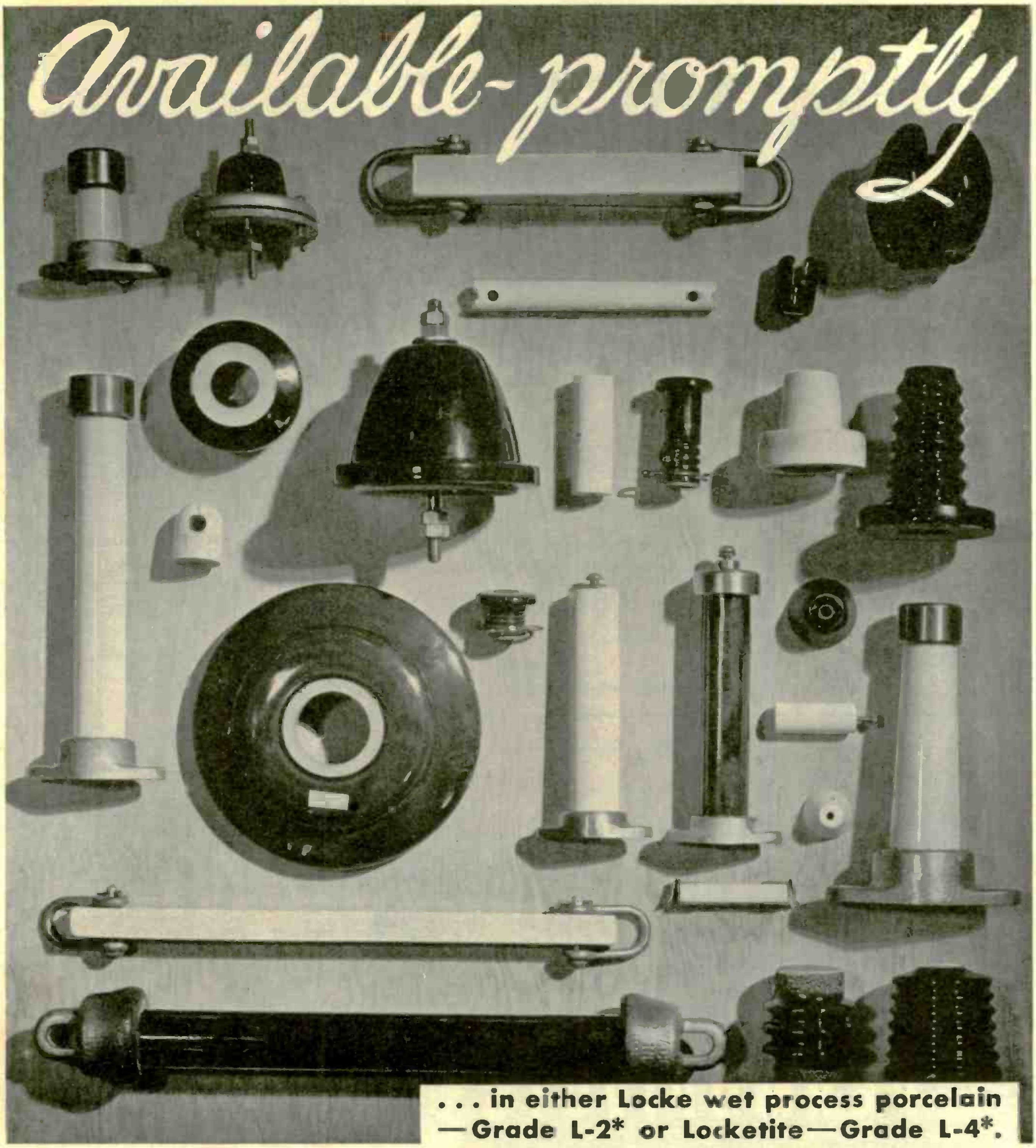
National Academy of Sciences Reelects Dr. Jewett

IN UNANIMOUS ACTION, the membership of the National Academy of Sciences reelected as its president for a second four-year term Dr. Frank B. Jewett, Vice-President of AT&T and Chairman of the Board of Bell Telephone Laboratories. The rare honor is recognition of Dr. Jewett's work as head of the Communications and Transportation Division of the National Defense Research Committee in OSRD.

Dr. Jewett came to the Bell System in 1904 as a transmission engineer with AT&T, and rose rapidly through one important executive position after another in the field of research. He served in the Signal Corps during the first world war, first as major, then as lieutenant colonel. He was a member of President Roosevelt's Science Advisory Board from 1933 to 1935, and holds many honorary university degrees.

Cable Secrecy is Questioned

AN ARTICLE entitled "Communications Secrecy" by Ray Hutchens in RCA Communication's magazine *Relay* suggests that the United States might be better off if it cut its own submarine cables. According to the author, it was definitely proved during and after the last war that submarine cables could be tapped at sea by electronic means, and messages intercepted without the knowledge of operators at the shore ends of the



. . . in either Locke wet process porcelain —Grade L-2* or Locketite—Grade L-4*.

Literally millions of Locke radio insulators are in active service with the armed forces. If you need approved units for the equipment you are making, and need them quickly, let us know. They may even be available from stock.

Our Radio Insulator Catalog is now being reprinted. If you do not have a copy we will be glad to send you one.

*ASA American War Standards C75, 1-1943 on Ceramic Radio Insulating Materials, Class L.

Locke

RADIO INSULATORS

LOCKE INSULATOR CORPORATION, BALTIMORE, MD.

cable. Despite this fact, some conservative diplomats still order their confidential messages to be sent by cable.

Submarine cable paths are charted and well-known, as also are locations of the shore ends of the cables, hence cable cutting by submarines is a relatively simple operation. This means that existing cables could be cut by the enemy. Although present duplication of cable circuits by radiotelegraph circuits is one deterrent to cable cutting, many communications men believe that the cables also remain intact because our enemies do not choose to cut them.

In contrast, radiotelegraphy offers changes in frequency, changes in transmitter locations and beaming of signals to supplement conventional coding of messages. Interception requires considerable equipment because it involves continuous monitoring of all the possible frequencies which can be used, hence enemy listening stations must generally be on land at a location disadvantageous with respect to beam paths and signal strength.

IRE-RMA Fall Meeting

A ONE-DAY War Radio Conference jointly sponsored by the Institute of Radio Engineers and the RMA Engineering Dept. is scheduled to be held at Rochester, N. Y. on Nov. 8, 1943. Virgil M. Graham, P. O. Drawer 431, Emporium, Pa., is Chairman of this Rochester Fall Meeting.

New Synthetic Plastic Approaches Qualities of Mica

A NEW THERMOPLASTIC resin material announced by General Aniline and Film Corporation under the trade name "Polectron" has properties indicating usefulness in place of mica for dielectric and insulating applications. The material has an unusually high softening temperature for plastics, namely 140 to 160 deg. C, and excellent water resistance. Power factor is 0.1 percent or less at 25 deg. C from 1 kc to 1 Mc, retaining this value for temperatures up to 100 deg. C at 1 kc. Specific resistivity at 400 volts is over 10^{15} ohm cm, and the dielectric constant (1 kc

Towers that talk . . .

Tall towers of slender steel. A spider web of steel flung across the sky. A small building. Nothing more.

Nothing more?

Much, much more—for this is radio. And in radio as in man, the things unseen count most. Like the power of the human spirit, the energy of radio is invisible.

From the silence of these towers come the ringing words of patriot radio speakers—the lilt and lift of radio music—the saving grace of radio drama—the instruction and counsel of radio teachers and advisors—the linking of the people's needs and aspirations with the services of America's manufacturers and merchants.

This is the work of America's broadcasters, in which RCA is proud to assist. Through years to come radio broadcasting will render service now but dimly realized—not only in standard broadcast, but in FM, television, and facsimile—in these, too, RCA's special knowledge, extensive facilities and tireless research will play their part.

RCA's resources are today concentrated on war production. Yet RCA engineers are still available to help you solve your pressing technical problems. To the fullest extent possible under war conditions we shall continue to supply and service the vitally important broadcasting industry.

RCA

RCA BROADCAST EQUIPMENT

RCA VICTOR DIVISION · RADIO CORPORATION OF AMERICA · CAMDEN, N. J.

to 1 Mc) is 3.0. Dielectric strength is more than 1000 volts per mil.

Priorities have been granted by WPB for immediate construction of a Polectron manufacturing plant. The product is based on an undeveloped patent held by the former German-controlled General Aniline Corp. at the time it was taken over and Americanized under the trusteeship of the Alien Property Custodian.

• • •

Explanation of CMP

As outlined by WPB Vice Chairman J. A. Krug, the Controlled Materials Plan works essentially as follows: Each of the 13 government procurement agencies presents to the WPB Requirements Committee a list of the items it proposes to schedule for production. The committee adds together all the itemized lists, and compares the total requirements with the available supplies of controlled materials. If demand exceeds suply, the committee cuts some allotments the necessary amount and requires the agencies to adjust their programs accordingly. Each agency then schedules its allotment among its prime contractors, and these in turn must schedule the flow of parts and components from sub-contractors in accordance with the current production schedule.

CMP thus requires coordination of programming, scheduling and flow of materials in order that American industry can meet its program of producing 75 billion dollars worth of war materials in 1943. The plan goes into full operation July 1.

• • •

New Tantalum Deposits Found

Ore containing a high percentage of tantalum has been discovered in New Mexico by a private geologist, and research work on a method of concentrating the ore has been completed by the pilot plant of the Bureau of Mines at Rolla, Missouri. Metals Reserve Co., a Federal agency, is paying the geologist \$3.50 per pound for the beneficiated material.

Tantalum has been largely imported in the past, and was originally a laboratory curiosity because of its rarity. The metal leaped into prominence with its widespread use in radio tubes and in the filaments of

electric lamps. Carbides of tantalum are extensively used today in the tool and die industry, for wire-drawing dies, cutting tools and dies for cold-nosing artillery shells. Tantalum is noted for its extremely high melting point, acid-resisting and wear-resisting qualities. It is actually rarer than gold.

Radio Business News

ON THE BASIS of normal civilian production of radio equipment, it would take 150 years to produce the $4,300,000,000 output of military radio equipment in 1943, according to Frank H. McIntosh, Assistant to the Director of WPB's Radio and Radar Division, in his talk before the convention of the National Association of Broadcasters on April 27. In transmitter manufacture alone, war needs have boosted output from a normal $3,500,000 per year to the present figure of approximately $300,000,000 per year.

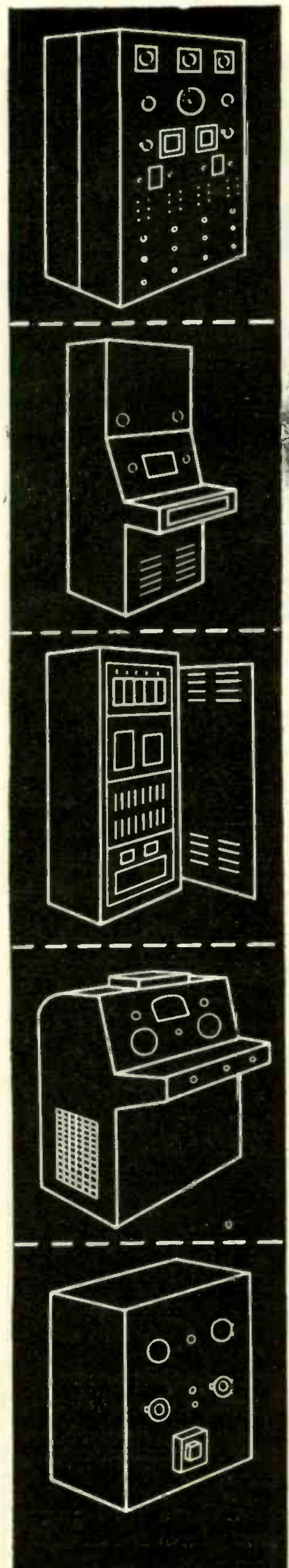
ALLIED CONTROL Co., Inc., manufacturers of relays, have moved their main offices to 2 East End Ave., New York City.

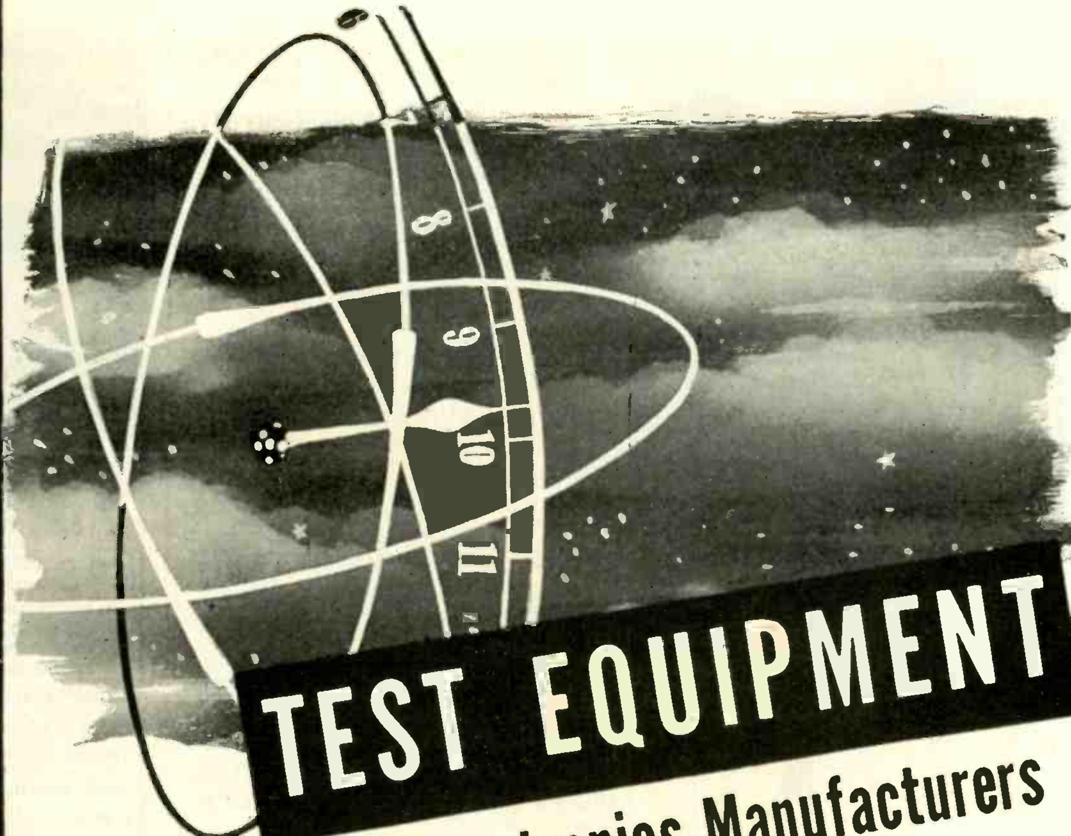
ASSOCIATION OF ELECTRONIC PARTS AND EQUIPMENT MANUFACTURERS or simply EP & EM, is the new name chosen for the Sales Managers Club, Western Group. The organization meets monthly in Chicago, with Jerome J. Kahn as the present chairman.

