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electronics

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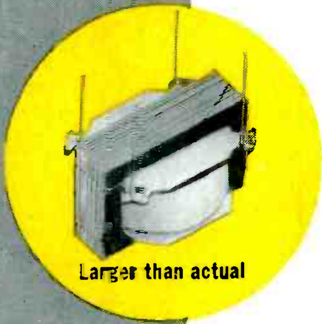
UTC FOR COMPACTNESS

World's smallest transformer

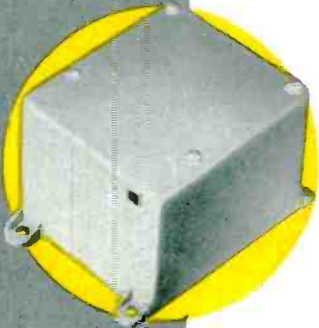
These units, 7/16" x 9/16" x 3/4", are the optimum in small transformer design . . . they have been in production for five years.



Larger than actual

Weight reduction 95%

This dual purpose aircraft filter was reduced in weight through UTC design from 550 to 27 ounces.



Ouncer transformers-Hermetic

Hundreds of thousands of UTC Ouncers have been used in the field. Solder sealed hermetic constructions effecting the same weight and space savings are now in production.

May we cooperate with you on design savings for your applications . . . war or postwar?

ARMY E NAVY ALL PLANTS

United Transformer Corp.

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electronics

A McGRAW-HILL PUBLICATION

MAY • 1945

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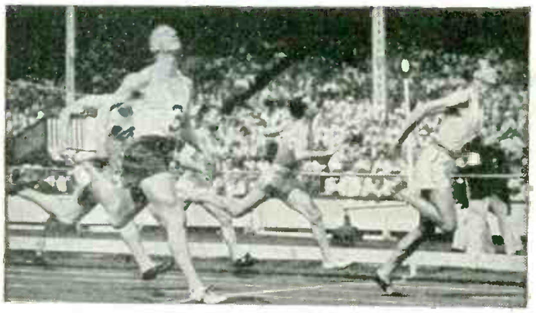
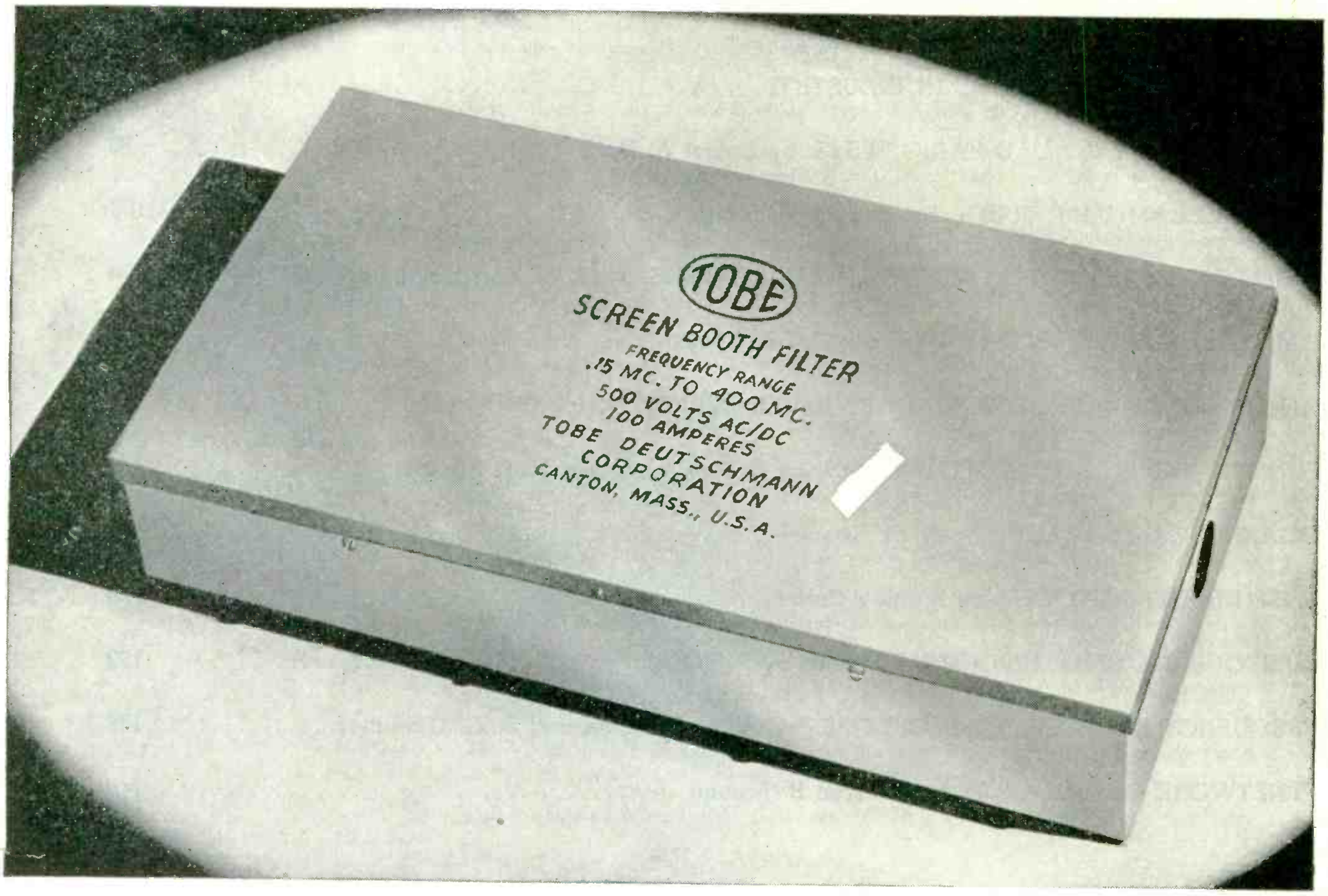


AWAY AHEAD!

TOBE LEADS IN NOISE ELIMINATION



NEW SCREEN BOOTH FILTER

HERE is more evidence of Tobe's Leadership in the noise elimination field. This remarkable SCREEN BOOTH FILTER is designed for use in laboratory testing rooms, including those already shielded to prevent outside electrical interference. It is attached to the power line at the point of entrance into the booth, and is designed to eliminate troublesome interference which might upset vital testing work. *Note the exceptional frequency range,* from .15 MC to 400 MC.

CONTAINER DIMENSIONS

Length . .	20 1/16"	Height . .	4 1/8"
Width	7 15/16"	Weight . .	35 lbs.

Whenever your problem is connected with eliminating electrical interference, the name to remember is . . . TOBE! We have a great inventory of knowledge on this subject, backed by 17 years' experience. Your inquiries are welcome at any of our offices. Investigate the applications you can make of TOBE Filters, including the unusual SCREEN BOOTH FILTER described on this page.

TOBE DEUTSCHMANN CORP., CANTON, MASS.

SUPPRESS MAN-MADE RADIO STATIC
TOBE
FILTERIZED

GRAND CENTRAL TERMINAL BUILDING
NEW YORK 17, N. Y.

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HANDLING is believing. Get the finger tips of your left hand on the control ring of a PARAGON Drafting Machine. The lightest pressure is all you need to set the scales at the angle you want, anywhere on the drawing board. Your right hand is always free. For the full story of PARAGON features, convenience and handsome modern appearance, write on your letterhead to Keuffel & Esser Co., Hoboken, N. J.

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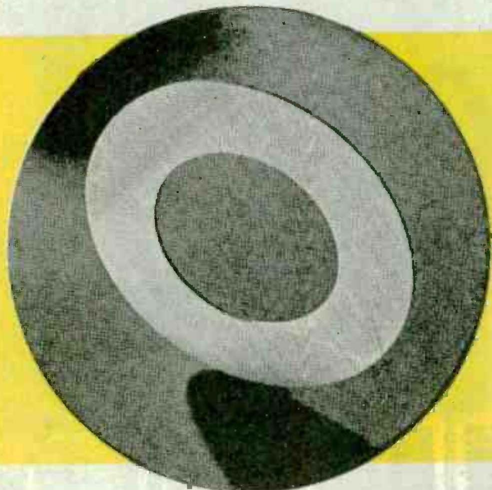
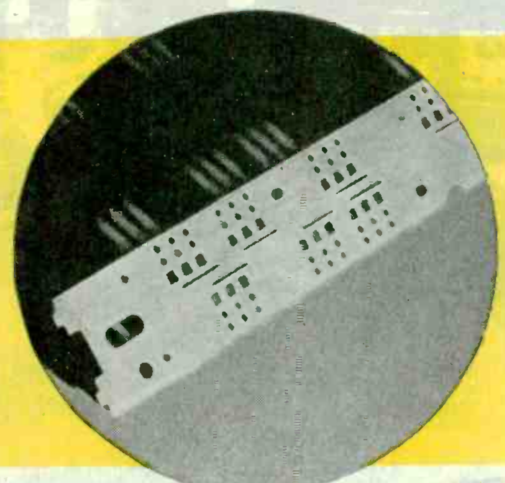
PLASTICS
where PLASTICS belong


SHEETS
RODS • TUBES
FABRICATED PARTS
MOLDED-MACERATED
MOLDED-LAMINATED
SYNTHANE

Plastics is a Word . . . like Metals



THRUST WASHER—Dimension stability, moisture resistance, compressive strength and immunity to oil are factors in the selection of Grade C (fabric reinforced) Synthane.



RADIO TERMINAL STRIP—Low power factor, low water absorption, low dielectric losses and stability of these properties led to the use of Synthane Grade XXXP.

BREAKER ARM—Synthane molded-laminated with a fabric filler is notable for its high impact strength, excellent wearing qualities and good electrical properties.

● **IT IS IMPORTANT TO AVOID** using the word "plastics" loosely or generically. It is as imperative to distinguish between plastics as between metals, say as between steel and bronze—and then to distinguish further between types of the same general plastics as you would between various steels and various bronzes.

● **SYNTHANE IS OUR NAME** for one type of plastics, made from phenol formaldehyde resins and various fillers. This type is thermosetting, that is, it does not soften under a reapplication of heat as do thermoplastic materials. The phenol formaldehydes, including Synthane laminated, are newsworthy among plastics for their *combination* of high tensile strength, high compressive strength, high flexural strength, high impact strength and high dielectric strength. Synthane has, of course, many other desirable properties in combination such as light weight, hardness, low thermal expansion, low moisture absorption, and resistance to corrosion.

● **THERE ARE, HOWEVER,** various grades of Synthane, just as there are various kinds of bronze, steel, aluminum, and other metals. Naturally, you will not find the optimum values of all properties combined in any one grade. For instance, one grade, reinforced with a paper filler is most suitable for its mechanical characteristics, another for its dielectric qualities. In addition to paper grades there are grades reinforced with fabric, asbestos, and glass fillers and impregnated with a diversity of resins.

● **THE SELECTION OF A GRADE** of Synthane is influenced not only by its inherent physical, electrical, mechanical or chemical properties but often by processes of machining required to produce from Synthane the finished parts you require.

● **AS AN ILLUSTRATION,** production of the parts you have in mind may only be economical by punching. Depending on your requirements, paper base grades as XP, XXP or XXXP (the "P" denotes a punching or plasticized grade) may be amply adequate for your purpose.

● **USUALLY ONE OF THE MANY** standard grades of Synthane can be found to meet satisfactorily all your specifications, both in properties and in machinability. If not, we may have already developed, or have to develop, a special grade which will.

● **REMEMBER THAT SYNTHANE** is as adjustable within its combination of properties as an alloy of a metal, and that if you are not sure there's a grade of Synthane to fill the bill for you, just ask us. If possible, let us help you before you design and, in so doing, give us the opportunity to assist you in selecting the right Synthane material for your application and for ease in fabrication.

SYNTHANE

SYNTHANE CORPORATION, OAKS, PENNSYLVANIA
Representatives in All Principal Cities


"SUPER-PROS"
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Five thousand hours of continuous operation demand good engineering. The "Super-Pro" receivers in the CAA installation at La Guardia Airport have been on duty twenty-four hours a day for over four years.
THE SIGN OF QUALITY
ESTABLISHED 1910
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THE HAMMARLUND MFG. CO., INC., 460 W. 34TH ST., NEW YORK 1, N.Y.
MANUFACTURERS OF PRECISION COMMUNICATIONS EQUIPMENT

Available through Leading Radio Equipment Distributors!

AMPEREX

WATER AND AIR COOLED TRANSMITTING AND RECTIFYING TUBES

The more popular AMPEREX tubes are available through leading radio equipment distributors. Thus, engineers may now obtain many of our standard tube types with minimum delay. The AMPEREX line, especially for industrial and electro-medical applications, is probably the most complete in the industry. AMPEREX engineers pioneered in the design and development of these types, and our name stamped on a "bottle" designates longer life with corresponding economy. If we can be of service to you, on present or peacetime assignments, we will be very glad to oblige.

AMPEREX

... the high performance tube

AMPEREX ELECTRONIC CORPORATION

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WASTEPAPER IS A CRITICAL WAR REQUIREMENT . . . SAVE EVERY SCRAP


The TINYMITE
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yet 100%
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TYPE P5N
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FEATURES
1. Bakelite Resinoid Ends. Lead wire cannot pull out, even under hot conditions.
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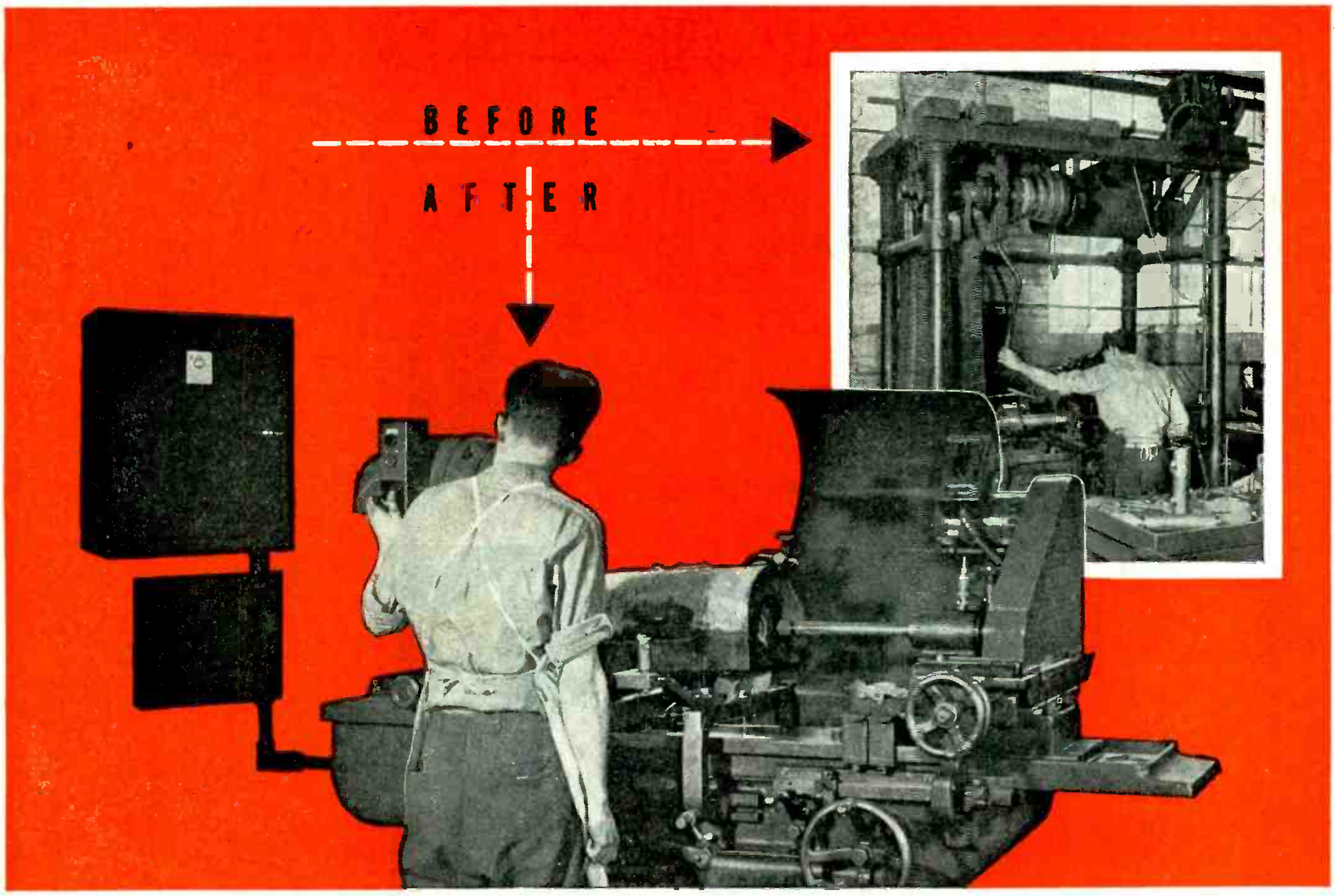


producing better than ever . . . after 30 years

ELECTRONIC MOTOR CONTROL

The Westinghouse Mot-o-trol . . . employing Thyratron tubes to convert a-c to d-c . . . provides wide-range stepless speed control through a 20 to 1 range, from an a-c *power source.* Pushbutton control station enables the operator to start, stop and control the speed while the machine is running. At any speed setting, variations in load cause little or no change in speed.

The Allies' urgent need for more oil recently created a demand for greatly increased production of hardened steel pump liners. To a leading West Coast manufacturer, this brought the problem of maintaining precision at a much higher production rate.

Internal grinding of these liners had been done on machines with overhead belt and pulley drives . . . providing only four speeds in definite steps. These grinders were unable to meet the stepped-up demand. Excessive vibration ground chatter marks into the liners. Subsequent honing became inaccurate. Setup time was high. To obtain delivery of a modern machine would require months.

Westinghouse engineers, working with the manufacturer, suggested modernizing the drives by applying Mot-o-trol, an electronic drive providing stepless speed control over a 20 to 1 range, with handy pushbutton control.

Result: the grinding operation showed immediate improvement. Vibration and chatter marks were eliminated. Setup time was reduced. And the new arrangement *saved 35% in floor space.*

This is typical of the modernizing possibilities with electronic equipment . . . not only in control, but in power conversion, processing methods, counting and sorting operations and countless other industrial tasks.

Your nearest Westinghouse office is ready to provide helpful assistance and information on electronic applications for *your* industry. Or write Westinghouse Electric & Mfg. Company, P. O. Box 868, Pittsburgh 30, Pa.

J-91072

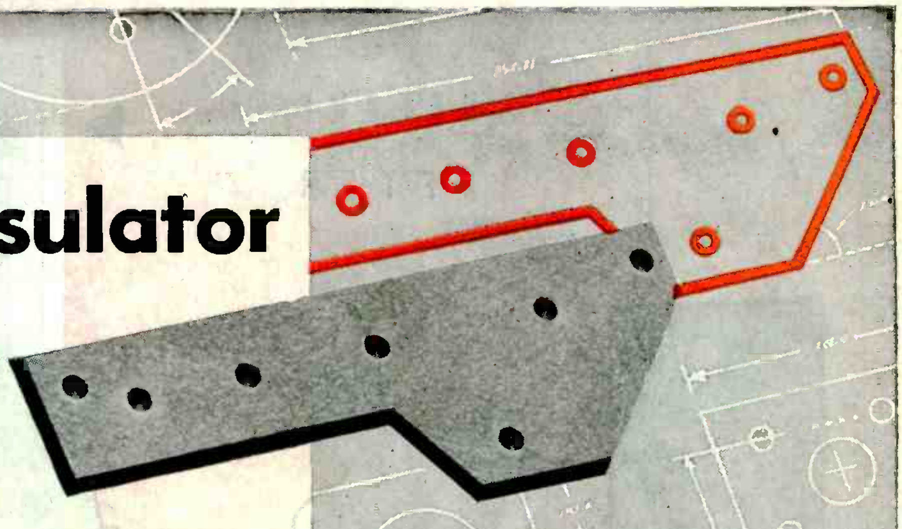
Westinghouse

PLANTS IN 25 CITIES . . . OFFICES EVERYWHERE

Electronics at Work

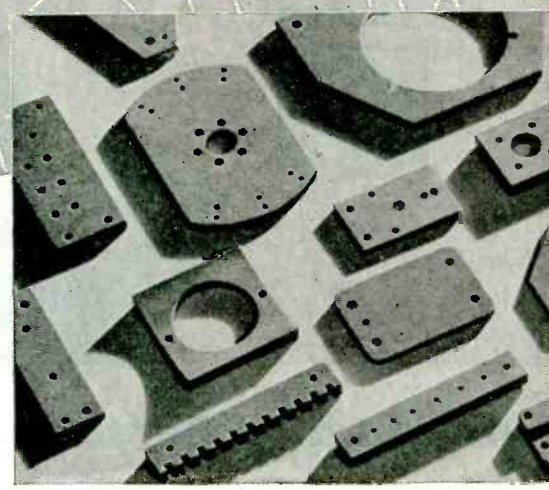
ELECTRONIC EQUIPMENT FOR INDUSTRY AND HOME—ELECTRONIC TUBES—RADIO AND TELEVISION

When insulator design calls for *Quick Action*



DEPEND ON MYKROY

PERFECTED MICA CERAMIC INSULATION



A representative group of parts fabricated in Mykroy to customer's specifications in our own plant. We have complete facilities to produce such parts in any quantities on rapid delivery schedules. Send us your specifications.

When time is of the utmost importance the ease and precision with which Mykroy can be fabricated into insulator parts makes it exceptionally useful to electronic and electrical engineers. Make those design changes on the spot . . . make them *quickly* and economi*cally* with Mykroy, for, here is a ceramic which can be worked in your own shop. Just transfer your design to the Mykroy sheet . . . then using conventional shop tools . . . produce the desired part by simple cutting, grinding, drilling, tapping and polishing techniques.

Because it has high structural strength and physical stability Mykroy can be machined to critical tolerances more readily than other types of ceramics. In addition, its electrical characteristics are of the highest order and do not shift under any conditions short of actual destruction of the insulation itself. This, plus excellent chemical and physical properties, makes it one of the best insulating materials ever developed for general and high frequency applications.

Get the full facts about this versatile dielectric now. Ask for a copy of the new MYKROY BULLETIN 102 which describes the new larger (19¼" x 29¾") sheet now available and call upon our engineers to help with your problems.

MECHANICAL PROPERTIES*

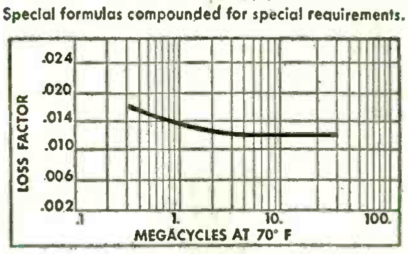
MODULUS OF RUPTURE.................18000-21000psi
HARDNESS
Mohs Scale 3-4 BHN. BHN 500 K9 Load. 63-74
IMPACT STRENGTH........ASTM Charpy .34-.41 ft. lbs.
COMPRESSION STRENGTH.......................42000 psi
SPECIFIC GRAVITY......................................2.75-3.8
THERMAL EXPANSION.........000006 per Degree Fahr.
APPEARANCE.....................Brownish Grey to Light Tan

ELECTRICAL PROPERTIES*

DIELECTRIC CONSTANT......................................6.5-7
DIELECTRIC STRENGTH (⅛").........630 Volts per Mil
POWER FACTOR............001-.002 (Meets AWS L-4)

***THESE VALUES COVER THE VARIOUS GRADES OF MYKROY**

GRADE 8. Best for low loss requirements.
GRADE 38. Best for low loss combined with high mechanical strength.
GRADE 51. Best for molding applications.
Special formulas compounded for special requirements.



Based on Power Factor Measurements made by Boonton Radio Corp. on standard Mykroy stock.

MADE EXCLUSIVELY BY

ELECTRONIC MECHANICS INC.

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CHICAGO 47: 1917 N. Springfield Ave., Tel. Albany 4310
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MYKROY IS SUPPLIED IN SHEETS AND RODS — MACHINED OR MOLDED TO SPECIFICATIONS

Designed for the modern 50-kw transmitter!

a G-E high-vacuum, forced-air-cooled tube

Up-to-the-minute **in its design characteristics and performance**

Powerful **for amplifier use in large AM stations**

Versatile **in its filament operation from direct current or single, 3-, or 6-phase alternating current**

Compact**—28" high, 14⅛" in diameter**

● **Type GL-893-AR** was created for the newer 50-kw transmitters which broadcast at standard frequencies, and with power-tube installations employing forced-air cooling. The same tube may be obtained with water-cooled anode as Type GL-893-A, for services such as industrial high-frequency heating or international 50- and 100-kw broadcasting.

● **Important advancements** in design establish the GL-893-AR as a power amplifier better and more dependable than any predecessor. Its filament structure uses new, improved methods of springing and suspending the loops, so that when the phase-voltages are unbalanced, the tendency of the filament to move and short with the grid is minimized. Improvements in grid construction also have been introduced to reduce the possibility of arcing over, thus making Type GL-893-AR easier to break in.

● **Well-known** for its multi-strand filament which permits, for all classes of service, operation from direct current or single, 3-, or 6-phase alternating current, Type GL-893-AR is being used increasingly in modern transmitting sets. A recent, substantial reduction, moreover, has lowered the price from $1,150 to $800. Consult your nearest G-E office or distributor for further data about G-E transmitting tubes, or write to *Electronics Department, General Electric, Schenectady 5, New York.*

TYPE GL-893-AR. PRICE $800.

A 3-electrode, forced-air-cooled vacuum tube for use as a r-f amplifier, oscillator, or Class B modulator. Operates from direct current or single, 3-, or 6-phase alternating current. In Class B a-f service, with a signal plate output for two tubes up to 70 kw, the maximum ratings per tube are: plate voltage 20,000 v, signal plate current 4.0 amp; signal plate input 60 kw, dissipation 20 kw. In Class C plate-modulated service, with a power output up to 18 kw, the maximum ratings per tube are: plate voltage 12,000 v, current 2.0 amp; plate input 24 kw, dissipation 12 kw. Highest frequency at full ratings is 5 megacycles; at reduced ratings, 25 megacycles.

Type GL-893-A also is available with the same design and ratings, but with water-cooled anode. Price $450.

Hear the G-E radio programs: *"The World Today" news, Monday through Friday 6:45 p. m., EWT, CBS. "The G-E All-Girl Orchestra," Sunday 10 p. m., EWT, NBC. "The G-E House Party," Monday through Friday, 4 p. m., EWT, CBS.*

GENERAL ELECTRIC

161-D6-8850

FM does it

with *triple* the tone range

to bring new program brilliance to your listeners

In the range of tone from low to high, a present-day AM broadcast system reproduces the values of tone from approximately 100 to 5,000 vibrations per second. Compare this range with that of an FM broadcast system which is capable of reproducing *all values of tone from 50 to 15,000 vibrations per second*—a range that matches the ability of the normal ear to hear! Within this extended range provided by FM is ample room for all the highs and all the lows of natural sound. Here is space for the vital lacework of overtones that gives sound its "natural color"—that enables the listener to distinguish the piano from the banjo, the oboe from the flute, each voice and instrument from all others.

Nor are these values lost in the FM broadcast receiver. Here each tone and overtone is clearly heard against a background of silence, for FM does away with background noise that normally masks AM reception, particularly at low sound levels. Each crescendo reaches its true value, for an FM receiver is designed to handle without distortion the entire range of sound intensities from the softest whisper to the swell of the full concert orchestra.

FM gives broadcasting "natural-color" reception. To your audience this means fuller program enjoyment. To you, this means stimulated audience interest and improved service to your advertisers.

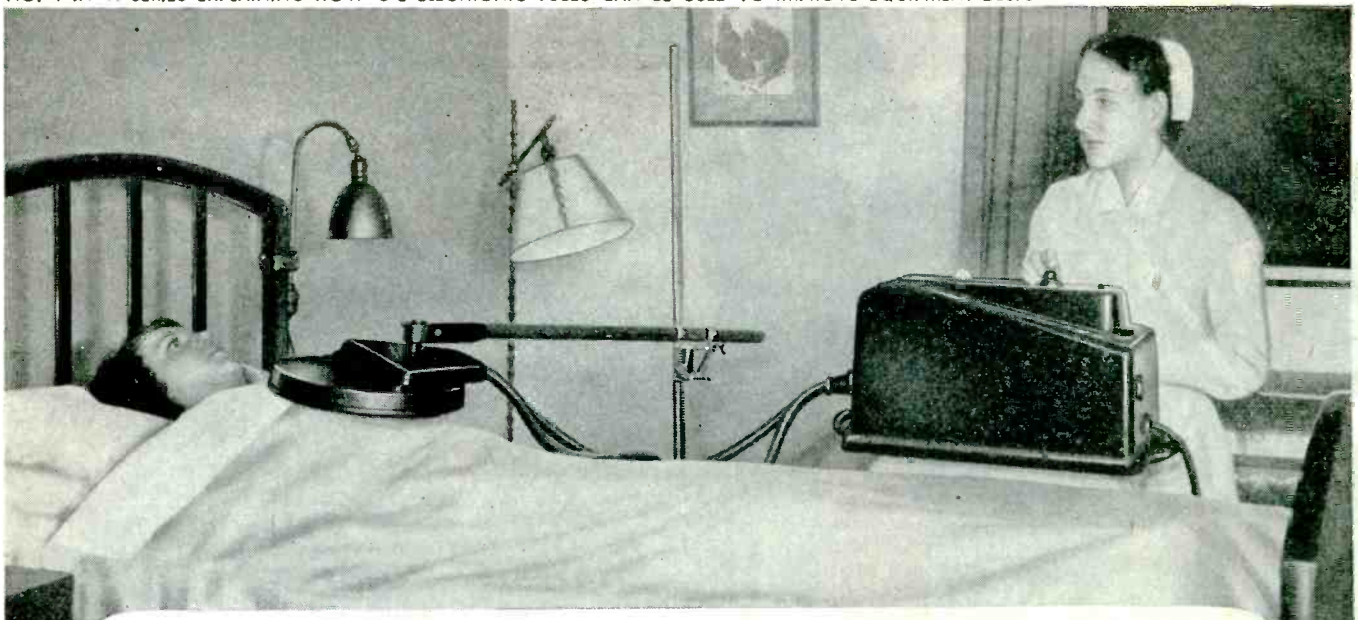
When you plan your FM station make full use of General Electric's vast background of experience in the FM field. G.E. is the one radio manufacturer with experience in designing and building complete FM broadcast systems—from transmitters to receivers. G.E. has designed and built more FM broadcast transmitters than any other manufacturer. G.E. built the first FM home receivers and has furnished a large percentage of the half million now in use. Today, the six studio-transmitter FM relay links now operating in the 340-megacycle band are all G.E.—with thousands of hours of regular operation to their credit. And at Schenectady, G.E. operates its own FM proving-ground station, WGFM. For information on General Electric FM broadcast equipment, write *Electronics Department, General Electric, Schenectady 5, N. Y.*

AM AM brings listeners only one-third the range of tone the ear can hear. Many tones and overtones are missing. Realism is lost.

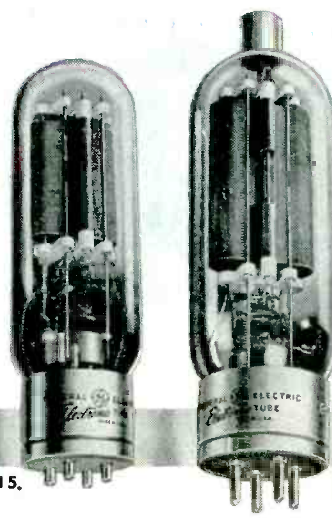
STUDIO AND STATION EQUIPMENT • TRANSMITTERS

GENERAL ELECTRIC

160-D8-6914



These specially designed G-E pliotrons produce the high-frequency currents used in diathermy



TYPE FP-285. $15.   TYPE FP-265. $22.50.

Three-electrode, high-vacuum, oscillator tubes for supplying the high-frequency currents used in diathermy. Basic ratings are:

	FP-285	FP-265
Cathode voltage	10 v	10 v
Cathode current	3.25 amp	5.2 amp
Max plate voltage	1,350 v	1,500 v
Max plate current	200 ma	200 ma
Max plate input	270 w	350 w
Max plate dissipation	100 w	160 w
Frequency in megacycles at maximum ratings	20	15
Frequency in megacycles at 50 per-cent ratings	80	40

Growth in the use of diathermy for treating various pathological conditions has increased the need for equipment that is efficient, dependable, and modern in all respects. Design of such equipment starts with the electronic tubes which supply the high-frequency current, applied to the tissues either by induction or dielectrically.

G-E Types FP-285 and FP-265 are pliotrons — high-vacuum, 3-electrode, oscillating tubes—engineered especially for short-wave therapy. Apparatus designers may place full confidence in these G-E tubes, which embody many features of superiority. Frequencies are in the high range, and power output is ample for most effective treatment of the patient.

For facts on the application of electronic tubes in diathermy, consult General Electric tube engineers.

Also ask for "How Electronic Tubes Work," an illustrated booklet about tube types and functions. Telephone your G-E office or distributor, or write to *Electronics Department, General Electric, Schenectady 5, New York.*

Hear the G-E radio programs: *"The World Today" news, Monday through Friday, 6:45 p. m., EWT, CBS. "The G-E All-Girl Orchestra," Sunday 10 p. m., EWT, NBC. "The G-E House Party," Monday through Friday, 4 p. m., EWT, CBS.*

G. E. HAS MADE MORE BASIC ELECTRONIC-TUBE DEVELOPMENTS THAN ANY OTHER MANUFACTURER

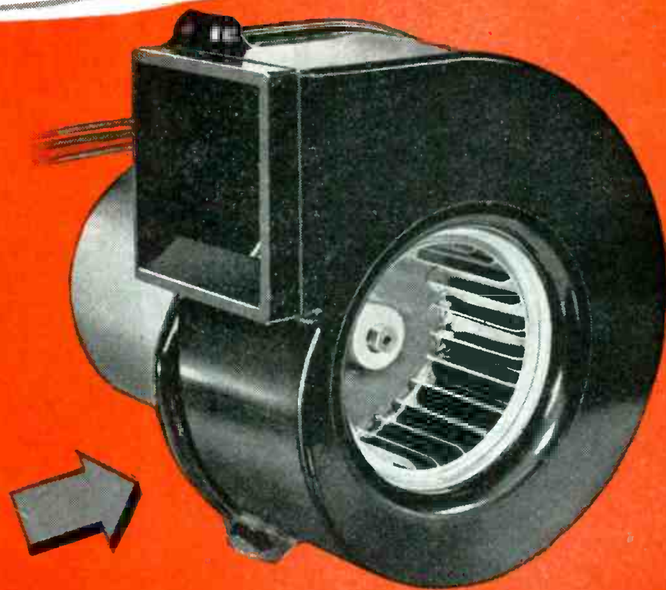
GENERAL ELECTRIC

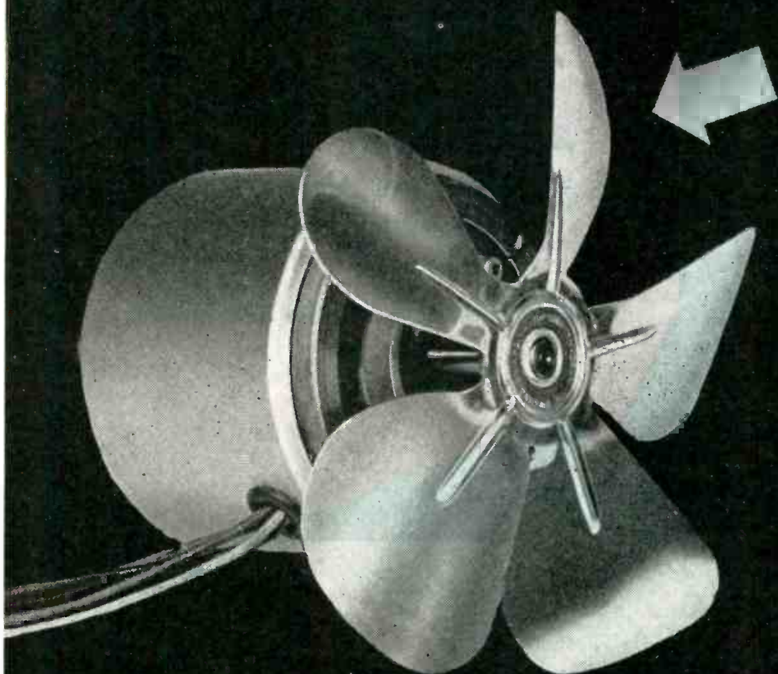
162-D8-8650

EASTERN AIR DEVICES presents
2 NEW HIGHLY EFFICIENT BLOWERS

MODEL J57
CENTRIFUGAL BLOWER
110 C.F.M. FREE AIR

60 cycles • 115 volts • single phase capacitor start and run motor • 3300 R.P.M. • 4 mfd capacitor required • weight of unit 3 lbs. 10 oz. • overall width 5½" • overall length 5¾".

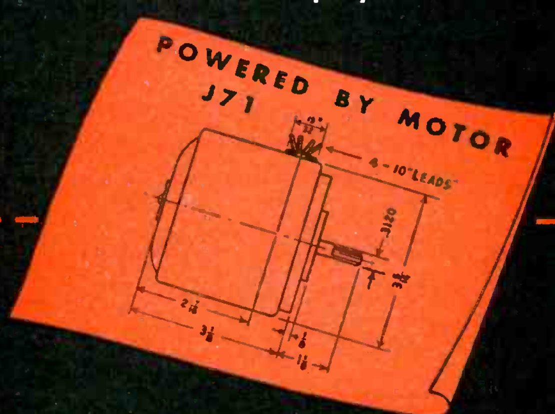




MODEL J87
AXIAL FLOW BLOWER
475 C.F.M. FREE AIR (NEMA CODE)
175 C.F.M. FREE AIR (NAFM CODE)

60 cycles • 115 volts • single phase capacitor start and run motor • 3300 R.P.M. • continuous duty • 25 watts input • 4 mfd condenser required • 87% power factor • weight of unit 3 lbs. 1 oz. • Fan: 5 blade propeller type, 5½" diameter.

We invite inquiry!



EASTERN AIR DEVICES, INC.
585 Dean Street • Brooklyn 17, N. Y.
An Affiliate of The Fred Goat Co., Inc., Est. 1893

MANUFACTURERS OF CONTROL DEVICES AND COMPONENTS FOR ELECTRICAL, ELECTRONIC AND MECHANICAL APPLICATIONS

RCA Announces its New

195 VoltOhmyst

4 IMPORTANT NEW FEATURES

1. Diode for a-c measurements. Flat 20 cycles to 100 kc.
2. Linear a-c scale for all ranges.
3. New plastic meter case with one-piece crystal-clear transparent front. No glass to break or loosen.
4. Shielded a-c cable and probe.

Send for Bulletin:

A special bulletin showing and fully describing this new improved version of the well-known VoltOhmyst is now being printed. Fill in and return the coupon for your copy.

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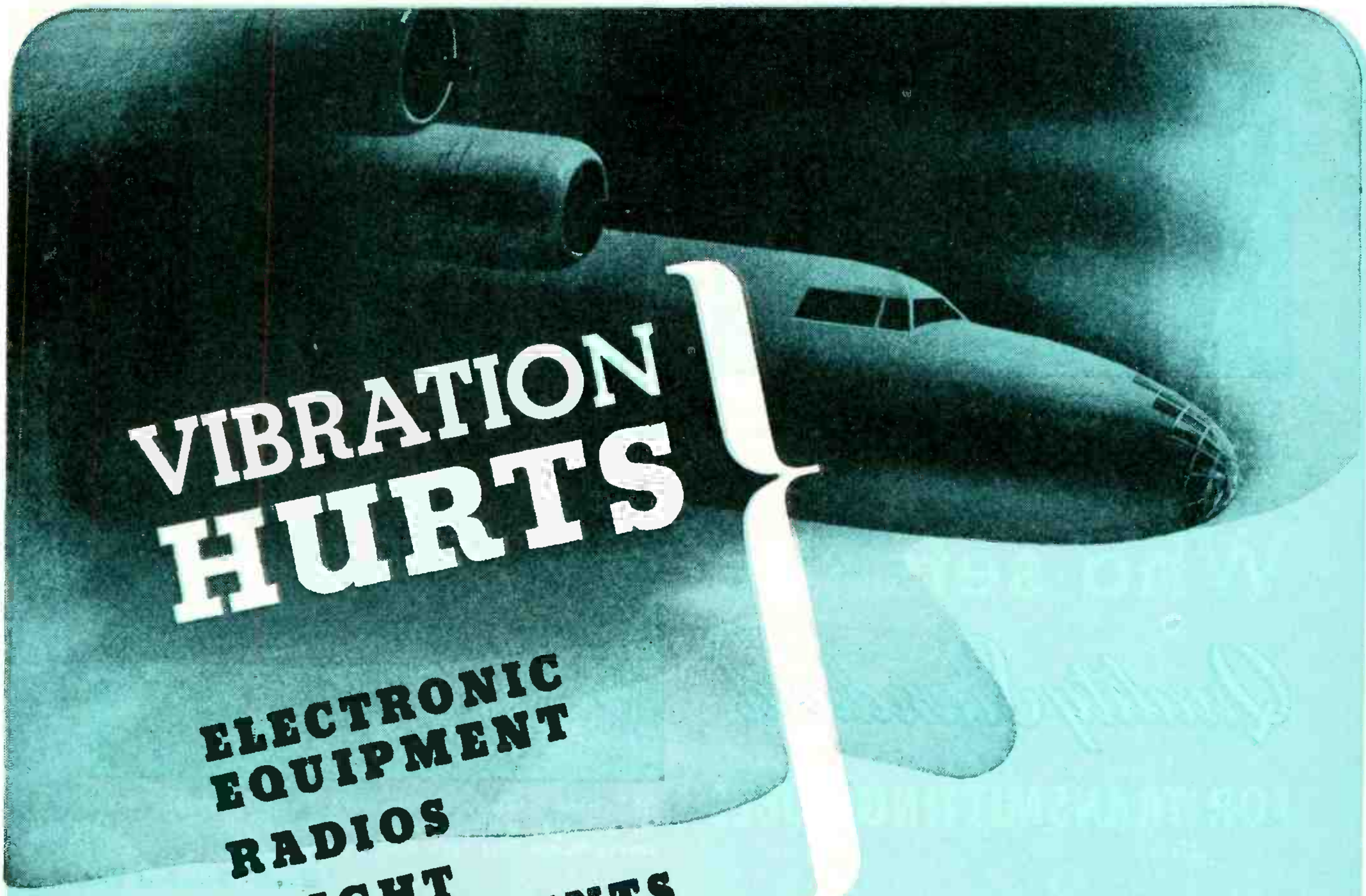


VIBRATION HURTS

ELECTRONIC EQUIPMENT
RADIOS
FLIGHT INSTRUMENTS

. . . . . so that airborne equipment fails repeatedly even under normal service conditions. Yet such failures, accepted as inevitable can be virtually eliminated if vibration is adequately controlled.

Robinson Vibrashock* suspensions are guaranteed to absorb over 90% of all vibration within the operating range of aircraft. This represents a new high standard of performance for shock mounts. In every instance when shock mounts for vital airborne equipment are replaced by Vibrashock suspensions, the results exceed expectations. The reliability of the equipment supported is increased, the service life extended and maintenance costs reduced.

Vibrashock suspension designs are adapted to each vibration problem of importance. This procedure differs from the conventional method of selecting shock mount units from a catalog, and assembling them to a tray. But valuable equipment deserves vibration engineering if the best control is desired — a poor shock mount is expensive at any price.

We would like to show you curves indicating the improved performance of Vibrashock suspensions as compared with conventional type shock mounts. Let our engineers show you how Vibrashock can solve your vibration problem.

*Trade Mark

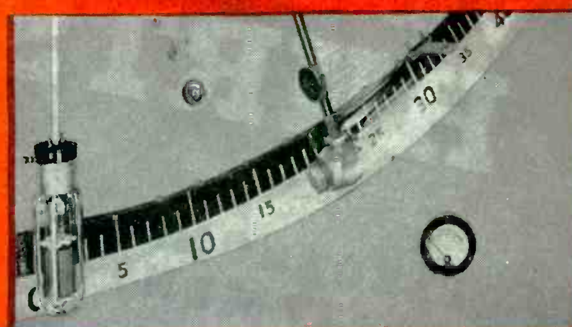
ROBINSON AVIATION, INC.
730 Fifth Avenue, New York 19, N.Y.
First National Building, Hollywood 28, Calif.

VIBRATION CONTROL ENGINEERS

*QST-1—Life testing is an important Quality Standard test at United. It is a strictly observed procedure whereby life expectancy is controlled in "run-of-production" tubes.

QST-2—A unique test is applied to every United tube to assure noise-free operation.

Who sets the *Quality Standard* FOR TRANSMITTING TUBES



QST-3—United tubes designed for very rough service have extra, built-in shock resistance proved by the severe Bump Test each tube must pass.

*Quality Standard Test

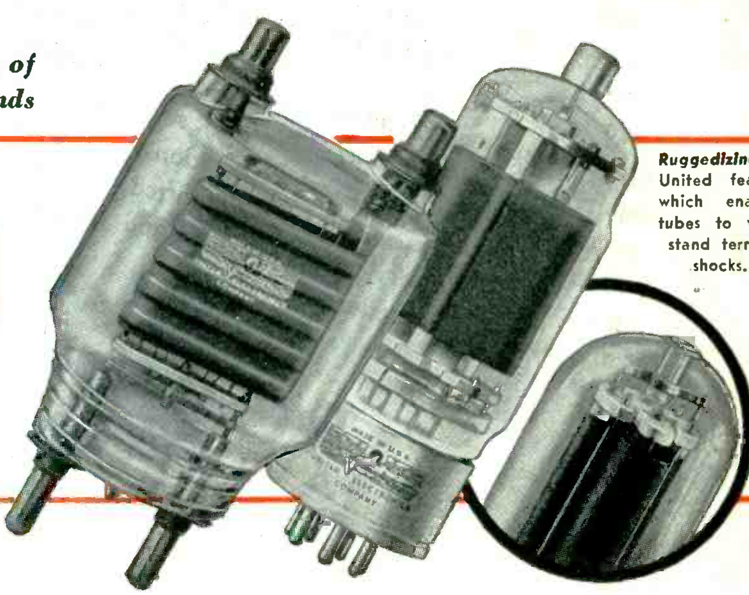
Brilliant United craftsmanship is steadfastly verified and maintained by skillful and vigilant testing—truly representative of daily production. For this reason every United tube must pass through a series of critical examinations that do not permit any defects, no matter how minute they may be, to escape unnoticed.

By maintaining Quality Standard Tests of the highest order United engineers and technicians have achieved recognition for leadership. To engineers everywhere, the name United is the *trusted* standard by which other transmitting tubes are judged and measured.

For every electronic application including radio communication, physiotherapy, industrial control and electronic heating, standardize with tubes that are *the* Quality Standard. "Tube up" with United.

Order direct or from your electronic parts jobber.

Masterpiece of Skilled Hands



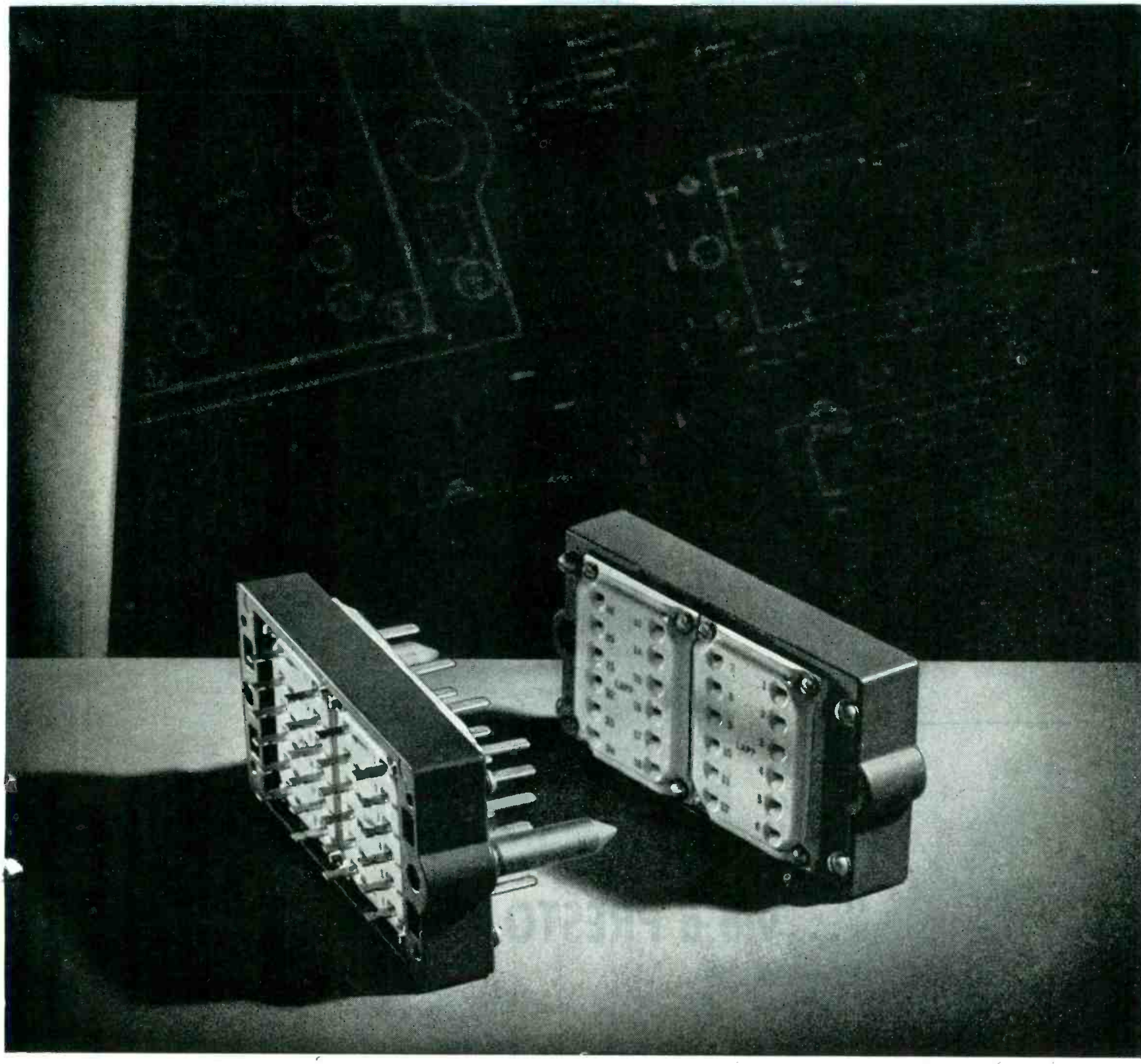
Ruggedizing: A United feature which enables tubes to withstand terrific shocks.

UNITED

ELECTRONICS COMPANY

NEWARK, 2 NEW JERSEY

Transmitting Tubes EXCLUSIVELY Since 1934



An Electronic Part ...ENGINEERED TO A SPECIFIC NEED

This is a special-purpose electronic part. It is a plug-receptacle assembly for use with rack-panel type of mounting. Twenty-four silver-plated phospher-bronze contacts are provided, each male and female contact full floating between steatite plates. Heavy guide pins and matching holes in the frame assure perfect alignment.

We don't know that your product has any need for such a part as this. We do know, however, that this part is most exactly suited to its special requirement just as are hundreds upon hundreds of other parts which have been created through Lapp engineering and Lapp production facilities directed to the solution of specific problems.

With a broad basic knowledge of ceramics—their capabilities and their limitations—Lapp has been able to simplify and to improve many types of electronic equipment through engineering and production of sub-assemblies that make most efficient use of porcelain or steatite and associated metal parts.

There may be a way you can improve performance, cut costs and cut production time through use of Lapp-designed and Lapp-built sub-assemblies. We'd like to discuss your specific requirements with you. *Lapp Insulator Co., Inc., LeRoy, N. Y.*

Lapp

"Here's how Courtney checks up on Courtney!"

Alan Courtney

"...via a PRESTO recorder"

"An announcer must check up on his technique constantly," says Alan Courtney, popular announcer of WOV's *1280 Club* program. "My own way of doing this is to make frequent recordings of my voice on a portable PRESTO recorder. Then, by listening to the records, I can get an idea of how I sound to the radio audience. Naturally, the accuracy of the recording is of the utmost importance. I find a PRESTO recorder ideal for the work, because, even in amateur hands, it produces cuttings of uniformly high fidelity and clarity."

PRESTO sound recording and transcription equipment is used by major broadcasting companies, in industry, in schools and colleges, and by the Armed Forces. Every PRESTO unit, from the largest to the smallest, is a product of high engineering skill and uncompromising manufacturing standards. Write for information.

WORLD'S LARGEST MANUFACTURER OF INSTANTANEOUS SOUND RECORDING EQUIPMENT AND DISCS

PRESTO
RECORDING CORPORATION
242 West 55th Street, New York 19, N. Y.
Walter P. Downs Ltd., in Canada

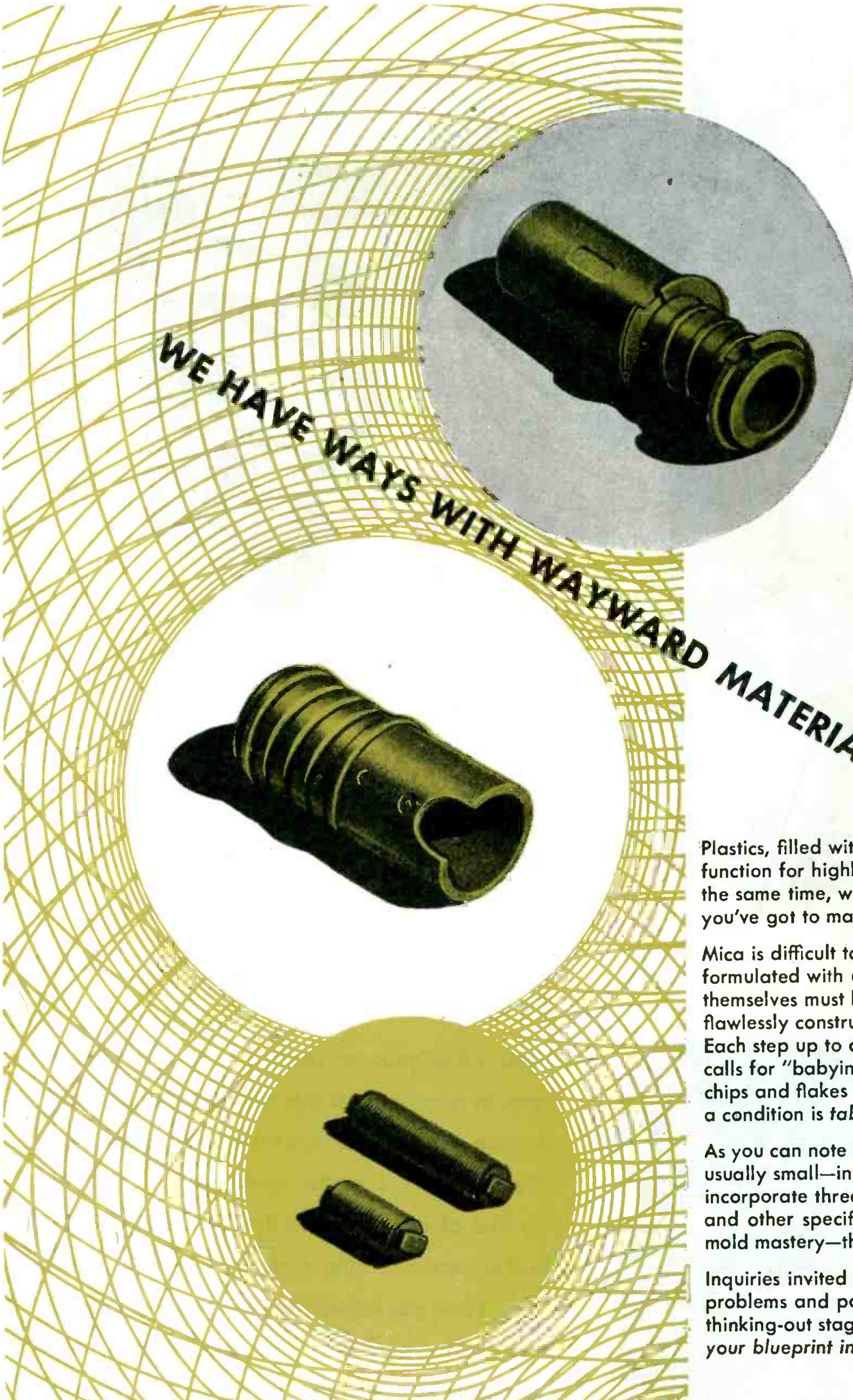
This Audio Oscillator Transformer Meets 5-Cycle Temperature Test Requirements

STURDY TERMINALS ASSURE SECURE CONNECTIONS

HI-MU alloy plus a special sealing process! There, in a nutshell, is the reason why this capsule-size transformer operates with great stability under all climatic conditions . . . This is only one of our complete line of midget audio transformers and filter reactors . . . Our many years of pre-war experience has not only helped us solve the problems of war demands, but also prepares us to serve in the postwar future.

SUPER ELECTRIC PRODUCTS CORP.
1057 Summit Ave., Jersey City, N. J.

Manufacturers of Transformers for Power, Audio Frequency, Luminous Tube, Testing



WE HAVE WAYS WITH WAYWARD MATERIALS!

Plastics, filled with mica, have what it takes to function for highly specialized coils . . . at the same time, while in process, it takes all you've got to make the material behave!

Mica is difficult to handle . . . must be formulated with extreme care . . . the molds themselves must be ingeniously developed . . . flawlessly constructed . . . specially finished. Each step up to and through transfer molding calls for "babying"; otherwise, you get chips and flakes for your effort. Such a condition is *taboo!*

As you can note here, the finished parts are usually small—intricately designed—incorporate threading, flanges, holes, cut-aways and other specification set-ups. All call for mold mastery—the Consolidated way!

Inquiries invited from those whose present problems and postwar plans have reached the thinking-out stage. Consolidated guarantees *your blueprint in plastic*—the right plastic!

Consolidated
MOLDED PRODUCTS *Corporation*
309 CHERRY STREET, SCRANTON, PA.

CMP

BRANCHES: NEW YORK • CHICAGO
DETROIT • CLEVELAND • BRIDGEPORT

Callite components help Federal make the "Megatherm"

The Federal "Megatherm" Induction Heating Unit is designed to deliver a 25 kw output continuously at frequencies adjustable within a range of 2 to 5 mc. The use of this frequency range makes possible accurate control of heating depth and permits effective and speedy heating, soldering or brazing of brass, copper, aluminum alloys and steel.

The Federal Telephone and Radio Corporation long has relied on Callite for tungsten and molybdenum wire and fabricated parts such as filaments, filament supports, grid side rods, etc.

Callite processes tube components by methods perfected after years of research and experience. Let us cooperate with you. We may be able to save you time and money. Callite Tungsten Corporation, 544 Thirty-ninth St., Union City, N. J. Branch Offices: Chicago, Cleveland.

CALLITE TUNGSTEN CORPORATION CT

Callite *Tube components*

Hard glass leads, welds, tungsten and molybdenum wire, rod and sheet, formed parts and other components for electron tubes and incandescent lamps.

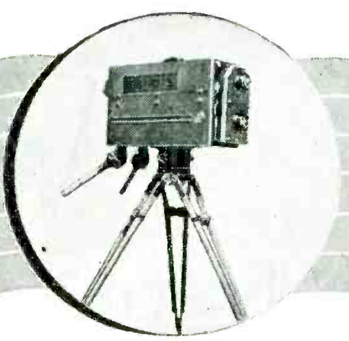
In Equipment for

RCA engineers developed the modern "all-electronic" system of television and introduced it to the public more than ten years ago. Practically all of the chief components of the television system in use today were devised by RCA engineers and first demonstrated in RCA equipment.

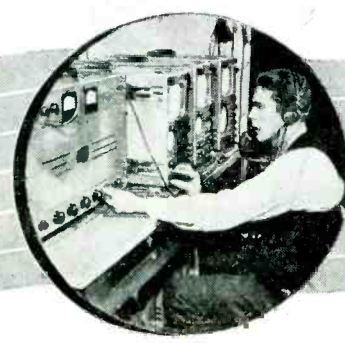
Before the war, RCA was the main builder of commercial television transmitting equipment — including cameras, control equipment, film scanners, audio and video transmitters, relay transmitters, antennas and field pickup equipment. A considerable number of these equipments are in use today in stations in this country and abroad.

RCA HAS EVERYTHING FOR TELEVISION

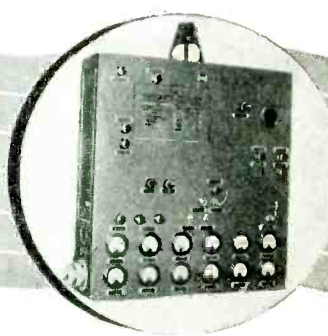
1. THE ICONOSCOPE — The "electric eye" of the television camera. Developed by Dr. V. K. Zworykin, RCA scientist, and brought to a high degree of perfection by RCA engineers.



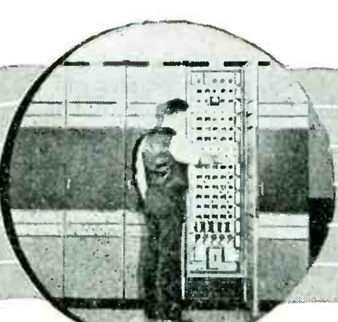
5. THE FIELD CAMERA — The RCA field pickup camera shown here is the first camera to use the "orthicon" pickup tube—by far the most satisfactory for "outside" pickups.



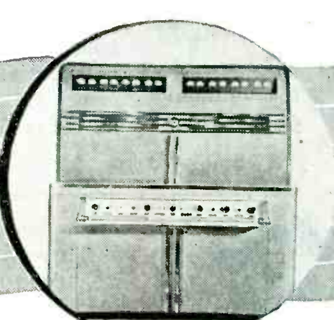
6. REMOTE PICKUP EQUIPMENT — RCA engineers built the first television equipment for field pickups—and the first such equipment (shown here) for use with the "orthicon" camera.



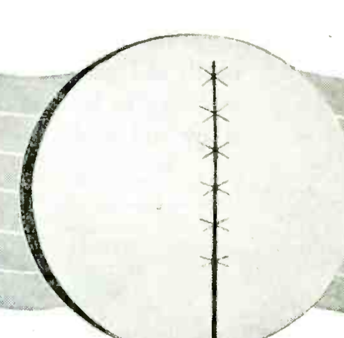
7. THE RELAY TRANSMITTER — The first transmitters to be used for television relaying were built by RCA engineers—the one shown here is for relaying from a remote pickup point.



11. THE SYNCHRONIZING GENERATOR— Furnishes the signals that key transmitter and receiver together. This type of synchronizing, now almost universally used, was developed by RCA.



12. THE VIDEO TRANSMITTER— The first commercially produced video transmitter, the 4 KW model shown here, was designed and manufactured before the war by RCA.

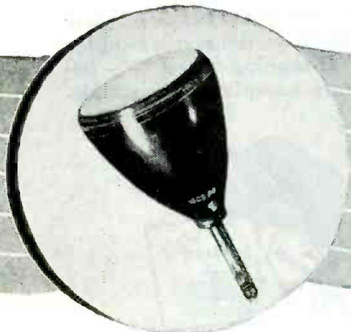


13. THE TELEVISION ANTENNA—RCA engineers have designed a large number of antennas for television. The turnstile antenna, shown here, was developed by Dr. G. H. Brown of RCA Laboratories.

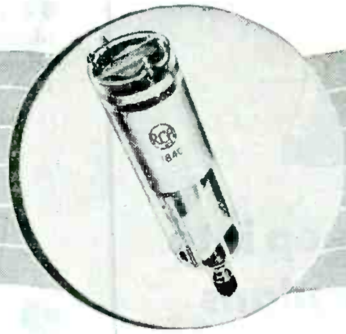
Television Broadcast Stations

Moreover, RCA engineers, having had actual experience in designing and building commercial television transmitting equipment, have, during the war, been adding to their experience by building for the services the most advanced type of radio and other electronic equipment.

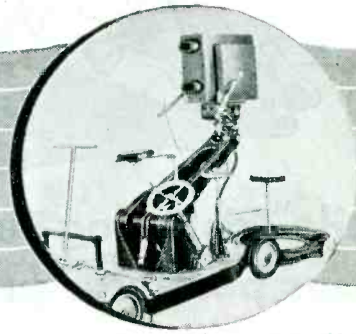
After the war, as before, RCA will be the leader in building television transmitting equipment. For television broadcast stations, RCA will offer a complete new line of equipment—highly efficient, simple to operate, and requiring minimum maintenance.



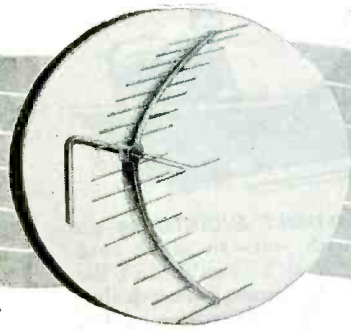
2. THE KINESCOPE — The reproducing tube used in all present-day receivers. Developed by Dr. V. K. Zworykin of RCA Laboratories as part of his "all-electronic" television system.



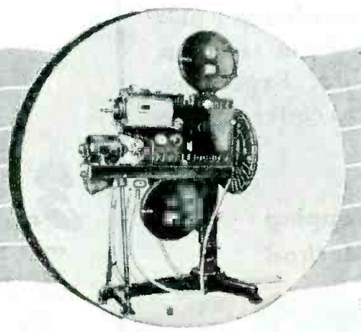
3. THE "ORTHICON" — The high-sensitivity pickup tube, which requires much less light and hence makes outside pick-ups practical. Developed by Dr. Rose and Dr. Iams of RCA Laboratories.



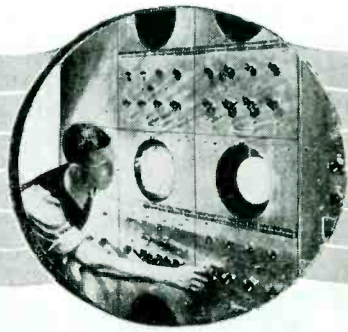
4. THE STUDIO CAMERA — Deluxe-type studio cameras shown here were first designed and built by RCA. Cameras of generally similar design are now used in nearly every television studio.



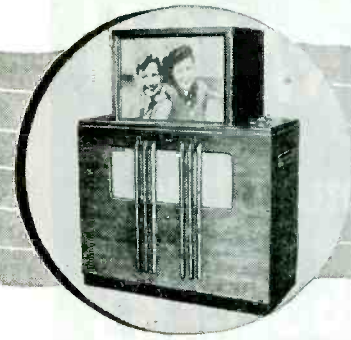
8. BEAM ANTENNAS — Beam antennas such as the one shown here, which may be used with the relay transmitter shown at left, are largely based on original RCA research.



9. THE FILM SCANNER — The arrangement which allows standard motion picture films (24 frames) to be televised over a 30-frame, interlaced system was devised by RCA engineers.



10. THE MONITOR EQUIPMENT—The system of monitoring several video channels by means of a picture tube and an oscilloscope for each channel was first used by RCA engineers.



14. "BIG SCREEN" RECEIVERS—RCA engineers designed and RCA factories built the first home television receivers. Their newest contribution, shown here, is the home receiver with a built-in, large-size screen for comfortable viewing from any point in an average-sized living room. Picture is unretouched.

BUY MORE WAR BONDS

RCA

For Everything in Television

RADIO CORPORATION OF AMERICA

RCA VICTOR DIVISION · CAMDEN, N. J.

Don't get caught Napping

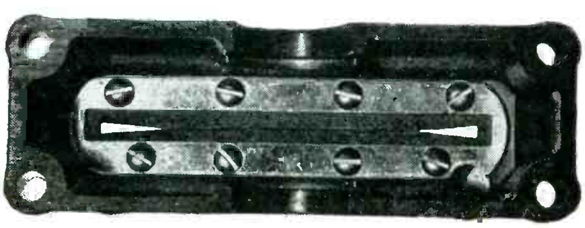
while "Fastening Bugs" creep into your post-war product plans

The time to decide on fastenings for your post-war product is *now* – while it is still in the design stage. Too many products are all tooled up and in production before "fastening bugs" are discovered. Why wait to change *later*? Why sacrifice the savings you could be making from the start?

You will want to use P-K Self-tapping Screws wherever possible, because this *short cut fastening method* can save you from 30% to 50% in assembly time and labor. Experience proves you can save time – speed assembly – cut costs – reduce rejects – in 7 out of 10 cases.

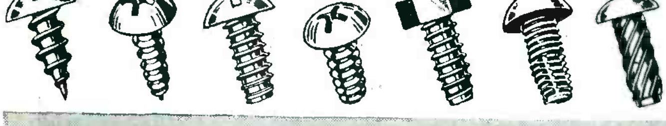
• • •

Sperry Products, Inc., eliminates tapping with the "Short-cut" Fastening Method



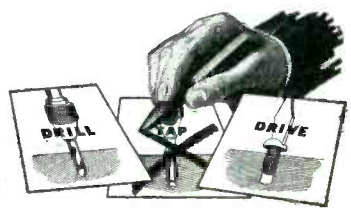
Eight P-K Type "F" Screws fasten a metal gasket retainer and gasket to an aluminum transmitter cover used on a Hydraulic Control mechanism.

"Tapping these parts would tie up equipment in our machine shop badly needed for other important operations, and seriously delay production," says a Sperry Engineer. Why not make sure of similar savings on your assemblies . . . clear out any needless tapping "bugs" hiding in your plans – *now*!

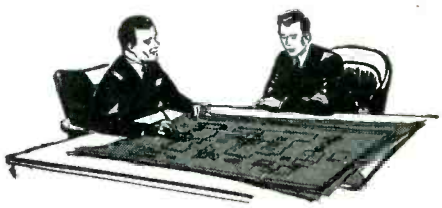


HERE'S HOW TO START ASSEMBLY SAVINGS WHEN YOU START PRODUCTION

1. ***QUESTION EVERY FASTENING*** **in your plans. Ask – "Can it be done the simpler way – with P-K Self-tapping Screws?" – before you O.K. more complicated methods.**



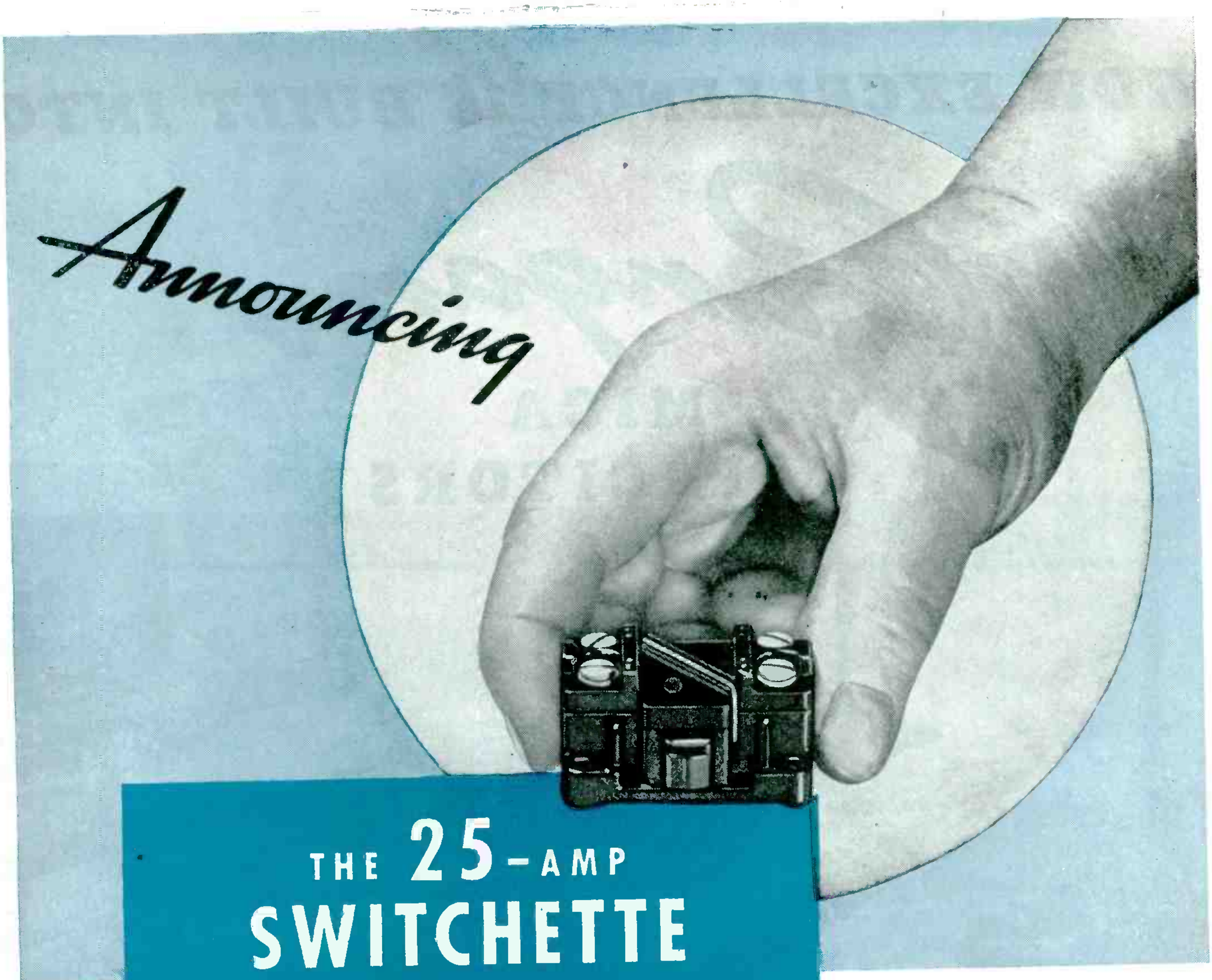
2. ***ELIMINATE NEEDLESS TAPPING,*** **awkward bolting, riveting in hard-to-reach places by specifying one of the several types of P-K Self-tapping Screws designed for all metal and plastics assemblies.**



3. ***ASK A P-K ASSEMBLY ENGINEER*** **to go over your plans with you – to make sure you find all the "bugs". You'll find his advice unbiased, because Parker-Kalon makes all types of Self-tapping Screws. Or, send assembly details for recommendations. Parker-Kalon Corporation, 208 Varick St., New York 14, N. Y.**

PARKER-KALON
Quality-Controlled
SELF-TAPPING SCREWS

For Every Metal and Plastic Assembly

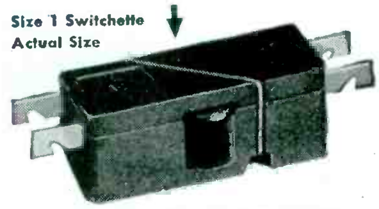


Announcing

THE 25-AMP SWITCHETTE

"Big" brother of our little 10-amp Switchette

Size 1 Switchette
Actual Size



THIS new form of G-E Switchette is suitable for a wide variety of limit-switch and other industrial control applications where space is limited and long life is required.

This new (Size 2) Switchette is rated 25 amperes at 24 volts d-c (115 volts a-c). It has screw-type terminals for easy wiring, and is completely enclosed for protection from dust.

Three contact arrangements are available: single-circuit, normally closed; single-circuit, normally open; and two-circuit. These Switchettes are suitable for use at altitudes up to 50,000 feet, and in temperatures from 93.5 C to minus 56.6 C. They resist corrosion and high physical shock and vibration, and are designed to withstand millions of mechanical operations.

Approximate dimensions are 2 by 1⅜ by 1 inch; approximate weight is 2 ounces. Ask your local office for Bulletin GEA-4259, which gives dimensions and complete description. *General Electric Company, Schenectady 5, N. Y.*

AND DON'T FORGET

We also have more than 200 forms of the original (Size 1) Switchette, as well as a variety of compact limit switches, transfer and selector switches, and other control devices built around this tiny contact mechanism. The Size 1 Switchette is rated 10 amperes at 24 volts d-c, and its dimensions are 1¼ by ½ by ½ inch. Bulletin GEA-3818 gives complete specifications and dimensions.

General Electric Company, Section 676-143
Schenectady 5, N. Y.

I would like to have more information on Switchettes. Please send me

.... Bulletin GEA-3818, covering Size 1
.... Bulletin GEA-4259, covering Size 2

Name ....

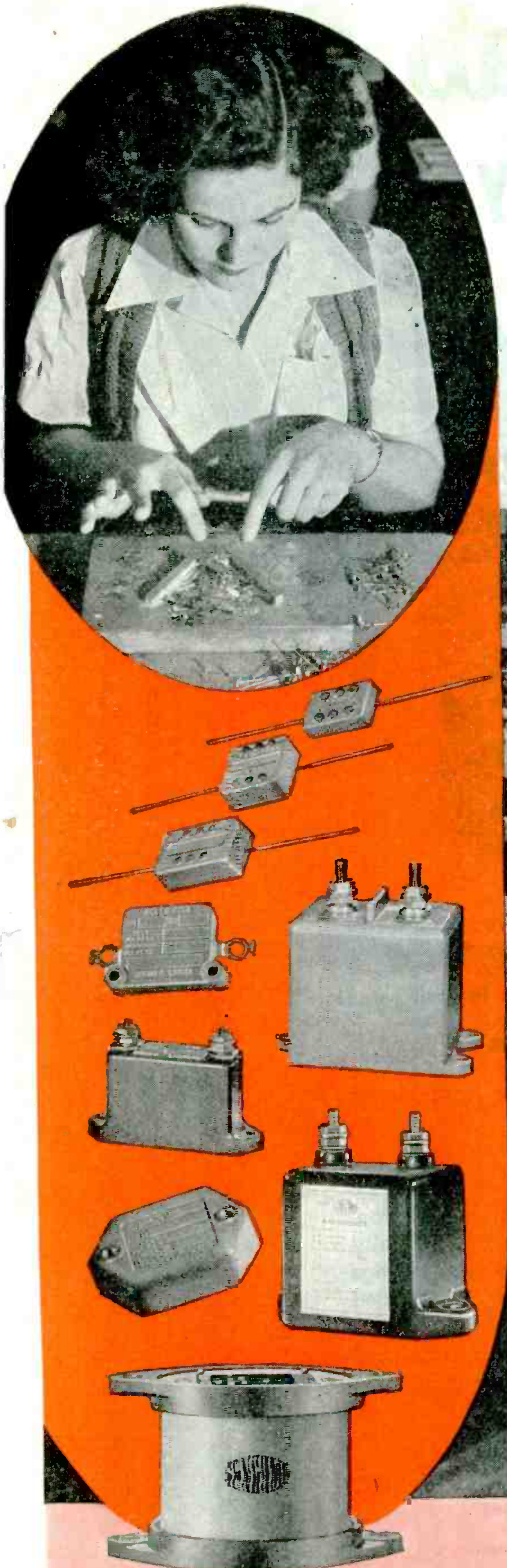
Company ....

Address ....

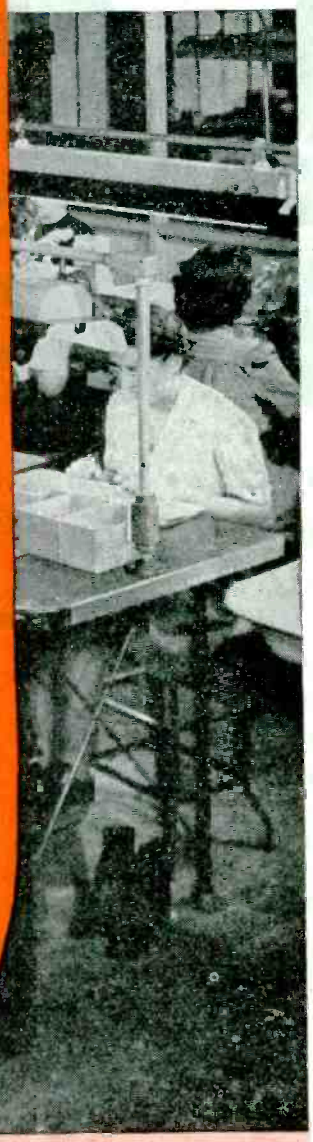
....
8940

Buy all the Bonds you can — and KEEP ALL YOU BUY

GENERAL ELECTRIC



★ *This operator is assembling mica and metal foils to form a unit which constitutes the essential element of a mica capacitor. Hand operators are utilized where only a few sheets of mica and foil are required for units of low capacitance value. Specially trained operators insure proper placing of component parts, resulting in a finished product of high quality.*



Hand Stacking

Capacitors utilizing mica as a dielectric are manufactured in a complete range of sizes, from very tiny wire lead units having capacity values of as low as 5 mmfd. to large ceramic-housed units having capacities which may be as high as several microfarads. Voltage ranges, too, vary from small units having dielectric strength test of only 300 volts or less, to those units built to withstand 40,000 or 50,000 volts or more.

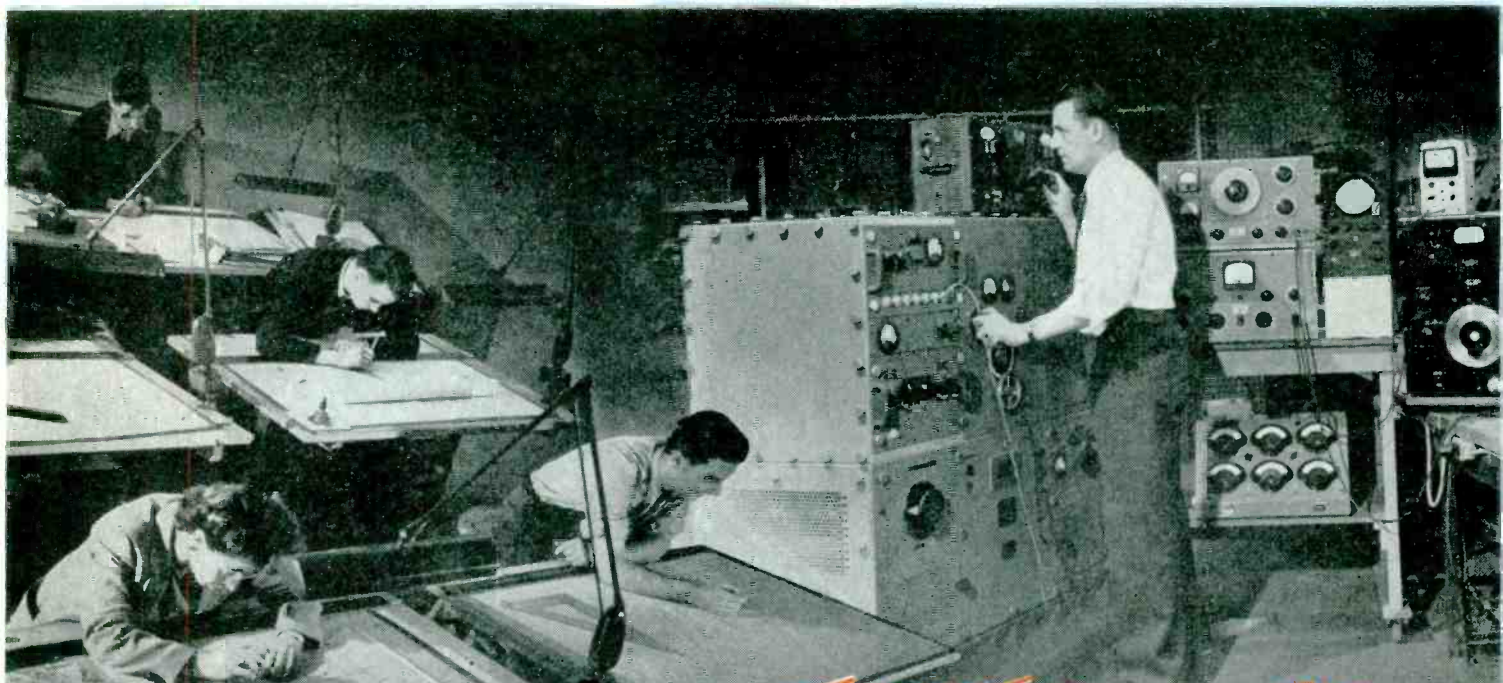
In the manufacture of the large units, the stacking of the mica element is performed by special machines designed for that purpose. In the manufacture of the very small units with low capacitance values, plates are sometimes utilized and it is, consequently, impractical to stack these with automatic equipment. In these cases, hand operators are utilized who become very skillful in stacking the alternate layers of foil and mica, and in keeping the exact alignment so necessary for the production of a good capacitor.

Where special characteristics are required, a silver deposit is sometimes placed on the mica and fired on, and thus becomes the conducting plate in the capacitor assembly. By firing silver on mica, very intimate contact is made with the dielectric, and as a consequence, stability, that is, capacitance drift, is improved and special temperature characteristics obtained. It is essential that the silver coating be of uniform texture, with clean, well defined edges, so as to prevent excessive corona and ultimate voltage breakdown of the capacitor unit. Sangamo builds many thousands of the silver mica capacitors each day and is well equipped to produce and test these units in accordance with the required characteristics.

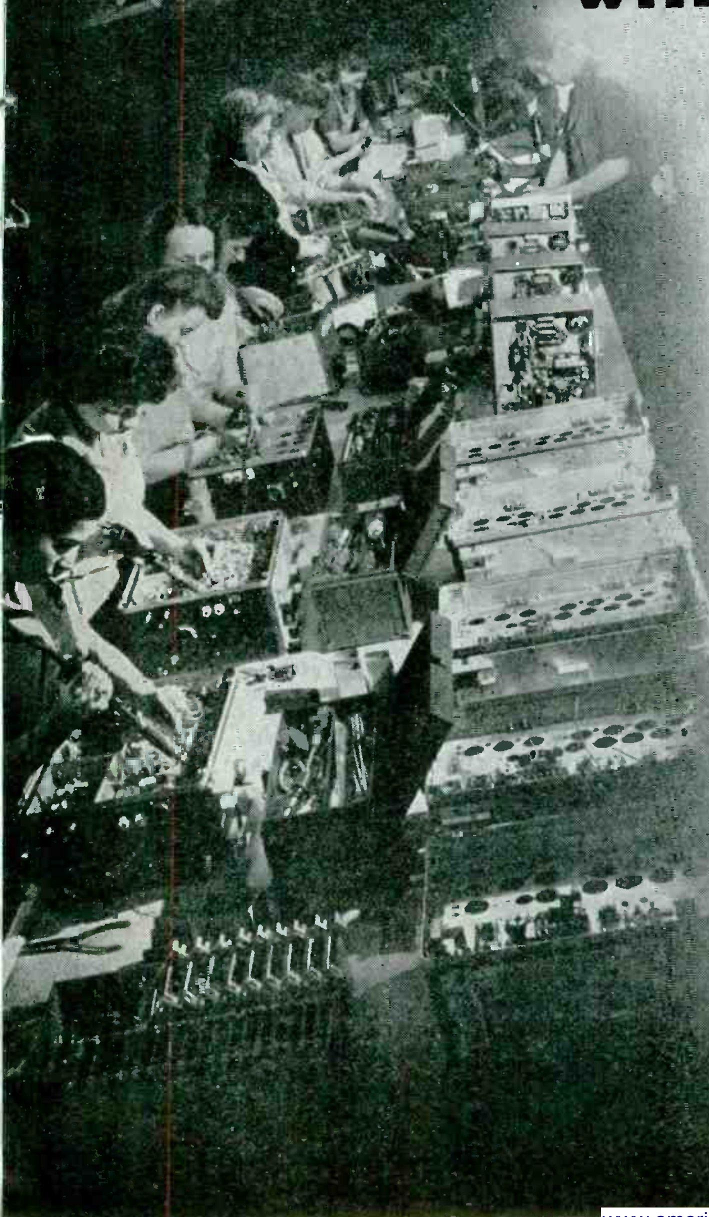
☆

COMPANY SPRINGFIELD ILLINOIS

. . WATT HOUR METERS . . . TIME SWITCHES . . .



Let TEMCO Versatility help solve your problems with electronics



TODAY many things are being done *better... faster* and more *economically* through the application of electronics. More and more, this amazing new science is performing miracles of increased efficiency in the fields of Communications, Medical Science and throughout all Industry.

In these ever broadening fields, Temco engineers are contributing heavily in the application of electronics to the manifold demands of war. Restrictions do not permit us to describe these achievements now but we can speak about the engineers who made them possible.

Underlying these accomplishments are the versatility and the vision of a closely knit organization of pioneering minds—rich in ideas—mature in judgement. Keeping pace with progress in radio research, they are constantly meeting the challenge of many new and diversified assignments.

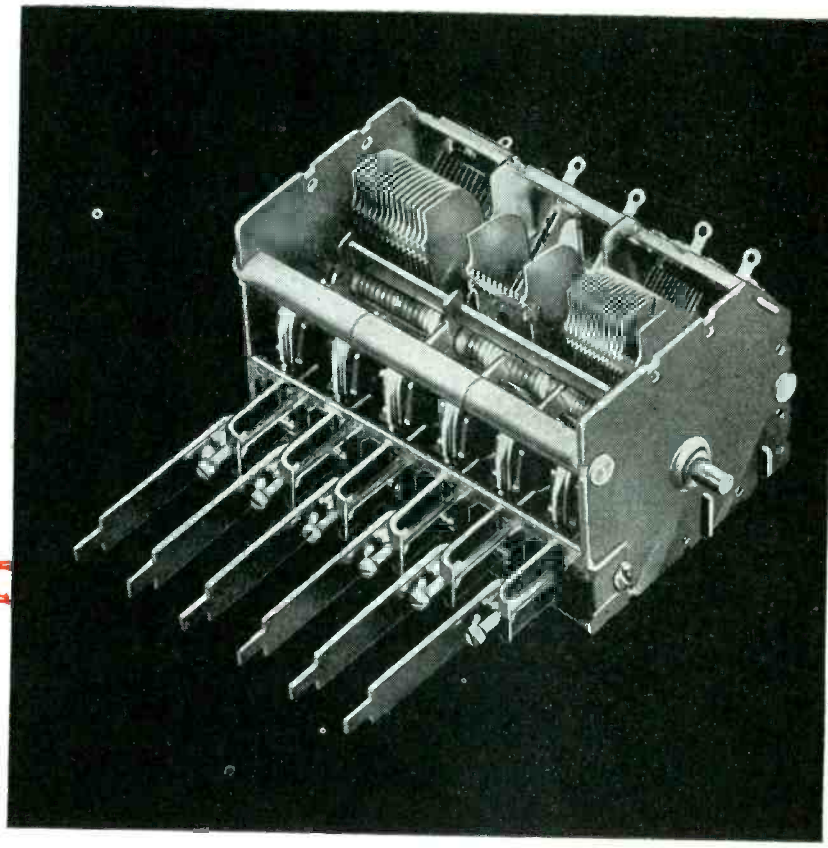
However complex or different your problem may be, bring it to Temco with the assurance that the concerted effort of specialists will yield results to satisfy your most exacting standards and requirements. Let us show you what we have accomplished for others.

TEMCO

RADIO COMMUNICATION EQUIPMENT

TRANSMITTER EQUIPMENT MFG. CO., INC.

345 Hudson Street, New York 14, N. Y.



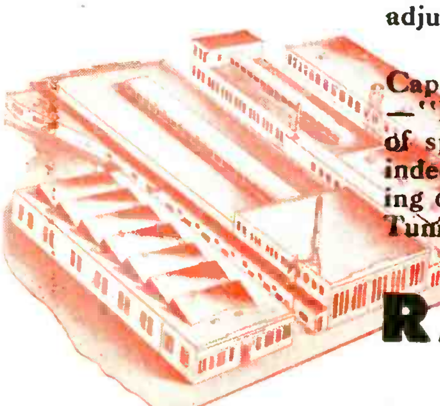
PRECISION MECHANICAL PUSH BUTTON TUNING

by R/C

THE demand will be greater than ever for Automatic Tuning on the Post-war radio.

For a long time past, R/C has led in the development of Mechanical Push Button Tuning Devices. Results have been sturdy, precision-built mechanisms, micro-adjustable to a high degree of accuracy.

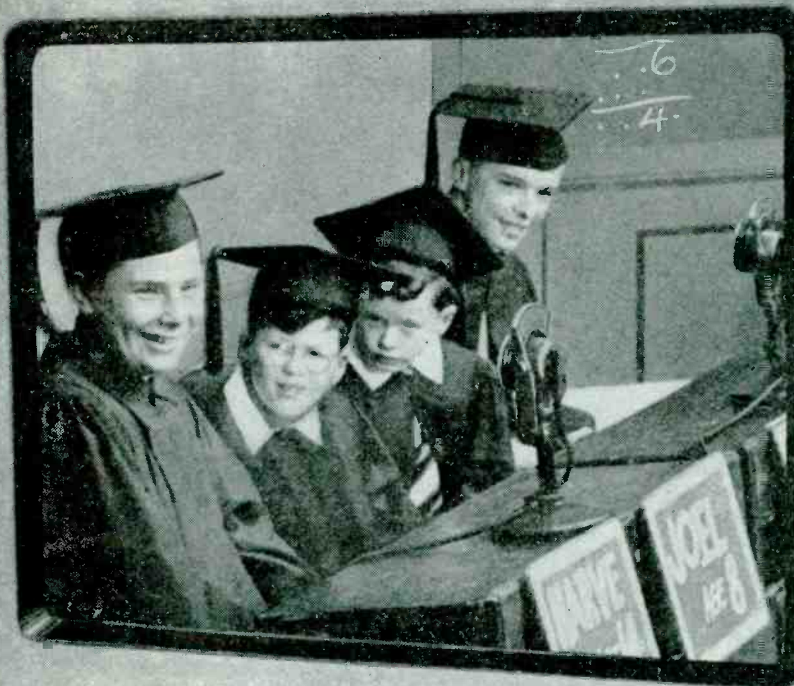
This and many other developments in the Variable Capacitor field attest to the "Know-how" of R/C engineers—"Know-how" gained through almost a quarter of a century of specializing in Variable Capacitors exclusively. Ours is indeed a background founded on a single aim—that of building ONLY Variable Capacitors and Mechanical Push Button Tuning Devices and building them well.



RADIO CONDENSER CO.

CAMDEN, N. J.

RADIO CONDENSER COMPANY, LTD., TORONTO, CANADA



The *Quiz Kids* say:

"DuMONT TELEVISION IS COSMIC LEGERDEMAIN"

You will agree that these diminutive stars,* while rarely at loss for correct answers, are seldom available when prospective operators of postwar Television stations have questions to ask. Fortunately, DuMont Television "know how" can be tapped as needed . . . cost and engineering data on every phase of station design, construction and operation . . . the accumulated knowledge gained through more than 4 years' station management and production of programs.

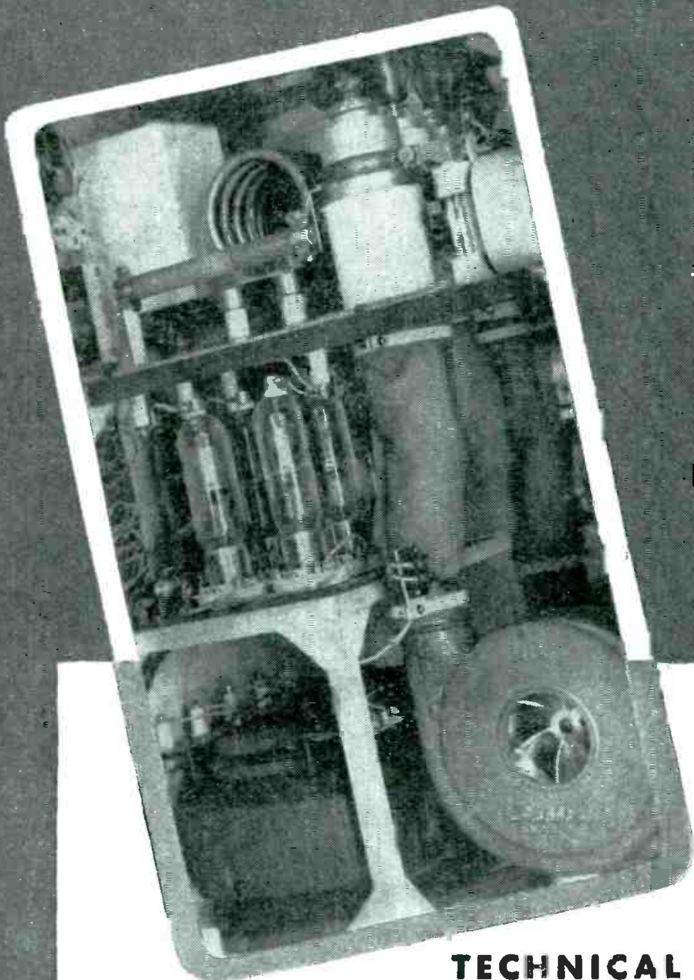
The low operating cost, extreme flexibility and rugged dependability of DuMont Television transmitting equipment are being convincingly demonstrated week-in and week-out in 3 DuMont-equipped stations. New postwar designs embody all wartime advances. You can arrange *now* for early peacetime delivery of station equipment and training of personnel through the DuMont Equipment Reservation Plan. Visit DuMont's Station WABD, New York. Call, write or telegraph for appointment . . . Station Equipment Sales Division, Allen B. DuMont Laboratories, Inc., 515 Madison Avenue, New York 22, N. Y.

*Appearing Sunday evenings on the Blue Network.

DUMONT *Precision Electronics and Television*

ALLEN B. DuMONT LABORATORIES, INC., GENERAL OFFICES, 2 MAIN AVE., PASSAIC, N. J.
TELEVISION STUDIOS AND STATION WABD, 515 MADISON AVENUE, NEW YORK 22, N. Y.

PACKED WITH POWER



THE NEW Thermatron "HEATMASTER"

ELECTRONIC DIELECTRIC HEAT GENERATOR 5 KW OUTPUT*

Looking into electronic dielectric heating applications for **your** business? Specify the 5 KW "Heatmaster" — get enough power. Many important production savings through use of high frequency heating have been passed up due to insufficient power in making initial tests.

TECHNICAL DATA

OUTPUT—5 KW plus.

INPUT—3 KVA (approximate).

LINE VOLTAGE—220 volt 60 cycle, 3 phase.

FREQUENCY—30 mc. — 15 mc. 5 mc. optional.

HEAT OUTPUT — Up to 17,000 BTU's per hour

OUTPUT CIRCUIT—Permits heating of loads of widely varying characteristics with a minimum amount of adjustment.

TUBES—New long-life external anode tubes.

SIZE—24" wide; 28" deep; 59" high.

WEIGHT—Approximately 1000 lbs.

Completely self-contained ready-to-use. A compact power-packed model, particularly designed for heavy-duty where floor space is at a premium. Will heat a 3.3 pound preform in one minute or a 5 pound preform in 90 seconds. Its generous capacity also makes it suitable for rugged general purpose production use as well as research requirements involving substantial power.

Complete specifications of the new **THERMATRON** "Heatmaster" and other standard models from 500 watts to 30 kilowatts contained in our new circular sent on request. Custom equipment up to 125 KW designed and built.

**All Thermatrons rated on output*

Thermatron Division

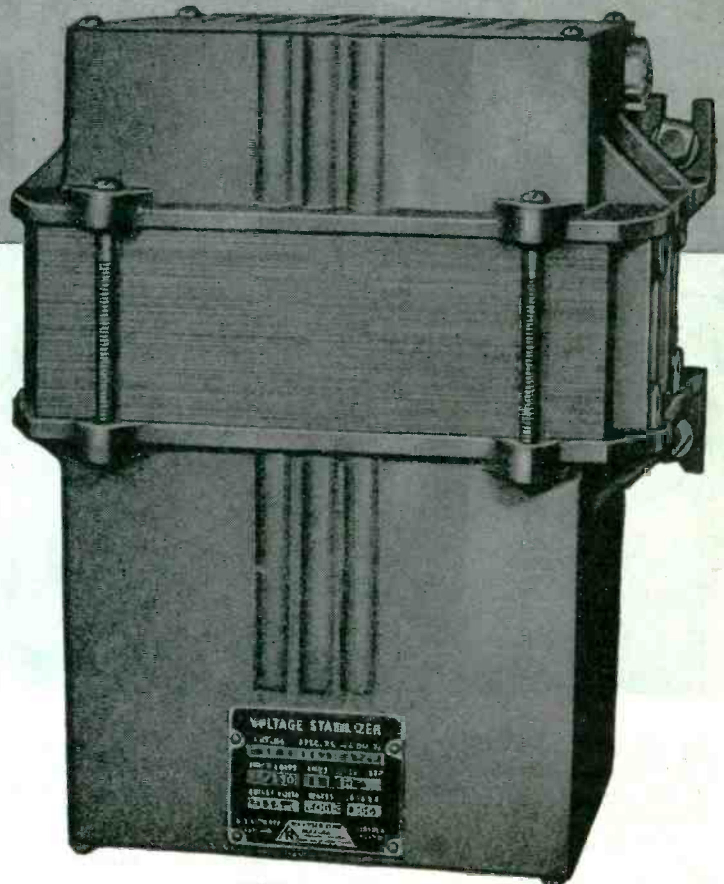
RADIO RECEPTOR COMPANY, INC.

251 WEST 19th STREET NEW YORK 11, N.Y.

Engineers and Manufacturers of Airway and Airport Radio Equipment

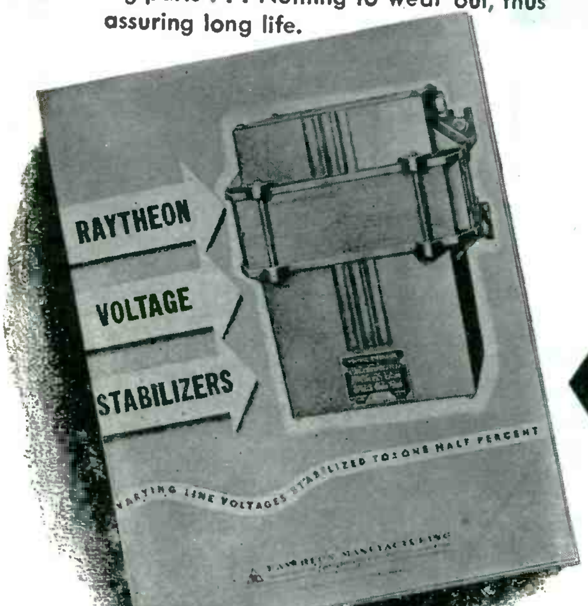
SINCE 1922 IN RADIO AND ELECTRONICS

How RAYTHEON VOLTAGE STABILIZERS Assure Dependable Operation of Precision Equipment



ENDBELL MODEL

- **CONSTANT AC OUTPUT VOLTAGE**
  Raytheon Voltage Stabilizers control fluctuating input voltages and hold constant output voltage to ±½%.
- **WIDE AC INPUT VOLTAGE LIMITS**
  Raytheon Voltage Stabilizers will stabilize input voltages varying from 95 to 130 volts.
- **QUICK RESPONSE**
  Raytheon Voltage Stabilizers stabilize the varying input voltage *within 2 cycles.* Variations cannot be observed on an ordinary volt meter.
- **ENTIRELY AUTOMATIC**
  Raytheon Voltage Stabilizers are entirely automatic in operation. They require no adjustments or maintenance.
- **NO MOVING PARTS**
  Raytheon Voltage Stabilizers have no moving parts . . . Nothing to wear out, thus assuring long life.



SEND FOR THIS NEW BULLETIN . . .

It contains a complete description of how the stabilizer operates, its advantages, performance curves, dimensions and other pertinent facts. Simply request Bulletin DL 48-537 and your copy will be promptly mailed.

The coveted Army-Navy "E", for Excellence in the manufacture of war equipment and tubes, flies over all four Raytheon Plants where over 12,000 men and women are producing for VICTORY.

RAYTHEON MANUFACTURING Company
190 WILLOW ST WALTHAM, MASS

• The reproducer unit in this loud speaker was especially developed by JENSEN for use in the intercom systems in navy vessels. It reproduces speech clearly and sharply through high levels of noise. Ruggedly built, it withstands extreme shock and vibration, and is weatherproof against severe weather exposure conditions, dust and smoke . . . Like all JENSEN military models, this speaker is built around the most powerful permanent magnet material ever developed, ALNICO 5, as all JENSEN PM Speakers will be when conditions permit.

Now being introduced for the intercom systems on trains, and specifically designed for that purpose, this particular model has many possibilities for use wherever a heavy, rugged speaker with clear, sharp speech reproduction is needed. Write for complete engineering data on this speaker. Samples can be furnished on proper priority.

Jensen SPEAKERS WITH ALNICO 5

Specialists in Design and Manufacture of Acoustic Equipment

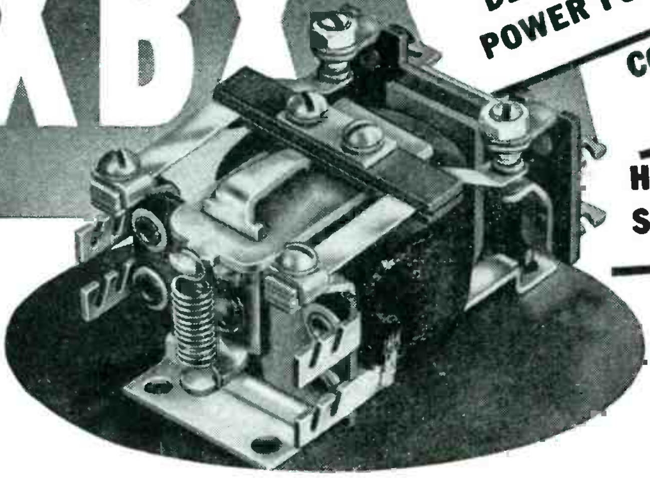
JENSEN RADIO MANUFACTURING COMPANY, 6601 SOUTH LARAMIE AVENUE, CHICAGO 38, ILLINOIS

10XBX

DELIVERS A LOT OF POWER FOR ITS SIZE

COVERS A WIDE RANGE OF APPLICATIONS

HIGHLY RESISTANT TO SHOCK AND VIBRATION



...A GOOD RELAY TO KNOW!

If any Relay type ever deserved the name "All-Purpose" it is Type 10XBX of the Struthers-Dunn 10-frame series. While new and special types come and go, this popular 2P. D.T. relay continues in heavy favor with leading users to whom its extreme versatility on a wide range of applications holds strong appeal. From audio frequency circuits to motor control circuits; from naval battle announcing stations where shock resistance is important, to aircraft use where vibration is a big factor, 10XBX relays are performing competently and well.

These relays are light, small, and sturdy. Highly electrically efficient, they deliver a lot of power for their size. Contact pressures up to 50 grams are available. Bakelite insulation is supplied for power circuit applications, and ceramic insulation for radio-frequency use. A-C coils to 115v, 60 cycles; or d-c coils to 115v are available. Contacts may be in any desired combination up to and including 3 pole, double throw. All 10XBX relays withstand 10G vibration and are highly resistant to shock. Other relays of the 10-frame series are available in either single or three pole contact arrangements.

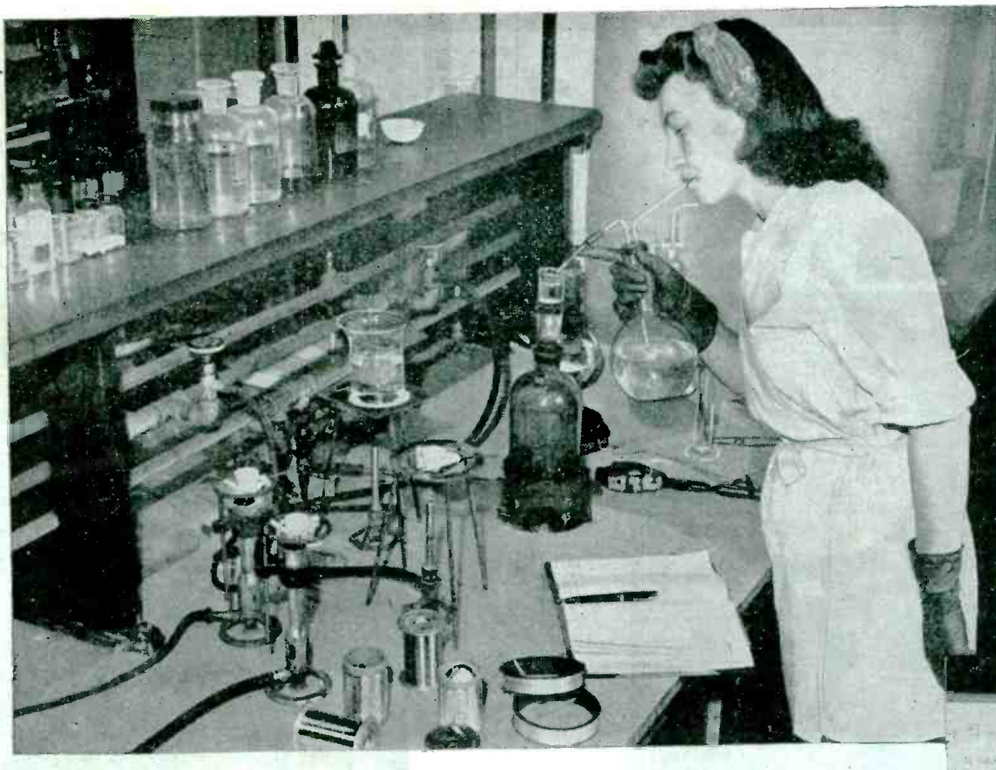
STRUTHERS-DUNN, Inc., 1321 ARCH ST., PHILADELPHIA 7, PA.

WRITE *for the big Struthers-Dunn 48-page Catalog and Relay Engineering Data Book.*

STRUTHERS-DUNN

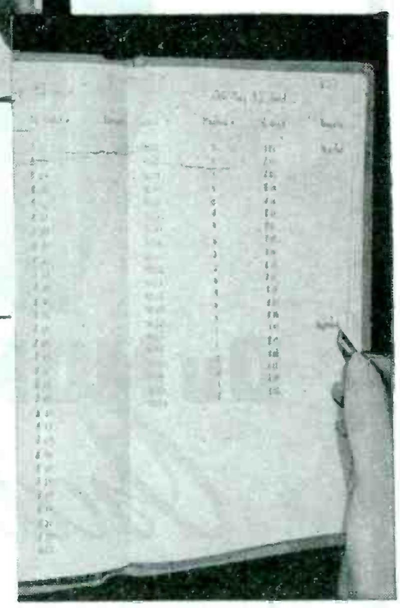
5,312 RELAY TYPES

DISTRICT ENGINEERING OFFICES: **ATLANTA • BALTIMORE • BOSTON • BUFFALO • CHICAGO • CINCINNATI • CLEVELAND DALLAS • DENVER • DETROIT • HARTFORD • INDIANAPOLIS • LOS ANGELES • MINNEAPOLIS • MONTREAL NEW YORK • PITTSBURGH • ST. LOUIS • SAN FRANCISCO • SEATTLE • SYRACUSE • TORONTO • WASHINGTON**



Preparing a unit sample of fine wire for checking percentage of gold by weight of base metal. This chemical operation removes the wire core. Each spool is tested and recorded in test book (see below).

Checking Amount of Gold on Clad Wire



The superior quality of NORELCO gold-clad fine wire is the result of closely-controlled processing techniques and rigid tests that insure precise adherence to all customers' specifications.

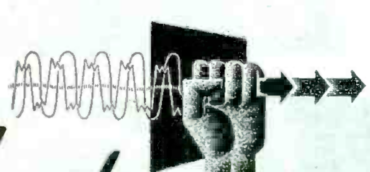
As an example, the special cladding equipment designed by our engineers can coat fine wire with percentages of gold by weight ranging from 0.1% to heavy layers with great accuracy. Where tolerances are not specified, the gold coating is made slightly in excess of the percentage called for.

To make sure that tolerances are being maintained, a specimen from each spool is tested for its gold percentage. A unit sample is chemically treated to dissolve the base metal, and the remaining gold weighed on precision scales.

North American Philips manufactures gold-clad fine wire up to .010" diameter in base metals of silver, tungsten, molybdenum and radio alloys. We also manufacture fine wire below .003" in silver, copper, nickel-chrome, aluminum alloy and other metal alloys. Radio tube manufacturers have found our unusual skill of great value in helping them meet wartime production schedules and reduce material shrinkage. North American Philips has the knowledge of processes and techniques developed by an organization with a background of over half a century in the electrical field. Call on our specialized engineering service whenever you have a fine-wire problem.

OTHER PRODUCTS: In addition to fine wire and diamond dies for our own drawing, we make: Tungsten and Molybdenum products; Quartz Oscillator Plates; Amplifier, Transmitting, Rectifier and Cathode Ray Tubes; Searchray (Industrial X-ray) Equipment; X-ray Diffraction Apparatus; Medical X-ray Equipment, Tubes and Accessories. We invite you to visit our office and showroom when in New York City.

Where NORELCO Fine Wires Are Used in the Electronics Field — Precision wire-wound resistors; hearing aids; radio head phones; sensitive recording and indicating meters; sensitive relays; electronic tube grids and filaments; fractional horsepower motors and hundreds of other uses wherever fine wire is required.



Send for NORELCO Fine Wire Booklet on your letterhead. It contains valuable conversion tables for ready reference of buyers and design engineers.

North American Philips Company, Inc.
100 East 42nd Street, New York 17, N. Y.

Gentlemen:

Please send me a copy of your booklet "Norelco Fine Wire."

Name ____________

Title ____________

Company ____________

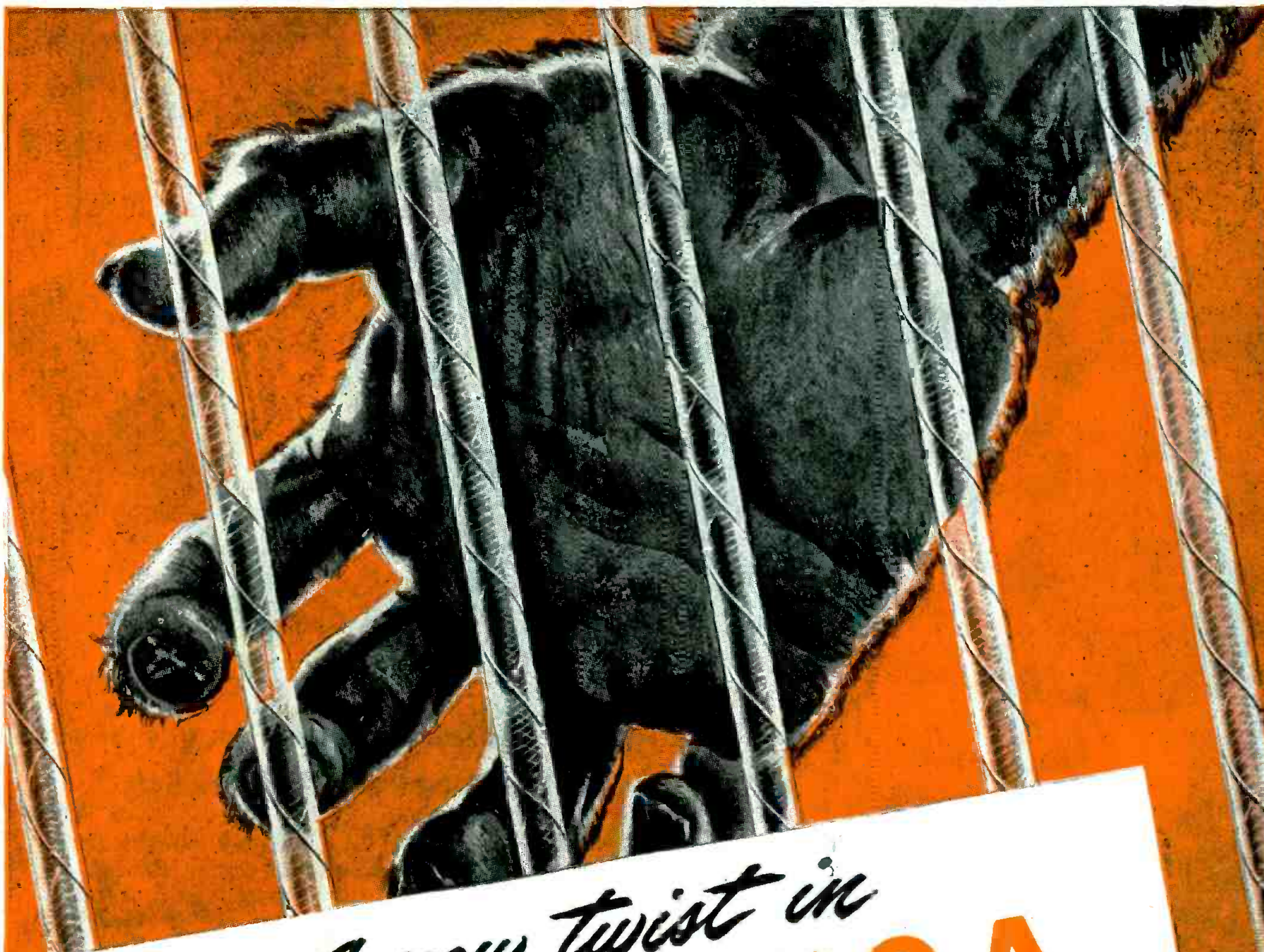
Address ____________

Dept. S-5

Norelco Reg. U. S. Pat. Off. ELECTRONIC PRODUCTS by

NORTH AMERICAN PHILIPS COMPANY, INC.

Executive Offices: 100 East 42nd Street, New York 17, N. Y.
Factories in Dobbs Ferry, N. Y.; Mount Vernon, N. Y. (Metalix Division); Lewiston, Maine (Elmet Division)



. . . for thinking he couldn't afford to use these AMERICAN PHILLIPS SCREWS!"

Yes, it's always a shock (*but a welcome one!*) to see how much has been missed by sticking to slotted screws because of a mistaken idea that American Phillips Screws cost more. In small shops and big plants, cost-comparisons, production sheets and inspectors' reports always tell this same story: *The screws that really COST LEAST to use are American Phillips Screws.*

And that's simply because an American Phillips Screw is not a *loose end* on the driver. It's a firm-fitting, self-aligned *part* of the 4-winged Phillips driver which can't twist out or drive crooked. This means ease and certainty of handling and operation which pays off in time-savings of at least 50% in unscarred work-surfaces and unbroken screw-heads . . . in lower fatigue and higher morale among workers . . . in higher output and lower fixed costs.

And there are still other cost-cutting advantages in the *American* brand of Phillips Screws . . . 3-point inspection of head, thread and point, to give you highest "perfection-percentage" in every lot of screws shipped . . . and American engineering experience to solve your special fastening problems.

Try American Phillips Screws yourself . . . and see how they cut *your* costs, too.

AMERICAN SCREW COMPANY, PROVIDENCE 1, RHODE ISLAND

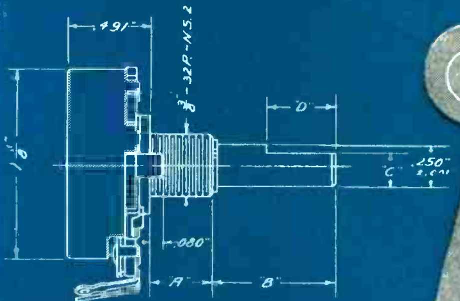
Chicago 11: 589 E. Illinois Street — *Detroit 2:* 502 Stephenson Building

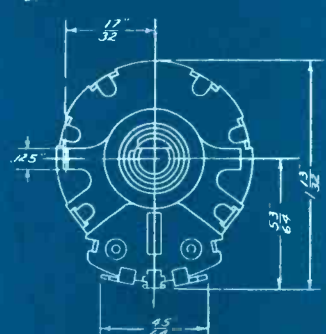
PUT THE SCREWS ON THE JAPS . . . BUY WAR BONDS

AMERICAN PHILLIPS *Screws*

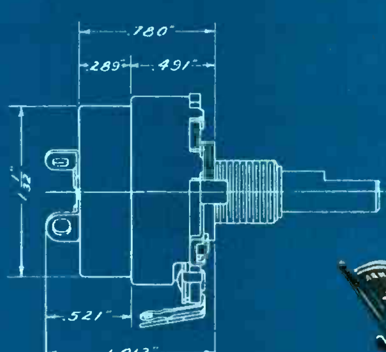
Dependable VARIABLE RESISTORS

SPACE REQUIREMENTS FOR 35 SERIES AND AC-35 SERIES

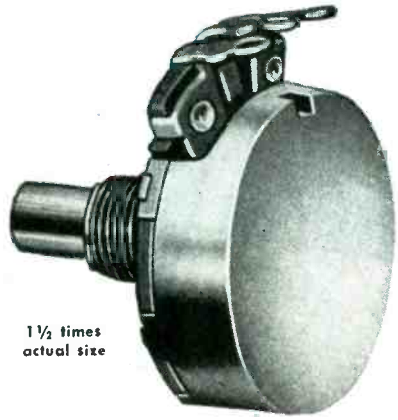




35 SERIES (above)



AC-35 SERIES



1½ times actual size

Dependability in CTS variable resistors is considerably more than just meeting a customer's specifications. Years of research and experience in this one highly specialized field have taught CTS engineers to fit their products to each customer's *needs*.

It sometimes happens, in the hectic process of drawing up specifications for a new product, that some slight error creeps in. This must be corrected later at the manufacturer's expense. CTS avoids this costly procedure by submitting samples on each variable resistor order for new applications. Thus oversights are corrected *before* production begins.

Such complete dependability in every phase of operation has made CTS variable resistors the leaders throughout the world.

CTS delivery promises are as dependable as CTS products. For your variable resistor needs, call on Chicago Telephone Supply Company.

Manufacturers of Quality Electro-Mechanical Components Since 1896

VARIABLE RESISTORS
PLUGS AND JACKS
SWITCHES, RINGERS
TELEPHONE GENERATORS

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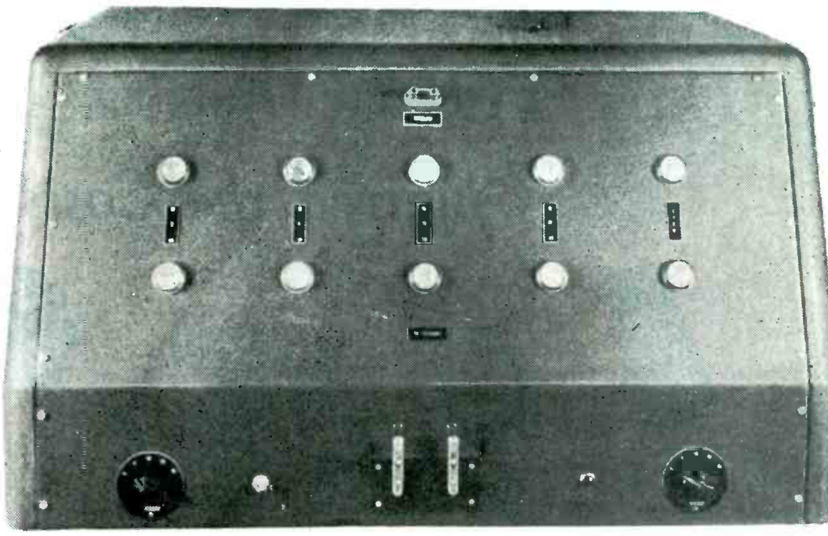
Visual and Audible indication

ACCURATE TO .1%

PRECISION TOLERANCE BRIDGE



MODEL SE 10

Quality Control Minus Risks of Human Failure

Electronically, "GO-NO-GO" Visual Gauge Can Be Used As:

- Inspection Tool—for incoming inspection of components (condensers and resistors) to act as a safeguard against faulty components and as a quality safeguard for the equipment manufacturer.
- An indispensable tool on the production line, this unit serves as an automatic filter to grade components for their individual tolerance.
- Overall precision of unit is .1%.
- Checks A.C. resistance and impedance, capacitance and inductance.
- No controls for operator to adjust or set.
- Test is automatic.
- Human error is eliminated by substitution of indicating lights for tolerance reading.
- Visual and audible indication of rejects, instead of meter readings.
- Each tolerance in percentage steps has its individual light.
- Can be used by anyone; knowledge of inspecting procedure is unnecessary.
- Eliminates the error of parallax in meter readings.

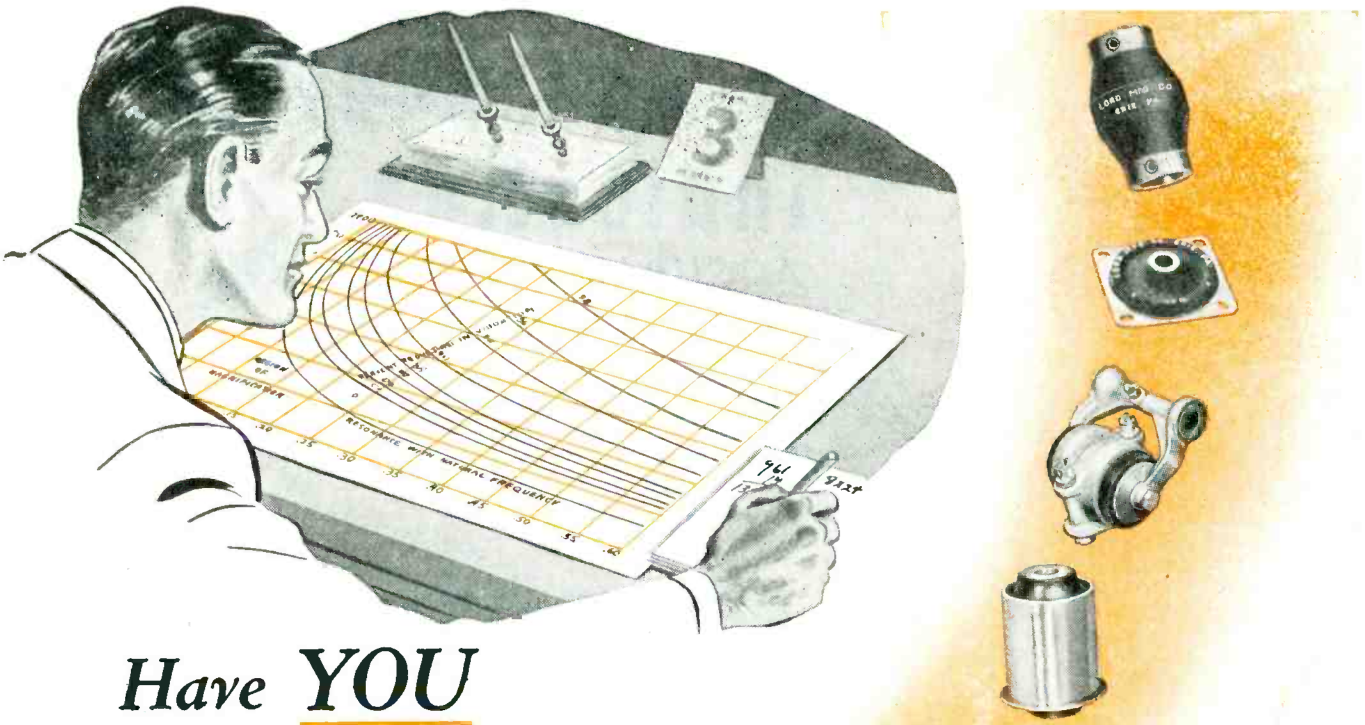
Sherron Electronics

SHERRON ELECTRONICS COMPANY

Division of Sherron Metallic Corporation

1201 FLUSHING AVENUE, BROOKLYN 6, N. Y.

"Where the Ideal is the Standard, Sherron Units are Standard Equipment"



Have ***YOU***
figured the Costs of Vibration?

VIBRATION shortens the life of all types of equipment ranging from light delicate instruments to heavy, massive machinery. Vibration lowers workers' morale, slows them up, increases absenteeism. Vibration is the enemy of efficiency. Lord is the enemy of vibration.

Lord is the Pioneer and leader in the science of vibration control and isolation, and Lord Shear Type Mountings and other Bonded Rubber Products are the embodiment of many exclusive techniques and patented features developed through years of research and practical application.

The bond in Lord Mountings between metal and rubber is as strong as the rubber itself, guaranteeing against failure of the mounting under stress which the rubber itself can take.

The rubber element in Lord Mountings is designed and molded to throw flexing action away from the metal parts into the rubber body, preventing stress concentration at the edge of the bond.

The rubber, either natural or synthetic, is carefully compounded to possess the correct degree of stiffness and other qualities required in the job for which the mounting is designed.

Lord designs and processes allow the rubber element to function in free shear without chafing, providing uniformity of action and resulting in a greater degree of vibration control.

Proper application of the Lord plan of scientific analysis and control make it possible to reduce by 80% or more, the destructive forces of vibration. Without obligation to you, Lord Engineers will make a study of vibration problems in your product, offering recommendations for its effective reduction and control.

LORD
SHEAR TYPE
Bonded Rubber
MOUNTINGS

IT TAKES **BONDED RUBBER** *In Shear* TO ABSORB VIBRATION

LORD MANUFACTURING COMPANY
ERIE, PENNSYLVANIA

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RAILWAY & POWER ENGINEERING CORP., LTD
TORONTO, CANADA

★
BUY EXTRA
WAR BONDS
★

Originators of Shear Type Bonded Rubber Mountings

HOW hallicrafters EQUIPMENT COVERS THE SPECTRUM

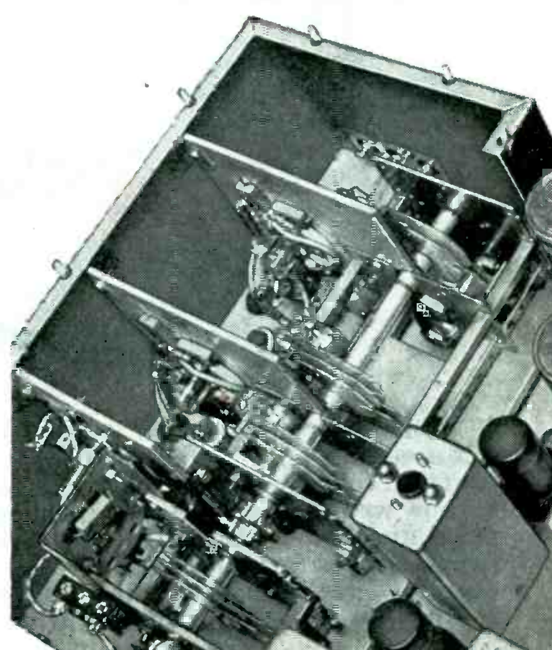
Model S-37

FM-AM

for very high frequency work 130 to 210 Mc.

THE new Model S-37 FM-AM receiver is an outstanding example of Hallicrafters pioneering work in the upper regions of the spectrum. Covering the frequencies between 130 and 210 megacycles, the S-37 provides VHF performance which is in every way comparable to that of the finest communications receivers operating in the medium and high frequency bands. The average over-all sensitivity of the S-37 is approximately 5 microvolts. The image ratio of at least 1000 times is achieved through the use of two pre-selector stages and an intermediate frequency of 16 megacycles. No band switching is necessary and exceptional ease of tuning is provided by mechanical band-spread with 2300 dial divisions between 130 and 210 megacycles. The pre-loaded gear train is completely enclosed and is equipped with a positive stop at each end of the tuning range. Hermetically sealed transformers and capacitors, moisture proof wiring, and extra heavy plating, all contribute to the long life and reliability of the S-37 . . . the only commercially built receiver covering this frequency range.

The amazing performance of the Model S-37 is largely due to the RF section shown at right. It is mounted as a unit on a brass plate 1/4 inch thick. The two type 954 RF amplifiers and the type 954 mixer are placed in the heavy shields which separate the stages. The type 955 oscillator is mounted directly on its tuning condenser. Exceptional stability is assured by the use of individually selected enclosed ball bearings, extra-heavy end plates, and wide spacing in the oscillator condenser – rigid mounting of all components – and inductances of 1/8 inch copper tubing wound on polystyrene forms. All conducting parts are heavily silver plated.



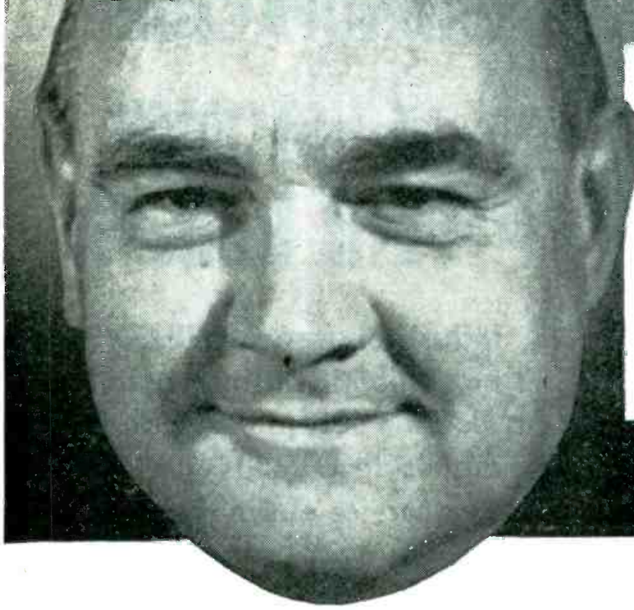
Write for Catalog No. 36H, describing Hallicrafters complete line of high frequency receivers and transmitters.

BUY A WAR BOND TODAY!

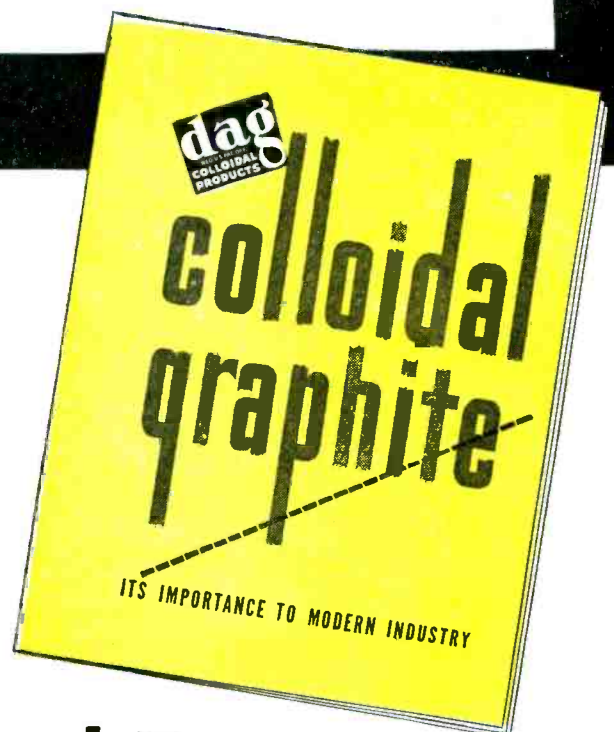
hallicrafters RADIO

THE HALLICRAFTERS CO., MANUFACTURERS OF RADIO AND ELECTRONIC EQUIPMENT, CHICAGO 16, U.S.A.

You can SOLVE PROBLEMS like these:



- Electrostatic Shielding
- Corona Prevention
- Undesired Thermionic Emissions
- Variable Condenser Lubrication
- Electrodes for Light Sensitive Cells



Bulletin No. 430

Not so long ago, headaches in the electronics industries like those in the box above were considered insurmountable. That was before Acheson engineers had developed the versatile new dispersions of "dag" colloidal graphite. Today, with almost a score of colloidal and semi-colloidal products available, you may obtain real assistance from this amazing material.

There are several new booklets and bulletins ready to help you become better informed about "dag" colloidal graphite. Check the list below and use the convenient coupon to send for free copies of those which fit your specific needs.

dag REG. U.S. PAT. OFF. **colloidal graphite**

ACHESON COLLOIDS CORPORATION, Port Huron, Michigan

TO GET THESE:

This new literature on "dag" colloidal graphite is yours for the asking:

- **430** A general booklet on the story of "dag" colloidal graphite. 12 pages profusely illustrated.
- **440** A complete list of "dag" colloidal graphite dispersions with applications.
- **421** "dag" colloidal graphite for ASSEMBLING AND RUNNING-IN ENGINES AND MACHINERY.
- **422** "dag" colloidal graphite as a PARTING COMPOUND.
- **423** "dag" colloidal graphite as a HIGH TEMPERATURE LUBRICANT.
- **431** "dag" colloidal graphite for IMPREGNATION AND SURFACE COATINGS.
- **432** "dag" colloidal graphite in the FIELD OF ELECTRONICS.

MAIL THIS:

JML Co. A-EI

ACHESON COLLOIDS CORPORATION
PORT HURON, MICHIGAN DEPT. 5-E

Please send me, without obligation, a copy of each of the bulletins checked:

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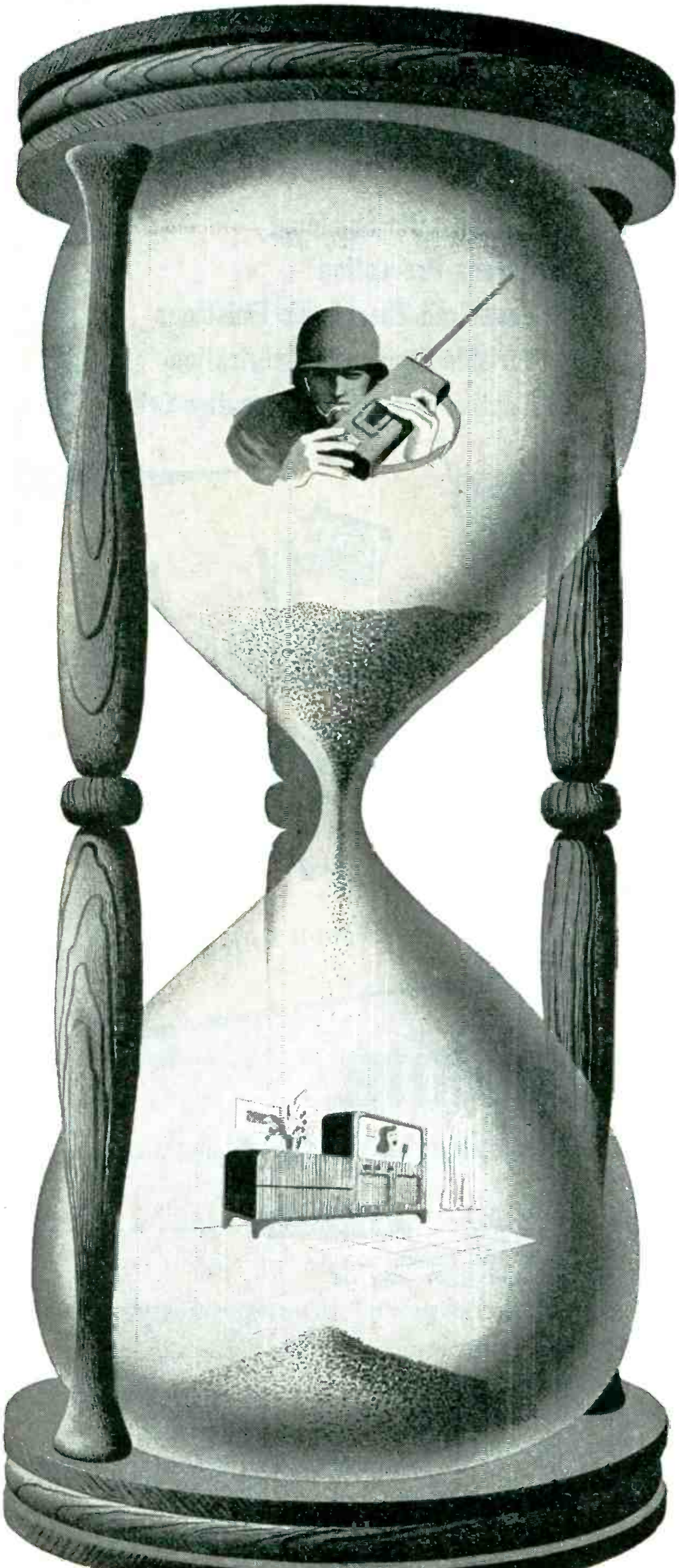
No. 440 ☐ POSITION ____________
No. 421 ☐ FIRM ____________
No. 422 ☐ ADDRESS ____________
No. 423 ☐ ZONE No. ________ STATE ________
No. 431 ☐ OUR PRESENT OIL SUPPLIER IS ____________
No. 432 ☐ (Lubricants containing **dag** colloidal graphite are available from major oil companies.)



Every MANUFACTURING CUSTOMER Will Benefit

Industrial users of WILCO Products will find the increased facilities, the new products and techniques developed by WILCO for war service of great advantage to their own postwar products.

As the Hourglass indicates . . . with the coming of peace, many WILCO products now making for precision performance in airplanes, ships, tanks, guns and instruments of the Army and Navy will play an equally important role in meeting civilian needs for hundreds of useful and reliable products.

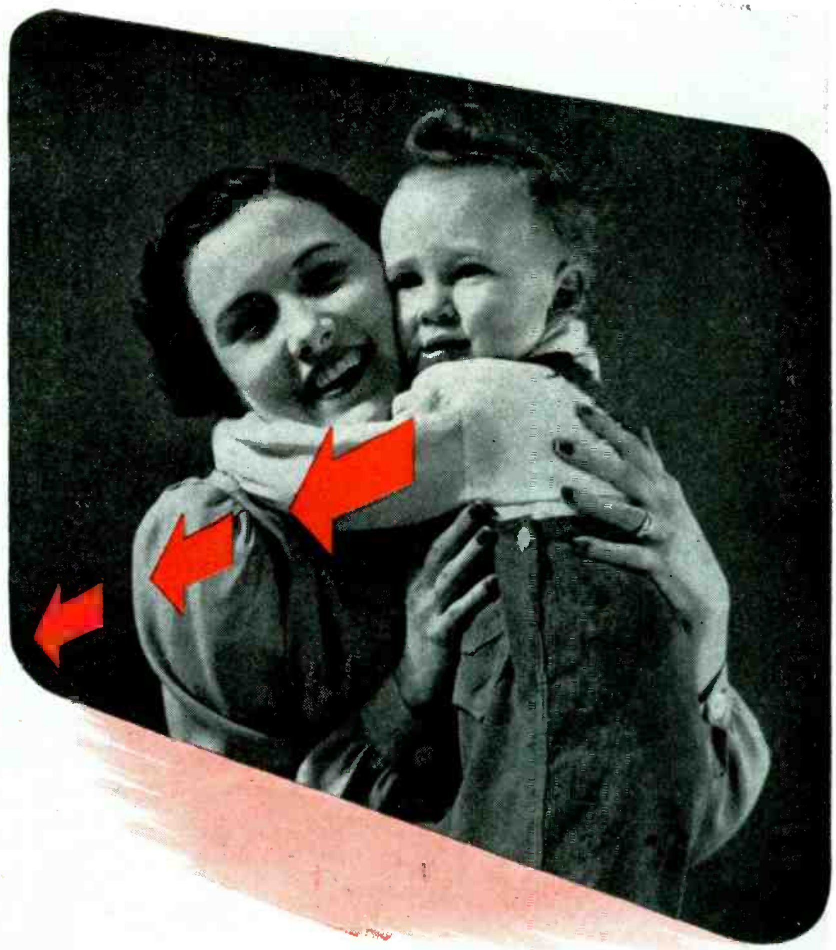
The demand of all branches of the service for Thermostatic Bimetals and Electrical Contacts has motivated many WILCO developments of great potential value to postwar industry. New products added to an already extensive line; increased facilities for refining and fabricating precious metals; greatly extended rolling mill facilities—these new additions and improvements, now devoted principally to the war effort, will prove equally helpful to manufacturing customers in meeting their peacetime production and marketing problems.

