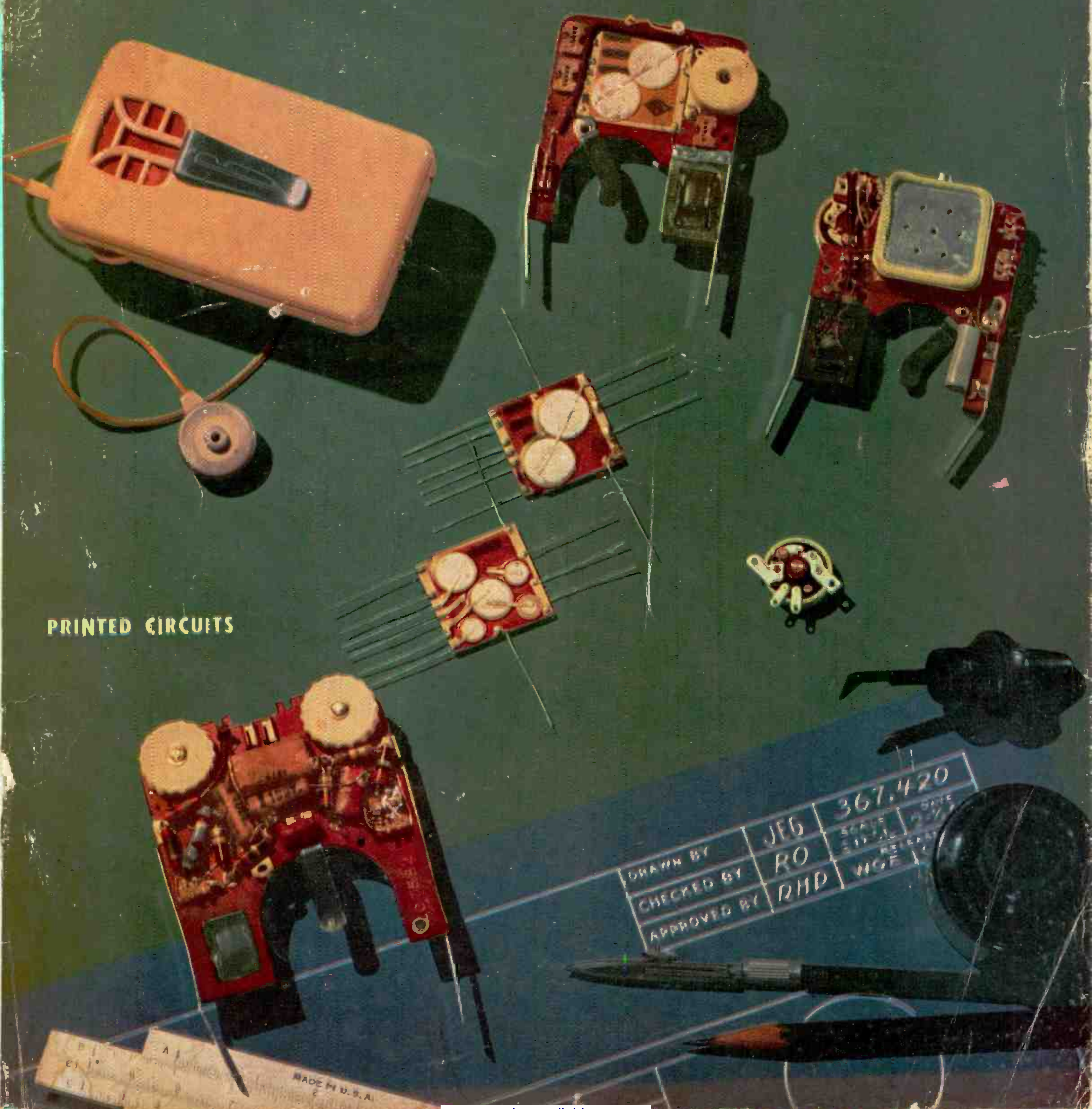
AUGUST · 1948

electronics

A McGRAW-HILL PUBLICATION



PRINTED CIRCUITS

NOW! ..LARGE PROJECTED PICTURE

perfected by NORTH AMERICAN PHILIPS COMPANY, INC. Norelco PROTELGRAM

The 2½″ magnetic projection triode 3NP4 has a face as small as a compact and is only 10½″ long.

A VAST NEW MARKET OPPORTUNITY FOR MANUFACTURERS OF TELEVISION RECEIVERS

NOTE THESE 10 SIGNIFICANT FEATURES

1. Flat 16″ x 12″ non-reflecting picture provides fatigueless viewing from less than 5 feet up.
2. Wide-angle visibility – square corners.
3. True photographic black and white picture quality—no color distortion.
4. Compact unit—even fits table model cabinets.
5. Long-life, low-cost picture tube.
6. Standard chassis for 10″ direct-viewing tube system can be easily adapted for use with PROTELGRAM.
7. Easy to service.
8. High contrast ratio and broad gray tone range.
9. Simple optical adjustment system.
10. *Quality built* after more than 10 years of development.

NORELCO PROTELGRAM consists of a projection tube, an optical box with focus and deflection coils, and a 25 kv regulated power supply unit, making possible large-size home projection. More than ten years of exhaustive research led to the determination of the ideal system for reproducing a 525-line projected picture. The optical components were designed to produce perfected projection for a 16″ x 12″ image as the optimum picture size for steady, distant observation and also for *proper viewing at less than 5 feet.*

* *Other NORELCO products* include standard 10″ direct-viewing tubes and special-purpose cathode-ray tubes for many applications.

Norelco Reg. U. S. Pat. Off.

PROTELGRAM IS PICTURE PERFECTION IN PROJECTION

NORTH AMERICAN PHILIPS COMPANY, INC.

DEPT. TE-8, 100 EAST 42nd STREET, NEW YORK 17, N. Y. ★ IN CANADA: PHILIPS INDUSTRIES LTD., 1203 PHILIPS SQUARE, MONTREAL

EXPORT REPRESENTATIVE: PHILIPS EXPORT CORPORATION, 750 S. FULTON AVENUE MT. VERNON, N. Y.

electronics

A McGRAW-HILL PUBLICATION

AUGUST • 1948

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James H. McGraw, Jr., President; Curtis W. McGraw, Vice-President and Treasurer; Eugene Duffield, Executive Assistant for Publications; Nelson Bond, Director of Advertising; Joseph A. Gerardi, Secretary; and J. E. Blackburn, Jr., Director of Circulation. ELECTRONICS, August, 1948. Vol. 21; No. 8. Published monthly, with an additional issue in June, price 75c a copy; $1.00 for Latin America; $1.50 for all other foreign countries. Directory issue $2.00. Allow at least ten days for change of address. All communications about subscriptions should be addressed to the Director of Circulation. Subscription rates—United States and possessions, $6.00 a year, $9.00 for two years, $12.00 for three years. Canada (Canadian funds accepted), $7.00 a year, $11.00 for two years, $14.00 for three years. Pan American countries $10.00 for one year, $16.00 for two years, $20.00 for three years. All other countries $15.00 for one year, $30.00 for three years. Please indicate position and company connections on all subscription orders. Entered as Second Class matter August 29, 1936, at Post Office, Albany, New York, under the Act of March 3, 1879. BRANCH OFFICES: 520 North Michigan Avenue, Chicago 11, Ill.; 68 Post Street, San Francisco 4; Aldwych House, Aldwych, London, W.C. 2; Washington, D. C. 4; Philadelphia 3; Cleveland 15; Detroit 26; St. Louis 8; Boston 16; Atlanta 3, Ga.; 621 So. Hope St., Los Angeles 14; 738-9 Oliver Building, Pittsburgh 22.

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The NEW NORWOOD Director

.... last word in exposure meters

Engineered and Manufactured by MARION

AND HERE'S REAL UNIFORMITY

Calibration inspection slips, packaged with each Norwood Director, show uniform high accuracy of the product.

Leading photographers, both amateur and professional, have given this new American Bolex product astonishing acceptance throughout the nation. This proves that they were quick to understand the revolutionary light-gathering Principle of the Director's unique Photosphere; quick to appreciate its beauty and compactness of design, its simplicity of operation and its *unexcelled accuracy*.

Marion alone was chosen to *engineer and manufacture* this superb light measuring instrument because of Marion's recognized reputation for producing trouble-free meters.

Whether a complete product or a component part of your product, Marion "Special Instruments" offer increased *sales* appeal. This special Marion service can give your product real sales advantages over competition. When you want it *engineered* to the application and manufactured to *quality* specifications write, wire or telephone.

THE NAME "MARION" MEANS THE MOST IN METERS

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M·E·I

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MANCHESTER, NEW HAMPSHIRE

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It has been the goal of K&E in developing Helios†, to bring you a better, more dependable line of dry diazo reproduction materials than had ever been made before. To achieve this, K&E established a new, modern plant for the manufacture of Helios materials exclusively. We not only make the finished products —but we manufacture, to our own exacting standards, the required color-forming components. You see the results whenever you make prints on Helios papers, cloths or films—for their consistently high quality is due to the fact that, from start to finish, Helios materials are made with the skill, care and vigilance characteristic of K&E throughout 81 years of making drafting and reproduction materials and equipment.

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You can make positive line working prints on black line, blue line or maroon line opaque Helios papers or cloth *directly* from original drawings, layouts, letters, documents, forms. Or you can save your originals and reproduce positive line working prints *directly* from positive line intermediate originals on Helios transparent papers, cloth or films. For samples, write Keuffel & Esser Co., Hoboken, N. J., or ask your K&E Dealer or K&E Branch for a demonstration. Remember . . . you're *positive* with Helios!

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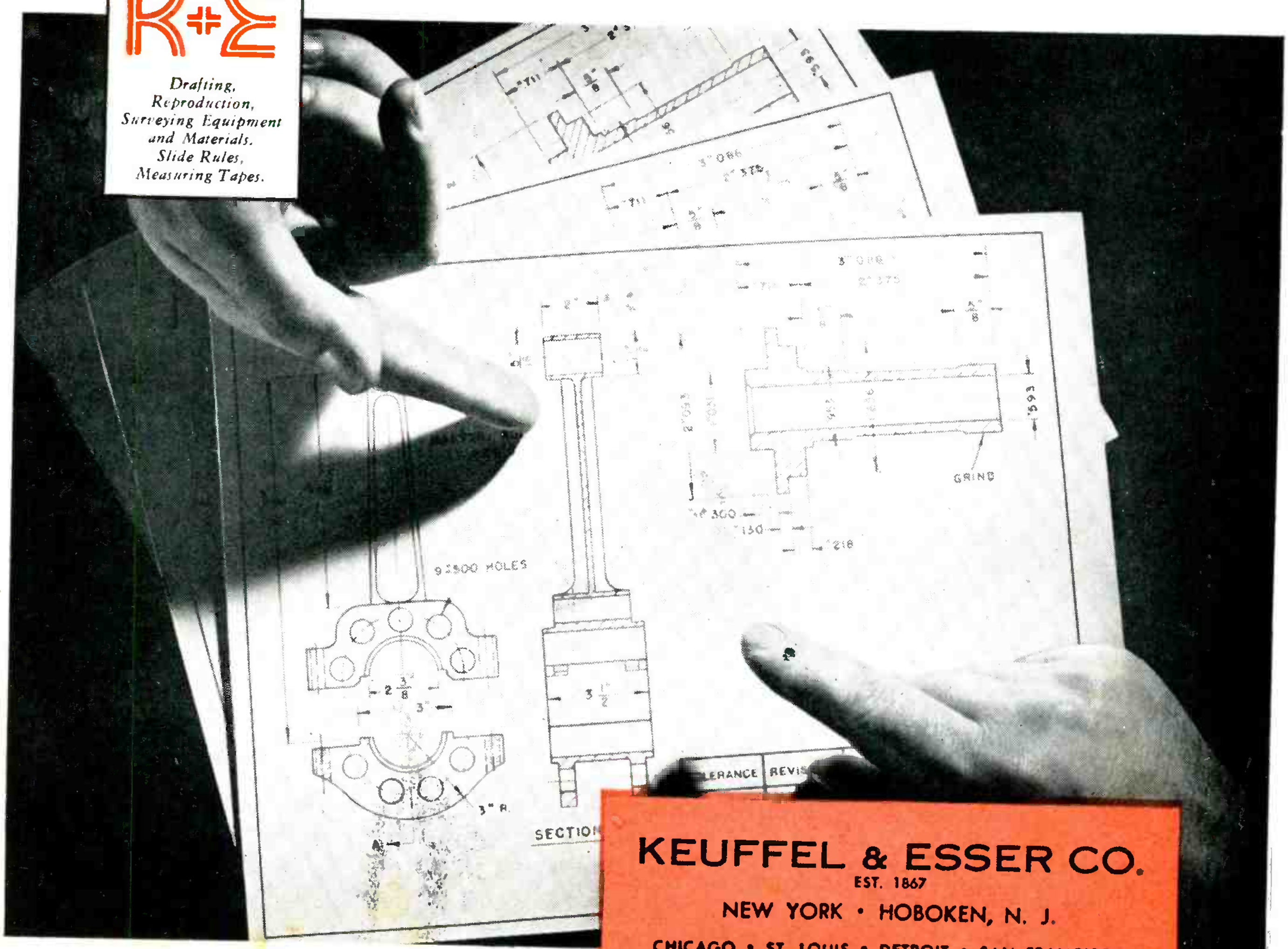

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†Reg. U. S. Pat. Off.

SINGLE SIDEBAND RADIO SYSTEMS . . .

How single sideband conserves power

THIS IS DOUBLE SIDEBAND

Voice modulation of carrier produces two beat frequencies—the sum and the difference of carrier and voice frequencies. Transmitter is called on to produce both sidebands in addition to carrier. This is inefficient in use of frequency spectrum and wastes power.

THIS IS SINGLE SIDEBAND *(carrier reduced)*

One sideband is suppressed by filters and carrier is reduced. Power thus saved is available for remaining sideband. This method of transmission conserves space in frequency spectrum, requires only a fraction of the power of double sideband, and provides *an improvement of 9 db in signal-to-noise ratio.*

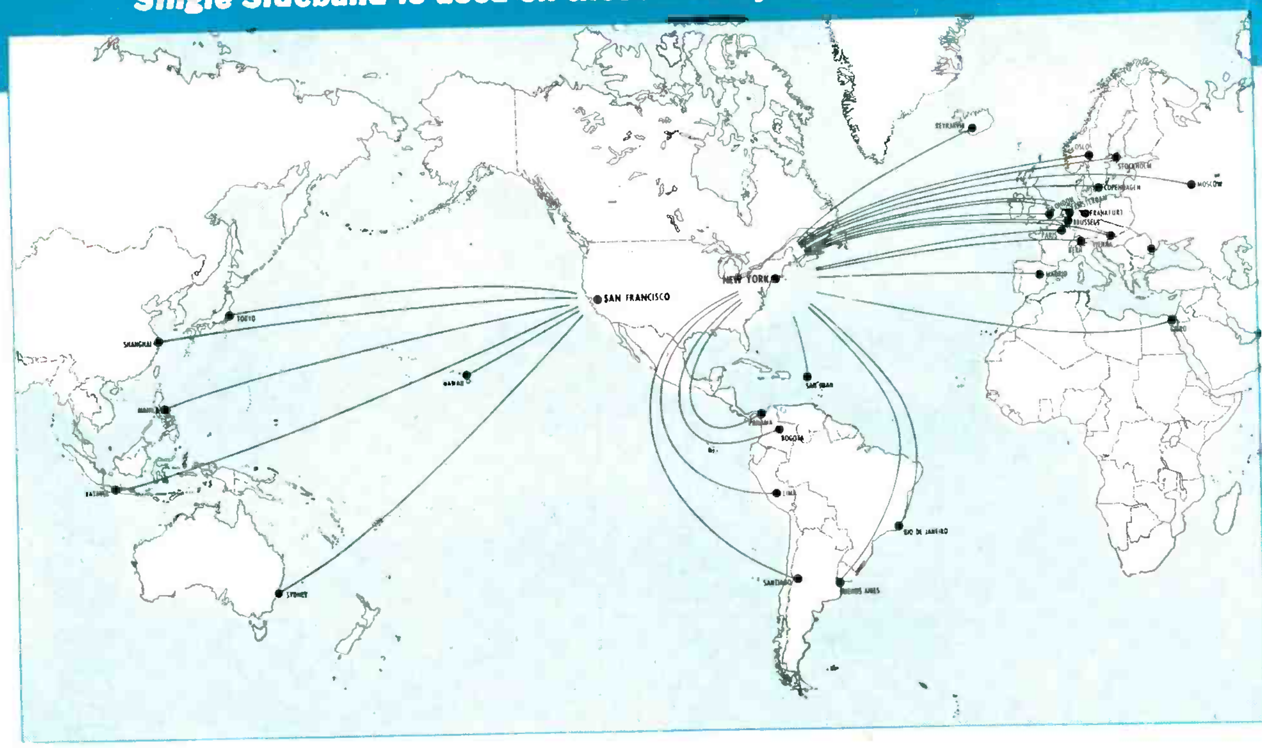
This system was originated and perfected by Bell Telephone Laboratories and Western Electric

THE RESEARCH that resulted in single sideband started at Bell Telephone Laboratories as early as 1915, when speech was first successfully transmitted overseas by radio. To improve the quality of voice reception, Bell scientists began studies of the fundamental nature of voice modulation. They proved that the radio transmitter was handling two similar versions of the voice (the sum and difference beat frequencies) in addition to the carrier.

Question: ***Could one of the sidebands be suppressed—thereby increasing efficiency?***

For the answer, new tools were needed and were forged by other Bell scientists: a balanced modulator that will reduce the carrier to any desired degree; an electrical

Single Sideband is used on these Bell System overseas circuits



BELL TELEPHONE LABORATORIES

World's largest organization devoted exclusively to research and development in all phases of electrical communications.

. . Bell System Voice Links with the World

wave filter that could accurately select one sideband and suppress the other; a very stable carrier frequency source and many other devices were originated. This accomplished, first transatlantic test of single sideband radio was carried out January 14, 1923.

1927 marked the entry of single sideband into commercial two-way long-wave radiotelephony, and the development by Bell Laboratories of crystal-controlled oscillators soon made possible its extension to short-wave communications.

Today one single sideband transmitter can simultaneously transmit as many as three separate radiotelephone conversations, using but little more frequency space than would be required for one double sideband voice transmission. Now, single sideband equipment—originated and perfected by Bell Laboratories, built by Western Electric—joins the U. S. with practically all major points throughout the world by radiotelephone.

The birth and growth of single sideband

1915. Bell engineers analyze nature of frequency band fed into antenna in voice-modulated transmission.

1918. Bell System makes first commercial application of single sideband, in carrier telephony.

1923. Bell System makes first transatlantic single sideband voice transmission.

1927. Single sideband enters radiotelephony field with opening of long-wave U.S.—England link.

1928. First commercial short-wave transatlantic single sideband radiotelephone circuit opened.

1930-1939. Single sideband service to South America, Honolulu, Paris, Manila.

1941-1945. Single sideband equipment built by Western Electric extensively used by Armed Forces, as well as government agencies.

1945-1948. Many more Western Electric single sideband radio systems put in service throughout the world.

Now... NEWEST IN SINGLE SIDEBAND

the economical, low-power LE System

LATEST development in single sideband is the compact, low-power Western Electric LE System. Like the higher-powered LC now in wide use, the new LE is built to Bell System specifications for operation with a minimum of maintenance.

The LE System consists of three self-contained units: transmitter, receiver and control terminal. New electronic speech privacy equipment is incorporated into transmitter and receiver.

With the LE System, the Bell System now makes use of the demonstrated advantages of single sideband in the field of medium-distance radiotelephony.

LE-T1 Transmitter **LE-R1 Receiver** **B4 Control Terminal**

—QUALITY COUNTS—

LE Single Sideband equipment is distributed outside the U. S., Canada and Newfoundland by Westrex Corp., 111 Eighth Ave., New York, N. Y.

Western Electric

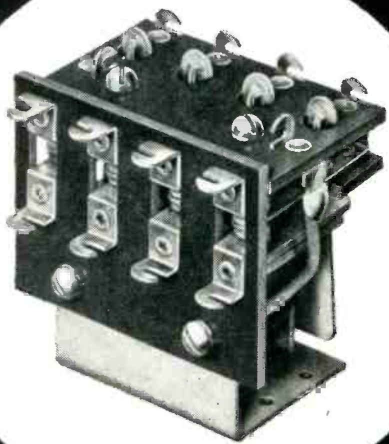
Manufacturing unit of the Bell System and the nation's largest producer of communications equipment.

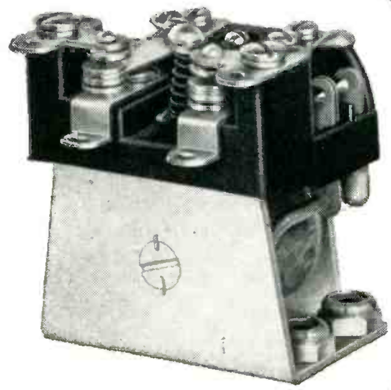
These Three

ALLIED POWER RELAYS

FROM SINGLE-POLE TO FOUR-POLE

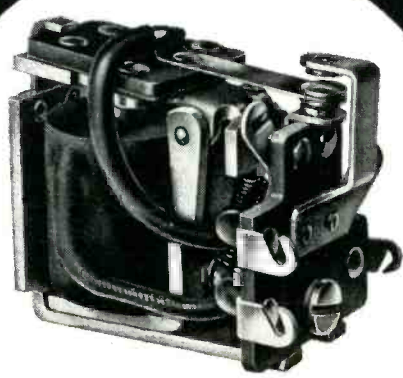
TYPIFY ALLIED VERSATILITY





3-POLE & 4-POLE "PO" TYPE RELAY

This medium power relay is supplied with contact arrangements up to 4-pole double-throw. Standard silver contacts rated at 15 amperes for 24 volts DC or 110 volts AC non-inductive. Coil rating 2.5 watts up to 112 volts DC and 10.5 volt-amperes up to 230 volts AC. Dimensions: 3-pole 2-1/4" x 1-7/8" x 1-5/8". 4-pole 2-1/4" x 1-7/8" x 2-3/16".



DOUBLE-POLE "BO" TYPE RELAY

This all-purpose power relay is supplied with single or double-throw contacts. Molded insulation throughout. Standard silver contacts rated at 15 amperes for 24 volts DC or 110 volts AC non-inductive. Coil rating of 2.5 watts up to 112 volts DC and 4.5 volt-amperes up to 250 volts AC. Dimensions: 1-7/8" x 1-13/32" x 1-5/8".

SINGLE-POLE "AS" TYPE RELAY

This small, light-weight power relay is supplied with single or double-throw contacts. Standard silver contacts rated at 5 amperes for 24 volts DC or 110 volts AC non-inductive. Coil rating 1 watt up to 95 volts DC and 3.5 volt-amperes up to 230 volts AC. Dimensions: 1-3/8" x 1-5/8" x 15/16".

Like all Allied Relays, types "AS," "BO" and "PO" may be had hermetically sealed, with choice of standard octal plug-in base or solder-type terminals.

For complete information on these and other Allied Relays, write for latest Bulletin.

NEW RELAY GUIDE

This new folder shows 24 small, compact Allied Relays with a carefully detailed table of characteristics and specifications. Write for YOUR free copy today.

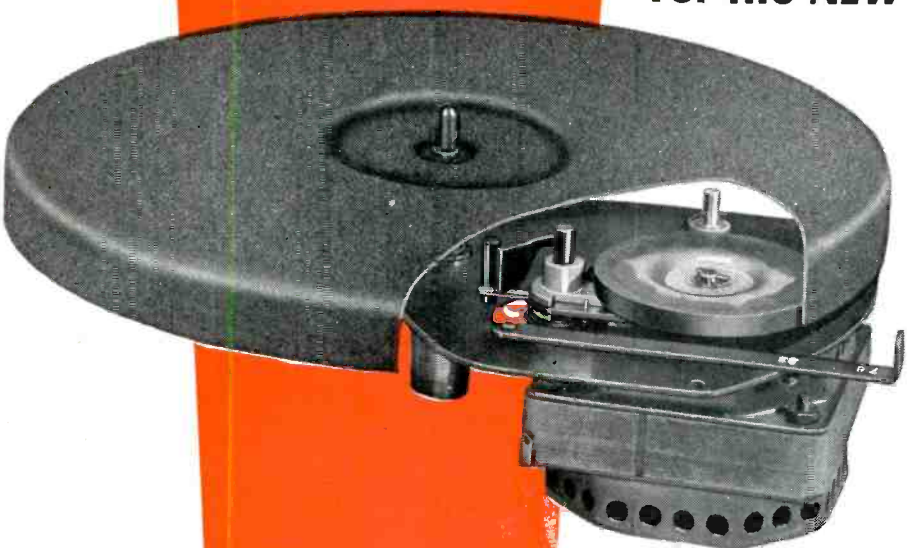
ALLIED CONTROL COMPANY, INC.

2 EAST END AVENUE, NEW YORK 21, NEW YORK

For the first time . . .

RIM DRIVE DUAL SPEED PHONOMOTORS!

For the *NEW* 33⅓ R. P. M. RECORDS



MODEL DR — Deluxe model 4 pole, shaded pole motor designed for use in all high-grade instruments in which the ultimate in performance is desired. Novel speed change mechanism is both simple and positive in operation.

MODEL DM — Compact low cost 2 pole, shaded pole motor designed for portables, table models, and other instruments in which space is an important factor. Ingenious speed change mechanism incorporates highest quality molded rubber belt.

Another General Industries' *first* . . . low cost, dual speed phonomotors that will play both the new 33⅓ R. P. M. and conventional 78 R. P. M. records. Both motors have external speed change control levers . . . both are engineered and built to the same high quality standards which distinguish all phonomotors, recorders and record changer-recorders in the famous GI *Smooth Power* line.

Complete information about this newest development in the phonomotor industry is available upon request. Write or wire today *to:*

GI

The GENERAL INDUSTRIES Co.

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PROBLEM: HOW TO PRODUCE
ANSWER: WESTINGHOUSE
FOR EXAMPLE!
FINGER-TIP SPEED CONTROL WITH ONE SMALL DIAL
AC
DC
WIDE, STEPLESS SPEED RANGE
AUTOMATIC SPEED REGULATION
SMOOTH, FAST ACCELERATION
AUTOMATIC CURRENT LIMITATION

BETTER, FASTER, CHEAPER ELECTRONIC CONTROL

MOT-O-TROL... a wide, stepless speed control for d-c motors from a-c power line

You get complete motor control from a single control station with Westinghouse Mot-O-Trol—a new development that provides a wide, stepless range of speeds for d-c motors operated from alternating current. Mot-O-Trol starts motors. It brings them up to preset speed smoothly and rapidly. It permits wide change of speed at any time. It regulates speed under varying loads. It applies dynamic braking for stopping. It reverses motors. Mot-O-Trol provides precise control in a packaged drive that needs no additional equipment. It can be mounted on or built into machines.

Today, Mot-O-Trol versatility is solving drive problems in nearly every industry. In yours, too, there may be an application where exacting control will step up the efficiency of men and machines. Investigate Mot-O-Trol advantages today. Get all the facts . . . the complete story. Call your nearest Westinghouse representative and ask for booklet B-3256 or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania.

J-60679

CHECK THESE MOT-O-TROL FEATURES

- Smooth, automatic acceleration. Current limit is preset to suit load requirements.
- Finger-tip speed control on one small dial.
- Minimum number of circuits and industrial type components.
- Constant torque—low to base motor speeds.
- Constant horsepower—base to higher speeds.
- Protection against overloads, low voltage and field failure.

Mot-O-Trol cabinet for 15 hp drive

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PLANTS IN 25 CITIES . . . OFFICES EVERYWHERE

Electronic Control

Mot-O-Trol—the complete packaged adjustable speed d-c drive.


The Cord
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MAKES
A DIFFERENCE
Belden
400
FAILURE
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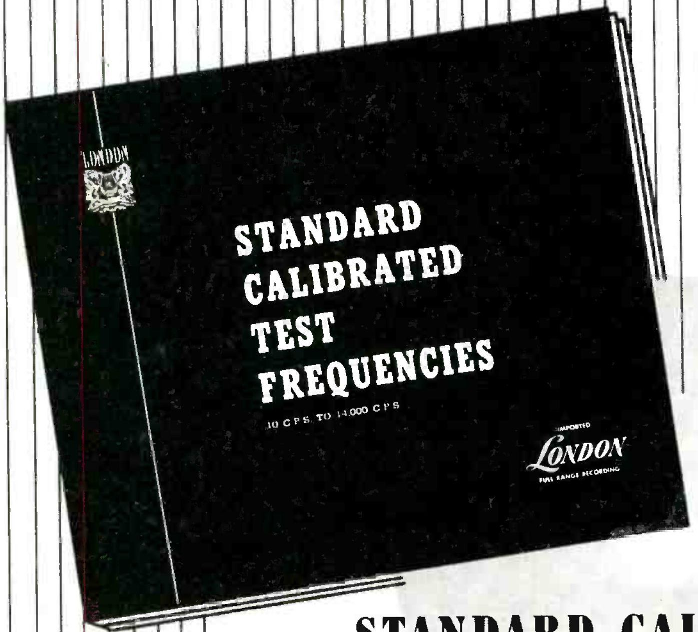


STANDARD CALIBRATED FREQUENCY RECORDS

10 C.P.S. TO 14,000 C.P.S.

London Gramophone Corporation offers to all technicians associated with the audio-frequency reproduction art, an album set of three, double-sided, 12", 78 r.p.m. records covering the frequency band of 10 c.p.s. to 14,000 c.p.s.

Two records, each covering 10 c.p.s. to 14,000 c.p.s. are "gliding tone" recordings, one of which is cut to the standard "LONDON" recording characteristic while the other employs a flat characteristic from 14,000 c.p.s. to 400 c.p.s., with quoted levels below 400 c.p.s. The third covers 30 c.p.s. to 14,000 c.p.s. in 18 bands of steady tones. The fullest attention has been paid to accuracy of the stated frequencies and their recording levels; full technical data, with frequency/level curves, is given in the liners of the album.

These discs are manufactured from the standard "LONDON" high (22%) shellac content "mix" which ensures the extremely hard surface essential for hard life and the avoidance of distortion at the higher frequencies, arising from "give" of groove walls when pliable disc material is used.

This album set is ready for immediate delivery, post paid upon receipt of remittance of $15 or will be sent C.O.D. for $15 plus charges, direct from:—

THE LONDON GRAMOPHONE CORP.
Technical Division
16 West 22nd Street, New York 10, N.Y.

IMPORTED
LONDON
FULL RANGE RECORDING

RCA WR-39A Television Calibrator **RCA WR-59A Television Sweep Generator** **RCA WO-58A Television Oscilloscope**

THE RCA TV TRIO...

for Production and Laboratory use

a complete set-up for the precision alignment of television receivers

● The new RCA Television Calibrator, Sweep Generator, and Cathode Ray Oscilloscope are high-precision instruments incorporating design features which reflect the wide experience of RCA engineers in television. The RCA TV Trio provides a complete set-up for testing and aligning television receivers in the laboratory or in production and quality-check positions.

RCA Television Calibrator WR-39A has two crystal oscillators for establishing the calibrator frequency. The marker oscillator operates on fundamental frequencies in all bands, and provides markers at all TV frequencies. An easy-reading scale enables quick crystal-harmonic identification, and a built-in speaker is provided for zero-beat indication.

RCA Television Sweep Generator WR-59A covers all broadcast television channels, TV- and FM-if bands. All ranges employ fundamental signals, are pre-set, and can be quickly selected by means of a band switch. Sweeps are provided for both 10.7-Mc. and 25.75-Mc. if bands, and for video channels to 10 Mc. Amplitude variation is less than 1 db. The piston attenuator has a maximum ratio of 20,000/1.

RCA Oscilloscope WO-58A has a flat response from 5 cycles to 2 Mc., with less than 2 per cent tilt and overshoot, and rise time of less than 0.15 microsecond. It displays all TV sync. signals accurately, and is easily calibrated for use as a peak-to-peak voltmeter. A phase-shift control is provided.

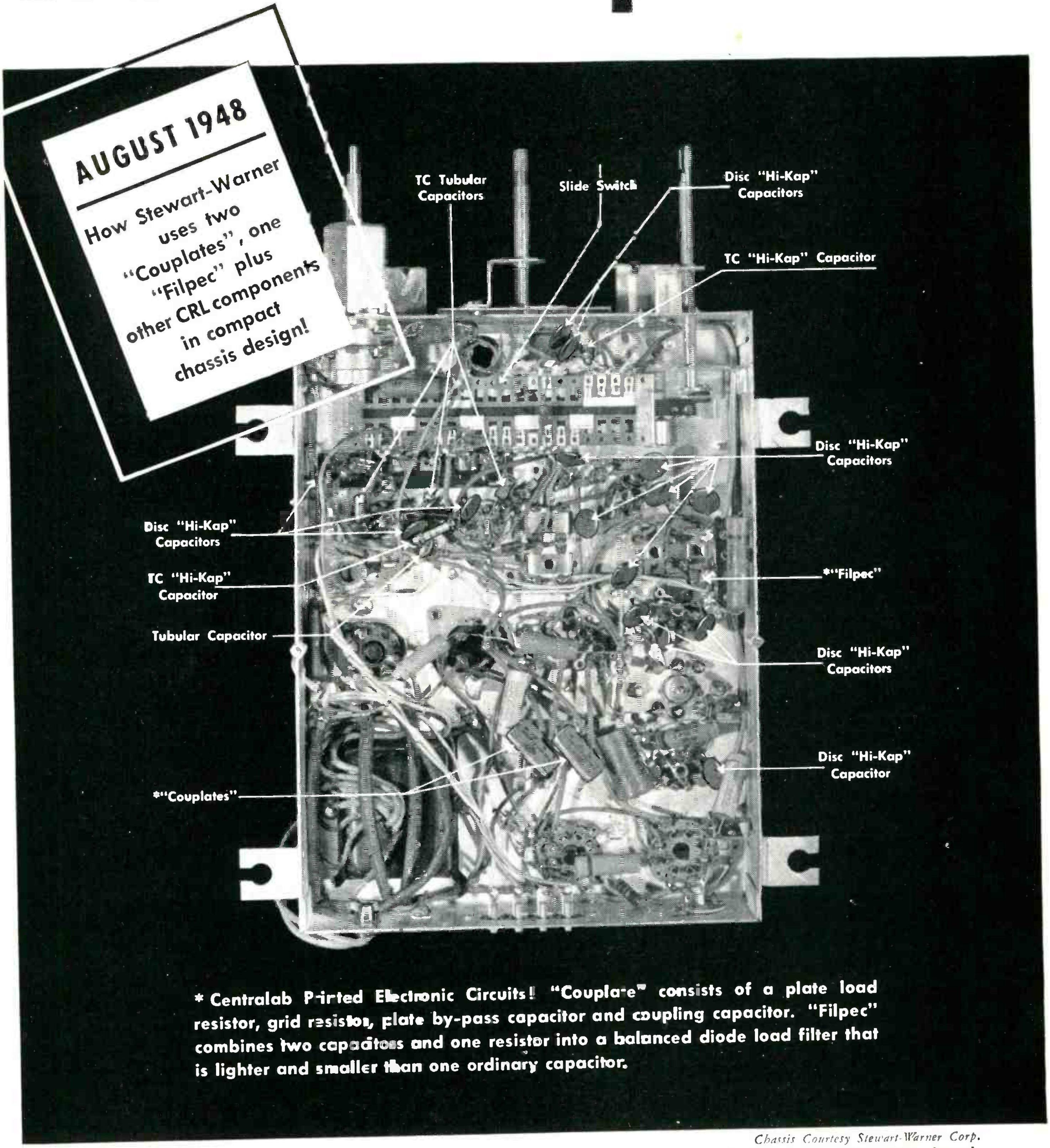
For complete technical data on the RCA Television Trio, see your RCA Test Equipment Distributor, or write RCA, Commercial Engineering, Section HY40, Harrison, N. J.

Available from your RCA Test Equipment Distributor.

RADIO CORPORATION of AMERICA

TEST AND MEASURING EQUIPMENT **HARRISON, N. J.**

Centralab reports to



*** Centralab Printed Electronic Circuits! "Couplate" consists of a plate load resistor, grid resistor, plate by-pass capacitor and coupling capacitor. "Filpec" combines two capacitors and one resistor into a balanced diode load filter that is lighter and smaller than one ordinary capacitor.**

Chassis Courtesy Stewart-Warner Corp.

1 Simplified wiring and assembly . . . fewer individual components . . . fewer leads to be soldered — these are just a few of the advantages you get with CRL *Printed Electronic Circuits!* That's why Stewart-Warner uses them, and that's why you will want to see and test them yourself. For quality performance, dependability and long life, Stewart-Warner also uses Centralab's *Slide-Switch*. Ceramic Disc and Tubular *Hi-Kap* Capacitors. See your CRL Representative, or write for complete information.

ASSURING *Top Production* from ELECTRIFIED MACHINES

By integrating the WESTON "per-cent load" ammeter or wattmeter into the machine, designers now make it easy for operators to secure *optimum production* from machine tools and other motor-driven equipment. This instrument continuously provides operators with the following indications:

- MAXIMUM SAFE LOAD . . . *reduces tool breakage.*
- CHANGING LOAD . . . *indicates need for sharpening or resetting tools, redressing grinding wheels, etc.*
- OVERLOAD . . . *permits corrections before serious troubles occur.*

Installed on milling machines, grinders, polishers, turret lathes, automatics, etc., the "per-cent load" indicator is proving a valuable aid in *increasing production . . . providing uniformly high quality with fewer rejects . . . assuring longer life from motors and tools.*

Consult your nearest WESTON *representative, or write Weston Electrical Instrument Corp., 618 Frelinghuysen Ave., Newark 5, N. J.*

WESTON *Instruments*

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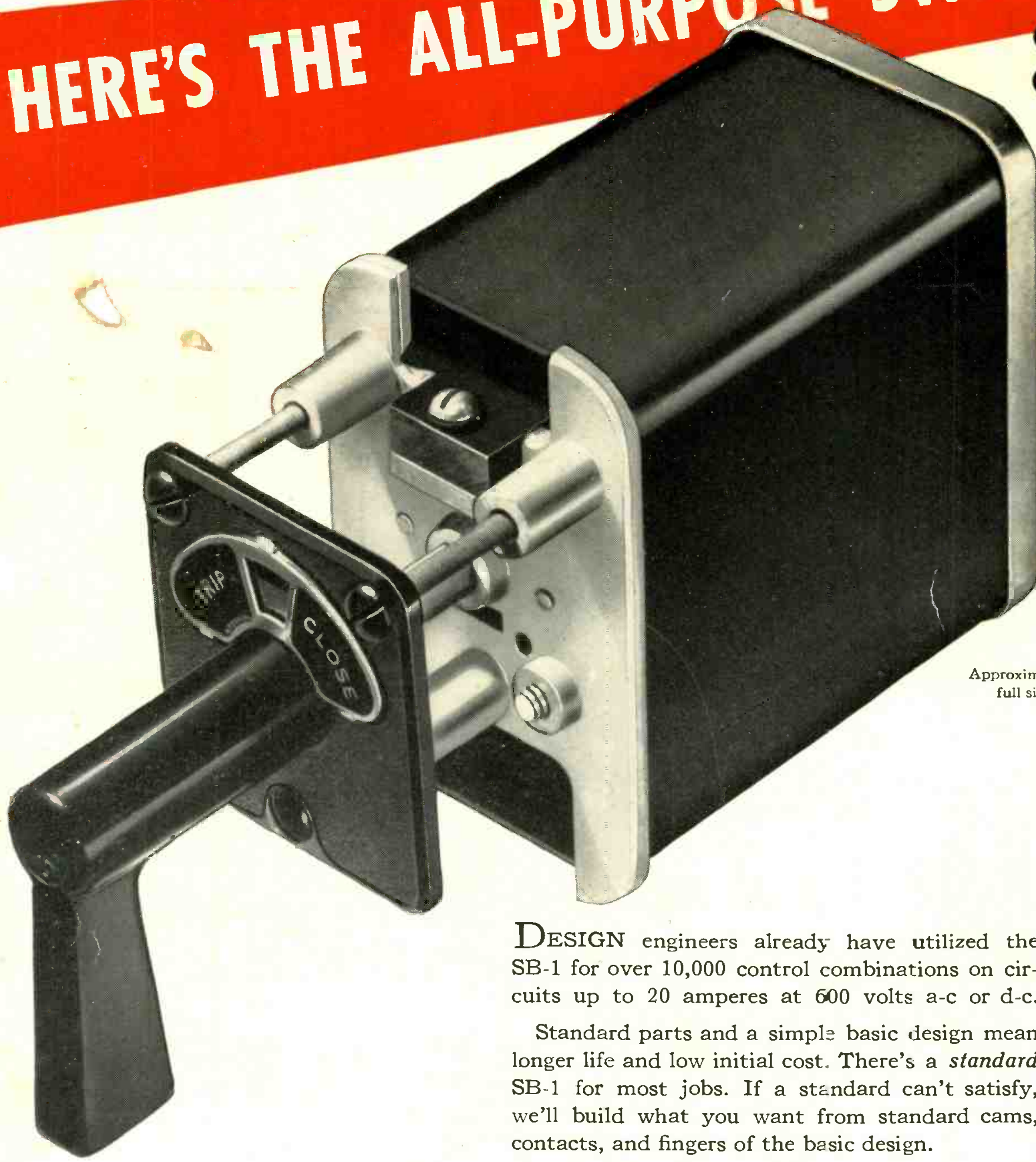
HERE'S THE ALL-PURPOSE SWITCH *



Approximately full size

DESIGN engineers already have utilized the SB-1 for over 10,000 control combinations on circuits up to 20 amperes at 600 volts a-c or d-c.

Standard parts and a simple basic design mean longer life and low initial cost. There's a *standard* SB-1 for most jobs. If a standard can't satisfy, we'll build what you want from standard cams, contacts, and fingers of the basic design.

A variety of attractive switch handles, and water-tight, dust-tight, oil-immersed, fabricated-metal, or explosion-proof housings are available to fit your particular installation problems.

Your nearest G-E sales representative will be glad to assist you in the selection of an SB-1. Also, ask him for a copy of GEA-4746 which gives additional information about the SB-1, or write to *Apparatus Department, Section 856-6, General Electric Company, Schenectady 5, New York.*

SB-1

* it's the.... **CONTROL AND TRANSFER SWITCH**

GENERAL ELECTRIC

THESE are your capacitors. By and large, they are the result of challenges made on the drawing boards of your equipment design engineers—challenges that have led us to new concepts in capacitor development and design.

We have made contributions—the introduction of the liquid dielectrics Pyranol and Lectronol, the development of thin kraft paper and Lectrofilm, and the use of silicone rubber bushings and gaskets—all evidences of our efforts toward smaller size, lower weight, higher quality, and lower-cost capacitors.

But basically these capacitors have been built to meet your needs. We hope sincerely that you will call upon us whenever we can be of assistance.

GENERAL ELECTRIC

407-158

SERVICE-PROVED COMPONENTS

Available Over Wide Range of Ratings

The extensive experience gained by General Electric in design and manufacture of electronic components for the Armed Forces is available to builders of commercial electronic equipments. In many cases the range of available ratings is wider than ever before.

RESONANT REACTORS, OIL-FILLED, HERMETICALLY SEALED

Resonant-charging reactors, accurately designed and constructed for radar service. Usually required in ratings of 40 kv and below, 1 ampere and below and 300 henries and below. Higher ratings are being built, and can be considered. When required, small- and medium-size designs can be provided with 3 to 1 range of inductance adjustment.

PULSE TRANSFORMERS, OIL-FILLED, HERMETICALLY SEALED

Pulse transformers for use with either hard-tube or line-type modulators. Available in voltage ratings of 10 kv or above. These units are ideal for radar applications, stepping up or down, impedance matching, phase reversing and plate-current measurements. Also suitable for nuclear physics research work, television and numerous special applications in and out of the communications field.

FILAMENT TRANSFORMERS, OIL-FILLED, HERMETICALLY SEALED

Filament transformers available with or without tube socket mounted integral with the high-voltage terminal. Low capacitance. Ratings to match any tubes; insulated to practically any required level.

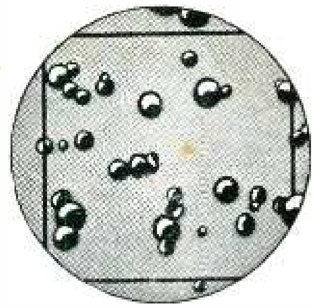
For price and delivery on the above components, write your nearest General Electric Apparatus Office or direct to General Electric Company, Capacitor Sales Divisions, 16-215, Pittsfield, Mass.

GENERAL ELECTRIC

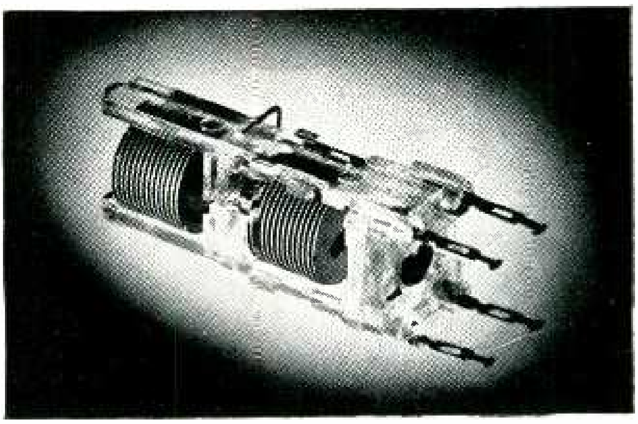
The "core" of Electronics

G. A. & F.

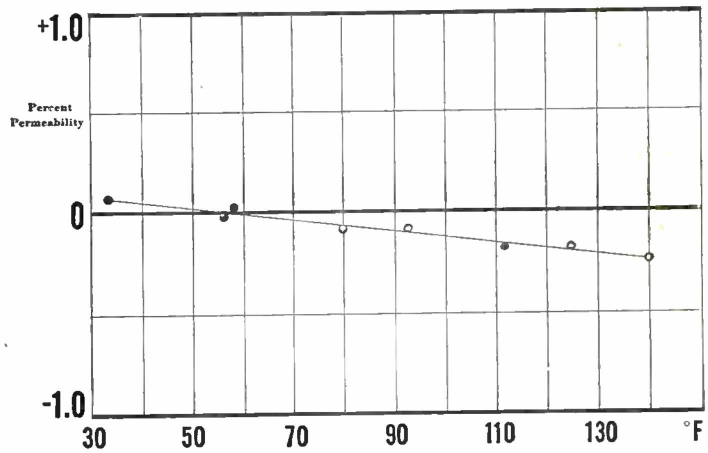
Carbonyl Iron Powders



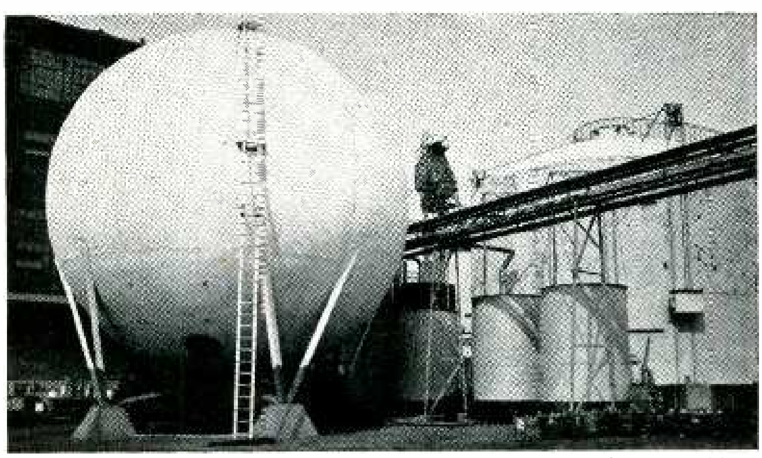
1. Used chiefly for cores in high frequency magnetic fields, G. A. & F. Carbonyl Iron Powders are especially high in iron content, and free from disturbing non-ferrous metals. The individual particles are spherical. Some grades contain agglomerates of several particles. Microphoto above: Grade TH at 350X. Average particles of this grade have a diameter of 5 microns.



2. I-F and H-F applications of G. A. & F. Carbonyl Iron Powders include: I-F transformer cores, H-F adjusting cores, AM inductance tuning cores, TV wave trap cores, short-wave transmitter tank coil cores, direction finder loop antenna cores, carrier telephony cores and cups. Photo above: "K-Tran," revolutionary top quality I-F transformer, only possible with cores of G. A. & F. Carbonyl Iron Powder.