Personnel

F. J. Healy, in his new post as Vice-president in charge of Operations for Sylvania Electric Products Inc., will be responsible for all manufacturing operations in both the lighting and radio tube divisions. He joined the firm in 1918 as a floor boy.

R. E. Onstad becomes President and General Manager of Thordarson Electric Mfg. Co., following the resignation of C. H. Thordarson as President at the age of 76. Mr. Thordarson, founder of the company nearly half a century ago, will continue his services as technical consultant.



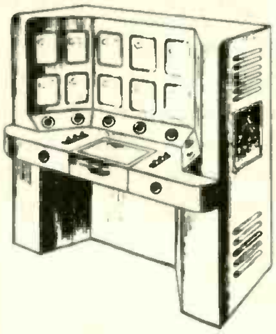


TEST EQUIPMENT

For Electronics Manufacturers

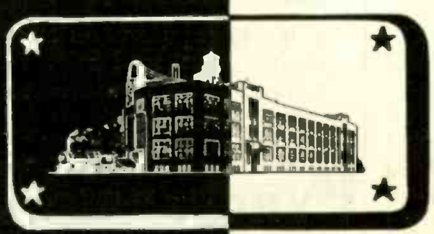
FACILITIES FOR ENGINEERING, DESIGN, MANUFACTURING and ASSEMBLY . . . . COMPLETE UNIT PRODUCTION TO SPECIFICATIONS

We offer an unusual combination of facilities to manufacturers faced with design, development or production problems. Our engineering ability, plus wide manufacturing experience offers many advantages to companies requiring highly specialized electronic testing units. In many instances we have been extremely valuable in augmenting the work of organizations maintaining their own engineering staffs.



PARTIAL LIST OF CURRENT PRODUCTION: **Automatic and semi-automatic electronically operated devices, for production and testing; high frequency and ultra high frequency equipment at highpower levels; exhaust machine controls, bombarders, oscillation aging, static characteristic test, oscillation characteristic test, noise test, ionization test, filament flashing, gas aging. *UNIT OR QUANTITY PRODUCTION.***

ELECTRONIC DIVISION



SHERRON METALLIC

C O R P O R A T I O N

1201 FLUSHING AVENUE, BROOKLYN, N. Y.

Dr. Vladimir Zworykin, director of electronic research for RCA, and **Dr. Lee Alvin DuBridge,** director of the Radiation Laboratories at MIT, were among the 26 new members elected to the National Academy of Sciences. The importance of this honor is indicated by the fact that the total membership is only 450.

Dr. Zworykin was born in Russia, educated in Petrograd and in France, came to the United States in 1919, worked for Westinghouse from 1920 to 1929, then joined RCA. He has made outstanding contributions to the design of television cathode-ray tubes and the electron microscope.

Dr. DuBridge is on leave from the University of Rochester, where he is Dean of the Faculty of Arts and Sciences. He has written numerous articles and books on the subjects of electron emission, nuclear physics and photoelectric phenomena.

M. P. Mims is now in charge of Sales Engineering and Manager of Raytheon's Watertown, Mass. plant. He had owned and operated Mims Radio Co. of Texarkana for many years, specializing in the development, production and marketing of rotary beam antennas.

A. M. Arnt and **Karl Kopetzky** have been elected Vice-presidents of Oxford-Tartak Radio Corp., taking charge of production and electronic developments respectively.

Chester F. Horne has been named General Manager of the lighting division of Sylvania Electric Products, Inc., replacing F. J. Healy. He has been with the firm since 1920.

Manfred K. Toeppen has been appointed Assistant Chief Engineer and Chief of the Common Carrier Division of FCC, succeeding Lt. Comdr. Gerald C. Gross who in turn succeeded Commander Andrew W. Cruse. He has been with the FCC since 1935.

Paul Rankin has been appointed head of all the crystal laboratories for Aircraft Accessories Corp. He joined the company as a laboratory helper and came up "through the ranks".

Inside this package ⬇ there's something important...

UNTIL the war is over, there are very few things that we can tell you about the KLYSTRON* tube.

We can say that it is a vital factor in electronics, that it was developed by the Sperry Gyroscope Company following initial research at Stanford University.

Right now, the KLYSTRON* is making very important contributions to essential military equipment. And other advances in this field have been made—after the war is over, some of these will undoubtedly contribute to the security and comfort of a world at peace.

SPERRY
GYROSCOPE COMPANY
BROOKLYN, NEW YORK

DIVISION OF THE SPERRY CORPORATION

*The names KLYSTRON and RHUMBATRON were officially registered at the U. S. Patent Office on October 3, 1939, by Sperry Gyroscope Company, Inc. KLYSTRON is registration No. 371650. RHUMBATRON is registration No. 371651.

Arthur G. Peck joined the staff of Airborne Instruments Laboratories of Columbia University, at Mineola, Long Island. He has been on the engineering staff of WCCO, Minneapolis-St. Paul, for the past six years, and for the past year was Sec.-Treas. of the Twin City IRE chapter.

George T. Royden has been appointed chairman of the IRE Admissions Committee. He is assistant chief engineer of the Aerial Navigation Products Dept. of Federal Telephone and Radio Co. in Newark.

Winfield G. Wagener has been made Chief Engineer of Heintz and Kaufman, Ltd., after five years with the firm during which he has been

working out practical applications of vacuum tubes in uhf circuits. He has recently headed up development of two new tubes for military service.

Lt. Col. George E. Pickett, 24-year old Signal Officer of a Division in the North African expeditionary forces, is believed to be the youngest Lieutenant Colonel in the American Army. He is responsible for the communication facilities of his division, and has frequently had to supervise stringing of telephone wires under fire on exposed battlefronts.

Karl E. Hassel was elected Assistant Vice-president of Zenith. He was one of the three founders of the company, and has been a director since 1932.

ANNOUNCING A NEW HIGH SPEED LOW COST METHOD FOR

Automatic MOISTURE PROOFING

(HOT WAXING and VARNISHING)

DEHYDRATING AND AUTOMATIC DIPPING, IMPREGNATING, CENTRIFUGING

This 4-fold moisture-proofing process evenly coats all surfaces, punch holes, thin edges, etc., and impregnates to full extent of porocity.

CAN HANDLE ALL TYPES OF SMALL PARTS

Delicote or rugged, this process will moisture-proof mica, bakelite, paper, cork, metal gaskets, porcelain insulators, coils, chokes, condensers and other small parts.

EXPERIENCE WITH ALL VARIETIES OF WAXES AND VARNISHES

Specifications are accurately met. We have vast experience in handling all type finishes.

When specifications call for moisture-proofing of small parts . . . choose this quick, easy economical way. Let PRODUCTION ENGINEERING CORP. serve as your moisture-proofing department. Our new Process, developed for one of the largest government radio contractors, enables us to do high speed quality work with economy and dispatch. Our process passes all U. S. Signal Corps, WPB, Army and Navy tests. Results often are better than specifications. Why not join the list of outstanding radio and electronic firms who now use this specialized service?

● Due to the great variety of parts we prefer not to quote on individual items. Prices depend on impregnating time and quantity. We suggest you send typical shipment. We guarantee prices to be lower than your present costs. In Metropolitan area . . . 24 hour pick-up and delivery service is available.

Phone or Write for Full Details

PRODUCTION ENGINEERING CORP.

666 VAN HOUTEN AVENUE, CLIFTON, N. J. • TEL. PASSAIC 2-5161

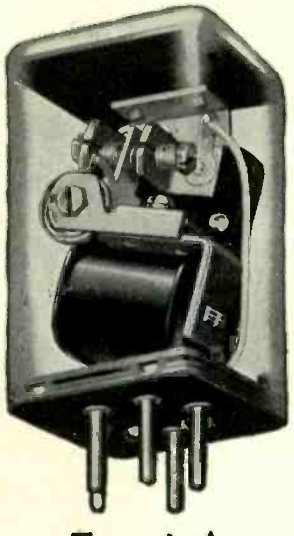
Arthur Van Dyck, head of RCA License Lab., has been called to active duty in the Navy, with the commission of lieutenant commander. He is attached to the Office of Naval Operations in Washington. He has been with RCA since 1922, was president of IRE in 1942, and is a charter member of IRE, with radio experience dating back to amateur experimention and commercial operating from 1907 to 1910.

Dudley E. Foster has been named Vice-president in Charge of Engineering for Majestic Radio & Television Corp. Since 1941 he had been Executive Vice-president of Rogers-Majestic Ltd. of Toronto. He is a member of IRE, holds over 40 radio and television patents, and was given the Modern Pioneer Award by the National Association of Manufacturers for his inventive contributions to the field of electronics.

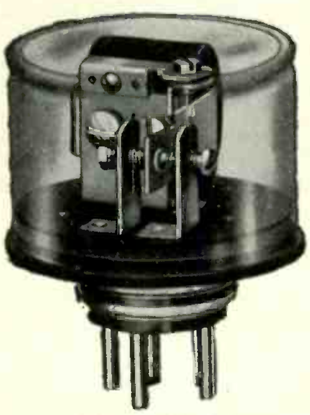
W. M. Angus was recently named engineer of the Receiver Division of the G-E Electronics Dept. in Bridgeport. He received the Coffin Award in 1940 for an automatic method of winding the coils used in touch tuning systems.

Jack Gregath has been promoted to superintendent of the crystal laboratories for Aircraft Accessories Corp. He started as crystal finisher in 1941.

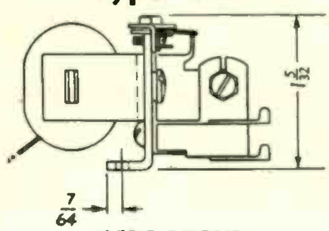
The NEW Type 4R



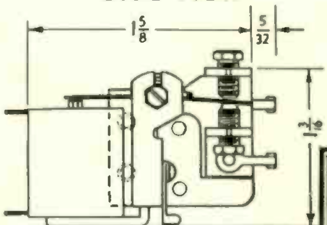
Type 4-A



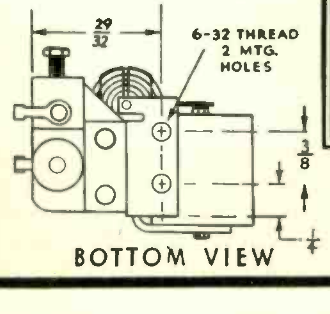
Type 4-F



SIDE VIEW



TOP VIEW



BOTTOM VIEW

SIGMA Sensitive Relays TYPE 4 SERIES

GENERAL SPECIFICATIONS

All relays of the "4" series are designed to operate at low input currents, varying from a few milliwatts to a maximum of one watt. The normal rating of the single-pole double-throw switch circuit is 150 watts at 110 volts A.C. noninductive. However, when proper provision is made for it and when the input is 100 or more milliwatts, very much higher currents may be carried, and we have furnished relays of this series capable of handling 20 amperes D.C. at 24 volts highly inductive. Relays of this series are particularly suitable for use in aircraft or wherever vibration is a problem, having balanced springs and armatures. For this class of service, inputs of at least 30 and preferably 50 or more milliwatts are recommended. Coils supplied where humidity is a factor will stand the severest tests without failure. Of low mass construction these relays are exceptionally fast-acting and can be made to "follow" pulsations occurring at a rate of several hundred per second. Relays supplied where precise adjustment is required are free from any observable remanence or rentivity effects and can be set for drop-out as high as 95% of pull-on voltage with relatively high power in-put.

ADJUSTMENT

While we cannot too strongly urge that the matter of adjustment be left to us, all our relays, except those which are hermetically sealed, may be readjusted very simply. Both the spring and the position of the two contacts which limit armature travel are adjustable.

MOUNTING — TYPE "4" SERIES

4-A 5 pin standard tube base (See cut.) Dimensions above socket: — 2⅝" high, 2 3/16" diameter Cover, snap-on

4-AH Same as above, except hermetically sealed. 2⅛" diameter

4-F (See cut.) No cover or base; mounts directly to chassis with two No. 6-32 screws. Connections to soldering lugs for load circuit, flexible leads for input.

4-AP, 4-AHP Same as 4-A or 4-AH, except no tube base, 1¾" high. Mounting by three peripheral lugs. Connections to soldering lugs under base through hole in chassis. 5/32" diameter mounting holes equally spaced on 2 13/32" diameter circle.

Other mountings available when required.

CONNECTIONS: —

coil — pins "1" and "5" common load contact, pin "3" normally closed contact, pin "2" normally open contact, pin "4"

INPUT CHARACTERISTICS

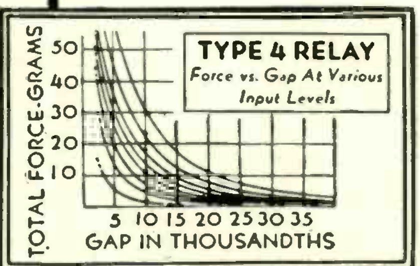
COIL RESISTANCE FROM 5 TO 10,000 OHMS OPERATION ON INPUTS FROM 6 MILLIWATTS TO 1 WATT DEPENDING ON CONDITION — More Detailed Data Together With Operation Characteristic Curves Will Be Furnished To Design Engineers Upon Request.

RELAYS FOR USE ON A.C. INPUTS

All Sigma type "4" relays may be supplied for operation on alternating current of from 60 to over 2,000 cycles per second. When adjusted at the factory for service conditions they are unusually free from noise and hum and entirely reliable in operation. Input power sensitivity is less than in the case of the D.C. models and circuit characteristics must be known before we can make intelligent recommendations for particular application.

CONTROL CIRCUITS

We are equipped to develop and/or produce control circuits and apparatus wherein relays are combined with other electronic components. Because of our experience with the interrelationships between relay operation and other circuit elements, we are often able to produce a better design than would be achieved in the absence of this background. Accordingly we cannot too strongly recommend that the whole basic control problem as well as the proposed solution be presented to us at an early stage when resort can still be had to modifications found advisable.



★

Write for "Performance Analysis — Type 4 Relays" including curves which enable an engineer to predict the exact performance of these relays in proposed circuits.

Consideration of these data will save you fruitless experimentation and ensure the desired results the first time.

And remember! We're never too busy to try to help you solve a problem that's important to the war effort.

SIGMA INSTRUMENTS INC.

78 FREEPORT STREET, *Dept. RN*, BOSTON, MASS.

NAB post-war planning committee members are: John J. Gillin, Jr. of WOW, Omaha; William B. Way of KVOO, Tulsa; G. Richard Shafto of WIS, Columbia, S.C.; Nathan Lord of WAVE, Louisville; James Woodruff, Jr. of WRBL, Columbia, Ga.