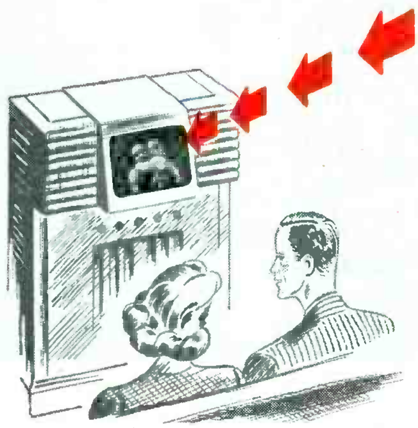
WILCO PRODUCTS ARE: *Contacts*—Silver, Platinum, Tungsten, Alloys, Sintered Powder Metal. *Thermostatic Bimetal*—High and Low Temperature with new high temperature deflection rates. *Precious Metal Collector Rings* for rotating controls. *Silver Clad Steel*—for bearings, shims, reflectors. *Jacketed Wire*—Silver on Steel, Copper, Invar, or other combinations requested. Rolled Gold Plate. Special materials.

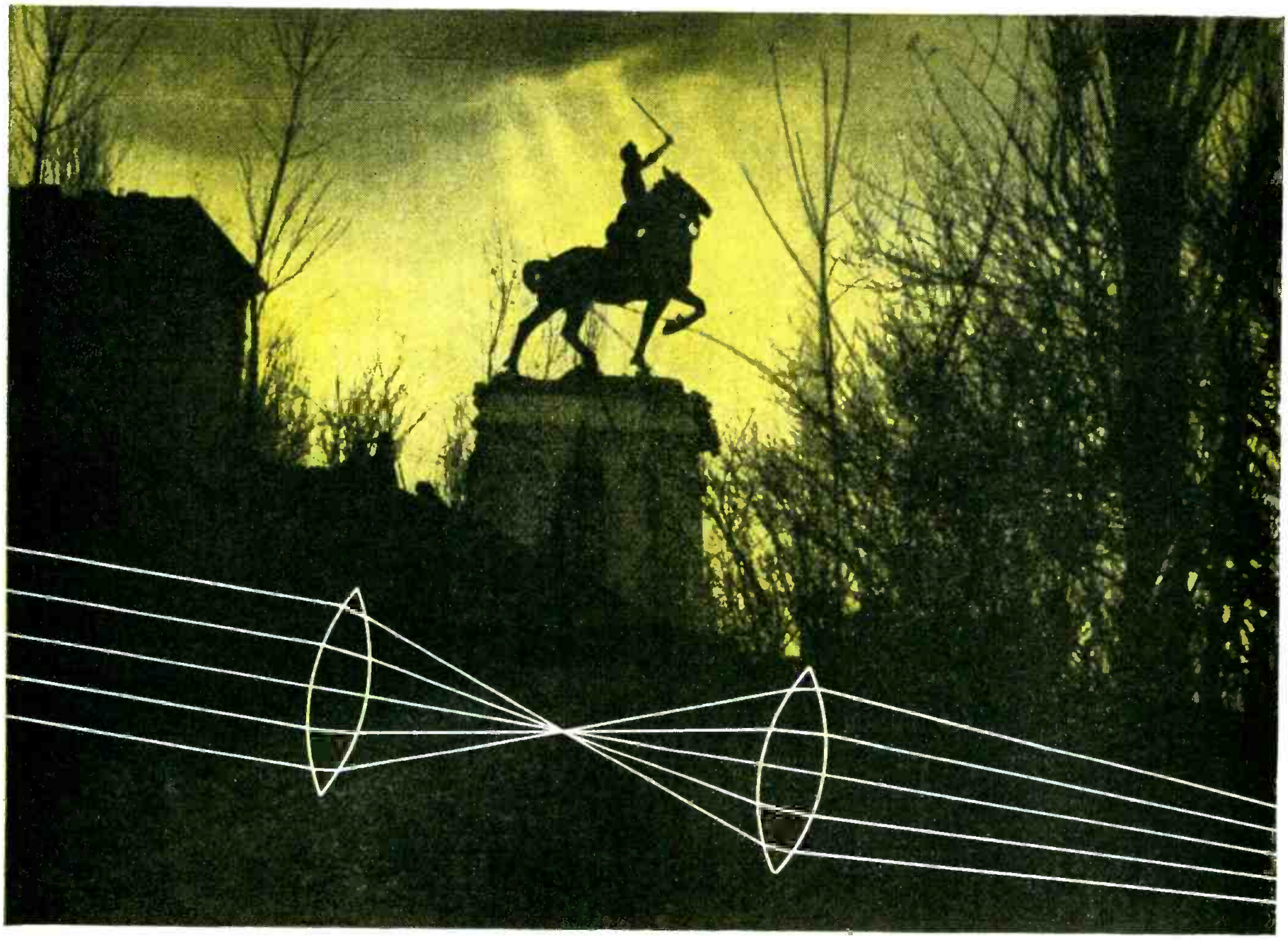
THE H. A. WILSON COMPANY
105 Chestnut Street, Newark 5, New Jersey

Branches: Detroit • Chicago

Thermometals—Electrical Contacts
Precious Metal Bimetallic Products

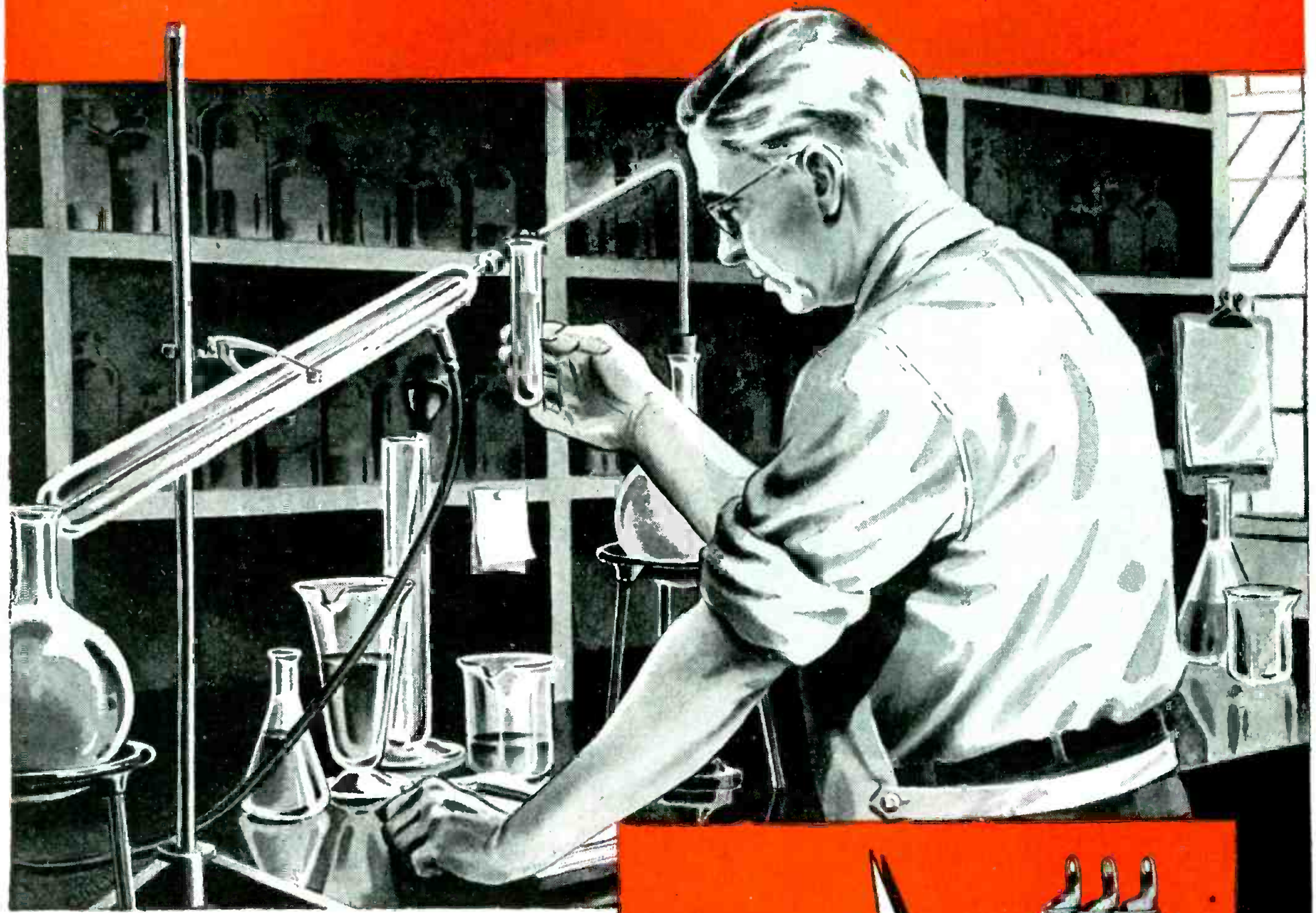






chemical analysis

means better materials and manufacturing processes



What have test tubes to do with capacitors?

A great deal. Here in our laboratory, every process used in manufacturing Cornell-Dubilier capacitors comes under the patient, searching scrutiny of expert capacitor chemists.

The evidence must be positive. These specialists are meticulous people. They take nothing for granted. No detail is too insignificant, too commonplace to merit their closest attention.

They apply their research to practical purposes. Their tests and keen analysis insure better materials for making capacitors.

That is why more engineers specify C-D than any other make. If you have a capacitor problem, get the help of a specialist. Write to Cornell-Dubilier Electric Corporation, South Plainfield, New Jersey. Other plants: New Bedford, Brookline, Worcester, Mass., and Providence, R. I.

TYPICAL C-D ADVANCEMENT IN DESIGN IS THE TYPE YAT

a compact, low capacity Dykanol "G" bypass capacitor — hermetically sealed in specially-treated drawn metal container.

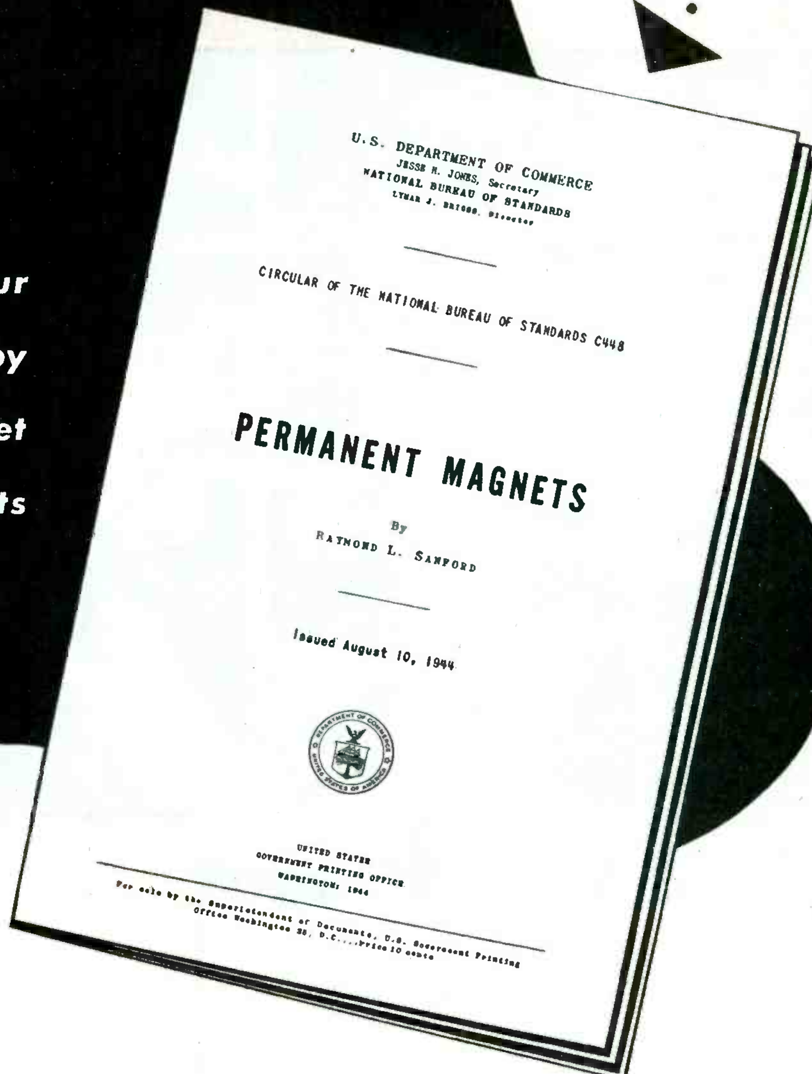
600V—.05 mfd. to 1 mfd.; at 100 V-.05 mfd. to .5 mfd.

CORNELL - DUBILIER CAPACITORS 1910 1945

WET AND DRY ELECTROLYTICS · MICA · DYKANOL · PAPER ·

YOURS!

Just write us, on your letterhead, for your copy of this valuable booklet on permanent magnets



● As a service to industry, The Arnold Engineering Company is "lending a hand" in the distribution of what Arnold engineers believe to be a very informative study on the subject of permanent magnets.

This 39-page book of permanent magnet theory, design data and references was published by the government. Arnold is pleased to make it available to you free of charge and without obligation. Write for it today!

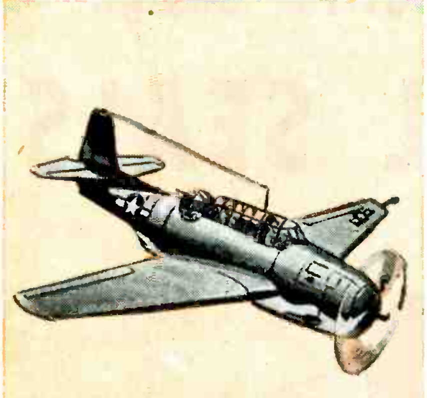
ARMY E NAVY

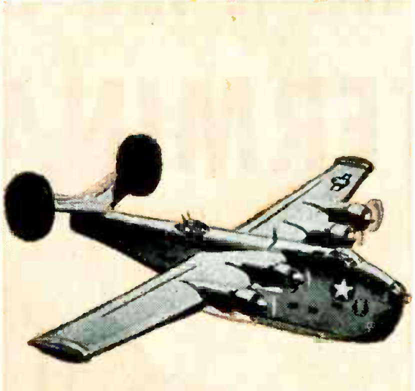
THE ARNOLD ENGINEERING COMPANY

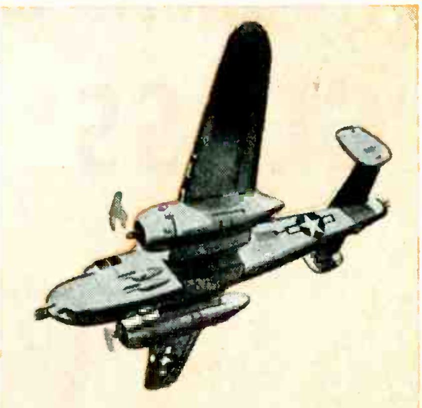
147 EAST ONTARIO STREET, CHICAGO 11, ILLINOIS

Specialists in the Manufacture of ALNICO PERMANENT MAGNETS

These U. S. Navy Planes Carry Collins Autotune Transmitters

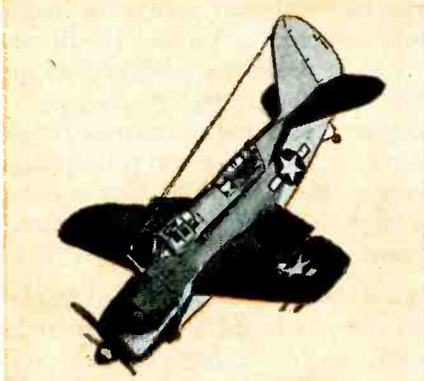

GRUMMAN TBF AVENGER


PB2Y-3 CORONADO

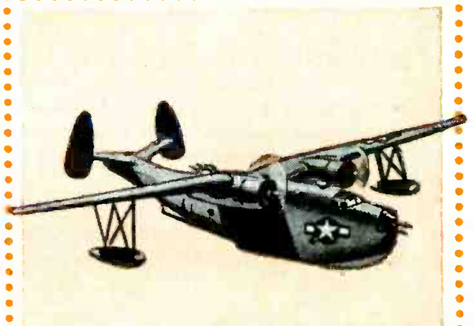

MARINE CORPS PBJ MITCHELL

The voice of thousands of Navy fliers

THE COLLINS ATC Autotune transmitter is regulation equipment for most two-place-and-larger types of Navy aircraft. It is the military successor of Collins airborne Autotune transmitters which were adopted by several of the great commercial airlines years before the war. Since Japan struck, the Navy has ordered many thousands. In advanced design and rugged construction, today's ATC reflects the lessons of war learned in every quarter of the world. It is a foretaste of the reliability and efficiency to be expected of Collins by commercial and private users after victory. Collins Radio Company, Cedar Rapids, Iowa; 11 West 42nd Street, New York 18, N. Y.

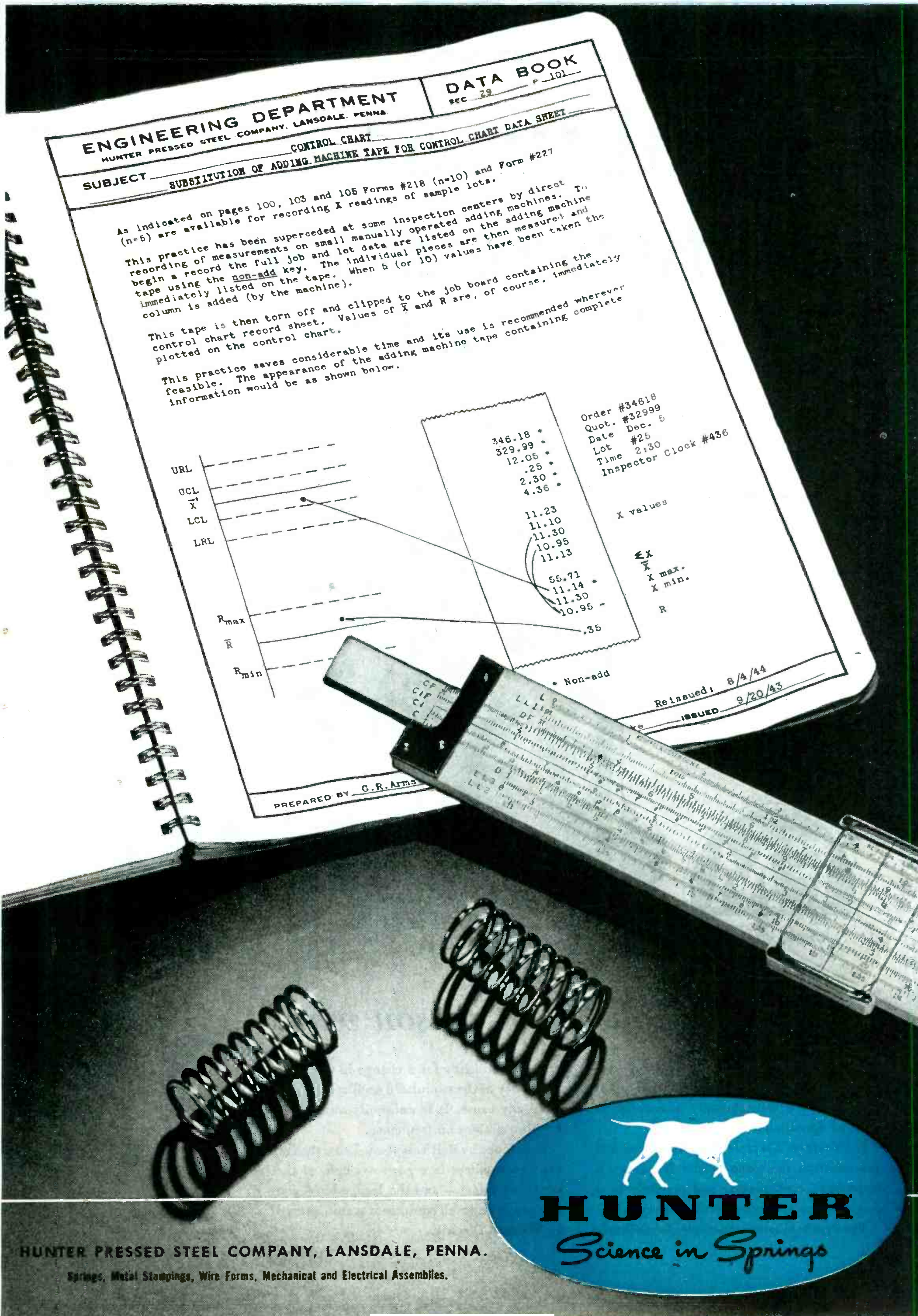

CURTISS SB2C-1 HELLDIVER


PB4Y-2 PRIVATEER


MARTIN PBM-3D MARINER

ARMY E NAVY

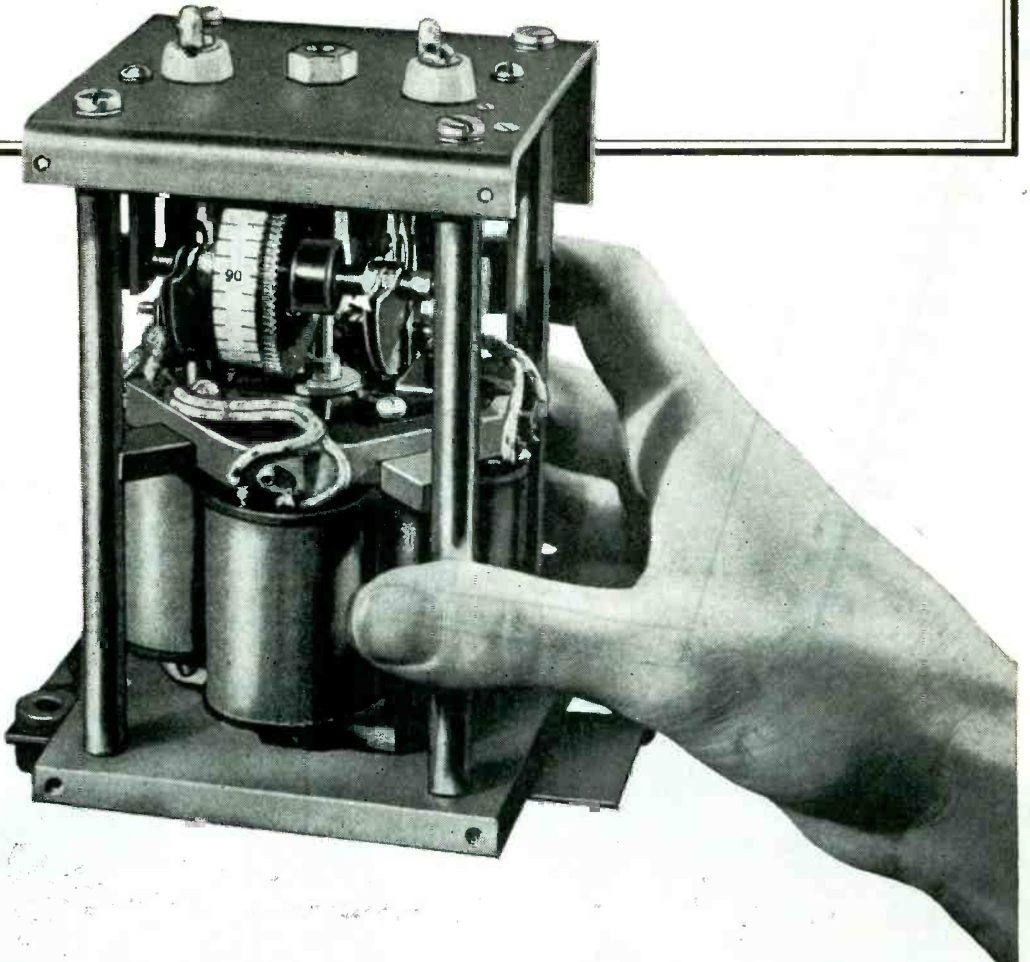
IN RADIO COMMUNICATIONS, IT'S . . . COLLINS


ENGINEERING DEPARTMENT
HUNTER PRESSED STEEL COMPANY, LANSDALE, PENNA.
DATA BOOK
SEC 29 P 101
SUBJECT CONTROL CHART
SUBSTITUTION OF ADDING MACHINE TAPE FOR CONTROL CHART DATA SHEET
As indicated on pages 100, 103 and 105 Forms #218 (n=10) and Form #227 (n=5) are available for recording X readings of sample lots.
This practice has been superceded at some inspection centers by direct recording of measurements on small manually operated adding machines. To begin a record the full job and lot data are listed on the adding machine tape using the non-add key. The individual pieces are then measured and immediately listed on the tape. When 5 (or 10) values have been taken the column is added (by the machine).
This tape is then torn off and clipped to the job board containing the control chart record sheet. Values of X̄ and R are, of course, immediately plotted on the control chart.
This practice saves considerable time and its use is recommended wherever feasible. The appearance of the adding machine tape containing complete information would be as shown below.
URL
UCL
X̄'
LCL
LRL
Rmax
R̄
Rmin
346.18 *
329.99 *
12.05 *
.25 *
2.30 *
4.36 *
11.23
11.10
11.30
10.95
11.13
55.71
11.14 *
11.30
10.95 -
.35
Order #34618
Quot. #32999
Date Dec. 5
Lot #25
Time 2:30
Inspector Clock #436
X values
ΣX
X̄
X max.
X min.
R
* Non-add
Reissued: 8/4/44
ISSUED 9/20/43
PREPARED BY C.R.Arms
HUNTER PRESSED STEEL COMPANY, LANSDALE, PENNA.
Springs, Metal Stampings, Wire Forms, Mechanical and Electrical Assemblies.
HUNTER
Science in Springs

In FM Broadcasting

Western Electric

equipment leads the way



FM
Synchronized
Western Electric

...and here's one good reason why!

It's the Western Electric Synchronizer—announced in 1940 as a real contribution to FM—now proved outstandingly successful in years of operation.

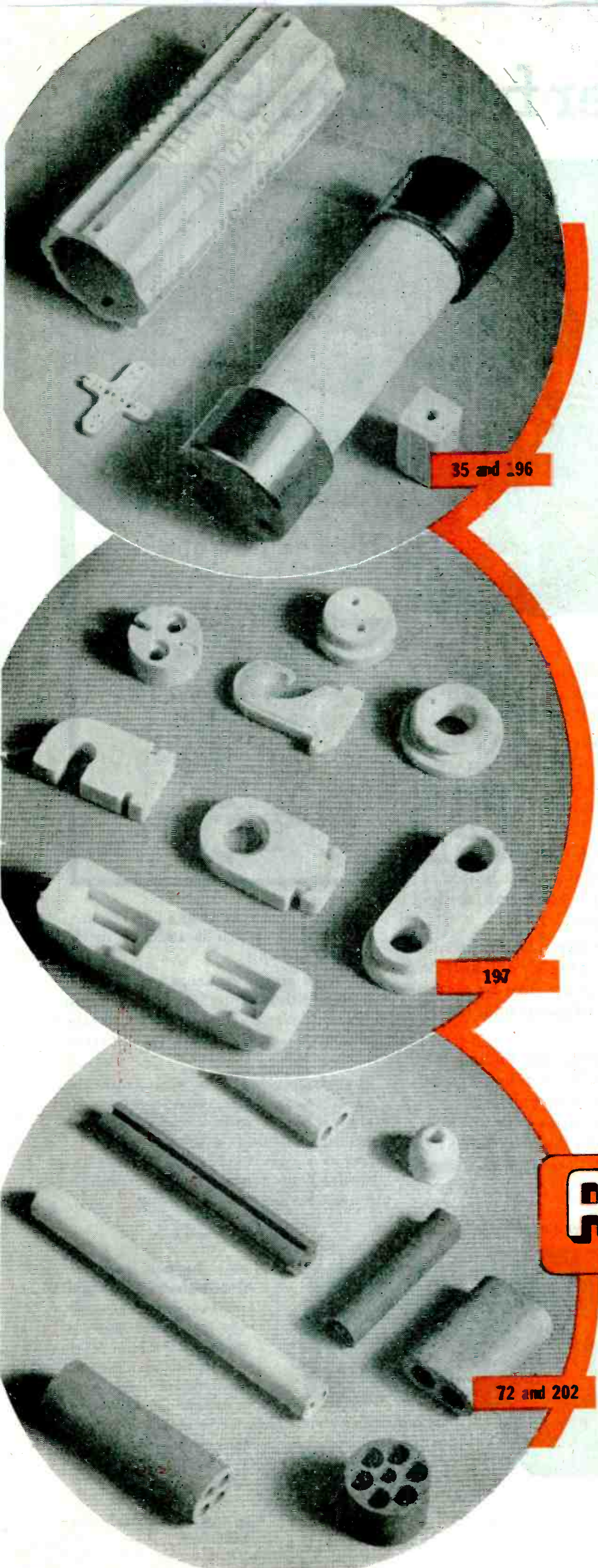
In Western Electric Synchronized FM Transmitters, the mean carrier frequency is maintained continuously and precisely by a single low temperature coefficient crystal.

The Synchronizer compensates *immediately and automatically* for a change in the mean frequency of the modulated oscillator arising from any cause. It is uncannily accurate in keeping stations on frequency.

Developed by Bell Telephone Laboratories, the Synchronizer is a good example of the advanced design—and the leadership—you can count on in all equipment manufactured by Western Electric.

Western Electric
Distributed by Graybar Electric Company

Buy all the War Bonds you can...and keep all you buy!



THE ALSIMAG CERAMICS

ALSIMAG is the trade name of a wide variety of ceramic bodies, each with its own particular physical and electrical characteristics. Among those finding widest applications are the following:

ALSIMAG 35 and 196 Possessing high mechanical strength combined with low electrical loss at high frequencies, these bodies are ideally suited to most electrical and electronic applications.

ALSIMAG 197 Good mechanical strength and resistance to high temperatures for sustained periods make ALSIMAG 197 especially valuable in the field of electrical heating devices.

ALSIMAG 72 and 202 Low co-efficients of expansion, coupled with ability to withstand thermal shock, make these materials desirable in combustion tips and thermocouple insulation.

Whatever you are planning in the electronic or electrical field, we believe our specialized knowledge, experience, constant research and development will be helpful. Let's work together.

AMERICAN LAVA CORPORATION

Chattanooga 5, Tennessee

43RD YEAR OF CERAMIC LEADERSHIP

ALSIMAG

TRADE MARK REG. U. S. PAT. OFFICE

CERAMICS

ARMY ★★ E NAVY

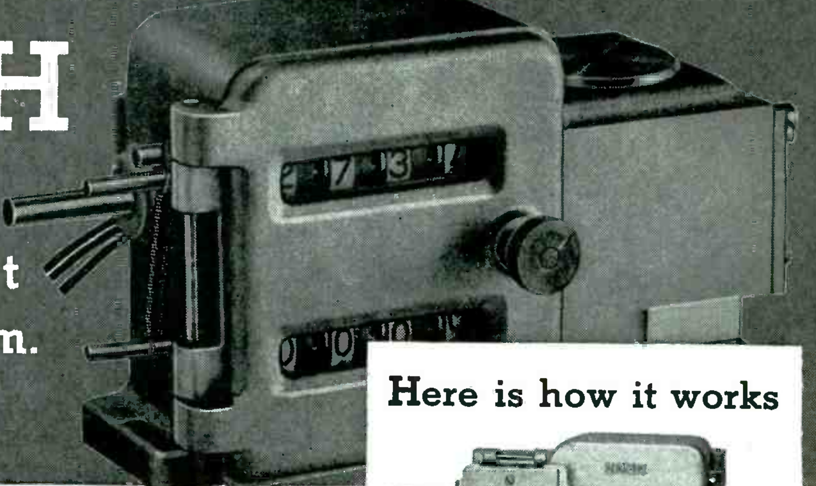
ALCO has been awarded for the fifth time the Army-Navy "E" Award for continued excellence in quantity and quality of essential war production.

"Take a Number from 1 to 9999"

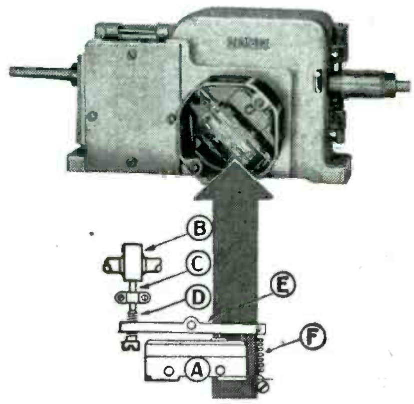
MICRO SWITCH

SNAP-ACTION

Will "Remember" It even at 2500 r. p. m.



Here is how it works



This Cycle Repeater of the Counter and Control Corporation of Milwaukee, Wisconsin, employs a Micro Switch snap-action switch to make or break the circuit at any predetermined number from 1 to 9999.

The Counter and Control Corporation chose a Micro Switch product for the operating heart of this Cycle Repeater because of its proven accuracy of response through millions of repeat operations. Too, its tiny, compact size combines with its rugged construction to meet the needs of their application.

This device is an automatic, predetermined counter, self-resetting and self-repeating . . . something new in controlled production. It is used as an integral part of production machinery to control cycles, operate signals, lights, bells, relays, motors, conveyors and elevators.

Once the predetermined number is set, the Cycle Repeater can be run at as high a speed as 2500 r. p. m., and the snap-action switch will make or break the contact at the point required. This is accomplished by a cam which actuates the switch after the proper sequence of gear revolutions in the counter mechanism.

Hundreds of designers, in every branch of industry, are finding the ability of Micro Switch products to switch substantial loads at line voltage . . . without the use of relays . . . makes them ideally suited for a wide variety of electrical controls in both war and peace production. Design engineers should know all about these Micro Switch controls. We'll be glad to send you as many copies of our Handbook-Catalog as they may require.

The plastic enclosed switch "A" is bolted to a bracket which is attached to the counter housing.

After the proper sequence of gear revolutions in the counter mechanism, a cam "B" on the gear arrangement presses the plunger "C" against the adjusting screw "D".

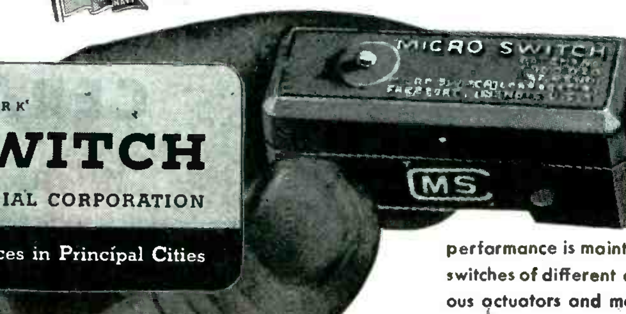
The lever pivoted at "E" then causes the bar to release its pressure on the switch plunger which either opens or closes the electrical circuit as desired. Spring "F" acts as a counterbalance to restore immediately the pressure on switch plunger for another cycle of operations.

LET'S ALL BACK THE ATTACK — *BUY EXTRA WAR BONDS*

MICRO SWITCH TRADE MARK

A DIVISION OF FIRST INDUSTRIAL CORPORATION

Freeport, Illinois, U. S. A., Sales Offices in Principal Cities



This is the basic switch — a thumb-size, feather-light, plastic enclosed, precision, snap-action switch. Underwriters' listed and rated at 1200 V. A., at 125 to 460 volts a-c. Capacity on d-c depends on load characteristics. Accurate reproducibility of performance is maintained over millions of operations. Basic switches of different characteristics are combined with various actuators and metal housings to meet a wide range of requirements.

FROM COMPONENT...TO COMPLETE STATION

A vital link in a long chain of equipment . . . from microphone to antenna . . . the lead-in cable plays an important part in dependability of operation.

Federal's Intelin Cables *are* dependable. They've proved that in broadcast and military installations all over the world . . . standing up under severe operating conditions . . . in all kinds of climate.

And that's typical of *all* Federal broadcast equipment. From lead-in cable to complete station, it has earned a reputation for *performance* because it's *built to stay on the air.*

Amplitude Modulation, Frequency Modulation, and Television . . . for quality, efficiency, dependability . . . look to Federal for the finest in broadcast equipment.

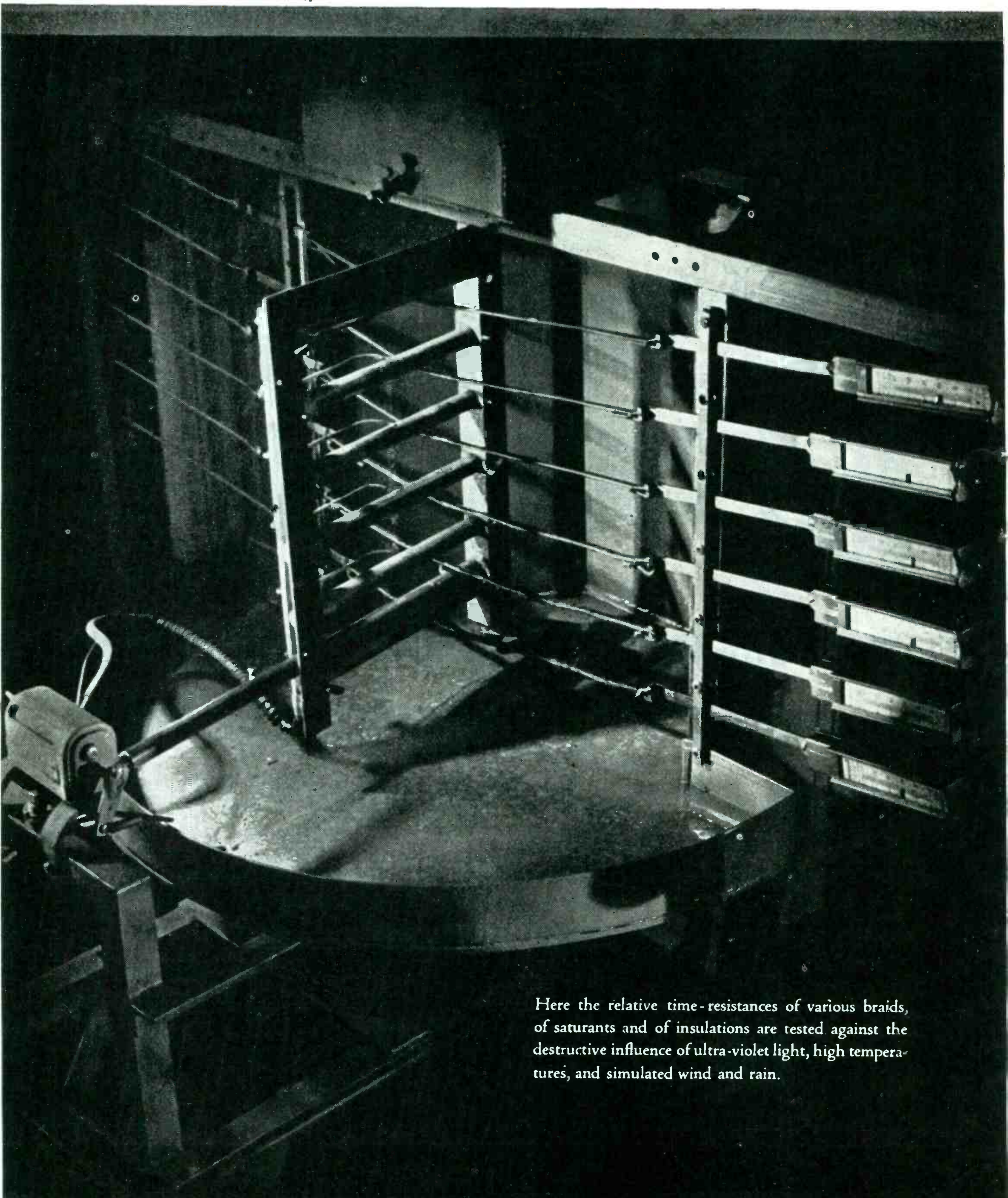
FEDERAL FTR TELEPHONE & RADIO

Federal Telephone and Radio Corporation

AN IT&T ASSOCIATE

Newark 1, N. J.

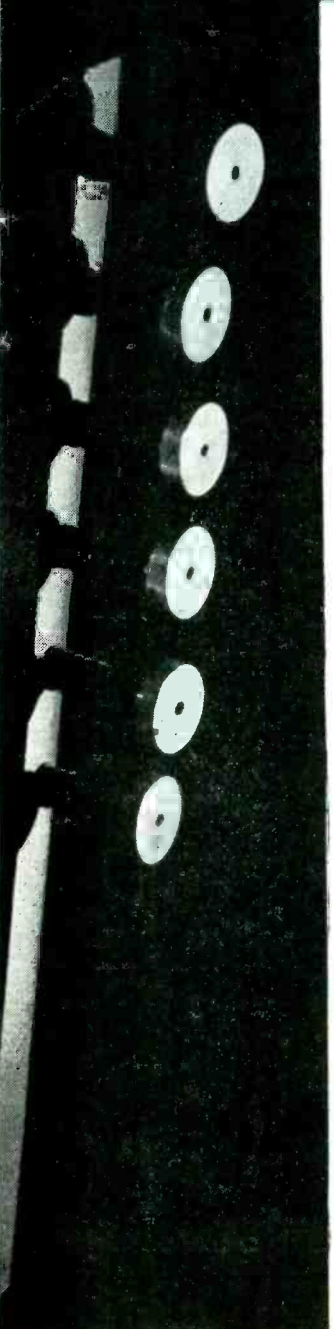
ENDURANCE



Here the relative time-resistances of various braids, of saturants and of insulations are tested against the destructive influence of ultra-violet light, high temperatures, and simulated wind and rain.

IN COVERINGS

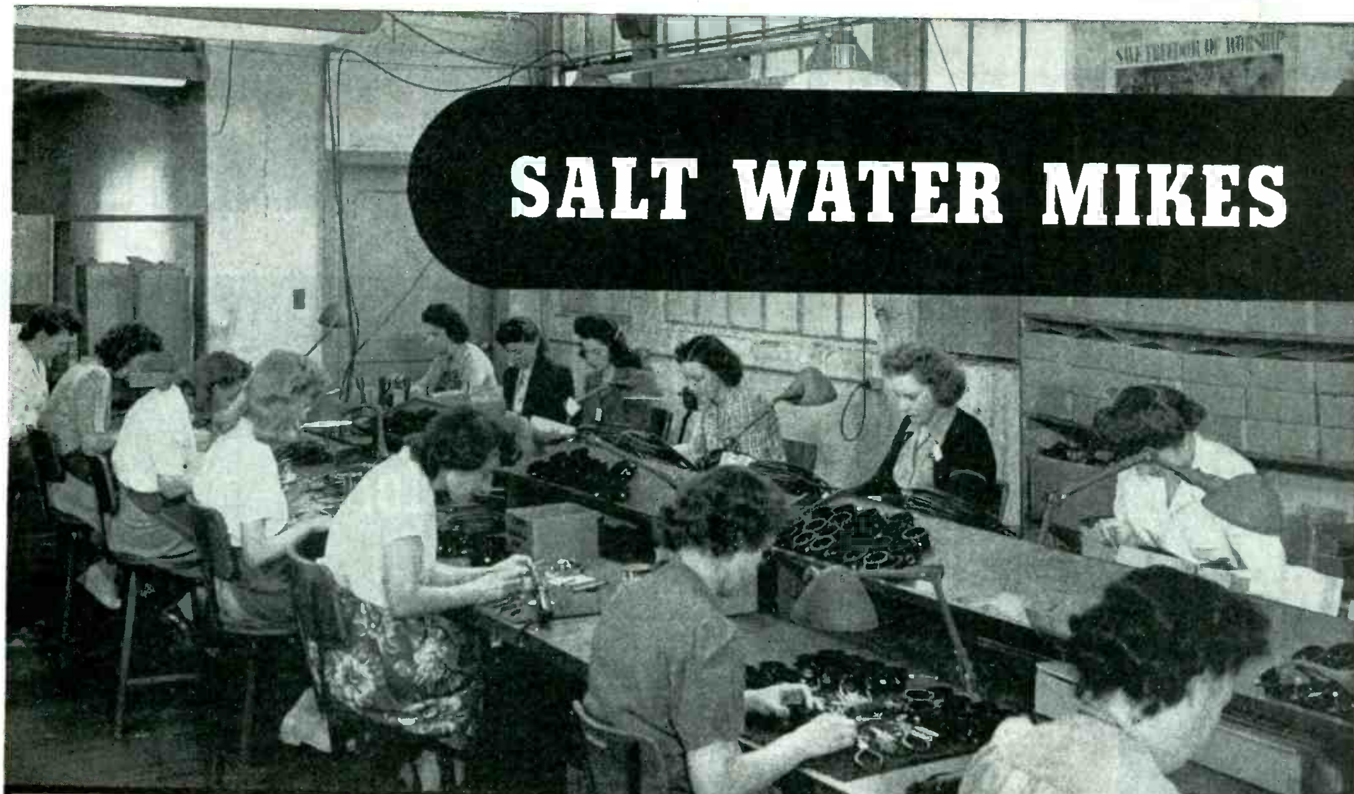
For every braid or wrapping: — constant Research-testing for all possible securities of service.



General Cable's research program recognizes no *minor* problems of conductors, insulations, or of coverings. The abrasion hazards in the winding of motor armatures, the longevity of pole line installations, the cutting down of friction in pulling-in building wires—all of these and a host of other problems are subjected to searching scrutiny. For the testing of the textile yarns as raw materials, at various stages of manufacture and in the finished product, specialized practice is employed, using the most sensitive equipment that engineering brains can devise.

GENERAL CABLE CORPORATION

Manufacturers of Bare and Insulated Wires and Cables for Every Electrical Purpose



SALT WATER MIKES

Marine microphone assembly. Plastic and metal parts designed, made and assembled by Remler to meet Navy and Merchant Marine specifications.

PLUGS & CONNECTORS

Signal Corps · Navy Specifications

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

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

OTHER DESIGNS TO ORDER

ONE REMLER ASSIGNMENT is the production of amplifying and transmitting systems for our Navy and Merchant Marine. Systems are complete—from shock-proof microphones, built to resist the corrosive action of salt air and water to transmitters and bull-horn speakers for baby Flat Tops. • Remler was organized in 1918 to manufacture ship wireless. Present activities in marine communications are a logical development of early activities in this field. The facilities and experience of this organization are at your disposal.

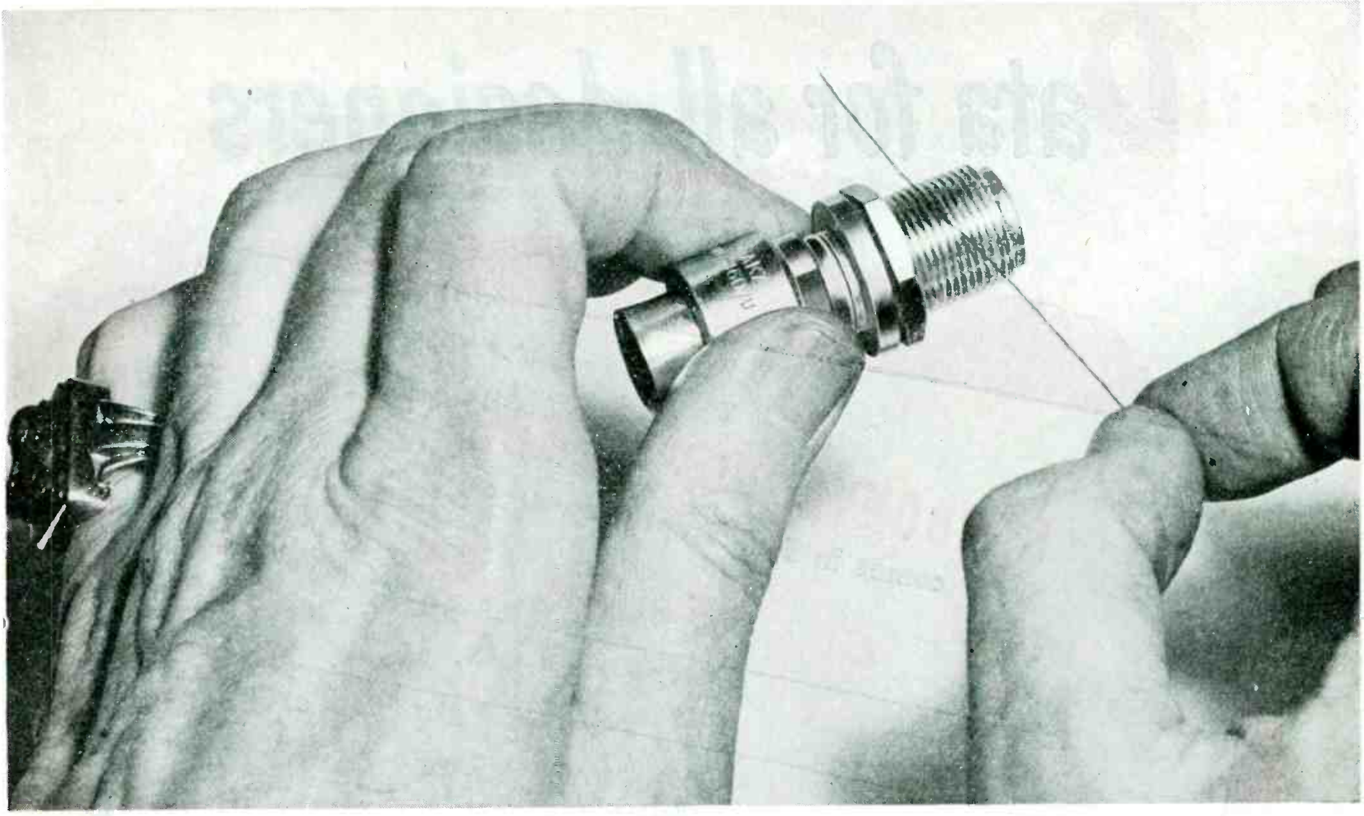
Further assignments in radio and electronics invited. Consult—

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

REMLER

SINCE 1918

Announcing & Communication Equipment



DID YOU SAY "TO A HAIR"?

You can divide the diameter of the finest human hair by 13, and the tolerance for silver plating at DICO will still be smaller: 1/20,000th of an inch.

All machining and assembling and processing tolerances at DICO are comparable in fineness. DICO means precision; and precision, in electronics, means performance.

Take up with DICO now what you will need later in its exceptional facilities to prepare your own product for the change from war to peace.

PRODUCT ENGINEERING, MACHINING, GOLD AND SILVER PLATING, CASTING, SOLDERING, ASSEMBLING, FINISHING

DICO

DIAMOND INSTRUMENT CO.

NORTH AVENUE • WAKEFIELD, MASSACHUSETTS

Data for all designers

CARBONYL IRON POWDER

comes in 5 different grades

L C E TH SF

For use in cores for different applications the powders are processed:

1. With different amounts of particle-to-particle insulation,
2. With different types of insulation or bonding material,
3. With different ratios of iron to inert material,
4. With different pressures to different densities, and
5. With different form factors and shapes.

To obtain exactly specified:

1. Permeability 2. Q value
3. Eddie current loss 4. Hysteresis loss
5. Temperature coefficient

Data for circuit & coil designers

COMPARISON OF AIR-CORED AND CARBONYL IRON CORED COILS:

For Medium Frequencies

Specification	Typical air-cored coil	Typical CARBONYL IRON cored coil	Thus: CARBONYL IRON
VOLUME	0.61 cubic-inches	0.12 cubic-inches	Saves 80% of Space
WEIGHT Exclusive of Housing, Mounting, etc.	1.5 ounces	1.0 ounces	Saves 33% of Weight
WIRE-LENGTH	25 feet	11 feet	Saves 60% of Wire
INDUCTANCE	117 Micro-Henries	169 Micro-Henries	Increases Inductance 40%
Q Value at 1.0 Mc	94	260	Increases Q Value 170%

For further data write: General Aniline & Film Corp., Special Products Sales Department, 437 Hudson Street, New York 14, N. Y.

G.A.F. CARBONYL IRON POWDERS

COLE

STEEL EQUIPMENT COMPANY

Experience and "know-how" are why so many of America's leading manufacturers depend upon "Cole Steel Equipment" for

sheet metal fabrication

We welcome tough assignments . . . instrument housings . . . water-test boxes . . . chassis; some made to extreme precision, others to gauge limits. Send us *your* blueprints!

Send for our Brochure
"The Plant Behind Your Plant"

349 Broadway, New York 13, N. Y.
Factory: Brooklyn, N. Y.

COLE STEEL OFFICE EQUIPMENT

will again be available after the war

America's Foremost Family of Alloys

AT YOUR SERVICE FOR 45 YEARS

Best proof of the superiority of D/H Alloys lies in the record. For 45 years, Driver-Harris has been the foremost producer of an internationally recognized group of alloys.

Best known member of this famous alloy family is NICHROME*—most widely used of all resistance alloys. No less renowned and equally preferred in their specialized fields are the more than 80 other D/H Alloys.

Underlying this preference is the quality plus factor in every D/H Alloy assured by the high degree of metallurgical control that enters into their manufacture from furnace to spool. Therefore, to insure longer life and improved performance in your product, send your metal specifications to us and depend on it . . . Driver-Harris will supply the alloy possessing the best electrical and physical properties for your requirements.

D/H SPECIAL PURPOSE ALLOYS SINCE 1899

Driver-Harris

COMPANY

HARRISON, N. J.

Branches: Chicago · Detroit · Cleveland
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ARMY E NAVY

FOR ELECTRICAL RESISTANCE

NICHROME*
NICHROME*V
ADVANCE*
HYTEMCO*
CHROMAX*
MAGNO*
MIDOHM*
COMET*
LUCERO*
MANGANIN
11 ALLOY
30 OHM ALLOY
LOHM*
90 OHM ALLOY

FOR HEAT OR CORROSION RESISTANCE

NICHROME*
NICHROME*V
NICKEL A†D†E†Z†
CIMET*
MONEL†
K-MONEL†
R-MONEL†
D/H STAINLESS STEELS
INCONEL†

FOR RADIO SETS AND TUBES

NICHROME*
NICHROME* V
NICHROME* 111
GRIDNIC A-B-C-D-E-F*
RADIOHM*
MANGANIN
ADVANCE*
52 ALLOY
FILAMENT ALLOYS
D/H STAINLESS STEELS
NICKEL A†D†E†
MONEL†
42 ALLOY
NILVAR*

FOR SPARK PLUG APPLICATION

MAGNO*
R-63 ALLOY
SPECIAL NICKEL ALLOYS

In addition to the above general classifications many other industries are served by Driver-Harris Alloys. Space does not permit listing them all.

*Trade Mark Reg. U.S. Pat. Off. by Driver-Harris

†Trade Mark Reg. U.S. Pat. Off. by The International Nickel Company, Inc.

...for BETTER rectifier performance!

The diversified E-E line of rectifiers—high vacuum, mercury vapor and grid control types—offer complete suitability for all industrial and communication requirements. All incorporate exclusive mechanical and electrical features that assure the extra dependability customarily associated with E-E engineering.

For example, the E-E 3B27, half-wave high vacuum rectifier typifies this performance-plus factor inherent in E-E tube designs. Suitable for single or multi-phase operation at high voltage this tube handles peak plate currents to 0.6 amps. at peak inverse voltages to 8,500 or plate currents to 1.0 amps. peak at 6000 volts peak inverse voltage. It is ruggedly constructed for industrial or portable use, and is quiet in operation for communication application. Ceramic spacer minimizes leakage and double heater and cathodes are provided for long, dependable service life.

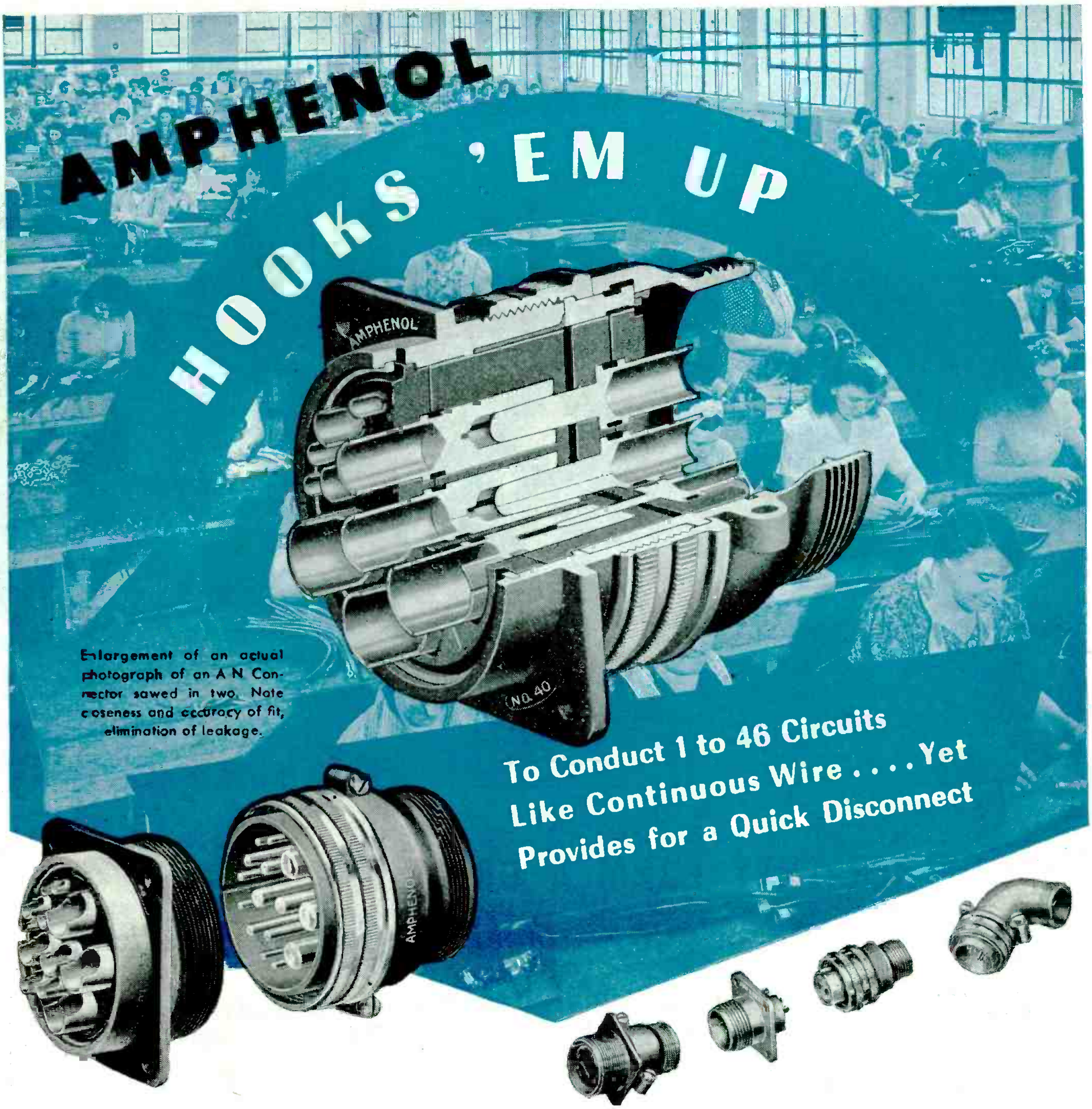
WRITE FOR DATA BOOK

This 30 page compilation of electronic vacuum tube types, characteristics and operational information, will be sent on request on company letterhead. An important, concise addition to technical libraries in all phases of industry.

ELECTRONIC ENTERPRISES, INC.

ELECTRONIC ENTERPRISES

GENERAL OFFICES: 65-67 SEVENTH AVENUE, NEWARK, 4, N. J. EXPORT DEPT. 25 WARREN STREET, NEW YORK CITY, N. Y.



Machine-time-out is time lost . . . money lost. The answer to that one, as learned by the aviation industry early in the days of fighter plane construction, is going to help all industry.

Today complex electrical circuits and operating units, in the plants as well as the planes, can be disconnected and reconnected in a few seconds time.

Depend upon AMPHENOL Quality

Interchangeable units can be replaced quickly. In the future, builders of electrical and electronic equipment of many types will use this improvement in design to their customers' advantage.

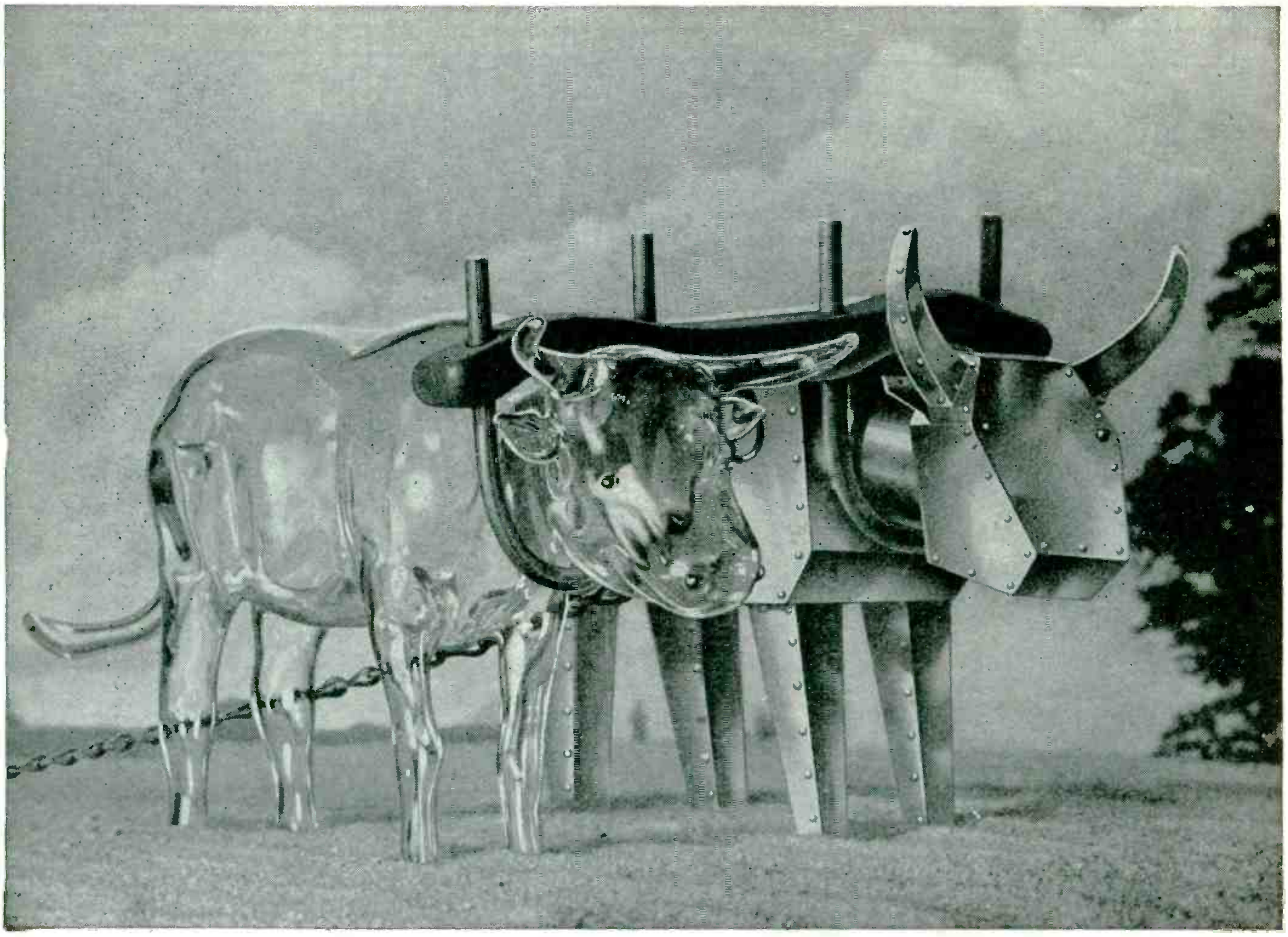
A typical Amphenol connector shown above, is being used all over the world by the Army, Navy and Air Corps under all kinds of conditions. Connections are absolutely secure! Shock or vibration cannot break them but they may be disconnected in an instant. Amphenol connectors are being made in water-proof, gas-proof, pressure-proof and other types—others to mate with British equipment, still others for U.H.F. use.

If you're design-conscious be sure to get Amphenol-conscious. Write for descriptive catalog sheets.

AMERICAN PHENOLIC CORPORATION
Chicago 50, Illinois

In Canada • AMPHENOL LIMITED • Toronto

Connectors (A-N, British, U.H.F.), Fittings, Cable Assemblies, Conduit, U.H.F. Cable, Radio Parts, Synthetics for Industry



TOGETHER THEY FORM A GREAT TEAM...

thanks to Corning Metalizing!

GLASS and metal work together for the electronics industry under a yoke fashioned by Corning Research in Glass.

Metalized glass has been used for many years, mainly for decorative purposes. But Corning Research developed a metalizing process which can be accurately controlled and which is permanent under severe industrial service conditions.

The superior electrical properties of glass are well known in the electronics field. Low power factor, high dielectric strength, extremely high resistance, wide range of dielectric constants — coupled with fine mechanical properties — make glass invaluable in electronic applications. The addition of metalized areas permits hermetic seals between glass and metal by ordinary soldering methods. Corning's metalizing process, particularly when applied to low expansion glasses, also produces accurate and fixed inductances, capacitances or shielding.

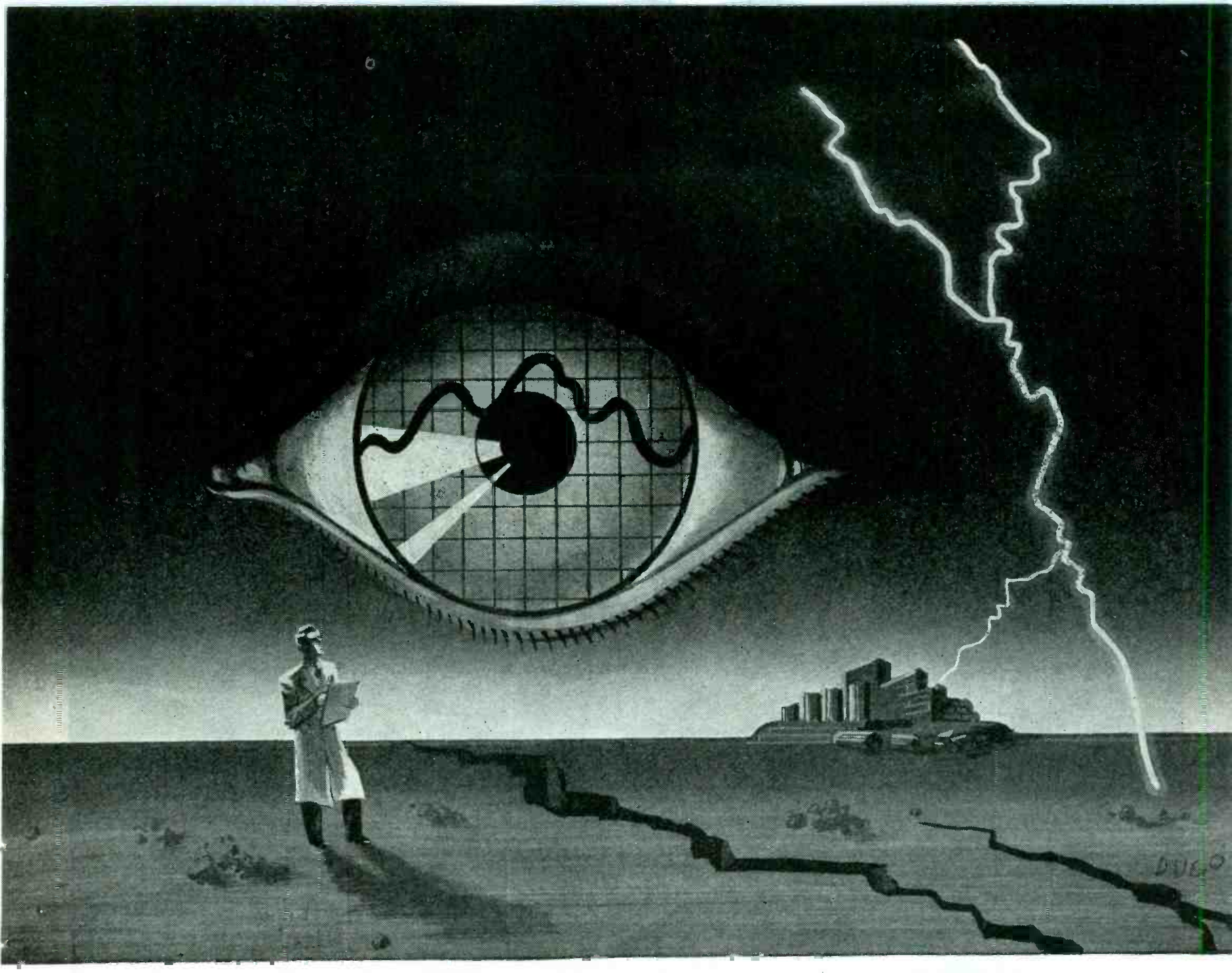
Perhaps our team of glass and metal can help you. Write us about your problem. Address Electronic Sales Department E-5, Bulb and Tubing Division, Corning Glass Works, Corning, N. Y.

CORNING means Research in Glass

Electronic Glassware

VYCOR — CORNING — PYREX

"PYREX", "VYCOR" and "CORNING" are registered trade-marks and indicate manufacture by Corning Glass Works, Corning, N. Y.



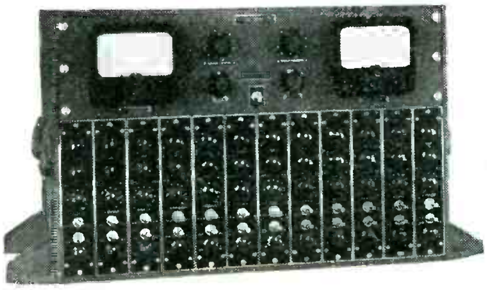
12 JOBS AT ONE TIME

FOR THE RAPID determination of static or dynamic strains on large or complex structures, Waugh offers a range of instruments of extraordinary value. There is the 12-channel strain gage control unit which, together with recording equipment, permits 12 simultaneous measurements of strain and vibration. With this equipment, dynamic strains, velocities and accelerations from 0 to 1500 and 3 to 6000 cycles per second can be recorded.

Then there is the vector computer . . . a robot brain for the evaluation of linear strain measurements on the surface of a structural element when rosette gages are used. The output of the instrument furnishes directly the principal stresses as well as the stresses or strains at any angle to the axes of the rosette.

These instruments are indicative of the range of modern instruments available for purchase or rental through Waugh Laboratories. Write for details—Strain Gage Control Unit Type MRC10 and Vector Computer Type 30-101.

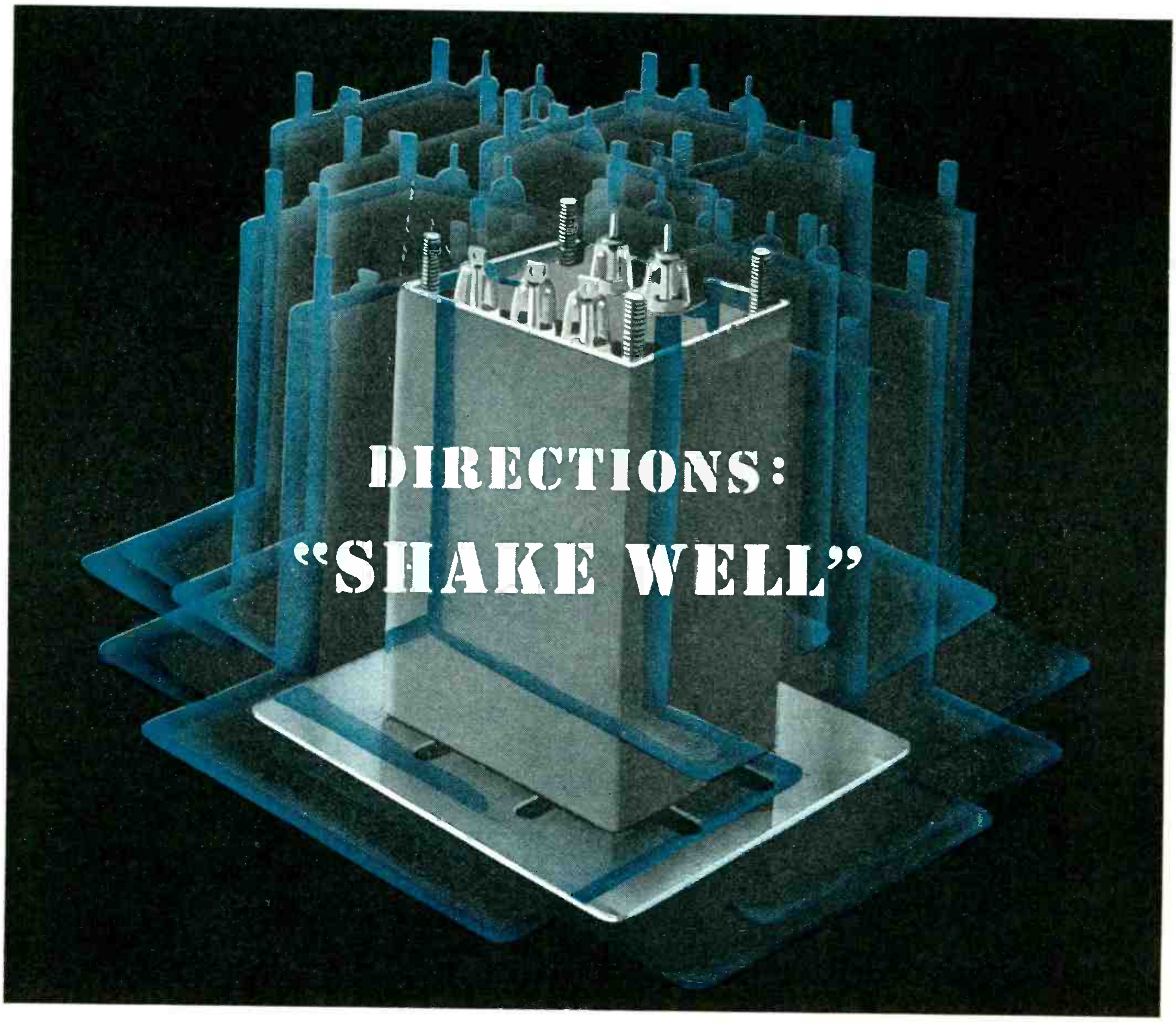
Write for Rental List and Service Manual on business letterhead.



Strain Gage Control Unit Type MRC10

WAUGH Laboratories

Pacific Coast Branch: 180 East California St., Pasadena 5, California ◆ **420 LEXINGTON AVE., NEW YORK 17, N. Y.**



Upside down and sideways—and this transformer puts in overtime!

This is just one more reason why Thermadors are known as America's quality transformers.

There is a machine called a Shaker. It goes up and down while it rotates. The motion varies from a gentle rhumba to an earthquake of cataclysmic proportions. In 10 minutes an ordinary transformer sails off into the steel mesh net.

At Aireon Manufacturing Corporation's Kansas City plant they bolted a Thermador transformer to the shake-bed of this machine. They turned the shaker on for an hour—then they left it going overnight, unbolted the Thermador transformer, connected it to the test line. The needle showed not an nth of variation.

Why this incredible performance? Just this. Transformers were formerly mounted to the cover of their cases. Thermador developed a strong stamped bracket from strip steel and projection-welded it to the case body—independent of terminal boards or covers. As a result, Thermador transformers can be mounted in any position—up and down and sideways—and take the worst beating you can give them.

THERMADOR ELECTRICAL MANUFACTURING COMPANY
5119 SOUTH RIVERSIDE DRIVE • LOS ANGELES 22, CALIF.

Thermador Transformers

DEFEAT COLD • HEAT • HUMIDITY

Seven Leagues Ahead

These 22 *Gammatron* types are being standardised by HEINTZ AND KAUFMAN LTD.

Heintz and Kaufman Ltd. is coming to the aid of equipment designers and manufacturers by standardizing the physical and electrical characteristics of 22 types of Gammatron tubes. These types will conform to Joint Army-Navy Specifications, where applicable.

So design your circuits around these Gammatrons—with the assurance that they will always meet the same high standards, and always be readily available, thus making unnecessary the problem of redesigning equipment because of changes or variations in tube types.

14 TRIODES

TUBE TYPE	PLATE DISSIPATION
HK-24	25 watts (Grid lead to base)
HK-24G	25 watts (Grid lead through envelope)
HK-54	50 watts
HK-254	100 watts
HK-354C	150 watts (Low Amplification Factor)
HK-354E	150 watts (High Amplification Factor)
HK-454L	200 watts (Low Amplification Factor)
HK-454H	200 watts (High Amplification Factor)
HK-654	300 watts
HK-854L	450 watts (Low Amplification Factor)
HK-854H	450 watts (High Amplification Factor)
HK-1054L	750 watts
HK-1554	1000 watts
HK-3054	1500 watts

1 PENTODE

HK-257B Plate Dissipation, 75 watts (Beam pentode)

4 RECTIFIERS

HK-253	Inverse Peak Volts, 15,000
HK-953B	Inverse Peak Volts, 30,000
HK-953D	Inverse Peak Volts, 75,000
HK-953E	Inverse Peak Volts, 150,000

3 IONIZATION GAUGES

VG-2 VG-24G VG-54

REPLACEMENT *Gammatron* TUBES

The following Gammatrons will be made available primarily for replacement use. Design engineers are asked to consider recommended standardized types when designing new equipment.

REPLACEMENT TUBE TYPE	DESCRIPTION	RECOMMENDED STANDARDIZED TUBE TYPE
HK-354	Triode, grid lead to base pin, ratings same as HK-354C	HK-354C HK-454L HK-454H
HK-354D	Triode, Medium Amplification Factor	HK-354C or E HK-454L or H
HK-354F	Triode, High Amplification Factor	HK-354E
HK-257A	Beam Pentode	HK-257B
HK-153	High Vacuum Rectifier, inverse peak volts, 5000	HK-253
HK-54S	Triode. Same as HK-54 except fil. current is 3.35 instead of 5 amps.	HK-54
HK-2054A	Triode	
HK-2054C	Triode	

HEINTZ AND KAUFMAN LTD.
SOUTH SAN FRANCISCO • CALIFORNIA

KEEP BUYING WAR BONDS

Gammatron Tubes

Export Agents: M. SIMON & SON CO., INC.
25 WARREN STREET, NEW YORK CITY, N. Y.

SENSITIVITY

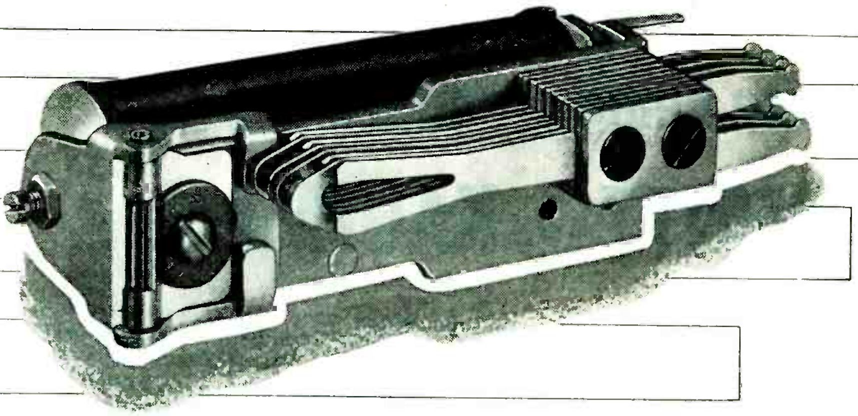
CONTACT PRESSURE

DEPENDABILITY

DURABILITY

COMPACTNESS

VERSATILITY



— in Greatest Combination

THE NEW AUTOMATIC ELECTRIC CLASS "B" RELAY

• When you need a relay that's sensitive enough to operate on minute current, yet has the high contact pressure needed for perfect closure, you'll find the Automatic Electric Class "B" Relay worth investigating.

If you need a relay that will switch many circuits, yet is compact enough for multiple mounting in small space, you'll find Class "B" the perfect solution.

Or perhaps you are interested in extra durability, for long service under tough conditions. Then you'll need the in-built quality for which Class "B" has become famous.

No other relay—even in the Automatic Electric line—can give you a greater combination of all these essential qualities. Get the full story on Class "B"—one of the forty basic types described in the Automatic Electric catalog. Ask for your copy of Catalog 4071.

CHECK THESE FEATURES of the New Class "B" Relay

Independent Twin Contacts—for dependable contact closure.

Efficient Magnetic Circuit—for sensitivity and high contact pressure.

Unique Armature Bearing—for long wear under severe service conditions.

Compact Design—for important savings in space and weight.

Versatility—Available for coil voltages to 300 volts d-c and 230 volts a-c, and with capacities up to 28 springs; also with magnetic shielding cover, when specified.

No other relay can give you a greater combination of all these essential qualities.

Relays AND OTHER CONTROL DEVICES by AUTOMATIC ELECTRIC

AUTOMATIC ELECTRIC SALES CORPORATION
1033 West Van Buren Street • Chicago 7, Illinois

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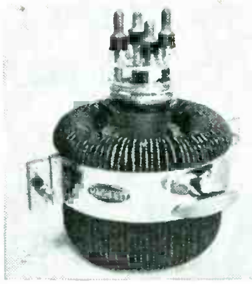
PARTS AND ASSEMBLIES FOR EVERY ELECTRICAL CONTROL NEED

A stable high vacuum is essential to the production of an electron tube if it is to give uniform, predictable performance. But there is much more to the process of getting a vacuum than just pumping.

Molecules of gas are not only present within the space inside the tube, and inside the metal parts, but also adhere tenaciously to all inner surfaces, or are "adsorbed". There is a special Machlett technique for dislodging those molecules. During pumping both the glass and the metal are brought to high temperatures. Cathode and anode are heated alternately many times, in order to capture molecules that are driven from one surface to the other. Most important of all, the tube is actually operated at voltages far in excess of values generally used in the vacuum tube field. All this takes many hours, the use of perfected apparatus including Machlett-designed pumps and other equipment, and the highest skills of laboratory-trained technicians.

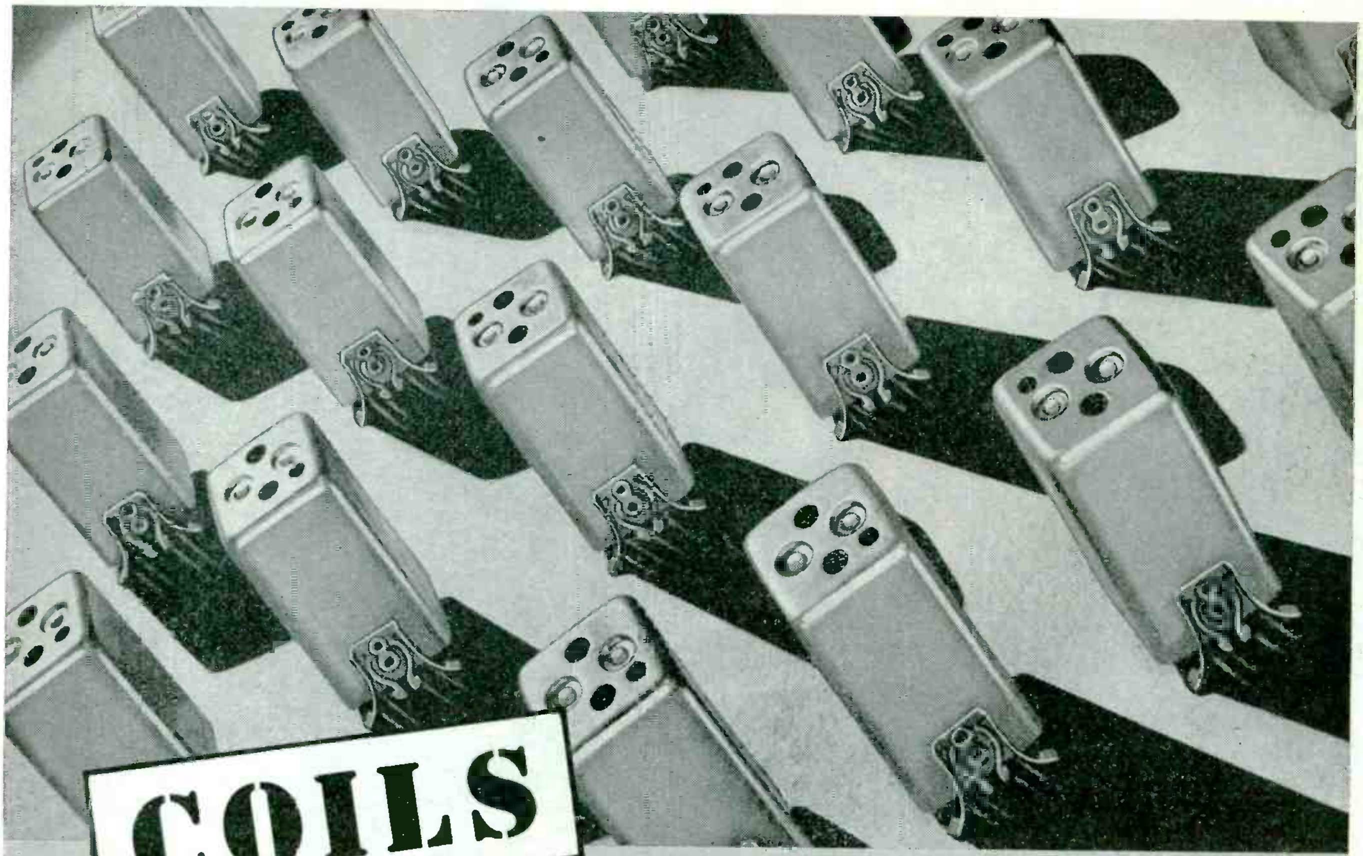
Thus when the tube is finally sealed we know the heat of operation cannot free enough molecules to affect its performance in your hands. This Machlett technique was developed for our X-ray tubes, and was in part responsible for the Machlett reputation. When we began the manufacture of radio and industrial oscillators, amplifiers and rectifiers, the same methods of capturing the molecules were adopted. That is one of the many reasons why users of Machlett radio and industrial tubes join with medical and industrial users of Machlett X-ray tubes in praising their reliability and economy. It will pay you to buy Machlett tubes. For information as to available types, write Machlett Laboratories, Inc., Springdale, Conn.



ML-889-R, a rugged forced-air-cooled triode, designed for h-f broadcast and dielectric heating applications

MACHLETT

APPLIES TO RADIO AND INDUSTRIAL USES ITS 48 YEARS OF ELECTRON-TUBE EXPERIENCE



COILS

Before the war

We made millions of coils each year

For many years.

Our organization was mass-production minded.

That organization is intact.

We are still mass-production minded.

Order your mass-production coils from people who "know-how".

ARMY E NAVY

AUTOMATIC MANUFACTURING CORPORATION

COMPLETE ELECTRONIC ASSEMBLIES & COMPONENT PARTS

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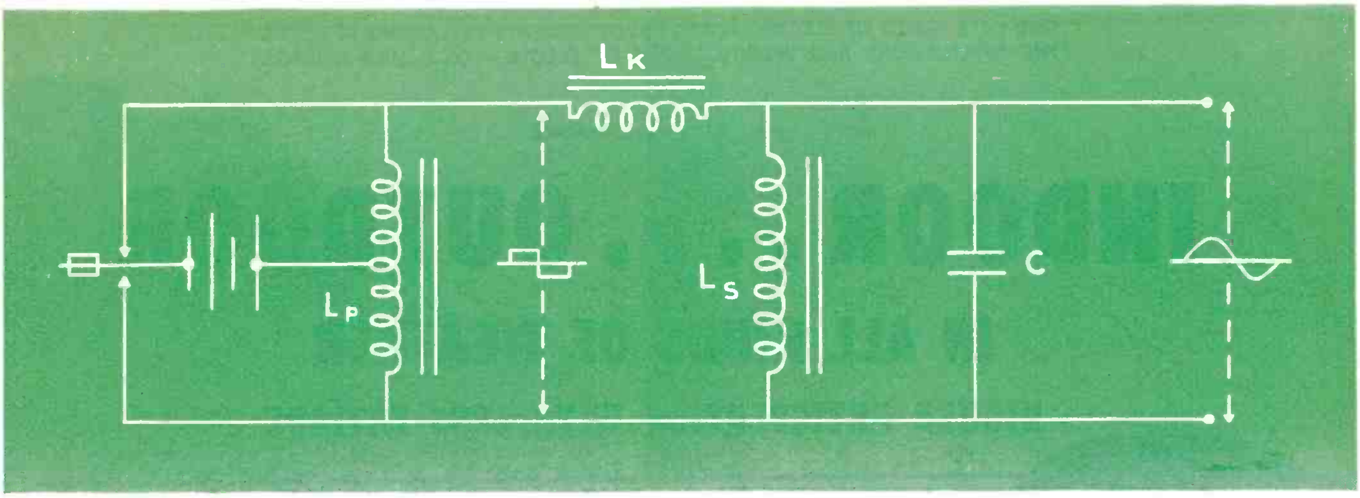


NOW, A VIBRATOR POWER SUPPLY WITH A SINE WAVE OUTPUT

For years, it has been taken for granted that the output wave form of a Vibrator Power Supply necessarily must be a rectangular wave with its characteristic "swingback" or commutation lines. With the development of very sensitive radio equipment this, of course, caused shock excitation of the audio and RF tuned circuits. In equipment designed for sine wave, operation on square wave resulted in the wrong ratio of A and B voltages applied to the tubes.

Realizing the need for eliminating the difficulties arising from square wave operation, Electronic Laboratories research department has perfected a Vibrator Power Supply which can supply a sine wave at powers up to several hundred watts from any DC source. In addition, this output is stable and has excellent regulation characteristics with load and input voltage.

Referring to the diagram at the top of this page, L_k (leakage reactance) and the condenser, "C", form a series resonant circuit. This circuit establishes a voltage across the secondary inductance, L_s. This voltage rises as L_k is varied until it is established by the saturation of the secondary inductance, L_s. The saturation characteristic of the inductance, L_s, is such as to sustain sinousoidal voltage across the condenser, "C". This results in a smooth sine wave output voltage, substantially independent of the input voltage. An elementary form of this system is shown in figure 1. The power transformer consists of a primary winding, "P", energized from the battery through the vibrator. The secondary winding, "S", is separated from the primary by magnetic shunts, and the tank condenser, "C", is across the secondary winding.

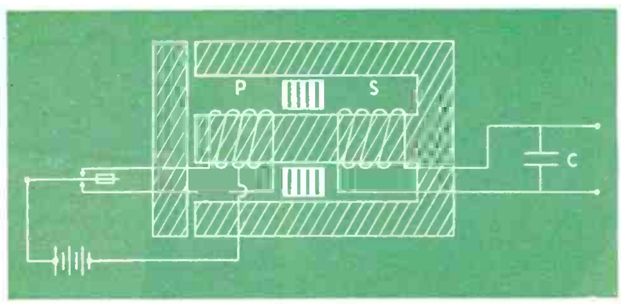


Figure 1

Since the reactive energy stored in the system is large, compared to the actual energy dissipated by the load, this system is also independent of load changes. Careful design of the primary circuit insures proper commutation for long life and reliability. Any number of voltages can be had from the system by properly tapping the tank circuit.

* * * * * *

E·L Vibrator Power Supplies have wide application in many fields: radio, electrical, electronic, marine, aviation and railroad. Their high efficiency and versatility with multiple inputs and outputs, enable them to meet many power supply needs. They may be designed to provide any wave form required for specific equipment. . . . Economy is assured because of long, efficient service with minimum maintenance. E·L Engineering Service is available to discuss your power supply problem and to design a vibrator power supplv to meet specific voltage, power, size and weight requirements. *Model illustrated is a typical E·L Vibrator Power Supply with sine wave output and voltage regulation.*

Electronic LABORATORIES INC.

INDIANAPOLIS

VIBRATOR POWER SUPPLIES FOR LIGHTING, COMMUNICATIONS, ELECTRIC MOTOR OPERATION • ELECTRIC, ELECTRONIC AND OTHER EQUIPMENT

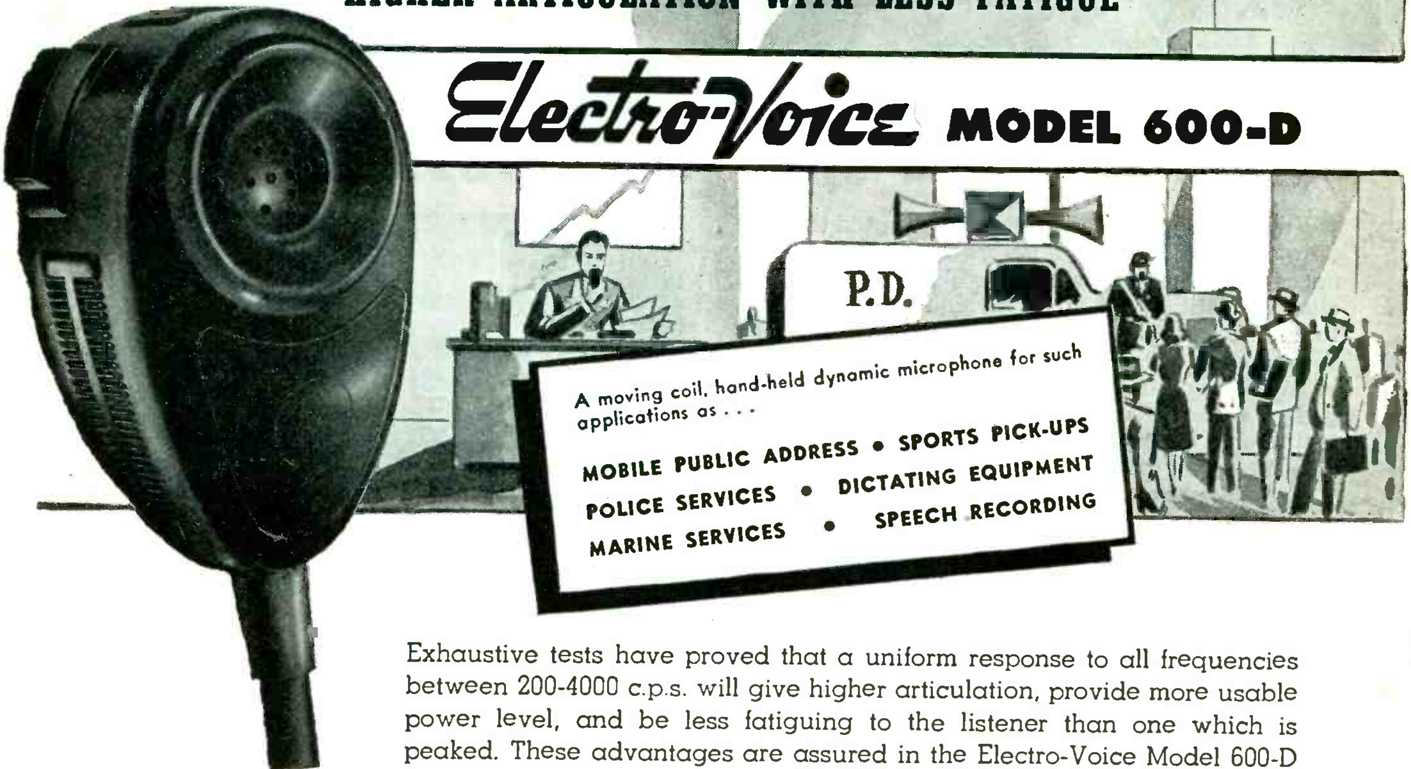
ONE OF A SERIES OF ELECTRO-VOICE ADVERTISEMENTS EXPLAINING IN DETAIL THE APPLICATIONS AND SPECIFICATIONS OF ELECTRO-VOICE MICROPHONES

INDOOR . . . . OUTDOOR

IN ALL KINDS OF WEATHER

HIGHER ARTICULATION WITH LESS FATIGUE

Electro-Voice MODEL 600-D



A moving coil, hand-held dynamic microphone for such applications as . . .

MOBILE PUBLIC ADDRESS • SPORTS PICK-UPS
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Exhaustive tests have proved that a uniform response to all frequencies between 200-4000 c.p.s. will give higher articulation, provide more usable power level, and be less fatiguing to the listener than one which is peaked. These advantages are assured in the Electro-Voice Model 600-D because the frequency response is unweighted and substantially flat. Where ambient noise does not interfere or distract, high fidelity speech transmission is provided, indoors or outdoors . . . in any kind of weather.

OUTPUT LEVEL RATING: Power: 56 db below 6 milliwatts for 10 dynes/cm pressure. Voltage (high impedance): 5 db above .001 volt/dyne/cm², open circuit. Voltage developed by normal speech (100 dynes/cm²): .177 volt.

FREQUENCY RESPONSE: 100-6000 c.p.s.

WEIGHT: 9 ounces.

HARMONIC CONTENT: Less than 2% at all frequencies.

DIAPHRAGM: Made of heat-treated duralumin, corrosion inhibited.

VOICE COIL: Made of pure aluminum, high-Q design.

CASE: Constructed of finest quality, high impact phenolic.

PRESS-TO-TALK SWITCH: Sliding contact, self cleaning type; standard circuit opens microphone and closes relay simultaneously. Other combinations optional.

TRANSFORMER CORE: Made of nickel alloy, hydrogen annealed metal; low capacity windings.

MAGNETIC CIRCUIT: Employs Alnico V and Armco magnetic iron.

IMPEDANCES: Hi-Z (Direct-to-Grid), 50, 200, 250, or 500 ohms.

Equipped with 6 feet of two conductor and shielded synthetic rubber jacketed cable.

Model 600-D, List Price .... **$27.50** **Model 600-DL**, with switch lock, List Price **$29.00**

See your nearest radio parts distributor today. His knowledge of Electro-Voice microphones may aid you in selecting the appropriate type for your specific needs. He may also be an important factor in speeding your order.

SUPPORT THE SEVENTH WAR LOAN DRIVE

Electro-Voice MICROPHONES

ELECTRO-VOICE CORPORATION • 1239 SOUTH BEND AVENUE • SOUTH BEND 24, INDIANA
Export Division: 13 East 40th Street, New York 16, N. Y., U. S. A. Cables: Arlab

Combining

1. SPECIAL PURPOSE ENGINEERING
2. RECEIVING TUBE TECHNIQUES

The 2C26A exemplifies Hytron's ability to build in soft glass, at high speed, and for economical prices, special purpose tubes. Hytron solved a tough problem for the Services by designing in the 2C26A a tube capable of performance and high ratings never before — or since — achieved in soft glass. This small tube — approximately the same size as the 50L6GT Bantam — is capable of delivering 2 KW of useful r.f. power at 200 megacycles. It replaces larger and much more expensive hard glass transmitting tubes which must be operated at much higher potentials.

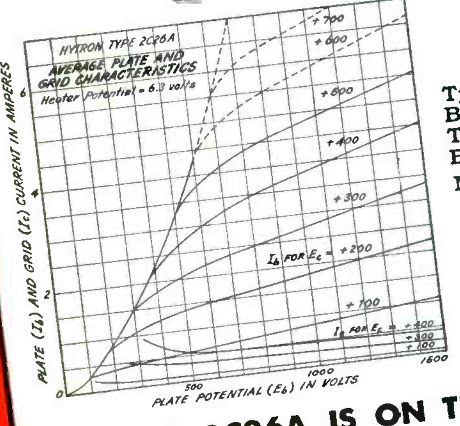
HYTRON TYPE 2C26A

VERY-HIGH-FREQUENCY TRIODE PULSE OSCILLATOR

The Hytron type 2C26A is a special triode for use as a grid or plate pulse oscillator up to 300 megacycles. Its cathode is designed and processed to provide the extremely high peak plate currents required in pulse operation. Special top cap design permits use of the maximum potentials, without external voltage breakdown, at the higher altitudes. Other notable features are: convenient size, standard octal base, high-voltage internal ceramic insulators, and extremely rugged construction.

ELECTRICAL

Coated Unipotential Cathode	
Heater Voltage	6.3 volts
Heater Current	1.1 amps.
Plate Dissipation	10 max. watts
Grid Dissipation	2.5 max. watts
Plate Potential (plate pulsed)	3500 max. peak volts
Plate Potential (grid pulsed)	2500 max. dc volts
Grid Bias	– 700 max. dc volts
Average Characteristics for	Eb:400V; Ec:-15V; Eh:6.3V
Plate Current	16 ma.
Amplification Factor	16.3
Transconductance	2250 micromhos
Average Direct Interelectrode Capacitances	
Grid-to-Plate	2.8 mmf.
Grid-to-Cathode	2.6 mmf.
Plate-to-Cathode	1.1 mmf.
Frequency for Maximum Rating	300 MC



MECHANICAL

Type of cooling	Convection
Base	Intermediate shell octal 8-pin phenolic
Top Caps	Skirted miniature with insulating bushing
Bulb	T-9
Maximum overall dimensions	
Length	3 11/16 inches
Seated Height	3 1/8 inches
Diameter	1 5/16 inches
Net Weight	1 1/2 ounces

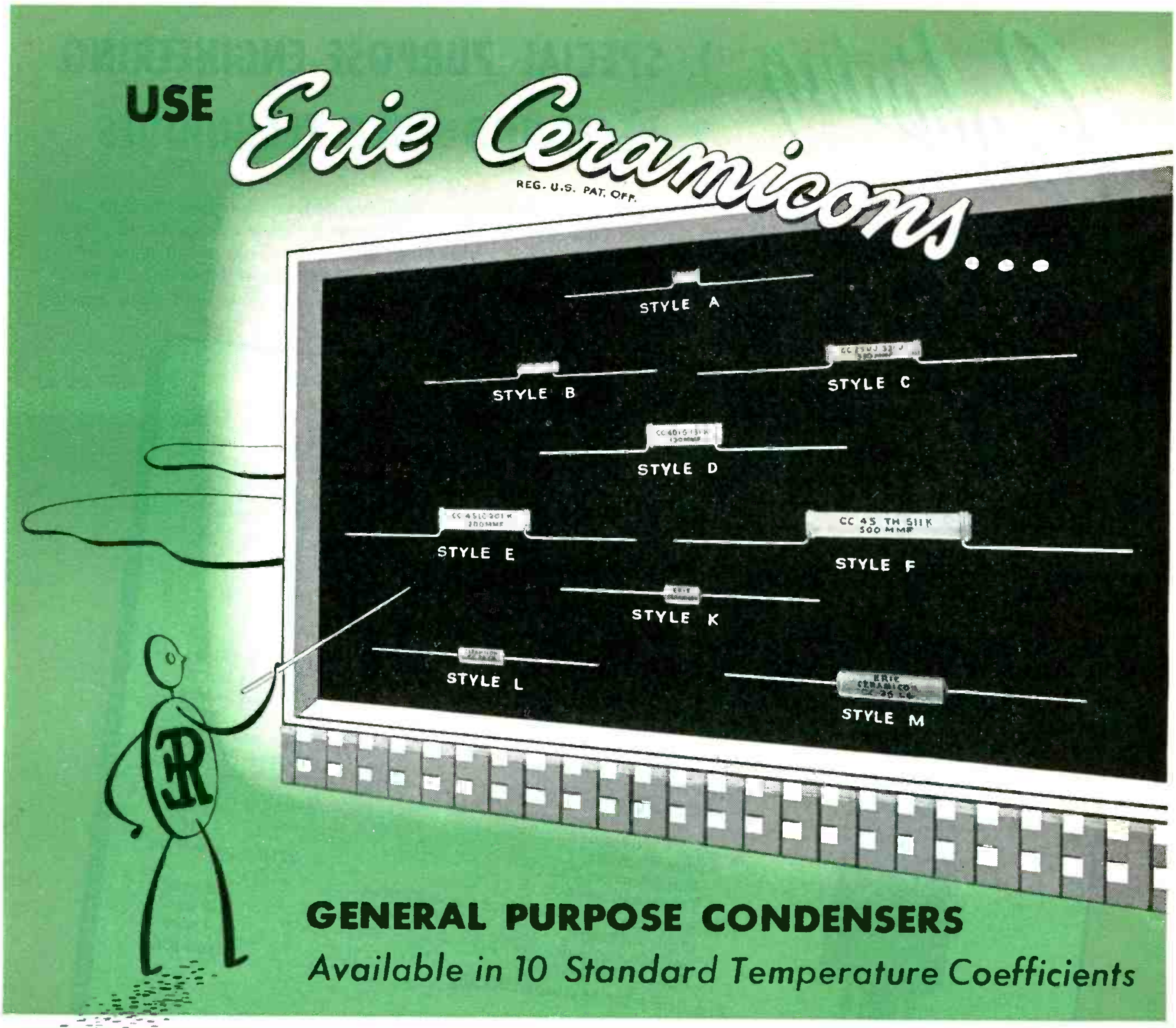
2C26A IS ON THE ARMY-NAVY PREFERRED LIST

OLDEST EXCLUSIVE MANUFACTURER OF RADIO RECEIVING TUBES

HYTRON
RADIO AND ELECTRONICS CORP.

MAIN OFFICE: SALEM, MASSACHUSETTS
PLANTS: SALEM, NEWBURYPORT, BEVERLY & LAWRENCE

FORMERLY HYTRON CORPORATION



THE tremendous wartime demand for condensers has provided a splendid opportunity to prove the reliability and adaptability of Erie Ceramicons* as extremely stable, general purpose capacitors, in circuits where a moderate degree of capacity change with temperature is permissible.

Originally designed and developed almost a decade ago to provide engineers with a simple and effective method of compensating for frequency drift in other components, Erie Ceramicons are now being used in a wide range of applications with complete success.

Erie Ceramicons are available in ten standard coefficients ranging from +120 to −750 parts/million/°C, inclusive. Capacity ranges, style designations, and dimensions are given in the chart at the right.

When specifying Ceramicons under JAN-C-20 for general purpose use, temperature coefficient characteristic "SL" should be given. If Erie designations are used, specify "any temperature coefficient between P100 and N750." The temperature coefficient of these Ceramicons will be between +150 and −870 parts/million/°C. In many cases, particularly in the low capacity ranges, these temperature coefficient limits will permit us to ship from stock. We will gladly submit samples of Erie Ceramicons to you for your general purpose applications.

CHARACTERISTICS

CAPACITY RANGE IN MMF	JAN-C-20 STYLE	ERIE STYLE	MAXIMUM OVERALL DIMENSIONS
1 to 51	CC20 CC21	A K	.200 x .400 .250 x .562
52 to 110	CC25 CC26	B L	.200 x .656 .250 x .812
111 to 360	CC35 CC36	C M	.265 x 1.125 .340 x 1.328
361 to 510	CC40	D	.375 x 1.110
511 to 820	CC45	E	.375 x 1.560
821 to 1100	CC45	F	.375 x 2.00

*CERAMICON IS THE REGISTERED TRADE NAME OF SILVERED CERAMIC CONDENSERS MADE BY ERIE RESISTOR CORPORATION.

Electronics Division

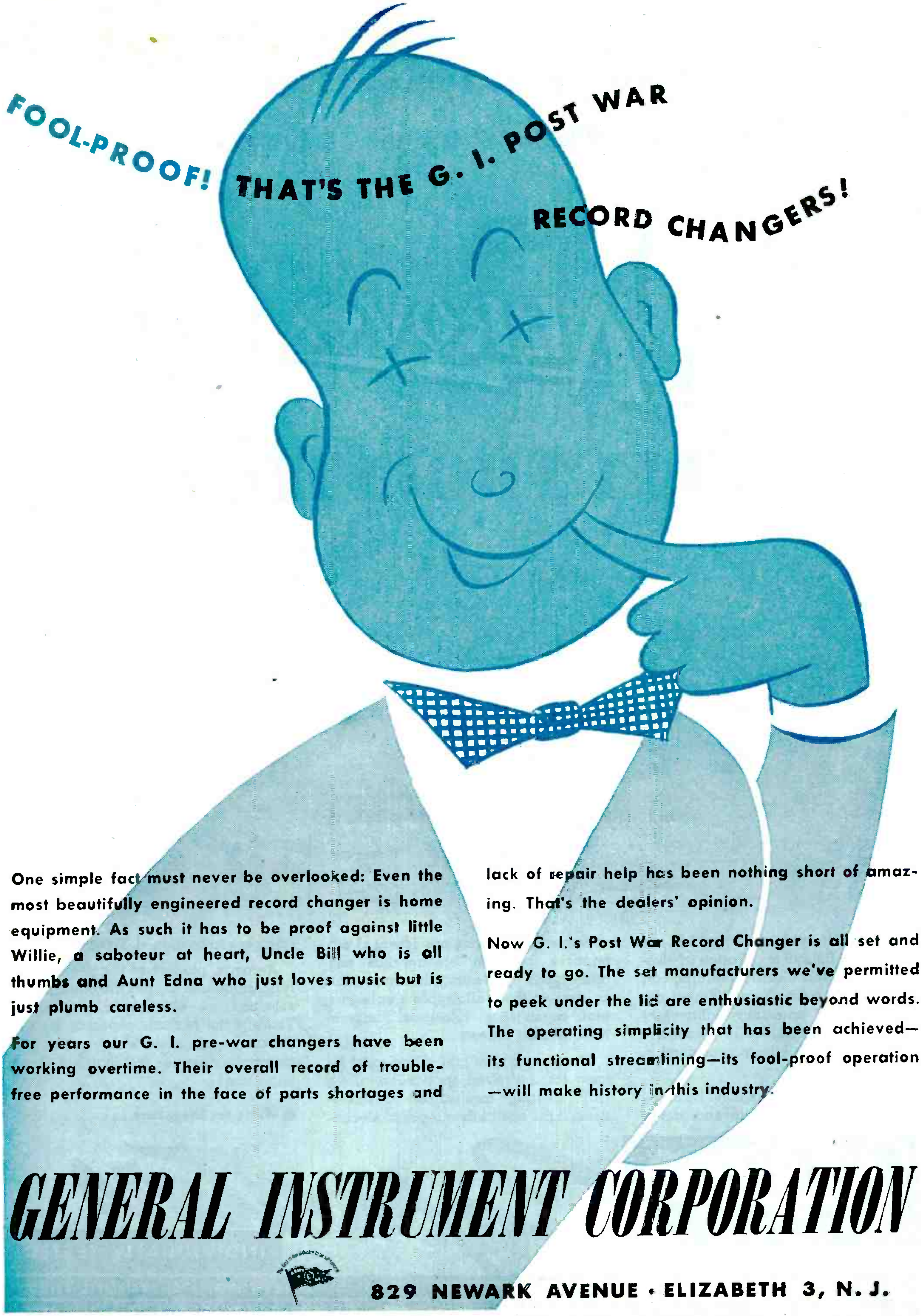
ERIE RESISTOR CORP., ERIE, PA.

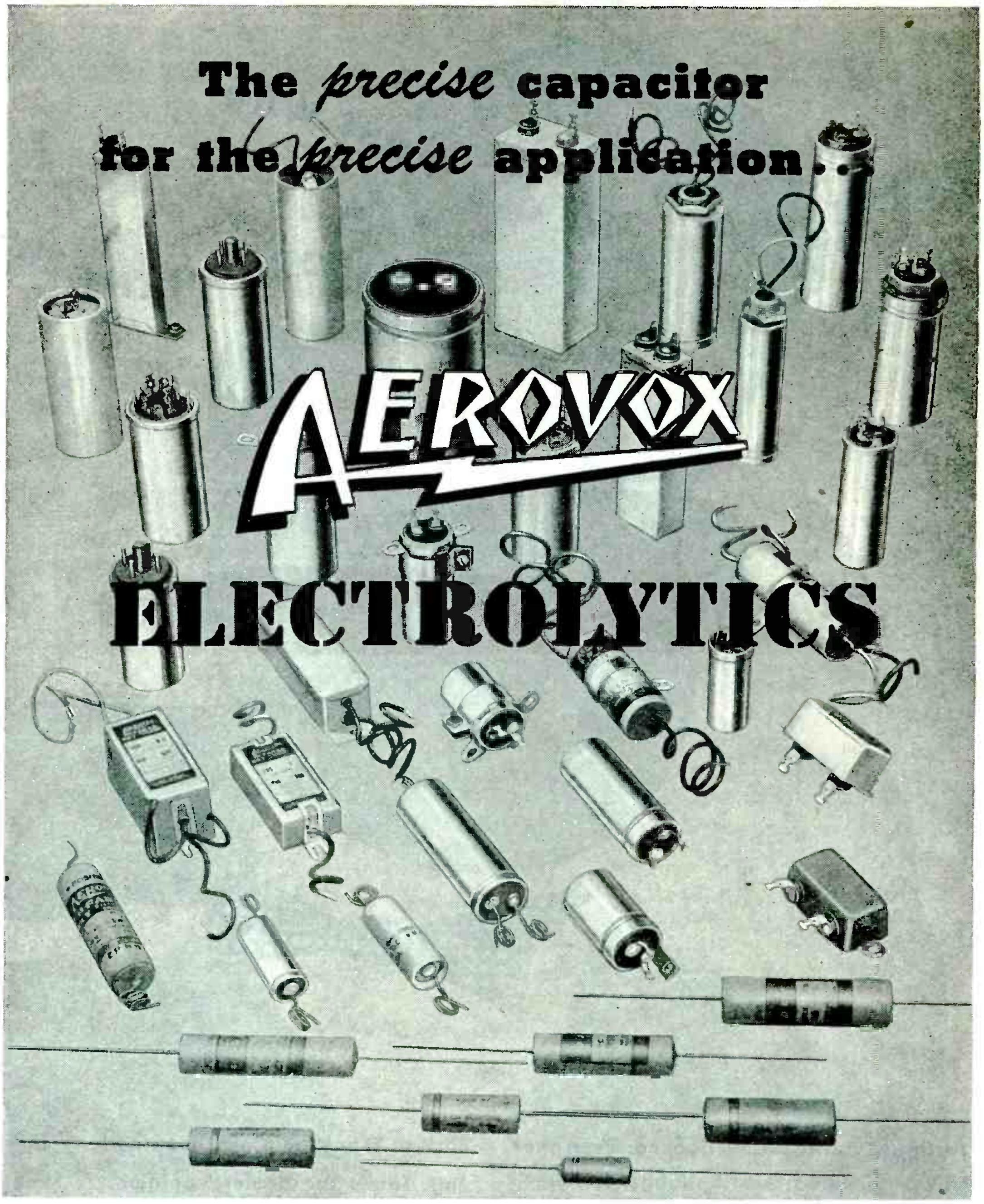
LONDON, ENGLAND • • TORONTO, CANADA

BUY MORE WAR BONDS

ARMY NAVY E

FOR HIGH ACHIEVEMENT IN WAR PRODUCTION


FOOL-PROOF! THAT'S THE G. I. POST WAR
RECORD CHANGERS!
One simple fact must never be overlooked: Even the most beautifully engineered record changer is home equipment. As such it has to be proof against little Willie, a saboteur at heart, Uncle Bill who is all thumbs and Aunt Edna who just loves music but is just plumb careless.
For years our G. I. pre-war changers have been working overtime. Their overall record of trouble-free performance in the face of parts shortages and lack of repair help has been nothing short of amazing. That's the dealers' opinion.
Now G. I.'s Post War Record Changer is all set and ready to go. The set manufacturers we've permitted to peek under the lid are enthusiastic beyond words. The operating simplicity that has been achieved—its functional streamlining—its fool-proof operation—will make history in this industry.
GENERAL INSTRUMENT CORPORATION
829 NEWARK AVENUE • ELIZABETH 3, N. J.



● The electrolytic capacitor has its own special field of application in electronic, radio and electrical equipment. This type provides the equipment designer with *an unusually lightweight unit* of high capacitance in a compact container. Also, it effects considerable savings. **BUT . . .**

Electrolytic capacitors must be properly applied for long life and stable characteristics. There are essential differences between electrolytics and other types that restrict their use, such as over-voltage, allowable ripple current, capacitance, tolerance, temperature. **WHICH MEANS . . .**

The proper type and rating must be used for the given application, along with meeting mechanical considerations, if the basic advantages of electrolytics are to be gained. **THAT IS WHY...**

Aerovox, pioneer of the dry electrolytic, continues to offer the outstanding selection of electrolytic capacitors. There is the PRECISE capacitor for the PRECISE application, which guarantees satisfactory service and long life. Don't improvise!

● **Write for literature . . .**

AEROVOX *Capacitors*

INDIVIDUALLY TESTED

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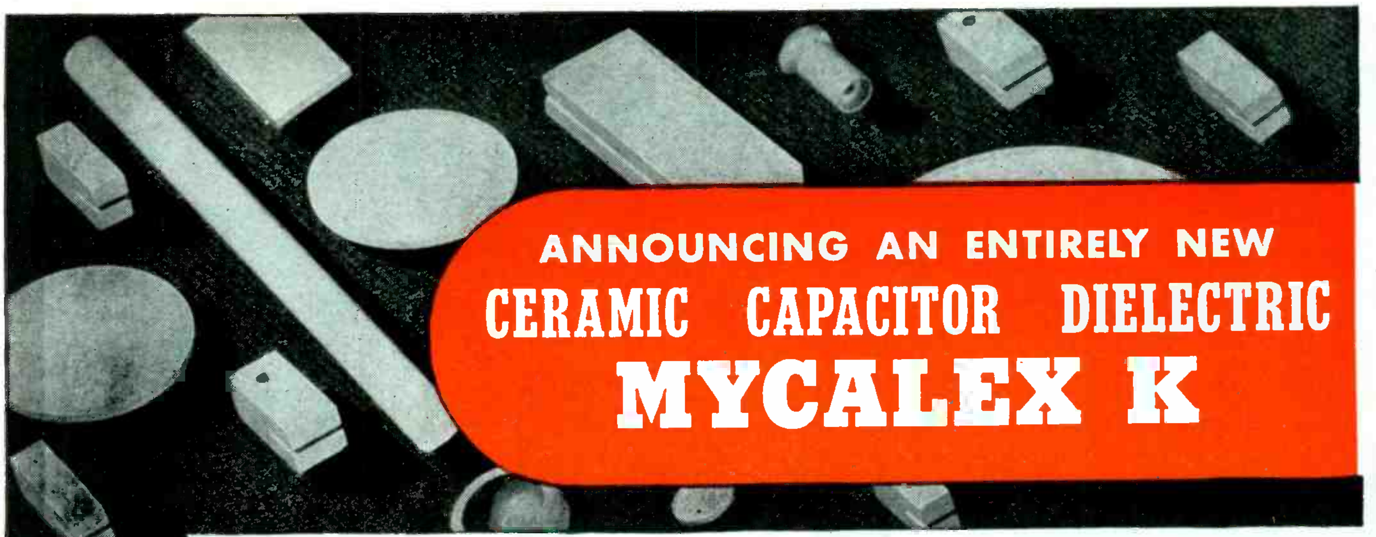


ANNOUNCING AN ENTIRELY NEW

CERAMIC CAPACITOR DIELECTRIC

MYCALEX K

The MYCALEX CORPORATION OF AMERICA has developed and now has in production a new capacitor dielectric which embodies important new advancements in properties.

Designated MYCALEX "K," this new ceramic material is unique in that it offers a *selective* range of dielectric constants, from 8 to 15 at one megacycle.

Engineers whose requirements call for a material with a dielectric constant of 10, need only specify MYCALEX K-10. If a dielectric constant of 8 is indicated, MYCALEX K-8 will meet that exact requirement. Other applications might call for use of MYCALEX K-11 or K-12, etc.

MYCALEX K-10 already has been approved by the Army and Navy as Grade H1C5H4 Class H material (JAN-I-12). While other Class H materials are available, to the best of our knowledge these are all steatite or bonded titania or titanate types, obtainable only in relatively small dimensions and subject to wide variations in tolerances. MYCALEX K is available in sheets 14" x 18" in thicknesses of 1/8" to 1"; in thicknesses down to 1/32" in smaller sheets, and in rods 1/4" to 1" in diameter.

Of importance also is the fact that MYCALEX K series can be molded to specifications, with electrodes or metal inserts molded in. It can be fabricated to close tolerances.

So far as we are aware, the MYCALEX CORPORATION OF AMERICA is the exclusive developer and only supplier of this kind of capacitor dielectric.

Write today for further information to Department 12.

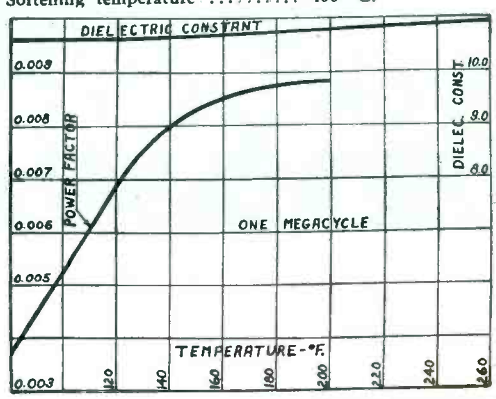
MYCALEX K-10

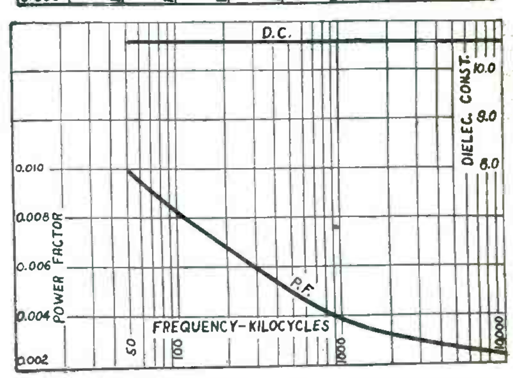
Grade H1C5H4, in accordance with JAN-I-12

Dielectric constant ....10.6 } 1 megacycle
Q-Factor ....310 } 1 megacycle
Loss Factor ....0.034 } 1 megacycle
Volume resistivity .....6.0×10^{12} ohms—cms.
Dielectric strength .... 270 volts/mil (0.10" thickness)
Modulus of rupture.... 9000 lbs./sq.in.
Fractional decrease of capacitance with temperature change 0.0056
Fractional increase of capacitance with temperature change 0.0076
Porosity—no dye penetration after six hours at 10,000 lbs./sq. in.

The above properties were measured in accordance with the procedures of JAN-I-12.

Density .... 0.116 lbs. per cu.in.
Specific gravity 3.22
Softening temperature .... 400° C.





Other Products of Mycalex Are:

MYCALEX 400—the most highly perfected form of MYCALEX insulation, approved by Army and Navy as Grade L-4 insulation. In sheets, rods and fabricated form.

MOLDED MYCALEX available to specifications in irregular shapes and into which metal inserts may be incorporated.

MYCALEX THE INSULATOR
TRADE MARK REG. U. S. PAT. OFF.

MYCALEX CORPORATION OF AMERICA

"OWNERS OF 'MYCALEX' PATENTS"

Plant and General Offices
Clifton, N. J.

Executive Offices
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SMALL BUT
STURDY...

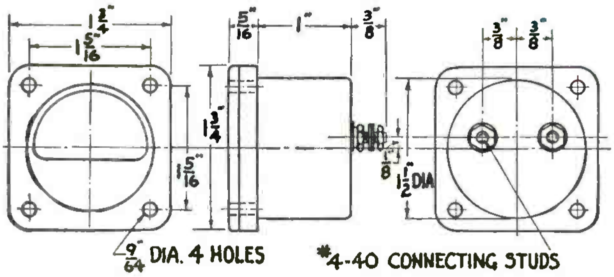
The New Line of ROLLER-SMITH 1½" Panel Instruments

Instrument shown actual size.

Design and development of this line of 1½" instruments were based on rigid U. S. Army Air Force specifications. They are built to withstand extreme conditions of temperature, humidity, vibration and shock, and immersion tests have demonstrated their ability to withstand a hydrostatic pressure of 14.7 psi.

Roller-Smith 1½" instruments are now available in d-c voltmeters, 1000 ohms per volt, in all practical ranges above 100 millivolts, and 100 ohms per volt in ranges from 50 to 100 millivolts; d-c ammeters in all practical ranges above 500 microamperes. For certain applications instruments can be supplied with ranges below those specified. Correspondence is invited.

When desired, solder lugs can be furnished instead of the connecting studs shown.



ROLLER-SMITH BETHLEHEM, PENNA.

Canadian Plant: ROLLER-SMITH MARSLAND, LTD., Kitchener, Ontario

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STANDARD AND PRECISION ELECTRICAL INSTRUMENTS • AIRCRAFT INSTRUMENTS • SWITCHGEAR • AIR AND OIL CIRCUIT BREAKERS • ROTARY SWITCHES • RELAYS • PRECISION BALANCES

SUSTAINED CONSTRUCTION ACTIVITY

One Step Toward High Level Employment

IN the 34th editorial of this series, it was pointed out that sustained prosperity, based on high level employment, was a major postwar goal accepted by government, management and labor.

That editorial developed the theme that, if the goal were to be approached without undue sacrifice of our essential liberties, we must forego the search for magic panaceas, and follow the harder but more promising course of analyzing step by step, and industry by industry, the measures that might contribute toward the end sought.

This is the first of a number of editorials following such a particularized approach. It will examine the role of the construction industry in forwarding sustained prosperity.

☆ ☆ ☆

The influence of construction upon the general level of economic activity is important but not decisive. The claim is frequently advanced that major fluctuations of the business cycle might be ironed out by a properly devised and timed public works program; but any examination of the relatively modest contribution of construction activities to total national output will demonstrate its extravagance.

In the twenty years from 1920 through 1939, the value of new construction averaged just over 8½% of the gross national product. If we add repair and maintenance expenditures, the total is increased to a little over 12% of the gross product. But approximately two thirds of the construction of this period was privately initiated, and only one third was represented by government construction, federal, state and local combined. To expect that we can level out the peaks and valleys of our whole economy through manipulating the 4% portion that is represented by government construction is to expect a very small tail to wag a very large dog.

In fact, the record of construction activity in the past has been on the side of disequilibrium rather than stabilization. In boom times construction activity has climbed to relatively higher peaks than those reached by the economy as a whole; in depression periods it has fallen to deeper troughs. Aside from the special work relief program of the depression thirties, the performance of public construction in this respect is little better than that of private. New government construction mounted with the general trend of the boom from 1921 to 1929, thereby adding its weight to the inflationary trend.

Instead, then, of expecting the construction industry to stabilize our whole economy—a task clearly beyond its power—it would seem appropriate to ask that it look to the more attainable goal of leveling out its own violent fluctuations. If this can be done, many of the most vexing problems of the construction field and of its sphere of influence will be mitigated, employment will be regularized in one important segment of industry where the past record has been particularly uneven, and one aggravating contribution to general business instability will be removed.

The achievement of these highly important, if limited, aims will require the thoughtful, vigorous, and concerted cooperation of management and labor in the construction industry, of a variety of governmental agencies, and of those who direct the sources of construction credit. Of the many measures that must be woven into an ordered program, it is practicable here to present only the broad outline of those which seem to offer the greatest potential usefulness.

☆ ☆ ☆

1. Stabilization implies the holding of a balance rather than a freezing at a given level. No rigid formula for a most desirable level of construction activity is possible or desirable. However, it may be accepted as a reasonable initial premise, that we could sustain in the future without major distortion something like the 12% ratio of total construction to gross national product that has been approximated in the past. If it is to serve as an useful reference point, such a generalized premise must be subjected to constant testing both nationally and locally. There must be careful and continuous scrutiny for signs of demand saturation, cost inflation, and labor shortages, all danger signals of far greater reliability than any percentage formula.

The first requisite then is the general availability of information along such lines, far more complete and current than has hitherto been at hand. The second is a general will to hold building activity at a level as high as but not higher than we probably can sustain. Once this principle is accepted, the problem becomes one of marshalling all available instrumentalities to forward it.

2. Public construction, although too small to exert a decisive influence upon economic activity as a whole, can

condition construction trends to a major degree. If, in the decade following the war, government construction approximates its 1920 to 1940 average of one third of all construction, its properly timed impact could do much to level out the construction cycle.

To do this most effectively, public construction should be deferred where and when private building is going forward at a satisfactory pace, and should be started when and where private activity shows undue slack. All government construction does not lend itself to such adjustment. But a large portion of it could be held up for the three to five years which, upon past experience, would provide the necessary leeway to counteract the more violent fluctuations in private building.

Such a program presents numerous difficulties both political and administrative. None should be insurmountable, and the results promise to be of sufficient moment to justify the extraordinary effort that would be required to coordinate federal, state and local government programs. Here is an excellent forum for testing whether or not government economic activity can be made to supplement rather than supplant private effort to serve ends upon which all are agreed.

3. Since private building, postwar as in the past, must supply the preponderant share of construction activity and employment, costs will continue to play a dominant role in determining levels of operation. Wartime restrictions have created formidable backlogs of deferred demand for most types of private, and for many of public, construction. Such demand is so great that it almost certainly will provide the impetus for a postwar building boom of several years duration. There is considerable doubt that in the beginning our building trades, dislocated by war and at low ebb, can organize rapidly enough to carry their share of the anticipated general advance.

However, if former patterns hold, building activity, after a lagging start, will soar, costs will mount, and eventually will saturate effective demand with resultant collapse. That, of course, is precisely the sort of a situation we are seeking to avoid. Crucial to this end is the prevention of rising costs or, better still, the reduction of building costs from present swollen levels.

A recent study by technicians of the War Production Board on the outlook for private housing construction illustrates the point. From 1900 to 1940 the number of housing units built in this country closely matched the statistics of new family formation. The former ran considerably ahead of the latter from 1920 to 1929, and fell behind by the same margin in the following decade.

If the market for new houses were to be similarly limited for the period from 1940 through 1949, the effective demand for new housing during the last five years (1945-1949) is estimated at 3,000,000 units. That is after allowing for houses built from 1940 through 1944, and for vacancies, demolitions, and other factors. If, however, prices could be reduced to 1939 levels, the 3,000,000 unit demand is estimated as increasing to more than 7,000,000 units. Since the latter figure is substantially beyond our production capacity for the period, a backlog would be created that would support an effective sustained demand for the subsequent decade (1950-1959) of 1,000,000 units per year, as against half that amount if rents and sales prices mount with increasing incomes.

The precise accuracy of such an estimate may well be questioned. There can be no question as to the general validity of the point illustrated. The progressive lowering of construction costs will stimulate demand in this field as it has in others. Building management, labor, and their suppliers and customers stand to gain from such a result. Unnecessary restrictions against the adoption of improved technologies and increased productivity should, therefore, be removed, whether imposed by codes of government, regulations of unions, collusion of managements, or inertia of workers. Unless there are compelling social justifications such restrictions must be judged harmful to the whole economy.

4. Numerous other measures could contribute substantially to increased and increasingly stable construction activities. Space remains only to stress the importance of careful consideration for the use of credit facilities as a means of stabilization. In recent years the establishment of the Federal Housing Administration provided a needed stimulus to mortgage lending in the field of housing. The modern pattern of long-term mortgages, providing for regular amortization as well as interest, should be a steadying factor in periods of liquidation. However, there appear to be further possibilities for using credit facilities as a brake when construction activity threatens to climb beyond a level that can be sustained. If public and private lending agencies could devise sound means for raising mortgage rates, increasing down-payment requirements, shortening amortization periods and basing value appraisals upon normal rather than inflated costs, they might exert a healthy influence against the tendency of the construction bubble to inflate until it bursts.

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There is no royal road to sustained high level employment. There is not even a single path to assured construction stability—there are many paths, all strait and narrow and all paved with bruising cobbles. This is true for all other major segments of industry.

It is easier to seize upon a magic formula such as monetary control, or deficit spending, or any one of a score of others, than to undertake an intricate task of piecemeal exploration. But only the latter course will lead to prosperity.

James H. McGraw, Jr.

President, McGraw-Hill Publishing Co., Inc.

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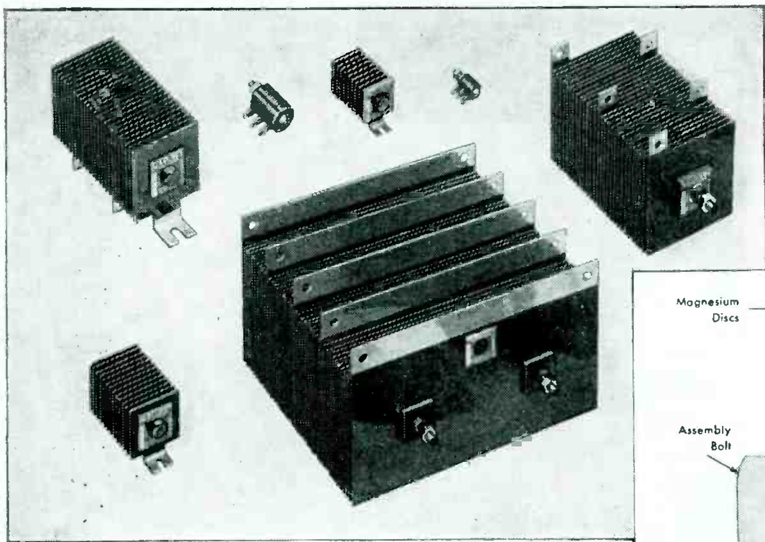

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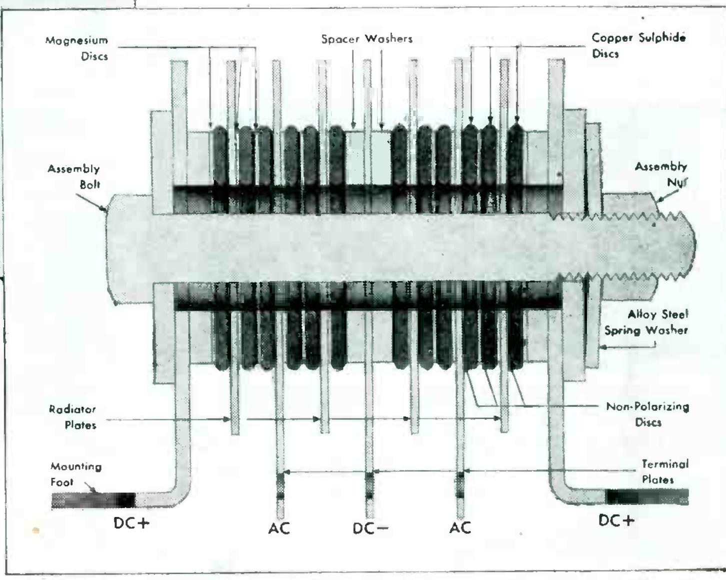

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CROSS TALK

►**COLOR** . . . Color ads appearing in national magazines depicting the wonders of television have a lot of us drooling, just in anticipation. The trouble is that many people are going to experience a distinct shock when they see their first demonstration and find out that television is not in full color—as in the ads—but in black and white. Careful reading of the ads discloses no claim or promise but the implication is there just the same. Isn't it just possible that this color advertising will create sales resistance for the dealers and make more difficult their problem of transferring the products of the manufacturers to the homes? As a matter of cold fact, won't the mere promise of color delay the distribution of the black-and-white receivers?

►**BD** . . . As of May 1, this year, Beverly Dudley leaves his post as Western Editor of ELECTRONICS and becomes editor of The Technology Review, alumni technical journal of the Massachusetts Institute of Technology. "Dud" had been on the editorial staff of ELECTRONICS for eight years, first as associate editor, then 2½ years as managing editor and since October of 1944 he has been in Chicago, where he was actively engaged in making and keeping friends for his paper when the opportunity came along to return to his Alma Mater as a member of its administrative staff.

►**FM** . . . For the record, Major E. H. Armstrong wishes it known that he was wrongly quoted by some of the newspapers and others at the time of the FCC hearings on f-m. It was stated that he would forego his royalties for a period of a year if f-m remained in the frequency band where it now is. Actually, as shown by the record of the proceedings, he said that if f-m went up to the 80-100 megacycle region, he felt large-scale use of f-m would be delayed for a year. Under these conditions he would turn over his royalties to a Board to use as seemed fitting.

Thus the newspaper reports were exactly opposite to the actual offer.

►**SURPLUS** . . . Among the vast quantities of surplus and used equipment which the armed forces will ultimately release for sale will be much electronic apparatus which could be useful to colleges. The government could, in slight measure, repay many of the institutions of learning for their war-time aid by making it easy to purchase measuring apparatus, typical radio and radar demonstration units, tubes and all sorts of electronic stuff. Financially, colleges will be in no better condition after the war than they are now, and much of the equipment they need for proper instruction of the on-coming electronic experts will be out of sight economically if purchased first-hand. Disposing of the used or surplus material in this manner should annoy few manufacturers.

To prevent misuse of the purchase at low prices, all this educational gear could be so labelled. Sale could be restricted to those institutions which have contributed through ASTP, V-12, ROTC or in other ways.

►**INDEX** . . . One of the greatest service problems of the Editorial Department is to answer quickly and accurately the question, "When did you publish an article on such-and-such?". To aid us in our end of this problem, all the annual indexes since 1930 have been offset and bound into a sort of cumulative index of indexes. Readers who could use a copy of this super index can obtain it by writing the Editorial Department and enclosing seventy-five cents.

Electronic Applications in Industry

A year's work among 796 manufacturing and service plants in 11 major industries determines the type and number of electronic devices at present in use. More light is thrown on the potential market by indications of interest among non-users and suggested new applications. Highlights of a 192-page report are given here

HOW EXTENSIVE is the present-day use of electronic equipment by industry? What is the potential market? To throw more light on these two questions the Research Department of the McGraw-Hill Publishing Company conducted a survey throughout 1944, and in early 1945 rendered a 192-page report*.

The report, which can only be highlighted here, does not profess to be a complete and cannot hope to be a final answer. A perfect answer to the first question would necessarily involve collection of data from every plant in every industry, obviously impractical if the report was to be completed in time to guide post-war planners and particularly so at a time when restrictions still bar researchers from some factory corners. And the answer to the second question will constantly change as industry becomes more and more familiar with what electronic equipment can do.

In spite of these qualifications, which suggest that facts presented in the report do not in every case ideally lend themselves to projection and certainly should not be employed in this manner without careful consideration of all the factors involved, it is felt that the study represents the best work on the subject to date. Some illuminating general conclusions can be safely drawn from it. For example:

While the present industrial users of electronic equipment are less numerous than the man in the street supposes, they are more numerous than many hard-boiled engineers within the electronic industry itself suspect. The number of duplicate units of electronic equipment found in factories employing such gear is greater than many surmise. While certain specific industries are larger users of electronic apparatus than others at the moment, interest expressed by non-users indicates that the potential market still spreads pretty much right across the board. Many industries with jobs to do that can best be done by means of electronic equipment are not aware of the fact that similar jobs are already being done with such gear, despite the publicity which the art has enjoyed since the outbreak of the war.

How the Survey Was Conducted

The survey was conducted among 796 readers of the following magazines:

American Machinist
Aviation
Business Week
Chemical & Metallurgical Engineering
Coal Age
Electrical Contracting
Electrical World
ELECTRONICS
Engineering & Mining Journal
Engineering News-Record
Factory Management & Maintenance
Food Industries
Power
Textile World

It was felt that the fields served by these Company publications represented a good if not a complete cross-section of industry. No attempt was made to weight replies in accordance with the total number of firms engaged in specific industries, as projection of figures was not contemplated. Nor was there any attempt to concentrate contacts among men holding specific jobs. Those furnishing data included management, engineering, production, maintenance and even sales personnel.

During the course of the survey it became evident that data was more readily obtainable from the larger companies, and the final report reflects this. It should be kept in mind when the report itself, or the figures extracted therefrom and presented in these columns, are scanned.

Tabulation of Results

The tabulation of results presented here, containing a mere fraction of the data contained in the report, presents highlights considered of particular interest to readers of ELECTRONICS. To facilitate study the following information relative to the tabulation is given:

The first column (*Function or Device*) is broken down into eight

* "Electronic Applications in Industry" ($2.50), Research Department, McGraw-Hill Publishing Company, Inc., 330 West 42nd St., New York 18, N. Y.