3. G. A. & F. Carbonyl Iron Powder advantages: Low eddy current, residual, hysteresis losses (resulting in higher Q). Excellent temperature and magnetic stability. Savings (as against air-cored coils) in volume, weight, wire length. Graph above: the small permeability change due to temperature of uncompensated toroids of G. A. & F. Carbonyl Iron Powders, Grades E, TH and SF.



4. Made by exclusive carbonyl process: CO gas and iron ore form liquid iron penta carbonyl. Decomposed by heat into powdered iron, CO gas. Two unique results: *chemically pure* iron penta carbonyl and *spherical* iron powder particles. Photo above: Hortonsphere for storing CO under pressure.

Ask your core manufacturer about Carbonyl Iron Powders. Or write to:

ANTARA PRODUCTS
444 Madison Avenue
New York 22, N. Y.
Department 82

Carbonyl Iron Powders are an Antara® Product of General Aniline & Film Corporation

For Quality and Performance

offers

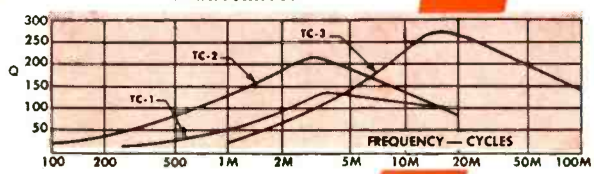
High Q TOROIDAL COILS

The solution of filter network problems, has been greatly simplified through the use of toroidal coils wound on molybdenum permalloy cores. Design engineers have learned to depend upon them since discovering that only these toroids possess all the necessary qualities of a good high "Q" coil.

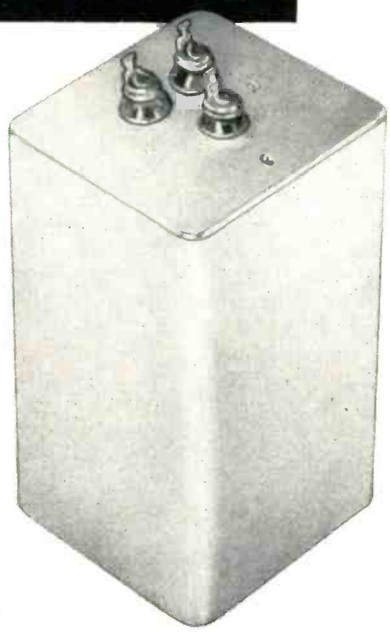
Of the 30 different items now being manufactured, the most available types now being supplied are:

TYPE	RANGE
TC-1 Any Ind. up to	10 HYS
TC-2 Any Ind. up to	30 HYS
TC-3 Any Ind. up to	750 MHYS

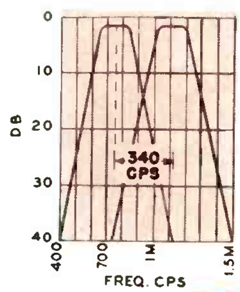
Be sure to state desired inductance.

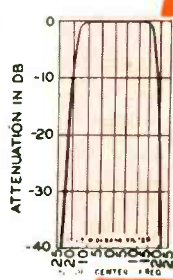


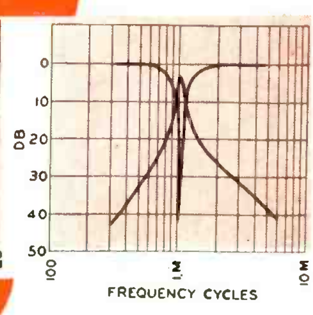
TOROIDAL COIL FILTERS



Our toroid filters have become a by-word in every phase of electronics where only the best results are acceptable. Toroidal coils wound on MOLYBDENUM PERMALLOY DUST CORES are the primary basis for our success in producing filters unexcelled in performance. We are producing toroidal coil filters which consistently demonstrate the value of toroidal coils. These filters cannot be matched in stability, accuracy and sharpness by filters made with the usual laminated type of coil.







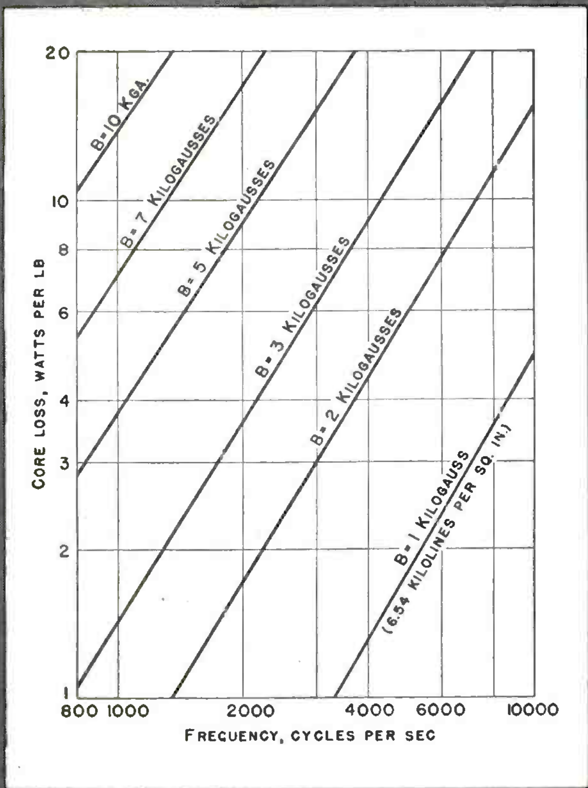
ALL INQUIRIES WILL BE PROMPTLY HANDLED
WRITE FOR OUR CATALOGUE

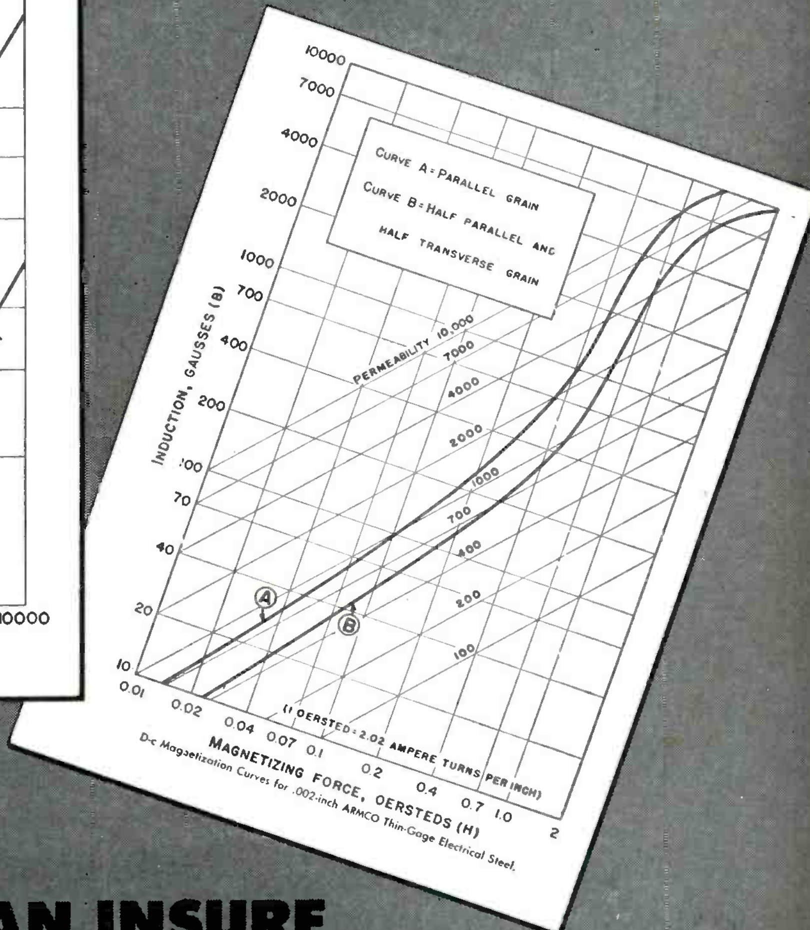
Burnell & Company

DESIGNERS AND MANUFACTURERS OF ELECTRONIC PRODUCTS

45 WARBURTON AVE., YONKERS 2, N. Y.

CABLE ADDRESS "BURNELL"





NOW YOU CAN INSURE low energy loss at high frequencies

ARMCO Thin-Gage Electric Steel—a war-born development of ARMCO Research—is making its mark in the development of magnetic cores for television, radar, sonic detection, and many other high-frequency devices.

Whenever applications involve changes in magnetic flux equivalent to frequencies from 400 to as high as 1,000,000 cycles per second, this steel has five definite advantages:

1. Supplied in coils suitable for high-speed punching operations or for winding into cores.

2. Skin-effect does not become appreciable at high frequencies because thicknesses as light as 1 or 2 mils are obtainable.

3. Considering the gage and insulation on both sides, the stacking factor is high. Four hundred sheets of .002-inch insulated steel make a stack only 1 inch high.

4. CARLITE Insulation, formed by a new surface treatment developed by Armco, effectively insulates each lamination and assures minimum interlamination loss.

5. Hysteresis is unusually low for such thin steel.

Write us for further information pertaining to your specific products. Just address the Armco Steel Corporation, 208 Curtis Street, Middletown, Ohio.

EXPORT: THE ARMCO INTERNATIONAL CORPORATION

ARMCO

ARMCO ELECTRICAL STEELS

FOR all products to be made by drawing, stamping and similar sheet metal operations, Revere sheet and strip of copper or brass offer maximum ease of fabrication. Not only are these metals naturally ductile, but they benefit further from the metallurgical skill which Revere has gained in 147 years of experience.

In composition, mechanical properties, grain size, dimensions and finish, you will find Revere metals highly uniform. They enable you to set up economical production methods and adhere to them. They can help you produce better products at faster production rates, with less scrap and fewer rejects.

Revere copper, brass and bronze lend themselves readily to the widest variety of finishing operations—polishing, lacquering, electro-plating. With these superior materials it is easy to make radio shields and similar products beautiful as well as serviceable.

That is why wise buyers place their orders with Revere for such mill products as—*Copper and Copper Alloys:* Sheet and Plate, Roll and Strip, Rod and Bar, Tube and Pipe, Extruded Shapes, Forgings—*Aluminum Alloys:* Tubing, Extruded Shapes, Forgings—*Magnesium Alloys:* Extruded Shapes, Forgings—*Steel:* Electric Welded Steel Tube. We solicit your orders for these materials.

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COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

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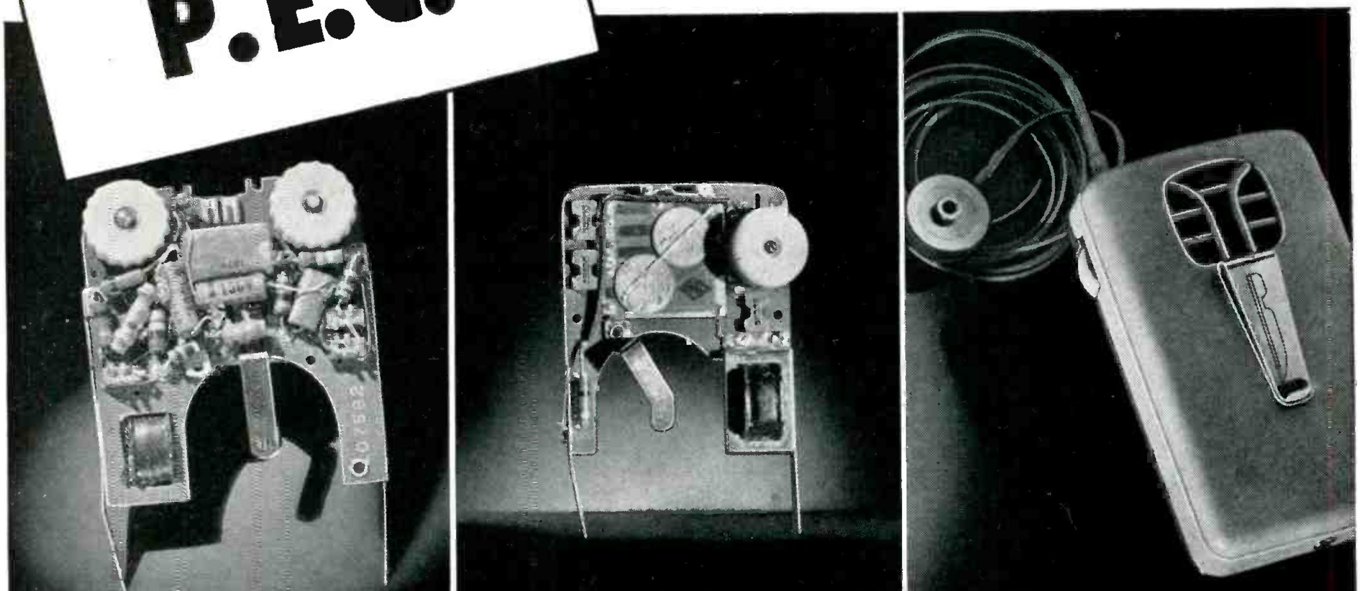
Mills: Baltimore, Md.; Chicago, Ill.; Detroit, Mich. New Bedford, Mass.; Rome, N. Y.

Sales Offices in Principal Cities, Distributors Everywhere.

PROGRESS REPORT ON P.E.C.*

How Beltone uses Centralab's "Printed Electronic Circuit" to design and manufacture the "world's smallest hearing aid"



PROBLEM: How to overcome size and weight limitations of ordinary electronic components and design a smaller, lighter Beltone hearing aid.

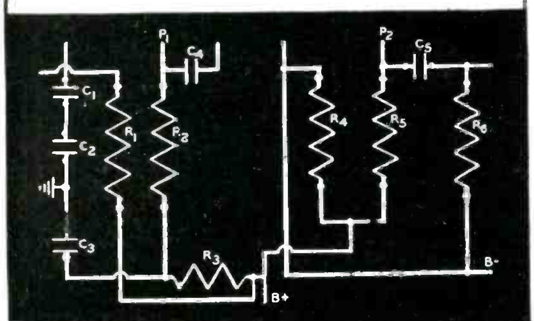
SOLUTION: Using Centralab's "Printed Electronic Circuit", 45 parts, including capacitors and resistors, have been combined into one compact chassis.

RESULT: The new, vastly improved 1948 Beltone Hearing Aid—smaller and lighter with improved performance and important production savings.

Models courtesy of Beltone Hearing Aid Co., Chicago

ACTUAL SIZE

REAR VIEW of Beltone PEC unit is shown above. Note ceramic disc capacitors, "printed" silver leads and resistors (black paths). See below for schematic diagram of entire *Printed Electronic Circuit*.



*Centralab's "Printed Electronic Circuit" — Industry's newest method for improving design and manufacturing efficiency!

For use where miniature size is of the utmost importance, nothing has ever been offered to manufacturers of electronic equipment which combines ruggedness, dependability and resistance to humidity and moisture in such a small unit package. That's what engineers of the Beltone Hearing Aid Co., Chicago, say about CRL's *Printed Electronic Circuit*, and that's what you will say when you have seen and tested this amazing new electronic development.

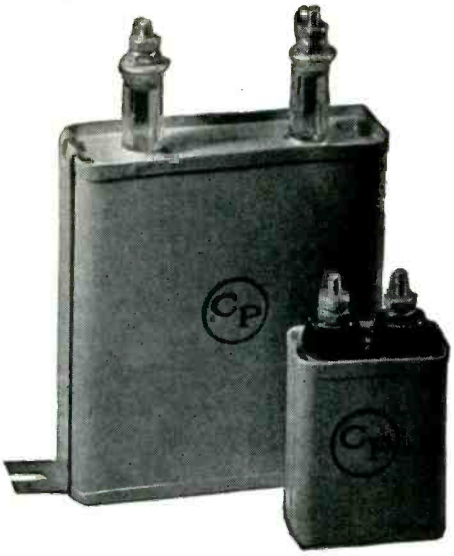
Integral ceramic construction: Each *Printed Electronic Circuit* is an integral assembly of "Hi-Kap" capacitors and resistors closely bonded to a steatite ceramic plate and mutually connected by means of metallic silver paths "printed" on the base plate. All leads are always the same length, each plate is an exact duplicate of the original or "master".

This outstanding new hearing aid development, illustrated above, was the product of close cooperation between Centralab and Beltone engineers. Working with your engineers, Centralab may be able to fit its *Printed Electronic Circuit* to your specific needs. Write for complete information, or get in touch with your nearest Centralab Representative.

LOOK TO **Centralab** IN 1948!

CRL

Division of GLOBE-UNION INC., Milwaukee



PLASTICON
Plastic Film Oil-Filled
CAPACITORS—

1. More Economical
2. Smaller—Lighter
3. Better Electrical Characteristics

1. MORE ECONOMICAL

MFD.	VOLTS DC	List Price PAPER CAPACITOR	List Price PLASTICON AOC	SAVING
10	1000	$15.18	$10.67	$4.51
4	2000	13.67	9.24	4.43
2	3000	22.78	15.40	7.38
1	4000	33.54	27.50	6.04
2	5000	48.73	41.25	7.48
Above are typical examples.				

PLASTICONS are the result of technological advances . . . cost less to manufacture, give better performance.

2. SMALLER—LIGHTER

MFD.	VOLTS DC	Approx. Weight		Approx. Cubic Dimensions	
		PAPER CAPACITORS	PLASTICONS	PAPER CAPACITORS	PLASTICONS
10	1000	1.95 lbs.	1.7 lbs.	31 cu. in.	30 cu. in.
4	2000	2.0	1.23	31	23
2	3000	2.0	1.21	31	19
1	4000	1.77	.94	28	19
2	5000	5.2	2.9	70	60

3. BETTER ELECTRICAL CHARACTERISTICS

	Paper Capacitors	Plasticons
Power Factor at 85°C 60 cycles	0.7%	0.3%
Resistance at 85°C megohms per Mfd.	40	100
Capacitance/Temp. Coefficient 100% at 25°	−40°C=73% +85°C=97%	−40°C=94% +85°C=103%

PLASTICON CAPACITORS given are Type AOC, mineral oil-filled.
PLASTICON ASC silicone-filled have better characteristics.
Paper Capacitors given are chlorinated diphenyl impregnated.

CP **Condenser Products Company**

1375 NORTH BRANCH STREET • CHICAGO 22, ILLINOIS

MANUFACTURERS of GLASSMIKE CAPACITORS and HIGH VOLTAGE POWER SUPPLIES.

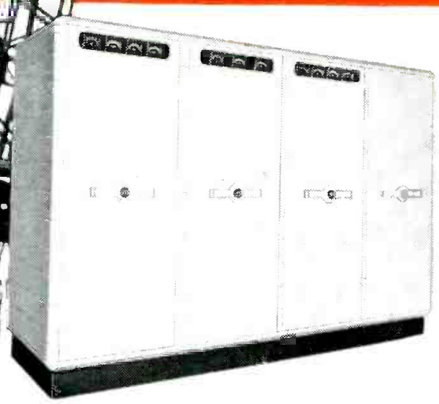
FEDERAL

BROADCAST EQUIPMENT

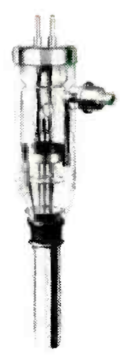
. . . An Outstanding Line Offering Finest Performance and Real Economy

In standard AM and FM transmitters . . . TV transmitters for low or high band operation . . . square loop antenna . . . special new developments including Studio-to-Transmitter Links . . . Dummy Antenna . . . TV Monitors . . . High Power Transmitting and Rectifier Tubes.

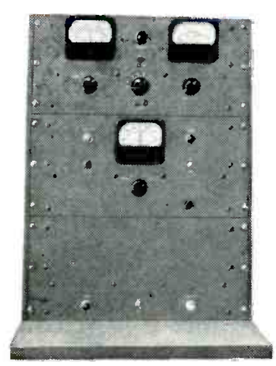
You can count on Federal Broadcast Equipment—from a complete system to an individual installation. Federal Broadcast Equipment brings you the latest in engineering technique and practice . . . high quality of materials . . . precision craftsmanship of the highest order. There is real economy in both initial cost and operation. And you are assured of the finest performance, because Federal sees every job through. This Federal policy upholds a reputation established by more than 38 years of continuous achievement in the radio transmission field.



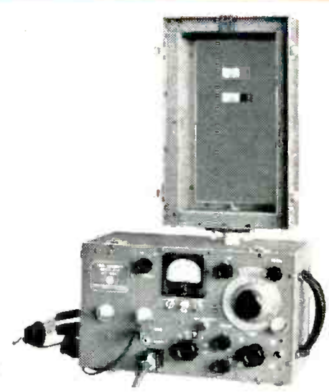
FEDERAL'S FM 10 KW Transmitter, officially approved by the FCC, has the exclusive "Frequematic" FM Modulator. It reduces distortion and noise well below RMA specifications, and stabilizes mean carrier frequency within 0.001 per cent of assigned value. This transmitter combines outstanding fidelity with economy, accessibility and highly dependable performance.



FEDERAL'S Transmitting Tubes provide long service. They stand up under severe operating conditions, and maintain original characteristics for life.

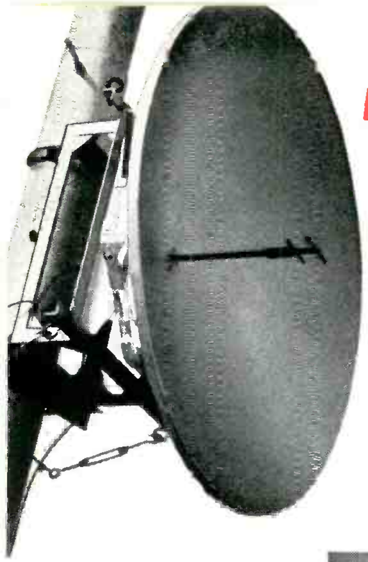


FEDERAL'S TV Monitor meets all FCC requirements. Designed for long service life, it accurately measures video carrier frequency, and monitors sound carrier and modulation.



FEDERAL'S Field Intensity Meter accurately measures signal intensity of AM broadcasting stations whether in the standard band of 530-1600 Kc—200 to 400 Kc—1600 to 3600 Kc—or 3600 to 7000 Kc. This 29-lb. unit is portable.

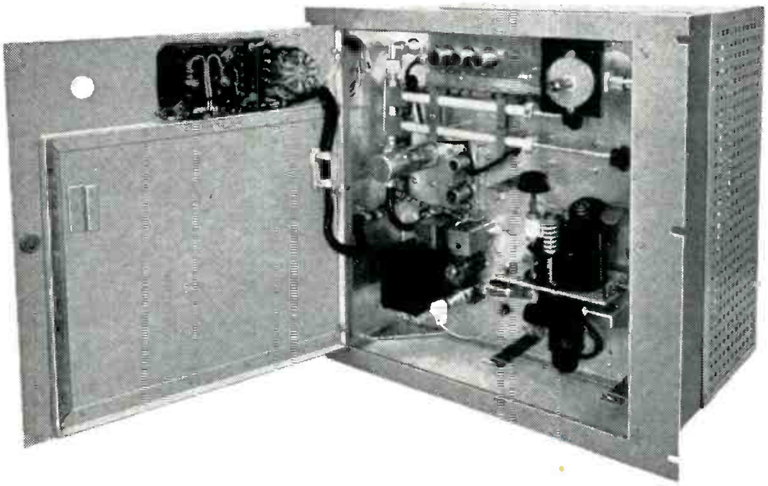
HIGHEST GAIN IN THE FIELD WITH FEDERAL'S SQUARE LOOP ANTENNA. In many installations from coast to coast, this design is producing an effective radiated power of as much as twelve times the Kilowatt rating of the FM transmitter. This means new power and new range for better and wider service. Federal's Square Loop Antenna also brings you simplicity of mechanical and electrical design . . . greater accessibility for maintenance . . . no operational tuning . . . maximum lightning protection . . . immediate delivery and ease of installation.



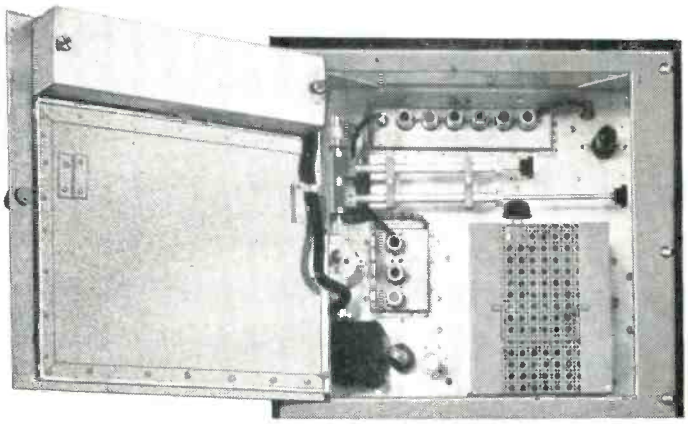
Federal's Studio-to-Transmitter Link for High Fidelity Program Transmission

Here's the new Federal microwave system to eliminate S-T wire and cable circuits. Combining outstanding fidelity – distortion less than 1% over 50-15,000 cycles – low noise level, 65 db below 100% modulation – and a 35-mile "line of sight" range – this system complies with all applicable FCC regulations for good engineering practice. Link consists of a transmitter, receiver and two standard 6-foot parabolic reflectors (4- or 8-foot reflectors supplied on request).

ONE OF MANY NEW DEVELOPMENTS BY FEDERAL TELECOMMUNICATION LABORATORIES

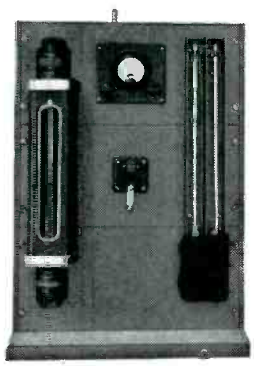


TRANSMITTER employs advanced-design direct frequency modulation and crystal-controlled klystron power oscillator. Complete monitoring facilities include frequency and power measurements, aural monitoring, and vacuum tube metering. Designed for mounting on standard 19" relay rack, it is only 35" high and 13" deep.



RECEIVER is a single superheterodyne which utilizes reflex-klystron local oscillator. It features pre-selection to reduce possibility of spurious interference. Relative stability is maintained within 0.01 per cent with automatic frequency control. Metering is provided for all vacuum tube circuits, carrier level, and crystal current. Same mounting and size as transmitter.

FEDERAL'S De Luxe Studio Console combines control of all facilities of an FM transmitter into one unit – a "nerve center" – convenient, foolproof, and handsome in appearance.



FEDERAL'S All-Metal Dummy Antenna meets the need of the Broadcasting Industry for testing of high power, VHF and microwave (FM and TV) transmitters. No conventional resistors and insulators. Compact, light, water-cooled – determines RF power accurately.

FEDERAL'S Standard 5KW AM Broadcast Transmitter assures high fidelity performance and maximum operating efficiency. Nominal output of 5KW can be transferred instantaneously to 1 KW. Every component is conservatively operated. Every circuit is engineered for maximum life of its elements. A new simplified power supply reduces maintenance to a minimum. Standard operating band.

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An IT&T Associate

Federal Telephone and Radio Corporation

100 KINGSLAND ROAD, CLIFTON, NEW JERSEY

KEEPING FEDERAL YEARS AHEAD... is IT&T's world-wide research and engineering organization, of which the Federal Telecommunication Laboratories, Nutley, N. J., is a unit.

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Export Distributors: International Standard Electric Corp. 67 Broad St., N. Y.

Use one alone—

or stack em' like hot cakes...

I-T-E OVAL RESISTORS SAVE SPACE!

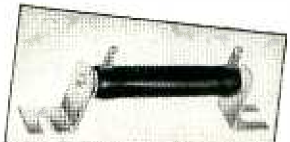
When space is limited—as in aviation, sound, or electronics applications—I-T-E Oval Resistors and Oval Resistor Assemblies may be the solution you're looking for.

Specially designed to meet the exacting and changing needs of the electronics industry, these modern, wire-wound power resistors are distinguished by their high unit-area wattage ratios, which are due in part to the heat dissipation qualities of the mounting brackets.

An I-T-E Oval Resistor—or an assembly of I-T-E Oval Units—has a much higher wattage rating than that of a conventional round resistor of comparable size. You save space and, at the same time, gain the dependable performance of I-T-E *quality* resistors.

No matter what your resistor problem is—space, exacting service, or dependable performance—be sure to investigate I-T-E Oval Resistors. Complete technical information, as well as valuable application data, are contained in the new I-T-E Resistor catalog. Send for it today.

There's an I-T-E Resistor for Every Purpose→

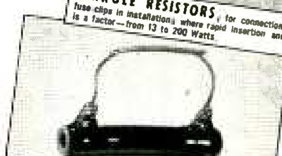


STANDARD FIXED RESISTORS from 5 to 200 Watts

ADJUSTABLE RESISTORS from 10 to 200 Watts

OVAL RESISTORS for limited space requirements—from 30 to 75 Watts

FERRULE RESISTORS, for connections through fuse clips in installations where rapid insertion and removal is a factor—from 13 to 200 Watts



RESISTORS FOR SPECIAL APPLICATIONS made to order. I-T-E Power Resistors are made with a normal tolerance of 10%. Tolerances of 5% and less are made to order.

I-T-E OVAL RESISTORS

Type	Watts	Length	Maximum Recommended Resistance	Mounting Centers
108 Oval	30	1¼"	10000	2"
200 Oval	40	2"	15000	2¾"
316 Oval	55	3½"	25000	4¼"
424 Oval	65	4¾"	35000	5½"
600 Oval	75	6"	50000	6¾"

POWER RESISTORS

The Leader In Technical Excellence

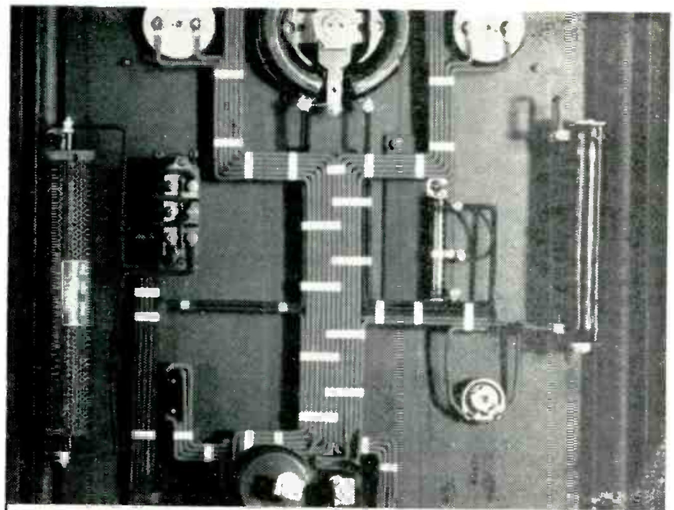
I-T-E CIRCUIT BREAKER CO., RESISTOR DIVISION, 19TH & HAMILTON STREETS, PHILADELPHIA 30, PA.

SWITCHGEAR • UNIT SUBSTATIONS • AUTOMATIC RECLOSING CIRCUIT BREAKERS • RESISTORS • SPECIAL PRODUCTS

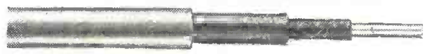
We Make a PERMANENTLY INSULATED Wire, Cable or Cord for Whatever You Make

Appliances, Ranges and Heating Devices

ROCKBESTOS APPLIANCE LEAD AND RANGE WIRE



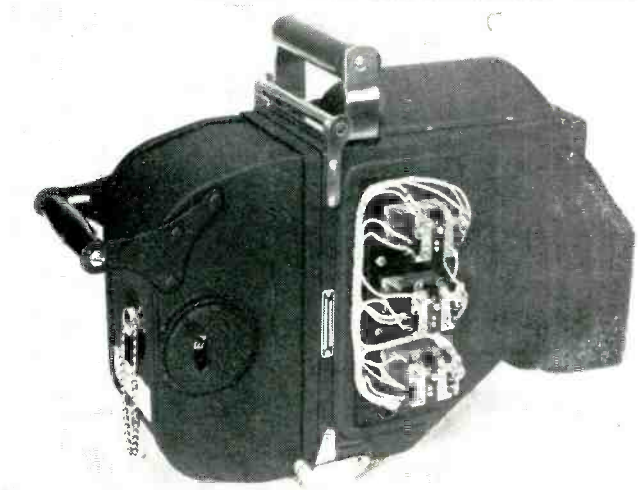
Control Panels, Switchboards, etc.



ROCKBESTOS A.V.C. SWITCHBOARD WIRE

Aircraft and Aircraft Equipment

ROCKBESTOS FIREWALL AIRCRAFT WIRE



Recording Cameras, Calculators, Motors, etc.

ROCKBESTOS FIREWALL HOOKUP WIRE

Here are four of the 125 permanently insulated wires, cables and cords designed and developed by Rockbestos to protect product performance and give lasting service.

Impregnated felted asbestos insulation is what makes Rockbestos wiring dependable . . . *permanent under use and abuse.*

And dependability makes a good name and repeat sales for your products.

WRITE TODAY — for your copy of the new No. 10-F Catalog, sectioned for easy reference to permanently insulated Apparatus Wires and Cables; Lighting Wires, Power and Control Cables; Switchboard, Appliance, Fixture, Electronic, Aircraft and Magnet Wires.

Rockbestos Products Corp., 462 Nicoll St., New Haven 4, Conn.

NEW YORK CLEVELAND DETROIT CHICAGO
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ROCKBESTOS

THE WIRE WITH PERMANENT INSULATION

For every radio receiver, there's a Ward Aerial which gets more stations, gets them clearer and more dependably. You'd naturally expect that from Ward, the world's leading mass producer of radio aerials exclusively. But, large as Ward is, this organization always has believed that resting on your laurels invites rust. Especially so in the fast changing FM and television fields. Accordingly, the Ward experimental laboratory constantly is probing the electronic horizon with the fervor of the true scientist. Many aerial developments still to be unveiled would, if revealed today, cause many a raised eyebrow. Tomorrow, these new developments will mean finer performance at lower cost for the radios you build or install. This same technical know-how is available to design and mass produce custom-designed aerials for anyone needing them in quantity. If you have an aerial problem, bring it to Ward. Your inquiries are invited.

WARD AERIALS

THE WARD PRODUCTS CORPORATION
1530 EAST 45th ST. CLEVELAND 3, OHIO
DIVISION OF THE GABRIEL CO.

Export Department: C. W. Brandes, Manager, 4900 Euclid Avenue, Cleveland 3, Ohio
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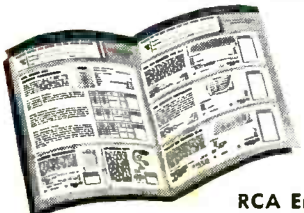


KEEP IT HANDY!

RCA Engineering Products Dept.
Camden, New Jersey

Please send me my copy of your bulletin on RCA's Audio Equipment Accessories.

Name__________

Address__________

Station__________ Position__________

City__________ State__________

REPRESENTED HERE are items from broadcasting's most complete line of fine audio accessories. Microphone stands . . . studio warning lights . . . cabinet racks . . . panel-mounted auxiliary units . . . transformers of many kinds. In all, more than 100 different items—with every type of unit you need from large size cabinet racks down to patch cords.

Designed by audio men *for audio men,* these accessories are built with the professional thoroughness needed to meet the most exacting requirements of broadcast use. Mechanically and electrically, every unit is built to "take it."

For information on RCA's complete line of audio accessories . . . immediately available from stock . . . call your RCA Broadcast Sales Engineer, or Dept. 36-H, Engineering Products, RCA, Camden, New Jersey.

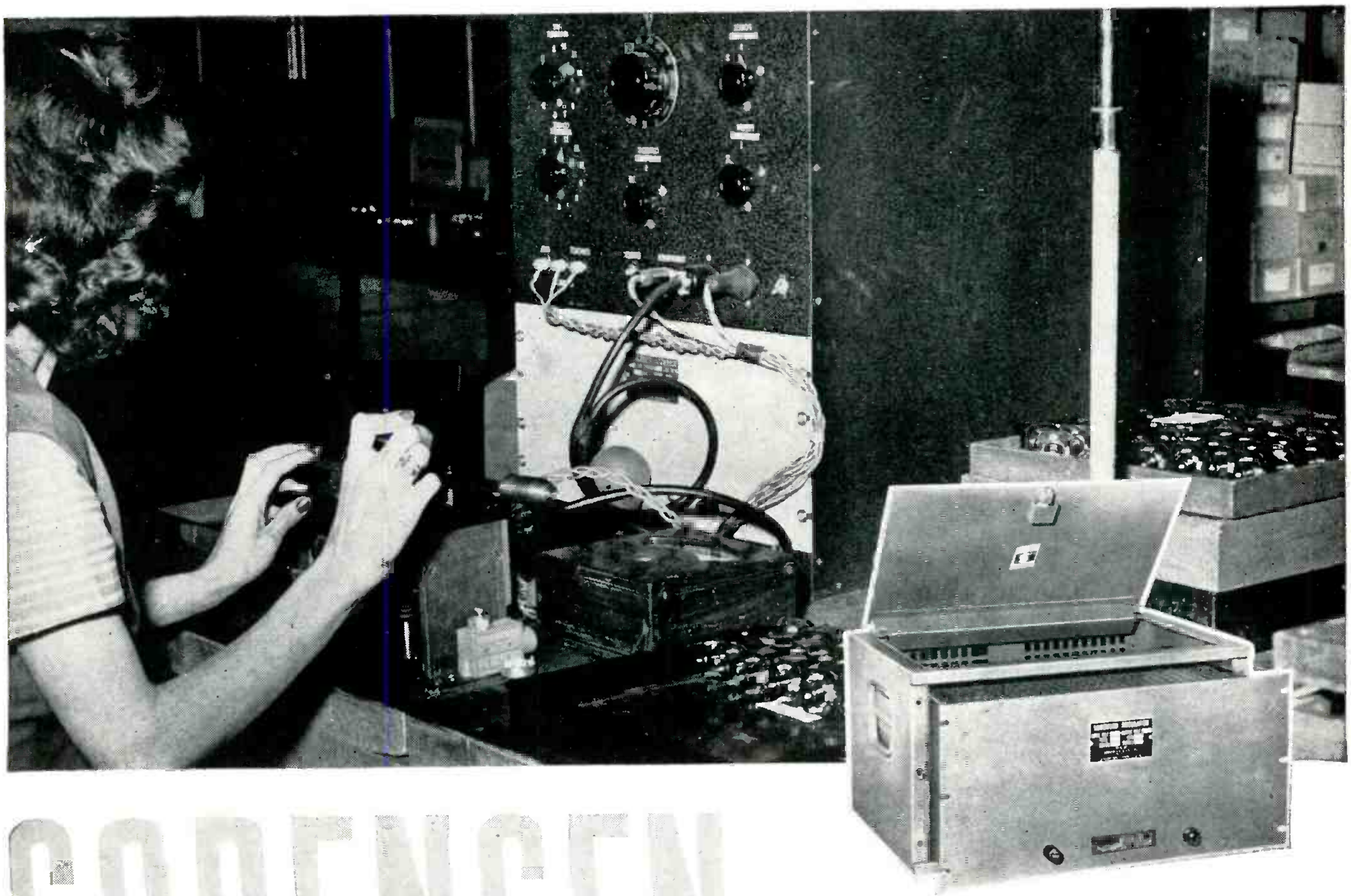
BROADCAST EQUIPMENT

RADIO CORPORATION of AMERICA

ENGINEERING PRODUCTS DEPARTMENT, CAMDEN, N.J.

In Canada: RCA VICTOR Company Limited, Montreal

PRECISE VOLTAGE REGULATION FOR TESTING RELAYS



SORENSEN PROTECTS

Spencer Thermostat Company uses Sorensen voltage regulators to test their Klixon C-6360 motor starting relay. They say, "Sorensen regulators speed up our testing processes by providing a steady supply of current enabling us to turn out a uniform product."

Model 1000 shown provides full protection of your unit against *OVER LOAD* and *OVER VOLTAGE.*

Sorensen protects your equipment against over load and over voltage and at the same time provides regulation of 2/10 of 1% with a minimum of wave distortion and wide input ranges. Precision Klixons are themselves assembly line tested with Sorensen regulators. In turn, Klixon units installed in Sorensen equipment provide automatic shut-off of the output in case of over load. In practically all AC and DC units the Heinemann circuit breaker incorporated into Sorensen regulators insures against over voltage.

Write today and arrange to have a Sorensen engineer analyze voltage regulation requirements in your plant. He can select a standard Sorensen unit from 150 VA to 20 KVA to fit your most exacting application.

Send for your copies of the Sorensen Electronic Library

SORENSEN & COMPANY

SORENSEN & COMPANY, INC.

375 FAIRFIELD AVENUE • STAMFORD, CONNECTICUT

The First Line of Standard Electronic Voltage Regulators

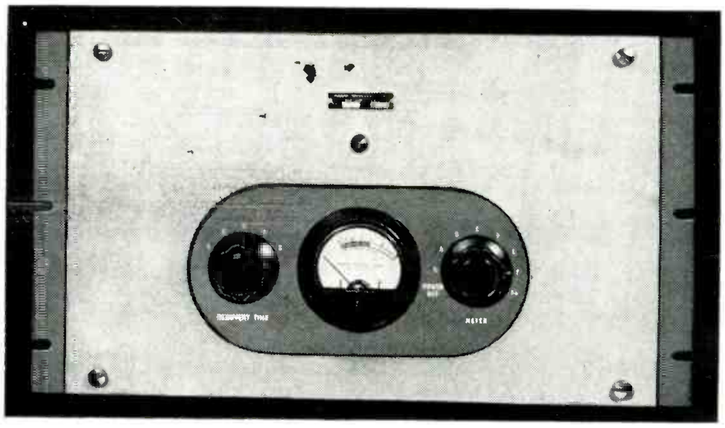
File this under A

[Two new Presto **A**mplifiers]

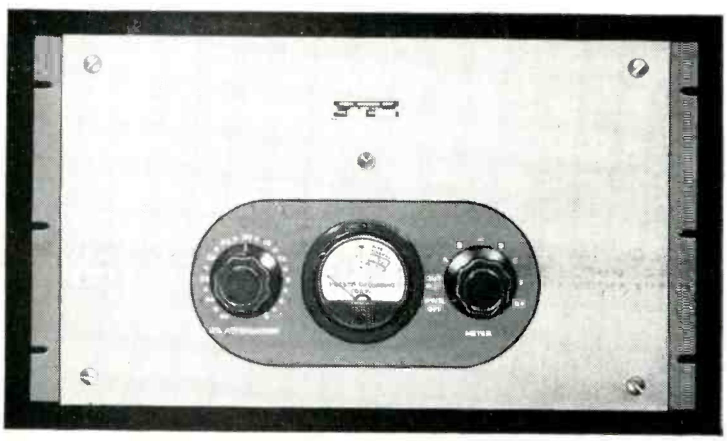
Engineers will welcome these two new additions to the PRESTO line of superior equipment.

Presto Peak Limiting Amplifier (*Type 41A*)

DESIGNED to control program peaks, Type 41A removes the cause of over-cutting and distortion in recording and over-modulation in broadcasting. Proper degree of peak limiting permits an appreciable increase of the average signal with consequent improvement of signal to noise ratio. Serves simultaneously as a line amplifier; its 60 db gain adequately compensates for line losses due to pads, equalizers, etc.



Type 41A. Chassis construction is for vertical mounting in standard racks. Removable front panel gives access to all circuits. Meter and selector switch indicate amount of limiting taking place and current readings of all tubes.



Type 89A. Chassis construction is for vertical rack mounting. Removable front panel for easy access to all circuits. Meter and selector switch provide convenient indication of output level at 1000 cps and current readings of all tubes.

Presto Power Amplifier (*Type 89A*)

FOR recording, or monitoring use, 89A is the perfect high fidelity, medium power unit. 25-watt output, it fills the need for an amplifier between Presto 10-watt and 60-watt units. All stages are push-pull and sufficient feedback is provided to produce a low output impedance and general performance of the type 807 tubes which is superior to that of triodes.

FULL SPECIFICATIONS OF THESE TWO NEW AMPLIFIERS WILL BE SENT ON REQUEST.

PRESTO

RECORDING CORPORATION

Paramus, New Jersey

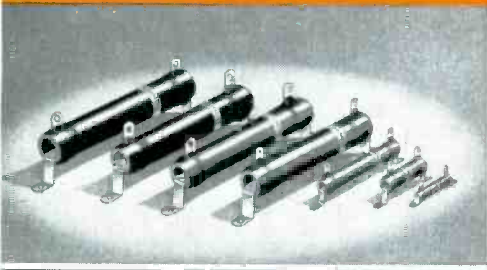
Mailing Address: P.O. Box 500, Hackensack, N. J.

In Canada: WALTER P. DOWNS, Ltd., Dominion Sq. Bldg., Montreal

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

OHMITE Resistors

Sizes and Types for Every Service

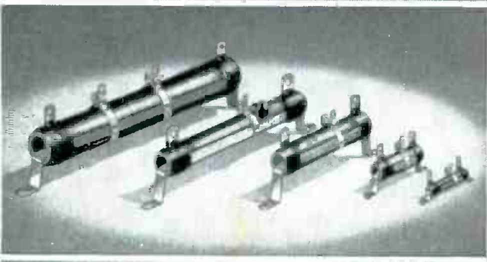


LUG TYPE

Most popular type for general purpose applications. Connected by soldering or bolting to lugs. Protected by vitreous enamel coating.

FERRULE TYPE

Winding terminated on metal bands for mounting in standard fuse clips. Provides easy interchangeability without tools.

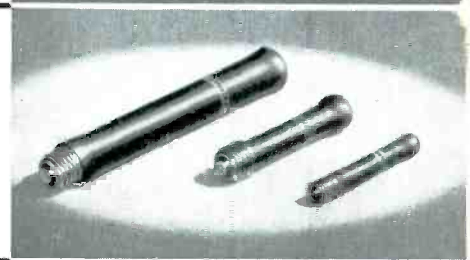


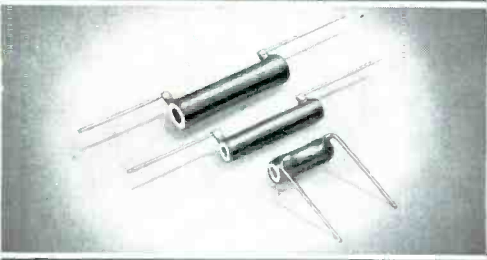
"DIVIDOHM" ADJUSTABLE TYPE

Provided with adjustable lugs for securing odd values of resistance quickly and easily.

EDISON BASE TYPE

Mounted in ordinary lamp type screw sockets for easy interchangeability without the use of tools.



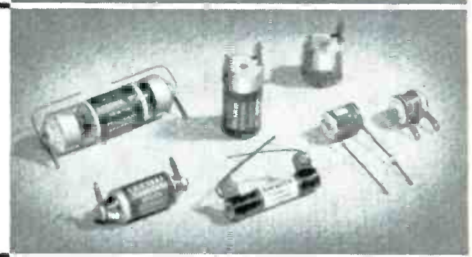


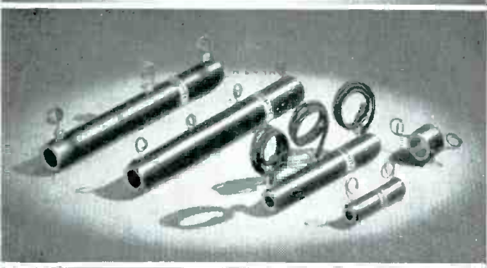
WIRE LEAD TYPE

Small vitreous enameled resistors which can be connected and supported by their own wire terminals. Maximum size approx. 20 watts.

PRECISION TYPE

Low wattage resistors of ± 1% or closer tolerance. Made in vacuum impregnated, glass sealed, or vitreous enameled type units.



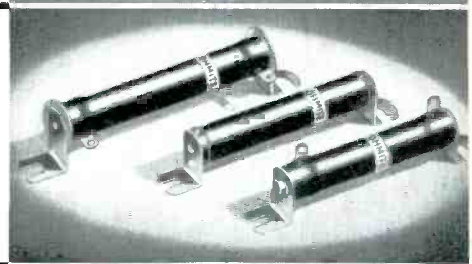


FLEXIBLE LEAD TYPE

Winding is connected to stranded bare or insulated leads. Used where it is desired to have connecting wires a part of the resistor.

BRACKET TYPE

Have metal end brackets. Live bracket type is connected by bolting brackets to panel terminals. Dead bracket type has separate lugs.

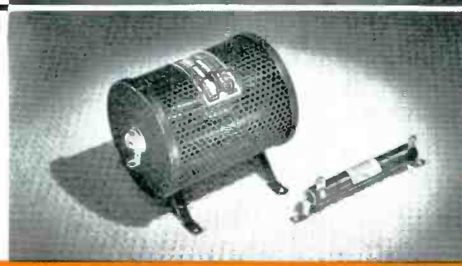


"CORRIB" TYPE

Has edge-wound, exposed corrugated ribbon winding. For low resistances where 100 watts or more must be dissipated in small space.

NONINDUCTIVE TYPE

For radio frequency circuits where constant resistance and impedance are required. Made in rugged, vitreous-enameled type construction.