G. E. Gustafson was elected Vice-president in Charge of Engineering for Zenith Radio Corp. He has been

with the company since 1925, has been chief engineer since 1933, and has been Assistant Vice-president since 1940.

D. J. O'Conor, Jr., is now assistant Chief Engineer of Formica Insulation Co.

Frederick R. Lack has been elected a Vice-president of Western Electric Co., and has resigned as director of ANEPA to take over again the direction of the firm's radio division in New York City. He joined the firm in 1911 as an assembler, carried out development work in radio telephony after returning from France in 1919, installed a radio-telephone link between Peking and Tientsin, supervised designing and building of equipment for the ship-to-shore radio telephone on the Leviathan, was in charge of vacuum tube development from 1935 to 1939, and resigned on Nov. 1, 1942, to join ANEPA in Washington.

J. E. Brown was elected Assistant Vice-president of Zenith. He has been handling their engineering work in television and frequency modulation since 1937.

Photronic Cells now being made for war purposes only, hold many new possibilities for design engineers searching for better methods or new products for post-war markets.

The improved Type 3 photo-cell has a marked increase in sensitivity and can be produced in various outputs and various linearity factors, to meet specific circuit requirements. They can be matched in spectral sensitivity, too; to give practically the same spectral response curve throughout the color spectrum. And since the fatigue factor has been materially reduced, their response is more uniform, and far more rapid.

The development of the Type 3 is the result of continued research and experience in the processing of photo-cells dating back to 1930 . . . the year in which WESTON introduced the first American-made commercial cell of the barrier-layer type.

Type 3 Photronic Cells can be supplied in various styles and cases, as well as unmounted in a variety of shapes and sizes. Complete technical data, in booklet form, available to design engineers on request. Weston Electrical Instrument Corporation, 618 Frelinghuysen Avenue, Newark, New Jersey.

*PHOTRONIC—*A registered trademark designating the photoelectric cells and photoelectric devices manufactured exclusively by the Weston Electrical Instrument Corp.*

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

WESTON

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

FOR OVER 54 YEARS LEADERS IN ELECTRICAL MEASURING INSTRUMENTS

Arthur W. Freese has been named Vice-president in Charge of Production for Majestic. He had been General Works Manager for Zenith from 1930 to 1940, and recently was Vice-president and General Works Manager of Automatic Instrument Corp.

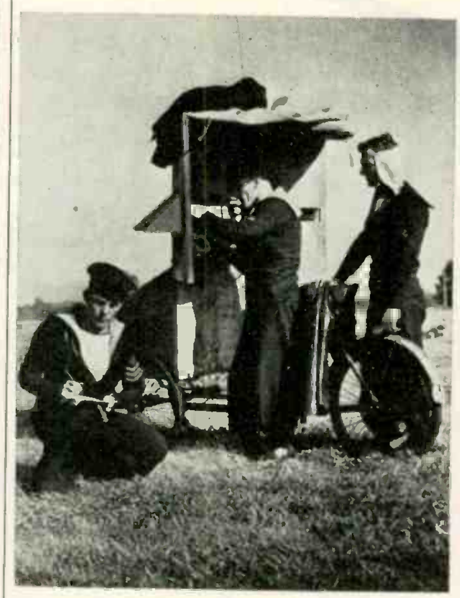
London News Letter

By JOHN H. JUPE
London Correspondent for ELECTRONICS

Point-to-Point Radio. The use of uhf transceivers, along the lines of the much publicized "walkie-talkie" sets of the Army, will undoubtedly make active the question of greatly increased use of such equipment for personal purposes such as, for example, at camps, and between boats and vehicles as well as between vehicles and fixed points. The future trend here, of course, is largely dependent upon the utilization of the wavelengths involved so as to minimize interference, a problem for Federal control.

• • •

WIRELESS TELEGRAPH STATION ON TRICYCLE



Direct contact with aircraft during the training of pilots for the Fleet Air Arm is conducted by tricycle wireless telegraph stations. These stations are maintained by members of the British Naval radio unit. This photo shows the unit in operation. By this contact the faults of the pilot trainees can be pointed out to them immediately

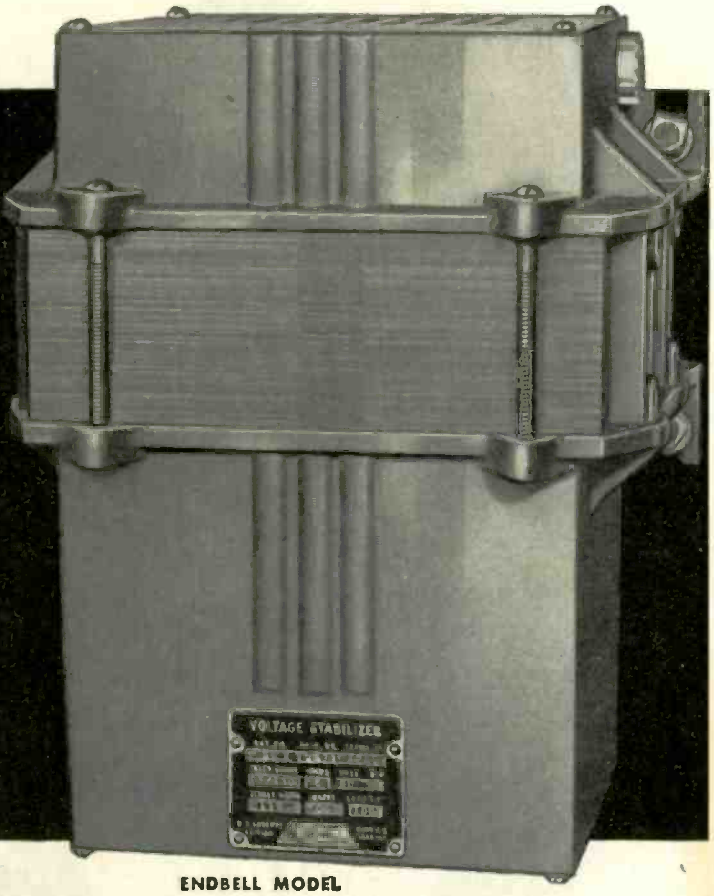
Raytheon

VOLTAGE STABILIZERS

(Manufactured since 1927. U. S. Patents 1,985,634 and 1,985,635)

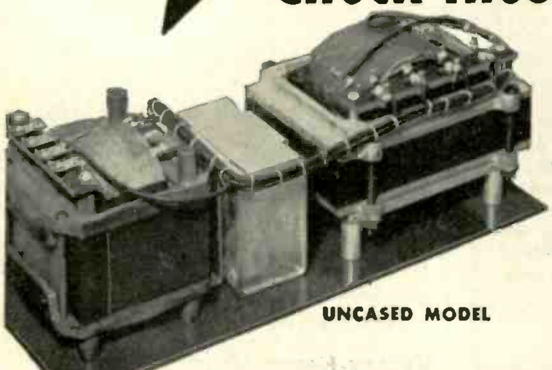
FOR

- Television
- Colorimeters
- Radar & Radio
- Signal Systems
- X-Ray Machines
- Sound Recording
- Electronic Devices
- Testing Equipment
- Photo-Cell Devices
- Production Machinery
- Constant Speed Motors
- Motion Picture Equipment
- Communications Apparatus
- Precision Laboratory Apparatus
- Other Applications Requiring Regulated Voltages.



ENDBELL MODEL

✓ Check these Raytheon Advantages



UNCASED MODEL

Holds constant A.C. output voltage to ½%.

Stabilizes at any load within its rating.

Quick action—fluctuating voltage is stabilized instantly, variations can't be observed on ordinary volt meter.

Wide A.C. input voltage limits—95 to 135 volts.

Entirely automatic . . . No moving parts . . . Connect it and forget it.

Available in sizes from 30W. to 25KVA. Write for Bulletin.

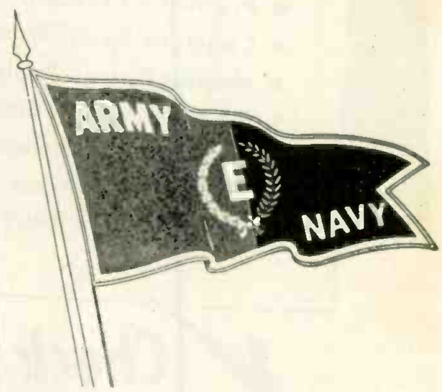
The coveted Army-Navy "E", for Excellence in the manufacture of war equipment, flies over all four Raytheon plants where 12,000 men and women are producing for VICTORY.

RAYTHEON MANUFACTURING Company
190 WILLOW ST. WALTHAM, MASS.

Television. Television is inherently a short-wave application and this war has greatly increased our knowledge of how to generate, control and to receive the higher frequencies. Therefore, many technical improvements in television will undoubtedly result. The same reasoning applies to F-M broadcasting as to television.

Television in South Africa. It looks as if South Africa is going to take some big action in the television line when peace comes. In a report presented to the South African parliament, the S. A. Broadcasting Corp. mentioned a $1,100,000 television expansion program.

Television in France. Although little technical news comes out of the enslaved continent of Europe, *Wireless World* reports that a television demonstration was given in Lyons not long ago. The screen used measured 14 inches by 12 inches and the number of lines in the transmission was 567.



Bardwell and McAllister, Inc., Hollywood, Cal.

Driver-Harris Co., Harrison, N. J.

Federal Telephone and Radio Corp., Newark, N. J.

Kelley-Koett Mfg. Co., Covington, Ky.

Stupakoff Ceramic & Mfg. Co., Latrobe, Pa.

Thordarson Electric Mfg. Co., Chicago, Ill.

Transmitter Protection

(*Continued from page 99*)

rectified output of the station's modulation monitor for the thyratron control voltage. As mentioned previously, trouble developing after the final stage may not sufficiently increase or decrease the load of this stage to provide adequate protection, although the radiated signal will drop sharply. The use of a small receiving antenna or transmission lines and r-f pickup coils, at the base of the antenna system to provide bias for the control tubes, will overcome this difficulty.

If the amount of r-f pick-up to the rectifier tube is made adjustable then R_{13}, R_{14}, and R_{15} of Fig. 2 can be eliminated. These resistances provide individual plate and cathode bias control where the input voltage is fixed. A number of control tubes such as the RCA 884, 885, 2050, or 2051, will give satisfactory results. Other changes or substitutions can readily be made to fit the individual needs of the station. For example, fully automatic control of change-over to an emergency transmitter can be made by the use of an additional pair of contacts on RE_3 of Fig. 1.

The device as described has been installed at WMCA for the past six years and has not failed one time over this period. It has been found to be an important tool in the operation of this station, being responsible for a minimum loss of transmitter time and a maximum of transmitter protection.

• • •

NEWS FROM U. S.

American soldiers who have a chance to loaf a bit, tune in to hear news from the United States over their radio. This photo was taken before the U. S. forces began their offensive to re-take Buna

NEW PRODUCTS

Month after month, manufacturers develop new materials, new components, new measuring equipment; issue new technical bulletins, new catalogs. Each month descriptions of these new items will be found here

Speed Control of A-C Motors with Thyratrons

The search for an adjustable-speed electric motor which would operate from an a-c line has been carried on ever since the first commercial use of alternating current.

Many possible solutions have emerged, each with certain undesirable features such as limited speed range, high initial cost, high maintenance, poor speed-torque characteristics or mounting problems. Even a d-c motor operated from a d-c line does not fulfill all requirements; for many uses it should have a more stable speed range, better speed regulation and smoother acceleration.

The newest of the electronic motor drives aimed at meeting this industrial need, known as the Westinghouse Mot-O-Trol, combines the relatively old basic idea of grid-controlled thyratron rectifiers with recent refinements and simplifications which eliminate many of the earlier handicaps of electronic drives.

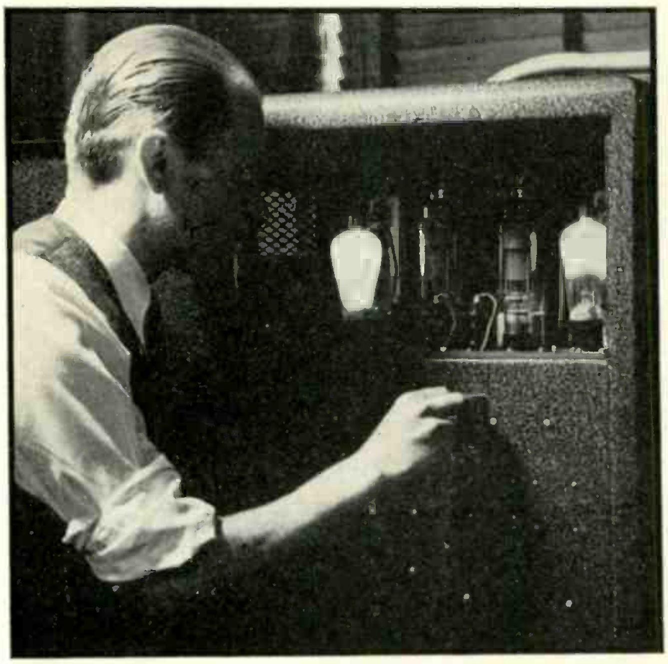
In the new control as developed for 1-hp and smaller motors, a pair of KU-627 thyratrons in a full-wave rectifier circuit provides d-c field current, and a pair of larger WL-672 thyratrons in a similar full-wave circuit provides the full d-c armature voltage for the motor. The arrangement is shown in simplified form in the diagram below.

Speed can be changed simply by rotating a control knob. For the range from minimum speed up to the base speed of the motor, the control varies the phase of the grid voltages on the armature thyratrons so as to vary the armature voltage, with field current remaining fixed at its normal full value. The base speed, corresponding to full armature voltage, is the highest that can be obtained by armature voltage control. Further rotation of the speed control leaves the armature voltage at this full value and gradually reduces field current to secure still higher speed. Field current reduction is obtained by changing the phase of the grid voltages on the field thyratrons so as to reduce the portion of each cycle during which these tubes pass current.