SUMMARY OF ELECTRONIC SURVEY

Function or Device	Present Users			Potential Users	
	No. Co.	No. Dev.	Chief User	No. Co.	Greatest Interest
Control					
Carrier Current	35	218	Elec. Util. (28)	29	Elec. Util. (26)
Combustion	18	57	Metal Work. (6)	28	Chem. Proc. (11)
Electrostatic Precipitation	50	267	Metal Work. (25)	51	Chem. Proc. (14)
Filament Carburization	3	3	Metal Work. (3)	—	—
Illumination	38	145	Elec. Util. (19)	14	Metal Work. (6)
Induction Heating	10	24	Metal Work. (9)	5	Metal Work. (5)
Level	35	227	Chem. Proc. (18)	31	Chem. Proc. (16)
Electric Load	16	55	Elec. Util. (8)	9	Elec. Util. (5)
Door	25	91	Metal Work. (13)	27	Metal Work. (11)
Motion	22	83	Chem. Proc. (8)	17	Metal Work. (7)
Motor	48	247	Metal Work. (31)	61	Metal Work. (22)
Application of Coatings	2	4	Misc. Mfg. (1)	4	Metal Work. (3)
Register	18	156	Food (6)	11	Misc. Mfg. (6)
Remote	11	37	Elec. Util. (5)	17	Elec. Util. (8)
Switching	11	67	Metal Work. (8)	8	Elec. Util. (3)
Synchronization	11	32	Elec. Util. (8)	10	Elec. Util. (7)
Temperature	131	1,504	Metal Work. (68)	65	Chem. Proc. (20)
Timing (exc. welding)	62	294	Metal Work. (30)	13	Metal Work. (4)
Train	2	82	Metal Work. (1)	4	—
Welding (timing)	130	2,034	Metal Work. (100)	39	Metal Work. (24)
Relaying	19	104	Metal Work. (7)	19	Elec. Util. (11)
Humidity	1	1	Misc. Mfg. (1)	13	Text. (5)
Flow	25	80	Chem. Proc. (13)	13	Chem. Proc. (8)
Moisture	5	32	Chem. Proc. (4)	5	Text. (2)
Elevator Levelling	6	14	—	3	—
Germ, Insect	5	31	Chem. Proc. (3)	7	Food (3)
Color	—	—	—	8	Chem. Proc. (4)
Pressure	1	3	Elec. Util. (1)	5	Chem. Proc. (2)
Frequency	5	5	Elec. Util. (4)	4	Elec. Util. (4)
pH	6	19	Chem. Proc. (5)	13	Chem. Proc. (5)
Misc	12	45	Metal Work. (6)	5	Const. (2)
Counting, Sorting, Weighing					
Inspection for Missing Parts	1	4	Food (1)	14	Metal Work. (7)
Counting	31	112	Metal Work. (13)	53	Metal Work. (18)
Flaw Detection	17	259	Metal Work. (5)	42	Metal Work. (24)
Sorting and Grading	12	65	Metal Work. (9)	41	Metal Work. (9)
Insulation Testing	20	69	Elec. Util. (12)	12	Elec. Util. (8)
Metal Detection	23	118	Const. (12)	14	Misc. Mfg. (3)
Surface Analyzing	19	43	Metal Work. (17)	9	Metal Work. (7)
Weighing	11	86	Chem. Proc. (6)	35	Food (15)
X-Ray Inspection	42	97	Metal Work. (26)	18	Metal Work. (12)
Heating					
Ferrous and Non-Ferrous Metals	15	29	Metal Work. (13)	25	Metal Work. (16)
Ferrous Metals	46	89	Metal Work. (40)	52	Metal Work. (38)
Non-Ferrous Metals	22	61	Metal Work. (17)	25	Metal Work. (19)
Food Sterilization, Dehydration	—	—	—	23	Food (20)
Gluing, Drying Wood, etc.	5	7	Misc. Mfg. (3)	27	Misc. Mfg. (10)
Plastics	10	12	Chem. Proc. (6)	14	Metal Work. (8)
Rubber	—	—	Misc. Mfg. (1)	4	Chem. Proc. (2)
Sheet Materials	4	5	Metal Work. (3)	11	Chem. Proc. (5)
Textiles and Paper	2	2	Misc. Mfg. (2)	16	Text. (6)
Misc.	6	12	Chem. Proc. (3)	5	Chem. Proc. (2)
Measurement and Analysis					
Balancing Machines	28	66	Metal Work. (22)	5	Metal Work. (3)
Capacitance	34	129	Metal Work. (23)	—	—
Color	27	59	Chem. Proc. (10)	21	Chem. Proc. (7)
Conductivity of Solutions	19	23	Chem. Proc. (11)	3	Chem. Proc. (2)
Electric Current		3	Metal Work. (3)	4	Metal Work. (3)
Curve Tracing	20	49	Metal Work. (14)	13	Metal Work. (5)
Density, Opacity	16	93	Metal Work. (9)	11	Chem. Proc. (7)
Dielectric Properties	15	51	Metal Work. (9)	5	Elec. Util. (2)
Frequency	27	323	Metal Work. (21)	5	Elec. Util. (2)
Flux	6	10	Metal Work. (5)	4	Metal Work. (3)
Gas Detection and Analysis	12	30	Chem. Proc. (6)	22	Chem. Proc. (10)
Geodetic, Geophysical, Meteor	6	1,016	Misc. Non-Mfg. (3)	6	Mining (3)
Impedance and Reactance	25	96	Metal Work. (18)	—	—
Light Intensity	16	64	Metal Work. (7)	—	—
Humidity	—	—	—	7	Food (2)
Noise	29	63	Metal Work. (22)	3	Metal Work. (2)
pH	86	203	Chem. Proc. (39)	17	Food (4)
Pressure	7	9	Metal Work. (4)	9	Metal Work. (5)
Reflection	5	11	Chem. Proc. (4)	—	—
Resistance	25	107	Metal Work. (15)	4	Const. (2)
Speed	63	151	Metal Work. (41)	12	Metal Work. (7)
Smoke Detection, Recording	25	44	Metal Work. (6)	3	Chem. Proc. (2)
Sound Level	30	63	Metal Work. (16)	6	Const. (6)
Strain	14	74	Metal Work. (13)	1	Metal Work. (1)
Telemetering	34	123	Elec. Util. (25)	24	Elec. Util. (15)
Thickness, Distance	9	19	Metal Work. (6)	12	Metal Work. (10)
Time	14	70	Metal Work. (9)	2	Misc. Mfg. (1)
Titration	22	29	Chem. Proc. (14)	9	Metal Work. (3)
Turbidity	10	11	Chem. Proc. (4)	4	—
Vacuum and Ionization Gages	13	286	Metal Work. (7)	—	—
Tube Testing	23	49	Metal Work. (13)	1	Metal Work. (1)
Voltage	81	407	Metal Work. (51)	5	Metal Work. (3)
Wave Form	33	122	Metal Work. (22)	2	Metal Work. (2)
Electron Microscope	9	11	Metal Work. (5)	3	Chem. Proc. (2)
Level	6	12	Chem. Proc. (3)	8	Chem. Proc. (4)
Moisture	15	52	Food (7)	5	Food (2)
Flow	—	—	—	11	Chem. Proc. (4)
Weight Measurement	18	53	Metal Work. (12)	25	Metal Work. (12)
Temp. Indication and Recording	29	252	Metal Work. (11)	14	Metal Work. (6)
Misc. Testing Equip.	25	90	Metal Work. (11)	3	—
High-Speed Photography	7	14	Metal Work. (4)	—	—
Hardness	2	8	Metal Work. (1)	5	Metal Work. (5)
Chemical	31	51	Chem. Proc. (16)	22	Chem. Proc. (8)
Vibration	25	50	Metal Work. (18)	8	Metal Work. (4)
Meter Testing	15	38	Elec. Util. (13)	3	Elec. Util. (3)
Quartz Crystal	6	265	Metal Work. (5)	2	Metal Work. (2)
Amplifiers	15	341	Metal Work. (10)	1	Metal Work. (1)
Oscillators	51	577	Metal Work. (41)	1	Metal Work. (1)
Oscillographs	72	312	Metal Work. (48)	2	Metal Work. (1)
Molecular Vibration					
Chemical Processing	—	—	—	14	Chem. Proc. (10)
Germ and Insect Killing	—	—	—	16	Food (10)
Supersonic Detection	—	—	—	11	Metal Work. (7)
Power Conversion					
Frequency Conversion	7	11	Metal Work. (4)	9	Metal Work. (5)
Inversion	4	36	Metal Work. (2)	6	—
Electro-Plating and Processing	9	68	Metal Work. (6)	8	Metal Work. (5)
Rectification	176	1,668	Metal Work. (67)	46	Metal Work. (10)
Regulation					
Generator Voltage	27	125	Elec. Util. (12)	44	Elec. Util. (26)
Skew	8	18	Tex. (7)	8	Chem. Proc. (3)
Speed Regulation	11	42	—	16	Metal Work. (8)
Slack Regulation	5	8	Chem. Proc. (4)	15	Metal Work. (4)
Voltage, Current, Phase	20	205	Metal Work. (10)	12	Elec. Util. (4)
Process Regulation	7	15	Chem. Proc. (2)	35	Chem. Proc. (13)
Safety					
Combustion	69	757	Metal Work. (30)	20	—
Fire and Smoke	4	6	Metal Work. (2)	8	Metal Work. (3)
Liquid Overflow	4	15	Chem. Proc. (4)	2	Mining (1)
Intrusion	25	62	Elec. Util. (13)	7	—
Lighting	3	6	Chem. Proc. (2)	10	Elec. Util. (3)
Machinery Stopping	32	286	Metal Work. (16)	44	Metal Work. (14)
Over and Under Voltage Alarms	9	218	Metal Work. (5)	5	Elec. Util. (2)
Fume Detection	6	15	Chem. Proc. (2)	6	—
Traffic	8	190	Const. (3)	13	Coal Min. (5)
Misc. Alarm	15	44	Chem. Proc. (5)	11	—

major divisions. To experienced electronic engineers some possible duplication between the sub-divisions beneath them will be apparent. It will be noted, for example, that the word "combustion" appears under "Control" and also under "Safety." Inasmuch as the data was largely obtained from men without specialized electronic knowledge it was necessary to tolerate such duplication.

The second column (*Number of Companies*), used intelligently, provides some measure of the relative importance of various types of electronic apparatus in industry at the present time. It will be seen, for instance, that users of tubes for rectification, under "Power Conversion", are, as might be expected, in the majority. On the other hand, the fact that users of tubes for temperature control are neck and neck numerically with those owning welding controls might come as something of a surprise. In this column, as in all other columns, the inclusion of percentages is deliberately avoided to discourage projection at least until the more voluminous report from which the figures are taken is thoroughly digested by the reader.

The third column (*Number of Devices*) provides a further measure of the relative importance of various electronic devices in industry, since the number of duplicate units in a plant as well as the suitability of a specific device for industrial use determines the potential market and, particularly, its "packaged" item possibilities. Note that rectifiers, temperature and welding controls are not only used in many plants but that they are purchased in considerable volume by these plants.

The fourth column (*Chief User*) is a useful key to the probable potential market. For purposes of compression here it has been necessary to show only the largest present user of each electronic device although in several instances other users were nearly on a par with them. It is desirable when attempting to evaluate the data in this column in terms of post-war potential that it be considered in conjunction with the data included in column six. It is also necessary to know that the industry classifications employed in this abstract are very broad indeed. The "Metal Working" industry classification, for example, embraces manufacturers of:

Iron and Steel Accessory Products
Non-Ferrous Accessory Products
Machinery (except Electrical)
Electrical Machinery and Equipment
Transportation Equipment (except Automobiles and Aircraft)
Automobiles and Automobile Equipment
Aircraft and Parts
Ordnance and Accessories (except Explosives)

So far we have dealt with data supplied by industries already using specific electronic equipment, under "Present Users." Now let's move over into the columns for which data was supplied by "Potential Users," people who may now use electronic equipment of some kind but lack it entirely for the specific uses under consideration.

Column five *(Number of Companies)* must obviously be studied in conjunction with columns two and three in order to speculate concerning the potential market. Similarly, column six *(Greatest Interest)* should be considered in conjunction with column five, and probably also in conjunction with columns two,three and four. Steady growth along lines already indicated by sale of equipment to present users appears to be a reasonable conclusion. Some shifts of interest will be noted but, in line with our introductory admonition relative to projections, conclusions relative to these must be left to the reader.

Potential Applications

Not the least interesting and instructive portion of the report are the many pages devoted to comment from men in industry who have unsolved problems and wonder if electronic equipment could solve them. While it is true that some of these problems might best be solved by other than electronic means, and while it is also true that some of them have already been solved by means of electronics, a few extracts should prove generally stimulating.

Typical remarks follow:

Metal Producing. "Photoelectric cells could be used to limit travel of furnace doors where high temperatures cause failures in existing limit switches, or could be used to open building doors for towmotors, or could be used to sound an alarm for pedestrians as crane hook is lowered down through hatchway."

"We should have some sort of temperature control and flame failure alarm in soaking pits and reheating furnaces."

"Our roll grinding machines, although of the latest design, could be greatly improved by supplying electronic control on the grinding wheel drive motor to maintain constant peripheral speed on the grinding surface of the wheel under varying feed of work and decreasing wheel diameter due to wear."

Metal Working. "In undercutting commutators on small motors, it is impossible to use an indexing arrangement to turn the commutator from mica to mica due to slight variations in the thickness of the mica and the copper, making the bar spacing non-uniform. We are working on an arrangement using the electric eye to position the mica by contrast of color between the copper and the mica."

"The many hundreds of individually motor-driven lens polishing machines which we use have very crude mechanisms for speed control. These might well be modernized by electronic motor speed control. A programming control on speed as the lenses are polished might be extremely valuable and greatly improve production."

"We need an electronic device to ring an alarm in case of a leak in our air conditioning system. Freon (refrigerant agent) is quite expensive and very hard to get. It has the property of turning the color of certain gases or chemicals. By having a photoelectric cell sensible to a certain degree, to the change of color of a chemical placed near the refrigerating coils, a leak could be easily detected, and an alarm given, or the cell would break the current to the compressors by means of relay. This device would save a large amount of money to industries using air conditioning."

Chemical Processing. "How about

gas analysis in the determination of the amount of isobutane in a mixture? Present method uses the infra-red spectrometer."

"Liquid level control of pressure vessels presents a problem when ordinary methods such as rotary stem packing glands and flexible discs are used. More development along the lines of a capacitive and inductive pickup type controller using a vacuum tube amplifier would eliminate hysteresis and sticking encountered in the mechanical type of controller."

"We have an operation involving the dipping of rubber-impregnated fabric into a solution containing an inflammable solvent. It is a continuous process, and static on the stock ignites the solution if the static eliminator fails. A collector connected to the sensitive grid of a tube should shut the machine down if static starts to accumulate."

Food Processing. "We need an electronic device to inspect our beverage bottles before filling and again after they are filled and capped. After the bottles are filled they are cased up manually and then pulled out of the case four at a time and inspected over a light. We need some sort of electric eye on the final inspection. Frequently when the operator is fatigued she or he will pass a dirty bottle after it is filled. We hope something electronic will protect us on this."

"Electronic measurement of dehydrator humidity levels to take the place of wet bulbs or hair hygrometers at dry bulb temperatures of above 200 deg F, where both the latter are inaccurate, would be useful."

"In a continuous vacuum pan operation on evaporated milk, we believe that if you had an electronic device that would measure the density of the milk and regulate the discharge pump and the milk intake that you would do the industry a great service. The operation at present is manual and most pan operators over-condense with a resulting waste of time and power. A device which would register the change in concentration of the milk in the pan that would be visible to the operator at all times is needed."

Textile Mills. "Warping, slashing, and weaving require careful regulation of slack yarn ends, so that a quality fabric will result from these operations. Proper tension throughout the various processes is one of the most important regulations confronting us."

"There are numerous points in the processing of cotton textiles at which package counters could be used, and we believe that a survey should be made of a large textile plant to ascertain the points at which such a device would be practical."

"An electronic device which would indicate breakage of warp or filling thread is needed for loom protection. Such a device would eliminate a considerable amount of mechanical motions. Also a device which would indicate an empty bobbin."

Public Utilities. "Use of voltage amplifier and thyratron trigger tube combination to replace electromechanical relaying schemes at present used on all power lines seems desirable. The idea is to standardize the unit and vary applications by variations in input networks and accessories, thus adapting to operation by voltage, current, frequency, power factor, etc., and assuring faster operation than afforded by conventional type relays, without the necessity of using carrier frequencies."

"Quicker and more accurate means of cable fault locating are needed and it is felt that there is a wide field of application for electronic cable fault locating equipment."

"We have a boiler that has an induced draft fan and a short smokestack. This fan is driven by a 2300-volt motor connected to fan by a hydraulic coupling. In the event of electric power interruption this fan stops and if the natural gas fuel is not cut off immediately, there is danger of improper combustion mixture with a resulting explosion. This is a 1000-hp boiler."

Coal Mining. "Control and signal for mine ventilating fans is needed. Where the air must not stop, someone should know at once if control of fan fails, or cave-in blocks the air's natural flow."

"Detection of poisonous methane and carbon monoxide gases in coal mines is not yet being well handled."

Other Mines. "Using hand labor at the present to make rip-rap. Sizes 25 to 150 lb, minimum of four inches thick in one dimension. Material weighs 165 lb per cubic foot and can be any shape or size between the weights and dimensions given. We would like to sort these sizes from material loaded from quarry face. Material will run from fines to four or five hundred pound rock."

"Detection of tramp iron and steel on ore belts."

"Generator voltage regulation and excitation. Three widely scattered hydro-electric plants are operated in connection with mining operation. Power regulation is a problem, particularly in starting up large power consuming equipment."

Construction. "Analysis of soils, aggregates, asphalts and wetting agents to determine their electrochemical properties. Whether molecules are positively or negatively charged. This will enable us to make a more homogeneous and compatible mixture of the materials for road pavements. We are in a research program at this time involving this problem and are in dire need of a method of determining the properties of these and other materials such as paint, steel, cement, etc."

"Chlorine residual determinations in municipal water supplies, including control at plant and portable instrument for accurate determinations at various points in the field, are needed."

"An electronic device to measure humidity is badly needed. Evaporation from large reservoirs, especially in the arid West, will become a more important factor in operation than it now is. A device that will permit evaluation of evaporation from water surfaces, from snow surfaces and, for that matter, from land surfaces undergoing application of water, is greatly needed. If possible, it should be so arranged as to measure water content of the air specifically or afford a comparison from, or with, unaffected surfaces nearby."

For further details relative to the gear in use and wanted by the 796 companies encompassed in the survey the reader is referred to the report.—W. MAC D.

ROCK ISLAND RAILROAD Radio Tests

Communications problems peculiar to railroading, such as the necessity for equipment design capable of withstanding unusual vibration and shock and capable of operating from a variety of power supplies, are analyzed on the basis of seven years of experiment. Signal-to-noise ratios on 40, 118, 150 and between 2000 and 3000 Mc are charted

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THE DEVELOPMENT of railroad radio has progressed rapidly in the last year. Many articles have been published on the utilization of radio by railroads, but little has been published on recent technical advances in the art. It is the purpose of this article to record the research and operating experience of one railroad in developing its own radio system of communications.

In the near future, radio seems destined to play an important part in the progress of American railroads. Although intensive research for the development of radio facilities has been under way for only a short period of time, important possibilities have already been uncovered. For example, radio makes possible two-way communication between: (1) both ends of a train, (2) yards and trains, engines, or cabooses, (3) different yards and stations, (4) wayside stations and trains, engines and cabooses, (5) different trains, en route or in yards and stations, and (6) brakeman and flagmen.

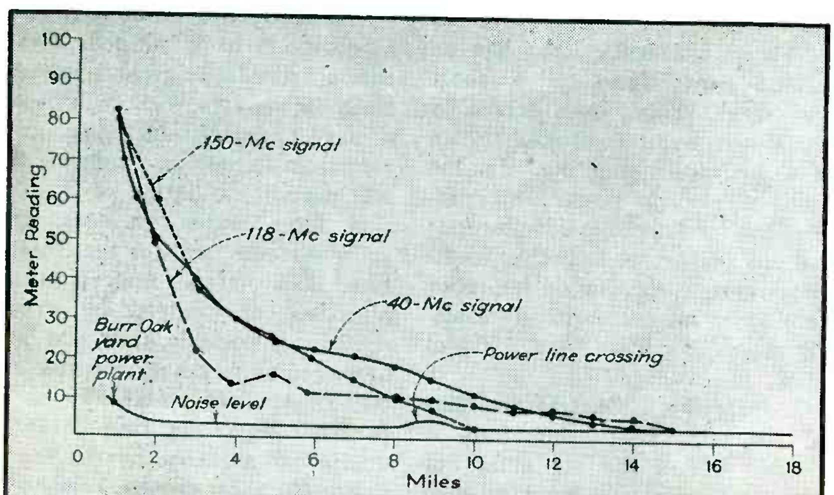


FIG. 1—Curves showing signal-to-noise ratios on three different test frequencies, recorded as a train carrying the Rock Island Railroad's radio test caboose rolled away from the yard at Blue Island, Illinois. Transmitter power employed was 10 watts output in all three cases

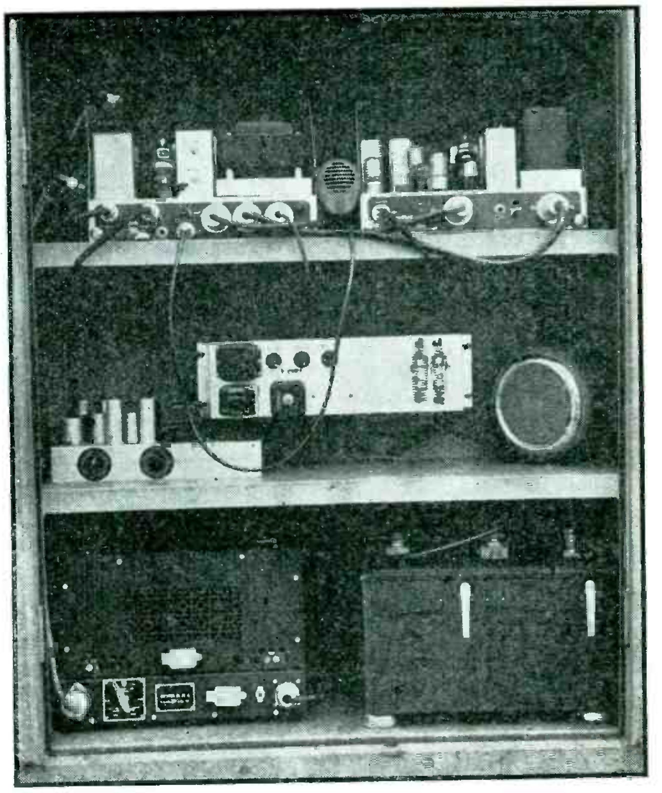
While radio will merely provide supplementary communication facilities in some of these cases, it serves to increase safety, to speed freight and passenger traffic, and to provide effective communication in the event of storms, floods or other emergencies. In other cases, particularly when trains are in motion, radio provides the only form of communication which is feasible. The need for railroad radio communication has greatly increased with extensive war-time use of 100 and 150-car trains.

Vibration Mounts and Power Supplies

Considering the rapid advances which have been made in mobile radio communication systems within the past decade, it might be presumed that commercially available equipment built for other purposes could be applied directly to railroad use. Such a procedure has not been found to be entirely feasible, however, because of a number of unusual requirements. The problems of shock and vibration, of appropriate power supply, and of determining suitable operating frequencies and methods of modulation must all be considered in developing a satisfactory system of communication for railroad use.

In actual railroad service, all units must be capable of withstanding terrific shocks. Measurements made on a caboose of the Rock Island Railroad showed that a deceleration

Freight engineer using a radiophone in the cab of a diesel locomotive

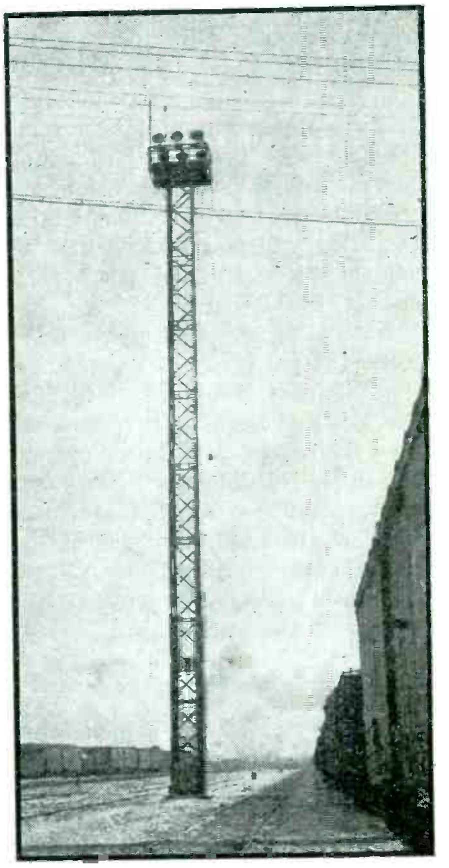


Motorola and Mallory equipment installed at the base of a lighting tower in a yard, comprising a fixed radio station

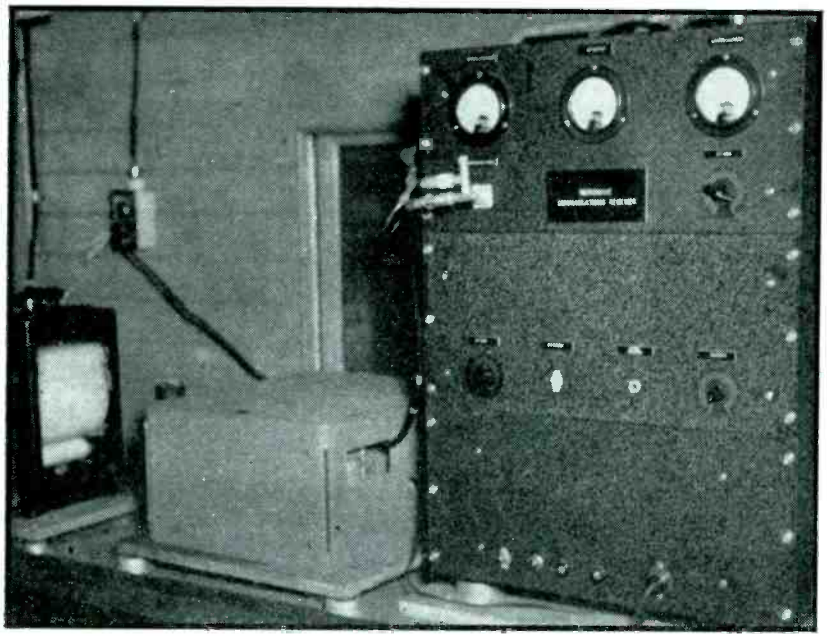
of six g's (193 ft/sec/sec) was encountered on a train moving at seven miles per hour when brakes were applied. There is an average slack of four to five inches between each car. When a hundred-car freight train starts up there may be slack of as much as 40 feet taken up before the caboose is finally moved ahead. By the time the engine has taken up all of the slack it may have attained a velocity of two miles per hour, or three feet per second. The caboose will be required to change its velocity instantly from zero to two miles per hour. Thus all the receivers and transmitters must be shock-mounted in two directions, up and down to prevent bouncing and front-to-rear to minimize shocks of starting and stopping.

Another problem in setting up a system of railroad radio communication involves choice of the most suitable power supply. The power supply must be capable of operating a receiver and transmitter on locomotives, cabooses, and at fixed stations. Most railroads have 64-volt d-c power available in their diesel locomotives. A 25-volt d-c power supply is usually available in steam locomotives, but as yet no power supply is ordinarily provided in the caboose. If d-c dynamotors are used for power conversion, two units are required—a low-voltage unit for tube filaments and a high-voltage unit for plate supply. If radio units are designed to operate from a-c power, then only one device with a rotatable armature is necessary to convert from d-c power to a-c power. This seemed the logical answer in our case to the problem of power supply on locomotives.

On steam locomotives the steam power is directly available. A turbine connected directly to an alternator was used to provide power. With mechanical steam regulation, 117-volt, 60-cycle a-c power was obtained with regulation better than 1 percent. On cabooses, a 12-volt generator charging a 300 ampere-hour battery supplied power to a rotating machine that delivered a-c power. The use of a-c power throughout means that all transmitters and receivers are directly interchangeable with one another on either steam or diesel units. This



A typical fixed installation in a yard, showing antennas at the top of a lighting tower and the compartment containing transmitter and receiver at the base



Experimental 2000-3000 Mc radio receiver using a Klystron oscillator. The Esterline-Angus recorder used to check signal-to-noise levels may be seen at the left

makes for extreme flexibility.

Late in 1937 we set out on a program of planned progress, and the road's recent studies of radio communication on trains is a part of that program. This included the setting up of an Electronic Section whose first job was to study the available communication facilities and the possibility of adapting these to railroad operation, and the design of new communication facilities which would utilize developments which had taken place during World War II.

In setting up this program of tests, several types of communication systems were studied. The first distinct field for investigation was frequency modulation versus amplitude modulation. Since experimentation covered frequencies from 40 megacycles to 3,000 megacycles, other characteristics of radio wave propagation entered the picture in the comparison.

Modulation and Frequency Studies

The normal factors which influenced our choice of frequency modulation over amplitude modulation were: (1) the advantage of frequency modulation over amplitude modulation in the elimination of noise; because of the characteristics of the limiter tube, (2) freedom from interference with f-m as compared to a-m, and (3) the constancy of audio output so long as the frequency deviation is constant, whereas with amplitude modulation the amplitude decreases with the distance from the source of the signal. The last-mentioned factor was a particularly important one, since on the basis of noise reduction alone the advantage of frequency modulation over amplitude modulation might not have been decisive where both types of service were tried at high frequencies at which noise is minimized.

As the frequency is increased and wavelengths become shorter, buildings, towers and natural obstacles tend to reduce the amplitude of the signal. Moreover, microwave signals may be received over two different paths so that the resultant received signal varies in amplitude according to the relative phases of the two waves. Wave reflections and standing waves increase amplitude variations. Now, if such changes in amplitude are present and the train is moving at a reasonable speed, the amplitude changes will produce an effect similar to amplitude modulation, the frequency of which will depend upon the number of nodes or antinodes in a given distance, and the train speed. This modulating effect will hereafter be referred to as the flutter effect. The flutter effect became more and more pronounced as the carrier frequency was raised. At 40 megacycles it was barely audible, at 157 megacycles it was very pronounced, and between 2,000 and 3,000 Mc satisfactory communication was impossible with amplitude modulation while the train was in motion. When using frequency modulation, signals were sufficiently strong (even over the greatest distances for which communication was required) to saturate the receiver limiter and the flutter had no effect on the audio output.

The actual operating frequency chosen was to be determined by investigation. Measurements were made at 40 megacycles, 55 megacycles, 157 megacycles, 300 megacycles, and between 2,000 and 3,000

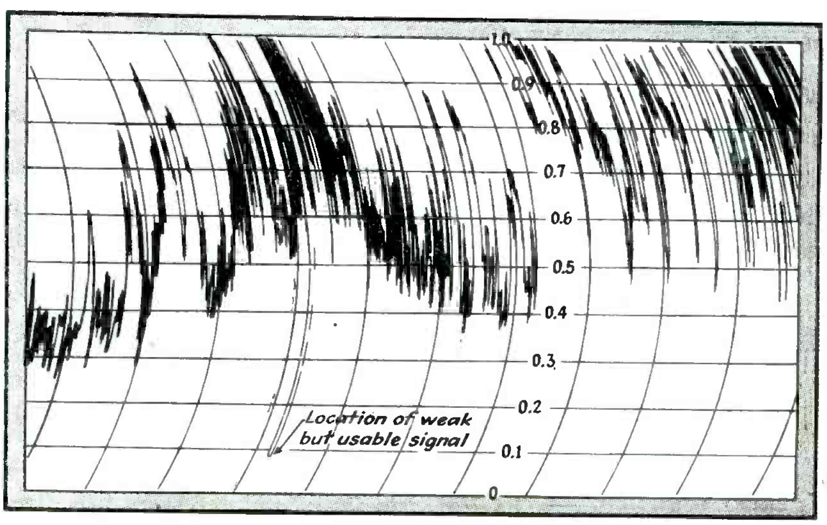


FIG. 2—Recording showing typical signal-to-noise ratio on 2000-3000 Mc (Scale shown on chart gives arbitrary values)

Mc. In each case a quarter-wave antenna was used. In these measurements only carrier radiation strength was measured at a given distance and used as a basis for comparison.

Experimental Signal-to-Noise Investigations

A mobile field laboratory was set up for making all signal strength measurements for yard operation and front-to-rear service, for checking apparatus, for measuring shock, and for developing appropriate power supplies. This unit consisted of an all-steel caboose, equipped with a gasoline power supply. A gasoline-driven 1000-volt a-c generator was mounted on the roof, and a battery-operated charging generator was installed. The communication equipment was operated from the battery supply, while all test equipment, fluorescent lighting and auxiliary gear was run from the a-c generator.

The caboose was equipped with a complete work bench, standard frequency source, and receivers for calibrating from WWV standard frequencies. Most measurements were made continually over territory served by the Rock Island Lines, including Chicago to Kansas City and Kansas City to Denver, and in connection with the Denver and Rio Grande Railway through mountainous area and through the Moffat Tunnel. For the first time in the history of the Rio Grande, radio communication worked through the six-mile-long Moffat Tunnel. High-frequency tests indicated that the tunnel had a waveguide effect. The signal from the caboose had no trouble in reaching the locomotive, or inversely, if the engine was outside and the caboose inside.

An Esterline-Angus recording meter was set up for obtaining a permanent record of noise versus signal strength. The system set up to do this was as follows: At the frequency to be investigated, noise measurements were made in a complete run over the railroad route. Next, a complete run was made with the transmitter on 100 percent of the time, making continuous measurements of the output of the receiver limiter. This gave the signal strength throughout all parts of the route covered. The ratio of the first to the second set of measurements yielded the signal-to-noise ratio over the entire route.

Direct comparisons of noise and signal were made at a number of frequencies on this basis. Results at some of the lower frequencies are shown in Fig. 1. Figure 2 shows results between 2,000 and 3,000 Mc. The very much larger signal-to-noise ratio obtainable there made it possible to obtain satisfactory communication with lower power fed into the antenna and indicated the desirability of a swing to the microwave frequencies.

Details of Equipment

The first project under development was the establishment of a yard communication system enabling the yardmaster to communicate with either the yard foreman or the engineer on a locomotive. The need for this becomes very apparent when it is realized that a switching locomotive may travel 10 to 20 miles to pick up cars from another yard, the stockyards, or a fruit terminal, and haul them into our yards. Some actual uses of the equipment during the tests are shown in a chart included here.

One master station was installed for this kind of service. This station was set up with a receiver and transmitter at the base of a lighting tower. A coaxial type antenna at the top of the tower was connected to the transmitter and receiver by means of a coaxial cable. In this system the receiver and transmitter combination can be controlled from various points in the yard or from remote stations. The yardmaster or yard superintendent can call any locomotive working in or within the neighborhood of that yard.

In actual operation, the locomotive number was used to identify each locomotive, such as Diesel 700 and Engine 2103. When the engine is in some other yard, a call may be put through for some special car, or to add cars to trains in this yard, thereby saving a full trip or a return trip in order to pick up the extra cars. If for any reason the engineer is not clear on instructions, on what cars to pick up, or

TYPICAL RAILROAD RADIO USES

ENGINE TO CABOOSE

Purpose	Est. Time Saved (min.)	Comments by Conductor
Checking air line four times during day	40	Air was set and released by use of radio
Hot box	20	Train stopped within five minutes after receiving signal. Car set out and train moving after 25-minute delay
Clearing East Main for 504	15	Backed 127-car train across to West Main
Hot box	15	Received signal at Rockdale and informed engine crew to stop at Joliet for necessary repacking
Talk to engineer	15	Try air, tell engine no. cars in train, tons
Talk to engineer	25	Advise head end to set out hot box at Columbus Jct.
Set out bad order car	30	Car set out and bill left at Trenton
For air test and high-balling	60	One hour saved between Trenton and Kansas City
High-ball from Blue Island	——	Only way of knowing rear of train was coming
Talk to engineer	15	Tell engineer 9 had us cut out so could not pick up train order at depot. Would have been necessary to stop train
Hot box in middle of train	——	Would have been necessary to pull the air and break train in two
Test air and high-ball	20	Kept in close connection with front end
Emergency air-brake setting	25	——
Talk to engineer	5	Let head end know rear brakeman was on
Hot box	15	——
Set out car behind 80 cars. Each move made with radio because of curvature of track	15	Used radio at various times to converse with engineer regarding movement of train
Test air and high-ball to leave town	10	Amount of time used by carmen making this air test
Have train pull over insulated joints to clear blocks	15	Saved walking 84 cars to tell head end to pull up
Pull up so 11 could get in clear behind 93	15	Saved walking 84 cars to tell head end to pull up
To get speed of train up hill	——	After leaving siding top speed up hill was 32 mph.
Talk to engineer	——	Checking speed of train
Talking to head end testing air and high-balling	30	Used for high-balling after slow orders and in regard to train movement
Setting out 8 cars	30	——
Setting out 44 cars	20	Testing air and high-balling
Talking to BI yard office	——	Found out what track to use
Talk to head end	10	Give engineer number loads, empties and tons in train & OK departure
Talk to head end	——	Give OK to proceed after passing over slow order
Hot box rear car; give instructions move slowly due to bad condition	30	Saved walk of 122 cars to give instructions as to speed and where to dispose of car. Also avoided setting air from rear end
Instruct engineer when to stop and have switch engine take rear car off train. Also give OK to proceed	20	Rear car in train taken off by switch engine at Joliet. Burr Oak Yard notified to have switch engine waiting at Joliet

(*Continued on next page*)

(Continued from preceding page)

Purpose	Est. Time Saved (min.)	Comments by Conductor
Talk to head end	—	Find out why stop was made for red block
Test air	5	Save pulling out draw-bars and braking knuckle, won't have to set air from rear end
Let engineer know when train was over slow track	5	Radio is a time-saver getting over slow tracks and heading out of passing track
Let Engineer know switch closed and brakeman on	6	The fuses we can save to give signal on a long train will pay for a radio
Notify head end to set and release air and train ready to proceed	10	This saved time as there was no mistake in signals
Hot box	10	Would have had to set air from rear end
To advise head end when train was in clear	—	This avoided stopping when train was not in clear
To get signal to engineer that flagman was on	—	Could not have signalled head end if no radio
Talk to engineer	—	Told engineer I was going back to ask dispatcher about 91 which was delayed at Letts
Hot box	25	Engineer called to tell me what was wrong, saved walking 116 cars
Talk to engineer	5	Engineer called when they set out and were ready to go, and if flagman was on and ready to go
Air test	10	
Clear passing track for 98	20	Not only used radio for our train but save signals to 98 to let him know when he cleared the main
Air test	10	Had 100 cars, difficult to see hand signals that far with a background of city lights
Get train in clear on passing track	—	Track wasn't long enough to get in clear. Dispatcher held train back of first signal at Allerton to run 18 against Ex. 97 Clio to Allerton
Hot box	40	Hot box 69 cars behind engine. Called engineer, had him cut engine off and come to rear end of train
Let engineer know when rear end train made up and test air	—	—
Talk to engineer	15	Had slued truck on head car. Instructed head end what to do with car
Converse with head brakeman to set out head car with slued truck	15	Saves lots of time if you have to instruct head end about a bad order car
Let engineer know when flagman was on	5	—
Hot box	20	Would have had to set air from rear end as I had 101 cars and could not get signal to head end. Might have got draw bar or knuckle and caused big delay
Air test	10	140 cars, half of train around curve
Talk to engineer	10	In passing through passing track instructed engineer re closing switch, etc.
Air went into emergency	25	Burst air hose behind 137 cars. Could not see signals

Purpose	Est. Time Saved (min.)	Comments by Conductor
Talk to engineer	20	Head end missed order. Called to find out if rear end got it. Made contents known to head end. Saved stop
Talk to head end	20	Talked to head end about block and crossing at Polo
Talk to head end	—	Talked to head end account hot wheels
Talk to head end	—	Head end stopped to inspect hot box rear end. In 3 min. had train off main road

YARD TO ENGINE

Purpose	Comments by Yard Master
Test	—
Detail on movement through plant, lead to short 1, call tower on phone	—
Called account move on So. Chicago caboose at north end yard	—
Lined up 700 on some work	Changed work on 700
Had 700 come up out of yard—to couple up track 14 to be ready for eng. 2557, to take off on Hill	—
I. H. B. Spec., due on Hill 3:00 A	
To make change in work and put 700 engine and crew into lunch	—
700 called to find out where to put cars	—
Instruct crew on added work	—
700 called to secure disposition on two cars not carded	—
Lined up crew on work	—
Test	—
Instruct crew	No way to contact except by radio
Change work	Could not get switch tender
Instruct crew	—
Change work on yard	—
Instruct crew	No way to contact
Line up crew on work in yard	Diesel at north end of yard. Could not get switch tender
Instruct crew on work	—
Had two R.C. cars for B.O.C.T.; these cars were delivered, and Rettker, with Engine 2103 had the bills out of X5 for these cars. Made this call to have him deliver the bills to B.O.C.T.	—
Called engine 2103 at 12th St. Yard, to make test	—
Line 700 up with new work	—
Instruct crew on take off 96	No contact, only through tower
Instruct crew	Could not contact except through tower. 700 called to instruct crew on work
Line up crew	—
700 called about car	Car in train 700 switching. No card on car. In on road train. 700 called for information on car
Lined crew up to do some extra work	—
Called to line up crew on work, later cancelled call	Normal contact would be on phone through Gresham Tower. Probably could not contact crew for an hour or more

has any questions concerning instructions on pick-up or perishability of freight, he can call the yardmaster to get complete instructions on handling this project.

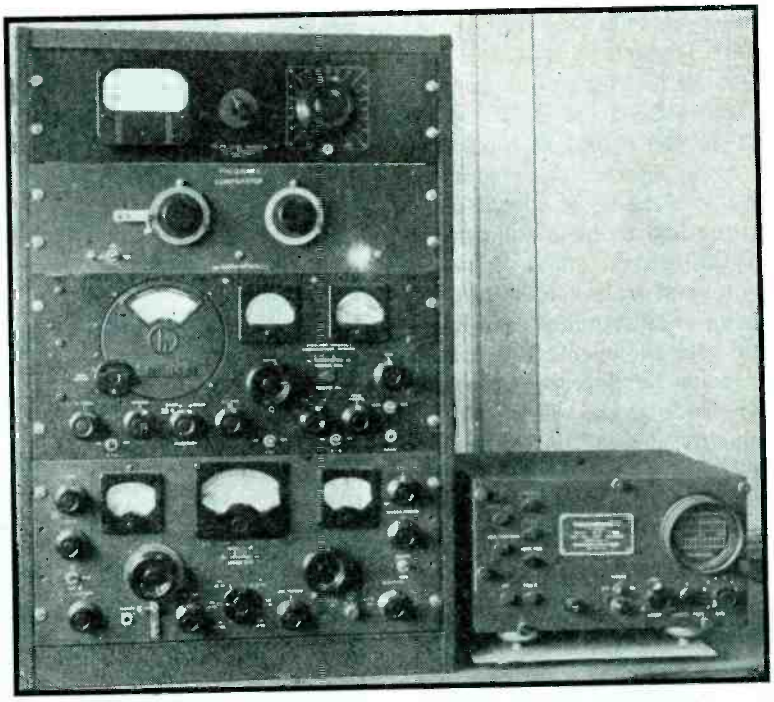
In this service, direct comparisons were made between apparatus operating on various frequencies. At all frequencies the service area was covered equally well, but atmospheric noise was lower at 157 megacycles, and had disappeared completely between 2,000 and 3,000 Mc. A slight flutter effect was noticed on 157 megacycles when amplitude modulation equipment was used. The maximum a-c power input was 300 watts. The radio-frequency power output of the final stage was 10 watts. Satsifactory communication was obtained for a radius of 15 miles from a central point.

In front-to-rear train communication the equipment is used by the conductor and the engineer. Under present operating rules the conductor is in charge of the train movements at all times and must initiate any instructions as to starting and stopping of trains, the handling of hot boxes, or relating to any emergencies which might develop. In the actual operation of this equipment, the conductor can save a considerable amount of time in the handling of a train, as indicated by the chart, which shows typical actual equipment uses.

Without front-to-rear communication the conductor must stop the train from the rear. This means that the brakes on the caboose go on immediately, on the next car a short time later, and so on. When such an occasion arises the engine keeps pulling after the caboose has stopped, resulting in flat wheels or breaking a train in two, which may result in a derailment, personal injury, or serious delay. On the other hand, when the conductor can talk to the engineer in the locomotive, he can tell the engineer to apply his brakes immediately and the train will stop normally from the front end. Also, in starting a train the car brakes must be pumped up and checked for operation. This is called checking the air. This can be accomplished in less time when the conductor can report the air pressure back to the engineer and then give him the high-ball to get out all the air. In yards and on switchings, he can inform the engineer when the train is in a safe position, i.e., when the last car is on a siding of the main line. All these problems have been intensified recently with the advent of 100 and 150-car trains.

For front-to-rear communication service, comparisons were made between signals at various frequencies. As in other cases, all units worked satisfactorily, with atmospheric noise present on 40 megacycles, less on 157 megacycles, and disappearing between 2000 and 3000 Mc. A flutter effect was audible on 157 megacycles when going through towns or areas with high buildings or water tanks.

In order to make patterns of the radiation from antennas located on various portions of locomotives, two diesel locomotives and one steam locomotive were equipped with quarter-wave antennas and mounted at various locations on each of the locomotives. The locomotives were then driven on a turntable and the carriers turned on. A receiver was set up about 100 feet away and the turntable rotated through 360 degrees. From the results obtained, information was compiled which indicated that for the best radiation pattern the antenna should be mounted in the center of the cab roof.



Panoramic and Hallicrafters equipment used to visually check the frequency of transmitters as trains using them pull into the yard. A block diagram of the setup is shown in Fig. 3

Microwave Tests

Tests on 2000-3000 Mc were conducted between Chicago as one terminus and Salt Lake City, Denver and Kansas City as the other. Included in these tests were applications of radio communication to all the various forms of railroad operation. It is believed that the 2000-3000 Mc equipment is still sufficiently novel to warrant a brief description.

An antenna, fed by a 10-watt crystal-controlled transmitter, was placed on the locomotive; a stub-supported line was used to connect the antenna and the transmitter in the locomotive. The receiver was located in the caboose and was connected by means of the stub-supported line to the receiving antenna.

A Klystron local oscillator was used to beat against the incoming signal and both signals were fed to a crystal-type detector or mixer. The intermediate-frequency output was then fed to the i-f channel, as in the usual superheterodyne receiver. The limiter current in the superheterodyne was measured by means of an Esterline-Angus recording meter, which made a direct comparison between the noise and the signal received at any given point.

Very interesting results were obtained. While the train was motionless the signal was constant. As the train moved the signal would increase and decrease just as if it were actually passing through waves of energy. The operation of this system, using very low power, was excellent.

Service and Maintenance

The installation and maintenance of equipment becomes quite a problem in railroad operation. It has been found expedient to divide the work into two categories and between two organizations. The installation work, involving power supplies, power switches, and generators on locomotives, is all done by the electricians' group. The installation of telephones and radio equipment, and tuning and adjusting of the sets, is done by the communication department.

Two sets of frequency standards

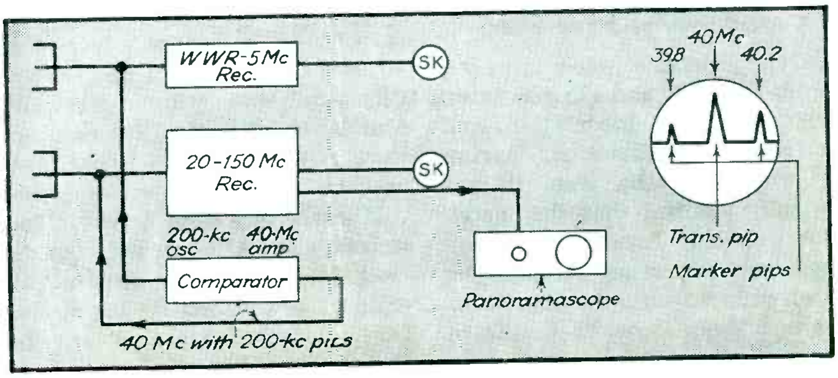
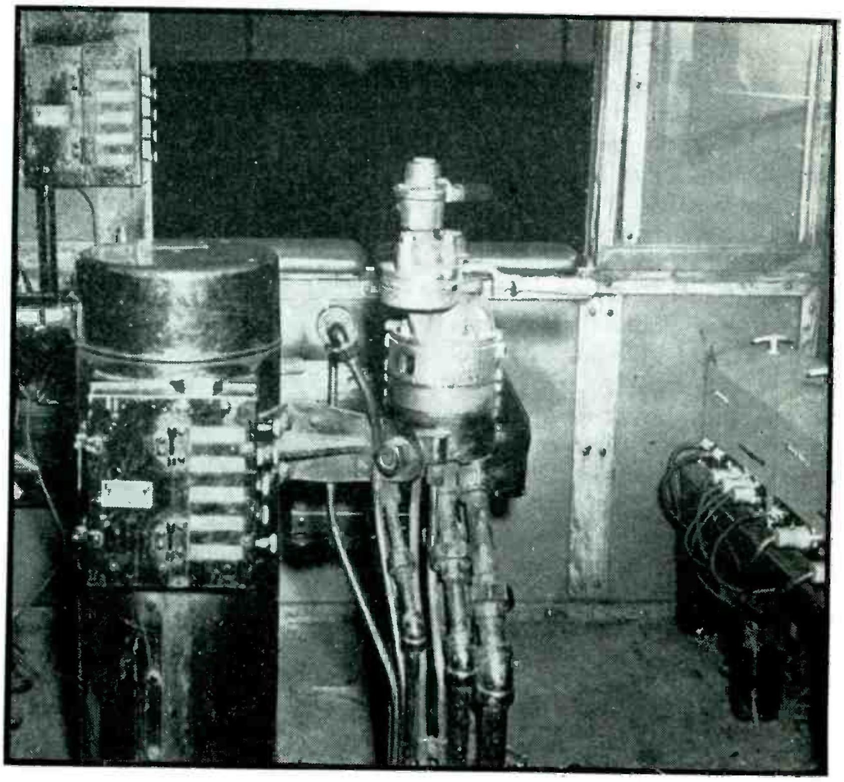
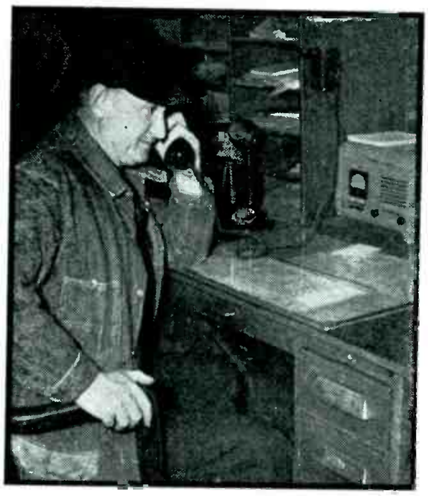


FIG. 3—Block-diagram showing system used for visual frequency checks

have been set up, one indicating maximum frequency deviation and the other indicating minimum frequency deviation from the assigned carrier. In the actual maintenance of the radio equipment, frequency checking is done by a visual comparison method using a Panoramic unit at the central office. As each radio-equipped train comes into the yard, the maintenance engineer calls and asks the operator to transmit a carrier for five seconds without any modulation. This carrier then appears visually on the screen of the Panoramic between the two peaks designating limits of frequency deviation. If the carrier is outside the peaks, the equipment is removed from service and brought into the shop for frequency checking. The visual system has advantages over taking meter readings because of its simplicity and the speed with which a large number of remote units can be checked. This system is illustrated in Figure 3.



Frequency-modulated equipment, installed in the cab of a locomotive, can be seen at the right



Remote control position for a typical yard station

Carrier Systems Investigated

Carrier systems were tried on frequencies of 80 and 175 kilocycles, using amplitude modulation and also frequency modulation. During the process of the tests it was originally planned that the installation should investigate long-range communication through the use of carrier, with the short-area coverage being done by means of radio.

Space radio was to be used for yard systems and terminal operation where no wayside wires were within a relatively short distance of the locomotive or caboose, as when yards were a mile or two miles wide and five or six miles long. It was assumed that radio signals broadcast in all directions from a certain point would easily cover two or three yards working in the same locale, with no worry about proximity to wires.

Further investigation late in 1944 proved that although carrier systems were excellent for long-distance transmission, the problem of interference with other railroads also using carrier systems appeared. To cite an example: A 120-car freight equipped with the carrier system was approaching Kansas City. It was actually more than 40 miles away from the Kansas City yards when train orders being sent by the Kansas City Southern were received on the Rock Island caboose.

If there had been three or four railroads operating in the same district, all would have received the train orders issued by the Kansas City Southern. Since a very limited number of channels were available it was believed best, therefore, to drop the induction system in favor of a complete space radio system in which directional antennas would tend to guide radiation along the bounds of the railroad. Another important advantage appeared in favor of space radio. If wires were down or had more than two or three breaks, an induction system would be out of service. The space radio system would still have its normal operating characteristics, and would be relatively little affected by sleet storms, floods and similar emergencies.

Conclusions

As a conclusion to the various tests made by the Rock Island Railroad, it would definitely seem from the results we have secured that (a) the space radio system is preferred, and that (b) frequency modulation, (c) low power, and (d) directive high-gain antennas are all in line for further development for railroad communication.

The use of safety devices working on a pulse or radiated wave pattern will surely find a way into railroad warning systems. At the present time we are building several experimental units using high-frequency radiation for warning systems.

Orbital-Beam U-H-F TUBES

Output frequencies as high as 500 Mc can be varied continuously or shifted back and forth between two or more values by applying appropriate keying signals to electrostatic deflecting plates, so as to vary the transit time between control grid and plate

By R. M. SMITH *Camden Forge Co. Camden, N. J.*

FEW conventionally designed electron tubes will operate with any efficiency above 100 megacycles and fewer still at frequencies of 500 Mc and higher. However, this is not to say that successful operation is not obtainable in the ultrahigh-frequency band (300 to 3,000 Mc) with conventional tube construction, because there do exist some new types of tubes which have been designed especially for such frequencies. These tubes are not generally spoken of as being conventional, however, at this stage of the game.

The writer had occasion to assist in the development of a secondary emission type tube especially designed for use at 500 megacycles or lower. The tubes had the appearance of an overgrown acorn tube. From the laboratory work a number of unique characteristics were found which suggested some new uses and advantages offered by this kind of tube.

Ultrahigh-Frequency Problems

Aside from the problem of efficiently driving the input control grid at ultrahigh frequencies to put the useful signal onto the grid element where it has control on the amount of electrons passed on to the anode, there are a number of other problems arising from within the tube itself. Among these are the limitations imposed by the electron transit time. Electron travel time from the cathode to the control grid constitutes one source of trouble and the result of this is a loading effect causing poor power factor for the input driving circuits. With extremely close spacing between the cathode and control grid and with high electron velocities this loading effect can be reduced to workable values where tubes of the acorn variety are used.

The characteristics which we are to discuss herein, however, are those imparted by the flight time of the electrons after they leave the control grid and until they strike

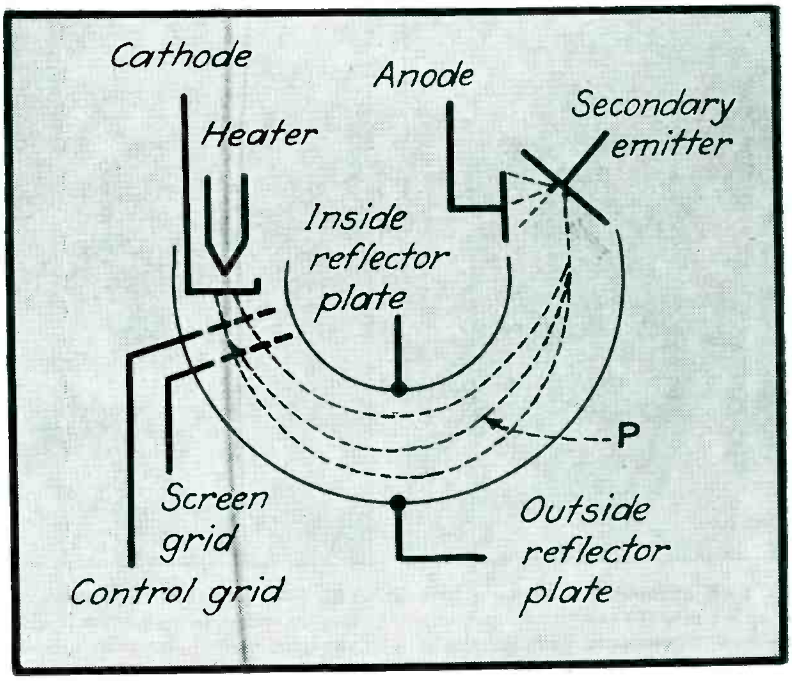


FIG. 1—Basic electrode arrangement in an orbital-beam tube

the anode or, in this particular case, the secondary emitter. This flight time, if appreciable compared to the interval of time represented by one cycle of the operating frequency, very definitely has control over the operation of the device.

Grid-Anode Transit Time

In view of this consideration the electron transit time was made approximately equal to the time of one cycle of the operating frequency, so as to have a synchronous or in-phase relation. It was found that this in-phase relation does exist and that if the transit time was made to vary, a corresponding shift in frequency response or a reactive effect on the external circuits was observed. Thus we can say that a change in the electron transit time has a corresponding reactive effect, the sign of which being determined by the direction of the change in time relative to the carrier frequency. These reactive influences were utilized as a means of control over the tube and its associated circuits.

Although a secondary emission type was used for the experimental work, the principles of control by transit time variation would apply in triodes and similar tubes where the electrons are collected by the anode, bearing in mind that the physical design must allow for the control of the electron transit time in the manner described. A triode oscillator circuit is generally preferred for simplicity. Since we were interested mostly in receiver circuits with high gains per stage, the secondary emitter tube was used because of its inherent high mutual conductance. As a power amplifier this tube was found advantageous, as will be pointed out later.

Principle of Orbital-Beam Tube

The essential elements of the first orbital-beam tube are shown in Fig. 1, and include a heater, cathode, control grid, screen grid, inside reflector plate, outside reflector plate, secondary emitter, and anode. If we were to visualize the flight of a single electron, for example, we find that after its emission from the cathode, attraction by the positively connected screen grid provides it with an initial velocity sufficient to carry it through the screen grid, beyond which the higher potentials applied to the various other elements speed it along some curved path, say P, to the secondary emitter where its collision with the activated plate causes the radiation of secondary electrons, some of which strike the anode.

The velocity of the electron during this flight remains substantially constant as determined by the static potentials applied to the various elements, and its path has been made purposely circular. The circular path permits lengthening or shortening of the flight path, thereby causing more or less time to be required by the electron in traveling from the control grid to the secondary emitter. The normal direct voltages applied to the various elements are approximately as follows: screen grid—150 v, inside reflector plate—150 v, and outside reflector plate—200 v. To lengthen the path a greater d-c potential is applied to the outside reflector or less to the inside reflector. The electron having an initial velocity and potential as determined by the screen grid is either attracted toward a higher-potential field or repelled by a lower one, so that it is effectively guided along the curved course by the curved electrostatic field existing between the two reflecting plates. In other words, by adjusting the d-c potentials applied to the reflecting plates the mean diameter of the circular flight path taken by the electron is caused to vary more or less. This control effect is the nucleus of the characteristics utilized in this conception. The principle of electron stream deflection is similar to that employed in other applications such as the cathode-ray oscilloscope, beam tubes and others.

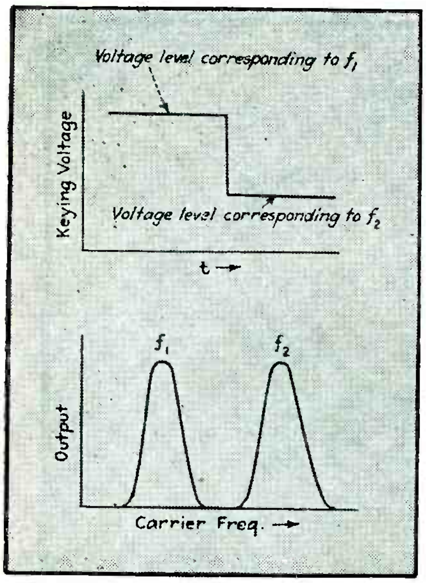


FIG. 2—A square-wave keying signal fed to an orbital-beam oscillator gives two-band transmission with a single transmitter

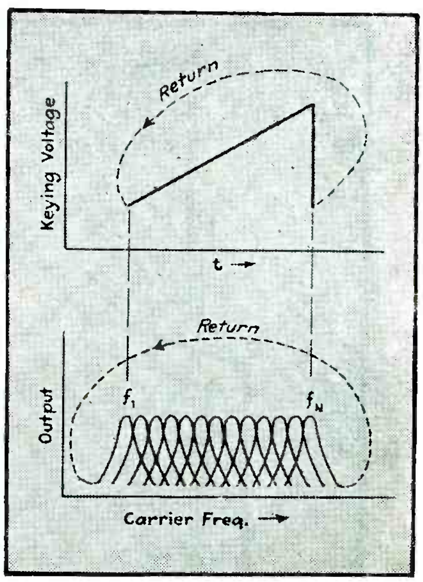


FIG. 3—A saw-tooth keying signal fed into an orbital-beam oscillator gives a sweeping effect covering an entire band of frequencies

Pulling Effect

If the tube and its connected circuits were made to oscillate at a frequency corresponding to the order of time taken by the electron in its traveled path, it was found that by varying the length of the electron flight path and consequently the time taken, considerable reaction or pulling effect was reflected upon the circuit, resulting in a change of operating frequency. The degree of control made possible is appreciable. By way of example, the particular tubes which were used gave a response variation amounting to ±0.5 percent at

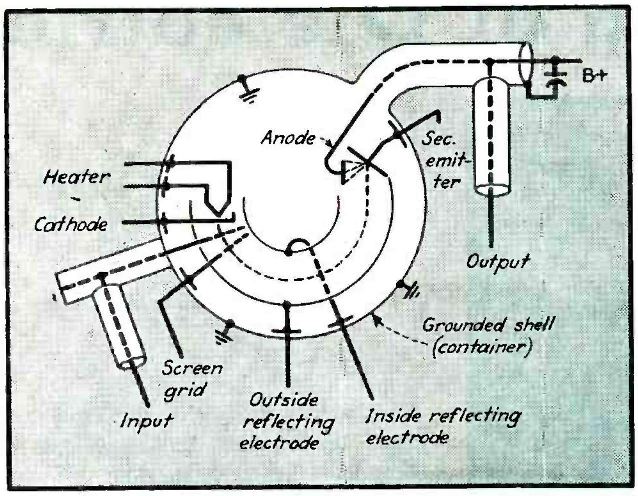


FIG. 4—Single-ended operation of an orbital-beam tube acting as an amplifier

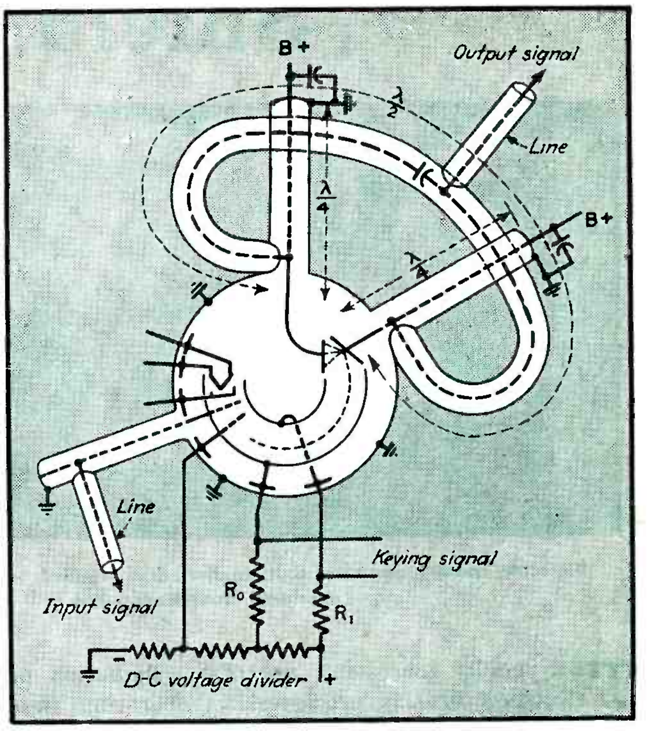


FIG. 5 (at right)—Use of a coaxial resonant line with an orbital-beam tube to secure push-pull amplification

500 megacycles before any reduction in oscillation strength took place. This frequency change was obtained by a 2-percent variation of the d-c potential applied to either reflecting plate.

It can be shown that the above phenomenon can be reduced to capacitive or inductive reaction effects and thus utilized for a number of circuit functions such as circuit compensation, oscillator stability and frequency response change, regeneration control, multiple-band and wide-band reception.

Possible Applications

These considerations immediately suggest the possibility of applying modulation signals to the reflecting plates for obtaining the following modes of operation: sine-wave modulation for communication and other uses; square-wave keying signals to obtain two or more distinct operating conditions, such as multiple-band reception or transmission (see Fig. 2), and saw-tooth keying signals to obtain a sweeping effect covering a continuous band of frequencies (see Fig. 3).

An orbital-beam tube is normally used in single-ended fashion as shown in Fig. 4, where the output circuit is connected to the anode. It was found that it also worked quite well as a push-pull driver, with the secondary emitter and the anode connected to the opposite ends of a push-pull resonant circuit as shown in Fig. 5. In the latter case, when used as a power amplifier, a power gain equivalent to 1.414 times that of the single-ended circuit was obtained.

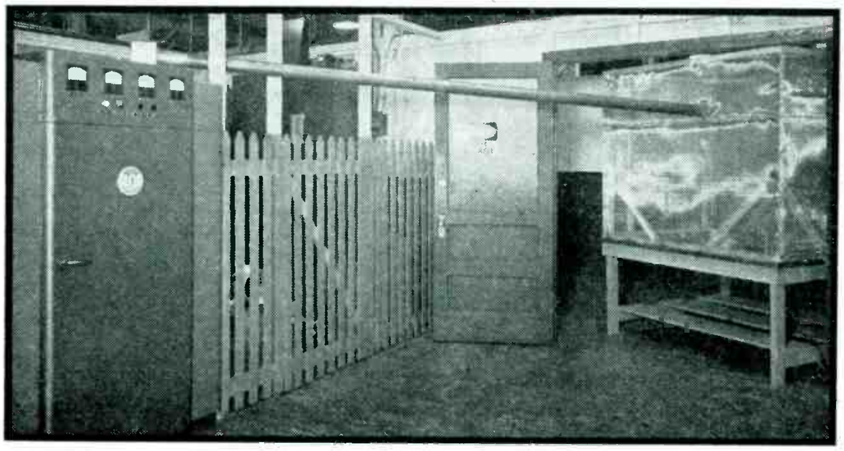
External Circuits

A few words about the external circuits are in order at this point. At 500 megacycles the advantages of concentric resonant line circuits, either $\lambda/4$ or $\lambda/2$ in effective length, are numerous and these lines were used in the work of development. Proper matching of the input and output terminals of the tube to their connected circuits is most essential, as well as the effective grounding of the other elements at the operating frequency. If modulating signals are applied to one or both of the reflecting plates, then band-pass type filtering is required in the leads to these elements in order to properly ground the r-f carrier currents while passing the modulating signals.

In Fig. 5 it will be noted that provision is made for impressing a modulating signal onto the reflecting plates. Resistors R_0 and R_1 are in series with the battery leads to these plates. Generally only one plate is used for a single application; however, there are conceivable applications where both plates might be used for a dual modulation scheme.

In conclusion, it should be remembered that in order to control the electron flight time within a given tube, assuming constant velocity, a circular or orbital path with suitable deflecting plates must be provided, and to obtain the reactive or phase effects discussed herein the physical dimensions must be such to cause the flight time to be approximately equal to the time of one cycle of the operating frequency. Whether the tube is a secondary emitter or a straight anode collector does not matter in the sense and manner of control. It does, however, make a difference in the relative gain derived, being somewhat in favor of the secondary emitter type. A greater flexibility in circuit arrangements, with some added complications, is possible with the latter type.

Shielding of Dielectric



Dielectric heating generator (left) connected to shielded work table (right) by overhead transmission line

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and
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THE rapidly increasing use of electronic heating processes in industry has required the installation of many high-power radio-frequency generators. All of these generators radiate some power and thus become potential sources of interference with radio services.

The investigation to be described was undertaken to determine by actual measurement the effect of various shielding arrangements upon the radiation from electronic heating equipment.

Electronic heating is divided into two distinct fields: the heating of metals, called induction heating, which is done mostly at frequencies below 500 kilocycles, and the heating of nonconductors, called dielectric heating, which is done almost entirely at frequencies above two megacycles.

Field strength measurements made around several 20-kilowatt, 400-kilocycle induction heating installations operating in manufacturing plants show that no measurable field strength exists beyond 300 feet from the equipment. Thus it appears that usually no shielding beyond that required for safety will be necessary for induction heating installations. Similar measurements made on two 15-kilowatt dielectric heating installations, operating near 10 megacycles without special shielding, gave average field strengths as shown in Fig. 1.

Radiation on harmonics of the operating frequency must also be considered. Figure 2 shows comparative field strengths of fundamental and harmonics measured at one commercial installation operating at 9 megacycles. A similar ratio of harmonic radiation was measured at the start of these tsts.

The ratio remained approximately the same as the fundamental field strength was reduced by shielding. The harmonics disappeared below the noise level while the fundamental was still easily measurable.

Usually the ambient noise level in localities where industrial equipment is used will be fairly high. Around the installations plotted in Fig. 1 it was about 20 microvolts. At the measuring position used in this investigation it was 15 microvolts.

Conditions of Tests

The tests were run on a dielectric heating generator located in the RCA development laboratory in Camden. The field strength measurements were made with an RCA 308A field intensity meter placed at a fairly open spot 360 feet from the generator. Later, when radiation had been considerably reduced, the meter was moved to 100 feet from the generator.

All readings were converted to the equivalent field at a distance of one mile by means of the inverse square law which, as Fig. 1 shows, fits the case quite closely. This was done to conform to the standard broadcasting practice and to provide a common base for comparison of all readings regardless of the distance at which they were taken.

In order to simulate the average factory installation, the applicator electrodes and work table were set up about 12 feet away from the generator and were connected with it by a concentric transmission line. The generator was housed in a partially copper-plated steel cabinet. Metal conduit extended from the cabinet to the incoming power source, the plate transformer, and the remote control station. In order to provide the usual safety ground, the system was also directly connected to a driven ground pipe by 5 feet of No. 4 solid copper wire.

The load on the generator consisted of a water resistance in series with a two-plate air capacitor formed by the applicator electrodes. The low-voltage electrode was the

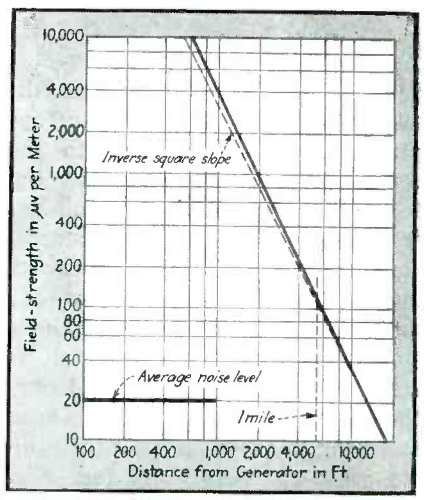


FIG. 1—Average field strength of two dielectric heating installations (solid line) closely follows the inverse square slope relation

From a paper presented at the IRE 1945 Winter Technical Meeting in New York.

Heating Installations

Field intensity measurements in the vicinity of a 9-Mc electronic generator show effects of various shields, grounding arrangements and line filters on radiation when feeding 6 kw into a dummy load. An oscillating wavemeter locates points of radiation leakage

sheet copper top of the work table. This arrangement is shown in Fig. 3. The plate power input to the generator was 6 kw, which remained constant throughout the tests. The frequency was 9 Mc. The voltage across the load was 4000 volts.

Unshielded Work Table

The first measurement was made with no shielding of any kind over the work table. The resulting field strength was 316 microvolts at one mile. From this starting point some

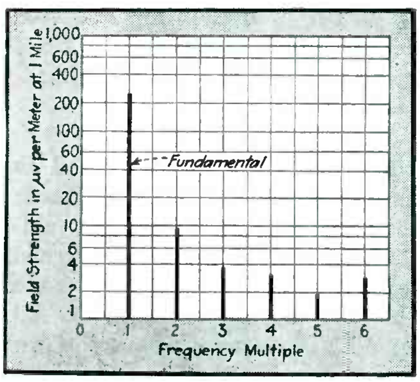


FIG. 2—Harmonic field strength from a 15-kw dielectric heating generator, measured at 900 feet and converted to one-mile values

150 readings were taken before the many sources of radiation were located and the field strength was reduced to noise level. However, only the more significant values will be mentioned here.

In order to determine how much of the radiation could be attributed to the incoming power line, a three-phase low-pass filter consisting of a pi arrangement of two 0.1-μf capacitors and a 4.4-μh choke per phase was mounted as in Fig. 4. At the time the field measurements were made on the industrial installations previously mentioned, this filter was inserted in the power

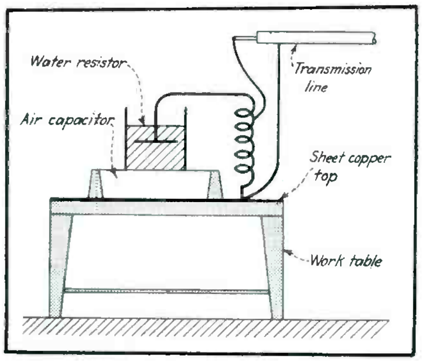


FIG. 3—Dummy load for work table, and method of shielding table with copper

line just ahead of the generator and check readings were taken at each place. No appreciable reduction in field strength could be found. The result was the same when the filter was tried in this test. Radiation from other sources was so strong that reduction of radiation from the power line was too small to be readable.

Use of Shielding Cage

The first attempt at shielding was to place a cage over the work table. This cage was 5 x 5 x 5 feet and was covered with 16-mesh bronze wire screening turned under the bottom edges so that it would make contact with the sheet copper work table top all around. The small access door was covered by a piece of $\frac{1}{32}$-inch sheet copper which overlapped the door opening about one inch on all four sides. This cage reduced the field strength to 1.3 microvolt.

To provide a very low-impedance return circuit a two-foot-wide sheet of copper was run from the work table top, under the door of the generator cabinet, direct to the oscillator filaments. The field strength

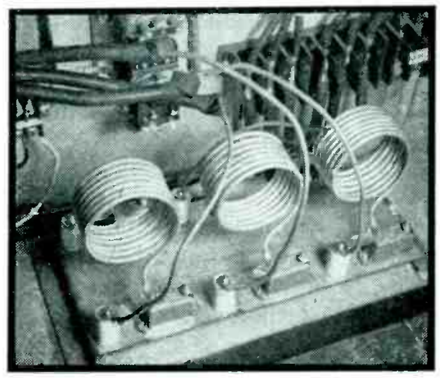


FIG. 4—Three-phase line filter inserted in the power line serving the electronic generator

was then reduced to 1.2 microvolt.

Following this a number of changes were made, such as insulating the low-voltage applicator electrode from the top of the work table, adding a three-inch tube shield over the 1$\frac{5}{8}$-inch transmission line, and putting the applicator inside a second shielded box. All these changes produced variations in field strength, some increasing it, some decreasing it, but never getting it below about 0.93 microvolt. Even connecting and disconnecting the copper ground sheet from the cage made very little difference.

Then, for another reason, the ground sheet was removed from under the generator door and the field strength immediately dropped to 0.3 microvolt. The sheet acted as an antenna as long as it extended into the generator compartment. This indicated that about as much radiation was leaking out of the various holes and cracks in the generator cabinet as out of the work enclosure; consequently, the transmission line was disconnected from the generator and a means was sought of detecting points of maximum radiation around the cabinet.

Leakage Radiation Detector

The instrument finally developed for this detective work was a small shielded loop coupled to an oscillating wavemeter which provided indications on a grid meter for strong signals and by heterodyne beat in headphones for weaker signals. This instrument proved extremely valuable throughout the investigation. It is shown in Fig. 5. With the help of the loop it was easy to find that the oscillator cabinet door joints were the strongest source of radiation. By coupling the loop close to the surface of the cabinet it was possible to map the direction of current flow around the various portions of the cabinet.

Causes of Leakage Radiation

Sealing the door was first attempted by bridging the joints with small copper clips, but this was far from satisfactory. Eventually the door was continuously bonded with weather stripping made of bronze screen extending all the way around. Only then did radiation from this source become undetectable.

Meters and controls which extended through the front panel were also quite capable radiators and had to be shielded by wire screening between the back of the panel and the r-f circuits. Radiation from the ½-inch mesh ventilator grill in the top of the cabinet was also strong until the ventilator was covered with 16-mesh screening. The remote control and safety interlock wiring were found to be good radiators and they were entirely disconnected. Thus one small source of radiation after another was eliminated until the field strength from the generator alone was reduced to 0.05 microvolt.

Addition of the transmission line and load then raised the radiation to 0.37 microvolt, whereas the value was 0.3 microvolt before any shielding was done on the generator cabinet. This result emphasizes the fact that the measurement of the field strength is not a particularly reliable method for determining the effectiveness of various shielding measures unless measurements are made at more than one point around the installation.

Two improvements in the generator shielding, each of which produced a definite reduction of field at the meter when applied separately, may often show an increase of field at the meter when applied together. Many interference effects of this nature were noted.

After some further improvements of the inner load-shield and after connecting the inner and outer transmission line tubes sep-

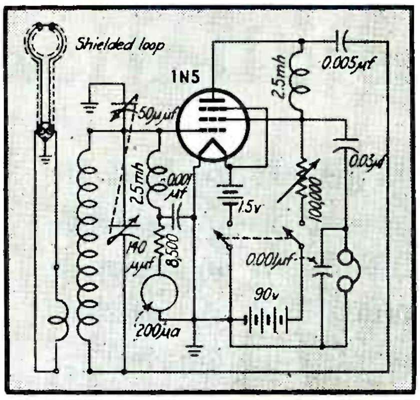


FIG. 5—Circuit of oscillating wavemeter used to detect points of radiation leakage around cabinet of electronic heating generator

arately to the inner and outer load shields, the radiation was reduced to 0.05 microvolt.

Special Ground Not Needed

All the previous tests had been made with the system connected to the driven ground pipe. This connection was now broken, but no change in field strength resulted. Connections to various other grounded objects were made and broken without effect. It appears that in a reasonably well shielded system, if any ground at all is required for reduction of radiation, the ordinary electrical conduit or Underwriters' safety ground is sufficient.

In order to make the installation complete, the remote control station wiring, which had been disconnected at the beginning of the tests, was replaced. The field went up to 0.74 microvolt and did not come down again until a warning lamp, which had been connected into the remote-control box with unshielded wire, was removed. This piece of rubber-covered cord had been the source of all radiation charged to the remote control wiring.

The above-described system of shielding was quite complicated. The double-shielded transmission line and double load-shield were particularly undesirable; therefore, an attempt was made to simplify the shielding without significantly increasing the field strength.

TABLE I. Summary of Shielding Tests

Conditions	Field Strength in μV/Meter Converted to 1 Mile	Total Attenuation in db
As Installed; No Load Shielding	316.	0
Single-Screen Cage Over Load	1.3	45
Generator Cabinet, Shielded	0.12	69
Double-Screen Cage Over Load	0.007	93
Double-Screen Door On Cage	0.0036	99
Slot 1x30 in. with 8 in. Extension	0.4	78

Soldering Iron Phenomenon

The outer transmission line tube was removed and both load-shields were connected to the remaining outer conductor. This doubled the indicated field strength to 0.09 microvolt. Removal of the inner load shield raised the value to 0.12 microvolt where it stayed, in spite of a number of additional changes, until a soldering iron was plugged into a nearby receptacle. The field strength immediately dropped to an extremely low value. This was another interference phenomenon which was found to be due to voltage picked up by the iron cord from the cage leakage. It helped to force the reinstatement of an inner load-shield.

A new inner shield of 16-mesh bronze screening was fastened to the inside of the wooden frame which supported the original single shield. The screening, turned under the edge of the frame, made contact with the outer shield all around. The frame was set down on the copper work table top as before. The field strength with this arrangement was 0.007 microvolt and no longer could any voltage be detected on the iron cord.

Effectiveness of Line Filter

Now that most of the other radiation had been eliminated, the line filter became an important part of the system, for when the filter was disconnected, the field strength rose to 0.31 microvolt. No further changes in arrangements inside the cage had any effect on the field strength. The insulated lower applicator electrode was removed, thus making the table top serve as the electrode and carry the total load current, but no appreciable increase in field occurred. The final arrangement is shown in Fig. 6.

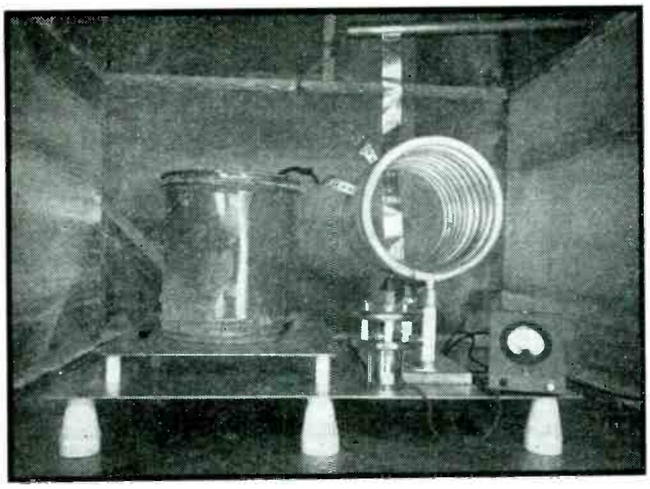
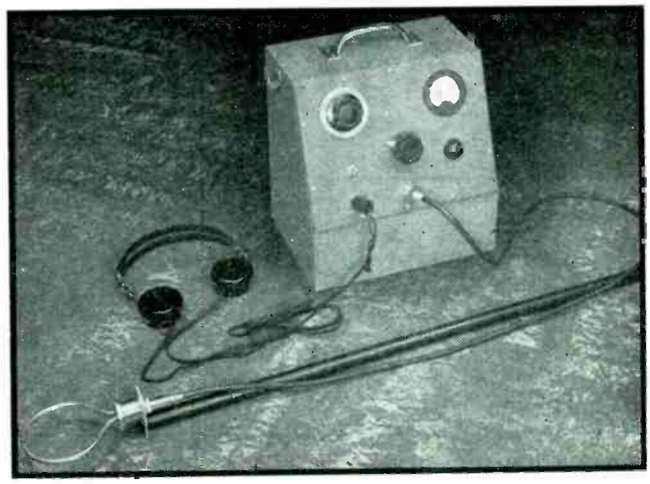


FIG. 6—Final arrangement of work table, with dummy load on low-voltage electrode that is insulated from the copper top of the work table



Radiation detector and search coil used for locating points around doors of shielded cage at which appreciable radiation was escaping into space

Up to this time a copper sheet bonded to the outer screen had been used as the cage door. This was now replaced with bronze screening bonded to the outer screen. The field rose from 0.007 to 0.01 microvolt. With the single screen door bonded to the inner screen the value went back to 0.007 microvolt, and with a double-screen door it dropped to 0.0036 microvolt. A field strength of 0.0036 microvolt is quite small compared to the original 316 microvolts; it represents a reduction of about 85,000 to 1.

Shield for Conveyor Applications

In some installations it is desired to pass the work continuously through the applicator by some means such as a conveyor belt. This requires an opening on each side of any shield which may be used. To investigate this condition a horizontal slot 30 inches long and adjustable in width was cut in the sheet copper cage door. With a slot $\frac{1}{16}$-inch wide, a field of 0.09 microvolt was produced. A one-inch slot raised it to 0.13 microvolt.

The first attempt at reducing this radiation was a sort of vestibule having the same cross-section as the slot and extending outward perpendicular to the side of the cage, as in Fig. 7. With a length of eight inches this device reduced the radiation from the $\frac{1}{16}$-inch slot to 0.01 and from the one-inch slot to 0.04 microvolt. These values compare favorably with those previously obtained. Although more work remains to be done it appears that the extension of the edges of a cage opening offers a possibility of providing open entrance and exit doors without allowing excessive radiation.

Summary of Results

For convenient comparison the most important values in this report, together with the corresponding attenuation in db, have been tabulated in Table I. In summarizing the results of this investigation it is well to divide the problem into shielding of the generator and shielding of the applicator. Since the shielding of the generator is the simpler of the two, it should be done as completely as possible. This involves three important points: first, the radio-frequency parts of the generator circuit must be enclosed in a separate section of the cabinet, the walls of which are copper plated and conductively bonded at the joints. (The copper provides a better and more permanent contact across wall joints).

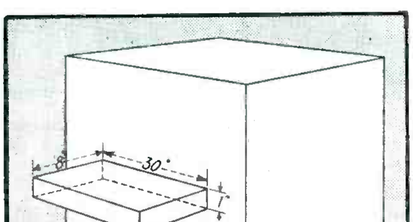


FIG. 7—Method of attaching a vestibule to the shielded cage of the work table, for providing conveyor belt openings without allowing excessive radiation

All wiring and components not essential to the r-f circuits should be kept outside of this r-f compartment. This refers to control wiring and especially meters or controls which may extend through the walls of the main cabinet. Any ventilators should be covered with small-mesh bronze screening. Second, any access door into the r-f enclosure must be conductively bonded along all edges. If this is not done, the door will be a major source of radiation. Third, a good low-pass filter should be provided in the power supply line.

The shielding of the transmission line and of the work applicator and tuning equipment will then control the amount of radiation from the system. When the double screen cage is used, the two screens may be in contact with each other at points such as access openings; both should maintain good contact with a single sheet-copper floor which may be used as an applicator electrode if desired.

No unshielded wires should be run into or out of the system. The use of special external ground connections, such as wires to water pipes or to buried plates, has no appreciable effect upon the reduction of radiation.

It is hoped that the findings of the foregoing investigation may serve as a reference for the economical construction of load shielding.

F-M FIELD SURVEY

Detailed description of the procedure used to secure data for plotting actual coverage contours of WMFM as required by the FCC one year after an f-m station first goes on the air, with practical data on equipping, calibrating and using a field car

ONE YEAR from the date of the first regular operation of a high-frequency f-m broadcast station, a survey must be submitted to the Federal Communications Commission establishing the actual field intensity contour. Continuous field intensity records are made along each radial specified in the construction permit (CP), and the actual routes of the field car are plotted on a map along with the two service contours. The primary service area then corresponds to the area inside the 1000-microvolt contour, and the secondary service area is inside the 50-microvolt contour.

Transmitter Power Requirements

During the months of August and September, 1943, a survey like this was made to prove the antenna performance of WMFM, one of the Milwaukee Journal's radio stations. In order that the calculated distance to the 50-microvolt contour would conform with the map attached to the CP, an effective radiated power of 41.5 kilowatts was necessary to deliver the desired coverage of 8500 square miles.

The radiating system of WMFM consists of a two-bay turnstile antenna which has a power gain of 1.23. The required transmitter power, for an effective power radiation of 41.5 kw, is therefore 41.5 divided by 1.23, or 33.8 kw. The loss in the coaxial transmission lines to the antenna was computed to be 2.5 kw, thereby requiring an increase in the transmitter output power to 36.3 kilowatts. WMFM uses a 50-kw REL 521DL f-m transmitter with a power input to the final stage of 60.5 kilowatts.

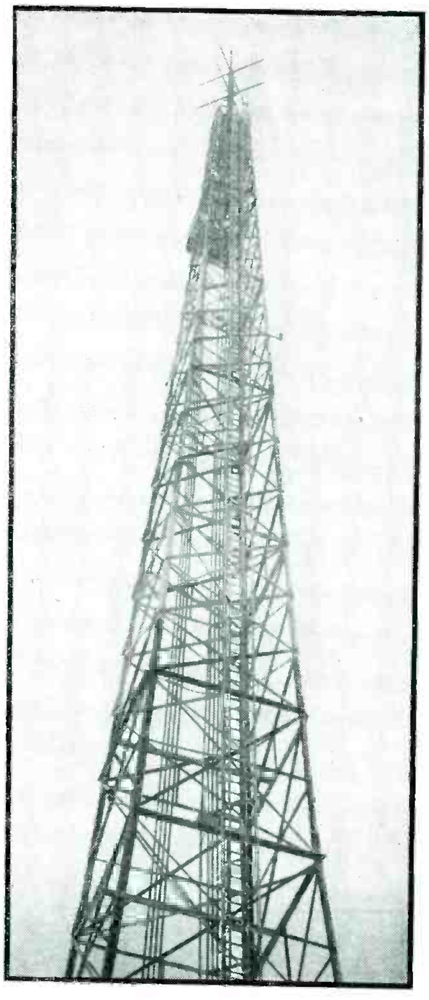


FIG. 1—Tower, transmission lines and turnstile antenna system used by WMFM at Richfield, Wisconsin

The indirect method of computing the output power was used, assuming an efficiency of 60 percent for the power amplifier. The operating power then is $0.6\ E_p I_p$, where E_p is the plate voltage applied and I_p is the total plate current of the last radio-frequency amplifier stage. This results in 36.3 kilowatts being fed to the transmission lines and an effective 41.5 kilowatts being radiated.

The turnstile antenna, shown in Fig. 1, is mounted on a 200-foot self-supporting tower and has a total effective height to the center of the array of 224 feet. The STL receiving antenna platform is incorporated in the tower design. The eight transmission lines on the tower, each feeding a single antenna element, can also be seen. The transmitter, located about 21 miles northwest of Milwaukee proper and about 15 miles inland from Lake Michigan, was described in a previous article.[1]

Measuring Equipment

The 50 and 1,000-microvolt contour lines were determined by taking continuous measurements along each of eight radials spaced 45 deg apart, using an RCA 301A v-h-f field intensity measuring set with a 93A vibrator power unit.

The field intensity meter was designed for measuring field intensities of stations operating in the high-frequency spectrum, for the purpose of checking antenna efficiency, service area and carrying out research or propagation studies. The instrument covers the band of 20 to 125 megacycles and has a range of 10 to 500,000 microvolts when used in the f-m band (officially designated as the high-frequency broadcast band). It is designed particularly for field use and consists of three units—the field meter, antenna and power supply. The primary source of power to the vibrator unit is a non-spillable storage battery de-

TECHNIQUES

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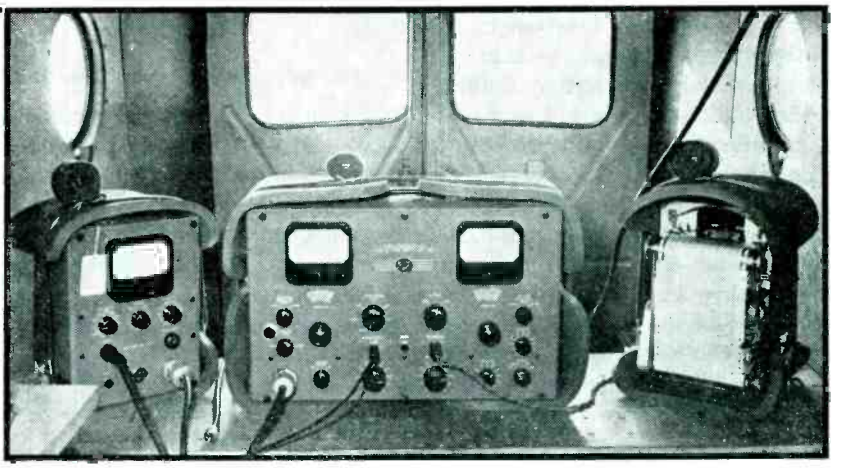

FIG. 2—View of the v-h-f field intensity measuring set mounted in the car and ready for use. At the left is a noise meter

signed to operate continuously for eight hours without recharging. The recorder was an Esterline-Angus model AW 5-ma instrument.

The equipment was securely mounted on rubber kneeling pads in a Dodge delivery truck, as shown in Fig. 2. In addition to these equipments an f-m receiver was taken along to monitor the station; this proved valuable at the outer fringe of the service area.

The antenna of the measuring set was mounted on the roof of the field car and the support extended down through to the floor inside. This made it possible to control the antenna from the inside while the field car was in motion. The antenna used at the transmitter is a horizontal turnstile, and consequently similar polarization was used for the car antenna. A marker was attached to the base of the antenna mast and set up to indicate the relative position of the dipole above. This was helpful when the field car made turns along the highway, and minimized time in orienting the antenna. The output of the antenna was connected by means of a flexible transmission line to the field measuring set, which in turn was connected to the Esterline-Angus recording milliammeter. Figure 3 is a picture of the field car with the antenna mounted in place.

FIG. 3—View of the field car with the telescopic antenna raised. The antenna pivots on a bearing inside, permitting orientation for maximum signal

Calibration of Field Car Installation

The metal in the truck body made it necessary to check and recalibrate the measuring instrument. Therefore, before the equipment was installed in the field car the measuring set was taken to a location well away from and free of power lines, fences and buildings. The nearest obstacles were more than 300 feet distant. A compass rose was laid out and readings taken to determine the field intensity in this local area. The signal intensity in this open-field area was found to be 1634 microvolts, and no fading existed here to upset the calibration. The antenna length was 54 inches, or about 0.21 wavelength each side of the dipole for the above tests. The height of the antenna was adjusted to 13.5 feet, which was the maximum height of the telescopic support.

A semi-permanent installation was then made in the field car. It was found that the top of the truck body did not present a uniform capacitance back to the antenna as it was rotated over 360 degrees. After several tests it was determined that the antenna had to be elevated slightly more than one quarter wavelength above the steel top in order to minimize the effect of the truck body. It was deemed necessary to set up and calibrate this variation as the truck body was rotated in relation to the transmitting station. The compass rose previously laid out by driving wooden stakes in a circle was used to recalibrate the unit. Readings were taken at each 30-degree position and the antenna always oriented to deliver the maximum field intensity as the truck body was rotated through 360 degrees. The placement of the antenna with reference to the body of the truck can be seen in Fig. 4, which corresponds to the 270-degree position shown in Table I.

The highest signal intensity was received at positions 2 and 8, corresponding to 1577 μv per meter. The lowest signal received was 1520 μv per meter, at positions 4-5-6-7. Prior to the installation on the field car, a signal of 1634 μv per meter was received at this identical location. This represents a reduction of 57 microvolts at positions 2 and 8 and 114 microvolts at 4-5-6-7 when introducing the metallic body of the truck in the field.

Correction of Antenna Constant

From the data in the instruction book furnished with the field intensity instrument it was found that an antenna constant of 9.5 was needed to carry out the computation for the field intensity at 45.5 megacycles. This constant takes care of any losses in the 30-foot transmission line from the dipole to the input terminals of the field meter. Changing this constant was a very convenient way to compensate for any effect that the truck body might have on the pick-up antenna. The new constant K was found by the following formula: K = 1634 μv $\div$ attenuator scale $\times$ meter reading in milliamperes.

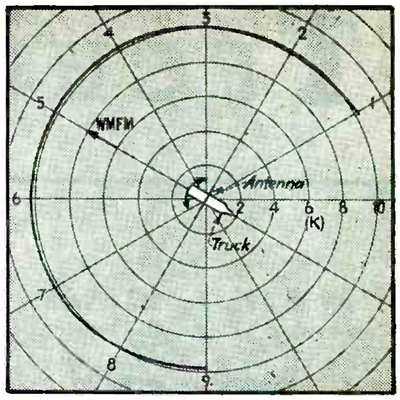

FIG. 4—Graph showing the variation of the antenna constant with the position of the field car in relation to the direction of the transmitter as the only variable. The dipole antenna was oriented for maximum signal for each new position, and the transmitter power held constant

The field unit was used only for measurements while moving directly away from the transmitting station, and therefore calibrations were made for only the rear and the two sides of the truck, as shown in Fig. 4. Positions 2 to 8 were averaged, and resulted in a change of the antenna constant from 9.5 to 10.0. The overall height of the antenna then was permanently fixed on the field car at 13.5 feet above the ground or 6.5 feet above the metal roof. After all the radials were run, the calibration of the measuring set was again checked under the same conditions and found to be the same.

Percent Modulation Was Lowered

It should be realized that this method of continuous recording of field intensity is quite different from that used in the regular broadcast band. Here the measurements are generally made at isolated points free of wires and other obstructions, and under favorable conditions. The measuring instrument used was primarily meant for a-m use and has a bandwidth of about 50 kc. Modulating the f-m transmitter at full 100 percent, corresponding to a swing of $\pm$75 kc, produced an excessive variation on the field meter. Consequently, during the periods that the measurements were being taken the overall percentage of modulation was dropped by lowering the audio input to the transmitter until satisfactory stability was obtained. This was achieved by low-

TABLE I. EFFECT OF TRUCK BODY ON ANTENNA CONSTANT

Position No.	Position Angle	Attenuator Scale	Reading in ma	Field Intensity in μv/m, using K = 9.5	New Antenna Constant K
1	60°	20	8.1	1539	10.08
2	30°	20	8.3	1577	9.85
3	360°	20	8.2	1558	9.96
4	330°	20	8.0	1520	10.21
5	300°	20	8.0	1520	10.21
6	270°	20	8.0	1520	10.21
7	240°	20	8.0	1520	10.21
8	210°	20	8.3	1577	9.85
9	180°	20	8.3	1577	9.85

TABLE II. RADIAL No. 8—N 354.5° E

Sector Number	Attenuator Setting	Dist. to end of Sector	Median Field Reading	Median Field at 13.5 ft = μv/m	Median Field at 30 ft = μv/m	Max. Field Reading	Max Field at 30 ft = μv/m
1	2	3	4	5	6	7	8
1	10,000	0.6	8.0	800,000	1,760,000	10.0	2,200,000
2	10,000	1.0	4.0	400,000	880,000	7.0	1,540,000
3	10,000	2.4	2.0	200,000	440,000	4.3	950,000
4	2,000	3.5	3.0	60,000	132,000	7.2	316,000
5	500	5.0	4.0	20,000	44,000	8.5	93,500
6	500	7.0	5.2	26,000	57,400	9.5	104,000
7	500	9.0	2.5	12,500	27,500	5.0	55,000
8	500	10.6	1.8	9,000	19,600	3.4	37,400
9	100	12.5	3.5	3,500	7,700	7.6	16,700
10	100	16.0	1.5	1,500	3,300	5.6	12,300
11	20	20.0	6.4	1,280	2,820	9.6	4,200
12	20	25.0	5.1	1,020	2,250	9.8	4,300
13	20	27.5	4.0	800	1,760	7.6	3,350
14	20	32.5	2.6	520	1,140	9.0	3,960
15	20	36.0	1.5	300	660	3.9	1,720
16	5	40.0	4.0	200	440	10.0	1,100
17	5	42.5	5.0	250	550	10.0	1,100
18	5	45.5	1.8	90	196	6.6	722
19	1	50.0	5.5	55	121	10.0	220
20	1	55.0	6.2	62	136	9.6	212
21	1	60.0	6.0	60	132	10.0	220
22	1	65.0	1.5	15	33	4.0	88
23	1	70.0	2.0	20	44	6.1	134

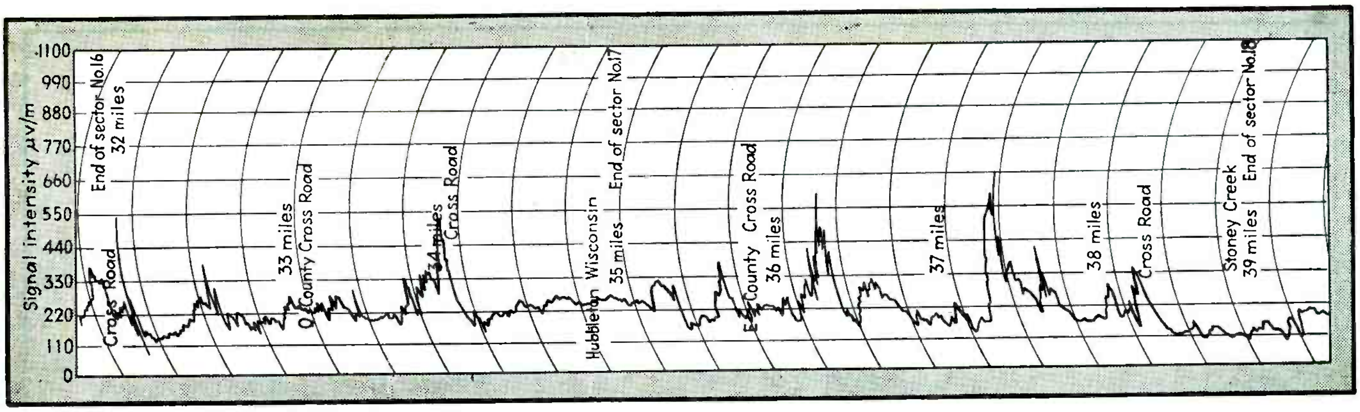

FIG. 5—Signals recorded with equipment shown in Fig. 2 and 3

ering the input 4 to 5 db. Satisfactory monitoring of the program modulation could not be obtained with this amplitude instrument so the signal was monitored on the f-m receiver which was carried along.

Field Work and Routes

In planning for the runs on each of the eight radials, care was taken to see that they were carried well beyond points of predicted service, so as to arrive at a sufficiently accurate determination of the contour boundary. This is particularly important at the 50-microvolt contour because of distance to be retravelled if the field records are found to be incomplete. The radials were spaced approximately 45 degrees about the transmitter.

The survey was conducted only during the daylight hours. While driving along the radials a uniform driving speed of 15 miles per hour was maintained and a sufficient number of landmark and roadway notations were written on the record for later chart analysis. These locations were noted on the chart as often as necessary, so it was easy to determine the exact location of the field car when the chart analysis was made later on. This definitely fixed the relation of the car location to the measured field intensity. Figure 5 shows a record taken on radial 6 between sectors 16 and 18, corresponding to 32 and 39 miles from the transmitter.

In choosing the routes for the car, roads were chosen that ran parallel (or nearly so) to the radials, as deviations of the topography can cause a great difference in the recorded results. The routes traveled by the field car in relation to each radial are shown in Fig. 6. In some cases wide deviations from the radials were necessary because of rivers and their lack of bridges. This was the case on radial No. 1 where it was impossible to cross the Milwaukee River. Another case was on radial No. 5 at Janesville, where the Rock River interfered. On the northwest radial a large area known as Horicon Marsh made passage impossible. Most township roads run east and west, with very few diagonal roads, hence trouble was also experienced with the radials going northwest, southwest and northeast. On the southeast radial a diagonal highway, U.S. 41, ran directly along the radial and through the city of Milwaukee.

The antenna height above the car proved to be rather awkward during the field runs and trouble was experienced, particularly on country roads. The antenna had to be replaced several times because of the driver's inability to spot electric fence wires strung rather low across the highway, or because of overhanging branches. One radial per day was all that could be accomplished. This was partially due to the regular program schedule which began at noon and therefore necessitated a late start.

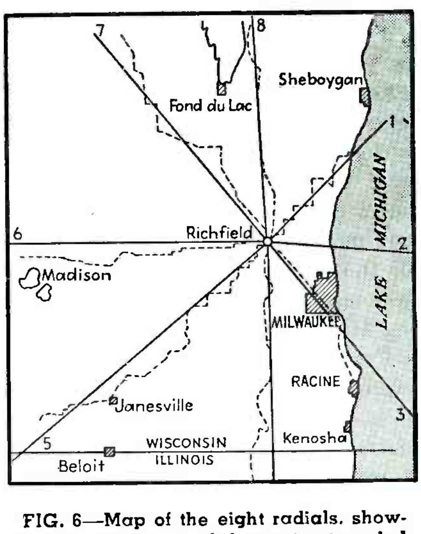

FIG. 6—Map of the eight radials, showing the deviation of the routes traveled by the field car (dashed lines) with respect to the radials

Predicted vs. Measured Results

After the measurements were completed, the charts from the recording meter were analyzed. The first step was to divide them into sections, each representing a sector of a radial along the topographic map. Each sector was not more than one tenth of the service radius or not more than five miles in maximum length. The charts of the field intensities were analyzed to determine the electric field intensity obtained 50 percent of the distance along each sector.* This will be referred to as the median field intensity for antenna height of 13.5 feet. The value is associated with each particular sector and is presented in tabular form. An example of one of these tabulations, shown in Table II, was compiled from the data taken along radial 8.

Column 1 of Table II is the sec-

* In the Standards of Good Engineering Practice for High Frequency Broadcast Stations[2], set up by the Federal Communications Commission, is the definition: "The signal intensity for the 50-microvolt per meter 50 percent distance is interpreted to mean the contour bounded by the sector on a radial on FCC map No. 41722, Signal range for high frequency broadcast stations, wherein the signal of the station for 50 percent of the distance represented by the sector of the radial is equal to 50 microvolts per meter. The boundary of the service area shall be taken as the outer edge of the sector nearest the transmitter wherein the signal is the desired value for 50 percent of the distance."

TABLE III. COMPARISON OF PREDICTED AND MEASURED CONTOURS FOR WMFM

DATA FOR 1000-μv/m CONTOUR

Radial	Bearing	Average Elev.	Eff. Ant. Height	Predicted Distance	Measured Distance
1	N 45°E	800 ft	479 ft	29.1 mi	31.0
2	N 96 E	685	594	31.5	In Lake
3	N 140 E	745	534	30.8	31.0
4	N 180 E	913	366	26.5	28.2
5	N 231 E	946	333	25.5	25.6
6	N 270 E	979	300	24.8	23.0
7	N 320 E	1030	249	23.0	24.5
8	N 354.5 E	995	284	24.1	31.5

DATA FOR 50-μv/m CONTOUR

Radial	Bearing	Average Elev.	Eff. Ant. Height	Predicted Distance	Measured Distance
1	N 45°E			In L. Mich.	
2	N 96 E			In L. Mich.	
3	N 140 E			In L. Mich.	
4	N 180 E	837 ft	442 ft	66 mi.	64 mi
5	N 231 E	891	388	64.5	64.5
6	N 270 E	932	347	62.5	58.0
7	N 320 E	982	297	60.5	59.0
8	N 354.5 E	1000	279	60.0	65.0

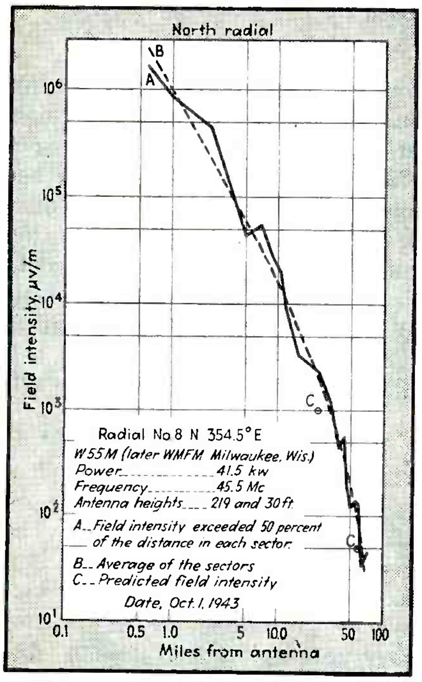

FIG. 7—Graph constructed from data given in Table II. Similar graphs were made for each of the other seven radials

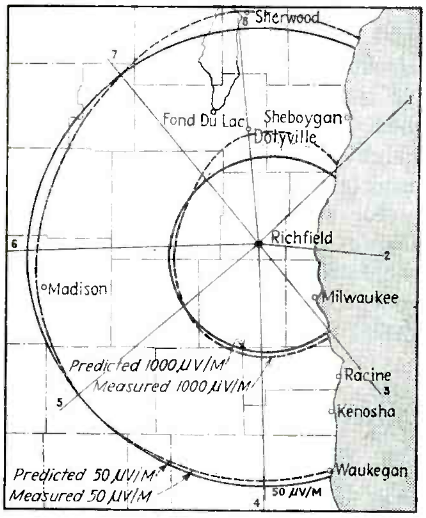

FIG. 8—Map showing the measured 50 and 1000-microvolt contours as heavy dashed lines. The solid line represents the predicted contours. The primary service extends to the far side of the city of Milwaukee and its southern suburbs

tor number. The next column is the attenuator setting on the field meter. Column 3 shows the distance from the transmitter to the end of each sector. Column 4 is the median field reading in milliamperes 50 percent of the distance along each sector. The fifth column is the field intensity already computed directly in microvolts at 13.5 feet. This is the product of column 2 and column 4 multiplied by the fixed antenna constant of 10.0. Column 6 is the median field intensity at 30.0 feet. Since the field intensity is directly proportional to the antenna height (above $\frac{1}{4}$ wavelength) for horizontal polarization, a factor of 2.2 was used to interpolate the field intensity values from 13.5 to 30 feet. Column 7 shows the maximum field reading in milliamperes in each sector for an antenna height of 13.5 feet. The last column is the maximum field intensity obtained about 10 percent of the distance at 30 feet, and represents the peak signal value in each sector.

For reference and comparison purposes the values of field intensity are referred back to an antenna height of 30 feet since this is the height specified by the Standards of Good Engineering Practice. In addition, this is the receiving antenna height at which all the calculations were made for the original construction permits of the station.[3, 4, 5, 6]

From column 6 of Table II, the values of field intensity in microvolts per meter at 30 feet were plotted graphically against distance in miles from the transmitter. One of the eight graphs is shown as Fig. 7. The solid line is the measured signal intensity 50 percent of the distance in each sector. The dashed line represents an average struck to obtain the signal intensity at any intermediate distance. Indicated also are the two predicted contour points, shown by the letter notation *C*. It is evident that on this radial both contours fell inside the calculated distance.

A comparison of measured and predicted values of field intensity at WMFM for all eight radials is shown in Table III. Each contour distance was tabulated along with the predicted distances as stated in the construction permit issued by the FCC. Notice that the 50 μv per meter contour to the northeast, east and southeast falls in Lake Michigan and could not be measured.

Figure 8 shows the map constructed from the data given in the previous chart. The solid lines on the map represent the predicted 50 and 1,000-microvolt contours, while the dashed lines show the actual measured contours.

The 5 and 2.5-millivolt contour lines are not drawn on the map, but Table IV shows the distances at which these lines fall.

The total area covered by the transmitter is about 12,000 square miles. Thirty percent of this area falls in Lake Michigan, as may be seen by referring to the map. The Milwaukee trade area extends many more miles to the north and west than it does to the south.

Analysis of Discrepancies

The predicted area, not including the lake, was 8,500 square miles, which is the area specified in the present license for WMFM. The actual measured area inside the 50-microvolt per meter contour was 8400 square miles or a decrease of about one percent. The area inside the 1,000 microvolt per meter contour was predicted at 1,860 square miles and the measured area was found to exceed this by 90 square miles or an increase of about five percent. This discrepancy between calculated and actual values is attributed to the inability to obtain accurate values of elevation of the topography to the north on radial No. 8 when the prediction was made for the construction permit. It is along this radial where the predicted signal was exceeded. This section of the state of Wisconsin had never been surveyed, and therefore there were no quadrangle maps. The records available gave only such sparse data as the positions of railroad stations, airport elevations and the like. The data on the area was computed by the use of a planimeter on the original airway map.

Within the 1,000-microvolt contour, the population was estimated at 834,607 based on the 1930 census figures. The predicted and measured distances to the service contours on the various radials are essentially the same with the exception of radial 8. The contour distance at this point extends about 7 miles farther out but no city of any size is included in this additional area. This small variation from the predicted contour makes no appreciable change in the population served by the station.

Within the 50-microvolt contour, the population is estimated at 1,522,544. In general, the measured results show the 50-microvolt line to be 2 to 3 miles inside the predicted distance. Exception again is made in the case of the north radial 8, where the measured distance exceeded the predicted by 6 miles. This variation makes no appreciable change in the population figures within the 50-microvolt service area.

TABLE IV. DISTANCES TO CONTOURS

5 Millivolt Radial	Miles	2.5 Millivolt Radial	Miles
1	17.0	1	27.0
2	14.0	2	....
3	17.5	3	22.8
4	15.0	4	20.0
5	12.5	5	17.6
6	12.0	6	16.0
7	13.0	7	17.0
8	16.6	8	22.0

At the 50-microvolt point noticeable fading existed on several radials. This tended to influence the analysis of the field measurements and resulted in a lower than predicted value of field intensity in some areas. Milwaukee proper and its suburbs has a population of 766,885 and makes up the major market area of the station.

Fading

In conclusion, a few words on the stability of the signal intensity at the outer fringe of the service area and points closer may be of interest since experience has shown that appreciable fading can exist. After reaching the end of a particular radial a few minutes were spent checking the approximate placement of the 50-microvolt contour. This was done so that on the return trip along the same route a suitable spot could be picked as close to the contour as possible for a spot check on signal fading. A position was chosen for these checks which was representative of the country traveled and which was also free of wires, rather than a position suitable for high or low signal intensity. In most cases several hours of recording was done at the close of the daylight hours and shortly after sunset, to observe diurnal effects if any existed.

One recording location was at Dotyville, on radial 8, just outside the 1,000-microvolt or primary contour line. It gave a signal of 225 microvolts maximum and 160 minimum at 13.5 feet. This is an overall variation of 65 microvolts with a median signal of 200 microvolts. The distance to this point from the transmitting antenna was 34 miles.

Another location at which fading was observed is at Sherwood, also on radial 8, but near the 50-microvolt or secondary service contour. The distance here was 65 miles to the transmitter. The signal reached a maximum of 25 microvolts and a minimum of 7 with a median signal of 17 microvolts over a period of 22 minutes, as shown in Fig. 9. These checks were made with an effective antenna height of 13.5 feet, and to be correct should be multiplied by a factor of 2.2.

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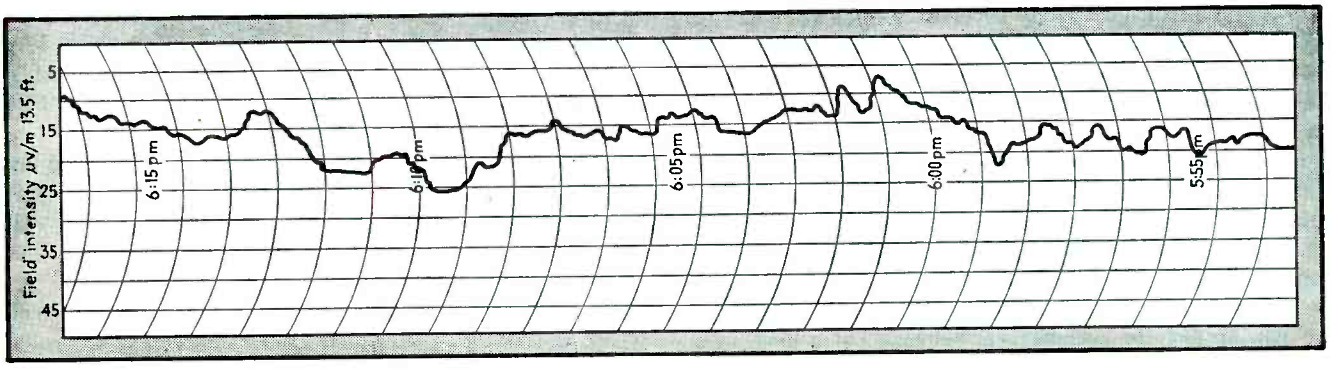

FIG. 9—Record of the fading at Sherwood, Wisconsin, on radial No. 8 at a point 65 miles from the transmitter and just barely inside the service area of WMFM

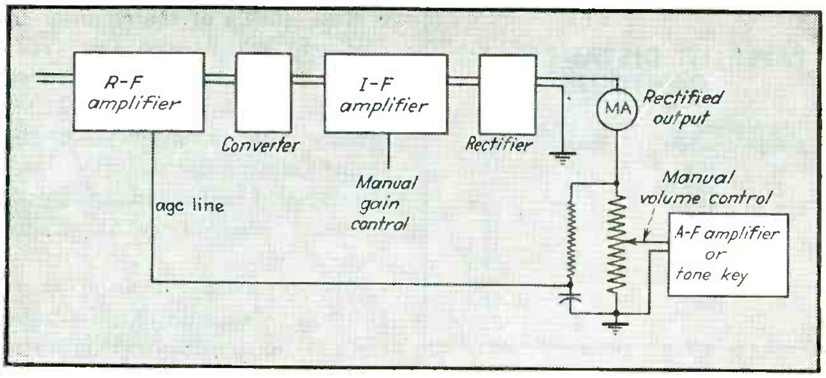

FIG. 1—Stages in a typical communications receiver having automatic gain control of the r-f amplifier

AGC-Noise Considerations in Receiver Design

Automatic gain control is considered for communications receiver service from the standpoint of its effect on signal-to-noise ratio at various signal voltages. The desirability of employing high gain in controlled stages and the limitations of such use are pointed out

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AUTOMATIC control of the output volume of radio receivers is so universally employed that there is apt to be a tendency to simply incorporate it in any design as a matter of course. It is the purpose of this present treatment to point out and discuss some of the factors that are not always obvious but that are important where the best possible performance must be obtained, as in commercial communications service; also, to deal with certain compromises that often must be made.

The simplified diagram given in Fig. 1 is a generalized schematic arranged to show the functional sub-divisions of a complete receiver. Control of the output volume is obtained in this generalized receiver by means of a manual volume control in the a-f amplifier (for phone service) or in the tone keyer (for telegraph service). The output volume thereby can be adjusted independently of the gain of the r-f and i-f amplifiers. For this reason, which is important in many types of equipment for commercial service, the commonly-used term *automatic volume control* (avc) is not applicable. The preferable term, which will be employed in this discussion, is *automatic gain control* (agc).

Figure 2 gives a generalized schematic circuit of a three-stage r-f amplifier, with agc, such as might be used in the complete receiver of Fig. 1. A particular feature to be noted in this circuit is the use of taps on the tuned-circuit inductances. The purpose of these is to make it possible to obtain any desired value of overall gain, up to the maximum, without the necessity for changing the tube voltages or operating points from their optimum values. Other features of the circuit are conventional, except perhaps for individual r-f filtering of the supply voltages to each tube. This latter is essential in any high-gain r-f amplifier operating at the higher frequencies.

Diode Output vs Carrier Amplitude

The usual criterion of agc action is the shape of the characteristic of rectified output vs r-f carrier input. Such a graph shows how nearly constant the output is maintained over the indicated range of r-f input voltage. For some purposes, this is sufficient. Such data do not, however, show what the signal-to-noise ratio in the output will be. For reasons which will be brought out in following paragraphs, this signal-to-noise performance may be quite different over a wide range of r-f input voltages than one would be led to expect from a statement of noise equivalent of the receiver.

In Fig. 3 are shown two typical graphs of output noise level, expressed in db below 100 percent modulation, plotted against r-f carrier input signal in microvolts. For the moment, let us consider only the general features of these two characteristic graphs.

Between the points indicated by *A-A′* and *B-B′*, the graphs are linear. A check of various points will show that the noise equivalent, in microvolts at the input of the receiver, is essentially constant over these linear portions of the graphs. For example, a noise level of 20 db below 100-percent modulation at

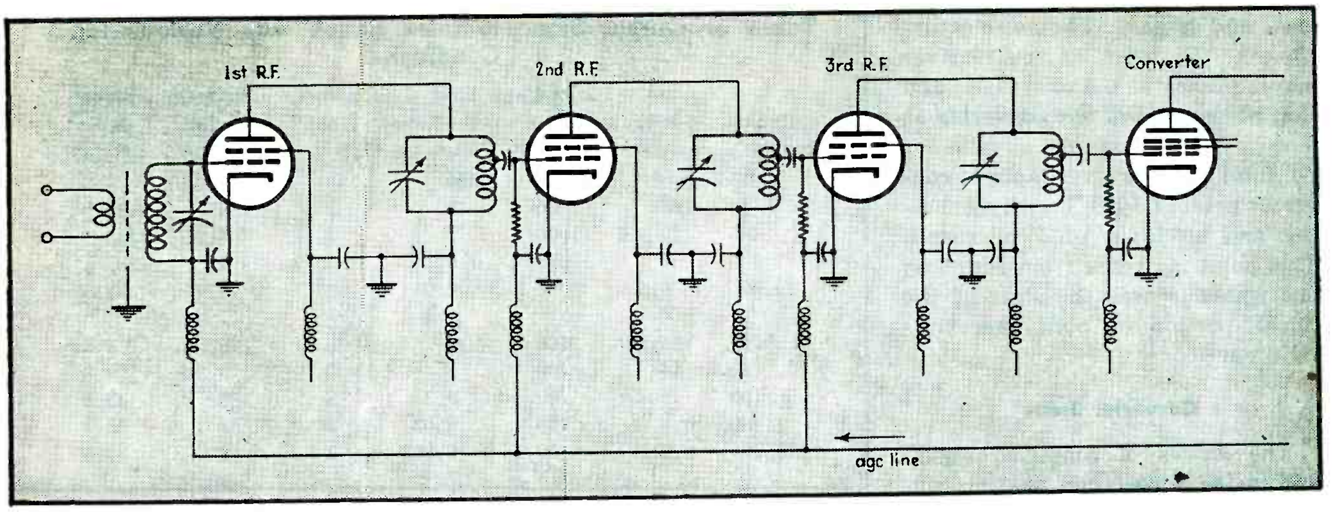


FIG. 2—Three-stage r-f amplifier and converter used for purposes of discussion by the author. Taps on the inductances permit adjustment for any desired value of gain without changing other operating conditions

a carrier input value of 2.6 microvolts (average) gives a noise equivalent of 0.26 microvolts at the receiver input. This method of expressing noise levels is convenient and useful because it provides a figure which can be compared directly with values of r-f signal input in microvolts.

Effect of Increased Signal

The ideal condition is that one in which the noise equivalent, at the receiver input, is constant regardless of signal strength. Then, and then only, is the full benefit of increased signal strength realized. In the curves of Fig. 3, it will be observed that the characteristic does not continue linear at the higher values of input signal. Instead, each characteristic levels off. Increasing the signal input ten times, from 100 microvolts to 1,000 microvolts, does not produce a corresponding improvement in signal-to-noise output of the receiver. A further increase from 1,000 microvolts to 10,000 microvolts produces an even smaller improvement. As a practical matter, there is no object in having such characteristics continue linear down to extremely low levels in the design of radio receivers for general use. The level at which the characteristic will be permitted to flatten off is, therefore, determined by practical considerations of the performance required.

In order to compare different performance curves directly, some common base or starting point must be used when making the measurements. For the curves of Fig. 3, the starting point was a diode output of 0.1 ma for zero r-f input signal. The particular equipment used in the tests maintains a diode output of approximately 0.6 ma at normal operating values of signal strength. In other equipment, a similar ratio between normal output and starting-point output of the diode could be used. Adjustment to the desired value of rectified output for zero r-f signal input is obtained by means of the manual gain control associated with the i-f system as shown in Fig. 1.

The flattening-off level, for such curves as those of Fig. 3, is determined by the amount of r-f gain employed between a given input stage and a given converter (Fig. 1). Three stages are shown to give the required r-f selectivity and also the desired agc action as judged by constancy of output over a wide range of r-f signal input. The overall gain is fixed at a desirable value by proper choice of the positions of the taps on the coils of the tuned circuits. This permits obtaining the desired reduction of maximum gain without changing tube voltages and operating points and thereby sacrificing agc performance.

To explain the foregoing, let us

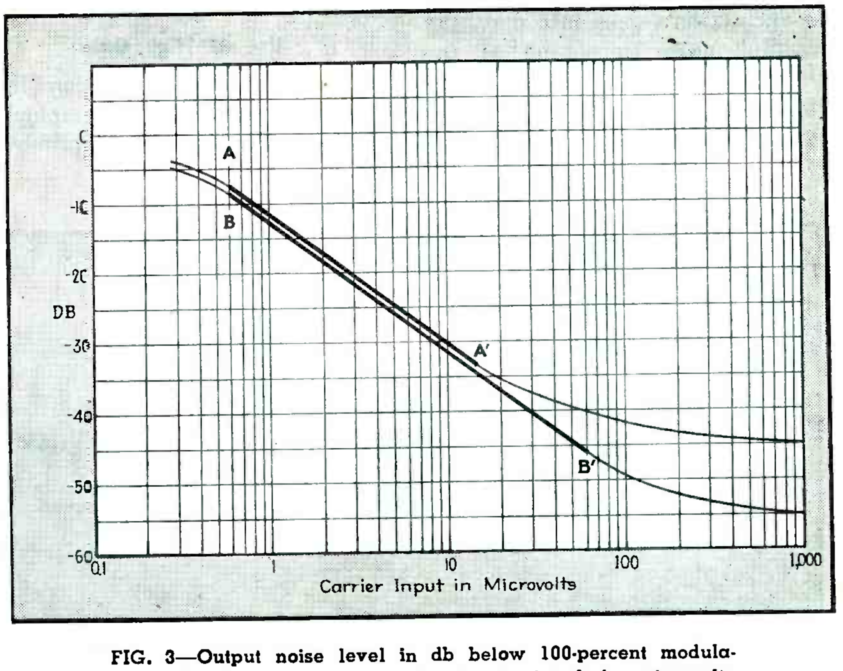


FIG. 3—Output noise level in db below 100-percent modulation, plotted against r-f carrier input signal in microvolts

assume some values of noise equivalent and of gain. The noise equivalent at the input of the receiver may be taken as 0.3 microvolt; and that at the grid of the converter as 3 microvolts. Assume a value of r-f gain, from receiver input to converter grid, of 1000/1 with agc acting and an input of 1 microvolt. This point is chosen from Fig. 3 as one which is near the start of the linear portion of both characteristic curves.

Table of Output Signal-to-Noise Ratios with Various Input Conditions

Input Signal, μv	R-F Gain	At Conv. Grid. Signal, μv	At Conv. Grid. Noise, μv	Converter Noise Equiv., μv	Converter Total Noise, μv	Signal Noise Ratio
1	1000	1000	300	3	300	3.3
10	100	1000	30	3	30	33.3
100	10	1000	3	3	4.2	238
1,000	1	1000	0.3	3	3	333
10,000	0.1	1000	0.03	3	3	333
1	100	100	30	3	30	3.3
10	10	100	3	3	4.2	23.8
100	1	100	0.3	3	3	33.3
1,000	0.1	100	0.03	3	3	33.3
10,000	0.01	100	0.003	5	3	33.3

Converter Noise

The values of amplified signal and noise appearing at the converter grid for different values of r-f input are given in the accompanying table. These are based on the somewhat idealized assumption that the agc action holds an absolutely constant output and therefore a constant signal level at the grid of the r-f converter. The assumption also is made, for the purpose of this simplified illustration, that the second and third stages contribute no appreciable portion of the noise. For purposes of illustration, these assumptions are justifiable; the errors involved being too small to appreciably affect the validity of the illustration.

The tabulated figures show that at low levels of input signal the final signal-to-noise ratio in the output of the receiver is determined by the signal-to-noise ratio existing at the input of the receiver. As the signal input is increased, and the agc action comes into play, the amplified noise appearing at the converter grid becomes less in magnitude compared to the noise equivalent of the converter itself. The result is that, at the higher levels of signal, the signal-to-noise ratio of the output of the receiver is determined not by that existing at the input but rather by the noise equivalent of the converter. The agc-characteristic of signal-to-noise vs r-f input therefore flattens off as shown in Fig. 3.

In the lower portion of the table, the r-f gain is assumed to be 100 instead of 1000. This lower value of r-f gain results in poorer signal-to-noise ratios at the higher values of signal input. The curve for this case therefore would flatten off at a considerably higher level of noise. This is illustrated by the two curves of Fig. 3, which are plotted from actual data rather than from the assumed data tabulated in the table for purposes of simplified explanation.

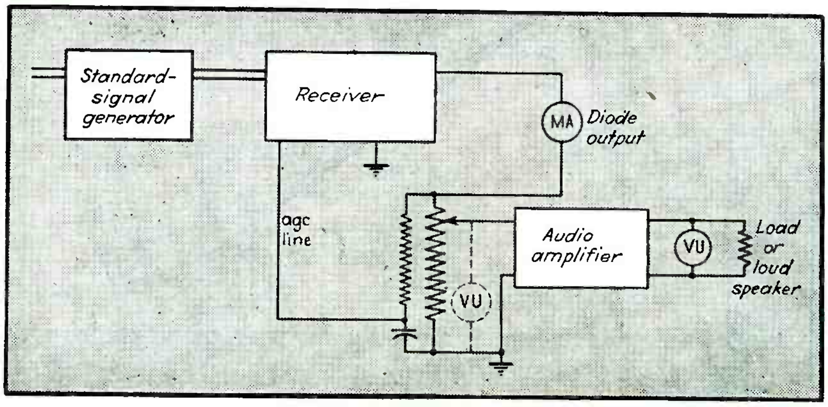
Use of High Gain

The foregoing discussion indicates the desirability of employing high gain in the r-f amplifier to which agc is applied. There are certain limitations, though, to the amount of gain that can be safely used. One is stability, or freedom from self-oscillation, at all frequencies. A second is protection of the r-f converter tube from being overloaded by stronger signals on channels adjacent to the desired signal.

If the r-f gain and the agc hold the desired signal at 10,000 microvolts at the grid of the converter, and a signal 100 times as strong as the desired one is received on an adjacent channel, the interfering signal will have a voltage of about one volt at the grid of the converter. This is apt to produce serious overloading and interference.

In actual use of a receiver such as depicted in Fig. 1 and having agc-noise characteristics as shown in Fig. 3, it is customary to manually readjust the i-f gain in order to obtain optimum performance on very weak and also on very strong signals. In this way the agc-noise characteristic may be shifted from its positions shown on Fig. 3 to best handle existing conditions and ranges of signal strength, noise, and interference. Obviously, the design of the agc system should be such as to cover the greatest possible range of input signal without the need for manual re-adjustment of the i-f gain.

The final design generally must be a compromise between the various factors discussed; the exact compromise being determined by the performance required and the conditions under which the equipment will be used.



Arrangement of equipment used to determine the output current of a diode at various carrier signal levels

FUNGUS AND MOISTURE PROTECTION

Treatment of equipment to permit operation under climatic extremes involves—among other factors—consideration of surface conditions, qualities of finish, and fungistatic values established. These are discussed here in the light of current information

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In surroundings like this far cry from the placid corner of a living room, moisture and fungus treatment of a radio may make the difference between hours and months of maintenance-free operation

As applied to the protection of electronic equipment against unfavorable ambient conditions, the term tropicalization refers to (1) keeping out moisture to prevent electrical leakage, (2) inhibiting fungus attack and consequent loss of insulation resistance, and (3) forestalling corrosion which results from both moisture and fungus.

Tropicalization is more than a wartime requirement. It is forced upon us in any location where continuous high humidity combined with rapid changes of temperature cause excessive condensation. Fungus has a considerable hand in increasing and maintaining moisture deposits, and hence aggravating corrosive action. That it also causes chemical changes in insulation and other organic materials is generally admitted, but it is impossible to draw sharply any line of demarcation between the effect of moisture alone and the acceleration due to fungus.

Extensive tests made in the laboratory and correlated with outdoor exposure in Florida swamps show that moisture proofing is of the utmost importance, but that biological factors must not be neglected. A few laboratories have made accelerated tests without this correlated exposure and the results do not bear out actual conditions.

TABLE I. VULNERABILITY OF COMMON MATERIALS TO FUNGUS ATTACK

Most vulnerable: Cellulose, cement, cordage, cotton, felt, glue, leather, paints, phenolics, paper, varnish, varnished cambric, and waxes (most)

Less vulnerable: Melamine, rubber (natural and synthetic), and waxes (micro-crystalline)

Least vulnerable: Glass (clean), glass fiber, inorganics, polystyrene, and polyvinylidene chloride

Severity of Service

In the field of electrical and electronic equipment, extensive service in foreign countries and in temporary quarters has brought about environmental conditions quite different from peacetime ones. Particularly in the case of electronic equipment which in pre-war years was normally well sheltered, the whole technology of manufacturing components and assemblies grew up with no severe service conditions or exposure background. The early days of the war found American industry hastily multiplying its production many times and, in the main, following previous commercial and civilian practices.

It should be emphasized that actual field conditions in many cases are as severe as our previous ideas of accelerated tests. For example, it used to be considered a severe test to expose components to 10 days of high humidity and high temperature, that is, 90 to 95 percent relative humidity at 100 deg F. While the temperature may be a few degrees high for field conditions, it is certainly no accelerated test as far as humidity goes. A minimum of 30 days exposure to such conditions may be normal for any extensive campaign.

Frequent rainfall in many parts of the world, rapid temperature cycles with extremes—both high and low—all occur in the life of equipment. Every factor in equipment design, outside the electrical functioning, has been inadequate to some degree for the rigorous service occuring in military operations.

It is more or less customary for engineers to treat corrosion deterioration and service degradation as though they all took place in a sterile environment—one totally free of organic life forms and to a considerable extent as though it were free of organic debris.

Actually, the most casual inspection of any surface would indicate three common phenomena: (1) lodgment of air-moved organic dust; (2) presence of micro-organisms in large quantities—either in the form of spores or in the form of colonial and active growths; and (3) presence of insects and other living forms with their inevitable residue of mucus or non-living organic matter. Also present are inorganic dirt, dust, and debris; condensed and absorbed moisture; and specific chemical salts.

In great measure, degradation depends on conditions of moisture, temperature and light but microorganisms on any given surface may produce any of several effects. By their mere presence, they may produce paths of low electrical resistance and no further damage. However, during the course of their life cycle, they may produce electrolytes which augment corrosion of the base or deteriorate certain porous insulation surfaces.

As a third alternative, they may particularly and specifically deteriorate organic material, leading to such outstanding examples as the destruction of cellulosic materials by *chaetomium globosum* and other species. In addition, there occurs a chain of attendant effects hard to distinguish and isolate. These include: (1) retention of moisture on surfaces that would normally dry out more quickly; (2) increased wetting of relatively non-wettable surfaces; or (3) establishment of osmotic-equilibrium conditions favoring solution of metals.

Materials of Construction

PHENOLICS, both molded and laminated, absorb water at a rapid rate. This causes leakage paths and at times, swelling to such an extent that molded pieces may crack and laminates become separated. Several methods of phenolic protection have been devised whereby the rate of moisture absorption can be reduced to a minimum.

Normal spray equipment is used in fungus-proofing procedures. Regulations requiring booths and ventilating systems are generally regarded as adequate for toxicant-bearing finishes as well as conventional types

For instance, air-dry lacquers generally have poor adhesion to phenolic parts. An air-dry varnish is more successful for this application, but by the very nature of a phenolic surface, a baked-on finish is the only type that really provides a reasonably permanent coating. As an alternative treatment, impregnation with a fungistatic wax compound has proved more water-resistant than a baked-on finish. Fungicidal concentrates that may be added to standard waxes are obtainable in various forms. However, where resistance to surface-arcing is necessary, the baked finish should be used.

Wax-filled or wax-coated components are frequent sources of breakdown from fungus attack. This difficulty may be alleviated by using a fungicidal wax at the time of manufacture or else giving the part a flash dip in a similar compound before incorporation in the equipment. Inasmuch as there is extremely poor adhesion to a waxed surface by either lacquer or varnish, using the fungicidal wax is the safer and more lasting method.

FIBER PIECES react to moisture in a manner similar to phenolics, with the additional problem of extreme fungus attack. They may be well protected by either a baked coating or by wax impregnation—both containing fungicides.

TEXTILE-COVERED CORDS and cables require treatment for a dual purpose—they must be made water-repellant and fungistatic. If this were not done, the electrical resistance would drop below the point of operating efficiency in an amazingly short time. The Signal Corps has approved materials for this purpose which provide excellent service.

LEATHER is another material requiring treatment for both water repellance and fungus-proofing. The Signal Corps has developed a solution which can be purchased, ready for use, from manufacturers and which is easy to apply.

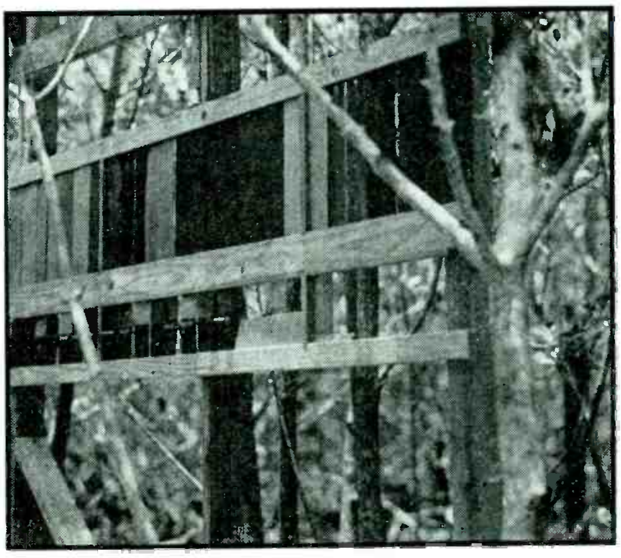
FELT, which unfortunately cannot be water-proofed without changing its characteristics, can nevertheless be fungus-proofed. Felt manufacturers provide their product already finished, but where there are stocks on hand, fungicidal preparations can be applied.

CERAMIC PIECES should be glazed, or where this is impossible, must be wax-impregnated with a fungicidal wax.

LACING CORDS for use in wire-harnesses should be impregnated with a fungicidal wax.

DYNAMOTORS AND GENERATORS have occasioned considerable difficulty primarily through corrosion, and only moderately through fungus attack. It is therefore recommended that armature and field coils be varnish impregnated and dip coated as usual, but instead of applying an air-dry sealer over the primary insulation, there be substituted a baking compound that retains its fungistatic properties after the baking process. There are such products approved by the Signal Corps and now in use to a considerable extent. All other circuit elements in the dynamotors should be sprayed according to specification No. 71-2202A.

HOOK-UP WIRES offer a considerable problem due to the fact that ordinary lacquers and varnishes attack the lacquer finish with which the wires are coated by the manufacturer. One lacquer approved by the Signal Corps does not attack this coating, and dries in a few minutes. The wires should be dipped in this product before incorporation in the set.



Actual exposure of test panels in tropical climate is used by the Insl-X Co. to correlate laboratory work with field results. Full-scale equipment runs are made under the same conditions

Treatment

Probably only a small percentage of our equipment failure can be blamed solely on biological factors. Nevertheless, not to do anything about this percentage of failure would be as negligent as to overlook any other factor.

Knowledge gained from research and practical field work accomplished in the past two years should serve industry well in the period of reconstruction which must take place in occupied countries when Japanese domination ends. Equipment manufacturers who have an eye on Eastern export trade after the war will, by study of tropicalization requirements, find a means of providing goods that will be able to cope with prevailing conditions.

In certain sections of our own country and in South America similar conditions prevail, and certain practical adaptations of tropicalization prove advantageous on all equipment.

The methods presently adopted by our Armed Forces have increased the life of electronic equipment from a few days to many months, providing, of course, that the component parts selected by the manufacturer for inclusion in the apparatus are of good quality.

Under the existing program, the prime contractor may order his material from the sub-contractor with the proper treatment already applied. Furthermore, in several sections of the country, organizations have been set up to handle all tropicalization requirements up to final assembly.

Tropicalization of electronic equipment must, of necessity, be divided into two sections: (1) The protection of component parts and (2) Overall sprays. The general intent of Signal Corps Specification No. 71-2202A is to provide a treatment for assembled equipment only. Component parts should be treated separately according to a number of supplementary recommendations issued by Fort Monmouth Signal Laboratory. Films entirely suitable as protection for completed equipment are by their very nature not satisfactory on a number of components.

One of the problems connected with the application of Specification No. 71-2202A is ascertaining the simplest method by which complete coverage can be achieved. It has been found by many manufacturers that the surest method is to spray each sub-assembly separately; this enables the sprayer to coat rear sections which are inaccessible in the complete assembly. When the entire set is assembled, practically all that then need be done is touch up the connections.

At present there is no method of verifying the completeness of treatment given an assembly. However, a program to be adopted will include the addition of fluorescent dyes to the coating materials so inspection can be performed under infrared light.

Tests prove that lacquers and varnishes developed for overall sprays must be designed so that the ultimate in moisture resistance is provided. Moisture resistance of any organic insulation film is generally evaluated in the laboratory on the following properties:

I. Electrical
   - Dielectric Strength (Wet).
   - Insulation Resistance (Wet).

II. Physical
   - Resistance to high temperatures.
   - Resistance to low temperatures.
   - Resistance to high- and low-temperature shock.
   - Adhesion to various surfaces—metal and non-metal.

III. Moisture Vapor Permeability
   - Resistance to migration of water capor under the conditions of high tem-

perature and humidity.

IV. Corrosion Resistance
Resistance of the organic system coated over a metal panel to immersion either in salt or fresh water or to salt-water spray tests.

If the organic system in question, with or without a fungicide, will give good values when tested for the various properties mentioned above, such a system may be considered moisture resistant and definitely good insulation.

Lacquer or Varnish

Lacquer and varnish systems each have their specific points of advantage, and selection of the most suitable coating can be made from the following comparison of factors:

DRYING. A lacquer, generally speaking, dries by simple evaporation of solvent, and the rate of through-film drying is determined by the volatility of the solvents. Solvents can be alcohols, esters, ketones, ethers, or hydrocarbons. Drying time tack-free as short as a minute is possible, although not generally advisable.

A varnish generally dries in two phases. First, an evaporation of solvent, followed by further polymerization and frequently oxidation. Only very short varnishes with high resin content dry tack-free in 15 minutes to an hour, and through-drying generally takes 4 hours and longer. This slow through-drying means difficulty in applying a second coat. Also, the short varnishes that dry rapidly require a high percentage or all of the solvent to be aromatic hydrocarbons which possess strong solvent power.

Lacquer solvents are also high in solvent power but due to their faster release from a lacquer film generally can be adjusted to cause less effect on undercoats of organic materials. Most lacquers are available with alternate solvent formulas to keep solvent effect at a minimum.

FLEXIBILITY. Varnishes in general are relatively hard—the shorter the harder, and they generally increase in hardness with age. Lacquers can be made with any degree of flexibility and distensibility and while they may lose flexibility with age, they lose it at a much slower rate than varnishes.

ADHESION. Varnishes—particularly short varnishes—exhibit good adhesion but lacquers can be formulated to produce adhesion to a much greater variety of surfaces.

LOW-TEMPERATURE CHARACTERISTICS. Varnishes—particularly short oil varnishes—become brittle at low temperatures and may lose adhesion on a great variety of surfaces. Lacquers, on the other hand, can be formulated to have initially better flexibility and to retain a much better low-temperature adhesion.

HIGH-TEMPERATURE CHARACTERISTICS. Varnishes withstand high temperatures better than lacquers since they are thermosetting and may improve with heating, to a point—after which they heat-age rapidly. Continued heating above a certain temperature is destructive.

Lacquers are generally thermoplastic and soften with heat but reharden on cooling without damage. Continued heating may harden or toughen the film but below the decomposition point continued heating does no permanent damage.

VAPOR PERMEABILITY. Generally, the short oil varnishes have lower rates of vapor permeability than lacquers.

Types of Fungicides

The question then arises as to the type of fungicide to be used—with special consideration to the volume required. It would seem evident that the fungistatic agent that gives the greatest protection with the least quantity, providing all other factors are given consideration, should be the one which will least disturb the structure of the coating.

Three materials have been generally accepted as providing good fungistatic properties. These are:

(1) Phenyl mercuric salts
(2) Pentachlorphenol
(3) Salicylanilide

Acceptable minimums for use in lacquers and varnishes are as follows: Phenyl mercuric salts—1 percent, Pentachlorphenol—15 percent, Salicylanilide—10 percent.

Besides quantity, another important consideration is longevity of the toxicant. Naturally, the use of a product that displays excellent general inhibitive value for the first month or two is of little value when, as a rule, electronic equipment is in storage for several months before it even reaches the field, frequently under hot and humid conditions.

The question of toxicity to personnel has been brought up many times. It is generally agreed that the customary risk of dermatitis from the use of lacquers and varnishes is not increased by addition of any of the three presently used toxicants. The laws of most states require that spray booths and ventilating systems be employed when using lacquers and varnishes, and if proper methods are followed no ill effects should result.

Perhaps the most controversial matter in the whole subject of tropicalization is the effect on selenium rectifiers of lacquers and varnishes containing phenyl mercuric salicylate. There is no doubt that mercury vapors affect uncoated selenium disks, but tests run by one of the best qualified independent laboratories in the country show that in 1500 hours of operation a number of uncoated selenium rectifiers dipped directly in a lacquer containing phenyl mercuric salicylate showed no degradation. On the other hand, Signal Corps tests showed that in sealed containers breakdown occurred. The correct answer may involve agreement on proper test methods, purity of the phenyl mercuric salt, reaction of the lacquer or varnish with the toxicant, and development of a satisfactory moisture-proof coating for rectifiers.

Spore Tests

It is known that the fungus tests now used for acceptance under Specification No. 71-2202A may not be entirely representative of actual conditions and it has been suggested that more than one organism should be used in any evaluated fungus tests. Of the three common fungicides only phenyl mercuric salicylate will pass both a mixed-spore and a single-spore test. Until such time as a means is created to show that this test can be correlated to field exposure, these present requirements should, for safety's sake, be followed.

On area of inhibition, one other consideration is life of the fungicide when subjected to operating temperatures of equipment and natural dissipation through volatilization. Table II shows fungistatic value of the three selected fungicides after exposure to various temperatures, and using both a single spore and a spore mixture.

Micro-Organisms

Under the general classification of those organisms so small that a microscope is required for their study are:

(1) *Protozoa*, uni-cellular animals, many of them living in water and obtaining their food from organic material. A large number utilize other micro-organisms.

(2) *Molds*, a sub-division of the fungi group.

(3) *Yeasts*.

(4) *Bacteria*, these are normally considered the smallest and lowest of all forms of life. Undoubtedly some are below visibility even with the highest magnification of an optical microscope.

(5) *Algae*, micro - organisms which possess chlorophyll—these are aquatic.

Some authorities divide the fungi into three main divisions, starting with the bacteria as generally covering the smallest in size, the *actinomyetes* intermediate, and largest, the various fungi species forming colonies visible to the eye.

A true conception of the number and rapidity of growth of these organisms is not common in the engineering world. It is difficult to look at a few drops of transparent water and realize the infinite number of living organisms present. It is even more difficult to realize the complex, intricate, and never-ending cycle of life taking place in such a small quantity of material.

For example, normal surface sea water contains as many as a million micro-organisms per cc. Every time a wave breaks, there are thrown into the air untold numbers of marine bacteria, some of which are carried hundreds of miles, still viable and capable of growth and multiplication as soon as suitable conditions arise.

We are only now getting some inkling of the ability of micro-organisms to utilize organic materials for energy. During the past two years, Dr. Zobell at Scripps Institute has found that many of the marine bacteria are capable of oxidizing pure hydro-carbons. Specifically, certain species have been isolated as able to utilize gasoline, paraffin, benzene, toluene, paradichlorbenzene and others. The same investigator likewise found that rubber and synthetic rubber could be destroyed by the presence of certain bacteria.

It is likely that as investigations in this field progress, we will find that many organic materials are particularly susceptible to deterioration by individual species. It will then be more expedient to protect the material against these specific agents than against the broad classification.