In addition to the many types of resistors shown above, Ohmite offers resistors in more than sixty different core sizes, and a wide range of wattages and resistance values. Ohmite engineers will be pleased to help you in selecting the right resistors for your needs.

OHMITE MANUFACTURING CO.

4816 Flournoy Street Chicago 44, Illinois

Write on Company Letterhead for Catalog and Engineering Manual No. 40.

Contains 96 pages of useful data on the selection and application of rheostats, resistors, tap switches, and other equipment.

Be Right with ...

OHMITE

RHEOSTATS · RESISTORS

TAP SWITCHES

Industry's First Choice

Facts for Manufacturers of High Frequency Equipment

Power Loss = $55.5\varepsilon^{1} \tan\delta \times f \times V^{2} \times 10^{-6}$ Watts

ZIRCON PORCELAIN

Because they influence efficient and effective operation, low loss characteristics of Zircon Porcelain are most desirable in the manufacture of high frequency equipment.

Meeting the requirements of the power loss formula, Zircon Porcelain retains its low loss characteristics over a wide range of temperatures and frequencies. This factor is clearly demonstrated in the charts shown.

For applications in the field of radio, radar and other equipment of this nature, it will pay to get more detailed information. Write direct or discuss the use of Zircon Porcelain with one of our qualified field staff.

CHART 1

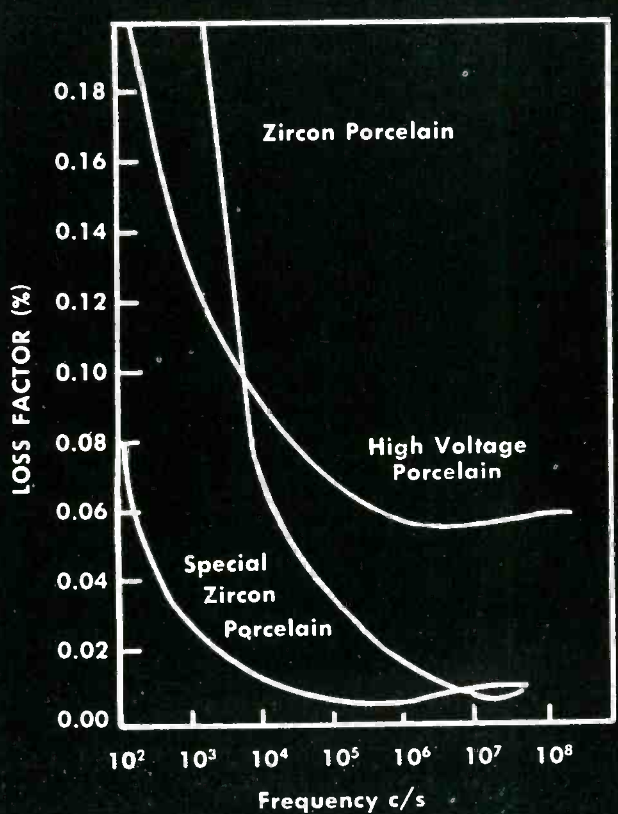
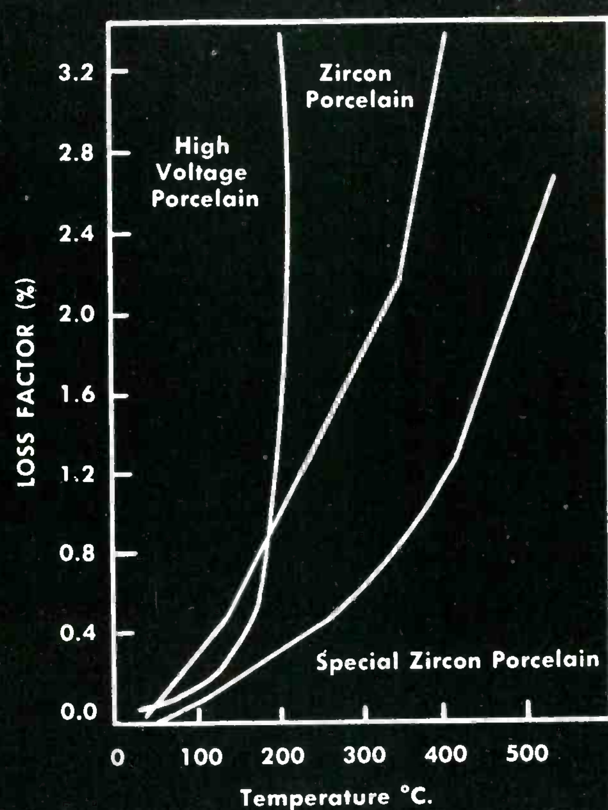


CHART 2



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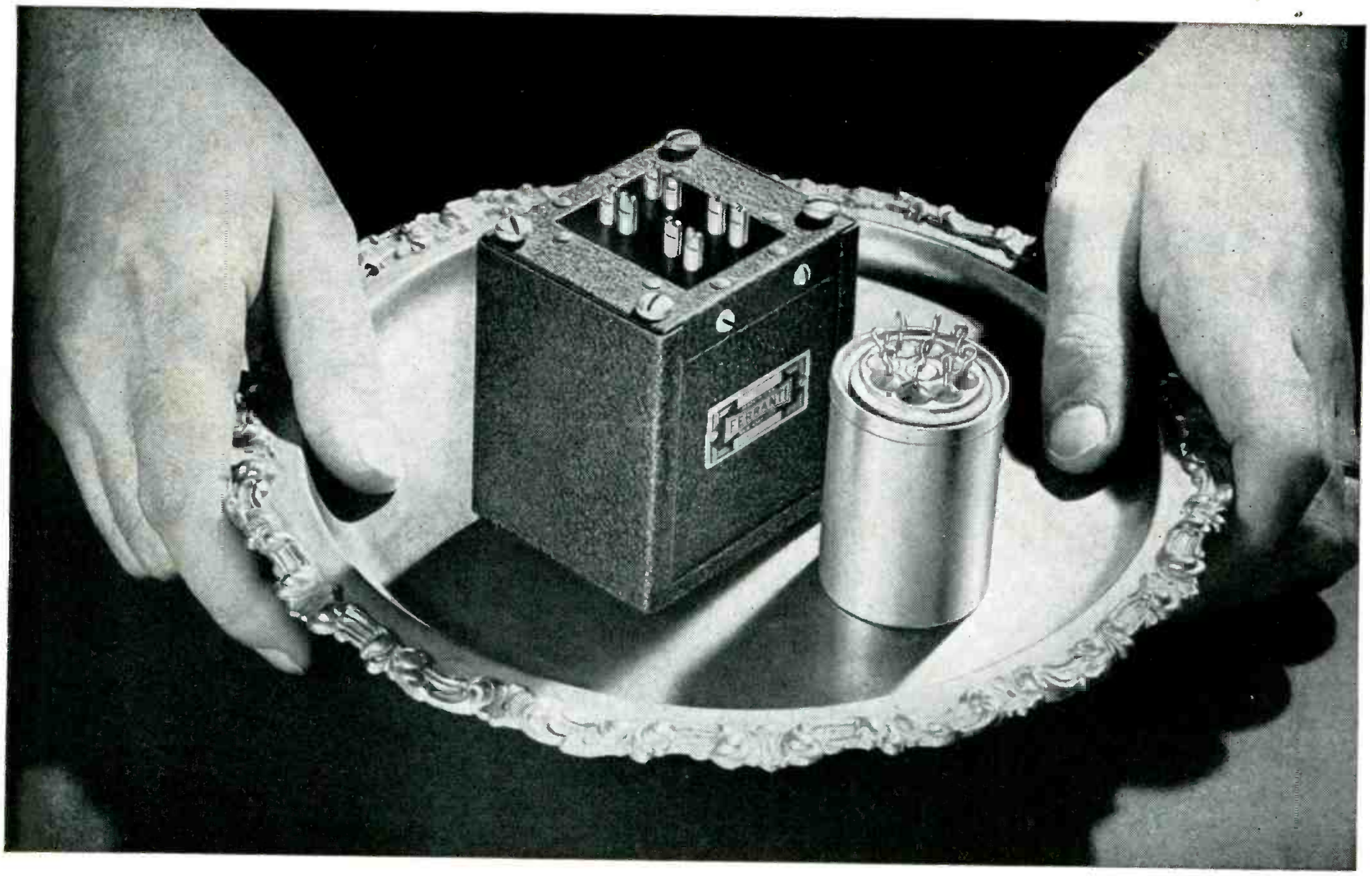

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From our more than 20 years' experience as transformer specialists, come precision transformers of every type—custom-made for YOUR new applications. FERRANTI facilities permit unusual service to each customer, whether large or small, and insure prompt deliveries.

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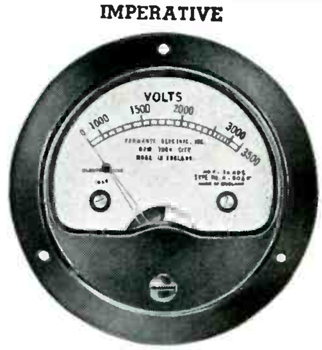
POWER TRANSFORMERS	**REACTORS**

HERMETICALLY SEALED WHEN SPECIFIED

We also build power supply units and electronic assemblies to specifications at prices comparable to those of stock assemblies. We invite your inquiries.

ALSO FOR MODERN HIGH VOLTAGE DEVELOPMENTS WHERE ZERO CURRENT DRAIN IS IMPERATIVE



THE FERRANTI ELECTROSTATIC VOLTMETER

Types available for maximum readings from 150 to 3500 volts. 2½ in. dial, flush mounting, projecting and portable models. Write for informative literature.

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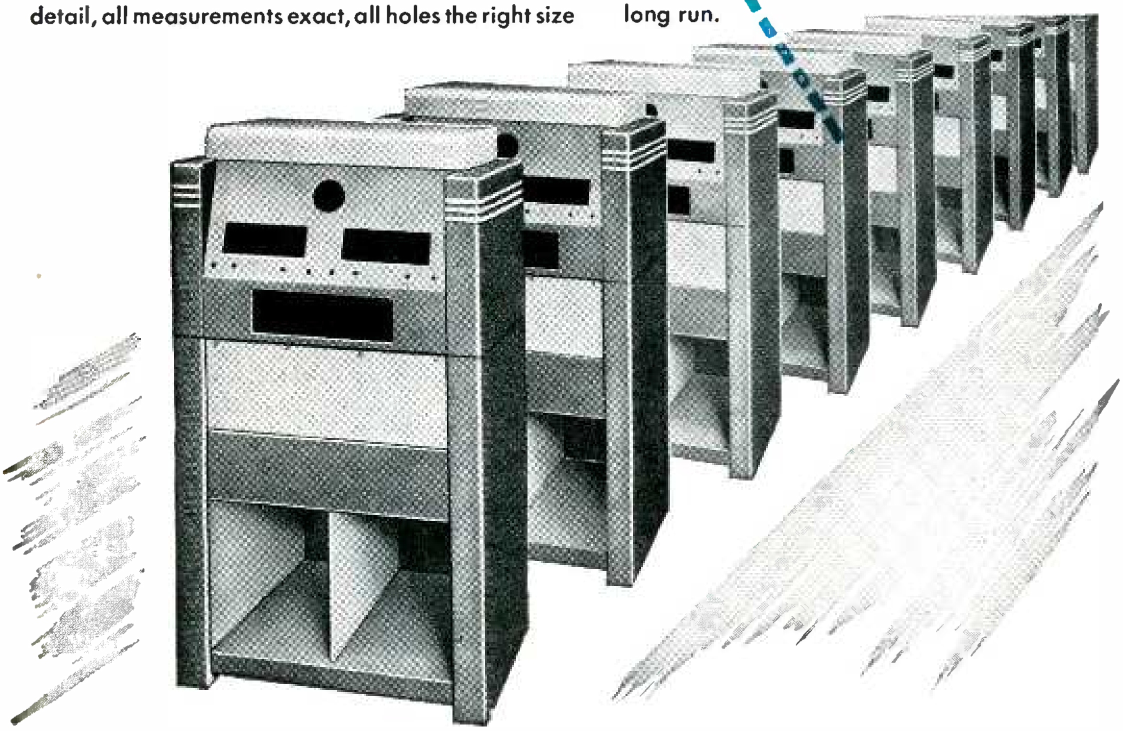
30 Rockefeller Plaza • New York 20, N. Y.



improved performance for your combinations with the Seeburg "S"

Radio-phonograph combinations are often judged by the performance of the record changer. It's important then that the changer match the overall perfection of the instrument.

The Seeburg "S"—a new single-post changer—is designed and built for today's market. For while the Seeburg "S" is moderately priced, it possesses many of the features you expect to find on only the most expensive changers.

Plan now to give your table models and popularly priced consoles important competitive advantages by equipping them with the Seeburg "S."

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RECORD CHANGERS ★ MUSIC SYSTEMS

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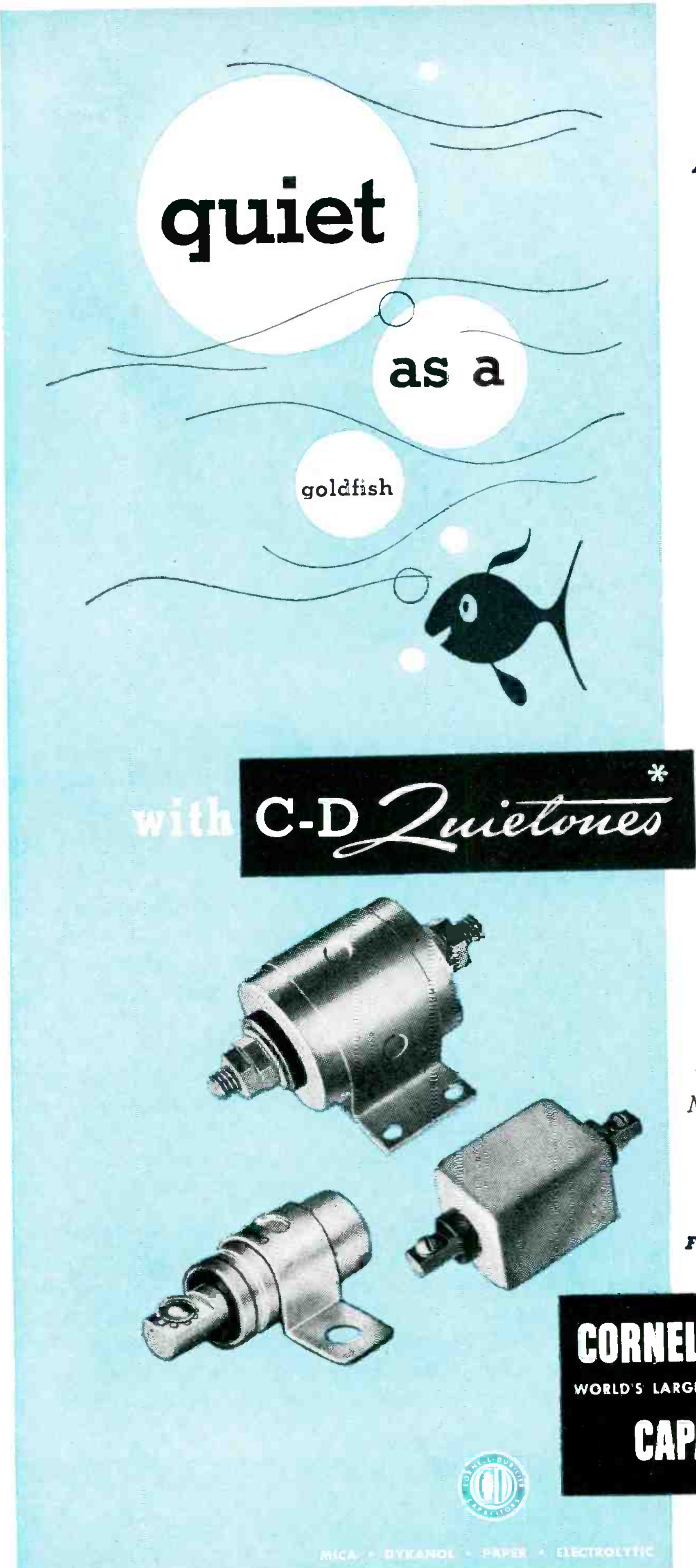
FEATURES THAT SPELL IMPORTANT COMPETITIVE ADVANTAGES

- Sturdy, single-post changer
- Modern styling—smart, shield-shaped base
- Lightweight tone arm
- Automatic shut-off after last record is played
- Recessed turntable
- Strong, quiet motor assures constant turntable speed
- Plays twelve 10-inch or ten 12-inch records. May also be set for manual play
- Shock-mounted center spindle for minimum center hole wear of records—record load stacked in horizontal position



***A lot of** electronic and electrical equipment is going to sea these days. But it won't stay there long—in fact, it won't even stay sold—unless it is Noise-Proofed against radio interference.*

To you—the manufacturer—this means that your product should include C-D Quietones in its basic design. With safety at sea—as well as listening pleasure—at stake, your marine customers demand the kind of interference-free equipment operation C-D Quietones are designed to give. Of the hundreds of Quietone types available, there may be one which will fit your needs to a "T"; if not, our sleeves are rolled up and we're ready in our modern and complete Radio Noise-Proofing Laboratory—to design the specific filter you need. C-D Quietones will solve your radio noise and spark suppression problems speedily, permanently and effectively. Your inquiry is invited. Cornell-Dubilier Electric Corporation, Dept. K8, South Plainfield, New Jersey. Other large plants in New Bedford, Worcester, and Brookline, Massachusetts, and Providence, R. I.

Make Your Products More Saleable with C-D Quietone Radio Noise Filters and Spark Suppressors.

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An Invitation from C-D
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without obligation

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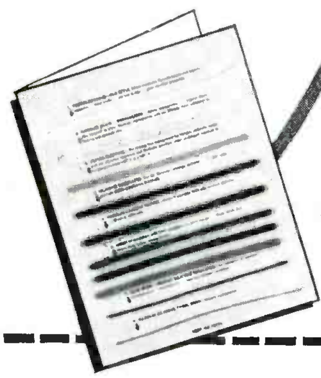
Bendix AVIATION Uses Temperature-Abrasion Tests to Determine Best Sleeving for Automatic Pilot Component

To assure dependable performance throughout all types of operating conditions that aircraft might encounter, Bendix Aviation puts its Automatic Pilot Systems through drastic heat and cold tests as normal production procedure.

Extremes of 300° F and —65° F rule out many materials that serve adequately in normal or limited-range temperature conditions—but in VARGLAS Silicone, Bendix found a sleeving that satisfied their requirements. VARGLAS Silicone retained its insulating and color properties at the high temperatures, and continued pliable and flexible in the very cold tests. Bendix also established that the Silicone material was remarkably resistant to abrasion. Result: VARGLAS Silicone sleeving is used on the leads to the low-inertia motor in the Servo unit.

For tough insulation jobs that defeat ordinary insulation materials—VARGLAS Silicone often is the answer. We make a complete line of sleeving and tubing including VARGLAS treated and untreated Lite-Wall Sleevings (ECC-A and ECC-B). Write for our free folder containing working samples of VARGLAS Silicone electrical sleeving and tubing.



● Mail coupon for this free folder containing working samples of VARGLAS Silicone sleeving and tubing.

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CHICAGO TRANSFORMERS AND REACTORS

POWER

PLATE AND FILAMENT SUPPLY TRANSFORMERS

For both capacitor and reactor input filter systems. High voltage secondaries provide a range of rectified d-c outputs from 260 to 425 volts, 55 to 300 ma. Standard 5-volt, 2, 3, or 6-ampere rectifier filament windings and 6 3-volt amplifier filament windings, center-tapped, in a convenient range of current ratings.
Mounting Type B or C.

FILTER REACTORS

A range of d-c ratings from 55 to 300 ma. for use with the power transformers above. Inductance values of 15, 12, 10, and 8 henries, d-c resistances of from 385 to 70 ohms. Insulated for 2,500 test volts.
Mounting Type B or C.

FILAMENT TRANSFORMERS

A useful series with secondaries supplying from 2.5 volts, 5.25 amps. to 11 volts, 10 amps. Insulated for 2,500 test volts, except for units designed for high voltage, rectifier filament supplies, which test at either 5,000 or 9,000 volts. Latter have bushing-insulated terminals.
Mounting Type B.

PLATE TRANSFORMERS AND REACTORS

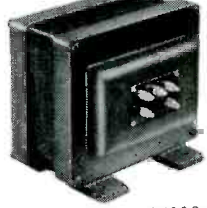


Plate transformers with 115/230-volt primaries, in a range of capacities — secondaries for supplying from 750 to 3,000 volts (d-c after filter), 250 to 500 ma. Filter chokes with d-c ratings to match. Inductance values of 10 or 6 henries. Insulated for either 7,500 or 9,000 volts.

Transformers of SPECIAL DESIGN

... form the major part of Chicago Transformer's business. To fill your special requirements, CT offers the most complete engineering and manufacturing facilities in the transformer field.

A complete range of basic mounting parts — drawn steel cases, vertical and horizontal shields, frames, brackets, etc. — is available to your specification.

Besides the types of transformers listed elsewhere on this page, CT also makes

- Wave Filters
- Vibrator Transformers
- Instrument Transformers
- Oscillator Transformers
- Television and Other Special-Purpose Transformers

AUDIO

FULL FREQUENCY RANGE

30 to 15,000 CYCLES — Uniform response within ±½ db over this entire range. Response within very close limits up to 20,000 cycles. Exceptionally low percentage of distortion at all frequencies.

INPUT TRANSFORMERS

Applications: Line to single or push-pull grids, line bridging to p-p grids, line to line, or interstage. Split and balanced primary and secondary windings, center-tapped. Power levels up to +30 dbm. Nickel alloy hum shielding allows operation at levels as low as −70 and −90 dbm.
Mounting Type A.

OUTPUT TRANSFORMERS

Applications: Single Plate to Line (600/150 ohms) or push-pull plates to line or voice coil (16/8/4 ohms). Power levels up to +43 dbm.
Mounting Type A.

DRIVER AND MODULATION TRANSFORMERS — MODULATION REACTORS

In matched sets for 250-watt, 1-KW, and 5-KW transmitters. Response within ±1 db over the Full Frequency Range. Distortion percentage very low — well within FCC limits. Largest units are mounted in oil-filled cases, constructed of welded steel plate; others in drawn steel cases or in shield-and-frame mountings similar to Plate Transformers.

PUBLIC ADDRESS RANGE

50 to 10,000 CYCLES — Uniform response within ±½ db over this range. Very low transmission losses.

DRIVER TRANSFORMERS

Application: Push-pull plates (20,000 ohms or 5,000/10,000 ohms) to push-pull grids. Primary d-c ratings of 10, 25, and 100 ma.
Mounting Type B or C.

OUTPUT TRANSFORMERS

Application: Push-pull plates (5,000, 6,000, or 10,000 ohms) to Line or voice coil. Primary d-c ratings of 80, 150, and 200 ma. Have tertiary windings to provide 10% inverse feedback for improved fidelity of output.
Mounting Type B or C.

COMMUNICATIONS RANGE

200 to 3,500 CYCLES — Response variations not exceeding ±1 db over the range of voice frequencies.

INPUT TRANSFORMERS

Applications: 600/150-ohm line to single or push-pull grids (100,000 ohms) and 125/50-ohm microphone to single or push-pull grids (125,000 ohms).
Mounting Type B or C.

OUTPUT TRANSFORMERS

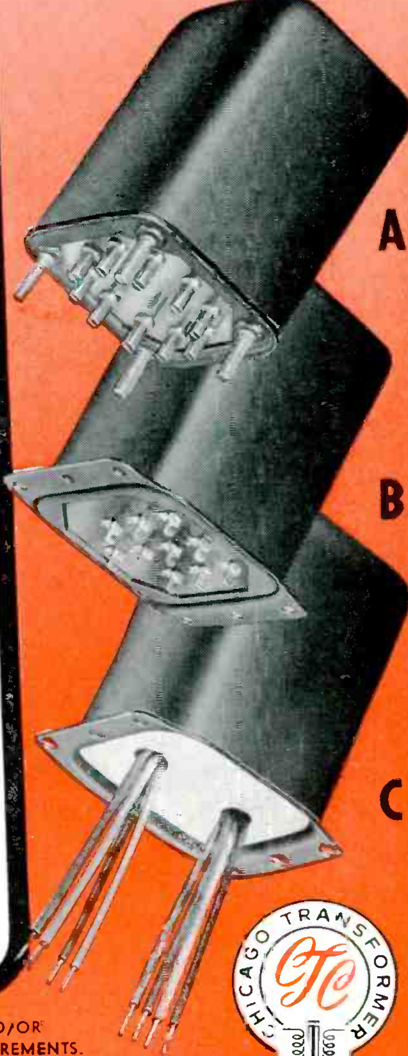
Applications: Single plate (either 5,000 or 8,000 ohms) to line or voice coil.
Mounting Type B or C.

DRIVER AND MODULATION TRANSFORMERS

Suitable for application in 250-watt communications-type transmitters.
Mounting Type B or C.

NOTE THESE FEATURES:

- **MATCHED TO MODERN TUBES** — Ratings fill the requirements of today's most-used receiving, transmitting, and industrial tubes.
- **SEALED IN STEEL** — Drawn steel case constructions in 3 variations. (Descriptions at left keyed to illustrations A, B, and C below)
- **CHOICE OF CONNECTORS** — Either solder lugs or RMA color-coded leads available in most units.
- **TRUE HIGH FIDELITY** — 3 practical ranges of audio transformers.



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CHICAGO TRANSFORMER *DIVISION OF ESSEX WIRE CORPORATION*

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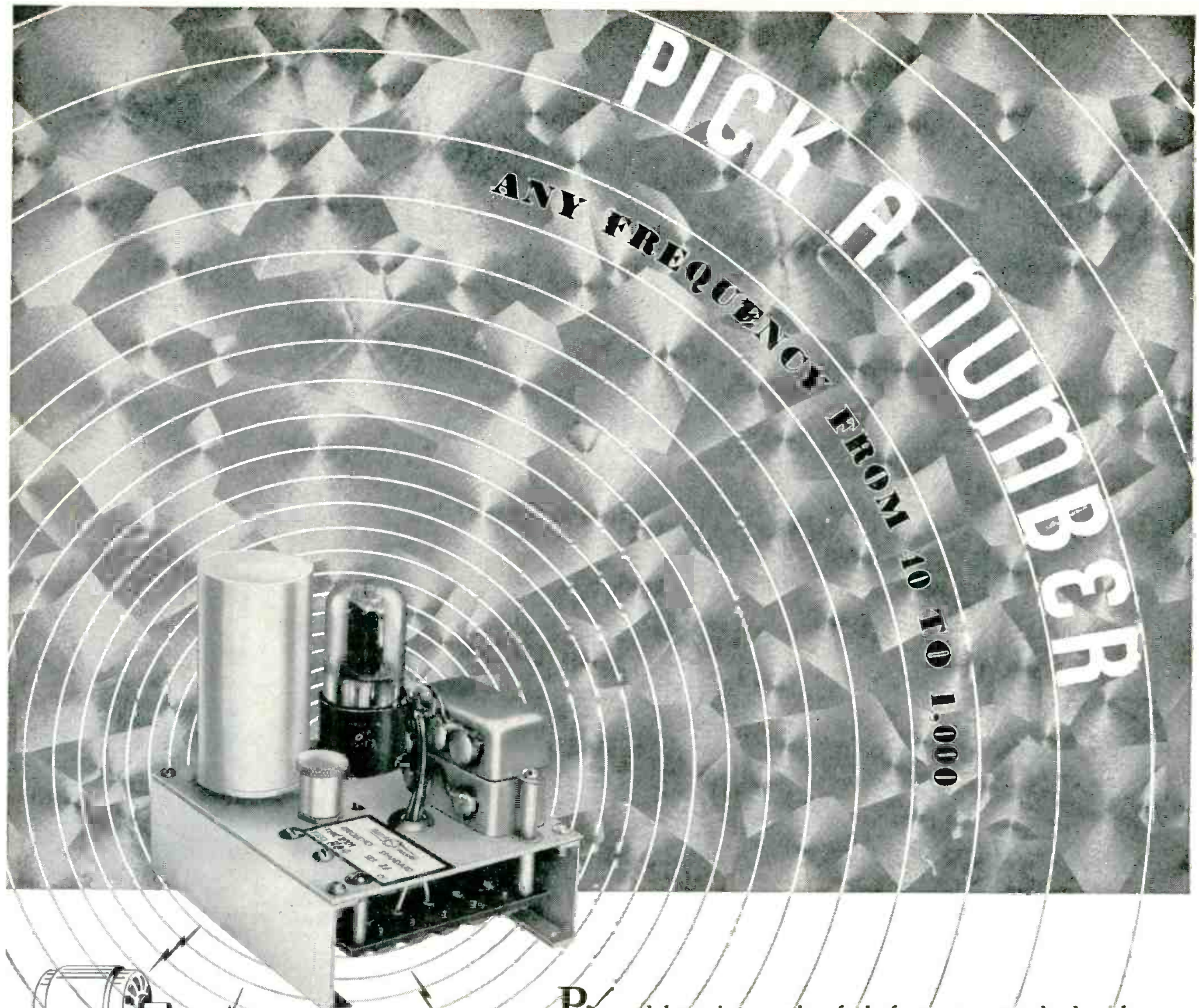

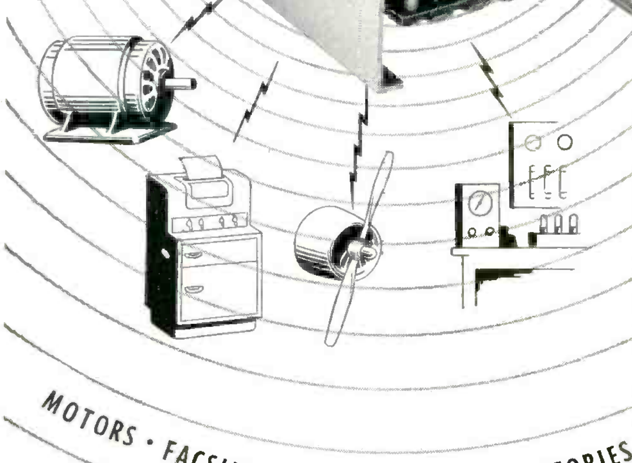

Pictured here is a tuning-fork frequency standard with accuracy guaranteed to one part per million per degree Centigrade. The fork is temperature-compensated and hermetically sealed against variations of barometric pressure. This standard, when combined with basic equipment, facilitates accurate speed and time control by mechanical, electrical, acoustical or optical means.

The unit is available separately or in conjunction with complete timing instruments. Our engineers are ready to cooperate on any problem.

American Time Products, Inc.

580 Fifth Avenue New York 19, N. Y.

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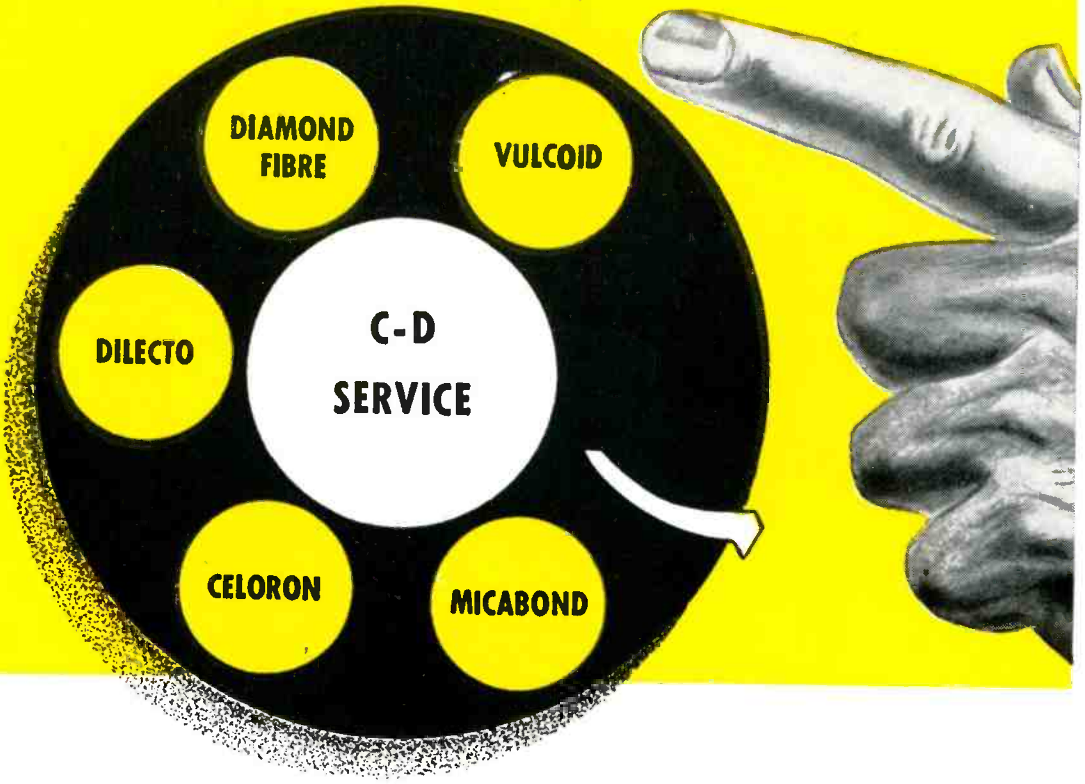
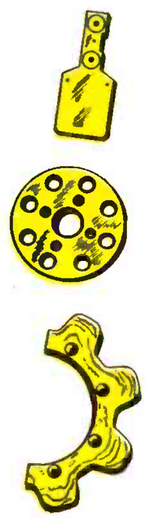
The right material for your job ... right at your fingertips!



How to Save Production Hours and Dollars on Your Electrical Insulating Jobs . . .

One of the surest ways to reduce unit costs on any job is to be right the first time when selecting materials. Continental-Diamond's complete line of high strength electrical insulating materials makes proper product engineering easy.

There are trained C-D technicians on hand at all times to give you personal help in getting better, lower-cost applications. To be sure of being right the first time in the selection of materials, call your nearest C-D office whenever the need arises.



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Continental-Diamond FIBRE COMPANY
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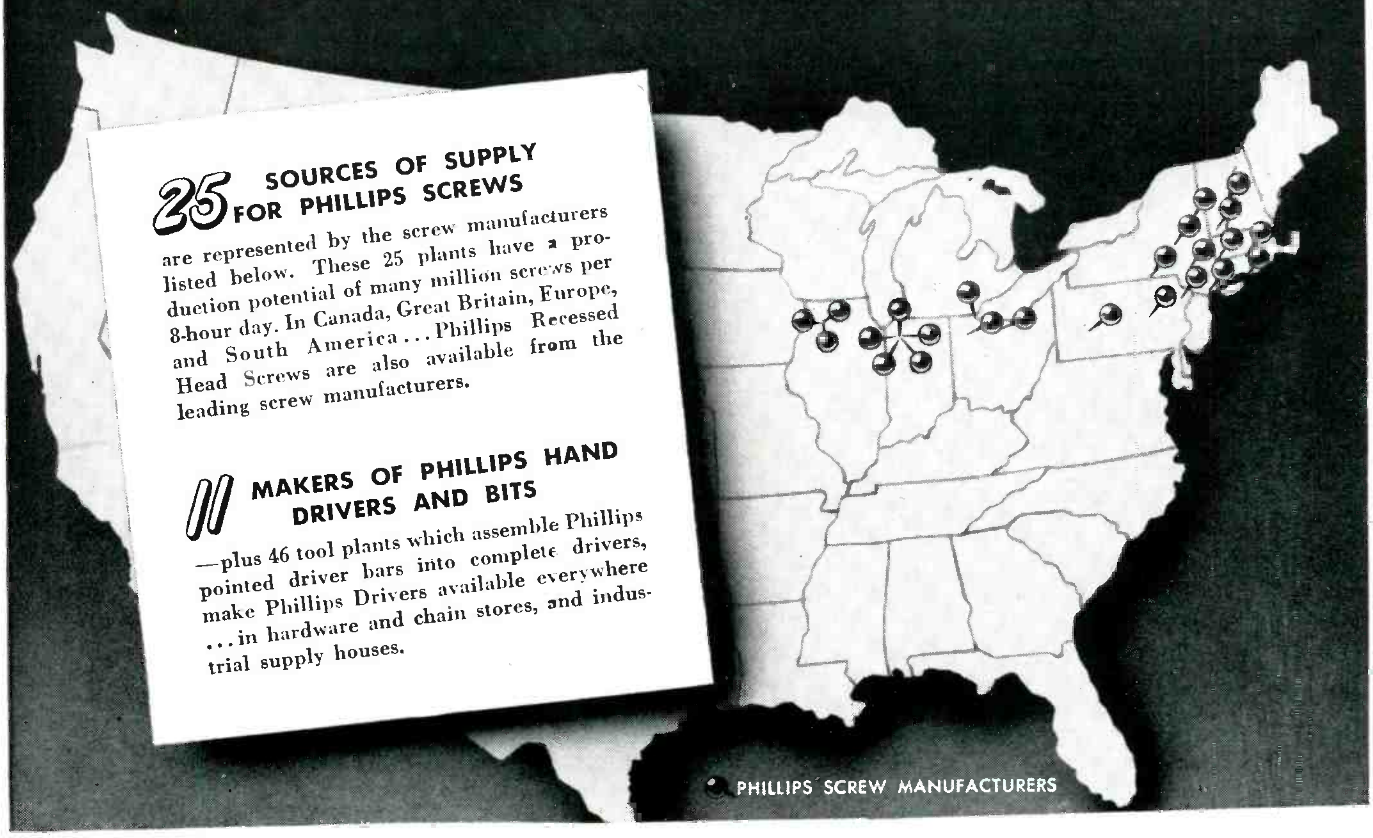
ONLY PHILLIPS RECESSED HEAD SCREWS

OFFER PRODUCTION POTENTIAL ADEQUATE TO MEET *ALL* INDUSTRY'S NEEDS



LOOK AHEAD when you choose a cross recessed head screw. Whatever the supply situation, at any time, this tremendous capacity makes Phillips Screws constantly available.

Wherever your product is sold and used, there are, and always will be Phillips Drivers available for disassembly and reassembly.

Remember, unlimited production potential is one of the basic essentials you can't afford to overlook in choosing a cross recessed head screw. With Phillips Screws, you can depend on it. Specify *Phillips.*

GET *ALL* THE ADVANTAGES OF ASSEMBLY WITH CROSS RECESSED HEAD SCREWS . . .

GET

PHILLIPS *Recessed Head* SCREWS

Wood Screws • Machine Screws • Self-tapping Screws • Stove Bolts

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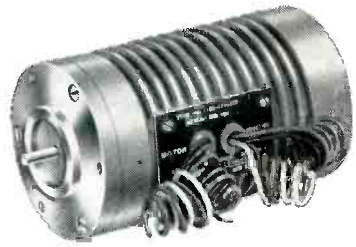
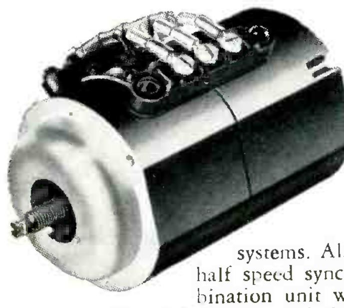
Kollsman offers additional AC units for remote indication or control applications

SYNCHRONOUS MOTORS—for timing applications where variable loads stay in exact synchronism with constant or variable frequency source. Synchronous power output up to 1/100 H.P.



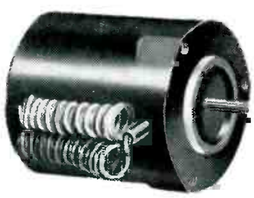
MOTOR DRIVEN INDUCTION GENERATORS — combination of a 2-phase, high-torque, low-inertia induction motor and an induction generator. Used as a fast reversing servo motor. Available with maximum stall torques of 1.0 (unit shown) to 6.7 (other units) oz/in.



SYNCHRONOUS DIFFERENTIAL UNITS—electro-mechanical error detector with mechanical output for use in position or speed control servo systems. Also a torque-producing half speed synchroscope. Small combination unit with two variable frequency synchronous motors and differential gearing.

Output: Speed $= \frac{N_1 - N_2}{2}$; torque up to 1.0 oz/in.

TELETORQUE UNITS—precision built selsyn type units for remote indication. Accurate to ±1 degree. Actuated by units producing as little as 4 gr/cm of torque.



DRAG CUP MOTORS — miniature 2-phase motors with high torque/inertia ratio and extremely fast stopping, starting and reversal characteristics. Suitable for many special applications requiring torque of 0.4 oz/in. or less.

GEARED INDUCTION MOTORS—miniature 2-phase servo motors with gear reducer. Desirable motor features: Maximum torque at stall with low wattage input and high torque/inertia ratio. Gear reducer conservatively rated at 25 oz/in. Maximum torque with gear ratios from 5:1 to 75,000:1 available.

Because of their high responsiveness and precision, Kollsman Special Purpose Motors are particularly suited to systems requiring extremely accurate remote indication or positive electronic control. The units shown above are only representative of a complete line which includes many similar units in various voltages and frequencies. Among them, the instrumentation or control engineer will find, in many instances, the device that fills his specifications exactly.

Reliable performance, light weight and compact size are characteristics of the entire line. In each unit is to be found the same ingenuity of design and care in manufacture that has for twenty years made Kollsman the outstanding leader in the field of aircraft instrumentation.

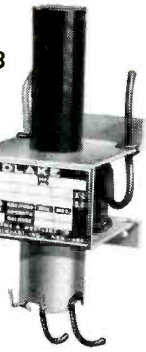
For full information on any or all of these Special Purpose Motors, write to: Kollsman Instrument Division, Square D Company, 80-08 45th Avenue, Elmhurst, N. Y.

KOLLSMAN INSTRUMENT DIVISION

SQUARE D COMPANY

ELMHURST, NEW YORK — GLENDALE, CALIFORNIA

Type 1040-8
Time delay



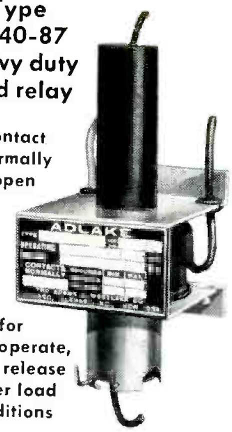
contact normally open

maximum time delay up to 20 minutes

Type 1040-34
Time delay

contact normally closed for A. C. energization

Type 1040-87
Heavy duty load relay



contact normally open

for quick operate, quick release under load conditions

Type 1040-97
Heavy duty load relay

contact normally closed

Adlake TRADE MARK

An ADLAKE Relay for your every need

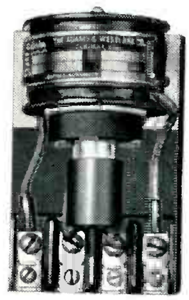
Not all of the Adlake Relay line is shown on this page. But whatever your relay needs may be, there's an Adlake to do the job. Adlake Relays have handled hundreds of tough and unusual assignments for American industry—offering dependable, tamperproof control.

Adlake Mercury Plunger-Type Relays are hermetically sealed against dust, dirt, moisture and oxidation. Their mercury-to-mercury contact makes them silent and chatterless, impervious to burning, pitting and sticking. They are absolutely safe, require no maintenance.

Let us give you the benefit of our experience in making your Adlake Relay selection. Address your request for catalog to The Adams & Westlake Company, 1107 North Michigan Avenue, Elkhart, Indiana.

THE Adams & Westlake COMPANY

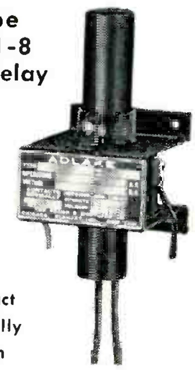
Established 1857 • ELKHART, IND. • New York • Chicago
Manufacturers of Adlake
Hermetically Sealed Mercury Relays for
Timing, Load and Control Circuits



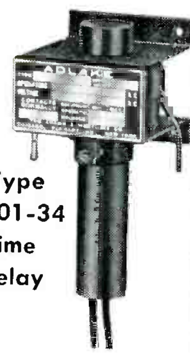
Type 1045
Quick acting relay with terminal block

designed for use with sensitive thermo regulators

Type 1101-8
Time delay



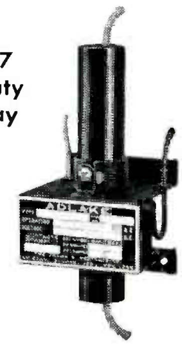
contact normally open



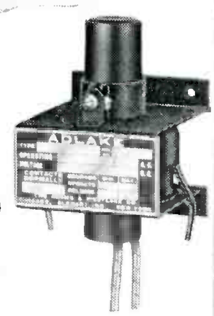
Type 1101-34
Time delay

contact normally closed

Type 1101-87
Heavy duty load relay

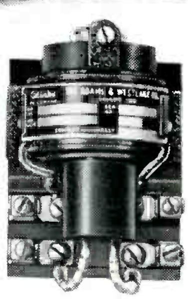


contact normally open



Type 1101-100
Light duty load relay

contact normally open or normally closed



Type 1110 Relay with terminal block

contact normally open or closed; handles 30 amps.

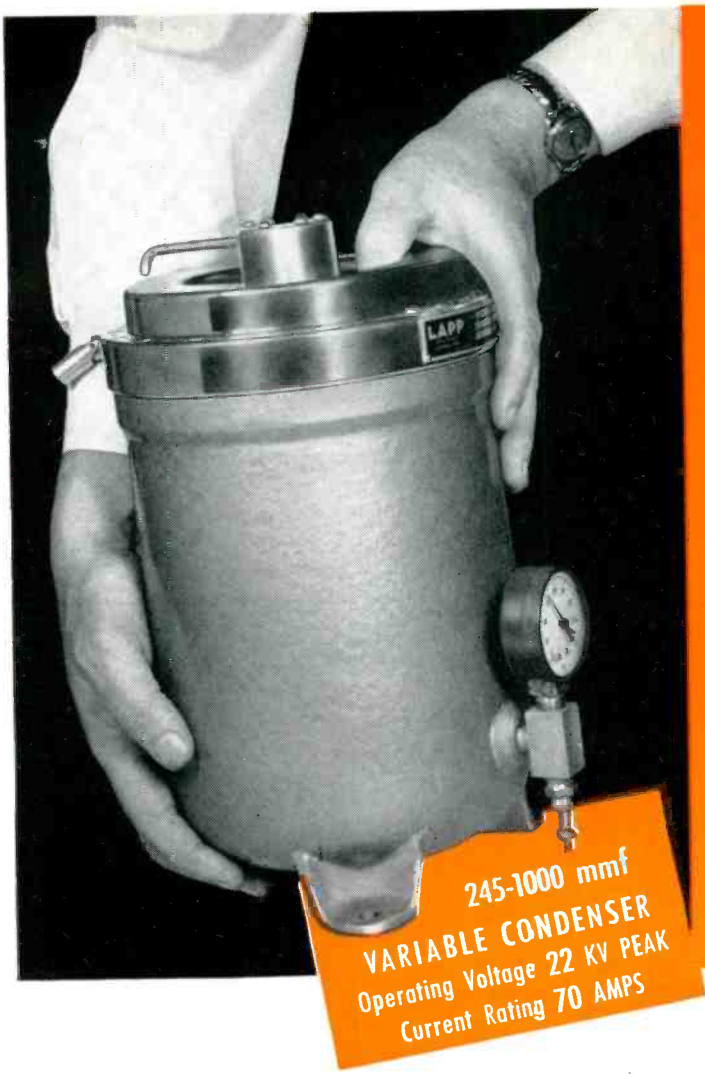
Type 1200
Time delay

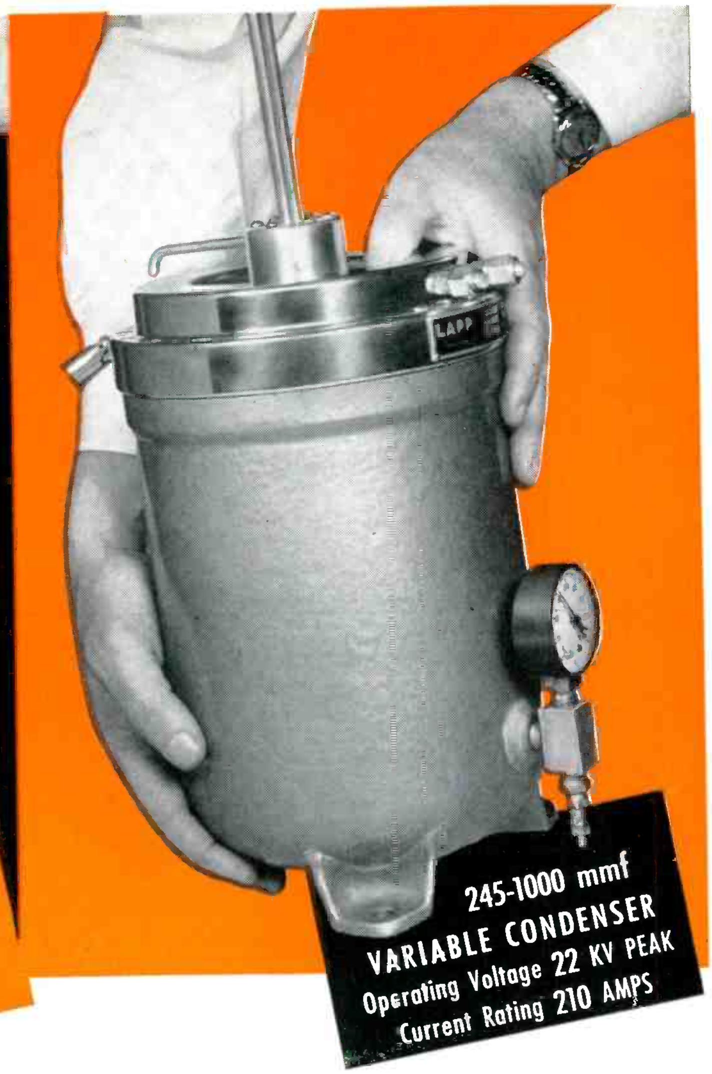
contact normally open or normally closed

maximum time delay, 20 minutes. For D.C. energization

Type 1200 Double unit relay

contacts normally open or normally closed. For D. C. energization





LAPP GAS-FILLED CONDENSERS OF NEW DESIGN

offer HIGHER current ratings in SMALLER unit sizes

The two Lapp Gas-Filled Condensers above are identical in every respect, except that the condenser on the right is fitted for water-cooling, with consequent increase of current rating by 300%. The water-cooling is simply accomplished and carries only a nominal premium in price. All models of the *new* Lapp condensers offer reduced size (about 70% of previous models). In addition, effective voltage ratings, current ratings, and safety factors have been increased. Current paths are shorter, losses lower. Tuning shaft on variable models at ground potential. Constant capacitance, without regard to temperature change, is provided. Puncture-proof, the Lapp Gas-Filled Condenser is the dependable source of capacitance at high voltages or high currents. Write for Bulletin No. 265 which carries description and specification of the complete range of sizes and models.