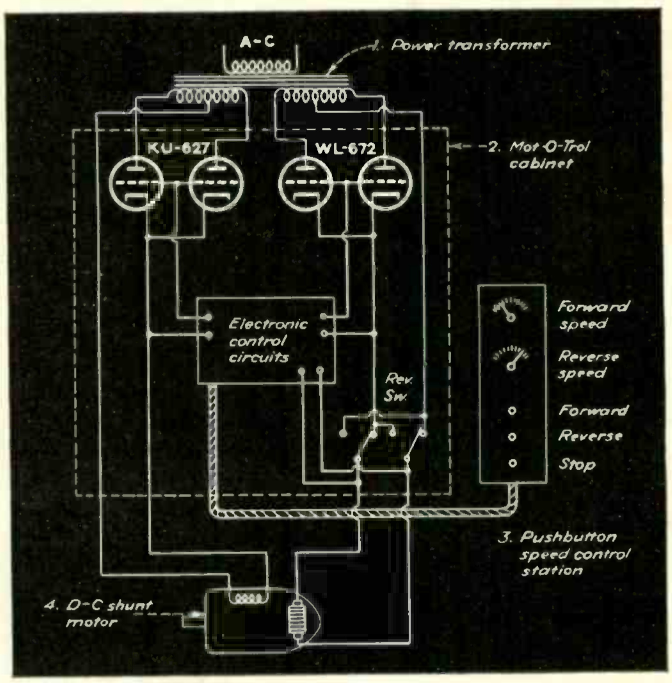
When different preset speeds are required in forward and reverse directions, duplicate controls are used. Once set, the motor can be operated in the desired manner simply by pressing the forward and reverse pushbuttons in turn.

Close speed regulation is provided over a 20-to-1 speed range, the maximum variation from no load to full load being within 8 percent. As soon as the stop pushbutton is pressed, a resistor is automatically connected across the motor armature to provide dynamic braking. The amount of braking resistance can be adjusted to control the rate at which the motor is brought to a stop.

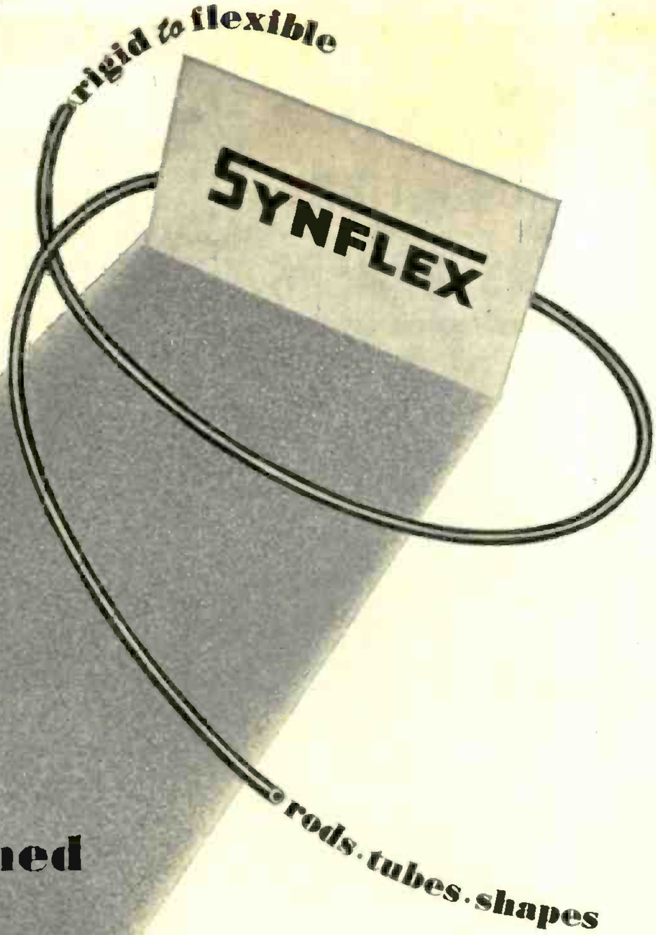
Time-delay switches insure that the mercury vapor tubes will get the required five-minute warm-up period at starting. Once warmed up, however, these tubes are heated continuously even when the motor is stopped, unless the line switch is opened or a protective switch opens. Fast, smooth acceleration is obtained.



Moto-O-Trol control cabinet. The brightly glowing thyrathrons control the field current of the motor



Simplified circuit of new electronic motor drive system operating from an a-c line



Three distinguished materials for electrical insulation

SYNFLEX

FT-11 . . a low temperature (transparent) rubber-like synthetic tubing

FT-22 . . a versatile rubber-like synthetic tubing for electrical insulation

FT-33 . . a high-heat resistant flexible tubing (for uses where soldering, baking, etc. are employed)

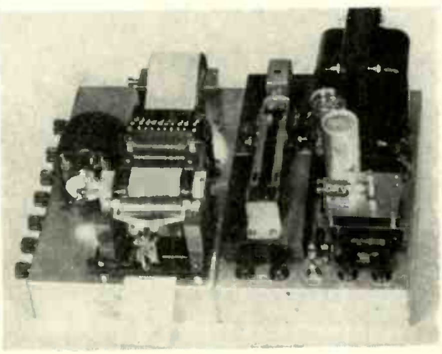
Our laboratory, compounding and processing facilities are available to develop specific materials for your specific uses. Your inquiries are invited.

INDUSTRIAL SYNTHETICS CORPORATION

60 WOOLSEY STREET, IRVINGTON, NEW JERSEY

Multi-Element Recording Timer

THE METRON, TYPE 4, multi-element recording timer is a chronograph for recording the duration and sequence of time intervals. Two models are available. Type 4-A is for operation from a 6-volt, d-c battery with a self-contained 60-cycle tuning fork power supply. Type 4-b operates from 110-volts, 60 cps. The instrument uses an electrically sensitive recording paper which gives a clearly visible record without processing. The record paper is 2 inches wide, and a complete record consists of eight traces, the two outside traces being for timing purposes, and the six inside traces for recording. The timing traces consist of a series of dots 1/60 second apart. By laying a straight edge across the record, the exact starting and stopping times of the various traces can be determined.

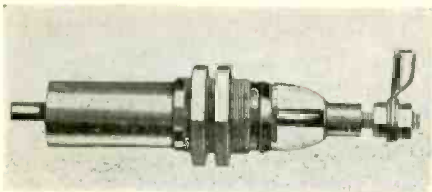


Uses of the instrument include monitoring of power distribution systems, measuring at various points the instantaneous speed of traveling objects, timing of switches and relays, timing of electrically or mechanically controlled processes and events, and for general purpose laboratory and field use for measuring time intervals ranging from 1/60 second up to 12 minutes.

Metron Instrument Co., 432 Lincoln Street, Denver, Colo.

Gas-Tight Terminal

A GAS TIGHT TERMINAL, developed for use on radio coaxial cables, is also applicable in many other places where an insulated terminal is required for equipment in a sealed container. The seal is obtained by fusion of glass to metal. A metal alloy of suitable coefficient of expansion is

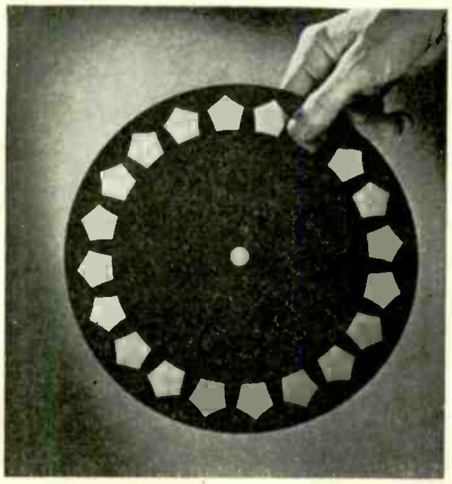


used. The unit shown is installed on the end of a 7/8 inch coaxial cable, and is priced at $6.00. Other sizes are available.

Victor J. Andrew Co., 363 East 75th Street, Chicago, Illinois.

Lapping Discs

LAPPING DISCS for use in quartz crystal manufacture for radio sets and other radio equipment are available in Vinylite (plastic) rigid sheets.

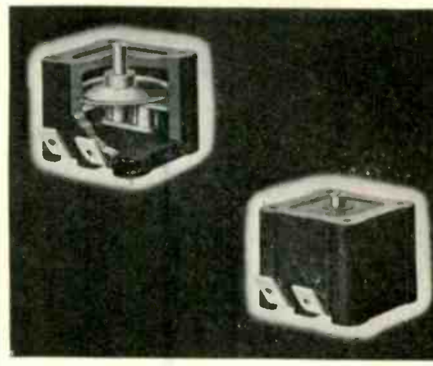


The manufacturer states the discs are easy to handle, will not warp, and are durable.

Carbide and Carbon Chemicals Corp., 30 East 42nd St., New York, N. Y.

Sealed Switches

TYPE A3 AND A5 switches are sealed in Bakelite cases to protect their contacts against dirt, dust, sand and oil. Contact arrangement is SPST. A3 is normally closed, double break and A5 is normally open, double break. Contact ratings are non-inductive, 50 amps at 12–24 volts d.c. and 110 volts a.c. The operating pressure is 1½ to 3½ lbs; travel differential is 0.006 to 0.012 inch; over travel is rated at 0.050 to 0.070 inch at maximum pressure; vibration rat-

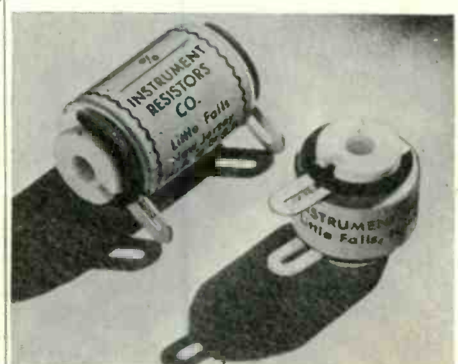


ing is 10 G for either horizontal or vertical positions. The switches measure 1 15/16 x 1 15/16 x 1 19/32 inches and weigh 5 ounces.

Allied Control Co., 2 East End Ave., New York, N. Y.

Resistors

Two new types of slotted-terminal resistors available are Type P-2 and Type P-4. Type P-2 has one-half watt rating with a maximum resistance of 500,000 ohms. It measures 9/16 inches long with a diameter of 9/16 inches. Type P-4, with a one watt rating, has a maximum resistance of

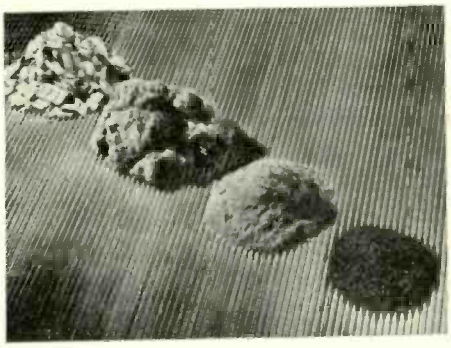


one megohm. Measurements are 1 inch long and 9/16 inches in diameter. Terminals on both types are 0.025 hot tinned copper, slotted to take stranded or solid wire. Mounting is permitted by No. 6 holes through centers of bobbins.

Instrument Resistors Co., Little Falls, N. J.

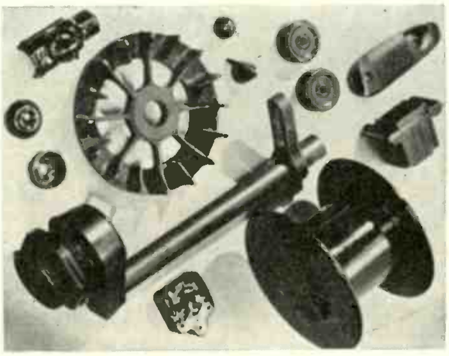
New Non-critical Plastic from Redwoods

A new non-critical phenolic thermoplastic, called "Shellerite", is chemically perfected from phlobaphanic structures of the redwoods,



Shellerite in process of manufacture

and is available in quantity for both war and civilian items formerly manufactured from hard rubber and other thermo setting plastic compounds. It is readily adaptable to either compression molding or standard equipment of hard rubber plants. When special properties are desired, it can easily be mixed with other resins and plasticizers with absolute control of the formulation ingredients.



Finished products made from Shellerite

Credit for the discovery of this new plastic is shared by The Pacific Lumber Co., San Francisco, Cal., The Institute of Paper Chemistry, Appleton, Wis., and the Sheller Mfg. Corp., Portland, Ind.

Further details may be obtained through the Sheller Mfg. Corp.

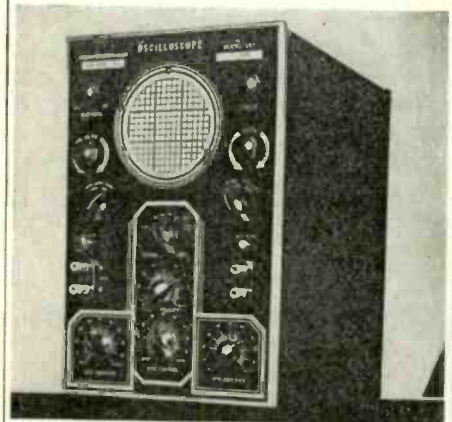
Labels for Wires

E-Z-CODE LABELS are for coding electrical wires and conduits. The labels are protected with a special transparent coating for permanence and are made of a strong flexible composition that keeps in place when pulled through conduits. The labels are easy to use and are available in many standard code numbers, or may be manufactured to specifications.

Western Lithograph Co., 600 E. Second St., Los Angeles, Cal.

3-inch Oscilloscope

MODEL 553 is an 3-inch oscilloscope which is compact, sturdily constructed and designed as a portable field instrument. All controls and terminals are located on the front panel. Switching arrangement permits applying input either directly to deflection plates or to input of the amplifier. Position and stable locking of the image can be obtained with either the vertical signal or any external signal. The high gain amplifiers use television tubes for maximum sensitivity. The power supply is 110–120 volts, 50–60 cps; power



consumption is 50 watts; fuse protection 1.0 amps; input inpedance through either amplifier is 0.5 megohm (20 $\mu\mu$f) and without amplifier 2.2 megohm (40 $\mu\mu$f); deflection sensitivity through either amplifier (maximum gain) is 0.6 rms per inch and without amplifier 35 rms per inch; amplifier frequency response is rated $\pm$35 db on 20–100,000 cycles; linear time base frequency range is 15–220,000 cycles; synchronizing signal sources (internal) 60 cycles.

Radio City Products Co., Inc., 127 West 26th St., New York, N. Y.

Frequency Meter

MODEL 500A Frequency Meter is designed to measure the frequency of an alternating voltage from 0 to 50 kc. It is useful in making frequency measurements in both laboratory and production work. It can be used to measure the frequency difference between two radio frequency signals. It is particularly suited to crystal grinding work where it can be used

to measure the frequency deviation from the standard quickly and accurately. The simplicity and accuracy of this instrument makes it useful in any electronic laboratory and invaluable in certain production testing applications.

Hewlett-Packard Co., 692 Page Mill Rd., Polo Alto, Cal.

Gasoline Driven Generator

A PORTABLE GASOLINE driven generator for rapid battery charging is designed to charge 6–12–24 volt batteries at 10 to 300 amps, and consists of a specially designed generator driven by a 6 hp single cylinder, air cooled, gasoline engine which is equipped with air cleaner, gasoline filter, magneto, self-starter, rope starter, gas tank and remote stop control. The unit may be used in airplane factories for starting motors or charging batteries or as a d-c lighting plant with output range from 1000 to 3000 watts.