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TABLE II. FUNGISTATIC VALUES

IN A VARNISH SYSTEM

TEMPERATURE: 85 DEG C   TIME: 2 HR

(Specification No. 71-2202A)

Toxicant	Percent Toxicant *	Single Spore Test**	Spore Mixture Test***
Phenyl Mercuric Salicylate	1	OK	OK
Pentachlorphenol	10	NG	NG
Pentachlorphenol	15	OK	NG
Salicylanilide	10	OK	NG
Salicylanilide	15	OK	NG

TEMPERATURE: 85 DEG C   TIME: 24 HR

Phenyl Mercuric Salicylate	1	OK	OK
Pentachlorphenol	10	NG	NG
Pentachlorphenol	15	NG	NG
Salicylanilide	10	OK	NG
Salicylanilide	15	OK	NG

TEMPERATURE: 130 DEG C   TIME: 2 HR

Phenyl Mercuric Salicylate	1	OK	NG
Pentachlorphenol	10	NG	NG
Pentachlorphenol	15	NG	NG
Salicylanilide	10	NG	NG
Salicylanilide	15	NG	NG

TEMPERATURE: 130 DEG C   TIME: 5 HR

Phenyl Mercuric Salicylate	1	OK	NG
Pentachlorphenol	10	NG	NG
Pentachlorphenol	15	NG	NG
Salicylanilide	10	NG	NG
Salicylanilide	15	NG	NG

IN A LACQUER SYSTEM

TEMPERATURE: 85 DEG C   TIME: 2 HR

(Specification No. 71-2202A)

Phenyl Mercuric Salicylate	1	OK	OK
Pentachlorphenol	10	OK	NG
Pentachlorphenol	15	OK	NG
Salicylanilide	10	OK	NG
Salicylanilide	15	OK	NG

TEMPERATURE: 85 DEG C   TIME: 20 HR

Phenyl Mercuric Salicylate	1	OK	OK
Pentachlorphenol	10	NG	NG
Pentachlorphenol	15	NG	NG
Salicylanilide	10	OK	NG
Salicylanilide	15	OK	NG

TEMPERATURE: 50 DEG C   TIME: 96 HR

Phenyl Mercuric Salicylate	1	OK	OK
Pentachlorphenol	10	NG	NG
Pentachlorphenol	15	NG	NG
Salicylanilide	10	OK	NG
Salicylanilide	15	OK	NG

TEMPERATURE: 100 DEG C   TIME: 8 HR

Phenyl Mercuric Salicylate	1	OK	OK
Pentachlorphenol	10	NG	NG
Pentachlorphenol	15	NG	NG
Salicylanilide	10	NG	NG
Salicylanilide	15	NG	NG

*Based on total weight.
**Aspergillus Niger.
***Aspergillus Niger, Penicillium Luteum, Actinomycetes Conyolutus, and Rhizopus Nigricans.

Coaxial Cable

Exact and approximate formulas for determining basic parameters of coaxial cable facilitate determining effects of conductors, dielectrics and dimensions on electrical characteristics. Graphs indicate variations that can be expected from changes in materials and construction

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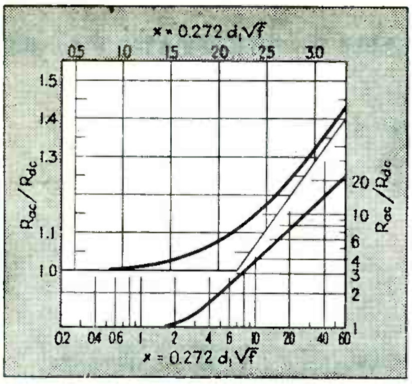


FIG. 1—Skin effect resistance factor for solid round copper wire

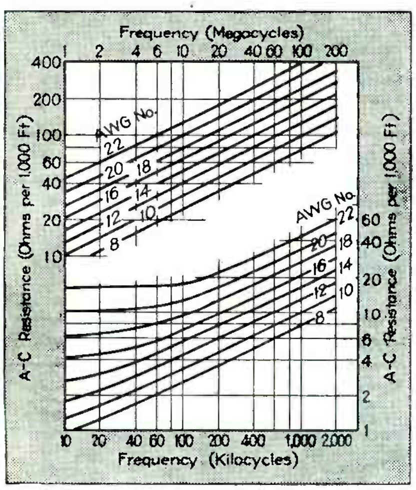


FIG. 2—Alternating-current resistance of solid round copper wire

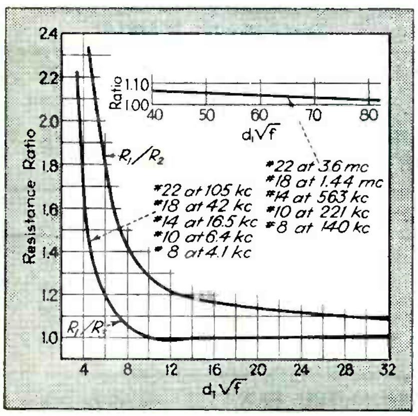


FIG. 3—Relative errors of Eq. (3) and (4) compared to values obtained from Fig. 1

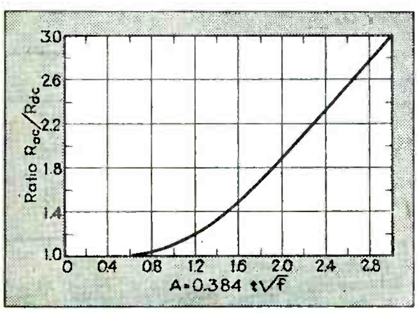


FIG. 4—Relative inside a-c resistance of the concentric conductor

DESIGN AND USE of coaxial cable at radio frequencies requires a knowledge of the cable parameters and the manner in which they vary with cable construction and operating frequency. Exact equations are cumbersome, but within limits they can be simplified for use in design or in obtaining approximate indications of the major influences on cable parameters.

Basic parameters which determine characteristic impedance, attenuation and phase-shift constant of coaxial cable are series resistance and inductance, and shunt capacitance and conductance. These parameters are functions of the electrical characteristics of the material used for conductors and dielectric, the geometric design of component parts and the frequency at which the cable is to operate.

Series Resistance

Total series resistance (R_0) of a coaxial cable consists of two components: resistance of the center conductor and of the concentric conductor.

Formulas for determining resistance of a solid round-center conductor at any frequency have been published in text books and technical papers. However, these formulas, which involve Bessel functions, are complicated and do not lend themselves to rapid calculations. Fortunately for the design engineer there have been published in the Bureau of Standards' Circular No. 74 tables of the ratio of resistance at any specified frequency to the d-c resistance for round solid conductors as a function of diameter and frequency. Resistance ratios are presented in graphic form in Fig. 1 for round solid copper wire having a resistivity (ρ) of 1724 abohm-centimeters as a function of x, the skin-effect resistance factor

$$x = 0.272\, d_1 \sqrt{f} \qquad (1)$$

which is derived from

$$x = \pi d_1 \sqrt{2\mu f/\rho} \qquad (2)$$

where μ = magnetic permeability of the conductor.

Resistance (R_1) of various sizes of conductors in the frequency range of 10 kilocycles to 400 megacycles, as determined from the ratio curve, is plotted in Fig. 2.

Note that the resistance ratio curve (Fig. 1) is practically a straight line for values of x greater than 5. This permits the determination of the following approximate equations for the straight-line portions of the curve

$x > 4$

$$R_2 \sim 0.284\, R_{dc} + 0.993 \sqrt{f}\, 10^{-3}/d_1 \text{ ohms/1000 ft} \qquad (3)$$

$x > 10$

$$R_3 \sim 10^{-3} \sqrt{f}/d_1 \text{ ohms/1000 ft} \qquad (4)$$

$$\text{where } R_{dc} = 0.01037/d_1^2 \text{ ohms/1000 ft} \qquad (5)$$

It is very important to the design engineer to be able to utilize at all times the simplest formula possible. Variations in magnitude of the resistances as calculated by the above methods for various sizes of conductors at different frequencies are plotted in Fig. 3 as ratios of R_1/R_2 and R_1/R_3. Figure 3 also shows frequencies at which resistance limitation ratios are not greater

Design

than 1.05 for several sizes of conductor. Which of the three methods to use for calculating resistance of a solid round inner conductor depends upon the accuracy required.

Resistance of Stranded Conductors

In a large number of coaxial cables the inner conductor consists of several strands. Resistance calculated by any of the mentioned methods will give values lower than those actually measured. Unfortunately at present there is not enough data to evaluate the increase in resistance for a stranded conductor as compared to a solid conductor of the same area and diameter.

Bureau of Standards' Circular No. 74 suggests as a rough guide that the resistance ratio of strands of bare wires placed parallel and making contact with one another is the same as for a round solid wire which has the same area of cross-section as the sum of the cross-sectional areas of the strands. However, when a precise knowledge of the resistance ratio is required it should be measured. The following tentative rules are suggested as a guide to the behavior of a stranded conductor. (1) An increase in the number of strands for a given total area of copper increases high-frequency resistance. (2) For a given total area of copper and number of strands, a conductor cabled with strands having a long lay will have a slightly lower high-frequency resistance than for an equivalent conductor having a short lay.

Concentric Conductor

The concentric conductor of a coaxial cable has two functions: to act as a shield and to act as a conductor. The resistance of a concentric conductor when it consists of a thin-wall tube may be determined from formulas which have been published by Whinnery.

Figure 4 is a plot of the ratio of resistance of a concentric copper cylinder at any frequency to d-c resistance as a function of

$$A = t/y = 0.384\, t \sqrt{f} \qquad (6)$$

where

t = wall thickness of outer conductor in inches

y = depth of field penetration in inches

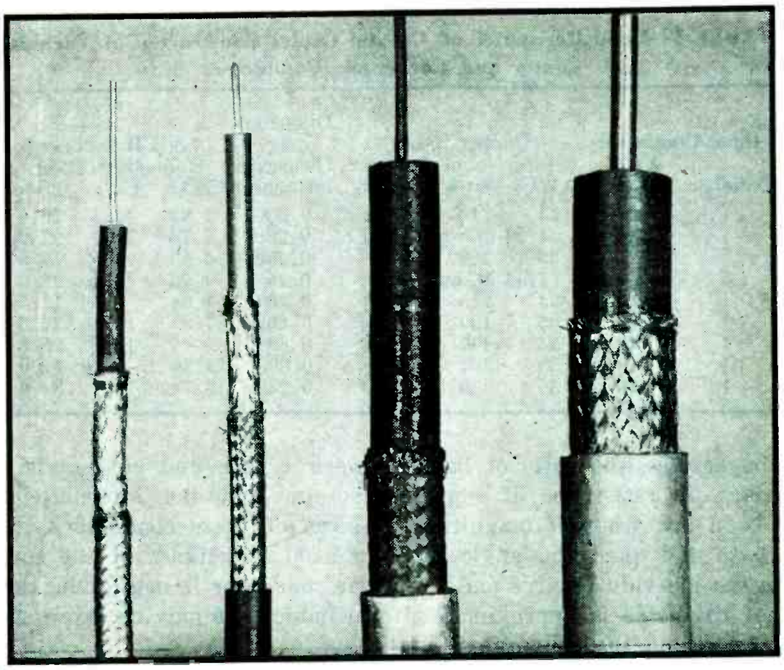
when the inside diameter d_2 of the cylinder is at least ten times the wall thickness (t).

When the parameter (A) is greater than 3, the resistance of this type of concentric conductor may be expressed as

$$R \sim 10^{-3} \sqrt{f}/d_2 \text{ ohms/1000 ft} \qquad (7)$$

Most coaxial cables utilize a copper braid for the concentric conductor. At present, as far as the author knows, no formulas permit calculation of high-frequency resistance for this type of concentric conductor. However, tests have indicated that the following tentative rules apply: (1) Resistance of braided concentric conductor decreases with an increase in length of lay of individual strands of the braid. (2) For braid having a given lay, an increase in the number of strands decreases resistance. (3) For braid of a given percent coverage an increase in size of the individual strands causes a decrease in resistance. (4) Resistance of a given braid will increase when individual wires are corroded. (5) Resistance of a given braid will vary with variations in contact pressure between strands.

In the frequency range of 100 to



Typical coaxial-cable construction employing solid dielectrics

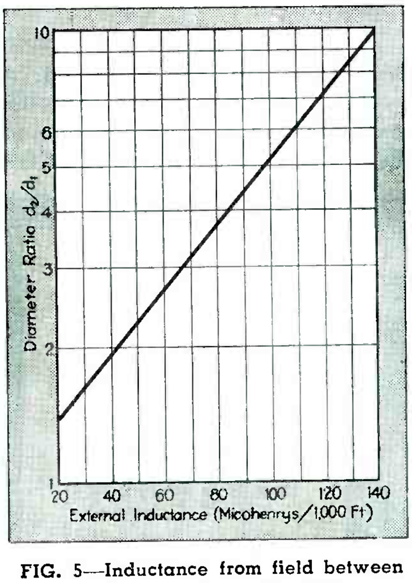


FIG. 5—Inductance from field between conductors of coaxial cable

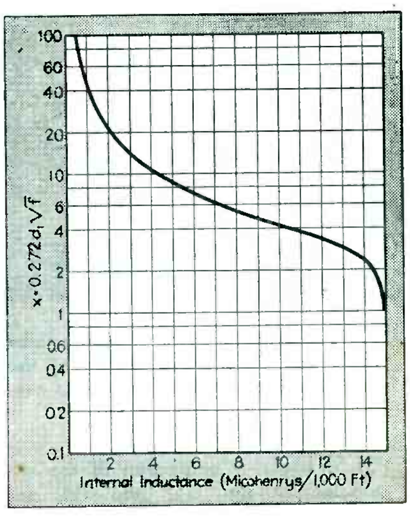


FIG. 6—(right) Inductance from field within center coaxial conductor

TABLE I—Loop Resistance of Coaxial Cables Constructed of Various Center and Concentric Conductors

Inner Conductor Number	Inner Conductor AWG No.	Copper Braid Size AWG	Copper Braid No. of Wires	Copper Braid Lay Inches	Diameter over Dielectric in Inches	Loop Resistance Ohms/1000 ft. at 50 kc	300 kc	1 Mc
7	21	33	216	1.55	0.280	4.95	12.1	20.6
7	21	(4/64 in. wall Lead)			0.280	5.78	16.1	27.9
7	21	33	288	1.60	0.460	4.65	10.6	19.6
7	21	(4/64 in. wall Lead)			0.460	4.96	13.1	22.8
1	12	33	216	1.72	0.280	4.84	9.54	17.5
1	12	33	120	0.50	0.280	7.3	16	27.2
1	12	34	144	0.57	0.489		14.7	26.6
1	9	30	384	4.00	0.690	2.39	6.76	12.0
1	18	36	480	1.26	0.280	10.7	19.1	34.8

400 megacycles, the ratio of braid resistance to resistance of copper tube is in the order of magnitude of 2.5 to 4.5 when the angle between the individual wires and the axis of the cable is approximately 25 degrees and the coverage is at least 90 percent. When the coaxial cable consists of a stranded inner conductor and a copper braid for the concentric conductor, the only accurate method of obtaining total resistance at any frequency is by accurately measuring that combination of conditions. Table I lists measured resistances of several combinations of inner and outer conductors.

Series Inductance

Total inductance (L_0) of coaxial cable consists of the inductance between center and concentric conductors, and the internal inductances of these conductors. Since internal inductance of the concentric conductor is negligible, the total inductance may be expressed as

$$L_0 = L_e + L_i = [0.140 \log_{10} (d_2/d_1) + 0.015 (L_{ac}/L_{dc})] \times 10^{-3} \text{ henrys/1000 ft} \quad (8)$$

L_{ac}/L_{dc} = ratio of L_i at a-c conditions to L_i at d-c conditions

The external inductance term (L_e) of the total inductance is plotted in Fig. 5 as a function of the ratio of diameter under the concentric conductor to diameter over the center conductor. Figure 6 shows graphically the internal inductance (L_i) of the center conductor. This inductance decreases with an increase in frequency and/or an increase in diameter.

At frequencies so high that the internal inducance term 0.015 L_{ac}/L_{dc} may be neglected, the total inductance may be simplified to

$$L_0 = L_e = 0.1404 \times 10^{-3} \log_{10} (d_2/d_1) \text{ henrys/1000 ft} \quad (9)$$

Although a definite rule cannot be stated for the frequency at which the approximate equation may be used, internal inductance may in general be neglected at frequencies greater than 2 Mc. A comparison of measured and calculated inductance for coaxial cables having a center conductor consisting of seven strands of copper indicates that for that type of conductor a better agreement between theoretical and measured values is obtained when the diameter over the center conductor is assumed to be equal to the square root of the circular mil area.

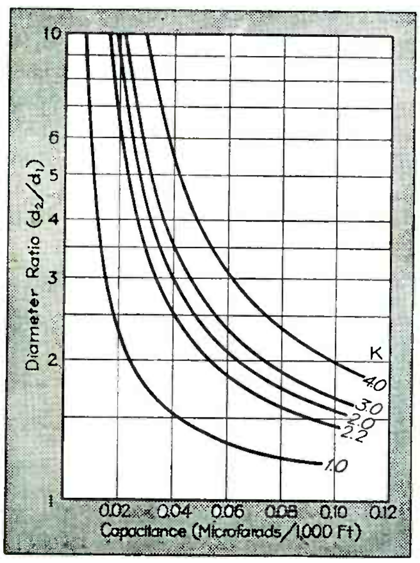


FIG. 7—Capacitance of coaxial cables varies with relative diameters of the conductors and with the dielectric constant

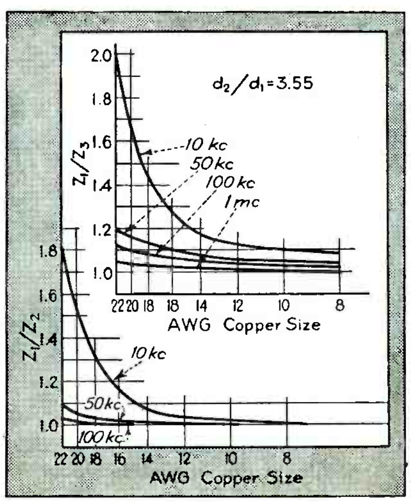


FIG. 8 (right)—Comparison of the accuracies of Eq. (14) and (15) for characteristic impedance

Shunt Admittance

Shunt capacitance (C) depends upon the ratio of diameter under the concentric conductor to the diameter over the center conductor, and the effective dielectric constant (K) of the insulating material. If the dielectric constant varies with frequency, there will be a direct change in capacitance. Fortunately most dielectrics are relatively constant with frequency. The formula for the capacitance is

$$C = \frac{7.36 K\ 10^{-9}}{\log_{10} (d_2/d_1)} \text{ farads/1000 ft} \quad (10)$$

Variations in the capacitance as a function of (K) and the ratio of diameters are shown graphically in Fig. 7. An accurate knowledge of capacitance is important due to its effect on characteristic impedance, as will be shown later.

Shunt conductance (G) depends upon frequency, capacitance and dissipation factor of the insulating material and may be determined from

$$G = \omega DC \text{ mhos/1000 ft} \quad (11)$$

Of the terms in this expression, capacitance remains essentially constant with frequency; the dissipation factor (D) of the dielectric may vary considerably. Since conductance loss contributes increasingly to attenuation with increasing frequency, it is very important that the dissipation factor be accurately known for the frequency at which conductance is to be determined.

Characteristic Impedance

The user of coaxial cables, such as the designer of high frequency equipment or a radio transmission engineer, is not so much interested in the cable's basic parameters as in the operating parameters, which are characteristic or surge impedance, attenuation, and phase-shift.

Characteristic impedance (Z_0) is that impedance which, terminating a line, will theoretically reduce reflection losses to zero. In practice ideal conditions may not be realized, but nevertheless a line terminated in its characteristic impedance will have a minimum reflection loss. Coaxial cables in the radio-frequency range and higher are normally designed to have a characteristic impedance of 50 ohms or 70 ohms.

This parameter may be determined at any frequency from

$$Z_0 = \sqrt[4]{\frac{R_0^2 + (\omega L_0)^2}{G^2 + (\omega C)^2}} \text{ ohms} \quad (12)$$

Where R_0 = total resistance in ohms/1000 ft.
Experience has shown that this equation is more flexible when written as

$$Z_0 = \sqrt{\frac{\sqrt{R_0^2 + (\omega L_0)^2}}{\omega C\ \sqrt{D^2 + 1}}} \text{ ohms}$$

As dielectrics utilized in coaxial cables have power factors considerably less than 5 percent, the term $\sqrt{D^2 + 1} \sim 1$, hence

$$Z_1 \sim \sqrt{\frac{\sqrt{R_0^2 + (\omega L_0)^2}}{\omega C}}$$

$$\text{or}\quad Z_1 \sim \sqrt{\frac{L_0}{C}}\sqrt{\left[\frac{R_0}{\omega L_0}\right]^2 + 1} \text{ ohms} \quad (13)$$

When R_0 is very small as compared to ωL_0 Eq. (13) may be simplified to

$$Z_2 \sim \sqrt{L_0/C} \text{ ohms} \quad (14)$$

When the frequency is such that the internal inductance L_i may be neglected the characteristic impedance can be determined from a very simple equation

$$Z_3 = \sqrt{L_e/C} = (138/\sqrt{K}) \log_{10}(d_2/d_1) \text{ ohms} \quad (15)$$

No definite rule can be made as to the frequency range in which the approximate equations may be used due to the variables involved. However, as a guide to their limitations the impedance ratios Z_1/Z_2 and Z_1/Z_3 as a function of frequency and diameter of the center conductor are plotted in Fig. 8.

These ratios were determined for coaxial cables having a ratio of $d_2/d_1 = 3.55$, a round solid copper center conductor, and a copper-tube concentric conductor. The dielectric medium was assumed to have a dielectric constant of 2.3 and a dissipation factor of 1.0 percent. For other diameter ratios there are corresponding changes in the limitations of the approximate formulas.

It is interesting to note that the accuracy of the impedance formulas is independent of dielectric constant for a given ratio of d_2/d_1

$$Z_1/Z_2 = \sqrt[4]{(R_0/\omega L_0)^2 + 1} \quad (16)$$

$$Z_1/Z_3 = \sqrt{1 + (L_e/L_i)} \times \sqrt[4]{(R_0/\omega L_0)^2 + 1} \quad (17)$$

$$Z_2/Z_3 = \sqrt{1 + (L_e/L_i)} \quad (18)$$

Because characteristic impedance is a function of the diameter ratio d_2/d_1 and the dielectric constant, it is of considerable aid in designing a cable for a given impedance to know the effects of variations in these components due to manufacturing limitations and the dielectric to be used. Such variations may be easily studied by means of a graph as in Fig. 9 for the frequency range in which impedance may be expressed by Eq. (15). Furthermore this graph may be used in making first approximations of the ratio d_2/d_1 for frequencies in which the impedance may be determined from Eq. (14).

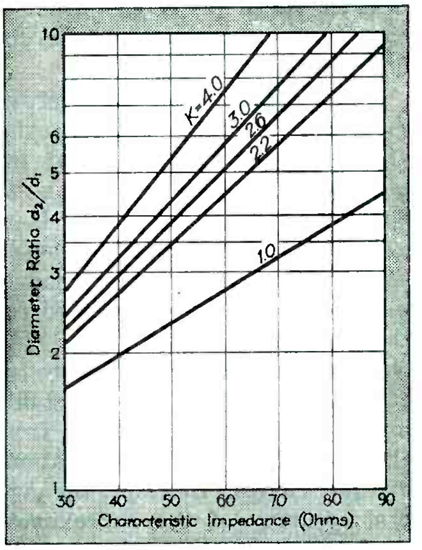


FIG. 9—Dependence of characteristic impedance on dielectric constant and diameter ratio

TABLE II—Symbols for coaxial cable parameters and the equation or figure in which they are presented

α_0	Attenuation constant of cable: Eq. (19)
$\alpha_1, \alpha_2, \alpha_3$	Alternate forms of α_0: Eq. (20), (21), (22)
α_c	Attenuation due to loss in conductor: Fig. 12
α_d	Attenuation due to loss in dielectric: Fig. 12
β_0	Phase-shift constant of cable: Eq. (23)
β_1, β_2	Alternate forms of β_0: Eq. (24), (25)
C	Shunt capacitance of cable: Eq. (10); Fig. 7
D	Dissipation factor of dielectric
d_1	Outside diameter of center conductor
d_2	Inside diameter of outside conductor
G	Shunt conductance: Eq. (11)
K	Dielectric constant of coaxial dielectric
L_0	Total series inductance of cable: Eq. (8)
L_e	External-inductance component of L_0: Fig. 5
L_i	Internal-inductance component of L_0: Fig. 6
R	Approximate a-c resistance of outer conductor: Eq. (7); Fig. 4
R_0	Total series loop resistance of cable: $R + R_1$
R_1	A-C resistance of center conductor: Fig. 1 & 2. Alternate forms for limited ranges are given by Eq. (3) & (4)
V	Velocity of wave in cable: Eq. (27)
V_0	Velocity of wave in free space (984 $\times 10^6$ ft/sec)
x	Skin effect resistance factor: Eq. (2); Fig. 1
Z_0	Characteristic impedance of cable: Eq. (12)
Z_1, Z_2, Z_3	Alternate forms of Z_0: Eq. A(13), (14), (15)

Attenuation

Attenuation of coaxial cable at any frequency may be determined from

$$\alpha_0 = 6.14 \sqrt{\sqrt{[R_0^2 + (\omega L_0)^2]\,[G^2 + (\omega C)^2]} + (GR_0 - \omega^2 L_0 C)} \quad (19)$$

decibels/1000 ft

This equation can be written in a more practical form by grouping terms

$$\alpha_1 = 6.14 \times \sqrt{\omega C[\omega L_0(\sqrt{(R_0/\omega L_0)^2+1}\sqrt{D^2+1}-1)+DR_0]}$$

decibels/1000 ft (20)

Note that variations in attenuation due to variations in basic parameters are more clearly seen from a study of Eq. (20) than Eq. (19). At high frequencies the attenuation formula may be simplified to

$$\alpha_2 \sim 4.34\ (R_0/Z_1 + GZ_1) \quad (21)$$

When the frequency and size of the inner conductor are such that the impedance can be expressed by Eq. (15), a further simplification may be made

$$\alpha_3 \sim \sqrt{K}\left[\frac{0.0315\ R_0}{\log_{10} d_2/d_1} + 27.7\ f\ D\ 10^{-6}\right] \quad (22)$$

decibels/1000 ft

The first term of these equations

is often called the copper attenuation (α_c), and the second term the dielectric attenuation (α_d).

The limitations of the approximate equations are shown graphically in Fig. 10 as ratios of the attenuation determined from α_1, to the attenuations determined from α_2 and α_3 as a function of frequency and diameter of the inner conductor for the conditions specified for the impedance calculations. The shape of these curves will vary for cables having dielectric constants and power factors different from those assumed in the calculations of these curves. However, the general accuracy of the approximate attenuation formulas is as indicated.

Effect of Dielectric

The effect of the dissipation factor of the dielectric on attenuation is very important. This can be seen graphically in the attenuation vs frequency curves shown in Fig. 11 for a No. 8 solid copper center conductor, 0.020-inch wall copper sheath and a dielectric constant of 2.3. The dielectric is assumed to have a dissipation factor of either 0.1 percent or 1.0 percent. For simplification of calculations, attenuations were determined from α_3.

Note that the dissipation-factor effect increases with frequency and either the attenuation due to the copper or to the dielectric may predominate. It has been found of considerable aid in designing coaxial cables to construct graphs similar to those in Fig. 12 for α_c and α_d vs. frequency as a function

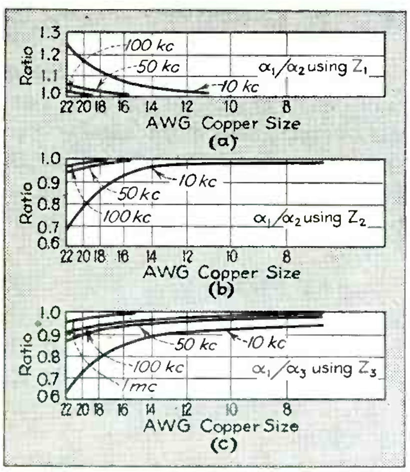


FIG. 10—Relative accuracies of attenuation factor as calculated from various approximations

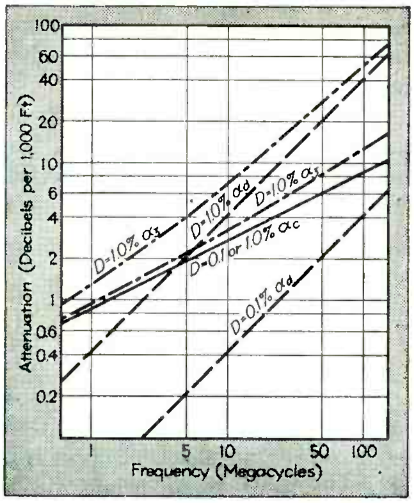


FIG. 11—Comparison of the effect of dissipation factor on attenuation, and the relative importance of copper and dielectric attenuation

of their individual variables. Copper attenuation is calculated for the condition that $\alpha_c = 4.34R_0/Z_3$ and dielectric attenuation for $\alpha_d = 27.7fD\sqrt{K}\ 10^{-6}$. For values other than those plotted in this graph, attenuations may be obtained by applying proper correction factors; that is, $\alpha_d = 0.042$ db/1000 ft at 10 megacycles when $K = 2.3$ and $D = 1$ percent. When $K = 2.4$ and $D = 1$ percent at 10 megacycles the dielectric loss $\alpha_d = 0.042\sqrt{2.4/2.3} = 0.0429$ db/1000 ft. Although these curves apply only to the frequency range in which the formula for α_3 may be used, the information obtained from them is useful in obtaining an approximation of the general design of a coaxial cable for any attenuation.

Phase-Shift Constant

Phase-shift constant or wavelength constant may be expressed at any frequency as

$$\beta_0 = \sqrt{0.5\sqrt{[R_0^2 + (\omega L_0)^2]\,[G^2 + (\omega C)^2]} - 0.5\,(GR_0 - \omega^2 L_0 C)} \quad \text{radians/1000 ft} \qquad (23)$$

Similar to the attenuation, the form of this equation may be changed to

$$\beta_1 = \sqrt{0.5\omega C\,[\omega L_0\,(\sqrt{(R_0/\omega L_0)^2 + 1}\,\sqrt{D^2+1} + 1) - DR_0]} \quad \text{radians/1000 ft} \qquad (24)$$

At high frequencies this equation may be simplified to

$$\beta_2 \cong \omega\sqrt{L_0 C} \quad \text{radians/1000 ft} \qquad (25)$$

The limitation of this formula, as for attenuation, depends upon the relative magnitude of the parameters and the frequency. However, as a general guide based upon a ratio of $d_2/d_1 = 3.55$, a solid-center conductor, a copper tube concentric conductor, and a dielectric having a dielectric constant of 2.3 and a dissipation factor of 1 percent, Eq. (25) may be used at frequencies as low as 50 kilocycles when the center conductor is at least No. 18 AWG.

The operating engineer is often interested in wavelength (λ) and velocity of propagation along the coaxial cable (V). These terms are a function of β_0 and may be determined from

$$\lambda = 2000\pi/\beta_0 \text{ feet} \qquad (26)$$

$$V = 1000\omega/\beta_0 \text{ feet/second} \qquad (27)$$

Velocity along the cable expressed in ratio to velocity in free space (V_0) is

$$V/V_0 = 1.016\,(\omega/\beta_0)\,10^{-6} \qquad (28)$$

With the exact formulas available for checking accuracy, the approximate equations and the curves presented herein can reliably be used to determine basic cable parameters and from them the working parameters. Thus the cable-design engineer can study variations produced by cable dimensions and components, and the circuit engineer can interpret these factors in terms of cable performance.

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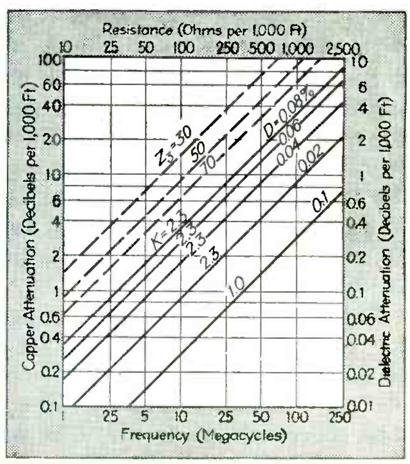

FIG. 12—Illustrative copper and dielectric attenuations, showing the manner in which they can be expected to vary

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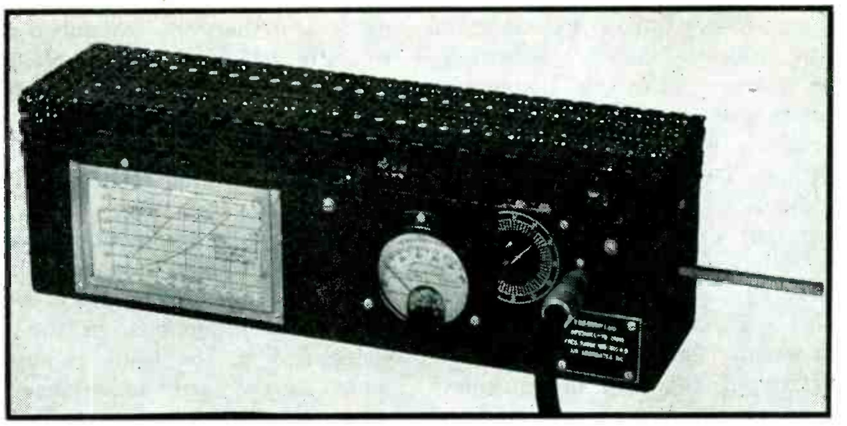


Dummy antenna for testing v-h-f transmitters

V-H-F DUMMY ANTENNA

Distributed reactances of a physical resistor are compensated, giving a pure resistance that simulates the antenna load of transmitters. A built-in thermo-galvanometer indicating power dissipated in the load facilitates tuning and coupling adjustments

THE PROBLEM of providing a dummy load with suitable characteristics for testing u-h-f and v-h-f transmitters has probably received the attention of many engineers, particularly in connection with production testing.

Development work and production testing require that the transmitter be operated into a load having an impedance which exactly represents that for which it is designed. This is particularly important where plate tuning and antenna coupling controls must be precalibrated at the factory. In this case a reactive load will usually cause plate circuit resonance to occur at a different point on the tuning control from that with the correct load, and also the degree of physical coupling to the output circuit will generally be different.

It is impractical, of course, for the manufacturer to use the actual load into which the transmitter will operate since this is usually a radiating system. Many radio factories are located near areas of important military or aircraft communication networks and radiation of any kind may cause serious interference. Development work and production testing, then, must be done with a compact load which does not radiate.

Requirements of Dummy Load

Rarely will the transmitter be designed for operation on only a single frequency, and as a result the dummy load will usually be called upon to operate over a range of frequencies. It must therefore have wide-band characteristics, or it must be easily adjustable for operation at any frequency within the desired range. This requires that the input impedance remains constant and essentially resistive over the operating frequency band.

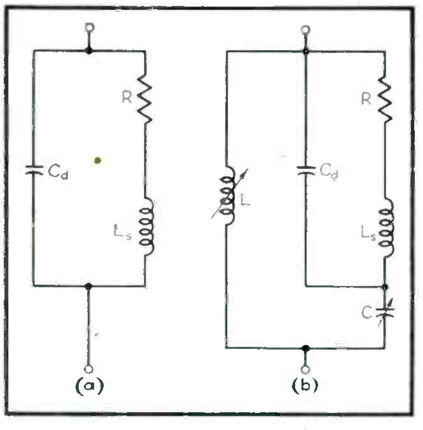


FIG. 1—(a) Distributed capacitance and inductance of a resistor at high frequencies can be represented by lumped constants. (b) To counteract these reactances, an external inductor L and capacitor C can be added to the resistor

Since the primary function of the transmitter is to deliver a given amount of power, the ideal dummy load should instantly give a reasonably accurate indication of the power delivered to it. There should be no time lag between the application and indication of the power, and fluctuations of short duration should register on the power indicator. This requirement eliminates calorimetric types of power meters. The power indicator should preferably operate at any value of power below the rated maximum so that loads do not have to be changed when measuring power levels at maximum and minimum transmitter output coupling. Thus incandescent power elements wherein pyrometers or phototubes are used to measure power can not be used because of their great impedance change with temperature variation.

In order to simplify calibration, the power indicating instrument should give an indication proportional to the v-h-f load current or voltage. This will permit complete calibration for any power input with only a single calibration point. A thermocouple ammeter meets these requirements more closely at v-h-f than does any other type instrument. The impedance characteristic of the load must remain constant regardless of the amount of power delivered to it in order that transmitters of different power ratings may be tested with the same load, and so that quick checks may be made of the decoupling characteristics of the transmitter output circuit.

Lastly, the power indicator must be sufficiently stable to maintain its calibration over long periods of time. This requires a dissipating element of rugged construction which can stand the mechanical abuse to which such an instrument is usually subjected. In addition, calibration should not be affected by changes in ambient temperature or by heat generated from power dissipated in the load resistor.

Distributed Reactance

Design centers around the dissipative element of the dummy load. A resistor becomes a complicated reactive and resistive network at very high frequencies and so cannot be used without modification. Inherently the carbon or composition resistor is perhaps most suited to u-h-f and v-h-f use since the reactive components can be kept small by careful design of the resistor. Further, the resistance can be quite constant with increasing frequency since skin effect is less pronounced in materials of high resistivity. Skin effect can be further reduced by molding the resistor in the form of a thin tube.

The composition resistor at very high frequencies may be represented as shown in Fig. 1(a). Here distributed inductance in the resistor and in the leads is represented by the series inductance L_s, while C_d represents the distributed shunt capacitance. If a resistor is chosen having the desired resistance value at low frequencies, the reactances appearing at high frequencies may be canceled by forming a series resonant circuit with an external capacitor and the distributed inductance, and a parallel resonant circuit with an external inductor and the distributed capacitance. This circuit arrangement is shown in Fig. 1(b). The impedance will now be resistive and equal to the high-frequency resistance of the resistor.

Typical resistors meeting requirements for this application are types A, B and CX, manufactured by the Globar Company. They are available in various resistance and power values. Type A has an essentially zero resistance-temperature coefficient, while types B and CX have slightly negative and slightly positive coefficients respectively.

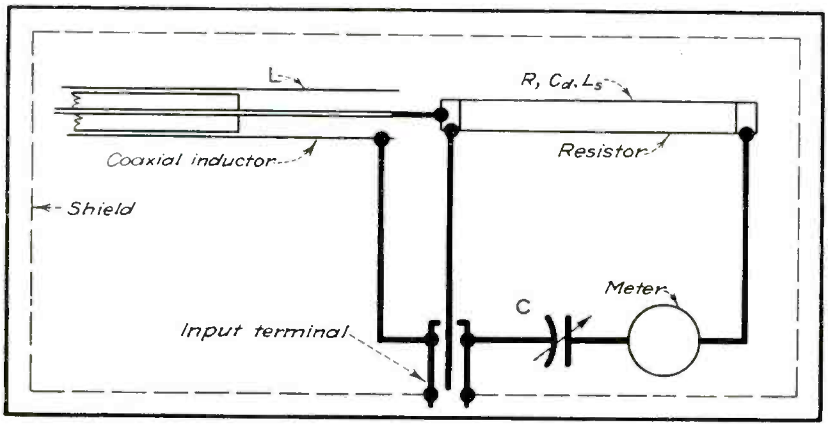


FIG. 2—Diagrammatic electrical circuit of artificial unbalanced load for v-h-f

Reactive Compensation

Series inductive reactance in a resistor of this type and its connecting leads is approximately 40 ohms at 100 Mc and may easily be resonated with a capacitance of approximately 40 $\mu\mu$f.

Shunt capacitance is extremely small and must be resonated with an inductance having a very high Q if the resistive component of the network is to remain unaltered. An ordinary coil of wire would be unsatisfactory for this purpose; however, a shorted section of coaxial transmission line, slightly less than a quarter-wavelength long, makes an excellent high-Q inductor and can be made readily adjustable.

The shunt inductance used to resonate the resistor was made from a piece of ⅜-inch brass tubing. A No. 12 copper wire supported on ceramic beads formed the inner conductor. The outer tube was cut approximately in half and folded back on itself to conserve space. The shorting rod was made from $\frac{3}{16}$-inch brass tubing plugged at one end and drilled axially through the plug to accommodate the No. 12 wire. A small piece of phosphor bronze formed into a finger insured contact between the wire and the shorting rod. No beads were used on the adjustable section.

Figure 2 is a schematic diagram of the final load with the coaxial inductor and shunt ammeter. The unit was designed for operation over a frequency range of 105 to 135 Mc, but the values of external capacitance and shunt inductance may be varied so that the load operates at frequencies up to ap-

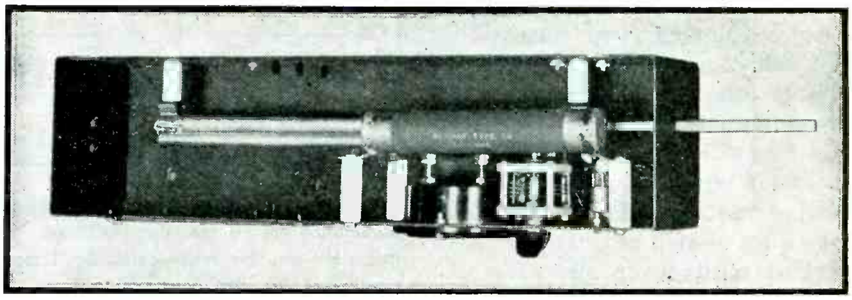


FIG. 3—Arrangement and proximity of parts is important in the v-h-f load

proximately 300 Mc. Above this the series reactance would be so large that it would be difficult to obtain a finite external capacitor small enough to give resonance. The high-frequency limit might be extended somewhat by replacing the capacitor with a shorted section of transmission line slightly longer than a quarter wavelength.

Built-in Wattmeter

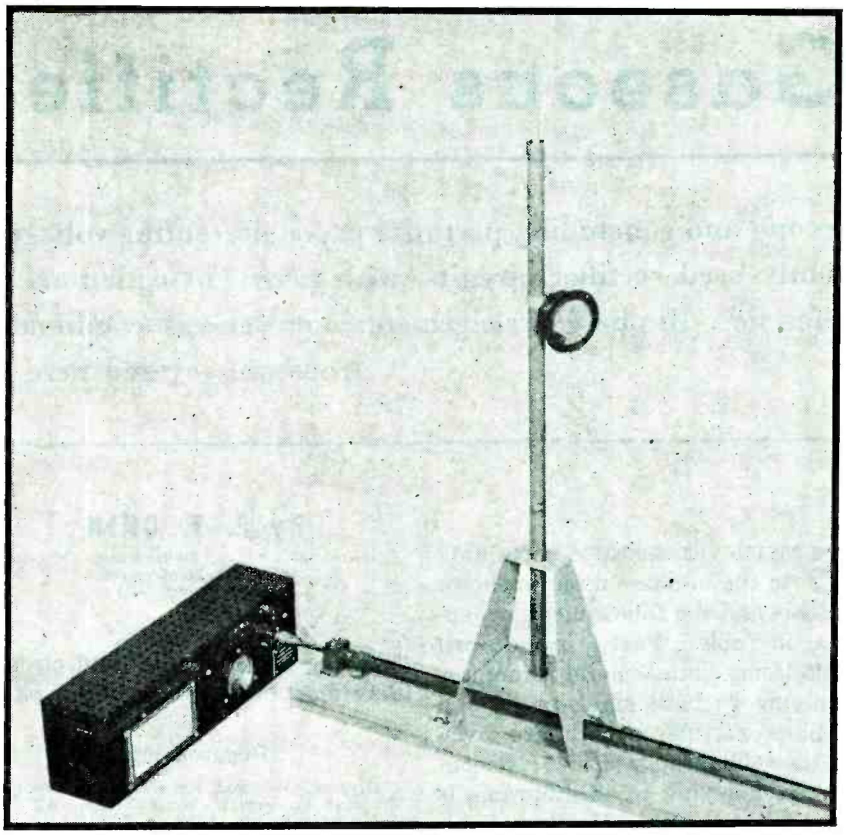
The load presents an essentially nonreactive impedance of 70 ohms to an unbalanced coaxial line and uses the Globar type of CX 70-ohm, 50-watt carbon resistor. All connecting leads between resistor, capacitor, and ground are made with wide copper straps. The terminals of the thermo-galvanometer used to measure power are connected directly across the section of the strap that joins the low-potential end of the resistor and the series capacitor, thus keeping the meter near ground to avoid effects of stray capacitance.

Arrangement of components, particularly the thermocouple ammeter and connecting leads, is important. It can be seen in detail in Fig. 3.

The wattmeter for the artificial load has a full-scale range of 115 ma. The width of the strap between its terminals was adjusted to give a half-scale deflection at 50 watts input. Being a current-squared thermocouple meter with the scale divided into 100 equal parts, the calibration in watts is linear. The useful lower limit of this load is 2 watts. Although the resistor is rated at only 50 watts the load can be used for short periods up to the full-scale reading of 100 watts. A slight adjustment of the shunt across the meter would allow full-scale readings on power inputs as low as 1 or 2 watts. No change in standing wave ratio was noticed at any power input. A model now under construction and using a removable shunt will have a full-scale range of either 10 or 100 watts.

Calibration

Input impedance was measured and the calibration of C, L, and I was done with a section of slotted coaxial transmission line. An infinite-impedance probe voltmeter was made from a shorted section of coaxial transmission line one-quarter wavelength long, mounted in a trolley to ride in the slot. A sensitive thermo-galvanometer was shunted across a small section of the probe near the shorted end. The shorting bar was adjustable so that the probe could be resonated at any frequency in the range.



Slotted transmission line and high-impedance coaxial voltmeter used to calibrate the v-h-f dummy load

The slotted line used for measurement had a characteristic impedance of 66 ohms, while the load was designed for 70 ohms. Theoretically the standing wave ratio under these conditions would be 1.06 to 1. With L and C adjusted for optimum conditions the measured standing wave ratios were 1.06, 1.05, and 1.02 to 1 at frequencies of 130, 119, and 108 Mc respectively.

The wattmeter was calibrated by connecting to the slotted line an incandescent lamp-type load which had been calibrated at 60 cps. The maximum and minimum indications of the probe voltmeter were then recorded for a given power input. The power transmitted through a transmission line at high frequencies is $P = V_{max} V_{min}/Z_0$. If $V_{max}/V_{min} = A$, these two equations may be solved simultaneously, yielding $V_{max} = \sqrt{APZ_0}$. In this manner it was possible to calibrate the probe meter in terms of absolute voltage. The new load was then connected to the line and the power calculated from the new values of maximum and minimum probe voltage. It was necessary to calibrate at only one power level because of the linear voltage scale.

Considerable variation in power readings was expected with change in frequency; however, they were found to be remarkably constant varying over a range of 105 to 130 Mc only ± 3 percent from the calibration at 119 Mc. To allow for extreme accuracy, a multiplication factor was determined for these three frequencies and a curve plotted to cover the band.

Wide latitude in design is possible in power-handling capability, impedance, and frequency range by judiciously applying the principles outlined above. If care is taken to insure absolute symmetry from each input terminal, a balanced-input load arrangement can be built along these same general principles.

Gaseous Rectifier Circuits

Second and concluding part of a paper presenting voltage and current wave forms of commonly used rectifier circuits, with pertinent equations alongside curves for convenient reference. Bi-phase arrangements for various combinations of phanotrons and thyratrons are covered here

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SPECIFIC REFERENCES pertaining to the bi-phase circuits shown on this and the following pages appear in Table I, Part I, in the April 1945 issue, while general references applying to both single-phase and bi-phase rectifier circuits are given in the bibliography below. Nomenclature applying to all diagrams is tabulated in Table II, Part I, although in most cases the significance of each letter symbol in the equations can be deduced from the labelling on the curves and circuit diagrams in this concluding part.

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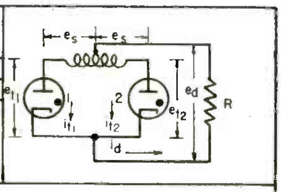
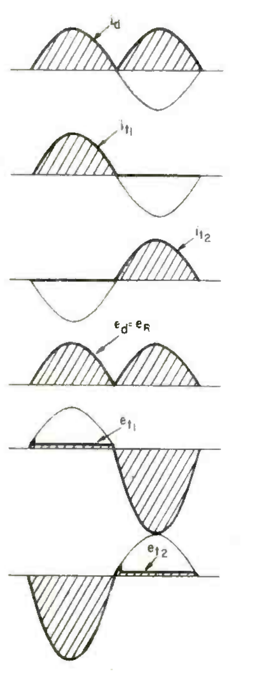
BI-PHASE UNCONTROLLED RECTIFIER

NO. OF TUBES: 2 PHANOTRONS

NATURE OF LOAD: R

FIG. 21





$i_d = \frac{E_s}{R} \sin\omega t \qquad \pi \geq \omega t \geq 0$

$= -\frac{E}{R} \sin\omega t \qquad 2\pi \geq \omega t \geq \pi$

$(I_d)_{av} = 0.638 \frac{E_s}{R}$

$(I_d)_{rms} = 0.707 \frac{E_s}{R} \qquad i_{pd} = \frac{E}{R}$

$i_{t1} = \frac{E_s}{R} \sin\omega t \qquad \pi \geq \omega t \geq 0$

$= 0 \qquad 2\pi \geq \omega t \geq \pi$

$(I_{t1})_{av} = 0.319 \frac{E_s}{R}$

$(I_{t1})_{rms} = 0.5 \frac{E_s}{R}$

$I_{pt1} = \frac{E_s}{R}$

$e_R = E_s \sin\omega t \qquad \pi \geq \omega t \geq 0$

$= E_s \sin\omega t \qquad 2\pi \geq \omega t \geq \pi$

$(E_R)_{av} = 0.638\ E_s \qquad (E_R)_{rms} = 0.707\ E_s$

$e_{pi1} = 2 E_s$

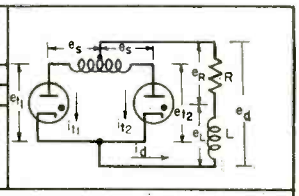
$e_{pi2} = 2 E_s$

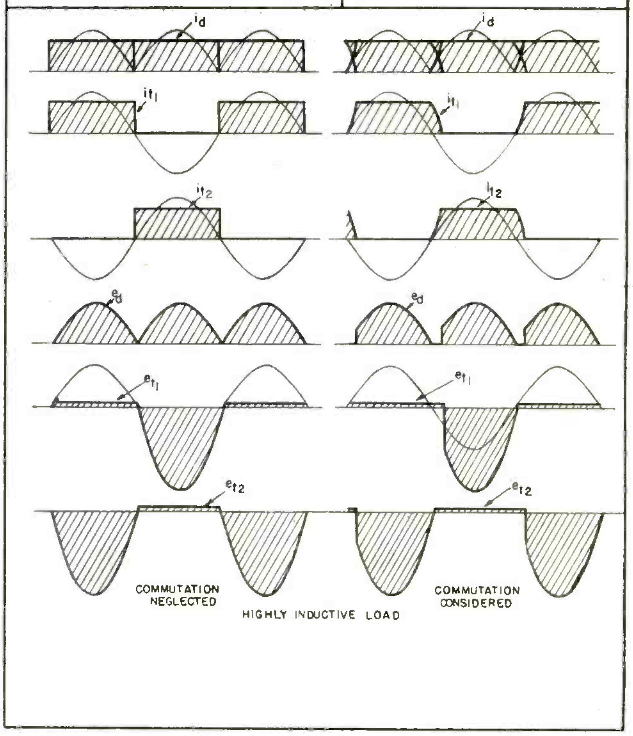
BI-PHASE UNCONTROLLED RECTIFIER

NO. OF TUBES: 2 PHANOTRONS

NATURE OF LOAD: R, L IN SERIES

FIG. 22





BI-PHASE UNCONTROLLED RECTIFIER

NO. OF TUBES: 2 PHANOTRONS

NATURE OF LOAD: R, L IN SERIES

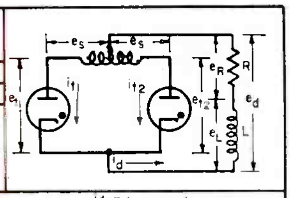
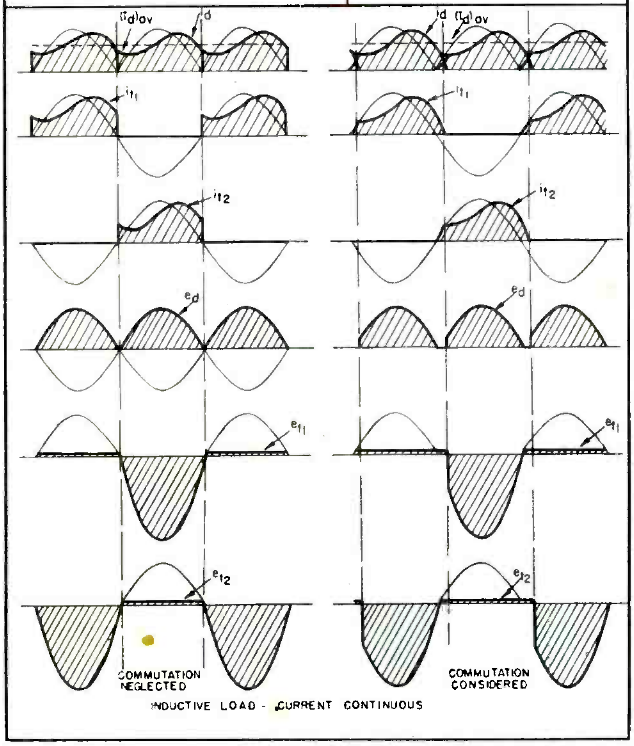


FIG. 23



BI-PHASE UNCONTROLLED RECTIFIER

NO. OF TUBES: 2 PHANOTRONS

NATURE OF LOAD: R, L, E_B IN SERIES

CONTINUOUS CURRENT

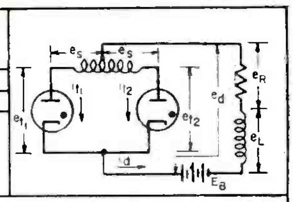
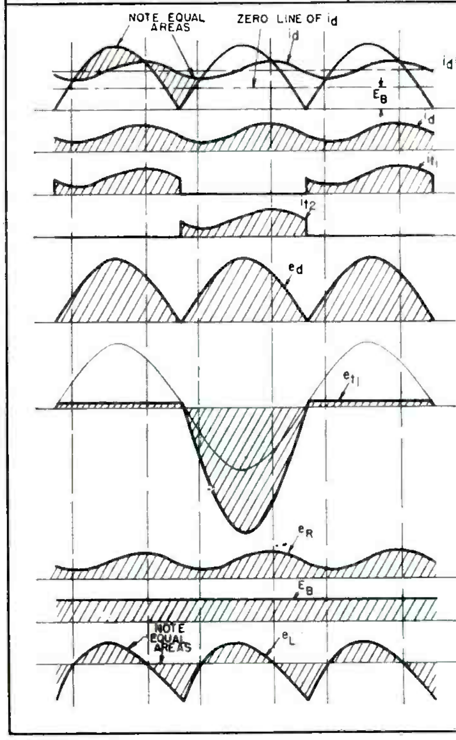


FIG. 24



$$i_d = \frac{2E_s}{Z}\,\frac{\sin\phi\,\varepsilon^{-\omega t\cot\phi}}{(1-\varepsilon^{-\omega t_1\cot\phi})} + \frac{E_s}{Z}\sin(\omega t-\phi) - \frac{E_B}{R}$$

$\pi > \omega t > 0$

BI-PHASE UNCONTROLLED RECTIFIER

NO. OF TUBES: 2 PHANOTRONS

NATURE OF LOAD: R, L, E_B IN SERIES

DISCONTINUOUS CURRENT

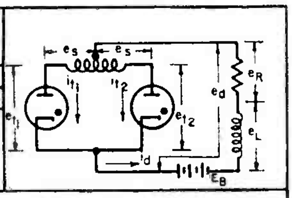
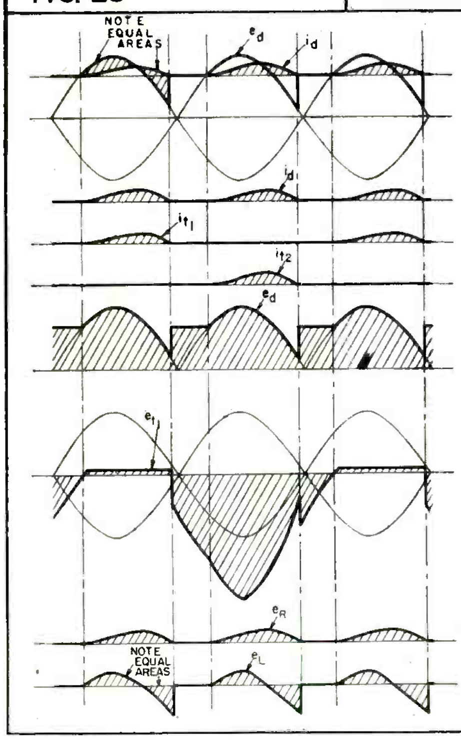


FIG. 25



$$i_d = \frac{E_s}{Z}\sin(\omega t+\theta_f-\phi) - \left[\frac{E_s}{Z}\sin(\theta_f-\phi)\right]\varepsilon^{-\omega t\cot\phi} - \frac{E_B}{R}(1-\varepsilon^{-\omega t\cot\phi}) \text{ WHERE } \theta_f = \sin^{-1}\frac{E_B}{E_s}$$

BI-PHASE CONTROLLED RECTIFIER

NO. OF TUBES: 2 THYRATRONS

NATURE OF LOAD: R

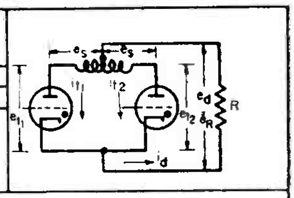
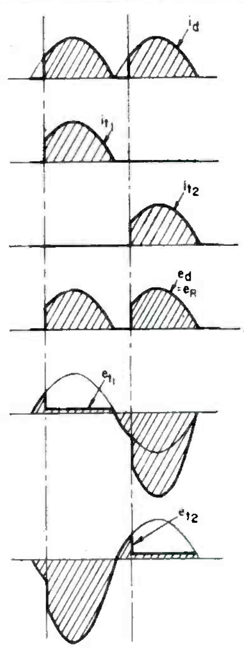


FIG. 26



$$(I_d)_{av} = \frac{(1+\cos\theta_f)}{\pi}\,\frac{E_s}{R}$$

$$(I_{t_1})_{av} = \frac{(1+\cos\theta_f)}{2\pi}\,\frac{E_s}{R}$$

$$(I_{t_2})_{av} = \frac{(1+\cos\theta_f)}{2\pi}\,\frac{E_s}{R}$$

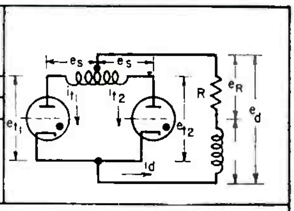
$$(E_R)_{av} = (E_d)_{av} = \frac{(1+\cos\theta_f)}{\pi}\,E_s$$

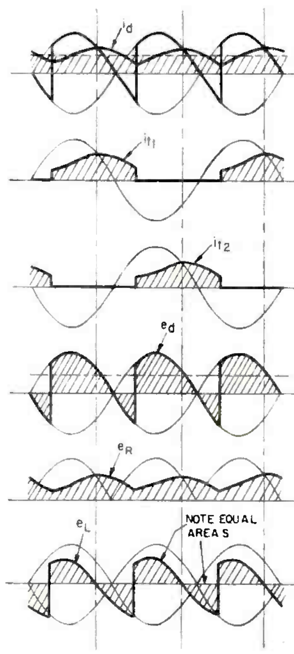
$$e_{pi_1} = e_{pi_2} \leq 2E_s$$

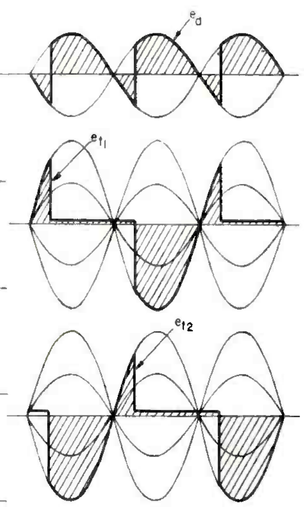
BI-PHASE CONTROLLED RECTIFIER

NO. OF TUBES:	2 THYRATRONS
NATURE OF LOAD:	R, L IN SERIES
CONTINUOUS CURRENT	

FIG. 27







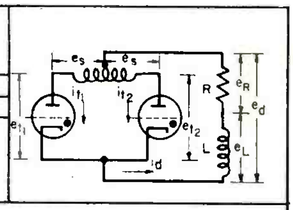
$$i_d = \frac{2E_s}{Z}\,\frac{\sin(\phi - \theta_f)\,\epsilon^{-\omega t \cot\phi}}{1 - \epsilon^{-\omega t_1 \cot\phi}} + \frac{E_s}{Z}\sin(\omega t - \phi + \theta_f)$$

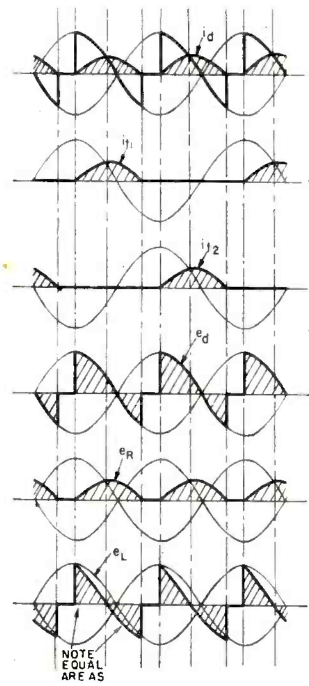
$$\pi < \omega t < 0$$

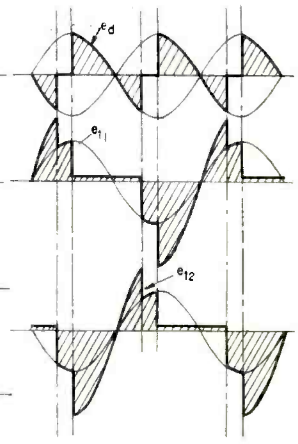
BI-PHASE CONTROLLED RECTIFIER

NO. OF TUBES:	2 THYRATRONS
NATURE OF LOAD:	R, L IN SERIES
DISCONTINUOUS CURRENT	

FIG. 28





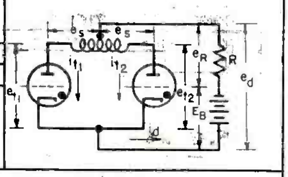


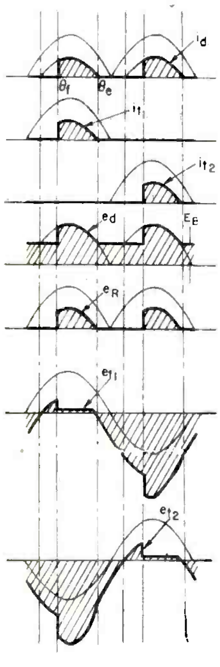
$$i_d = \frac{E_s}{Z}\sin(\phi - \theta_f)\,\epsilon^{-\omega t \cot\phi} + \frac{E_s}{Z}\sin(\omega t - \phi + \theta_f)$$

BI-PHASE CONTROLLED RECTIFIER

NO. OF TUBES:	2 THYRATRONS
NATURE OF LOAD:	R, E_B IN SERIES

FIG. 29





$$\theta_e = 180° - \sin^{-1} E_B/E_s$$

$$(I_d)_{av} = \frac{E_s \cos\theta_e + E_B\left(\theta_f - \frac{\pi}{2}\right)}{\pi R}$$

$$(I_{t_1})_{av} = \frac{(I_d)_{av}}{2} = (I_{t_2})_{av}$$

$$(E_d)_{av} = E_B + (I_d)_{av} R$$

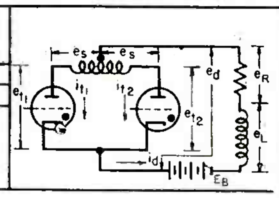
$$(E_R)_{av} = (I_d)_{av} R$$

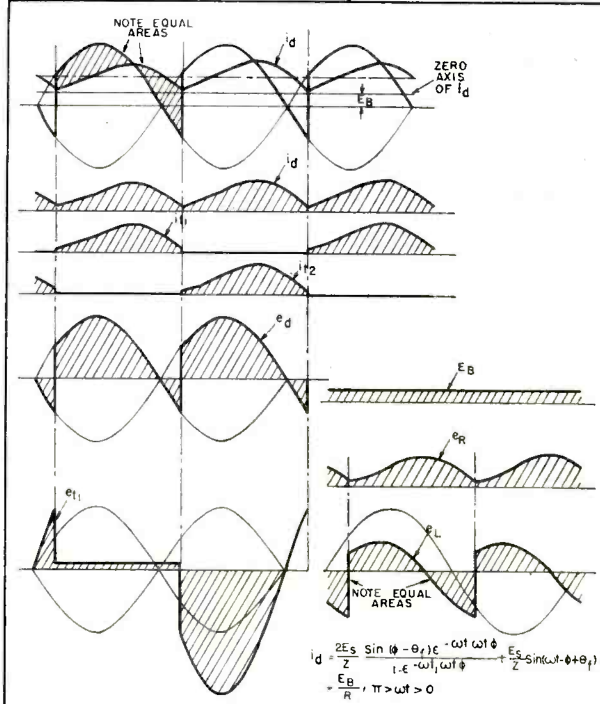
$$e_{pi_1} = e_{pi_2} = 2E_s$$

BI-PHASE CONTROLLED RECTIFIER

NO. OF TUBES:	2 THYRATRONS
NATURE OF LOAD:	R, L, E_B IN SERIES
CONTINUOUS CURRENT	

FIG. 30





$$i_d = \frac{2E_s}{Z}\,\frac{\sin(\phi - \theta_f)\,\epsilon^{-\omega t \cot\phi}}{1 - \epsilon^{-\omega t_1 \cot\phi}} + \frac{E_s}{Z}\sin(\omega t - \phi + \theta_f) - \frac{E_B}{R},\ \pi > \omega t > 0$$

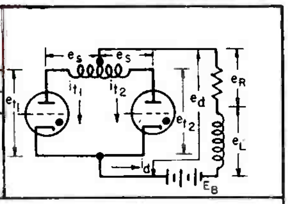
BI-PHASE CONTROLLED RECTIFIER

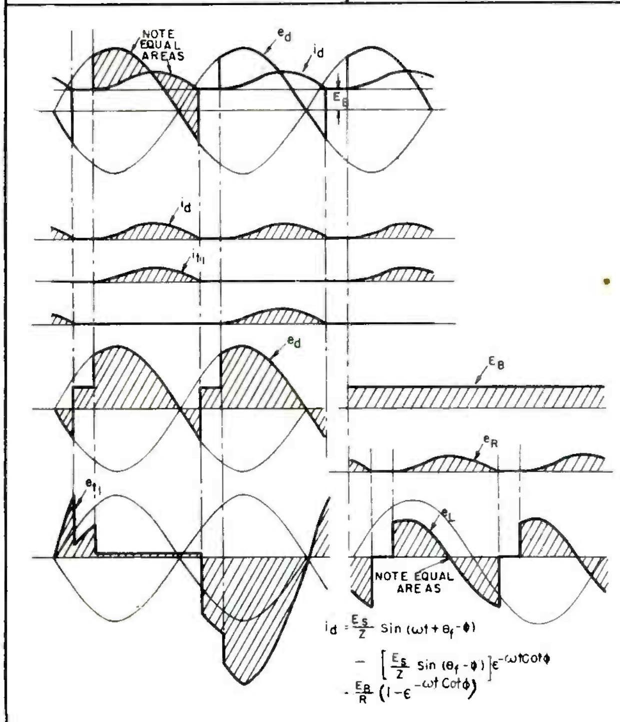
NO. OF TUBES: 2 THYRATRONS

NATURE OF LOAD: R, L, E_B IN SERIES

DISCONTINUOUS CURRENT

FIG. 31





$$i_d = \frac{E_s}{Z}\sin(\omega t+\theta_f-\phi) - \left[\frac{E_s}{Z}\sin(\theta_f-\phi)\right]\epsilon^{-\omega t\cot\phi} - \frac{E_B}{R}\left(1-\epsilon^{-\omega t\cot\phi}\right)$$

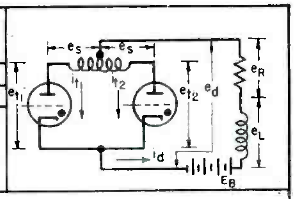
BI-PHASE CONTROLLED RECTIFIER

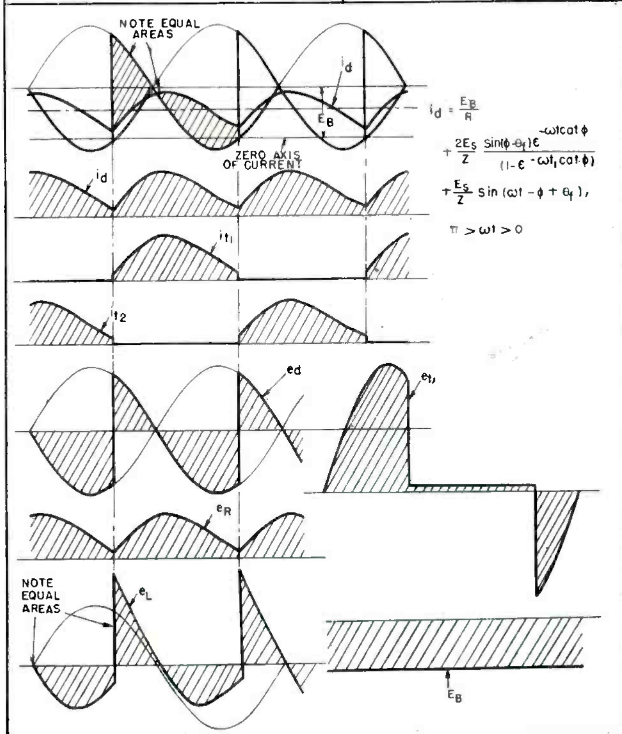
NO. OF TUBES: 2 THYRATRONS

NATURE OF LOAD: R, L, E_B IN SERIES

INVERSION (CONTINUOUS CURRENT)

FIG. 32





$$i_d = \frac{E_B}{R} + \frac{2E_s}{Z}\,\frac{\sin(\phi-\theta_f)\,\epsilon^{-\omega t\cot\phi}}{(1-\epsilon^{-\omega t_1\cot\phi})} + \frac{E_s}{Z}\sin(\omega t-\phi+\theta_f),$$

$$\pi > \omega t > 0$$

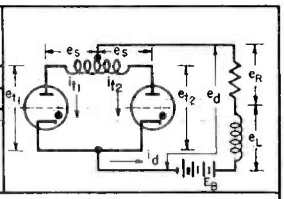
BI-PHASE CONTROLLED RECTIFIER

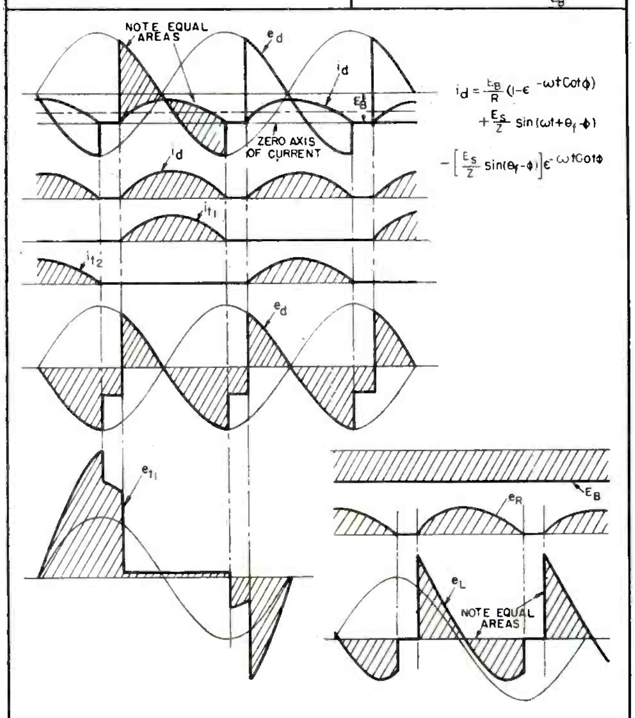
NO. OF TUBES: 2 THYRATRONS

NATURE OF LOAD: R, L, E_B IN SERIES

INVERSION (DISCONTINUOUS CURRENT)

FIG. 33





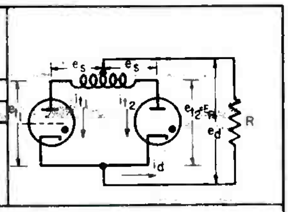
$$i_d = \frac{E_B}{R}\left(1-\epsilon^{-\omega t\cot\phi}\right) + \frac{E_s}{Z}\sin(\omega t+\theta_f-\phi) - \left[\frac{E_s}{Z}\sin(\theta_f-\phi)\right]\epsilon^{-\omega t\cot\phi}$$

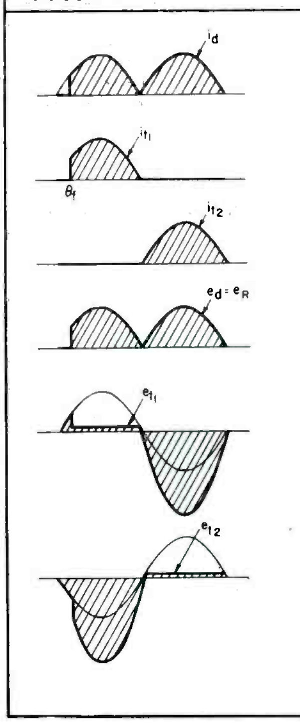
BI-PHASE CONTROLLED RECTIFIER

NO. OF TUBES: 1 PHANOTRON, 1 THYRATRON

NATURE OF LOAD: R

FIG. 34





$$(I_d)_{av} = \frac{(I_{t1})_{av} + (I_{t2})_{av}}{2}$$

$$(I_{t1})_{av} = \frac{(1+\cos\theta_f)}{2\pi}\,\frac{E_s}{R}$$

$$(I_{t2})_{av} = \frac{E_s}{2\pi}$$

$$(E_d)_{av} = (I_d)_{av}\,R$$

$$e_{pi_1} = 2E_s$$

$$e_{p12} \leq 2E_s$$

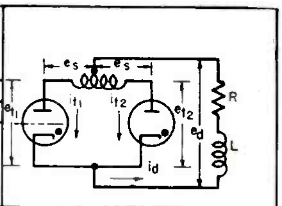
BI-PHASE
CONTROLLED RECTIFIER

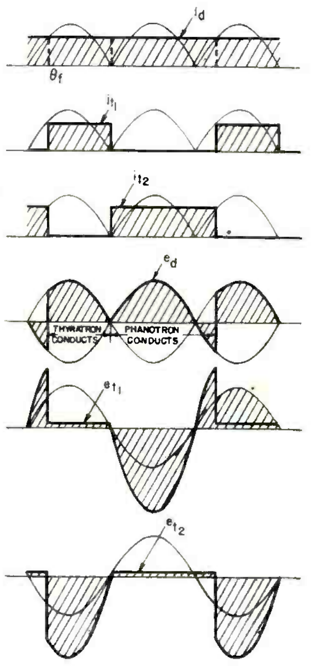
NO. OF TUBES: 1 PHANOTRON, 1 THYRATRON

NATURE OF LOAD: R, L IN SERIES

"HORSE & OX" CIRCUIT
(HIGHLY INDUCTIVE)

FIG. 35





$(I_d)_{av} = \frac{(1+\cos\theta_f)}{\pi}\frac{E_s}{R}$

$(I_{t_1})_{av} = \left(\frac{\pi-\theta_f}{2\pi}\right)(I_d)_{av}$

$(I_{t_2})_{av} = \left(\frac{\pi+\theta_f}{2\pi}\right)(I_d)_{av}$

$(E_d)_{av} = \frac{(1+\cos\theta_f)E_s}{\pi}$

$(E_d)_{rms} = \frac{E_s}{\sqrt{2}}$

$e_{p_{i_1}} = 2E_s$

$e_{p_{i_2}} < 2E_s$

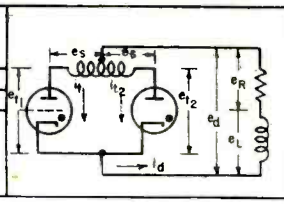
BI-PHASE
CONTROLLED RECTIFIER

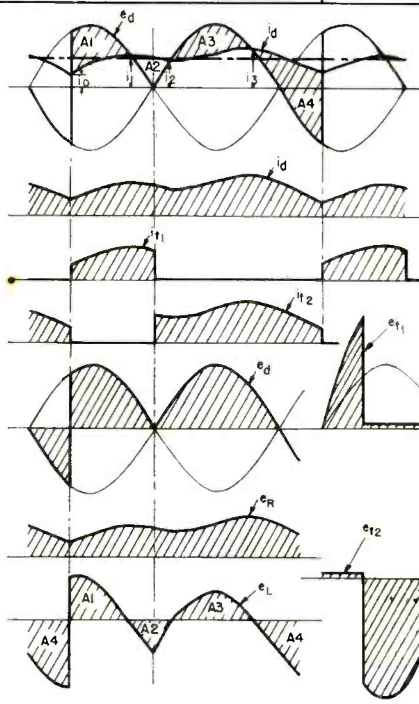
NO. OF TUBES: 1 PHANOTRON, 1 THYRATRON

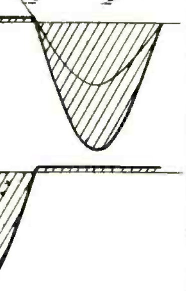
NATURE OF LOAD: L, R IN SERIES

CONTINUOUS CURRENT

FIG. 36







$i_1 - i_0 = A1/L$
$i_2 - i_0 = (A1 - A2)/L$
$i_3 - i_0 = A4/L$
$A1 + A3 = A2 + A4$

$i_d = \frac{E_s}{Z}\sin(\omega t + \theta_f - \phi) + \frac{2E_s}{Z}\left[\frac{\epsilon^{-\pi\cot\phi}\sin\phi\sin\phi - \sin(\theta_f - \phi)}{(1-\epsilon^{-2\pi\cot\phi})}\right]\epsilon^{-\omega t\cot\phi}$

WHEN THE THYRATRON CONDUCTS

$i_d = \frac{E_s}{Z}\sin(\omega t - \phi) + \frac{2E_s}{Z}\left[\frac{\sin\phi - \sin(\theta_f - \phi)\epsilon^{-(\pi-\theta_f)\cot\phi}}{1-\epsilon^{-2\pi\cot\phi}}\right]\epsilon^{-\omega t\cot\phi}$

WHEN THE PHANOTRON CONDUCTS

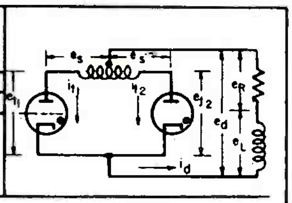
BI-PHASE
CONTROLLED RECTIFIER

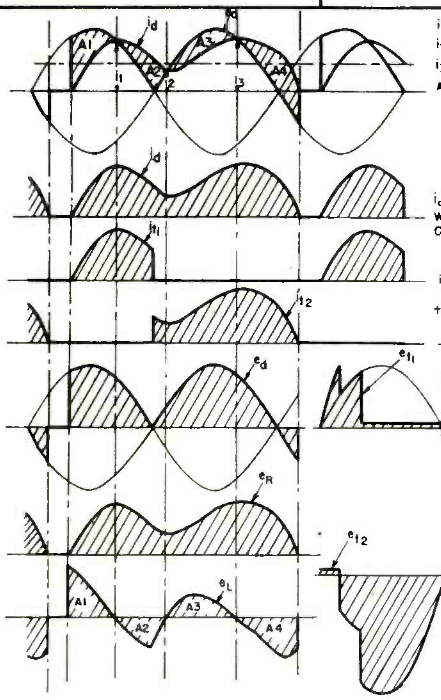
NO. OF TUBES: 1 PHANOTRON, 1 THYRATRON

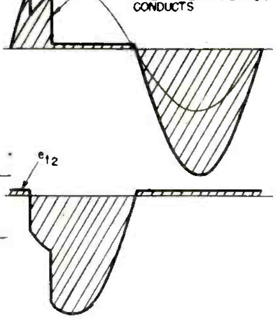
NATURE OF LOAD: L, R IN SERIES

DISCONTINUOUS CURRENT

FIG. 37







$i_1 = A_1/L$
$i_2 = (A_1 - A_2)/L$
$i_3 = A4/L$
$A_1 + A_3 = A_2 + A4$

i_d = SAME AS FIG. 11
WHEN THE THYRATRON CONDUCTS.

$i_d = \frac{E_s}{Z}\sin(\omega t - \phi) + \frac{E_s}{Z}\epsilon^{-\omega t\cot\phi}\left[2\sin\phi - \sin(\theta_f - \phi)\epsilon^{-(\pi-\theta_f)\cot\phi}\right]$

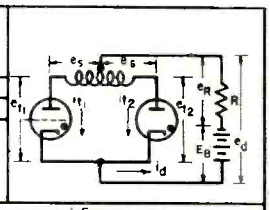
WHEN THE PHANOTRON CONDUCTS

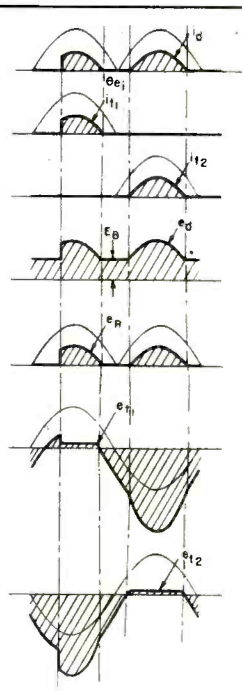
BI-PHASE
CONTROLLED RECTIFIER

NO. OF TUBES: 1 PHANOTRON, 1 THYRATRON

NATURE OF LOAD: R, E_B IN SERIES

FIG. 38





$\theta_{e_1} = 180° - \sin^{-1}\frac{E_B}{E_s} = \theta_{e_2}$

$\theta_{f_2} = \sin^{-1}\frac{E_B}{E_s}$

$(I_{t_1})_{av} = \frac{E_s\cos\theta_{f_1} + E_B(\theta_f - \frac{\pi}{2})}{\pi R}$

$(I_{t_2})_{av} = \frac{2E_s\cos\theta_{f_2} - E_B(\theta_{e_2} - \theta_{f_2})}{2\pi R}$

$(I_d)_{av} = \frac{(I_{t_1})_{av} + (I_{t_2})_{av}}{2}$

$(E_d)_{av} = E_B + (I_d)_{av} R$

$e_{p_{i_1}} = 2E_s$

$e_{p_{i_2}} < 2E_s$

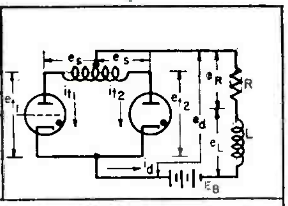
BI-PHASE CONTROLLED RECTIFIER

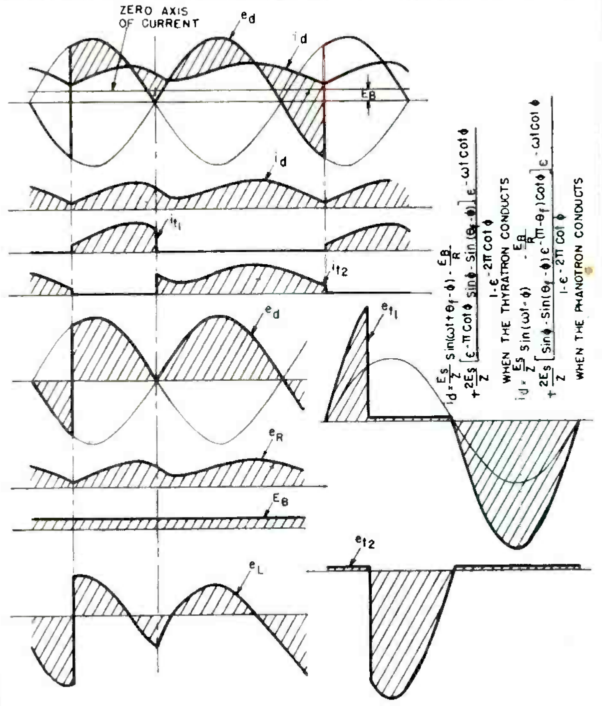
NO. OF TUBES: 1 PHANOTRON, 1 THYRATRON

NATURE OF LOAD: L, R, E_B IN SERIES

CONTINUOUS CURRENT

FIG. 39





$$i_d = \frac{E_s}{Z}\sin(\omega t + \theta_f - \phi) - \frac{E_B}{R} + \frac{2E_s}{Z}\left[\frac{\epsilon^{-\pi\cot\phi}\sin\phi - \sin(\theta_f - \phi)}{1-\epsilon^{-2\pi\cot\phi}}\right]\epsilon^{-\omega t\cot\phi}$$

WHEN THE THYRATRON CONDUCTS

$$i_d = \frac{E_s}{Z}\sin(\omega t - \phi) - \frac{E_B}{R} + \frac{2E_s}{Z}\left[\frac{\sin\phi - \sin(\theta_f - \phi)\epsilon^{-(\pi-\theta_f)\cot\phi}}{1-\epsilon^{-2\pi\cot\phi}}\right]\epsilon^{-\omega t\cot\phi}$$

WHEN THE PHANOTRON CONDUCTS

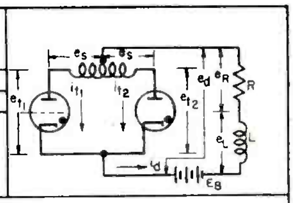
BI-PHASE CONTROLLED RECTIFIER

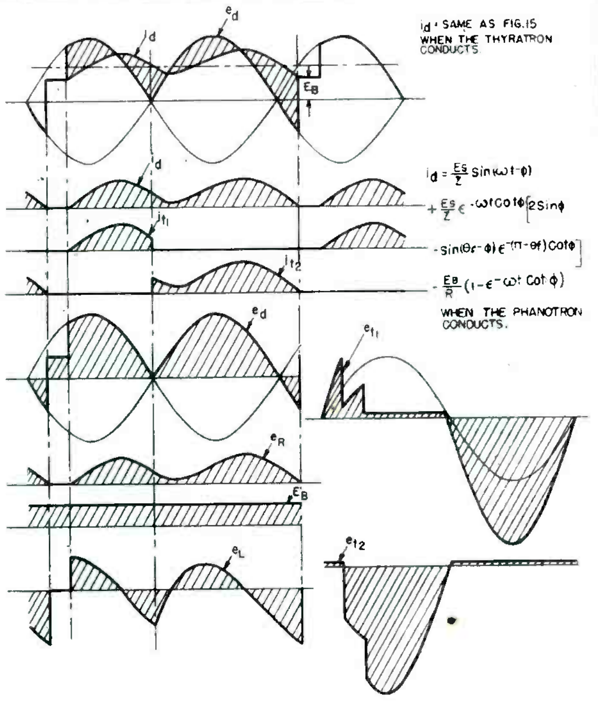
NO. OF TUBES: 1 PHANOTRON, 1 THYRATRON

NATURE OF LOAD: L, R, E_B IN SERIES

DISCONTINUOUS CURRENT

FIG. 40





i_d = SAME AS FIG. 15 WHEN THE THYRATRON CONDUCTS.

$$i_d = \frac{E_s}{Z}\sin(\omega t - \phi) + \frac{E_s}{Z}\epsilon^{-\omega t\cot\phi}\left[2\sin\phi - \sin(\theta_f - \phi)\epsilon^{-(\pi-\theta_f)\cot\phi}\right] - \frac{E_B}{R}\left(1-\epsilon^{-\omega t\cot\phi}\right)$$

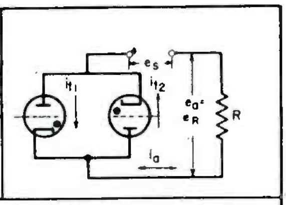
WHEN THE PHANOTRON CONDUCTS.

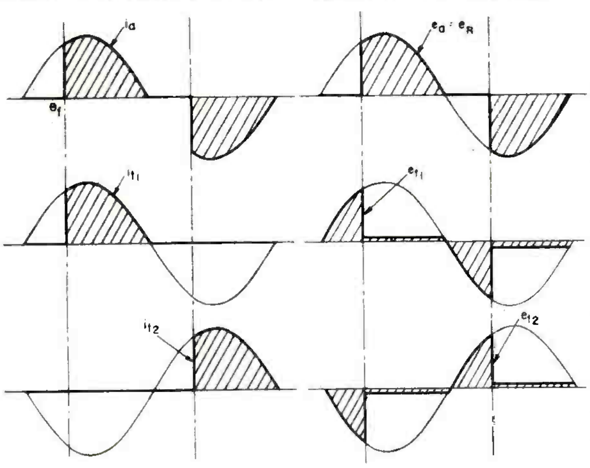
INVERSE PARALLEL CIRCUIT PHASE CONTROLLED

NO. OF TUBES: 2 THYRATRONS

NATURE OF LOAD: R

FIG. 41





$i_a = \frac{E_s}{R}\sin\omega t$ $\quad (0 \geq \omega t \geq \theta_f \quad 2\pi \geq \omega_t \geq (\pi + \theta_f))$

$= 0$ $\quad (e_f \geq \omega t \geq 0 \quad (\pi + \theta_f) \geq \omega t \geq \pi)$

$(I_a)_{av} = 0$

$(I_a)rms = \frac{E_s}{R}\left[\frac{1}{2\pi}(\pi - \theta_f) + \frac{\sin^2\theta_f}{4}\right]^{\frac{1}{2}}$

$e_{p_i} \leq E_s$

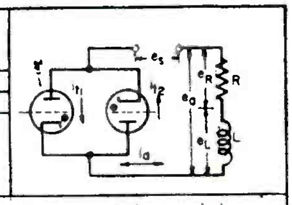
$e_R = i_a R \quad (E_R)_{av} = 0 \quad (E_R)_{rms} = (I_a)_{rms} R$

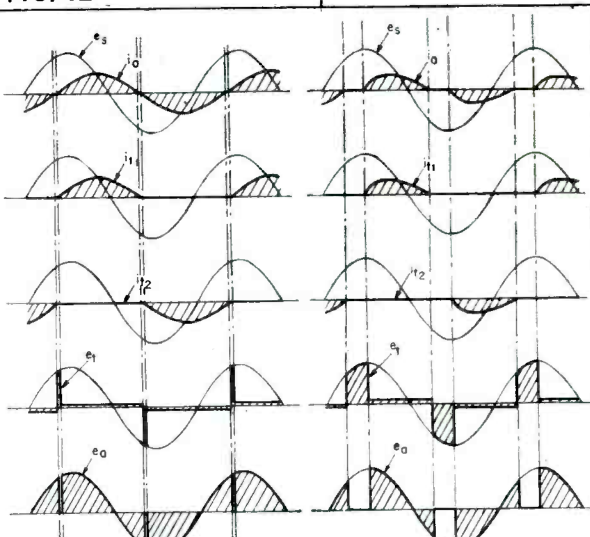
INVERSE PARALLEL CIRCUIT PHASE CONTROLLED

NO. OF TUBES: 2 THYRATRONS

NATURE OF LOAD: L, R IN SERIES

FIG. 42





MAX CURRENT

$\theta_f = \phi$

(FIRING ANGLE = P.F. ANGLE OF LOAD)

CURRENT REDUCED

$\theta_f > \phi$

(SEE SINGLE PHASE CONTROLLED RECTIFIER. NATURE OF LOAD R, L IN SERIES)

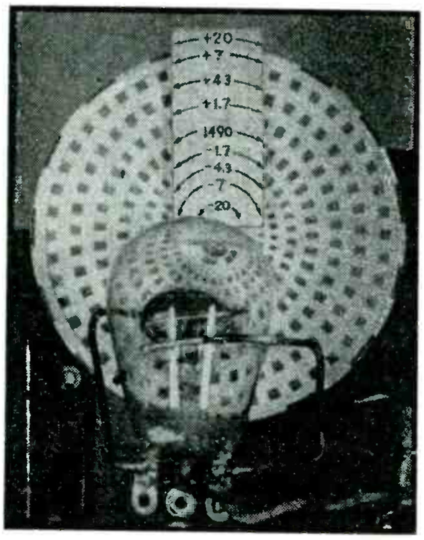
Frequency Monitor

Simplified operation and accuracy of reading within a tenth of a cycle are provided by a stroboscope used in conjunction with a Western Electric frequency monitor. The unit permits normal operation of the monitor when needed and requires no circuit change

FREQUENCY checks at KVOE had been made by pressing a push-button of the frequency monitor 68 times a day. For convenience, the idea of using a stroboscopic arrangement to provide a visual indication of frequency was evolved. This simplifies readings somewhat, saves relay adjustments, and satisfies the radio engineer's ingrained and inherent penchant for accuracy. The stroboscope shows frequency deviations to within a tenth of a cycle.

The unit was designed to operate in conjunction with the Western Electric 1-C frequency monitor. The frequency of the oscillator in the monitor is set 30 cycles above the station's assigned frequency. When the transmitter is on zero beat there is a difference of exactly 30 cycles between it and the monitor frequency and the needle of the FREQUENCY DIFFERENCE meter, with a scale reading 30-0-30, points to center scale or zero. The meter indicates frequency deviations, plus or minus, directly.

The output of the monitor oscillator and the r-f voltage from the transmitter are coupled to a detector having a polarized relay in its plate circuit. Since the detector output contains a beat frequency equal to the difference between the two r-f inputs, the relay armature vibrates, alternately charging a capacitor from the plate voltage supply and discharging it through the meter. Before conversion to type 1-C, the actuating relay was used rarely and only for radical frequency deviations of more than five cycles. The oscillator frequency of the old type 1-A was set at zero beat with the carrier frequency and operation was well within five cycles. Under this deviation, the FREQUENCY DIFFERENCE meter readings were not accurate and most operators will recall obtaining readings visually with a milliammeter plugged into the HEADPHONES jack. Now the relay is called upon to always vibrate at or near 30 cycles and while it is a well-designed precision item, and readings are accurate to one cycle, it needs adjustment more often.



Details of the completed disk which is illuminated by the neon bulb to provide the stroboscopic effect

Connection to Monitor

The output of the detector appears at the HEADPHONES jack of the monitor and the input to the stroboscopic circuit plugs in here. Thus, no changes are made in the circuit or operation of the frequency monitor itself approved by FCC.

Pulses from the monitor feed into the two-stage amplifier shown in the diagram. This in turn feeds a 2-watt neon lamp which illuminates a disk which is rotated by a synchronous motor. On the disk are dots or squares arranged in circles and spaced according to the frequency indications desired.

In designing the disk, variations will be necessary for different frequency ranges desired, disk speed, and a-c line frequency. Differences in assigned transmitter frequency matter not a whit whether your transmitter is operating on 550 or 1600 kc or anywhere beyond or between.

Assume the transmitter is on zero beat with its assigned frequency and assume also that the monitor is oscillating at the assigned frequency plus 30 cycles, so the beat from the detector circuit is exactly 30 cycles. Now assume the motor turns the disk at 300 rpm on your particular line frequency. This is 5 revolutions per second. The neon lamp is flashing 60 times per second since it flashes on each alternation of 30 cycles. Therefore there are 12 flashes for each revolution of the disk so if we mark 12 dots, spaced 30 degrees apart along a circular line on the disk, this circle of dots will appear stationary when illuminated by the neon lamp. Should the beat frequency be 32 cycles, the circle of dots will appear to move to the right or to the left according to whether the frequency shift is plus or minus.

Use of Other Lines

Any multiple of 12 will comprise a zero-beat line, so for better visibility use 24 or 36 dots for this line and locate it halfway between the center and the outside of the disk. We will have to avoid any multiples of 12 for the other lines or we'll run into harmonic troubles; so take an odd figure and add to or subtract it from our "primary standard" to construct the other frequency lines.

In the unit illustrated, it was decided to read frequency deviations of plus or minus 1.7 cycles, 4.3

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and S. G. GUENTHER
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Stroboscope

cycles and in-between. We add 1.7 to 12 and use the sum (13.7) in multiples for the PLUS 1.7 cycle line. Subtract 1.7 from 12 and use the difference (10.3) in multiples for the MINUS 1.7 cycle line. And so on for the other lines—as many as you wish, although five or six lines are sufficient for all practical purposes.

Construction of Disk

To make the disk, draw it first in pencil on a large piece of drawing paper about five or six times the actual size needed. Plot the number of marks or dots per circle by degrees or fractions thereof with a protractor. Then ink them in with dull black drawing ink. To one side on the same paper, draw an indicating scale that will designate the various values of the lines and make this to the same scale as the disk. Then photograph the drawings, reduce them to the size required, and mount them.

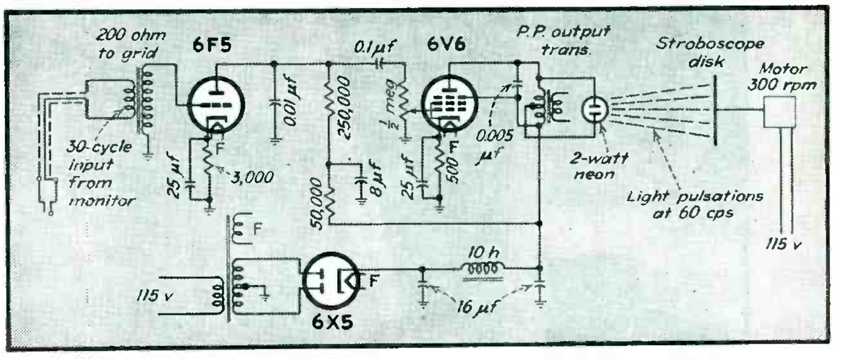
The disk can be mounted on the motor shaft with any suitable tin or cardboard backing. The scale is placed over and clear from it, supported either from the front or back. Mount a viewing lens in the can cover at a convenient angle.

Operation

Take a reading on the monitor itself, in the usual manner (by pressing the button). Let's say it reads plus 2 cycles. Now squint at the rotating disk and you'll discover the PLUS 1.7 line moving slowly to the left. The PLUS 4.3 line is moving quite rapidly to the right; therefore the actual frequency indication is a little more than 1.7 cycles but considerably less than 4.3 cycles. With a little practice, you'll be able to read frequencies so closely it will make your skin creep.

For example: If the carrier frequency or center line is moving to the right (clockwise) at the same speed that the MINUS 1.7 line is moving counterclockwise, the obvious difference is half of 1.7 or minus 0.85 cycles. The same method of interpolation is applied to the other lines to compute other fractional differences and you will be able to tell, at a glance, just how many cycles and tenths of a cycle the deviation is.

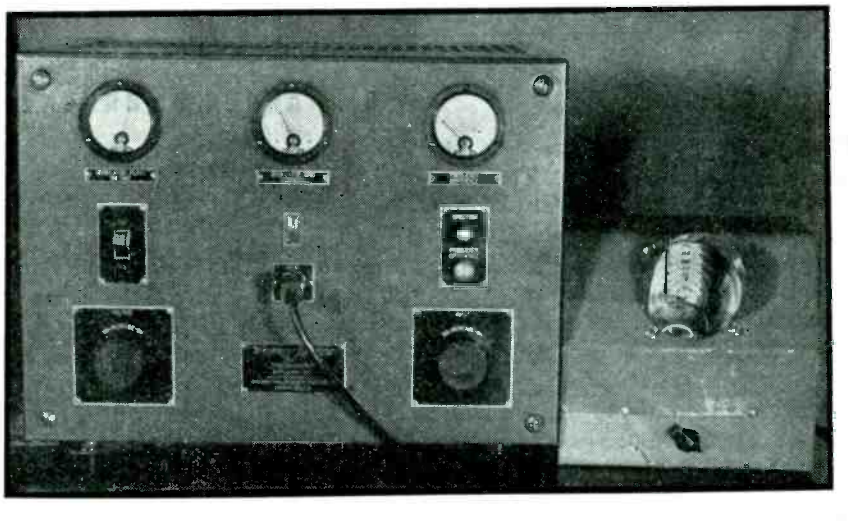
If your power frequency is dependable, if the computation used in drawing the disk is correct, and if the disk is turning at the speed computed, the indication of the stroboscope must be correct. Check it with the monitor. Change the frequency of the monitor by pushing the DIRECTION button which, on the Western Electric monitor, introduces an artificial frequency deviation. The speed of rotation of the various lines will change accordingly and you should be able to stop any one of them (within a range of 10 cycles), each of which should agree rather closely with the reading on the frequency-monitor meter.



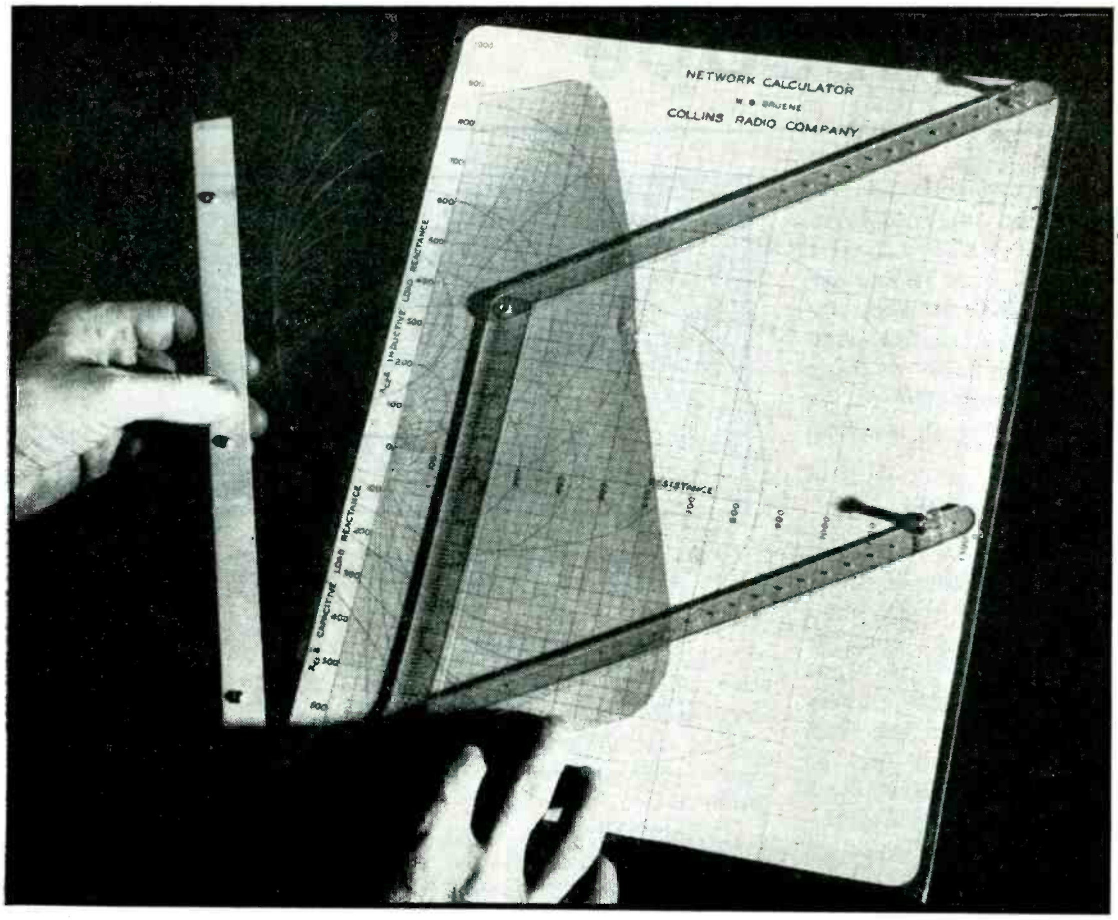
Pulses from the frequency monitor are amplified by the electronic circuit shown above to light the neon bulb on each alternation of the 30-cps signal

Other Factors

A check with an external standard might be somewhat confusing. This is explained by a possible and often simultaneous drift of transmitter frequency in one direction and a drift of monitor frequency in the other. The monitoring service will tell you the actual frequency of the transmitter only, while your own monitor may have drifted enough in the opposite direction to compensate for the transmitter drift, thereby indicating no drift at all or zero beat. The stroboscope is coordinated with the monitor alone and simply makes the reading easier and more accurate with respect to the monitor.



Frequency monitor and stroboscope set up for operation. A phone plug is the only connection between the two units



This calculator not only gives the solution to pi-network design problems, but also indicates the operating range, effects of tuning and load presented to the tube

Pi-Network Calculator

Graphical method of calculating reactances for a pi network that will match a given complex load to a given tube plate circuit. Changes in tube loading that are produced by varying the elements of the network can be studied directly from the calculator

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THE PI-NETWORK CALCULATOR described in this article was developed for obtaining rapid solutions of pi-network problems. It is also useful for studying the characteristics and limitations of a pi-network when used to couple an r-f power amplifier to a load. Only one setting of this calculator is necessary to determine all of the unknowns when the load is a pure resistance, and only one more setting is necessary if the load has a reactive component. The graphical solution, which forms the basis for this calculator, gives a clear picture of the relationship of the elements of the pi-network.

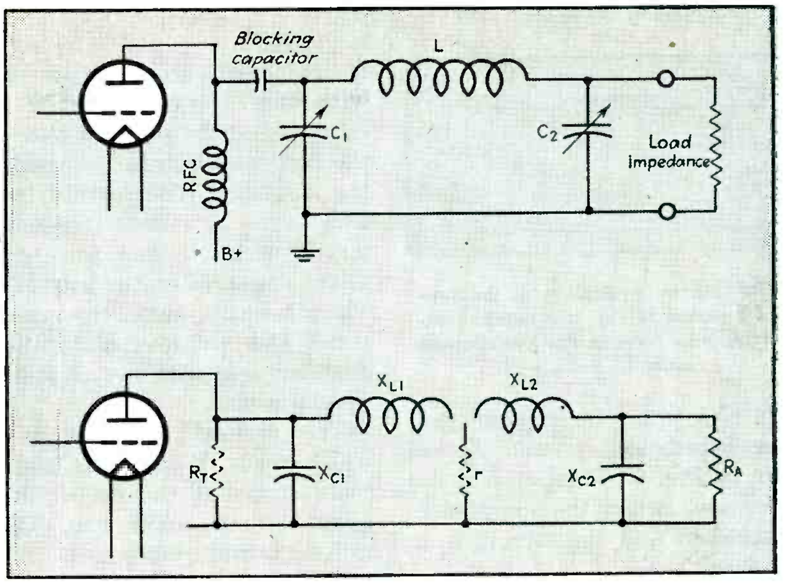
After indicating the function and requirements of a pi-network, the graphical analysis will be made, which will include a brief description of the calculator. The characteristics and limitations of the pi-network and the relationship of the elements will be discussed.

The pi-network, Fig. 1(a), which consists of two capacitors and an inductor, will provide a tank circuit of the desired Q and also match the tube impedance into a wide range of load impedances. The proper values of the reactances of the pi-network and their practical limits will be discussed.

Circuit Design Considerations

One of the first considerations to be made in designing a tank circuit for an r-f power amplifier is the circulating current or Q of the

FIG. 1—Upper circuit (a) shows the pi-network used to couple the tube plate circuit to the load. The lower circuit (b) shows this physical circuit divided for graphical analysis into two L-sections



tank circuit. Too low a value of Q will result in poor harmonic attenuation and lowered tube efficiency, while high values of Q if carried to extremes will result in lower tank-circuit efficiency and sideband clipping on high-fidelity transmission.[1] For most communication purposes a Q of 10 is a good choice, but usually values from 8 to 20 are satisfactory.

In a common parallel resonant tank circuit, inductively coupled to a load, the tank circuit Q can be considered as the ratio of the reactance of the coil to the load resistance reflected into it. This is also equal to the ratio of the r-f effective load resistance of the tube, R_T, to the reactance of the tuning capacitor X_{C1}.

$$Q = \frac{X_L}{r} = \frac{R_T}{X_{C1}}$$

In this discussion the latter ratio will be considered to be the tank circuit Q of the pi-network. The value of R_T can be determined from calculations of the operating conditions of the tube, or more simply, by estimating the r-f plate voltage and the power output and then calculating R_T. For example, if the d-c plate voltage is 1000 volts, the r-f plate swing for class C operation may be estimated at 800 volts. If the power output is 160 watts, then

$$R_T = \frac{e^2_{\text{peak}}}{2P} = \frac{(800)^2}{2\,(160)} = 2000 \text{ ohms}$$

Development of Graphical Method

For analytical purposes, divide the pi-network into two L networks that match into a common imaginary resistance as shown in Fig. 1(b).

With R_T known, choose a value of X_{C1} that will give the desired Q and then determine X_{L1} and r. This is done graphically[2, 3] as shown in Fig. 2(a). This operation converts the parallel resistance R_T and re-

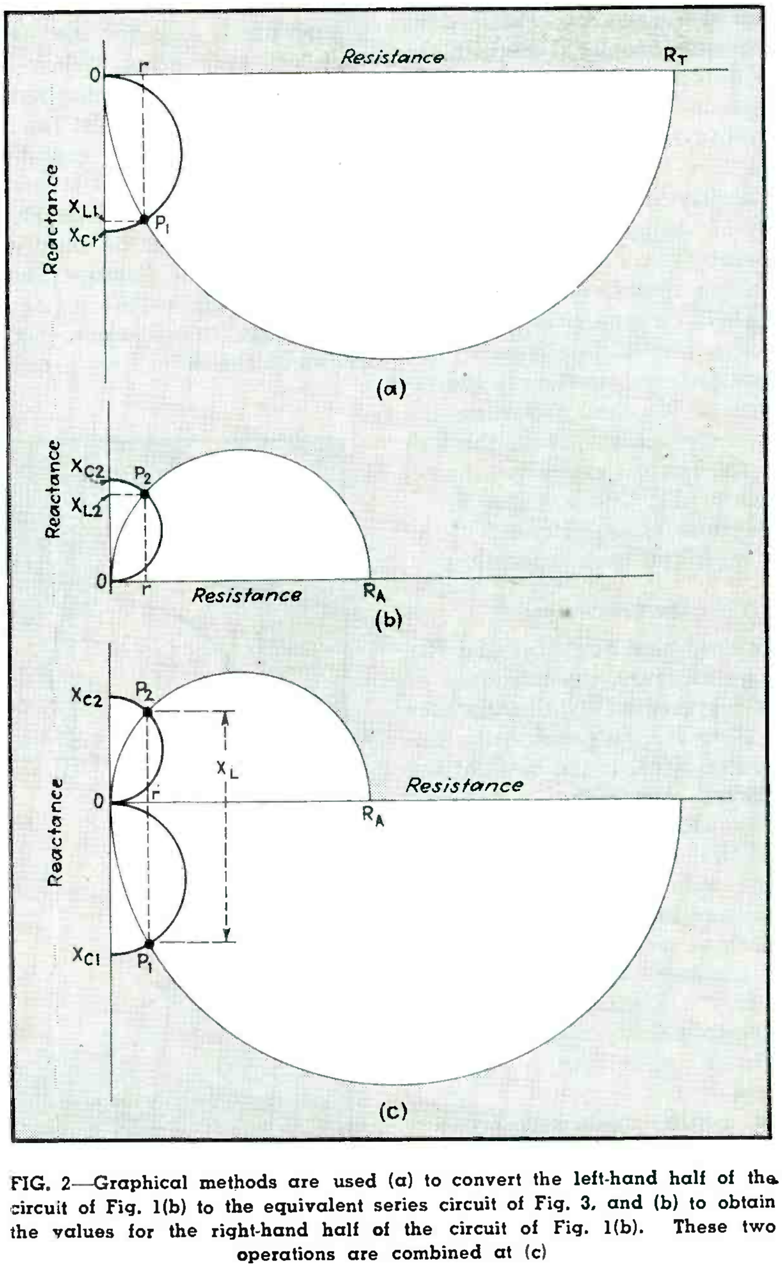


FIG. 2—Graphical methods are used (a) to convert the left-hand half of the circuit of Fig. 1(b) to the equivalent series circuit of Fig. 3, and (b) to obtain the values for the right-hand half of the circuit of Fig. 1(b). These two operations are combined at (c)

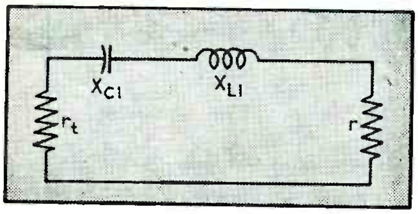


FIG. 3—Series equivalent of the left-hand L-section of Fig. 1(b) matches the effective tube load to the hypothetical reflected load r

actance X_{C1} to their equivalent series impedances, r_t and X_{c1}, as shown in Fig. 3. Then $r = r_t$ and $X_{L1} = -x_{c1}$ when the impedances are matched and the circuit is in resonance.

Knowing r and the load resistance, we may determine the reactance of X_{L2} and X_{C2}. This is done by the same graphical method, the only differance being that the knowns and unknowns are different. This step is shown in Fig. 2(b).

If a chart is used which has a family of semicircles on each axis, the point P_2 can readily be found by tracing the circle which passes through R_A around to where it intersects a vertical line from r. The vertical distance represents the reactance of X_{L2}, and following the other circle, which passes through P_2, to the vertical axis gives the reactance of X_{C2}. Since $X_L = X_{L1} + X_{L2}$ the value of each element of the pi-network has been determined.

The Calculator

If we combine Fig. 2(a) and (b) into one diagram, the reactance of X_L is represented by the distance from P_1 to P_2. This composite diagram, Fig. 2(c), is the basis of the pi-network calculator.

When a pi-network is being designed that must cover a wide frequency range and also match into a wide load impedance range many calculations must be made, always using the same value of input impedance, R_T. The calculator is a device which greatly simplifies these operations in solving a network problem.

The ¼-inch shellacked plywood base is 11½ by 14½ inches. The base chart on which the inductance and resistance circles are constructed is standard cross-section paper with lines every millimeter. It is cemented to the plywood base with the vertical lines exactly parallel to the left edge. The vertical inductance arm is 0.040 transparent plastic with the inductance graduations engraved on the bottom side. The pivot arms are of the same material and are pivoted to the inductance arm with two close-fitting tubular rivets.

The vertical arm has a scale which reads X_L in ohms and this scale starts at the center of the pivot with the lower arm. This is called the inductance arm. A hole is drilled in each pivot arm a distance of $R_T/2$ from the center of the pivots on the inductance arm, and a push pin is used for the pivot in each of these holes. When these pins are placed, it is important that the center of the pivot at the lower end of the inductance arm be exactly over the zero resistance and reactance point on the chart, that the inductance arm be exactly vertical and that the distance from the lower push pin to the upper push pin equals the distance between pivots on the inductance arm. Now when the inductance arm is moved, the lower end of the inductance scale will automatically follow the circle which passes through R_T.

The lower end of the inductance arm has two curved lines extending to the left from the pivot point. These curved lines were developed so that for two values of R_T they would cross the vertical axis of the chart at X_{C1}. The two values of R_T chosen for developing these curves were the maximum value accommodated by the calculator and one half of the maximum value. (If the value of R_T in a problem does not fall between these limits, all scales may be multiplied or divided by some factor so that it will.) These two lines are close together so it is easy to interpolate between them for setting X_{C1}. With this device, the circles shown in Fig. 2(a) are no longer needed for solving the first half of the network problem.

Manipulation of the Calculator

To use the calculator set the curve on the inductance arm at X_{C1}. Then follow the circle which passes through the load resistance

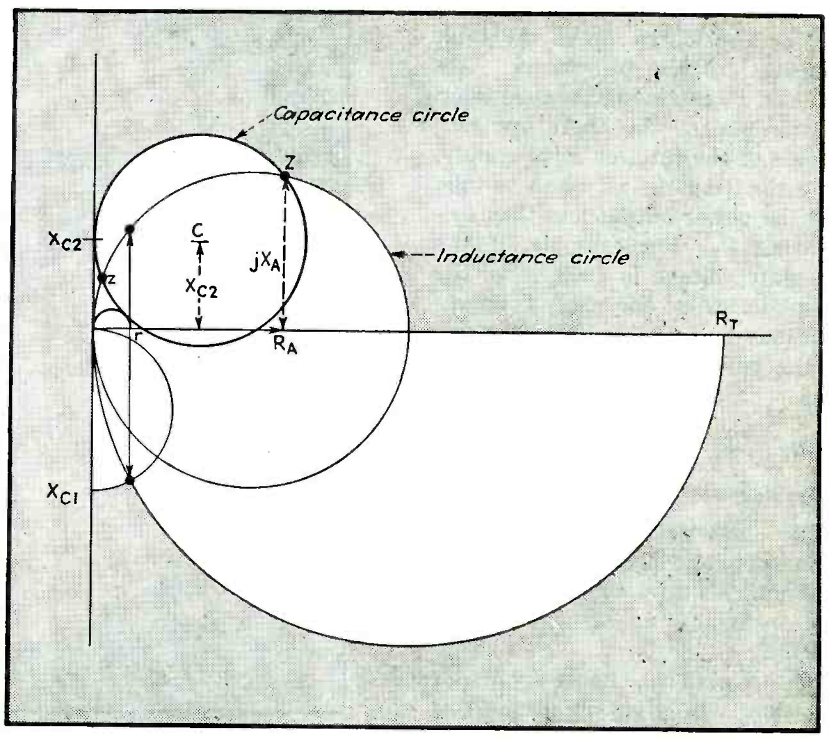


FIG. 4—Addition of a slide carrying circles tangent to the reactance axis permits making matching calculations for reactive loads

R_A up and around to where it intersects the vertical scale on the inductance arm. Read the inductive reactance at this point, then follow the other circle over to the x axis and read X_{C2}.

Up to this point the load has been considered as a pure resistance. If the load has a reactive component, it can be converted into equivalent parallel resistance and reactance. Solve the problem by matching into this equivalent parallel resistance and then correct X_{C2} by the amount of the equivalent parallel load reactance. This can be quickly done by converting each reactance into positive or negative capacitance at some frequency by use of a reactance chart.[4] Add, if the load is inductive; subtract, if it is capacitive.

For example, if the load is $500 - j500$, the equivalent parallel impedances are 1000 ohms resistance and 1000 ohms capacitive reactance. Assume that the network requires 200 ohms X_{C2} to match into the 1000-ohm resistance. At 1 megacycle, 1000 ohms is 159 $\mu\mu$f and 200 ohms is 795 $\mu\mu$f. The actual capacitance of C_2 is then 795 $\mu\mu$f minus 159 $\mu\mu$f, or 636 $\mu\mu$f and its reactance X_{C2} is 250 ohms.

Capacitance Calculations

Another simple method was developed which permits X_{C2} to be read directly when the load impedance has a reactive component. It was found that the center of a circle, which passes through the load impedance point and is tangent to the x axis and tangent to a circle whose diameter is r, is a distance X_{C2} above the zero reactance line.[5] This circle is shown in Fig. 4.

The capacitance slide has a family of circles which are all tangent at a common point, and is constructed so that it can be slide up and down with this common point of tangency always on the x axis. The circles are scribed on 0.010 transparent plastic sheet, and a guide is fastened to the sheet with screws.

To use this device, slide it up or down so that some circle or interpolation between circles passes through the load point and is tangent to a circle whose diameter is r. X_{C2} is read at the line on the slide which is on the horizontal diameter of the family of circles. This works the same way when the load has a capacitive reactance as when it has an inductive reactance.

Interpretation of Calculator Results

In Fig. 4 it should be noted that the circles intersect at two points. This other point, z, is the other value of load impedance that the network will match into as well as Z and it represents the condition beyond critical coupling. When the load impedance is low and inductive, Z and z may be close together and the network can be tuned for either operating condition. It is easy to know when one is operating at point z because an increase in the loading capacitance, C_2, will increase the loading; whereas, when operating normally (at point Z) decreasing the capacitance of C_2 increases the load on the tube.

For practical purposes there are several factors which limit the range of load impedances that the pi-network will match into. The network will not match into load impedances in the area below the semi-circle whose diameter is r and extending down to negative infinity, as illustrated in Fig. 5. This area can be reduced by increasing the circuit Q as this decreases the value of r.

Another common practical restriction is caused by the minimum and maximum capacitance of capacitor C_2. At minimum capacitance the reactance X_{C2} will be highest so that the load impedance must be inside a circle tangent at X_{C2} and also tangent to the circle whose diameter is r. At maximum capacitance of C_2, X_{C2} is at its minimum so the load impedance is restricted to an area outside of a circle tangent at X_{C2} and to the circle whose diameter is r. This latter restriction exists only when the network is always adjusted to a point less than critical coupling.

The most important restriction is the maximum safe operating voltage for capacitor C_2. This capacitor has the same voltage across it as the load. For example, if the maximum safe voltage across C_2 is 2000 volts peak and the power output is 1000 watts, the maximum load resistance is

$$R = \frac{E^2}{2P} = \frac{(2000)^2}{2(1000)} = 2000 \text{ ohms}$$

for an unmodulated carrier. If the carrier is amplitude-modulated 100 percent, the above value of load resistance must be divided by two and is then only 1000 ohms. If the load has a reactive component, the maximum impedances, which have

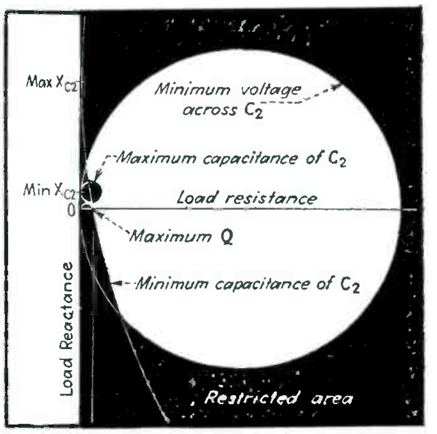


FIG. 5—Impedance transformations possible with a pi network limit the load that can be matched to within the area indicated by the calculator

the same load voltage, lie on the circle which passes through the maximum resistive load as determined above. It is seen that a load impedance of $500 + j500$ will have the same voltage for a given power output as 1000 ohms pure resistance. The inductance circles on the calculator can thus be used as constant load-voltage circles.

In determining the above restrictions, it was assumed that the inductance could be adjusted to any necessary value. The maximum amount of inductance required is determined at the lowest frequency at which the network is to be used by using the desired amount of X_{C1} and making a calculation on the amount of inductive reactance necessary to match to the highest load impedance to be encountered. For lower load impedances and higher frequencies, the coil can be tapped to secure lower inductance. In practice, a considerable frequency range and load impedance range can be covered on a given tap position by just tuning the two capacitors. The limit to the frequency range which can be covered is determined by the maximum and minimum values of Q desired. For a given load, when the frequency is increased, the capacitances will decrease and so will the Q. When the minimum desired Q is reached, the coil is switched to the next lower tap, which is located so that the network will have the maximum desired value of Q when retuned. If the load impedance is lower (or higher), the same tap will be changed at a higher (or lower) frequency.

Balanced or push-pull pi-network problems can be solved with this calculator by considering only one-half of the network as working from one tube into one-half of the load impedance. The two halves of the balanced pi-network have identical reactances.

The accuracy of the calculator depends on its physical size and the precision used in making it. The original calculator was accurate to about 5 ohms when determining the reactances of the pi-network elements except that it becomes less accurate when r becomes very small (Q becomes high). In general, the results are as good or better that can be obtained using a slide rule. Because the number of operations to be performed on the calculator are few, chances for mathematical errors are greatly reduced when designing any type of pi-network.

A very interesting study of the relationship of the elements of the pi-network can be made with this calculator. There are three reactance elements in the pi-network plus the input resistance and the load impedance, any one of which may be varied to observe the effect on another.

Circuit Analysis

For one example, illustrated in Fig. 6, consider R_T, X_{C1}, and X_L fixed and observe the locus of load impedances that can be matched by varying only X_{C2}. Any load impedance which lies on the inductance circle, which passes through the value of X_L on the inductance arm, can be matched by varying only X_{C2}. As the load impedance point moves clockwise around this circle the reactance of X_{C2} increases (capacitance decreases).

When R_T, X_{C1}, and X_{C2} are fixed, the locus of load impedances, shown in Fig. 7, which can be matched by varying X_L, lies on the sliding capacitance circle which is tangent to the circle whose diameter is r. As the load impedance point moves clockwise around this capacitance circle, the reactance of X_L decreases.

Prediction of Tube Operation

A graphical picture of what happens when the pi-network, shown in Fig. 1, is tuned up is shown in Fig. 8(a). The load impedance, R_A is a fixed resistance and a value of X_L is chosen which will result in a satisfactory circuit Q when the network is tuned for proper loading of the tube and for resonance. The tube resistance R_T depends on the load placed upon the tube. When the tube is lightly loaded R_T will be high and when it is loaded heavier, R_T will be less. The adjustments of C_2 and C_1 serve to load the tube to the desired power input (or output) and to tune the circuit to resonance.

This graphical construction shows the relationship between X_{C2}, X_{C1} and load resistance on the tube. The one pivot arm must pivot on the center of the circle which passe through the load resistance. If X_{C2} is increased and X_{C1} is decreased to bring the network back

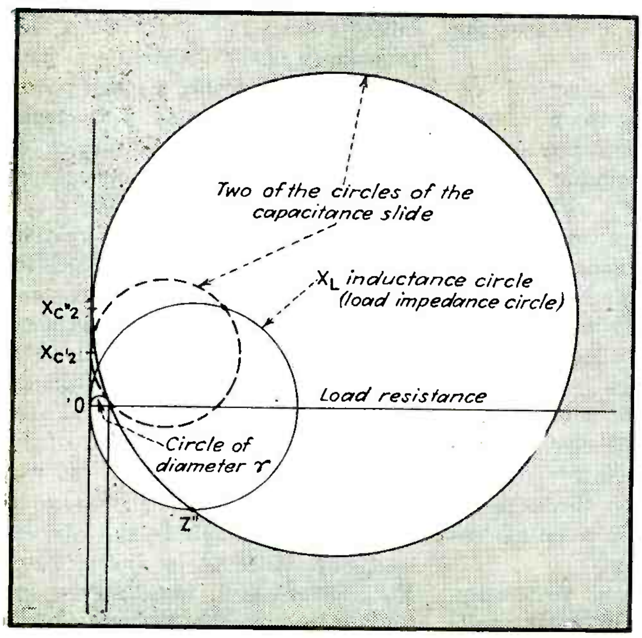


FIG. 6—Impedances that can be matched by varying X_{C2} are determined by settings of the capacitance slide

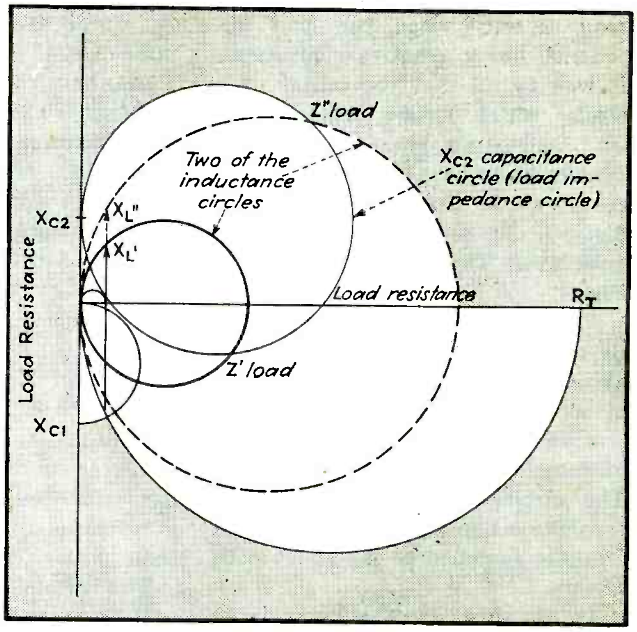


FIG. 7—Impedances that can be matched by varying X_L with all other parameters constant can be found

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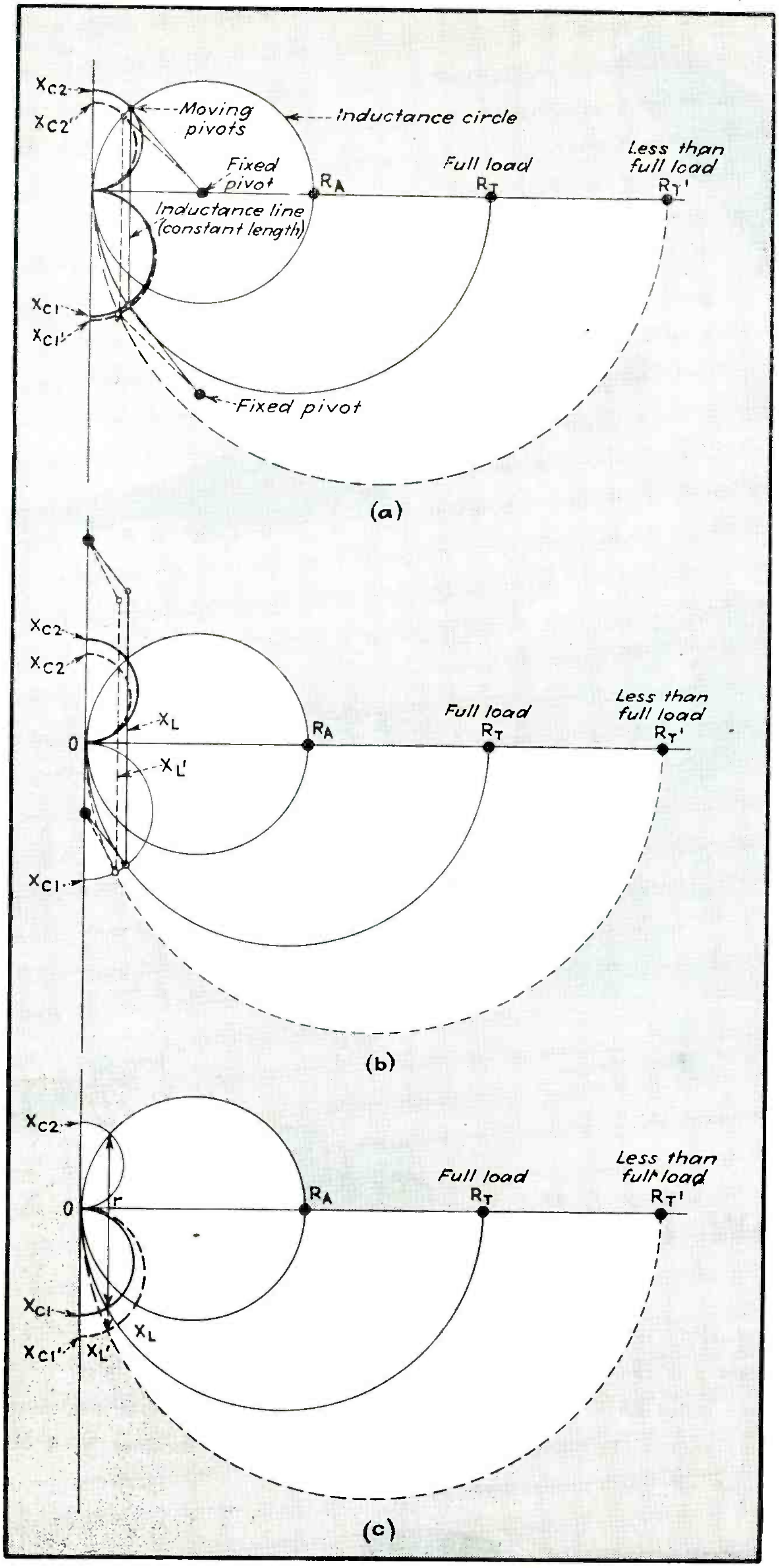

FIG. 8—(a) Effect on tube loading of varying the tuning capacitors is readily shown on the calculator. Other variables can be used such as (b) X_L and X_{C2} or (c) X_L and X_{C1} and the effect on the load that is reflected back to the tube can be studied

into resonance, then R_T is found to be less, which means that the tube is loaded more heavily.

This operation is just the opposite of what the calculator was intended to do, but it can be done easily if the fixed pivot on the lower pivot arm is located a distance equal to X_L exactly below the center of the inductance circle which passes through the load resistance, R_A.

Figure 8(b) shows the relationship when X_{C1} and R_A are fixed and tuning is accomplished by varying X_L and X_{C2}. The calculator can also be set to perform this calculation if it is desired.

If X_{C2} is fixed and X_{C1} and X_L are the variables, the construction is rather simple and is shown in Fig. 8(c).

Conclusions

In conclusion, it is suggested that a simple and inexpensive calculator can be made which is based on the construction shown in Fig. 2(c). A family of circles with their centers on the horizontal axis, and also the two families of semicircles with their centers on the vertical axis, are constructed on millimeter ruled paper as was used for the base chart for the calculator. A transparent centimeter scale can be used for the inductance scale. The end of the scale is placed on point P_1, with the scale placed in an exactly vertical position. The inductance can be read off on this scale at point P_2 using the same scale (ohms per centimeter) as used on the base chart.

This base chart is also useful for other purposes, as for calculating L-network reactances and converting series resistance and reactance to their equivalent parallel resistance and reactance.

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(3) Toombs, R., Chart for Equivalent Series and Parallel Circuits, ELECTRONICS, 16, p. 109-110, Apr. 1943.

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(5) Smith, Phillip H., L-Type Impedance Transforming Circuits, ELECTRONICS, 15, p. 48-54, 125, Mar. 1942.

Building Tomorrows into Today's Products

IF George Washington could have owned a modern electric refrigerator, it might not be a museum piece today. Judging by performance tests of Mallory contacts for refrigerator motors, 194x's electric refrigerator could have cooled the drinks and preserved the food of George Washington and be capable of performing the same service for today's guests at Mt. Vernon.

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TEST	OPERATION CYCLES	HOUSEHOLD SERVICE EQUIVALENT	CONDITION OF CONTACTS
#1	1,556,000	85 years	Good
#2	2,134,000	171 years	Good
#3	3,075,000	168 years	Good
#4	3,230,000	177 years	Good
#5	3,277,000	180 years	Good

Mallory contacts are used on refrigerator motors to cut out the starting winding after full motor speed is obtained. Under adverse conditions, a refrigerator motor goes through fifty such operations in twenty-four hours. Speeding up the time interval to 512 operations per hour on five motors, running at 1750 R. P. M., it was demonstrated that Mallory contacts could operate perfectly for 85 to 180 years and *still be in good condition*. This again is indicative of the built-in quality of Mallory contacts which assures faultless service from standard contacts engineered to out-live the product for which they were designed.

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Photoelectric Gaging of Piston Rings

TO ELIMINATE the human element in production checking of piston rings and thus attain a very high degree of accuracy, a new electronic instrument automatically inspects the trueness of periphery and the width of gap of a specific size of piston ring. Inspection is much faster than present hand-checking methods and the production rate is determined by the speed at which the rings are presented to the gage. The inspection cycle per piece is less than five seconds.

Piston rings are inserted in a master ring and rotated under a light beam for electronic checking of true and width of gap

The piston ring to be checked is inserted inside a master ring of correct dimensional quality which is placed on the instrument table and rotated by a power-driven roller. The gaging functions are performed by scanning beams of light directed onto phototubes which energize electronic circuits to illuminate three signal lights.

As the ring revolves, one beam of light is projected on the periphery of the piston ring. A clearance between it and the master ring will result from any out-of-round condition of the piston ring, permitting part of the light beam to fall on the phototube. This actuates a red rejection signal should an excessive amount of light indicate that the piston ring is out-of-round beyond an acceptable point.

If the periphery is within tolerance limits, a green signal flashes on at the end of one complete revolution provided the width of gap is also within tolerance. The beam of light is interrupted by a mechanical shutter arrangement at the time the gap is passing this point.

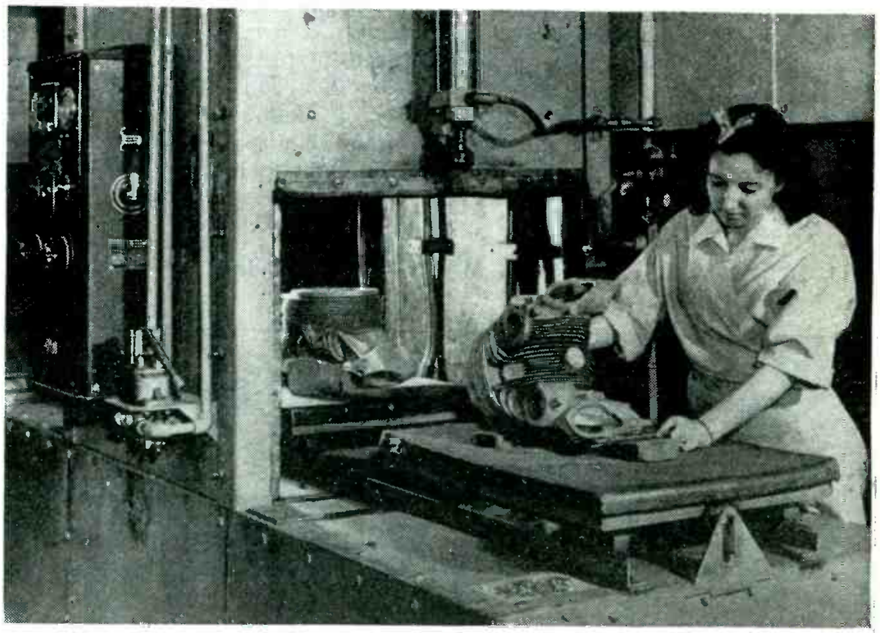
Another beam of light scans the width of gap and actuates a yellow signal should the gap be undersize. A third beam of light energizes another circuit to illuminate the red rejection signal should the width of gap be oversize.

Master piston rings of known dimensional quality are used in adjusting the instrument for the desired tolerances. Made by The Sheffield Corporation, the instrument can be adapted to various nominal sizes, gaps of varying width, and also for variations on the allowable out-of-roundness of the periphery. Trueness of the periphery can be determined within a tolerance of 0.0001 inch.

Industrial X-Ray Installations in Ford Plant

OF ALL THE WAR PLANTS throughout the country, Ford Motor Company is a leading user of x-ray industrial equipment. Radiation at voltages from 5,000 to 1,000,000 covers the entire range of industrial radiography, from the study of very thin samples by microradiography to inspection of steel castings eight inches thick.

Castings passing through a Ford production x-ray department are segregated into groups according to the x-ray unit best adapted for their examination. Sorting tables, numbering machines, and record entries precede the transfer to gravity conveyors where operators place the castings, with proper fixtures and identification numbers,



Cast aluminum cylinder heads for 2,000-hp Pratt & Whitney aircraft engines are placed on lead-covered trays and rolled into the cabinet for x-raying. A pneumatically operated door is closed during exposure for protection of the worker. About 700 exposures are made per day

COMPACT!

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No bigger 'round than a nickel and wafer thin, this new Fingertip Control will find many important applications in miniature electronic devices. An all-inclusive unit, its unique design eliminates the usual bulky knob, shaft and bushing without any impairment of functional operation.

Of neat appearance and available in either black or colors, this Type H control is intended for edgewise installation. A light-pressure, fingertip rotation of the knurled edge of the cover permits ready resistance adjustment.

Embodying suitable mechanical strength and many of IRC's famous features as found in Type CS and D controls, the Fingertip Control has a rotation of 290°, a power rating of 0.25 watts and 500 ohms to 3 megohms, as standard resistance values. Fingertip Control may be had with linear taper or with standard audio tapers.

Inquiries are invited from interested manufacturers of hearing aids and other miniature equipment. Engineering Bulletin on the Type H control is now in preparation.

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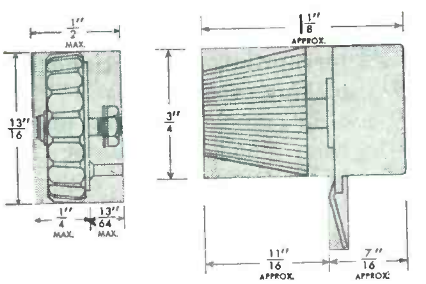

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on cassettes which hold the film. The castings are manually pushed onto the conveyor belt which carries them into the x-ray exposure chamber and out the opposite side according to a set cycle of operations. After radiography, the castings usually are stored in numbered bins until final disposition can be made after study of the x-ray films.

Two General Electric million-volt industrial x-ray units routinely inspect, in 16 minutes, the same number of steel parts that required 60 hours with low-powered apparatus. One of these units is in the $27,000,000 aircraft engine buildings at the River Rouge plant, which has been turning out 2,000-hp Pratt & Whitney engines, and the other is in a new steel foundry.

The million-volt unit at the aircraft engine plant is used to x-ray heavy steel castings, turbo-supercharger parts, and a wide assortment of bomber and glider castings for faults such as blow holes, tears, shrinkage cavities, inclusions and cracks.

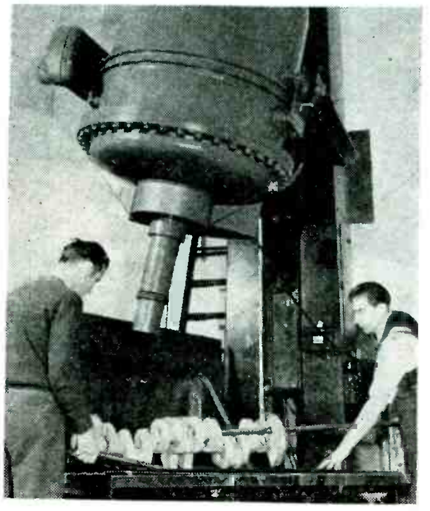
Ford engineers have found that the million-volt unit can examine 64 times the volume formerly x-rayed with their 400,000-volt unit, and 24 times the volume possible with radium of average amount in the same floor area and with the same handling facilities.

Multiple Inspection

Because of the large spherical angles available for useful radiographic examination with the million-volt apparatus, a large number of castings can be examined at each exposure. The limiting factor on the number that can be examined each day is almost entirely dependent upon the handling facilities. As many as 50 films have been simultaneously exposed.

The other million-volt unit in the steel foundry examines unmachined crankshafts for the Ford-built 500-horsepower tank engine, and also heavy castings for the M-8 light-armored car.

Every crankshaft built into a Ford V-8 tank engine undergoes radiographic inspection with the million-volt unit. Each shaft is three feet long and weighs about 250 pounds. To speed up examination, Ford technicians ingeniously designed a wooden fixture so that 12 of the big crankshafts could be x-rayed at one time. They are fitted into the fixture which is placed on



A crankshaft casting for a Ford V-8 tank engine being placed in position for x-raying by a General Electric million-volt industrial unit

a large lead-covered truck operating on tracks. Three different exposures are taken from different angles. The films in cassettes are placed in racks under points where the crankshafts are suspended in the fixture. The cassettes slide out quickly for changing. It requires 34 minutes to x-ray all 12 crankshafts one way. Another 18 minutes is necessary to radiograph separately two groups of six crankshafts each from a different angle. These two exposures take 36 minutes or a total of 70 minutes to completely radiograph all 12 crankshafts in three exposures.

After the films are developed, any defective crankshafts are removed for salvage, and the good ones are stamped with a star showing they have passed x-ray examination.

In the steel foundry, the designer and foundryman together use radiography in determining both the best design for the castings and the best way for producing it. Initial castings are radiographed and melting, temperature of the pour, location of gates and risers, ramming, shrinkage, and many other factors affecting quality are studied. The design itself, or the casting procedure, may be changed as a result. It has been found that by this method better castings are produced, with savings of time, materials, and money.