Lapp

LAPP INSULATOR COMPANY, INC., LE ROY, NEW YORK

Balanced Electrical and Mechanical

No. 8

in a series of advertisements designed to aid in the selection of electrical insulation. The importance of mechanical properties and methods of tensile strength testing are discussed.

STRIKING A BALANCE

Many difficult problems in the design of electrical equipment are posed by the interplay of electrical and mechanical properties in the performance of insulating materials. Unfortunately, there is no direct correlation between these properties. High tensile strength, for example, may or may not be accompanied by high dielectric strength (see table below).

Differing mechanical and electrical reactions to service conditions are also noted. For example, while moisture is being driven off during a temperature rise, dielectric strength of electrical insulation may increase temporarily[1], and mechanical strength may decrease. In some instances it has been observed that mechanical stresses approaching the elastic limit of the material may reduce the electrical breakdown strength considerably[2]. In other cases, however, electrical insulation may become extremely weakened and embrittled, yet still perform effectively as a dielectric so long as it remains mechanically undisturbed.

Obviously, there is no easy rule for striking the proper balance between properties: often, combination materials can be selected which bring together good electrical properties of one material with mechanical strength of another. Individual conditions related to fabrication, assembly and service will determine the choice in each instance.

LAMICOID SHEETS — AVERAGE VALUES

NEMA Grade	Tensile Strength lbs./sq. in.	Moisture Absorption % by weight 1″ x 3″ x 1/16″	Dielectric Strength v/m 1/16 to 1/8 th. short time
X	12500	4.0	500
P	8000	3.0	500
XX	8000	1.1	500
XXP	8000	1.3	500
XXX	7000	1.0	470
XXXP	7000	1.0	470
C	9500	3.0	150
CE	8000	1.5	360
L	9000	2.0	150
LE	8500	1.2	360
A	8000	1.25	160
AA	10000	1.5	50

MECHANICAL STRENGTH TESTS AN AID

Mechanical strength tests, while they seldom duplicate the conditions of service, are indispensable in determining which materials or combinations of materials will be best suited for a specific application. It is well to remember, however, that materials react differently to humidity and temperature rise, influencing their response to tensile stress as well as their dielectric strength.

TENSILE STRENGTH TEST[3]

Standard methods have been set up to determine the tensile strength of sheet and plate materials used in electrical insulation. These methods include the standardization of temperature and humidity conditions to which test specimens are subjected before and during testing.

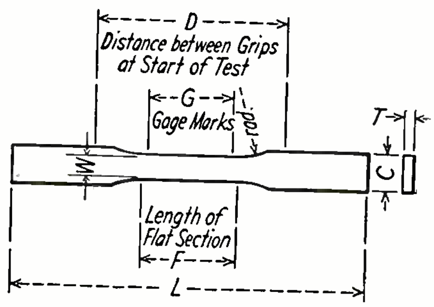
The testing machine consists of (a) a fixed member carrying one grip, (b) a movable member carrying another grip, (c) grips for holding the sample, which are self-aligning and provide means to prevent slippage, (d) a drive mechanism which impels the movable member at a uniform, controlled velocity, and (e) a load indicator to show total tensile load carried by the test specimen.

Figure 1 illustrates a tension test specimen for sheet insulating materials. Exact specifications according to material types and thicknesses are completely defined in ASTM Designation D229-46. In all cases the length of the reduced section and the radius of curvature are fixed. The 3″ radius of curvature was selected as sufficiently large to minimize breaks outside the reduced section or at the point of curvature.

Tensile strength is obtained by dividing the total load in pounds required to pull the sample apart by the area of cross-section in square inches at the breakage point, and is expressed in pounds per square inch.

Test reports include: (1) identification of material; (2) method of preparing test specimen; (3) type of test specimen and dimensions; (4) conditioning of sample; (5) ambient conditions of test; (6) number of specimens tested; (7) speed of testing; (8) mean rate of stressing; (9) mean rate of straining; (10) tensile strength, average value and average deviation; (11) percentage elongation, average value and average deviation; (12) elastic modulus, average value and average deviation; (13) date.

[1] See Advertisement No. 4 in this series.
[2] See Advertisement No. 3 in this series.
[3] ASTM Designation D229-46.



Dimension (inches)	Thickness (T) ¼″ or under	Over ¼″, to ½″ Incl.	Over ½″ to 1″
C	0.750	1.125	1.500
W	0.500	0.750	1.000
F	2.250	2.250	2.250
G	2.000	2.000	2.000
D	4.5	4.5	5.25
L	8.5	9.75	12.
Radius	3	3	3

Figure 1—Tension test specimen for sheet and plate insulating materials, Type I[3].

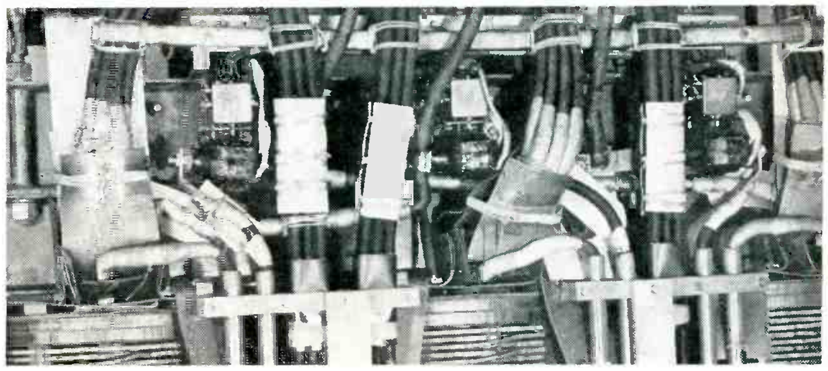
MICA

Properties Important to Insulation Performance

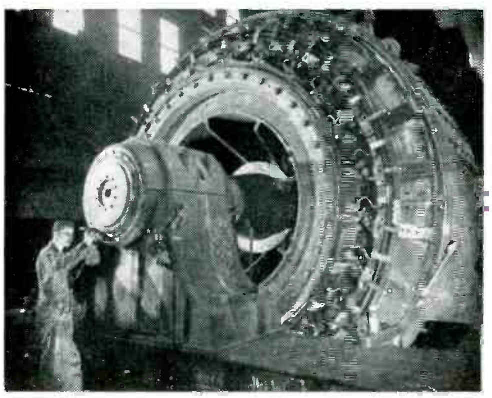
"MICO" ELECTRICAL INSULATION OFFERS MANY COMBINATIONS OF PROPERTIES

Increased efficiency in manufacture and improved product performance are determined by the selection of the electrical insulating material which affords the best combination of properties for each specific use. Mica Insulator Company offers a line of insulating materials with a wide variety of properties in many combinations to meet any requirements for balanced design. Illustrated below are several applications employing well-balanced properties to advantage.

LAMICOID combines excellent fabricating properties with good electrical characteristics for this terminal block. Because it can be easily machined, sawed, drilled and printed for circuit identification, its use results in manufacturing economy. For terminal connections that must be sealed against moisture and various liquids, Lamicoid is obtainable with bonded rubber surface.



MICANITE sheets, sleeves and tapes can be used to good advantage for such applications as this 12,000/16,000 KVA, 3 ph transformer. In combination with such carriers as Fiberglas, condenser paper and cloth, the excellent dielectric properties of mica are secured with the good mechanical properties of these other materials.



EMPIRE silicone varnished Fiberglas possesses excellent physical characteristics — high tensile strength, small stretch, flexibility and good resistance to moisture, most acids, corona, ozone and high temperature. It will withstand temperatures from 175°C (347°F) to 250°C (482°F). These qualities combined with good dielectric strength provide dependability for wrapping cores of armatures, stators, and transformers.

Mica Insulator Company has specialized in the development and manufacture of electrical insulating materials for 55 years. We offer a complete line to meet your needs. Bring your problems on electrical insulation to our Technical Service Department.

MICO ELECTRICAL INSULATION

Trade-mark

Mica Insulator COMPANY

SCHENECTADY 1, NEW YORK

Atlanta • Birmingham • Boston • Chicago • Cincinnati • Cleveland • Detroit • Houston
Los Angeles • Milwaukee • New York • Philadelphia • Rochester • St. Louis • San Francisco

"IT'S THE BEST YET!"

Yes! We think it's the best yet. We think this transmitter ideal for such applications as Police, Forestry, Airport Traffic Control, Oil Fields, Aerophare, Beacons, Explorations, Public Utilities, Mining, Emergencies and Point-to-Point requirements. It can be controlled either locally or from remote position; either for telephone (A-3) or telegraph (A-1 or A-2) service . . . it is compact, complete and designed for hard service.

Other Equipment made and designed by Aerocom: Models VH-50 and VH-200 transmitters, operating range, 118-165 Mcs. (crystal controlled), power 50 and 200 Watts respectively; Model 12ACX-2A. 1 Kw. dual channel radio telegraph transmitter for medium and high frequencies (1.6 to 24 Mcs.); Model GM-8 modulator when used with above provides full modulation with a 750 Watt carrier. Complete Engineering data on Request.

Model 50HXS

Radiotelegraph or telephone Transmitter output 75 Watts (A-1); 50 Watts (A-2 or A-3) Frequencies 200-500 Kcs. and 1.6-13.5 Mcs. using plug in coils and crystals. A complete compact self-contained unit.

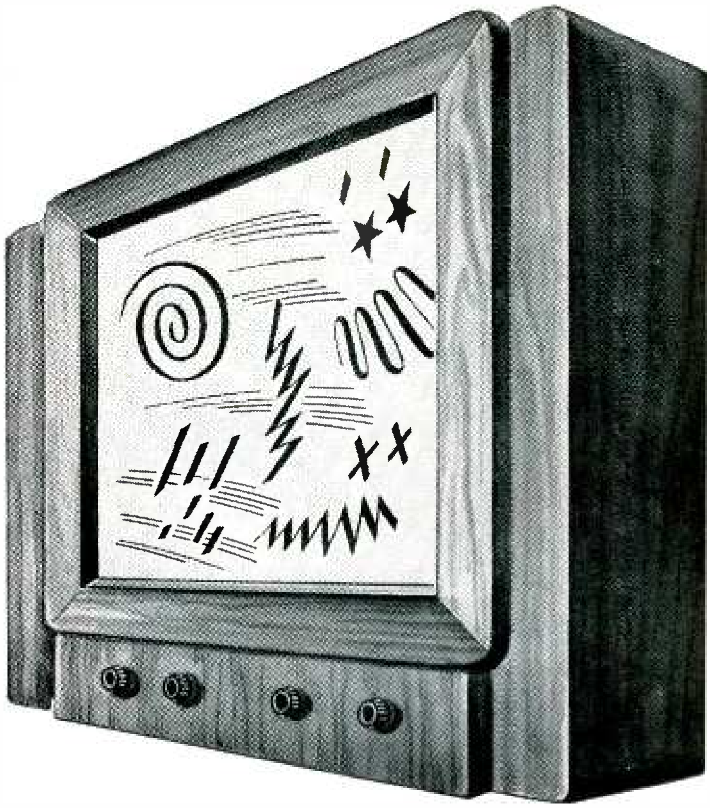
CONSULTANTS, DESIGNERS AND MANUFACTURERS OF STANDARD OR SPECIAL ELECTRONIC, METEOROLOGICAL AND COMMUNICATIONS EQUIPMENT

AER-O-COM
Reg. U. S. Pat. Off.

AERONAUTICAL COMMUNICATIONS EQUIPMENT, INC.
3090 Douglas Road, Miami 33, Florida

DEALERS: Equipeletro Ltda., Caixa Postal 1925, Rio de Janeiro, Brasil ★ Henry Neuman Jr., Apartado Aereo 138, Barranquilla, Colombia

How to Smooth



ROUGH RECEPTION

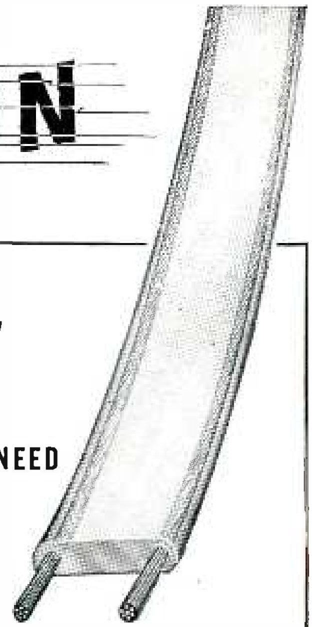
ANACONDA Type ATV* Lead-In Lines go a long way towards bringing perfect reception to television and FM sets.

The effects of attenuation and impedance mismatch on reception are minimized by ATV lines. The satin-smooth polyethylene insulation of this line sheds water readily—thus avoiding subsequent impedance discontinuities. This insulating material also has high resistance to deterioration.

Count on Anaconda to solve your high-frequency transmission problems—with anything from a new type lead-in line to the latest development in coaxial cables.

48457

*Reg. U.S. Pat. Off.



A TYPE ATV LEAD-IN FOR EVERY NEED

Anaconda offers a complete selection of Type ATV lead-in lines for 75, 150 and 300 ohms impedance, unshielded and shielded lines of high impedance. For an electrical and physical characteristics bulletin, write to Anaconda Wire and Cable Company.

ANACONDA

Anaconda Wire and Cable Company

25 BROADWAY, NEW YORK 4, N. Y.

When electrical equipment must operate in sub-zero temperatures, it's performance and not pennies that counts in insulation and every other component part. Even at —50°F. at 30,000 feet elevation, BH Extra Flexible Fiberglas Sleeving will not crystallize. Will not break down. Retains all of its remarkable flexibility, heat resistance and dielectric strength.

That is why parts suppliers for some of America's great planes come to Bentley, Harris for this remarkable insulation. Read what they say:

> Co. A: "BH Extra Flexible Fiberglas Sleeving does not fray, does not break down while in service."

> Co. B: "The principal reason for using BH Extra Flexible Fiberglas Sleeving is that it does not scorch or burn like ordinary saturated sleeving."

Non-fraying qualities of BH Extra Flexible Fiberglas Sleeving are achieved without use of hardening varnish or lacquer. Stays flexible as string. Will not split or crack when bent. Resists abrasion and wear.

If you require unusual heat resistance — up to 1200°F. — specify BH Special Treated Fiberglas Sleeving. Write us today.

BENTLEY, HARRIS MFG. CO., CONSHOHOCKEN, PA.

BH Fiberglas* SLEEVINGS

*BH Non-Fraying Fiberglas Sleevings are made by an exclusive Bentley, Harris process (U. S. Pat. No. 2393530). "Fiberglas" is Reg. TM of Owens-Corning Fiberglas Corp.

USE COUPON NOW

Bentley, Harris Mfg. Co., Dept. E-25, Conshohocken, Pa.

I am interested in BH Non-Fraying Fiberglas Sleeving for ______________ (product)

operating at temperatures of ____°F. at ____ volts. Send samples so I can see for myself how BH Non-Fraying Fiberglas Sleeving stays flexible as string, will not crack or split when bent.

NAME ______________ COMPANY ______________

ADDRESS ______________

Send samples, pamphlet and prices on other BH Products as follows:

- ☐ Cotton-base Sleeving and Tubing
- ☐ Ben-Har Special Treated Fiberglas Tubing


An Entirely New Product
Non-metallic diaphragm for permanent superior acoustic performance.
Strong trunions lock projector in any position but never freeze—trunion parts are stainless steel and rust-proof metal.
Internally and externally completely corrosion-proof and rust-proof.
Weatherproof and anti-corrosion terminal box with removable cover.
Heavy, rugged U bracket with three holes making centering and "aiming" easy.
New Alnico 5 driver unit entirely enclosed within the one piece rigid horn, yet may be removed without special tools.
Jensen Hypex
Hypex
Exclusive Jensen Hypex formula (Patent 2,338,262) gives improved acoustical performance and wider sound distribution.
Four Reflex models from 24-inch to 9-inch. Two Reflex Radial models from 24-inch to 10-inch. Representing new highs in performance . . . new lows in price.
Jensen
6607 So. Laramie Ave., Chicago 38
Designers and Manufacturers of Fine Acoustic Equipment

New vital link

ANNOUNCING THE GENERAL ELECTRIC S-T BROADCAST SYSTEM!

• With it—your signal from studio to transmitter now rides on air!

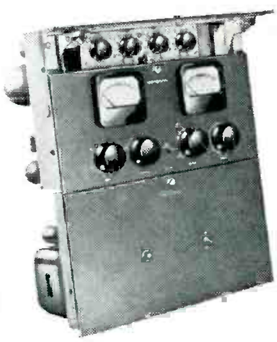
With it—your problems of outages due to weather or rugged terrain are solved! Sleet storms, fires or floods can damage studio to transmitter transmission lines or cables—but not micro-wave transmission from General Electric S-T broadcast system. There are no transmission lines or cables.

With it—you can select the best sites for your station and transmitter with increased assurance of reliable program service!

The new General Electric S-T Link equipment is easily installed and occupies remarkably little studio space. A product of the research and engineering skills assembled at Electronics Park, this system is another General Electric contribution to better broadcasting.

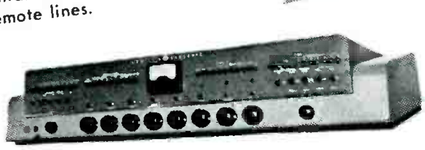
Broadcasters, station managers and engineers will want all the facts.

Your nearest G-E office can give them to you. Call there, or write: *General Electric Company, Transmitter Division, Electronics Park, Syracuse, New York.*



Limiting Amplifier designed by General Electric for efficiency plus. Like all G-E audio equipment, it fits into standard cabinet rack.

G-E two-studio Consolette contains all controls needed for split-second control of two studios, an announce booth, two turntables, and a total of eight remote lines.



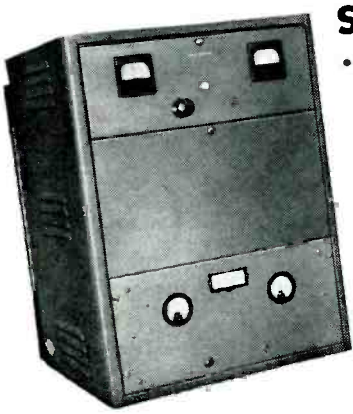
S-T TRANSMITTER

- Conservatively rated 10 watts output. Continuously adjustable 1 to 10 watts, for maximum tube life.
- Remarkably easy installation.
- Single unit. Entire transmitter is complete within its cabinet. All maintenance done under comfortable indoor conditions.
- Low power consumption: 675 watts total input.
- Can be tuned and adjusted without special test equipment.
- Instant accessibility. All meter and tuning controls immediately at hand when front doors are open.
- Rear doors interlocked for maximum safety to personnel.
- Simple and easy to change tubes.

WHAT THE SYSTEM DOES FOR YOU . . .

- Operates in band 920 to 960 MC. This includes the band permanently assigned by FCC for S-T broadcast service.
- Permits you to meet all FCC FM broadcast system requirements.
- Remote controlled over single-pair telephone line.
- Uses standard type "N" RF fittings throughout.
- Provides high fidelity performance:
  - —Less than 1% distortion from 50 to 15,000 cycles.
  - —Noise level better than 65 db.
  - —Frequency response well within ± 1 db from 50 to 15,000 cycles.
- Designed for unattended remote operation.

for dependable broadcasting



S-T RECEIVER

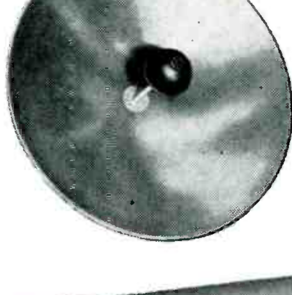
- Double-conversion superheterodyne circuit, fully crystal controlled for maximum long-term frequency stability.
- Standard receiver tubes throughout.
- Sensitivity — 95 db below 1 watt (for specified system performance).
- Total power input only 135 watts.
- Compactly assembled for mounting in standard 19-inch cabinet rack.
- All tuning adjustments are made from the front.

10-KW FM Transmitter. A famous member of a famous family. Skillfully engineered and sturdily built—a dependable unit that has helped to bring continuing FM leadership to General Electric.

Circular FM Antenna — provides high power gain with low wind loading. This strong "Doughnut" antenna is available in 1, 2, 4, 6 and 8 bay models.

S-T ANTENNAS

- 40-inch reinforced aluminum paraboloid, with dipole feed.
- Power gain each antenna 15.3 db over standard dipole. Total gain 30.6 db.
- Low standing-wave ratio over full frequency range (920-960 MC) without adjustment.
- Two-clamp mounting construction permits firm attachment to single structural member or pole.
- Easy to install and aim.
- Fully protected from adverse effects of icing.
- Designed for 100 m.p.h. wind loading.



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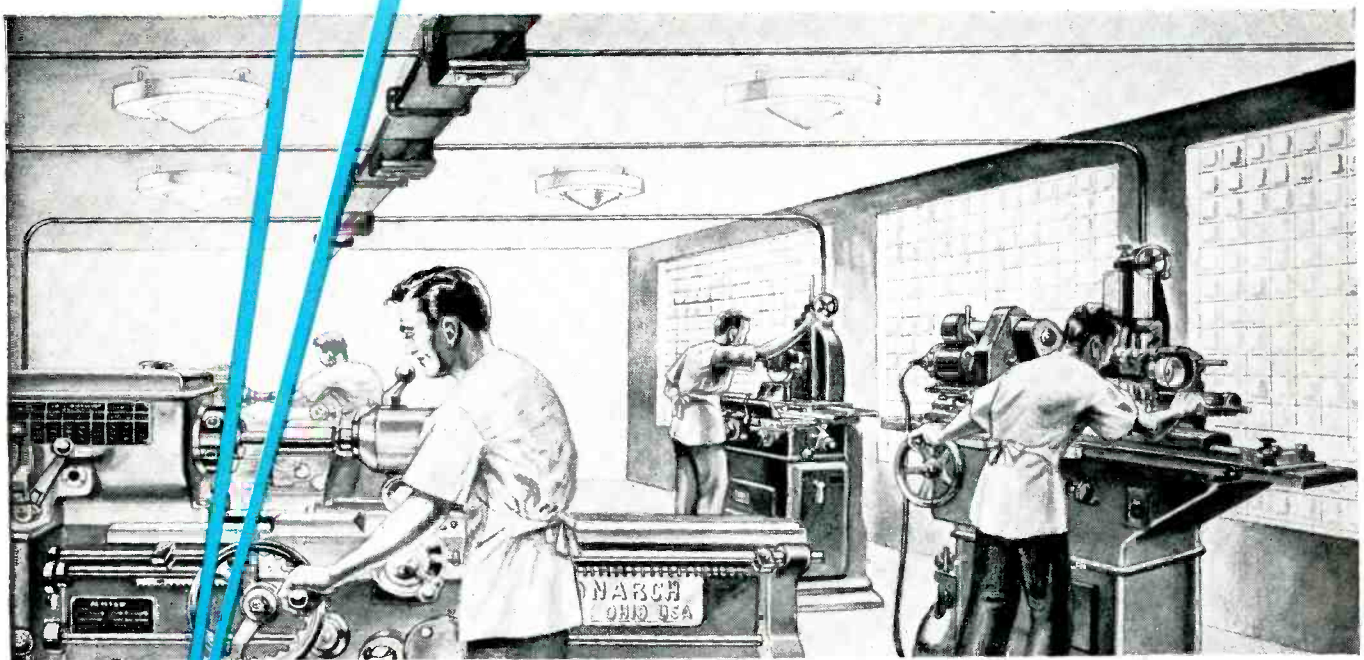
is *Vital* to



PRECISION ELECTRONICS

THE SHERRON ELECTRO-MECHANICAL LABORATORY SERVES IN THE FABRICATION OF MECHANICAL COMPONENTS FOR:

- *Mechanical Equipment for Electronoptics*
- *Special Precision Wave Guides*
- *Computers*
- *Vacuum Tube Structures*
- *Precision Tuning Units*
- *Precision Drive Mechanisms*
- *Servo Mechanisms*

Shown above is a view of the Sherron electro-mechanical laboratory. Here you will see the finest modern tools. Every machine, every piece of apparatus is a precision instrument. Lathes, jig bores, shapers, heat treating equipment, locators, millers — they're all here. Yes, and the entire gamut of standards, gauges, mechanical measuring instruments . . . We allow no margin for error in any detail of the electronic equipment we make. As a result, the Sherron electro-mechanical laboratory performs a vital function in our complete and co-ordinated service to manufacturers . . . Why not consult our electro-mechanical engineering group on your "precision electronics" problems?

Sherron Electronics

W2XDK

SHERRON ELECTRONICS COMPANY

Division of Sherron Metallic Corporation

1201 FLUSHING AVE. • BROOKLYN 6, NEW YORK

RADIO "TRAFFIC COP" with a good heart!

Operating where audio frequencies crowd the thoroughfares, variable attenuators assure precision volume control in speech input equipment for radio consoles, sound motion pictures, public address systems, and television.

With a "traffic cop" of this type in each microphone circuit of a multi-microphone set-up, input volume of one unit can be gradually faded out while that of another is increased; close-up and background program effects can be reproduced with whatever degree of contrast is desired; and the resultant mixing of all microphone inputs can be precisely and smoothly handled, through a master gain control, to meet all variations in program tonal intensity.

Since impedance of a circuit is kept constant while volume is changed, uniform performance is obtained without sacrifice of quality.

To assure topnotch results, the maker—Daven Company of Newark, N. J.—specifies that *all* its resistors, "standards in the industry", be wound with wire drawn from Driver-Harris electrical heat and corrosion-resisting alloys: Nichrome*V, Nichrome*, Advance*, D-H Manganin and the newly developed 331 Alloy which has very high specific resistance and a very low temperature coefficient of resistance.

If *you* require electrical resistance wire of outstanding uniformity, high stability, and long life, be guided by the example of Daven, whose products are used the world over, and have Driver-Harris supply your needs. For D-H alloys are the very heart of good electrical equipment of all kinds. Send us your specifications.

SPECIAL PURPOSE ALLOYS SINCE 1899 — D-H — TRADE MARK REG. U. S. PAT. OFF.

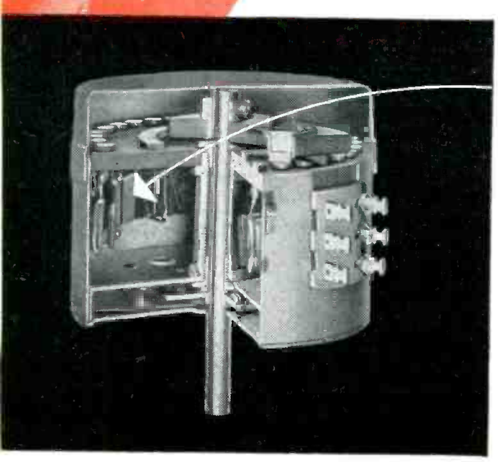
Nichrome is Manufactured only by

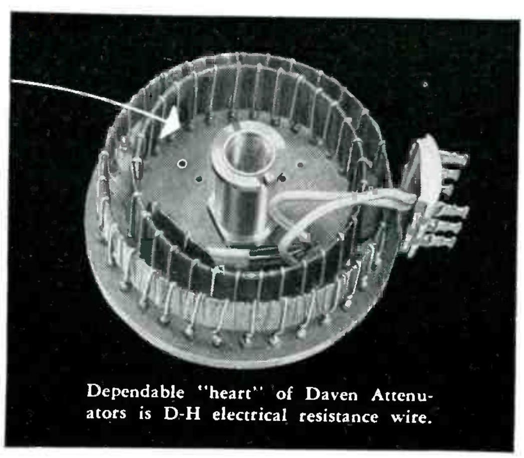
Driver-Harris Company

HARRISON, NEW JERSEY

BRANCHES: Chicago, Detroit, Cleveland, Los Angeles, San Francisco, Seattle
Manufactured and sold in Canada by
The B. GREENING WIRE COMPANY, LTD., Hamilton, Ontario, Canada

*T.M. Reg. U. S. Pat. Off.



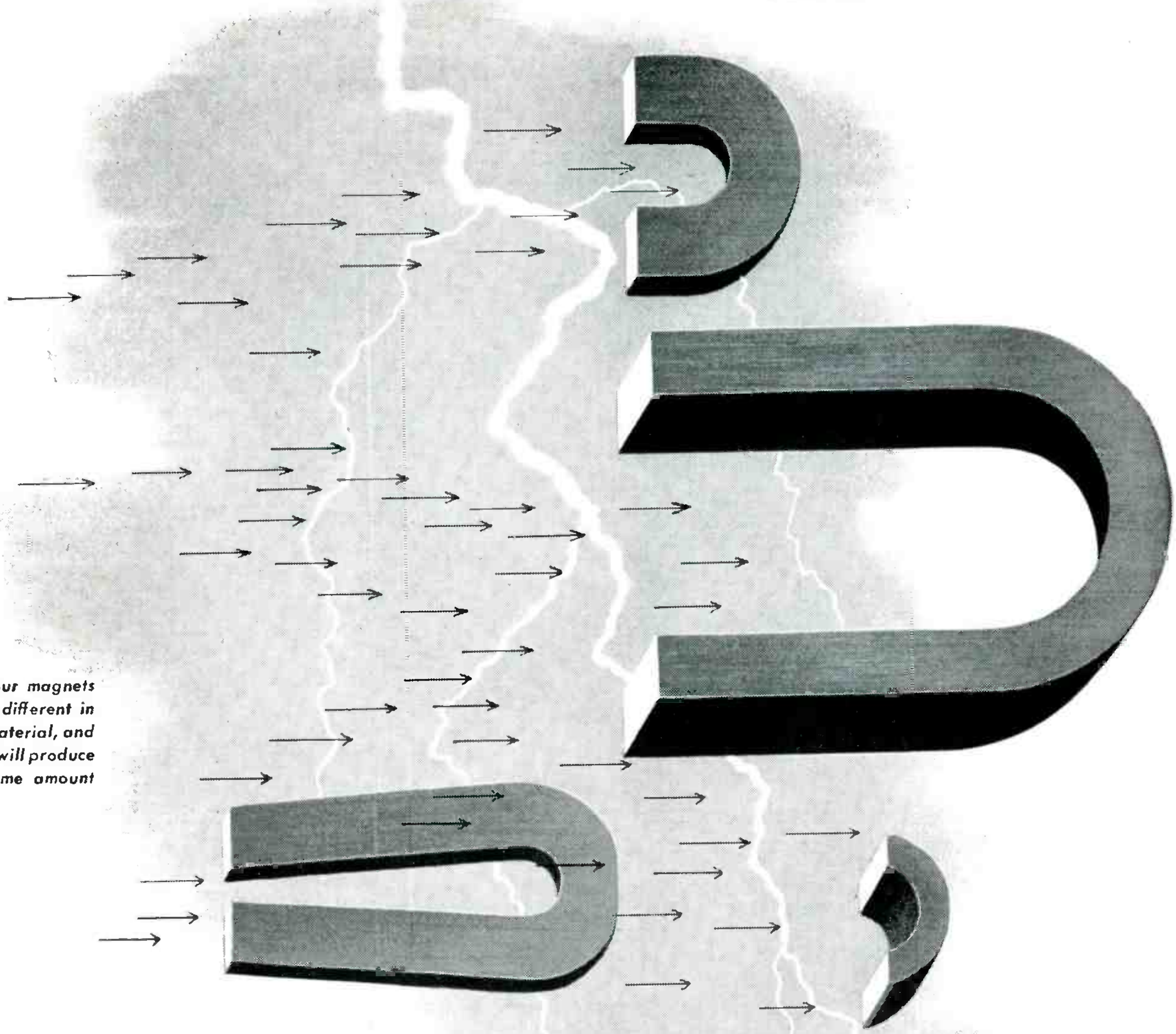


Dependable "heart" of Daven Attenuators is D-H electrical resistance wire.

Silver alloy contacts assist in improving performance.

Notably compact, Daven Rotary-type Variable Attenuators are made in sizes from 1¾" to 2¾" outside diameter. Standard units, giving up to 45 steps of attenuation, are available with built-in cueing control, enabling recordings, transcriptions, remote or network programs to be cued without necessity for auxiliary switching mechanism. Accuracy of resistance: from 0.1% up.

INDIANA PERMANENT MAGNETS MAY BE YOUR ANSWER, TOO



Each of the four magnets shown here is different in size, weight, material, and price; yet each will produce exactly the same amount of energy.

"PACKAGED ENERGY" SAVES SPACE, CUTS COSTS

INDIANA permanent magnets fit your need like a doctor's prescription—the right material, the right design, the *right* magnets to *do your job best.*

When you buy *Indiana* permanent magnets, you buy *product improvement* . . . new and higher efficiency . . . new versatility . . new economy. Today, *Indiana* magnets are performing operations that were impractical only a few years ago—actually replacing many mechanical and electrical devices—and with less weight, less bulk, *lower cost.*

For example, certain radar magnets of Alnico originally weighed 14 pounds. Through *redesign* by *Indiana,* their size was reduced materially and their weight cut to 3½ pounds. Both were of identical material; both produced the same energy. The substantial savings in weight and cost were accomplished wholly by a change in design. Consultation with our engineers may result in similar savings for you.

INDIANA permanent magnets bring you (1) the largest possible output of energy per dollar of cost, or (2) a required number of energy units at lowest cost, or (3) a fixed amount of energy in the smallest space.

Indiana is the *only* manufacturer of all types of commercially used permanent magnet alloys. Continuous research and production control assure top quality and uniformity of *all* your *Indiana* permanent magnets, regardless of size or quantity. Call on our Special Design Service in solving *your* problems.

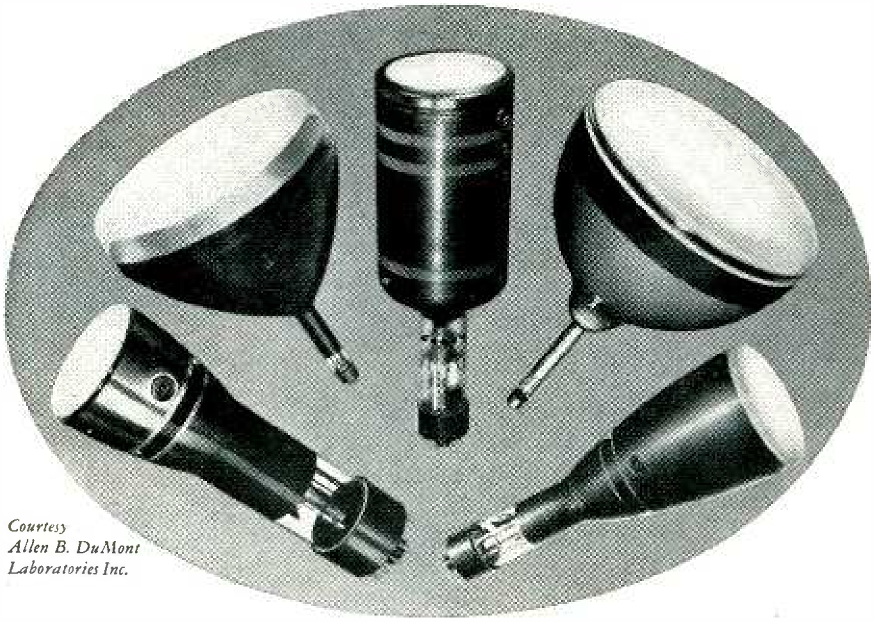
THE INDIANA STEEL PRODUCTS COMPANY

PRODUCERS OF "PACKAGED ENERGY"
6 NORTH MICHIGAN AVENUE • CHICAGO 2, ILL.

SPECIALISTS IN PERMANENT MAGNETS SINCE 1910
PLANTS: VALPARAISO, INDIANA; CHAUNCEY, WESTCHESTER COUNTY, N.Y.

The *NEW* "dag" CRT Wall Coating . . .

for *all* CRT glass envelopes



Courtesy Allen B. DuMont Laboratories Inc.

Here's an entirely *new* CRT Wall Coating, developed by Acheson Colloids specifically and solely for use on CRT glass envelopes.

"dag" CRT Wall Coating is very easily applied . . . adheres tenaciously to all types of glass . . . does not yield objectionable by-products on heating.

Prominent cathode-ray tube manufacturers have already found this opaque, electrically conductive **"dag"** CRT Wall Coating eminently satisfactory, especially in tubes intended for television reception.

Let Acheson Colloids help you with your CRT wall coating problem. Mail the coupon today for information on this or other electronic applications of **"dag"** colloidal graphite dispersions.

Give me information on "dag" colloidal graphite dispersions for:

- Wall coating of CRT's ☐
- Electrostatic shielding ☐
- Corona prevention ☐
- Dry-film lubrication ☐
- Copper oxide rectifier disc coating ☐
- Electrical resistances ☐
- Filament cement ☐

HH5

40th Anniversary Year

dag REG. U.S. PAT. OFF. COLLOIDS

Acheson Colloids Corporation

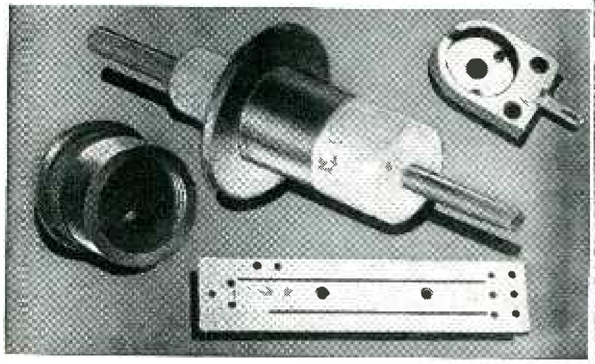
Port Huron Michigan

SINCE 1919 MYCALEX THE INSULATOR TRADE MARK REG. U. S. PAT. OFF.

THE LOW-LOSS, HIGH FREQUENCY INSULATION for every electrical and mechanical requirement

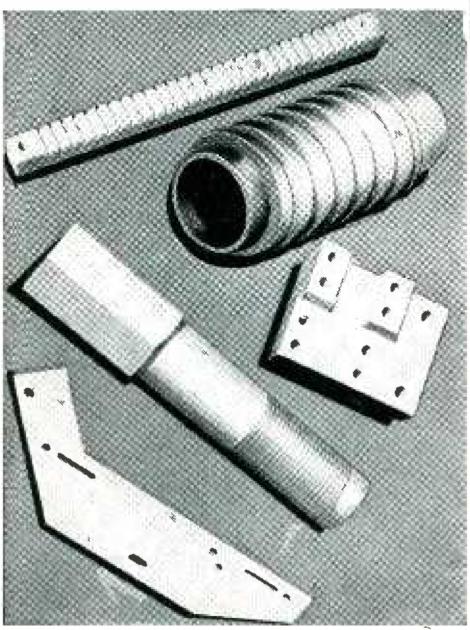
MYCALEX, a most versatile, low-loss insulation material, possesses unusual characteristics that ideally suit it for use in ultra high-frequency applications. It can be molded, or machined to very close tolerances—it is impervious to water, oil or humidity; has dimensional stability, high dielectric strength and will not carbonize. Metal inserts can be molded into the material giving it an almost endless number of applications in the field of electronics. It is available in the three following types:

MYCALEX 410



This injection-molded form of Mycalex is useful in 4 cases: 1. When shape is too intricate to permit fabrication by machine. 2. When quantities necessitate high production and low cost. 3. When great dimensional stability is essential. (Mycalex 410 can be molded to very close tolerances.) 4. When metal inserts must be incorporated into the insulator. These inserts may be made of any common metal that can withstand temperatures of about 1200° F and that has a coefficient of thermal expansion of the order of 100 to 175 x 10^{-7} per degree C. Mycalex metal seals can withstand pressure of 90 psi.

MYCALEX 400



Compression molded for high-frequency applications. Its loss factor is well within requirements for operation in this portion of the electromagnetic spectrum. An outstanding characteristic is the long frequency range over which the loss factor is a minimum. Tropical climates do not impair its electrical and physical properties. It is, therefore, used for insulation in radio transmitters, radio receivers, communication panels, switchboard panels, arc shields in high tension switches, brush holders, relay contact supports, etc. Available in sheets 14 by 18 in.; thickness of ⅛ to 1 in. Rods 18 in. long, diameter ¼ to 1 in.

MYCALEX K series

Ceramic Capacitor Dielectrics. Many ceramic materials offer low power factor, negligible moisture absorption, high dielectric strength, lack of cold flow, ability to withstand high temperatures. Few, however, include a dielectric constant greater than 7 or 8 at radio frequencies. Few are available with flat surfaces of large dimensions that don't warp, or close tolerances in rods. Mycalex K capacitor dielectrics combine all of them and is available in practically any form. Power factor varies from 0.002 to 0.004 at 1 mc.

MYCALEX FABRICATING SERVICE

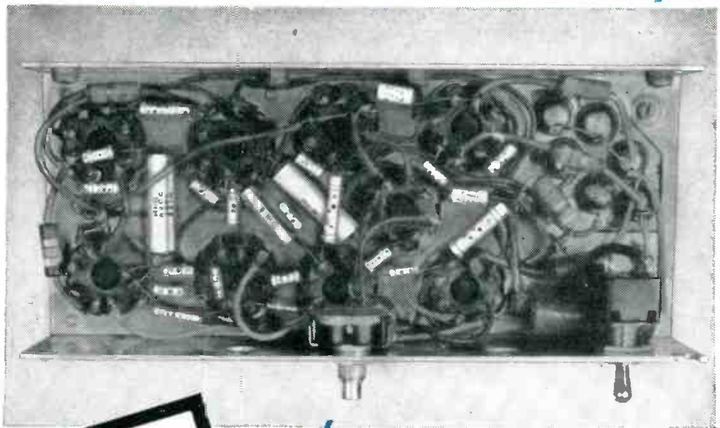
Mycalex can be machined to customers' exact specifications in our new plant at Clifton, N. J. This plant is especially tooled for large volume machining of Mycalex in a wide variety of forms. This service offers the following advantages . . . PRECISION WORKMANSHIP: specialized equipment that assures remarkable precision and supervision by skilled engineers. REDUCED COSTS: substantial savings effected by efficient performance on a quantity basis. RELIEF TO PLANT BOTTLENECKS. PROMPT DELIVERIES. Consult our engineering staff for advice on the application of Mycalex to your insulating problems.

MYCALEX CORPORATION OF AMERICA

"Owners of 'MYCALEX' Patents"

Plant and General Offices CLIFTON, N. J. Executive Offices, 30 ROCKEFELLER PLAZA, NEW YORK 20, N. Y.

Specify HI-Q COMPONENTS *for* MINIATURIZATION



FOR superior performance in a limited space, the utilitarian compactness of **Hi-Q** components is sure to meet your enthusiastic approval. Although **Hi-Q** components are compact, there is no sacrifice of accuracy, dependability or uniformity. Each component meets or surpasses rigid standards for capacity, tolerance and performance. This compactness is accomplished through application of up-to-the-minute processing techniques, combined with use of highest quality materials and complete control of quality throughout all stages of manufacture. Specify **Hi-Q** for *maximum* efficiency in a *minimum* amount of space.

Hi-Q MINIATURE G. P. TUBULARS

G. P. Miniatures providing capacities from 5 mmf to 33,000 mmf will cover the majority of your by-passing problems. By the use of our new body 41 the above extended capacity ranges are now available. These smaller units provide closer coupling of leads thus insuring the minimum of inductance and highest self resonant frequencies.

Illustration at left is actual size.

Hi-Q DISK CAPACITORS

BPD Another example of accurate and dependable miniaturization is this high dielectric by-pass, blocking or coupling Hi-Q Disk Capacitor. Many applications where physical shape is more adaptable than the tubular unit. Available in two standard capacities:

Type BPD-5: .005 mfd guar. min.
Type BPD-10: .01 mfd. guar. min.
Type BPD-1.5: .0015 mfd. guar. min.

Illustration at right is actual size.

Hi-Q COMPONENTS BETTER 4 WAYS

PRECISION Tested step by step from raw material to finished product. Accuracy guaranteed to your specified tolerance.

UNIFORMITY Constancy of quality is maintained over entire production through continuous manufacturing controls.

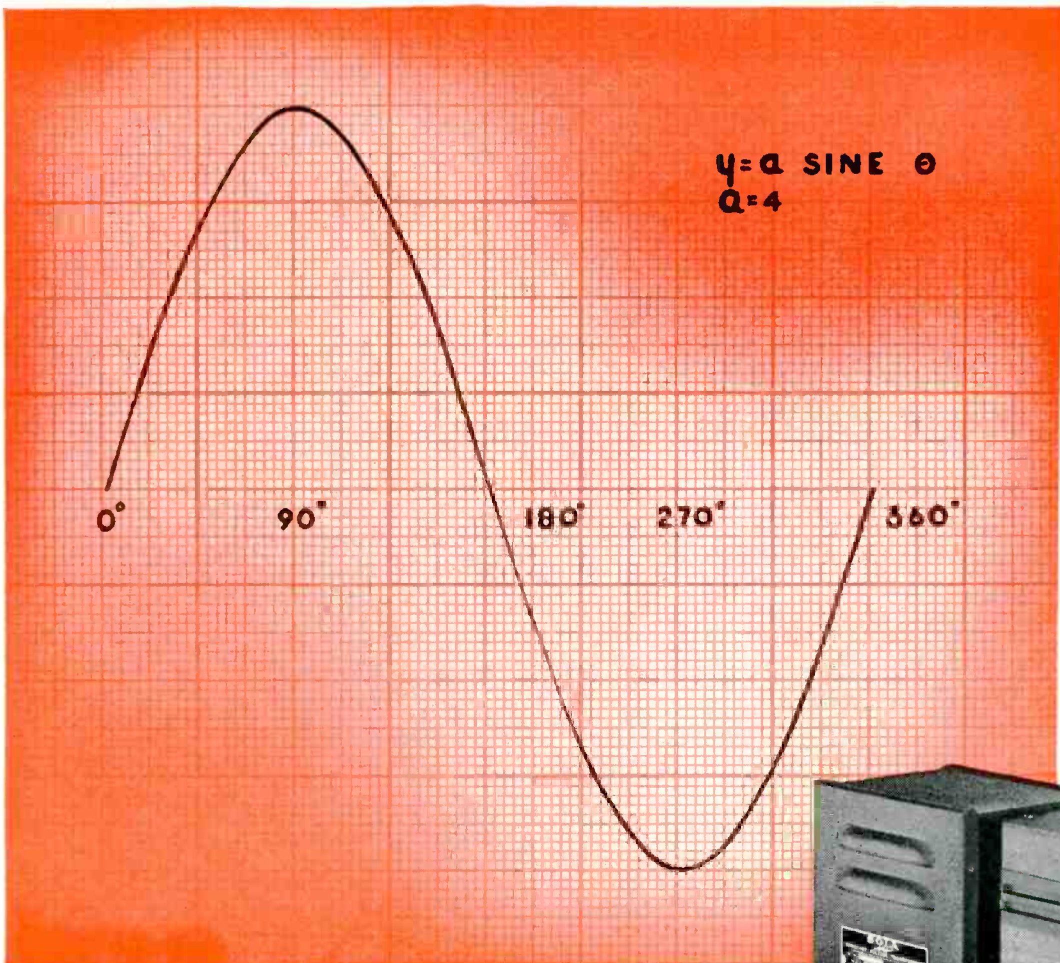
DEPENDABILITY Interpret this factor in terms of your customers' satisfaction . . . Year after year of trouble-free performance. Our Hi-Q makes your product better.