Hunter-Hartman Cor., St. Louis, Mo.

Cellulose Acetate Plastic Material

DURASHIELD IS A CELLULOSE acetate plastic material (for use as name and instruction plates on ships, machinery and equipment) which can be fabricated to almost any size, shape, thickness, or color schemes. It can be die cut readily and will permit the punching of holes of any size and can be readily engraved. The manufacturer states that the material successfully withstood tests in water, salt solution, oil, gasoline, paint and impact, and that it meets the Navy specifications for being fire retardent.

Plastic Fabricators, Inc., 440 Sansome St., San Francisco, Cal.

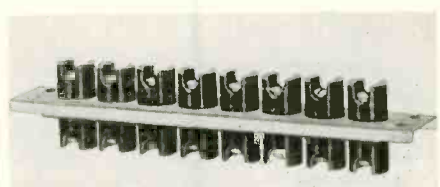
X-ray Quartz Analysis Machine

To PERMIT the fullest utilization of new manufacturing techniques and also to increase the speed of test procedure, the Philips Metalix Corporation is offering an x-ray quartz analysis machine equipped with two goniometers, with a newly-designed natural face orientation table as optional equipment. This arrangement succeeds the former combination of a single goniometer and a natural face orientation table. The use of two goniometers almost doubles the volume of crystals that can be handled by one analysis machine. Machines already in use can have their usefulness increased by replacement of the natural face orientation table with a goniometer designed for use on the left side of the machine.

Bulletin No. 202 describes the new apparatus and can be secured from the Philips Metalix Corporation, 419 Fourth Avenue, New York City.

Terminal Blocks for Sub-Panel Assembly

A MULTIPLE TERMINAL block, for subpanel and chassis construction, with feed-through terminals meets present-day demands of electronic and electrical design, which require external terminals. The terminal block consists of individual feed-through terminals, mounted in bakelite, which are permanently held in a metal strip in any combination desired. Factory production now includes blocks having any number of units between 1 and 10.



Terminals can handle circuits carrying up to 300 volts, 20 amps. Center to center distance between terminal units is $\frac{5}{8}$ in. No. 8 screws are used on each side of terminal units for securing connection. The two mounting holes at each end of the terminal base take No. 8 machine screws.

Curtis Development & Mfg. Co., 1 N. Crawford Ave., Chicago, Ill.

Frequency Meter

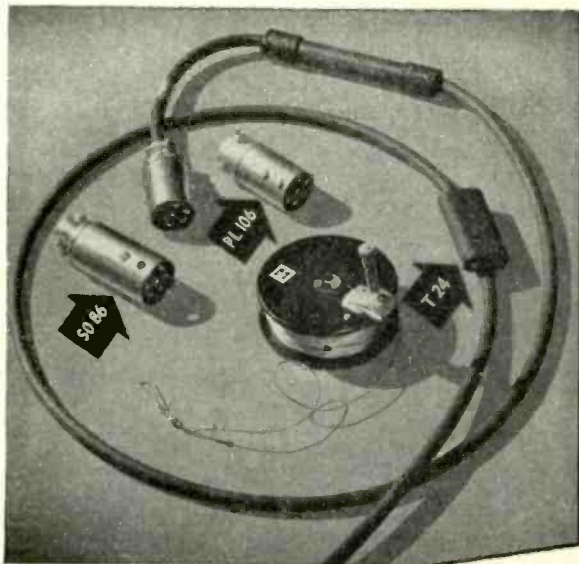
FOUR NEW MODELS have been added to the TELRAD line of frequency meters. All models are crystal-controlled and, by means of a class C harmonic amplifier circuit embodied in the units, accurate frequency carrier signals are provided every 10 kc and every 100 kc from one hundred cycles to forty-five Mc. A carrier signal is also produced every 1000 kc from 1 Mc to 120 Mc. A convenient panel-mounted "on-off" switch permits use of a 1000 cycle modulated note.

These Frequency Meters are used for (1) setting transmitters that are not crystal-controlled on any desired frequency; (2) continuously monitoring transmitted signals; (3) locating any desired frequency on a receiver dial; (4) checking frequency characteristics of crystal-controlled transmitters or receivers; (5) aligning and calibrating receivers, in both i-f and r-f stages; (6) checking accuracy of field or production oscillators, signal generators, and frequency meters that are not crystal-controlled; and (7) checking crystals in the field or in production.

Special models are available equipped with two precision crystals that have been ground to produce exact frequencies of 100 and 1000 kc and tested for efficient operation at temperatures from—35 deg. to 55 deg. and have temperature coefficients of maximum drift of 2 and 3 cycles per Mc per degree respectively.

Models are available for either a.c. or portable battery operation.

Fred E. Garner Co., 43 E. Ohio St., Chicago, Ill.



Precision Coil-Turn Counter

A COIL-TURN counter for laboratory or factory use in determining with precision the number of turns in wound electric coils is capable of checking or determining the effective turns ranging from 1 to 11,110 turns, at a rate of from 80 to 100 coils of like specifications per hour.

In addition to a magnetizing current control box, the new coil-turn counter comprises a portable light-beam galvanometer, two yoked test rods, a galvanometer control panel, and a foot-operated switch—all conveniently assembled for operation on a table or bench.

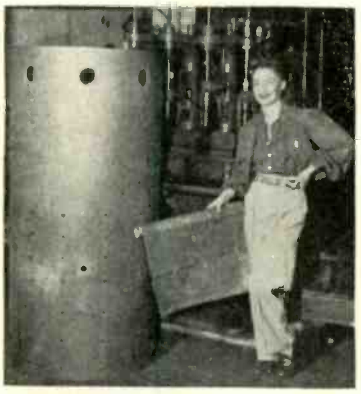
No additional wiring is required. All that is necessary is to plug in the connecting cord of the box. The magnetizing circuit is designed to operate from a 120-volt d-c supply when used with a resistor furnished as part of the control box, or from a 20-volt storage battery without a resistor.

The accuracy of the counter is one turn in a thousand for coils having air cores at least $\frac{5}{8}$ in. in diameter, an outside diameter of 8 in. and less, a coil build-up to $2\frac{3}{8}$ in., and up to 6 in. in height. Accuracy is not as high for coils outside these limits.

General Electric Co., Schenectady, N. Y.

Plastic Coil Forms

PHENOLIC LAMINATED sheet material for coil forms may be had fabricated into very large coil forms. The illustration shows one of a production lot recently fabricated by the manufacturer.

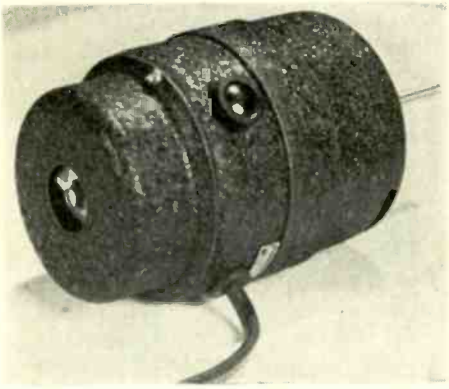


It contains over one hundred holes with close tolerances in size and location.

Electrical Insulation Co., Inc., 12 Vestry St., New York, N. Y.

Electric Motor for Antennae Reel

THIS MOTOR MEASURES $2\frac{5}{16}$x$3\frac{1}{8}$ inches and is rated at 1/13 hp at 8000 rpm.



It was designed for aircraft communication systems, and reaches full torque very quickly.

Electric Motor Corp., Racine, Wis.

Electrical Rectifiers

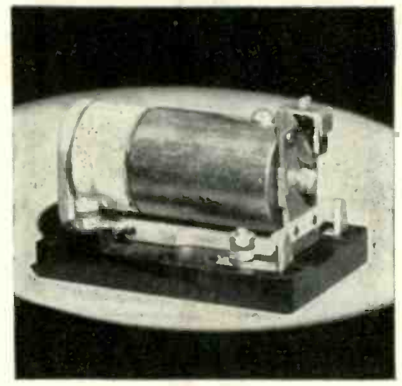
RECENT DEVELOPMENTS in the field of electrical rectifiers have brought forth a new product claimed to have many advantages over generator sets for general industrial use. This new machine, called the RECTODYNE, can be furnished in either stationary or portable models with various capacities ranging up to 4,000 watts. It provides smooth d-c power for such purposes as aircraft testing, engine starting, operating d-c motors, charging industrial and military batteries, electrolytic processes, arc lamps, etc.

Various models range in price from $163 to $495. D-c voltages of 6, 12, 24, 36 and 48 volts can be furnished, and a dual voltage feature is available which permits doubling the d-c amp capacity at half voltage by means of a series-parallel switch. Output control is conveniently regulated by a rotary tap switch connected in the primary circuit and operated by a knob on the front panel. Intermittent overload capacities as high as 100 percent can be handled. The unit incorporates a rugged dry-disc type of rectifying element. Dimensions are 16x16x29 inches.

McColpin-Christie Corp., Ltd., 4920 S. Figueroa St., Los Angeles, Cal.

Time Delay Relay

A TIME-DELAY relay, specifically designed for aircraft applications where time-delay drop-out is required, is available in two sizes, one providing up to 0.4 second time delay, and the other up to 0.3 second time delay. Designed for use in ambient temperatures from plus 95 deg. C to minus 40 deg. C., both sizes are compact, suitable for mounting in



any position, and corrosion proof, withstanding 95 percent humidity at 75 deg. C. on 48-hour tests and operating successfully immediately thereafter. The normally closed, double-break, silver contacts of the relays will carry 20 amps continuously at altitudes up to 40,000 feet above sea level. Also, the operating coils can be furnished for operation on either a 12 or a 24-volt circuit.

General Electric Co., Schenectady, N. Y.

• • •

Corrugated Ribbon Resistors

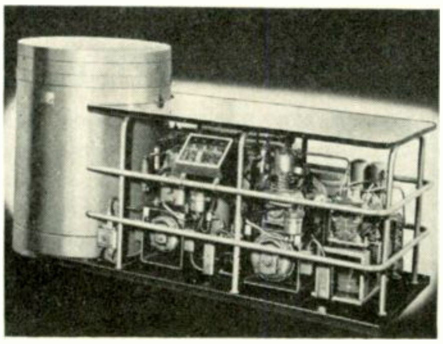
THE "CORRIB" resistor is a heavy duty type of resistor particularly adapted for use where the resistance required is low and the current carrying capacity must be high. It consists of a corrugated ribbon of resistance alloy metal space-wound edgewise around a strong ceramic tube with the ends of the ribbon mechanically fastened and brazed to heavy terminal lugs. Ohmite vitreous enamel holds the ribbon securely in place.

The resistor may be used for motor starting circuits and similar intermittent duty (and continuous duty) applications and can be operated at high wattage. The resistances which are available range from 0.04 ohm to 70 ohms. The maximum resistance value depends upon the size of the core. Core sizes range from 5/16 in. diameter by 4 in. long to 2½ in. in diameter by 20 in. long. The maximum wattage rating is 1500 watts.

Resistors are listed in Catalog and Engineering Manual No. 40 available from Ohmite Mfg. Co.. 4835 Flournoy St., Chicago, Ill.

Chilling Machine

NEW FEATURES of this improved "Cascade" industrial chilling machine are a temperature controlling device for accurate temperature control at any point from atmosphere to —120 deg. F.; a table top for convenience and safety; and a new system of three compressors and three motors which develops maximum thermal efficiency and eliminates the necessity of water connections and drain facilities.



The machine may be used in shrinking, treating and testing of instruments and metals, and is designed for high production metal chilling of any part where large quantities of heat must be removed fast. When the machine is operated at very low temperatures and when the work is immersed in convection fluid, it is capable of removing 1000 B.T.U.'s per hour. Other models available include Model D-70 which removes 800 B.T.U.'s per hour at —70 deg. F; the Santocel machine for working temperatures as low as —50 deg. F; and other models which are built to meet special requirements.

Deepfreeze Div., Motor Products Corp., 2301 Davis St., North Chicago, Ill.

Vertical Glass Sealer With Rotating Fires

A NEWLY DESIGNED vertical type glass sealing machine, has been introduced by the Eisler Engineering Co., Newark, New Jersey. The features of this machine are:

1. The work is stationary while the flames rotate around the work.
2. The work can easily be placed at any angle in relation to the revolving fires.

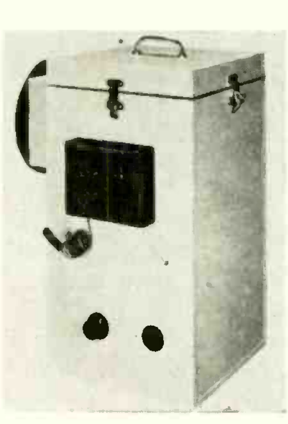
With this arrangement the work can be held firmly and perfectly aligned in the various holding fixtures, supplied to the machine, without interfering with the fires. The machine is employed for special stem making and sealing operations, for butt sealing a body to a glass ball, sealing glass to metal, and perforating or piercing holes in tubular or balloon-shaped glass bodies. Cathode-ray and television tubes from 6 to 10 ins. in diameter; x-ray tubes up to 10 ins. and transmitting tubes can be worked on this machine.

Eisler Engineering Co., Inc., 740 South 13th St., Newark, N. J.

Apparatus for Testing Plastics

THE SERVO SUB-ZERO cooler is a small unit for conditioning test samples through a wide range of temperatures, varying from minus 90 deg. to plus 150 deg. F. The dimensions of the unit are 14 ins. sq. and 24 ins. high. It absorbs approximately 1500 BTU's per hour.

The plastic samples to be tested are placed in the testing equipment and surrounded by a small box that is built locally. In one side of the box a hole, 4 inches in diameter, is cut and to it is connected the portable Servo unit which is plugged into an ordinary wall socket and

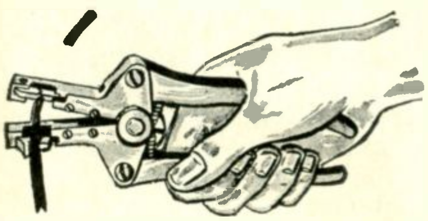


charged with 50 pounds of dry ice ($1.50). With the blower operating, the Servo unit will deliver 125 cubic feet of air per minute at temperatures as low as −110 deg. Fahrenheit. This blast of air chills the sample and the box quickly to the desired temperature.

Tenney Engineering, Inc., 8 Elm St., Monclair, N. J.

Wire Stripper

"SPEEDEX" WIRE Stripper is an effective tool for speedily stripping the insulation from any type of electric wire. It promises to find favor



in many fields because of the time it saves in doing the job.

Wood Specialty Mfg. Co., 919 Taylor Ave., Rockford, Ill.