Crack Detector for Bottles and Jars

FLAWS, such as minute cracks and surface irregularities that prevent airtight sealing of glass jars, can be detected electronically without interrupting the continuous bottle-making process.

In one glass-making plant it had been found that two our of every hundred containers with flaws escaped detection by human inspectors. With the new technique, developed by General Electric in collaboration with Hartford-Empire Co., even those flaws barely visible to the naked eye are rapidly detected.

In operation, the containers automatically move in front of a phototube and are whirled rapidly under a strong light. Since the phototube is not affected by a steady light, the light reflected by perfect glass produces no effect. Any imperfection on the edge of the jar causes the lightbeam to flicker and this modulation of the intensity of the beam causes an electronic amplifier connected to the phototube to operate and cause the jar to be rejected.

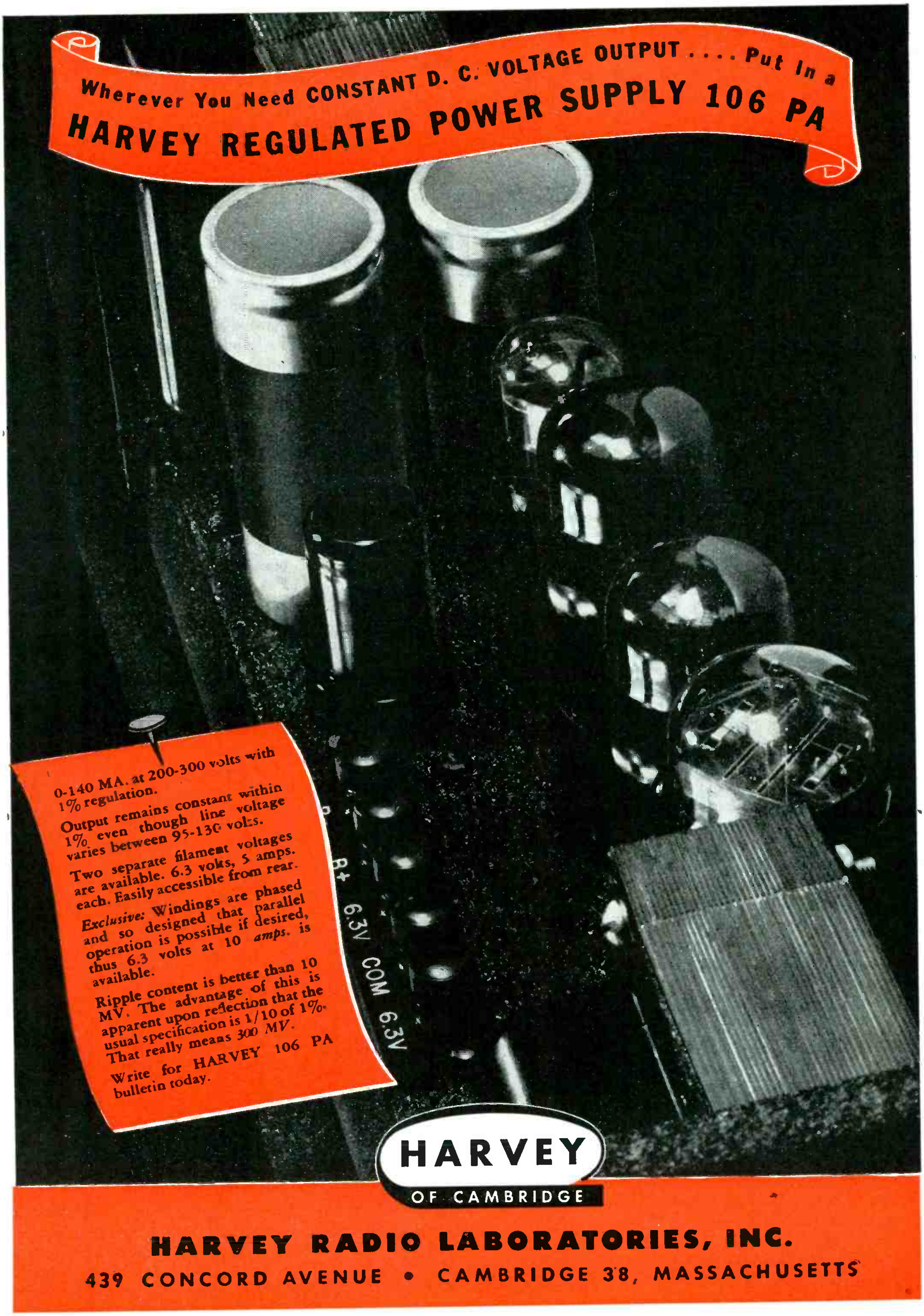
Frequency Meter for Use by Factory Personnel

By W. R. STRAUSS
Project Engineer
North American Philips Co.

WAR INDUSTRIES that use audio frequencies in measurement work have use for a frequency meter that measures from ten to 50,000 cycles and that can be operated by non-technical personnel, after a few minutes instruction. To fit these requirements, engineers at North American Philips designed the unit illustrated for use in their plant.

The frequency meter they developed has sufficient power to operate a strip-chart recorder without an auxiliary amplifier regardless of voltage variations between 2 and 200 volts.

The input circuit consists of a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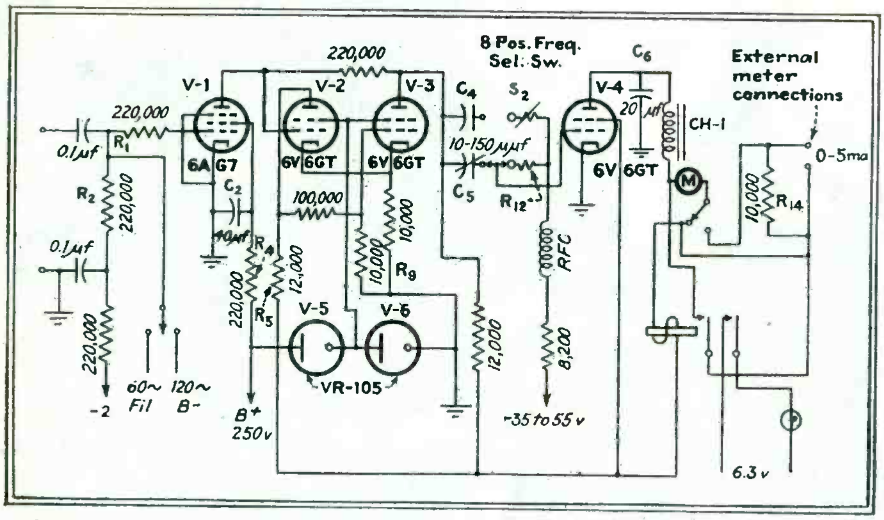
limiter as shown in the diagram. This stage employs resistor R_1 to bias the control grid of the input tube on the peaks of a cycle.

In clipping the peaks of a cycle, the output shows a square wave with steep fronts. The square wave results regardless of whether the input frequency is a pure sine wave or one with distortion and irregularities. In case of a badly distorted wave, the grid circuit will favor the predominant frequency over the lesser peaks by a ratio of about 3 to 1.



Circuit of electronic meter for production testing of frequencies between ten and 50,000 cycles. A linear direct-reading dial permits rapid reading by non-technical personnel

Floating Screen

Plate output voltage of tube V-1 is held constant by a floating screen grid. Since plate current changes are a function of screen voltage, increase of audio input voltage results in a decrease of screen voltage. This, in turn, is affected by the bias developed across R_1. Screen voltages reduce proportionately with increase of grid bias developed across R_1. Stabilization of screen resistor R_4 to ground, or B- with a bleeder resistor, would limit the range of constant output to a narrow band of frequencies. Capacitor C_2 is an audio bypass to prevent any part of the original wave shape from entering the plate circuit. The *RC* time constant of R_1 and C_2 is sufficient to delay any small part of the original wave from coinciding with the square wave, thus avoiding valleys and discharge peaks.

At *V*-1, a type 6AG7 was found to be best from the standpoint of high transconductance and high screen-grid wattage dissipation. The input sensitivity is slightly more than one volt, for almost all frequency ranges. Input impedance is greater than 100,000 ohms for most frequencies but not higher than the value of R_2.

Multivibrator as Amplifier

The multivibrator circuit formed by *V*-2 and *V*-3 is directly connected to the plate of *V*-1, and is at rest by virtue of bias-resistor R_9. The value of R_9 is selected to permit the multivibrator circuit to operate at the instant a square-wave voltage is present at the plate of *V*-1. The multivibrator circuit has no resonant characteristics; its function is to amplify the output of *V*-1 without alteration.

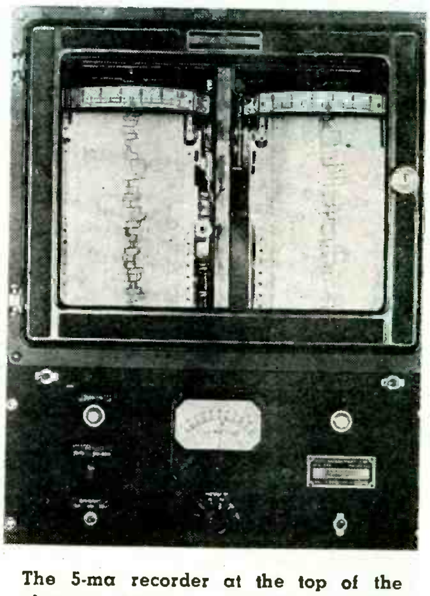
Amplified square waves are then fed into an *RC* integrating network (C_6,R_{12}, etc.) which determines the amplitude of the pulse that is to appear on the grid of *V*-4. Capacitors in the frequency-selector circuit are either air-type trimmers or silver-mica types having negative coefficients to minimize calibration drift caused by heat within the instrument.

Operation of the *V*-4 tube circuit is similar to class C audio amplification. The grid bias is adjusted to zero plate current with no signal input. This circuit functions as a linear amplifier in which plate current changes are directly proportional to grid voltages.

Safety Circuit

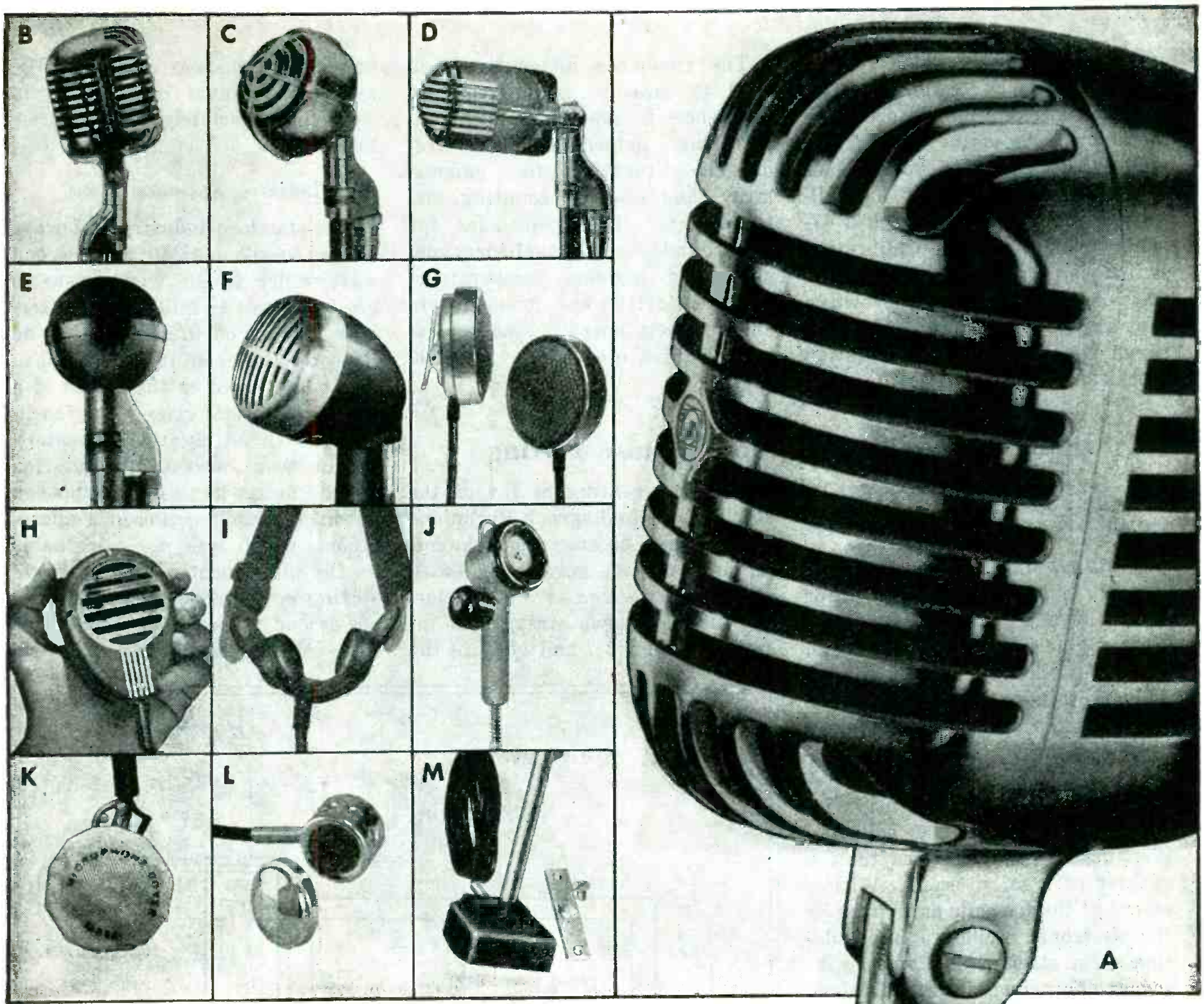
External and panel meters are protected from burnout by a relay in the plate circuit of *V*-4. The relay shorts the meter when current exceeds 10 ma and releases at about 4 ma. The meter circuit is arranged to permit reading the panel and external meters simultaneously. Accurate frequency indication on the external meter is only limited by the meter itself. If a recorder is used, overshooting and undershooting of the pen (determined by chart paper travel) must be taken into consideration. If the frequency meter is accurately calibrated and stabilized, the inherent circuit error will be less than 2.0 percent of full scale over the entire range of 10 to 50,000 cycles.

An *RC* network having a long time constant (C_6, CH_1) is incorporated into the plate circuit of *V*-4. Without the *RC* network, some recorder pens resonate badly at 100 to 130 cycles with the selector



The 5-ma recorder at the top of the photo is driven by the direct-reading frequency meter of the lower panel without an auxiliary amplifier

switch (S_2) set on 100 or 500-cycle positions. External meters having a 5-ma movement and a coil resistance not exceeding 1000 ohms may be used without recalibration. An external meter-damping resistor, R_{14} of 10,000 ohms, was chosen as an optimum value and accommodates most recorders without



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affecting calibration.

For frequency calibration 60 cycles at 6.3 volts is obtained from the filament leg of the transformer and 120 cycles at 2.5 volts comes from the B-minus leg of the full-wave power rectifier through a 47-ohm resistor. The calibration switch is normally open (center position) as shown. Selector switch S_2 is placed on the 100 or 500-cycle range when making a calibration check.

The frequency meter has been used to measure audio-frequency differences in quartz crystal manufacturing, determine pulse frequencies, function for gamma, x-ray, and electron counting, determine a-c line frequencies for power and audio transformer design, and measure temperature-coefficient-drift on transmitters and receivers operating under test temperatures of from −40 to 200 deg F.

Industrial Oscillograph for Impulse Testing

By Otto Ackerman
Protective Device Engineering
Westinghouse Electric & Manufacturing Co.

The industrial electronic oscillograph is largely responsible for recent advances in design of aircraft engine ignition systems, high voltage insulation, circuit breakers, and lightning arresters. Investigation of the electrical phenomena associated with these devices requires the measurement of non-repetitive transients which may rise to a value of thousands of volts and then drop to zero in less than a quarter of a microsecond. With a record of these events as written by the electronic oscillograph, insulation surge strength and voltage recovery characteristics are obtained and designs are modified to give better service, longer life, and improved performance.

The high-voltage electronic oscillograph operates on the same principle as the sealed-glass-tube cathode-ray oscilloscope.

Sealed-off cathode-ray tubes up to 15 kv rating have been available commercially and equipment of this type is being used to some extent for impulse testing because it is relatively inexpensive. The extremely high voltages and rapid buildup rates used in modern testing methods have resulted in an ever-increasing demand for a recording instrument with a voltage and speed range far beyond that of the sealed-glass oscilloscope. To meet this demand, the streamlined Westinghouse electronic oscillograph shown in Fig. 4 was developed.

The high-voltage oscillograph is primarily useful in the study of single transients which are essentially non-repeating as far as the employable oscillograph technique is concerned because the behavior of the test piece may change with every applied surge, as when exploring the breakdown strength of insulation (Fig. 2), and because the powerful discharges of large surge generators cannot be obtained in close and absolutely regular time intervals.

Industry Standard Wave

The standard industry test wave is the so-called 1½-40 microsecond wave which is one which rises to crest in about 1½ millionth of a second and falls off to half value in 40 microseconds from its start. It can well be observed on the screen of a good sealed-off glass tube oscilloscope. In all but the elementary routine tests, however, the question usually arises as to what happened in this or that fraction of a microsecond which was not discernable on the instrument of the lesser resolving power. Such fractional micro-second records, taken with the high-voltage oscillograph, are pre-

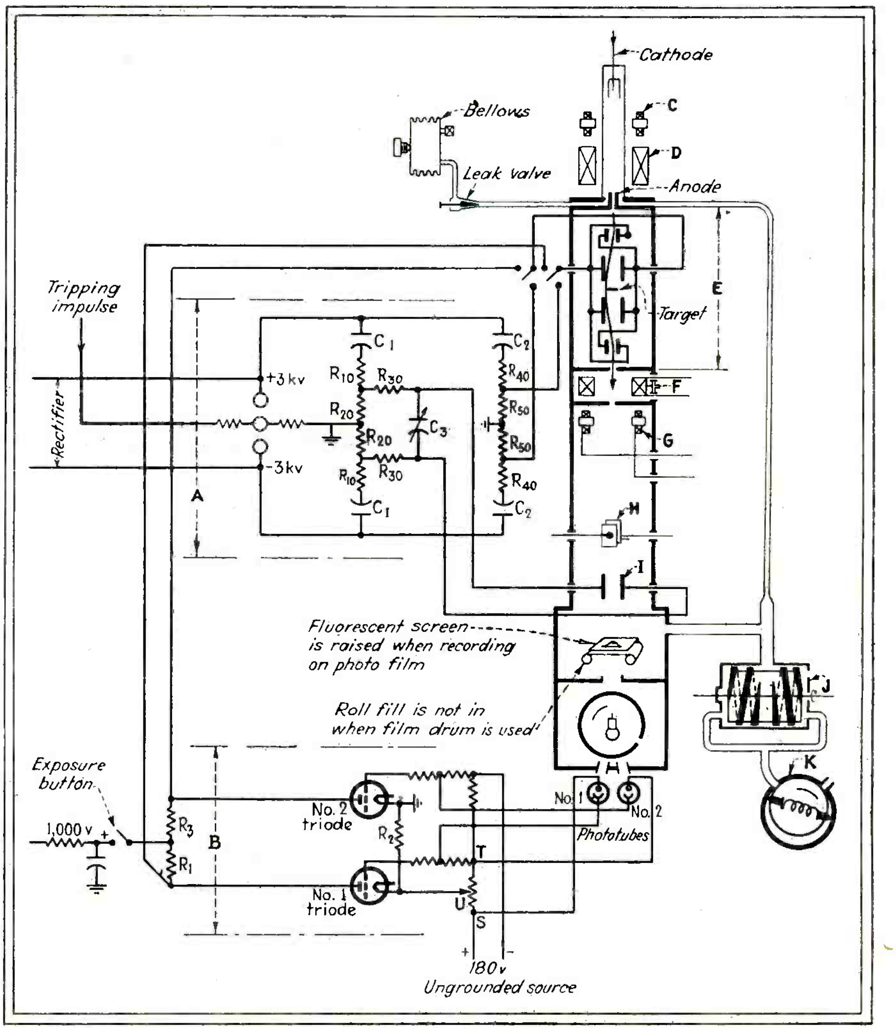
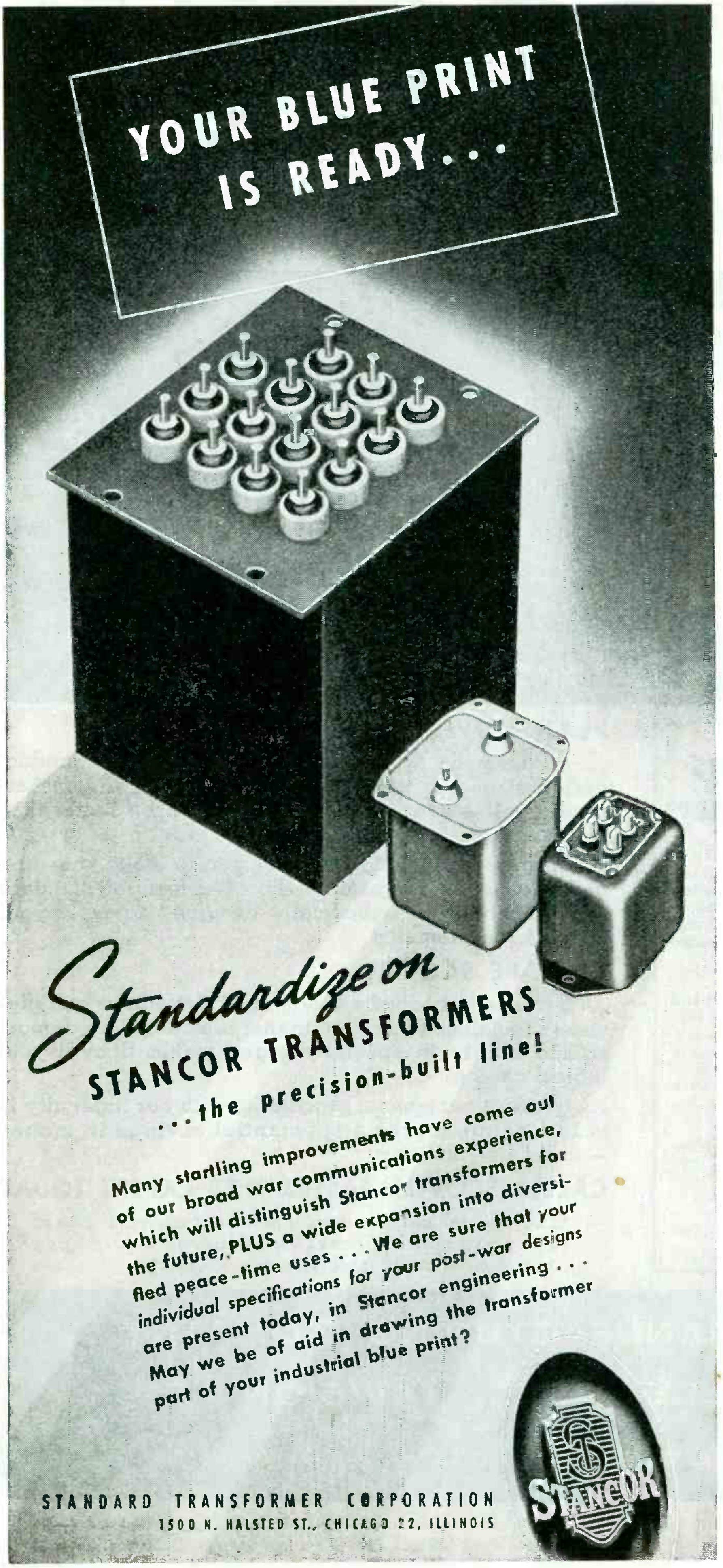


Fig. 4—Oscillograph body with timing circuits and pumping system. At (a) is the timing circuit for stationary film and at (b) the film drum exposure control whose operation is started by pressing the exposure button. Details of the instrument are: (c) upper deflecting coils, (d) upper concentration coils, (e) ray-blocking section, (f) main concentration coil, (g) lower deflecting coils, (h) measuring electrodes, (i) timing electrodes, (j) molecular pump, (k) rough vacuum pump



sented in Fig. 2 and 3. They are taken on regular roll film 3⅝ inches wide. The film is exposed directly to the cathode beam; this eliminates the intermediate elements of fluorescent screen and optical system, which are essential with the sealed glass tube. The size of the picture renders enlarging unnecessary.

Timing Circuit

The timing of the cathode-beam release and of the beginning of the time axis are accomplished by a simple but very effective circuit (Fig. 4). The phenomenon under observation is connected to the oscillograph timing circuit through capacitance coupling with the center electrode of the double gap (Fig. 4). It should be noted that in all records of Fig. 2 and 3 the surge starts at exactly the same point with respect to the zero point on the time axis. This means that the action of the synchronizing circuit, including the double gap, is so consistent that no variations can be detected even at scales which ren-

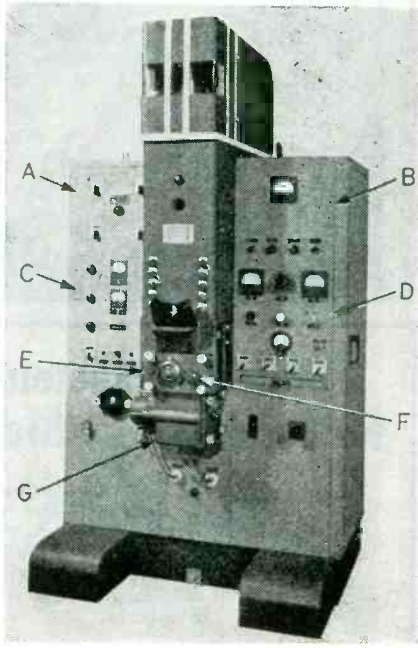


Fig. 1—Front view of Westinghouse electronic oscillograph. The sections are:

- **(a) Timing circuit panel for stationary film.**
- **(b) Unit containing calibrating circuits and film-drum exposure control.**
- **(c) Focusing and bias coil panel.**
- **(d) High-voltage and vacuum control panel.**
- **(e) Roll film operating knob and position indicator.**
- **(f) Fluorescent screen hinge knob.**
- **(g) Film drum attachment.**

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1. Type of molding material—manufacturer, name, number, and filler (if any).
2. Method of molding at present—compression or transfer.
3. Dimensions of preform; please include sketch.
4. If the shape of your preforms is irregular, do you know of any reason why it cannot be altered for more efficient application of electronic heat? (With electronic heating, vastly improved material-flow properties result; consequently, highly irregular preform shapes are probably unnecessary).
5. Weight of preform: ....lb. ....oz.
6. Number of preforms per charge.
7. How many presses are now used for this job?
8. What is present press cycle? Closing time ....seconds; curing time .... seconds; number of cycles per hour ....
9. Temperature rise required: From ....°F to ....°F.
10. Present method of preheating (if any).
11. Description and significant details of molded piece.
12. Power supply available—voltage and frequency.
13. What priority can be extended?
14. Please describe any special problems you encounter.

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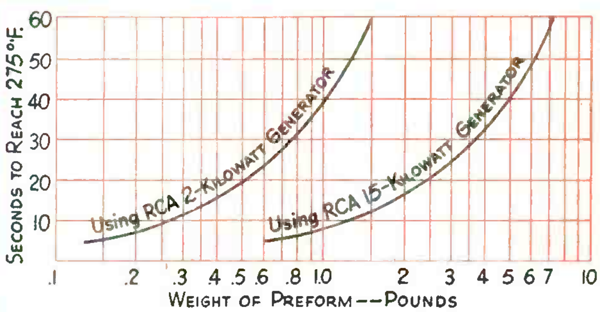

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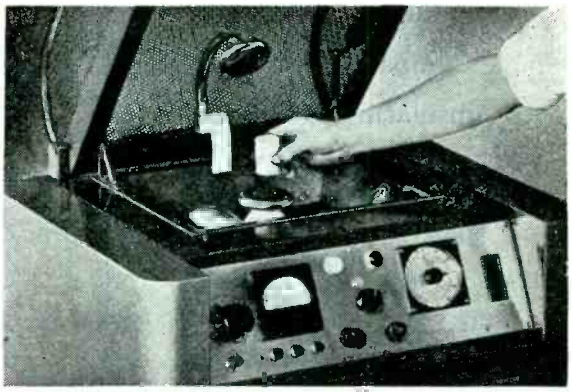

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der visible one hundredth of a microsecond.

The timing circuit for stationary film is shown at (a) in Fig. 4. A direct voltage of about 3 kv is applied to the outer electrodes of the double gap, whose spacings are set so that they are just above breakdown at this steady-state condition. The center sphere is normally at ground potential. Any disturbance in the circuit under test, such as the beginning of the surge to be measured, is transmitted to the center sphere through resistance or capacitance coupling. This sphere is temporarily thrown off ground potential which makes one of the gaps break down; flashover of the other side follows immediately as it now

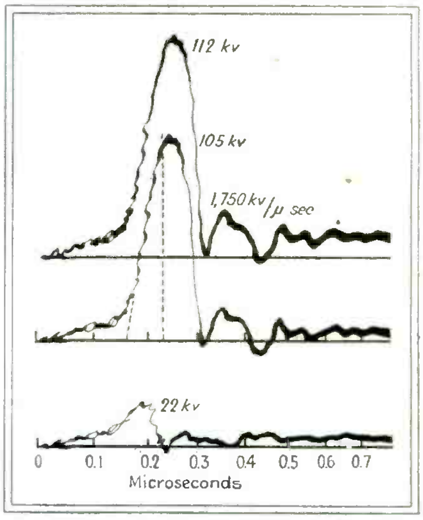

Fig. 2—This oscillogram of a dielectric strength test of a certain insulating part shows the effect of a rapid voltage rise. If a 60-cycle test voltage of 30 kv was applied to the specimen, flashover would occur along the outside surface. Such a test would invite the conclusion that the piece could not be punctured, but that the discharge would always take place along its surface. However, if the voltage is applied so fast that outside flashover has no time to develop, the discharge will force the much shorter but harder passage right through the material. On the first shot, the flashover occurred around the outside; the oscillogram discloses that the voltage had risen to 112 kv. At the second shot, no outside flashover was visible; the oscillogram shows it took 105 kv to puncture the material which probably had already been damaged by the preceding surge. The next oscillogram proves that the sample now definitely is punctured as the voltage collapses at 22 kv. This demonstrates that it takes a rate of voltage rise of about 1750 kv per microsecond to puncture this particular insulating member. This voltage rise is about 100,000 times as fast as that produced by the 60-cycle test and cannot be recorded by anything but a high-voltage oscillograph

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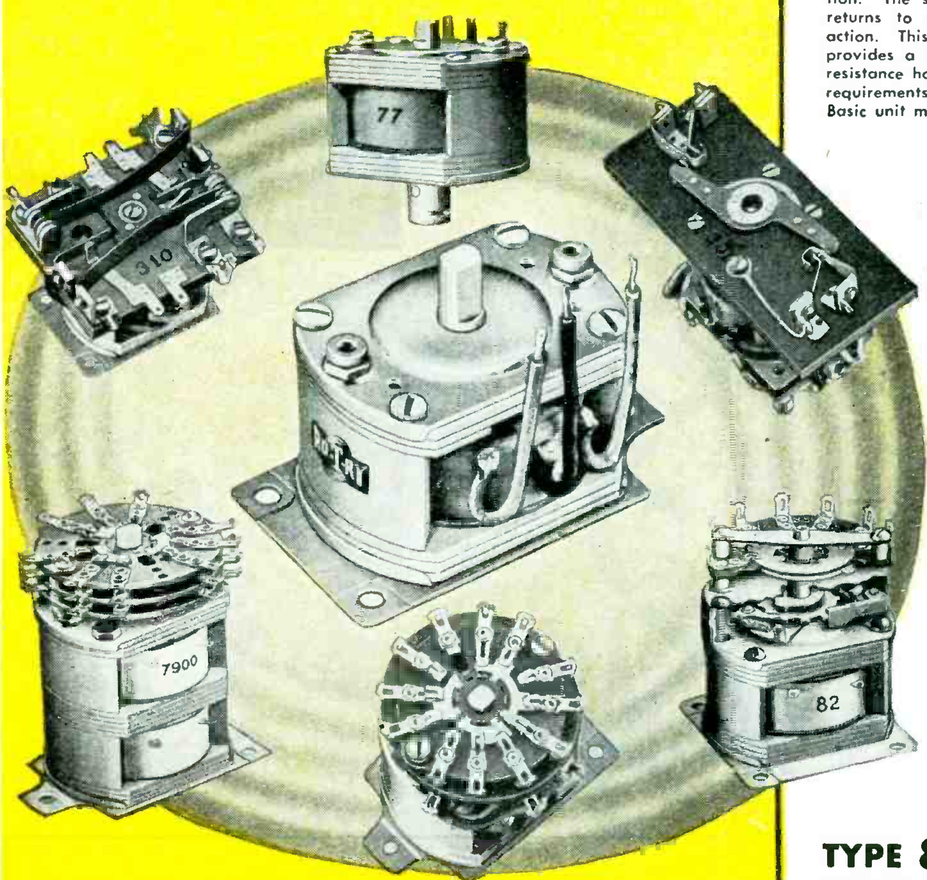

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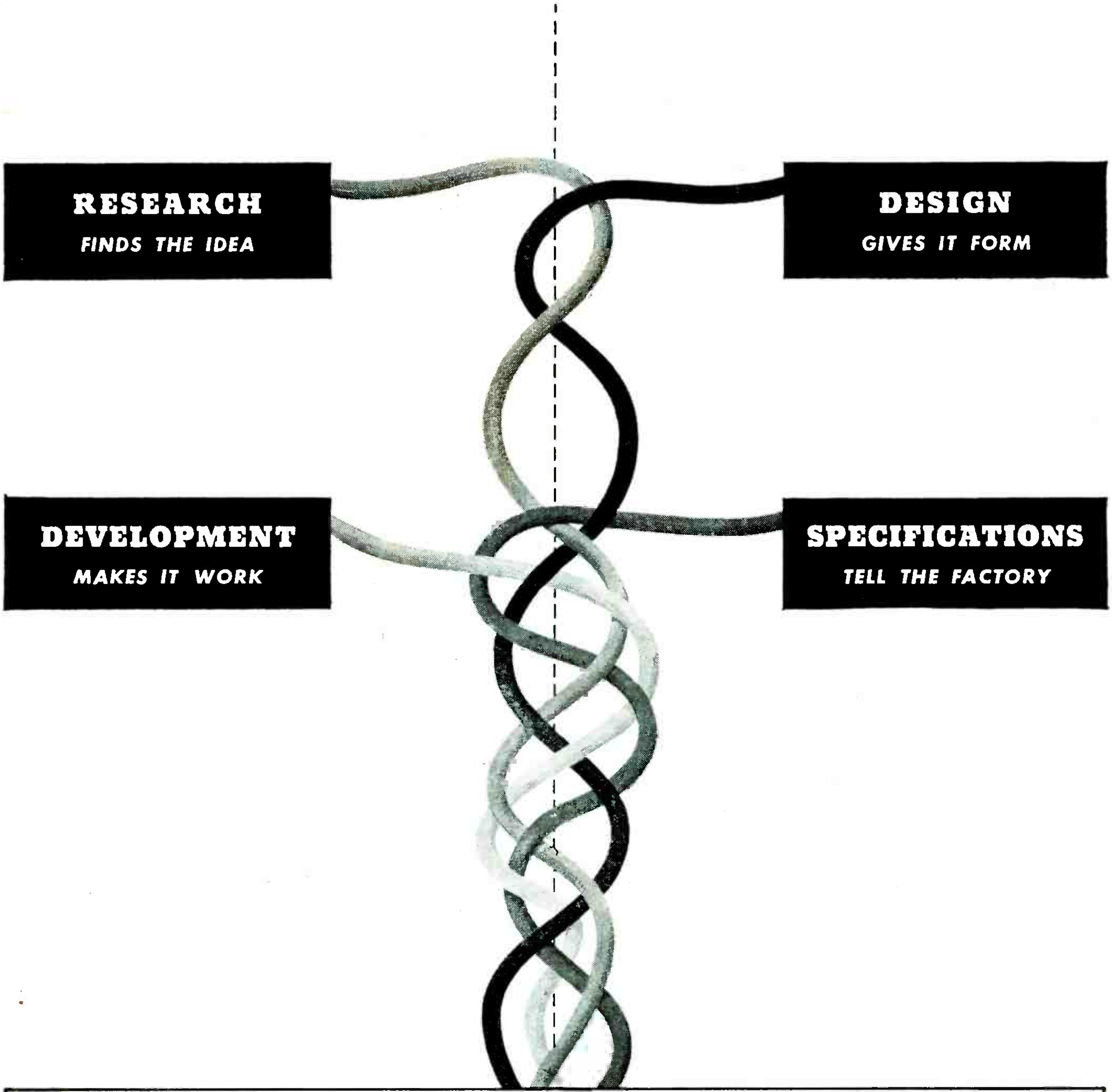

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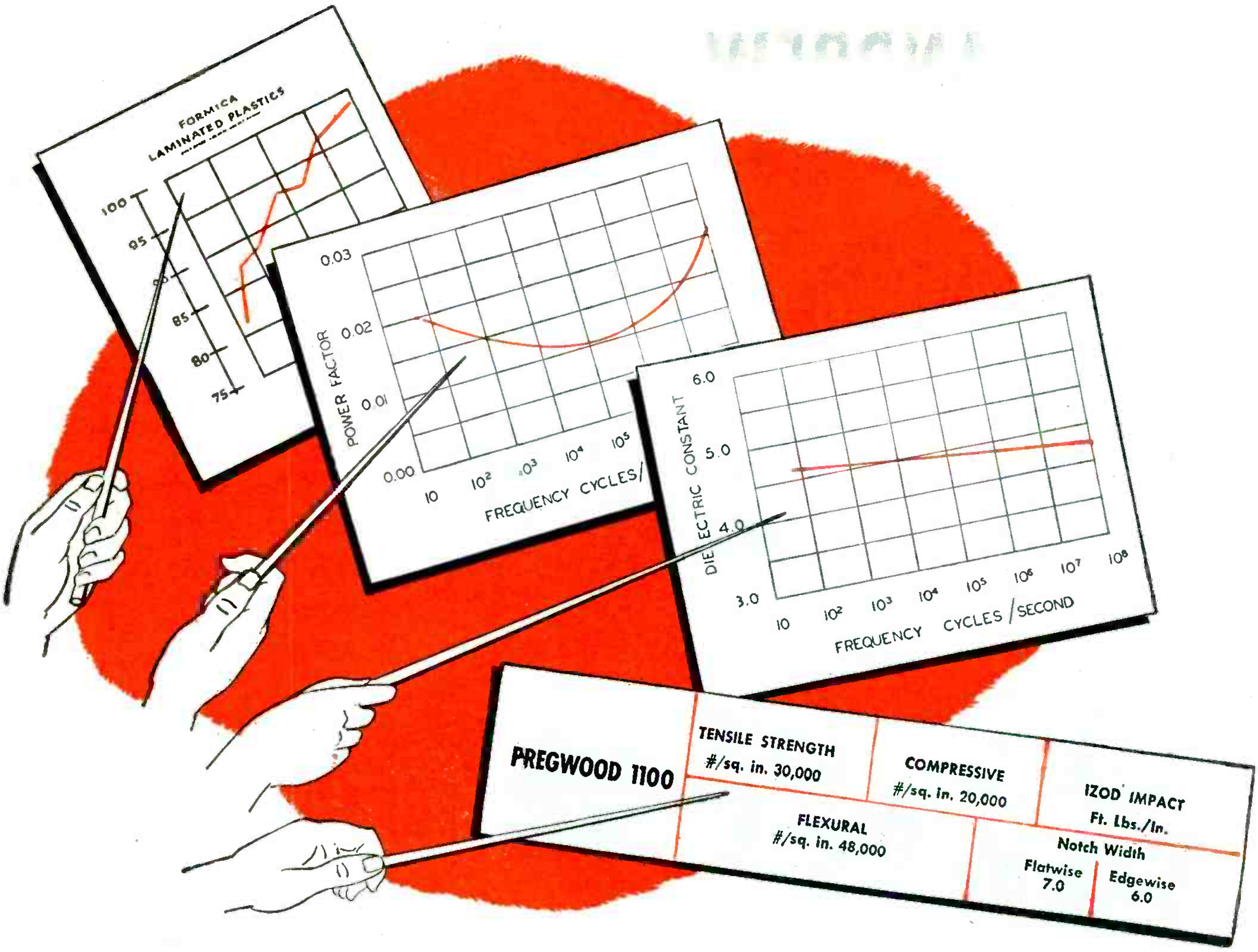

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is subjected to double voltage. The pair of C_1 capacitors discharges, causing the voltage at C_3 to rise at a definite rate which in turn produces the time sweep in the oscillograph. At the same instant, voltage is thrown on to the electrodes of the ray-blocking section by the discharge of capacitor C_2. This bends the beam around the target.

Sharpness of the electron pencil, high writing speed and accuracy in timing are not the only features required for high-quality recording. The oscillograms primarily must be true and free of distortion. In high-voltage laboratories, where voltages rise and collapse at the rate of hundreds of kilovolts per microsecond and where surge currents of thousands of amperes are discharged, spurious voltages and magnetic fields are a considerable problem. Their influence on the accuracy of measurements is reduced further if the measuring voltage applied to the deflecting plates is large in proportion to the spurious disturbances. A high voltage at the deflection plates in turn demands a much higher potential for generating the cathode beam because its speed, having been established by the cathode-anode accelerating potential, must remain essentially constant as it passes the fields of the deflecting electrodes; the latter should produce only a comparatively small lateral deflection. The measuring voltages would radically accelerate and retard it and deflect it beyond the limits of the recording space if they were of the same

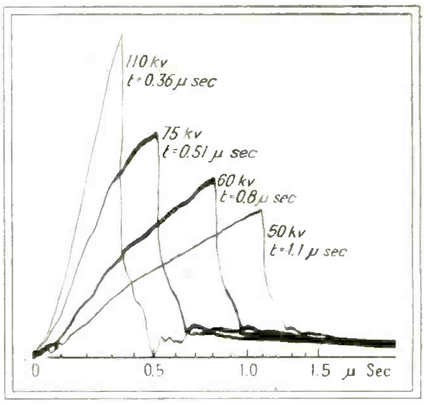
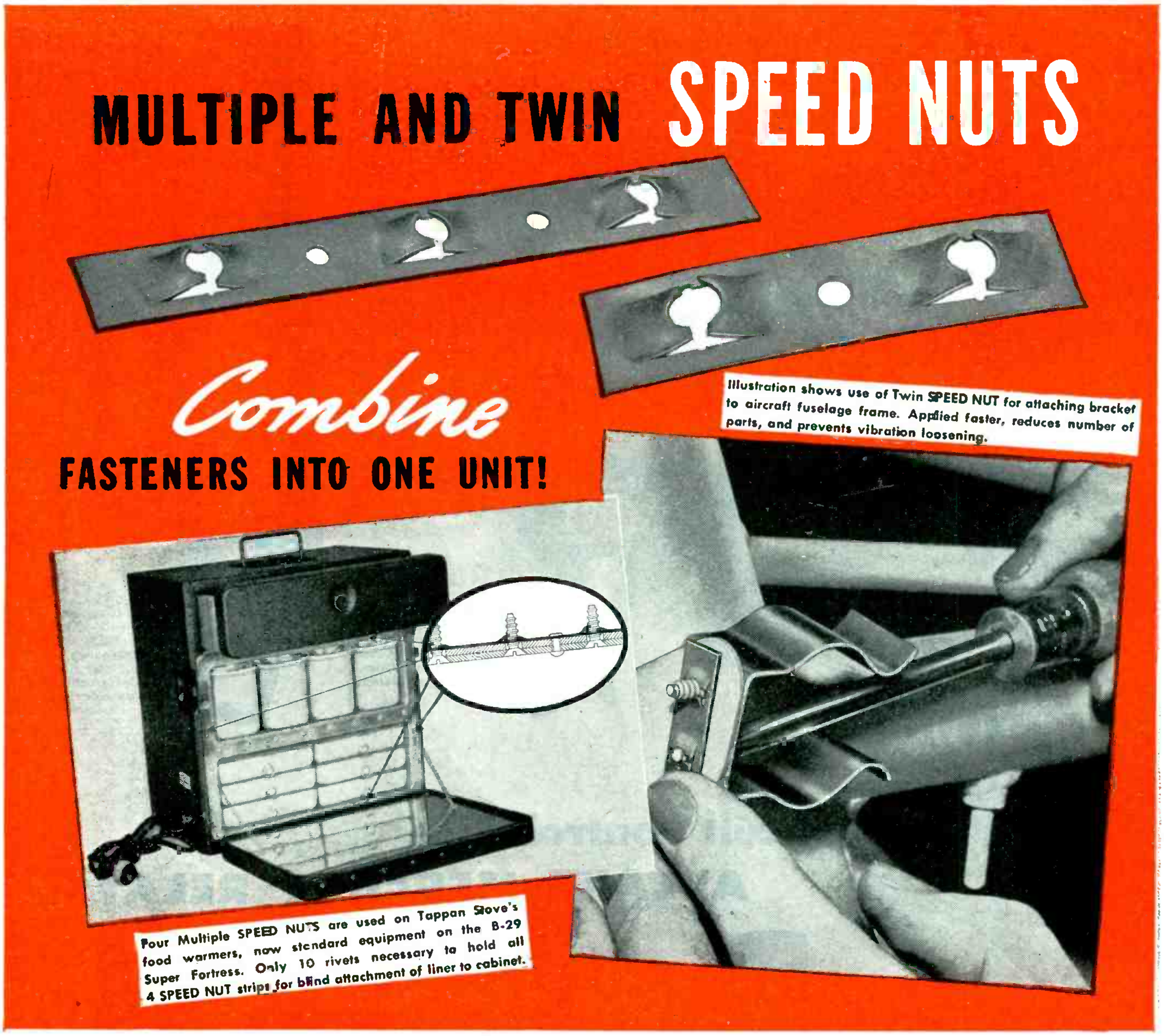


Fig. 3—Four tests of the sparkover time of a protective device at four different rates of voltage rise. The time sweep starts within less than 1/10 microsecond from the beginning of the surge



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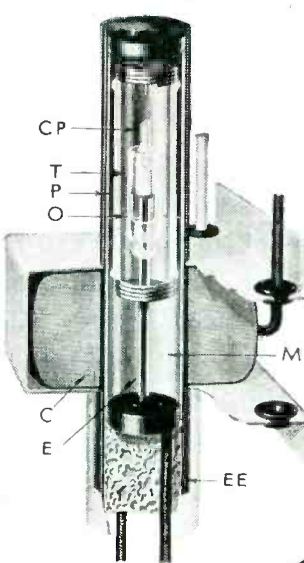

HOW THEY WORK

ENERGIZED—Coil **C** pulls plunger **P** down into mercury **M**. Mercury thus displaced enters thimble **T** through orifice **O**. Inert gas in thimble gradually escapes through ceramic plug **CP**, thus producing time delay.

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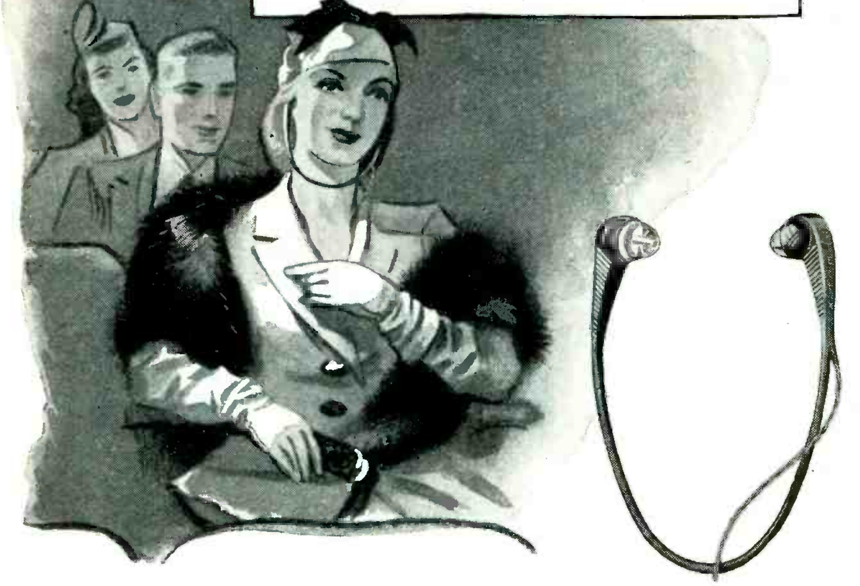


order as the beam-generating potential.

The pumped oscillograph with internal film also shows very desirable performance characteristics when it is used for long high-speed oscillograms obtained by means of the rotating drum (Fig. 5). In taking them, the cathode beam is deflected only in accordance with the measured voltage while the time scale is provided by the motion of the motor-driven drum. The drum periphery is 18 inches; hence, records 5 to 6 times as long as those possible on stationary film or screen are obtained in one revolution. The time scale is by no means as fast as that possible with stationary film as the maximum speed permitted by

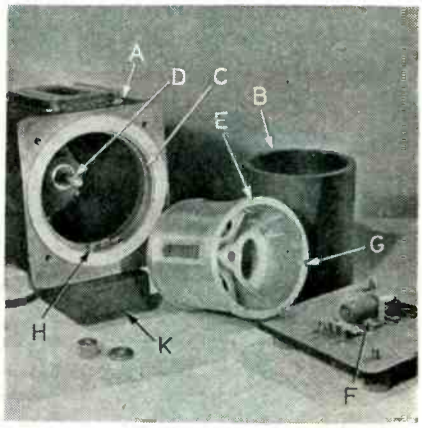
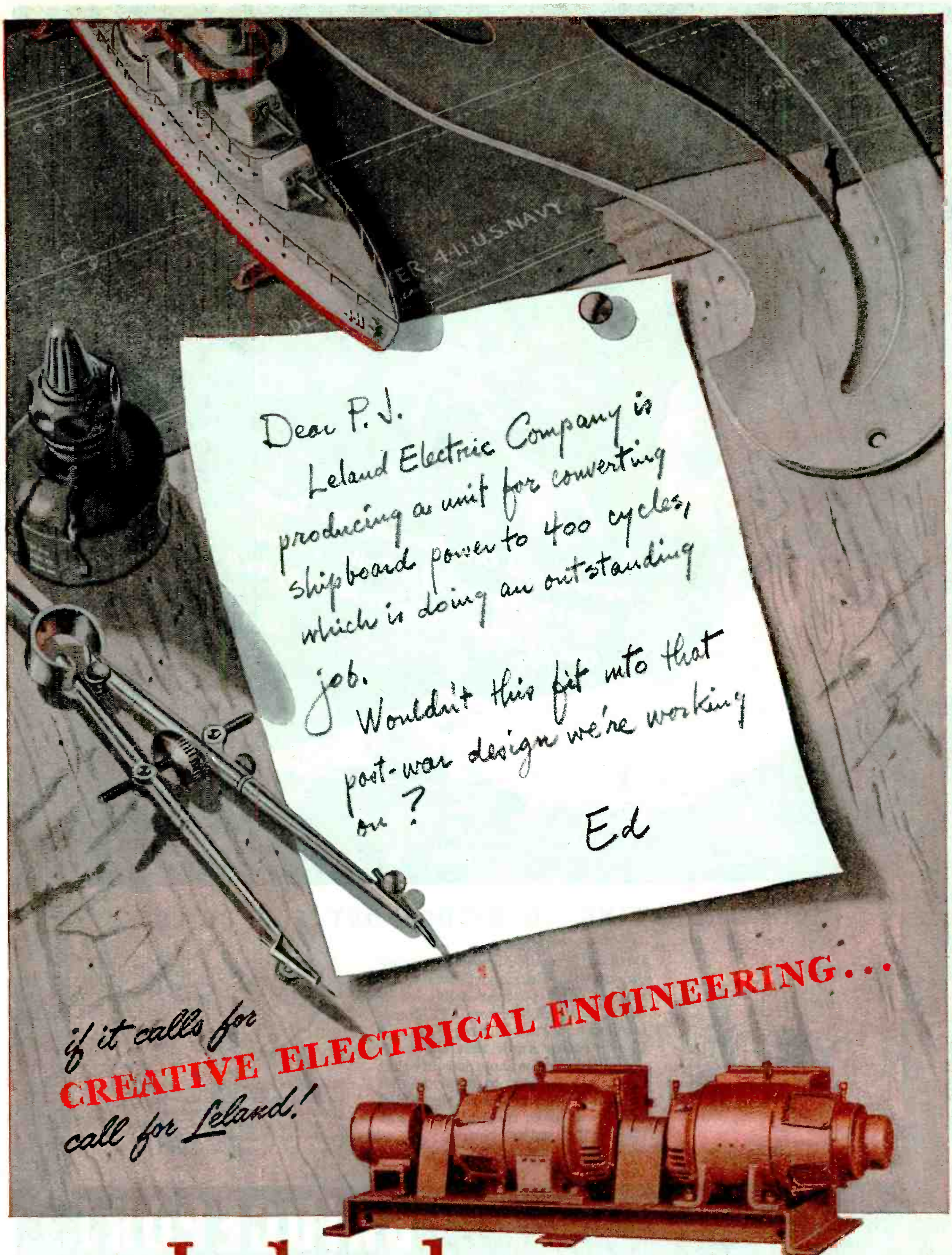


Fig. 5—(a) Film drum housing shown attached to the bottom end of the oscillograph in Fig. 1. Dark shield (b) is used to carry loaded film drum to oscillograph. Dark shield cylinder, containing the drum, is set into recess (c) and drum is pushed on to shaft (d). When dark shield is removed, drum is sealed against light by the close clearance between its rim (e) and the surrounding housing. For timing, light source (f), through slot (g) and tubes (h) will energize phototubes in container (k)

the strength of the film is about one inch in 1/2000 second.

If the rotating-drum method is employed with a sealed-glass tube, the image on the fluorescent screen must be photographed. With the time sweep remaining inoperative, the voltage deflection moves up and down along a fixed line. Therefore, the fluorescence due to one single deflection must be allowed to fade out before the same line can be retraced by the cathode beam. Otherwise, the oscillogram will be one continuous blur. Similar problems are encountered in television tubes and other field-scanning applica-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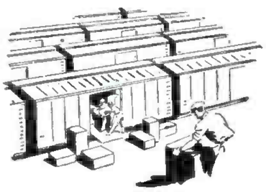

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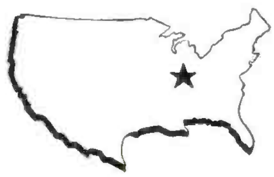

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Awarded to our Hicksville, L. I. plant for outstanding achievement in war production tions and have led to the development of low-retentivity screen materials. The latter, however, have a much lower light output and require the application of tubes with different screen characteristics when changing from high-speed stationary to rotating film recording.

In taking film-drum records of highly irregular voltage phenomena, it is important that the film be exposed for not more than one revolution because otherwise the superposition of traces would render it illegible. Single-revolution exposure of the drum regardless of speed is accomplished by the application of phototubes in combination with the regular ray-blocking scheme of the Westinghouse instrument (Fig. 4). In the ray-blocking section of the oscillograph tube, a metal tongue or target bars the electron beam as long as it is not deflected from the centerline of the instrument by a potential difference between the electrodes located above it. If a sufficient field develops between these electrodes, the beam moves off the target and an identical set of plates below the target brings it back on the centerline.

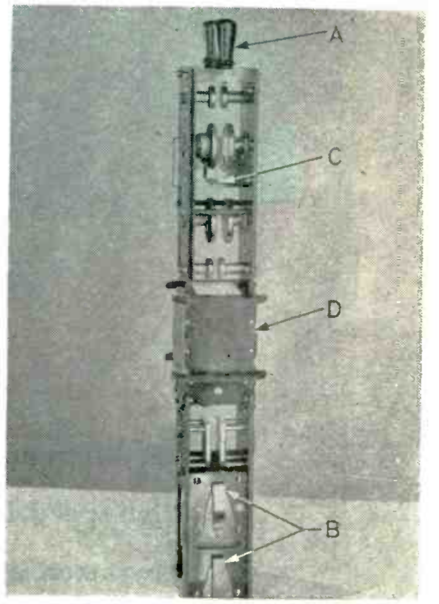

Fig. 6—By means of handles (a) temporarily inserted into its top plate, the frame carrying all beam deflecting elements can be pulled out of the oscillograph tube. Contact springs (b) connect the various electrodes to the bushings in the housing. Most parts can be identified by reference to Fig. 4. (c)—Target. (d)—Magnetic shield around main concentration coil

When closing the exposure button (lower corner of Fig. 4), the same

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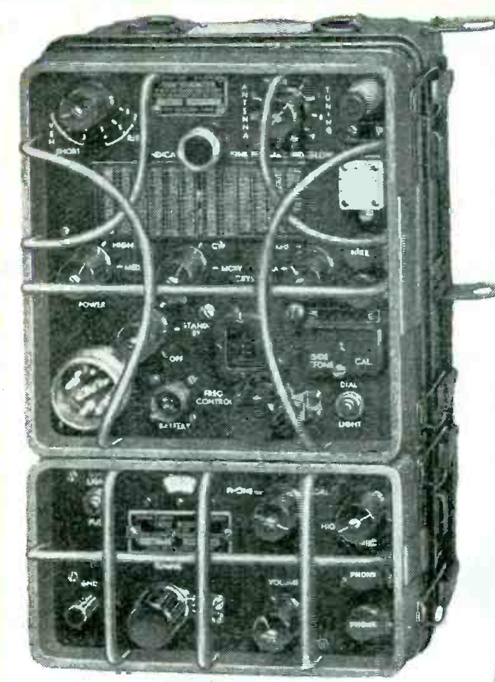
The Laboratory . . . here are born electronic weapons that are making history. Our American systems of army communications have proved mighty factors in our fighting successes, due primarily to the remarkable achievements of the Signal Corps Laboratories, known as SCGSA, comprising a chain of research units under one centralized supervision. At one of these Laboratory Units, Camp Coles (pictured above), was conceived the SCR-694, a compact, lightweight, highly versatile and efficient two-way radio telephone and telegraph outfit, for use in vehicles, as a portable ground station or front line command post.

It is a pleasure to give full recognition to the creative genius and organization of SCGSA and the really vital work it accomplishes, necessarily without public attention

E. N. Rauland

President, The Rauland Corporation



SCR-694 TRANSMITTER-RECEIVER

Weight 22 lbs. ★ range sufficient for vehicle use ★ waterproof and fungus proof ★ ideally adapted to jungle or sub-zero operation ★ powered by hand generator, gasoline engine or vehicular vibrator power supply ★ converted from vehicle to field use immediately.

Whether in a foxhole or jeep, in jungle or on the beach, in a tropical downpour, blizzard or surf, the SCR-694 can "take it." When its switch is pressed, this radio is ON THE AIR.

Quotes from field reports —from the Pacific:

"During a rainstorm the 694's were the only sets in one section that remained operative."

"The weight of the set, its construction, its features such as crystal control, etc., make it ideal for use in amphibious operations."

SCR-694 in operation with America's newest fighting unit in Central Burma.

Electroneering is our business

Photos courtesy U. S. Army Signal Corps

RADIO • RADAR • SOUND

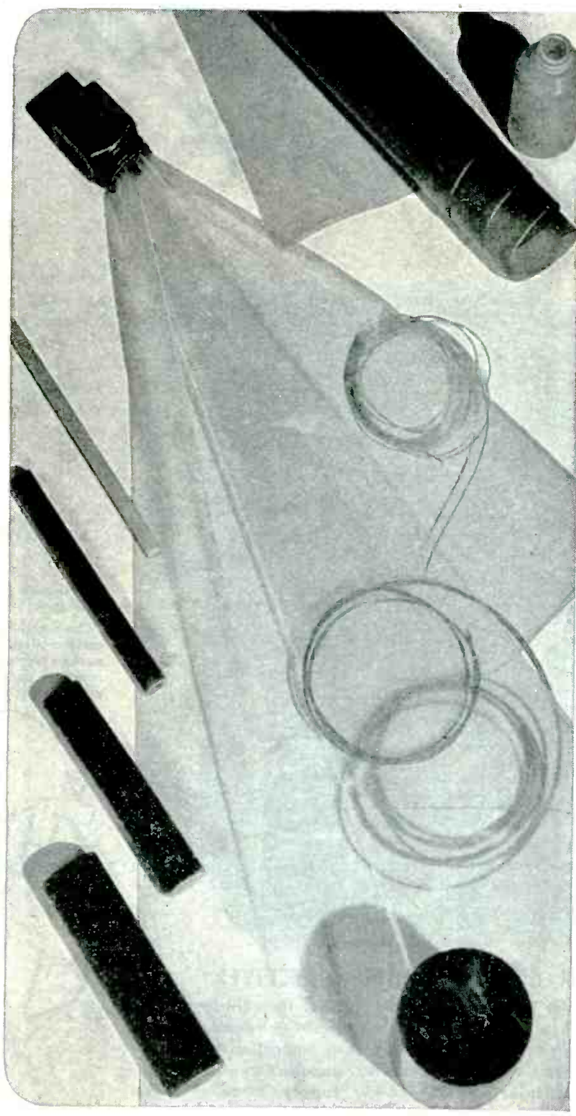
Rauland

COMMUNICATIONS • TELEVISION

THE RAULAND CORPORATION • CHICAGO 41, ILLINOIS

Rauland esteems it a high honor to have been selected by SCGSA for the development of SCR-694

DATA ON PLAX POLYETHYLENE PRODUCTS



Polyethylene is supplied by Plax in film, slab, rod, tube, fiber and blown ware forms, in a wide range of sizes and in all colors, from clear to pearlescent. The unusual characteristics of this material are as follows:

MECHANICAL

Elongation, 77°F, %	30-500
Tensile Strength, p.s.i. (−70°, 77°, 170°F)	5000; 1700; 700
Modulus of Elasticity in Tension, p.s.i. x 10^5	.146
Flexural Strength, p.s.i.	1700
Rockwell Hardness	13R
Impact Strength, ft. lbs. per in. of notch; ½" x ½" notched bar Izod tests, 4 ft.-lb. machine, room temperature	Does not break
Water Absorption, 24 hrs., %	0.01
Specific Gravity	.92

ELECTRICAL

Volume Resistivity, ohm, cms. (50% rel. hum. at 25°C)		10^{17}
Dielectric Strength, short-time volts per mil, ⅛ in. thick		1000
Frequency	Dielectric Constant	Power Factor
60	2.3-2.4	.0002-.0005
10^3	2.3	.0002-.0005
10^6	2.3	.0002-.0005

THERMAL

Distortion Temperature, °F	122
Softening Point, °F	219-239
Specific Heat, cal. per °C per gram	0.5
Burning Rate	Ignites and burns slowly
Thermal Expansion, 10^{-5} per °C	10.5
Thermal Conductivity, 10^{-4} cal. per sec. per sq. cm/1°C per cm.	7

CHEMICAL EFFECTS

Weak Acids	None
Strong Acids	None
Weak Alkalis	None
Strong Alkalis	None
Alcohols	None
Esters	Slight
Ketones	Slight
Hydrocarbons	Considerable

The outstanding electrical properties, toughness and resistance to moisture of Plax polyethylene products adapt them to a vast range of uses. For data on sizes and adaptability to specific applications, write Plax.

The following illustrated literature is available:

Several bulletins on Plax polystyrene products and how to machine them.

Data on Plax cellulose acetate, cellulose acetate butyrate, and methacrylate products.

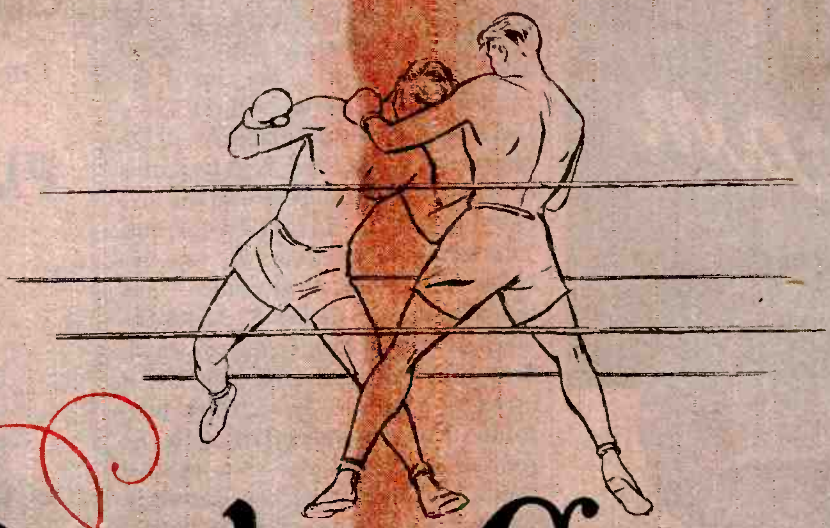
An article on Plax's blown products.

Ethyl Cellulose and styramic are among the other materials offered by Plax in various forms. In cooperation with the Shaw Insulator Company, Irvington 11, N. J., Plax can give you help covering nearly all plastic materials and methods. For such help, or for any of the literature listed above . . . write Plax.

PLAX

FOR PLASTICS

NOT SUBSTITUTES···IMPROVEMENTS



Quality Counts

In 1892, James J. Corbett beat John L. Sullivan to win the heavyweight championship of the world. Corbett, who was considered a novice in the ring, weighed only 186 pounds to Sullivan's 220, and yet he knocked out Sullivan in the 21st round. Corbett had that touch of quality—of extra quality—that expressed itself in victory. For superior performance in any product—just as with Victory in the prize-ring —*Quality Counts!*

For years, the antennas manufactured by THE WARD PRODUCTS CORPORATION have been known as quality products, the workmanship of craftsmen using modern equipment under ideal conditions. Constant adherence to the principles of quality coupled with manufacturing experience has made WARD the leader in the production of sectional and one-piece antennas . . . For quality antennas for all applications, look to WARD.

WARD Antennas

BUY WAR BONDS

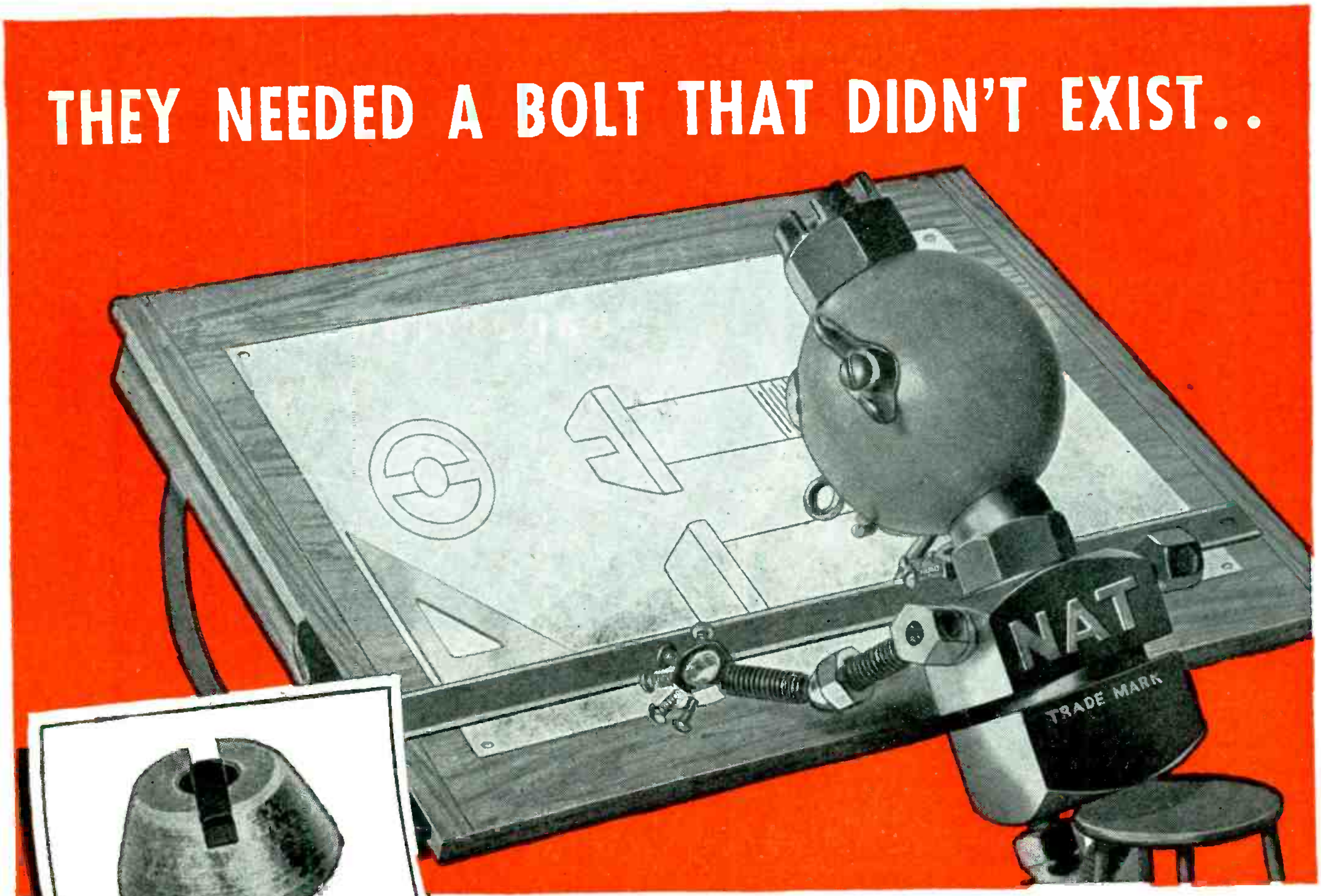
THE WARD PRODUCTS CORPORATION
1523 East 45th Street
Cleveland 3, Ohio

potential of about 1000 volts is applied to all ray-blocking electrodes; there is yet no field between them and the beam remains cutoff. However, when the slot in the rim of the rotating drum permits light from the lamp inside the drum to strike phototube No. 1, the negative bias of triode No. 1 collapses and the circuit branch R_1, R_2 carries current. The voltage drop across R_1 now unblocks the beam. At the same time, the voltage drop across R_2 raises the level of the voltage source which first kept the grid of triode No. 2 strongly negative. Now, when phototube No. 2 is energized again by light through the slot (one revolution after the process was started in No. 1), the collapse of its potential is sufficient to make the grid of triode No. 2 positive. This starts current through R_3 which practically cancels the potential difference between the opposing ends of R_1 and R_3 and hence retraps the beam.

Construction

The cathode tube of the unit is constructed of seamless steel tubing joined with high-grade iron castings; the latter are visible in front of the center of the steel cabinet. They contain the rotating film drum, the stationary film holder and the fluorescent screen. All accessories, including the 50-kv cathode voltage supply, are housed in the same cubicle. The pumps, consisting of an oil pump for the fore-vacuum and a mechanical, grooved cylinder-type molecular pump, exhaust the instrument in about 10 minutes to a hard vacuum at which no discharge can form between the anode and the cold cathode. The latter consists of a small aluminum cylinder without any heater. The electron pencil is formed through ionization by collison. This requires a definite gas pressure which is controlled by air admitted through the leak valve. The latter reduces air of atmospheric pressure to the required vacuum which ranges from 5 to 15 microns depending on the desired beam current. Despite the high reduction in pressure accomplished with the valve, the latter is very sensitive to small changes in atmospheric pressure. Small variations of the intake pressure can readily be produced by taking the

THEY NEEDED A BOLT THAT DIDN'T EXIST..



So we designed a Special Bolt..

The right fastener for the job!

Here's another typical example of National's Technical Service—a special fastener designed for the particular application when standard fasteners don't meet the need:

In a certain rubber molding operation a bolt was required that could be pulled up tight and used for many applications. Extra large bearing surface was needed, as well as exceptional strength and high "torquing" capacity.

We designed the bolt of alloy steel, with a specially formed slot which permits use of a reinforced driver. This prevents slipping or shearing of the driver point. The large diameter at the base of the head affords ample bearing surface, while the tapered sides reduce the amount of metal in the head, making it possible to upset the bolt, an important cost factor.

You may need just such a service as this to improve your fastenings. Often we can save production time and cost by upsetting a part instead of milling from bar. Let us have your inquiry.

Send for a copy of this case history booklet describing briefly, with diagrams, typical instances of National's Technical Service. Ask for the "Savings" booklet.

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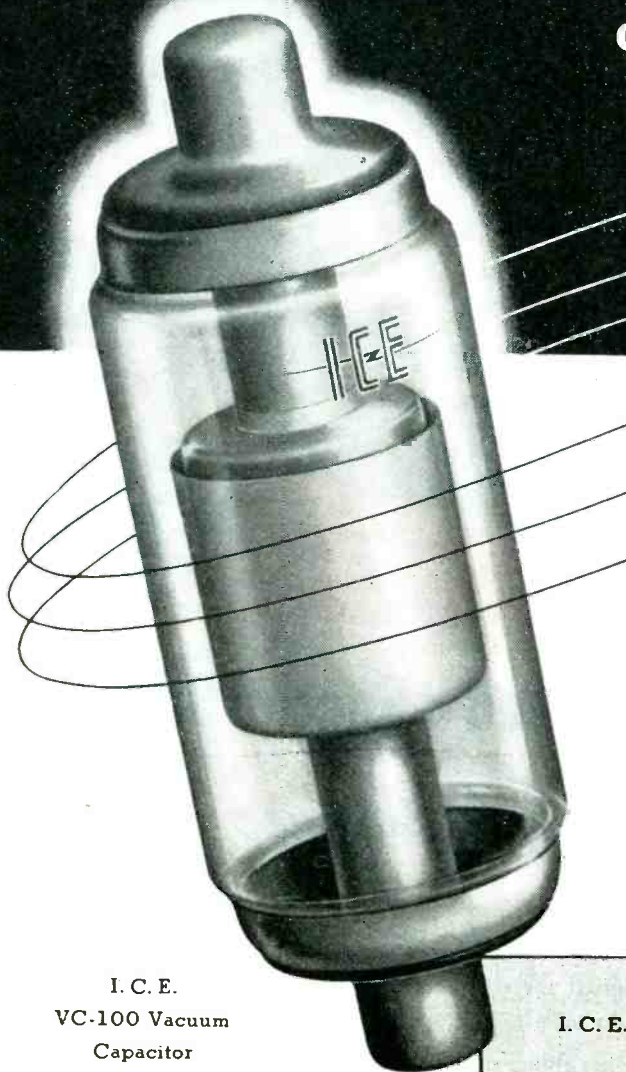
ONLY I.C.E. VACUUM CAPACITORS give you the precise capacitance value you want



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VC-100 Vacuum
Capacitor

Now I. C. E. makes it possible for you to order vacuum capacitors with the correct capacitance value to meet requirements of your equipment. I. C. E. Vacuum Capacitors are now available in any value range from 6 to 110 mmfd. in steps of 1 mmfd.

I. C. E. Vacuum Capacitors Give You Close Tolerances

Beside offering you a wide range of capacitance values, I. C. E. Vacuum Capacitors are built to give you previously unobtainable tolerances.

I. C. E. PRECISION GRADE VACUUM CAPACITORS

Value Range	*Accurate to*
6 mmfd. to 25 mmfd.	±0.5 mmfd.
26 mmfd. to 60 mmfd.	±1.0 mmfd.
61 mmfd. to 110 mmfd.	±1.5 mmfd.

I. C. E. XX GRADE VACUUM CAPACITORS

Value Range	*Accurate to*
6 mmfd. to 25 mmfd.	±0.2 mmfd.
26 mmfd. to 60 mmfd.	±0.3 mmfd.
61 mmfd. to 110 mmfd.	±0.5 mmfd.

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air from a chamber rather than directly from the atmosphere. The pressure in this chamber can be finely varied by the screw-controlled expansion and contraction of a set of bellows. The device can remain set in any particular position for a long time as the rate of air flow through the leak valve is very small.

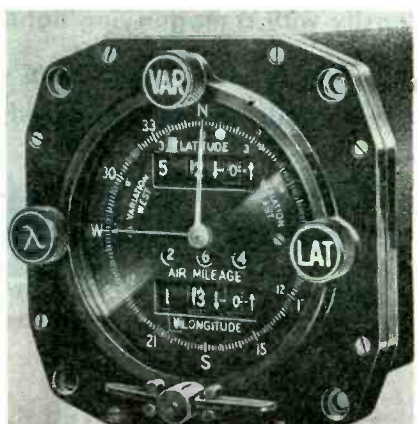
This and other means for furthering ease of operation and reliability, developed through years of use in high-voltage laboratories and on factory test floors, have made the high-voltage electronic oscillograph the instrument which now finds application in new branches of engineering such as the field of airplane engine ignition.

• • •

Automatic Position Indicator for Aircraft

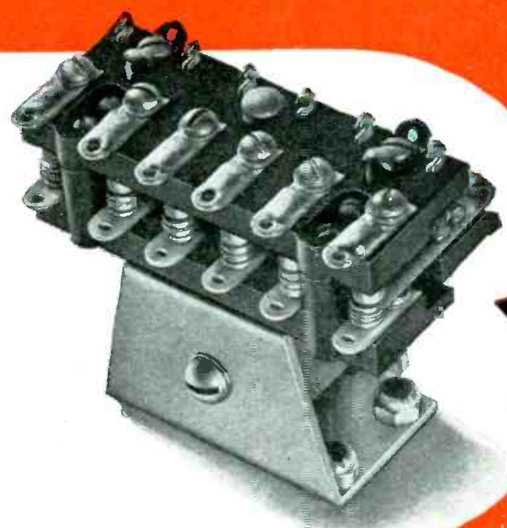
ONE REASON for the success of the bombing raids on Japan is the use of an automatic position indicator that gives continuous indications of latitude and longitude while in flight. These are shown on the instrument panel compass dial shown in the illustration. The unit was developed by engineers of Eclipse-Pioneer Division of Bendix Aviation Corporation in cooperation with the Army and Navy air forces.

The air position indicator, called API, combines the rotational speed of the true airspeed pump with the directional signal from the compass and produces continuous indication of the air plot in latitude and longitude. Proper application of the wind vector (the distance by which the air mass has moved over a specified



Closeup view of the panel indicator showing the counters for latitude and longitude change and air mileage

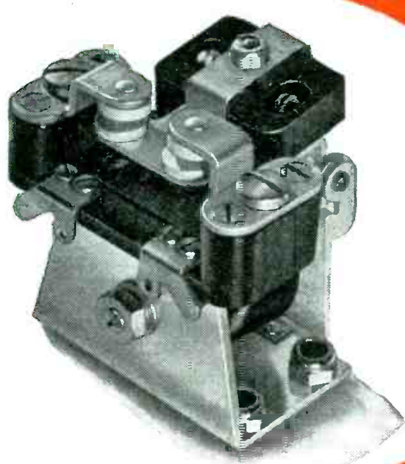
Here is *advanced* Relay Engineering!



TYPE BN

The Allied 6-pole, double-throw BN type embodies many new improvements for heavy duty 6-pole switching . . . permits individual adjustment of contacts. Molded Bakelite is used throughout the relay. Contacts are rated at 10 Amperes. As in all Allied relays, the BN is designed for compactness and minimum weight. May be furnished normally open or normally closed or double-throw. Available in AC or DC. Weighs 11 oz. Write for complete operating characteristics, etc.

Height: 2 9/16" Length: 3" Width: 1 23/32"



TYPE CN

The CN relay is the result of advanced engineering technique and succeeds Allied's successful AN type . . . a power relay expressly designed for breaking heavy current. Contact rating is 50 Amperes at 24 Volts DC with silver contacts; with alloy contacts the contact rating is 75 Amperes at 24 Volts DC. *(The latter arrangement with the alloy contacts is known as the CNS type.)* The contact arrangement is single pole, single throw, double break, normally open or normally closed. The new design incorporates molded Bakelite insulation, greater electrical clearance and over-all improved mechanical structure. Available in AC or DC. Complete data on request.

Height: 2½" Length: 2¼" Width: 2"

The two relays described above are typical examples of the many new types of relays Allied is constantly designing for its customers' widely diversified requirements.

Allied's engineering staff continually works to improve relay designs and to develop new magnetic control devices for present and future manufacturers whose products require electrical control. The highly practical accumulated knowledge of these men is at your command. Send us your control problems!

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FACTORIES: NEW YORK CITY • PLANTSVILLE, CONN.

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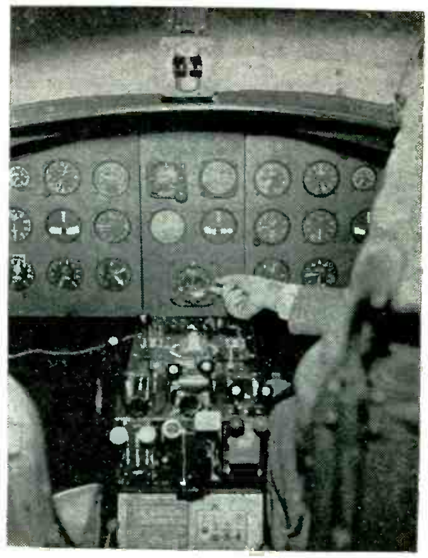
ALLIED CONTROL COMPANY, INC. • 4321 NORTH KNOX AVENUE • CHICAGO 41, ILLINOIS period of time) to this air position yields ground position. The readings of latitude and longitude appear on the two drum-type counters, which are initially set to the proper latitude and longitude of the take-off point and can be reset anytime when passing over a check point in flight. The indicator, more specifically called the computer, also registers total air miles traveled and has a compass dial and pointer which must necessarily indicate heading with respect to true north.

Corrections

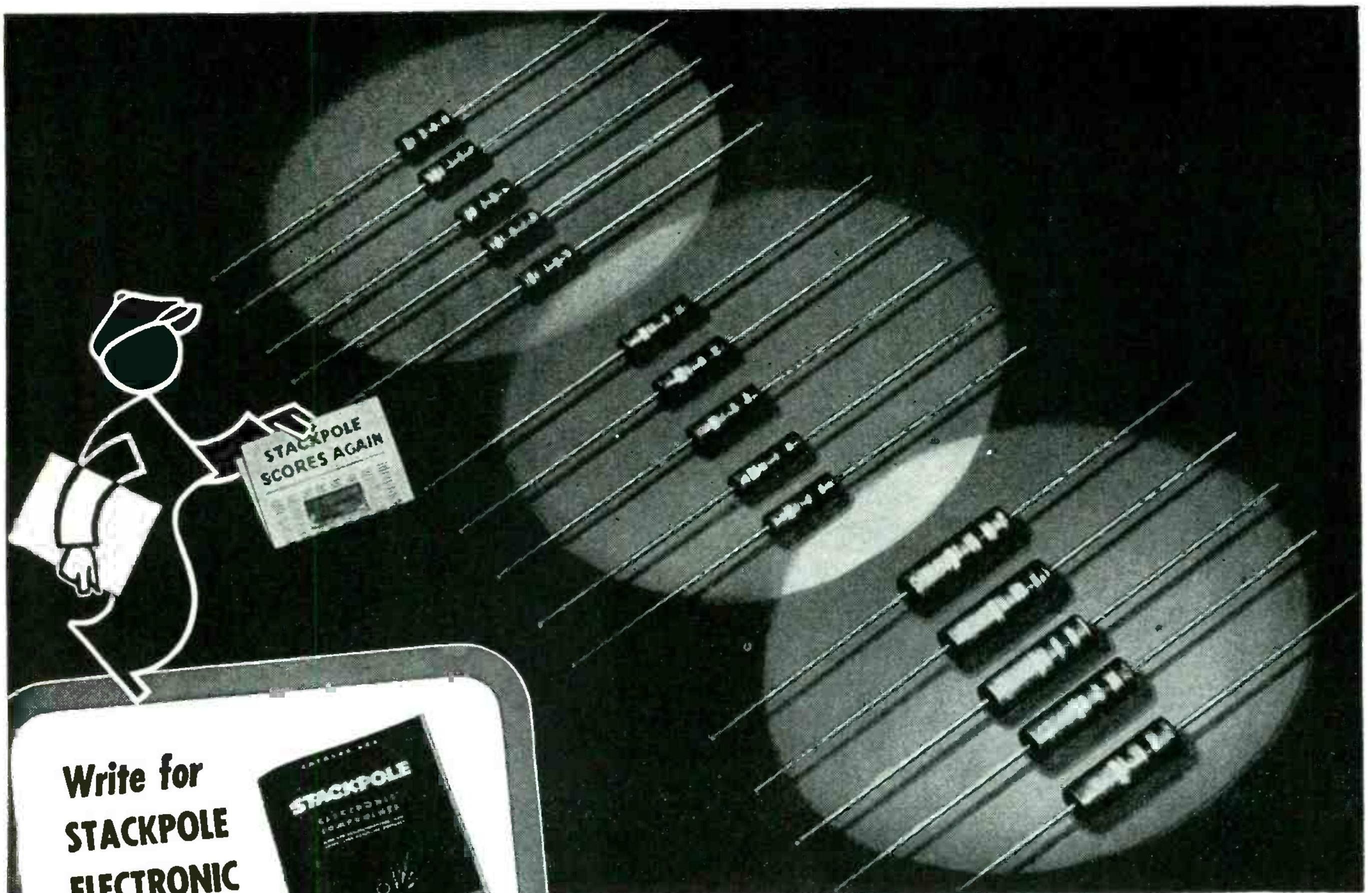
Operation of the instrument consists of checking the compass, energizing the API, and setting the counters to the proper latitude and longitude before take-off. During the take-off run, the true airspeed pump begins to operate at about



API installed on a typical aircraft instrument panel to provide continuous readings of latitude and longitude

seventy or eighty miles per hour, and the API then swings into operation. Magnetic north variation must be set in manually a degree at a time as the flight progresses, in order that the compass input reference is true north for resolution into geographic coordinates.

Wind can be determined by the API itself by noting the difference in air position as read on the API and ground position as determined by a check point, after flying for about forty minutes from a point where the API was set to ground position. The wind thus determined can be used for future flying



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Whether for today's needs or post-war engineering, write today for your copy of this 36-page Catalog RC 6 replete with helpful engineering data.

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LINE, SLIDE, ROTARY ACTION SWITCHES

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INSULATED RESISTORS

Designed to Match War Standards Specifications

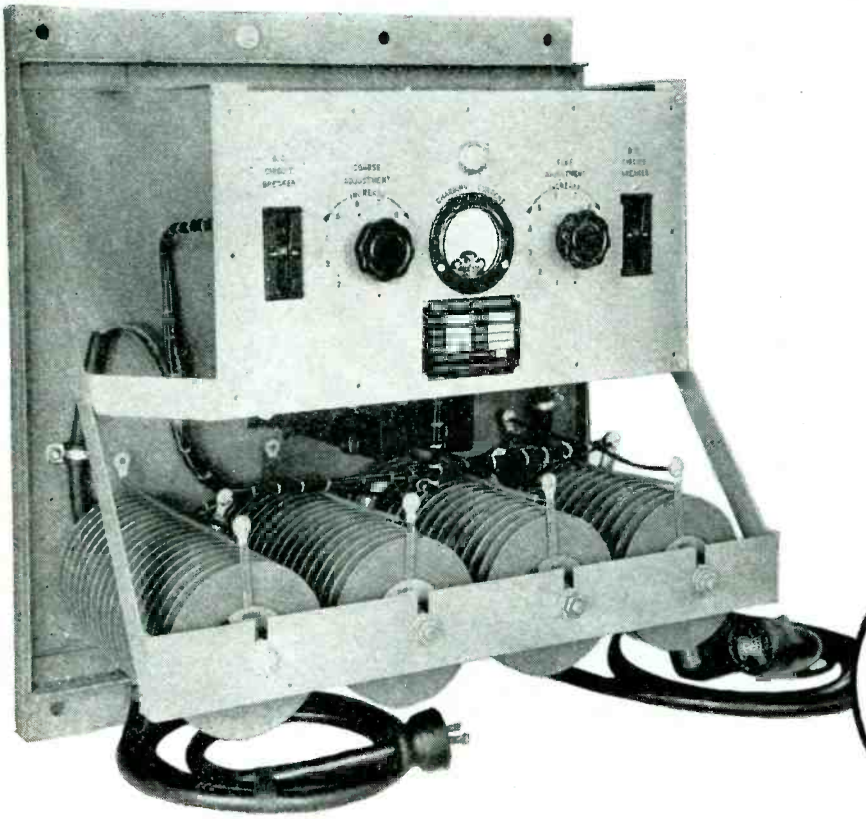
Integrally molded in one operation under laboratory controlled production standards, Stackpole Type CM Resistors in 1/3-(RC-10): 1/2-(RC-21): and 1-watt (RC-30) sizes have been specifically designed to meet the newly issued Army-Navy specifications. The construction of these new resistors is such that they offer an exceptional degree of stability under load—the average change being less than 5% after 1000 hours under test at full load. In addition to having highly satisfactory humidity characteristics well within today's exacting requirements, Stackpole Type CM Insulated Resistors meet up-to-the-minute salt water immersion specifications.

Samples to any required tolerance on request.

STACKPOLE

STACKPOLE CARBON COMPANY, ST. MARYS, PA.

This New *LOW RIPPLE* D C Power Supply is a Trim, Businesslike Job!



Close-up of the Federal Telephone and Radio Corporation FTR-3106-S combination battery charger and DC power supply shows the simplicity and neatness of internal wiring, protected by Natvar Grade A-1 Tubing.

Federal's new FTR-3106-S is flexible. Used as a power supply, it will furnish direct current from 5 to 80 volts in 121 steps, at 12 amperes, maximum. As a battery charger it will handle from 1 to 24 two-volt storage cells at a maximum current of 12 amperes.

Selenium Rectifiers — pioneered by Federal — provide the efficient, dependable means of converting single phase AC power to DC power. Conservative design which eliminates the need for fans or other moving parts, plus heavy overload capacity, along with the wide voltage range makes it suitable for a variety of laboratory and experimental work, as well as a rugged source of rectified DC for production equipment.

Natvar flexible tubing is used to protect the wiring of FTR-3106-S because of its high dielectric and mechanical strength, and because of its high uniformity.

What are your insulation requirements? Write, wire or phone us for deliveries, either from stocks located near you or from our own.

Natvar

- Varnished cambric — straight cut and bias
- Varnished cable tape
- Varnished canvas
- Varnished duck
- Varnished cellulose acetate
- Varnished special rayon
- Varnished Fiberglas cloth
- Varnished papers
- Varnished tubings and sleeving
- Varnished identification markers
- Lacquered tubings and sleevings
- Extruded vinyl tubing
- Extruded vinyl identification markers

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. . . If your V-Day products will require dry batteries, be sure to include Ray-O-Vac in your plans. The know-how that has solved so many portable power problems for the armed forces can be of great value to you. Ray-O-Vac engineers are at your service. Write Dept. I-A.

RAY-O-VAC COMPANY, MADISON, WISCONSIN

OTHER FACTORIES AT CLINTON, MASS., LANCASTER, O., SIOUX CITY, IA., FOND DU LAC, WIS., MILWAUKEE, WIS until a wind shift is suspected or observed, and is frequently more suitable than a wind determined by double drift because the latter is a spot wind whereas the former is an average wind.

Main Units

As in use by the Army Air Forces today, the system consists of the compass, the pump, the controller, the electronic amplifier, and the computer.

The pump consists simply of a d-c series motor with a centrifugal blower or fan mounted on its shaft. This has a compartment around it for circulating outside air in order to maintain it as nearly as possible at outside air temperature. Static pressure of the outside air is led into the axis of the centrifugal blower, which generates a differential pressure above this static pressure as it runs. The motor also carries a gear reduction to which is connected the output shaft to the computer.

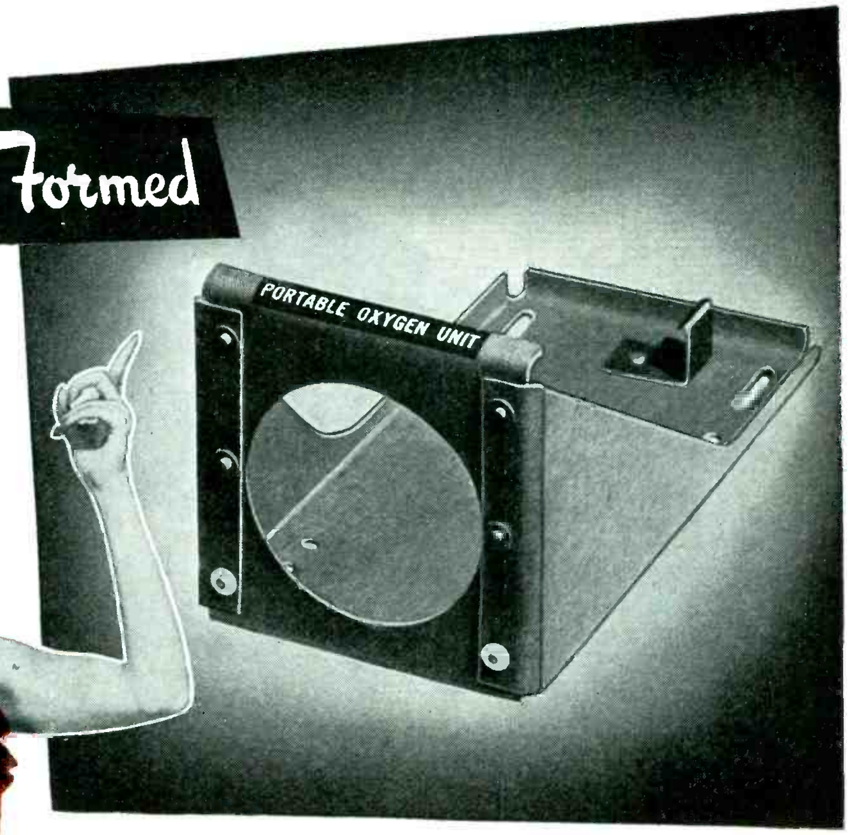
The pressure generated by the pump is fed into one diaphragm in the controller. The other diaphragm in the controller receives pitot pressure, and together these two control a switch to the driving motor in the pump. In attempting to keep the pressures in these two diaphragms matched, the pump speed varies with pitot pressure, and in doing so its speed of rotation is directly proportional to true airspeed.

The rotational speed from the pump motor is fed into the computer, which employs the well-known ball-disk integrator scheme. The pump motor actually drives two disk-plates, one for latitude and one for longitude. The latitude disk plate drives by friction a ball, which in turn drives a cylinder geared directly to the latitude counter. The speed and direction of rotation of the cylinder, and of the counter, is directly proportional to the speed of the disk plate and the radial position of the ball on the disk plate. This radial position is determined by the input compass signal through the API amplifier. The latitude counter is driven in a similar manner.

Aid to Navigator

When properly operated, the air

Beautifully Formed



Formed in a single operation

with Post-Formed Phenolite, this portable oxygen unit support used in B-29 Super-Fortresses illustrates a revolutionary new development in laminated plastics.

Post-Formed Phenolite*

Offers You New Possibilities for Profitable Post-War Products

Here, through a new development in laminated phenolic plastics, a whole new avenue of applications is opened for you . . . new potentialities for successful post-war products.

Economical to produce, Post-Formed Phenolite parts are made by heating the sheet material for a few seconds and forming in an inexpensive wooden mold with standard press equipment. In a matter of minutes, practically any shape or form may be obtained—without sanding or removing "flash." Fabrication may be done before or after the forming operation.

Phenolite is light in weight (about half the weight of aluminum) . . . is an excellent electrical insulator . . . has remarkable mechanical strength . . . possesses good machinability . . . and is highly resistant to moisture. This unusual combination of properties makes it a versatile material suggesting an almost endless number of industrial applications.

Now used almost exclusively for structural parts in aircraft—demonstrating its stability under varying atmospheric conditions—Post-Formed Phenolite is being supplied for important war purposes only. But, in it, you'll find countless possibilities for profitable peacetime products. Write today for further information and the assistance of one of our trained technical men in planning your post-war projects.

*A formable thermosetting sheet material

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A LOWER COST of MANUFACTURING
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You can save time, grief and money by utilizing our specialized facilities for producing wiring assemblies, flexible leads, and other cable products . . . Furthermore, the economies gained will be big factors in enabling you to lower your cost of manufacturing...No job is too complicated for us. Our experience is broad, and our production facilities are adequate . . . During the past 25 years we have supplied cables to manufacturers of a widely diversified list of products, and our present-day facilities should be of great value to makers of trucks, tractors, trailers, tanks, radios, electric ranges, hot water heaters, airplanes, ships, electric appliances, battery chargers, scientific equipment, and many other items . . . In addition to an engineered wiring service, Whitaker also offers a quality line of standard cable products... We cordially invite you to write to us.

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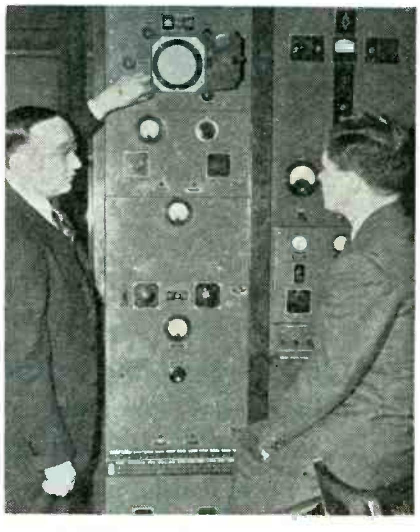
position indicator gives the navigator a continuous indication of his air plot. However, it cannot be called an automatic navigator and was never intended to replace the navigator. Its purpose is to act as an aid to the navigator, to do his job of dead-reckoning for him when his other means become impossible as during evasive action, to carry on for him over limited periods of time when he must leave his work to do other jobs such as operate guns. Such other functions include keeping account of distance traveled between celestial shots, determining winds, and aiding in computing gasoline consumption and range. It can also be used on long straight flights but is really not necessary because of the simplicity in performing such a task with elementary instruments.

• • •

50,000 Hours for C-R Tube

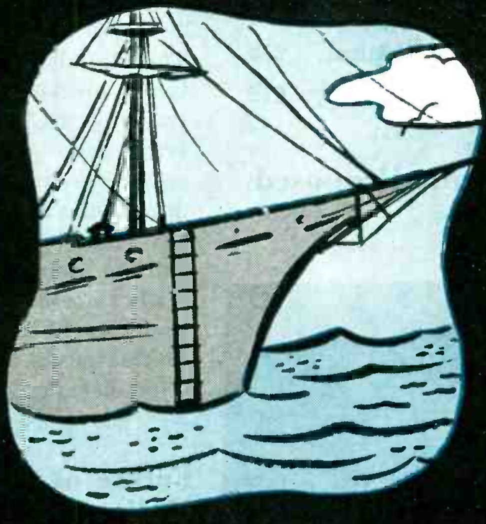
INSTALLED IN the WCAE, Pittsburgh, transmitter in August 1939, an RCA type 904 cathode-ray tube is still operating as well as it did five and a half years ago.



At WCAE, Pittsburgh, chief engineer James Schultz shows the long-life cathode-ray tube to J. H. Keachie of RCA. Installed more than five years ago in the modulation monitor, the tube still provides clear patterns on its screen

This amounts to a service record of 50,000 hours, better by a year and a half the service given by the previous RCA 904 tube, the original tube installed in the transmitter in 1935. This tube operated continuously for four years and was then replaced by the present tube which had been held as a spare replacement.

Solving DESIGN • MANUFACTURING AND PRODUCTION PROBLEMS *is a Franklin Forte!*



TRY YOUR KNOW-HOW ON THIS ONE!

A rope ladder ten feet long is hanging over the side of the ship. The rungs are a foot apart. The bottom rung is resting on the surface of the ocean. The tide rises at the rate of six inches an hour—when will the first three rungs be covered with water, and why?

The answer to this one will be given in next month's advertisement or in reply to your written query. But don't give up, it's simple to solve as is our ability to solve your design, fabricating, production and assembly problems.

Millions of Franklin products, in use, daily attest to their inherent qualities of design manufacture and production... low priced, yet sturdy and long life... performers... designed and manufactured to blue print where specifications exist or to meet ideas not yet put on paper.

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PLUGS
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SWITCHES
•
PLASTIC FABRICATION
•
METAL STAMPINGS
•
ASSEMBLIES

At Franklin you will find engineers with the Know-How of design and the What-With in equipment and facilities for coordinated efficient production . . . tool and die makers who click the first time . . . facilities for compression molding of bakelite parts . . . equipment for making plastic parts including laminations . . . machinery for fabricating small metal parts . . . hot tinning . . . plating . . . parkerizing . . . vacuum impregnating . . . tropicalization . . . all the facilities to do a job from the raw material to the finished part and complete assembly.

Franklin coordinated engineering, design, fabrication and production assures economical use of materials, low competitive costs and quick certain deliveries . . . let Franklin solve your production problems.

LAST MONTH'S PROBLEM AND ITS SOLUTION

Problem—Ten books are arranged in orderly fashion on a shelf. Each book has 100 pages, making 1,000 pages in all. A worm starting on the first page of the first book eats through the last page of the last book. How many pages has he eaten?

Solution—He ate 802. Look at a row of books on a shelf. You can see why the worm didn't touch 99 pages of the first book and 99 pages of the last book. Simple, wasn't it?

ELECTRONIC COMPONENTS **A.W. FRANKLIN** MANUFACTURING CORP.
175 VARICK ST., NEW YORK 14, N.Y.

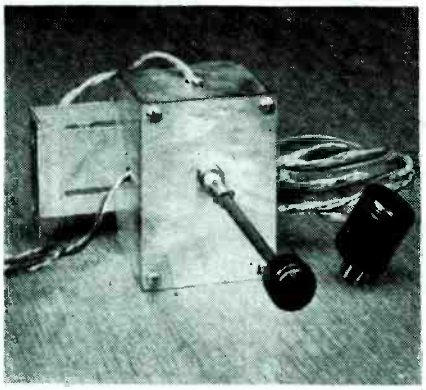
SOCKETS • TERMINAL STRIPS • PLUGS • SWITCHES • PLASTIC FABRICATION • METAL STAMPINGS • ASSEMBLIES

TUBES AT WORK

Adapting Present F-M Receivers to Tune Proposed FCC Allocation

NEW CONVERTERS for receiving the proposed f-m band from 84 to 102 Mc were the subject of much discussion at recent FCC hearings in Washington. Factory-built models include a one-tube and a three-tube unit. FCC engineers showed a two-tube design whose circuit is given below.

The one-tube converter contains a single 7S7 tube and can be installed in the cabinet of most f-m sets. The r-f input feeds a band-pass filter in place of a continuously tuned circuit and the oscillator section is operated at a fixed frequency. A switch, to be mounted on the receiver panel, connects different values of capacitance into the band-pass and oscillator circuits of the converter to provide two fixed-tuned receiving frequencies. With the switch in one position, tuning from 84 to 92 Mc is accomplished by varying the regular receiver dial so that the receiver acts as a tunable i-f stage. Setting the converter



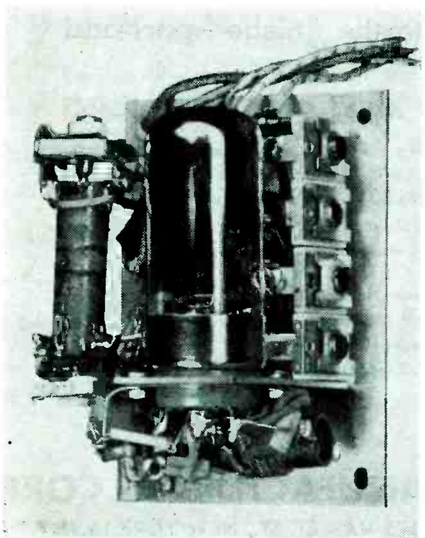
Complete one-tube converter for receiving stations in the proposed f-m band from 84 to 102 Mc. Fixed-tuned, the switch selects either of two frequencies so that further tuning is done with f-m receiver dial

switch to the second frequency position permits tuning from 93 to 102 Mc. Power for the converter tube is obtained from one of the output tube sockets by means of an adapter. Designed and built by engineers of Hallicrafters Company, the unit would sell for about $5.60 in quantity to a single buyer, fob Chicago. This price does not include Federal or state excise taxes.

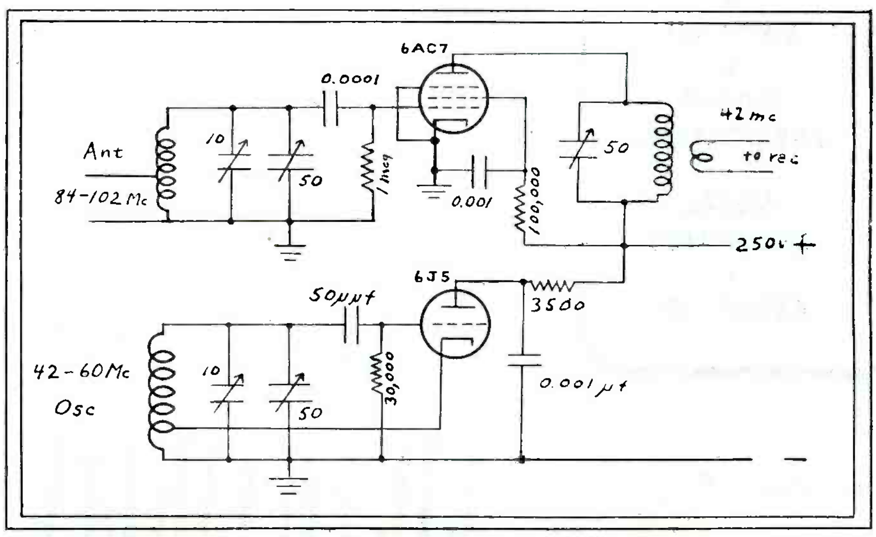
The experimental three-tube model contains a 7V7 mixer, a 7A4 oscillator, and a 6X5GT/G rectifier. This unit has its own continuously tuned circuits with the oscillator tracking 42 Mc below the mixer frequency. Output of the converter feeds into the antenna terminals of the f-m receiver which is left tuned to 42 Mc while receiving stations between 84 and 102 Mc. Hallicrafters estimate that this model could be built for $11 fob Chicago whenever the priority situation permits.

Future of Citizens Radiocommunication Service

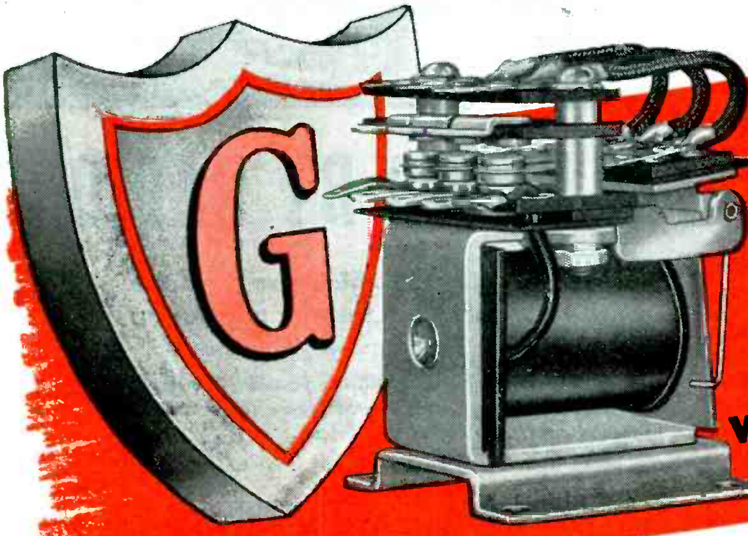
THE FEDERAL Communications Commission proposal to allocate the band from 460 to 470 Mc to a new radio service for civilian use was prompted by the success of the walkie-talkie type of short-range radio communications equipment used on the battlefront and the possibilities for its varied peacetime uses. According to FCC chairman E. K. Jett, "the proposed service will be thrown wide open to any citizen, whether he be an individual who may want a portable suitcase-type set for his own purposes or whether it be a department store, or laundry, or farmer, a taxicab concern, bus, or anybody else." In



Compact construction of the one-tube converter of Hallicrafters Company



Mixer and oscillator circuits of a 2-tube converter shown by FCC engineers. The two 50-μf variable capacitors are used for tuning and have a common shaft



GUARDIAN Series 345 RELAY
a "Basic Design" with many variations

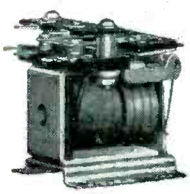
meets special applications
saves time . . . saves tooling . . . speeds delivery!

If your application requires a specially designed relay Guardian engineers can be of great help to you. But, as a result of their wide experience in designing "specials" they have evolved a standard design so flexible that it is now specified in numerous applications that would ordinarily require a specially designed unit. Perhaps you can use it in your "special" application . . . with a saving in money and delivery time. This unusually flexible relay is the SERIES 345. Its chief features are the large coil winding area, numerous contact combinations, the non-binding pin type armature hinge pin, its resistance to shock and vibration, and an ability to operate in extremes of temperature. It is now being used in aircraft, radio, and other exacting applications to insure dependable performance.

STANDARD SERIES 345—The ample coil winding area of the SERIES 345 gives you a wide range of windings for various voltages and currents. Coil winding area is approximately .75 cubic inches. Average power required is 3.56 watts with three pole, double throw contacts of 12½ amp. capacity. Coils are available for either A.C. or D.C. operation.

The maximum switch capacity of the Standard Series 345 is three pole, double throw. Contacts are rated at 12½ amperes at 110 volts, 60 cycles, non-inductive A.C. Moving contacts are attached to but insulated from the armature by a bakelite plate. Terminals are solder lugs. Weight is 6½ ounces.

VARIATIONS OF THE SERIES 345 RELAY



TIME DELAY

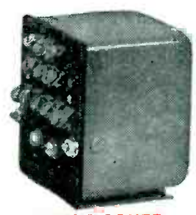
WINDING—Multi-wound coils are available for operation on two or more circuits. Or coil may be wound to operate on the discharge of a 3 mfd. condenser.

CONTACTS—Normal switch capacity is three pole, double throw; maximum switch capacity may be up to six pole double throw with 12½ amp. contacts, or any variation of contact combinations within this range, including the operation of contacts in sequence. The flexibility of the contact springs may be increased through the use of coil spring rivets.

TIME DELAY—On D.C. coils a time delay of 0.25 seconds on release or 0.06 second on attract may be achieved through the use of copper slugs which require these time intervals for saturation or de-energizing depending on whether they are used on the heel or head of the coil.

DUST COVER—For applications where this relay may be subject to injury or in atmosphere where dust may be present in sufficient quantity to impede operation, the SERIES 345 may be equipped with a metal dustproof cover.

SCREW TERMINALS—Screw type terminals are optional for applications where terminals must be disconnected occasionally or where solder lug terminals are not otherwise practical.



DUST COVER

INTERLOCKING: Here the series 340 a-c relay is coupled with the d-c coil of a series 405 short telephone type relay in an overload application. Under normal conditions the series 340 contacts are mechanically held in a closed position. Normal current flows through the series 405 coil and then through the series 340 contacts to the circuit for which overload protection is desired. Excessive current, however, energizes the series 405 coil, releasing the locking arrangement and breaking the series 340 contacts. Push button control resets to normal but is ineffective if current is still excessive.

INTERLOCKING UNIT

SERIES 345 RELAY DATA

Normal Volts	Minimum Volts	Normal M.A.	Minimum M.A.	Coil Resist.	Normal Wattage
6	4.8	600	480	10	3.56
12	9.8	300	245	40	3.56
24	18	148	111	162	3.56
32	25.6	112	89	287	3 56
115	92	31	25	3720	3.56

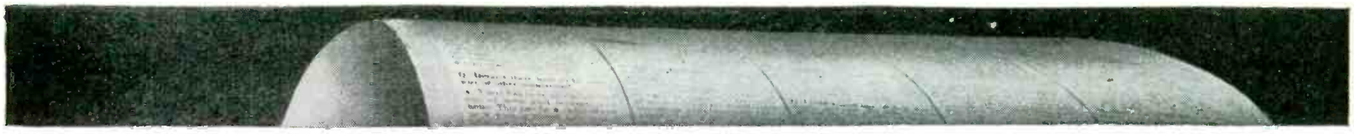
Minimum operating wattage........................2.3

If you will write us about your relay problems our engineers will be glad to make recommendations which may save you time and money. Should you desire a quotation, please mention quantity.

GUARDIAN ELECTRIC

1625-F W. WALNUT STREET — CHICAGO 12, ILLINOIS

A COMPLETE LINE OF RELAYS SERVING AMERICAN WAR INDUSTRY



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. . . with paid advertising

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FINCH TELECOMMUNICATIONS, INC. • PASSAIC, N. J.

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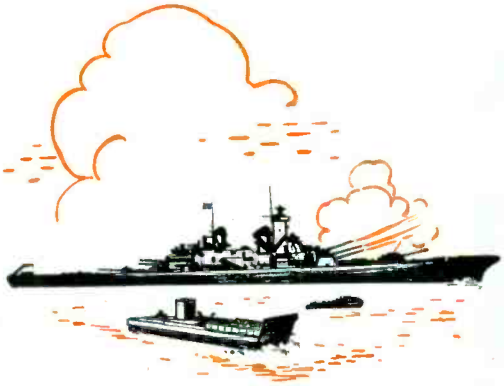

Crouching in an old shell hole on shore, a fire control party directs a battleship's deadly salvos against enemy strong points holding up Allied invasion forces. On the world's far-flung fighting fronts, battle-tested Spencer precision wire used in communication equipment is hastening the day of final Victory.

PHOTO U.S. SIGNAL CORPS.

SPENCER *Precision* WIRE

★ ★ ★ ★ ★ ★ ★ ★ ★ ★

FINE STEEL AND ALLOY WIRE

Spencer Wire Company
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WEST BROOKFIELD • MASS.

the past, it has been necessary, because of the limited number of frequencies available, to grant frequencies only to common carriers, the safety services, broadcasting and the amateurs.

This new allocation is regarded by FCC as a challenge to radio engineers to develop equipment, both transmitting and receiving, for such a service. After a reasonable time, if it is found that the frequencies are not used, they will be reassigned to some other service. If the allocation is inadequate, the Commission plans to expand the service up or down in relation to its proposed spot on the spectrum. It is also recognized that the bandwidth may be reduced later on, if necessary. The operating standards can be reduced considerably below those necessary for commercial or safety services because it is offered as a service "for convenience".

Four Possibilities

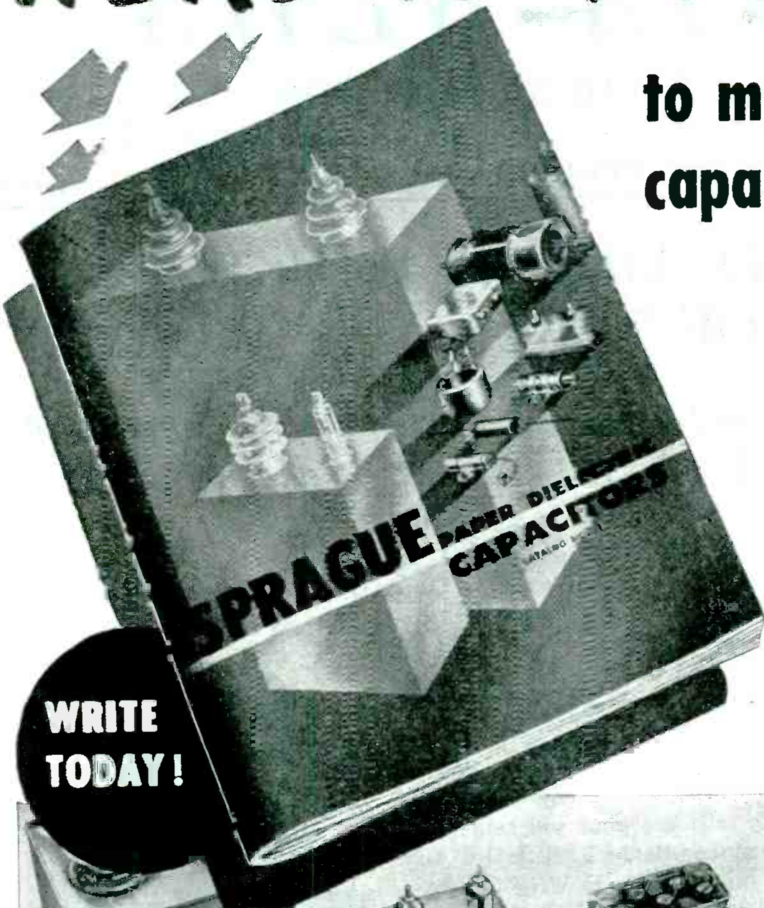
The Commission has stated that the possible uses of the service are as broad as the imagination and the ingenuity of equipment manufacturers can devise. Commissioner Jett envisions developments along these lines:

(1) A handie-talkie for battery operation (fraction of a watt), light in weight, not much larger than a small camera, small antenna that can be pulled out a foot or so, placed at side or in hand, and useful for a very short range. The range would be a mile or two. An example of its use would be on a farm to communicate with a tractor. This equipment probably would use dry batteries but it could use storage batteries.

(2) A walkie-talkie, the size of a small suitcase, will weigh from 20-50 pounds. There will be different types—some with handles, some for mounting in autos or boats. May use storage batteries (2 watts or so) and can be recharged from house current. If built in autos or boats, it can be recharged as radios in autos are today. Example of use: Express Company might want to change order of trucks loading at platform and could use walkie-talkie to order certain trucks to the front. Also,

HERE IS YOUR GUIDE

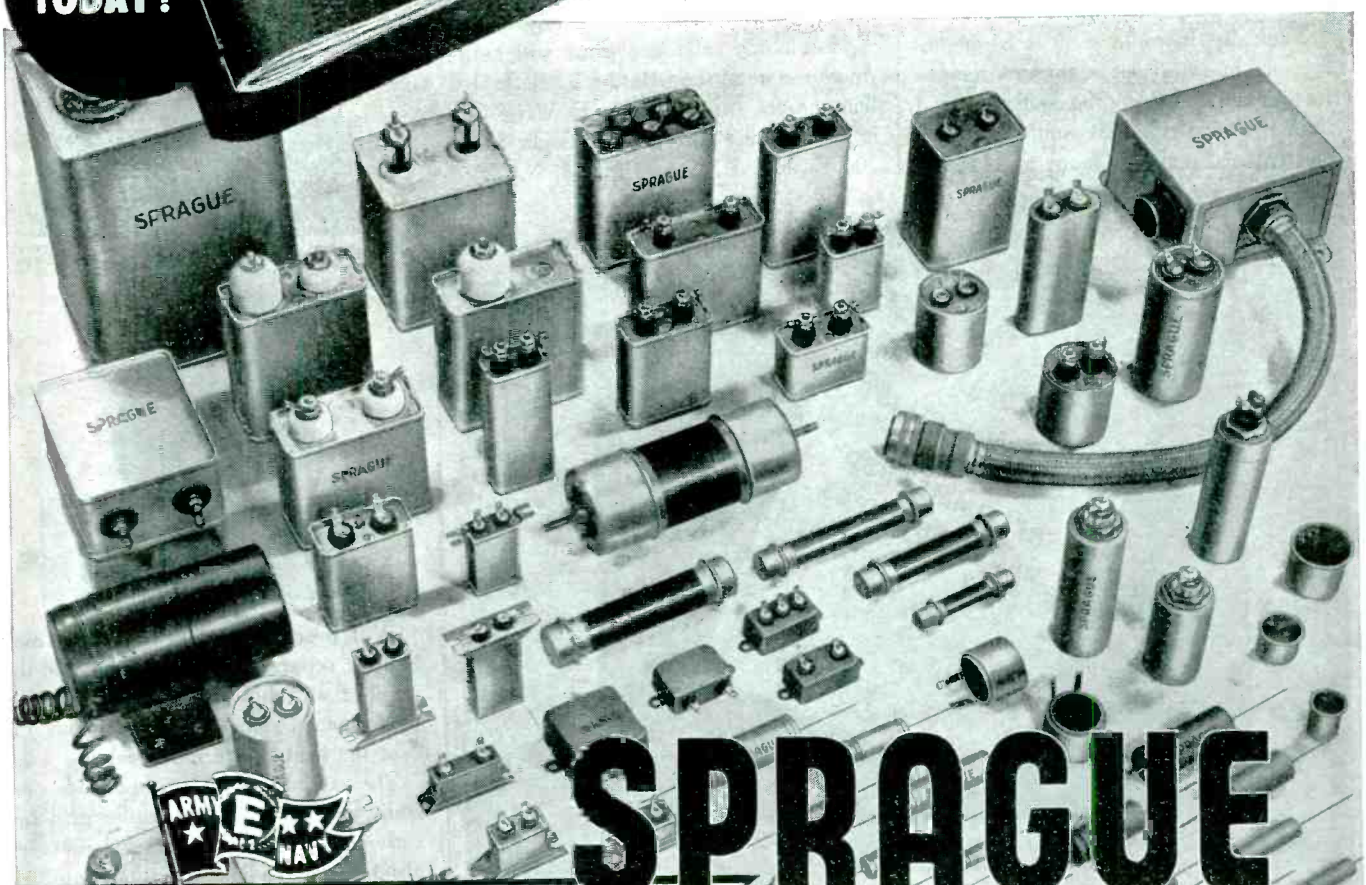
to modern paper dielectric capacitor selection and use



Months of painstaking work have gone into making this 56-page Sprague Catalog a complete guide to the design and engineering possibilities inherent in today's greatly enlarged line of Sprague Paper Dielectric Capacitors in hundreds of standard and special sizes and types.

Write for your copy today. You'll find it unsurpassed as a guide to the exact matching of up-to-the-minute Capacitor requirements!

SPRAGUE ELECTRIC CO.
North Adams, Massachusetts



SPRAGUE

PIONEERS OF ELECTRIC-ELECTRONIC PROGRESS

SYLVANIA NEWS

ELECTRONIC EQUIPMENT EDITION

MAY — *Published by* SYLVANIA ELECTRIC PRODUCTS INC., Emporium, Pa. — 1945

SYLVANIA'S CHART AIDS STANDARDIZATION OF TUBES

Reference List Recommendations Reduce Radio Tube Types

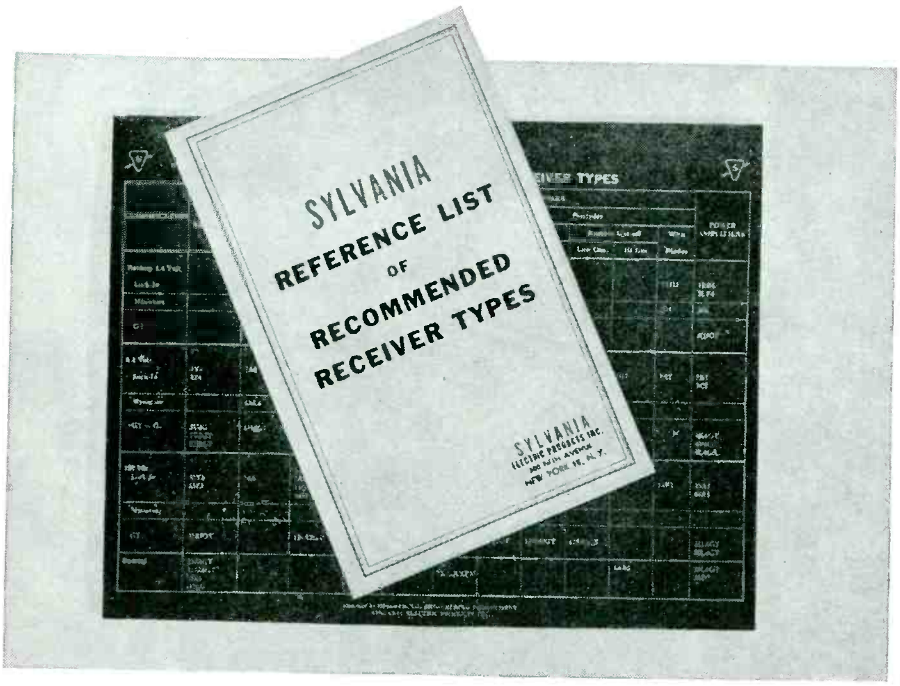
AS an aid to the standardization of radio receiver tube types, Sylvania has prepared the chart reproduced below—another item in Sylvania's long-time program of technical assistance to the radio industry.

The number and variety of tube types have grown in recent years, and this trend has intensified war scarcities.

Naturally, it would seem to be advantageous to radio set manufacturers to further standardize tube selection and limit their variety. This would probably meet with approval in many parts of the radio industry, particularly among radio servicemen since they are in an active position when it comes to tube replacement and general radio set repairing.

(An indication of their opinion concerning tube types was revealed in Sylvania's survey in which 90.5% of the servicemen questioned said they would prefer fewer and simpler tube types.)

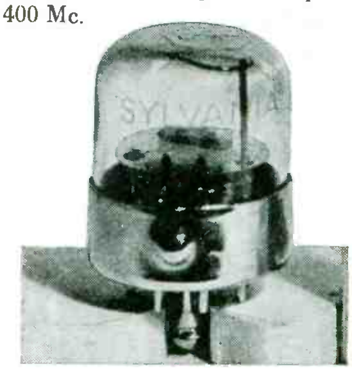
This handy reference chart will help smooth some of the wrinkles of the problem and act as a future guide. Write for it to Sylvania Electric Products Inc., 500 Fifth Ave., New York 18, N. Y.

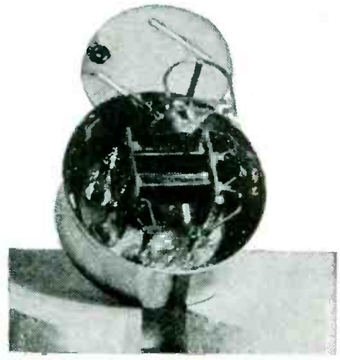


Double Triode Tube Has Two Uses

Acts As Converter Or Amplifier

Sylvania's new high mutual conductance double triode tube—Type 7F8—is designed for use at frequencies up to 300 or 400 Mc.





With precautions the two sections may be used separately, saving space and the number of tubes required for a given performance since all the elements except the heaters are independent.

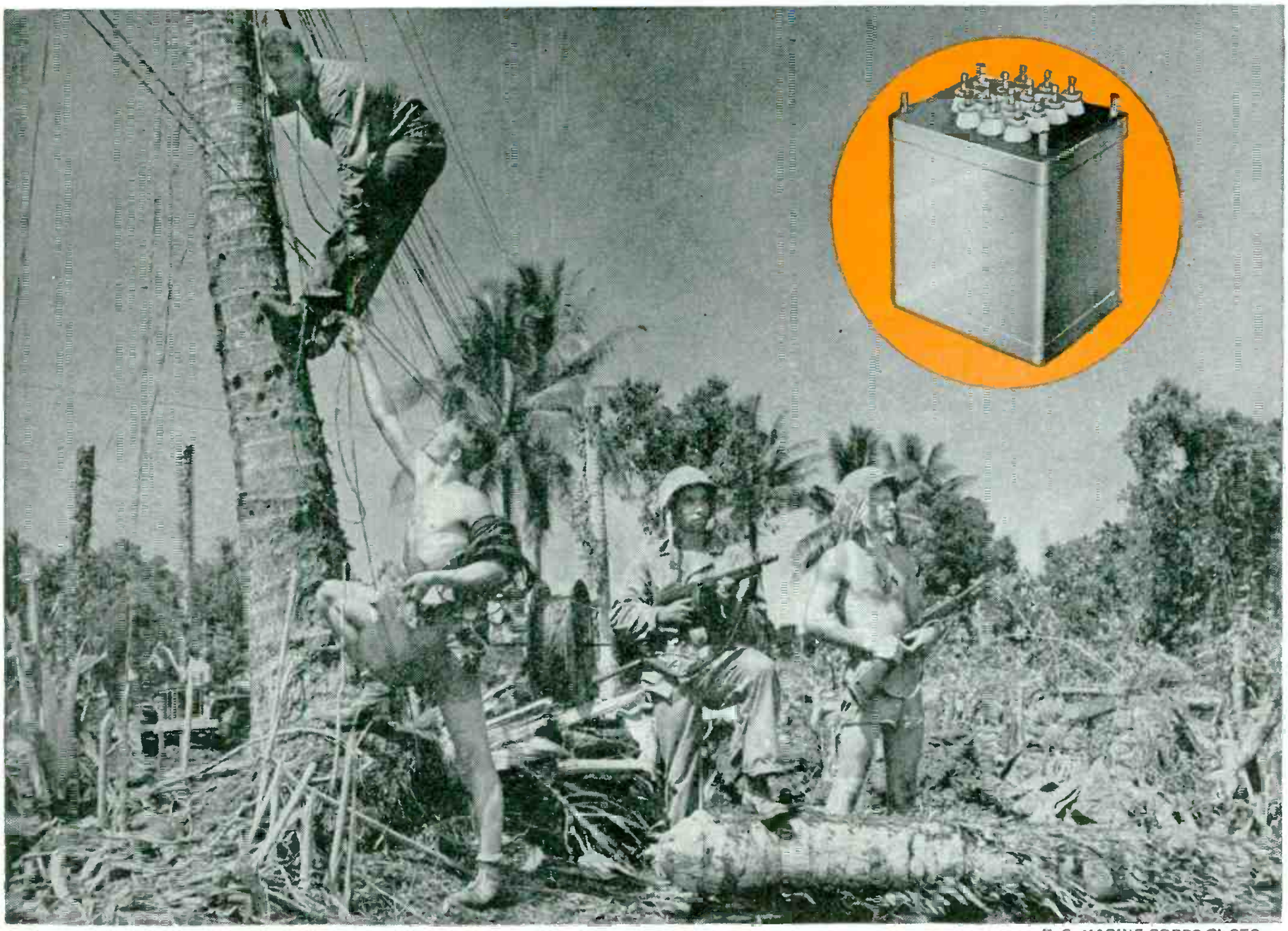
The cascade operation thus made possible is useful in u-h-f grounded grid and cathode follower amplifier service. It may also be used as a push-pull u-h-f amplifier.

SYLVANIA ELECTRIC

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

HERMASEAL

HERMETICALLY SEALED TRANSFORMERS —DEPENDABLE IN JUNGLE WARFARE



U. S. MARINE CORPS PHOTO

AmerTran has always adhered rigidly to high quality standards. For this reason, Hermaseal Hermetically Sealed Transformers had no difficulty in meeting the strict requirements of government procurement officers for "tropicalization" of these components.

Precautions include vacuum varnish impregnation of core and coil, infra-red pre-heating before compound filling, induction soldering of case seams. Ceramic terminals are protected by torque gauging and resilient gaskets. To insure thorough hermetic sealing, each unit is subjected to a vacuum immersion test. Write for details.

AMERTRAN ASSIGNED "APPROVED" QUALITY CONTROL RATING BY AIR FORCES

On March 14, 1945, the Air Technical Service Command of the Army Air Forces delegated to the American Transformer Company full responsibility for meeting contract requirements. This assignment of an "Approved" Quality Control Rating which eliminates duplicate inspection during fabrication was awarded on the basis of AmerTran's record in adhering to quality standards.

AMER-TRAN HERMASEAL

THE AMERICAN TRANSFORMER CO., 178 Emmet St., Newark 5, N. J.

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

AMERTRAN

MANUFACTURING SINCE 1901 AT NEWARK, N. J.

gas-filling stations or country stores might have calling stations. The range of the walkie-talkie is 5 to 8 miles, depending on the terrain.

(3) Larger equipment would have elaborate antenna, for installation at a fixed location, such as the roof of a department store, laundry, dairy or office building. It would afford communication between fixed points.

(4) Portable equipment, which will include a broadcast receiver, and be about the size of a walkie-talkie. Since it will be necessary to have an audio system in the walkie-talkie to take care of the two-way personal communication service, Mr. Jett sees the possibility of including a radio-frequency unit to provide for the reception of standard or f-m broadcast signals. The equipment could be used not only for two-way communication, but also as a broadcast receiver. An alarm system, remote control systems and other devices might be added to equipment to meet particular needs.

As in the case of the amateur service, the Commission proposes to assign no channels within the band. By use of comparatively simple circuits already known, the Commission believes that it should be possible to provide both transmitters and receivers tunable over all of the 460-470 Mc range, emitting signals sharp enough to minimize interference.

Citizens Radio League

It is recognized that if a large number of people operate transmitters in the same community there is bound to be interference. The suggestion is made that a non-profit, citizens radio league be organized to assign local operating frequencies. For example, citizens in a certain community might get together and decide that department store No. 1 will use channel No. 5; department store No. 3 will use channel No. 19; laundry No. 2, channel No. 7, etc.

Interference Problem

It is hoped that frequencies, because of their characteristics, may be duplicated throughout the U. S. without a great deal of interference. With low-power devices used on the

VINYLITE plastic insulated wires, made by Surprenant Electrical Instrument Company, contribute to the Sonotone's efficiency.

Grandfather demanded,
"LOUDER, PLEASE"

Grandfather lived before the age of miracles. Today, of course, he'd relax with a modern hearing aid. And, in a Sonotone, he'd find the magic effectiveness of the instrument protected by a handsome receiver cord with transparent insulation made of VINYLITE plastics by Gavitt Manufacturing Company.

Thin, flexible, light weight, and perfectly smooth, VINYLITE insulation makes the "quietest" cord available for hearing aids. It eliminates the amplified and annoying sounds of friction made when stiffer and less smooth cords move against the clothing. It is also resistant to perspiration which formerly caused electrical leakage between conductors. It withstands the attacks of body oils, and its long life is assured by its resistance to wear and aging.

VINYLITE plastic insulation for wires and cables has dielectric strength that permits thin-wall construction. Highly resistant to oils, water, alkalies, and many chemicals, it has been found an invaluable improvement by manufacturers of electronic equipment, public utilities, and construction concerns, and marine, and airplane manufacturers.

Write Department 18 for your copy of "VINYLITE plastics Wire and Cable Insulation."

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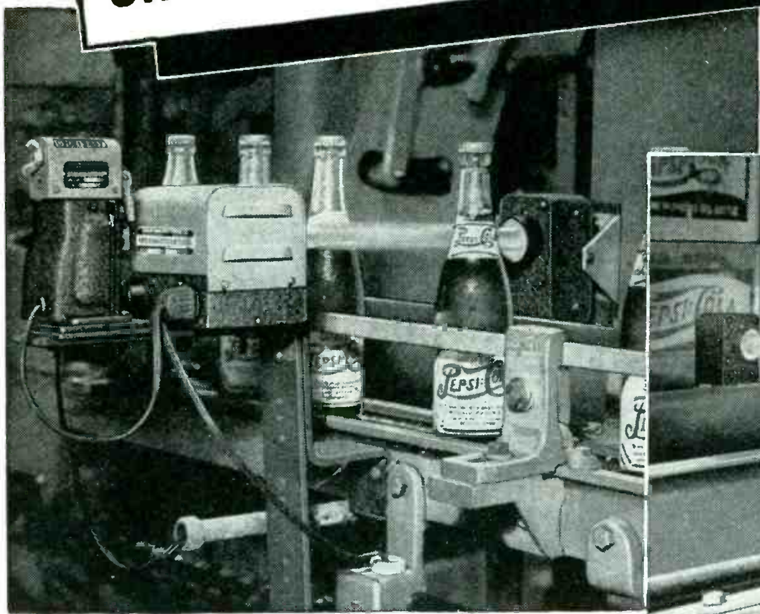
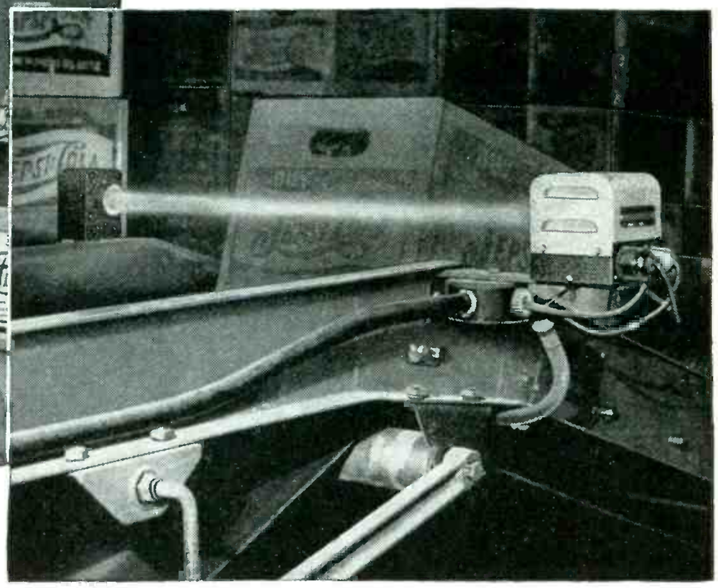
TRADE-MARK





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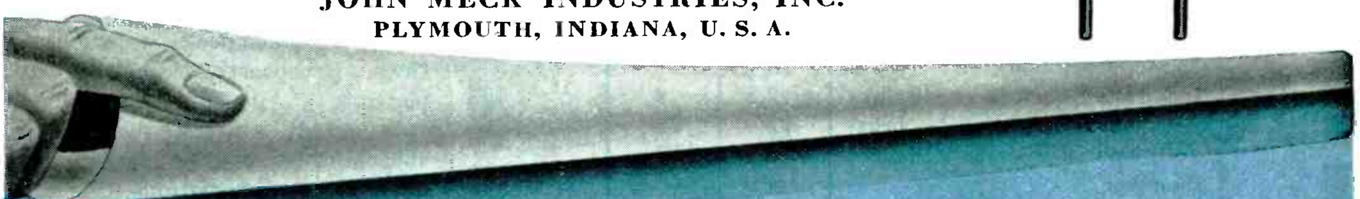
John Meck crystals are now—and always will be—characterized by high quality and rigid precision. In an industry as exacting in mechanical design and as intricate in conception and execution as the field of sound electrically controlled and amplified, the engineering staff must work to standards of "absolute" precision. This devotion to accuracy is reflected in the attitude and work of every individual contributing to the completion of John Meck products. The low percentage of final test rejections at John Meck Industries is a tribute to the splendid, conscientious personnel and their ability.

JOHN MECK INDUSTRIES, INC.
PLYMOUTH, INDIANA, U. S. A.



John Meck Industries, Inc., will produce radio receivers and phonographs on the resumption of civilian production. Your salesmen will find that our purchasing department is interested in establishing dependable sources for parts and supplies. Our requirements will represent a growing volume of business through the years.

John Meck

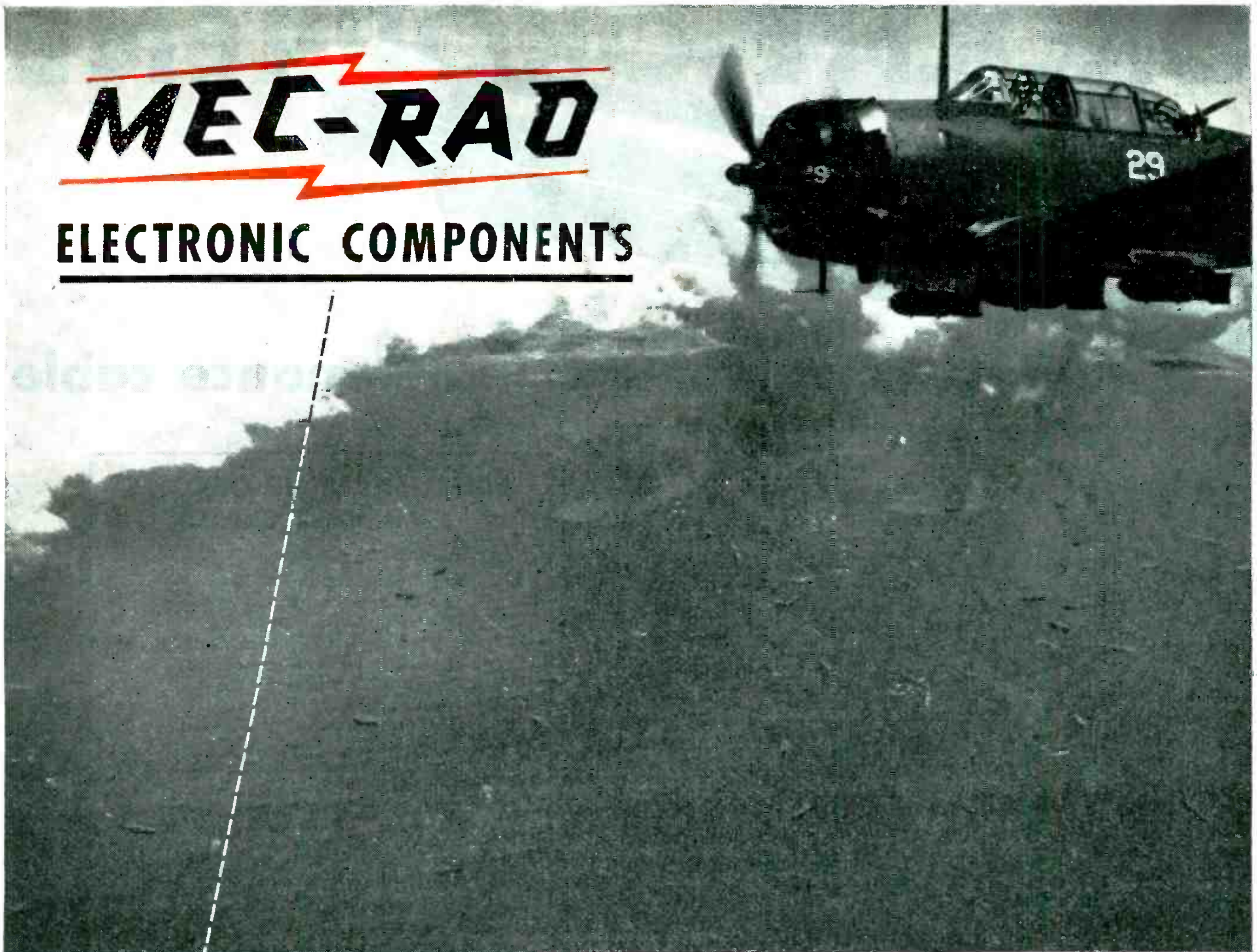
ground, the range will probably be from 2 to 15 or 20 miles depending upon the terrain. If one is high on a hill with an unobstructed path of 25 or 30 miles, the range will be even greater. On the other hand, if one is down in a valley, the useful range would not be more than a couple of miles. "Boosters" or automatic relay installations will be permitted where necessary. Most transmitters on this band are likely to be of low power and will not need extreme antenna heights. In rural areas where there is no interference, higher power may be permitted.

The Commission makes it clear that common carrier operation in the citizens communication band will not be permitted and no charge can be made for the licensed facilities or for transmission of messages.

License Requirements

Only the minimum requirements of the Communications Act with a few minimum traffic rules will be set up by the Commission. Operator licenses will be granted to American citizens only and no technical knowledge will be required. It is proposed to issue a license to run for five years. It will be printed probably on a pocketbook size card, the operator's license on one side and the station's license on the other. The only qualification for the operator's license will be certification by the applicant that he has read the rules and regulations of the Commission and understands them. Station licenses, according to FCC's present plans, will be limited to "point-to-point, fixed point-to-mobile, mobile-to-mobile, and multiple-address communications. Broadcasting is not contemplated."