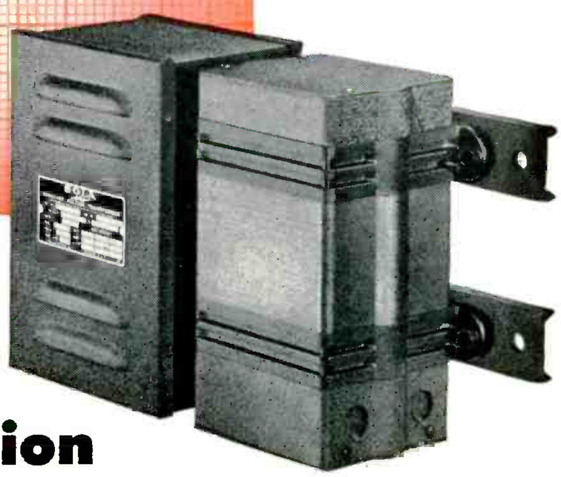
MINIATURIZATION The smallest BIG VALUE components in the business make possible space saving factors which reduce your production costs . . . increase your profits.

Hi-Q *Electrical Reactance Corp.*

FRANKLINVILLE, N. Y.

Plants: FRANKLINVILLE, N. Y.—JESSUP, PA.
Sales Offices: NEW YORK, PHILADELPHIA, DETROIT, CHICAGO, LOS ANGELES





CONSTANT VOLTAGE
with low harmonic distortion

TYPE CVH, an important newcomer in a famous line—a Sola Constant Voltage Transformer designed for use with equipment that requires a source of undistorted voltage. These new transformers, available in 250, 500 and 1,000 VA capacities, provide all of the voltage stabilizing characteristics of the standard Sola Constant Voltage Transformer, with less than 3% harmonic distortion of the output voltage wave.

Since the output voltage wave is essentially sinusoidal, these transformers may be used for the most exacting applications such as general laboratory work, instrument calibration, precision electronic equipment or other equipment having elements which are sensitive to power frequencies harmonically related to the fundamental.

As in all Sola Constant Voltage Transformers the regulation is automatic and instantaneous. There are no moving parts, no manual adjustments and every unit is self-protecting against short circuit.

Type CVH represents an outstanding advance in automatic voltage regulation and an important contribution to precise electronic equipment.

WRITE FOR THESE BULLETINS

DCVH-136—*complete electrical and mechanical characteristics of the new Type CVH Constant Voltage Transformers.*

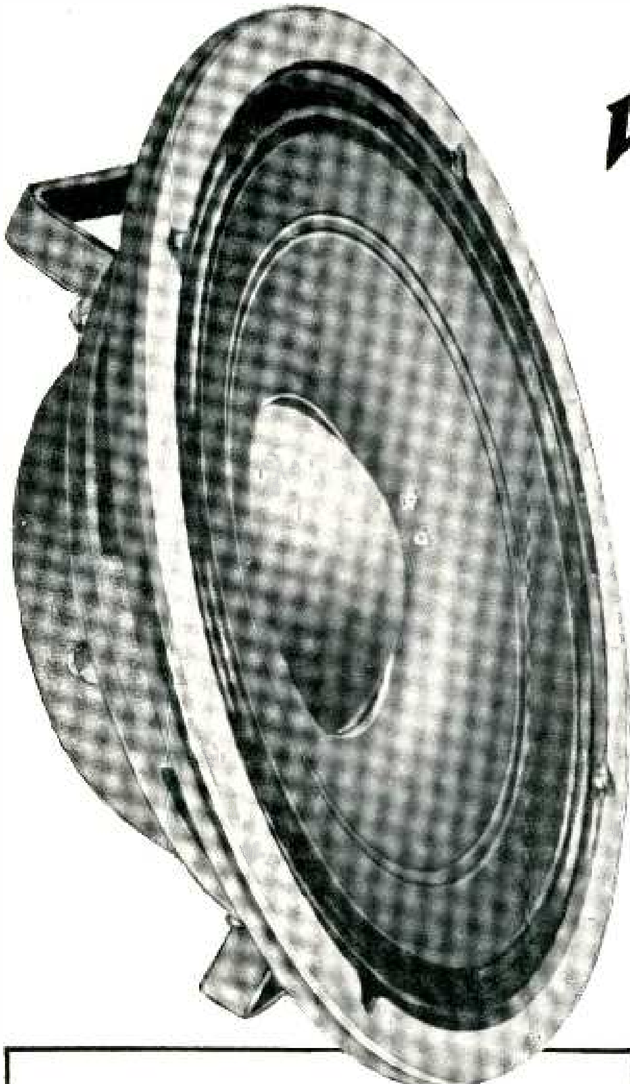
DCV-102 — *complete engineering handbook and catalog of standard Constant Voltage Transformers available for remedial or built-in applications.*

SOLA *Constant Voltage* **TRANSFORMERS**

Transformers for: Constant Voltage • Cold Cathode Lighting • Airport Lighting • Series Lighting • Fluorescent Lighting • Luminous Tube Signs Oil Burner Ignition • X-Ray • Power • Controls • Signal Systems • etc. • **SOLA ELECTRIC COMPANY, 4633 W. 16th Street, Chicago 50, Illinois**

Manufactured under license by: ENDURANCE ELECTRIC CO., Concord West, N. S. W., Australia • ADVANCE COMPONENTS LTD., Walthamstow, E., England UCOA RADIO S.A., Buenos Aires, Argentina • M. C. B. & VERITABLE ALTER, Courbevoie (Seine), France

So much of everything you want packed into this 10-inch speaker!



The new *Western Electric* 756A

20 watts capacity
Superb quality of reproduction
Compact and simple to install
Available for immediate delivery

Before you select any speaker for broadcast monitoring, wired music, program distribution systems or home radios and record players, look at the 756A and listen to its brilliant tonal quality.

The 756A is just one of a line of new Western Electric speakers with power capacities from 8 watts to 30 watts. Get the full story on all of them from your Graybar representative, or write Graybar Electric Co., 420 Lexington Ave., New York 17, N.Y.

SPECIFICATIONS

FREQUENCY RANGE: 65 to 10,000 cycles.

IMPEDANCE: 4 ohms.

COVERAGE ANGLE: 60°.

POWER CAPACITY: 20 watts continuous.

EFFICIENCY: At distance of 30 feet on the axis, will produce a level of 89.5 db above 10^{-16} watt per sq. cm. at 20 watts, on basis of warble frequency covering range of 500 to 2500 cps.

DIMENSIONS: Diameter 10¼"; depth 3¼".

BAFFLE HOLE DIAMETER: 8-13/16".

WEIGHT: 10 lbs.

ENCLOSURE REQUIRED: 2½ cubic feet completely enclosed.

—QUALITY COUNTS—

Distributed by Graybar — Offices in 100 principal cities

DISTRIBUTORS: IN THE U. S. A.—Graybar Electric Company. IN CANADA AND NEWFOUNDLAND—Northern Electric Company, Ltd.

BUSINESS BRIEFS

By W. W. MacDONALD

Seasonal Patterns taken for granted before the war but forgotten since then are returning to the business. Next time anyone says business is off ask if they mean by comparison with normal prewar, wartime-boom, or postwar seller's market. Then the statement can be examined in its proper perspective.

Magnetic Amplifiers (p 124, Sept. 1947) are destined to play an important part in the design of industrial control equipment, will eliminate tubes in some instances. Invented by GE's E. F. Alexanderson many years ago, such amplifiers were limited in application by lack of suitable materials. The Japanese developed very efficient materials during the war, and the Germans put them to work. American scientists have since further extended the technique.

Extremely efficient d-c amplifiers were described at a recent symposium in Washington (see p 128, this issue). So also were low-frequency a-c types. Several speakers left the distinct impression that it is not at all beyond the range of possibility that core materials may soon be improved to a point permitting use of magnetic amplifiers at audio frequencies and, perhaps, even at radio frequencies.

Sound may be the answer for manufacturers of vacuum cleaners who wish to shake rugs without using a rotating brush or beater. One of our readers who has a patent pending on the application says that 15 to 20 watts of 60-cycle power fed into a loudspeaker held an inch or so above the floor should do a job, and that even 5 watts will produce visible movement of a rug. He says, furthermore, that if it is properly done the user is not disturbed by the sound.

Name and address on request.

Believe It Or Not, one of the problems bothering meat packers is the fact that when the ground is icy hogs slip and become bruised. The bruises show up in hams, but not until the hams are cut.

One big packer recently wrote to a company in our field and asked if bruised hams might not be detected by radar, indicating once more the sad fact that while many outsiders still don't know what electronics can and cannot do they are anxious to give us a whack at their business.

If anyone can think of a practical solution we'll be glad to pass it along.

Tele Service, if not installations, will in our opinion soon have to gravitate to retailers. Sets are moving so fast that facilities set up by manufacturers are being severely taxed, and the business has just started. One factory-affiliated organization alone already has 30 shops, 600 trucks and 1,700 men.

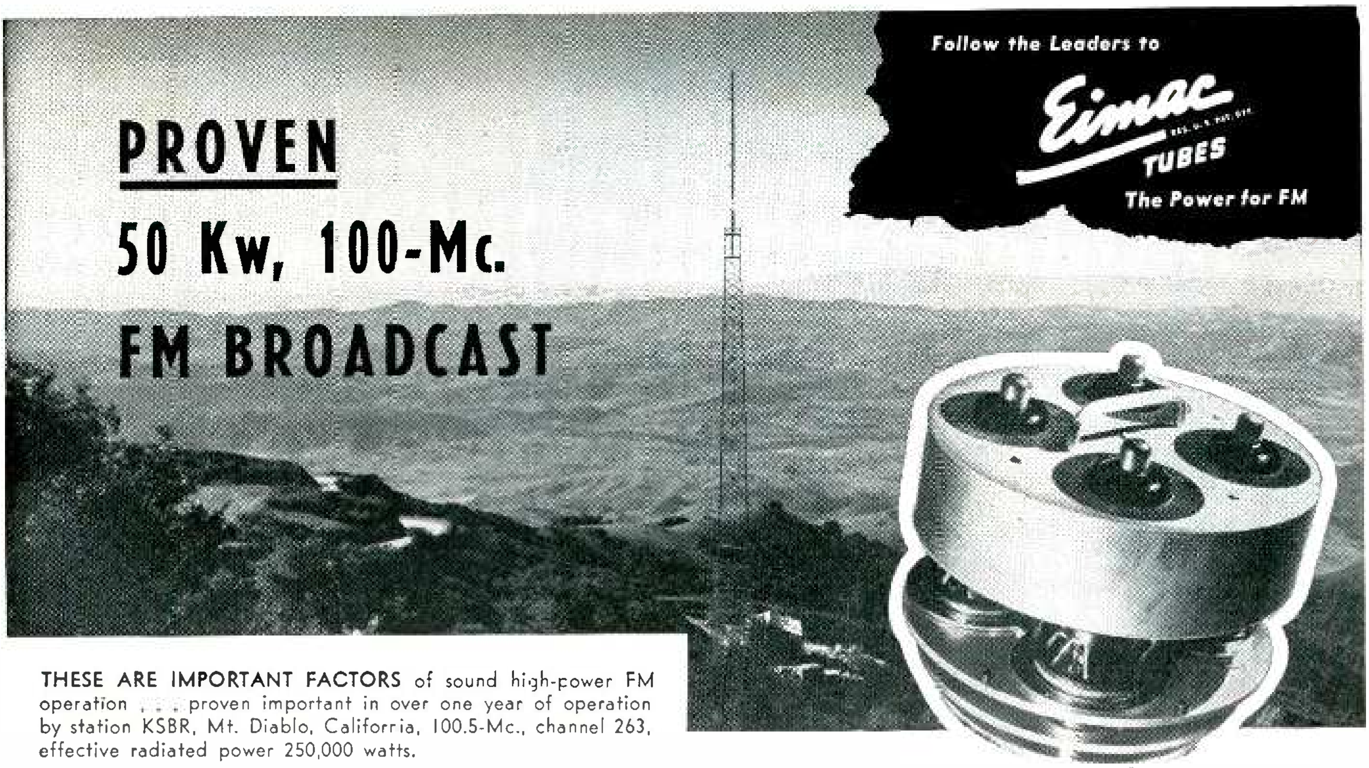
Incidentally, Howard Sams tells us he is receiving quite a few letters out in Indianapolis from appliance distributors, asking for information on the replacement parts business. This is another straw in the wind.

Hams have found a simple way to substitute a 12-inch cathode-ray tube available in the surplus market at $7 to $10 for the 7-inchers built into many television receivers. It seems that if one of the large bottles is operated below 2,500 volts instead of the 6,000 volts for which it was designed the fact that it is a long-persistence type is not too bothersome.

Brilliancy of the picture is not bad. Only a test pattern or other still-life picture exhibits marked hold-over. And all one has to do is to change the tube socket.

All Is Not Serene with respect to television receiver front ends. What with radiation, dead spots due to resonance of unused circuits, and other trick effects, trouble is being experienced in many markets.

Watch for early improvements particularly in switches. And



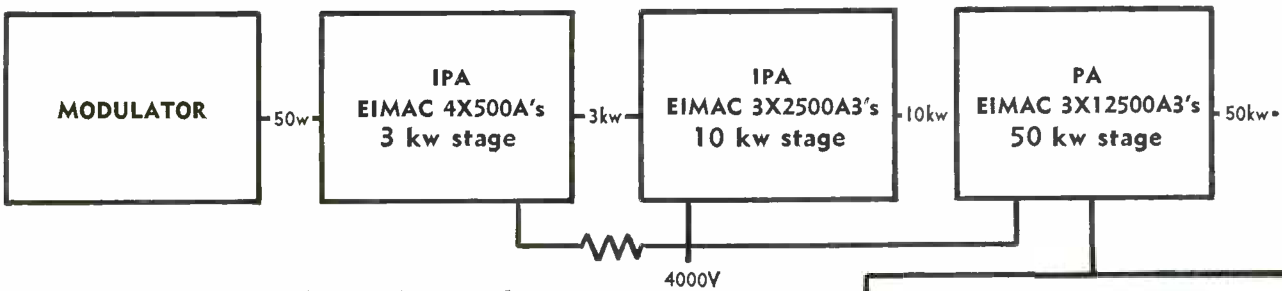
THESE ARE IMPORTANT FACTORS of sound high-power FM operation . . . proven important in over one year of operation by station KSBR, Mt. Diablo, California, 100.5-Mc., channel 263, effective radiated power 250,000 watts.

1) Overall power consumption is under 90 kw.
2) Equipment is of compact design.
3) Power tubes have highly efficient thoriated tungsten filaments.
4) Tube servicing is possible without special tools, equipment, and training.
5) Vacuum tube components are capable of supplying sufficient output without being run at maximum ratings.
6) 50 kw. final is driven directly by the 10 kw. stage.
7) Air cooled. 3, 10, and 50 kw. stages only require the output of a single blower driven by a 1 h. p. motor.

And they are made possible because of one component . . . the Eimac multiunit triode, type 3X12500A3. A pair of these tubes (as grounded grid amplifiers) are capable of providing over 50 kw. of useful output power with but 10 kw. watts of drive. The lineup of KSBR equipment and operational data, below, further illustrates advantages inherent to equipment designed around the 3X12500A3.

Analyze the vacuum-tube components in the equipment you consider . . . be sure their design presents the highest advantage to you. The Eimac sales department will gladly furnish names of equipment manufacturers and engineers using Eimac tubes. Phone, write or wire direct.

HERE'S THE KSBR LINE-UP



OVERALL EFFICIENCY: input from 50 watts to 50KW - - - - - - - 65%
OVERALL POWER CONSUMPTION - 85KW
TOTAL FLOOR SPACE USED BY EQUIPMENT - - - - - - - 22 sq. ft.
TUBE REPLACEMENT COST
4X500A $97.50, 3X2500A3 $180.00, 3X12500A3 $875.00*

*$115 credit for return of radiator and mechanical assembly in good condition. $35.00 credit for return of crete in good condition.

OPERATING CONDITIONS
(Two Tubes)

D-C Plate Voltage	4000 volts
D-C Plate Current	14.4 amperes
D-C Grid Voltage	-620 volts
D-C Grid Current	1.9 amperes
Driving Power (Approx.)	12 kilowatts
Plate Dissipation (total)	15.4 kilowatts
Plate Power Input	57.6 kilowatts
Useful Power Output	54.4 kilowatts[1]
Apparent Efficiency	94 per cent

[1]Actual power delivered to water-cooled load. Amplifier output estimated to be 3 kw higher, due to resistance and radiation losses between amplifier and load.

EITEL-McCULLOUGH, INC.
201 San Mateo Avenue, San Bruno, California

MULTI UNIT DESIGN IS ANOTHER EIMAC FIRST

watch the columns of ELECTRONICS for the technical dope.

Picture Sizes advertised by some makers of direct-view television receivers cause us to wonder if something has recently gone wrong with our math. When we figure out the area of the largest rectangle having the correct frame dimensions that can be placed within a circle this is what we get:

Tube Diameter	*Rectangle*
3	4.3 sq. in.
7	23.2
10	48.0
12	69.0
15	108.0
16	123.0

Are the copy-writing boys cutting corners, or just where are we wrong?

Reverse English: New York's Hotel Taft is substituting 7-inch television receivers for some of the 10-inchers it has been renting, says the larger size is too big for a small room.

Hotels, incidentally, are getting \$2 to \$3 extra per day for rooms with television, and one reports that room service in such cases triples while bar and restaurant business declines.

Vehicular Tunnels carrying heavy traffic must be constantly monitored to avoid serious tieups. In the two under the Hudson River between New York and New Jersey cops are stationed every few hundred feet and noise and carbon monoxide make it necessary to relieve them at frequent intervals.

This suggests another possible application for industrial television equipment. Pickup units might be located in tunnels in place of men, and receivers placed at more comfortable control points. John Taylor says RCA has already had an inquiry on the subject.

Laymen are frequently awed by the title "Electronic Engineer." Reminds us of the way we ourselves feel about M.E.'s who design those tricky automatic record-changers.

Research Laboratory of one of the large companies in our business employs 355 people. Of these, 105 are engaged in pure research having no known industrial applications, 140 are working on pure research but of a somewhat specialized nature, 90 are devoting their time to research having a definite industrial endpoint, and 20 are engaged in the conversion of initial equipment designs into practical commercial forms.

McGraw-Hill's World News Bureau reports that in Australia 45 firms make radios but only one makes tubes, and that none yet make f-m or television sets on a commercial scale.

Aussie radio prices are high, three to five times as high as ours for comparable models. Cheapest set retails for $55 and is a four-tube a-c model covering broadcast only; five-tube two-band jobs go for about $120; a six-tube three-bander sells for $195; and an eight-tube allwave phono-combination console lists at $400.

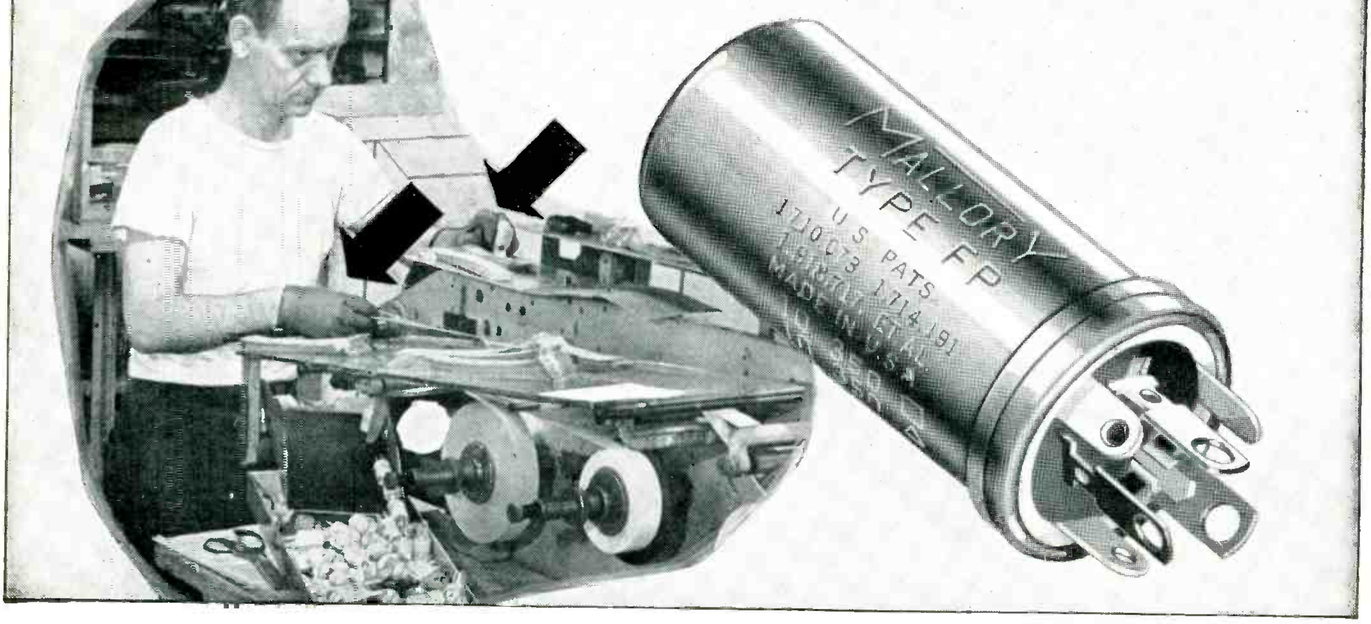
Reader N. B. Cook kids us, with good reason, about our plea for a small, cheap, low-power, high-fidelity amplifier design (p 66, May). He says, correctly, that we ourselves have published several good circuits back over the years. We hasten to ask, as originally intended: but who *makes* one commercially?

Striking Simile is used by an astronomer writing in ELECTRONICS this month (p 98) to illustrate the extreme sensitivity of one particular photoelectric device employed when studying the stars. He says it could theoretically *measure the light of a candle in England from California.*

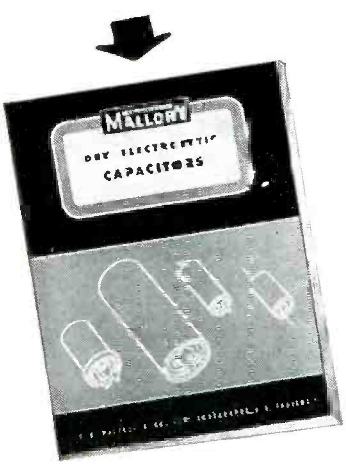
Hams who have gone in for directional beams will be amused to know that professional designers of f-m and tv antennas, and their salesforces, are just now beginning to wax violent on the subject of driven element, reflector, and director spacing. Thus the wheel turneth . . . back to where many of us cut our eye teeth.

Plaintive Query: Why does music sound so good on certain f-m stations, while the announcer sounds like a man talking into a rain barrel?

Mustn't Touch!



The moisture of human hands can shorten the life of an electrolytic capacitor. Hands perspire. Perspiration contains salt. That's why workers at Mallory wear rubber gloves when handling electrolytic capacitors. For the same reason the chloride content of raw materials is kept to *one-half of one part per million.*



Yours for the asking!

Send for the Mallory Capacitor Catalog, which contains useful data on all types of Mallory Capacitors—sizes, electrical characteristics, test measurements, mounting hardware.

Precautions Lead to Longer Life

Due to such precautions, Mallory FP Capacitors can be depended on for longer shelf and service life. Kept free from deteriorating impurities and then carefully and completely sealed in air-tight aluminum cases, they have frequently been used without re-aging after five to six years in stock.

More Capacity in Equivalent Space

Use Mallory FP Capacitors when you need more capacity and voltage in equivalent space. Use them for extreme service when moisture or fungi are present. Wherever you use them, *you pay no premium* for the assured quality of this Mallory Approved Precision Product.

Buy Mallory Assured Quality at Regular Price Levels

P.R. MALLORY & CO. Inc.
MALLORY CAPACITORS
(ELECTROLYTIC, OIL and WAX)

P. R. MALLORY & CO., Inc., INDIANAPOLIS 6, INDIANA

CROSS TALK

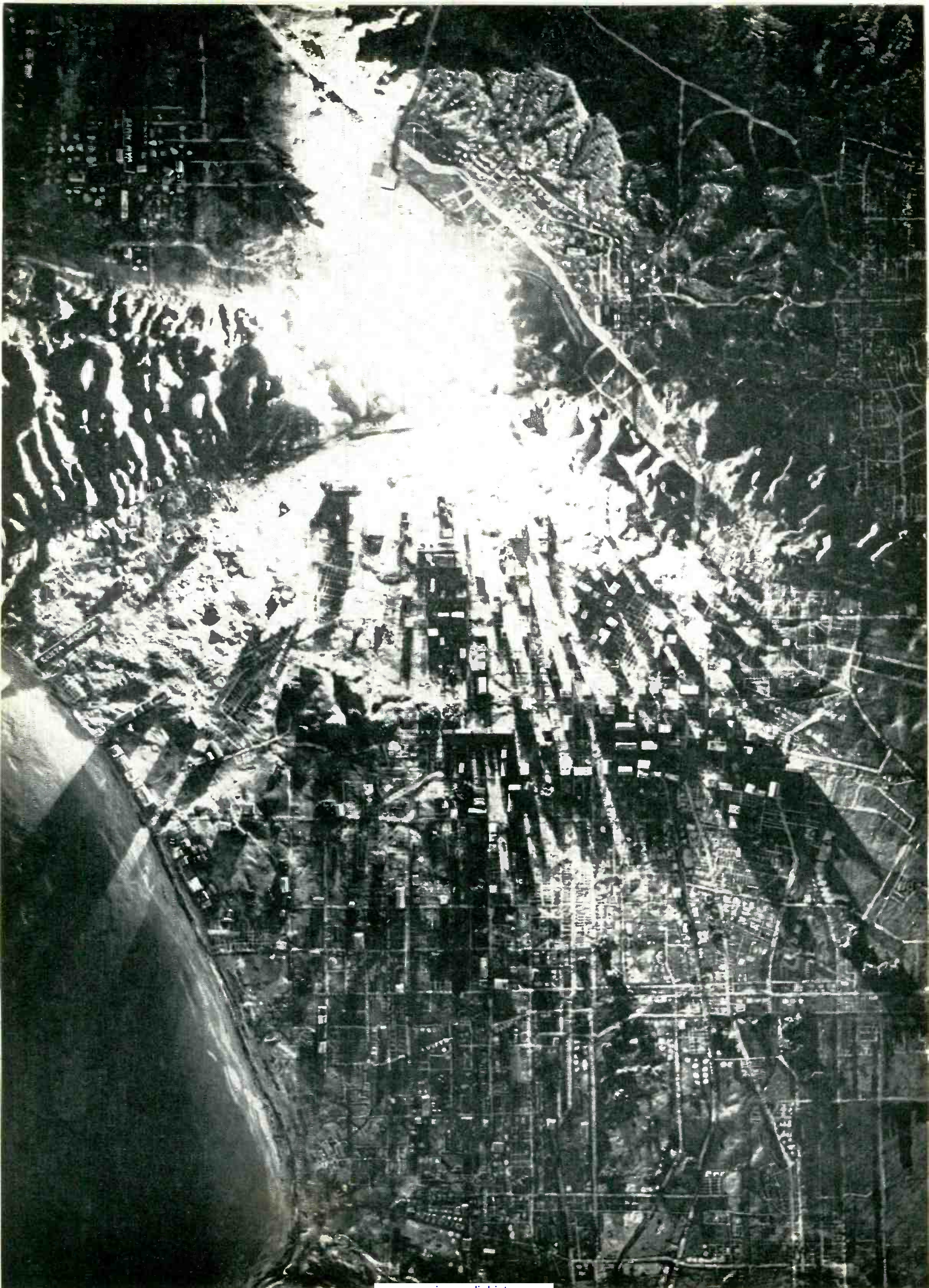
►**JTAC** . . . The IRE and RMA have announced the formation of the Joint Technical Advisory Committee, a group of eight impartial engineers whose duty shall be to advise government agencies and industrial groups on the wise use and regulation of radio facilities. The JTAC will call on existing IRE and RMA committees, as well as other qualified groups, for detailed study and analysis of the problems presented to it. Having thus come by the information from specialists best fitted to supply it, the JTAC will review the data, resolve conflicts of fact or opinion, and exclude commercial bias before passing its findings to the agency seeking its help. Its first task is to assemble, at the request of the FCC, information on the future utilization of the television frequencies between 475 and 890 mc, in preparation for the September 20th FCC hearing on this subject. Details of its plan of operation will be published in these pages next month.

The new agency was initiated by President Shackelford of the IRE and W. R. G. Baker, Director of the RMA Engineering Department. It differs from similar organizations of the past, such as the National Television System Committee and the Radio Technical Planning Board, in that it will not argue for particular services, but will present and interpret the facts for the benefit of the profession and the public, as a whole. It is no secret that many of the RTPB panels were so violently partisan for particular services that they were, in effect, pressure groups. The JTAC's pressure, if any, will be for the incontrovertible fact and the broadest available interpretation. JTAC has its sights set high. Its responsibility is great, its opportunity wide. It depends on the support of every engineer who can contribute to its findings. Based on such support, JTAC can assist government and industry agencies to avoid repeating the mistakes of the past in setting allocations and standards.

►**QRN** . . . We note progress in the amelioration of man-made radio interference in some fields, stagnation in others. There is still some argument over the FCC's action in taking jurisdiction over industrial, scientific and medical devices capable of causing interference, but the clamor daily grows fainter. A recent voluntary action by a manufacturer of germicidal lamps, taken at the instance of the FCC, produced an almost unbelievable improvement. The lamp as originally used caused severe interference with police services at distances as great as three miles. When the design was cleaned up, it failed to interfere with that most vulnerable of all radio devices, a television receiver, when operated at a distance of one foot. Everybody is very happy about that case, the FCC, the police and the manufacturer.

But progress in the field of ignition interference is very spotty. Nowadays, when the price of nearly every car sold includes several hundred dollars for accessories, it would appear feasible to include ignition interference suppression facilities without incurring customer resistance. But, unfortunately, those devices which do the job well sometimes have a perceptible influence on the performance of the engine. So competitive is the automotive field that no manufacturer known to us is willing to install a suppression system as standard initial equipment. That makes it optional with the customer. And *that* makes for a great deal of uncontrolled interference. Perhaps, when a majority of car owners own television sets, and the serious nature of ignition interference is sufficiently publicized, any slight degradation of engine performance will be accepted as well worth its cost. We hope it comes a lot sooner than that. We predict everybody will be happy on that occasion, too.

►**DECISION** . . . Along with the editors of the *New Yorker*, we are impelled to object to the recent Supreme Court decision which refused to abate the sound truck nuisance on the ground that such would be an abridgement of the right of free speech. The right to privacy, the right to select what speech to listen to, and the right to turn the damned thing off, are equally basic rights. The tuning control and the on-off switch on radio receivers are truly democratic institutions. But the self-imposing sound truck leaves no alternative but a quick sprint in the opposite direction.



WHAT'S WRONG WITH

U. S. Frequency Allocations

By JEREMIAH COURTNEY

Courtney, Krieger and Jorgensen
Washington, D. C.

THE AUTHOR, a practicing attorney, was Assistant General Counsel of the FCC in the period between 1942 and 1946.

Prior to that time, he was associated with Cadwalader, Wickersham & Taft, New York.

INCREASING USE of radio, for broadcast and non-broadcast purposes, has served to focus attention on the manner in which frequency allocations are made within the United States.

That this spirit of critical examination represents a healthy development all agree. Any changes that facilitate more productive use of the increasingly valuable natural resource that is our radio spectrum should be welcomed by both government and industry.

Faulty Practices

Chief among the basic faults in present frequency-assignment practices are the following:

(1) The dual system of allocations pursuant to which the Interdepartment Radio Advisory Committee is empowered to assign frequencies to government radio stations, while the Federal Communications Commission does likewise for non-government stations, both agencies enjoying equal and plenary authority over the entire spectrum.

(2) The practice of IRAC in making frequency assignments on the basis of government-agency statements of frequency need without any or sufficient proof of need, and without recurring independent examination of frequency utilization by such agencies.

(3) The practice of FCC in making frequency assignments on the basis of paper showings of prospective need, not speedily readjusted in the light of actual frequency utilization as thereafter independently determined by the monitoring staff.

(4) The practice of the FCC in assigning blocks of frequencies for the use of particular services on a national basis, without providing for their use by other services in areas where such frequencies are not used or likely to be used by the service to which they were originally assigned.

IRAC—FCC Relationship

In passing upon the question whether a non-government applicant should be licensed to use certain aeronautical frequencies then in use by a government station, the FCC recently had occasion to remark (FCC Docket 6988, p 363):

> In any event, however, the Commission has the legal authority to assign to the applicant the use of the same frequencies that the C.A.A. is using at New York for reasons that will now be outlined.
>
> "Station WSY is a government owned and operated station and so not required to be licensed by this Commission, its frequencies being assigned by the President as provided in Section 305(a) of the Communications Act. As we have previously seen, the frequencies of non-government stations are assigned by this Commission (Sec. 303(c)). As a matter of legal theory, neither assignment is controlling on the other, although there are manifest practical difficulties in the way of an assignment by the Commission to a non-government station of a frequency used or intended to be used exclusively by government stations, or by the President to a government station of a frequency used or intended to be used exclusively by non-government stations.
>
> "Mainly to coordinate and regulate

TELEVISION SHADOWS

RELIEF MAP of Los Angeles and vicinity, lighted by a small electric lamp placed on Mt. Lee in Hollywood.

Illuminated areas show probable line-of-sight coverage by a television transmitter in a simple, effective manner.

Photograph by I. L. Bateman, Los Angeles Department of Water & Power the assignments of frequencies to government stations with those assignments made to non-government stations, the various federal agencies in 1922 voluntarily established the Interdepartment Radio Advisory Committee which the President has used as an advisory body to recommend to him what frequency assignments should be made to government stations. Procedurally, IRAC has been authorized to make interim assignments which are periodically confirmed by Executive Order of the President, each order again conferring authority upon IRAC to make further interim assignments.

"By mutual agreement between IRAC and the Commission, certain portions of the radio spectrum area are, from time to time, marked for government assignments exclusively, others for non-government assignments exclusively, and still others for the shared use of both government and non-government stations."

Merely to state the FCC-IRAC relationship is to prove its faults. Each agency, legally, can assign the entire spectrum. With that bludgeon in the hand of each, it is not difficult to understand how they have both agreed that the radio spectrum should be divided equally between the government and industry, as it approximately now is. If each has the power to devour the whole apple, as reasonable men they will agree to split it down the middle.

But should the radio-spectrum apple be split down the middle, half to government and half to industry? There is considerable evidence that it should not, but the question can never be conclusively answered until one agency is given authority over the entire spectrum. Then government frequency needs can be weighed against industry needs on merit and by application of the same standards. Only thus can there be any assurance that the FBI, for example, does not get from IRAC more channels than it needs at the same time the State Police (which are treated as non-government users) get from FCC less channels than they need very badly indeed.

Government Needs

Requests for frequency assignments presented to IRAC by government users are not subject to the same examination of need that is made with respect to industry requests presented to FCC.

D. E. Noble of Motorola, and Chairman of Panel 13 of the Radio Technical Planning Board, testified on April 1, 1948 before the House Interstate and Foreign Commerce Committee regarding House Joint Resolution No. 78:

"An applicant before the Federal Communications Commission must face a weighing of the values and an examination of the factors of public interest, convenience, and necessity before channels are granted.

"According to a statement by an IRAC spokesman at an FCC engineering conference, when a governmental department requests channels it is presumed that the channels are needed and there is no process of sitting in judgment upon the request, or of weighing the request in relation to other important needs of the non-governmental services operating under the control of the Federal Communications Commission.

"If IRAC had not been so profligate in its demand for channels, the Federal Communications Commission would have had an easier task in allocating the channels for commercial and city and state use. In the desirable mobile-frequency band between 30 and 220 mc, the federal government assignments exceed the non-federal mobile assignments by a factor of two to one."

Why government frequency requests are not subjected to critical IRAC examination of need is indicated by a provision in IRAC bylaws that the Committee shall endeavor to reach unanimous agreement on all questions discussed. Further pressure in that direction is inevitably generated by the fact that IRAC is made up entirely of frequency users (Agriculture, Commerce, Navy, State, Treasury, War, Interior, Justice, FCC, and U. S. Maritime Commission). Thus, if one IRAC member should vote against or attempt to examine into another member's need for requested frequencies the action would be undertaken only with the greatest circumspectness and delicacy, in the certain knowledge that the member so aggrieved would before long be in a position to pass upon the objecting member's own frequency requests. This is stating the case mildly.

Whether or not IRAC accords a critical examination of frequency need to the requests of its members, it is certain that assignments are not based on the same criteria of need as are FCC assignments, made only after periodic overall spectrum review of each industry's needs against those of every existing and meritorious new radio service. The short supply of frequencies now available for industry purposes makes it imperative that government assignments be based on equal needs, with all assignments subject to periodic independent examination to determine the extent of frequency utilization actually obtaining.

Allocation Post-Audit

Although superior to those of IRAC, FCC allocation procedures are themselves subject to improvement in at least two important respects.

While FCC does periodically undertake to revise spectrum allocations in the light of the needs of existing and new radio services, such allocation proceedings are few and far between. In the interim, frequency assignments and uses frequently get out of balance. In the long periods intermediate between general allocation proceedings insufficient effort has in the past been made by FCC to determine the extent to which the frequencies allocated to particular services are actually used by those services.

So far as is known, the monitoring offices of FCC have not often been used for the purpose of determining service frequency utilization. Certainly there has been no announcement regarding such studies. Indeed, it was not until last year (after the American Telephone & Telegraph Company had introduced, in a proceeding before FCC, charts of frequency utilization studies made in three major cities showing striking discrepancies in channel utilization by the various occupants of the 152 to 162-mc non-government and 162 to

174-mc government bands) that there was created a Frequency Utilization Section in the FCC's Washington offices' Engineering Department.

The importance of an independent determination of frequency utilization is apparent. For in general allocation proceedings one industry and service is striving against another, not only for presently needed spectrum space but for space for future expansion as well. Frequency allocations have been made by FCC on the basis of paper showings, chart projections of present use, and estimates of future needs which may or may not come into being. This has resulted from time to time in inequities in frequency assignments, as revealed by the acid test of frequency utilization.

For example, in October 1947, two-and-a-half years after the FCC's 1944-45 general allocation proceeding had been completed insofar as frequencies above 25 megacycles were concerned, the railroads had 60 frequencies allocated for their purposes in the 152 to 162-mc band, and were using the same frequency for land and mobile station use. The taxicab industry had 2 frequencies in that band, using one frequency for land stations and the other for mobile stations, the two frequencies thus constituting a single communications channel. Neither industry had any frequencies outside the 152 to 162-mc band. On the railroads' plethora of 30 channels there were 100 land stations and 900 mobile units operating; on the taxicabs' single communications channel, there were almost 1,000 authorized land stations in operation, employing thousands and thousands of mobile units. In fact the vice-president of one of the leading manufacturers in the non-broadcast radio field testified before FCC (Docket 8658, p 686):

"One pair of channels assigned to the taxicab industry alone accounted for approximately half of the total 2-way radiotelephone communications equipment business during the past year."

If such inequities in frequency assignments are to be promptly corrected the FCC must be prepared periodically to post-audit the paper showings of frequency need put forward by the various radio services in the light of actual frequency utilization, without waiting for the next distant and time-consuming general allocation hearing.

Flexibility Needed

Not only should frequency assignments be periodically readjusted to comport with frequency utilization, but all assignments should be sufficiently flexible to permit use by another service when not used or likely to be used by the service for which originally assigned.

The present FCC practice is to assign frequencies to services on a national basis. In the railroad-radio service, for example, 60 frequencies have been allocated for that industry's use throughout the country. These frequencies were deemed necessary to provide for railroad communication needs in the congested Chicago terminal, into which 33 different railroads operate. In many areas outside the congested terminals of Chicago, St. Louis, and New York, however, the railroads cannot use or justify the use of 60 frequencies. If frequencies had been assigned on a basis that would permit use by other services in those areas where the railroads cannot conceivably use 60 frequencies it would not have been necessary for the taxicab industry, for example, to long thirst for additional frequencies in California, Texas, Massachusetts, Florida and many other states into which only a few railroads operate.

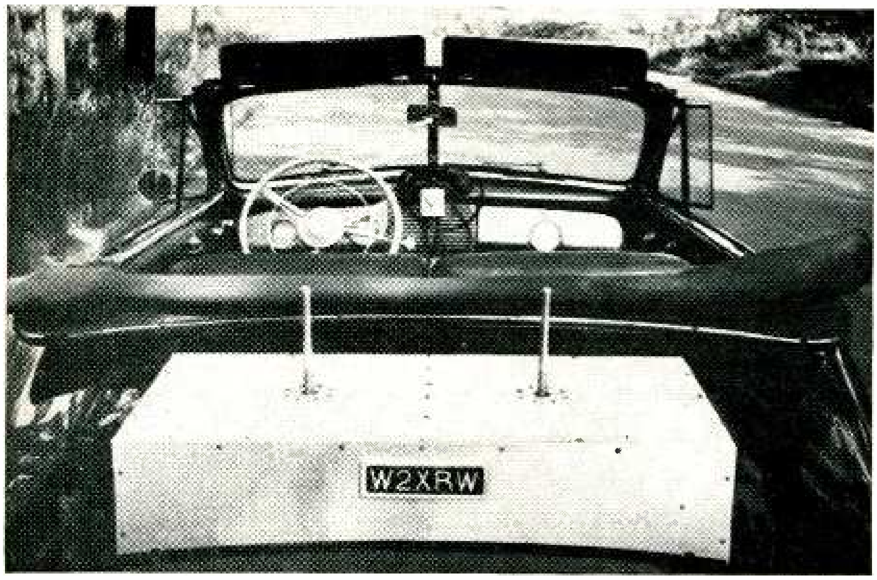
FCC is, by statute, required to assign radio frequencies in the public interest, convenience and necessity (Communications Act, Sec. 309 (a)). Like so many other agencies administering similar statutes, however, the interest, convenience and necessity considered is not always that of the public but is often that of the agency or its personnel. This is usually not so much the fault of the agency as the result of limited funds made available for the agency's activities. It would not be convenient for the FCC or its staff to determine how many of the 60 railroad frequencies can be properly used for taxicab dispatching in the states of California, Texas, Massachusetts and Florida without conflicting in any way with railroad-radio communication needs.

The *raison d'être* of the administrative agency is its capacity for dealing with complex technical problems. No needed frequency should be permitted to go to waste anywhere if the objection to its use is merely the imposition of a workload of minor, or even major, proportions on the FCC's technical staff. Frequencies are too valuable, too much in demand, to die by application of the rule of administrative convenience or the interposition of obstacles in the path of the prospective user by way of complicated showings or expensive and time-consuming hearings.

The Future

In the nature of things there will be considerable delay in placing the radio spectrum under the jurisdiction of one agency, and probably also in IRAC's revision of its standards of frequency need. For that very reason, however, it becomes increasingly important for FCC to see that frequency assignments and use are in balance and that a high degree of flexibility in frequency assignments obtains always, to the end that a single frequency shall not lie fallow in a single community where needed.

That such is not the case today only underlines the need for immediacy of action by the Federal Communications Commission in post-auditing frequency assignments against utilization and in correcting any inflexible frequency service assignment practices which are wasteful of frequencies.



Transmitting and receiving ground-plane antennas and of Mobile 2 unit. Dashboard mounting of handset and send-receive switch provides convenience

Photographed from the antenna site atop the McGraw-Hill Building, this view shows

CITIZENS BAND

Complying with FCC class B specifications, iff transponders are modified to provide useful two-way communication from car to car for moderate distances and over a greater range to a fixed station having greater antenna height

By WILLIAM B. LURIE

W10XEM-W2XRW
Bronxville, New York

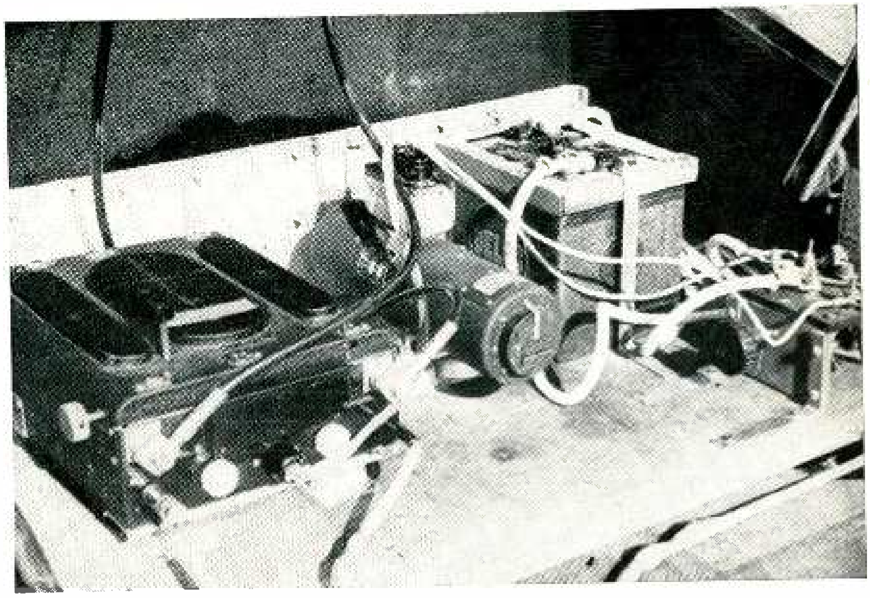
THE equipment to be described was developed as type B equipment for the Citizens' Radio Service and has been used by the author and his associates in successful field trials.

Because of the nature of facilities available, and because this project was undertaken on a spare-time basis, it was decided to develop three units, two of which would be mounted in passenger cars, while one would be a-c operated, though easily movable from point to point. Advantage was taken of readily convertible surplus electronic equipment, namely the iff transponder BC-645, still available at about $10. A complete transmitter and receiver can be assembled for less than $25.

Class B FCC tolerances are ±0.4 percent, or ±1.86 mc at 465.0-mc center frequency, and it has been found that the transmitter stability is well within these limits. Once it had been determined that the license requirements would be met, no great effort was made to establish the inherent drift or instability, but the transmitters have been used repeatedly, often after periods of weeks during which the whole unit rode, not shock-mounted, in the trunk of the author's car, over 60 miles per day at speeds up to 55 miles per hour, at ambient temperatures ranging from −10 F

The equipment and tests described here were developed by Mr. Lurie as an independent consultant in cooperation with the ELECTRONICS Citizens Radio Project described in November 1947, page 80.

the buildings adjoining Ninth Avenue, left, and Eighth Avenue, right



Complete two-way equipment of Mobile 2 set up for 12-volt operation in trunk. Left to right, the transceiver, dynamotor, extra battery and switch

TRANSCEIVERS

Part IV of a series

ELECTRONICS CITIZENS RADIO PROJECT

PART I
Transmitter for the Citizens Radio Service, November 1947.

PART II
Receiver for the Citizens Radio Service, March 1948.

PART III
Antennas for Citizens Radio, May 1948.

PART IV
Citizens Radio Transceivers, August 1948.

PART V
Power Amplifier for the Citizens Transmitter, coming.

to +80 F. Frequency shifts of 0.5 mc (about 0.1 percent) were seldom observed.

As shown in the block diagram of Fig. 1, the transmitter consists of a 316A oscillator in a Lecher-line type of oscillator circuit, with a 6V6 modulator and 7F7 preamplifier. No effort was made to select tube types or components carefully; the transmitter has been largely designed around the numerous components used in the BC-645.

The modulator is a conventional audio amplifier that provides constant-current, class A Heising modulation. A sufficiently high modulation level is achieved, although 100-percent modulation is not obtained. The oscillator plate line is fed through an r-f choke, thereby allowing the voltage node on the oscillator plate line to form where it sees fit. As shown in Fig. 2, the oscillator grid line is returned to ground through a resistor, tapped on the line at what was presumed to be a voltage node. One method of adjusting the input power to the rated value is to adjust the oscillator grid-leak resistor, thereby varying the plate current at fixed plate voltage.