Rubber Alternates for Gasket and Sealing

THREE NEW SEALING materials as alternates for rubber include reclaimed rubber R-196 which has water-resistant qualities and which will resist compression and abrasion, especially where high tensile strength and tear resistance are not essential such as for pads for electrical conduit work or for gaskets in water applications. It can be supplied in plain gasket form only, and comes in thickness of from 0.020 to 0.125 inches.

Syntoflex is for more severe conditions such as oil, aromatic fuels, gasoline and other chemical applications. The third sealing material is a synthetic rubber strip material for use as an alternate to sponge rubber strip material. It consists of a felt base impregnated with synthetic rubber and simulates the spongy characteristics of sponge rubber stripping. It is obtainable in various shapes and in lengths up to 6 ft.

Felt Products Mfg. Co., 1504 W. Carroll Ave., Chicago, Ill.

Oscillograph

A NEW TESTING instrument for both radio and industrial use is the RFO-5 oscillograph. It is used in both r-f and i-f stages for single or consecutive stage-by-stage trouble shooting from antenna post to speaker in FM, AM and television receivers. It has a self-contained 100 to 900 kc Sweep FM oscillator (basic frequency 23 Mc) for FM and television servicing. This oscillator can be modulated from external frequency sources such as phonograph pickup, microphone or audio frequency oscillator. It also has a 10–30 kc Sweep FM oscillator (basic frequency 1000 kc) for visual alignment on AM receivers, demodulators, etc., a self-contained mixer circuit, demodulator, video amplifiers, signal tracer, visual a-c vacuum tube voltmeter 0.2 to 1000 volts, calibrated screen, fuse protection, and phasing control. This oscillograph measures 11x13x15¼ inches and weighs nearly 50 pounds.

The Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio.

Literature

Brush Springs. Bulletin No. 5 consists of two parts. Part I is for the user of brush springs, shows why 1-S "Micro-processed" beryllium copper brush springs have answered the demands of manufacturers of small electric motors. Part 2 is for the designer of brush springs, includes data and formulae for designing. Available from Instrument Specialties Co., Inc., Little Falls, N. J.

Radio Circuits. "Radio Circuit Handbook" contains radio and electronic circuits with analyses, comparisons and discussions. Fundamental principles are explained and illustrated and the application of these principles to components of receivers, transmitters and other electronic units are shown. This booklet is handy for home study and classroom study. Available from Allied Radio Corp., 833 W. Jackson Blvd., Chicago, Ill.

Transformers. "Transformer Encyclopedia of the Radio and Electronic Industry" contains detailed specifications covering transformers and chokes for replacement and general purpose use. A classified and numerical index and price list are included. Available from Standard Transformer Co., 1500 N. Halsted St., Chicago, Ill.

Engineering Manual. Catalog No. 40 contains data on several resistance applications. Resistors, rheostats, tap switches, chokes and attenuators are described and illustrated. Included also is a guide for the various resistor types and close control rheostats. Catalog 40 available from Ohmite Mfg. Co., 4835–55 W. Flournoy St., Chicago, Ill.

Collodial Graphite. Bulletin No. 423-EE describes "dag" colloidal graphite used as a high temperature lubricant. The limitations of liquid and semi-liquid lubricants in high temperature applications are discussed together with the properties of colloidal graphite which make it suitable for such applications. Available from Acheson Colloids Corp., Port Huron, Mich.

Precision Bearings. The applications of radial and pivot type bearings from ⅛ to $\frac{1}{16}$ inches outside diameter in both steel and non-magnetic beryllium are described and illustrated in Bulletin No. 43. The applications given for the radial series are; delicate mechanisms, high load capacities, severe service and low temperature applications. The pivot series are chiefly for non-magnetic applications. Dimensions and load ratings at varying speeds for each size and type of bearing are included in tabular form. Available from Minature Precision Bearings, Keene, New Hampshire.

Morse Code Album. A modern system of instruction in the International Morse Code has been incorporated in a six record album. The album and accompanying booklet are designed to acquaint students with the actual sound of the Morse code letters as they would be sent over the air and to provide practice transmissions which should develop ability to copy regular code messages. The first 8 lessons consist of alphabet instruction and special practice in letters. Then there is a study of coded five letter groups, longer words, sentence structure, English transmission and finally a practice session of five letter cipher groups using all the letters of the alphabet. Available from RCA Victor Div. of the Radio Corp. of America, Camden, N. J.

Controllers. Catalog No. 1200 describes three types of controllers; on-off, throttling and automatic reset. The adjustable on-off model is popular for industrial applications having small time lag and large heat capacity. The full range throttling model is for use on applications for considerable process lag or small heat capacity. The full range throttling with automatic reset is for use where large load changes are encountered. The booklet is well illustrated, several actual installation photographs are shown. Available from C. J. Tagliabue Mfg. Co., Park and Nostrand Ave., Brooklyn, N. Y.

Rheostats and Resistors. Bulletin No. 550 describes slide contact rheostats and fixed tubular resistors. The rheostats are single range type protected or unprotected and indicating four range types. Available from Herman H. Sticht Co., Inc., 27 Park Pl., New York, N. Y.

List Price and Index. Worner products as described in various engineering bulletins and a schedule of list prices are included in this booklet. Available from Worner Products Corp., 1019 W. Lake St., Chicago, Ill.

Capacitors. "Preferred-type capacitors" Catalog No. V-1 lists a minimum number of types anticipated by the official WPB war standards for civilian radio replacement capacitors "Preferred-type capacitors" catalog No. V-2, lists a minimum number of standardized oil-paper capacitors for government and industrial electronic applications. Both catalogs available from Solar Capacitor Sales Corp., Bayonne, N. J.

Catalog No. 12 is broken up into nine different sections. The sections consist of engineering data, d-c electrolytics, a-c motor capacitors, paper capacitors, fluorescent p-f capacitators, mica capacitors, radio-noise suppressors and capacitor analyzers. Catalog No. 12 available from the above address.

Telephone Cables. A new edition of "Telephone Cables" has just been released. This 37-page booklet describes lead covered, jute protected, wire armored, tape armored and switchboard cable. New materials which are replacing critical products such as silk and tin are described. Booklet available from Western Electric Co., 195 Broadway, New York, N. Y.

Tubes. Bulletin No. 443 contains useful information on tubing. This war edition includes tapered and formed tubes and a wide variety of special shapes. A Guide Chart giving rather complete detailed information on the chemical composition of 25 different metals, with size range available for each plus mechanical and physical properties. Available from Summerill Tubing Co., Bridgeport, Pa.

Lathes. Catalog No. 100 C describes the entire line of South Bend engine lathes, toolroom lathes, and turret lathes. Each size and type of lathe is illustrated and fully described. Specifications are tabulated which makes the selection of the lathe required for any desired application easier. Attachments and accessories are also illustrated and described. Catalog No. 100-C from South Bend Lathe Works, South Bend, Ind.

Insulation. Insl-X prevents moisture infiltration and gives maximum dielectric and mechanical strength with minimum thickness. In this booklet the characteristics of the various types of Insl-X and their purposes are given. Special heat resistant coating for wire-wound resistors and an arc-resistant coating for molded phenolic compositions are also described. Booklet available from Insl-X Co., Inc., 857 Meeker Ave., Brooklyn, N. Y.

Keying and Recording Equipment. This booklet is broken up into keying equipment and recording equipment sections; items outside the field of regular communication use are under special equipment and tape and ink requirements are listed under supplies section. The method of operation of automatic telegraphy is also explained. Booklet available from H. O. Boehme, Inc., 915 Broadway, New York, N. Y.

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LATEST MAP

The U. S. Army map makers latest development is a map which can be folded any way and when it becomes soiled from use it can be washed and dried. Lieut. Col. Frederick W. Mast (left) and Major James L. Austraw are shown experimenting with the map

Filter Chokes

(Continued from page 116)

of several factors. If the direct current requirement of the load circuit is constant there would be no purpose in installing a swinging input choke. The smoothing type would provide higher inductance, better filtering and lower choke excitation voltage. If the direct current is subject to variation over wide limits, a swinging choke will undoubtedly be the proper choice. If the future current requirements cannot be predicted it would be wise to install the swinging choke as a precaution. The approximate formula, Eq. (7) should always be used to determine the minimum permissible inductance at the maximum and minimum current conditions.

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FAR EAST LISTENING POST

Los Angeles has a "listening post" to the Orient which was opened by the National Broadcasting Co. The powerful short wave radio reception is staffed with foreign language experts who listen to reports being sent from China, Japan and other Asiatic countries. Under present plans the broadcasts will be released to various newspapers and news services as well as to radio listeners

Backtalk

This department is operated as an open forum where our readers may discuss problems of the electronic industry or comment on articles which ELECTRONICS has published

April 27, 1943

The Editor, *"Backtalk"*
Electronics
330 West 42nd Street
New York, N. Y.

Dear Sir:

The letter by Mr. F. S. Macklem in "Backtalk" of the April 1943 issue regarding signal-to-noise ratio in feedback amplifiers is an interesting discussion of a point of view which may have some merit. Whether the signal-to-noise ratio of amplifiers of unequal gain should be compared on the basis of equal output or equal input voltage is a moot question. The usual assumption made in the standard texts when comparing noise with and without feedback is that the power output and load resistance is the same in both cases. If this is so the feedback amplifier (since its absolute noise level is lower) has the best signal-to-noise ratio.

It is, however, possible to obtain very disappointing results in applying feedback to an amplifier with the idea of reducing noise and actually find that the absolute noise output due to power supply ripple is increased. This is due to the type of circuit employed and may be demonstrated mathematically as follows:

Figure 1 (a) shows the simplified schematic diagram of a common type

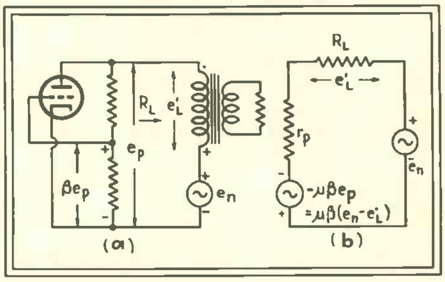


Fig. 1—Common feedback amplifier

of feedback amplifier with zero signal voltage and Fig. 1 (b) is the equivalent circuit. The noise voltage is represented by e_n appearing between the bottom of the transformer and the cathode. The plate voltage is divided by the resistors to give the feedback voltage βe_p (β negative for negative feedback). The voltage across the load resistance with feedback is e_L'.

Then:

$$e_L' = \left\{ e_n + [-\mu\beta(e_n - e_L')] \right\} \frac{R_L}{r_p + R_L}$$

$$= [e_n - \mu\beta(e_n - e_L')] \frac{R_L}{r_p + R_L}$$

Solving this gives

$$e_L' = e_n \frac{R_L}{\frac{r_p}{1 - \mu\beta} + R_L}$$

This shows that the effective plate resistance of the tube as seen from the noise source has been decreased and the percentage of noise voltage appearing across R_L is therefore higher with feedback.

The noise voltage across the load without feedback is

$$e_L = e_n \frac{R_L}{r_p + R_L}$$

and the ratio

$$\frac{e_L'}{e_L} = \frac{r_p + R_L}{\frac{r_p}{1 - \mu\beta} + R_L} \qquad (1)$$

But the gain of the stage

$$\alpha = \frac{\mu R_L}{r_p + R_L}$$

from which

$$R_L = \frac{\alpha r_p}{\mu - \alpha}$$

Substituting this value of R_L in (1) above gives

$$\frac{e_L'}{e_L} = \frac{1 - \mu\beta}{1 - \alpha\beta}$$

When β is negative (for negative feedback) the numerator is greater than the denominator so that an increase in absolute noise output is indicated.

However, if the amplifier circuit had been changed slightly as shown in Fig. 2 (a) a different result would

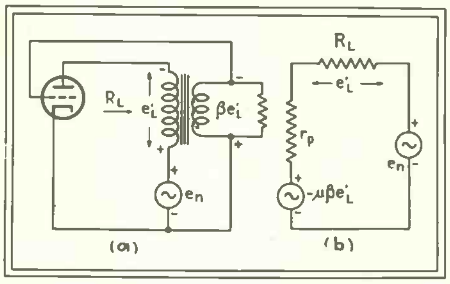


Fig. 2—Modified feedback amplifier.

have been obtained. In this case the phase of the grid voltage is such as to oppose the plate-current flow caused by the noise voltage and

$$e_L' = [e_n - (-\mu\beta e_L')]\frac{R_L}{r_p + R_L}$$

$$= (e_n + \mu\beta e_L')\frac{R_L}{r_p + R_L}$$

Solving this gives

$$e_L' = e_n \frac{R_L}{r_p + R_L(1 - \mu\beta)} \qquad (2)$$

and

$$\frac{e_L'}{e_L} = \frac{r_p + R_L}{r_p + R_L(1 - \mu\beta)}$$

Again substituting for R_L;

$$\frac{e_L'}{e_L} = \frac{1}{1 - \alpha\beta}$$

This is the usual equation given in the text-books for the reduction in noise in a single stage feedback amplifier.

Equation (2) above may be rearranged in the form

$$e_L' = e_n \frac{R_L}{(r_p - \mu\beta R_L) + R_L} \qquad (3)$$

which indicates that the effective plate resistance has been increased by the addition of the quantity $-\mu\beta R_L$ as far as the noise voltage is concerned. Note however that, viewed from the load, the plate resistance is decreased by the same factor as in the circuit of Fig. 1.

It is interesting to note what happens if a current-feedback circuit is employed such as that shown in Fig. 3.

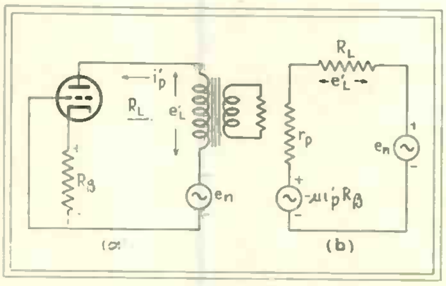


Fig. 3—Current feedback circuit

This time, assuming $R_\beta << r_p + R_L$,

$$e_L' = i_p' R_L = \frac{e_n - (-\mu i_p' R_\beta)}{r_p + R_L} R_L$$

$$= \frac{e_n + \mu i_p' R_\beta}{r_p + R_L} R_L$$

Solving for the plate current,

$$i_p' = \frac{e_n}{r_p - \mu R_\beta + R_L}$$

Since the feedback factor in this case is

$$\beta = \frac{R_\beta}{R_L}$$

$$i_p' = \frac{e_n}{r_p - \mu\beta R_L + R_L}$$

and

$$e_L' = i_p' R_L = e_s \frac{R_L}{(r_p - \mu\beta R_L) + R_L}$$

which is exactly the same as (3) above.