In recent hearings before the subcommittee of the House Committee on Appropriations, Commissioner Jett was questioned as to the effect of this proposed new service on the local telephone. He said that he does not believe it will ever take the place of the local telephone, and reports he has had to date indicate that telephone officials are enthusiastic about the possibilities of the service. There is a maintenance cost to be considered in the pro-



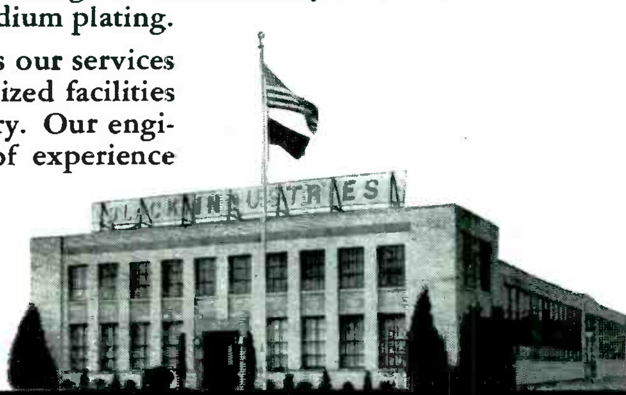
Navy plane patrolling the water off Saipan on "D-Day" for that Marianas base. Official U. S. Navy Photograph.

*add a margin of safety for navy pilots

Vital to the success of our air attack are ingenious electronic devices. Mec-Rad is now devoted 100% to the manufacture of vital mechanical and electro-mechanical assemblies for these important electronic units.

Our work includes "fancy brass plumbing" of all types involving soft and hard soldering, close tolerances, precision machining, careful assembly and finishes ranging from lacquered to silver and rhodium plating.

We will continue this program as long as our services are needed—but after the war our specialized facilities will be available to the electronic industry. Our engineering "know-how" based on years of experience designing and manufacturing precision mechanical-electrical components is at your service now to help you with your post-war planning.



MEC-RAD

DIVISION-BLACK INDUSTRIES

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OKOLITE-OKOPRENE

. . . a versatile, low-maintenance cable for use in your plant or as part of your product

Check over the principal advantages of Okolite-Okoprene cable and see how it can meet your needs. Used in various installations under all kinds of conditions, millions of feet of Okoprene-covered cable have proved its versatility, dependability, long-life.

Okolite-Okoprene cables (U. S. Patent 2,312,058) may be installed in ducts, buried directly in the earth and exposed to the elements *without additional protection.* Simple to handle, splice and terminate, they are designed in all standard sizes and many colors for service up to 5000 volts.

Briefly summed up at the right are the principal features of Okolite-Okoprene cables including the electrical and physical operating advantages and advantages in installation.

Okonite engineers are always ready to help you. With their long experience in the electrical field, their viewpoint is especially useful when it is joined with that of your own engineers in discussing any problems of electrical distribution. The Okonite Company, Passaic, New Jersey.

Patents Protect Jobs—Let's Protect Them

ADVANTAGES OF OKOLITE-OKOPRENE CABLES

ADVANTAGES IN DESIGN

1. Simple construction
   a. No tapes or braids
   b. No metallic coverings
2. Insulated by Strip Process, which means
   a. Perfectly centered conductors
   b. Uniform thickness of Okolite insulation
   c. Uniform thickness of Okoprene covering
3. Vulcanized in a continuous metal mold, which means
   a. Tough, dense covering
   b. Uniform vulcanization throughout length

OPERATING ADVANTAGES — ELECTRICAL

Okolite Insulation

1. Ozone resistant
2. High dielectric strength
3. Stable electrical characteristics
4. Low specific inductive capacity
5. High current carrying capacity (75° C copper temperature)

Okoprene Covering

1. Additional dielectric strength
2. High surface resistance eliminates charging current drainage from surface of cable
3. Ozone resistant

OPERATING ADVANTAGES—PHYSICAL

1. No braids to rot
2. High moisture resistance
3. Resists oil and solvents
4. Resists acids, alkalies and corrosive chemicals
5. Non-flammable covering
6. Can be operated at 75° C
7. Unaffected by sunlight
8. Weatherproof
9. Long-lived

ADVANTAGES FOR INSTALLATION

1. No potheads required
2. Easy to splice
3. Light weight
4. Small outside diameter
5. Smooth, snag-proof covering
6. Easy to pull into ducts
7. High abrasion resistance
8. High tensile strength sheath
9. Flexible at low temperatures
10. No saturants to soften in heat or flake off in cold weather
11. Can be bent on small radius

4066

OKONITE OKONITE SINCE 1878 **insulated wires and cables**

THE JACK WITH THE CHANNEL-BEAM FRAME . . . BY FEDERAL

You can swing forty pounds from the free end of this jack without bending it from the horizontal.

Because . . . Federal has taken sturdy stainless-steel and die-drawn it to form a rigid channel-beam jack frame, instead of the bend and spot weld method of construction normally used.

This rigidity is all-important in a jack — not only in supporting heavy cable harnesses, but allowing the spring nests to provide positive tension on the plug . . . even though worn from years of constant service.

Jack springs are of nickel silver and the palladium crossbars assure positive contact at all times.

Federal's jacks are available with either plain or threaded bushings in 15 different spring combinations, including all of the more commonly used arrangements. Additional combinations can be provided where needed.

When required Federal's jacks can be supplied fungus and moisture proofed.

Another superior communications component by Federal, and another reason to see Federal first.

DESIGN FEATURES: Rigid Construction, Positive Spring Tension, Stainless Steel Channel-Beam Frame, Plain or Threaded Bushings, 15 Standard Spring Combinations, Phenol Fiber Insulation.

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Federal Telephone and Radio Corporation

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posed citizens radiocommunication service. Considering that there must be two transmitters and two receivers to carry on two-way communication, it will average much more than the cost of subscribing to telephone service. However, there are many places in the United States without telephone service, and many needs that telephone service cannot fill.

Don't look for citizens radiocommunication service to be licensed until after V-J Day.—G.T.M.

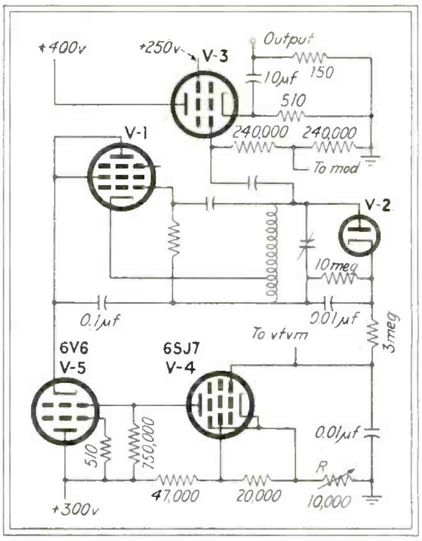
• • •

Wide-Range Signal Generator with Automatic Amplitude Control

By Howard T. Sterling

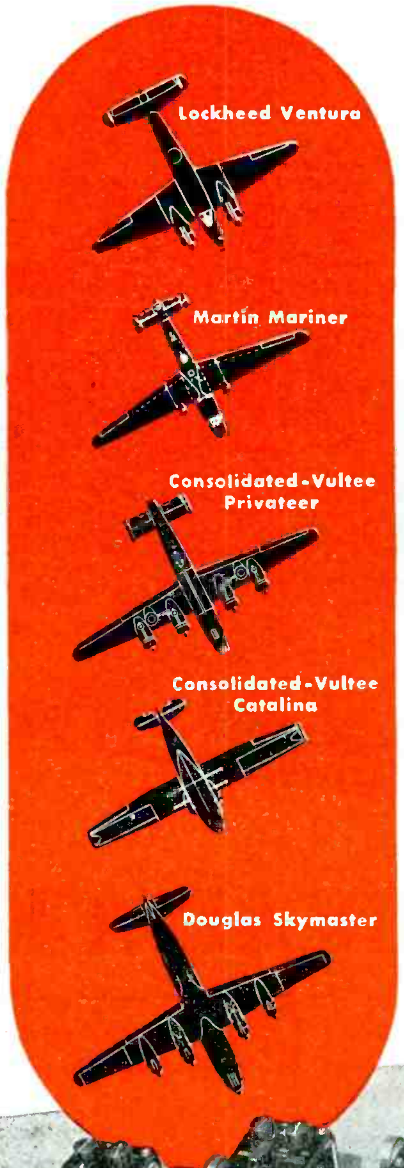
After experimenting with various types of amplitude control for L-C oscillators involving shunting of the tuned circuit, with results not wholly satisfactory, the following scheme was worked out with much better success. It was inspired by the use, in General Radio's model 605 signal generator, of plate voltage control to set oscillator output to the desired amplitude.

Referring to the circuit illustrated, the output of the oscillator, *V*-1, is rectified by the diode, and



Circuit of a system of automatic amplitude control of an oscillator in a signal generator

the positive voltage resulting is fed to the grid of *V*-4. This tube is operated at low current, the variable cathode resistor *R* providing sufficient bias despite the positive



ALL 5

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For the first time radio and interphone control systems have been completely standardized for more than one type of aircraft ... by Pacific Division. Altair Model LY-10A system is being used on the Lockheed *Ventura*, Martin *Mariner*, Consolidated-Vultee *Catalina* and *Privateer* and the Douglas *Skymaster*. Designed to Navy specifications by Bureau of Aeronautics and Pacific Division engineers, this is a complete system to control all communication and radio navigation equipment in large aircraft.

This feature alone is recognized as an important step forward in aircraft accessory design. Model LY-10A, however, incorporates — also for the first time — the use of isolation amplifiers which eliminate all crosstalk without the use of multiple audio output stages in each receiver. Selection of up to 9 receivers and 3 transmitters at flight deck stations can be provided.

Altair Model LY-10A, which provides a simple control for a large number of complex radio units, is an example of Pacific Division's understanding of a job that could result only from long experience. Pacific Division invites inquiries on any radio problem.

Pacific Division
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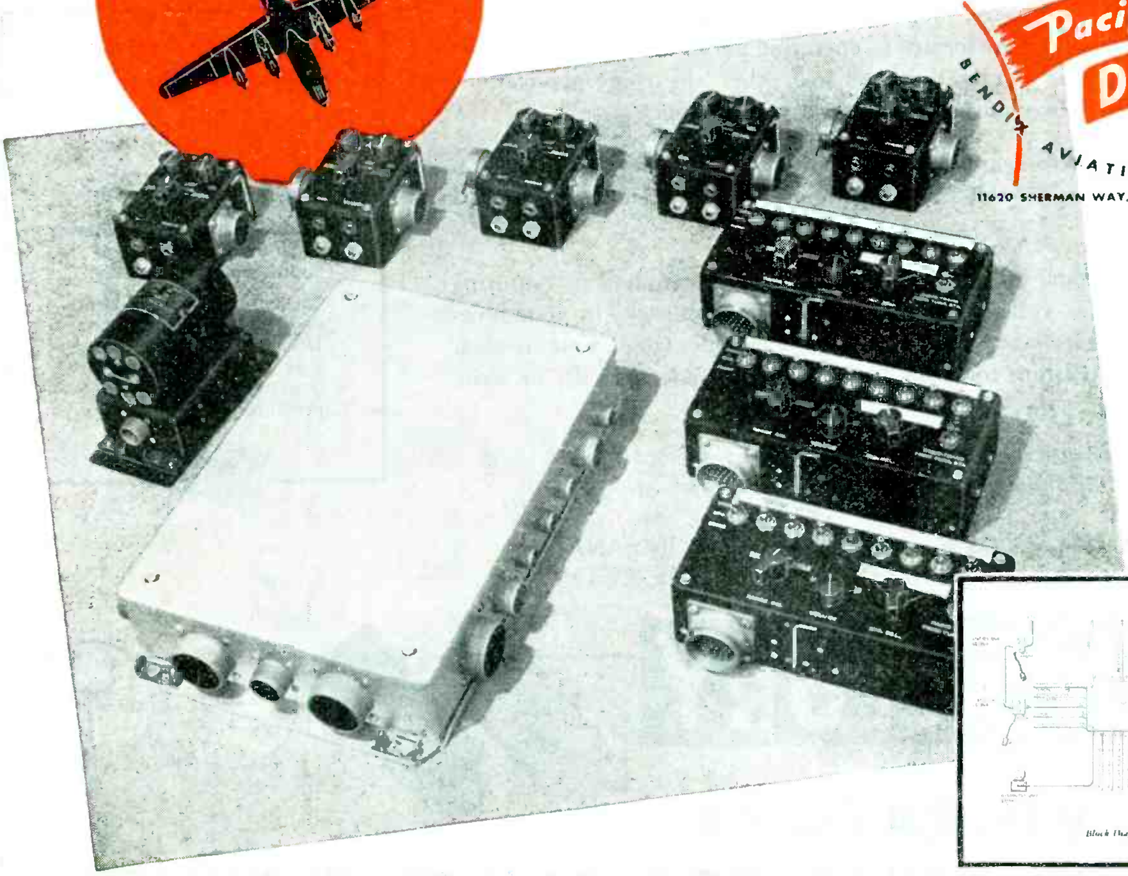

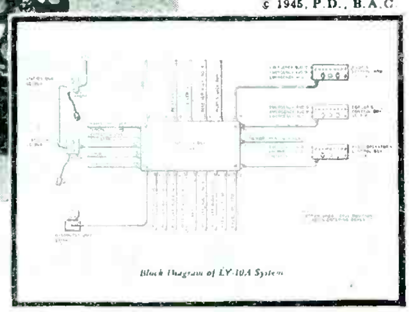

Block Diagram of LY-10A System

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Sales Engineering Offices: Lincoln Building, New York City 17; Continental Building, St. Louis 8.

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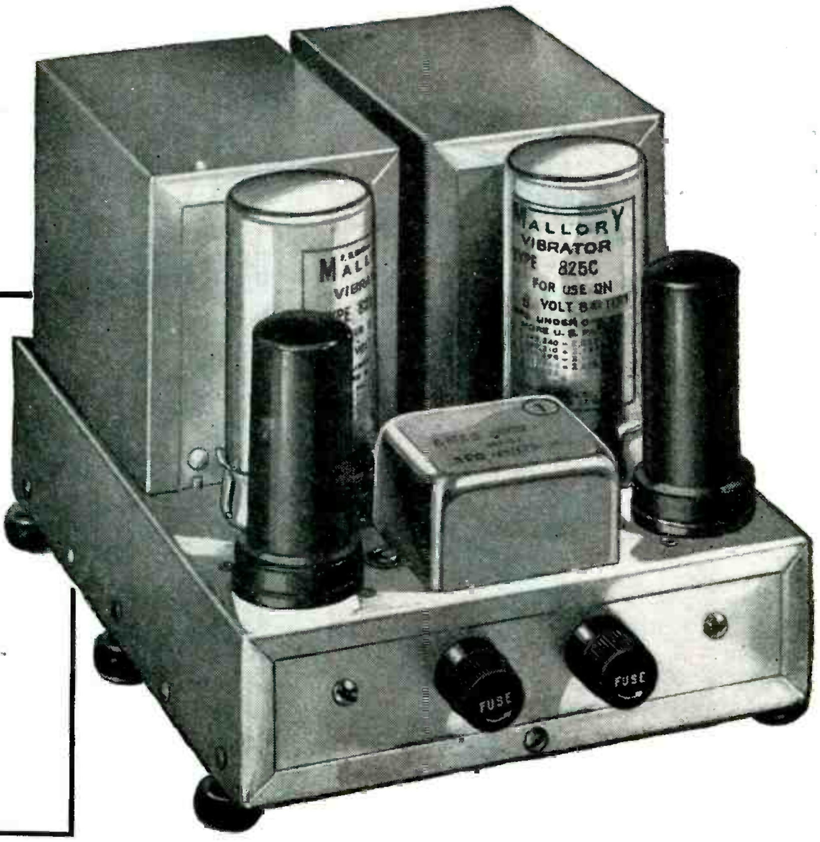

Specifications of Heavy-Duty Vibrapacks VP555, VP557

Input Voltage: 6 volts, nominal.

Output Voltage: VP555—300 volts, 200 ma.† nominal.
VP557—400 volts, 150 ma.† nominal.

Filtering: VP555 completely filtered for audio and RF vibrator hash. Ripple approximately 1½% at max. load.
VP557 has efficient RF filter for vibrator hash.

Applications: VP555—ideal for mobile PA systems and two-way radio service.
VP557—specially designed for radio transmitter service, automotive, aircraft and marine.

†*Intermittent rating for transmitters and public address systems.*

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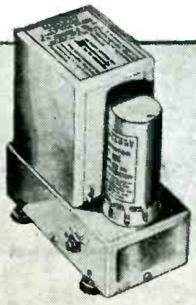

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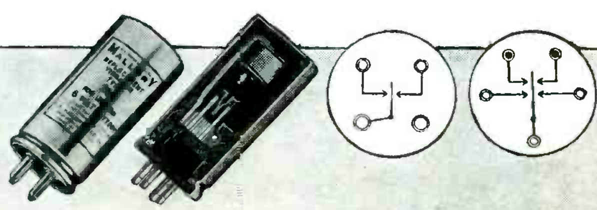

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they speak for themselves **audiodiscs** voltage at the grid due to oscillator output. Variations in oscillator output are amplified by V-4 to control the bias on V-5 and hence the oscillator plate voltage.

The signal voltage at V-4 grid can be applied to a vtum to read oscillator (and signal generator) output. Since the control depends upon change of amplitude, regardless of the level, it will be seen advisable to operate the oscillator at a relatively high level. In practice, twelve to fifteen volts peak was found most satisfactory. With a fairly high-Q variable capacitor (such that amplitude does not fall below this value at the low-frequency end of a band) the output of the generator can be kept constant plus or minus 2 percent from 50 kc to 50 Mc.

The tube finally chosen for V-1 was a 6AC7. Everything from a 6J5 through a 6L6 was tried, but the 6AC7 behaved most consistently and provided highest output. Any convenient diode can be used for V-2. A 6L6 was used at V-3 for high output.

Power Supply

The oscillator plate and V-4 screen supply should be regulated, although it is not entirely necessary. The control circuit is essentially degenerative so that the output will not vary much with change in the line voltage. The screen potential on V-4 will affect the gain of that stage, though the plate voltage need not be regulated. Tube V-4 and its associated bleeder draw about 5 ma and this is the only additional plate current drain introduced by this control circuit.

Any doubts as to the advisability of changing the plate voltage of the oscillator may be set at rest; the resulting slight shift in frequency is far less than the one-percent tolerance that must be expected in the best of wide-range signal generators.

The output can be adjusted by R; in practice this should be set and locked, although a vernier control of comparatively low resistance may be placed in series with it and brought to a knob on the panel to correct for residual amplitude changes of one and two percent if desired. With distortion, 100 percent modulation of V-3 is possible,

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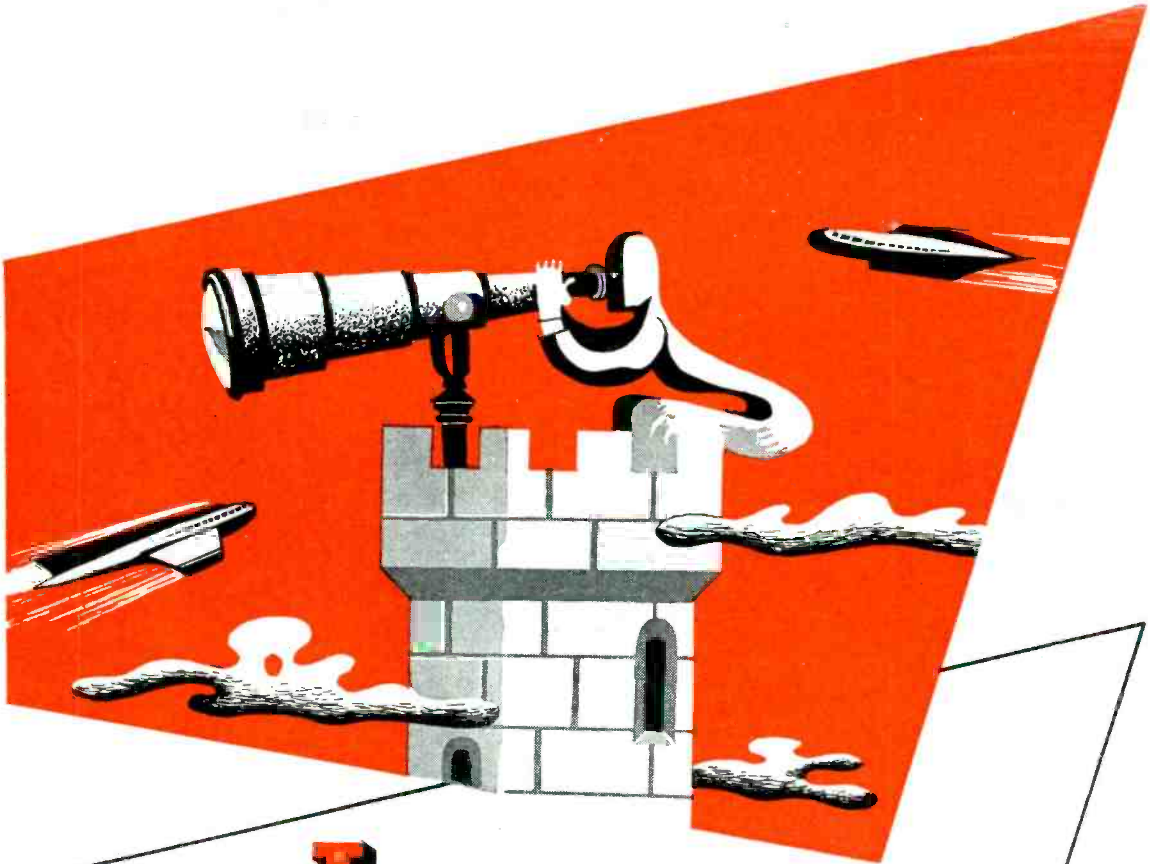

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NEW YORK • CHICAGO • KANSAS CITY • BURBANK but 50 percent modulation is very clean and requires about 15 volts peak of audio.

The line termination at the generator consists of the cathode impedance of the tube and the 500 and 150-ohm resistors in parallel. Twelve volts r-f to the grid of V-3 will result in 2.5 volts output with a termination of 73 ohms at the far end of the line.

• • •

Projection Systems for Theater Television

TWO METHODS of large-screen television projection were described at the March meeting of the Society of Motion Picture Engineers, Atlantic coast section, by Dr. A. H. Rosenthal, director of research and development of Scophony Corporation of America.

To obtain a screen image of maximum brightness it is desirable that the elemental picture image be either intensely bright, or that it be moderately bright for a long period of time. To obtain great brilliance of the picture element in systems in which the modulated electron beam produces the light directly through fluorescence, as in cathode-ray tube television projection, it is necessary to sacrifice definition in the interest of exciting an appreciable area of the fluorescent material. Thus this method of picture projection has an inherent limit of brilliance-to-definition ratio.

Optical Gate and Image Storage

A more satisfactory method of television projection, according to Dr. Rosenthal, is to use the signal not to produce the light, but to modulate an independent light source. This source can be as bright as need be. Standard motion-picture projector light sources such as carbon arcs or mercury pressure lamps can be used. In fact, this method of light modulation is analogous to film projection wherein the film density modulates the light passing through the optical system.

However, in film projection all picture elements are actively modulating the light simultaneously and for an appreciable portion of the total frame time. In television

Inductor Designs

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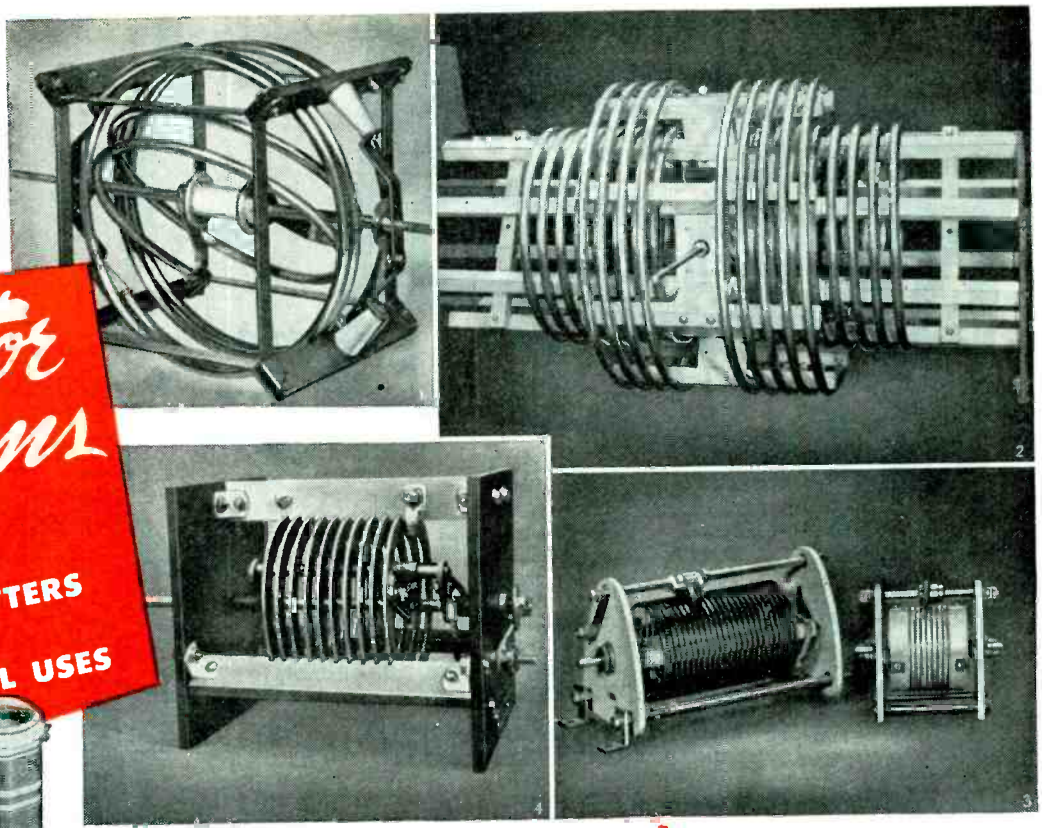

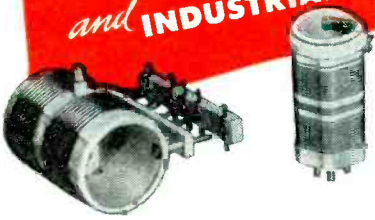

When you need an inductor for any purpose consult Johnson Engineers. Their files will probably contain a design for your required inductor, but if not, they can design one and make it to do your particular job.

Inductor design is quite a special study and no one conductor, no one insulator, no one type of construction is suitable for every requirement. Johnson may select a copper tubing conductor to handle high currents in one design, while edgewise strip is selected in another because of its narrow width and the ability to get a greater inductance in the same length. Other conductors are available too, such as solid wire, litz wire, flat strip, square Bars and special shapes, some plated, some polished and lacquered according to their use. In order to make contact to the conductor and bring off taps Johnson has produced a complete line of clips and connectors for use on fixed taps as well as sliders and rollers for continuously variable taps.

Insulation requirements vary. While steatite or mycalex may be used for low losses in a certain high frequency coil, plastics may be better for another because they stand more mechanical shock. Production facilities at Johnson provide for working any insulating material so the best one or the best combination, can always be selected to fit the special job.

Johnson inductors are designed and built for efficient operation and they have high Q. Some are fixed and some are variable. Some designs require special features such as rounded parts to minimize corona discharges at high voltages, water cooling, variation of inductance or variation of coupling.

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A1-F—15/32 long x 1/2" diameter. Mountable with 6-32 flat or filester screw No. 21 Tinned Copper wire leads. 1% standard accuracy. Non-inductive pie wound—1/2 watt, 200 D.C. maximum operating voltage. Fungusized varnish finish.

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"A-R"—Same as A-1, with leads reversed.

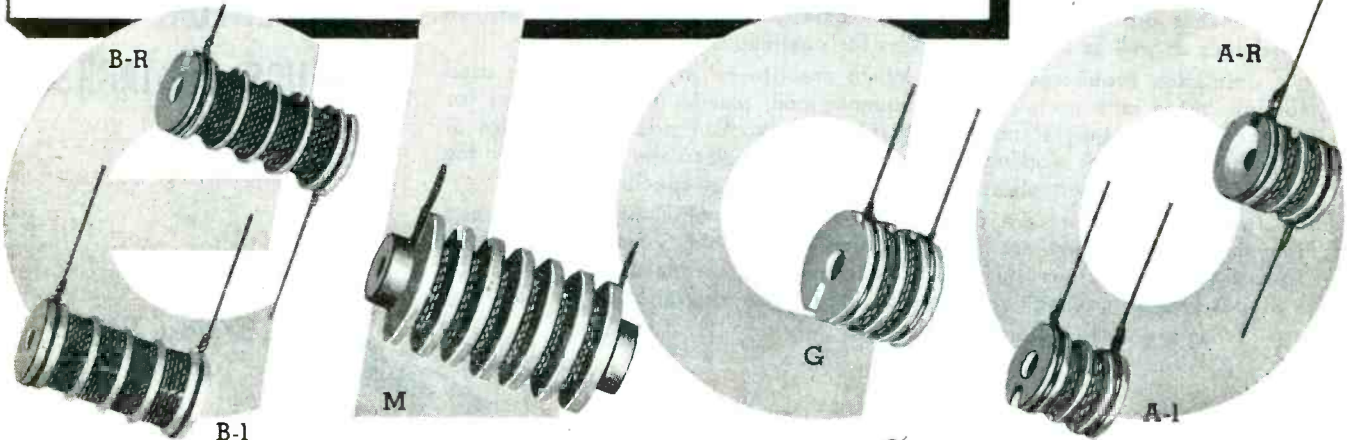
"B-1"—15/16 long x 1/2" dia.—Mountable with 6-32 flat or filester screw. No. 21 tinned copper wire leads. 1 to 500,000 ohm value—1/2% standard accuracy—non inductive pie wound—1 watt, 30° C. temperature rise in free air—100° C. maximum operating temperature—300 D. C. maximum operating voltage. Baked varnish finish.

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

"G"—15/32 long x 1/2" dia.—Mountable with 6-32 flat or filester head screw. No. 21 tinned copper wire leads. 1 to 500,000 ohm value. 1/2% standard accuracy—non inductive pie wound .8 watts, 30° temperature rise in free air. 100° C. maximum operating temperature. 200 D. C. maximum operating voltage. Baked varnish finish.

"B-R"—Same as B-1, with leads reversed.

PROMPT DELIVERIES on the New A1-F and others described and illustrated



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technique, where it is necessary to dissect the frame into successive elements and transmit them row after row, only one picture element would normally be modulating the light beam at a time, and thus the duration of projection of each element would be much less than that in standard motion-picture projection. To make up for this loss in available projection time, some method of storage for the picture elements is needed at the television projector over and above that necessary to avoid flicker.

Storage increases the practical throw of the projector. In one installation where adequate screen brightness was obtained with an 8-inch throw without storage, with a storage ratio of ½ (that is, the elements were retained by the projection system for half of the frame scanning time) the throw was increased to 200 feet (comparable to that in drive-in theaters) with the same screen brightness.

Supersonic Diffraction Valve

The first of the systems described to accomplish these objectives made use of the modulation element illustrated in Fig. 1. A quartz crystal vibrating in the supersonic range sends traveling compression waves across the fluid light gate. These waves are completely absorbed by the terminating window to avoid standing-wave patterns in the fluid. The compression waves cause the light to be diffracted. Standard optical-bar systems are used to obtain an amplitude-modulated light beam from the diffracted rays by selecting the diffracted beams. The system is linear.

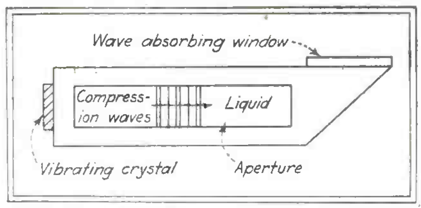

FIG. 1—Liquid light gate makes use of diffraction variation in the fluid, produced by amplitude-modulated supersonic vibrations, to control the intensity of light projected to the screen

The supersonic vibrations of the quartz crystal are amplitude modulated by the television signal. As these amplitude-modulated waves

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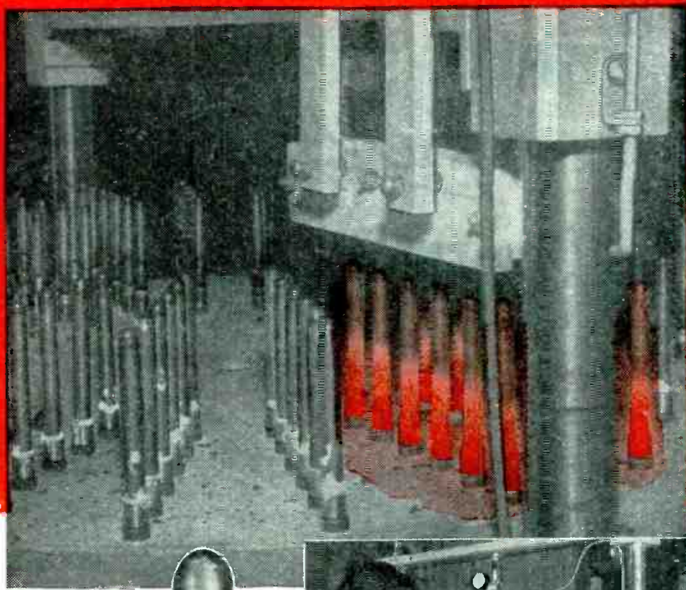

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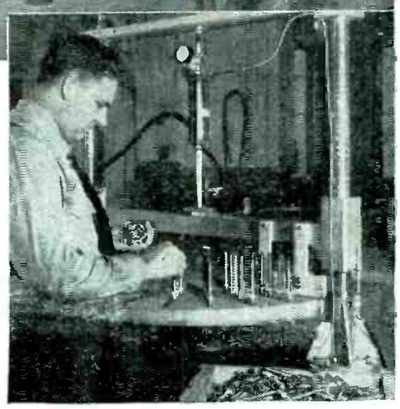
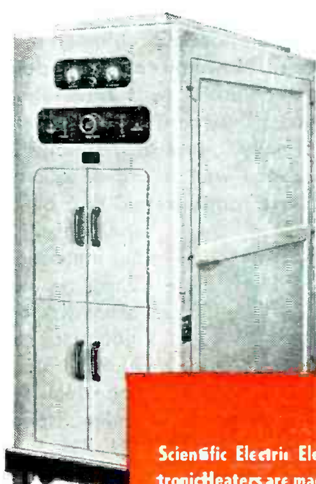
So here is a word of counsel . . . get plenty of advice before you buy. Consult with our recognized engineers who have pioneered in electronic heating since 1921 and, without obligation, they will demonstrate what electronic heating can do for you.



Above: This practical, automatic brazing turntable powered by a 40 KW. Scientific Electric heater speeded up production 700%—cut costs 87% and reduced rejects by 90%.

Left: Close-up of the finished two-piece tube assembly after being brazed by induction heating. Three complete brazing installations have been built for Progressive.



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	7½ KW	40 KW
	8 KW	60 KW
	10 KW	80 KW
	12½ KW	100 KW
	15 KW	250 KW

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traverse the fluid of the light valve they diffract the light beam. It will be recognized that it will take each part of the compression wave, corresponding to each picture element, a finite time to travel the length of the valve, thereby obtaining optical storage.

To counteract the movement of the modulation across the valve, which would result in the picture element traveling across the screen, a high-speed scanning wheel is introduced. A slow-speed scanning wheel directs each successive line of the frame to its place on the screen. This system has been in commercial operation in England in a number of theaters with great popular success.

Skiatron

The second system replaces the fluid valve and scanning wheels with a Skiatron vacuum tube shown in Fig. 2. Light is passed through a crystal of the type displaying electron-opacity, such as potassium-chloride. This crystal is in an electrostatic field, and is scanned by the electron beam from the gun. The beam intensity and motion are controlled as in cathode-ray projection tubes.

As the transparent positive ions of the crystal (potassium in the case of potassium chloride) are

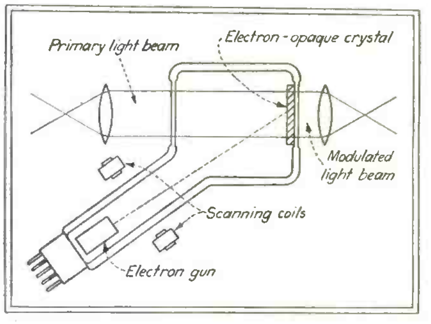
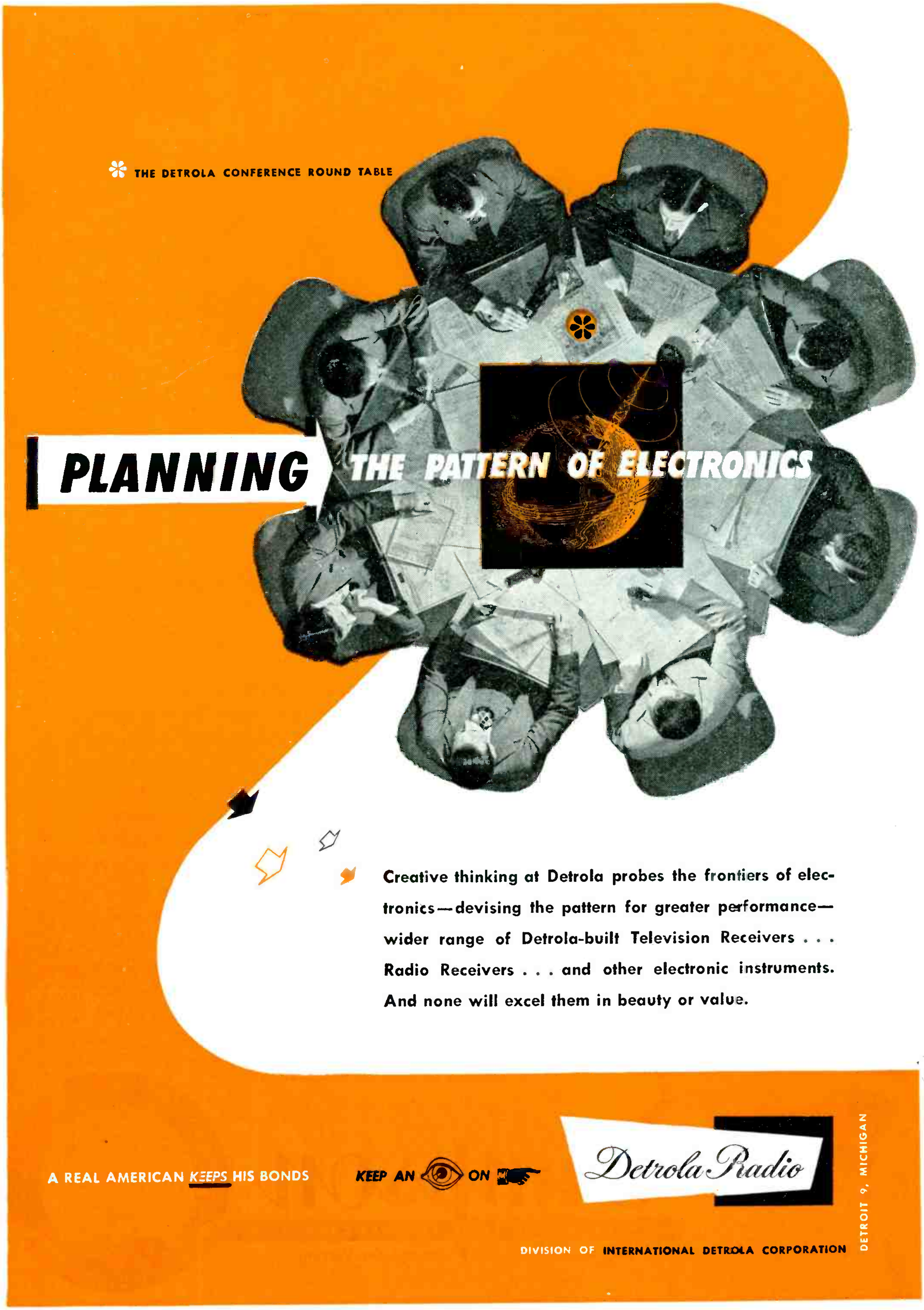


FIG. 2—The Skiatron, instead of using the cathode-ray beam to produce light for projection, uses the electron beam to control the opacity of the crystal, thereby modulating the primary light beam as does the standard motion-picture film

bombarded by electrons from the beam, they become opaque atoms. In this way the light beam is modulated.

It takes a finite time, dependent upon such factors as strength of the electrostatic field and crystal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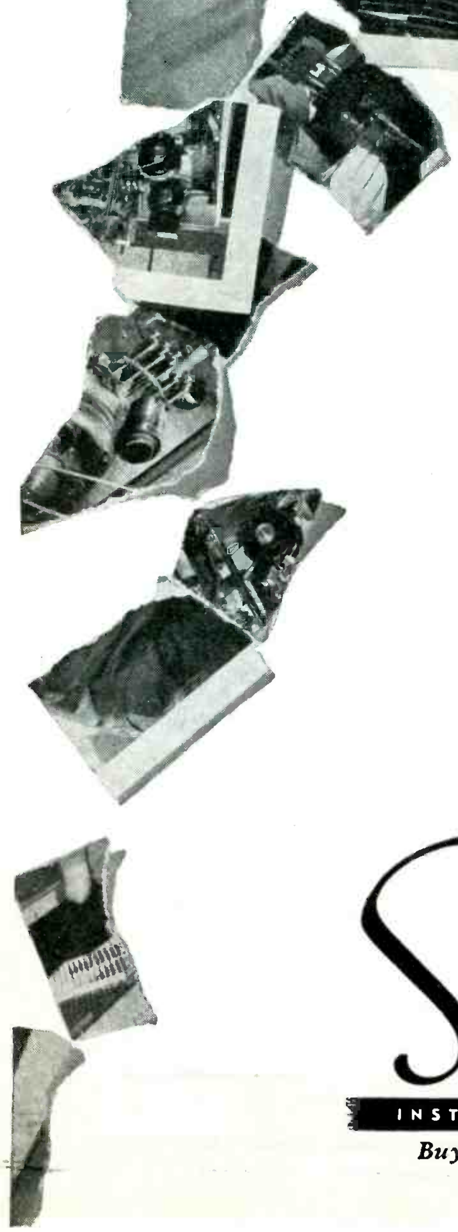

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Pieced together this picture shows one step in the making of dials for Simpson Instruments. We have scrambled it deliberately to emphasize the fact that Simpson employs many processes others do not in manufacturing electrical instruments and testing equipment. To the man who knows instruments this extra measure of engineering skill and craftsmanship is evident in every detail—a reflection of Simpson's never-ending quest for refinements in design that will at once improve performance and permit more efficient production. It is the experience gained through more than 35 years of such study which promises you, in Simpson Instruments, the ablest application of the great advances that will be forthcoming.

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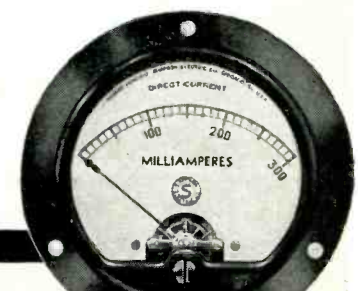

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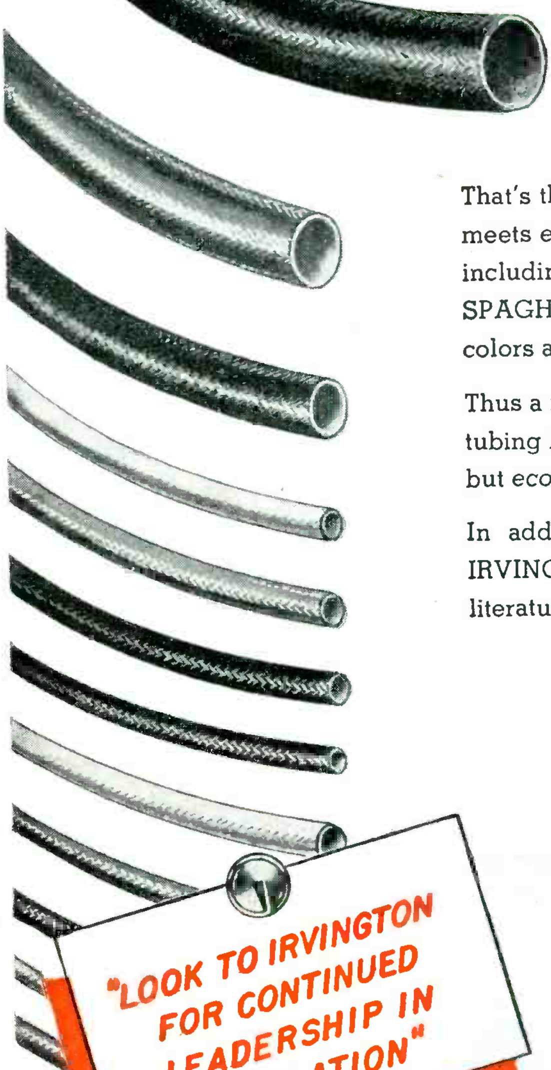

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history, for the loosely bound electron to abandon the atom and leave it again a transparent ion. The electron travels to the positive electrode used to produce the electrostatic field. In traveling from the atom to which it was originally directed, the electron successively neutralizes adjacent positive ions. In this manner, optical storage of the individual picture elements is obtained.

Using the Skiatron, the entire picture can be projected all the time; the time required for the electron to leave the electron-opaque crystal just coincides with the length of time required to scan the complete picture. Because of this melting of one frame into the next, there is a minimum of flicker. The number of frames that need be transmitted per second can be reduced, thereby permitting a greater number of picture elements to be transmitted per frame without increasing the transmission-frequency band. This would increase the definition of the final image.

Since the Skiatron operates on light absorption, it can be used efficiently in color television by associating with each of three tubes, through which the light to be modulated passes in succession, color filters rotating before each tube in synchronism with the color dissection filters at the television studio.

The Skiatron has been used successfully in large-screen home receivers for preliminary study of its commercial practicability. Both of these television projection methods have a gamma comparable to that of 16-mm motion-picture film.

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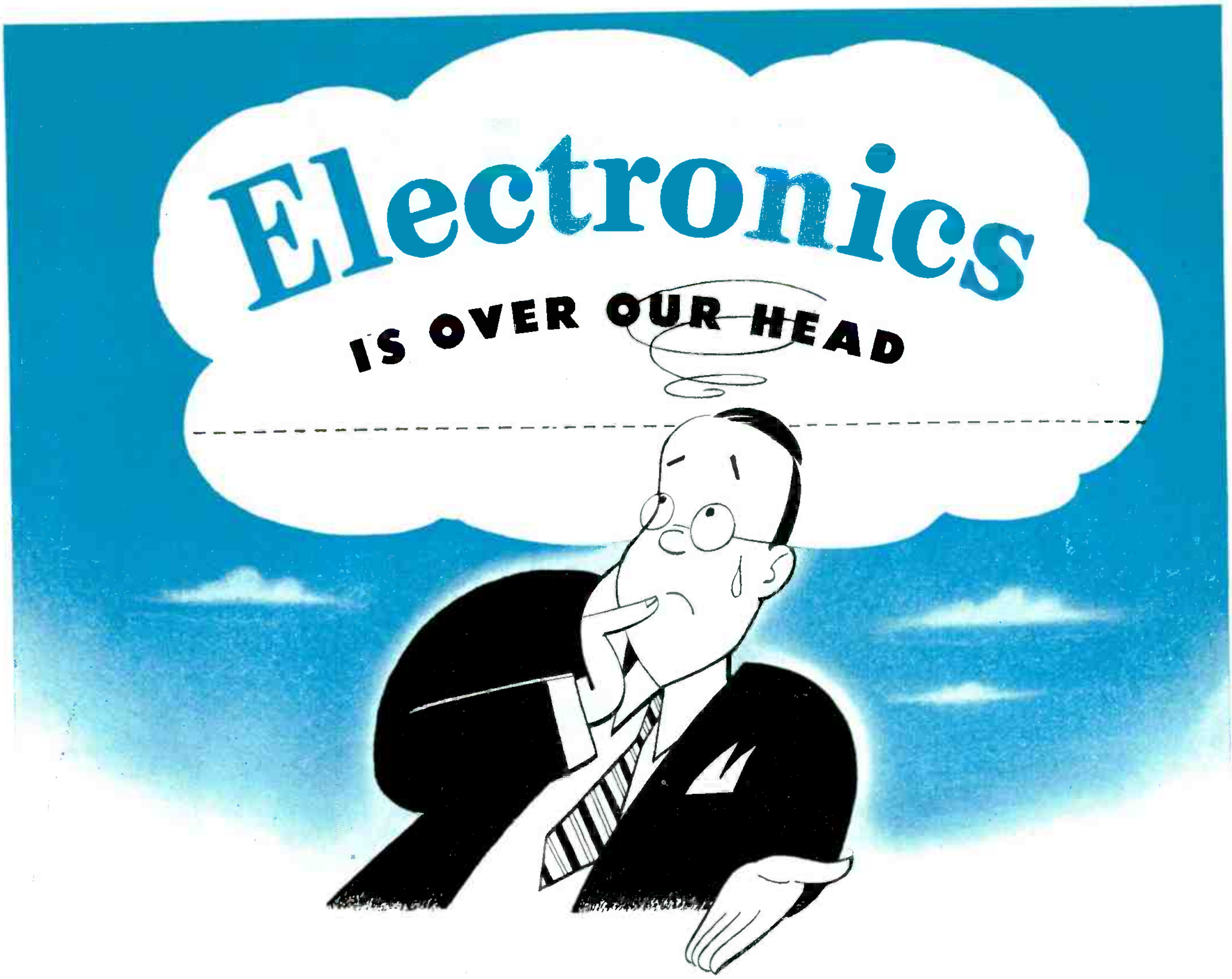

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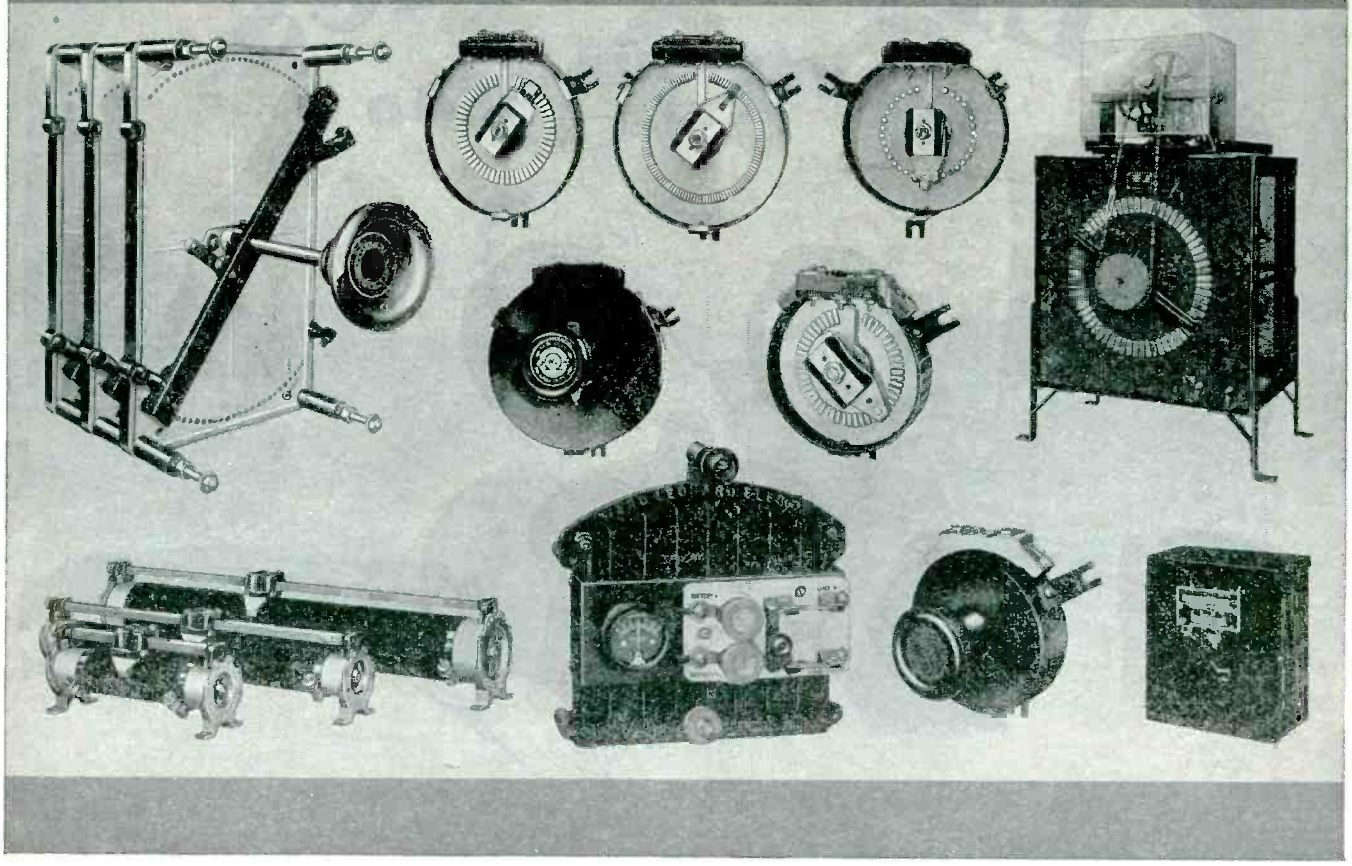

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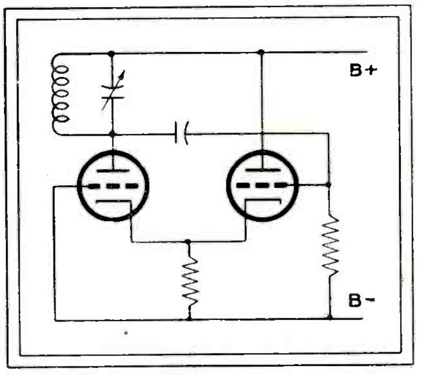
THE ELECTRON ART

Cathode-Coupled Oscillator Circuit

CATHODE-COUPLED oscillators have advantages of stability and small loading of the tuned circuit. Several circuits and equations for their operation are given by F. Butler in the November, 1944 issue of *Wireless Engineer* (Dorset House, Stamford St., London S.E. 1).

The basic oscillator circuit, shown in the diagram, has the advantages that the tank coil is not tapped, the high input impedance of the cathode-follower stage on the right imposes light loading on the tuned circuit, and unity gain in the cathode-coupling stage provides ample drive for reliable oscillations up to very high frequencies for low Q circuits. This circuit can be further stabilized for single-frequency operation by using individual cathode resistors and coupling the cathodes through a crystal. This connection, by operating the crystal at series resonance, reduces the capacitive shunting of the crystal by its holder.

If the feedback circuit from the tuned circuit to the grid of the cathode-coupling stage is opened and an external signal fed to this grid, the circuit provides a highly selective amplifier with a high input impedance. The off-resonance attenuation is greater than for conventional amplifiers and may be increased by tuned output circuits in place of the load resistances.



The circuit of a cathode-coupled oscillator. Convenience in band-switching is provided by the two-terminal inductance

Engineers Discuss Radar and Surgical Metal Locator

TWO TECHNICAL PAPERS dealing with the role of electronics as locating devices were presented at the March meeting of the Chicago Section of the Institute of Radio Engineers at which Dr. W. E. Gilson, School of Medicine, University of Wisconsin, Madison, Wisconsin, spoke on "A New Surgeon's Metal Locator", and Dr. W. L. Everitt, Head of the Department of Electrical Engineering at the University of Illinois, and now in the Office of the Chief Signal Officer, Washington, spoke on "Recent Wartime Developments In Electronics" and outlined general principles of radar.

Dr. Everitt's talk represented one of the first discussions, in an open engineering meeting, of the principles of radio direction and ranging equipment. In opening his talk, he stated that he had received permission to discuss certain principles of radar and the application of these principles to two sets, the SCR-268 and the SCR-270, but stated that his comments were completely off the record and requested that no notes be taken. It was also indicated that discussion of other radar developments could not be divulged.

Radar Problems

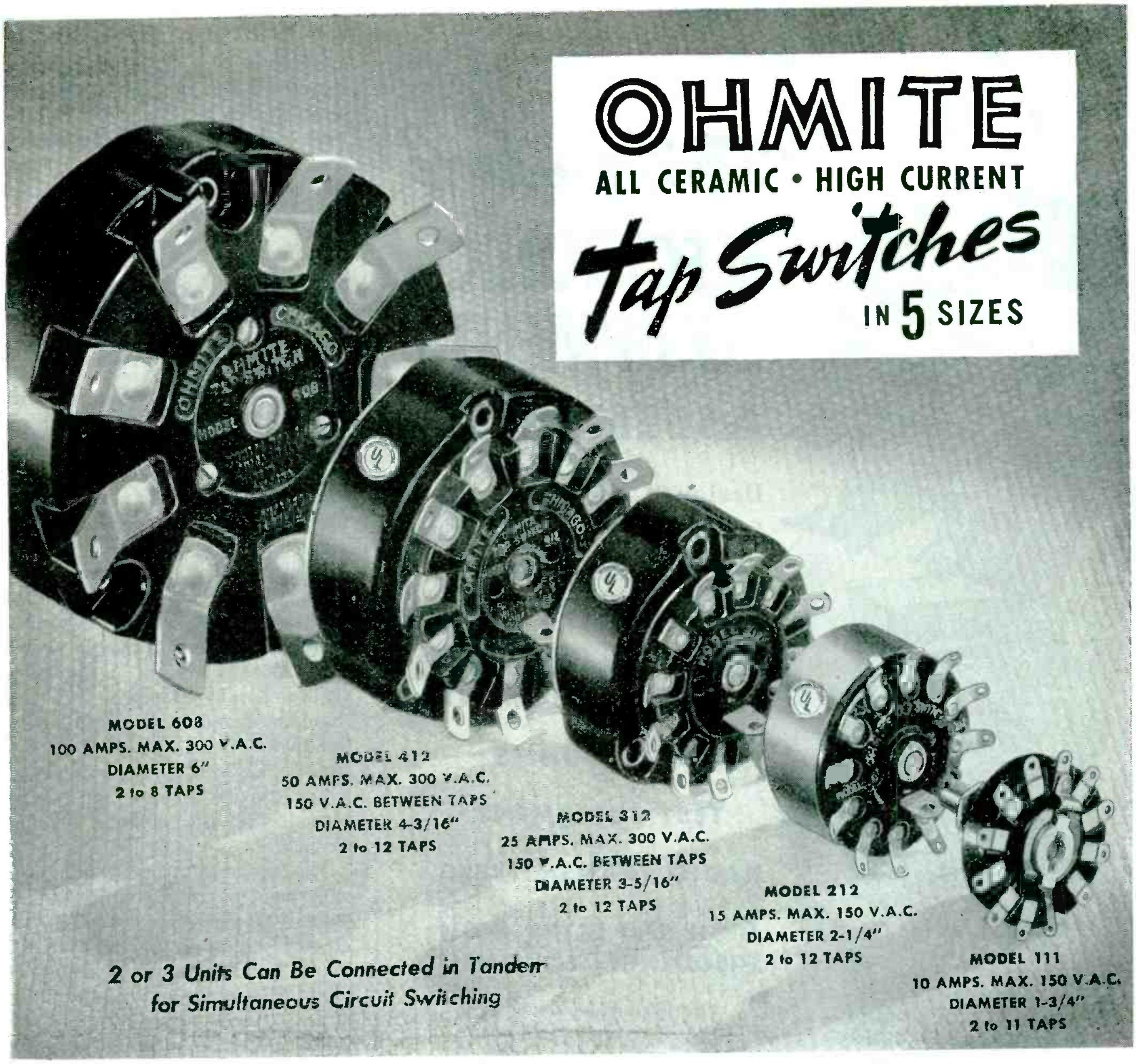
While such problems as decrease in field intensity with distance of the transmitter, effect of ground reflection, necessity for new method of rating tubes in terms of peak power rating, factors for consideration in locating radar equipment, and factors to consider in the design and construction of directive v-h-f antenna systems were all discussed, it must be admitted that the topics discussed were such as to give no comfort and aid to the enemy. In fact, all of the radar principles discussed by Dr. Everitt were either already known to qualified radio engineers or could easily be surmised after casual reflection on the requirements of radar transmissions.

New to many of the engineers were the photographic slides of the two Signal Corps installations. Most important of all, however, was the fact that Dr. Everitt's lectures (which were also given before other sections of the IRE in the Mid-West) are the first time that this all-important subject has been discussed in an open engineering meeting. It would appear that such a talk is highly desirable in view of the comparative freedom from censorship in Great Britain and the fact that none of the developments under discussion had taken place since the entry of this country into the war.

Bullet Locator

Dr. W. E. Gilson, of the University of Wisconsin, gave a brief outline of various methods which had been used in the past half-century for locating metallic objects imbedded in the human body. Early work in that field was inspired by the assassination of President Garfield on July 2, 1881, which led Alexander Graham Bell to develop a system of locating bullets in the human body by making use of the Hughes balance. It was only after the employment of electron tubes in such applications that metal locators became smaller in size, effective, and practical for medical use. The majority of such locators are quite satisfactory for magnetic material but not particularly suitable for the location of non-magnetic material.

Dr. Gilson described and later demonstrated a locator of metal objects making use of the principle of two beat oscillators. One of these oscillators, whose tuning may be varied, is adjusted to beat against



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Suggestions for Design of Volume Expanders

By RICHARD W. CRANE

IN THE PAST few years, circuits have been developed to expand automatically the volume range of radio, record, and motion-picture sound in an attempt to compensate for the manual and/or automatic compression necessitated by the transmitting or recording procedure. However, in spite of the ingeniousness and obvious desirability of such systems it may be shown that (1) they are not so necessary as is generally assumed, (2) they should be completely avoided in certain installations, and (3) they have certain defects and deficiencies which prevent them from exactly reproducing the original volume pattern.

The main argument for the use of expanders is that compression seriously reduces the dynamic range of the recorded or transmitted sound, but this is not so bad as it might seem since loudness is determined by the average sound power whereas compression depends on the instantaneous peaks.

Ten violins will certainly sound louder than one violin; however, even if all ten were playing the same note, due to the phase differences between the signals (the probability of all ten or even of any two of the signals being in phase for more than a fraction of a second is very small), the peak voltage values of the combined sound will not necessarily be any higher than those of one instrument, although the average voltage value will be about three times as large. Similarly, in a symphony orchestra, the kettle-drums produce about the highest instantaneous sound power of any of the instruments, but if we could imagine a solo series of beats on a single timpano the volume pattern would be a succession of very high peaks with practically

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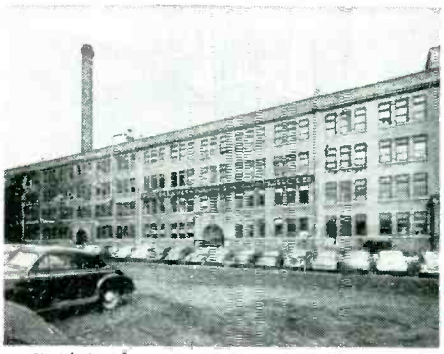

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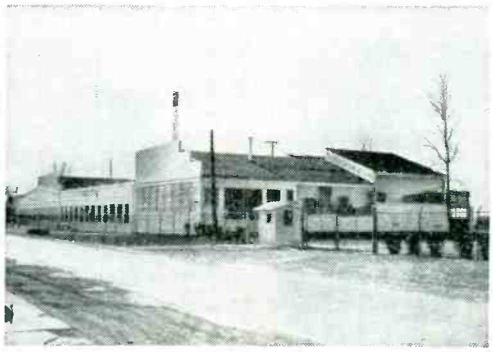

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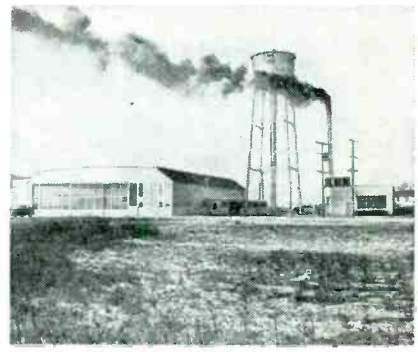

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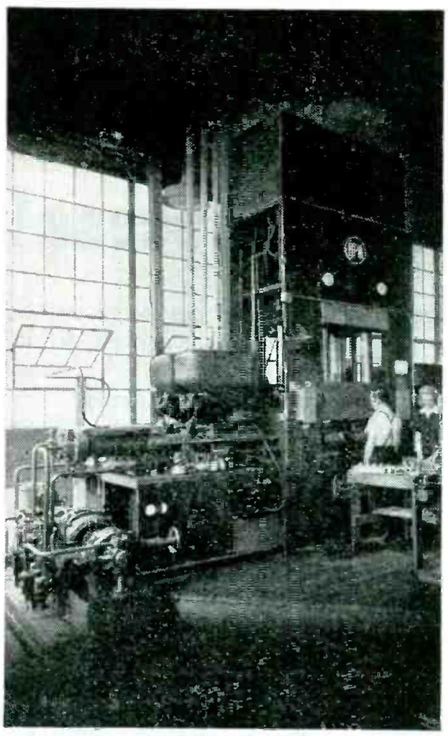

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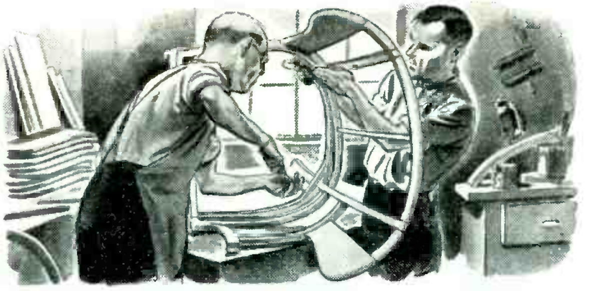

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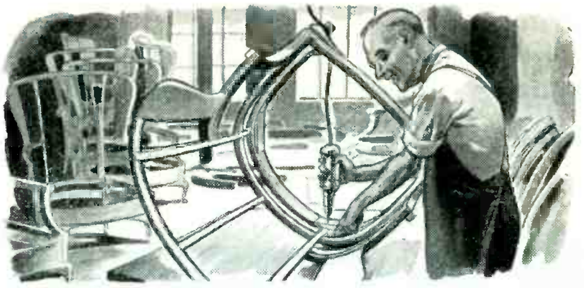

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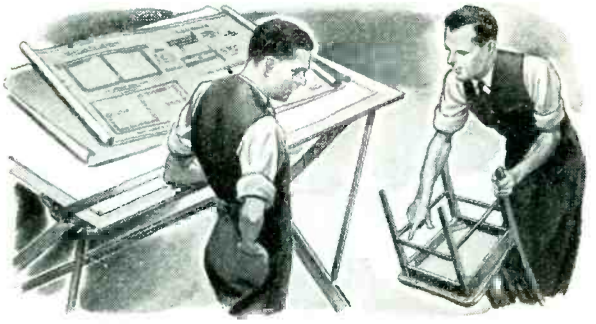

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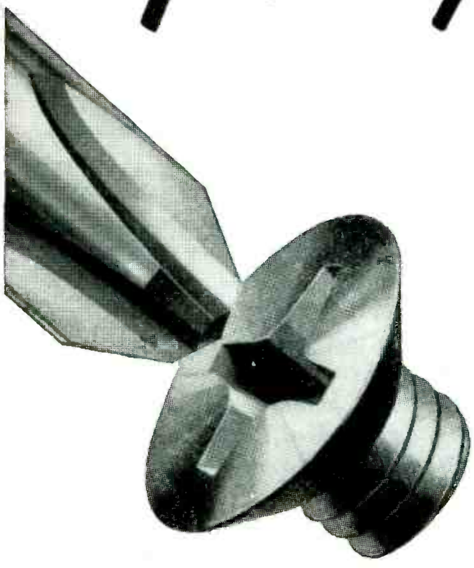

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If the entire orchestra played, the timpani sound peaks would still be the highest instantaneous sound levels and the maximum readings on the volume indicator would be no greater than when the solo drum was played, even though the average sound power would be far greater. Thus, the average sound power in many cases may vary greatly without the studio engineer having to compress it at all.

Effect in Different Locations

In some situations, the use of expander amplifiers is not at all desirable, especially if the loud speaker is located in a room which has a high noise level and little sound-absorbing material. The best example of this is the average motion-picture projection booth where the normal volume range in the picture (without benefit of expansion) is usually too great for

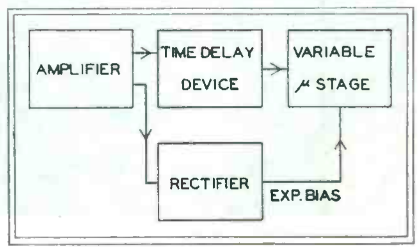

Fig. 1—Block diagram of automatic volume expander which anticipates changes in signal level and increases the amplifier gain before the peak passes through

the operator's comfort, the soft passages being drowned out by the projector noise and the loudest portions being re-flected and re-reflected by the hard walls until they are almost deafening. This would not be true in the theater auditorium, but in the reproduction of music in a factory or a railroad station similar conditions obtain and expansion should not be used. Even the typical city apartment has a high noise level, especially in the summer, and although it may have a fair amount of drapes and carpets, "enhanced" fortissimo passages drifting out the windows will not be greatly appreciated by the neighbors.

Another point that must be con-

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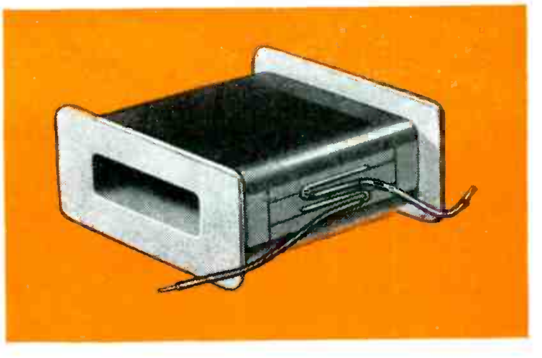

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sidered in using these circuits is the limitations of the equipment associated with the expander, for if this amplifier system does not have a dynamic range of at least 70 db (from noise level to overload point) expansion cannot be used to its full capabilities.

Time Lag

As to the defects of expander circuits, two might be noted. First, is the fact that expanders cannot anticipate changes in volume but rather have a slight time lag which makes it impossible for them to do more than approximate the original volume pattern. This lag is not important when volume changes are gradual, but on a sudden clash of symbols, for instance, the amplifier gain will not increase until after the sound peak has passed. This could be overcome by use of some sort of a time-delay device, perhaps a magnetic tape recorder, in a circuit such as Fig. 1 (which is otherwise a typical expansion circuit), the delay being adjusted so that the signal entering the variable-μ stage lags a little behind the bias variations. In this way, a sudden peak would increase the amplifier gain before the peak passed through rather than afterwards. The same idea could be used for compression where it should give better results than manual monitoring as it anticipates all changes in signal level.

Need for Balance

The second shortcoming of automatic volume expansion is that even if the circuit can foresee changes in volume it can never duplicate the original volume range because it has no way of knowing what these original levels were; that is, it will make the loud portions louder and the soft portions softer, but always by the same amount for a given input level. Thus the expander circuit might increase every signal that is 10 db above the average volume level to 15 db above the average, but the level in the studio might have been far higher than this, or even lower.

With manual compression, it would be extremely difficult to devise a circuit to overcome this fault, especially since most studio engineers ride gain on each microphone

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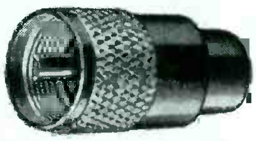

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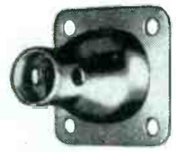
Elbow adapter for changing direction of wiring. Housing of die-cast zinc, silver-plated. Pin and socket silver-plated spring brass. Insulation is polystyrine.

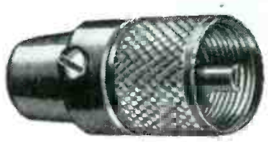
SHIELDING HOOD



Connector #47.447
Signal Corps #M-360
Navy Part #CI-49193

Silver-plated brass hood, used with plug #50.392-1 as a shield for the wiring cable. Holes provided for soldering to cable shield.

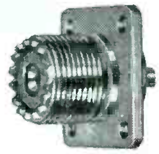
CABLE PLUG



Connector #50.393
Signal Corps #PL-259A
Navy Part #CI-49195

Navy designed. Mates with receptacle #50.392-1. Low-loss, mica-filled bakelite insulation. Metal parts of brass, silver-plated.

CHASSIS RECEPTACLE



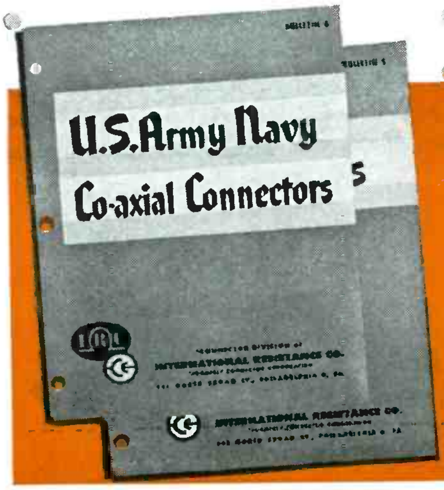
Connector #50.392-1
Signal Corps #SO-239
Navy Part #CI-49194

Flanged receptacle for chassis mounting. Housing is die-cast zinc. silver-plated. Low-loss, mica-filled bakelite insulation. Socket contact of silver-plated copper alloy.

CONNECTOR ADAPTER

Connector #50.415
Navy Part #CI-49544

Adapter is designed for interconnection of certain British and U. S. Army-Navy coaxial plugs or to permit the use of both U. S. Army-Navy and British plugs in the same piece of equipment. See table of possible connections in Bulletin #6.



For more detailed information, including dimension drawings, write for Bulletins #4 and #6.

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All Fairchild sound instruments are built to meet the increasingly important transcription requirements of the radio and communications fields. Descriptive and priority data are available. Address *New York Office:* 475 - 10th Avenue, New York 18; *Plant:* 88-06 Van Wyck Boulevard, Jamaica 1, N. Y.

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LET'S GET DOWN TO CASES—OF PLASTIC

● *Typical of the ingenuity of American industry in developing new products and improving old ones with plastics is the above-illustrated plastic binocular case which was produced by the Hood Rubber Company for Bausch & Lomb Optical Company.*

Due to the vital importance of binoculars to the Armed Forces, it was absolutely essential that these instruments be carefully safeguarded against injury.

In the quest for the ideal material, eight different types were considered. Of these, only one successfully passed all the requirements for binocular cases. This was a laminated and molded plasticized vinyl reinforced with Durez phenolic-impregnated fabric and other materials.

This new case passes the accelerated-weathering (240-hr. test), salt-spray (100-hr. test), impact-resistance (4 ft., -50° F.), accelerated-warp (7 days, 160 to -10° F.), flexural-resistance (1½-in. radial bend), abrasion-resistance, and construction tests as set up by the U. S. Navy. Another interesting feature is the resistance to fungi and bacterial growth which this case possesses, to the extent that the binoculars themselves are immunized.

The versatility of Durez phenolic plastics has made their use almost universal throughout industry. Such properties as dimensional stability at temperature extremes, diversity of finishes, dielectric strength, and resistance to moisture, heat, acids and alkalies, render them invaluable to the imaginative design engineer.

Perhaps you are searching for a material for some product which you intend to market in the post-victory era. If so, we suggest that you take advantage of the wealth of experience which Durez technicians have available for your benefit at all times. You are always assured of the complete cooperation of the Durez staff to help you solve plastic material problems. Durez Plastics & Chemicals, Inc., 325 Walck Road, North Tonawanda, N. Y.

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PLASTICS THAT FIT THE JOB

separately, rather than use the master gain control; however, with automatic compression the amount of compression can be measured and an extra signal transmitted or recorded whose amplitude varies with the amount of compression and this signal can be used in the receiver or phono amplifier to regulate the amount of expansion.

Suggested System

Figure 2 is a schematic diagram of how such a system might operate. The compressor circuit is similar to Fig. 1, but in addition the compression bias is used to control

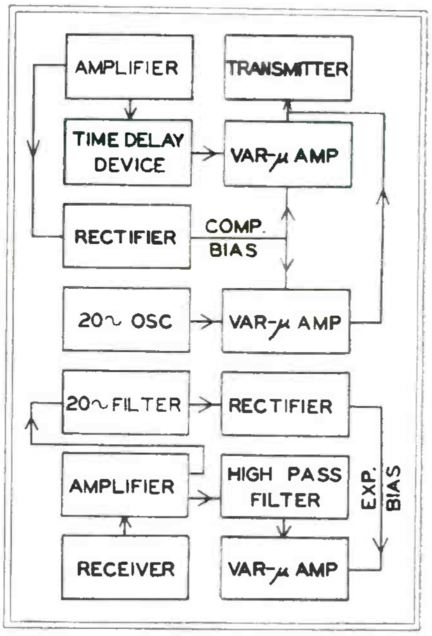

Fig. 2—Suggested system of volume expansion for a transmitter which employs a 20-cycle pilot signal whose amplitude varies with the amount of compression

the amplitude of a sine-wave signal whose frequency is just out of the audio range, for instance 20 cycles. This signal is then mixed with the regular signal and both are transmitted. In the receiver, the 20-cycle component is separated by a filter system and is rectified to furnish a volume-expansion bias. With careful design, an arrangement like this could give almost perfect volume-range reproduction.

Thus it may be said that although volume expansion is ordinarily desirable it is not as vital as might be expected, and in many installations would subtract from rather than add to the listener's enjoyment. In addition, the usual ex-

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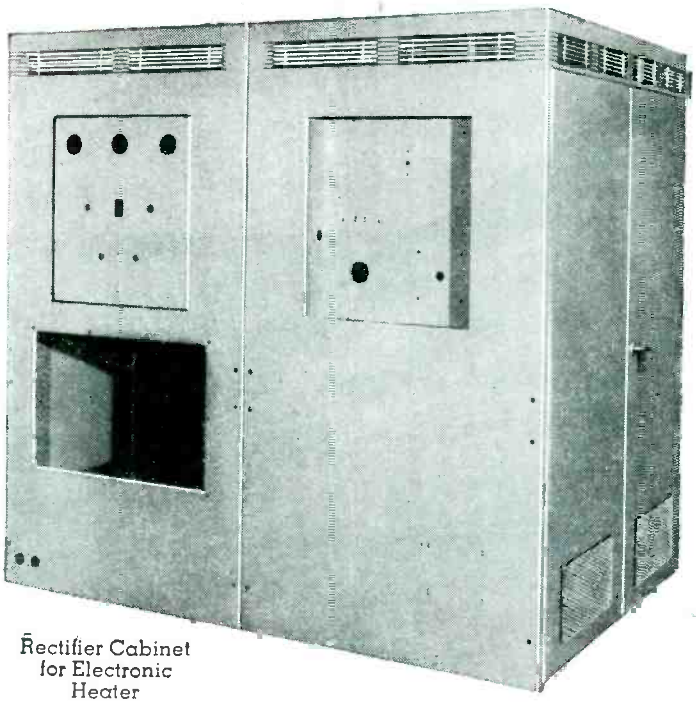

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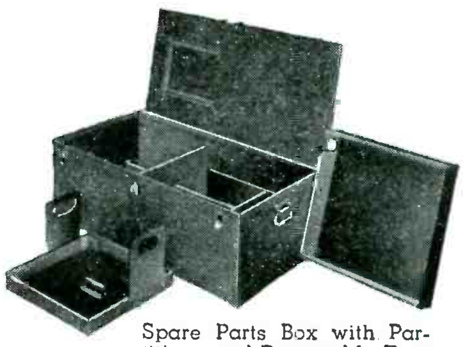
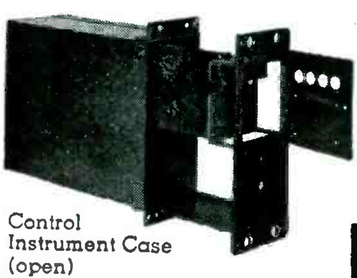
KARP craftsmen, thoroughly skilled and experienced in sheet metal work, individually construct each job to customers' specifications. Complete, modern facilities make possible any manipulation of the material in all stages of manufacture—from the making of the dies, through the fabricating and finishing. Hundreds of stock dies, already on hand, reduce or eliminate the cost of dies. Moreover, **KARP** goes over your plans with you . . . makes recommendations if they are necessary . . . and suggests means of expediting deliveries. Consult a **KARP** engineer or local sales representative when you require highly dependable sheet metal products—whether they be steel, brass, aluminum, monel, stainless steel or an alloy.



Spare Parts Box with Partitions and Removable Tray

Portable Battery Case

Amplifier Cover



Control Instrument Case (open)

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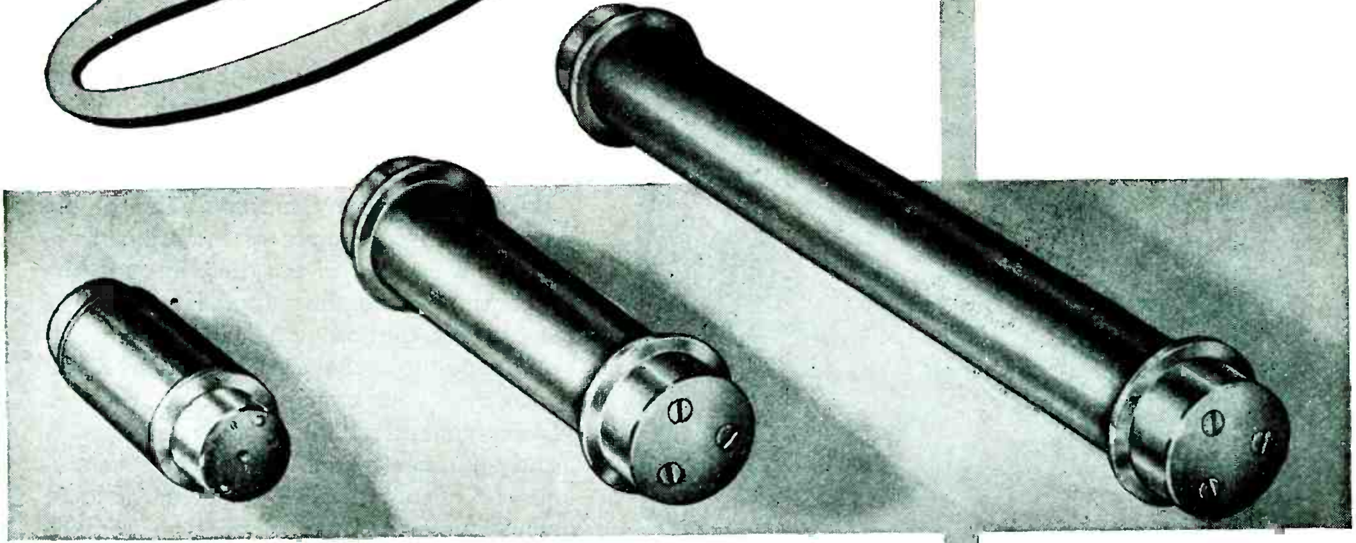

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WESTON tubular resistors . . . widely used since their introduction over a decade ago . . . furnish another outstanding example of *sound engineering* coupled with *engineering foresight.* For no new 'hurried' resistor design was needed in order to meet exacting military specifications that called for protection against tropical humidity, arctic and high working temperatures, and salt air. The WESTON tubular resistor met these new specifications . . . and in a rugged, non-fragile design *tried and proved* throughout the years. These resistors conform to and are approved under joint Army Navy Spec. JAN-R-29. Bulletin A-12 gives complete specifications. Send for your copy . . . Weston Electrical Instrument Corp., 589 Frelinghuysen Ave., Newark 5, N. J.

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pansion circuits will only roughly approximate the original volume pattern, an exact reproduction requiring a coördinated compression-expansion system.

• • •

Radar Terms and Abbreviations

FOLLOWING IS a list of the popular terms used by radar technicians as reported in *Aviation News* for April 2, 1945.

"A" Scope—An "A" scope indicates the range of the target as the distance along a horizontal line from the transmitted pulse to the signal (see Indicator)

AI—Short for Aircraft Interception. Short range airborne radar sets which guide nightfighers in their interception of enemy aircraft

ASV—Abbreviation for Air to Surface Vessel. ASV search sets are used in aircraft for detecting objects on the surface of the sea

AW—Aircraft Warning. **AWS**—Aircraft Warning Service

"B" Scope—A "B" scope shows the range vertically, and the relative azimuth or bearing horizontally. Signals appear as bright spots

Blip—British for pip. Term used to designate the signal on a scope or indicator

Blister—The housing for radar antenna (see Radome)

BTO—Bombing through overcast (e.g., with the "Mickey" set)

Chaff—Foil and paper strips dropped from airplanes to create false signals on enemy radar sets (see Window)

GCA—Ground Control Approach. The technique and/or apparatus for "talking down" an aircraft into approach for landing in poor visibility

GCI—Ground (or ship) Control of Interception. GCI stations vector (i.e., supply bearings to) to within visual or radar range of enemy aircraft

GL—Gun Laying. Range, bearing and elevation provided by GL equipment to direct ground or shipboard guns and control their fire

IFF—Identification of Friend or Foe. Method of automatically challenging and receiving posi-

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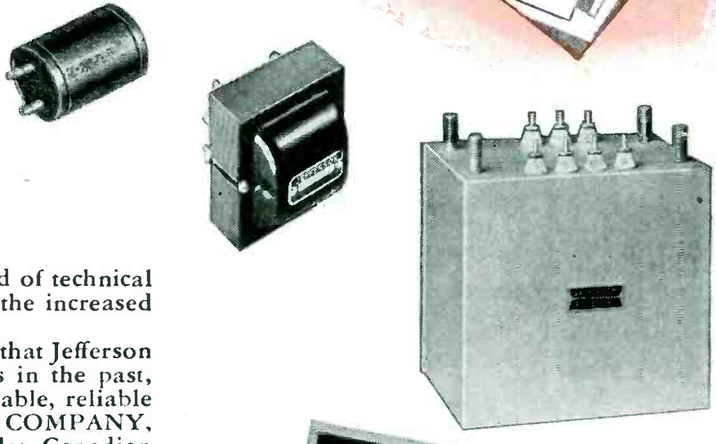
Magnified demand from the military as well as essential war industries during the past few years, has resulted in far-reaching transformer developments and methods of production. New needs, and many new applications have built up a great fund of technical knowledge that Jefferson Electric will use in serving the increased industrial demand of the great new peace era.

This vast reservoir of added experience assures you that Jefferson Electric Transformers will continue, in the future as in the past, to offer the same superior service that means dependable, reliable performance at all times. . . . JEFFERSON ELECTRIC COMPANY, Bellwood (Suburb of Chicago), Illinois. In Canada: Canadian Jefferson Electric Co. Ltd., 384 Pape Avenue, Toronto, Ont.



JEFFERSON ELECTRIC

TRANSFORMERS

tive response from aircraft or ship

Indicator — Radar signals displayed on face of a cathode-ray tube, the end of which is called the "scope" (from oscilloscope), or screen

Jamming—Introduction of false radiation into enemy radio and radar devices

Mickey—Radar set used by Pathfinder planes in BTO

Pip—American for "blip." Signal on scope

PPI—Plan Position Indicator, a circular map-type scope. May be compared with charts as a navigational aid. PPI scope photos have appeared in the press

Racon—Radar beacon, used as a navigation aid, "blind" landing of planes, etc. **Radome,** antenna housing (see Blister)

RDF—Radio Direction Finding, also Radiolocation. British terms for Radar (radio-detection-and-ranging), which is an American term

Window — Mechanical reflecting devices dropped from planes to confuse enemy radar

• • •

Third Chicago War Production Conference

IN AN ALL-DAY PROGRAM attended by more than 2,000 persons, the third Chicago War Production Conference was held on March 29, at the Stevens Hotel in Chicago. Thirty-six panels on a wide variety of technical topics were presented including radiography, x-ray applications, instrumentation, electronic control, and a general session on electronics.

Dr. L. T. Rader, director of the Department of Electrical Engineering at the Illinois Institute of Technology, spoke on "Motor and Industrial Process Control", pointing out that industrial electronic equipment must be designed and constructed on a different basis from that of communication equipment. Long life, dependability of operation under adverse conditions, and cost are important factors in the construction of industrial electronic devices. It was also pointed out that industrial electronics as such does not and probably will not stand on its own feet, but rather must be re-

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Variable from 1.0 to 1.5 Volts DC

OUTPUT CURRENT – 500 MA Max
This model suitable for use in place of A Batteries where a source of AC power is available

Model 42A

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General purpose supply which will deliver well-regulated DC at any voltage from 0-300

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Same characteristics as Model 44B except for lower current rating

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Other units can be designed to specifications.

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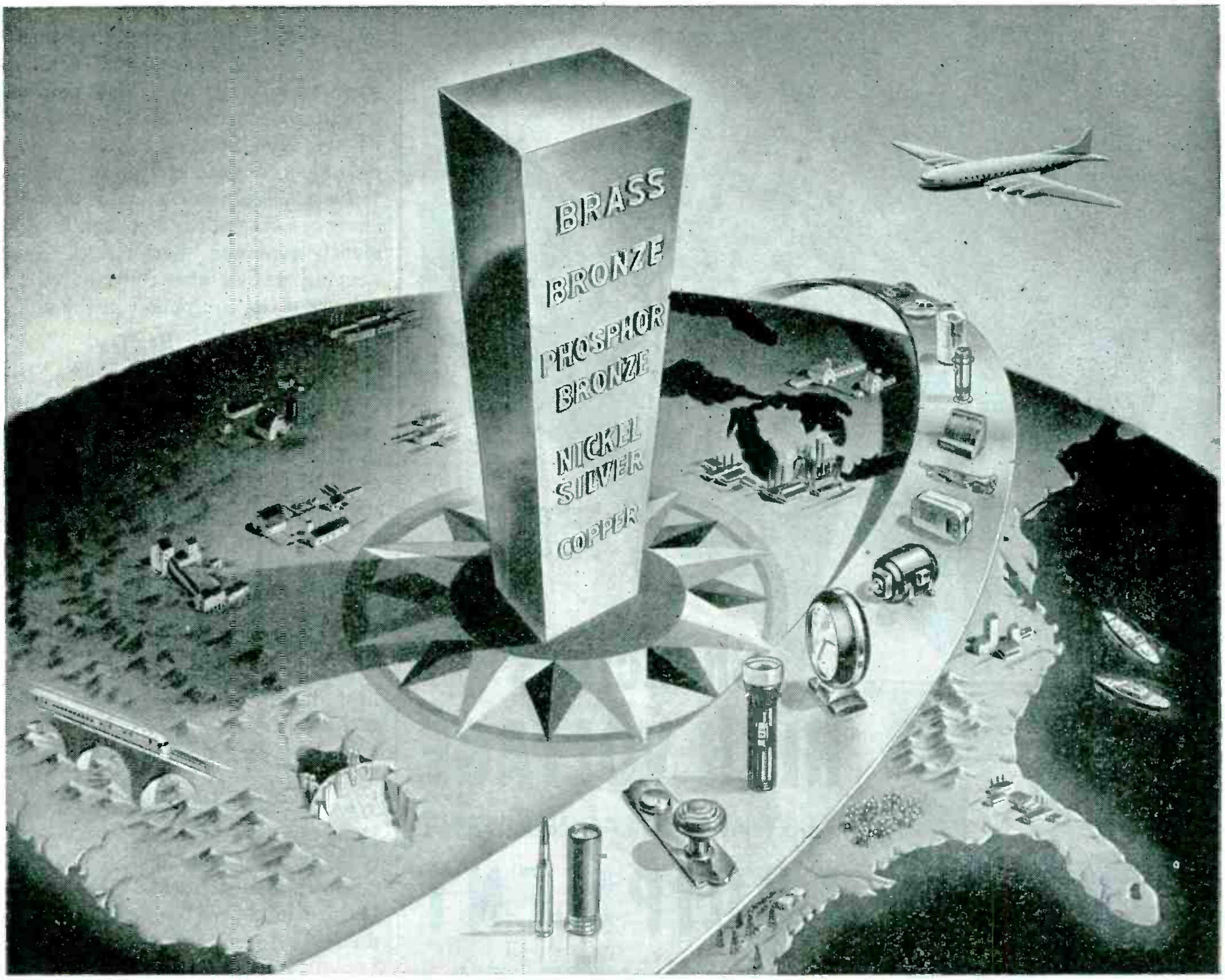

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BRASS • BRONZE • PHOSPHOR BRONZE • NICKEL SILVER • COPPER garded as a very important element in a completely integrated field of engineering. It was also pointed out that electrical components such as are used in the communication field are often too fragile for use in industrial equipment, and that in many cases a failure to provide sufficiently generous tolerances in engineering design also contributed to failure of the equipment in the field.

Electronic Heating

A talk on "High Frequency Induction Heating" was given by Mr. John M. Cage, engineer in charge of Electronic Control Division of Allis-Chalmers. The manner in which heat is generated in conducting materials, whether magnetic or not, was discussed and it was shown that the basic circuits of electronic heating units are all similar but that the number of applications is exceedingly varied. It was shown that the fundamentals of induction heating depend on: (1) induced voltage, (2) skin effect, and (3) hysteresis.

Carl Madsen, electronic engineer, Industry Engineering Department of Westinghouse, spoke on "High Frequency Heating of Dielectrics." Its use in the rayon and nylon industries, to set the thread to prevent twisting and stiffness of the yarn, was compared to the annealing process in metals.

He pointed out that the cost of sterilizing grain by electronic means is about 2 cents per bushel and that this cost was too high for this application. At the same time, the cost was sufficiently low that it could be applied to package goods.

Regarding food, Mr. Madsen commented on reports that it would be possible to cook meals by means of dielectric heating in the postwar period. This did not prove too attractive because it has not been found feasible to heat uniformly, since the fatty and lean portions heat at different rates. Moreover, in order to cook a 1-lb steak in 10 seconds, as has been held to be feasible, 150 kw of power would be required. Mr. Madsen did not state where or how the steak was to be obtained.

In the discussion following the panel on electronic controls, Dr. Rader pointed out that economic problems were of considerable im-

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Maybe you can't . . . but maybe you can. Stranger things have happened. "How come" the $10.19 cost? Is it labor . . . materials . . . or, as Atlas has often demonstrated, a stubborn adherence to outmoded machinery, slow and costly finishing processes, poor power distribution and control, double-back floor layouts . . . or should the product be re-designed for more efficient production?

The Atlas organization, 300 skilled designers, engineers and toolmakers, and one of the country's best equipped plants, has solved such problems for scores of America's leading industrial manufacturers . . . before and during the war . . . and is now designing products, creating and building tools, dies, jigs, building special automatic machinery and planning complete production lines for the coming civilian manufacture.

We offer a complete service or partial aid in any or all of these fields. In addition we are prepared and equipped to produce precise parts or products in our own plant . . . work which requires close tolerance machinery and strict inspection and testing.

If your post-war ideas are crystalizing but have not yet reached the "action" stage, we suggest a conference at your early convenience.

A load off your shoulders onto ours.

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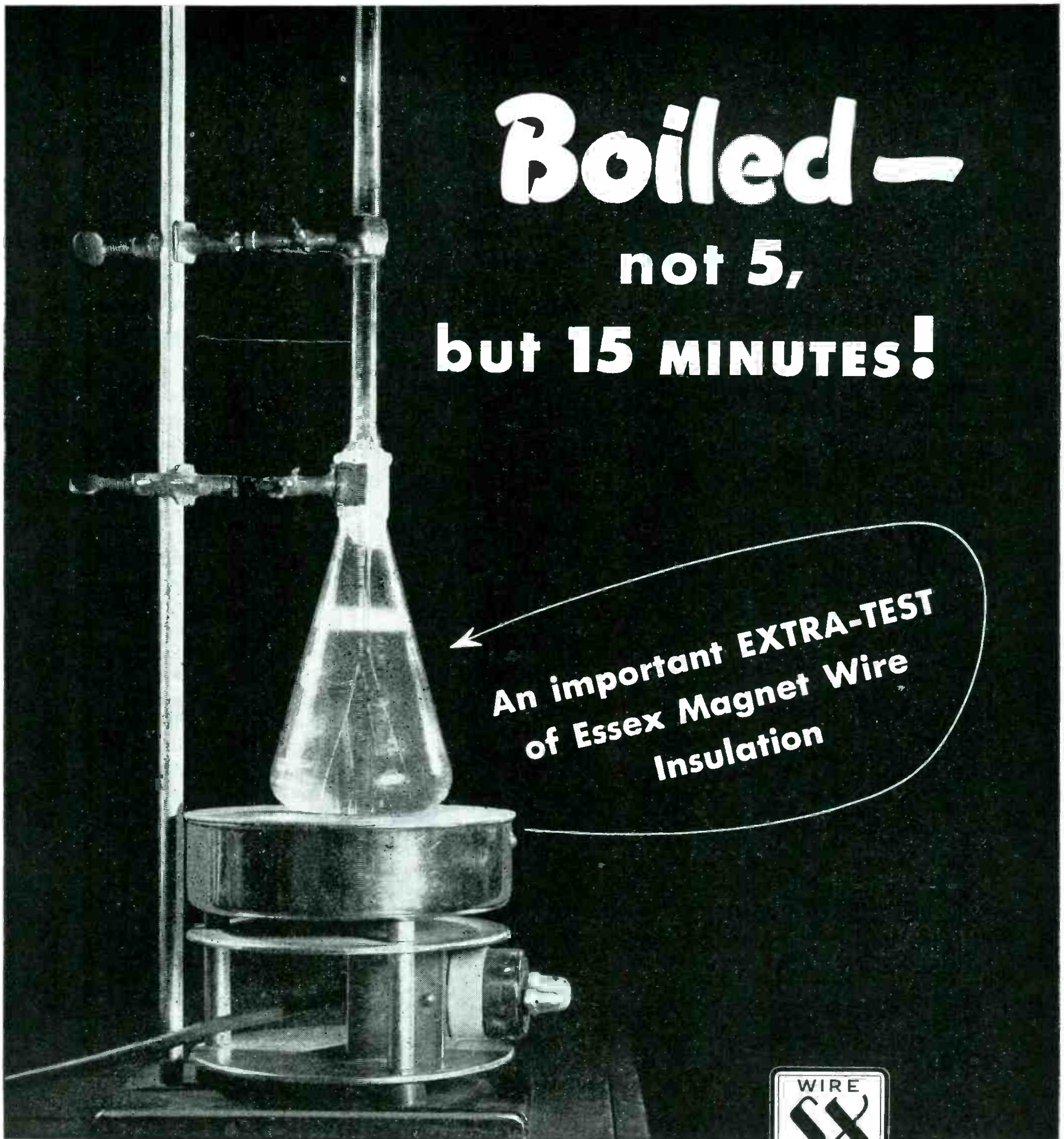

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Varnish is often hard on film-coated magnet wire insulation unless the film is properly cured or baked. That's why many users require boiling tests in toluol and alcohol solutions, for as long as 5 minutes.

To meet these requirements consistently, Essex engineers use even stronger toluol-alcohol solutions than usually required—maintain constant mixtures by special condensing apparatus—and boil the wire, not 5, but *15 minutes!*

The results of this *Extra-Test* enable Essex engineers to maintain complete control of curing or baking film-coatings within narrower limits—assuring insulation of maximum resistance to any varnish treatment—preventing varnish failures in the field.

Just one of many important reasons why Essex *Extra-Test* Magnet Wire has reached such an enviable "first choice" position in fifteen short years.

ESSEX WIRE CORPORATION
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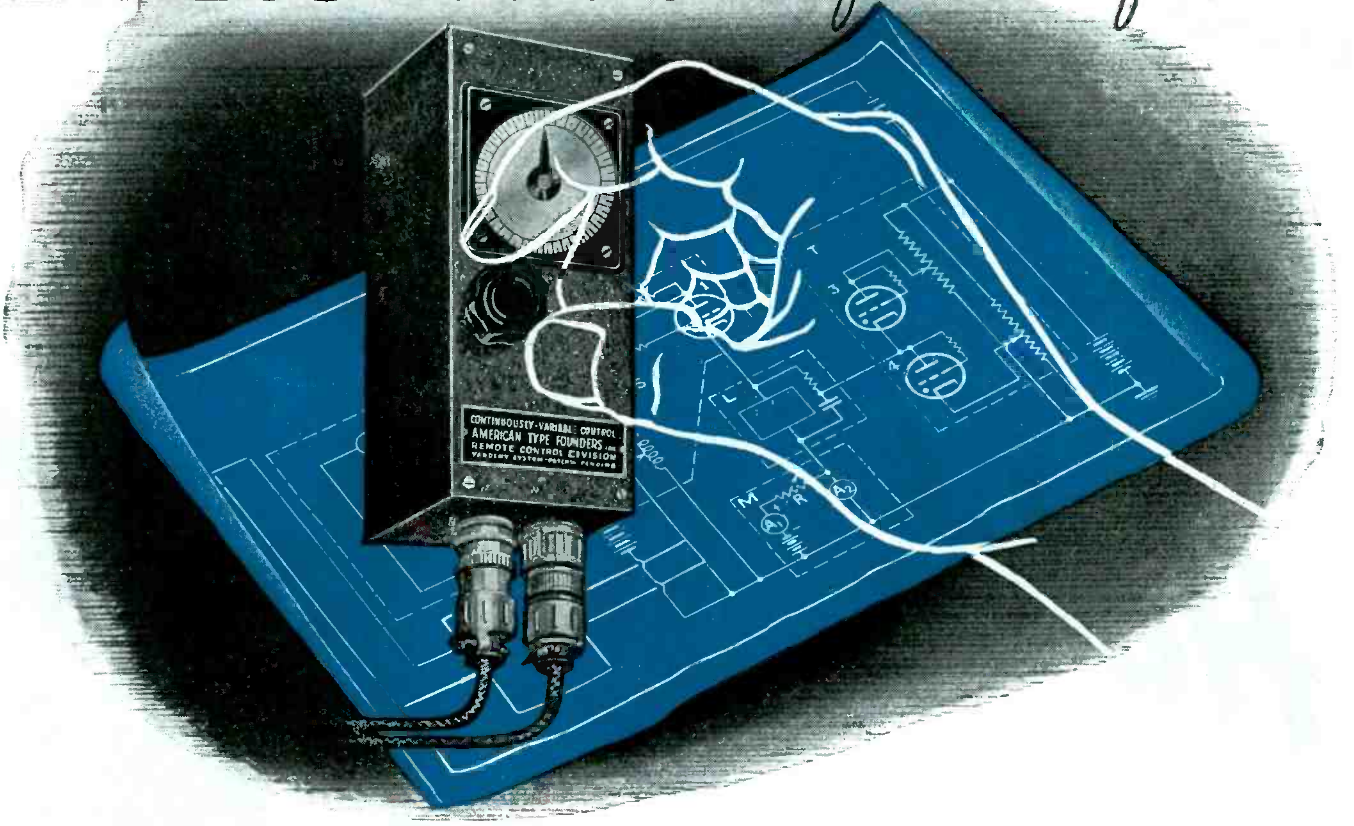
portance in industrial applications. It was his observation that many parts going into industrial equipment are not well designed or are sometimes misapplied in practice. The practice of applying electronic control to existing equipment he viewed unfavorably and he anticipates that rotating equipment, for example, will be redesigned in the future so as to be more suitable for electronic control.

Efficiency

Considerable discussion was devoted to induction and dielectric heating. In response to a question as to the efficiency of electronic heating units, Mr. Cage pointed out that the efficiency as given by various manufacturers is measured in different ways and usually refers to the maximum possible efficiency under desirable operating conditions. However, this maximum efficiency is not too important since it can seldom be achieved in practice. Moreover, the cost of power is not generally a significant matter in most fields in which electronic heating can be applied successfully. As a basis for judging the operation of equipment, it was felt that rotating machines could be considered as having an efficiency of 75 percent, mercury-vapor inverters 90 percent, sparkgap generators 50 to 70 percent, and vacuum-tube oscillators 50 to 75 percent as approximate values.

Mr. Madsen indicated that he believed commercial baking by electronic methods has possibilities although this problem is not yet solved and one of the major difficulties is that of providing a crust on the exterior of the bread. Heating of ink on fast-moving web belts did not appear too attractive an application for dielectric heating since this would require waves of frequencies of hundred of megacycles or else such high voltages that flash-over would probably occur. In general, it was stated that rods or wires less than ½ in. thick could not be easily treated by dielectric heating although much thinner sheets could be treated. As regards the size of equipment, Mr. Madsen stated that so far as he knew, a 150-kw unit was the largest that had been put into commercial service for dielectric heating whereas

IN YOUR DESIGNS for the future



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ATF precision remote controls are handling some of the war's most exacting remote control jobs. And they are finding wide application in planning for the exacting industrial jobs of tomorrow . . . for the accurate adjustment or setting of communications equipment, machine tools, valves, fuel supplies, power controls, and other machinery, from remote or obscured points.

If your post-war planning involves a problem of precise positioning, the solution may rest with one of these proved ATF electrical control units. Their hair-line precision, extreme simplicity, and their ability to withstand temperature extremes and mechanical abuse will give your product a decided edge in post-war selling.

Complete literature available. The services of ATF engineers are freely offered to assist in applying these units to your products.

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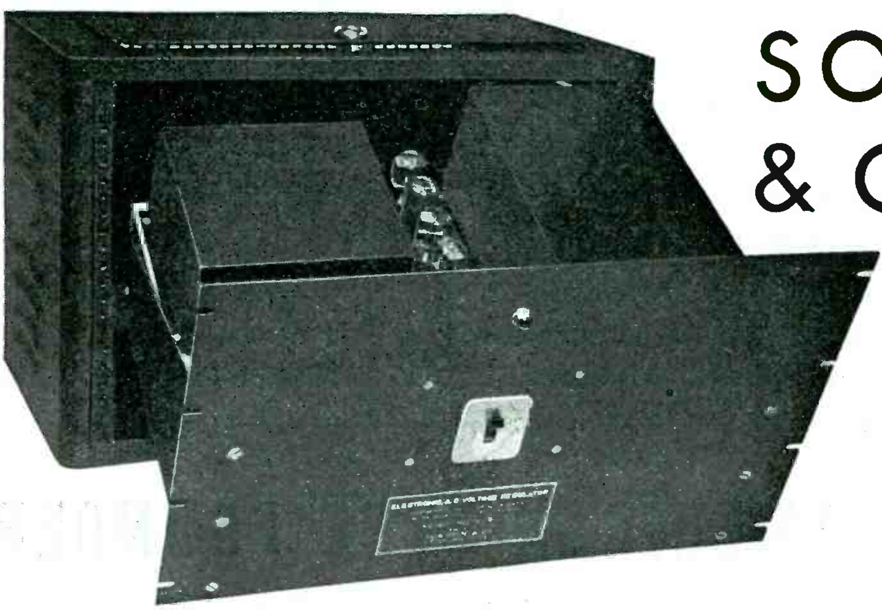

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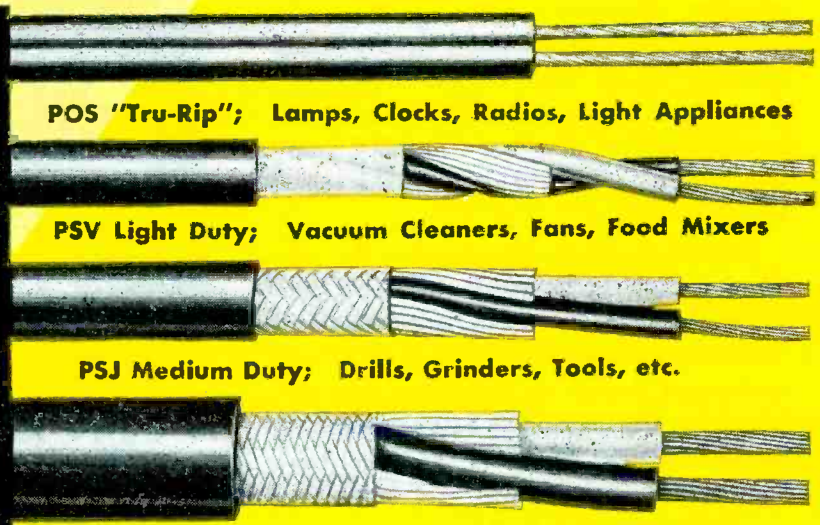

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for induction heating, a unit of 1200 kw has been built. These values do not necessarily represent the largest installation since in several cases several units were used in parallel.

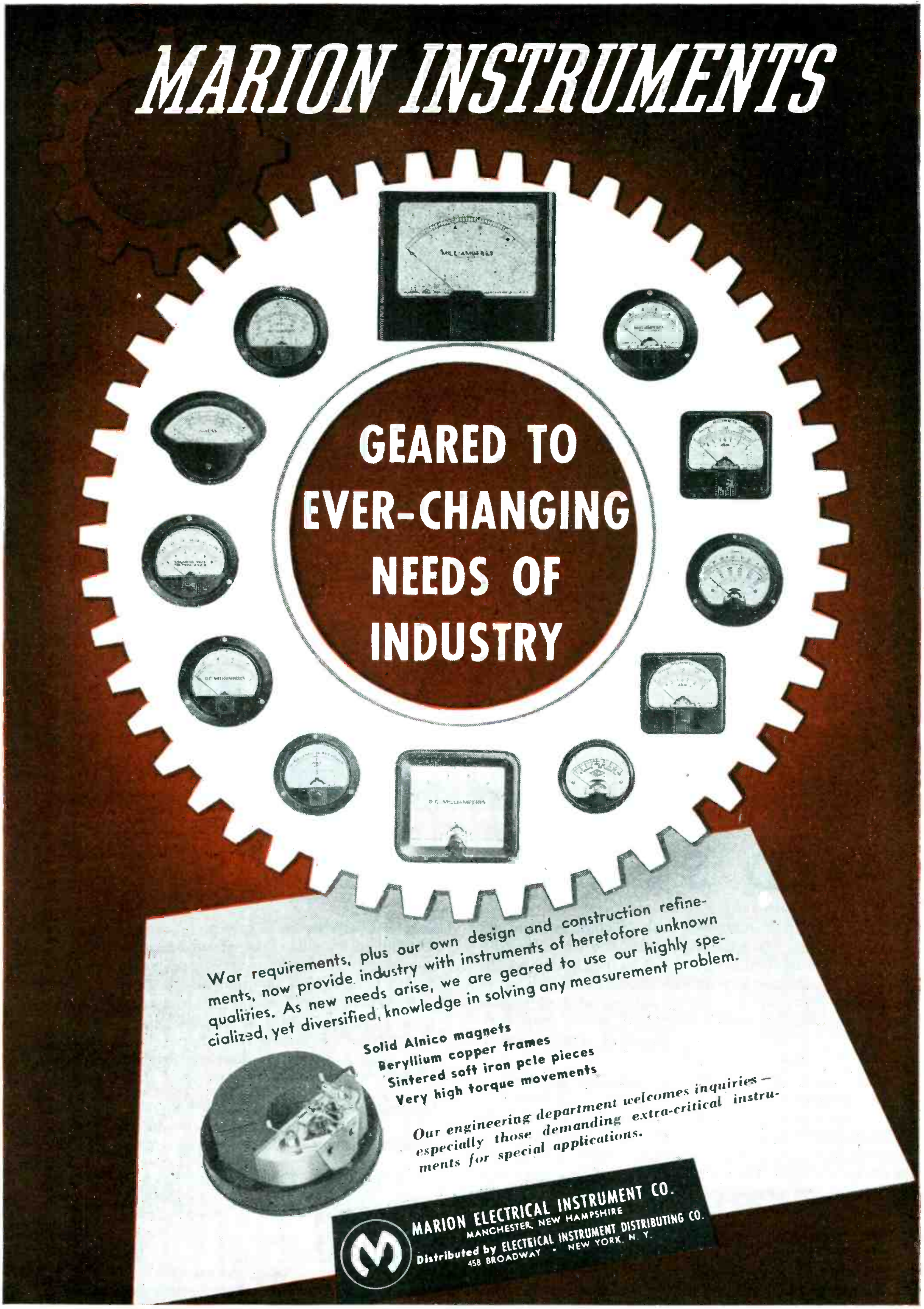
Special Problems

The question was asked whether it was possible to use dielectric heating in plastic molds where metal inserts were required. It was reported that by employing dielectric heating as a means of heating the pre-form, the plastic was made to form more readily in the molds and in this way could be used to reduce the difficulty.

As to the interference produced by electronic generating units, it was stated that efficient shielding of induction heating units and the relatively small field of these systems resulted in very little radio interference. Dielectric heating is most likely to produce greater interference because the output circuit was a more effective antenna. Mr. Madsen stated that in those cases where interference could not be suppressed by adequate shielding and filtering, consideration has been given to the operation of equipment on frequencies assigned by the FCC. Requests for frequencies of 13.6, 27.2 and 40 Mc for electronic heating have been submitted to the FCC.

Resistance Test Technique

The instrumentation panel was given over to measurements. J. F. Inman spoke on "High Voltage Insulation Testing", J. Dauber of the Acme Industrial Co. spoke on "Gaging Methods—Size, Angle and Flatness by Light Wave Methods" and D. O. Kochmich of the Trimount Instrument Co. spoke on "Static and Dynamic Pressure Measurements". Mr. Inman gave a historical review of high-voltage methods of measuring insulation resistance, pointing out that the calibration of resistance by means of current measurements (as in the usual ohmmeter) permits the calibration of very high resistances even though no standards are available. Measurements of resistance of cables subjected to high voltages frequently produce breakdown which is not always detected. To


MARION INSTRUMENTS
GEARED TO EVER-CHANGING NEEDS OF INDUSTRY
MILLIAMPERES
D.C. MILLIAMPERES
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War requirements, plus our own design and construction refinements, now provide industry with instruments of heretofore unknown qualities. As new needs arise, we are geared to use our highly specialized, yet diversified, knowledge in solving any measurement problem.
Solid Alnico magnets
Beryllium copper frames
Sintered soft iron pole pieces
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Our engineering department welcomes inquiries — especially those demanding extra-critical instruments for special applications.
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MANCHESTER, NEW HAMPSHIRE
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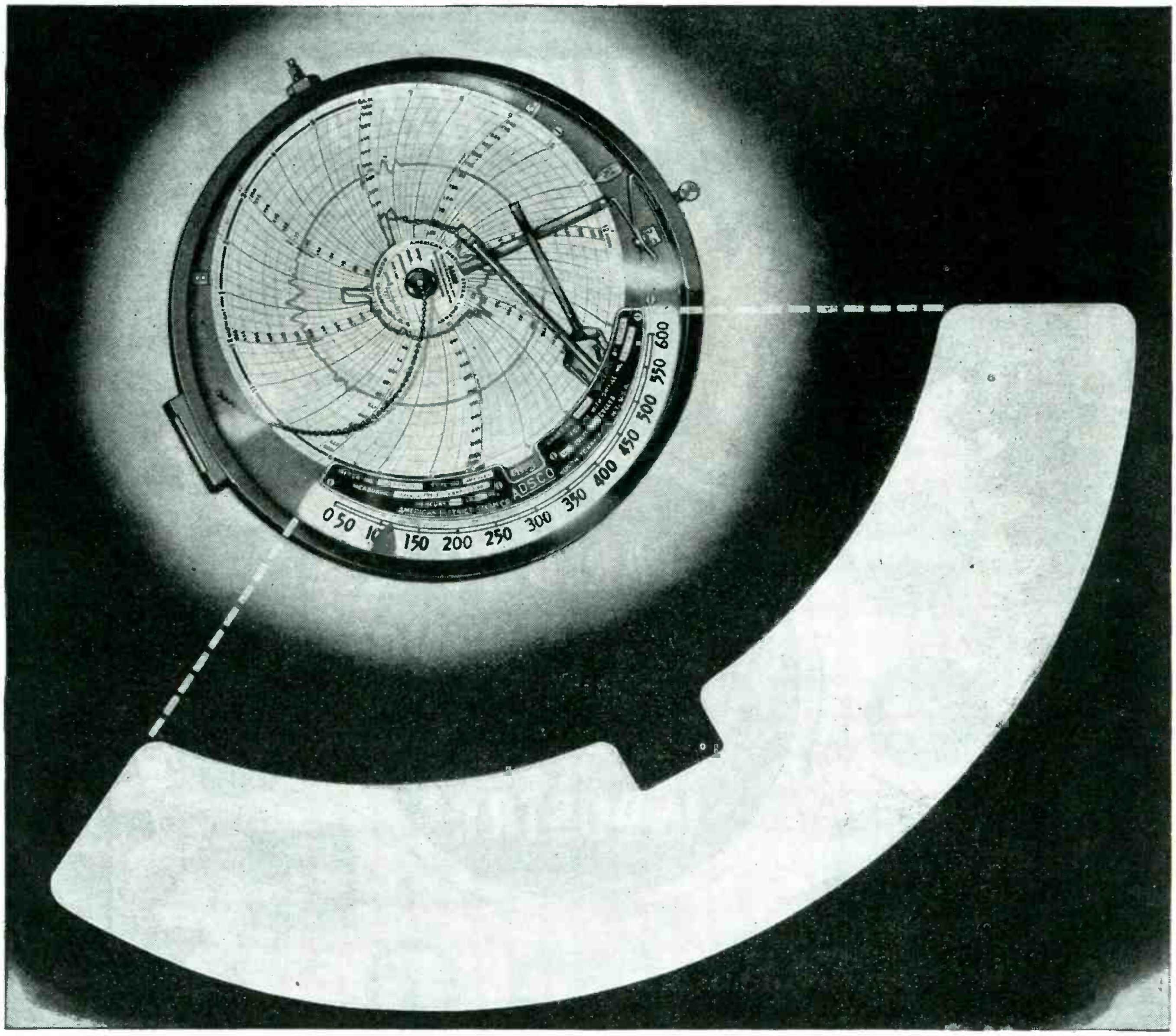

Molded for American District Steam Co., North Tonawanda, N. Y., by Dimco Plastics, Dayton, Ohio

BOLD SCALE

IN AMERICA'S important task of coal, gas and oil conservation, a major requirement is the detection of waste and inefficiency. Encouraging accomplishments have been made with the aid of highly accurate flow meter equipment such as shown above, which supplies a 24-hour visual record of steam consumption, steam pressure, and amount of steam passing through the line.

Much of this information is indicated on big, boldly-visible Plaskon Molded Color scales, upon which the meter markings are printed. Under all conditions these markings can be quickly, easily and accurately seen. Illumination behind the translucent Plaskon unit makes the entire scale glow brightly, so that each number and word stands out in sharp contrast. Plaskon also gathers the light from outside sources.

This is one of the many efficient industrial services of Plaskon. Because of its versatility, Plaskon has aided in the development and manufacture of important products for the battle front and home front. It is a strong, non-shattering material, with a smooth surface, and is available in a complete range of colors. It is unaffected by oils, fats, or common solvents; and is completely resistant to arcing or tracking under high voltages and high frequencies.

Plaskon Molded Color offers you a great range of manufacturing and sales advantages, both for present and postwar requirements. Experienced Plaskon men will gladly assist in adapting this versatile, colorful plastic molding material to your needs.

PLASKON DIVISION, LIBBEY·OWENS·FORD GLASS COMPANY

2136 Sylvan Avenue, Toledo 6, Ohio

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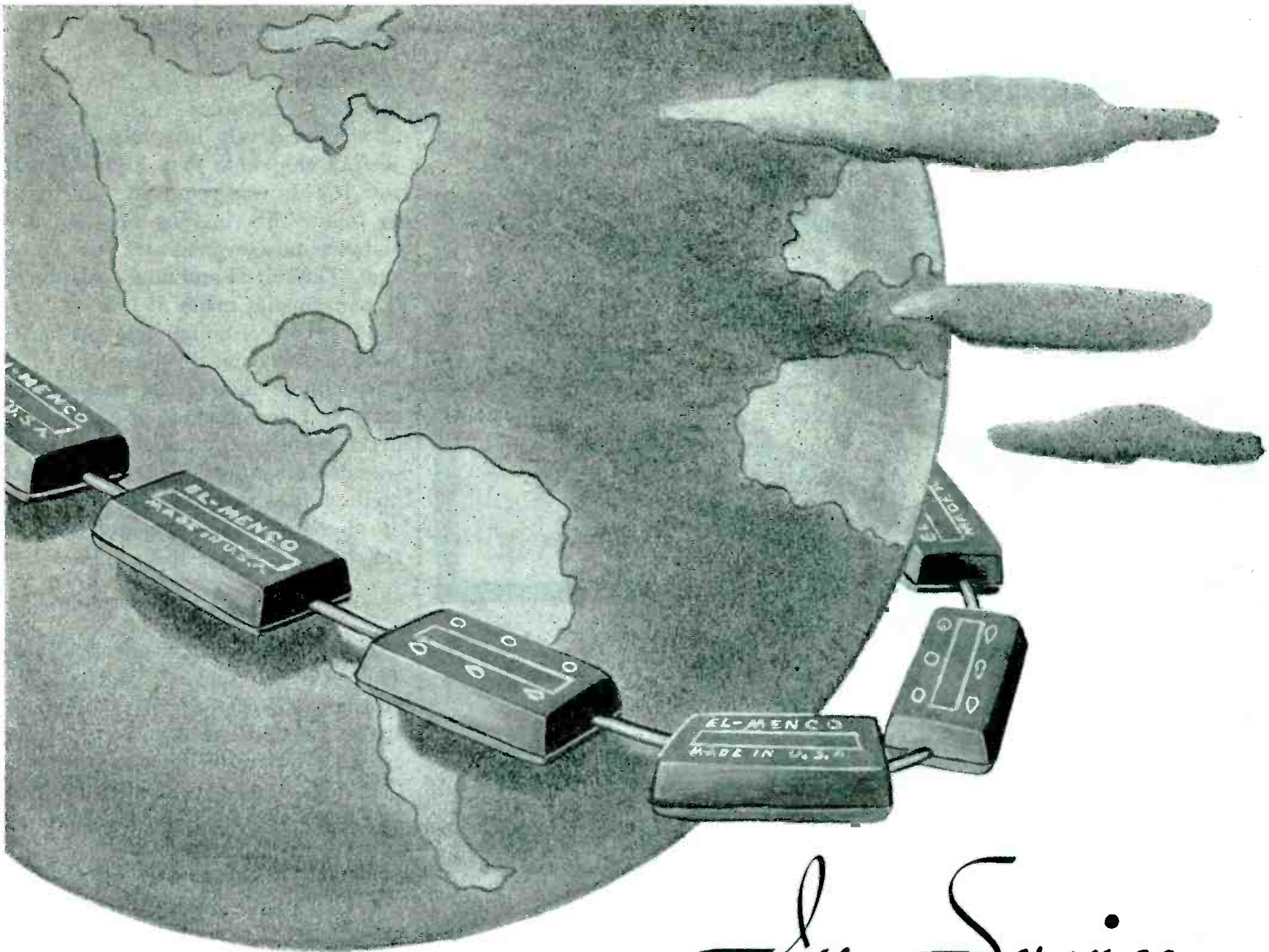
MOLDED COLOR



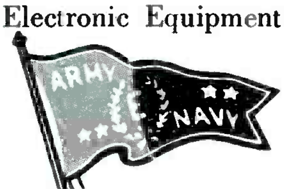
In Service

AROUND THE WORLD

El-Menco Capacitors are serving faithfully at countless vital spots in Army and Navy communications systems wherever they may be.

Because of their recognized high quality we know they will continue to girdle the globe after the war — in products whose manufacturers will demand perfection in *every* detail.

Manufacturers of Electronic Equipment:



Send, on firm letterhead for new Capacitor Catalog

THE ELECTRO MOTIVE MFG. CO.
Willimantic, Conn.

El-Menco
MOLDED MICA — MICA TRIMMER
Capacitors

make insulation tests, he recommended resistance measurements at comparatively low voltage, subjecting the cable to a high-voltage test if this was required, and then to follow this test by another resistance measurement at low voltage. The initial and final resistance measurements made at low voltage should check if no damage has been done to the cable insulation.

A simple method of measuring flatness, size and angle of gages and precision parts in industrial plants was described by Mr. Dauber. The method has for its basis the use of an optical flat in contact with the material under test.

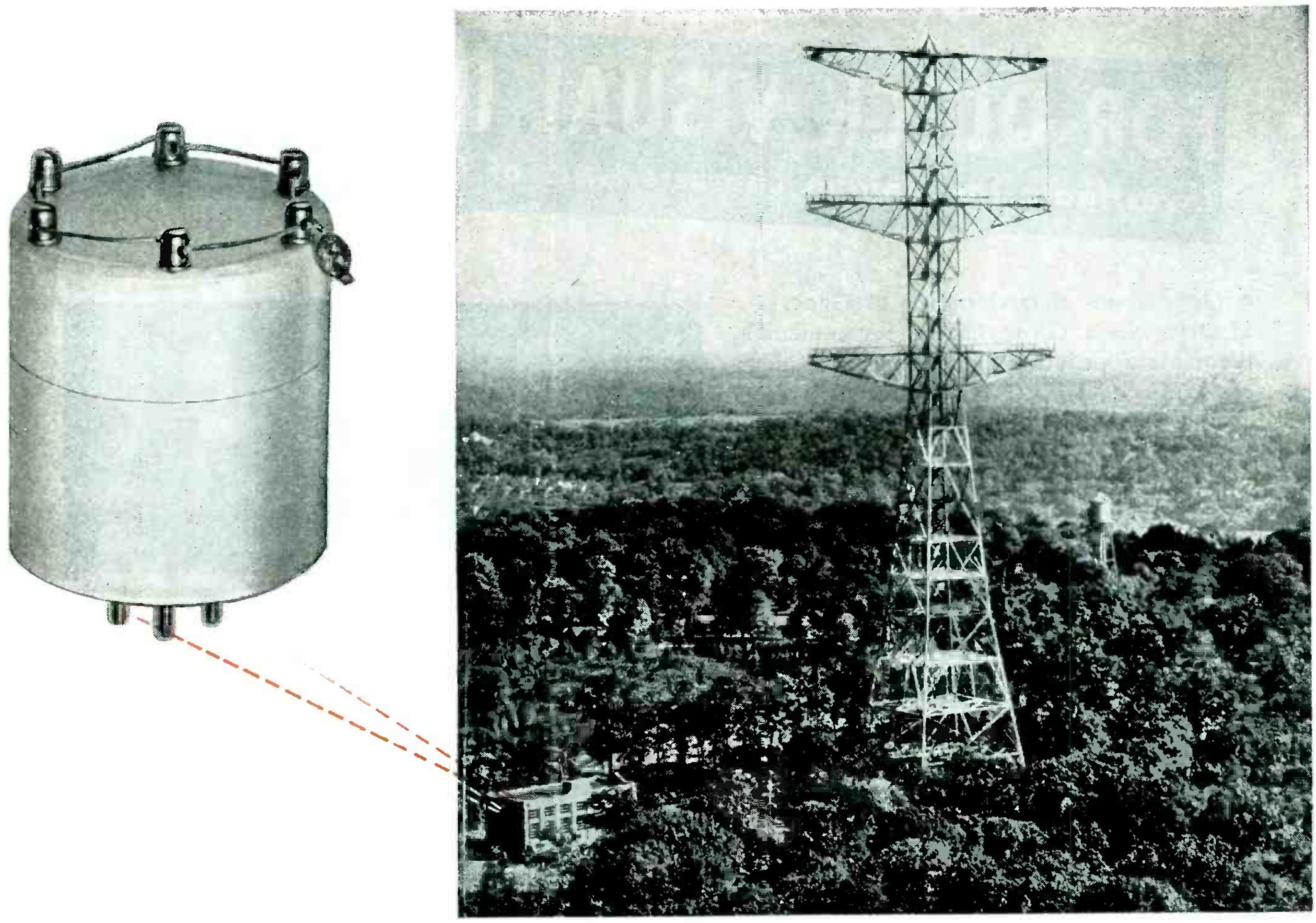
Spore Life

In speaking on "Tropicalization, The War on Spores", Wilfred F. Horner, Director of the Biological Lab., Belmont Radio Corp., discussed the work of his organization.

It was shown that the growth of fungus required the presence of water as a liquid, and oxygen, while essential nutrition was frequently provided by the material on which spores deposited themselves. It was found that spores multiply most rapidly at temperatures between 65 and 80 degrees and for values of pH between 6 and 7. Colored slides of spore growths and the effect of various fungicides were shown and several types of materials suitable as fungicides and for tropicalization were mentioned.

Leonard R. Robb, Production Control, Stewart Warner Corp., spoke on "Crash Program vs. Planned Production", outlining the difficulties that a manufacturer of electronic equipment faced during the war production schedule.

Raoul du Chatellier, Returned Communication Officer Military Intelligence Service, 1st Army A.E.F. and now with the Galvin Mfg. Co., in a restricted talk "What We Thought of FM in Normandy" outlined his experiences since landing in France last June. This talk served to outline some of the conditions under which communication equipment was operated, some of the difficulties in operation which were encountered in the field, and indicated the value of f-m equipment as compared to amplitude modulated equipment.



FOR QUICK VISUAL INDICATION

Investigate the Unique Characteristics of G-E Neon Glow Lamps

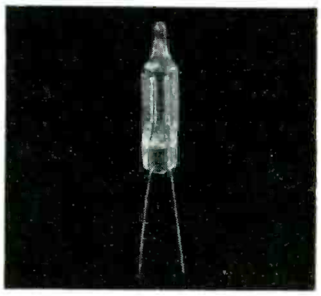
● The unique characteristics of General Electric Neon Glow Lamps recommend them for a variety of uses in radios and electronic devices . . . as indicators, voltage regulators, pilot lights and test lamps.

The uses described at right are typical. If you think G-E Neon Glow Lamps can be useful to you, write or phone the address below. Experienced General Electric Lamp Engineers will be glad to discuss your problems with you.

CONSIDER THESE ADVANTAGES

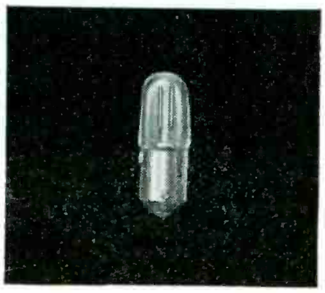
1. Distinctive orange-red glow—no colored cover glass needed.
2. Dependable performance and long life—rated at 3,000 hours.
3. Very low current consumption—less than ½ milliampere for smallest lamp.
4. Variety of sizes and wattages.
5. High resistance to vibration, shock.
6. Normally usable on a-c or d-c.
7. Screw base lamps for 105-125 v. circuits; similar lamps with bayonet bases available without resistors.
8. Produce practically no heat.
9. Nearly flat volt-ampere characteristics.
10. Insensitive to voltage variations above critical value.

NE-48 (also NE-16). Indicator lamps. Special volt-ampere characteristics of these lamps indicate use as voltage regulators. Screw base lamp available as NE-45.*



NE-2 One of the most widely used indicator and test lamps—popular because of compactness and small size. Nominal wattage is only 1/25 watt. This lamp is unbased—has wire terminals.

**NE—16 meets JAN-1A specifications for 991. Special marking JCG-991 supplied for small extra charge.*



NE-51 For general indication, such as showing existence of potential across various parts of electrical circuits.

NE-17 Indicator and pilot light lamp that flashes to show condition of B-battery in portable radios. Frequency of flashes decreases as battery runs down.

ORDER NO.	NE-2	NE-51	NE-17	NE-48	(4) NE-16	NE-45	NE-30	NE-32	NE-34	NE-36	NE-40	NE-42
Watts, Nominal	1/25	1/25	(3)	¼	¼	¼	1	1	2	2	3	3
Volts (Circuit)	105-125	105-125	(3)	105-125	105-125	105-125	105-125	105-125	105-125	105-125	105-125	105-125
Starting Voltage (1) AC / DC	65 90	65 90	(3)	65 90	— (5)	65 90	60 85	60 85	60 85	60 85	60 85	60 85
Base	Unbased (Wire Terminals)	S. C. Bay. Min.	D. C. Bay. Cand.	D. C. Bay. Cand.	D. C. Bay. Cand.	Cand. Screw	Medium Screw	D. C. Bay. Cand.	Medium Screw	Sk. D. C. Bay. Cand.	Medium Screw	Sk. D. C. Bay. Cand.
Maximum Overall Length	(2) 1 1/16"	1 3/16"	1½"	1½"	1½"	1⅝"	2 1/16"	2"	3 5/16"	3¾"	3 5/16"	3¾"
List Price (plus tax)	$.08	$.10	$.45	$.35	$.42	$.40	$.40	$.45	$.50	$.55	$.60	$.65

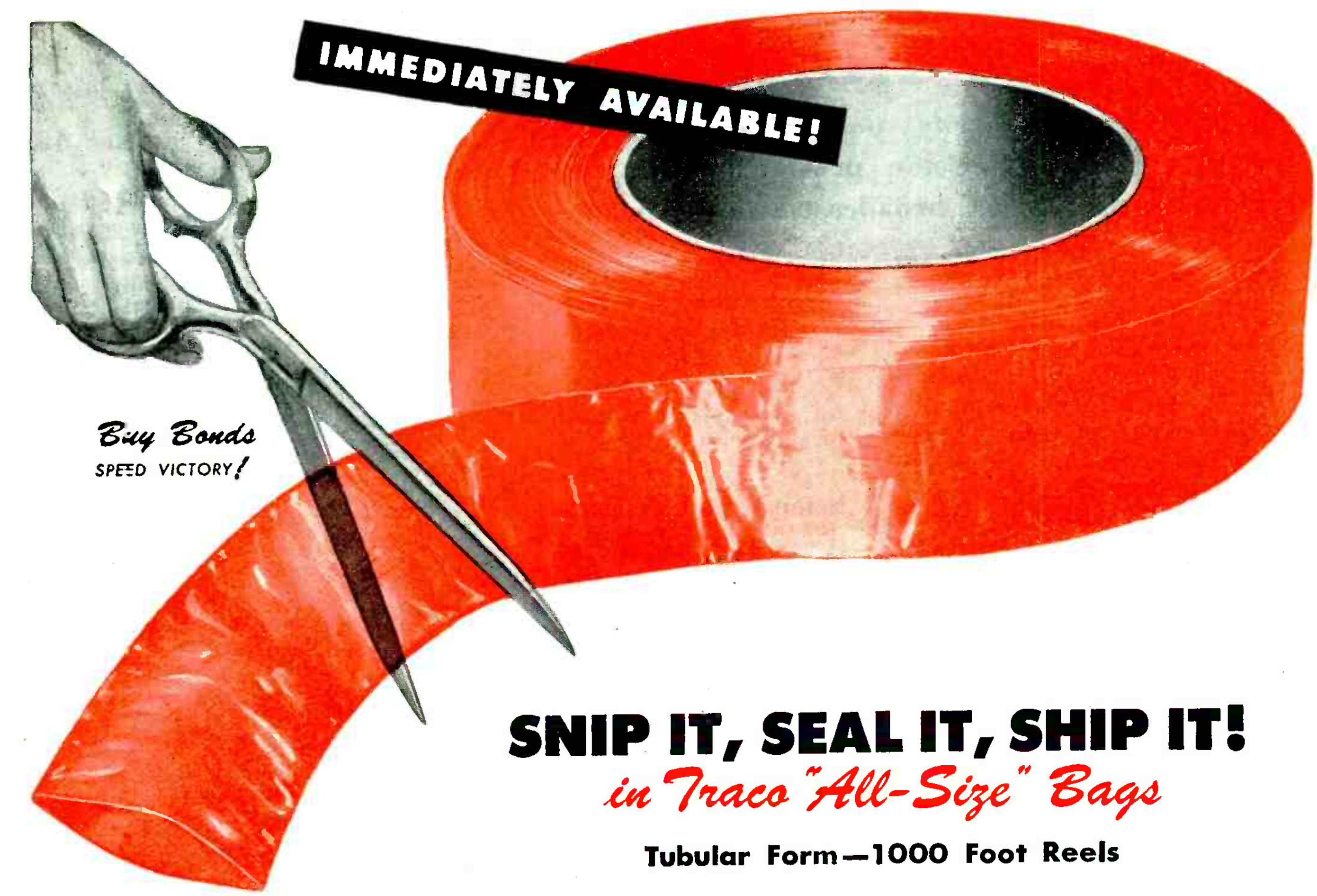
(1) Applies to lamp when new.
(2) Glass part; wire terminals extend additional 13/16".
(3) Designed for DC flashing operation in RC circuit.
(4) Meets JAN-1A specifications for 991. Special marking JCG-991 supplied at small extra charge.
(5) Designed for 67-87 Volts D.C. (D.C. operating voltage at 1.5 milliamperes, 53-65 volts).

For further information, write address below for Bulletin 7100.

NELA SPECIALTY DIVISION LAMP DEPARTMENT

GENERAL ELECTRIC

1 Newark Street, Hoboken, N. J.



SNIP IT, SEAL IT, SHIP IT!

in Traco "All-Size" Bags

Tubular Form—1000 Foot Reels

Make quickly in your own plant TITE-SEAL Cellophane Bags of any size that seal out dust, air, water and moisture-vapor. They protect military supplies from damage in transport or storage.

Acceptable for Methods I and IA, type III packaging . . . available in 3, 4, 6 and 8 inch widths under proper priority . . . 1000 feet to the reel. Saves stocking large quantities of special-sized bags. (Stock Bags also available in above widths.)

"All-Size" Containers and custom made bags can be furnished plain or printed in any widths or lengths desired on special orders of sufficient quantity.

Heavy foil-lined laminated bags or tubes meet every requirement of Methods I, IA and II Military Packaging. LOXTITE Partitions give crash protection to fuses, rations, and delicate or fragile items.

Reasonably prompt shipment can be made on government orders bearing end use. A card will place our technicians at your command.

T. M. Reg. & Patent applied for

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For parts identification and many other uses. Saves time and trouble. Pressure sensitive. Available in small quantities. Prompt shipment.

NEWS OF THE INDUSTRY

Science and prosperity; postwar markets; microwave relay systems; television preview; radar avigational aids; meetings; FCC broadcast actions; business news

Radio-Radar Openings

ACTIVATION of an Army Air Forces development project to be known as Watson Laboratories, at Red Bank, N. J., has created approximately 325 openings for radio and radar engineers. Salaries range from $2600 to $5600 per annum.

Work to be done in this installation is on the development of ground communication systems peculiar to the AAF. The positions are under civil service and carry all the rights and privileges of a war service appointment under the Classification Act of 1923. More information may be had from the New York office of the Civil Service Commission or by direct inquiry to the personnel office of the laboratories.

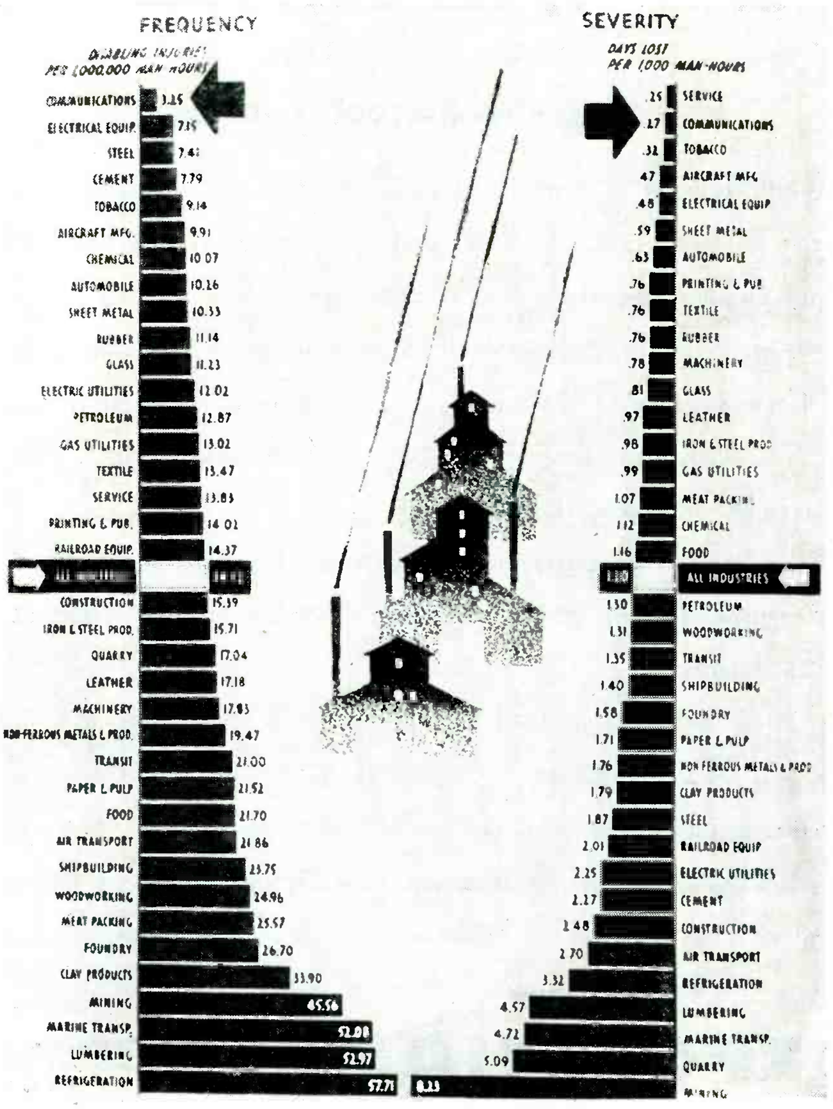
Science and Progress

OUR FUTURE advancement toward the necessary economy of abundance depends upon getting the greatest possible number of persons engaged in scientific pursuits, according to Samuel J. Novick, president of the Electronic Corp. of America.

Speaking recently at a New York Times Hall Forum in New York, he said that progress in science during the war is due to: (1) Every scientist who could contribute to the war effort being systematically sought out; (2) Huge expenditures for laboratory facilities and field work; (3) The war-imposed necessity for better organization and direction of research; (4) The fact that there was nothing to hold back new ideas; and (5) The natural incentive created by the vacuum of an unlimited market.

His suggestion was that we must maintain similar stimuli if we are to put our economy on an even keel after the war.

INJURY RATES FOR INDUSTRY—1943



From figures reported to National Safety Council

Street-Car Radio

FREQUENCY MODULATION radio equipment is planned for installation in major Pacific Coast war centers to speed the flow of street cars and buses, according to recent disclosures by transit officials in San Francisco, Oakland, and Los Angeles. Necessary priorities and FCC permits have been secured for the spending of about $40,000 on a two-way radio system in the Los Angeles Transit Lines. Facilities will include a 250-watt f-m station which communicates with emergency trucks, supervisors' automobiles, and many motor coaches and street cars as well.

In San Francisco, operators of the municipal railway have in mind a phototube recording device which would register the bunching up of street cars at strategic traffic locations, and radio equipment which would enable the dispatching of inspectors to the area. Repair and wrecking equipment would also be in two-way communication with the control tower. The entire installation would run to $50,000. Oakland plans similar facilities on the Key System.

Western Union Relay

FREQUENCY BANDS of various widths between 2,000 and 11,372 Mc have been allotted by FCC to Western Union Telegraph Co. for experimentation regarding the practicality of transmitting regular telegraph

PROBLEMS
in the UHF *Field* ?

Your present or proposed product may demand precision in design, manufacture and performance. As specialists in the development of UHF equipment, we may be able to aid you in accomplishing this . . . at a lower cost. It's worth checking into. To help in the development of new products . . . or improve old ones, LAVOIE LABORATORIES offers this 3-point service:

1. **TECHNICAL ADVICE** by thoroughly experienced UHF engineers who know the "how" and "why".
2. **DESIGN** — from the idea to the finished product, with a knack for practical, low-cost production.
3. **MANUFACTURE** of complete assemblies employing shop technique especially suited to UHF work.

Typical LAVOIE Products —

UHF PRECISION FREQUENCY METER

Completely portable *Accuracy 0.1%*

Battery or AC-Operated

Models available from 100 to 2000 megacycles with 2 to 1 frequency coverage on each model.