The oscillator filament circuit can not conveniently be tuned; one side has considerable inductance within the tube, while the other has a small inductance provided in the external lead to the tube before both leads and by-passed to ground. Frequency adjustment is made by moving a dielectric slug between

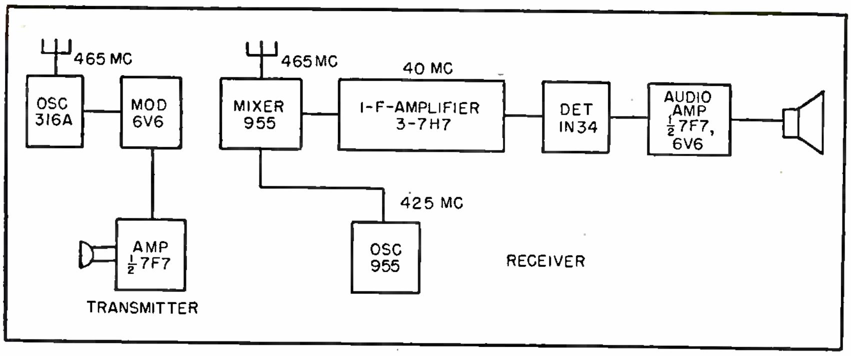


FIG. 1—Block diagram of stages in mobile and portable transmitters and receivers

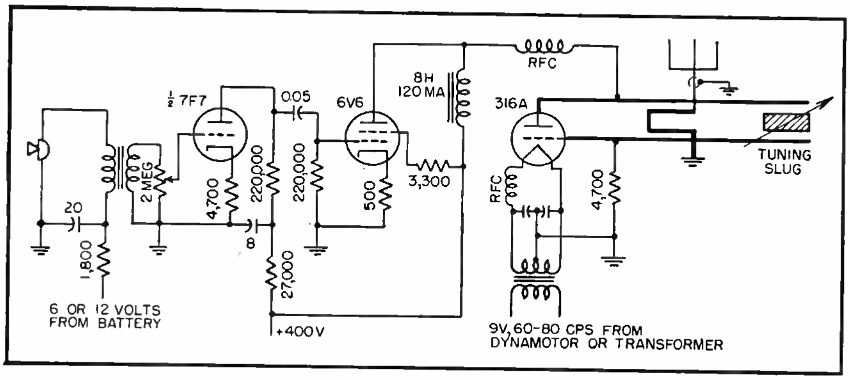


FIG. 2—Transmitter circuit requires only addition of the audio stages

the ends of the lines remote from the tube.

It was not found possible to increase the efficiency in the BC-645 beyond 15 percent at 400 volts plate voltage, or about 11 percent at 300 volts. A nominal radiated power of the order of one watt is therefore quoted as representative of the capabilities of the 316A at ten watts input, and the tantalum anode, with a rated dissipation of thirty watts, requires no cooling.

Receiver

The receiver is a superheterodyne using a 40-mc intermediate frequency, with a 955 local oscillator, a 955 mixer and no r-f amplifier. A 1N34 germanium diode is used as a second detector, its rectified, filtered output being used as avc voltage for the three 7H7 i-f tubes. A 7F7 audio amplifier and 6V6 power output stage follow.

The receiver was originally intended for the reception of coded pulses and use of an f-m signal generator revealed that the i-f bandwidth was over three megacycles. Removal of loading resistors and single-frequency peaking instead of stagger-tuning reduced the i-f bandwidth to about 250 kilocycles.

The local oscillator is a 955 acorn tube in a loaded Lecher-line oscillator similar to the transmitter. The frequency is adjusted by means of a large silver-plated disk brought near the plane of the grid and plate lines, L_2, varying their electrical length. A small capacitor provides coupling to the mixer tube; the oscillator voltage appears at the mixer grid along with the signal voltage, which is tapped off a resonant line to which the antenna is direct-coupled.

The 955 mixer tube operates with its cathode grounded, and its plate load, the primary of the first i-f transformer, is returned not only to r-f and i-f ground, but to d-c ground as well. The local oscillator voltage and velocity of electron emission from the mixer tube cathode provide enough voltage for the efficient operation of the mixer. No improvement of signal to noise ratio was observed when added voltage was applied, and so the mixer was left as originally designed.

As shown on the schematic diagram, Fig. 3, the signal from the antenna is tapped down on a short section of loaded transmission line L_3; capacitor C_1 across the open end is varied to resonate the line. The signal to the mixer is removed from the line at a corresponding point on the conductor opposite the point where the antenna is brought in. Again, coupling was varied in amount, by moving the taps, and inductive coupling to the line was attempted, all with no substantial gain. The original front end, therefore, was restored.

Power Supply

For the a-c portable unit, filament transformers were provided. Since the BC-645 was originally intended for 12- or 24-volt operation, the 12-volt connection was chosen and two 6-volt windings connected in series. For the 316A, requiring 2.0 volts at 3.65 amperes, a filament transformer in the BC-645 was intended for 9-volt, 80-cycle input, 2-volt output, center-tapped to ground. This 9 volts was provided at 60 cycles from ground to the center tap of the second 6-volt transformer. The B-supply is conventional and a portion of the B-voltage, obtained from a bleeder, is used for energizing the sealed-in, sensitive send-receive relay, furnished in the basic BC-645, and which switches the main B-supply from receiver to transmitter when keyed.

For the mobile units, dynamotors PE-101C (used with the BC-645 on aircraft) were obtained. This dynamotor requires either 12 or 24-volt input, with 400-volt output at 0.135 ampere, 9 volts at 1.1 ampere at 80 cycles, and 400 volts at 0.02 ampere. The latter winding was not used, the 9-volt winding supplies the 316A filament transformer, the 135-milliampere winding used for plate voltage, and the 12-volt input furnished from a second 6-volt storage battery in series with the car battery. A switch places the two batteries in series when running the radio equipment, or in parallel for charging both batteries from the car generator when not on the air. The transmitter-receiver, dynamotor, extra battery, and switch are all mounted on a board which slides onto the upper deck of the trunk compartment of a 1940 Buick convertible coupe,—Mobile 2 station.

Because of excessive dynamotor noise, Mobile 1 unit was rewired for 6-volt operation of the tube heaters, including a dropping resistor for the 316A filament, a PE-103 6- or 12-volt dynamotor was used on 6 volts, and the second battery was eliminated. This equipment is installed in a 1946 Dodge sedan,—Mobile 1 station. The batteries are also used, with a dropping resistor, for excitation of carbon microphones on the mobile units.

Antennas

Duplicate antennas are used for receiving and transmitting. RG-8/U cable with type-N fittings (UG-21/U) was used for Portable 1 and Mobile 2 units, while RG-29/U cable with type-N fittings (UG-15/U) was used on Mobile 1, to facilitate passage between the trunk door and the car body, leading to the antennas. The antennas on Mobile 1 are surplus AN/APQ-2A antennas, quarterwave vertical rods mounted atop a ground plane, the whole unit being attached to the car roof with suction cups, at a height of six feet.

The antennas on Mobile 2 are identical with those on Mobile 1, except that the ground plane is mounted on the trunk compartment door, as shown, with clearance holes for the cables provided through the trunk door. The antenna height is about four feet.

The antennas for the portable transmitter and receiver are two 5-element Yagi arrays, each consisting of a folded dipole, one reflector, and three directors, all made of $\frac{1}{8}$-inch silver-plated brass rod. The overall resistance is assumed to be a fair match to the 52-ohm RG-8/U cable feeding each array, and quite sharp patterns have been observed.

Vertical polarization is used throughout, although horizontal polarization with a phased turnstile array was used for some time on one of the mobile units. With an eye toward consistency with the practices of W2XSN, McGraw-Hill's station in New York, vertical polarization was decided upon.

Tuning Adjustments

The transmitter frequency was adjusted by monitoring the unmodulated radiated power near the antenna with a precision wavemeter such as a Lavoie microwave frequency meter. The method of adjustment chosen consisted of jamming down the limit stops on the relay which controls the position of the dielectric slug in the transmitter oscillator tuned line until the relay arm is tightly held in both directions. Final adjustment consists of adjusting the position of the relay arm and slug until the transmitter frequency is the required value.

Modulation percentage is increased until noticeable distortion of voice transmission is heard on a nearby receiver. A modulation control is provided for this purpose, and is also convenient for removing all modulation from the carrier when frequency checks and adjustments are made.

The receiver antenna coupling line is tuned to 465 mc, the only circuit in the receiver tuned to this frequency. The local oscillator operates at 425 mc providing a 40-megacycle i-f signal at the mixer tube plate. Three identical 7H7 i-f amplifier stages follow, with cathodes grounded and grids returned to ground through the avc line to furnish the only bias on these tubes. With no applied signal, tube and circuit noise develop about one volt of bias.

Demodulation is done by a 1N34 germanium diode. The audio signal is amplified in one-half of a 7F7 twin triode, and then in a 6V6 output tube which drives a loudspeaker or telephone handset receiver.

Alignment is accomplished with the top cover off, bottom plate on, by introducing a 40-mc unmodulated signal at the mixer tube grid, and observing, with a vacuum-tube voltmeter, the avc voltage developed across the diode detector load resistor. All i-f transformers are peaked for maximum gain.

An alternative is to apply a

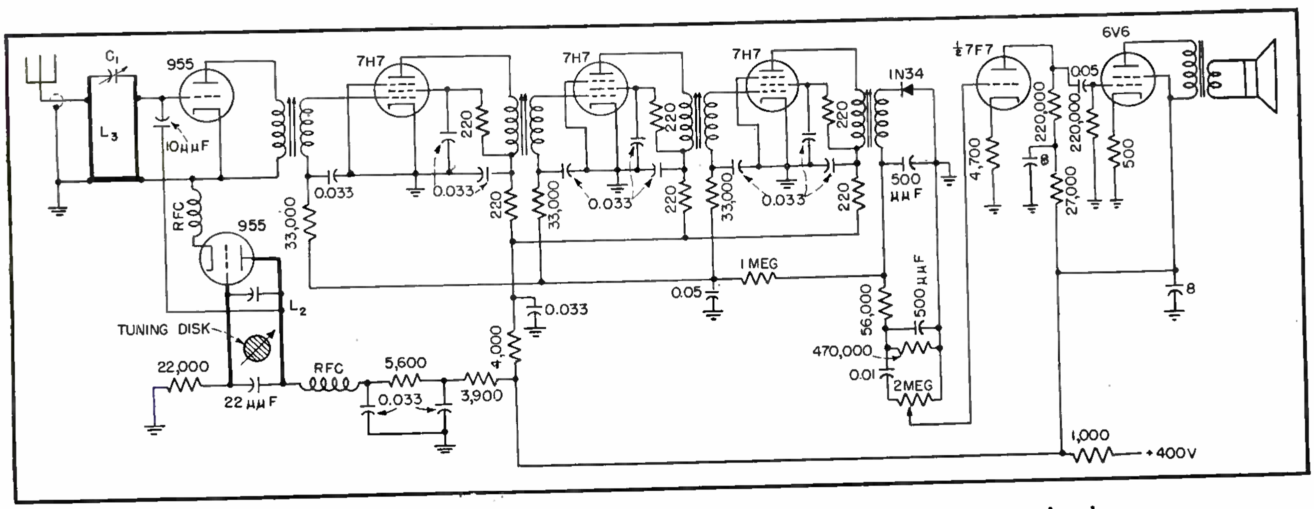


FIG. 3—Receiver portion of the BC-645 after modification for use in the citizens band

40-mc frequency-modulated signal, preferably over one megacycle wide, and to observe with an oscilloscope the voltage across the load resistor. The i-f transformers are peaked for maximum stable gain and minimum bandwidth. By this method the i-f B-supply voltage may be increased until the receiver is just below the oscillation point.

Bakelite shafts and knobs were added to the two receiver front-end adjustment points to facilitate alignment in the field. Adjustment is done with top and bottom covers in place, by observing the avc voltage with the receiver at any convenient distance from a stable signal source. The local oscillator is set at approximately 425 mc using an absorption wavemeter such as the General Radio butterfly type 1140-A. Next, the antenna coupling line is tuned for maximum avc voltage. The local oscillator is adjusted for maximum signal, after which the antenna line is readjusted, then the local oscillator again, until the maximum stable signal is obtained. This completes the receiver alignment.

Total d-c filament drain for the transmitter and receiver is 6.3 volts at 6.4 amperes. On a-c, the drain is 12.6 volts at 1.5 ampere and 9.1 volts at 1.1 ampere. The B-supply provides 400 volts, 60 milliamperes receiving, and 65 milliamperes when transmitting.

Portable a-c operated unit used on the roof of the McGraw-Hill building in New York for the field tests

Field Tests

Two types of tests were conducted: with both stations near ground level, and with one station well above surrounding terrain. In all cases, complete two-way communication was attempted, reducing to one-way communication as the separation between units was increased. In this manner, it was hoped to show up any significant differences between units, in signal-to-noise ratio and ultimate sensitivity, especially in the portable unit, which was often run without avc.

Communication between two mobile units has been the major part, but not the most significant part, of tests to date. The mobile units were built into privately-owned passenger cars, with vertically polarized non-directional antennas six feet above the road on Mobile 1, and four feet on Mobile 2.

First tests at Bronxville, N. Y. were made with the two mobile units separated by about 500 feet and each receiver aligned to each transmitter carrier. Separation of the two cars, maintaining line-of-sight, reduced the signal level until communication became noticeably affected by interception of the beam by cars, trees and buildings. At about 1,200 feet, reliable two-way communication was maintained, with the signal being reduced nearly to the noise level by beam interception.

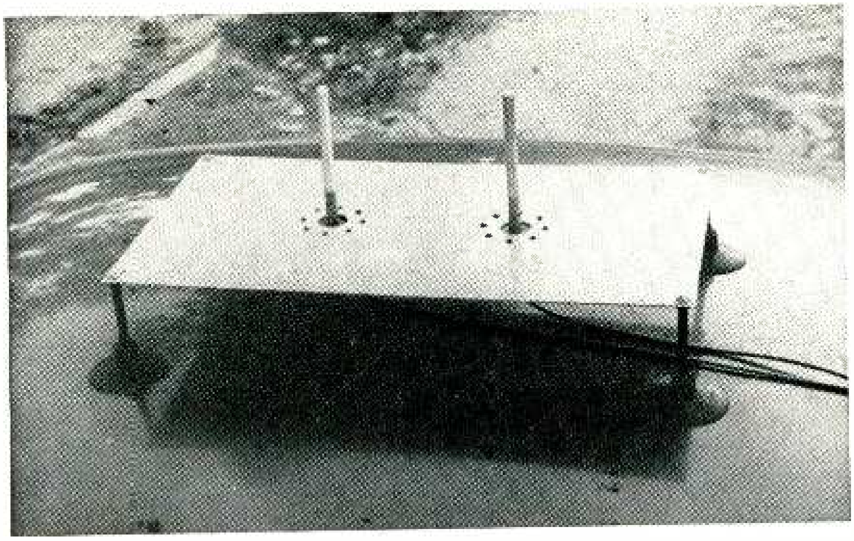
At distances up to 3,000 feet, occasional two-way contact was possible, with very wide variations of signal strength noted as the moving unit moved, sometimes only 20 to 30 feet, suggesting severe masking by groups of trees, small buildings or unusually large local absorption in the region where the moving receiver happened to be. During this test, both receivers had a bandwidth near one megacycle.

When the receiver bandwidths were narrowed to about 250 kc, a similar test was conducted under the same weather conditions (fair, good visibility). The results were quite similar, with one notable improvement: the ranges for reliable two-way communication and incidental reception were increased to about 2,000 and 5,000 feet, respectively, illustrating the effect of exclusion of the noise contribution from the portion of the received bandwidth not containing the desired signal. Since no further improvement in receiver performance was considered readily achievable, it was decided to make no further changes until a comparison was obtained with performance with one unit elevated above ground.

Ground-to-tower Communication

The a-c portable unit, including antennas, was placed on the roof of a six-story apartment building near which one of the mobile units had operated throughout the mobile-to-mobile tests. Due to a faulty component, this test was limited to a one-way trial, with the tower station transmitting and the mobile units receiving. The mobile antennas remained nondirectional, but a 5-element Yagi array was used for transmitting from the tower. The beamed antenna was so oriented that it would produce a somewhat narrow, flat beam along a fairly straight road leading away from the tower. The height of the fixed antenna was about 90 feet above the surrounding terrain for this test.

Reliable one-way communication



Antennas and mount on the car roof of Mobile 1 station

was obtained at one mile, with startling freedom from rapid fading. The signal strength at a mile was easily several times greater than during mobile-mobile tests at 1,000 feet. At about 6,000 feet, off the beam center by about 30 degrees, no noticeable effect was observed from proximity of trees, low buildings, street car tracks, overhead trolleys, or any of the other factors producing marked effects on mobile-to-mobile communication.

The a-c portable unit was next taken to the ELECTRONICS antenna location on the McGraw-Hill Building, and tests were conducted with the Workshop Associates beam antenna used for transmitting, and the usual 5-element Yagi array used for receiving. Both transmitting and receiving antennas for the fixed station were then about 500 feet above the street, and located on 42nd Street between 8th and 9th Avenues in New York. These antennas were beamed uptown (north), while the mobile antennas remained nondirectional.

At about one mile distance, each of the three receiver front-ends was aligned, in turn, on the appropriate remote transmitter. Reliable, clear two-way communication was maintained at one mile, in and out of line of sight, on Eighth Avenue and on Ninth Avenue. At this distance, very little effect was found from interception of the beam by moderately substantial buildings.

No convenient line of sight path over a mile in length and accessible by automobile was available on the island of Manhattan, so no attempt was made to establish the maximum usable range in open country, although tests in this direction are contemplated. Intermittent two-way communication was had at 1½ miles with marked effect from obscuring by tall and short buildings. Occasional one-way contact at two miles was achieved, but was not at all predictable from one block to the next. Although intermittent fading was found, no rapid fading such as was evident in mobile-to-mobile tests was present here.

Conclusions

In the last test, very poor communication was had at 500 feet with the mobile units at the base of the building straight down from the tower. This was not surprising, since, despite the proximity, the tower antennas had quite sharp patterns, with a distinct minimum predicted in a downward direction.

During routine mobile-to-mobile tests in residential areas, absorption in surrounding foliage appeared to cause significant fading, even though the foliage did not cross the line of sight path by several wavelengths. At times, the signal strength at a distance of 300 feet from a transmitter could change by a factor of, perhaps, ten, within a space of ten feet, due to beam interception by trees and wood-frame houses. In general, height of antenna appeared to play an extremely large role in determining range and reliability of communication. Mobile-mobile contact, and therefore walkie-talkie to walkie-talkie contact, can not be expected to be useful beyond a very limited range, with one watt of radiated power, with receivers of the sensitivity of the converted BC-645. The threshhold sensitivity of the BC-645 receiver is about 100 microvolts, according to measurements by Mr. Jerry Minter of Measurements Corporation, Boonton, N. J. Field trials of W2XSN with the equipment described in previous articles by Walter Hollis are expected to take place shortly, yielding data on low-powered crystal-controlled transmitters and receivers. In addition, W10XEM will continue tests with the current equipment and other antennas, while medium-powered (25 and 50 watts input) crystal-controlled transmitters and receivers are being developed, also largely from available Government surplus electronic equipment. The development of the 25-watt input transmitter is under FCC construction permit, call W2XRW.

The author wishes to thank the McGraw-Hill Publishing Company for use of the building and facilities, Paul Havenstein, Jr., John Lanefski and Ervin Steinberg for cooperation in testing and construction, and Joseph Leferson for assistance in frequency checking.

BIBLIOGRAPHY

Electronics Sponsors Citizens Radio Project, ELECTRONICS, p 80, Nov. 1947.

W. C. Hollis, Transmitter for the Citizens Radio Service, ELECTRONICS, p 84, Nov. 1947.

R. E. Samuelson, Field Tests for Citizens Band, ELECTRONICS, p 92, Jan. 1948.

W. C. Hollis, Receiver for the Citizens Radio Service, ELECTRONICS, p 80, Mar. 1948.

Howard J. Rowland, Antennas for Citizens Radio, ELECTRONICS, p 96, May 1948.

John T. Ralph, and H. M. Wood, Operating the BC-645 on 420 Mc, *QST*, p 15, Feb. 1947.

A. L. Samuel, Extending the Range of the Negative Grid Tube, *Jour. Applied Physics*, Oct. 1937.

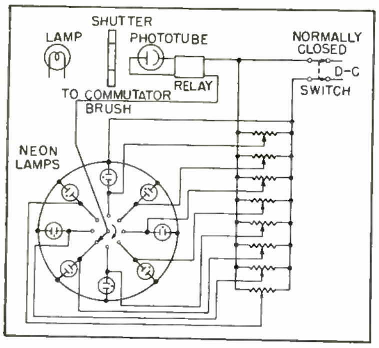


Fig. 1—The Fuller electronic chronometer

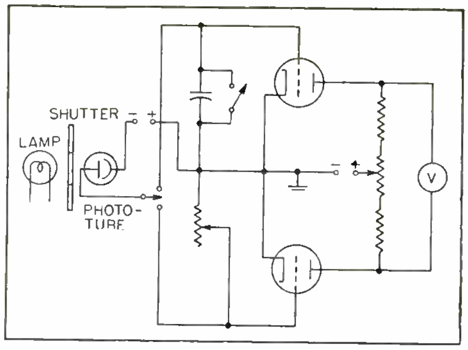


FIG. 2—Kelley's shutter tester

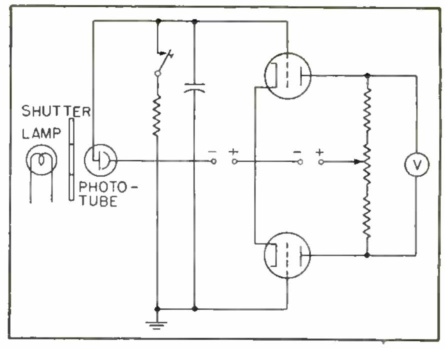


FIG. 3—Fundamental circuit of Penther

Testing Photographic Shutters

A review of the basic circuits used in electronic testers. Phototubes, neon lamps, multi-element vacuum tubes, cathode-ray tubes, and iconoscopes are variously employed. References include the more significant published articles and also a list of patents

By S. H. DUFFIELD and L. R. LANKES

Development Department
Eastman Kodak Co.
Rochester, N. Y.

THE USE of photography as a medium for producing a permanent record imposes the demand of versatility sufficient to cope with subjects having extreme ranges in brightness, size, and conditions of motion. While a photographic shutter acts merely as a valve, and does not contribute directly to the quality of the recorded image, it may, because of malfunction, result in failure of the process.

From the time when photographic emulsions had sufficient speed to make exposures of a fraction of a second practical, there has been a sustained interest in the whole subject of shutter speeds and efficiency, with much thought given to means of evaluating these functions. A great deal of work has been reported on the development of mechanical and electromechanical devices for this purpose dating from as early as 1882. Inasmuch as interest here is centered primarily on the electronic approaches, these other phases are treated in a separate paper.[1]

The low inertia inherent in electronic systems offers several advantages. It permits the use of equipment which is accurate, relatively simple, and easily operated to study all types of shutters as well as flashbulbs. Evolution began in the flashing-lamp technique for measuring only total-open-time with the incorporation of circuits to establish the points of the time scale automatically without the need of photography or, more specifically, without the use of film. One version by A. B. Fuller[2] involved the now common interposition of the shutter between a light source and a photocell shown in Fig. 1. Glow lamps were arranged to light in a known sequence and at known intervals by means of a motor-driven commutator through which the necessary starting voltage was distributed. This, in turn, was controlled by the photoelectric

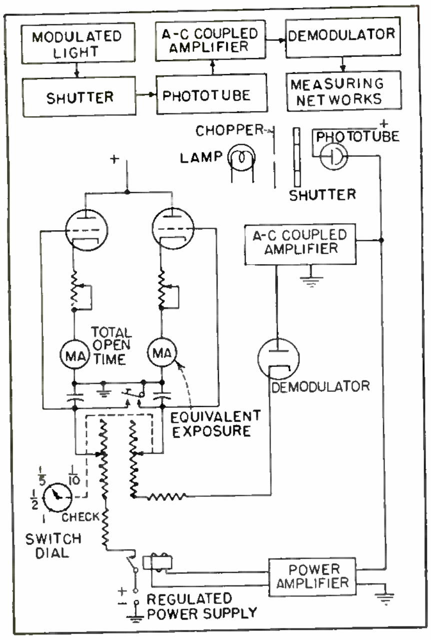


FIG. 4—Block diagram and basic circuit of Merriman and Nichols

detector. Inasmuch as sufficient voltage was always applied to sustain the discharge, once initiated, the lamps lighted during the open period of the shutter would remain so until a manual operation cleared the system. Thus an indication of the approximate total-open-time of the shutter might be had by counting the lighted lamps.

Widespread use is made of many variants of the fundamental scheme of measuring total-open-time as an appraisal of shutters. The measure has been quite usable since shutters are reasonably efficient at low speeds for all diaphragm openings. Also, compensating effects arise through film latitude and the reliance of the user on experience rather than shutter ratings. In addition, it has been difficult to measure any quantity other than total-open-time.

Evolution of Electronic Methods

Electronic systems often employ cathode-ray tubes as the indicating devices, although considerable use is made of equipment employing indicating voltmeters calibrated in terms of average or equivalent exposure. The variety of available phosphors permits a wide choice in the matter of a short-memory system for immediate visual appraisal or a photographic recording system for subsequent study purposes. In addition, the record is obtained in graphic form (relative shutter opening versus time, and relative flash intensity versus time) on a continuous basis as opposed to the discontinuous basis of early mechanical systems wherein some treatment of the data was necessary to produce the characteristic curve.

J. D. Kelley[3] described a photoelectric means of measuring average, or equivalent, open-time by establishing a photoelectric current proportional to shutter opening and using it to store charge in a capacitor. Through a transfer method, comparison is made with that current which measures maximum area of shutter opening. The indicator is, in essence, a vacuum-tube voltmeter. The basic circuit is suggested by Fig. 2. The principle of correspondence of mass-length-time units is directly satisfied, since the ratio of an electric charge to an electric current has the dimensions of time.

In the application of this system, a figure of merit for shutter speed is obtained only after the manual operation of adjusting a resistor or otherwise balancing circuit branches. During this time, charge is being held in the capacitor and is subject to leakage. C. J. Penther[4] recognized the shortcomings and suggested improvement by way of some circuit modification to simplify operation and to make the device direct-reading. The basic circuit modification, for purposes of our discussion here, is indicated in Fig. 3.

It was then a straightforward step to the shutter-tester of Merriman and Nichols[5] which incorporated a light-chopper and utilized the inherent stability and high gain of an a-c-coupled amplifier to accomplish the same end result. The block diagram and basic circuit of Fig. 4 should suggest the principal variation. One may note the addition of suitable R-C networks to permit choice in the indication of equivalent exposure time or total-open-time. This system represents fairly complete refinement in the application of basic principles.

Oscillograph Methods

Recognition of the advantages of the oscillograph method came very early—at a time when available oscillographs depended on moving elements of the mirror-galvanometer type.[6] However, widespread use and improvement of the method awaited the development of the cathode-ray tube and the coincidental advancement in photosensitive detectors. The need for a system of extremely low inertia in recording and studying transient phenomena in electrical power circuits (for example, lightning discharges) probably resulted in most of the published work along these lines. It would seem that its application to shutter testing must have been obvious concurrently.

Figure 5 is a block diagram indicating the typical use of the cathode-ray oscillograph wherein the vertical deflecting plates are

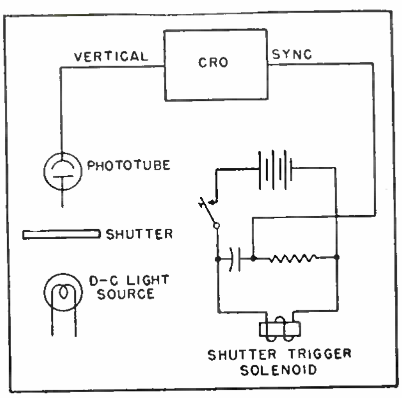


FIG. 5—A typical oscilloscope system

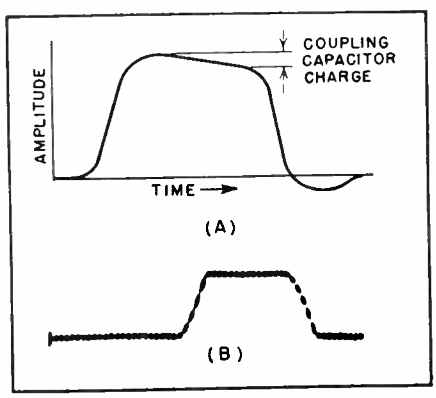


Fig. 6—Shutter traces on a cro

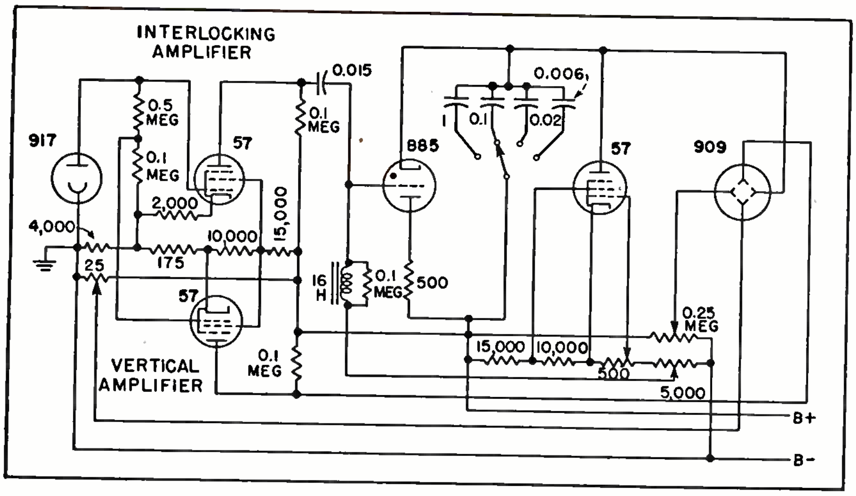


FIG. 7—Early cathode-ray type tester built by Kelley

coupled to the photoelectric detector through an amplifier. The shutter under test is interposed in the usual way between the phototube and a regulated light source. Thus there is the means of plotting ordinates continuously proportional to relative shutter openings. The abscissas are proportioned to time by means of the horizontal deflecting system which is excited by a triggered single-sweep circuit usually consisting of a gaseous discharge tube associated with R-C components of known time constants.

In application, sufficient low-frequency response must be present in the amplifier used for the vertical deflection system in order to minimize distortion of the trapezoidal type of pulse. Such distortion is suggested by Fig. 6A. Theoretically, a d-c amplifier would be preferred. Where amplifiers having serious limitations in this respect must be employed, a good approach can be made through the modulation of the light source by mechanical choppers, or through crystal, or Kerr-cell techniques at frequencies a few orders higher than that represented by the shutter speed being considered.

Figure 6B shows the characteristic curve of a standard type of shutter as traced by such cro system. A time scale is provided by millisecond modulation pulses. This particular shutter has a fair degree of accuracy at the speed setting under test (1/50 sec).

In 1935, Van Liempt and deVriemd[7] disclosed a shutter-testing technique employing a high-vacuum cathode-ray tube with associated electronic networks, an oscillograph camera, and a photoelectric detector. Their cathode-ray tube had a single pair of deflecting plates, the time-base being provided by a linear motion of the photographic plate in the camera. A record of time intervals, for measuring purposes, was made by including in the field of view a small neon lamp which flashed at the rate of 100 times per second. The reason for the choice of the camera they used is not apparent, for Van Liempt and deVriemd did recognize the now common approach when they wrote, "If no oscillograph camera is available, one can use a cathode-ray tube having two pairs of deflection plates with a single electrical time deflection. The pattern can then be taken with the usual still camera of large aperture."

In October 1937, J. D. Kelley,[8] reported the development of Fuller's earlier proposal for employing a cathode-ray tube system as such tubes were becoming available commercially. The advent of tubes with long persistence screens offered a medium with which moderate-speed transients could be studied without the need of photographing the trace. Kelley's circuit (with power supply omitted) is given in Fig. 7. He refers also to Williams and Wolfenden[9] who had already described the superposition of a time scale upon the observed pattern. This was accomplished by modulating the grid of the cathode-ray tube, thereby varying the intensity of the beam in accordance with time pulses of known frequency. The basic scheme thus represented is in general use. Variations appear primarily in differences of mechanical or electronic detail, and improvements in methods of obtaining standard time signals.

The fact that it is possible to modulate the electron-beam in the cathode-ray tube to control the brightness of the trace on the screen, makes it obvious that complementary circuits would be found wherein the spot brightness is suppressed during standby conditions and raised to maximum level during the sweep interval.[10, 11] This feature is now common in oscillographs which incorporate single-sweep circuits.

While others had already recognized the value of nonlinear time-bases for certain applications, H. M. Ross[12] used a logarithmic base and overcame the difficulty and inconvenience of readjustment of the instrument between testing different speed settings of shutters. He pointed out that, in a linear system, it is possible to test only a limited range of speeds. If the horizontal

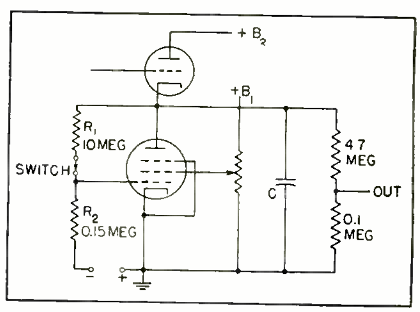


FIG. 8—The Ross logarithmic circuit

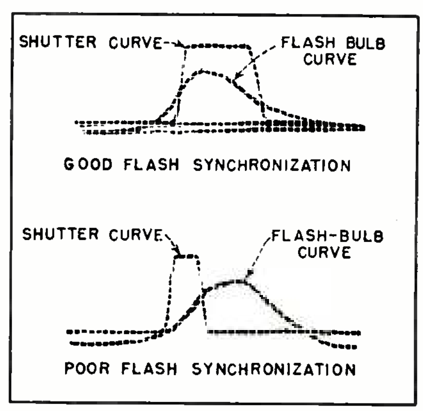


FIG. 9—Testing flash synchronization

sweep is suitable for viewing slow speeds, the pattern for a higher speed will appear unduly cramped and too small to measure properly. Conversely, if the sweep is suitable for viewing high speeds, the curves for slow speeds occupy more than the available screen space. In using an exponential time-base, equal percentage differences appear as equal displacements. Thus, where fixed percentage tolerances are used, they are represented as equal distances along the time base on the screen. A speed range of 20 to 1 is easily handled with no significant loss of accuracy.

In producing a logarithmic time base, a pentode is employed in a feedback circuit as suggested in Fig. 8. Use is made of the fact that the current through the pentode is independent of its plate potential over a wide range. If feedback to the control grid is applied through R_1, an exponential voltage decay will be obtained. A simplified analysis is supplied by Ross. At any instant $i = -dq/dt = -(CdV_c)/(dt)$ where i is the current in the capacitor C and q is its charge. The pentode control-grid voltage V_g is given by $V_g = (R_2 V_c)/(R_1 + R_2)$ disregarding the negative bias required to work on the straight-line portion of the characteristic curve. The current in the pentode (equal to that flowing from the capacitor) may be considered proportional to V_g

$$i = G_m V_g = G_m \frac{V_c R_2}{R_1 + R_2}$$

Therefore $$G_m \frac{V_c R_2}{R_1 + R_2} = -C\frac{dV_c}{dt}$$

or $$\frac{dV_c}{V_c} = \frac{-dt}{K}$$

from which $$V_c = V_0 \epsilon^{\frac{-t}{k}}$$

If a high degree of precision is required in the logarithmic scale, the range is limited to about one log cycle (10 to 1) by the necessity of keeping within the straight portion of the tube characteristic. If less precision is acceptable, it is possible to extend onto the toe of the characteristic and thereby obtain much higher ratios. This particular method permits the incorporation of a switch to make the circuit identical with that for providing an ordinary linear time-base by disconnecting R_1.

In 1946, C. E. Blake and L. R. Lankes, described their version (here published for the first time) of a cathode-ray tube method taking advantage of the availability of a tube having twin electron-gun structures. Since the deflection systems are electronically shielded, two different phenomena can be observed concurrently. A common horizontal sweep circuit provides the same time-base for both, thereby permitting a measure of phase differences. For the shutter-testing application, this technique furnishes the means of observing simultaneously the performance of a flashbulb and a shutter. Since there is then no problem in establishing a time-index relation, testing built-in flash synchronizers becomes automatic. Figure 9 shows a record of a shutter at two different speed settings: one with good, the other with poor, flash synchronization. The block diagram of Fig. 10A shows this application, employing two Du Mont type 208 oscilloscopes as complements to the individual sections of the 5SP11 tube. Normally this oscilloscope does not provide the choice of a single sweep in the horizontal deflection system. Therefore, the saw-tooth oscillator of one unit was modified by incorporating a diode in the plate circuit of the 6Q5, as shown in the schematic diagram of Fig. 10B. The 6Q5 will now ionize only when its

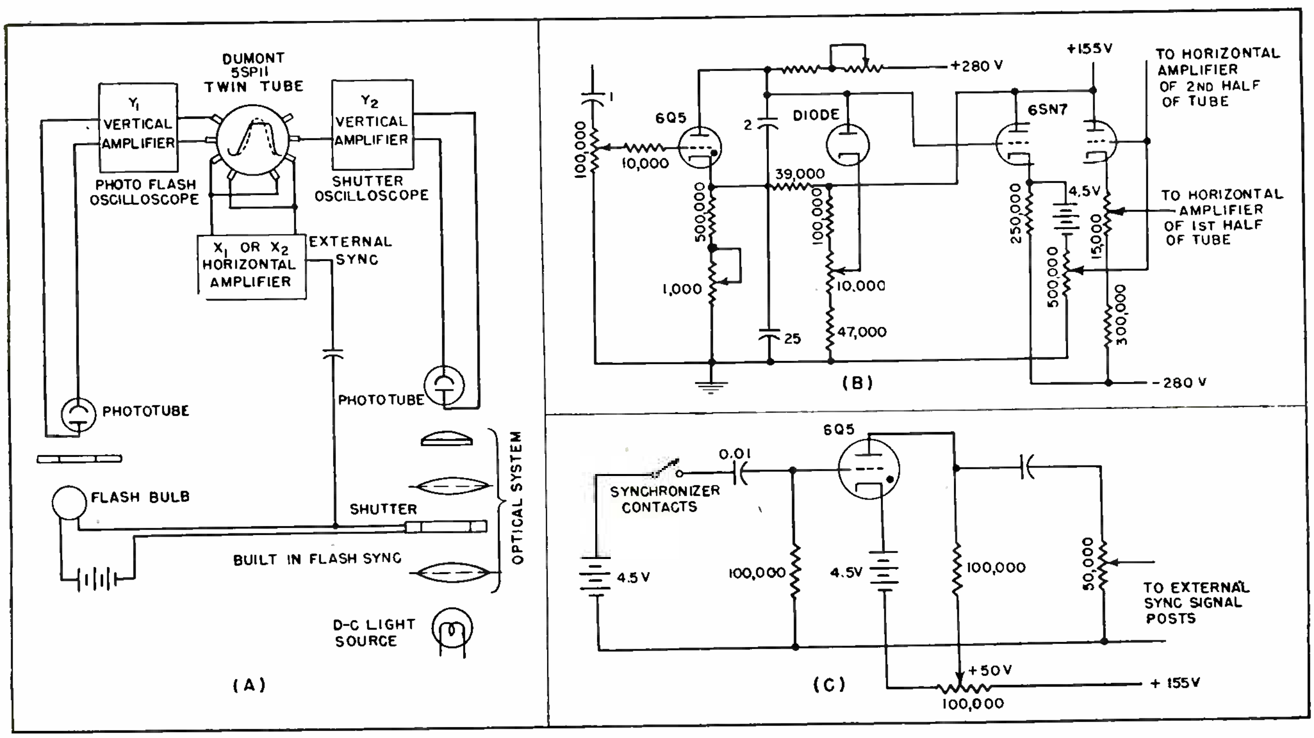


FIG. 10—Block diagram (A) of the Blake and Lankes system, single-sweep circuit used (B) incorporates an additional diode, and detail of the triggering circuit (C) for flash bulb synchronization measurements

grid receives a positive pulse, since the diode normally holds the plate potential to a value sufficiently low to prevent ionization. A simple circuit for providing the positive pulse (Fig. 5) is used when checking the ordinary between-the-lens shutter. In testing a shutter with built-in flash synchronizer, the shutter is triggered manually and the pulse-generating circuit of Fig. 10C is used.

The testing of focal-plane shutters, described in American War Standard Z52.65, is cumbersome. The usual attempts to simplify the procedure yield results which, although sufficiently accurate, generally fall short of those expected from a universal laboratory analyzer. These devices commonly employ spot-sampling techniques (at three positions along the path of travel) which are suited to production-line use. R. F. Redemske[13] described a versatile instrument which employed this approach. Since this description was published recently, its details will not be given here.

An ideal laboratory device should give a record from which could be determined, element-by-element, the variations in width of slit, equivalent-velocity of slit, and integrated exposure, for all parts of the picture area. While this is essentially a restatement of some of the objects outlined by Standard Z52.65, it is desirable to obtain the information with the same convenience found in the application of the cathode-ray tube to between-the-lens shutter testers.

The author and two associates, in devising a versatile laboratory analyzer, considered the use of an iconoscope for integrating purposes in testing focal-plane shutters. At the time, the expense of available iconoscopes did not justify such usage, and so a system was evolved which proved to be an acceptable compromise. This compromise will be more easily comprehended against a background of the iconoscope system which will be explained first.

By setting up equipment to establish appropriate factors and control their parameters, the moving slit of the focal-plane shutter under test can be imaged on the mosaic to give a measure of integrated exposure, element-by-element, over the picture area. Figure 11 is a block diagram employing the RCA 5527 iconoscope. The regulated light source uniformly illuminates the shutter along its path. The shutter slit is imaged on the mosaic. In operation, the shutter is released at the setting under test. The horizontal deflection circuit is triggered automatically, the control being common to both iconoscope and cathode-ray tubes. The signal from the iconoscope is fed to the vertical deflection system and a graph is thus plotted of integrated exposure against shutter displacement. The use of the twin-gun cathode-ray tube permits the separate derivation of a graph of shutter opening (slit-width) versus displacement. This is accomplished by the beam-splitter diverting a portion of the light into a phototube amplifier channel which, in turn, controls the vertical deflection system of the second electron gun. A time scale may be superimposed by feeding Z-signals to either electron gun, or to both guns, as preferred. The diagram includes additional control-details for factors which should not be overlooked. For example, the slit-width variation curve is made during the travel of the shutter, while the curve for integrated-exposure, by definition, requires some delay. As in the application of the twin-gun tube to testing between-the-lens shutters, a curve for synchronized photoflash may be obtained, in place of the curve for integrated exposure to permit appraisal of flash duration.

The block diagram of Fig. 12A illustrates a system by which Blake, Dixon, and Lankes simulate the mosaic of an iconoscope with its integrating possibilities. As many as 25 of the type 1P42 midget phototubes are employed in a row aligned with the travel of the focal-plane shutter slit or its projected image. This array of phototubes controls the means of measuring the time spent by the slit in exposing successive increments of picture area. A separate intensity-measuring phototube is so disposed to detect variations in slit width. This signal is fed to the vertical deflection system of the cathode-ray tube and appears for periods represented by the transit time of the slit-image over the apertures of the phototube array with the result illustrated by trace *A* in Fig. 12A. Trace *B* presupposes the use of the twin-gun tube to show another time scale, a photoflash curve, or both. Integrated exposure of an element of the picture is represented by the area of a rectangular increment of trace A, wherein its altitude is

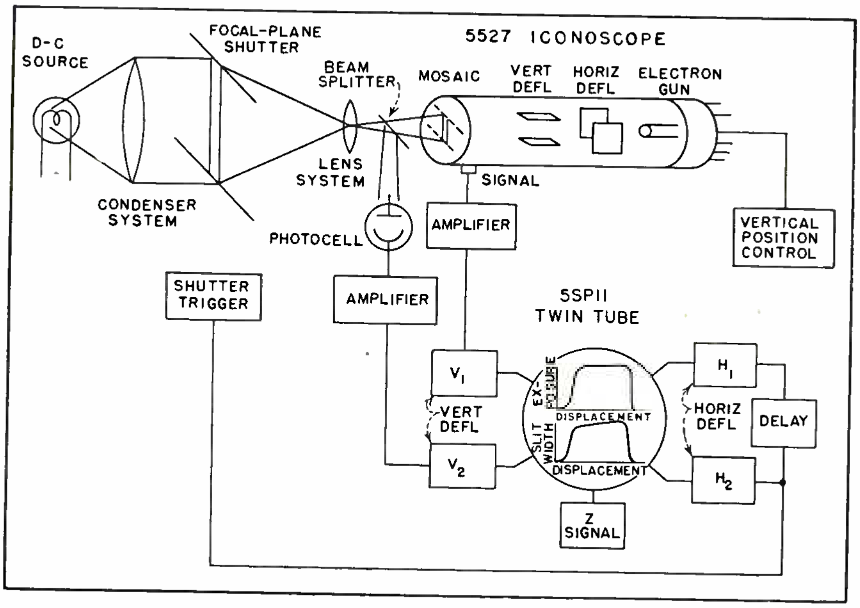


FIG. 11—Iconoscope used for focal-plane shutter testing. Photocell gives indication of slit width; iconoscope gives indication of integrated exposure

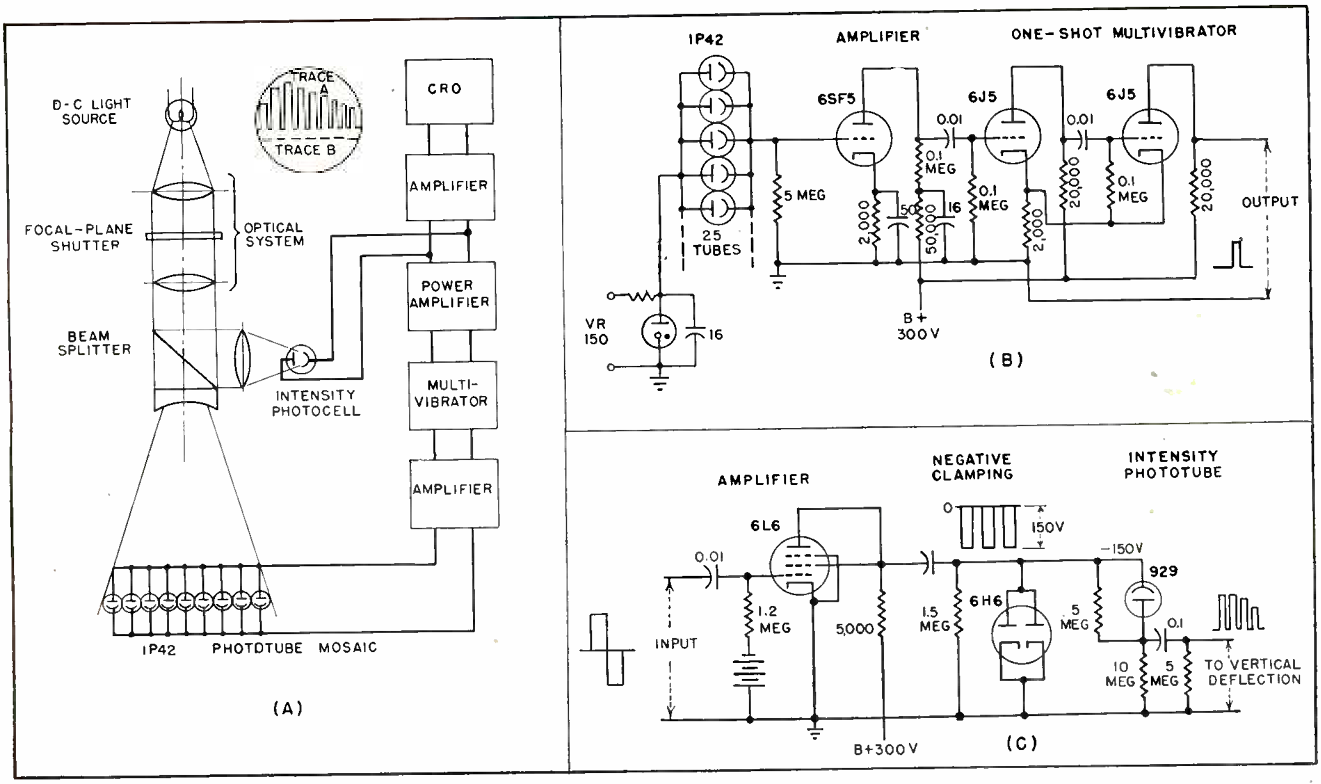


FIG. 12—A simulated mosaic system employing a multiplicity of small phototubes (A), circuit of the time-metering circuit that works on trailing edge of slit (B), and (C) phototube circuit for measuring slit width

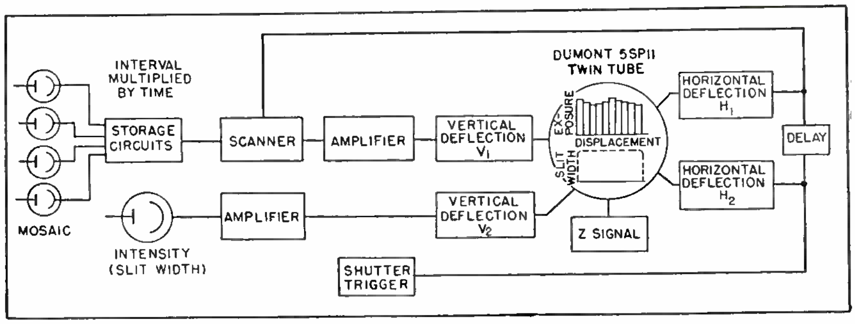


FIG. 13—A variation of the simulated mosaic system that uses a twin cathode-ray tube

a measure of light intensity and its base is a measure of time for that increment. Thus, the relative amplitudes (altitudes of the rectangles), or deviations in them, reveal changes in slit width; and the bases of the rectangles measure the relative incremental exposure time, or slit velocity. Figure 12B shows the diagram of the circuit to accomplish the time-metering function. This circuit is used to control that of Fig. 12C, which shows the disposition of the slit-measuring phototube.