The noise due to power-supply ripple is therefore again reduced by the factor $1/(1-\alpha\beta)$. In this case, however, the plate resistance as seen from the load is also increased by the addition of the quantity $-\mu\beta R_L$ which may not be desirable.

Use of the circuit of Fig. 1, or those similar to it covering several stages, may give a considerable increase in power-supply hum if the supply to the last stage is not well filtered.

J. T. Pratt

Engineering Division
Engineering Products Department
R.C.A. Victor Co. Ltd., Montreal, Que.

Voltage Regulator

WE NOTICE in your April issue a paper by Arnold Benson entitled "Electronic Regulators for A-C Generators."

You will be interested to know that a very similar voltage regulator was described by Clarence E. Weinland, formerly with this Laboratory, in *The Review of Scientific Instruments*, Vol. 3, No. 1, January 1932. In his paper Mr. Weinland did not claim credit for the fundamental principles involved in the regulator and gave numerous references to previous papers on the subject.

Incidentally, Mr. Weinland later modified his regulator by the addition of a second thyratron so that it operated as a full-wave rectifier. This regulator has been in use for approximately twelve years, supplying controlled voltage for our Thermal Conductivity Laboratory and has proved extremely reliable and convenient.

CLARENCE B. BRADLEY

In charge, Engineering and Insulation Testing, Johns-Manville, Manville, N. J.

Feedback

ON PAGE 211 in the April, 1943, issue of ELECTRONICS there appears an admirable discussion by F. S. Macklem on the effect of negative feedback on the reduction of noise in the output of an amplifier.

Mr. Macklem shows that a better signal to noise ratio is obtained by running an amplifier at full gain, and then following the amplifier with an attenuator to bring the gain to the required amount, than is obtained from the same amplifier with negative feedback and the same overall gain.

However, though the signal to noise ratio is improved the maximum undistorted output is reduced by the attenuation factor, and it seems that if outputs close to the theoretical maximum of the amplifier are required, then the use of negative feedback permits a reduction in signal to noise ratio that cannot be obtained in any other way.

This letter is no particular criticism of Mr. Macklem's note, but is only intended to bring out the limitation of maximum possible output brought about by an attenuator following an amplifier.

WINSLOW PALMER
West Hempstead, N. Y.

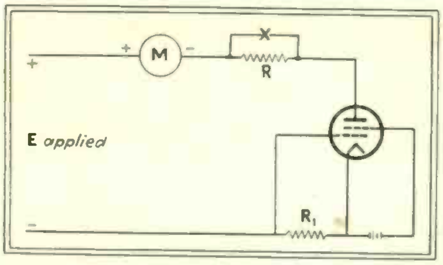
Meter Protection

I AM A TEACHER in a Signal Corps school and the men we train are not especially careful with meters. The result is that all our meters except the 1000 volt ones take a beating. What I would like is an electronic circuit that would not only protect the meter against overload but damp it so that the speed with which the needle moves on overload would be reduced.

V.J.
San Pedro, Calif.

FOR YEARS Littlefuse Company of Chicago has sold protective fuses for exactly this purpose. Of course these fuses add some resistance to the circuit; they seldom have the same thermal time constant as the instrument; they cannot protect the instrument for all possible combinations of applied voltage and current and time but there is no doubt about their value.

There are other tricks, such as shunting a copper oxide rectifier disc across the meter so that when the current rises to a high value the rectifier takes most of it, whereas at low values the rectifier resistance is high and most of the current flows through the instrument.



A short at *X* places full voltage on tube and current through it tends to rise. Because of the biasing effect of the voltage drop across R_1, however, the tube current cannot rise above any desired limiting value. Curves shown in the reference indicate very sharp rise of tube resistance with increased current

Two methods have been described in ELECTRONICS for meter protection. The first utilizes a vacuum tube in series with the meter. At low current values the tube has low resistance but at high circuit currents a high bias is put on the tube and its resistance rises, thereby protecting the current meter. The circuit is shown below. This will be found on page 122, May 1933 and also in "Electron Tubes in Industry" page 154, published by McGraw-Hill Book Company. The second method is in May 1936 ELECTRONICS and was designed to protect a microammeter used to test insulation resistance of spark plugs. The tube operated a circuit breaker when the current became high enough to damage the meter.—The Editor.

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'ROUND AND 'ROUND

The Army Broadcasting Service in North Africa provides entertainment for U. S. soldiers off duty. The discs are handed along for playing on a turntable. The A. B. S. is under the direction of Lt. Andre Baruch, center, former announcer and commentator. Most of the broadcasting is of request numbers on records. Shown in the photo are Sgt. Barney Weadock, New York City, script writer; Cpl. Milton Wolfe, Sgt. Frank Douthit, Lt. Baruch, and Sgt. Howard Ailbers, Syracuse, N. Y.

NEW BOOKS

Electromechanical Transducers and Wave Filters

By WARREN P. MASON, *Bell Telephone Laboratories, D. Van Nostrand Co., 1942, 333 pages. Price, $5.00.*

DR. MASON'S BOOK is the latest of a group of outstanding technical works from members of the technical staff of the Bell Telephone Laboratories. It is important not only because of the analytical approach to network theory and its applications to mechanical, acoustical, and electromechanical systems, but because it shows the interrelationships between these various branches of physics. It provides an introduction to the use of the results of electrical network theory, familiar to every electrical engineer, in the acoustical and mechanical fields, and deals with the applications of this theory to simple mechanical systems. A considerable portion of the volume is devoted to the mathematical statement of the behavior of electromechanical transducers, with the electrodynamic loud speaker and the supersonic piezoelectric sound generator as representative examples for detailed study.

The first portion of the book deals with the behavior of strictly electrical circuits, while mechanical and acoustical structures are studied in a later section. Considerable attention is given to the analysis of the various types of energy transducers which are of such practical importance to the engineer. Filters or frequency selective circuits of various types are treated. The section on electric wave filters is not so comprehensive as may be found in texts devoted entirely to this topic, but filters composed of acoustic or mechanical elements or even transmission lines receive greater treatment than has heretofore been given to these topics.

Dr. Mason's book, makes a distinct contribution in correlating several fields of physics. While undoubtedly the results will be more generally applied to the field of electrical communications, there is ample opportunity to use the results of the analytical methods which have been developed for applications in industrial electronics.—B.D.

MYE Technical Manual

P. R. Mallory & Co., Inc., Indianapolis, Ind. 407 pages. Price $2.00.

THE TWELVE ISSUES of the Supplemental MYE Technical Service which appeared about 1940 have been brought up to date and combined in this one handy cloth-bound volume, along with an additional section on receiving tube characteristics. The material is of interest and value to all who work with radio and electronic circuits of any kind, and is particularly useful to students, radio servicemen and radio engineers. As in all Mallory publications, diagrams are exceptionally well drawn and show worthwhile constructional details and operating principles.

The section headings, indicating the specific nature of the contents, are: Loud Speaker Design and Application; Superheterodyne First Detectors and Oscillators; Half Wave and Doubler Power Supply Systems; Vibrators and Vibrator Power Supplies; Phono-Radio Service Data; Automatic Tuning; Frequency Modulation; Fundamentals of Television Engineering; DC Dry Electrolytic Capacitors; Practical Radio Noise Suppression; Vacuum Tube Voltmeters; Useful Servicing Information; Receiving Tube Characteristics.

The contents are on the whole entirely different from material in previously-published Mallory Radio Service Encyclopedias, though some portions of the Automatic Tuning section are of necessity a duplication of material in the Second Edition of the Encyclopedia. A subject indext adds greatly to the reference value of the book.—J.M.

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Empirical Equations and Nomography

By DALE S. DAVIE, *McGraw-Hill Book Co. 1943, 200 pages. Price, $2.50.*

THE NUMERICAL SOLUTIONS of many types of problems is conveniently obtained through the use of nomographs or alignment charts in which the intersection of a straight edge and several properly related scales gives the desired answer. A nomograph may be thought of as a type of slide rule in which the various scales have been properly plotted for the particular problem to be solved, and in which the drawing of a straight line connecting the pertinent quantities in analogous to the setting of the index on the slider. The need for speedy computation by personnel not too highly skilled is particularly important at the present time, and undoubtedly much time and error could be saved through more widespread use of nomographs. But the construction of such charts has been a stumbling block to many engineers. It is the author's purpose to remove as much of the uncertainty as possible in this connection.

The first part of the volume deals with the determination of the equation best representing experimentally determined data, by the appropriate plotting and rectification of experimental relationships shown graphically. Methods of determining the curve best fitting experimentally determined data are given.

The second portion of the book deals with nomography, or the construction of alignment charts. This material is approached from the geometrical point of view rather than through the use of determinants as has been done by Alcock and Jones and other recent writers. The author feels, and perhaps with justification, that the physical relationships between the experimental data and their mathematical representation as given on the alignment chart are more readily perceived through such a procedure. Adequate consideration is given to the range of experimental data to be presented on the nomograph, and the size of the completed chart, together with the precision of results which may be obtained.

Throughout, a practical point of view has been attained, and many problems and examples from various fields of engineering and technology, are given.—B.D.

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Electrical Counting

By W. B. Lewis, *Cambridge University Press, 1942. American Edition—Cambridge University Press Dept., The Macmillan Co., New York City, 1943. Price $2.50.*

EXPERIMENTAL RESEARCH in atomic physics has brought about a great deal of electronic and instrumental development to take care of the needs in various measuring and recording equipment for the experimenter. The fundamental task of such apparatus is usually the recording of quantities of radiation, i.e., the number of quanta or particles per unit of time. The mode of detection utilized for such measurement is always by way of the ionization electrons or ions liberated by the radiation in a gas. One may then choose to collect these charges by an electric field and measure the current which they produce, or to count the number of individual charge spurts resulting from each ionization event (passage of a ray or particle), which then amounts to the counting of voltage impulses.

"Electrical Counting" describes the various means and methods of accomplishing such measurement. Instrumentally, the scope of the book therefore includes the problems of construction of ionization chambers, of pulse amplifiers for very high amplifications, of circuits for discriminating between pulses of different amplitudes, trigger circuits for the operation of electro-mechanical recorders, circuits for scaling down pulse rates, and information pertaining to auxiliary equipment such as voltage stabilizers.

The principles of operation of such circuits are briefly discussed; for the pulse amplifier, the limitations in amplification, and the dependence of

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FLUORESCENT MAPS

The new "light up" map developed by the Army map makers can be used by our fliers in dangerous night missions over enemy territory. Designed for use in darkened airplane cabins, these maps actually light up under the activation of a small ultraviolet lamp worn on the pilot's helmet. The ultraviolet ray is so dim it cannot be seen from the ground or by enemy planes operation on the frequency response characteristics are briefly described, unfortunately without an actual analysis of the latter which would be useful.

One short chapter is devoted to Geiger Müller tubes. In contrast to the rest of the book this chapter is of very little value. It is not merely incomplete, but very seriously incorrect. For anyone interested in GM-tube technique, therefore, it would be of no aid at all. The reason for this unfortunate deficiency can easily be found; the author himself, at the Cavendish Laboratory in England, remarks in his preface that present war-time conditions limited the outlook of the present book because of the disturbing effects of the war on the exchange of thoughts and scientific findings between continents.

With the exception of that chapter, then, the book is well capable of conveying the fundamental knowledge to anyone interested in the use of impulse amplifiers, electronic circuits handling electrical pulses, and auxiliary equipment.—P.W.

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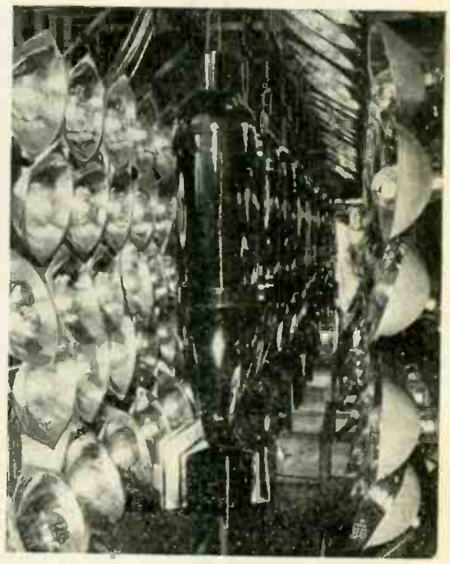
PLEASANT SIGHT



Bombs for the foes roll down the endless belt of production at one of the defense plants somewhere in the U. S. The freshly lacquered bombs are shown as they pass between banks of infrared drying lamps

Elements of Radio

By A. MARCUS and WILLIAM MARCUS, *edited by Ralph E. Horton, Prentice-Hall, Inc. 700 pages, $4.00.*

Pre-Service Course in Electricity

By WILLIAM C. SHEA, *John Wiley & Sons, Inc. 276 pages, $2.00.*

Pre-Service Course in Shop Practice

By WILLIAM J. KENNEDY, *John Wiley & Sons, Inc. 335 pages, $2.00.*

Essential Mathematics for Skilled Workers

By H. M. KEAL and C. J. LEONARD, *John Wiley & Sons, Inc. 293 pages, $1.50.*

ALL OF THESE ELEMENTARY BOOKS are designed for those who are refurbishing their previous education, or are trying to educate themselves in order to be better equipped for an Armed Service job. The two pre-service books are designed for high school use as part of the present plan to train boys for jobs in radio, in machine shops, in automotive mechanics and in electricity.

"Elements of Radio" discusses the home radio receiver at considerable length on the reasonable thesis that the reader would be most familiar with apparatus near at hand. The order of chapters is somewhat unusual, electron theory, direct and alternating currents, magnetism and other fundamental matters coming after a description of a radio receiver and even after direction finding equipment. Vacuum tubes come quite late in the book. This reviewer's chief black mark against the book, if he had to make one, would be on its size—670 pages—which may seem overwhelming for a high school text on radio. On the other hand the type is large and easy to read; and the book is planned for a year's study.

The two Wiley pre-induction books are small and look like very excellent examples of what is needed in these government-inspired courses. The authors get right down to brass tacks describing, in the one case the tools a man in a shop will use, (hand tools, machine tools, wood and metal working tools) and then, naturally, tells how to use these implements, how to keep them in condition, etc. The electricity book covers the elements of the subject up to and including motors, transformers, and rectifiers.

"Essential Mathematics" is a handy-sized book dealing with such matters as arithmetic, ratio and proportion, squares and square roots, algebraic equations, logarithms, geometry and triangulation. Throughout the authors have added practical problems.—K. H.

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Television Standards & Practice

EDITED BY DONALD G. FINK. *McGraw-Hill Book Co., Inc., New York & London. 1943. $5.00.*

TODAY'S OUTSTANDING television book is "Television Standards and Practice." Donald Fink, himself a member of the National Television System Committee and Editor of its Proceedings, has assembled the important documents and reported the important meetings in a unified story.