RECOMMENDED FOR:

- *Production testing*
- *Measurement of oscillator drift*
- *Independent alignment of transmitters and receivers*
- *Precise measurements of frequencies*

UHF HARMONIC FREQUENCY GENERATOR

PROVIDES output voltages which are multiples of 10 or 40 megacycles with CRYSTAL-CONTROLLED accuracy.

SELECTS 10 or 40 megacycle series and IDENTIFIES one of these harmonics by means of a Frequency Identifier which consists of a filter providing high attenuation of all voltages except that of frequency to be identified.

USED FOR calibration of receivers, wavemeters, or using internal beat detector, for calibration of oscillators and signal generators.

Lavoie Laboratories

RADIO ENGINEERS AND MANUFACTURERS
MORGANVILLE, N. J.

Specialists in The Development of UHF Equipment and in The Manufacture of UHF Antennas

service via radio relay. Test installations will be between New York and Philadelphia and two years' time has been authorized for construction.

A number of FCC regulations were waived in this case. For instance, regular commercial rates will be charged in order to create an exact parallel between wire and radio operation. Also, no call-letter transmission will be required.

Terminal stations will be located in the WU building in New York and in Camden, N. J., the latter station being remotely operated from Philadelphia. Two intermediate unattended repeater stations will be located in Bordentown and New Brunswick, N. J.

Maximum power at each station is to be 15 w and types of emission will include A0, A1 — A4, and special for multichannel telegraph, teleprinter, facsimile, and business machines. An RCA-developed modulation system will be used to get 32 circuits for each transmitter.

Future Equipment Market?

RUSSIAN FAMILIARITY with U. S. electronic equipment will very likely be a great aid in future commercial relations, it appears from information recently presented by Foreign Economic Administrator Leo T. Crowley before the House Foreign Affairs Committee.

He pointed out that 12,000 airplanes sent there from the United States were all equipped with the latest radio and radar equipment. Other electronic gear found its way to Russia installed in 3,300 armored cars, 6,000 tanks, 5,500 prime movers and 1,700 ordnance service vehicles.

Adapters for F-M Sets

IN THE LIGHT of discussion revolving about the question of shifting f-m frequencies to the 84-102-Mc band, several manufacturers have come out with equipment described as suitable for adapting old receivers to the new conditions.

Besides a unit which was presented during recent hearings by members of the FCC staff and reported as having been built for $8.85 at retail prices of components, both Hallicrafters Inc., and Emerson Radio & Phonograph Corp. have

. . . SOLVED WITH

Solder Seal and Zircon Prestite!

One of the most sensitive electronic assemblies in use by surface and submersible craft entails extremely rigid manufacturing requirements. A multiplicity of leads must be brought out through the cover. Units inside the case must be submerged in oil. Positive, vibration-proof hermetic seals must be maintained at every entrance point, as the slightest leak will cause condensation and failure.

A dual Westinghouse development is solving this problem —more effectively and more dependably than any means previously used.

This development is SOLDER-SEALING applied to Westinghouse PRESTITE porcelain and ZIRCON PRESTITE. Metallic bands, which are an integral part of the porcelain glaze, enable metal terminals and cover to be soldered directly to the porcelain. The result is a 100% hermetic bond between metal and porcelain at every point of contact.

The assembly is tested at pressures of 50 psi and 200° F temperatures. It has proved its ability to withstand any known temperature cycles and conditions of vibration encountered in its class of service.

This application is but one example of the vital part that several millions of Westinghouse SOLDER-SEALED bushings are playing in the success of military electronic and communications equipment.

Some of the many standard and semistandard SOLDER-SEALED assemblies available to manufacturers are shown in booklet B-3244. Ask for your copy. Westinghouse Electric & Manufacturing Company, P. O. Box 868, Pittsburgh 30, Pa.

J-05157

WHAT IS PRESTITE?

PRESTITE is an exclusive Westinghouse development that combines the high mechanical and dielectric strength of wet-process porcelain with the dimensional fidelity of dry-process porcelain.

PRESTITE is dense, nonporous. Compacting under high pressure and vacuum eliminates minute air pockets, and this minimizes distortion in voltage gradients and eliminates internal corona discharges. Rated L-2.

ZIRCON PRESTITE is a low-loss PRESTITE porcelain capable of operating at the ultra-high frequencies of present communications fields. It has exceptionally high mechanical strength and resistance to thermal shock. Rated L-4.

WESTINGHOUSE

Westinghouse

PLANTS IN 25 CITIES . . . OFFICES EVERYWHERE

COMMUNICATIONS EQUIPMENT

PATENT APPLIED FOR.— PHOTOGRAPH SHOWS SIZE OF JENNINGS "WALNUT" CAPACITOR IN RELATION TO HAND.

The latest and most highly successful electronic component is the Jennings "Walnut" size Capacitor, now in full production.

WALNUT VC, SERIES M — AMPERE SERIES 20

•

CHARACTERISTICS

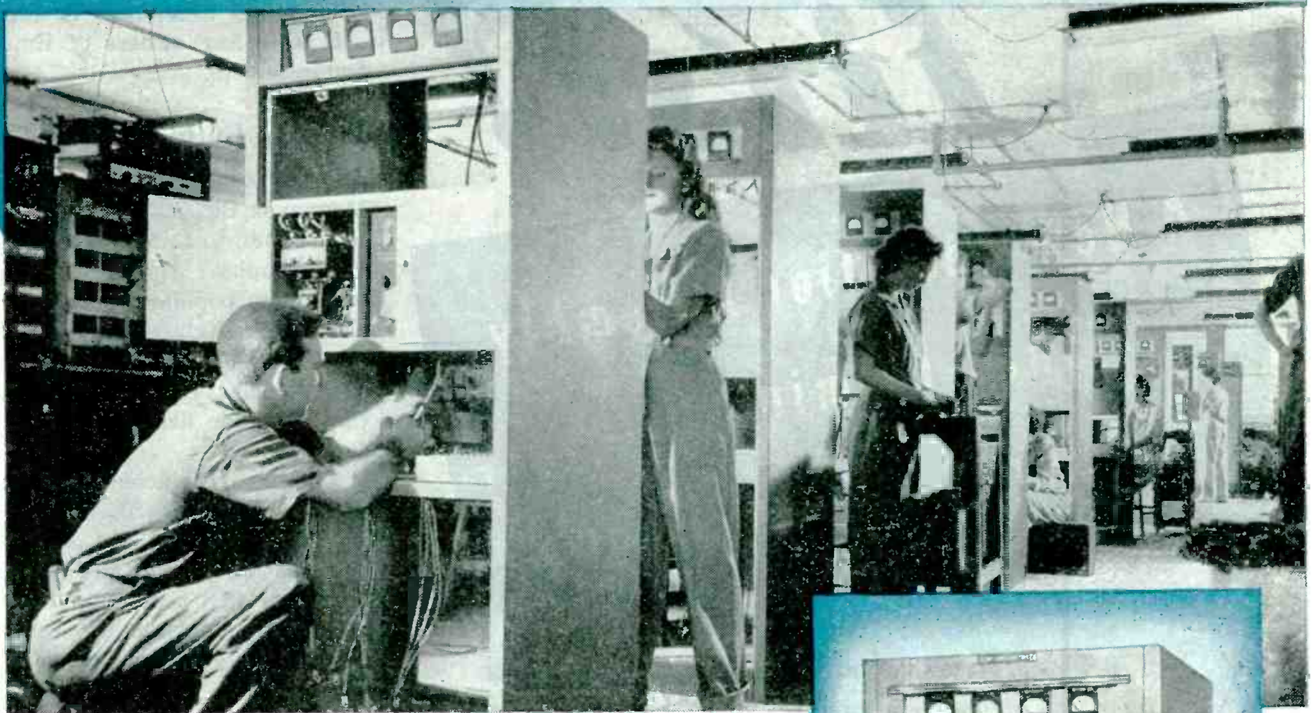
Capacity Range 6-50 mmfd. **Maximum Current 20 Amperes Peak**
Maximum Voltage 30KV Peak **Specially designed for high frequency operation**
Self-healing in case of overload

We can now accept orders for early delivery of this greatly improved, compact, plug-in type capacitor.

WRITE FOR BULLETIN E

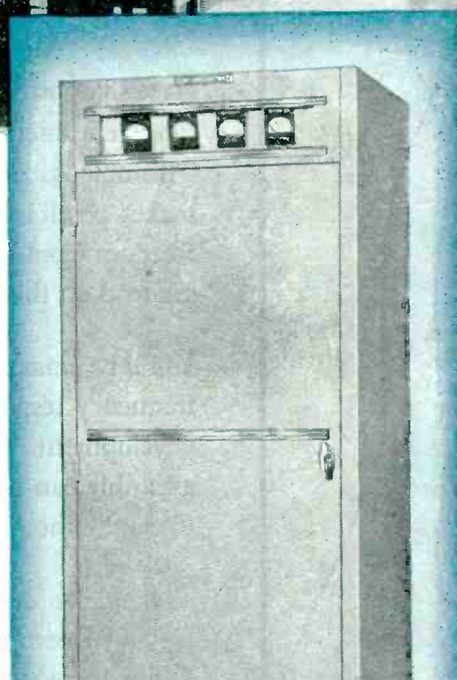
JENNINGS RADIO MANUFACTURING COMPANY • 1098 E. WILLIAM ST. • SAN JOSE 12, CALIFORNIA

"Line Production" Experience IN RADIO MANUFACTURING



From Wilcox's war experience, as one of the largest manufacturers of radio communications equipment, has come many new products . . . a completely modern mass production factory . . . a trained engineering staff . . . plans and the knowledge needed for both war and peacetime products of highest quality. Look to Wilcox for leadership in radio communications equipment!

Model 50A Modulator — The 1600 watt 50A Modulator, shown at right, may be used for transmitter modulation, or high-powered audio needs.



WILCOX ELECTRIC COMPANY, INC.

Manufacturers of Radio Equipment

FOURTEENTH AND CHESTNUT — KANSAS CITY, MISSOURI announced readiness of units of their own design.

Hallicrafters referred to two types which are ready to produce—one priced at $5.60 and one at $11, both FOB Chicago to quantity buyers. The more expensive of the two uses three tubes.

Emerson Radio & Phonograph Corp. described their adapter as relatively simple and expressed willingness to supply it free of charge to any owners of Emerson f-m receivers.

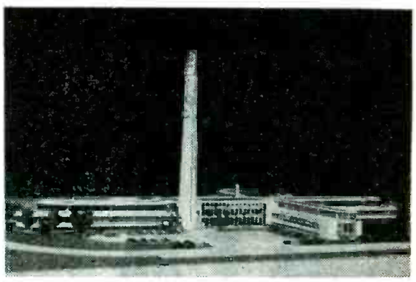
Fidelity Enthusiasts

As DISCOVERED in a poll taken by the Magnavox Co., a full two-thirds of the owners of Magnavox radio-phonographs consider popular music less popular than symphony and the other classics. Probably as a result, 44.3 percent of the owners list superior tone as the feature they look for first in home sound equipment.

Another significant fact uncovered by the investigation is that the record-player section of the combination is reported to be in operation 43.3 percent of the total playing time, while the radio receiver only gets the nod 56.7 percent.

Laboratory Consolidation

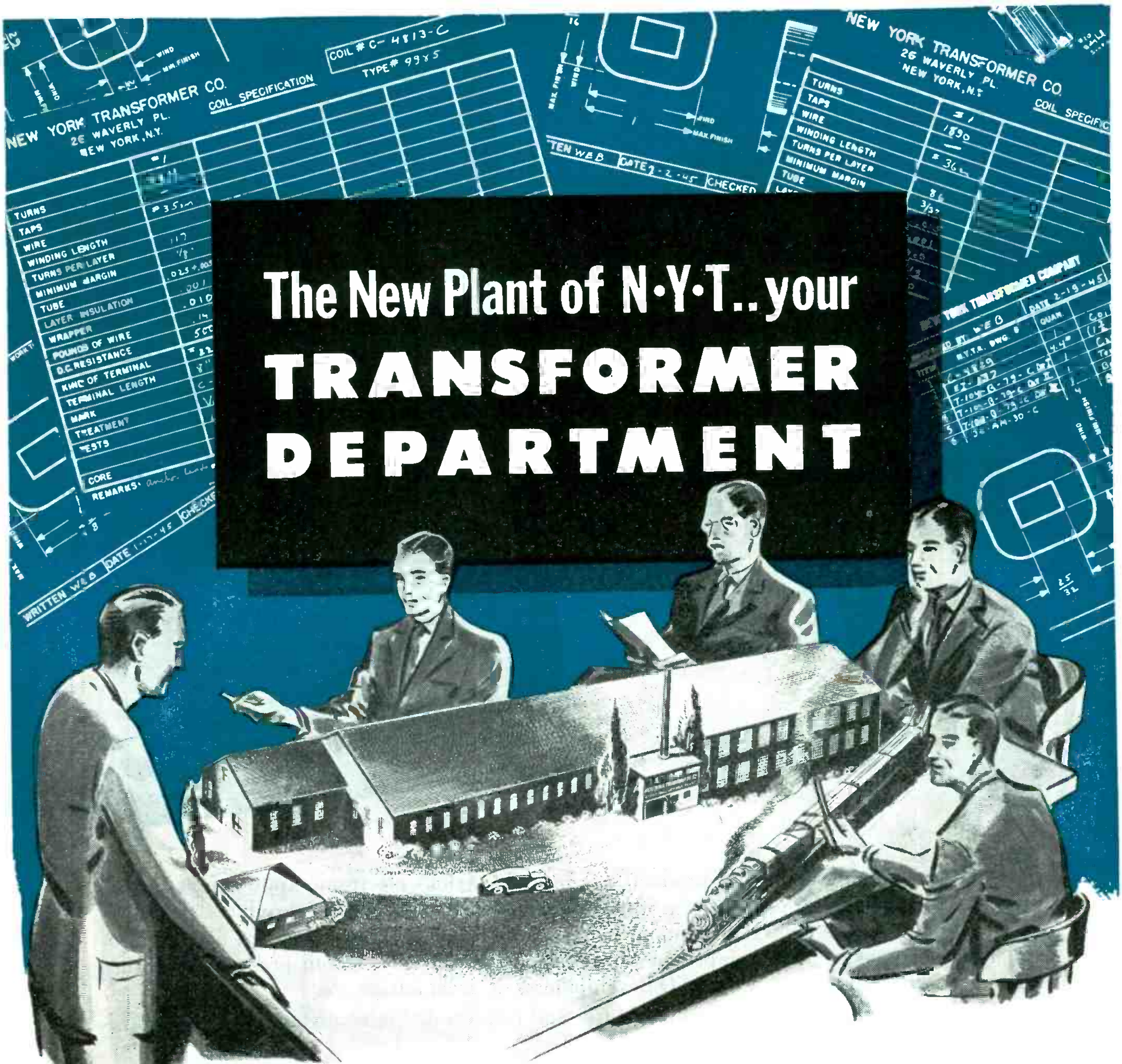
ELECTRONIC SCIENTISTS of IT&T (International Telephone & Telegraph Corp.) in the U. S. and other countries are now grouped into a corporate unit—International Telecommunication Laboratories, headquarters of which will be in the Nutley, N. J. project illustrated.



Designer's-eye view of the projected International Telecommunication Laboratories headquarters in Nutley, N. J. One unit has already been started

Capitalized at $2 million, the new corporation is owned jointly by IT&T and a subsidiary, International Standard Electric Corp. President is E. M. Deloraine, gen-

The New Plant of N·Y·T.. your TRANSFORMER DEPARTMENT



Complete engineering and production facilities for TRANSFORMERS, CHOKES and FILTERS

N·Y·T
HERMETICALLY-SEALED TRANSFORMERS

The product illustrated typifies N-Y-T hermetically-sealed components — transformers, chokes and filters—designed to meet unusual operating conditions for every type of application.

Tooled up and geared for full production, the latest addition to N-Y-T facilities is rapidly assuming the role of "Transformer Department" to leading electronic and electrical manufacturers.

Complete in every phase of manufacture, the Alpha Division is one of the most modernly equipped plants in the East.

Important, too, is N-Y-T engineering collaboration — offering valuable assistance to engineers responsible for the design of electronic equipment. Close cooperation in this early phase of design inception results in better component suitability. It frequently effects over all economies and improvements. Inquiries are invited; there is no obligation.

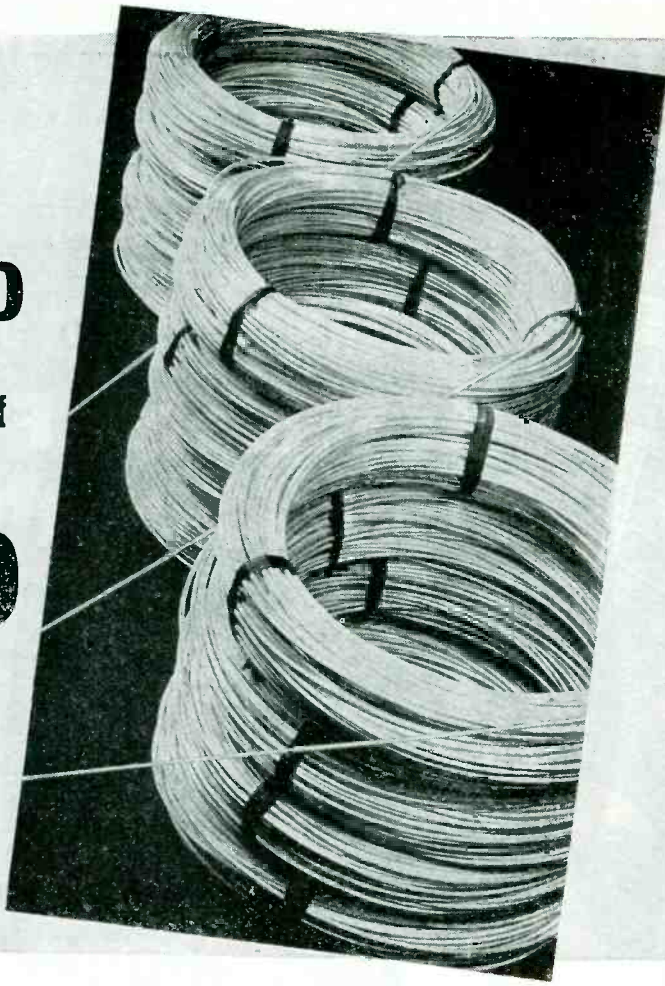
Address Inquiries to Dept. E

NEW YORK TRANSFORMER CO.
26 WAVERLY PLACE, NEW YORK 3, N. Y.

WILCO NOW EQUIPPED

for large scale production of

JACKETED WIRE



WILCO wire, tubing and other products are used in various electronic applications for the Army and Navy. In response to the wartime demand for these various products, the H. A. Wilson Company has enlarged its plant, increased its manufacturing facilities, added essential new equipment and developed new products and techniques. Both present and future customers will find these new WILCO developments of great advantage.

The H. A. Wilson Company manufactures and is interested in receiving inquiries regarding the following typical products—

WILCO JACKETED WIRE

Silver (Fine, Sterling or Coin)
Silver Jacketed Copper
Silver Jacketed Invar
Silver Jacketed Brass
Silver Jacketed Steel
Gold Jacketed Silver (Fine, Sterling, Coin)
Gold Jacketed Brass or Bronze
Copper Jacketed Monel
Nickel Jacketed Copper

WILCO JACKETED TUBING

Silver Tubing (Fine. Sterling or Coin)
Gold Tubing (any Color or Karat)
Silver Jacketed Brass or Bronze (one or both sides)
Gold Jacketed Silver (one or both sides)
Gold Jacketed Brass or Bronze (one or both sides)

WILCO STRIP MATERIAL

Silver (Fine, Sterling or Coin) on Brass or Bronze (Inlay or Overlay)
Gold on Silver (any Karat on Fine, Sterling or Coin)
Gold on Brass or Bronze

Other WILCO products include Electrical *Contacts*—

Silver, Platinum, Tungsten, Alloys, Powder Metal. *Thermostatic Bimetal* (High and Low Temperature with new high temperature deflection rates.) *Precious Metal Collector Rings*—For Rotating controls. *Silver Clad Steel. Rolled Gold Plate. Special Materials.*

Let us analyze your problems.

THE H. A. WILSON COMPANY

105 Chestnut Street, Newark 5, N. J.

Branches: Detroit · Chicago

For mobile two-way communication specify KAAR RADIOTELEPHONES

KAAR PTL-10X TRANSMITTER

10 WATTS • 1600-2900 KC*

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

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

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

KAAR AUTO-LOAD ANTENNA

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

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

KAAR 11X RECEIVER

6 TUBES • 1600-2900 KC*

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

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

KAAR

ENGINEERING CO.

PALO ALTO, CALIFORNIA

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

Export Agents: **FRAZAR & HANSEN, 301 Clay St. San Francisco 11, California, U.S.A.**

E. M. Deloraine, president of International Telecommunication laboratories; Nutley, N. J., science headquarters of IT&T

eral director of Federal Telephone & Radio Laboratories. Vice-presidents include Harold H. Buttner and Douglas B. Baker.

Dedicated to initiating inventions, developing them, and providing an interchange of information among system laboratories in New York, London, and Paris, the new corporation will be located in a structure specially designed to meet the exacting requirements of electronic research. The first unit is presently under construction.

Democratic Design

POSTWAR MODELS of Bendix radios will be influenced in their design by results of tests currently being conducted by that company. Audio-frequency range preferences are determined by comparison between a prewar receiver and a new wide-range job. Both instruments are set at peak bass and treble range for the first part of the test and at equal volume levels. Later one selection is played with both controls reduced. Listeners, who range from farm workers and business executives to bobby-sock swingsters and symphony patrons, record their votes on special forms.

Further tests for Bendix will be used to make decisions on the styling of receiver exteriors. Opinion Research, Inc. will conduct, throughout the nation, style clinics which will simulate actual retail showroom buying conditions.

More Basic Science

ON THE THEORY that building new postwar industries and products for mass consumption will depend on the continued discovery of new scientific laws, Battelle Memorial Institute is planning an expanded program of research education. The program, which will be directed at the graduate level, is an expansion

ADVANTAGES OF THERMOPLASTIC

There are fourteen practical advantages of theremoplastic insulation over older types of construction . . . advantages which PLASTIC engineering now makes possible at what, in most cases, is NO PRICE PREMIUM. Check them yourself: 1. Superior aging properties, 2. High resistance to oxidation, 3. Low moisture absorption, 4. High dielectric strength, 5. High tensile strength, 6. Resistance to flame, 7. Flexibility at low temperatures, 8. Resistance to abrasion, 9. Resistance to chemicals, 10. Resistance to oils and greases, 11. Ease of installation, 12. Increased capacity, 13. Attractive appearance, 14. Broad color range. Remember . . . when you're thinking of PLASTIC you're thinking of US!

Thermoplastic insulation specialists . . . producing a complete line from fine wires to heavy power cables . . . serving: Public Utilities, Radio, Electronic, Appliance and Instrument Manufacturers, Telephone Companies and Contractors.

PLASTIC

WIRE & CABLE CORPORATION *NORWICH CONN* of the plan which has been markedly successful thus far with Ohio State University. It is expected to be of special interest to returning veterans, whose battlefield experiences has given them an awareness of the importance of technology.

Boost Program Transmission

INCREASED TIME allotment and activation of new transmitters by OWI (Office of War Information) has made it possible for shortwave news and entertainment broadcasts to men and women of the armed forces overseas to increase by 50 percent. Shortwave transmitters on the East and West Coasts now transmit more than 960 hours of such material per week.

Postwar Receiver Markets

SIX YEARS' PEAK production for the entire radio industry is anticipated postwar by Westinghouse Electric & Mfg. Co. which sees a postwar market for 60,000,000 home radio receivers.

The company's decision to re-enter the field was made on the basis of an extensive survey, and five factors were taken into consideration: (1) Frequency modulation will hasten replacements by outmoding sets; (2) Demand for radio-phonographs will increase the size of the market by increasing the average sale; (3) Establishment of new homes by returning servicemen will create a huge new market; (4) Extra sets to provide listening convenience throughout the home are expected to amount to a handsome volume; and (5) A steady growth in home television is anticipated.

Sylvania Electric Products has also dug up some facts about the postwar receiver market. Their investigation leads them to estimate that 100,000,000 radios will be sold in the first five or six years after the war. More people told them they would pay an additional $75 for television than would spend $10 extra for fm, but if they can get fm for $5 the desire is practically unanimous.

Although only 5 percent of the set owners expressed a real dissatisfaction with their receivers, nevertheless 63 percent of the families who own three sets indicated that all were made by different manu-

Continental-Diamond

Engineered Dielectric Materials

The DILECTO parts illustrated are insulators in airborne radio equipment. Their insulating properties must remain stable at temperatures from 70° F below zero to 160° F above zero; in high humidity or extreme dryness.

KO-45

There are 6 C-D Engineered Dielectric materials, each of which provides designers and engineers with a different range of desirable properties. Each of these 6 C-D materials is made in several grades to meet specific electrical and mechanical problems. Our technicians will be glad to help you apply these C-D Dielectrics to your "What Material" problem.

C-D technicians have at their call the accumulated "know how" of 50 years of experience helping customers solve electrical insulating and mechanical problems. Use this wealth of information to help you solve your design and performance problems.

C-D PRODUCTS

The Plastics

DILECTO—A Laminated Phenolic.
CELORON—A Molded Phenolic.
DILECTENE—A Pure Resin Plastic Especially Suited to U-H-F Insulation.
HAVEG—Plastic Chemical Equipment, Pipe, Valves and Fittings.

The NON-Metallics

DIAMOND Vulcanized FIBRE
VULCOID—Resin Impregnated Vulcanized Fibre.

MICABOND—Built-Up Mica Electrical Insulation.

Standard and Special Forms

Available in Standard Sheets, Rods and Tubes; and Parts Fabricated, Formed or Molded to Specifications.

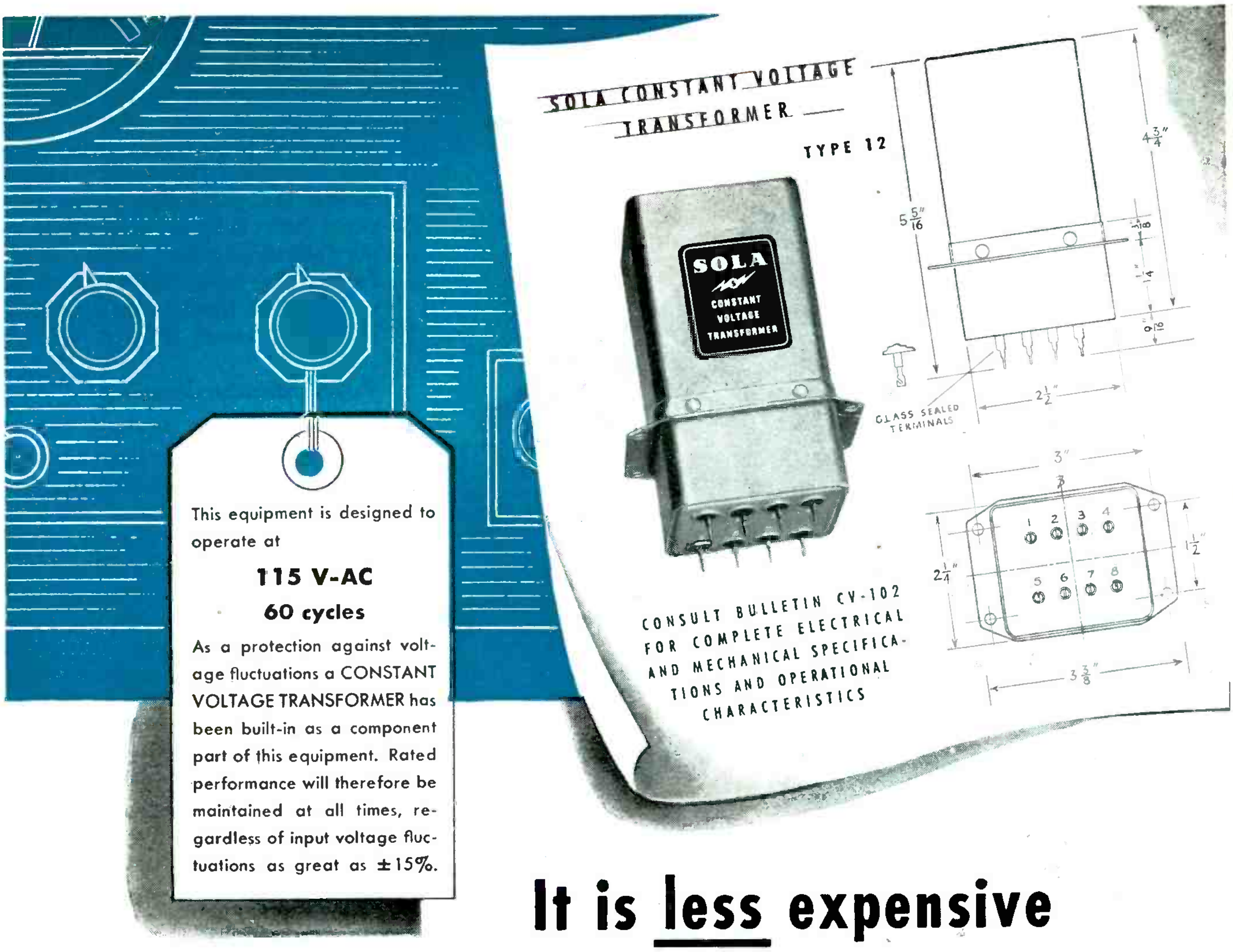
Descriptive Literature

Bulletin GF gives Comprehensive Data on all C-D Products. Individual Catalogs are also Available.

DISTRICT OFFICES
NEW YORK 17 CLEVELAND 14 CHICAGO 11
SPARTANBURG, S. C. SALES OFFICES IN PRINCIPAL CITIES
•
WEST COAST REPRESENTATIVES
MARWOOD LTD., SAN FRANCISCO 3
•
IN CANADA:
DIAMOND STATE FIBRE CO. OF CANADA, LTD., TORONTO 8

Continental-Diamond FIBRE COMPANY

Established 1895..Manufacturers of Laminated Plastics since 1911—NEWARK 16 • DELAWARE



It is less expensive to provide built-in CONSTANT VOLTAGE

When you specify a SOLA Constant Voltage Transformer as a built-in part of your equipment there will be several components that you can write off your cost sheets. That's your first saving.

Now, estimate the number of anticipated service calls that would result from unstable voltages during your guarantee period. Write those off too.

Then—you can write off some sales expense, because equipment that provides its own protection against voltage sags and surges, and maintains laboratory efficiency in its operation is easier to sell.

This Type 12 SOLA Constant Voltage Transformer, is one of several small, compact units that have been designed specifically for chassis mounting. They are being successfully used by manufacturers of many types of electrical and electronic equipment. Where volume is indicated their cost is surprisingly low.

If unstable voltages have been a problem in war-time imagine what will happen when all of the much publicized electrical and electronic gadgets make their appearance on a peace-time market.

Consultation with our engineers *now* may give you the competitive advantage you are seeking for your peace-time sales.

SOLA Constant Voltage Transformers

To Manufacturers:
Built-in voltage control guarantees the voltage called for on your label. Consult our engineers on details of design specifications.
Ask for Bulletin DCV-102

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

facturers. Push-button tuning is fairly popular. Of the 31 percent of the respondees having the feature, three-quarters like it while the rest of them report unsatisfactory service. Popularity ratings among the particular group surveyed indicate brand preferences in the following order: Philco, RCA, Zenith, Emerson, Silvertone, General Electric, Crosley, Majestic, Air Line and Stewart Warner.

Tube Standardization

TRANSMITTING, receiving, industrial, and non-industrial tubes will be standardized through the activities of JETEC (Joint Electron Tube Engineering Council). This agency is established in cooperation by RMA and NEMA. Present tube standards will not be affected. Four members will comprise the engineering council, two each of which will be from RMA and NEMA. Members are: O. W. Pike, General Electric, chairman; J. R. Steen, Sylvania Electric Products; A. Seanuke, Amperex Electronic Corp.; and D. D. Knowles, Westinghouse. Dr. W. R. G. Baker, GE and RMA, and A. C. Streamer, Westinghouse and NEMA, will be a policy committee to operate through the RMA Data Bureau.

Watts to Do About It

BROADCAST STATIONS have been asked to support the building fund campaign of IRE by keying their contributions to the power of their transmitters. Radio stations operating under 750 watts are asked to contribute 10 cents for each watt radiated, while stations over 750 watts are only called upon for 5 cents per watt.

Postwar Microwaves

TELEVISION, walkie-talkie, plane-to-plane, vehicle-to-vehicle, commercial radar and relay-link communication are only a few of the possible uses to which the transmission and reception of microwaves will be put as soon as the war is over, in the opinion of Dr. W. W. Hansen, research engineer for the Sperry Gyroscope Co., who addressed members of the IRE in Rochester recently.

He gives three reasons for this feeling: (1) Theoretically, at least,

THE VITAL LINK . . . Broadcasting originating in Station WEOD, Boston, are relayed without wires to station WGTR, Paxton, . . . 43 miles distant . . . and thence to the six stations which comprise the Yankee Network. Thanks to WGTR, and to its consistently fine performance, the Yankee Network has functioned perfectly since 1942.

REL installations have clearly demonstrated the dependability and efficiency of the Armstrong Phase Shift method of frequency modulation . . . the method employed in REL transmitters of all power ratings.

RADIO ENGINEERING LABS., INC.
Long Island City, N.Y.

more efficient ...in miniature

Imagine a lady carrying a bunch of keys for old time locks in her evening bag. Their bulk and weight would make this impractical... yet, for modern locks, it is common practise for her to carry several keys. Imagine trying to crowd a kit of old-style large tubes into the midget receiving set of the future. TUNG-SOL Miniature Electronic Tubes have indeed opened up new possibilities in compactness and weight.

When miniature tubes were introduced, they created much interest... but set manufacturers asked "will they work as well?" The answer is "yes." In most circuits, miniatures do a better job than large tubes. Some high frequency circuits could not even be designed with large tubes. Added advantages of miniatures are their small size and reduced weight.

The experience gained at TUNG-SOL in producing tubes of all kinds for wartime purposes is at the disposal of manufacturers engaged in building more efficient electronic equipment. TUNG-SOL engineers will be glad to aid in the improvement of circuits and in a better selection of tubes. Your future plans will be held in strictest confidence.

TUNG-SOL

vibration-tested

ELECTRONIC TUBES

TUNG-SOL LAMP WORKS INC., NEWARK 4, NEW JERSEY

Also Manufacturers of Miniature Incandescent Lamps, All-Glass Sealed Beam Headlight Lamps and Current Intermittors

"TAKE 'ER DOWN"

and Sickles "Submersible" R. F. Components are unharmed

WATER, corrosive chemicals and gases, even fungi are harmless to Sickles "Submersible" R. F. Components.

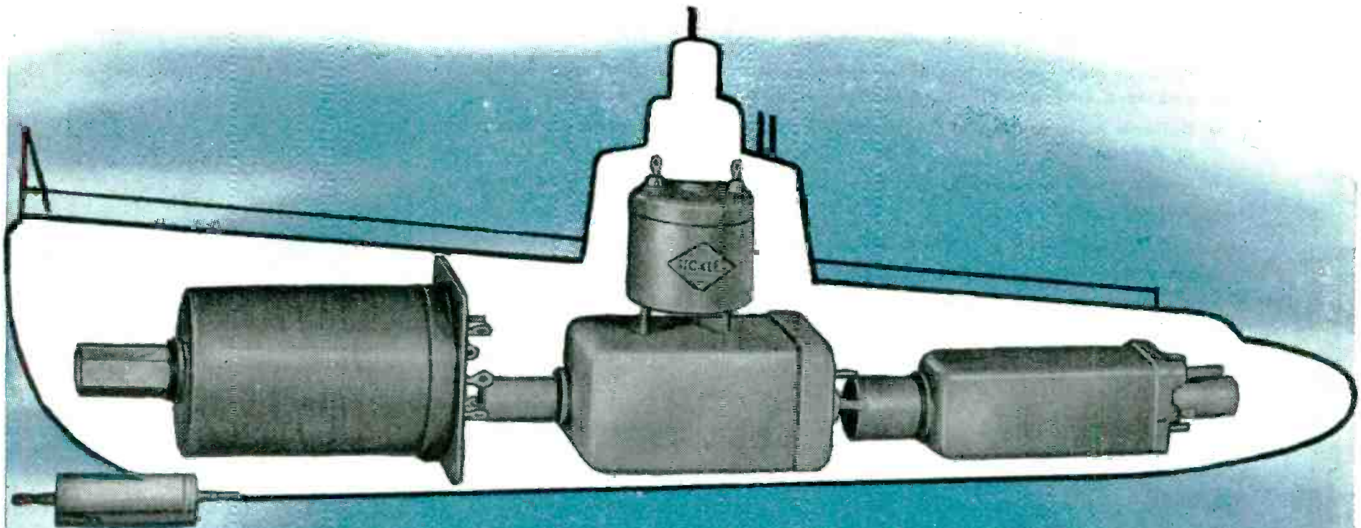
They are hermetically-sealed with wide soldered joints in sturdy deep-drawn zinc "hulls." They are equipped with fused metal-to-glass bushings. All adjustments are under rugged "hatches" that are sealed with Neoprene gaskets.

Permanent efficiency is sealed IN —
harmful elements are sealed OUT

Flexibility is practically unlimited. Tell us your needs, give us plenty of room and we can produce a "Submersible" R. F. Component that once installed can be forgotten.

For best in circuit components, specify Sickles.

THE F. W. SICKLES COMPANY • CHICOPEE, MASSACHUSETTS



SICKLES

Radio and Electronic Specialties for Today and Tomorrow two or three million stations can operate simultaneously and in the same neighborhood without interference; (2) Passage of signals between transmitter and receiver can often be accomplished with less attenuation than is possible with longer wavelengths; and (3) The small physical size of a wavelength makes it economic and practicable to manufacture equipment larger than several wavelengths in size—necessary for relaying and projected new methods of private communication.

Receiver Licensees

COMPANIES PLANNING to produce radio receivers after the war, and therefore having arranged licenses with Radio Corp. of America, include: Bendix Aviation Corp., New York; Lear Inc., Piqua, Ohio; ARF Products, River Forest, Ill.; Medco Mfg. Co., New York; Whiting & Davis Corp., Plainville, Mass.; Concert Master Radio & Television Co., Chicago; and Ranger Electronic & Mfg. Corp., New York.

Postwar Television Receivers

RADIO CORP. of America and National Broadcasting Co. recently demonstrated an advance development model of the Schmidt-system

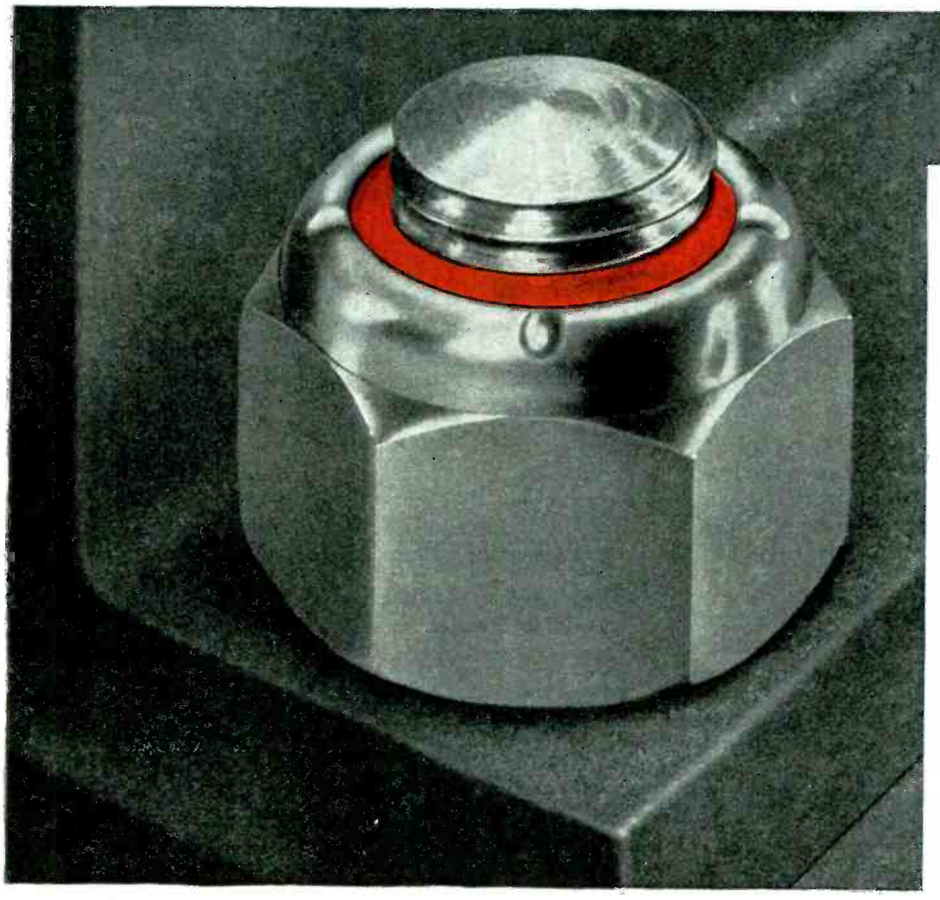
Large-screen television receiver of advance development type demonstrated in New York recently. Picture is 16 x 21⅓ in., and appears on a treated plastic viewing screen

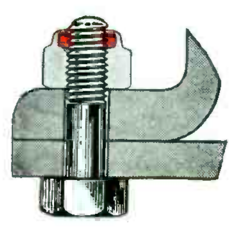
reflecting-type televison receiver described in ELECTRONICS, December 1944.

Audience reaction to the demonstration was universally good. Pictures, which came from the studio by wire line, were clear and had a bluish tone. The standard 525 lines were used and the screen was 16 x 21⅓ in.

Besides the reflective optical sys-

A HOLD-DOWN *for Keeps*





Elastic Stop Nuts have been successfully used for hold-down bolts where security is vital. They give a positive fastening wherever there is vibration, impact, shock, stress change. Let us send an application engineer to discuss the Elastic Stop Nut way of avoiding nut failures that may be a costly service item on your products.

This nut uses its head.

An Elastic Stop Nut carries its own insurance for a positive hold-down fastening — the elastic collar built into its head.

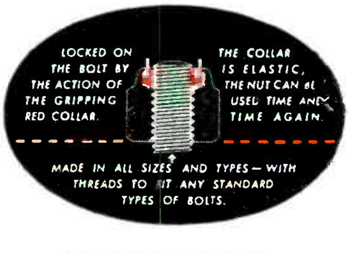
Here's how this device works:

The tough but resilient elastic collar forms itself to the individual bolt threads, grips them so tightly that the nut won't loosen up or back off even under the severest vibration.

Forget about cotter pins, lock-washers or any other auxiliaries when you use an Elastic Stop Nut. That means no chance of leaving off these extras as well as saving time in assembly and servicing.

Once on, an Elastic Stop Nut stays on. And it can be used over and over again without losing the grip of its headpiece.

Result: Economy in production and economy in use.



ESNA

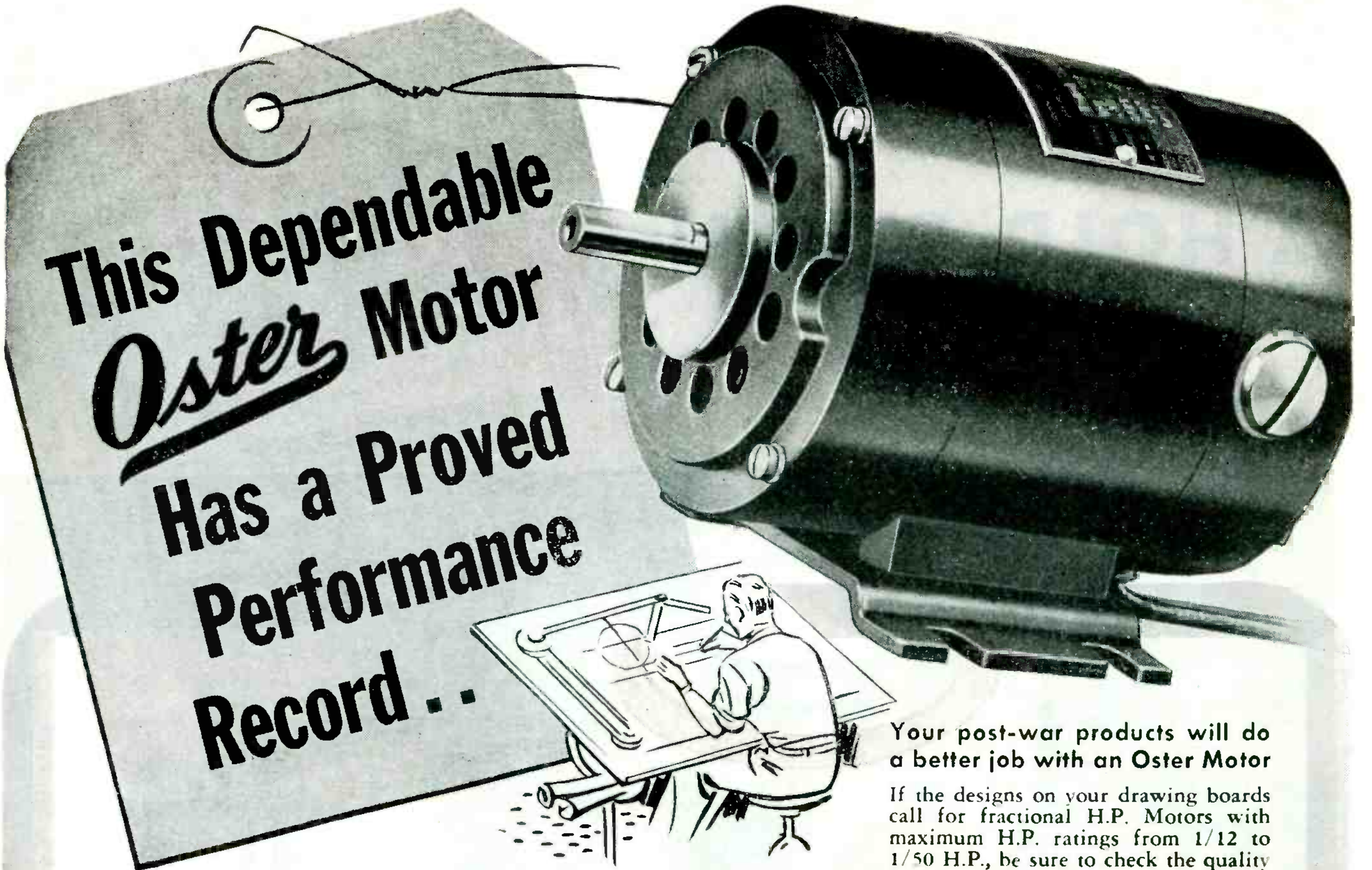
TRADE MARK OF

ELASTIC STOP NUT CORPORATION OF AMERICA

Union, New Jersey
and Lincoln, Neb.

Sales Office—1060 Broad St., Newark 2, N.J.

ELASTIC STOP NUTS
Lock fast to make things last



Your post-war products will do a better job with an Oster Motor

If the designs on your drawing boards call for fractional H.P. Motors with maximum H.P. ratings from 1/12 to 1/50 H.P., be sure to check the quality features and design characteristics of this Oster motor.

Behind this Oster Motor stands 15 years of experience in designing and building quality fractional H.P. Motors — motors that have won world-wide acceptance in famous Oster appliances . . . motors that have won laurels in the service of war.

This Oster Motor gives you the advantages of light weight, compactness, and dependable, trouble-free performance. Check the quality features and chart below. If these are the features you want, call us for further detailed information.

HOUSING—Die cast, open or totally enclosed.

FINISH — Black, baked enamel.

BEARINGS — Single shielded ball bearings. Bearing housing fitted with steel inserts.

BRUSHES — Furnished with metal graphite or electro graphite brushes of ample size to assure unusually long brush life. Phosphor bronze or beryllium copper brush springs.

WINDINGS — Available for operation on 12, 24 or 115 volts, in shunt, series, and split series types.

MOUNTING — Available for either base or flange mounting.

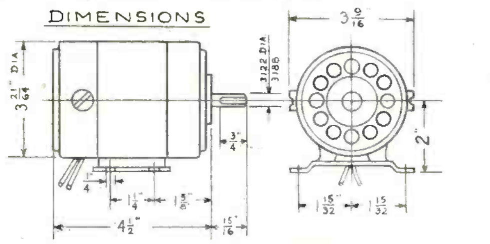
MODIFICATIONS — Motors can be furnished with special shaft extensions, finishes, leads, etc. Motors can also be furnished for operation in high ambient temperatures and high altitudes.

All ratings and data are approximate.

Let us help you fit this and other Oster Motors to your requirements.

24 VOLT SHUNT CONTINUOUS DUTY IN 25° C. AMBIENT					
Maximum H.P.	1/12	1/16	1/25	1/35	1/50
R.P.M.	7500	5800	3800	2800	1750
Amps Input	3.8	3.2	2.2	1.8	1.5
Starting Torque in % of F. L. Torque	200 min.	200 min.	200 min.	200 min.	200 min.

Specifications of Type E-8 Motor

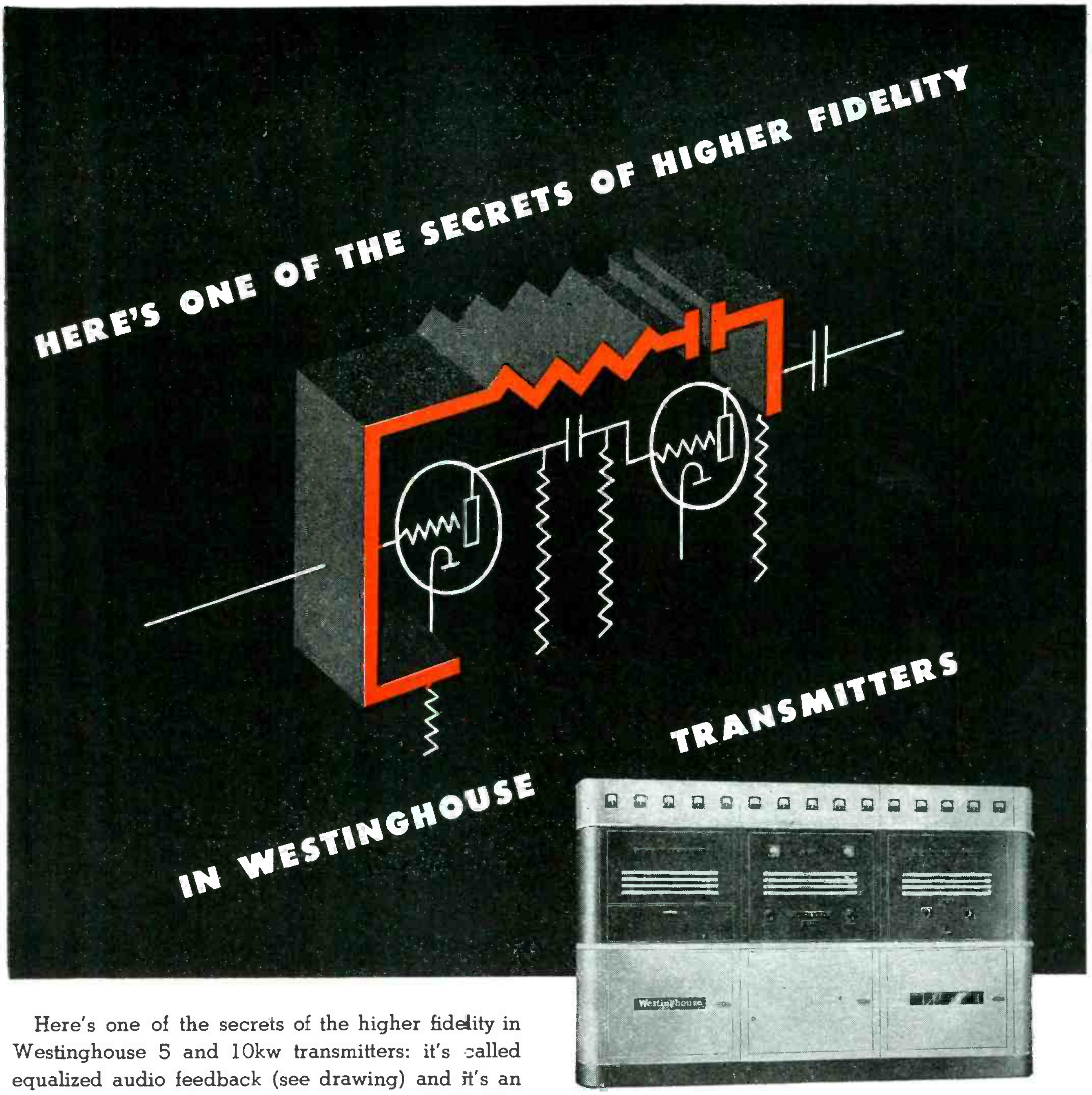


Oster FRACTIONAL H.P. ELECTRIC MOTORS

John Oster Manufacturing Co.

DEPARTMENT L-25 • RACINE, WISCONSIN

M-25



Here's one of the secrets of the higher fidelity in Westinghouse 5 and 10kw transmitters: it's called equalized audio feedback (see drawing) and it's an outstanding contribution to higher signal fidelity.

Equalized audio feedback strengthens the already high fidelity of the audio and modulation circuits in Westinghouse transmitters, and reduces audio distortion to even lower limits. The system is independent of any variation in rectified antenna output.

Control-simplicity, economy and high fidelity are natural partners of the solid dependability you find in the complete line of Westinghouse transmitters . . . 5, 10 and 50kw AM and 1, 3, 10 and 50kw FM. Your nearest Westinghouse office has all the facts on these newest achievements in faithful transmitter operation designed by Westinghouse . . . the oldest name in broadcasting. Westinghouse Electric & Manufacturing Company, P. O. Box 868, Pittsburgh 30, Pa. J-08110

Easy operation is another keynote of the smartly-styled Westinghouse 5kw transmitter . . . one master switch puts the transmitter on the air and cuts off power at close of broadcast day. Controls reset automatically whenever overloads occur in any circuit for any reason.

XXV—RADIO'S 25TH ANNIVERSARY—KDKA

Westinghouse

PLANTS IN 25 CITIES . . . OFFICES EVERYWHERE

Electronics at Work

tem and plastic correction lens, the unit features a built-in translucent plastic viewing screen; an automatic frequency control system, which virtually eliminates picture distortion caused by interference from noise impulses; and a new 27,000-volt cathode-ray tube. When put in production, RCA-Victor expects to market the receiver for $395.

Radar Traffic Control

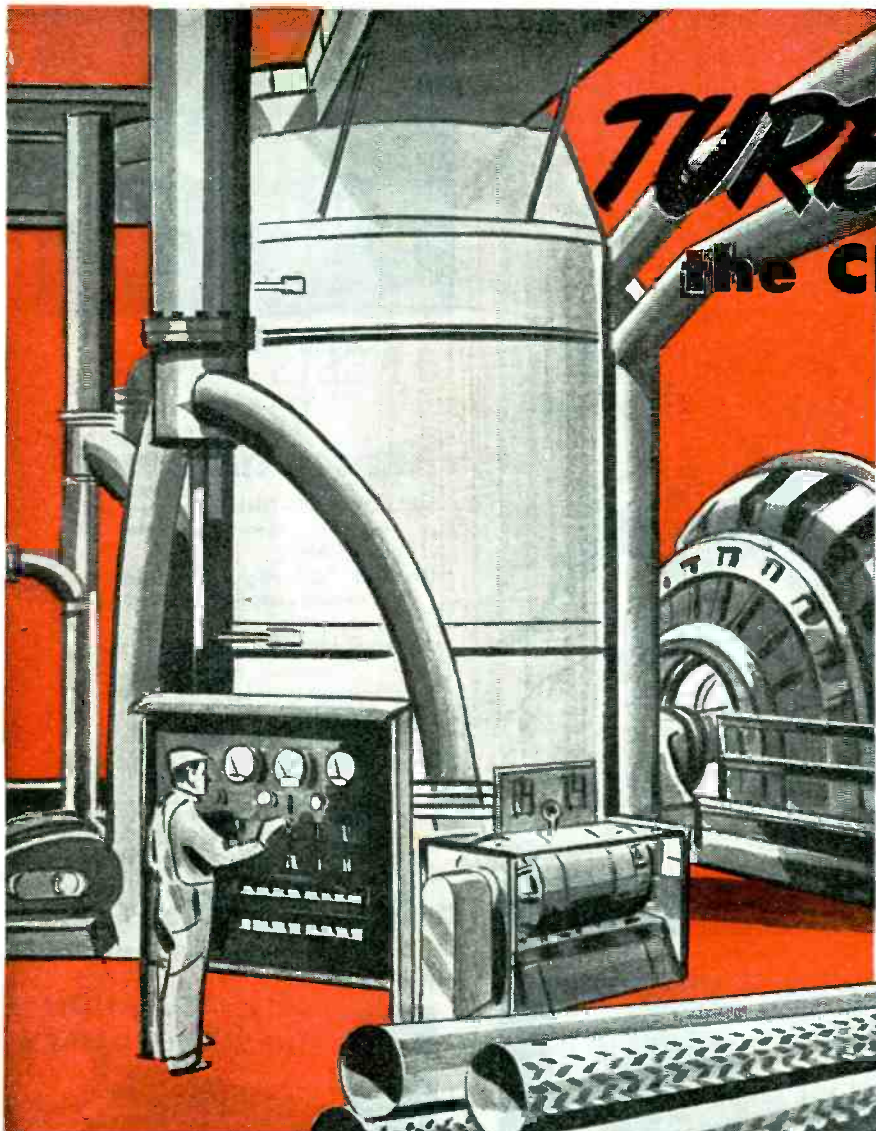
ULTIMATELY, in the opinion of William P. Lear, Lear Inc., aircraft and ship traffic will be controlled by radar systems. Speaking before the Aviation Writers' Association in New York recently, he suggested that an aircraft control tower might be equipped with a cathode-ray tube several feet in diameter with spot indications for all the airborne aircraft within the traffic area involved.

This indicator would be such as to reveal the position of planes up to a 5,000-ft. altitude and within a hundred mile radius.

From the point of view of the private flyer, other, more immediate developments described by Mr. Lear include a system of omni-directional ranges that makes it possible for a pilot to determine for himself the necessary angle to approach a given point. Such a unit is better than a direction finder since the pilot can make his correction for wind-drift to avoid flying a parabola-shaped course. This system has been made

• • •

Other members of WCEMA (West Coast Electronic Manufacturers' Association) look on as H. L. Hoffman (Hoffman Radio Corp., Los Angeles) left, shakes hands with Bud Bane (Technical Radio, San Francisco). Mr. Hoffman is retiring as president to be succeeded by Mr. Bane. Other officers include Herb Becker (Eitel-McCullough, Inc., San Bruno) as secretary and James L. Fouch (Universal Microphone Co., Inglewood) as treasurer.



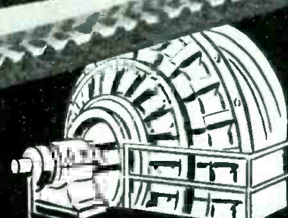
TURBO majors in the Chemical field

...and sets new standards for electrical insulation efficiency for all industries!

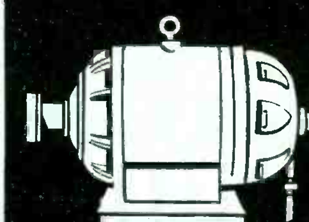
Chemical plants—tough proving grounds for any type of electrical insulation—involve severe deteriorating influences; acids, alkalis, solvents, corrosive fumes, vapor, moisture and humidity are usually encountered. Not to be outdone, wide temperature fluctuations add materially to the hazards of insulation, too.

TURBO Sleevings — diversified in characteristics — provide solutions to these adversities. They are available in four types to meet specific operating conditions—Extruded Tubing for immunity to subzero temperatures; Varnished Glass Tubing for resistance to high heat; Flexible Varnished Oil Tubing for resistance to chemicals, moisture, etc. All feature perfect concentricity and smooth bore for rapid and easy installation.

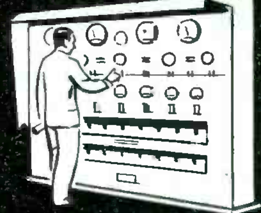
TURBO Wire Markers, too, are supplied in all sizes, colors and markings. They are easily applied, permanent and simplify maintenance and repair. Write today for the free TURBO Sample Board; specimens and sizes of each type tubing are included.



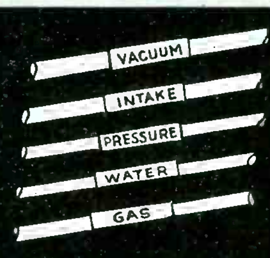
FLEXIBLE VARNISHED OIL TUBING: This product finds application where immunity to corrosive fumes, acids, alkalis and solvents is essential. It is impervious to moisture and non-hygroscopic. An important insulation for chemical installation.



VARNISHED GLASS TUBING: An extensively used sleeving, resistant to high temperature. Recommended for heavy duty in confined areas where ventilation is at a minimum. Suitable for enclosed motors and wiring subjected to high heat.



EXTRUDED TUBING: This smooth, wall tubing withstands the rigors of severe low temperatures. This immunity to embrittlement at sub-zero cold permits wiring runs adjacent to low temperature equipment, piping, etc. with assurance of dependability.

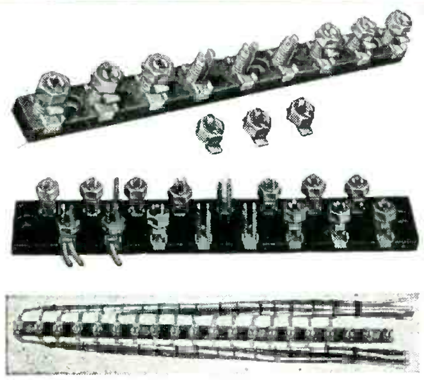


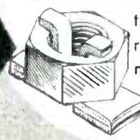
WIRE IDENTIFICATION MARKERS: Now available in two types—sleeve and tab. Furnished in any color and marking, they reduce identification and tracing of piping, conduits and cables to an accurate split second procedure.

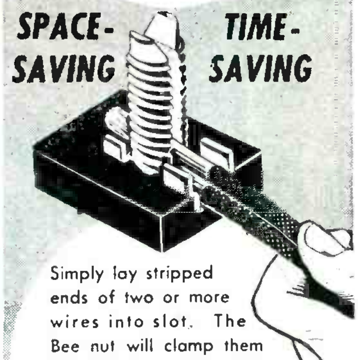
WILLIAM BRAND & COMPANY

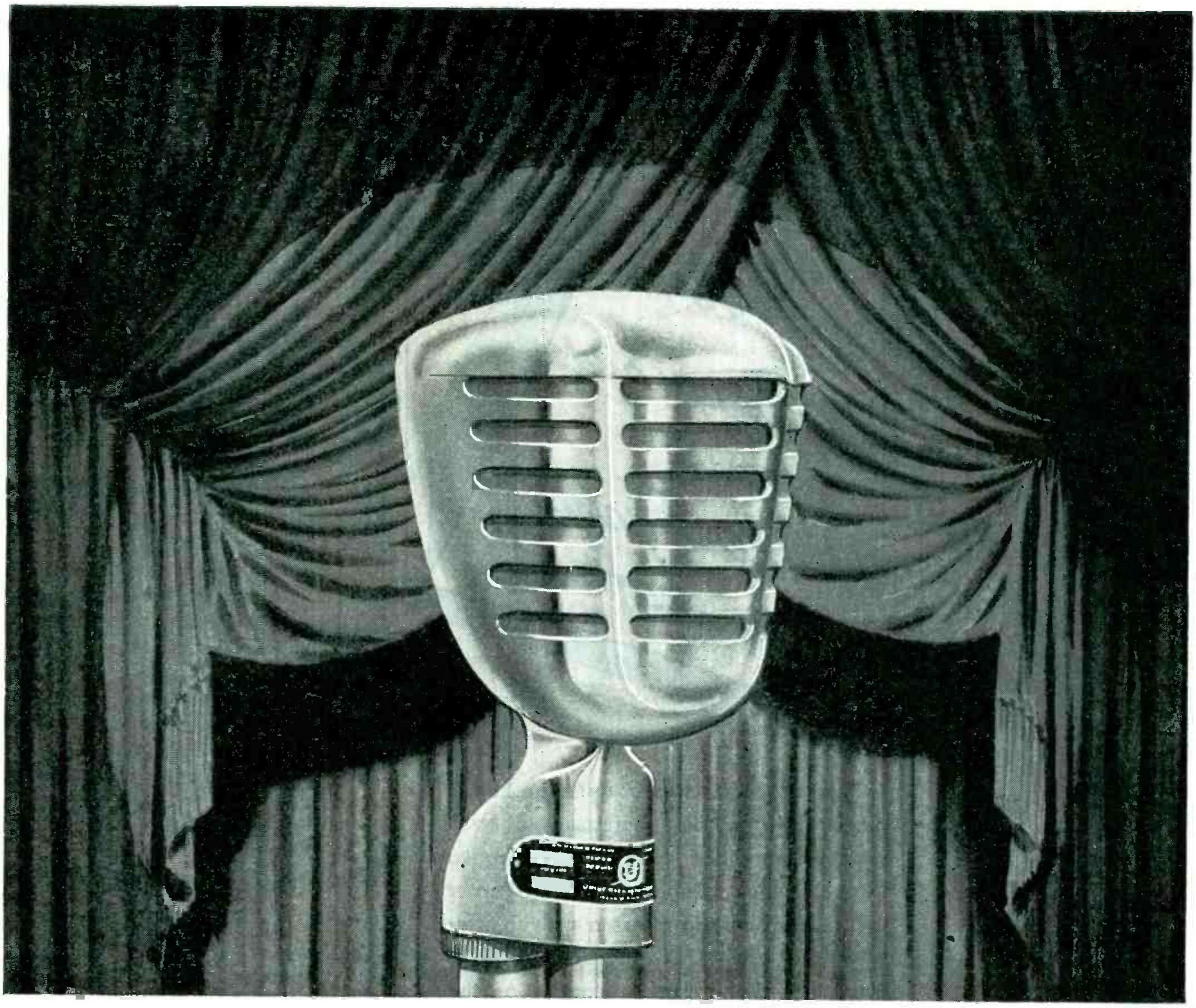
276 FOURTH AVENUE, NEW YORK 10, N. Y.
325 W. HURON STREET, CHICAGO 10, ILL.

BLOCK MICA • MICA PLATE AND PRODUCTS • VARNISHED OIL TUBING
SATURATED SLEEVING • VARNISHED CAMBRIC • CLOTHS AND COMPOSITES

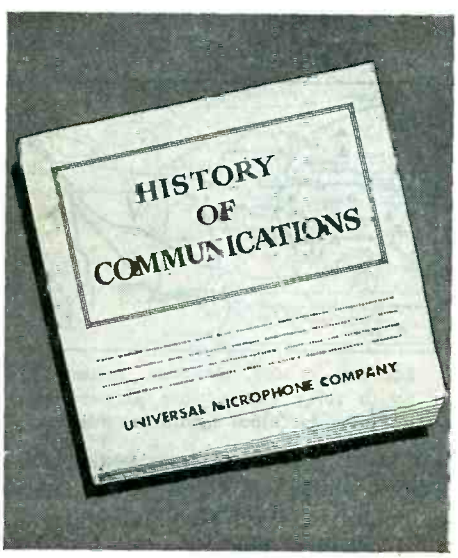








UNIVERSAL'S NEW D-20 MICROPHONE



The stage was set for something new and here it is. Universal's new D-20 Microphone . . . soon on your radio parts jobbers' shelves to fill your essential requirements . . . uses Universal's "Dynoid" construction . . . A dynamic microphone of conventional characteristics built to fill the utility requirements of war time plus advance styling of the many modern things to come. Orders placed now with your Radio Parts Jobbers will assure early delivery when priority regulations are relaxed.

Write for Bulletin 1458 covering this new microphone

< FREE – History of Communications Picture Portfolio. Contains over a dozen 11" x 14" pictures suitable for office, den or hobby room. Write factory for your Portfolio today.

UNIVERSAL MICROPHONE COMPANY
INGLEWOOD, CALIFORNIA

FOREIGN DIVISION: 301 CLAY STREET, SAN FRANCISCO 11, CALIFORNIA ·· CANADIAN DIVISION: 560 KING STREET WEST, TORONTO 1, ONTARIO, CANADA possible by use of vhf and is not feasible on medium frequencies.

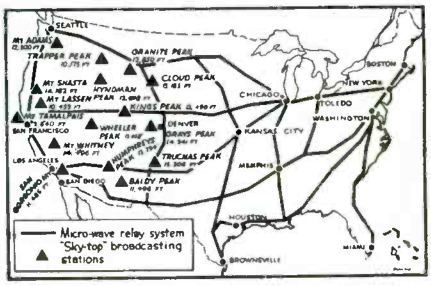
Another piece of equipment very much needed by private fliers is a small, light, inexpensive automatic pilot. This is because the necessary combination of piloting and navigational duties keep a solo flier on a cross-country hop very busy and allow little relaxation en route. It is the intention of Mr. Lear's company to supply such equipment in the postwar period.

Ten carloads of radar apparatus loaned by the Army and Navy are being used in the CAA Experimental Station at Indianapolis to conduct a series of tests aimed at the attainment of radar traffic control similar to that described by Mr. Lear. Two specific objectives are perfection of a screening device which will permit the tower controller to visualize the actual positions of all aircraft within a radius of approximately 25 miles and a collision warning device to be installed on the instrument panel of the plane, which would give constant visual indication of the relative position of other aircraft within a certain radius.

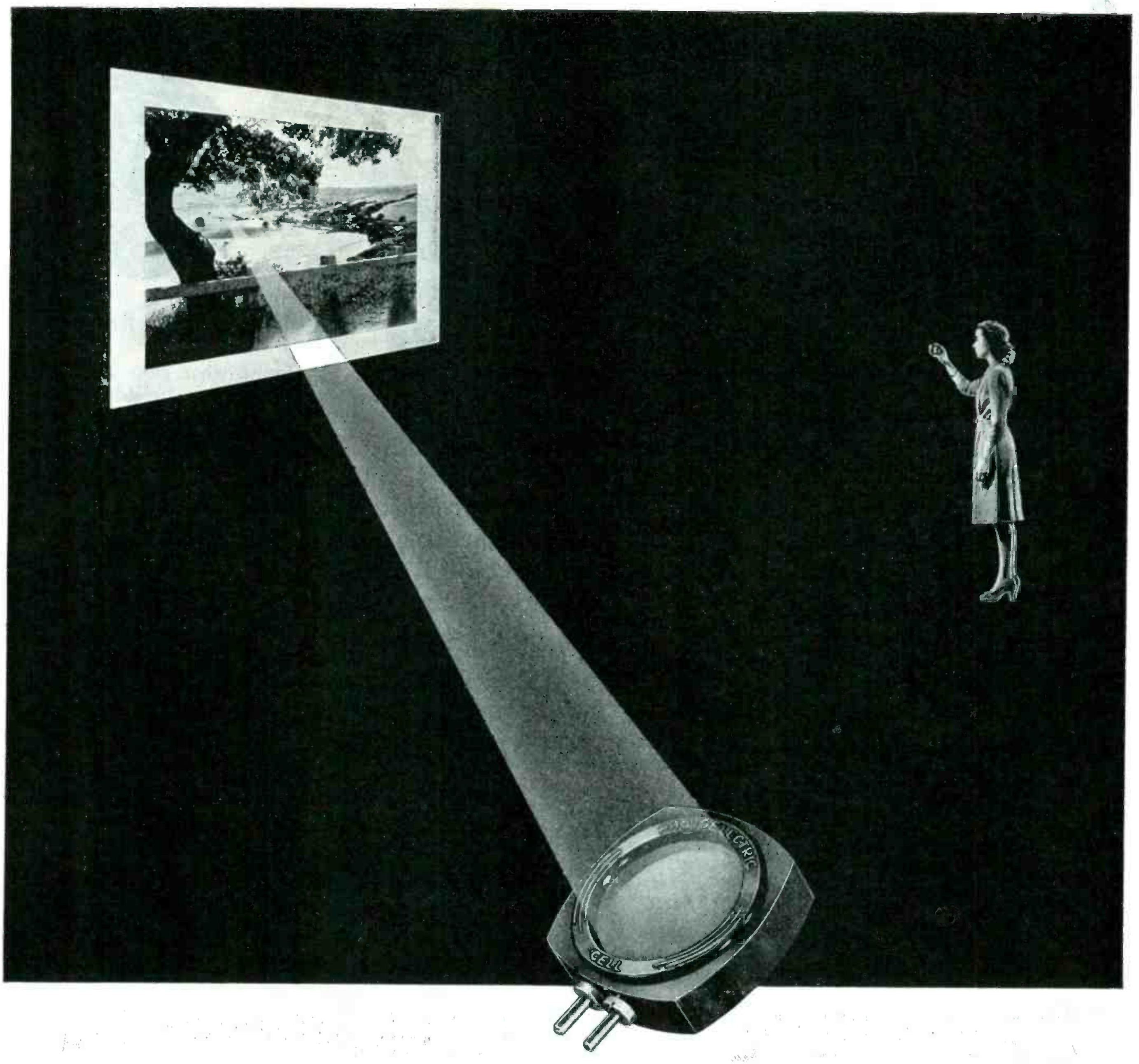
Microwave Relay System

SPANNING THE HIGHEST mountain peaks from Mount Adams in Washington to Mount Whitney in Southern California, a projected West Coast installation of television broadcasting chain facilities is described by Raytheon Mfg. Co., which has filed application with FCC for experimental frequencies.

The so-called "Sky-top" chain will involve building on the summits of several western peaks, stations which will combine the functions of safety for commercial and private airplanes within a radius of 300 to 500 miles, wide service-area television, f-m and a-m broadcast-



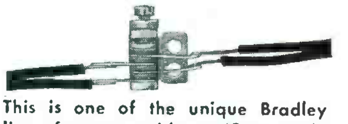
Location of the mountain peaks on which relay stations are planned by Raytheon for initial installation this year



MORNING BECOMES ELECTRIC!

Photographers use a small box they call an exposure meter. They take it for granted, like flicking a switch to light a room. But while vast generating systems bring power to your house, a light source alone works a meter or meter relay — when a photocell converts that light into electric energy. The simplicity and ruggedness of an exposure meter typify all Luxtron* photocell applications—from taking a good picture to precisely matching colors—from putting out a fire to increasing the heat of a furnace. No amplifiers are needed. Long equipment life is assured, under the most strenuous operating conditions. Ask Bradley how photocells can meet your own measurement or control problems.

Versatile "Coprox" Rectifiers



This is one of the unique Bradley line of copper oxide rectifiers, made with the same understanding of electrical circuits and plymetallic phenomena that goes into Luxtron photocells. Write for illustrated "Coprox" bulletin.

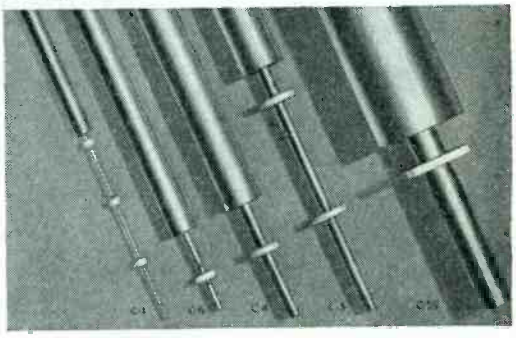
*TRADE MARK REG. U. S. PAT. OFF.

PHOTOCELLS—MASTERS OF LIGHT **BRADLEY** MASTER OF PHOTOCELLS

BRADLEY LABORATORIES, INC., 82 MEADOW STREET, NEW HAVEN 10, CONNECTICUT

Concentric Transmission Line

by Doolittle



A Standard Product Since 1934

• Ten years of experience in building concentric transmission line and associated impedance matching equipment assures you highest quality and workmanship.

Doolittle lines are made in seven standard sizes. Each line uses seamless copper tubing for the outer and inner conductor, except Types C-1 and C-6 which use solid inner conductors. The insulating heads are made of low loss ceramic—impervious to moisture—spaced and fastened securely for maintaining proper electrical and mechanical characteristics.

Carefully designed fittings and accessories for any requirements are also available.

Special sizes are made to order. For engineering information concerning installation and use, feel free to consult our engineering staff.

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Builders of Precision Communications Equipment
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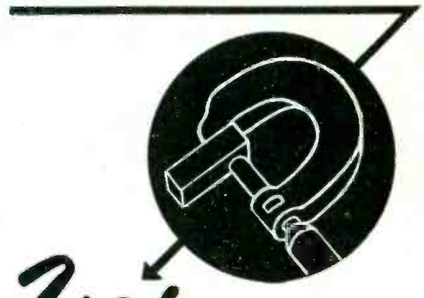

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We know what close tolerances mean . . . that precision is the First Prerequisite in Electronics.

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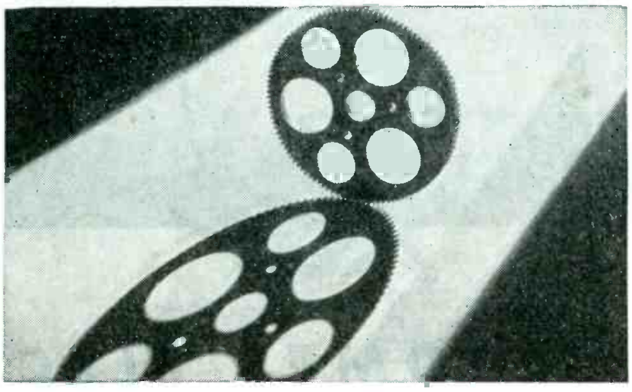
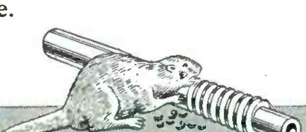
COMING EVENTS CAST THEIR SHADOWS



Greater "know-how" in gear cutting methods has resulted in finer accuracy and finish without additional cost. As a result, gear teeth stand up longer and roll more quietly. These will be important factors in the gear design of your future products, making them more dependable and attractive.

Our services and experience will help you solve production problems on small or medium size spur, helical and rack gears, worms, splines, sprockets and ground threads. Write for quotation on your specifications. No obligation of course.



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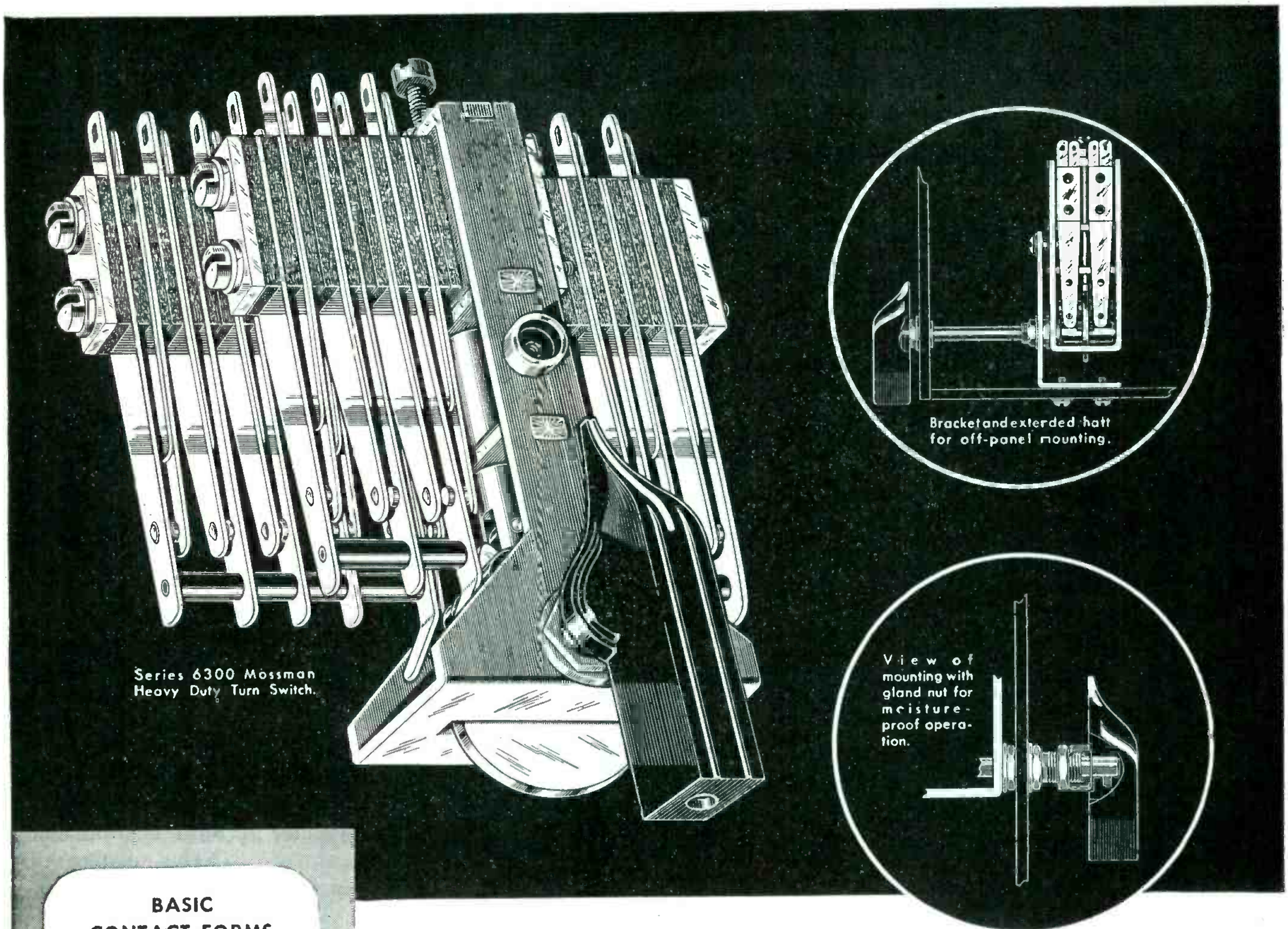
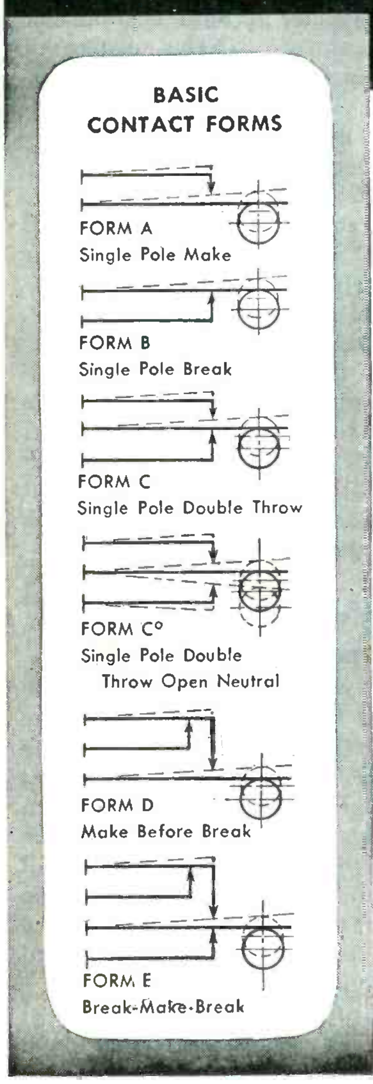




MOSSMAN SERIES 6300 HEAVY DUTY TURN SWITCH

Permits Almost Unlimited Circuit Arrangements

Latest development in the Mossman line of precision heavy duty multiple circuit turn switches is the Series 6300 . . . a big, husky switch for panel mounting that permits a most versatile control set-up.

Electrical and production engineers will find this switch most useful in such applications as: Signal systems, alarm systems, controls for machine tools and welding equipment, lighting systems, annunciators and many other types of electronic devices and controls.

The Series 6300 Mossman Heavy Duty Turn Switches are available as either three position (Series 6303) or two position (Series 6302) switches. An almost unlimited series of combinations of contact assemblies may be built up by use of any combination of the six basic forms shown.

Standard heavy duty contacts are of 3/16″ diameter fine silver, rated at 10 amperes, 110 volts A.C., non-inductive. Extra heavy duty contacts are of 5/16″ silver alloy rated at 20 amperes, 110 volts A.C., non-inductive. Breakdown rating of springs to ground is 2000 volts, A.C.

Send for complete information on the new Series 6300 Mossman switches. Also ask for catalog which describes the full line of Mossman precision electrical components, including many types of heavy duty, multiple circuit lever switches, turn switches, push switches, plug jacks and other special switching components.

DONALD P. MOSSMAN, INC., 612 N. Michigan Ave., Chicago 11, Ill.

MOSSMAN

"Electrical" "Components"

ing, a microwave relay system, public call facilities, highway control systems, and police-radio master stations. Initial permission from FCC is sought for experimental stations to be erected on the various mountain peaks shown in the accompanying illustration. Authority has been requested for initial tests on 30.66, 39.55, 90, 200, 400, 900, 1,900, 4,000, 6,000, 10,000, 16,000 and 26,000 Mc.

To avoid defacing the mountain sites, Raytheon plans to build all facilities, including living quarters underground with the only exposed portion being the antenna systems. The company announced that it will be in a position to initiate the first stage of the West Coast circuit and the first section of the Eastern circuit during 1945.

Postwar Electronic Employment

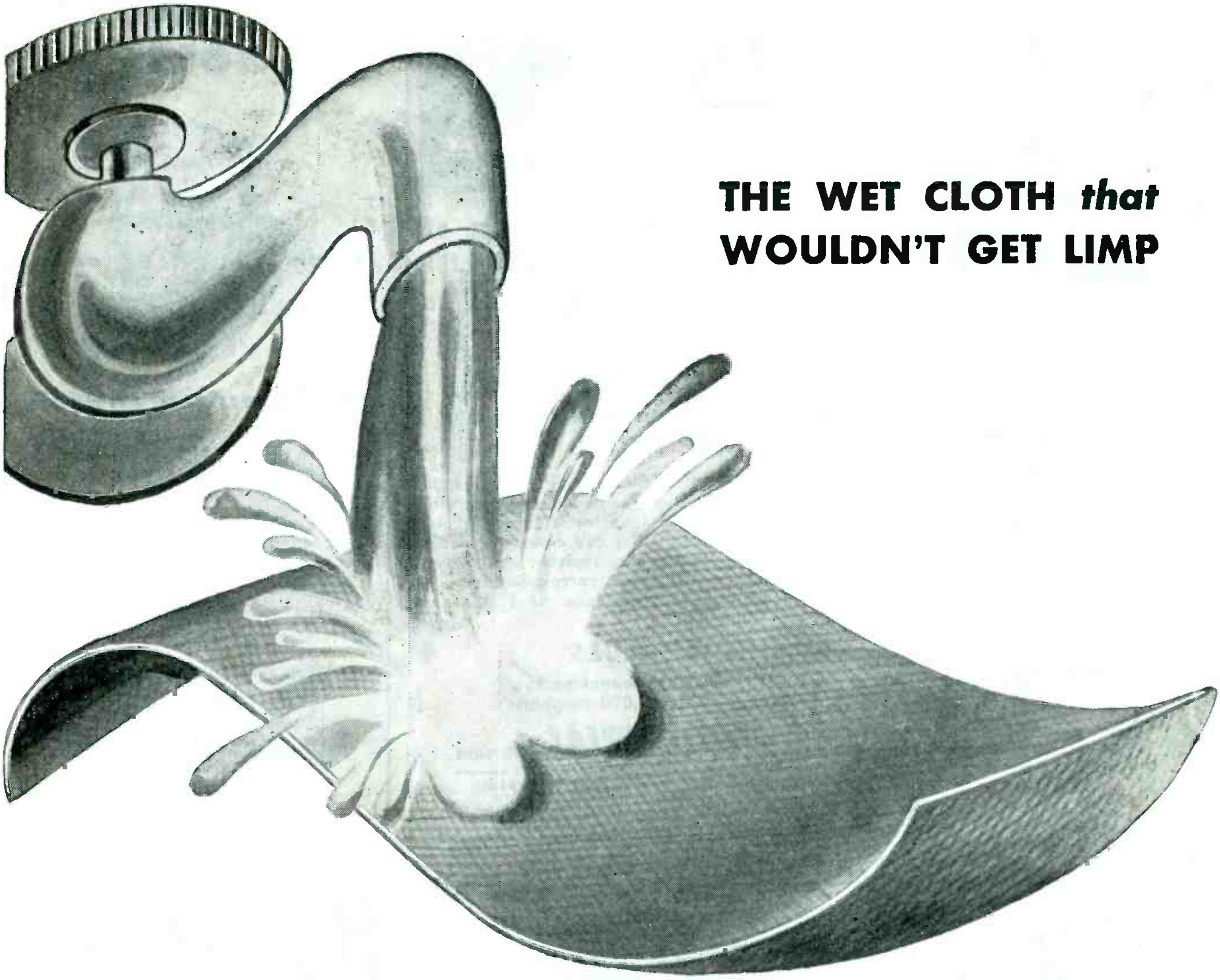
According to the findings of a survey made by the employment and personnel committee of RMA, the industry has a total current employment of 277,660 employees. This includes 36,374 former employees in the armed services. Results also reveal prospective postwar employment of 145,266. Figures are compiled from estimates of 202 companies, representing 64.9 percent of the industry, including the largest and virtually all substantial manufacturers.

It was estimated that 23.6 percent of the men and 27.9 percent of the women presently employed in the industry will not seek work there for various reasons, postwar and that 28.5 percent of the present employees will be forced to seek employment in other fields.

Kingdom for a Tube

Bell Telephone Laboratories recently came through with 1,000 special tubes like the one in the illustration for use in a telephone repeater station somewhere behind the American lines on the Western Front. When the installation was captured it was discovered that all the tubes had been removed. The system had been engineered by the Nazis but some of the repeaters had been built locally.

One of the engineers who worked on the job was discovered and found



THE WET CLOTH *that* WOULDN'T GET LIMP

We have made it and it still looks and feels like cloth; but, actually, every thread is impregnated with a synthetic resin and repels water and many ordinary chemicals. Water will go through it, but not into it. That is *impregnated* cloth.

We make it another way in which the openings between the threads are filled and water will not soak into it or pass through it. That is a *filled* cloth. These are typical of many processes of preparing cloth for special uses — of combining a cloth structure for strength and flexibility with some form of what may be termed a "plastic."

Do not confuse these and other Holliston processes with ordinary cloth finishing. We prepare cloth with special characteristics to meet special needs — functional or decorative. Many of these processes make cloth a "flexible plastic," capable of being folded, creased, stretched, glued or formed.

If you have a material problem for Post War production, consult our Research Department

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Cloth combined with special compounds, filled, impregnated, coated — to form a material with characteristics of a plastic and the flexible strength of a woven fabric.

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S·S·White RESISTORS

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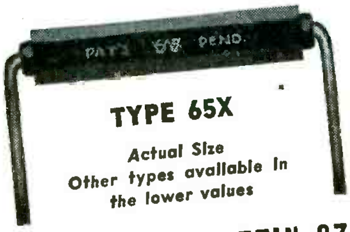

TYPE 65X

Actual Size
Other types available in the lower values

RESISTOR BULLETIN 37 GIVES FULL DETAILS . . .

It shows illustrations of the different types of S. S. White Molded Resistors and gives details about construction, dimensions, etc. A copy, with Price List will be mailed on request. Write for it—today.

WIDELY FAVORED because of NOISELESS operation, DURABILITY and fine PERFORMANCE in all climates . . .

STANDARD RANGE
1000 ohms to 10 megohms

NOISE TESTED

At slight additional cost, resistors in the Standard Range are supplied with each resistor noise tested to the following standard: **"For the complete audio frequency range, resistor shall have less noise than corresponds to a change of resistance of 1 part in 1,000,000."**

HIGH VALUES
15 megohms to 1,000,000 megohms

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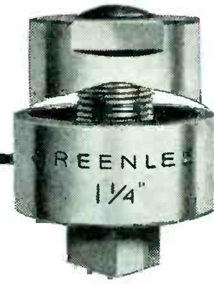

cut in radio chassis

Greenlee Punches make this tough job easy. No reaming, filing or tedious drilling. Tool has three parts: *punch* cuts through chassis, *die* supports metal to prevent distortion, *cap screw* is turned with wrench to cut holes. Sizes for holes ¾" to 3½". Ask your radio supply or electrical jobber or write for folder and prices. Greenlee Tool Co., 1925 Columbia Ave., Rockford, Illinois.

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ICA Irons embody these important construction features:—

Heating elements wound on high heat-resisting bobbin of machined and threaded Insulex. Winding utilizes special resistance wire. Complete bobbin is impregnated in non-hygroscopic ceramic compound. ICA Irons heat up to operating temperature in three minutes, and in one additional minute surpass the heat peak of ordinary irons. Special air chamber reduces heat losses. Thoroughly insulated. Rubber tube protects cord from excessive wearing and short-circuiting . . . Write for full details now.

Write for 48-page Catalogue describing the extensive line of ICA Radio-Electronic Products . . . Also 8-page brochure presenting the ICA Manufacturing facilities.

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WIRE - RIBBON - FOIL
SEAMLESS TUBING

SEND US YOUR INQUIRIES FOR ALL APPLICATIONS OF PRECIOUS METALS TO ELECTRONIC PRODUCTS.

PRECIOUS METALS — AWP — SINCE 1875

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30 new BEST speakers, incorporating every advance in speaker design for a quarter of a century, achieve higher efficiency at lower cost through the use of Alnico 5 permanent magnets.
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Transformers for varied applications, which perform to your most exacting requirements, are manufactured and tested in large quantity at BEST.
Tremendously increased winding facilities make BEST a preferred choice for bobbin or Universal wound coils of all types and sizes. The coil illustrated is hand layer-wound #42 wire.
The name BEST has been associated with the finest in coils, transformers and loud speakers since the days of radio's infancy. Illustrated are but a few of the many items manufactured by BEST which required skill, precision and efficiency. Because of the experience gained throughout the years, BEST has been able to meet the ever growing demands of this industry for greater quality, durability and quantity production.
We Invite Inquiry
Our modern production facilities are now available for the quantity production of coils and transformers of all types. Your inquiry will receive our immediate attention.
BEST MANUFACTURING CO., INC.
Electronic and Sound Reproducing Equipment
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capable of supplying some of the electrical characteristics of the badly needed tubes and eventually a single sample tube was found. The tube and the notes were rushed to New York and to the electronics department of the Laboratories. Electrical tests showed that there was no American telephone repeater tube suitable for substitution but that, with the exception of one grid and a base, a tube could

be built up from parts of various existing units. Special grid production was started, various machines were modified to suit the circumstances, and within three days eight tubes with handmade bases were on their way. Without waiting to hear the results from the prototypes, production was pushed along and on the seventeenth day the thousandth tube was waiting for shipment. PS, they worked all right.

Resistance Welding Prizes

ANNOUNCED BY RWMA (Resistance Welder Manufacturers Association) is this year's prize contest to encourage the preparation of outstanding papers on resistance welding subjects. The scope of former contests has been increased, bringing the total amount of the awards up to $1,000. Additional information can be obtained from Harold S. Card, educational director, RWMA, Citizens Building, Cleveland 14, Ohio.

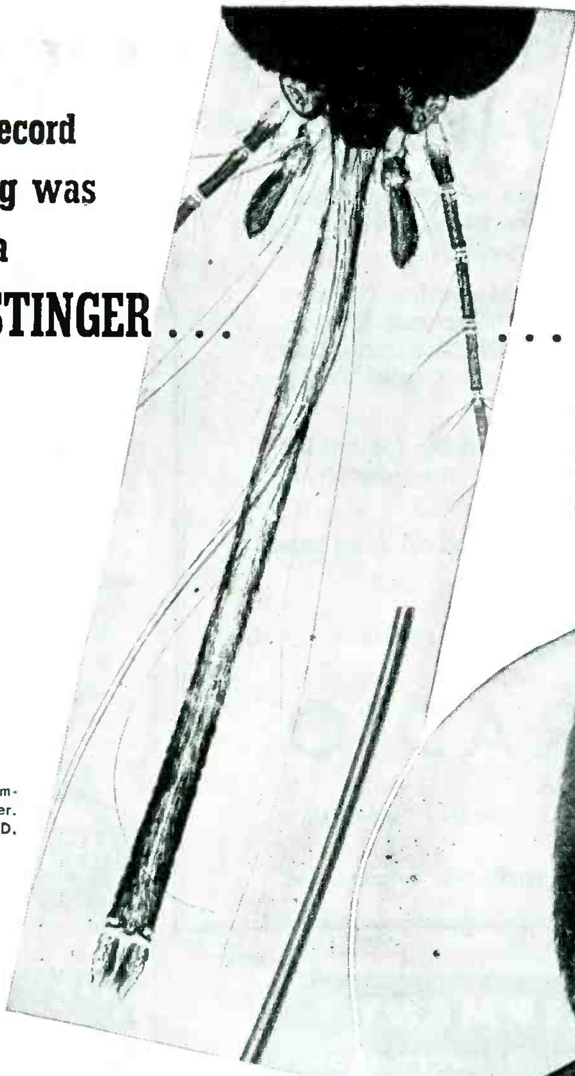
Technical Oscars

AWARDS BY THE Research Council of the Academy of Motion Picture Arts and Sciences have been announced for scientific or technical achievements during 1944. No award was made in Class I—the statuette corresponding to the familiar Oscars given to star performers.

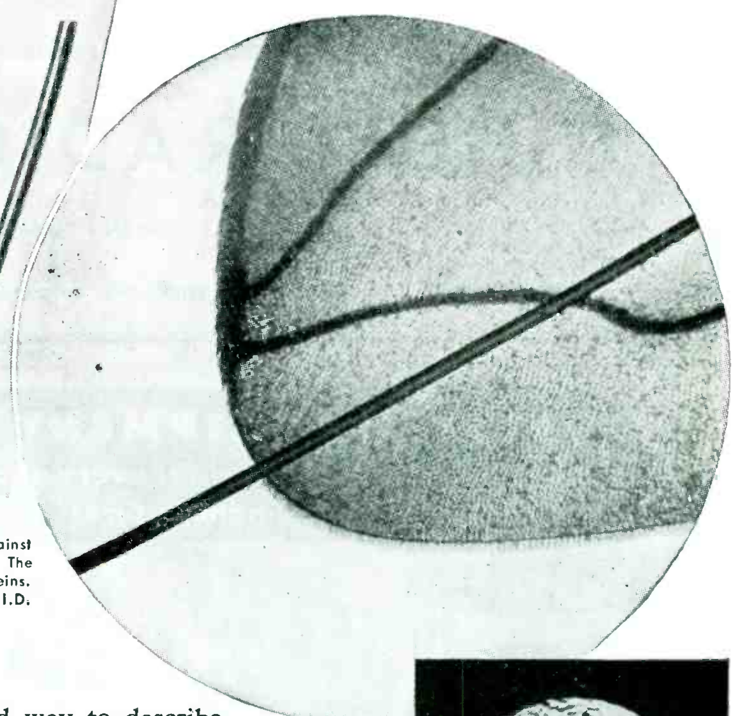
A single Class II or plaque award

It was a world's record when Nickel tubing was drawn finer than a MOSQUITO'S STINGER . . .

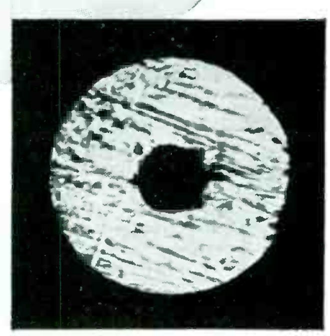
. . . but <u>now</u> . . . Nickel tubing has been drawn as fine as the VEINS in a FLY'S WING



The former record holder compared with a mosquito's stinger. 0.0019" O.D. 0.0004" I.D.



World's smallest tube against the tip of a fly's wing. The gray lines are two fine veins. 0.0014" O.D. 0.0004" I.D.



Cross-section of world's smallest metal tube. The bore is only 4 ten-thousands of an inch. *(Magnified 900X.)*

"Extremely workable!"

That's a good way to describe the INCO Nickel Alloys. For they can be produced in sizes ranging from the giant forged gate stems used at Boulder Dam down to wire smaller than human hair . . . strip one-third the thickness of this page . . . tubing as fine as the veins in a fly's wing.

The accompanying pictures amply prove this workability. Both tubes are made of pure Nickel — the metal found best for such fine drawing by the Superior Tube Company, Norristown, Pa.

The *new* world's smallest metal tube is so small that 37 piled one atop the other would only equal the thickness of a dime — and one pound would stretch more than 33 miles.

Another good way to describe the INCO family of Nickel Alloys is to call them, ***"strong, tough metals that resist heat, rust, corrosion, fatigue and wear."***

In addition to these group characteristics, the INCO Nickel Alloys also offer individual electrical properties uniquely suiting them to specific jobs in the electronic field.

You'll find properties and typical applications of these problem-solving metals interestingly described in *"Tremendous Trifles."* Your copy will be mailed on request. The International Nickel Company, Inc., 67 Wall Street, New York 5, N. Y.

NOTE: INCO Nickel Alloy tubing is drawn commercially to sizes down to 0.010" O.D. The world's smallest sizes are not yet produced commercially.

NICKEL INCO ALLOYS

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Sheet . . Strip . . Rod . . Tubing . . Wire . . Castings . . Welding Rods (Gas & Electric)

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We present a few items of equipment which our Post-War Plan proposes to release to you. These items are now being built for the U. S. Navy and other Armed Forces.

1. The original Portable Electric Megaphone*, now highly developed, for use by the Merchant Marine, yachts, airplanes, drydocks, shipyards, stadiums and outdoors arenas, construction companies, and Police and Fire Departments.

2. Our exclusive Divers Communication Equipment for use by marine salvage companies and manufacturers of diving suits.

3. Interior Communication Equipment and docking sets for all types of marine use.

Other equipment will be announced when released by the Armed Forces.

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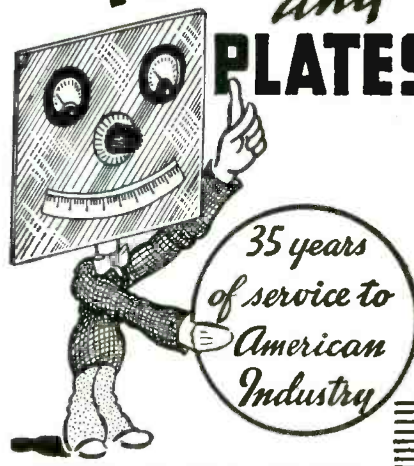
161 Sixth Avenue New York 13, N. Y.

* Patent No. 2,301,459
After the War any infringement of this patent will be prosecuted.

DIALS PANELS and PLATES



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..complete and diversified for every phase of electronic* manufacture!

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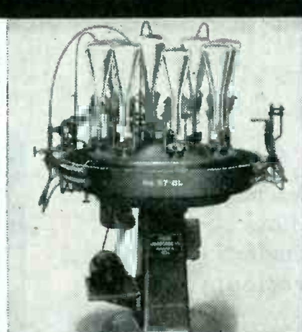
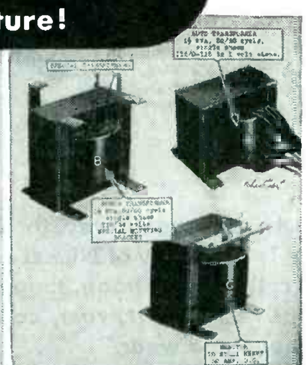


(B) No. 57-8L New Eisler 8 head type Tipless Sealing Machine. Adaptable for all types and sizes of bulbs.



(C) EISLER Special Transformers and Reactors — high or low voltage; air cooled, oil immersed or uncased.

The CHAS. EISLER line of specialized electronic tools, machines and devices is complete and diversified. Included are innumerable types of welders — spot, seam, butt, rocker, arm, pneumatic and special types. Also included are hundreds of devices for vacuum tube manufacture — glass tube cutters, slicers, stem and sealing machines as well as an all-inclusive line of transformers for every industrial and general need.

* EISLER serves 99% of American vacuum tube producers today. Write for completely illustrated catalog now—you incur no obligation.

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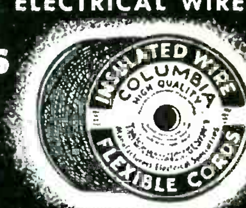
GUAGES #22 TO #12



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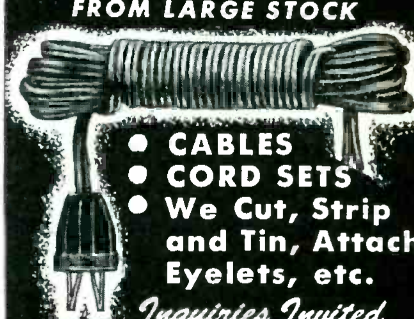

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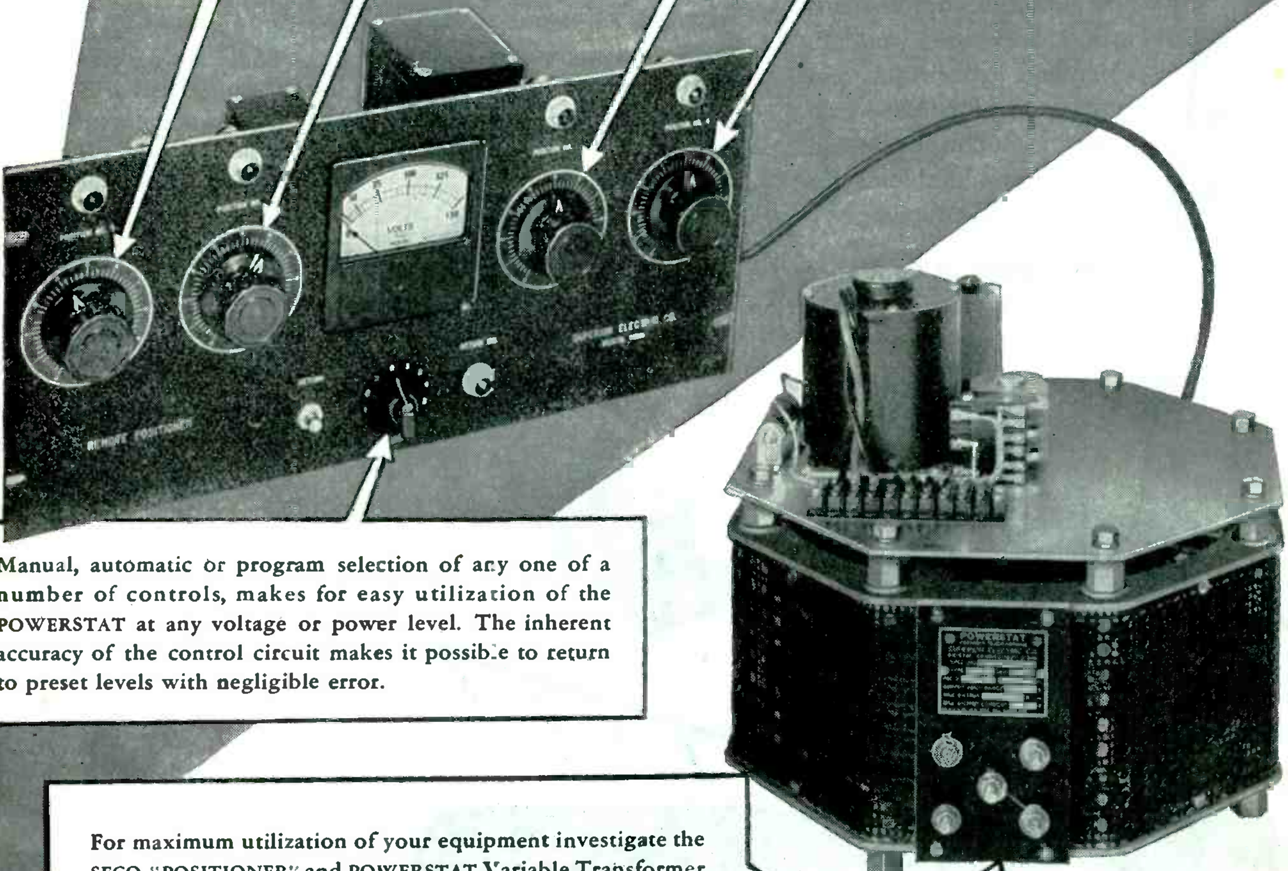
IT'S NEW

A servo-type VOLTAGE CONTROL

SECO'S "POSITIONER" will enable you to remotely and accurately set the output voltage of a POWERSTAT variable transformer. Control wires between the "POSITIONER" and the motor operated POWERSTAT serve as an "electrical flexible shaft". This type of coupling means servo operaton of the POWERSTAT variable transformer from a remotely located control dial.



Manual, automatic or program selection of any one of a number of controls, makes for easy utilization of the POWERSTAT at any voltage or power level. The inherent accuracy of the control circuit makes it possible to return to preset levels with negligible error.

For maximum utilization of your equipment investigate the SECO "POSITIONER" and POWERSTAT Variable Transformer combination for...dielectric and induction heating, infrared drying, photographic applications, and vacuum tube manufacture. Only SECO offers the motor-driven POWERSTAT Variable Transformer with SERVO control. SECO'S engineering staff will be pleased to assist with your applications.

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SUPERIOR ELECTRIC COMPANY

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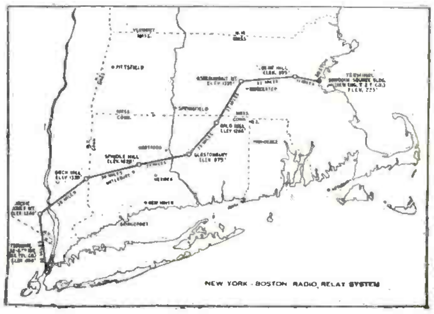
was made to Stephen Dunn and the RKO Radio Sound Department for design, and to Radio Corp. of America for additional development of the electronic compressor-limiter, a variable gain amplifier, the design of which is based on the logarithmic characteristics of hearing. Use of the compressor-limiter in a recording system is described as providing automatic control of intensity ratios and permitting the reproduction of sound, particularly speech, without exaggerated and unnatural volume surges. Intelligibility is increased.

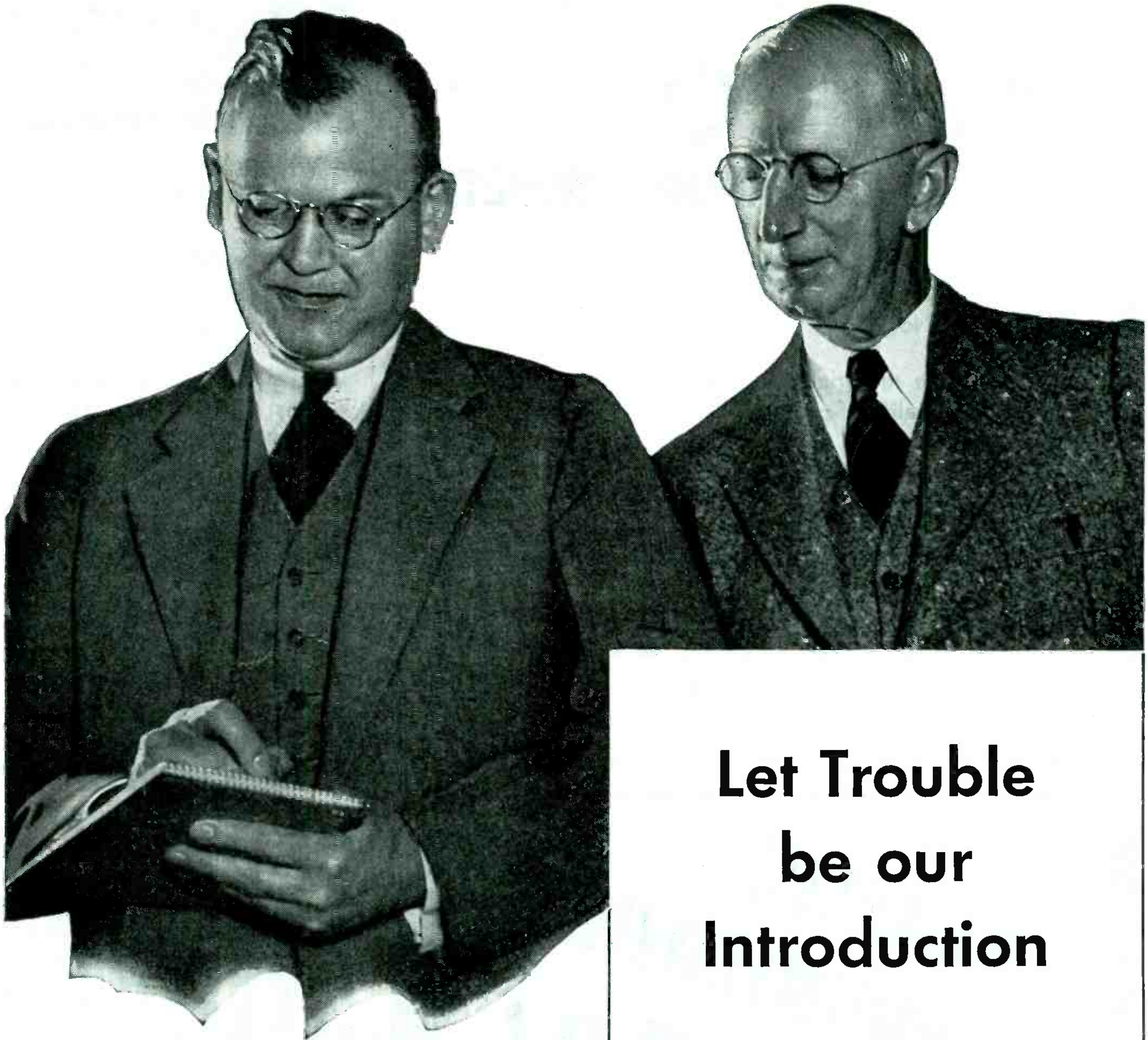
Class III Awards consist of honorable mention in the report of the Research Council. Among others, such awards were given to Western Electric Co. for the design and construction of a limiting amplifier for variable-density sound recording; to Radio Corp. of America and the RKO Radio Sound Department for design and construction of a reverberation chamber; and to Daniel J. Bloomberg and the Republic Sound Department for the design and development of a six-pole six-position switch for use in selsyn interlock systems. These eliminate the usual multiple patching plugs and cable connections which prevail throughout the industry.

Trial Radio Relay

SEVEN RELAY STATIONS between the terminals of the New York-Boston radio relay project are the subject of a new application filed with FCC by American Telephone & Telegraph Co. Purpose of the proposed trial is to determine in practical operation the relative efficiency and economy of radio relay for transmission of long distance telephone messages and also of sound and television programs, as compared with wire lines.

Sites for the relay stations shown on the accompanying map were





Let Trouble be our Introduction

THERE'S nothing like trouble to bring people together. That's how some of Revere's closest friends were gained — through a mutual struggle against difficulties, trouble such as occasionally beset any business.

Take the case of an important electronic product for war use costing several hundred dollars. Rejections were running extremely high, over 40%, costs were skyrocketing, and badly needed production was being lost. The manufacturer asked us if we would care to collaborate in solving the problem. Of course, we would. After studying the subject in detail with the manufacturer's engineers, we suggested a radical change in the properties of a non-ferrous product used in the manufacture of the vital part causing failure. New processes of manufacture were developed and in a short time test runs of the new material proved we were right. Rejections of finished units dropped to less than 1%. Thus a vexing and expensive bottleneck was broken, and we gained a new customer and a firm friend.

This success story demonstrates that Revere has an open mind as well as an informed one, and is always ready to question the customary, find new answers to new problems. If something is worrying you in your employment of non-ferrous materials in electronics, get in touch with Revere, not for ready-made answers, but for wholehearted cooperation, a joint search for better results. This help is given freely, without obligation, through the Revere Technical Advisory Service, which has at its command the knowledge and facilities of our laboratories, and the accumulated experience of the entire Revere organization. Just write the Revere Executive Offices.

REVERE

COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

Executive Offices: 230 Park Avenue, New York 17, N.Y.

Preview of Lear's next National Advertisement

Here you see the next advertisement in the Lear advertising campaign on wire recording and home radios. It is going to appear in:

Collier's, Aug. 11th • Fortune, June
Liberty, June 10th • Atlantic, June
New Yorker, May 26th
New York Times Magazine, May 6th

This means that 5,400,000 regular readers of these magazines, their families and friends, will see again the advantages of owning a Lear Home Radio with wire recording.

If you want to be able to offer Lear Radios with wire recording, write for information on the Lear Franchise.

Listen! That's your own voice you hear. Or a radio program caught and recorded straight from the air. Or maybe a program produced by your own youngsters.

It all comes from the thin wire that runs through the Lear Wire Recorder—a wire magnetically impressed with sound through an entirely new method of recording brought to its present high state in Lear laboratories.

Wire recording will be a part of Lear Home Radios. But home entertainment is only one of countless sensational applications. Think of a dictating machine with no records to break or keep shaved—and business conferences, meetings, telephone conversations kept precisely and permanently for future reference.

No one has yet begun to explore the full realm of possibilities that lie in Lear Wire Recording. But to give you a glimpse of how it works and a few of the ways it can be used, Lear has prepared a free booklet of questions and answers. Would you like one? Just drop us a line—or mail the coupon below.

LEAR RADIO

Grand Rapids 2, Michigan
Home Radio Sales: 230 E. Ohio St., Chicago 11, Illinois

LEAR, Incorporated
Home Radio Sales Division,
230 East Ohio Street, Chicago 11, Illinois.
Gentlemen:
Please send me your free booklet on Wire Recording offered in Lear national magazine advertising.

Firm Name____________________
Individual____________________
Address____________________

chosen for their elevation and facilities will be provided at the seven points to house transmitting and receiving apparatus. Field work during the coming year is expected to include building of roadways up to the hillsides to the relay station sites and similar preparatory work. Eight channel assignments are being asked—each 20 Mc wide —near 2,000, 4,000 and 12,000 Mc.

If the experimental facilities prove as satisfactory as company engineers expect, apparatus will be standardized in order that the Bell System may be prepared to install similar systems throughout the country as the need develops.

Ten Join RMA

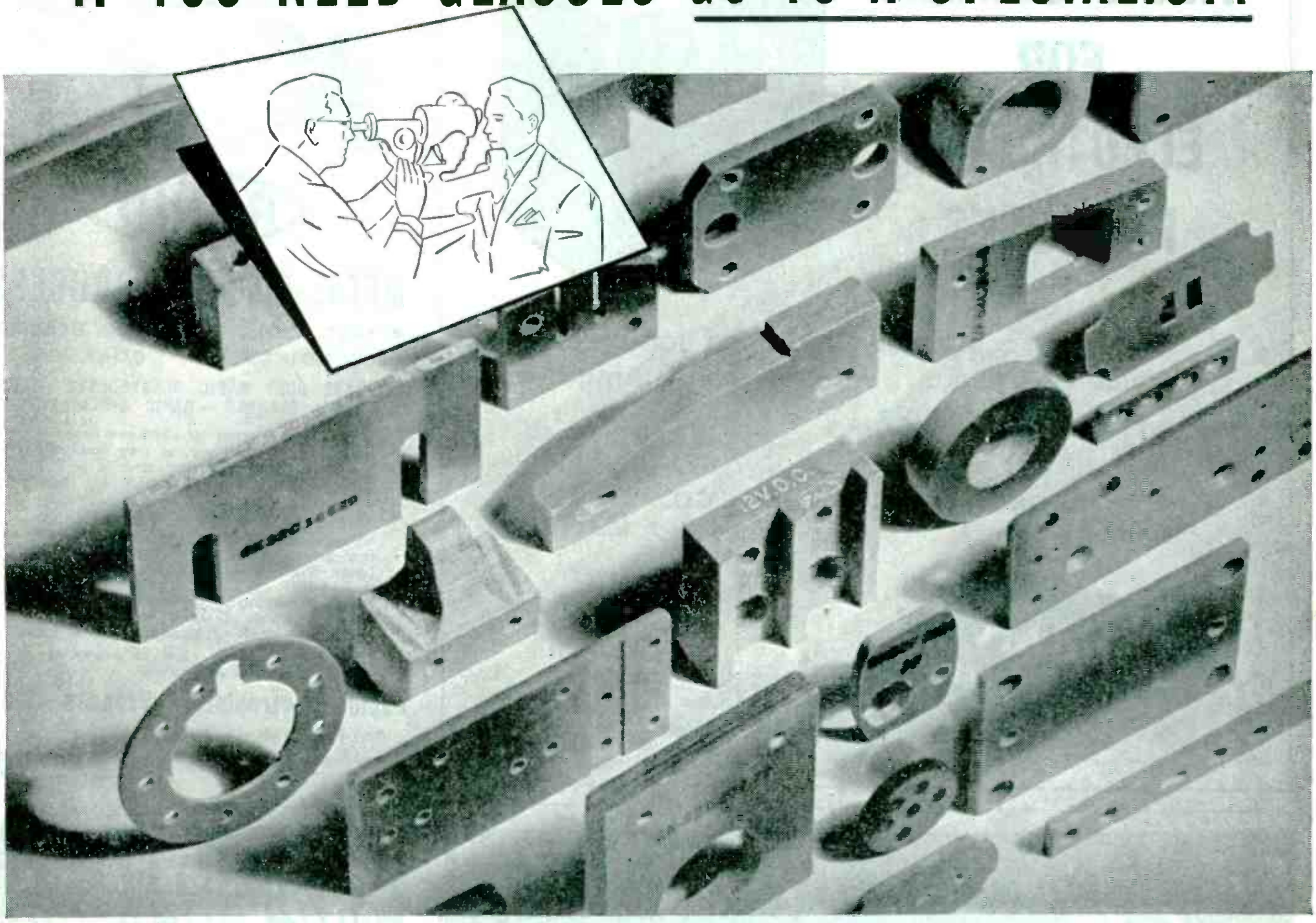
New RMA member companies include American Coil & Engineering Co., Chicago; Chicago Condenser Corp., Chicago; Electrical Reactance Corp. Franklinville, N. Y.; Jackson Industries, Chicago; Measurements Corp., Boonton, N. J.; Minerva Corp. of America, New York; J. P. Seeburg Corp., Chicago; Sherron Electronics Co., Brooklyn, N. Y.; U. S. Television Mfg. Corp., New York; and the Zell Co., New York.

NAB Grows

According to figures recently released, National Association of Broadcasters now has 654 active members and 37 associate members, or a total of 691. Active membership includes 635 a-m stations, 16 f-m stations, 1 television station, and 2 networks.

Recent activities within the association include the nomination of a number of individuals to be directors-at-large. Under each of the following classifications two directors are to be chosen: Large stations—W. H. Summerville, WWL, New Orleans, La.; J. Leonard Reinsch, WSB, Atlanta, Ga.; J. O. Maland, WHO, Des Moines, Iowa; Lee B. Wailes, KYW, Philadelphia, Pa.; Paul W. Morency, WTIC, Hartford, Conn.—Medium stations—G. Richard Shafto, WIS, Columbia, S. C.; T. A. M. Craven, WOL, Washington, D. C.; Robert E. Priebe, KRSC, Seattle, Wash.; Clarence T. Hagman, WTCN, Minneapolis, Minn.; E. E. Hill, WTAG, Worcester, Mass.; F. M. Doolittle, WDRC, Hartford, Conn.; George

IF YOU NEED GLASSES GO TO A SPECIALIST!



. . . IF YOU NEED FABRICATED PARTS

Come to Precision FABRICATORS, INC.

SPE-CIAL-LIST (-ist) n. ONE WHO DEVOTES HIMSELF TO A PARTICULAR BRANCH OF STUDY OR LABOR. Right you are, Mr. Webster! That's exactly what we have been doing for many years . . . devoting our entire facilities to the careful study and production of fabricated parts—precisely according to customer specifications. Our modern plant is geared to handle all types of jobs . . . large or small . . . simple or intricate.

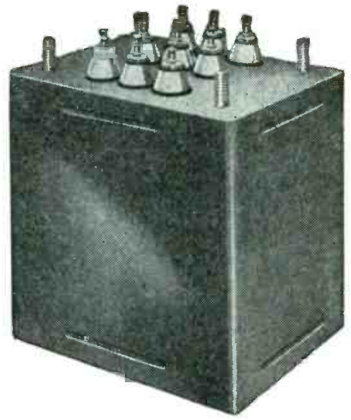
Send us the specifications for your next fabricated job and let us prove to you that we can produce it *better* . . . *faster* and more *economically!*

SPECIALISTS
IN THE
Specification Fabrication of
VULCANIZED FIBRE, CORK, CORPRENE, PHENOL FIBRE, RUBBER, ASBESTOS AND OTHER MATERIALS

Precision Fabricators, Inc.
East Rochester, N. Y.

Branch Offices:
4317 RAVENSWOOD AVENUE, CHICAGO 13
4835 WOODWARD AVENUE, DETROIT 1
1776 BROADWAY, NEW YORK CITY

TRANSFORMERS FOR ELECTRONIC PURPOSES



We are completely equipped for volume production. Write us concerning your requirements.

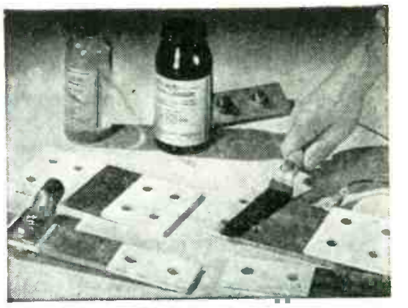
•

DONGAN ELECTRIC MFG. CO.
2977 Franklin — Detroit 7, Mich.

DONGAN TRANSFORMERS

The Dongan Line Since Nineteen-Nine

We Invite Inquiries



RAPID

METAL-COATING PROCESS

- **FAST AND ECONOMICAL**
- **FOR HEAVIER COATINGS**

REQUIRES ONLY RAPID ELECTROLYTE — RAPID METAL CLEANER — RAPID APPLICATOR

- Plating current is obtained from dry cells, storage battery, or any convenient source of direct current at 3 to 6 V., or use Rapid Plating Rectifier for heavy work.
- For silver surfacing bus bar connections, lugs, switch blades, etc. For plating or touching up miscellaneous surfaces with cadmium, nickel, zinc, copper and gold. Building up limited areas. Hard surfacing with nickel. Used in shop or field. Special applicators designed to speed up production line jobs.

Our laboratory is glad to cooperate. No obligation

Rapid Electroplating Process, Inc.
1414 S. Wabash Ave., Chicago 5, Ill.
621 Graybar Bldg. New York, N. Y. — 237 Rialto Bldg. San Francisco, Calif.

If you want

- CRYSTALS
- CABLES
- HARNESSES
- ELECTRONIC ASSEMBLIES
- CABINETS

Telephone Peru, Indiana
151

Serving the Radio and Electronic Industries with precision engineered products.

Wm.T.Wallace Mfg. Co.

General Offices: PERU, INDIANA
Cable Assembly Division: ROCHESTER, INDIANA

WIRE, RIBBON and Other Metal Products

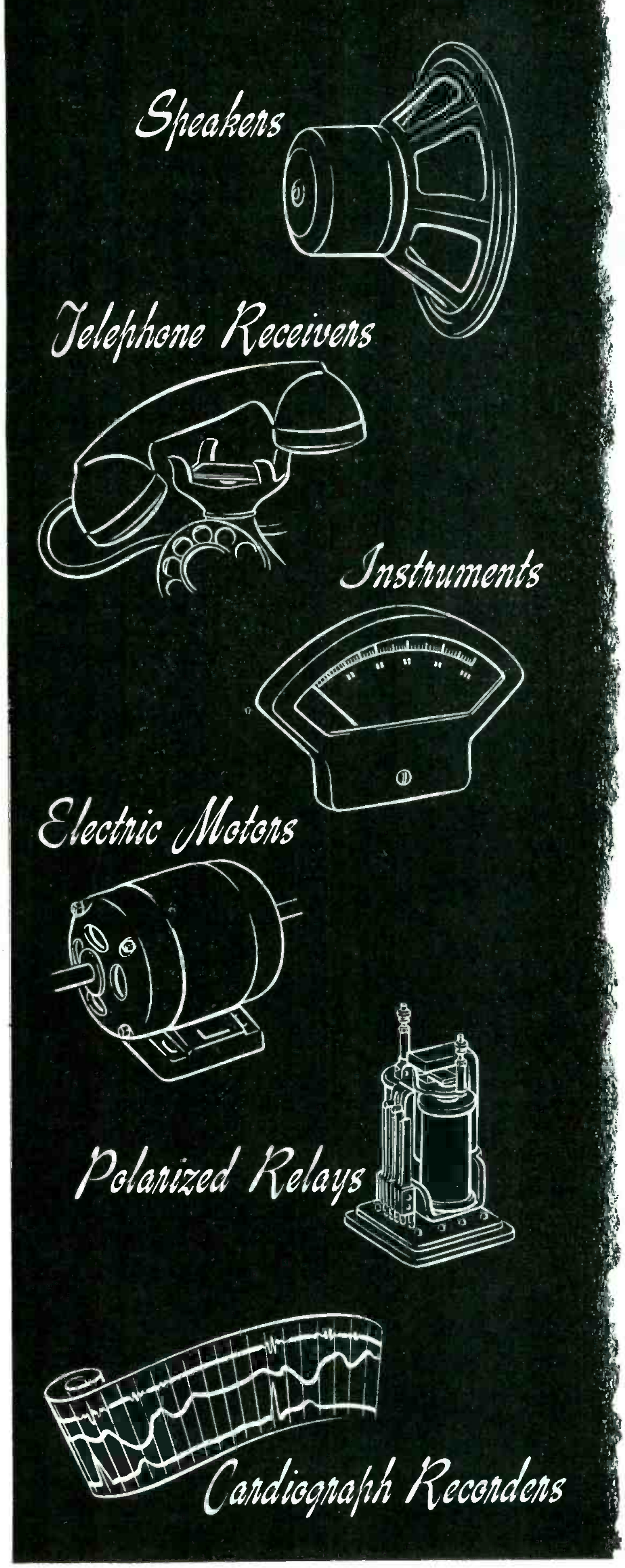
★ *Smaller than Commercial Sizes; closer than Commercial Tolerances*

An organization devoted to the research, development and production of wire and ribbon and similar products of Platinum and other Precious Metals, as well as Rare and Base Metals . . . This metallurgical plant is completely equipped with alloying, melting and working facilities for precision production. Equipment and staff permit specialization in smaller than commercial sizes and closer than commercial tolerances for the most exacting technical requirements.

SIGMUND COHN & CO. Since 1901
44 Gold Street • New York 7, N. Y.

PERMANENT MAGNETS MAY DO IT BETTER

This is the second in a series of four advertisements discussing the four major functions of permanent magnets



MECHANICAL ENERGY from ELECTRIC CURRENT through PERMANENT MAGNETS

The electric motor demonstrates how mechanical motion can be produced by the passage of an electric current with respect to a magnetic field set up by permanent magnets. Industry and science are making many profitable uses of this principle.

Mechanical energy may be transmitted to electrons moving in space to cause them to take a desired direction. A permanent magnet has been used, for example, to change the path of a cosmic ray in a cloud chamber. X-rays may be similarly directed; or the path of electrons in a magnetron tube can be changed.

The permanent magnet may be used as a polarizing agent, remaining stationary while mechanical motion is obtained by varying the magnetic field through variations in the applied electrical energy. Telephone receivers, magnetic recording heads, polarized relays, armature-type loudspeakers, and some kinds of vibrators employ this principle.

For specific applications of permanent magnets to your problems of product improvement, consult our engineers. For 35 years we have specialized in the manufacture of permanent magnets and are today the largest plant in the world in this field. Write for copy of free technical booklet: "Permanent Magnets Have Four Major Jobs."

★ **THE INDIANA STEEL PRODUCTS COMPANY** ★

6 NORTH MICHIGAN AVENUE · CHICAGO 2, ILLINOIS

Specialists in Permanent Magnets Since 1910

M. Burbach, KSD, St. Louis. Mo.—Small stations—Dietrich Dirks, KTRI, Sioux City, Iowa; Frank King, WMBR, Jacksonville, Fla.; Clair R. McCollough, WGAL, Lancaster, Pa.; Dale L. Taylor, WENY, Elmira, N. Y.; Matthew H. Bonebrake, KOCY, Oklahoma City, Okla.; and Marshall Pengra, KRNR, Roseburg, Oregon.

A special committee is working on the task of selecting a president to succeed Harold Ryan, whose term expires on July 1 and who has indicated his intention of giving up the office at that time.

Sound Reproduction Standards

AT THE REQUEST of the Armed Forces, ASA (American Standards Association) has completed a group of three standards designed to assure high fidelity in film sound reproduction.

All these standards deal with test methods for 16-mm sound motion picture prints. One, Z52.15, covers a method of making intermodulation tests on variable density prints; the second, Z52.39, describes a method of making cross-modulation tests on variable area prints; the third, Z52.38, is on a method of determining signal to noise ratio.

Each standard is divided into sections covering scope and purpose, test method, and test equipment. It is planned to specify limits of allowable sound distortion as a basis for acceptance or rejection of individual prints as soon as experience in the use of these tests is wide enough to warrant setting up definite limits.

MEETINGS TO COME

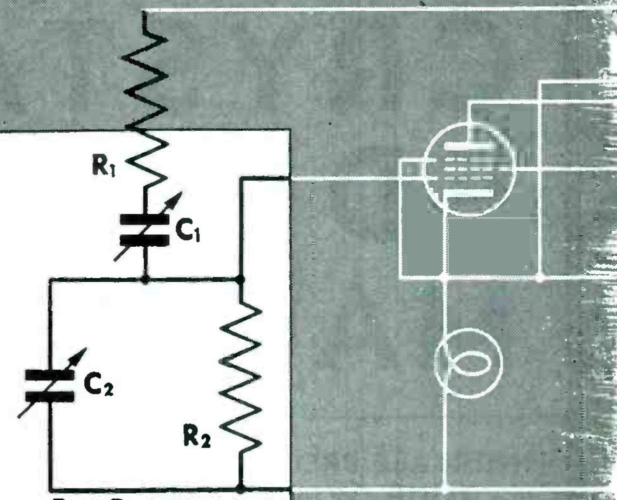
APRIL-MAY; NATIONAL ASSOCIATION OF BROADCASTERS, Annual Conference. . . . Cancelled.

MAY 2; INSTITUTE OF RADIO ENGINEERS, New York Section; Television, by P. I. Merryman, director of facilities development, NBC; Engineering Societies Building, New York, N. Y.; J. T. Cimorelli, secretary, Radio Corp. of America, Harrison, N. J.

MAY ——; SOCIETY FOR EXPERIMENTAL STRESS ANALYSIS, 1945

laboratory instruments for speed and accuracy

This fundamental circuit is the key to -hp- audio oscillator efficiency



$R_1 = R_2$
$C_1 = C_2$

$$f = \frac{1}{2\pi RC}$$

The resonant frequency of this network is inversely proportional to the product of resistance and capacity. Thus wide change in resonant frequency is practical with commercially available condensers. A decade gang switch to change resistances enables operator to cover a wide range in the easiest possible manner. This circuit is the basic reason why *-hp-* Resistance-Tuned Audio Oscillators are so easy to use.

This resistance-capacity network is operated in conjunction with a

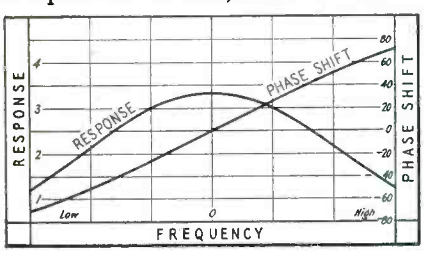


FIGURE 1

stabilized amplifier. Positive feedback is applied to this amplifier through the R-C network. The result is a very high effective "Q" for the circuit, which, combined with the phase shift characteristics of the network, provides an extremely stable output frequency. See Figure 1.

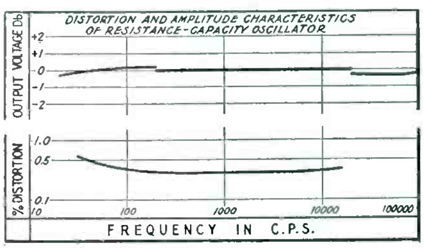
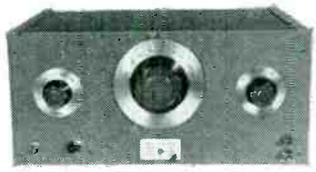


FIGURE 2

The unique balancing circuit automatically selects the proper operating point, keeps distortion at a remarkably low level, and maintains uniform output over the entire frequency spectrum. See Figure 2.

-hp- Audio Frequency Oscillators require no zero setting

It's just such engineered features as these that have made *-hp-* the outstanding laboratory instruments in the field today. Simplicity of operation . . . speed in making measurements without sacrifice of accuracy . . . that's the keynote of all *-hp-* instruments. Write for information . . . *-hp-* engineers are at your service.



-hp- Resistance-Tuned AUDIO OSCILLATORS cover a wide range

-hp- Model 200-A
Frequency range, 35 cps to 35 kc. In 3 ranges: 35 to 350 cps, 350 to 3500 cps, 3500 cps to 35 kc.

-hp- Model 200-B
Frequency range, 20 cps to 20 kc. In 3 ranges: 20 to 200 cps, 200 to 2000 cps, 2000 cps to 20 kc.

-hp- Model 200-C
Frequency range, 20 cps to 200 kc. In 4 ranges: 20 to 200 cps, 200 to 2000 cps, 2000 cps to 20 kc, 20 kc to 200 kc.

-hp- Model 200-D
Frequency range, 7 cps to 70 kc. In 4 ranges: 7 to 70 cps, 70 to 700 cps, 700 to 7000 cps, 7000 cps to 70 kc.

-hp- Model 202-D
Frequency range, 2 cps to 70 kc. The Model 202-D is similar to the Model 200-D, with the addition of a 2-50 cps band covering approximately 200 degrees on the main tuning dial.

-hp- Model 200-I
Frequency range, 6 cps to 6000 cps. In 6 ranges: 6 to 20, 20 to 60, 60 to 200, 200 to 600, 600 to 2000 and 2000 to 6000 cps.

All the above models are available in cabinets or for relay rack mounting.

HEWLETT-PACKARD COMPANY

BOX 1042A • STATION A • PALO ALTO, CALIFORNIA

Audio Frequency Oscillators · *Signal Generators* · *Vacuum Tube Voltmeters* · *Noise and Distortion Analyzers* · *Wave Analyzers* · *Frequency Meters* · *Square Wave Generators* · *Frequency Standards* · *Attenuators* · *Electronic Tachometers*

Spring Meeting, Buffalo, N. Y. W. M. Murray, president, P.O. Box 168 Central Square Station, Cambridge 39, Mass. Subject to postponement or cancellation.

MAY 3; INSTITUTE OF RADIO ENGINEERS & AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, New York Sections; Comparison of Various Modulation Methods in Higher Frequency Communication, by W. R. MacLean, Brooklyn Polytechnic Institute; Engineering Societies Building, 33 West 39 St., New York, N. Y.; tickets, G. L. Tawney, Hudson American Corp., 300 Pearl St., Brooklyn 1, N. Y.

MAY 10; INSTITUTE OF RADIO ENGINEERS & AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, New York Sections; Radiation and Propagation in Higher Frequency Communication by C. W. Hansel, RCA Laboratories; Engineering Societies Building, 33 West 39 St., New York, N. Y.; tickets, G. L. Tawney, Hudson American Corp., 300 Pearl St., Brooklyn 1, N. Y.

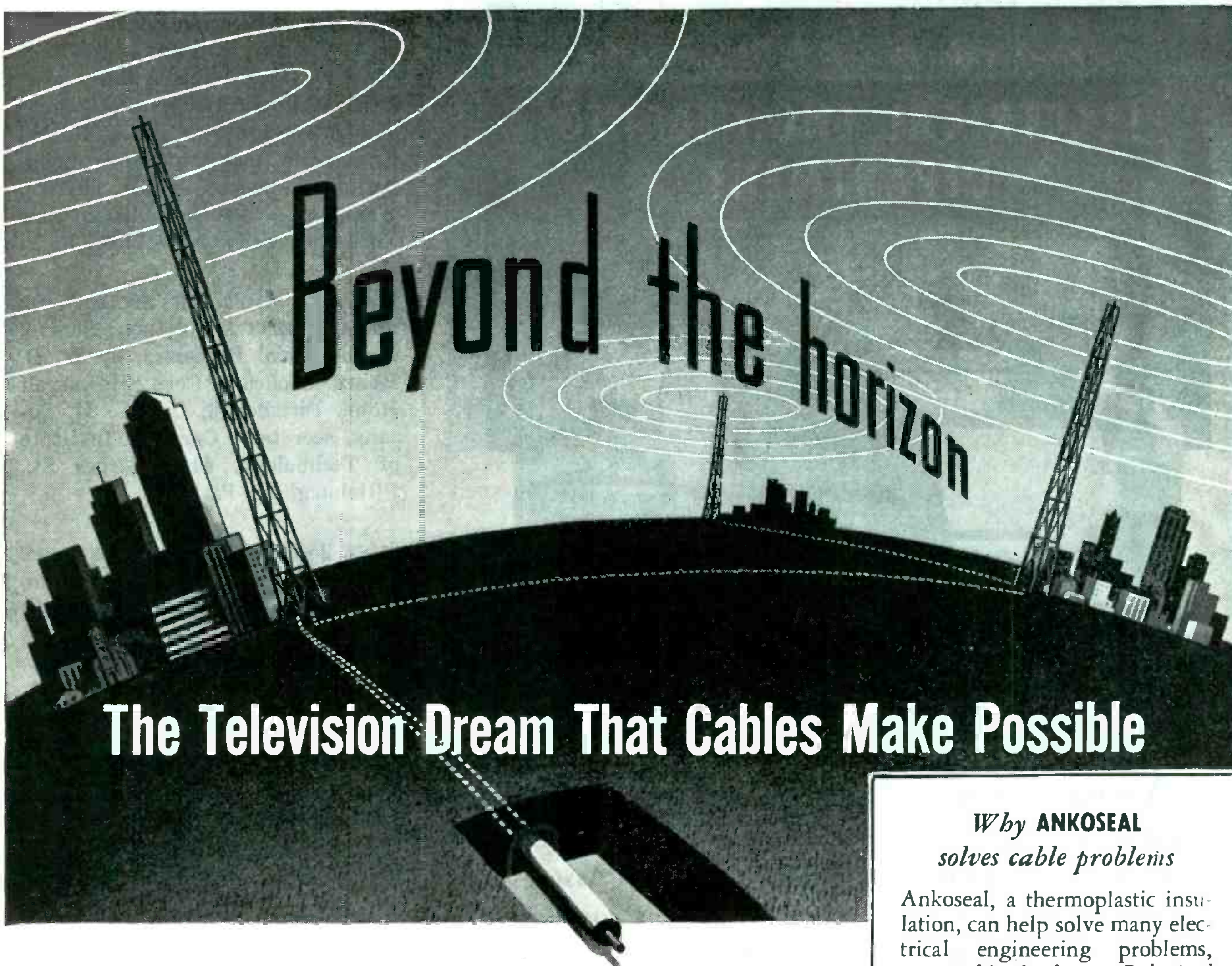
MAY 11-12; ACOUSTICAL SOCIETY OF AMERICA, Thirtieth Meeting; Hotel Pennsylvania, New York, N. Y.; Wallace Waterfall, secretary, 350 Fifth Ave., New York 1, N. Y.

MAY 14-18; SOCIETY OF MOTION PICTURE ENGINEERS, 57th Semi-Annual Technical Conference; Hollywood-Roosevelt Hotel, Hollywood, Calif; W. C. Kunzmann, convention vice president, P.O. Box 6087, Cleveland 1, Ohio.