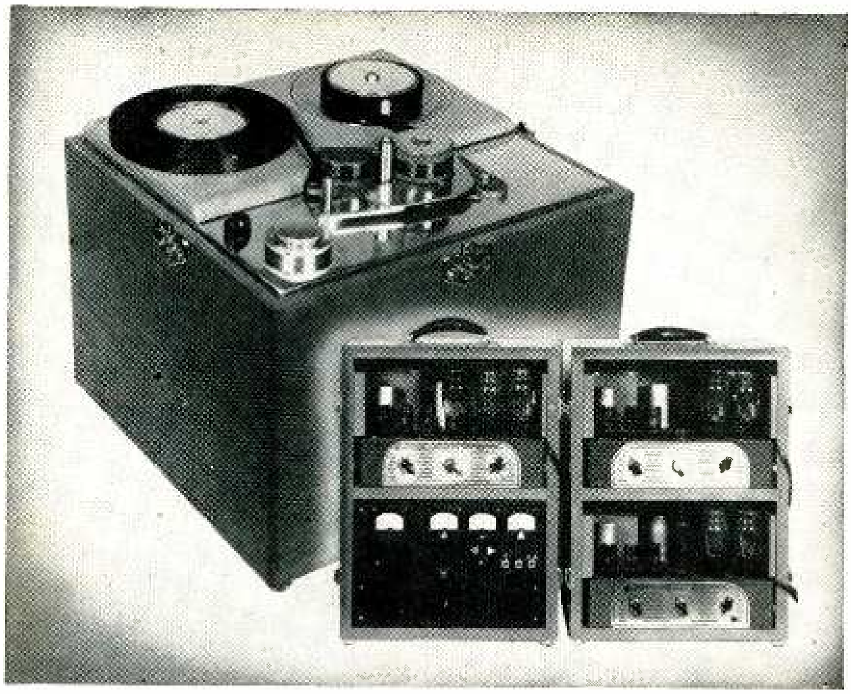
Variants may be devised to approach more closely an integrating system. One such is suggested in the block diagram of Fig. 13 (this being a modification of the basic idea of Fig. 12A). While the same scheme of operation applies, each phototube now is associated with an isolated storage circuit which is scanned by an electronic, or mechanical, commutator. The appearance of the cathode-ray trace is shown. Appraisal of integrated exposure, increment by increment, is simplified to the point where amplitude alone is a direct indication of the product of intensity and time.

The device described in conjunction with Fig. 12, has been found useful and satisfactory. The integrating possibilities of the variant suggested by Fig. 13, offer more convenience in appraising the results. However, the 5527 iconoscope is a more complete answer to the problem and offers the advantage of relative simplicity in a memory system and associated scanning.

The authors are indebted to many associates whose interest and cooperation aided substantially in developing the ideas herein presented.

REFERENCES

(1). S. H. Duffield and L. R. Lankes, The Testing of Photographic Shutters—Mechanical Systems *P. S. A. Journal*, ... 1948.
(2). A. B. Fuller, Electronic Chronometer, U. S. Pat. 1,954,313, 1934.
(3). J. D. Kelley, Camera Shutter Tester, U. S. Pat. 2,168,994, 1937.
(4). C. J. Penther, Timing Device and Method, U. S. Pat. 2,274,158, 1942.
(5) W. E. Merriman, et al., Photographic Shutter Tester, U. S. Pat. 2,376,-162, 1945.
(6). Reich and Marvin, *Review of Sci. Inst.*, Dec. 1931.
(7). J. A. M. V. Liempt and J. E. deVriemd, A New Method for Examining Photographic Shutter Speeds, *Zeitschrift fur Physik*, **Vol 98**, 1935.
(8). J. D. Kelley, An Instrument to Study the Intensity of Transient Light Pulses *Jour. of Optical Society*, **p 27, Vol 28** No. 1, Jan. 1938.
(9). W. C. Williams and J. P. Wolfenden, *Wireless Engineer* **14**, p 315, 1937.
10). O. S. Puckle, "Time Bases" (scanning generators), John Wiley & Sons Inc., Chapman and Hall Ltd., 1943.
(11). W. Wilson "The Cathode-Ray Oscillograph in Industry", Chapman and Hall Ltd., 1943.
(12). H. M. Ross, Nonlinear Time Bases for Testing Shutters and CRO Equipment, Private Communication from Research Laboratories, Kodak Ltd., Harron, England, Sept. 1946.
(13). R. F. Redemske, Electronic Shutter-Testers, ELECTRONICS, p 128, Feb. 1946.



The experimental three-channel stereophonic drive unit and (inset) the amplifiers and mixer. Three microphones and three loudspeakers complete the system

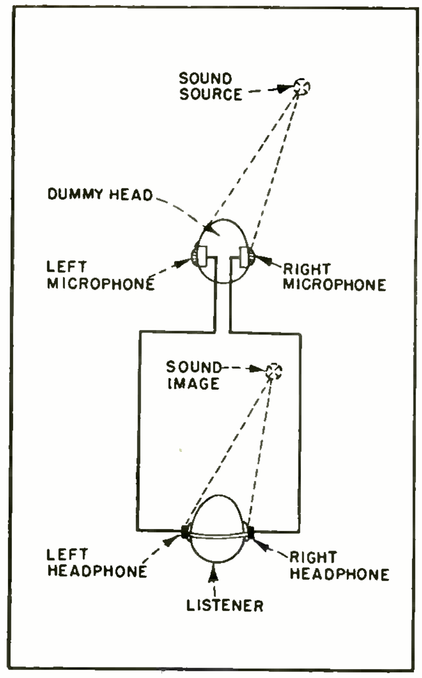


FIG. 1—Simple system for demonstrating binaural sound

STEREOPHONIC

Magnetic tape carrying three simultaneous channels gives a striking illusion of presence when played back through properly oriented speakers. Experiments indicate feasibility of two-channel home system in one cabinet

When a person listens directly to an orchestra, an important factor contributing to naturalness of the sound is binaural hearing. The left ear of the listener picks up a sound that is different in amplitude and phase from the sound picked up by the right ear. The two sounds are combined by the human hearing mechanism in such a way that the listener can judge the direction from which the sound comes, and the psychological effect creates a feeling of presence.

To obtain binaural sound reproduction a two-channel system as illustrated in Fig. 1 can be used. Sound is picked up by microphones placed in the ears of a dummy head. Each microphone is connected to corresponding earpieces of a headset. A person listening to sound through a binaural system has the illusion that the sound originates in the room rather than in the phones. The effect is striking to anyone used to hearing monaural sound from a headset.

Efforts to bring stereophonic sound into practical use have been directed toward entertainment in the theater and concert hall, because of the complexity and cost of such a system. For example, the portable equipment for *Fantasia's* road show employs eleven 62-inch racks of amplifiers plus power supplies and other equipment. It is packed in 45 cases weighing an average of 330 pounds per case, and occupies half a standard freight car.

One field so far neglected is that of home entertainment. Stereophonic reproduction for the home brings up a number of problems which are entirely different from those in the concert hall or theater. For one thing, the listening room in a home is much smaller, and the listener is closer to the loudspeakers. With speakers on each side of the room he cannot back away a distance comparable to the distance between speakers; in fact, the seating arrangement is often such that the listener faces the broader wall. Since the listener is free to move about the room to a considerable extent, the stereophonic illusion should be present throughout the room. Acoustics of the room are generally fixed and little can be done about them, so that the home stereophonic reproducer should ideally be adaptable to various

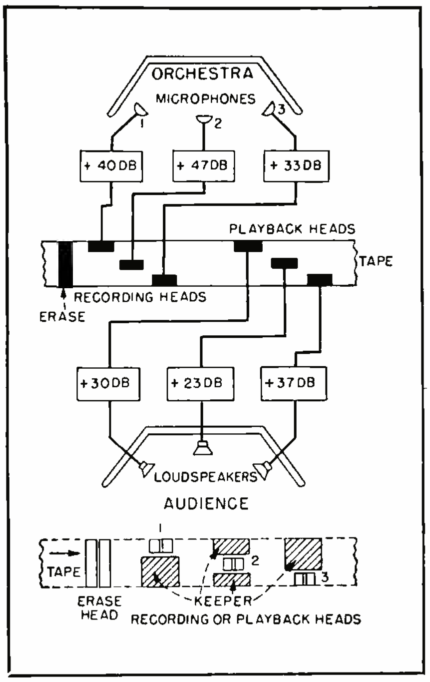


FIG. 2—Block diagram of elements composing three-channel recorder-reproducer

SOUND

shapes and layouts of living rooms.

The economics of a home stereophonic system are also important. A theater sound system can cost many thousands of dollars, and the film for a program of several hours can also be worth several thousand dollars. The home unit, on the other hand, must sell for the price of a high-grade phonograph combination, or somewhere between $250 and $1,000. The records should sell for not more than 1½ to 3 times the present cost of phonograph records for an equivalent playing time.

Experimental Systems

An experimental magnetic-tape recording and playback system recently demonstrated before the New York Section, IRE, by Marvin Camras of Armour Research Foundation, shows promise of approaching most of the economic requirements set forth above. Three channels are provided that are flat within 5 db from 50 to 10,000 cycles. There is less than 4 percent intermodulation distortion and less than 1 percent harmonic distortion at normal levels. The dynamic range is 60 db between maximum modulation level and noise level. Wow and flutter are less than 0.1 percent. At the normal running speed of 1 foot a second a full reel of quarter-inch tape plays for 20 minutes.

The simplified block diagram of Fig. 2 shows the elements of a three-channel system. In actual practice one set of heads serves for both recording and playback, while the recording amplifiers, with readjusted gain, are used in place of the two sets of three illustrated.

Arrangement of the stereophonic heads is presented in the detail at the bottom of Fig. 2. An erase head extends across the entire width of the tape and clears off all three channels. The recording heads are staggered along the length of the tape to permit mechanical and electrical isolation. At the section where one head is recording on its track, the other two tracks are covered by a keeper made of high-permeability alloy. This arrangement protects tracks 1 and 3 when head 2 is recording, and so on.

Because the same heads are also used for playback, when head 1 is reproducing, the adjacent channels are magnetically short circuited by keepers to prevent crosstalk. The other channels are protected in the same way. Without keepers it has been found that heads are sensitive to recordings on channels as far as 0.125 inch or more from the head, the effect being especially pronounced at low frequencies.

Generally the maximum sound

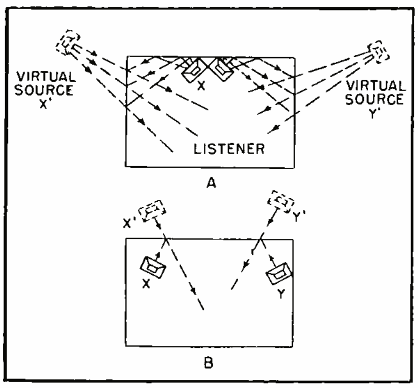


FIG. 3—Reflective speaker system, showing location of virtual sources

intensity picked up by the different microphones during a rendition will be different, necessitating a method for setting gain as indicated in Fig. 2. A test selection is played by the orchestra and the gain of each channel is set at the maximum point that will not produce overload of the recording at any time. Depending on microphone placement and relative loudness of the different instruments, typical settings might be as shown. On playback the gains of the amplifiers are set in inverse ratio to the recording amplification. Some adjustment from the values given might have to be made to compensate for speaker placement, acoustic conditions, and characteristics of the ear.

Comparisons between two- and three-channel systems indicate that a satisfactory simulation of realism is possible with only two channels. A third microphone that is caused to feed equally into both channels may be placed in any convenient location for soloist or announcer. To the listener, the reproduction of this voice appears to come from its customary center-stage location. The third microphone is not, however, mandatory in a home-recording system because pickup from two program microphones gives the illusion that the performer is in a larger room beyond the walls of the listening enclosure.

It has been found that the more conventional and obvious placement of speakers is, at best, difficult in the ordinary home. With reproducing units oriented as shown in Fig. 3, there is some undesirable attenuation of the high frequencies, but reflections from the walls give the effect of virtual sources located at an appreciable distance outside the room. A single enclosure with two speakers similar to the arrangement of Fig. 3A has been designed to hold the complete dual-channel magnetic-tape recorder-reproducer with associated power supplies and amplifiers, as well as a conventional radio-phonograph combination. An artificial center channel can be obtained by having ports in front that open into each of the speaker compartments to give acoustic mixing.—A. A. McK.

Television Receiver

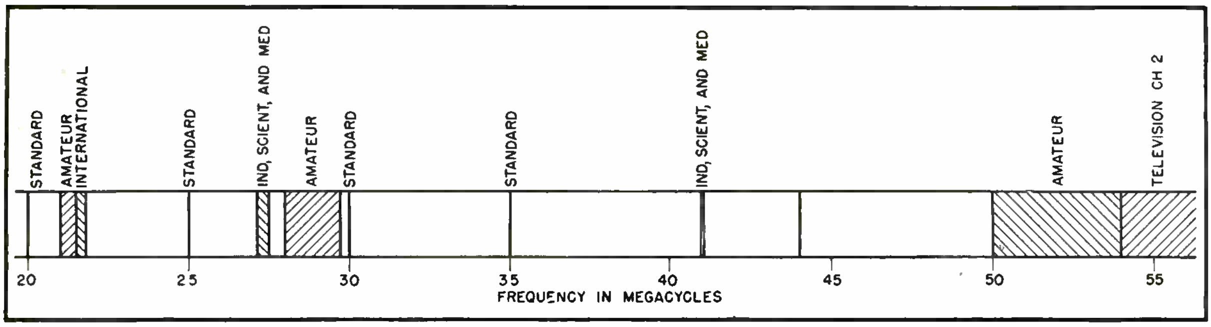


FIG. 1—Assignments in the 20 to 54-mc region capable of causing direct i-f interference

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THE INTERMEDIATE FREQUENCIES used in superheterodyne receivers for the reception of the a-m and f-m broadcast bands have in recent years become standardized at 455 kc and 10.7 mc respectively.

A recommended RMA standard specifies that the intermediate-sound-carrier frequency for commercial television receivers shall be between 21.25 mc and 21.9 mc. Field experience gained since its adoption has revealed that this choice has severe shortcomings. The data presented here were obtained to determine whether higher frequency i-f bands would be preferable.

The scope of the investigation was limited by two requirements on which there appears to be general agreement. *First:* The intermediiate-frequency bands should be located above 20 mc and below the lowest television channel (channel 2 since the recent deletion by the FCC of channel 1). *Second:* The local-oscillator frequency should, for channels 2 to 6 inclusive, be located above the desired channel. The latter requirement also determines the oscillator location for channels 7 to 13 inclusive, except for the case where an intercarrier sound system is used.

The principal performance characteristics determined or influenced by the selection of the i-f bands are as follows:

(a) The i-f bands must not coincide with a television channel.

(b) The i-f bands should exclude the standard-frequency broadcasts, amateur, industrial, scientific and medical, and international-broadcast bands.

(c) Harmonics of the intermediate frequencies should fall outside the television channels.

(d) The local-oscillator frequencies should fall outside the television and f-m channels.

(e) Cross-modulation between a television signal and another television signal, as well as signals from other services such as f-m and amateur, should not result in signals within the i-f pass-bands.

(f) The intermediate frequencies should minimize the possibility of harmful spurious responses.

(g) It should be possible to provide adequate selectivity in the selected i-f bands with practical coils.

(h) It should be possible to provide adequate gain in the selected i-f bands with commercial tubes.

Table I—Allocations in the Frequency Band 20 to 60 Megacycles

Kilocycles	U. S. Service
19,985–20,015	Standard-frequency broadcast
20,015–20,500	Fixed
20,500–21,000	Fixed and mobile
21,000–21,500	Amateur
21,500–21,700	International Broadcast
21,700–24,985	Fixed
24,985–25,015	Standard-frequency broadcast
25,015–26,960	Fixed and mobile
26,960–27,280	Scientific, industrial, medical, amateur
27,280–28,000	Fixed and mobile
28,000–29,700	Amateur
29,700–29,985	Fixed and mobile
29,985–30,015	Standard-frequency broadcast
30,015–34,985	Fixed and mobile
34,985–35,015	Standard-frequency broadcast
35,015–40,660	Fixed and mobile
40,660–40,700	Industrial, scientific and medical
40,700–50,000	Fixed and mobile
50,000–54,000	Amateur
54,000–60,000	Television Channel 2

In what follows, the frequencies for the r-f pass band are given in terms of the lowest frequency f_t of the television channel under consideration, while the frequencies of the i-f pass band are referred to the sound intermediate frequency f_o.

If with an intercarrier sound circuit the local oscillator is operated below the desired television channel on channels 7 to 13 inclusive, the sound carrier frequency for these channels, as referred to channels 2 to 6 inclusive, will be f_t +5.50 mc, while the limits of the pass band will remain unchanged.

Direct I-F Interference

Within the limitations imposed on this analysis, and considering that the i-f band cannot overlap the lowest television channel, it is evident that the highest frequency which can be considered for the i-f sound carrier is 48.25 mc.

Intermediate Frequencies

Recent experience indicates that the 21-mc and 26-mc intermediate frequencies now widely used in television receivers are too low. An exhaustive study of possibilities in the range from 20 to 50 mc, presented here, shows the superiority of values above 30 mc

To determine the effect of direct i-f interference it is necessary to examine the services located in the band between 20 and 60 mc, as listed in Table I. Referring specifically to the standard frequency band, is should be noted that the rated power in the 20 mc band is 8.5 kw while the 25, 30 and 35-mc transmitter rating is only 0.1 kw. These bands are shown on Fig. 1, together with television channel 2.

It will be seen that there is no space in the spectrum below 30 mc where it is possible to locate a 6-mc channel without possible interference from one or more services. However, if the standard-frequency band on 35 mc is not taken into consideration there exists at least one satisfactory band above 30 mc, and since the band from 44 to 50 mc has been turned over to low-power services there are two possible bands, 29.95–35.21 and 41.00–44.25 mc.

The RMA recommended intermediate frequencies encounter interference from the 21.0 to 21.5 mc amateurs, and the 21.5 to 21.7 mc international short wave band may interfere, particularly if the intermediate frequencies are selected in the low end of the recommended band. On the other hand, the industrial, scientific and medical band from 26.960 to 27.280 mc may also interfere, particularly if the intermediate frequencies are selected in the high end of the recommended band.

Interference From I-F Harmonics

To evaluate the interference which may be caused by i-f harmonics coupled into the antenna and r-f circuits, reference should be made to Fig. 2. In this diagram it is assumed that the i-f harmonics will consist primarily of harmonics of the i-f sound and picture carriers, that is, the frequencies of the interfering signals will be: $S_n = n\ f_o$ mc and $P_n = n\ (f_o + 4.5)$ mc.

It is possible to draw the following conclusions from this diagram:

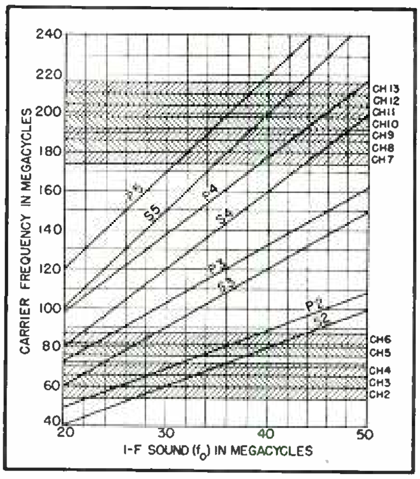

FIG. 2—Possibilities of i-f harmonic interference, plotted over the range from 20 to 50 mc. Curves P and S represent picture and sound second harmonic respectively

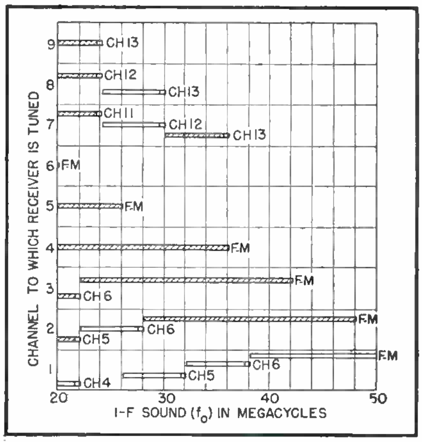

FIG. 3—Oscillator radiation as a source of interference to television and f-m channels. The cross-hatched bars represent other services assigned in the same area as the channel tuned in

(1.) The first harmonics cannot interfere.

(2) None of the 5 lowest harmonics will interfere with channels 7 to 13 inclusive if the sound i-f frequency is below 30.3 mc.

(3) To place the second harmonic of the sound i-f carrier above channel 6, it will be necessary to increase its value to at least 44 mc.

(4) In general, an increase in the i-f frequencies will tend to remove low-order harmonics from the pass bands and replace them with higher-order harmonics.

(5) It is possible to select intermediate frequencies so that some harmonics fall below 54-mc and between 72 to 76-mc.

Of particular interest is the i-f sound carrier on a frequency of 32.8 mc, where the only possible interferences are due to the facts that the second harmonic of the i-f sound carrier is located 150 kc below the sound carrier in channel 3, and that the fifth harmonic of the picture carrier is located 750 kc below the picture carrier on channel 9.

In the intercarrier sound system, when the oscillator is located below the band on channels 7 to 13 inclusive, the interfering harmonics will be $n\ (f_o + 1.0)$ and $n\ (f_o + 5.5)$ mc. Since the shift in frequencies takes place during the operation of the higher channels, no significant changes in the interferences will result.

Oscillator Radiation

To examine what advantages can be gained in suppressing oscillator radiation through the proper selection of the i-f bands, reference should be made to Fig. 3. On this diagram, the channels which may use a local oscillator frequency falling either in another television channel or within the f-m band, are tabulated on the left side. The location of the local oscillator frequency in relation to the other television channels and the f-m band is plotted for each channel as determined by the sound i-f frequency. The possible interferences are classified by cross-hatching those occurring between channels allocated in the same service areas.

As tabulated below, the possibilities of interference with another television channel decrease rapidly as the i-f sound-carrier frequency is increased.

Table II

I-F Sound (mc)	Interference Television channels	Probable in F-M channels
20.00–20.25	5	3
20.25–22.25	5	2
22.25–24.25	3	3
24.25–26.25	0	3
26.25–28.25	0	2
28.25–30.25	0	3
30.25–36.25	1	3
36.25–42.25	0	2
42.25–48.25	0	1
48.25–50.00	0	0

It will be noted that the RMA recommended standard i-f band is in a very poor location and that complete freedom from interference between television receivers will be obtained if the i-f sound carrier is raised above 24.25 mc. To effect a similar improvement with respect to radiation in the f-m band, the i-f sound carrier should be above 48.25 mc.

If an intercarrier sound circuit is used, with the oscillator operated below the desired channel on channels 7 to 13 inclusive, it can be shown that the numbers pertaining to the seven upper channels are interchanged. The possibilities for interference therefore remain unchanged.

Attenuation in a double-tuned circuit inserted between the mixer and the antenna will cause the power of the radiated local oscillator signal to be inversely proportional to the square of the intermediate frequency. Therefore, the selection of a relatively high intermediate frequency will in itself

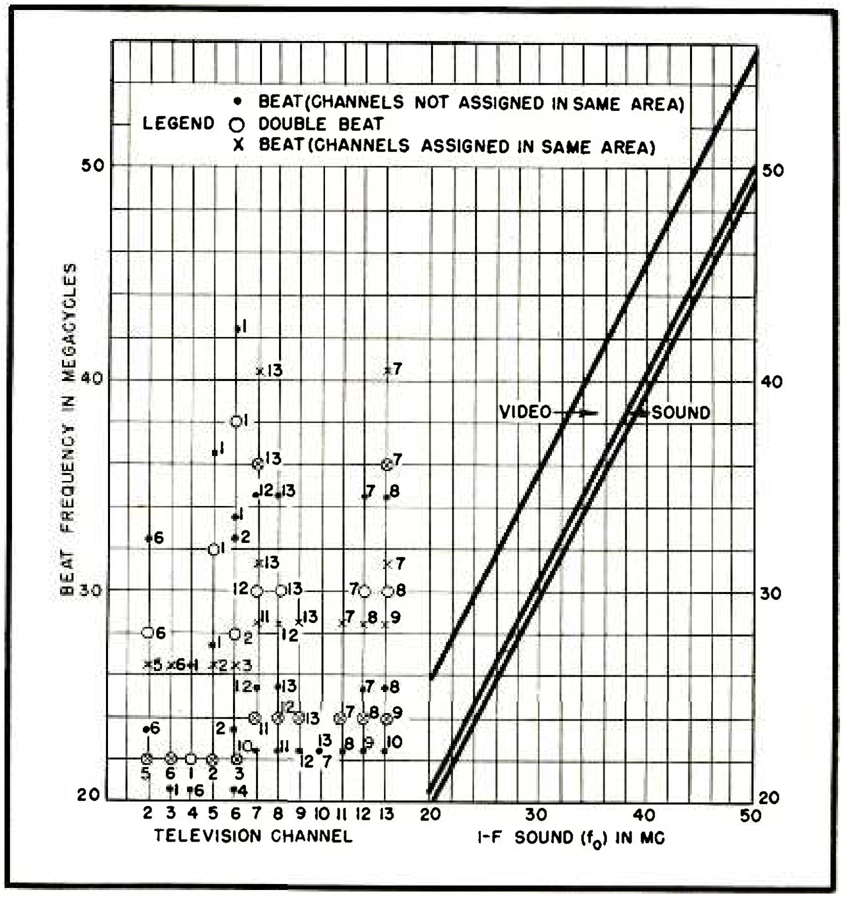

FIG. 4—Cross-modulation interference between television stations, causing a signal within the i-f band

minimize oscillator radiation.

Cross Modulation

The study of cross-modulation interference is limited to cases where a television transmitter provides one of the two signals which causes the beat frequency. The other signal may be provided by another television transmitter, an f-m transmitter, or an amateur transmitter. In general, it should be taken into account that an increase in the intermediate frequency will increase the attenuation of the interfering signal and minimize cross modulation.

Since the total number of television channels allocated below 300 mc at this time is twelve, it is possible to determine all possible beat frequencies between television stations. The result of such an investigation has been plotted on Fig. 4 for all beat frequencies above 20 and below 50 megacycles. Beats resulting from channels not allocated to the same service area have been marked with a point, while beats resulting from channels which are allocated to the same service area are marked with a cross. Furthermore, the double beats, that is, beats which result from a picture carrier with another picture carrier and a sound carrier with another sound carrier, have been enclosed within a circle.

In general, it will be seen that the number of probable interferences decreases rapidly with increasing intermediate frequencies. With the recommended RMA i-f band, cross modulation is probable on 10 television channels. However, the i-f sound-carrier frequency need only to be increased above 28.75 mc to reduce the number to 2. With a sound intermediate frequency above 40.75 mc there is no probability of cross modulation between the television channels.

The 88 to 108 mc f-m band is located too far below television channels 7 to 13 inclusive to produce cross-modulation interference. It is therefore only necessary to examine this interference with respect to the lower five channels. The interfering signal f_s is above the desired television channel and cross modulation may interfere with the sound channel if $(f_s - f_t - 1.50) < f_o < (f_s - f_t - 1.00)$ or $(f_s - f_t - 6.00) < f_o < (f_s - f_t - 5.50)$. Interference to the picture channel may occur if $(f_s - f_t - 7.00) < f_o < f_s - f_t - 1.50)$ or $(f_s - f_t - 11.50) < f_o < (f_s - f_t - 6.00)$. The results as calculated from the above formulas are tabulated below:

Table III

I-F Sound (mc)	Cross Modulation Possible to Tel. Ch. Numbers
20.00–22.40	3, 4, 5, 6
22.40–24.65	2, 3, 4, 5, 6
24.65–30.65	2, 3, 4, 5
30.65–40.65	2, 3, 4
40.65–46.65	2, 3
46.65–50.00	2

The four amateur bands which should be considered in connection with cross modulation are 28.0-29.7, 50.0-54.0, 144.0-148.0 and 220.0-225.0 mc. The interfering signal is below the desired television channel and cross modulation may interfere with the sound channel if $(f_t - f_s + 1.0) < f_o < (f_t - f_s + 1.50)$ $(f_t - f_s + 5.5) < f_o < (f_t - f_s + 6.00)$.

while interference to the picture channel may exist if $(f_t - f_s - 4.5) < f_o < (f_t - f_s + 1.00)$ $(f_t - f_s) < f_o < (f_t - f_s + 5.50)$.

The 220–225-mc band is located above the desired television band and the formulas derived for the f-m band will apply. The results calculated from the above formulas are tabulated in Table IV. It appears some possibilities for cross modulation cannot be avoided, since the number of possible interferences varies between a minimum of four and a maximum of eight. Interference from the 50–54 mc band may be avoided if the i-f sound carrier is made higher in frequency than 34.00 mc.

It may be seen that a substantial advantage exists only in the extreme high end of the band.

Spurious Responses

Image responses in a superheterodyne receiver may be caused by fundamentals as well as harmonics of the undesired signal and the local oscillator. However, this investigation was limited to consideration of the three most important spurious responses, the first-order image, second-oscillator image (plus) and second-oscillator image (minus).

The first-order image spurious response is caused by the fundamentals of the undesired signal and the local oscillator. With the local oscillator placed above the desired television channel, the image of the sound channel may be determined from $(f_t + 2 f_o + 5.50) < f_s < (f_t + 2 f_o + 6.00)$, while the image of the picture channel is $(f_t + 2 f_o + 6.00) < f_s < (f_t + 2 f_o + 11.50)$ or the image of the complete television channel is $(f_t + 2 f_o + 5.50) < f_s < (f_t + 2 f_o + 11.50)$.

The image responses for the television channels, as a function of the intermediate sound carrier frequency, are indicated on Fig. 5. It will be observed that no television channel will fall on the image of another television channel, unless the sound i-f carrier frequency is increased above 43.25 mc in which case channels 7 and 8 will fall on the images of channels 5 and 6 respectively. Other possible interfering signals are tabulated in Table V.

Table V

I-F Sound (mc)	F-M Ch. on the Image of Tel. Ch.	Amateur Ch. on the Image of Tel. Ch.
20.00–22.75	2	7
22.75–24.25	2	—
24.25–25.25	—	—
25.25–28.25	—	6
28.25–29.25	—	5, 6
29.25–30.25	—	5, 6
30.25–33.25	—	5
33.25–36.25	—	4
36.25–38.25	—	3, 4
38.25–39.25	—	3
39.25–41.25	—	2, 3
41.25–44.25	—	2
44.25–50.00	—	—

Considering first the RMA recommended i-f band, the f-m stations located on the image of television channel 2 are probably the most serious objection to the continued use of this band. Insofar as amateurs on the image are concerned, it will be observed that apart from the band from 22.75 to 25.25 mc and the frequency 33.25 mc and 44.25 mc, it will be necessary to go above 44.25 mc in order to avoid the possibility of this type of interference. While a higher intermediate sound carrier may not reduce the number

Table IV—Cross Modulation Between Television and Amateur Bands Resulting in Signal Within I-F Band

I F Sound (Mc)	Amateur Bands and Possible Interferences				Total Number of Possible Interferences
	28.0–29.7	50.0–54.0	144.0–148.0	220–225	
20.00–21.50	Ch 2	Ch 4–5	Ch —	Ch 10–11	5
21.50–22.00	2	4–5	7	10–11	6
22.00–22.50	2	5	7	10–11	5
22.50–23.50	2	5	7	9–10–11	6
23.50–25.80	2	5–6	7	9–10–11	7
25.80–26.00	2–3	5–6	7	9–10–11	8
26.00–27.50	2–3	5–6	7	9–10	7
27.50–28.00	2–3	5–6	7–8	9–10	8
28.00–28.50	2–3	6	7–8	9–10	7
28.50–31.80	2–3	6	7–8	8–9–10	8
31.80–32.00	2–3–4	6	7–8	8–9–10	9
32.00–33.50	3–4	6	7–8	8–9	7
33.50–34.00	3–4	6	7–8–9	8–9	8
34.00–34.50	3–4	—	7–8–9	8–9	7
34.50–36.00	3–4	—	7–8–9	7–8–9	8
36.00–38.00	3–4	—	8–9	7–8–9	7
38.00–39.50	4	—	8–9	7–8	5
39.50–41.80	4	—	8–9–10	7–8	6
41.80–42.00	4–5	—	8–9–10	7–8	7
42.00–44.00	4–5	—	9–10	7–8	6
44.00–45.50	5	—	9–10	7	4
45.50–47.80	5	—	9–10–11	7	5
47.80–48.00	5–6	—	9–10–11	7	6
48.00–50.00	5–6	—	10–11	7	5

of possible interferences, it will reduce their magnitude, due to greater attenuation in the antenna and r-f circuits.

If the intercarrier sound system is used, when the local oscillator is placed below channels 7 to 13, the image response of the sound channel will be $(f_t - 2f_o - 5.50) < f_i < (f_t - 2f_o - 5.00)$, while the image response of the picture channel will be $(f_t - 2f_o - 5.00) < f_i < (f_t - 2f_o + 0.5)$, or the image of the complete television channel is $(f_t - 2f_o - 5.50) < f_i < (f_t - 2f_o + 0.5)$.

Analysis shows that this oscillator arrangement will result in greater possibilities for image interference. If the intermediate sound carrier frequency for the lower channels is selected above 30.25 mc, f-m channels will be found on the image of the higher television channels, while in addition there is the probability of image interference from television stations above 40.25 mc. On the other hand, with the i-f sound carrier placed below 33.25 mc, the 144 to 148-mc amateur band is on the images on one or two of channels 7 to 13 inclusive.

Second-Order Image (Plus)

The second-order images (plus) may be determined as $(2f_t + 3f_o + 11.25) < f_i < (2f_t + 3f_o + 17.25)$ and the results are as shown on Fig. 6. It will be observed that such interferences are possible from the higher to the lower channels, but that the possibilities for interferences decrease rapidly as the sound intermediate frequency is increased.

With an intercarrier sound circuit, if the local oscillator for channels 7 to 13 inclusive is located below the desired band, the images may be determined as $(2f_t - f_o + 0.25) < f_i < (2f_t - f_o + 6.25)$ and an examination shows that no television channel will fall on the images of television channels 7 to 13 inclusive for the band of second i-f carrier frequencies under consideration.

Second-Order Image (Minus)

Interferences of the second-order (minus) type have been experienced on channel 5 from channel 7 and on channel 6 from channel 10. These images may be determined as $(2f_t + f_o + 5.75) < f_i < (2f_t + f_o + 11.75)$ with the results shown on Fig. 7. It will be observed that the possibilities for this type of interference vary only slightly when the intermediate sound carrier is varied from 20 to 50 mc.

With an intercarrier sound circuit, when the local oscillator for channels 7 to 13 inclusive is located below the desired band, the images may be determined as $(2f_t - 3f_o - 5.25) < f_i < (2f_t - 3f_o + 0.75)$ and examination shows that none of the television channels, 7 to 13 inclusive, will fall on the image of another television channel unless the sound i-f carrier frequency for the lower channels is selected above 42.25 mc.

Selectivity

It is necessary to determine the Q which will be required of the tuned circuits to provide the desired selectivity and shape of response within the pass bands. This information, which is required to

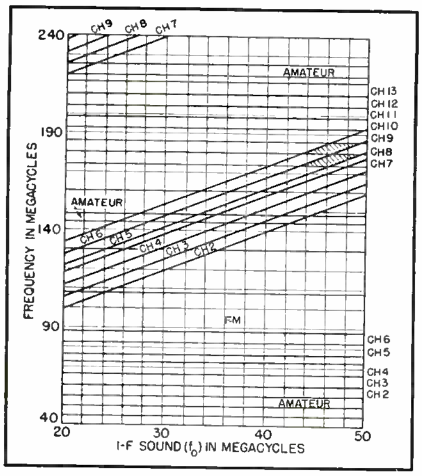

FIG. 5—First-order image responses as a function of the sound intermediate frequency

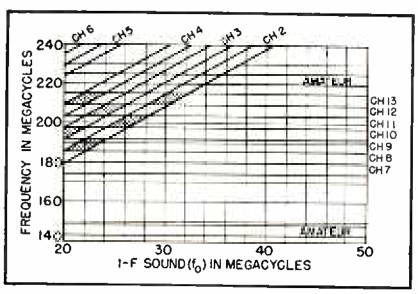

FIG. 6—Second-order image responses (+)

determine the feasibility of the tuned circuits, may be obtained with sufficient accuracy from the universal selectivity curves shown on Fig. 8 for double-tuned transformers having a coupling factor between 1.0 and 1.25 times the critical coupling factor.

If the sound-intermediate frequency is to be selected among the frequencies from 20 to 50 mc, it is found that the bandwidth required for the picture channel will necessitate that the Q of its tuned circuits must be held to less than 25. Since this is a readily achieved value, the selectivity of the picture channel imposes no restrictions whatever on the selection of the i-f frequency. However, it has been found difficult to obtain the close coupling required to attain the desired bandwidth with simple double-tuned circuits in the low end of the frequency band under consideration. The use of an intercarrier sound system makes further considerations of the selectivity requirements unnecessary, since the sound i-f selectivity will be independent of the choice.

Using a conventional intermediate frequency sound amplifier, it is assumed that the i-f channel will usually be made somewhat broader than the corresponding circuits used for f-m reception, to overcome the effects of the local oscillator drift. Let it further be assumed that it is desired to place the 10-db attenuation points 400 kc off resonance. It is then possible to tabulate the Q required for various choices of the sound i-f, as follows:

	20 mc	30 mc	40 mc	50 mc
$n = 1.0$	62	94	124	157
$n = 1.25$	69	103	138	172

These requirements approach the practical limits of attainable Q in the extreme high end of the band.

Gain

The selection of the frequencies for the i-f sound and picture bands will, for a given type of tubes operating in a given type of circuit, determine the gain which can be obtained from an i-f stage with a specified bandwidth and shape of response in the pass band. To evaluate the factors involved in this problem, we will determine, for a double-tuned stage, the maximum gain that can be obtained from the stage if the effects of the grid-plate capacitance are neglected. This figure for the gain is independent of the center frequencies of the tuned circuits and may be calculated from the mutual conductance of the amplifier tube and the capacitive load on the tuned circuits, together with the Q required to produce the desired shape of the i-f response characteristic. In addition the maximum safe gain which can be used without excessive regeneration, must be determined from the mutual conductance of the amplifier tube, the grid-plate capacitance of the amplifier tube, and the center frequency of the tuned circuits. If the latter gain is the lower, it will determine the available gain.

The maximum gain of an amplifier stage may be determined from

$$\left(\frac{Q}{f_0}\right) \cdot \left(\frac{g_m}{4\pi C}\right)$$

where the value of Q/f_o may be found from Fig. 8. Theoretical considerations, as well as practical experience, show that the maximum gain which can be obtained safely from an unneutralized *i-f* stage is $\frac{1}{2}\sqrt{g_m x f}$ where g_m is the mutual conductance of the amplifier tube and xf is the reactance of the grid-to-plate feedback capacitance.

It is found that the maximum gain in a sound i-f stage with three typical tubes is

6AC7	166 to 182 times
6SG7	97 to 107 times
6AG5	159 to 174 times

The corresponding maximum safe gain is listed below for the three types of tubes:

f_o (mc)	20	30	40	50
6AC7	32.6	26.6	23.0	20.6
6SG7	55.9	45.6	39.5	35.4
6AG5	20.1	16.4	14.2	12.7

These gains represent the maximum that can be used. The available gain per stage in the i-f sound channel is therefore inversely proportional to the square root of its center frequency. However, the difference in gain per stage is not great. Moreover the loss in sound i-f gain is of no importance if an intercarrier sound system is used.

The maximum gain in the picture i-f channel may be determined if we assume that a stage using an over-coupled transformer as shown in Fig. 8 will be used, and that the bandwidth is considered to the point where the loss in gain does not exceed 2 db. Then, for a 4-mc bandwidth, Q/f_o = 0.38 and the gains which may be obtained with the three types of tubes are: 6AC7-20; 6SG7-12; 6AG5-19.5.

For maximum safe gain we find correspondingly:

f_o (mc)	20	30	40	50
6AC7	30.2	25.3	22.2	20.2
6SG7	52.1	43.5	38.0	34.4
6AG5	18.7	15.6	13.7	12.4

Only in the case of the 6AG5 tube will a reduction in gain be experienced if the i-f band is moved towards the higher frequencies, since the maximum gains previously calculated are controlling in the other two types.

Selection of I-F

If it is decided to exclude amateur, industrial, scientific and medical, as well as international broadcast bands from the i-f pass bands, the lowest choice for an intermediate sound carrier frequency will fall in the band 29.95 to 35.21 mc. In this band 32.8 mc has been

Table VI—Summary of Performance Data

		STANDARD I-F BAND (A) Sound 21.9 mc Picture 26.4 mc	SELECTED I-F BAND (B) Sound 32.8 mc Picture 37.3 mc	SELECTED I-F BAND (C) Sound 41.2 mc Picture 45.7 mc
I-F Amplifier Characteristics	Gain per stage	Best	Poorer (0–1.8 db less than A)	Poorest (0–2.9 db less than A)
	Selectivity (sound channel)	Satisfactory (Q required, 70)	Satisfactory (Q required, 100)	Satisfactory (Q required, 130)
	Harmonic interference	Poorer (3 harmonics fall in television bands)	Better (2 harmonics fall in television bands)	Better (2 harmonics fall in television bands)
Spurious Responses	I-F attenuation	Best	Poorer (1 to 8 db less than A)	Poorest (2–24 db less than A)
	Stations on I-F band	Poorer (Diathermy and standard broadcast interference possible)	Better (No diathermy or standard broadcast interference possible)	Better (No diathermy or standard broadcast interference possible)
	Image attenuation	Poorest	Better (3–7 db more than A)	Best (5–12 db more than A)
	Stations on image frequency	Poorest by large margin (27 FM stations on image of ch 2. Amateurs on image of ch 7)	Much better than A (No FM on images) (Amateurs on image of ch 5)	Slightly poorer than B (Amateurs on image of ch 2)
	Second oscillator image (plus)	Poorest (Ch 9 on image of ch 2) (Ch 10 on image of ch 3) (Ch 13 on image of ch 4)	Better (Amateurs on image of ch 2)	Best (No amateur or television ch. on image)
	Second oscillator image (minus)	Better (Amateurs on image of ch 3) (Ch 7 on image of ch 5) (Ch 10 on image of ch 6)	Poorest (Amateurs on image of ch 2) (Ch 7 on image of ch 4) (Ch 9 on image of ch 5) (Ch 12 on image of ch 6)	Best (Ch 11 on image of ch 5)
Cross Modulation	Attenuation	Poorest	Better (4–9 db more than A)	Best (6–14 db more than A)
	With television stations	Poorest by considerable margin (Probable on 12 tel ch)	Much better than A (Probable on 2 tel ch)	Perfect (Not possible on tel ch)
	With F-M stations	Poorest (Probable on 4 tel ch)	Better (Probable on 3 tel ch)	Best (Probable on 2 tel ch)
Balanced-Oscillator Radiation	Radiated power	Poorest	Better (3.6 db less than A)	Best (5.8 db less than A)
	Radiation into tel ch	Poorest by considerable margin (5 probable combinations)	Much better than A (1 probable combination)	Perfect (No possible combination)
	Radiation into F-M band	Better (2 possible combinations)	Poorest (3 possible combinations)	Best (1 possible combination)

selected as the most desirable intermediate sound carrier frequency. The reasons for this choice are: The direct i-f attenuation and i-f stage gain make it desirable to choose the lowest i-f frequency for which the possibilities for interference are at a minimum. The interference from the second harmonic of the i-f sound carrier and the 144 to 148-mc amateur band are near a minimum at 32.8 mc. This value therefore complies with the above requirements.

Since the 44 to 50 mc band has been assigned to low-power services, the additional band from 41.00 to 44.25 mc is available as the intermediate sound carrier frequency. On the basis of second harmonic i-f interference a frequency of 41.2 mc is indicated as the intermediate sound carrier frequency.

Comparison of the Performance

The performance provided by an i-f sound carrier frequency of 32.8 mc, as compared to 21.9 mc, shows that four outstanding advantages may be gained through the use of the higher intermediate frequency, as shown in Table VI: (1) There is no diathermic band located within the i-f pass band. (2) There are no f-m stations located on the image of a television channel. (3) The number of television channels which may cross modulate, so that beats are formed within the i-f pass band, has been reduced from 10 to 2. (4) The number of television channels, which may experience interference due to local oscillator radiation, has been reduced from 5 to 1. The 32.8 mc, i-f sound carrier is superior in 10 out of 15 counts, satisfactory on one count, slightly poorer on 1 count and poorer on 3 counts.

The counts on which the 32.8 mc i-f sound carrier provides the poorer performance are: (1) The maximum safe gain per stage in the i-f sound channel has been reduced by 1.8 db but this loss must be classed as minor. Furthermore, this point has no significance if an intercarrier sound system is used.

(2) The attenuation of direct i-f interference has been reduced by 8 db when tuned to channel 2. Serious as this loss is, there are however two mitigating factors: First,

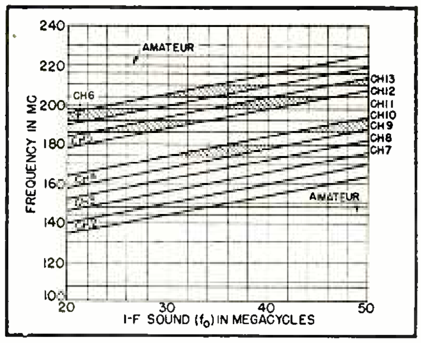

FIG. 7—Second order image responses (—)

i-f rejection may be built permanently into the r-f circuits, as the band to be rejected is fixed and outside the desired reception band. Second, there are no high power services in the frequencies of higher i-f band.

(3) The second oscillator image (minus) shows three television channels on the image of three other television channels, as compared to two responses of this kind with the lower intermediate frequencies. However, this shortcoming should to some extent be counteracted by the greater attenuation provided by the higher intermediate frequencies.

(4) There is the possibility of interference due to local oscillator radiation into three f-m channels with the higher intermediate frequencies, as compared to two with the lower intermediate frequencies. This difference, however, is minor and could readily be remedied by proper geographic and frequency station allocation.

The table furnishes corresponding data for the conditions which exist now that the 44 to 50-mc band is allocated to low-power services,

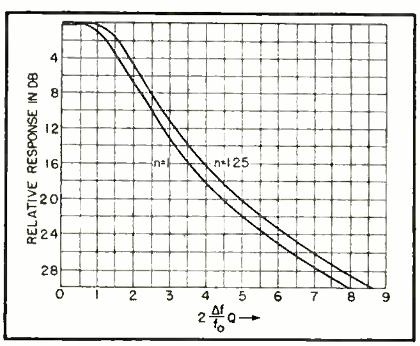

FIG. 8—Universal selectivity curves for critical coupling ($n = 1$) and 25 percent above critical ($n = 1.25$)

and the 41.2-mc intermediate sound carrier frequency becomes feasible. A sound i-f carrier frequency of 41.2 mc will require that the local oscillator be operated above the desired television channel, since operation below the band will result in f-m stations being on the image of television channels 7, 8, 9 and 10.

The performance provided by an i-f sound carrier frequency of 41.2 mc, compared to 32.8 mc and 21.9 mc, as noted in Table VI shows two outstanding advantages: (1) Cross-modulation interference between television channels has been eliminated. (2) Local oscillator radiation into television channels has been eliminated. As compared to 21.9 mc, the 41.2 mc, sound i-f carrier is superior on 11 counts, satisfactory on 1, slightly poorer on 1 and poorer on 2 counts, as enumerated below.