Although the book is essentially a technical work, the first chapter and parts of subsequent sections are a must for executives, financiers, and lawmakers who soon will require an insight into present day television and from whence it came.

Your reviewer has worked exclu-

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NEW LIFE RAFT

This new life raft, carrying complete equipment including radio, smoke signals, food, sails and waterproof suits, is being issued as replacement for the old type raft. It is designed to assure survival of seamen cast adrift after ship sinking. The demonstration was made recently in the Potomac River sively in television for fourteen years. He has witnessed misunderstanding and obstruction in the industry because one portion might not have known what another portion had already accomplished. Here is not a schoolbook on television technology but a reference work on an entire industry. Let no man now tamper with that industry until he has "caught up" with what has gone before!

Sponsored jointly by the Federal Communications Commission and the Radio Manufacturers Association, the National Television System Committee brought together the executive-engineering leaders of television. The investigations and deliberations of this body were exhaustive; the spirit of cooperative search for truth a tribute to American Democracy. The job has been completed and now the creed has been published. A unique opportunity is afforded outsiders to inform themselves, and for the indus-

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ARMY RADIO STATION

At an Army base somewhere in Alaska, soldiers operate their own 15 watt radio station. Ordinary sets can not pick up outside stations during the daytime, so the FCC recognized it for the duration and gave it the call letters of WCQ. The station is kept to 15 watts so that enemy fliers can not pick up the beam. The station goes on the air at 6 A.M. and signs off at 10:30 P.M. It has more than 5,000 records, a subscription to a transcription service and a clear channel for rebroadcasts direct from the United States. Most of the programs are put on by the soldiers themselves. Corpl. Norman Bobrow, Seattle, Wash. is shown broadcasting the news try to spring to a flying start once peace has been declared.

Needless to say, the engineering aspects of the art, from camera to reproducing screen, are covered in the ten chapters of the book. In addition, evidence and even the arguments as to why certain standards were chosen are told. References, bibliographies and appendices lead the reader to further information in any portion of the field. The book is unusual in that most of the text has not been previously published.

Your reviewer is proud to have been a member of the Committee and welcomes this opportunity to assist in "acquainting" American Industry with its soon-to-arrive infant, Television.—H. R. L.

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Guide to Cathode Ray Patterns

By MERWYN BLY, *John Wiley & Sons, Inc. Spiral bound; 8½x11 format, 40 pages. $1.50.*

THIS BOOK IS MADE UP almost entirely of cathode-ray patterns and of methods of interpreting them. The value of the book lies in the fact that the author has collected into one place over 100 diagrams which any laboratory may encounter on the screen of a cathode-ray oscilloscope. The patterns are grouped into natural chapters. Thus there is a group on phase determination, one on frequency determination, one on modulation, one on sine-wave and another on square-wave testing. The book should be most welcome in the average radio or sound laboratory.—K.H.

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A Course in Radio Fundamentals

By GEORGE GRAMMER, *American Radio Relay League, West Hartford, Conn., 103 pages. Price, $0.50.*

THIS CONVENIENT BOOKLET has been prepared as a study guide, examination book and laboratory manual for those (of which there are many at the present time) who are acquiring their first elementary knowledge of the operation and characteristic behavior of radio circuits. The text, upon which the present booklet is based, is the well known "Radio Amateur's Handbook," so that the "Course in Radio Fundamentals" does not stand alone as a complete unit. But this is the only defect (if it can be called that) which we have found with Mr. Grammer's latest piece of writing.

The book is divided into eight parts dealing with: (1) electricity and magnetism, (2) Ohm's law, (3) resonant circuits, (4) vacuum tube fundamentals, (5) radio frequency power generation, (6) modulation, (7) receivers, and (8) antennas. Each section contains assignments for the reader to follow in the "Handbook", a set of examination questions on the assigned reading, and describes a number of experiments which are to be performed to provide an understanding of the principles through laboratory practice. For each experiment, the equipment which may be required is specified and, where desirable, hints on the construction of suitable equipment are given. A particularly noteworthy feature of the experiments is that they have been designed to require a minimum of apparatus, a consideration which those not in the services can well appreciate. The radio amateur's junk box will provide practically all of the components needed for these forty experiments.

The course should be well suited to the needs of many who are now being trained for operating and radio servicing positions in the Armed Forces, for high school and trade school students in radio, and for radio amateurs after the war is concluded.
—B.D.

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CABLE AND WIRELESS RADIO

During the recent battle of Egypt photos by radio proved to be of such value that the service is expected to be extended to Montreal, Capetown and Bombay. Sir Edward Wilshaw, chairman of Cable and Wireless, is anxious to increase the facilities wherever an installation is possible. Here a photo is being transmitted to Cairo by the Cable and Wireless radio

Alternating Current Circuits

By Earle M. Morelock. *Harper & Brothers, New York, 175 pages.*

One of a series of textbooks prepared by the faculty of Rochester Athenaeum and Mechanics Institute as part of its program for developing teaching material that is closely related to the requirements of industry. The book is aimed at students in technical institutes, junior colleges and industrial and extension schools.

The book, as might be supposed under the above plan, is very practical in its subject matter. Many problems are added to the text; and nothing can tell a student quicker than a problem if he understands what he has read. The subjects of the individual chapters are a-c waves and quantities, vectors and complex arithmetic, single- and poly-phase systems. Answers are given to the problems; and thus this book is useful for a student who must study on his own. There is also a set of mathematical tables such as trigonometric functions, squares, etc.—K.H.

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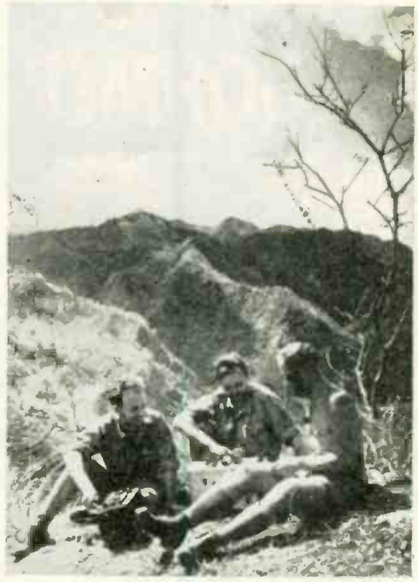
HOME MADE RADIO PUT TO GOOD USE



Australian guerillas who were left without communications to the mainland, after the Japanese moved into Timor, built a radio set which was powerful enough to contact the mainland. Three of the men who helped build the set are shown here. The mainland questioned their identification but one member of the party, to whom the question was directed, proved their identity

Laboratory Manual in Radio

By FRANCIS D. ALMSTEAD, KIRKE T. DAVIS and GEORGE K. STONE. *(Price 80 cents. 140 pages. McGraw-Hill Book Company.)*

THIS MANUAL OUTLINES the experiments in radio which may be made in high school or other elementary courses of radio communication. The experiments are grouped under the broad topics found in all text books and consequently the manual may be adopted as a companion for any high school text on radio.

The early part of the volume deals with the care and use of the soldering iron, and a recognition of circuits and component parts. Three experiments are devoted to a study of oscillators, five to the study of vacuum tube operation, four to Ohm's law, seven to a study of vacuum tube rectifiers, one to the study of wave form and the use of the oscilloscope, and one to the measurement of resistance. Six experiments are devoted to a study of the behavior of coil and condensers in d-c and a-c circuits and these are followed by an experiment on resonance.

Four experiments are concerned with what might be termed complete pieces of equipment, such as receivers and transmitters, two are devoted to a study of instruments and one deals with continuity tests in a radio circuit as an introduction to radio servicing.

The appendix includes a list of radio symbols, reference tables and formulas and miscellaneous information which is useful in the setting up or operation of a radio laboratory.

The laboratory manual is intended to be used as a working book and consequently the necessary graphs for plotting required information is provided as needed. In addition, space is provided for writing in the answers to various questions which are asked at the end of each experiment.—B.D.

• • •

What You Should Know About the Signal Corps

By HARRY MEYER DAVIS and F. G. FASSETT, JR. *W. W. Norton & Co. 1943. 2.5 pages, $2.50.*

WHAT WOULD YOU WANT to know about the Signal Corps? What it is, what it does, and how it does it?

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Chapters deal with the organization of the Signal Corps into its component branches; on the communications center in the War Department in Washington, of the various jobs the members of the Corps perform, at home and in the field; on the kinds of men which make up the organization, and their training, and finally a section on what the electronic experts of this war—who may be working in factories producing the apparatus other electronic experts are using in the Army—what these men and women may expect of their training, post war.

This is not a heavy book; it is quite interesting; and it certainly gives a good over-all picture of a most important branch of the Service of Supplies, United States Army.
—K.H.

• • •

A.S.T.M. Standards on Electrical Insulation Material

PREPARED BY COMMITTEE D-9 ON ELECTRICAL INSULATING MATERIALS. *441 pages. Price $2.50. American Society for Testing Materials, Philadelphia.*

THE CURRENT PROGRAM of unusually heavy production for wartime activities lends more than usual interest and emphasis to the volume which is the subject of this review. This volume contains a large number of standard specifications and test methods containing considerable supplementary material not in previous editions. Included in this volume are groups of specifications and tests on insulating varnishes, paints, lacquers, and their products, and molded insulating materials, including fourteen test methods on plastics. The section on plates, tubes and rods has two specifications and some ten standard test methods. Three standards are presented covering tests and specifications for electrical insulation and four other standards cover ceramic products, including glass insulators, porcelain and steatite.

This volume treats not only with the specifications and tolerances of a mechanical nature but also deals with the determination of insulating resistances, power factors and similar electrical tests and test procedures. The majority of the electrical test methods are made at power frequencies. For this reason, those whose work deals with frequencies of hundreds of megacycles or higher

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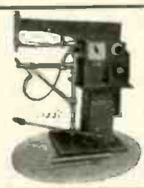

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will find little material directly aimed for their benefit. Nevertheless, the wealth of material provided in this volume should meet many of the host of problems on tests, measurements and specifications of commercial products.—B.D.

• • •

Magnetic Circuits and Transformers

By MEMBERS OF THE STAFF OF THE DEPARTMENT OF ELECTRICAL ENGINEERING, MASSACHUSETTS INSTITUTE OF TECHNOLOGY. *708 pages. Price $6.50. John Wiley & Sons, New York.*

THIS VOLUME is the second of a group of texts on the principles of electrical engineering for students specializing in power and communication engineering. The complete series of texts, of which there are three, is intended to cover the entire presentation of the basic technological principles of electrical engineering. The aim has been to make the series free from the duplication, repetition and unbalances which are often encountered in an unintegrated series of textbooks.

The preface states that, "Like the other volume in this series, this book is intended for a first basic course." One cannot quarrel with the over-all opinion of the aggregate of individuals comprising the faculty of departments of electrical engineering of a first-class school of technology; for the student using this text in his first course in magnetic circuits will certainly have a wealth of material available to him. Nevertheless, some educators and practicing engineers have felt that the M.I.T. series of texts are somewhat too advanced and too comprehensive for use as a first course in many colleges. This is a point, however, which will be of primary concern to those teachers who are in search for suitable text material for their courses and is quite aside from any comments dealing with the general merits of the book.

Any text which is subjected to the scrutiny of the entire department of an engineering college, and which has been used for a number of years in mimeographed form, must certainly possess the advantages of good balance, comprehensive consistent treatment, and may likewise be expected to be as free from errors as is humanly possible. Certainly these

(Continued on page 360)

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INDEX TO ADVERTISERS

(*Continued from page 356*)

characteristics are reflected in the present volume.

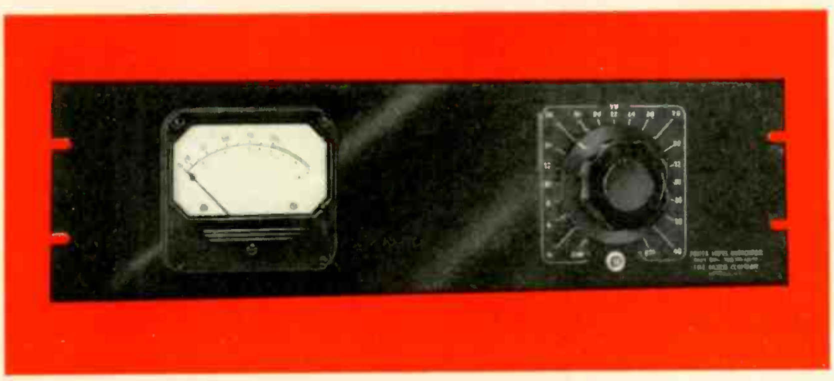
This work is divided into two main divisions. Part I, dealing with magnetic circuits, consists of eight chapters comprising 255 pages. This section deals with the properties of ferro-magnetic materials, magetic circuit concepts, principles of magnetic circuit computation, permanent magnets and energy in the magnetic field, losses in magnetic cores containing time varying fluxes, alternating current excitation characteristics of iron core reactors and transformers, model theory and design of iron core reactors, and thermal properties and heat flow. Part I is therefore devoted to the development of the fundamental principles or computation of the behavior of magnetic circuits. The emphasis is primarily on the elucidation of physical principles rather than on engineering application. Part II, comprising twenty-one chapters and approximately 430 pages of text, deals with what may be termed the engineering problems of ferro-magnetic transformers. As is to be expected, a predominantly large portion of this material is devoted to the purely technical problem of transformer engineering, although the mechanical and economic factors are adequately treated. In fact, one chapter is devoted to the physical features of transformers, while two chapters are devoted to general economic considerations. Thus, the student using this volume as a text becomes aware that the engineer's responsibility does not cease when satisfactory solutions have been attained for only the electrical phases of his assignment. Failure to recognize the mechanical, economic and in some cases even the psychological problems which may be encountered have been stumbling blocks to many an engineer.

Primarily the treatment of the second part of this volume is such as to be of more immediate use and application to power engineers than to the majority of communication engineers. Nevertheless, even a communication engineer can profit by the chapters on three-phase connections, unbalanced conditions, multi-circuit transformers and power operation of transformers. Chapters which appear to be specifically directed to the communication engineer are those discussing the frequency characteristics of transformers and the chapter on applications of transformers in telephone systems.

The chapter on frequency characteristics contains sections on output transformers and on input and interstage transformers which will be particularly of interest to the communication engineer.

In teaching classes in radio engineering, this reviewer has treated all transformers by means of coupled circuit theory since such a treatment lends itself well either to discussion of the principles of resonant or non-resonant air core and iron core transformers, both of which find extensive use in communication application. A rather complete treatment of iron core transformers from the point of view coupled circuit theory appears in Chapter 17, "Self and Mutual Inductances."

We may leave to the professional pedagogue any argumentative discussion concerning the use of this volume as a first course. Certainly, however, the volume will be found of considerable value to practicing engineers, graduate students or even advanced undergraduates as a general text and reference work.—B.D.



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