MAY 17; INSTITUTE OF RADIO ENGINEERS & AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, New York Sections; Television Relay System, by H. B. Fancher, General Electric Co.; Engineering Societies Building, 33 West 39th St., New York, N. Y.; tickets, G. L. Tawney, Hudson American Corp., 300 Pearl St., Brooklyn 1, N. Y.

MAY 18; INSTITUTE OF RADIO ENGINEERS, Chicago Section; Current Problems in Radio Engineering and Manufacturing, by Paul Galvin, president, Galvin Mfg. Corp.; Central YMCA, 19 South LaSalle St.; Alois W. Graf, secretary, 135 South LaSalle St., Chicago 3, Ill.

MAY 23; AMERICAN INSTITUTE OF ELECTRICAL ENG'RS, N. Y. Section,



Why ANKOSEAL *solves cable problems*

Ankoseal, a thermoplastic insulation, can help solve many electrical engineering problems, now and in the future. *Polyvinyl* Ankoseal possesses notable flame-retarding and oil resisting characteristics; is highly resistant to acids, alkalies, sunlight, moisture, and most solvents. Polyethylene Ankoseal is outstanding for its low dielectric loss in high-frequency transmission. Both have many uses, particularly in the radio and audio fields. Ankoseal cables are the result of extensive laboratory research at Ansonia—the same laboratories apply engineering technique in the solution of cable problems of all types.

TELEVISION—sign and symbol of the age to come—is one of the wonders that specially designed cable transmission makes practical. For the quality and fidelity of the transmitted image depend largely on how well the cables are engineered and manufactured, from tiny cables in the broadcasting mechanism itself to the great coaxial cables linking city with city, making possible the television networks of the future.

Thus the "wireless age" as it develops will actually need more wires—and more complicated cables—to achieve its realization! And in the solution of these problems, new and more complicated cables will be required.

Today, we will undertake to engineer and manufacture the radio and audio cable requirements of any government agency or private concern in war work. Moreover, we look forward to solving many of the most difficult cable tasks in peacetime—as we have in wartime. The same laboratories, the same Yankee ingenuity that have helped to whip many of the difficulties involved in the communications requirements of our Army and Navy are prepared to function for industry—whatever the problems of today and tomorrow.

THE ANSONIA ELECTRICAL COMPANY

Specializing in "Ankoseal" a Thermoplastic Insulation

ANSONIA • CONNECTICUT

A Wholly-Owned Subsidiary of

NOMA ELECTRIC CORPORATION

GENERAL OFFICES • NEW YORK, N. Y.

—In peacetime makers of the famous Noma Lights—the greatest name in decorative lighting. Now, manufacturers of fixed mica dielectric capacitors and other radio, radar and electronic equipment.

Focusing of Electron Beams, by Dr. E. U. Condon, associate director of research, Westinghouse Electric & Mfg. Co.; Pupin Laboratory, Columbia University, New York, N. Y.; Prof. C. W. van der Merwe, symposium chairman, dept. of physics, Washington Square College, New York University, New York, N. Y.

MAY 28; AMERICAN SOCIETY FOR MEASUREMENT & CONTROL; Control of Industrial Processes, by W. B. Heinz, Cochrane Corp.; Roosevelt Hotel, Pittsburgh, Pa.; L. M. Susany, secretary, Carnegie Institute of Technology, 4400 Forbes St., Pittsburgh 13, Pa.

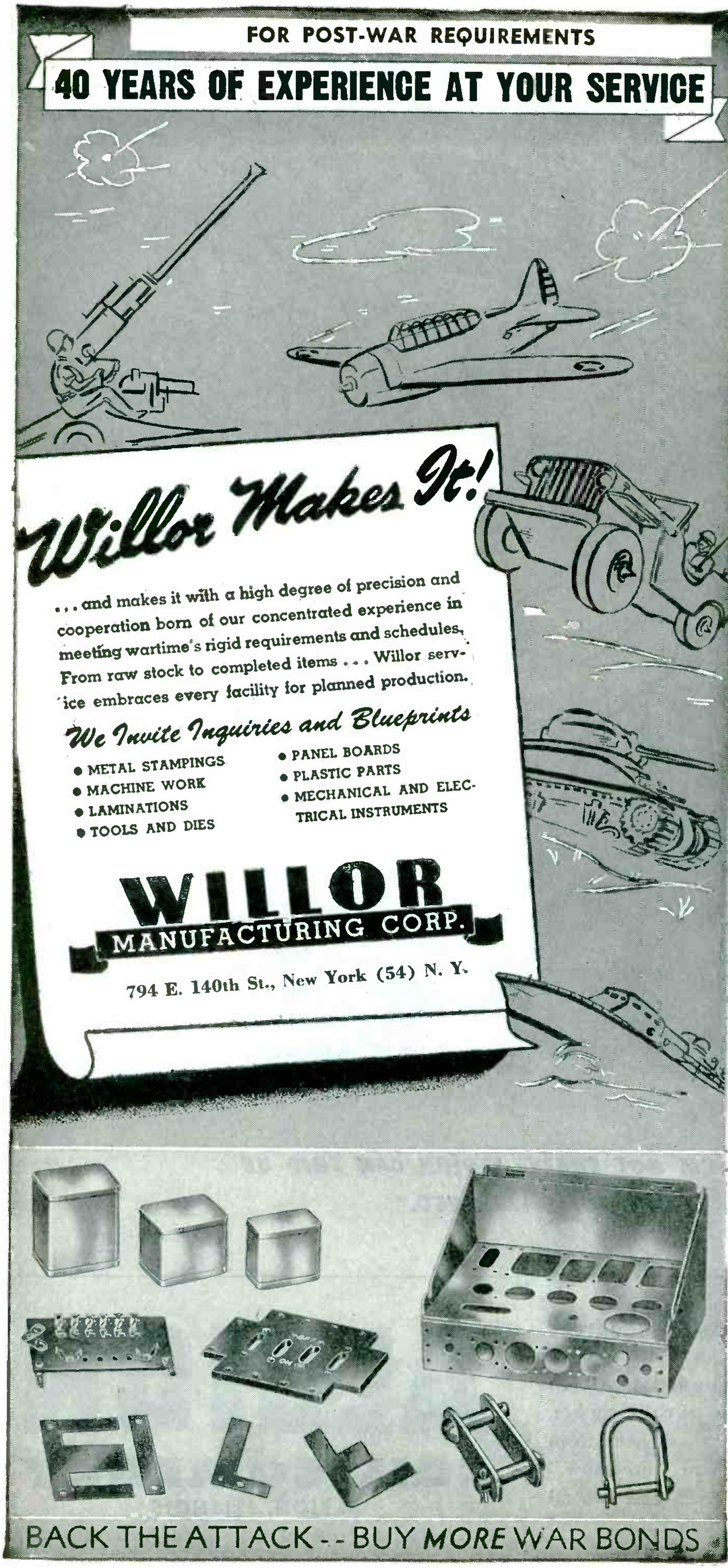
JUNE 25-29; AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, Summer Technical Meeting; Detroit, Mich.; H. H. Henline, secretary, 33 West 39 St., New York 18, N. Y. . . . Cancelled.

WASHINGTON NEWS

PRODUCTION. Looking toward a greater production effort in 1945 than was available in 1944, WPB points out that in the January and February schedules this year, communication and electronic equipment increased 10 percent. Summed up for the year 1944, actual production was $4,185,000,000, while December production was $335,000,000. As of January 1, 1945, the January schedule was $354,000,000 and the February schedule $380,000,000. It was also revealed that cumulative figures from July 1, 1940 through December, 1944 showed communication and electronic equipment standing at a total value of $9,405,000,000, with radio at $4,459,000,000 and electronic equipment at $2,827,000,000.

RETURNED MATERIEL. Under a new arrangement within the Signal Corps, supervision of all shipments of returned materiel from overseas will be handled by an organization at the Holabird (Md.) Signal Depot. Shipping instructions will be sent to every Atlantic port on all signal items which can be identified, assigning them to the different Signal Corps installations around the country. About 90 percent of all materiel is unidentified. This will be

"I TELL YOU I'M NOT CRAZY. ALBION CAN SHIP US ALL THE COILS WE NEED."



sent to Holabird where after examination it will be classified as serviceable, repairable, obsolete, excess, surplus or salvage. Serviceable materiel will be sent where needed, and obsolete apparatus will be dismantled so that parts can be used where possible. Materiel rated as salvage will be shipped to the salvage disposal division and simple repairs will be done. Materiel which can be repaired by the use of specialized equipment will be sent to various Signal Corps depots where the required equipment is available.

SURPLUS PRODUCTS. Toward the end of April, Section XI of a handbook of standards for describing surplus property was announced by Surplus Property Board. This section covers communications equipment, electronic devices, and alarm and signal control equipment. Produced to establish minimum standards for contractors and government owning agencies in describing inventories, the handbook will consist of 22 sections, 13 of which have been previously issued. In a still later section will be included instrument control apparatus, including scientific and professional equipment and supplies. Copies will be purchasable from the Superintendent of Documents, Washington, D. C.

SHORTAGES. Electron tubes still being in short supply, WPB is simultaneously trying to get all existing tubes in service and to obtain the maximum volume of new tube production. Information as to surplus radio receiving tubes is made available to manufacturers and distributors, so that any actual surplus supplies may reach dealers and service men for civilian supply. This does not mean that the civilian tube supply situation will improve materially. Rather, it is expected to remain about the same as in late 1944, approximately one and one-half million tubes a month.

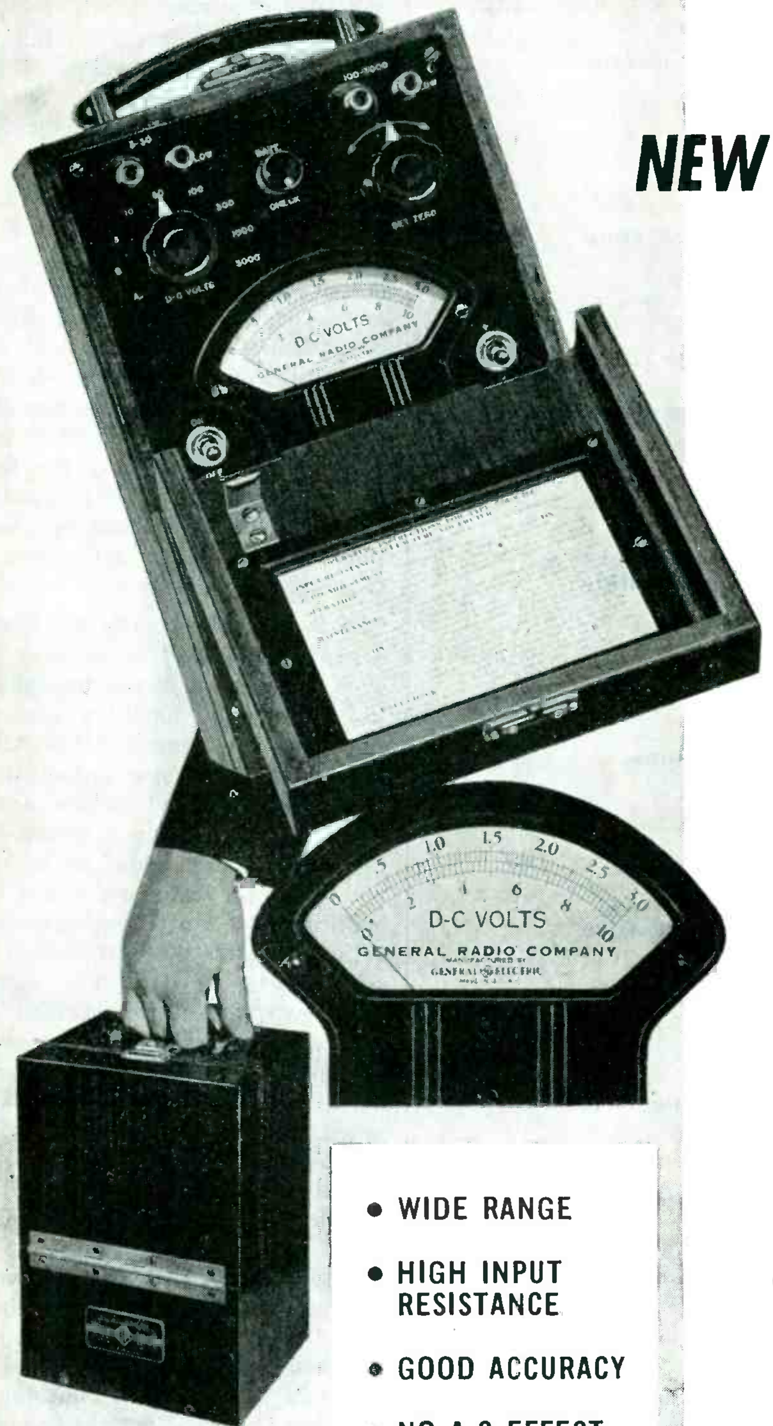
Although available production capacity is believed to be greater than military needs, transformers were reported as becoming critical again and closer control by WPB is anticipated.

Aluminum phonograph records are available only on high rated orders, remaining supplies being available only to broadcasting sta-

When You *Don't* Want to Draw Power

USE THIS

NEW D-C VACUUM-TUBE VOLTMETER



- WIDE RANGE
- HIGH INPUT RESISTANCE
- GOOD ACCURACY
- NO A-C EFFECT
- PORTABLE
- BATTERY OPERATION

HAVING the very wide d-c voltage range of 0.05 to 3,000 volts with exceptionally high input resistance, this new d-c v-t voltmeter is very useful in radio and electronic circuit design and testing.

Small, portable, lightweight, self-contained and accurate the new Type 728-A Voltmeter is especially useful when voltage measurements have to be made without drawing power from the circuit.

FEATURES

WIDE RANGE — 0.05 to 3,000 volts, in 7 full-scale values of 3, 10, 30, 100, 300, 1000 and 3000 volts, d-c

HIGH INPUT RESISTANCE — Over 5000 megohms on ranges below 100 volts; 1000 megohms above

GOOD ACCURACY — within ±3% of full-scale on low ranges to 30 volts; within ±5% on higher ranges

NEGLIGIBLE A-C EFFECT — superimposed a-c voltage up to 200 has negligible effect on meter indication

REVERSING SWITCH — switch on panel to ground either positive or negative terminal of source being measured

BATTERY OPERATED — instrument supplied complete with batteries

PORTABLE — weighs only 9¾ pounds with batteries; dimensions (length) 11 x (width) 6⅝ x (height) 5⅞ inches with cover closed

TYPE 728-A D-C VACUUM-TUBE VOLTMETER $110

At present this instrument is available only for high priority war orders; reservation orders for later deliveries are being accepted.

Write for a copy of the G-R Experimenter for December 1944 for complete description of this instrument.

ARMY E NAVY

GR

GENERAL RADIO COMPANY Cambridge 39, Massachusetts
NEW YORK CHICAGO LOS ANGELES

tions making master records, and then only when filling such orders as would not interfere with military and OWI requirements.

Workers are scarce to the tune of 10,000 in 153 radar plants which are now behind schedule. Ninety percent of these jobs can be handled by women.

RAILROAD RADIO. Mobile radio equipment allocations and lending for experimental purposes is expected to be controlled by WPB more closely than before. Small quantities of mobile equipment will be granted on a loan basis—usually 90 days—for essential experimentation which would be limited to just a few companies in any one field on the theory that other companies with parallel operations can base their future policy on results of these individual tests.

BROADCAST APPLICATIONS. Under a new policy effective January 16, 1945, FCC announces the following manner of handling applications for new standard broadcast stations or for changes in facilities:

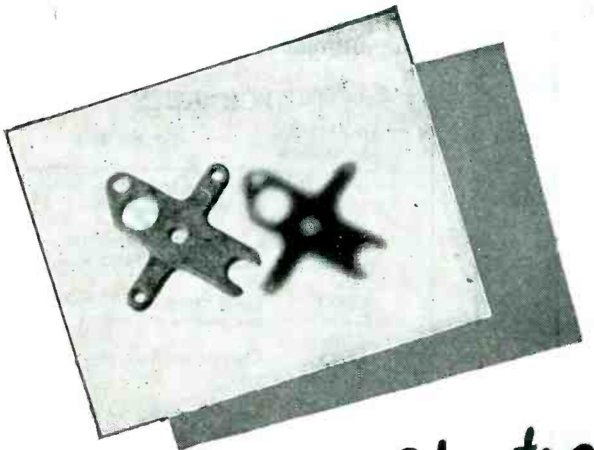
Applications filed before January 26, 1945, and upon which the Commission has taken no action, will be held in status quo unless the applicant files a petition requesting action or unless the Commission itself desires to determine issues which would require hearings regardless of material and manpower.

Applications filed before January 26, 1945, which have been designated for hearing but no hearing has been held, will be retained in status quo unless either of the alternative factors apply as indicated under the former category.

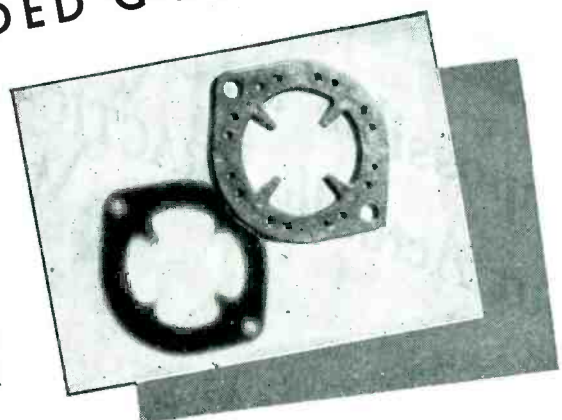
Applications filed before January 26, 1945, in which hearings have begun but the record has not yet been completed, will be finished and held in the pending file unless it appears that a grant can be made under the terms of the Commission's supplemental policy statement of Jan. 26, 1944.

Applications filed before January 26, 1945, and in which hearings have been concluded, will be decided and announced where a grant is possible under terms of the supplemental statement of policy or a denial is necessary regardless of the availability of materials and manpower.

Applications filed after January



Superior Electronic Components
WITH INJECTION MOLDED G-E MYCALEX



G-E Mycalex is doing a big job for the electronic industry. A speedy yet precision type of injection molding developed by the General Electric Company allows intricate shapes to be molded to extremely close tolerances.

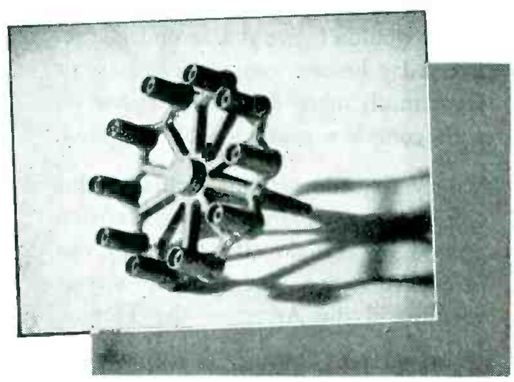
G-E Mycalex can be molded with metal inserts, and as a result, the metal and the G-E mycalex are fused into an unusually strong bond.

Having over-all electrical properties superior to porcelain products and refractory qualities superior to organic plastics, G-E mycalex remains the all-purpose, high-heat, high-frequency insulation material for use in the radio and electronic industries.

For further information write Section S-51, General Electric Company, One Plastics Avenue, Pittsfield, Mass.

G-E mycalex has the following properties:

1. High dielectric strength. 2. Low power factor. 3. Prolonged resistance to electric arcs. 4. Chemical stability; no deterioration with age. 5. Dimensional stability; freedom from warpage, shrinkage, etc. 6. Imperviousness to water, oil and gas. 7. Resistance to sudden temperature change. 8. Low co-efficient of thermal expansion.

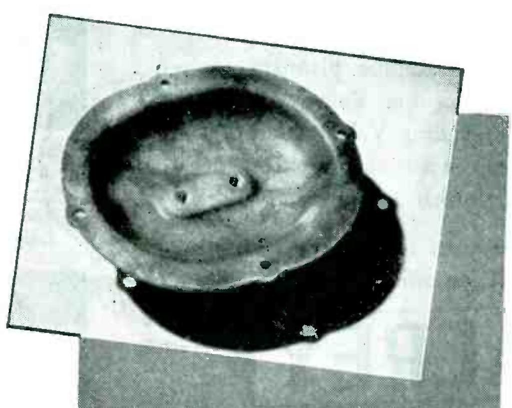


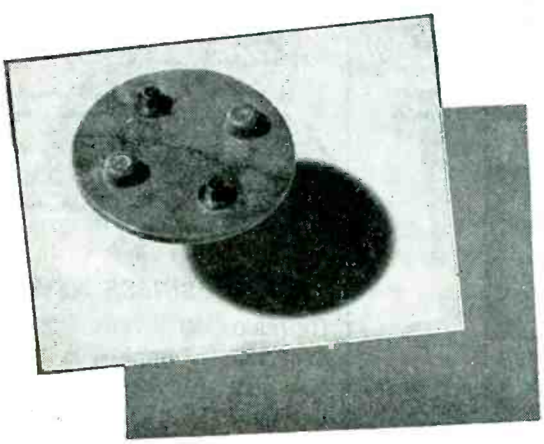
Hear the General Electric radio programs: "The G-E All-Girl Orchestra" Sunday 10 P.M. EWT, NBC. "The World Today" news every weekday 6:45 P.M. EWT, CBS. "G-E House Party" every weekday 4:00 P.M. EWT, CBS.

Buy War Bonds

GENERAL ELECTRIC

PD-51





26, 1945 will be processed and determined in accordance with the supplemental policy.

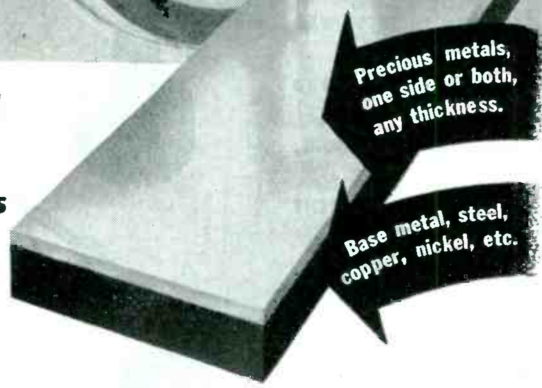
FCC ACTS

To permit this station	To do this:
KPQ Wenatchee Wash.	Change to 560 kc, Up power to 1 kw, Install new transmitter
WSCC Savannah, Ga.	Relay to WTOC on 30,820, 33,740, 35,820, and 37,980 kc with 2-w power
KRKO Everett, Wash.	Move transmitter and studio, install new antenna and ground
KFEQ St. Joseph, Mo.	Operate auxiliary transmitter
W3XO Wash., D. C.	Move transmitter for allocation and coverage studies in conjunction with W3XMB.
KCMO Kansas City, Mo.	Increase power to 5 kw contingent on later move of transmitter to protect KTBS and other points.
——— Dublin, Ga.	Construct new station on 1340 kc, 250 w unlimited time.
KOIN Portland, Ore.	Make changes in present transmitter equipment.
WJEF Grand Rapids Mich.	Operate a new station on 1230 kc, 250 w, unlimited time.
KELO Sioux Falls, S. Dak.	Operate with new antenna
WJNO West Palm Beach, Fla.	Move transmitter and studio.
WFBM Indianapolis, Ind.	Construct 1 kw auxiliary transmitter using directional antenna at night.
WNYG New York, N. Y.	Construct new relay broadcast station for 1622, 2058, 2150 and 2790 kc, 40 w.
——— Rome N. Y.	Construct new standard broadcast station to operate on 1450 kc, 250 w, unlimited time.
WEBC Duluth, Minn.	Change automatic frequency control unit of auxiliary transmitter.
WINS New York, N. Y.	Use former main transmitter as auxiliary of 1-kw power with directional antenna day and night.
WJOD Washington, D. C.	Move relay broadcast transmitter.
WEJC Washington, D. C.	Operate relay station transmitter at new location, move main transmitter, and change antenna.
WAGE Syracuse, N. Y.	Operate auxiliary transmitter with 250-w power using directional antenna at night.
WCHV Charlottesville Va.	Operate at frequency of 1240 kc.
WBKY Lexington, Ky.	Operate new non-commercial educational broadcast station on 42,900 kc, 500 w.
——— Cambridge, Mass.	Construct developmental broadcast station, frequency to be assigned, 250 w, AO, A4 and special emission for fm, unlimited time.
KONP Port Angeles, Wash.	Operate a new station at 1450 kc, 250 w, unlimited time.
WIBG Philadelphia, Pa.	Operate old transmitter as auxiliary.
WATW Ashland, Wis.	Operate at increased power of 250 w and with change in type of transmitter.
——— Sacramento, Calif.	Construct a new station to operate on 1490 kc, 250 w, unlimited time.
——— Sacramento, Calif.	Construct a new station to operate on 1340 kc, 250 w, unlimited time.

BUSINESS NEWS

General Electric Co. has paid $232,735 to employees for production-accelerating suggestions made during 1944. The total number of

Incorporate GENERAL PLATE LAMINATED METALS into your Post-War Products



If you want to be sure that your post-war products are out in front in the peace period, do as other manufacturers are doing . . . include General Plate Laminated Metals into your designs. These versatile laminated metals will give you many performance and sales advantages that cannot be obtained with solid metals. For instance, permanently bonded laminations of precious metals to base metals give solid precious metal performance at a fraction of the cost of solid precious metals. In addition, the precious metals provide better electrical conductivity or corrosion resistance and long wearing life. The base metals permit workability, ease of fabrication and strength. Don't be caught off guard in the coming sales battle, incorporate General Plate Laminated Metals into your products now. They are available in raw stock, sheet, wire or tube . . . inlaid or wholly covered or as completely fabricated assemblies. Our engineers will gladly give you every assistance in the selection of the right metal combination for your particular products. Write for their services, today.

General Plate Division OF METALS & CONTROLS CORPORATION

50 Church St., New York, N. Y.; 205 W. Wacker Drive, Chicago, Ill.; 2635 Page Drive, Altadena, California; Grant Bldg., Rm. 603, Pittsburgh, Pa.

ATTLEBORO, MASSACHUSETTS

ideas paid for was 19,488 and the record award was $2,000.

COLUMBIA BROADCASTING SYSTEM is giving a 60-week course in the operation of television studio and transmitter equipment to 175 of the network's technical employees. Divided into three sections of 20 weeks each, the course is being given by the division of general education and College of Engineering, New York University.

HYTRON CORP., Salem, Mass., has changed its name to Hytron Radio & Electronics Corp.

MCMURDO SILVER CO. is a new engineering and manufacturing concern established in Hartford, Conn. Activities will involve amateur parts, kits, and special equipment production as well as consulting engineering.

ALLEN B. DUMONT LABORATORIES, INC. has an order for the first television transmitter to be installed in Australia. The projected location is Sydney, N. S. W.

PHILHARMONIC RADIO CORP., a subsidiary of American Type Founders Inc. has been consolidated with the ATF remote control division, both at New York, N. Y. Home radio plans are being dropped.

OHMITE MFG. CO. makes an initial grant of $15,000 to Illinois Institute of Technology for establishment of a laboratory there. Activities will involve precision measurement of electrical and magnetic quantities with an ultimate goal of approaching the accuracy of the Bureau of Standards, Washington, D. C.

SONOTONE RESEARCH LABORATORIES, Elmsford, N. Y., has met the manpower shortage by the employment of large numbers of school girls from the bobby sox crowd of Westchester County.

WESTINGHOUSE ELECTRIC INTERNATIONAL CO., East Pittsburgh, Pa. is planning a Portuguese edition of *El Ingeniero Westinghouse*, the Spanish technical magazine produced for Latin America.

PHILCO CORP., Philadelphia, Pa. takes over the facilities formerly occupied by Hunter Mfg. Co. at Croydon, Pa. Utilizing approximately 200 employees, the new facil-

What's all this talk about "SMALL BUSINESS"?

There's no "small business" anymore. From now on, the main issue in this country will be *National Security* . . . and in this sense there are no more small businesses.

They are ALL Component Parts of BIG BUSINESS

National Security will increasingly come to mean spreading more and more business over more and more areas . . . with more and more qualified sub-contractors . . . thus making every community self-supporting . . . providing full employment . . . equalizing in the truest sense the distribution of our national wealth.

Business is no different from an army. The success of both depends upon the efficient integration of its component units . . . and no one unit is expected to do the entire job.

That's the lesson we've learned from the war. And the more we apply it expertly and unselfishly to our industrial problems of production, the sooner we will resolve most of the disturbing conditions that hitherto have continued to upset our economic balance.

Handling 5000 Contracts in One Year

Here at Lewyt, during 1944, we produced a great variety of component parts and assemblies of important war equipment . . . complicated electronic mechanisms that involved the use of many highly specialized skills. We successfully met the most exacting requirements of low-reject production and frictionless synchronization with other manufacturers' schedules. Our year's activities summed up to filling *5000 separate contracts for other manufacturers!*

Few plants make their entire product anymore. We have become a nation of sub-contractors. Sub-contracting has emerged from pre-war obscurity to occupy a place of dignity and ever-increasing stature in our future economy.

★ ★ ★

Write on your business stationery for 48-page book, "Let Lewyt Do It"—the story of the Lewyt organization in pictures. Lewyt Corporation, 60 Broadway, Brooklyn 11, N. Y.

ARMY E NAVY

Lewyt

A CONTRACT MANUFACTURER—EXPERTLY STAFFED TO PRODUCE COMPLETE ELECTRONIC AND MECHANICAL ASSEMBLIES, COMPONENT PARTS AND SUB-ASSEMBLIES, TO THE MOST EXACTING REQUIREMENTS

CONTINUE ☆ BUYING ☆ WAR ☆ BONDS

ities will specialize in the export packing of spare parts for radio and electronic equipment.

E. I. Du Pont de Nemours & Co. establishes an electronics group in its rayon department. Much of the activity of the group will be concerned with development of methods for control of various operations.

Hallicrafters Co., Chicago, Ill. announces an employee profit-sharing trust plan for workers with three years seniority. All payments to the fund will be made by the company.

Teckna Co. is the new name of the plastic-fabricating and product engineering concern formerly known as Teckna Plastic Co. The company is located in Bayside, L. I., N. Y.

University of Louisville establishes a non-profit Institute of Industrial Research whose purpose is to engage in engineering and scientific research for industrial and private clients on a contract basis.

Electronic Testing Laboratories Inc., Newark, N. J. has completed a program for expansion of its production facilities.

Adaptol Co. is now located in enlarged quarters at 260 Utica Ave., Brooklyn, N. Y.

James Knights Co., Sandwich, Ill., has effected a license agreement with Western Electric Co. and will manufacture electronic equipment under their patents.

Sound Apparatus Co. announces the location of new offices in the Woolworth Bldg. at 233 Broadway, New York 7, N. Y.

PERSONNEL

Frank P. Barnes, former instructor in electronic and radio engineering at the University of Washington and with General Electric Co. since 1937, is appointed district representative of the transmitter division of the company's elec-

tronics department. His headquarters will be in San Francisco.

WILBUR L. NELSON is made mechanical design engineer of The

Andrew Co., Chicago, Ill. Mr. Nelson has been with Western Electric Co.

ARDEN LEFEVRE, formerly divisional chief engineer of Stewart-Warner Corp., is appointed vice president and director of engineering of the division including instruments and radio.

DAVID C. PRINCE, vice president, General Electric Co., takes charge of the company's general engineering laboratory. Laboratory activities are being broadened to include the requirements of the entire company.

GEORGE W. OEHLSEN, JR., formerly assistant chief engineer of the radio division, becomes assistant director of engineering in Division One (instruments and radio), Stewart-Warner Corp., Chicago, Ill.

WALTER R. JONES is appointed to the newly created post of general engineering manager for radio re-

ceiving tubes by Sylvania Electric Products, Inc. Previously manager of commercial engineering, Mr. Jones has headquarters in Emporium, Pa.

KENNETH S. LUM, previously with Measurements Corp., becomes assistant chief engineer at Madison Electrical Products Corp., Madison, N. J.

F. A. HITER, senior vice president, Stewart-Warner Corp. is elected to the board of directors of RMA to

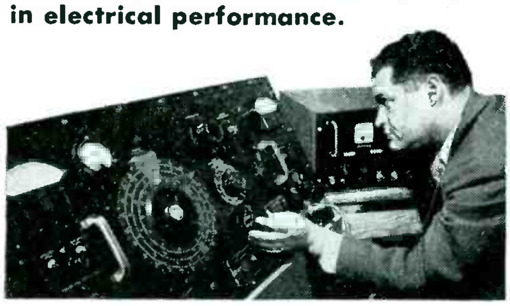
400 MICRO-MICRO WATTS (.000000000400 WATTS!)*

This figure represents the maximum limit of power radiated by the oscillator in Techrad's LRR-5 receiver!

Designed originally for use on ships operating in the combat zones, the LRR-5 low radiation receiver offers definite advantages to other services.

1. For monitoring or standby where a number of receivers are operated in close proximity.
2. For dual or triple diversity reception.

Low radiation has been accomplished in the LRR-5 receiver without compromise in electrical performance.



1. Radiation less than 400×10^{-12} watts throughout the entire range.
2. Signal-to-noise ratio at 15 micro volts is 20 db.
3. 10 watts audio output at 3% total harmonic distortion.
4. 50 to 15,000 cycle audio frequency response ± 1 db.
5. Variable selectivity.
6. Beat oscillator.
7. Coverage: 540-1600, 2.6-6.3, 6.3-18 mc.

*FCC approved

Your receiver problems will receive prompt and thoughtful attention when you consult our engineers. Write now for complete information and data.

technical radio company

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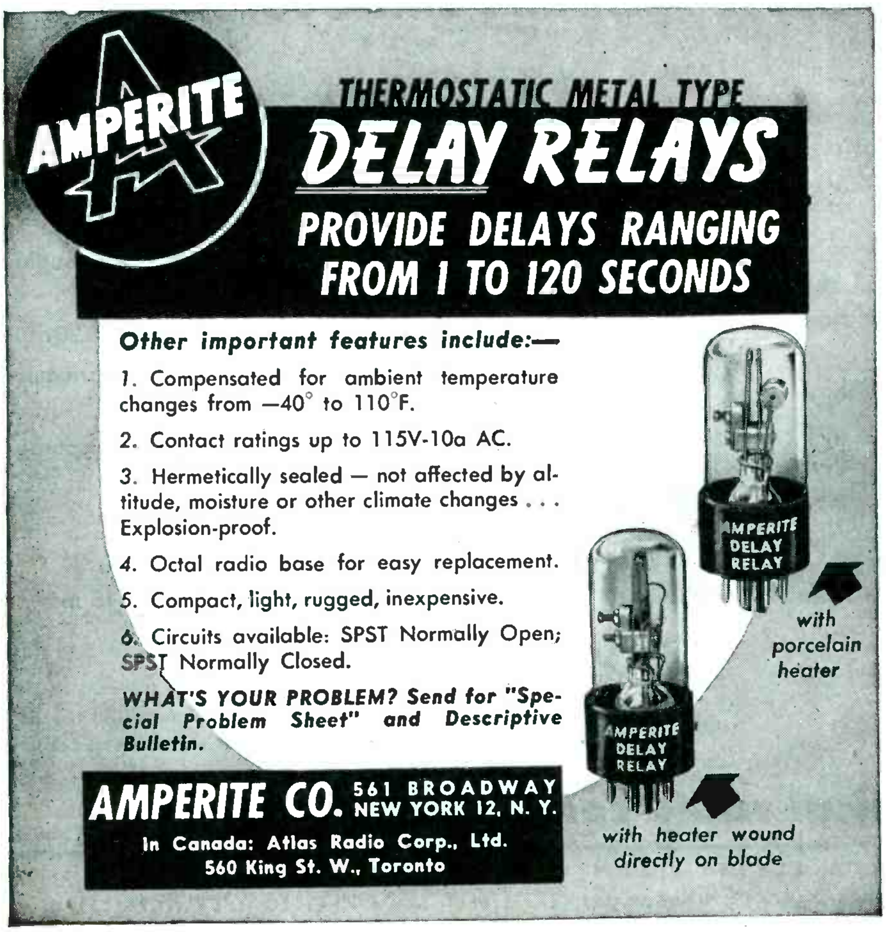
EXPORT AGENTS: FRAZAR & HANSEN, 301 CLAY STREET, SAN FRANCISCO 11, CALIFORNIA, U. S. A.

Over a decade of continuous experience



replace L. L. Kelsey, formerly with Stewart-Warner Corp. and now with the Belmont Radio Corp., Chicago, Ill.

CAMERON G. PIERCE, who has been active in radar development is district representative for Southern

California and Arizona in the transmitter division of General Electric Co.'s electronics department.

F. C. ALEXANDER joins Mackay Radio Telegraph Corp. to become executive assistant to the vice president and chief engineer. He has been in the office of the Director of Naval Communications.

AWARDS

Workers of the following concerns in the electronic field have been awarded Army-Navy burgees for excellence in production:

Belden Mfg. Co.
 Chicago, Ill.
 Richmond, Ind.

David Bogen Co.
 New York, N. Y.

Dobeckmun Co.
 Cleveland, Ohio

General Cable Corp.
 Buffalo, N. Y.
 St. Louis, Mo.

Muter Co.
 Chicago, Ill.

National Carbon Co.
 Charlotte, N. C.

Northern Radio Corp.
 Seattle, Wash.

Ohio Crankshaft Co.
 Cleveland, Ohio

Roller-Smith Div.
Realty and Industrial Corp.
 Bethlehem, Pa.

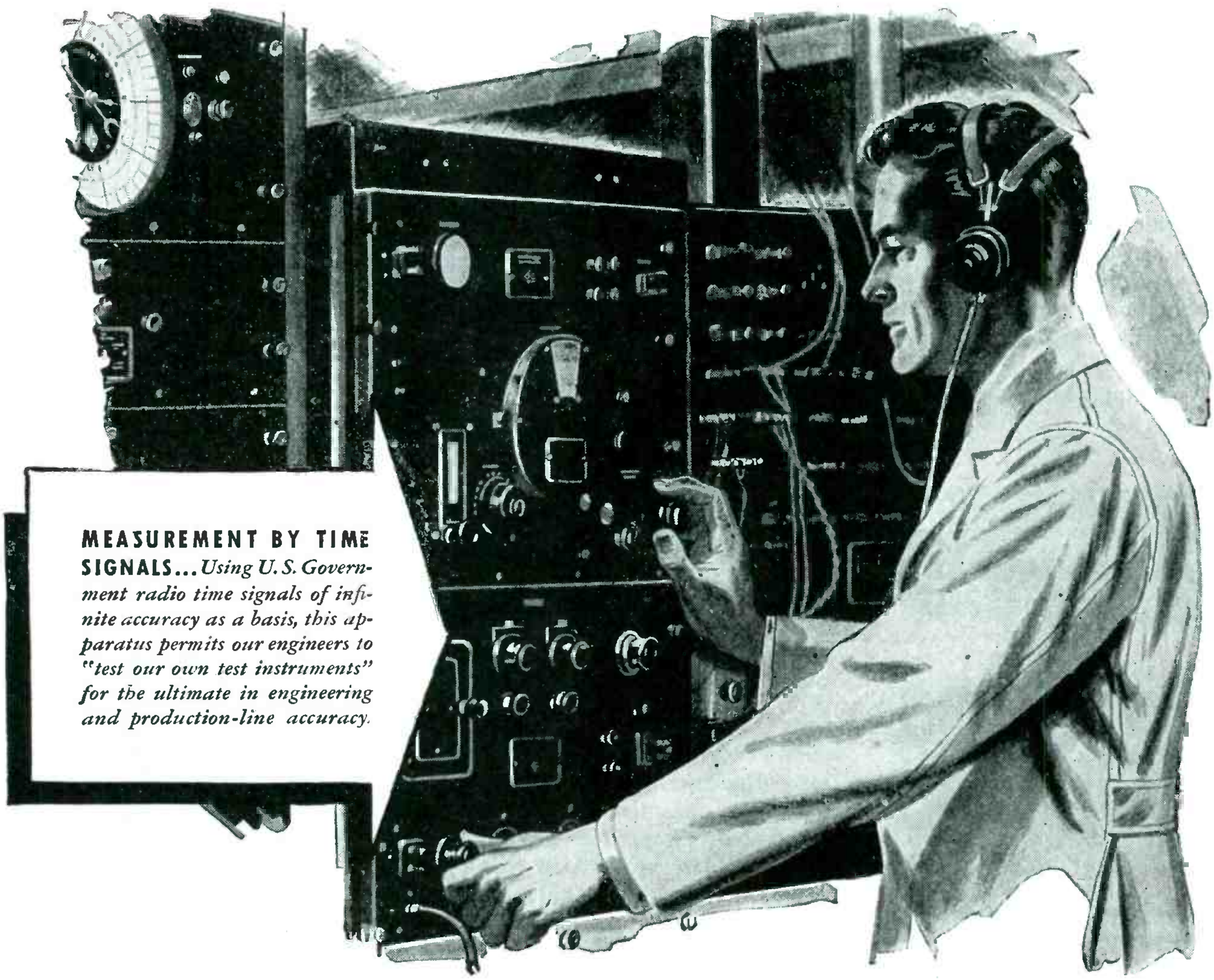
Santay Corp.
 Chicago, Ill.

Westinghouse Electric & Mfg.
 Sunbury, Pa.

WHY WE MEASURE OUR OWN "YARDSTICKS"

Complex, sensitive instruments are a commonplace not only in the engineering laboratories but on the production lines of Connecticut Telephone & Electric Division. These instruments enable us to maintain the extreme precision in telephone equipment and electronic devices called for by Signal Corps standards. So important is this high precision that we have special apparatus for measuring the accuracy of the test instruments themselves.

The result of this constant testing and retesting is *better products*... better telephones, headsets, switchboards and other devices, for our armed forces, a better, brighter future for your communicating systems, electrical and electronic equipment for tomorrow.



MEASUREMENT BY TIME SIGNALS... *Using U. S. Government radio time signals of infinite accuracy as a basis, this apparatus permits our engineers to "test our own test instruments" for the ultimate in engineering and production-line accuracy.*

CONNECTICUT TELEPHONE & ELECTRIC DIVISION

GREAT AMERICAN INDUSTRIES, INC. • MERIDEN, CONNECTICUT

TELEPHONIC SYSTEMS • SIGNALLING EQUIPMENT • ELECTRICAL EQUIPMENT • HOSPITAL AND SCHOOL COMMUNICATIONS AND SIGNALLING SYSTEMS • IGNITION SYSTEMS

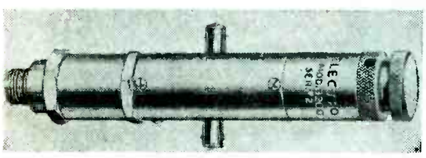
NEW PRODUCTS

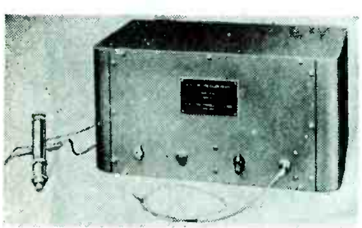
Month after month, manufacturers develop new materials, new components, new assemblies, new measuring equipment; issue new technical bulletins, and new catalogs

Pressure-Time-Curve Indicator

PRESSUREGRAPH is an electronic device which will indicate, in linear response on the screen of a cathode-ray oscillograph, the pressure-time curve of any internal combustion engine, pump, airline, or any other enclosed pressure system where pressure measurements are desired. It measures either static or dynamic pressures. It is easy to operate because only one control is necessary, and one initial adjustment to compensate temperature effects need be made.

Electro Products Laboratories, 549 West Randolph St., Chicago 6, Ill.

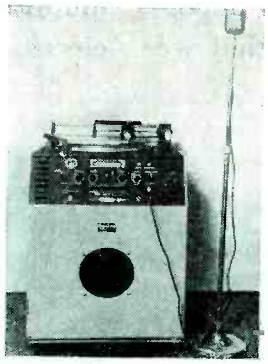


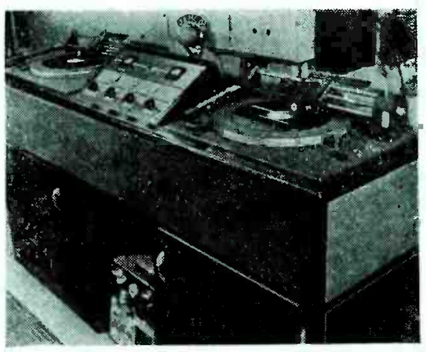


Top illustration shows pick-up section of Pressuregraph. Pickup response is transmitted, after amplification, to the screen of a cathode-ray oscillograph. Illustration below shows pickup hooked up to unit

Recording Unit

RADIOTONE is the name applied to recording equipment (for schools,





Above, the new console model described above. Below, shows Radiotone recording equipment installed at the Jack & Heintz Co., plant in Cleveland, Ohio

plants or studios) made by the Robinson-Houchin Optical Co., Columbus, Ohio. The new console model illustrated incorporates features of the manufacturer's RA-16 portable Radiotone, except that it also has an acoustic cabinet. The console consists of a recording cutter (which records speech directly or from the unit's own built-in radio); playback (instantaneous); and a PA system. The recorder operates at speeds of 78 or 33⅓ rpm, and cuts from inside or outside. The high-fidelity cutting head maintains its adjustment and has a uniform frequency response from 40 to 6000 kc. The ball-bearing, playback arm is counterbalanced, and uses a magnetic needle. Frequency range is from 30 to 7000 cps.

Other features of the equipment include: two equalizers used to vary the low-frequency response. One equalizer operates at about 100 cycles from 1 to 15 db above or below normal. The other gives constantly variable boost at around 7500 cps of from 1 to 22 db, or an attenuation of from 1 to 15 db below 5000 cps; two dual high impedance channels are provided with two separate jacks. One jack includes a preamplifier and gives an over-all gain of 115 db. The other jack skips the preamplifier tube and lowers the gain to 80 db; two volume controls, which can be operated simultaneously, and which regulate the input signal from two microphones, microphones and dubbing table, tuner and microphones, or tuner and dubbing table. One channel has a gain of 80 db and the other a gain of 115 db.

The equipment is easy to operate since all functions are regulated instantly by depressing one or more of seven different buttons.

Circuit Breaker

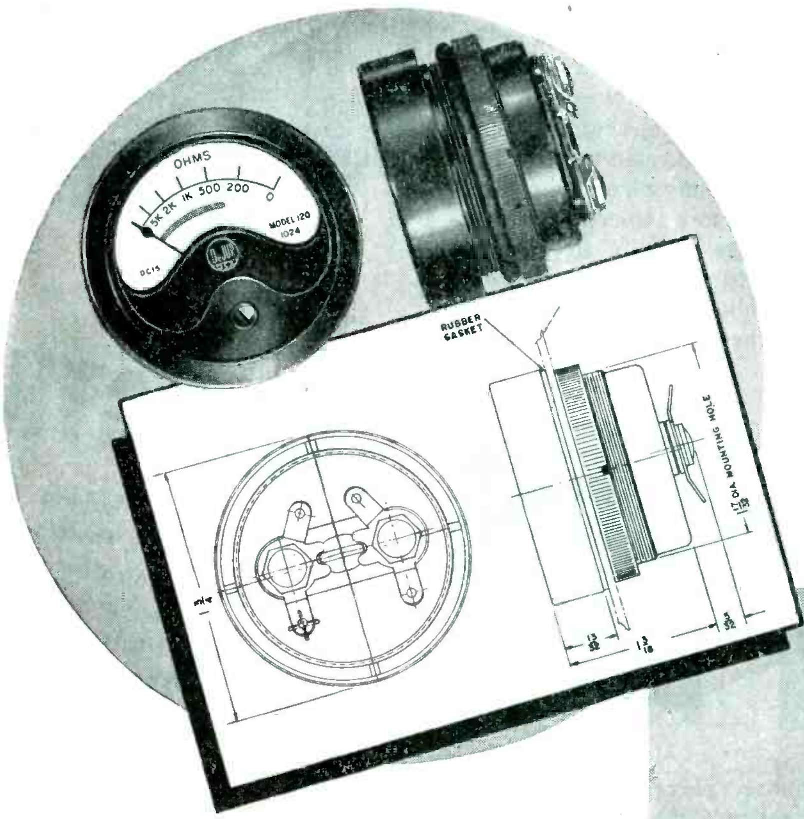
NOW IN PRODUCTION is a new and improved single-pole circuit breaker for 240 volts ac or 125 volts dc, 50 amp maximum which can be front or rear connected. Breakers have

instantaneous trip or a selection of three time delays. Overall dimensions are 5¼-in. long, 2$\frac{11}{16}$-in. high, and 1½-in. wide.

Heinemann Circuit Breaker Co., 97 Plum St., Trenton, N. J.

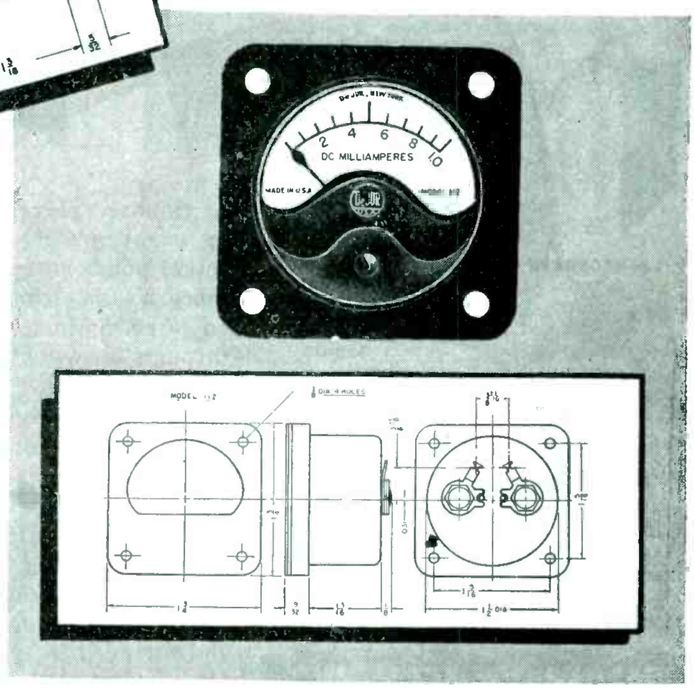
DeJUR HERMETICALLY SEALED MINIATURE 1½" METERS

Designed to aid in the development of small equipment for present or postwar applications



1½ INCH ROUND MODEL 120

The smallest meter of its kind, built with the care and precision of all DeJur larger instruments. Sealed to sustain immersion in 30 feet of water for as many as 7 days without harm to the mechanism. If the glass breaks, the meter case is designed to seal the equipment against water seepage. Terminal studs are also waterproof sealed. Another advanced construction feature is the ring mounting which makes for quick and easy installation—no mounting holes or screws necessary, just tighten on with the ring. A.S.A. type movement. Built to exacting specifications.



1½ INCH SQUARE MODEL 112

Entirely self-contained with built-in resistors and shunts. Available in wide variety of ranges. This model, too, may be immersed in 30 feet of water for 7 days without harm to the movement. In addition, it incorporates all other waterproof features of the Model 120. Though compact in size, no sacrifice has been made in quality of materials or construction details. It performs with high efficiency in a variety of applications. A.S.A. type movement. Built to exacting specifications.

Additional information supplied upon request . . . Write for the new DeJUR catalog

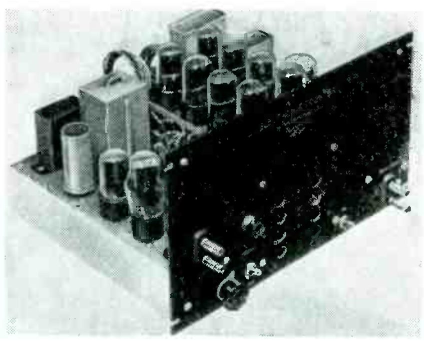
GIVE FULL SUPPORT
TO THE SEVENTH
WAR LOAN DRIVE

DeJUR AMSCO CORPORATION

GENERAL OFFICE: NORTHERN BLVD. AT 45th STREET, LONG ISLAND CITY 1, N. Y.
IN CANADA . . . ATLAS RADIO CORP. LTD., 560 KING ST. WEST · TORONTO, CANADA

Electronic Counter

A NEW TWO-DECADE counter, designed for industrial and laboratory uses, is actuated by a closing contact, sine wave, or pulse input (as from a photocell) at rates up to 1000 cps. Each decade divides by ten, giving a factor of 100. The count for 0 to 99 appears on two banks of neon lamps. A telephone-type relay is connected to the counter output and the contacts of this relay close once for each 100 input cycles. Contacts are connected to an output terminal. Conventional electro-mechanical countters may be connected to extend the count to as many places as desired. One of the more important applications of the unit is in counting rates exceeding 10 cycles a second. Other applications include: installations where long and high speed



continuous operation is necessary; in counting and calibrating the actual number of cycles that resistance welding timers apply; or as an interval timer by connecting it through a switch to a known external frequency (such as a 60-cycle line). When the switch is closed and opened, the instrument will count the number of cycles of the known frequency that have passed in the closed-switch time interval, giving a reading in terms of the number of cycles of the known frequency. The equipment is sturdy and intended for rigorous and long use. Operation is from a 60-cycle, 105- to 125-volt line. Weight of the unit is 25 lb.

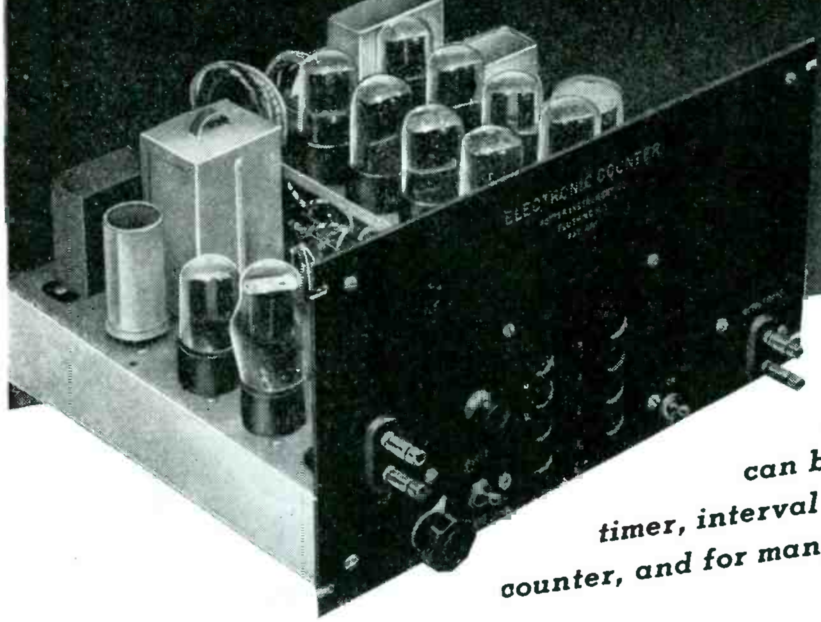
Potter Instrument Co., 136-56 Roosevelt Ave., Flushing, N. Y.

Rectifier Tube

TYPE 3B27 is a high voltage rectifier tube of rugged construction

A "FIRST" FOR INDUSTRY AND LABORATORY

Potter



TWO-DECADE ELECTRONIC COUNTER

An instrument that can be used as a counter, timer, interval controller, radiation counter, and for many other applications.

This new high speed counter eliminates many of the handicaps of commonly used counting methods. Operating at speeds up to 1000 cycles a second, each decade divides by 10, giving a scaling factor of 100. A telephone-type relay, whose contacts close once for each 100 input cycles, is connected to output terminals. An electro-magnetic counter may be added to this output to extend the count to as many places as desired. The Two-Decade Electronic Counter is useful for counting rates exceeding 10 cycles a second, generally too fast for conventional counters. It may also be used to replace conventional counters that may not stand up under continuous high speed operation. Another use for this instrument is counting and calibration of cycles in resistance welding operations. It may also be used as an interval timer by connecting it through a switch to a known external frequency. Readings are observed in terms of the number of cycles of the known input frequency. The unit can be supplied with switches making it predetermining and useful in control applications.

The Two-Decade Electronic Counter operates from a 60 cycle, 105 to 125 volt line. It uses 11 tubes.

Other counter products are—COUNTER CHRONOGRAPHS for measuring projectile velocities to accuracies of one part in 10,000; **PRECISION TACHOMETERS** that measure engine r.p.m. to a fraction of a revolution; **INTERVAL GENERATORS** that generate a predetermined time interval from 10 microseconds to 10 seconds in 999,999 steps of 10 microseconds; **RADIATION COUNTERS** which resolve repetition rates of well over 0.5 microseconds.

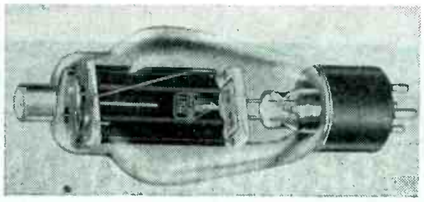
Equipment built to order only on a high priority.

INSTRUMENT Potter COMPANY

ELECTRONIC COUNTER PRODUCTS...

136-56 ROOSEVELT AVENUE FLUSHING, NEW YORK

BUY MORE . . HOLD MORE . . WAR BONDS



and suitable for industrial and mobile transmitter use. The tube is a high vacuum type. Ratings are: Peak inverse voltage 8,500; peak plate current 0.6 amp; average plate current 0.150 amp; filament draws 5.0 amp at 2.5 volts; four tubes in full bridge deliver 5415 d-c volts to a filter with 6000 volts total input; base is medium 4-pin bayonet type.

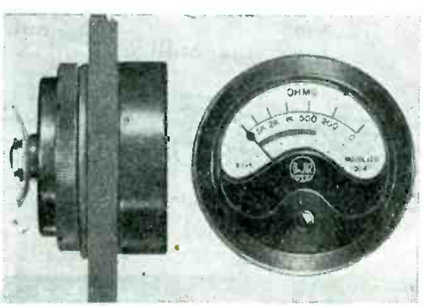
Electronic Enterprises, Inc., 65-67 Seventh Ave., Newark 4, N. J.

Method of Silver-Coating Quartz Crystals

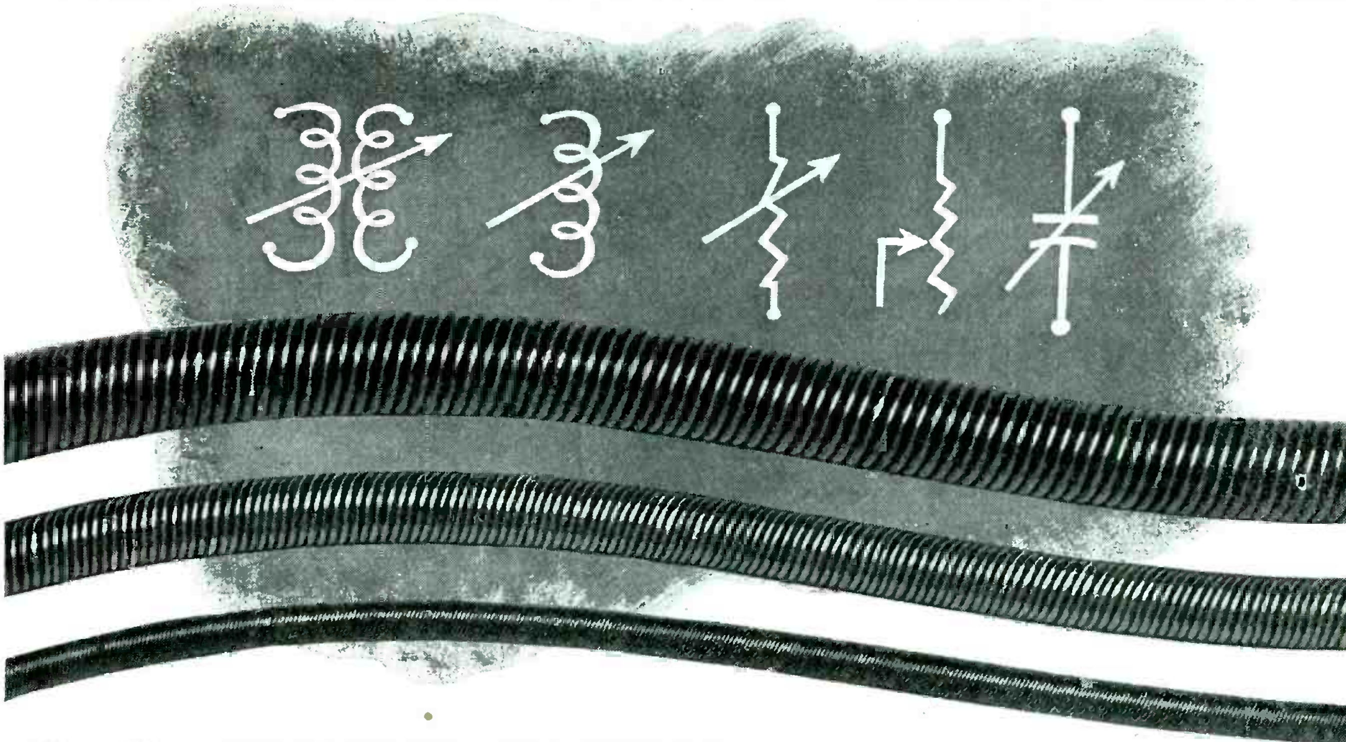
THIS NEW PROCESS is patented and is available to quartz crystal manufacturers for use in their own plants under license agreements. It is a method of applying a thin conductive silver coating to quartz crystals. The coating is applied simply by dipping the crystals in a series of solutions. It is easy to do and can be done by inexperienced operators. The only equipment required is a few photographer's trays, and clips to hold the crystals. Several hundred crystals may be coated simultaneously. Write Metaplast Co., 205 West 19 St., New York 11, N. Y.

Hermetically-Sealed Meter

TO MEASURE resistance there is available a hermetically-sealed, ring-mounted meter (Model 120) which is built to ASA specifications and which measures 1½ in. The manufacturer states the meter can be immersed in 30-ft of water for as many as 7 days without damage to its mechanism. Terminal studs



WHEN CIRCUITS CONTAIN THESE SYMBOLS



S. S. WHITE FLEXIBLE SHAFTS
merit your consideration

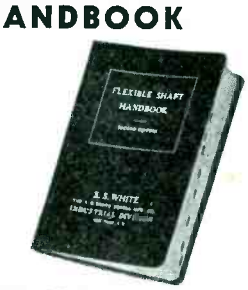
Here's why S. S. White flexible shafts merit consideration when you design electronic equipment containing elements that require operational adjustments.

These shafts provide a simple means of operating the various elements from remote points that functions as smoothly and sensitively as a direct connection. This gives you unrestricted freedom in placing the elements. You can put them where you want them for optimum circuit efficiency, easy assembly, ready wiring, space saving, convenient servicing. And at the same time you can centralize the controls in the most desirable spot.

With a single S. S. White shaft you can hook up any two points, regardless of curves, congestion or distance. And this goes for power driving as well as for remote control.

THIS 256-PAGE FLEXIBLE SHAFT HANDBOOK

will give you full information and engineering data about flexible shafts and how to apply them. A free copy will be sent to you, if you will write for it direct to us on your business letterhead and indicate your position.



S.S.WHITE INDUSTRIAL DIVISION

THE S. S. WHITE DENTAL MFG. CO.

DEPT. E, 10 EAST 40th ST., NEW YORK 16, N. Y.

FLEXIBLE SHAFTS · AIRCRAFT ACCESSORIES · MOLDED PLASTICS · MOLDED RESISTORS · FLEXIBLE SHAFT TOOLS

One of America's AAAA Industrial Enterprises

BACK THE INVASION—BUY MORE BONDS NOW!

are waterproofed and therefore the equipment remains waterproof even if the glass is broken. The unit is available in a wide variety of ranges (including microammeter or microvoltmeter specifications), for mounting on any thickness panel between 1/16 and 1/4 in, steel or bakelite.

DeJur-Amsco Corp., Northern Blvd. and 45 St., Long Island City, N. Y.

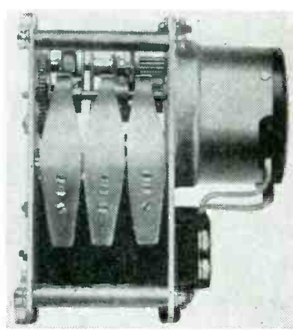
Plating Process and Machine

RECENTLY ANNOUNCED is the development of a new process and machine for high-speed plating of silver and gold on radar wire and parts with uniform specification deposits. The machine for handling wire can take wire measuring 0.0025 in. up to light cable, and is not limited to gold and silver but can handle any plateable metal. Patents have been applied for.

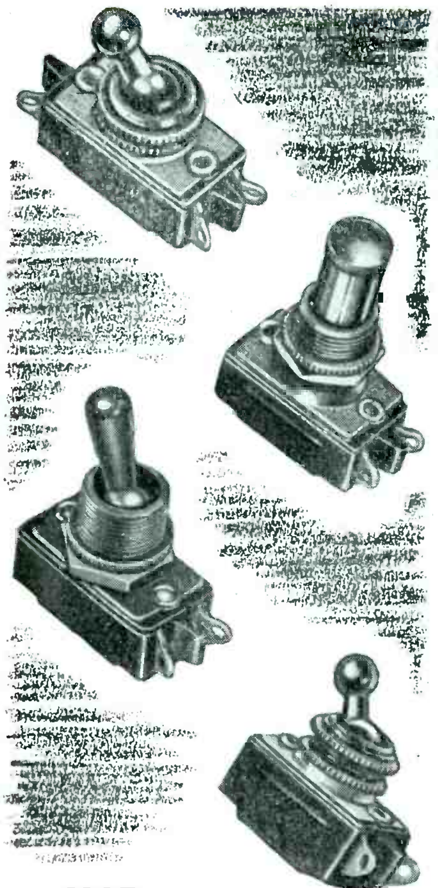
Inquiries should be directed to Joseph B. Kushner, Metal Finishing Engineer, 233 West 26th St., New York 1, N. Y.

Time Delay Relays

ALTHOUGH ORIGINALLY designed for airborne transmitter equipment, these Type MCR, motor-operated, time delay relays are available for



industrial applications for both a-c and d-c operations. Overall dimensions are approximately 2 9/16 x 3 13/16 x 3 3/16 in. Maximum time ranges are 25 or 50 sec, 2.5, 5.0, or 10.0 min. Minimum time settings are 1.25, 2.5, 7.5, 15.0 or 30.0 sec. Switching units are fully enclosed SPDT with quick, double-make, double-break contacts rated at 10 amp on either 24-volt dc, or 110-volt ac. One switch unit is used to provide an independent load circuit, the second switch is used for the motor con-

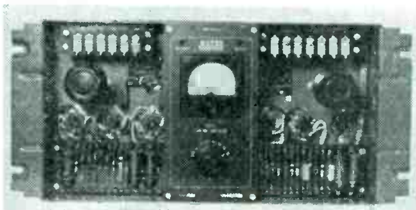


trol and is set to cut out the motor circuit at the end of the shaft travel. A third switch for a second load circuit can be provided. Motors are permanent-magnet types.

Bulletin No. 3100 describes these units. The R. W. Cramer Co., Inc., Centerbrook, Conn.

Limiting Amplifier

A 70-DB GAIN limiter amplifier eliminates thumping and monkey chatter in radio broadcasting and other sound-reproduction applications. Limiting is controlled from a pre-equalized voltage. Total input attenuation is 30 db in 1 db steps. The unit provides ten to one compression beyond the limiting points; permits a 5 to 6 db limiting action without being apparent; permits

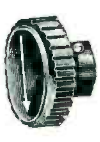


limiting of up to 15 to 20 db without distortion; provides a safety factor in high-power radio and PA nstallations; and effectively reduces over-modulation without distortion. Frequency characteristic rating is plus or minus 1 db over a range of from 20 to 20,000 cycles. The unit is for relay-rack mounting.

Altec Lansing Corp., 1210 Taft Bldg., Hollywood 28, Calif.

Instrument Knob

FOR COMMUNICATION equipment there is available a knob constructed of smooth-finished bakelite with pointer arrow on front. It comes



complete with a $\frac{1}{4}$-in brass insert and set screw. It measures $1\frac{3}{4}$ overall diameter, and $\frac{5}{8}$-in over-all height. List price 35 cents each. General Cement Mfg. Co., Rockford, Ill.

IDEAS + ENGINEERING

The ideas that will permit the successful development of your electrical equipment requiring the use of metallic rectifiers have perhaps already been developed by B-L engineers.

The Benwood Linze Company has pioneered in developing the application of dry plate metallic rectifiers wherever Direct Current is required from an Alternating Current source. The B-L Research Laboratories, established since 1921, have become an internationally recognized source for information in this specialized field.

Dry plate metallic rectifiers are an important electrical specialty. Many prominent, successful engineers—men who understand intimately most phases of electricity—have today, simply through unfamiliarity, only a limited knowledge of the wide variety of possible applications for rectifiers.

B-L engineering experience—in the development, research and designing of equipment for the conversion of AC to DC—is available to your technical staffs as an aid in meeting their production requirements.

We invite your inquiries—address Dept. A.

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Long Distance Telephone CEntral 5830

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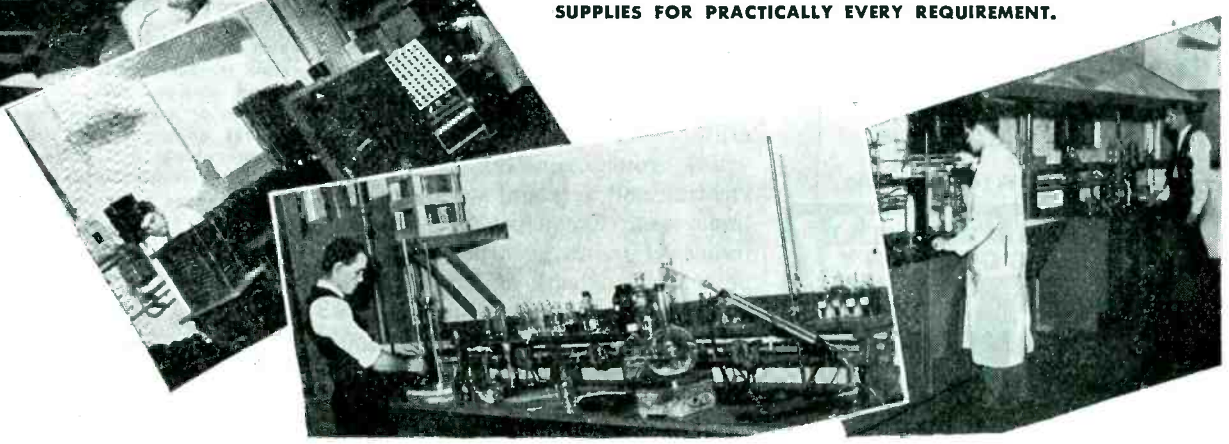
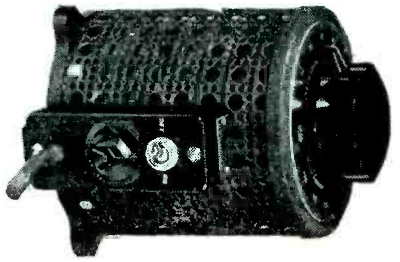
New York Sales Office:	Chicago Sales Office:
Murray Hill 5-5878	Telephone CENtral 2379
420 Lexington Ave.	20 N. Wacker Drive
New York 17, N. Y.	Chicago 6, Illinois

DESIGNERS AND MANUFACTURERS OF SELENIUM AND COPPER SULPHIDE RECTIFIERS, BATTERY CHARGERS, AND D. C. POWER SUPPLIES FOR PRACTICALLY EVERY REQUIREMENT.



Voltage Control Units

FOR VOLTAGE CONTROL of small power applications, Powerstats (No. 116 and No. 216) have been added to this manufacturer's standard line of compact, lightweight and ruggedly constructed variable transformers in the 1-kva range. An extra large aluminum brush heat radiator is combined in these new units with a new type of brush pressure adjustment spring to assure a small brush temperature rise and to lessen damage from sudden overloads. Both units have a total weight of 9 lb, including a protective screening and a totally-enclosed terminal box with input cord and plug, an outlet, and an "on-off" switch. Uncased models (designated as U types) are available for rear panel mounting. Powerstat 116 operates on a single phase 115-volt input to deliver a variable output voltage from zero to 135 volts with 7.5 amp available at any brush position. Model 216 has twice the voltage rating and a current rating of 3.0 amp. By mounting single units in tandem, different voltage and current ratings can be obtained. Circuit diagrams are contained in Bulletin No. 116 available from Superior Electric Co., Bristol, Conn.



Indicating Instrument

A NEW FREQUENCY meter and elapsed time meter comes in one case to save panel space and weight. It is for use on engine-driven generator sets and other equipment where proper operating speeds, lubricating and overhaul schedules are important. Frequency or speed is indicated to an accuracy of ±0.3 percent by a bank of 5 reeds calibrated in single cycle steps from 58 to 62 cycles. The running time meter is driven by a synchronous motor, and indicates elapsed time

MAKE YOUR RADIO A CLOCK AND ALARM, TOO

Here are dramatic new sales features for your post-war, low-priced bedside radio . . . it becomes a *clock* and an *alarm* when you add the Telechron C-40 electric radio switch clock. Installation cost is low. Operation is simple. Just pre-select the time with a single control knob—the C-40 turns on the program automatically and acts as a pleasant awakener.

The new Telechron C-40 electric radio switch clock will be available for panel mounting, with dial and hands styled to your special needs. Telechron accuracy, long life and dependability give you extra selling points. For full details, write or wire Industrial Sales Division, Dept. K, Warren Telechron Company, Ashland, Mass.

Telechron

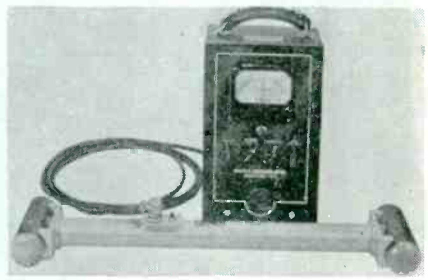
REG. U. S. PAT. OFF.

in hours and tenths. Designated as Model 31-FE, this meter operates on 110 volts, and is also available for 48 to 52 cycles and in half cycle steps for 59 to 61 cycles and 49 to 51 cycles, with accuracy of ±0.2 percent. Other ranges are under development.

J-B-T Instruments, Inc., New Haven, Conn.

Indicating Unit

ILLUSTRATED is an indicating unit, designated as Gradientometer, which quickly locates magnetic fields as in aircraft inspection, lost tools, underground piping, in searching for conduits, etc. The unit differs from the manufacturer's Magnetometer because it



requires no leveling. It cancels out uniform magnetic fields, such as the earth's field, and is designed primarily to locate magnetic gradients. By pressing a button it is converted into a Magnetometer and may be used to measure the strength of magnetic fields.

Waugh Laboratories, 420 Lexington Ave., New York 17, N. Y.

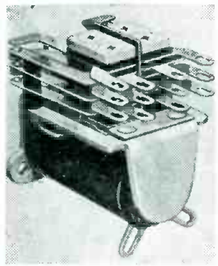
Gas Purifiers

THREE PALLADIUM catalyst chambers known as Duexo gas purifiers have been used successfully by the Vacuum Tube Div. of Federal Telephone & Radio Corp. (Clifton, N. J.) to remove hydrogen from nitrogen and to remove oxygen from hydrogen as part of a test of the new units developed by Baker & Company as a means to reduce costs and to save time in plants requiring pure gases.

Relays

WEIGHING $1\frac{3}{4}$ oz, Type 23000 signal and communication relays (meeting Signal Corps requirements for humidity, salt spray, and fungus) are

for use in airborn radio transmitters or for applications requiring relays that withstand vibration, humidity and temperature ex-



tremes. Units are available with 6 normally open contacts or in arrangements of normally open and normally closed contacts. Contacts are rated 3 amp, d-c non-inductive. The magnet coil bobbin is of a high-impact type. These relays are also available with heavy duty contacts rated at 10 amp, 28 volts d-c non-inductive.

R-B-M Mfg. Co., Logansport, Ind.

Hermetically-Sealed Resistors

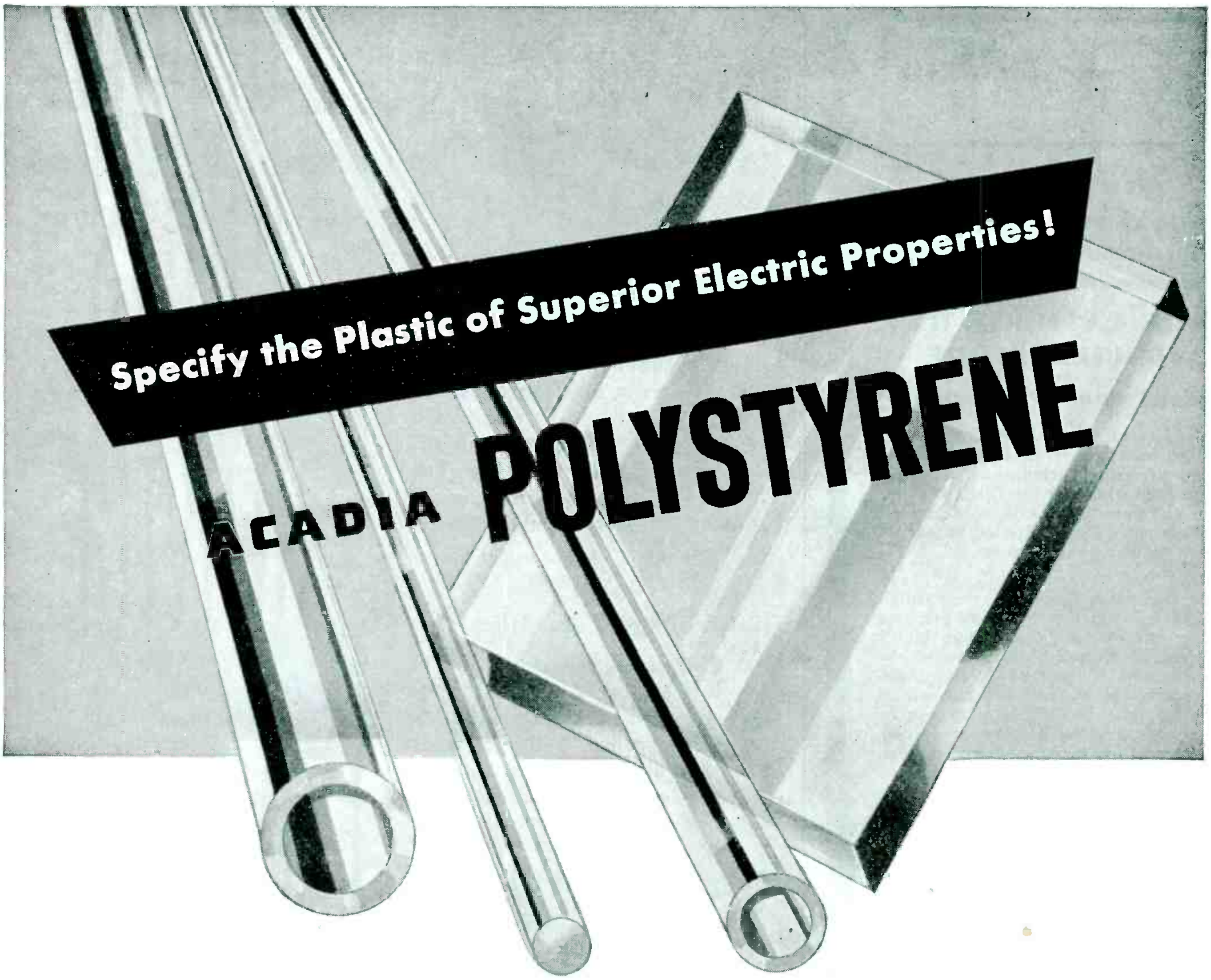
No. 1100 SERIES is a new type of hermetically-sealed, accurate-fixed, wire-wound resistor impervious to moisture, fungus, vibration, and rough handling. They are constructed without glass, or stud-

locked resistance elements, ferrule terminals or caps. The Series is available in two designs and in all resistance values from 1000 ohms to 10 megohms.

Shallcross Mfg. Co., Collingdale, Pa.

Evaporator

NOT ALL THE possible applications of Model C evaporator have been explored, but one application in the field of electronics is its use to evaporate silver on the surface of quartz plates in such a manner that wires may actually be soldered to the coating. Another adaptation of the unit is in the production of mirrors by evaporating metals such as alum-



• For any electrical application, Acadia Polystyrene is the outstanding plastic in the field. Combining highly desirable electrical properties, Acadia Polystyrene offers dielectric strength and power factor superior to any other commercial plastic, and comparing favorably with mica and ceramics.

Compression molded sheets of Acadia Polystyrene have properties superior to sheets fabricated by other methods—no shrinkage at normal temperatures—better heat resistance.

Consider also these additional values: zero water absorption; relative freedom from adverse effects by acids, alkalies, alcohol, stack gases, weather, etc.; an excellent dielectric constant value, and high tensile strength of 3500 to 5000 lbs. per sq. in. Add to these Acadia's wide experience in the plastics field, and you have the reasons why Acadia Polystyrene merits your investigation.

Complete details are available on request—for quick reference some of Polystyrene's outstanding values are given here:

Dielectric Constant	2.5 to 2.6 at frequencies 10^6
Power Factor, 60 cycles	.0001 to .0003
10^3 cycles	.0001 to .0003
10^6 cycles	.0001 to .0008
Dielectric Strength, Volts/Mil 1/8" thickness	
Short time	500 to 700
Step by Step	450 to 600
Volume Resistivity, ohms-cms	10^{17} to 10^{19}
Heat Resistance	150°F to 250°F
Softening Point	190°F to 250°F
Specific Gravity	1.05

Acadan "B"

Flexible at —100°F and has many of the electrical properties of Polystyrene. Ideal for numerous electrical applications. Write for information on forms now available, and data on physical and electrical properties.

Write Today

Send for complete data giving physical properties of Acadia Polystyrene, plus a table of specifications on its electrical properties.

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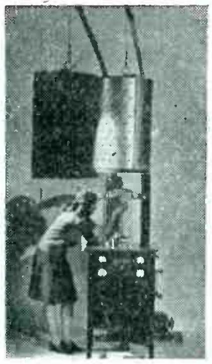
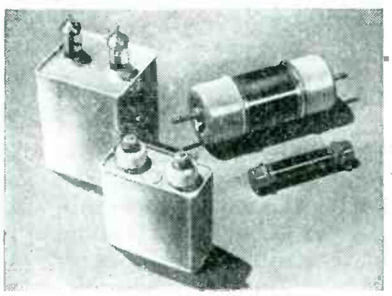


inum, chromium, silver, gold and rhodium on the surface of glass. Many applications of evaporated films on both conductors and dielectrics are being studied by The Vacuum Engineering Division of National Research Corp., Boston 15, Mass.

High-Voltage Capacitors

TYPE 25-P capacitors are for use in high temperatures, and high voltage applications. A special oil-impregnation, called Vitamin Q is used. Standard types include hermetically-sealed, rectangular metal container capacitors in styles for

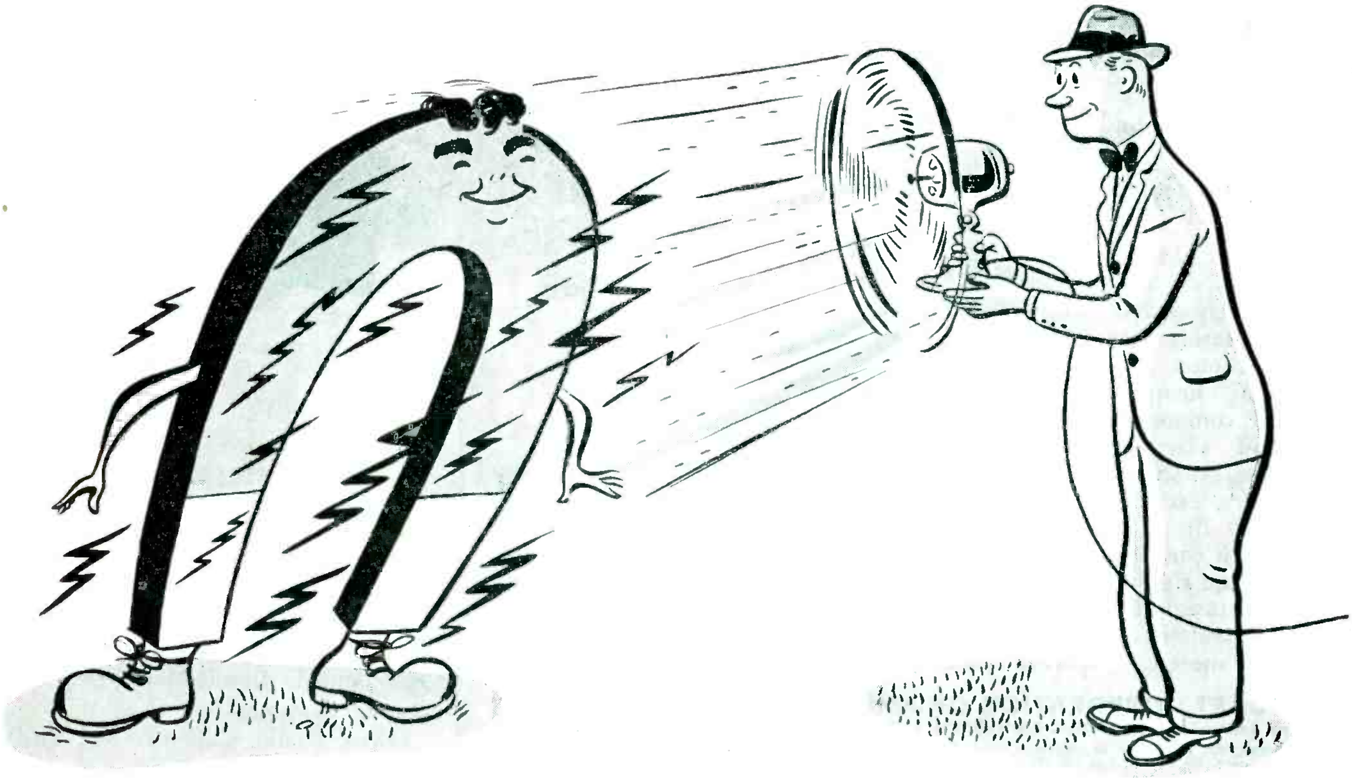


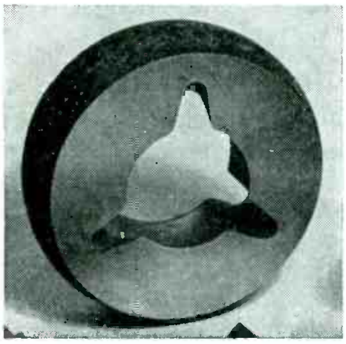
95 deg C and 106 deg C, continuous operation, and in d-c rated voltages ranging from 1000 to 16,000. Other types include 45-P hermetically sealed in glass shells with metal end caps.

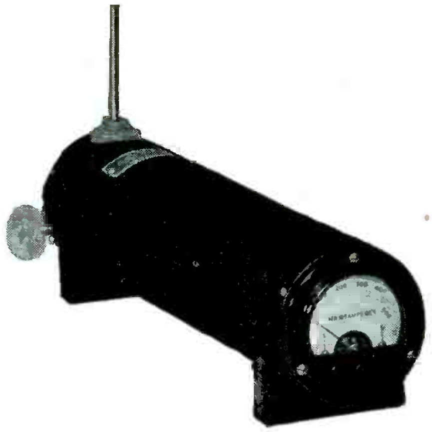
Sprague Electric Co., North Adams, Mass.

Resonance Meter

MW-70 DESIGNATES a resonance meter for use in studying u-h-f phenomena in the laboratory or in the field. It is for use in determining resonance and r-f energy in oscillators and transmitters; tank circuits, antenna systems, coupling networks and transmission lines. The instrument is designed around a high Q concentric resonance cham-







ber whose center conductor is made variable through the use of a rack and spur gear. A small plug in the pickup antenna is optimum coupled to the center conductor. Rectification is obtained with a miniature crystal cartridge. Indication of resonance is directly indicated on a d-c microammeter.

Erco Radio Laboratories, Inc., Hempstead, N. Y.

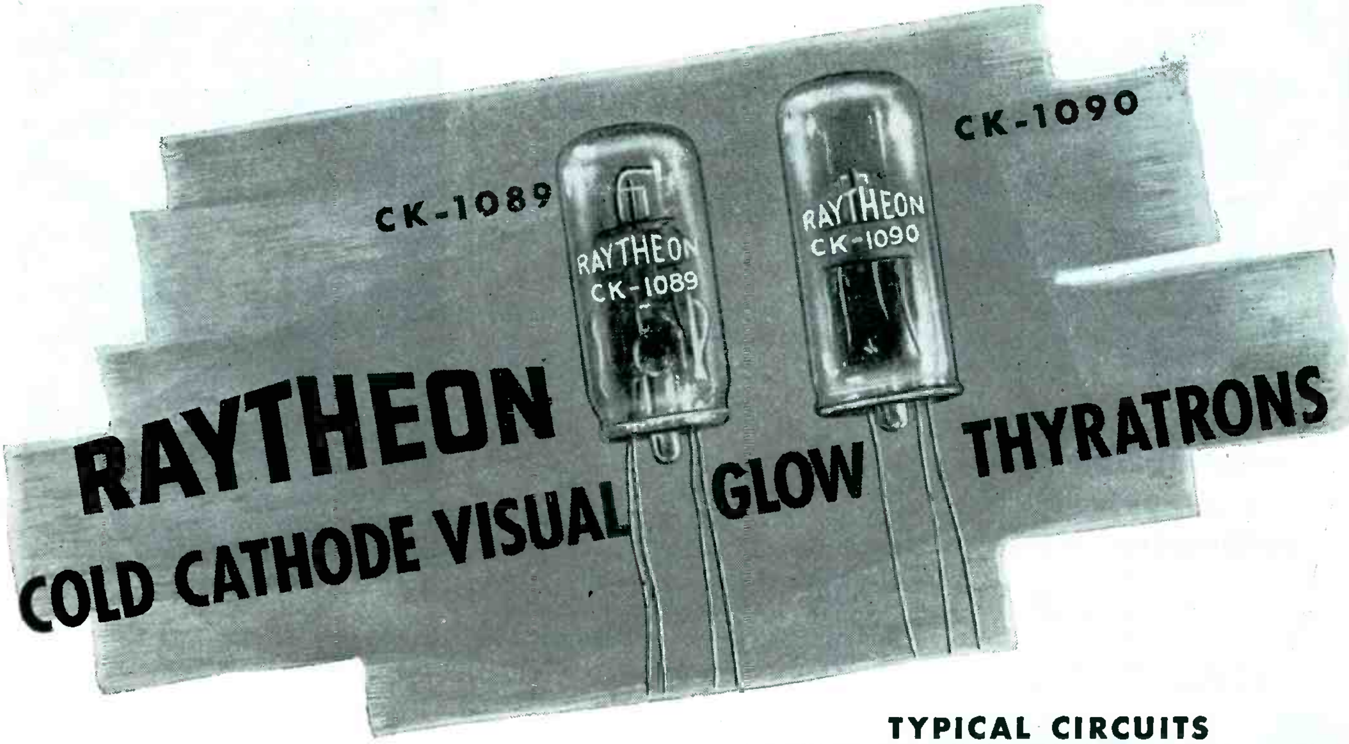
New Chemical Compound

A NEW CHEMICAL compound, Styraloy, is a cross between plastics, rubber and wood. A new million dollar plant is to be built to manufacture the material on a mass production basis. The material is light enough to float on water, it has good electrical properties, can be worked like wood, and molds like plastics. Its electrical properties are low loss, low capacitance and high dielectric strength. It is being used as an insulator in antennas.

Dow Chemical Co., Midland, Mich.

Link Joint

THIS MANUFACTURER uses solid shafting and no flexing or backlash to achieve accurate remote control in a new link joint. The joint features an adjustable link mechanism to transmit rotary motion around corners, and it permits operation of shafts at angles adjustable from a straight line to a right angle of 90 deg. The joint is mounted by means of three screws which hold it in position. The bearing arm holding the adjustable shaft may be hinged to any desired position from zero to 90 degrees and when in its proper location, a locking screw permanently holds its position. The unit

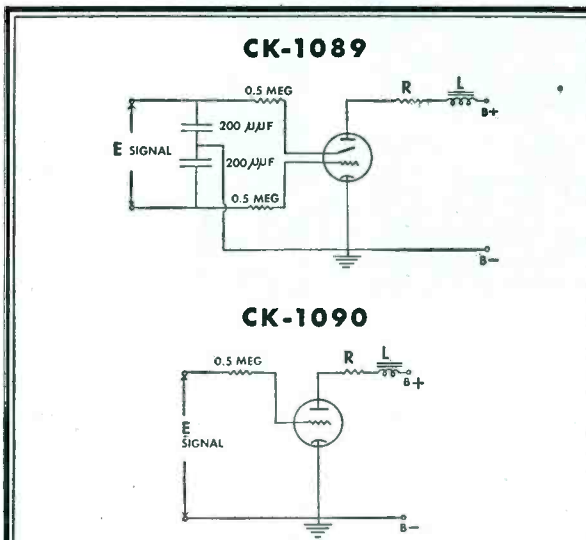


● Outstanding recent developments by Raytheon's research laboratories are two visual-glow cold cathode thyratrons, types CK-1089 and CK-1090.

The former is a tetrode incorporating two starter electrodes and so can be operated from a balanced line, whereas the latter is a triode with a single starter electrode for grounded line or unbalanced operation. In addition to normal grid controlled thyratron performance, these neon-filled tubes are engineered to produce a good visual glow near the top of the bulb.

This characteristic, and their small size, make them admirably adaptable to telephone switchboard applications where they can be wired directly as a combined relay and indicator lamp. It is also possible to actuate a separate relay in the anode circuit by the initiation of plate current, which, of course, is coincident with the glow. The resulting simplicity and the reduction in weight and size are highly desirable. Thousands of Raytheon CK-1089 and CK-1090 tubes are now giving dependable service in just such an application—even under the worst climatic conditions. Convincing proof, indeed, that Raytheon builds fine tubes... tubes that you should consider for your postwar products!

TYPICAL CIRCUITS



R = Current limiting resistance. L = Relay coil if used.

SPECIFICATIONS OF CK-1089 AND CK-1090

Minimum Peak Anode Breakdown Voltage (No Signal)	225 volts
Peak Positive Starter-Anode Breakdown Voltage Across Starter Electrodes on CK-1089 / Starter Electrode to Cathode on CK-1090	75 min. volts / 170 max. volts
Approximate Starter Electrode Voltage Drop	90 volts
Maximum Peak Cathode Current	20 ma
Maximum Average Cathode Current	15 ma

RAYTHEON

RADIO RECEIVING TUBE DIVISION

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All Four Divisions Have Been Awarded Army-Navy "E" with Stars

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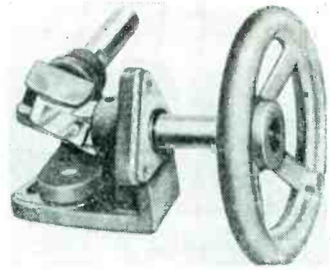
DEVOTED TO RESEARCH AND THE MANUFACTURE OF TUBES FOR THE NEW ERA OF ELECTRONICS



can be used for hand operation and slow speed power drives in the control of electrical switchboards, radios, automatic machinery and other mechanical devices. Another feature is the fact that the output shaft turns in exact angular rotation as the input shaft, giving an input turning angle equivalent to the output turning angle, when used in dial setting operations. Bulletin No. 45 is available on this subject.

Piezoelectric Corp., 110 East 42 St., New York 18, N. Y.

Insulation Resistance Tester

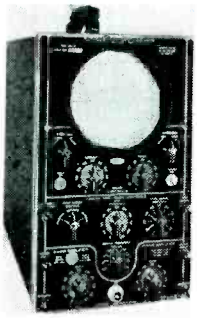
THIS TESTER, Vibrotest Model 238, is a new crankless instrument. The indicating instrument (permanently mounted within the unit) is a spotlight galvanometer having a 100 millimeter scale calibrated from zero to 20,000 megohms, direct reading, at a potential of 500 volts d.c.

Power is obtained from self-contained batteries. A guard circuit (connected to the unit) is supplied as protection on high ranges. Dimensions are 16 x 11 x 9 in. Weight is 24½ lb.

Associated Research, Inc., 231 S. Green St., Chicago 7, Ill.

Improved Oscillograph

DESIGN CHANGES and refinements have been made in Model 208-B os-

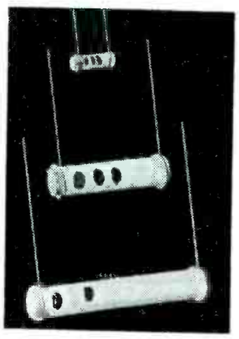


cillograph to make it more rugged and dependable in field service and in rough handling. Some of the changes in the instrument include the use of mineral oil impregnated, hermetically sealed, paper capacitors; high-voltage wire; tube changes; inclusion of a frequency-range adjustment potentiometer in the time base; addition of mounting straps on capacitors; tube clamps; and certain mechanical changes.

Allen B. DuMont Laboratories, Inc., 2 Main Ave., Passaic, N. J.

Capacitors

FIXED ceramic-dielectric capacitors which conform to joint Army-Navy specifications are available in quantities in preferred temperature co-



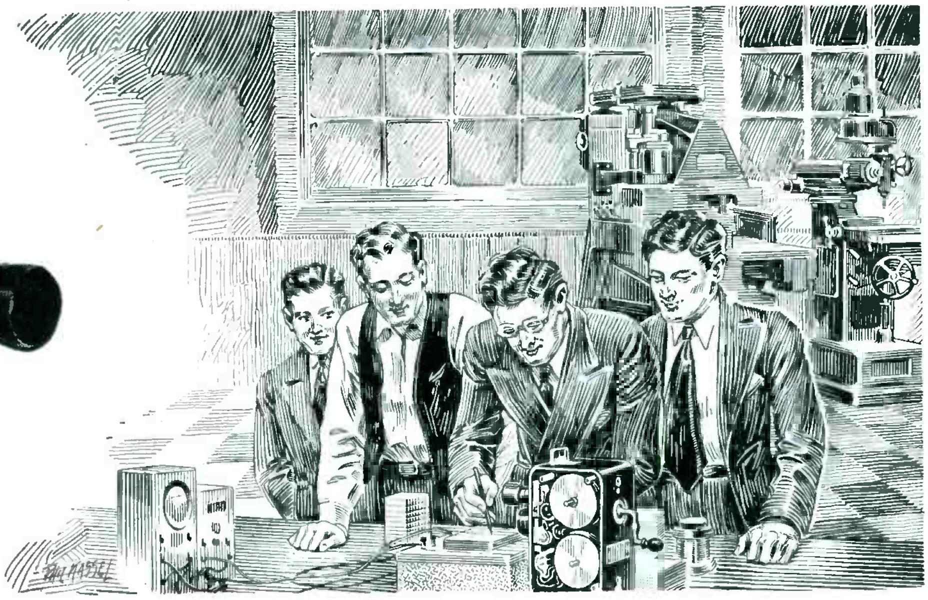
efficients for any capacitance under designations of CC20, CC25, CC30, CC35, CC40 and CC45.

Micamold Radio Corp., 1087 Flushing Ave., Brooklyn 6, N. Y.

Portable Amplifier

FOR A WIDE variety of applications there is a new, portable 30-watt amplifier (designated as W-J) which is being manufactured by Walker-Jimieson (distributors of electronic and radio equipment). The unit is distortionless and humless. It operates on 110-volt, 60-cycles, ac. Output impedances of 4, 6, 8 and 500 ohms may be selected at will. Fre-

Movies Instead of Delay!



JEROME *STILL and Motion Picture* CAMERAS

To train novice workmen to-day in the electronics field, motion pictures are supplanting the factory class. A "Movie" classroom avoids interruption of work at bench, machine and production line, and tangibly betters output.

The JEROME Still and Motion Picture Data Camera is in demand for this work, because it affords *two cameras in one,* thoroughly fitted for *both* still and motion picture photography. It is made for handling 35 mm film. A variety of lenses may be used, affording a wide scope of work.

Automatic control and adjustable speed, from 4 to 64 frames, changeable while operating.

Photographer can see and sharply focus the image, without opening the camera.

On still photography, for recording test or manufacturing data, the JEROME'S automatic features enable it to run for 70 days unattended, while photographing at 30-minute intervals. An interval range, from 15 seconds to 30 minutes is available.

There are so many exclusive advantages in the fine, yet rugged construction of the JEROME DATA CAMERA, that we can only hint at them here.

Write for full information.

28 Ways to Use JEROME CAMERAS

1 Photograph instrument panels, registering instruments, single, multiple frame, at pre-determined intervals.

2 Gun camera — recommended for heavy guns — 35 mm. Superiority over 8 mm., 16 mm.

3 As an Ordinary Camera: Despite special design camera can be used as regular 35 mm. camera.

4 Ground and aerial reconnaissance, surveys.

5 Recording duplications, Maps, Mail, valuable documents.

6 Medical research, fluoroscope screen and microscopic photographic recording.

7 Chemistry, records chemical research & action.

8 Coast Survey, Aerial Reconnaissance. Recording of depth and sounding instruments.

9 Buoy survey and patrol of sea in critical areas.

10 Electronic Research Instrument, photographicaly records cathode ray, oscilloscope.

11 Detection, automatically photographs objects passing within camera range.

12 Test work, general instrument, recording test performances, techniques.

13 Training Film, all types of school and educational photographs for training purpose, class room.

14 Deck Observation Camera, records deck action or position of ships in convoy.

15 Production Check Camera, checks machine, manual operations, increasing efficiency.

16 Aerial observation. At pre-set intervals will photograph landscape below at high altitudes.

17 Engineering Work. Used in construction of ship hulls, bridges, construction analysis.

18 Performance Guide, manual operation, gun crew action. Recording for future study.

19 Aircraft Landings & take-offs mounted on control tower. Records unusual incidents.

20 Aerodynamics research and flight test operations.

21 Material Testing. Automatic testing characteristics of materials, recording for analysis.

22 Meteorology. Isolated weather instruments and cloud formation and climatic study.

23 Traffic Check. Dangerous road intersections. Tunnel and bridge traffic analysis.

24 Marine observation, underwater photography fluora, fish habitats.

25 Firing Data Recording. Complete gun firing record, corrector range and site.

26 Front Line Warfare. Tank and listening post observation.

27 Restricted Area Detection. Registers pedestrian traffic thru gates, doors.

28 Photoelectric Cell operating camera operating from sound and vibrator detection.

JEROME ENGINEERING CO.

MASSAPEQUA, L. I., N.Y.

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BUILDERS OF PHOTOGRAPHIC EQUIPMENT
UNIVERSAL CAMERAS FOR EVERY TECHNICAL REQUIREMENT

WRITE FOR FULL DETAILS

Phone Massapequa 2100

quency response is 50-10,000 cycles. Record gain is 69 db, and the mike gain is 116 db. Units come in steel cabinets which measure 17 x 10½ x 19½ in. 311 South Western Ave., Chicago 12, Ill.

Crystal Holders

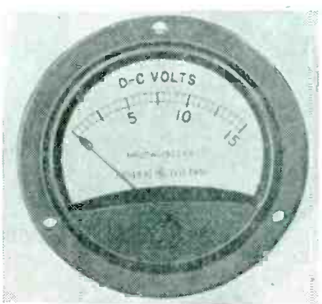
AN IMPORTANT feature of this line, No. FT-243, crystal holders, which have passed all Signal Corps tests, is the fact that they prevent deterioration of the crystal by repelling water vapor when used under tropical conditions.

National Electronic Mfg. Corp., 22-78 Steinway St., Long Island City, N. Y.

G.E. Instruments

FOUR NEW TYPES of instruments are available from General Electric Co., 1 River Road, Schenectady 1, N. Y.

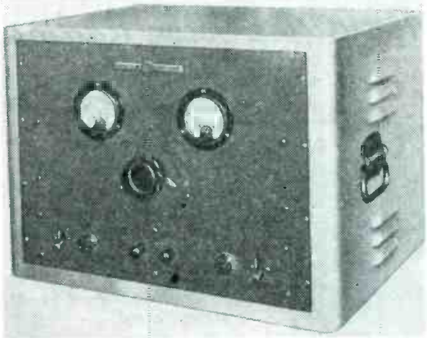
First, there is a new line of 2½-in. hermetically-sealed panel instru-



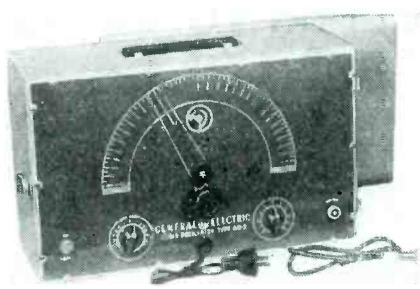
ments: d-c voltmeters and ammeters and a-c r-f ammeters, which are available in standard ratings and which conform to performance requirements of ASA Specifications C-39.2-1944. Hermetic sealing is achieved by glass-to-metal seals and soldered joints so that the instruments are unaffected by thermal or mechanical shock, or fatigue vibration. Units are housed in steel cases and are immune from effects of

moisture, humidity, chemical fumes, and other harmful agents. They are made for flush mounting on non-magnetic or steel panels.

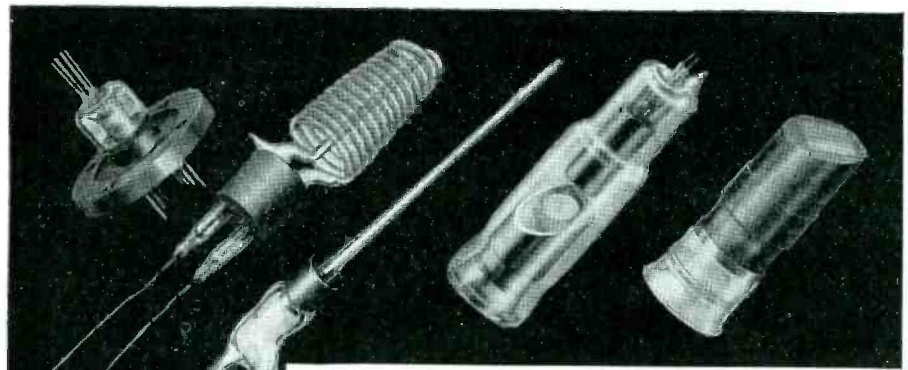
The second instrument is Type PS-5, a new self-contained regulated power supply which will hold d-c output voltage constant at any selected value, within the range of 160 to 1500 v, regardless of moderately large or rapid changes in the load current. The unit has a low internal a-c impedance useful as a power supply for devices requiring practical elimination of common coupling. Units may be used as component parts or as general purpose gadgets, or as d-c supply for micro-wave oscillators, or for photoelectric multiplier tubes.



A new beat-frequency audio oscillator (Type AO-2) simplifies measurements of audio amplifiers and radio receiver fidelity. The instrument can also be used for testing loudspeakers, for frequency measurements or calibration. Calibration is direct. The unit provides a stable sine wave, continuously variable frequency from 25 to 15,000 cps. A panel control knob regulates the output level from zero to full power output. Zero beat is indicated by the use of Type 6R5 electron-ray tube. Maximum output of the device is 120 milliwatts on the cathode-follower output impedance coupling circuit.



The last instrument is type CRO-3A portable oscilloscope for



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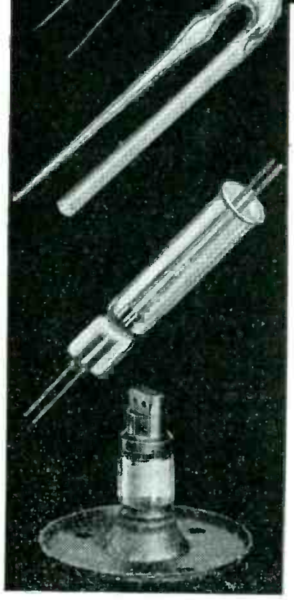
Intricate glass work and tubes made to your specification



The Universal X-Ray plant specializes in the production of metal-to-glass seals. Intricate glass seals are made to customers' specifications for electronic tubes, transformers, resistors, capacitors, condensers, vibrators, switches, relays, instruments, gauges, meters, receivers, transmitters, and other scientific apparatus.

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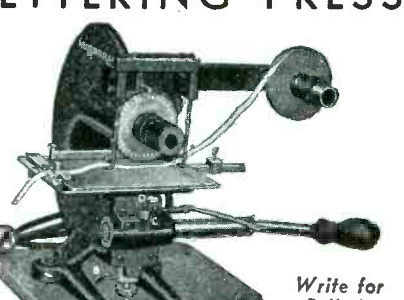

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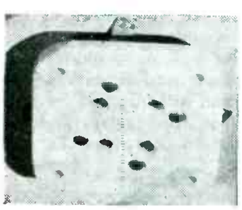
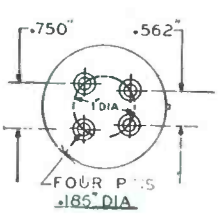
studying wave shapes and transients, measurement of modulation adjustment of radio receivers and transmitters, the determination of peak voltages, and the tracing of electron tube characteristics. The

unit utilizes a 906-Pl cathode-ray tube which has a greenish screen that can be viewed in daylight. Special design eliminates a-c ripple from the a-c transformer field and sharpens the signal picture. Moderately high-speed traces can be photographed on the screen. The unit has a wide range sweep circuit featuring a linear amplifier. Sweep rates are from 10 to 30,000 per second, adjustable by a 7-point vernier switch.

Transmitting Tube Socket

A TRANSMITTING TUBE socket (Catalog No. 244) of low-loss steatite construction is designed to accommodate jumbo 4-prong bases of 8008, BR6, GL146, SC22, GL152 and GL169 tubes. The socket measures $2\frac{5}{8}$ x $2\frac{5}{8}$ x $\frac{3}{4}$ in. thick. A one-piece base construction is used. Bosses are molded in on top of the socket, and are ground to present a flat mounting surface underneath a





chassis. Cadmium-plated brass contacts with steel spring reinforcements are riveted to the ceramic base so that they cannot turn.

E. F. Johnson Co., Waseca, Minn.

Literature

Government Contract Termination Bulletin. Joint Army-Navy Termination Regulations to be used by war contractors in the rapid settlement of war contracts. Other printed material pertaining to contract settlements is also available. The government urges all contractors holding war contracts to have their names placed on the mailing list for the Regulation and all subsequent changes. Write to Joint Army-Navy Distribution Center, Lt. E. P. Lull, 90 Church St., New York, N. Y.

Permanent Magnets. General information regarding the composition, treatment, and properties of magnetic material and the design and testing of permanent magnets are treated in a circular of the National Bureau of Standards (C448). The booklet is entitled, "Permanent Magnets," by Raymond L. Sanford, and is available at 25 cents from U. S. Government Printing Office, Superintendent of Documents, Washington 25, D. C.

Norelco Electronic Products. This 8-page booklet is really a general catalog which uses little space to tell much about such products as cathode-ray, transmitting, power and amplifier tubes; quartz crystal oscillator plates; Searchray (x-ray) inspection units; Geiger-counter x-ray Spectrometer; film-type x-ray diffraction equipment; quartz crystal x-ray analysis unit; metallurgical products and medical x-ray equipment. North American Philips Co., Inc., 100 East 42nd St., New York 17, N. Y.

Electronic Tubes. This 20-page, loose-leaf booklet contains diagrams and specifications of such power and transmitting tubes as: Type 3-16 ballast; Types 3B27, 371-B, 836 and 8020 half-wave high-vacuum rectifiers; Types 866-A/866, 575-A, 872-A and 8008 half-wave mercury-vapor rectifiers; Types 100-TH (tantalum anode), 811 and 812 (Zirconium-coated anode), and 808 transmitting triodes; Types EE-200 and EE-300 power amplifier, oscillator, class B modulators; Types 873 and

EE-17 half-wave mercury-vapor, grid control rectifiers; Types 274-A and 274-B, full wave high-vacuum rectifiers. One page is devoted to the operation of E-E mercury vapor rectifier tubes. Electronic Enterprises, Inc., 65-67 Seventh Ave., Newark, N. J.

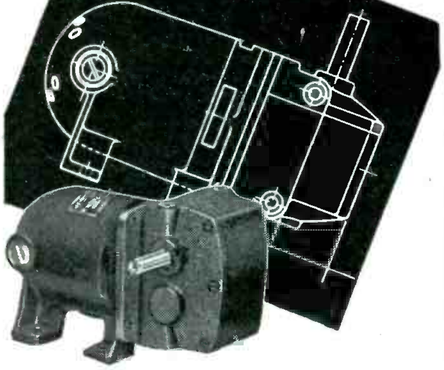
Relays. Aircraft relays illustrated and described in a 12-page bulletin (No. 30-D). Dimensional drawings are included. A quick reference index on the last page helps to locate specified relays. Hart Mfg. Co., Hartford, Conn.

Square Wave Analysis. "The Technique of Square Wave Analysis" is the title of a 4-page folder on this subject. Described on the last page of the folder is Model 71 square wave generator. Measurements Corp., Boonton, N. J.

Transformers, Chokes, Motor Generator. Wyse Laboratories (211 S. Ludlow St., Dayton 2, Ohio) 4-page folder announces the establishment of a department for the production of special transformers and chokes. Several pieces of equipment are illustrated. Another 4-page folder from Wyse is devoted to a brief description of a new, portable MG-39 motor generator built for U. S. Signal Corps for testing 400-cycle a-c and 27-v d-c instruments.

Permeability Tuning, Iron Powders. "Incremental Permeability Tuning" is the title of an article (reprinted from *Radio*) by W. J. Polydoroff describing a tuning system utilizing incremental permeability. Applications are indicated. Another piece of literature contains curves establishing the relation between the effective permeability of powdered compressed cylindrical cores and the permeability of the material itself, as measured in toroidal coils at low flux density. Five other pieces of literature include an 18-page catalog entitled "Carbonyl Iron Powders;" a sheet entitled "Electromagnetic Characteristics of Various Iron Powders;" 2-pages of data giving the comparison of different grades of carbonyl iron powders manufactured; and finally a 6-page

SpeedWay



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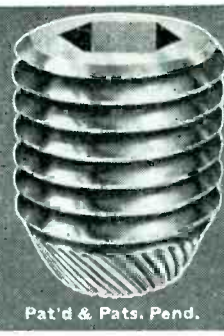

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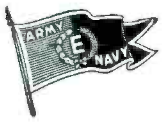

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GENERAL CONTROL COMPANY
1202 SOLDIERS FIELD ROAD, BOSTON 34, MASS

folder on "Polectron" products which are synthetic organic resins for coating and impregnating uses in the electrical field. General Aniline & Film Corp., Special Products Sales Dept., 435 Hudson St., New York 14, N. Y.

Steatite Insulators, Bushings. "Design Criteria for Steatite Insulators" is the title of a concisely written, illustrated booklet which is designed to give manufacturers and designers an opportunity to become familiar with the mechanical characteristics of Steatite (a ceramic body composed mainly of talc) for use as an insulator on h-f equipment.

Another piece of literature called "Sealex Bushings" describes hermetically-sealed bushings which withstand severe operating conditions encountered in military communication equipment.

General Ceramics and Steatite Corp., Keasbey, N. J.

Variable Capacitors. A 32-page book which contains unusually good illustrations and brief descriptions of approximately eighteen types of capacitors, as well as the facilities of this manufacturer to produce these components. The Hammarlund Mfg. Co., Inc., 460 West 34th St., New York 1, N. Y.

Insulating Varnishes. Insulating varnishes and compounds are described in a 56-page informative booklet which contains many helpful charts, tables and articles compiled for the purpose of providing a direct approach to insulating varnish problems. Four pages of the booklet are devoted to a short history of insulating varnish. The booklet is well illustrated. John C. Dolph Co., 168 Emmett St., Newark, N. J.

Electronic Heating Equipment. A loose-leaf catalog entitled "Industrial High Frequency Heating Equipment" contains a series of bulletins on the subject. Bulletin No. 401 is an introduction to inductive heating; bulletin No. 412 tells about induction furnaces; bulletin No. 413 describes, with the aid of charts and pictures, furnaces and crucibles; bulletin No. 414 tells about Trunnion-type furnaces;

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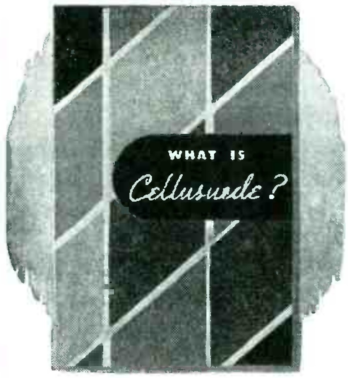

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bulletin No. 415 is devoted to foot-lifting furnaces. Ecco High Frequency Corp., 7020 Hudson Blvd., North Bergen, N. J.

Terminals. Hermetically-sealed terminals (including a stock of items and special forms to meet exact requirements) are described in a 1-page form. Electrical Industries, Inc., 42 Summer Ave., Newark 4, N. J.

Jobs in Television. A new 6-page leaflet on postwar occupations in television (Occupational Abstract No. 74) is a contribution by John E. Crawford of RCA. In brief, readable style the author discusses postwar prospects, training required, methods of entrance and advancement, range of salaries, advantages and disadvantages of television as a career. Sources of further information on the subject are given. Available for 25 cents from Occupational Index, Inc., New York University, Washington Square, New York 3, N. Y.

Soldering Flux. The advantages of Kwikflux, a hard soldering flux, are given in a 1-page form. Special Chemicals Co., 30 Irving Place, New York 3, N. Y.

Technical Apparatus Literature. Several pieces of literature describing instruments available from Technical Apparatus Co., 1171 Tremont St.; Boston 20, Mass.; include the following:

Direct reading megohmeter, Model 544, for measuring high resistances; interelectrode capacitance meter, a direct reading instrument for rapid measurement of capacitances down to 0.001 $\mu\mu$f; dielectric test set, Model 1031, which is for use as a convenient source of d-c potential for production testing of dielectric strength; model 1218 voltage-regulated power supply; and a 12-page booklet entitled "Technical Apparatus Co. Data" which illustrates and briefly describes such instruments as high-voltage power equipment, a sample production tube tester, a representative emission test set, an electronic capacitor comparator, life test panels, signal standards, noise analysis equipment, and a complex multi-function analyzer.

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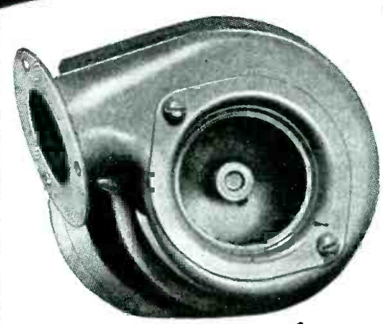

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Reference Manual Holders. Replacement specification sheets and new specification sheets on cathode-ray tubes are now available for owners of a reference manual got out by Allen B. DuMont Labs., Inc., Passaic, N. J.

Junior Engineers' Reading List. A revised "Reading List of Junior Engineers" has been issued by the Junior Committee on Professional Training of the Engineers' Council for Professional Development, 29 West 39th St., New York 18, N. Y. Price, 10 cents each, or 5 cents each in lots of 50 or more.

Capacitor Catalog. Catalog No. 20 contains 56 pages of data and illustrations of paper dielectric capacitors available from Sprague Electric Co., North Adams, Mass. The catalog is designed as a guide to the selection of these components for industrial uses.

Engineering Bulletin. "Multi-Meter Circuits For Use With HC Meter Scales" is the title of a new engineering bulletin (No. 1) which sells for 25 cents. The bulletin as well as HC meter scales are available from R. E. Nebel Laboratory, 1104 Lincoln Place, Brooklyn, N. Y.

Decade Inductance. Five types (2321 to 2325) of decade inductance units are briefly described in a 1-page bulletin. New York Transformer Co., 26 Waverly Place, New York, N. Y.

Automatic Voltage Regulator. Bulletin No. 163 contains specifications, applications, and some illustrations of an automatic voltage regulator for line-voltage control. Superior Electric Co., Bristol, Conn.

H-F Cable and Connectors. For this manufacturer's catalog there is available a new "Section D" which describes 26 types of RG cables and many companion h-f connectors for uhf and electronic applications. A chart giving molded "AN" insert connections is also available. American Phenolic Corp., 1830 South 54th St., Chicago 50, Ill.

Fasteners. Two manufacturers have available literature on fasteners.

The first of these is Shakeproof Inc., (2501 N. Keeler Ave., Chicago, Ill.) whose bulletin "Fastening Application" contains data on Quick Fasteners which open and close panels of mechanical equipment quickly and easily.

The second manufacturer, Camloc Fastener Corp. (420 Lexington Ave., New York 17, N. Y.) has two booklets, both of which tell about the 4002 Series of cowl fasteners (spring loaded stud). One booklet (catalog 44-A) gives a description and specifications while the second is an instruction booklet (No. 44-B) of installation procedure.

Ceramics Insulator Bodies. Bulletin No. 444 describes, with the aid of good illustrations, AlSiMag ceramic insulator bodies for electrical and other technical uses. American Lava Corp., Chattanooga, Tenn.

Mica Trimmers. Automatic Mfg. Corp., (formerly known as Automatic Winding Co., Inc.) manufacturers of complete electronic assemblies and component parts, have available a 12-page booklet which illustrates and describes approximately fourteen types of automatic mica trimmer capacitors. 900 Passaic Ave., East Newark, N. J.

Double Coil Washers. Double-coil, spring-lock washers available in any desired finish for No. 4 screws up to 1 in. and larger bolts are described in a leaflet available from George K. Garrett Co., Inc., 1421 Chestnut St., Philadelphia 2, Pa.

Fastener Assembly. A new one-piece fastener assembly (called the Spring Lock Fastener) which does not require nuts or receptacles is described and illustrated in a 4-page folder available from Simmons Fastener Div., Simmons Machine Tool Corp., Albany, N. Y.

Tubes, Television Brochure. "Time, Tubes and Television" is the title of a brochure intended as an introduction to the genealogy of science. It contains many illustrations and covers a lot of territory especially

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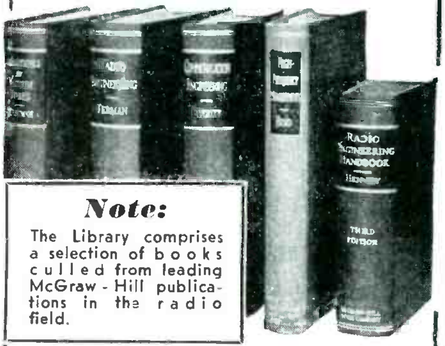

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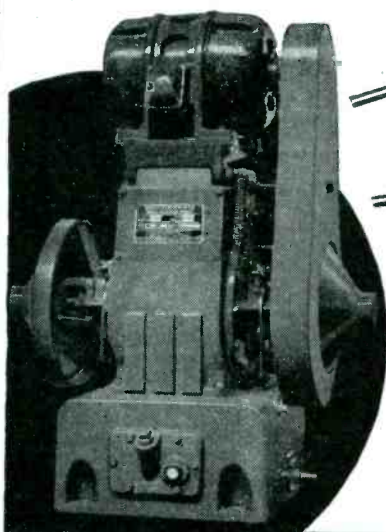

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with regards to the manufacturer's facilities and products. Several pages are devoted to clear illustrations of the cathode-ray gun. Allen B. DuMont Laboratories, Inc., 2 Main Ave., Passaic, N. J.

Tubular Metal Antennas. Construction diagrams, illustrations and descriptive data on antennas and antenna parts for use in police, marine, amateur and commercial installations are contained in a 24-page book. Premax Products, Div. of Chrisholm-Ryder Co., Inc., Niagara Falls, N. Y.

Facsimile Equipment. The story of facsimile equipment manufactured by the Alden Products Co., 117 North Main St., Brockton 64, Mass., is contained in an 8-page booklet by Milton Alden entitled "Suiting Facsimile Designs to Service Needs" reprinted from *FM & Television*.

Cathode-Ray Tubes. A 16-page illustrated booklet on "How & Why Cathode Ray Tubes Work" reprinted from *Communications* from a series of articles by J. R. Beers, Development Engineer, North American Philips Co., Inc. (100 East 42 St., New York 17, N. Y.) Contents deal with early history, manufacturing problems, testing, and special designs. Write North American Philips.

Rotary Electrical Equipment. A 4-page folder contains a brief review and illustration of dynamotors, motors, converters and generators of various types. Eicor, Inc., 1501 W. Congress St., Chicago 7, Ill.

High-Voltage Test Equipment. Bulletin F describes portable kilovoltmeters and multipliers suitable for use from 1 to 30 kv, as well as corona-protected kilovoltmeters and resistors for measurements up to 200 kv. Shallcross Mfg. Co., Collingdale, Pa.

Vertical Radiators. A 4-page brochure illustrates vertical radiators for broadcast stations and antenna supporting poles for other types of service. Handy information is given broadcasters for ground sys-

tems and FCC minimum radiator heights for all class of stations throughout the standard a-m broadcast band. John E. Long & Son, Inc., 28th St., & Buren Ave., Camden, N. J.

Television Studio and Transmitting Equipment. A 6-page folder illustrating and briefly describing products such as Model SE-100 television transmitter (video and audio models), SE-300 console studio control desk, SE-200 master control board and SE-400 transmitter control desk. Sherron Electronics Co., 1201 Flushing Ave., Brooklyn 6, N. Y.

Power Connections. Catalog No. 27 contains a good deal of data on power connections for electronic equipment. Harvey Hubbell, Inc., Bridgeport 2, Conn.

Parts and Assemblies. A booklet entitled "Silent Partner For Your Success" gives background data of this manufacturer, and illustrates and describes parts and assemblies. Orange Screen Co., Maplewood, N. J.

• • •

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Lt. (jg) Io St. Clair Clary gives a diathermy treatment to a patient at the U. S. Naval Hospital in Corpus Christi, Texas. More nurses are needed by the Navy, Marines, and Coast Guard. *Official Photograph, U. S. Navy*

NEW BOOKS

Prodigal Genius; The Life of Nikola Tesla

By JOHN J. O'NEILL. *Published by Ives Washburn, Inc., 29 West 59th St., New York 19, N. Y., 1944, 326 pages, $3.75.*

THERE CAN BE NO disputing the fact that Nikola Tesla was a great discoverer and inventor, particularly in the field of electrical engineering. At a time when electricity was just beginning to be investigated as a useful tool of mankind he was looking ahead to the days when this force could be controlled for the benefit of everybody. Thus, Tesla was thinking in terms of a-c power when direct current was the only type of electric current available. He was experimenting with world-wide radio when the wireless transmission of code signals was limited to a relatively few miles. And he was developing the wireless transmission of power nearly 50 years ago.

Like most so-called geniuses, Tesla had his shortcomings. For one thing, he was not as much interested in exploiting his discoveries and inventions as he was in making more discoveries. Therefore, he never realized anything from much of his work and opened the door to piracy, intentional or otherwise. Because of his lack of business sense he missed many opportunities to make money with which to continue his work as he would have liked to do. Tesla's personality was attractive socially but lacking in business acumen, so that many financiers who might have backed him did not do so because he was not enough of a "salesman."

But most important of all, Tesla did not commit to writing many of his thoughts and dreams for investigations that he planned to carry out "some day." When he died in 1943 many of his plans, which could have been carried on by others, died with him. It should be noted, however, that all of his papers, dealing with the experiments he performed, have been impounded until after the war. There is no way of telling, at this time, how much those notes have helped the United Nations, if at all.

Mr. O'Neill was a friend and ad-

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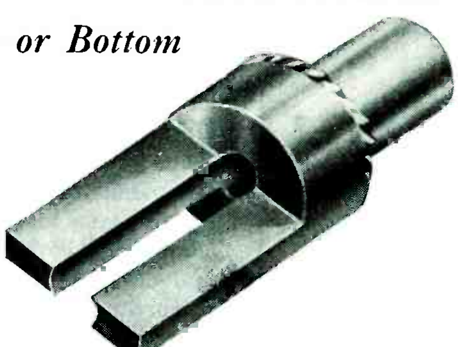

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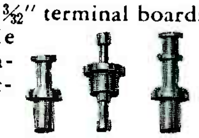

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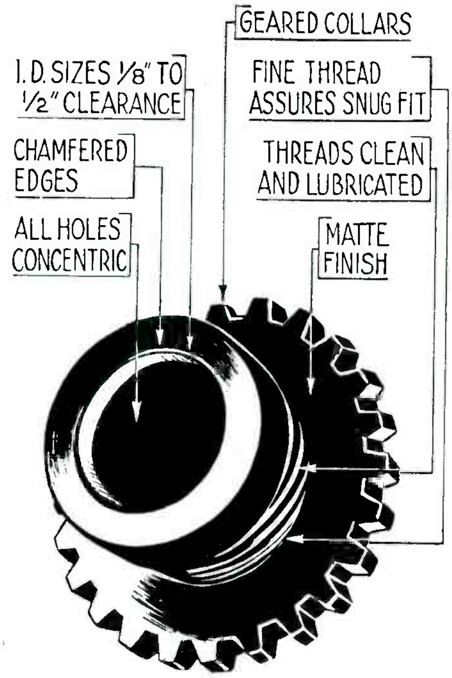

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mirer of Tesla for many years. In fact, his admiration borders on hero worship. It is logical, therefore, that he should write Tesla's biography. Because of his experience as science editor of the New York Herald-Tribune he is able to describe Tesla's work, much of which was highly technical, in simple terms that anyone can understand. This does not detract from the book, however, so far as engineers are concerned because he has faithfully kept to engineering terms wherever possible.

The excessive enthusiasm that the author displays for his subject is boring in spots, particularly when he repeats as frequently as he does his defenses and explanations of Tesla's shortcomings. On the whole, however, the book is well written and documented. A partial list of Tesla's patents and an index are provided. It makes good reading for any engineer or student, particularly those interested in electronics, because it is the life story of a man whose influence on our daily lives will be evidenced for centuries to come.—K.S.P.

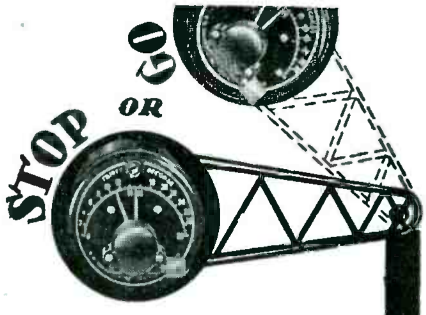
• • •

High-Frequency Induction Heating

By FRANK W. CURTIS, *Consulting Engineer, Springfield, Massachusetts, McGraw-Hill Book Co., Inc., New York*, 235 *pages, price* $2.75.

EXPERIENCES GAINED from commercial induction-heating installations are the background from which the greater part of this book is written. Principles and practices, which are discussed and amply illustrated both by diagrams and photographs of installations, cover a wide variety of induction heating applications. The opportunity that this presentation affords the production engineer to learn what has been proven effective in industrial heating applications, plus the fact that this is the first book to be devoted entirely to high-frequency heating, make it a useful guide both to designers of electronic heating equipment and to those who are or plan to use such apparatus.

The first sixth of the book, devoted to the principles of induction heating, unfortunately includes a number of statements open to question. For example, it is explained that "Since induction heating is a



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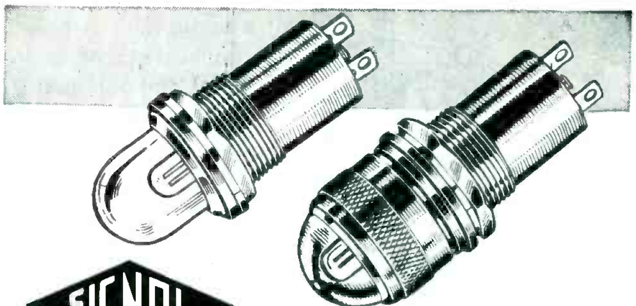

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process by which the temperature of a metal part is raised by electrical generation of heat within the material, the part being heated is in no way a part of any closed electrical circuit."

For those production engineers and others not familiar with electricity and electronics who are taking up the application of high-frequency fields to their heating problems, considerable more information on principles of electronic heating will be required than is given in the short first chapter of this book.

Techniques

The greater part of the book discusses the effect of the applicator coil shape on the area to which heat is applied. Diagrams illustrate the degree and penetration of heat produced by numerous coil contours and show how the coil can be designed to do the job at hand.

Methods of brazing various shapes are described and considerable attention is given to the technique of brazing carbide tools. Soldering techniques are also illustrated. Hardening is covered with special attention to zonal hardening, and setups for hardening complex shapes such as gears are discussed. Semi-automatic equipment is described.

Applications

In a chapter devoted to fixtures for use in hardening setups, methods of handling the work and types and requirements of continuous and automatic fixtures are described. The following chapter describes several miscellaneous industrial-heating applications which illustrate how widely induction heating can be applied if used with ingenuity. For example, one special device uses a phototube to determine when the work has reached the proper temperature by monitoring its color. Power to the high-frequency generator is turned off at the proper time by the phototube unit.

The book concludes with a chapter on special considerations necessary in the design of parts to be heat-treated by high-frequency induction, and a chapter that points out the saving in time, type of applications most suitable for, and the packaged equipment available for dielectric heating.—F.R.

Backtalk

This department is operated as an open forum where our readers may discuss problems of the electronics industry or comment upon articles which ELECTRONICS has published

Credit Where Due

Dear Sirs:

THE ARTICLE, Electronic Control of X-Ray Exposure Time, appearing on page 146 of the January issue of ELECTRONICS is of interest because it duplicates, in considerable detail, a similar article appearing in ELECTRONICS for July 1943. . . . I feel that I should recall to your attention that the work described was done at the University of Chicago. As a matter of fact, the Westinghouse model shown on page 146 was copied almost directly from a model supplied to them by the University of Chicago. The University did this in an effort to stimulate commercial production of the device at a time when it was needed in the war effort.

RUSSELL H. MORGAN
Radiology Section
Tuberculosis Control Division
U. S. Public Health Service
Washington, D. C.

• • •

Cathode-Follower Corrections

Dear sir:

THE ARTICLE by Mr. Pacini on Cathode Follower Calculations, appearing on page 137 of ELECTRONICS, October, gives a value for the output impedance of a cathode follower which I believe is in error.

In determining the impedance by assuming the cathode to be driven by a generator we must divide the voltage drop across the cathode by the current furnished to it from the external generator. This is equivalent to Mr. Pacini's analysis only if the R_t of his Eq. (3) is equal to zero. The equations with their solution are then as follows:

$$R_2 I_1 - R_2 I_2 = E_1 - R_2 I_1 + (R_2 + R_p) I_2$$

$$= - \mu (I_2 - I_1) R_2 \frac{I_1}{E_1} = \frac{\mu + 1}{R_p} + \frac{1}{R^2}$$

$$= g_m + \frac{1}{R_p} + \frac{1}{R_2}$$

The quantity I_1/E_1 is the value of the conductance offered by the cathode to the external generator of

zero internal resistance and the reciprocal of this quantity is the internal resistance of the cathode follower considered as a generator, or, in other words, its output impedance. It is immaterial that this impedance is determined in part by the ohmic value of the cathode resistor and in part by feedback.

This same expression for the output impedance can be obtained in an alternative manner by solving for the value of load resistor which, shunted across the cathode resistor, will reduce the gain to one half of the unloaded value. Let the gain of the unloaded cathode follower be

$$A = \frac{\mu}{R_p/R_k + \mu + 1}$$

in which R_p is plate resistance and R_k is cathode resistance.

When the load R_L is shunted across R_k the effective cathode resistor becomes

$$R_k' = \frac{R_k R_L}{R_k + R_L}$$

The gain A' with the new value of cathode resistor R_k' will be

$$A' = \frac{\mu}{R_p/R_k' + \mu + 1}$$

$$= \frac{\mu}{2\,(R_p/R_k + \mu + 1)}\,\frac{1}{R_k'}$$

$$= \frac{2}{R_k} + \frac{\mu}{R_p} + \frac{1}{R_p}\,\frac{1}{R_L} = \frac{1}{R_k'} - \frac{1}{R_k}$$

$$= \frac{1}{R_k} + g_m + \frac{1}{R_p}$$

Since the internal resistance of a generator is by definition equal to the load resistance that would reduce the output voltage to one half, it is seen that the output impedance is

$$Z_o = \frac{1}{g_m + 1/R_p + 1/R_k}$$

It is important to note when applying these equations that the values of g_m and R_p will in general be different from the handbook figures since they both depend on the static plate current and this is often less than the value assumed by the manufacturer.

RUSSELL N. SKEETERS
California Institute of Technology, Pasadena, Calif.

Dear Mr. Skeeters:

THE DIFFERENCE in the value of the output impedance of the cathode follower according to your derivations and mine are negligible, in the order of 5 percent or less, if the assumption is made (as I did, between equations 7 & 8) that the amplification factor of the tube is

(*Continued on page* 406)

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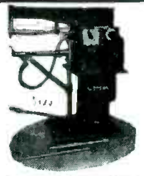

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(Additional Employment Ads on Pages 383, 395, 403, 404 and 405)

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For war time and post-war design and development of intricate, specialized, hermetically sealed transformers, and special purpose fractional h.p. motors.

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FOR DOMESTIC AND FOREIGN SERVICE

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Essential workers need release

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WANTED Radio or Electronic ENGINEER

For design and development of Army-Navy Electronic Equipment. The position offers an excellent opportunity with a well-established and expanding company in Connecticut, employing over 100 personnel. The company's big postwar program in the industrial electronics, audio and aircraft communication fields assures a continued opportunity to engineering personnel for advancement.

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Address: Personnel Director

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RADIO ENGINEERS

Medium-sized, progressive, Midwest manufacturer has openings for one senior and two junior engineers. Desire men for work on military projects now who will be adaptable later to postwar engineering. Prefer men with experience in radio receiver or television laboratory, and with college education in communication engineering.

Our staff knows of this advertisement.

P-798, Electronics

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LOOKING FOR ENGINEERS

An unusual opportunity to undertake engineering activities in design and development of ultra-high frequency electronic products.

Prior to the war, this Corporation was among the leading producers of Electronic equipment for Industrial application.

Now engaged as Prime Contractors on urgent War Contracts, involving interesting research and development. We need engineers with experience in designing and engineering VHF-UHF Electronic products, and with ambition.

Large projects in the field of Ultra-high Frequency and advanced Electronic applications are scheduled to follow in the post-war period, insuring security and fine environments to all our co-workers.

Write to L. R. Ripley, President, explaining your experience in detail. Your communication will be treated in complete confidence and no further investigation will be made without your express permission.

United Cinephone Corporation

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WANTED

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P-813, Electronics

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WANTED

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Also Electrical Engineer or Engineering Physicist for research position in fundamental and applied electronics. Some industrial experience preferred. Essential work with excellent postwar prospects. Write

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WANTED

RESEARCH ENGINEERS

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P-815, Electronics

520 N. Michigan Ave., Chicago 11, Ill.

Advancement For Electronics or Radio Engineers

Large well-established organization located in New York City wants graduate Engineers with three or more years experience in

ELECTRONICS
RADIO
RADAR
SYNCHRO-MECHANISM

For Present and Post-War research and development on a large variety of electrical products. Give us, in full confidence, your education, resume of experience, and photograph.

P-821, Electronics

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- **EXECUTIVE ELECTRICAL ENGINEER** Experienced in the sales and manufacture of Transformers utilized for the Radio Receiving Set Industry.
- **ELECTRICAL ENGINEER** Experienced in the design of Transformers and reactors for the Radio Receiving Set Industry.

These positions are permanent, offering excellent Post-War opportunities in a forty-year old transformer manufacturing company. Address replies to

Box No. P-823, Electronics, 330 West 42nd St., New York 18, N. Y.

WMC RULES PREVAIL

(*Continued from page* 400)

much greater than one. In all of my engineering design in the past I have never attempted to use a tube with a μ of less than 20 as a cathode follower, because it would lead to too high an output impedance. I am sure that you will agree with me that the cathode follower is used primarily as a low impedance source.

Equation 5 gives the value of the driving point impedance that the generator emf sees looking into the network. Equation 6 is the output impedance, obtained by subtracting R_1 from Z_1; and you may well see that it is the same as your end result except for the difference mentioned above. The generator could have been assumed to have zero internal impedance, but I chose to make the derivation more general by stating that the network be driven by a generator with internal impedance.

It is useless to calculate vacuum tube behavior to better than 5 percent because of the tolerances allowed by the manufacturers on the characteristics; and the characteristics do vary considerably, as you mentioned, because of the operating point.

Thank you for your interest in the article. I trust that I have clarified the point in question.

Humbert P. Pacini
Asbury Park, N. J.

Dear Mr. Pacini:

The point which I wished to make was simply that in neglecting the plate conductance (by substituting μ for μ plus one) and the conductance of the cathode resistor we are needlessly sacrificing precision of analysis. It is customary, as you say, to neglect the difference between μ and μ plus one in cathode follower calculations but I do not believe we should also throw out the effect of the cathode resistor and say that the output impedance is the reciprocal of the transconductance. This can easily lead to an additional 5 percent error.

Since the analysis is not appreciably simplified by these approximations why not take the precise expressions for amplification and output impedance as guides for design? We can neglect the minor terms if we want but at least we will know what we are neglecting.

Russell N. Skeeters
Pasadena 4, California

INDEX TO ADVERTISERS

INDEX TO ADVERTISERS

Continued

SEARCHLIGHT SECTION
(Classified Advertising)

SNW Wire Insulation made from GEON approved by Underwriters' Laboratories

WIRE insulation made from GEON has been approved by Underwriters' Laboratories for use in wet locations, eliminating the need for lead sheathing. Besides this advantage, GEON permits the use of thinner insulation and makes possible a smaller diameter wire—thus more conductors and more power per conduit. Other characteristics of GEON make possible an insulation which does not require a protective braid and which has superior all 'round long-time aging and electrical properties.

How's this for a test of an insulating material—*immersed in water for 106 days at 70 degrees C.* (This test conducted by Electrical Testing Laboratories, Inc.) Insulation made from GEON stood that test, and came out with its electrical properties practically unchanged!

SNW insulation made from GEON is flame resistant, too—it extinguishes itself, an added important property in wet locations where exposed connections increase the danger of short circuit and fire. Corrosive conditions are common in wet locations. But they have no effect on insulation of GEON which resists the action of acids, alkalies, oil, greases, mildew, heat, cold and many other normally destructive factors.

Urgently needed for military uses, all the GEONS are subject to allocation by the War Production Board. Our development staff and laboratory facilities are available to help you work out any special problems in connection with essential applications. For more complete information write Department FF-5, Chemical Division, The B. F. Goodrich Co., 324 Rose Building, Cleveland 15, O.

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57- Collins ad ART-13

DESIGNING TELEVISION, FM,
OR SHORT-WAVE EQUIPMENT?

119- BC-654, BC-611 jungle photo

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CAN BE A BIG HELP TO YOU

197- BC-654 photo
285- KAAR 10/11 radiotelephone set

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for greater stability

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SHORT INTERNAL LEADS
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LARGE PINS
for low-resistance contact

● Intrinsic features of RCA Preferred-Type Metal Tubes offer many advantages to set-designers.

Because metal tubes are little affected by stray fields, you get greater flexibility in mechanical layout, resulting in compact, stable circuits, which are economical to manufacture and easy to service.

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First to manufacture metal tubes, RCA has introduced over 90% of the metal types now available—and has built more than 150,000,000 metal tubes since 1935.

If you have a design problem involving receiving tubes, investigate RCA Preferred Types—metal, glass, or miniature. RCA tube-application engineers will be glad to help. Write to RCA, Commercial Engineering Section, Dept. 62-30E, Harrison, N. J.

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