The two counts where the 41.2 mc sound i-f carrier is the poorer are: (1) The maximum safe gain per stage in the i-f sound channel has been reduced by 2.9 db and although greater by 1.1 db than the loss with a 32.8 mc i-f sound carrier, it still should be classed as being of minor importance. Furthermore, the use of an intercarrier sound system would make this point of no significance. (2) The attenuation of direct i-f interference when tuned to channel 2 has been reduced by 24 db and 16 db respectively as compared to the attenuation provided by 21.9 and 32.8 mc sound i-f carriers. Although this loss is serious, the possibility of fixed traps and the absence of high-power services within the i-f pass band, as already stated, tends to mitigate this loss.

These tables would appear to justify the following conclusions: (1) Regardless of the disposal of television channel 1, an intermediate frequency of 32.8 mc offers much greater freedom from interference than the band from 21.25 to 21.9 mc. Its adoption would not complicate receiver design nor increase cost. (2) Now that the band from 44 to 50 mc is assigned to low-power services, still greater freedom from interference may be gained by the use of an intermediate sound carrier frequency of 41.2 mc.

Facsimile Goes Commercial

Simplex and multiplex transmissions on f-m broadcast band using 8.2-inch width at 105 lines per inch are authorized by FCC

COMMERCIAL facsimile using f-m broadcast frequencies has been given the high-ball and stands, as of July 15, in a position to gain some financial return for the investment ploughed into its development.

The technique of transmitting exact copies by wire or radio has been used for years and was developed to its present perfection for the armed forces. Other radio services[1] can and do employ it, but now, for the first time, there is the possibility of general public participation in use of the medium for entertainment, news dissemination, and education.

It would be difficult to assess the competitive position of facsimile with television other than to realize that progress of the one will greatly influence the other. For this reason, probably farm and rural acceptance of facsimile will come first. Urban utilization can be expected in the display field,—as in supermarkets and department stores.

The entertainment use of facsimile has recently been predicated on the status of f-m broadcasting which is now settled.

The program material that can be developed for public entertainment and information, the means of insuring financial sponsorship, are far behind the technical accomplishment. While success in the use of this new medium akin both to publishing and radio broadcasting is not the problem of the engineer, the money he receives for further technical improvements will depend directly upon the commercial success.

At the same time commercial programming was authorized, the FCC set up rules and standards for the service. Although agreement in the industry is by no means unanimous, the FCC decisions are based on a majority opinion of RMA and RTPB and are agreed to be fair and workable.

Both simplex and multiplex transmissions are authorized, but only a total of one hour of simplex (facsimile without sound) may be used from 7 am until midnight. Provided there is no degradation of the aural f-m program below 10,000 cycles, the FCC will authorize three hours multiplex transmission of facsimile and audio. It is further provided that these multiplex transmissions shall not affect the response of receivers that are not used for receiving facsimile. Between the hours of midnight and 7 am either type of program is permitted.

Thus the issue of multiplex, so necessary to a rational use of commercial facsimile, is being gently forced. This pressure is not unreasonable; E. H. Armstrong successfully demonstrated multiplexed f-m in 1934. J. V. L. Hogan feels that by the time equipment manufacturers are ready to go ahead the engineers will have worked out the complete answer to practical multiplex. It is not necessary to degrade f-m audio below 15,000 cycles by multiplexing and the f-m service should not be affected. Actually, the biggest engineering problem is degradation of facsimile by audio!

Transmitting equipment for simplex modulation is currently available in limited quantities from General Electric. Most of the output resulting from a half-million dollar contract is already assigned, but a small overrun was made. Conversion to multiplex can be accomplished for less than $300. The last of about 250 receivers worth $850 is coming off the line. Designed for simplex, they are easily modified for multiplex. About 50 simplex receivers are in production at J. H. Bunnell, Brooklyn, N. Y.

Alden Products, Brockton, Mass., has a line of broadcast station equipment immediately available as well as recording apparatus. Proponent of a 4.1-inch standard, as opposed to the 8.2-inch line authorized by FCC, Alden is tooled up for quick delivery of a small 4-inch recorder that can be quickly attached to any good f-m receiver. Although optimum results will not be obtained for every type of program material, the price of this simple attachment, starting at $100, and its availability, may influence public acceptance.

With an eye towards future development of color facsimile[2], Finch Telecommunications is pushing production of 100 transmitter scanners that can be used for either black and white or color. Production of 5,000 recorders for operation with any f-m receiver has been started with deliveries scheduled to begin the middle of August.

All these recorders employ a chemically treated paper now costing about one cent for a page this size. When paper demand attains volume proportions it is reasonable to expect the cost to drop to from half to a quarter of a cent a page. The Finch Colorfax recorder uses plain paper.

At the time of this writing, there are 11 stations throughout the country authorized to engage in experimental facsimile broadcasting.—A. A. McK.

REFERENCES

(1) VHF Link for Press Photos, ELECTRONICS, p 100, August 1947.
(2) Color Facsimile, ELECTRONICS, p 104, October 1947.

Electronics in ASTRONOMY

Accurate time-keeping devices, automatic aids to precise tracking of telescopes, and photoelectric photometers play an important part in astronomy. Details of equipment in general use are given, and some new devices under development touched upon

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ASTRONOMY deals with subtle quantities: minute amounts of radiant energy, accurate and delicate motions of massive instruments, and the detection and measurement of minute displacements of spectral lines or photographs of stellar images. Quantities of this type, though small and difficult to measure, must sometimes be measured tens of thousands of times in solving a single astronomical problem. Electronics furnishes at once, in its mastery of the smallest of all discreet particles, the electron, the required delicacy of detection and the means for automatically repeating certain operations rapidly, accurately, and efficiently. It is, thus, no wonder that astronomy is drifting rapidly from pure optical and mechanical methods of measurement and recording toward complicated combinations of optics, mechanics, and electronics, with electronics playing the dominant role in practically all cases where it appears.

A discussion of modern electronic devices as applied to astronomy may be clarified by dividing the devices into three major groups: (1) Timekeepers (2) Laboratory aids and (3) Photoelectric photometers.

Timekeepers

The use of a simple pendulum as a timekeeper has been known for centuries, and the best modern pendulum clock is simply a refinement of the age-old instrument. A pendulum is a reliable machine; it requires very little energy to keep it going; it requires little or no servicing to keep it in workable condition; and it can easily be made independent of short-duration power failures in its operation. For these reasons, the pendulum clock is still the most accurate timekeeper known for long time intervals. Pendulum clocks, of which the Shortt clock is an excellent example, have been known to make unbroken runs of six to eight years. Pendulum clocks, however, suffer from two defects: they have unpredictable short-period fluctuations, and, because they signal only once per second, careful interpolation must be performed to determine the time of an arbitrarily chosen instant. None of the principal defects of the pendulum clock are found in the electronic crystal clock. However, the crystal clock fails to have good long-interval timekeeping properties owing to the frequency of breakdowns resulting from power failures, and failures of some element of the relatively complex electronic assembly necessary to keep the quartz crystal vibrating. The ideal timekeeping installation therefore has both pendulum and quartz-crystal clocks. Usually three pendulum clocks and five to seven crystal clocks will be found in timekeeping laboratories.

The importance of the quartz-crystal clock as a short-interval timekeeper was first emphasized by the experiments of W. A. Marrison at the Bell Telephone Laboratories in 1929. Marrison demonstrated that time could be kept with a precision of 1 part in 10^8 over short intervals, 5 parts in 10^8 over ten-hour intervals, and with errors of less than 0.001 second over day-long runs. This degree of precision suggested the possibility of making a most interesting experiment. A. L. Loomis had long been interested in the problems of accurate timekeeping, and he had installed in his private laboratory a battery of three Shortt clocks. Now, pendulum clocks should exhibit a daily cycle of rate variation caused by variation in the force of gravity from the attraction of the moon. In order to demonstrate the existence of this phenomenon one needs a short-interval timekeeper of great accuracy whose rate is not affected by the force of gravity. The electronic crystal-clock was just such a timekeeper. By means of signals sent on special wires to his laboratory from the Bell Laboratories' crystal clocks, Loomis was able to demonstrate the presence of a lunar variation in the rate of his pendulum clocks having the expected half-amplitude of 0.00015 second. In many respects this was one of the most remarkable accomplishments known in the field of timekeeping,

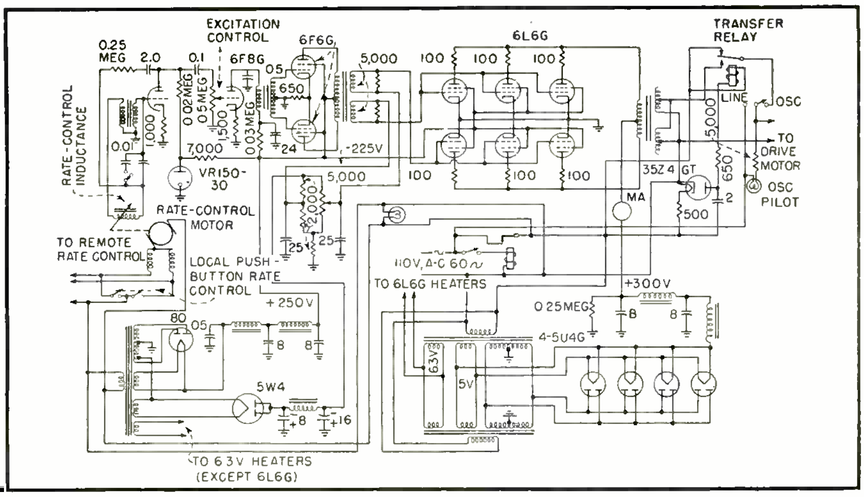


FIG. 1—Circuit of a variable-rate oscillator and power amplifier designed to drive the motor of a 36-inch refracting telescope. Such equipment is essential to compensate for rotation of the earth while studying a star

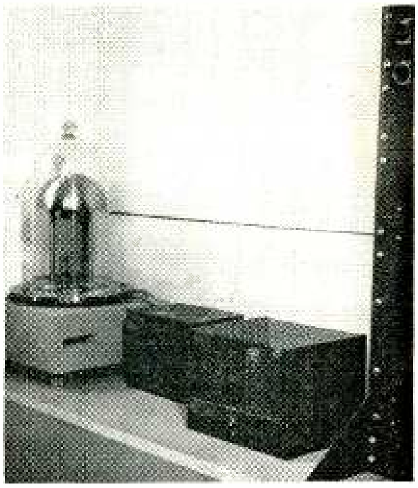


FIG. 2—Electronic equipment employed to drive a 20-inch telescopic camera, utilizing an electromechanical oscillator

and it would have been impossible without the electronic crystal clock.

Astronomers sometimes require clocks for purposes other than that of keeping highly precise time. For example, nearly all telescopes must be mounted in such a way that they can be moved to compensate for the rotation of the earth in order to make possible continuous training of the instrument on an astronomical object. Consequently, most telescopes are mounted so that one of their two axes of motion rotates parallel to the rotational axis of the earth. Such a system of mounting makes possible compensation for the rotation of the earth by rotating the telescope about its parallel axis at constant speed. Thus, a clock is required. The clock, however, must have special properties; it need not be an extremely good timekeeper, but its rate must be capable of convenient adjustment by the observer. The last requirement is caused by the fact that although the rotational speed of the earth is highly constant the rate at which a telescope must be moved to follow a star is not, because of bending of the telescope and mount and because of refractive effects of the earth's atmosphere. The latter effect makes celestial objects appear to rise sooner and set later than they actually do. The most convenient way to compensate for these variations is to provide for adjustment by the observer. The 200-inch reflector at Palomar Mountain was fitted with automatic devices for correcting the effects of flexure and refraction at great expense.

The requirements of a telescope-drive clock are best met by electronic equipment. The timing frequency is usually generated by an oscillator of some kind, either electromechanical, capacitance-inductance, or resistance-capacitance. The signal from this oscillator, whose frequency can be controlled over a small range by the observer to give rate control, is then subject to power amplification and is fed to a synchronous motor which drives the telescope. The usual frequency used is approximately 60 cycles per second, and power at this frequency is fed to the small motor, which is geared down to produce the necessary revolution of the telescope axis at about one turn per day. The telescopes at the Lick Observatory are equipped with electronic drives. The 36-inch Crossley reflector and the 36-inch refractor have been converted from weight drives, and a 20-inch telescopic camera was so equipped at the time it was installed in 1939. Figure 1 is a schematic diagram of an oscillator-amplifier drive for the 36-inch refractor. The oscillator is a variable-inductance resistance-stabilized L-C, and feeds a final amplifier consisting of six 6L6's in class-AB push-pull-parallel. This type of power amplifier is used because of the cheapness and availability of receiving-type tubes and because danger from high voltages is avoided. The output stage drives a 150th hp Bodine motor, which drives the telescope through a large speed reduction. The output stage will start the motor from a standstill, but a circuit is included which provides for starting the motor from the line when the device is turned on, and for transferring the motor from line to drive circuit as soon as the tubes are warm. The drive has been is use since 1942, with practically no servicing. It is of interest that the actual amount of power required to drive the 14-ton weight of the moving parts of the telescope is less than a 500th hp, owing to the slow speed.

Figure 2 shows the drive for the 20-inch telescopic camera. This drive starts with an electromechanical vibrating-wire oscillator whose signal ultimately drives a pair of FG-57 thyratrons as phase-inverters, necessary to drive the large motor with which the telescope was provided by its makers. The oscillator consists of a vertical metal wire held under tension, carrying a small piece of iron located at its mid-point. Each end of the iron projects into a small coil, one of which is used as a pickup, the other as a driver coil. When the pickup signal is amplified and used to energize the driver the system becomes an oscillator whose frequency may

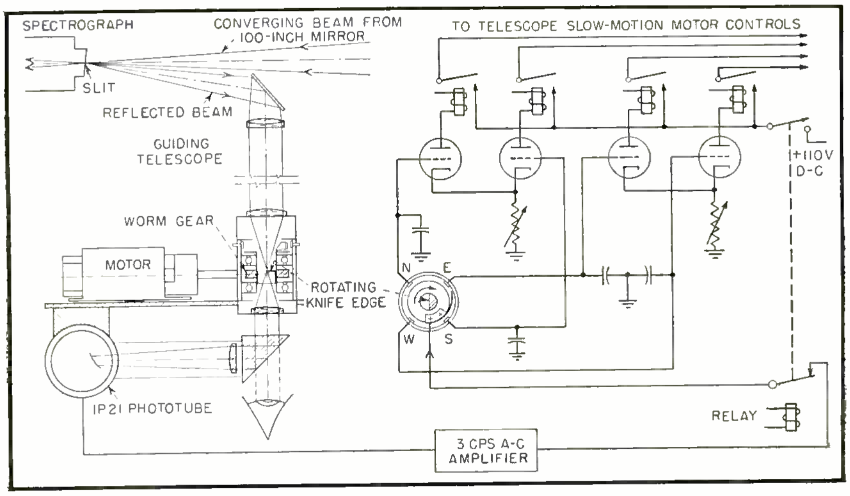


FIG. 3—Automatic guiding attachment for a 100-inch telescope, designed in such a manner that light from a star under observation causes correction of tracking errors

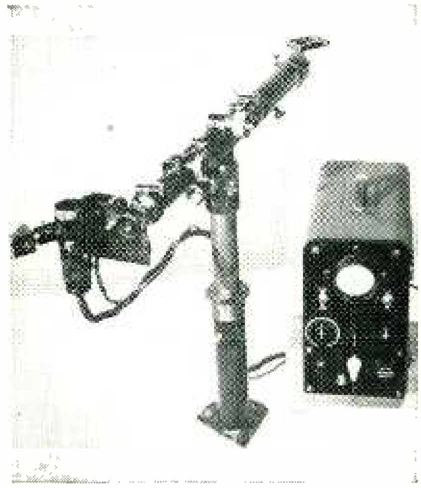


FIG. 4—Optical and electronic components of the guiding attachment

be changed by changing the tension in the wire. Tension is regulated from a remote station by varying the current in an electromagnet, whose attraction contributes to the tension. This time standard is capable of considerable precision. It was developed and built by the Warren Telechron Company.

Laboratory Aids

Most astronomical observatories are short of personnel, and are engaged in processing huge amounts of data. Any machine which can help speed the reduction of data is most welcome to the astronomer.

A machine for counting star images on a photographic plate has been placed in service. This problem is relatively simple, however, and less important than the problem of automatically making precision measurements of the positions of stellar images. A machine designed to make such measurements is being developed at the Watson Scientific Laboratories. In this machine, the photographic plate is mounted to move vertically. A photoelectric scanning head is so mounted that it can be moved horizontally by means of a precision screw turned by a servomechanism. Approximate positions of the stars, already stored in a punched-card catalog, may be coupled to the servomechanism for directing the scanning head to the approximate position of a star to be measured. The scanning head then makes a precise setting upon the image by means of coupling to the servo, automatically interprets the reading, and punches the new position on the card for the particular star.

The problem of automatically measuring the positions of lines on photographs of stellar spectra is being solved at the Lick Observatory. Here an experimental machine has been built which will center a scanning head upon a spectral line and make a record of the position of the line. The screw which moves the plate on which the spectrum has been photographed is driven by a motor at constant speed; when a spectral line enters the field of the scan an electronic circuit operating from the light-sensitive unit in the scanning head picks a point on the line midway between two positions of equal photographic density, and a graduated thimble carried by the lead screw is photographed at the proper instant by a small camera using motion-picture film. The machine then stops and signals the operator that he may start another cycle of operation on another line. One semiskilled operator working with the machine can measure about four times as fast as a skilled operator with a manual measuring machine, with equal or better precision, and with little fatigue.

One of the most tedious of all jobs in an observatory is that of manually guiding a telescope. The telescope-drive clock does most of the work, but it is incapable of taking care of the small guiding errors that result from flexure of the telescope, refraction deviations, and random errors caused by sudden shifting of optical parts. Such errors must be corrected by an observer who sometimes must devote painstaking attention to nothing else for many hours at a time.

The problem of automatic guiding was first tackled over ten years ago at the Washburn Observatory, University of Wisconsin, and was found to be without a fully satisfactory solution, owing to lack of photoelectric devices sufficiently sensitive to give a useful signal from the light of a sufficiently faint star. Recently, a satisfactory solution to the problem has been obtained by Horace Babcock at the Mt. Wilson Observatory by making use of the 1P21 multiplier phototube as the sensitive element. The star image is scanned by a rotating half-disk. A deviation of the position of the image from the axis of rotation is indicated by a sinusoidal signal from the multiplier, the amplitude depending upon the size of the error, and the phase (compared with a standard obtained from a commutator) depending upon the direction of the error. Amplitude and phase information is interpreted by an electronic circuit, and charges proportional to the errors in the two degrees of motion of the telescope are collected in capacitors for about three seconds. Relays already existing as part of the telescope control system are closed after each charge collection, to cause correction of the error. The error signals are portrayed by an oscilloscope to aid the observer in appraising the performance of the guider. The observer is almost entirely relieved of guiding for certain types of observing, and he may spend most of his time comfortably thinking about his work in a warm room, while the automatic guider does the tedious chores. Figure 3 is a schematic diagram of the principal components of the guider, and Fig. 4 is a picture of the attachments required to make the telescope self-guiding. This guider makes it possible to keep a stellar image at the 250-foot focus of the huge 100-inch telescope automatically positioned to within a small fraction of a millimeter.

An astronomical spectrogram is a photograph of the light of an object such as a star or nebula after the mixed light has been spread out in wavelength by means of a prism or grating. Such spectrograms contain large amounts of information concerning the properties of the objects, and the taking and analyzing of spectrograms forms a major part of the activities of many observatories. Among the measurements made on spectrograms are those designed to lead to the relative intensities of the light in various wavelengths. The degree of blackening of the photographic plate is, of course, an indication of the brightness of the light which caused it, and one would expect that a simple measurement of the blackening with a photoelectric device would suffice as the desired measurement. This is far from the fact, however. Photographic blackening is not linearly proportional to the incident light brightness; furthermore, the blackening will depend upon subtle things such as variations in photographic emulsions from one plate to another, the conditions of exposure of the plate, and the exact conditions of development. The necessary corrections to change blackening into light intensity can be applied by hand, so to speak, but the problem of treating large numbers of spectrograms in this manner is one of almost unbelievable tediousness.

For many years developmental work has been under way on machines to offer partial or complete solutions to the problem. This developmental work has culminated in the design and construction of a direct-intensity microphotometer, at the Mt. Wilson Observatory, which gives a complete, general solution and which is undoubtedly one of the best direct-intensity microphotometers ever built. Two photographic plates are mounted in the machine; one plate has the spectrum, the other is a plate from the same package, developed at the same time as the spectrum plate, and in the same developer. The second plate, however, is exposed as a standard in a special spectrograph which gives an imprint with two coordinates, one in wavelength, the other in known intensity. Light from a common source scans both plates alternately, and the two plates, mounted in separate carriages, move continuously in the wavelength direction. As the plates move, the blackening in both is compared by a 931A multiplier phototube, and the standard plate is moved, by means of a servomechanism, in its intensity direction by an amount sufficient to equalize the blackening in the two plates. This displacement is recorded by means of a pen on a continuously moving strip of paper. The system is a null method with respect to light measurements in the machine itself, and all of the gross peculiar characteristics of the photographic plate are removed by the comparison with the known standard. The curve drawn on paper represents the intensity of the original starlight striking the original plate, which becomes the spectrogram.

Photoelectric Photometers

In astronomical parlance, photoelectric photometry is the direct measurement of the intensity or color of starlight by means of photoelectric methods. The technique has been developed to the point where the systematic and accidental errors of observation are much smaller than those of photometry by any other method. Thus astronomers have made contributions to light measuring techniques.

The difficulty of the problem can be emphasized by considering the amount of energy with which one must work when measuring the intensity of starlight. A star of 6th magnitude is of such brightness that it can just be seen with the unaided eye on a dark, moonless night. The eye collects, from a star of this brightness, energy at the rate of 5×10^{-16} watt, a rate so small that it has no ordinary significance. Yet, the astronomer classes a star of 6th magnitude as a bright star. A 12-inch telescope gathers enough light (3×10^{-13} watt) from a 6th magnitude star to make it an easy object for modern photoelectric photometers, and there is little worry until one wishes to work on stars 100th as bright, or 11th magnitude, far too faint to be seen with the unaided eye, yet still not nearly at the limit of detection of the photocell or phototube.

Two types of phototube emission surfaces are in most common use by astronomers, the antimony-cesium (Sb-Cs), and the cesium-oxide-on-silver (CsO-Ag). The former is the most sensitive detector known for blue light, while the latter is the most sensitive surface known for the near infra-red. The problem of employing phototubes on faint light resolves itself into the problem of measuring the extremely small currents that are generated. The Sb-Cs surface will yield a current of about 3.3×10^{-14} ampere from the light of a 6th-magnitude star gathered by a 12-inch telescope, while the CsO-Ag surface will give about 0.25×10^{-14} ampere from the same light. Photometry with the Sb-Cs surface is a relatively simple technical problem if it is employed in the form of a multiplier such as the 1P21 multiplier phototube. In the 1P21, the original photocurrent is multiplied by a factor of about 5 million by successive stages of secondary-emission multiplication; this raises its output to the order of 1.5×10^{-7} ampere, a current large enough to be measured with ease by means of the proper equipment.

The proper equipment can take the form of a good galvanometer connected in the anode circuit of the multiplier. For greater sensitivity, especially if the multiplier is refrigerated to reduce its dark noise level, the galvanometer may be preceded by a low-grid-current cathode-follower stage. A circuit of this type was used recently by

A. E. Whitford in what was perhaps the most remarkable feat of measuring faint radiation ever accomplished. Whitford, employing a 1P21 refrigerated with dry ice, measured the light and color of an 18.2-magnitude extra-galactic nebula with the 100-inch reflecting telescope. It was estimated that, without the measurement of colors, the limit could have been pushed to 19.0-magnitude. The current output from the multiplier was 3.5 x 10^{-11} ampere, and the limit of detection was estimated to be 21.1-magnitude, the brightness of a candle in England viewed from California by way of the Atlantic.

The ease with which the multiplier phototube can be used has made it very popular among astronomers. The 1P21 is useful for photometry in the ultraviolet, violet, blue, green, and yellow regions of the spectrum. Valuable as it is, however, the tube has several shortcomings. Most important, the 1P21 is not sensitive to orange, red, and infrared light, and no satisfactory multiplier having such sensitivity is marketed. In addition, the cathode is partly veiled by a wire grid structure, and it is not of the highest attainable quantum efficiency. For photometry in the long wavelengths, and for achievement of the utmost in the measurement of faint radiation, one must therefore resort to a simpler phototube.

The principal difficulty resulting from the use of a conventional phototube for faint light arises from the extremely high impedance of such a tube, about 10^{14} to 10^{16} ohms. It is impossible, by simple methods, to match such high impedances to an amplifier, and a large mismatch will result in a serious loss of signal-to-noise ratio. As a general rule, a convenient indication time for photoelectric work is from ten to thirty seconds. Since the minimum practical input-circuit capacitance for a phototube photometer is about 10^{-11} farad, it follows that the maximum practical amplifier grid resistor is 5 x 10^{11} ohms, which is much too small for a good match. If the grid resistor is run up to, say 10^{13} ohms to get a much better match, the indication time will rise to values of around 500 seconds or more, much too long for practical astronomical measurement.

Recent developments have resulted in a practical solution to the problem. The difficulty of the long time-constant has been resolved by neutralizing most of the capacitance by means of positive feedback, using the interelectrode capacitance of the phototube itself to introduce the feedback. By means of this device, the use of loading resistors of from 10^{13} to 5 x 10^{13} ohms has been found practicable. Continental Electric now also makes a stable phototube in which gas multiplying factors, on faint light, of more than 100 are obtained. A phototube photometer using high-value grid resistors and this gas-multiplying cell has the same theoretical sensitivity as a multiplier-phototube type; in actual practice, gas phototubes have surfaces more sensitive than those found in multipliers. In addition, they have larger and better shaped light-receiving surfaces, greatly simplifying the somewhat difficult problem of receiving the steep-angled f:5 beam from a large reflecting telescope.

A modern photometer consists of a light-receiver containing the multiplier, or the phototube, grid resistor, and low-grid-current amplifying tube. The output from the receiver is amplified by a d-c amplifier sufficiently to give full-scale reading on a high-quality meter on about 25 to 50-millivolts input. At this gain, the shot-noise of the dark current in the receiver will have an amplitude of from 1 to 10 percent of full scale, sufficient for good resolution, and therefore for maximum sensitivity. It is not impossible to construct a photometer which will give maximum systematic errors resulting from nonlinearity of response of less than 0.1 percent for faint illumination. As a rule, the amplifier is designed to drive a 0 to 1 milliammeter, and thus either a dial-type meter can be used for visual reading and manual recording or a continuously recording meter such as the Esterline-Angus can be used.

Figure 5 shows the receiver of a of a multiplier-type photometer mounted at the prime focus of the 36-inch Crossley Reflector of the Lick Observatory. The coaxial cable is the anode (signal) lead; the other is an 11-conductor plastic-insulated cable which carries the necessary potentials to the secondary electrodes of the multiplier. Potentials for a multiplier are conveniently furnished by the new small dry batteries, such as the Eveready 413; the necessary 930 volts of batteries are contained in a small box measuring 12x9x1½ inches, fastened to the tube of the telescope. The batteries long outlast their shelf life, inasmuch as no appreciable current is drawn from them, and they will continue to deliver their rated voltage into the minute-current load of the multiplier long after they test dead with a voltmeter.

Figure 6 is a circuit diagram for a d-c amplifier as used with a photoelectric photometer. The lower left-hand portion of the diagram is devoted to the circuit for a phototube receiver, which may be switched into service by means of S_1. The portion of the unit enclosed by dotted lines is the phototube light-receiver, and is attached to the telescope. For proper operation, this part of the apparatus must be in a sealed container from which the air has been evacuated. Light is admitted through a small glass window, or through a fog-resistant cellophane window in the case of receivers that are refrigerated with dry ice to reduce their dark currents.

The output of the light-receiver goes first to the VX-41 phase inverter and amplifier; this drives the main d-c amplifier. It also furnishes the direct feedback voltage which partly neutralizes input capacitance by injection via the phototube voltage supply. The degree of neutralization is controlled by R_1. The capacitor C_1 limits the bandpass of the feedback amplifier to prevent unwanted high-frequency tube noise from being fed back. Switch S_2 acts inside the evacuated tank for grounding the input grid, and for selecting either a 10^{12} or a 10^{13} ohm grid resistor, depending upon sensitivity requirements. A multiplier receiver (not shown in the circuit diagram) may also be coupled into the d-c amplifier by means of S_1.

The d-c amplifier itself is a bal-

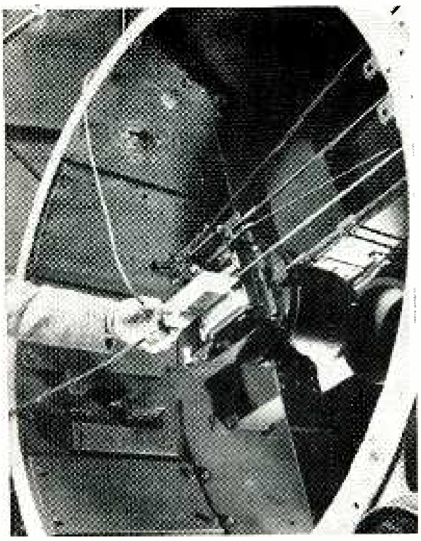


FIG. 5—Multiplier-phototube light-receiver attached to a reflecting telescope

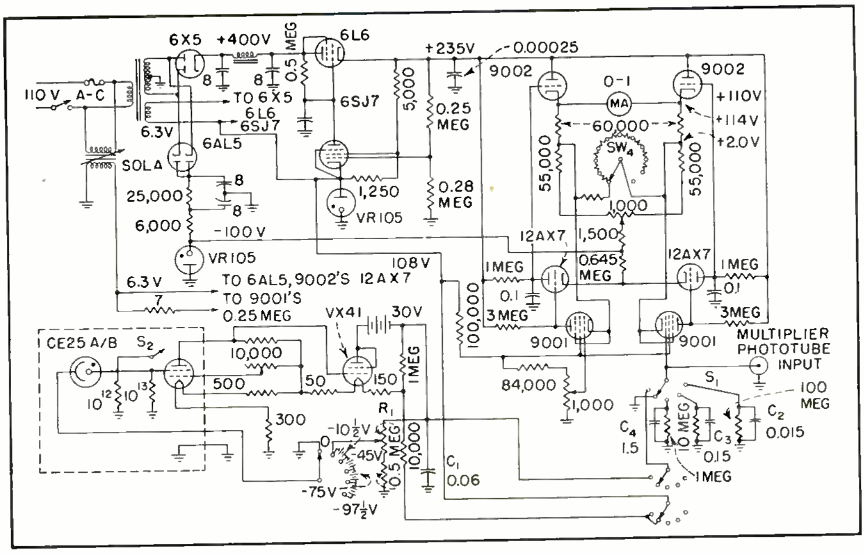


FIG. 6—Circuit of astronomical light-receiver and d-c amplifier used for photometry, employing either a conventional gas-phototube or a multiplier-phototube

anced inverse-feedback type, with a simple power supply, made possible by the insensitivity of the amplifier to variations in plate voltage. The heaters of the amplifier tubes must be supplied from a constant-voltage transformer, or from a storage battery, unless line voltage is free from variations of more than 2 volts. The input grid current of the 9001 stage is about 5 x 10^{-11} ampere, and the zero drift after proper aging of the tubes is less than 1 millivolt per hour. The amplifier is sufficiently free from microphonics that tubes need not have special mounts, and may be operated on a table on which a manual adding machine is being used, with no zero displacements. All batteries may be of the smallest type, as the largest current drawn from any of them is only 10 microamperes. Gain is controlled by varying the inverse-feedback factor (giving a factor of 10 in steps of 0.25 magnitude), varying load resistors (a factor of 10 for the phototube, 100 for the multiplier) and varying the phototube voltage (another factor of 10 to 100 for the phototube). Thus, for both types of photometric receivers, the gain may be varied with no loss of linearity over factors of greater than 1,000, equivalent to 7.5 stellar magnitudes. The capacitors C_2, C_3, and C_4 establish time-constants of 1.5 seconds for all loading conditions of the multiplier. This gives an indication time of 10 seconds, convenient for most photometry.

The phototube used in the photometer diagrammed is a type CE-25A/B without base. Such phototubes have unusually good insulation and low thermal emission, and it is not uncommon to find samples that have a dark current at 70 F of only 10^{-15} ampere. Those having higher dark currents (up to 10^{-13} ampere) usually have relatively higher infrared sensitivity. They cannot be used without bringing their dark current down by refrigeration with dry ice. When refrigerated, the dark current will be of the order of 10^{-17} ampere.

Within the last two years, a lead-sulfide (PbS) photoconductive cell has been brought into service by astronomers. Though the efficiency of this cell is less than that of the CsO-Ag-type phototube in the spectral region where they share sensitivity, the sensitivity of the PbS cell extends much further into the infrared. Some samples show good sensitivity at 30,000 angstrom units, though most extend little beyond 20,000. Of all detectors of radiation, the lead-sulfide cell is the most sensitive in the region from 12,000 to 25,000 angstroms. It has an abnormally high noise level in the very low frequencies, so it is usually employed in an a-c amplifier circuit in the frequency range from a few hundreds to a few thousands of cycles per second. At the Yerkes Observatory, the PbS cell has been used in infrared spectrophotometric investigations intended to reveal the composition of the markings and atmospheres of some of the planets. In the hands of A. E. Whitford, the PbS cell has seen through the great dust clouds of the Milky Way, and has indicated the existence and position of the hitherto unseen bright core of the galaxy.

BIBLIOGRAPHY

A. L. Loomis, The Precise Measurement of Time, *Monthly Notices of the Royal Astronomical Society*, **91**, p 569, 1931.

H. M. Jeffers, The New Driving System of the Crossley Reflector, *Publications of the Astronomical Society of the Pacific*, **50**, p 112, 1938.

S. W. McCuskey and R. M. Scott, A Photoelectric Star Counter, *Review of Scientific Instruments*, **12**, p 597, 1941.

R. C. Williams and W. A. Hiltner, A Self-Recording Direct-Intensity Microphotometer, *Publications of the Observatory of the University of Michigan*, **8**, p 45, 1940.

H. W. Babcock, A Photoelectric Guider for Astronomical Telescopes, Astrophysical Journal, **107**, p 73, 1948.

A. E. Whitford and G. E. Kron, Photoelectric Guiding of Astronomical Telescopes, *Review of Scientific Instruments*, **8**, p 78, 1937.

Joel Stebbins, The Measurement of the Light of Stars with a Selenium Photometer, with an Application to the Variations of Algol, *Astrophysical Journal*, **32**, p 185, 1910.

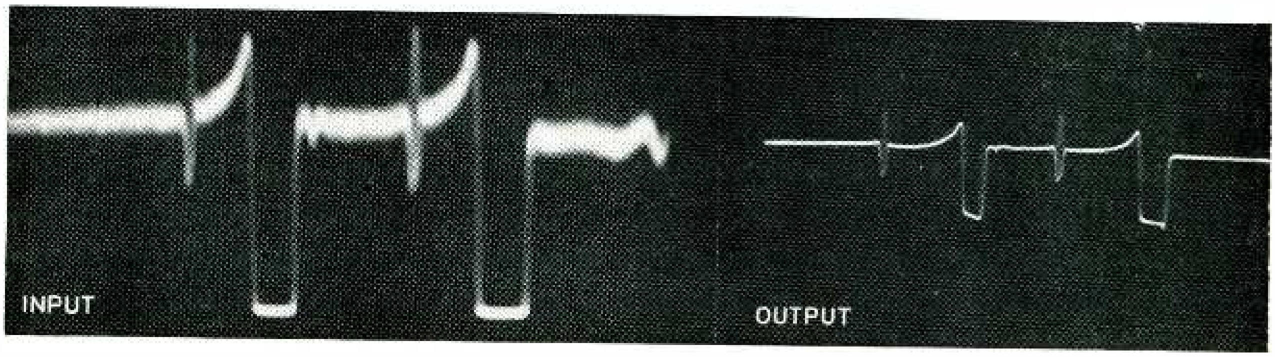
A. E Whitford, The Application of a Thermionic Amplifier to the Photometry of Stars, *Astrophysical Journal*, **76**, p 213, 1932.

G. E. Kron, Application of the Multiplier Phototube to Astronomical Photoelectric Photometry, *Astrophysical Journal*, **103**, p 326, 1946.

Sinclair Smith, The Limiting Magnitude Observable with a Photoelectric Stellar Photometer, *Astrophysical Journal*, **76**, p 286, 1932.

G. E. Kron, An Improvement in the Use of Photoelectric Cells for Stellar Photometry, *Publications of the Astrophysical Society of the Pacific*, **59**, p 190, 1947.

Harold L. Johnson, A Theoretical Discussion of the Ultimate Limits of Astronomical Photoelectric Photometers, *Astrophysical Journal*, **107**, p 34, 1948.



Oscillograms show (left) repetitive signal accompanied by noise; (right) signal after noise has been removed by storage tube

REPELLER

By HANS KLEMPERER and J. T. deBETTENCOURT

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STORAGE TUBES are the latest development in the cathode-ray tube family[1]. They perform the general function of storing electrical signals, usually written in the form of charges on an insulating plate. After a time delay the tubes retransmit or read out these charges in the form of electrical signals.

A cathode-ray storage tube has been developed that possesses internal memory and is also able to act as a discriminator between periodically recurring and new information. The operating principle, performance and application of this new tube are described.

Storage Plate and Repeller

Internal operation of storage tubes frequently depends on secondary emission. If a solid body is struck by electrons the average number of secondary electrons liberated by each incident primary electron is, for a given material, a function of the beam voltage. The secondary emission coefficient δ is larger than unity only for voltages in a critical range. Thus, if an insulator, acting as storage plate in a tube arranged as in Fig. 1A, is struck by an electron beam of lower than critical voltage, it will be charged to a negative equilibrium close to cathode potential. This equilibrium is reached when the target point is charged to a potential corresponding to the beam velocity. After that potential has been reached the beam is repelled toward the collector; no further electrons are accepted by the storage plate.

If the beam velocity is increased beyond the lower critical speed ($\delta > 1$) conditions are changed. More electrons leave the bombarded surface than are arriving, and equilibrium therefore is reached at a voltage that is positive with respect to anode or collector. Various current components involved in the action are sketched in Fig. 1B. The incident (primary) electron beam is denoted by i_1. The resulting secondary emission is divided into two parts; i_2 denotes the electrons that leave the spot for the collector or anode, and i_3 are those which are emitted but which return to the same spot, thus forming a space charge around it. In addition there is i_4, the small leakage current through the target material. Figure 2 shows the equivalent circuit.

If the tube is operated at the condition $\delta = 1$, the equilibrium potential of the beam trace on the storage surface is governed by the potential of the collector grid. This configuration is typical for this type of storage tube.

Efficient storage depends largely upon establishing a large difference in potential between the written trace and the surrounding surface.

Negative Bias of Storage Plate

Sensitivity is considerably improved by applying to the storage surface a high negative bias. (Bias potentials have been successfully applied to the Iconoscope in television work[2]). The storage surface can be raised to a negative potential by low-velocity electron bombardment from the front, or more effectively by connecting a conductive backing of the storage plate to an external negative source. If the cathode potential is 1,600 volts negative with respect to ground (collector or second anode), the storage plate or repeller electrode in back if it may be biased to −1,000 volts. The beam still hits the storage surface above critical speed, therefore the trace becomes slightly positive with respect to the collector. The potential difference between trace (at equilibrium) and surrounding surface, however, is raised to the order of 1,000 volts. Experiment-

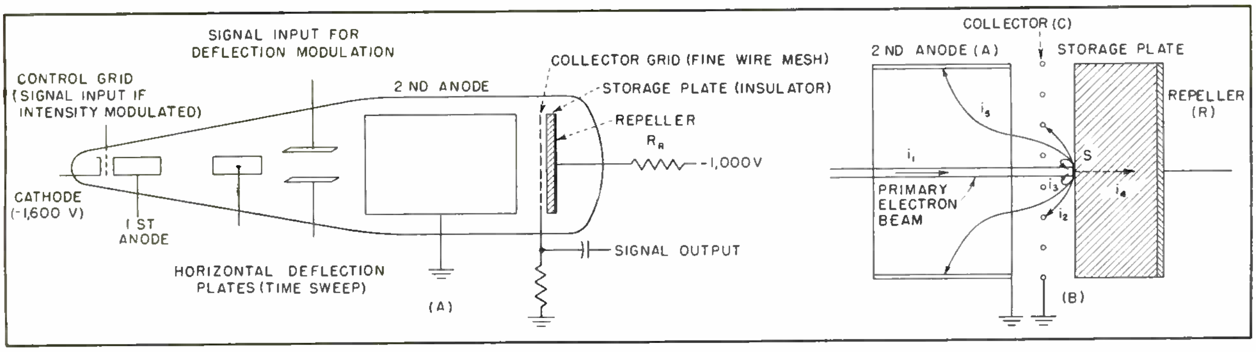

FIG. 1—Arrangement of cathode-ray repeller-type signal storage tube (A) and details of storage plate and electron paths (B)

STORAGE TUBE

Principle of operation and characteristics of a memory tube utilizing secondary emission from a bombarded insulator are described. Bias on repeller electrode behind storage plate increases available output. Using tube in receiver improves signal-noise ratio

ally, the repeller bias increases the signal output from microvolts to millivolts.

The action of the repeller is twofold: It increases the potential difference between trace and background; in addition it provides a parallel dielectric path between the storage surface and the collector grid. This, of course, presupposes a free-swinging repeller (high ground impedance). Under proper conditions, this positive signal is by far greater than the negative signal which is caused by direct action of secondaries on the collector.

A negative output signal, as sometimes observed in operation of this tube, indicates that the beam stays on the spot after the equilibrium charge has been reached. At that time displacement currents have subsided, while the secondaries continue to arrive at the collector. Thus, a negative signal is an indication of too high a beam intensity. If the impeller ground impedance is low the positive signal is by-passed to ground and weakened. In this case, positive and negative signals at the collector are apt to cancel each other and the tube ceases to operate.

Tube as a Cancellation Device

The mechanism has been described by which a positive signal is produced at the collector grid of the repeller storage tube whenever the charges are written by deflection of the beam or by intensity modulation. The first scan or group of scans writes down the intelligence. Usually, during this writing period the output amplifier is disconnected or gated off. As long as any successive trace is exactly

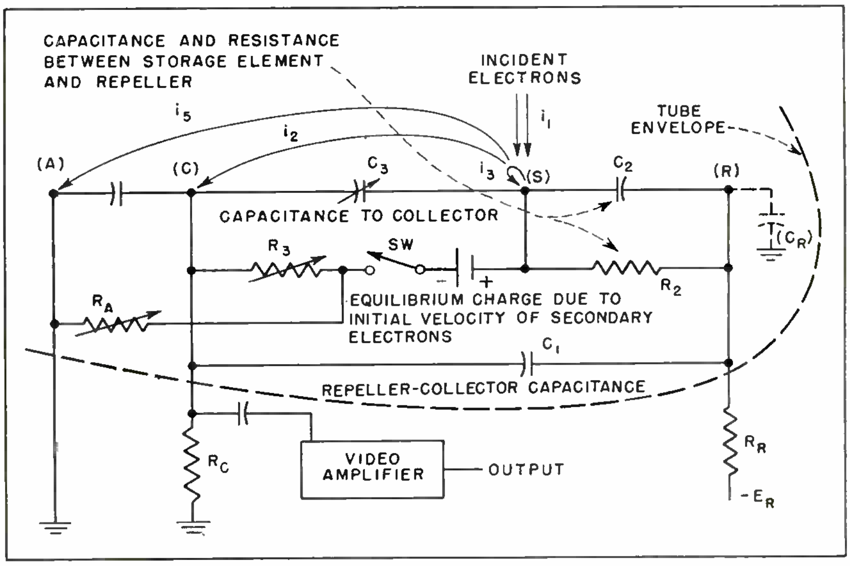

FIG. 2—Equivalent circuit of storage mechanism; labels of junctures and electron streams correspond to those on Fig. 1B

rescanning the pattern already established there is no change in charge and therefore no output signal. This assumes that the previous trace was written with saturation intensity and no charges have leaked off during the time between scans. Wherever a trace deviates from the preceding pattern there will be a change in charge distribution, and an output signal will show. Therefore, if information is periodically supplied to the storage tube, the tube will automatically compare successive traces and will transfer to the output amplifier only such signals that did not appear previously.

If deflection modulation is used, the writing speed of the beam depends on the amplitude of the input signals. Therefore, with beam current remaining constant the charge density of the trace decreases with rate of amplitude change of the signal. Hence, such parts of the trace that were written at a high speed may not reach equilibrium until after a number of retraces. As a result, differentiation spikes appear in the output. These residual indications are substantially reduced by applying a beam intensifier circuit. A fraction of the input is differentiated, amplified and supplied to the intensity-control electrode of the storage tube, while that part of the signal which goes to the input deflection plates of the storage tube is delayed to compensate for the delay of the differentiated signal in tubes and circuit elements. Due to some imperfections in the tube such as capacitive pickup, inhomogenity of the beam cross section or secondary emission from collector or other elements, some residuals from incompletely cancelled signals are nevertheless always found in the output.

Oscillograms of input and output signals of the repeller storage tube show the effectiveness of this action. The input signal is taken from a fur generator, which is a device that produces moving and stationary signals. The output oscillogram shows the moving signals, passed at a large amplitude, while the stationary signals are almost completely cancelled. The storage tube was operated under the following conditions: sweep repetition rate: 1,000 per sec, horizontal deflection speed: 0.1 cm per microsecond, beam voltage: −1,600 volts referred to second anode (ground), repeller voltage: −900 volts, intensity of writing beam: 8 microamperes, storage plate: lime glass at room temperature.

In this application the amplitude ratios of moving to fixed signal are compared for input and output and sometimes expressed in decibels as the so-called cancellation ratio. For instance, if, for a 100:1 ratio of input signals the output amplitudes are equal, the tube is rated as having 40 decibels of cancellation. Cancellations of that order are obtained in the laboratory, but to strive for high cancellation ratio is a little premature at a time when cancellation of actually fixed signals is just one of the many applications of the storage tube.

The tube described so far relies on natural leakage across the storage plate to remove trace charges after usage. Obviously, when the forgetting process depends on leakage through the storage plate no sharp line of distinction can be drawn between new and old information. The output signal of a repeating trace will depend on the time that has passed since its last notation in the same exponential manner as the stored signals disappear. For some applications this is not a serious limitation because the time constant of the storage plate can be adjusted (by choice of material or temperature) to fit the specific needs. However, the tube is more universally useful if it is provided with a memory that is free from leakage and that can be destroyed or wiped out suddenly. Present developments in that direction trend toward holding and destroying charges in storage tubes.[3]

Applications of Storage

The storage tube is applicable to a variety of problems, a few of which will be described by way of illustrations. As a cancellation unit the storage tube can be used to obtain records of nonrepeating transients such as lightning and arc-backs without the need for continuously exposing film. Similarly the tube can be used to compress or expand the rate of information transmission by reading out stored information at a different speed than information is read in. In this capacity, the tube can be used in communication systems to adapt the rate of incoming information to the capabilities of the transmission channel. Other applications have also been described.[4]

The repeller storage tube is also applicable as a means to raise periodically recurring weak signals above the noise level, as discussed in connection with the oscillograms. The tube is intensity modulated and the average recording beam intensity is adjusted so that several successive traces are needed to produce saturation of the trace. Because the random noise adds on a power basis while the recurring signal adds on a voltage basis, a theoretical gain of $10^{1/2}$ in signal noise ratio is obtained in reading out a trace made for 10 individual recordings. Thus, the storage tube is a useful addition to the cathode-ray tube family.

Acknowledgment

This article is based on a development carried out under Air Force contract W28099ac173. The storage tube used in this development was constructed by the Power Tube Division of Raytheon under this contract. The guidance and encouragement of personnel at the Radar Laboratory, Watson Laboratories, Red Bank, N. J., under Ralph Cole, and at Electronics Research Laboratory-AMC, Cambridge, Mass., are gratefully acknowledged.

References

(1) V. K. Zworykin and G. A. Morton, "Television: The Electronics of Image Transmission", John Wiley and Sons, N. Y., 1939; also R. A. McConnell, Video Storage by Secondary Emission from Simple Mosaics, *Proc IRE*, p 1258, Nov. 1947; and Knoll, *Z. Techn. Phys.*, p 467, 1935.

(2) Kronjager Krawinkel, *Salow Z. Tech. Phys.*, p 63, 1938, and in *Telegraph Funk Fernschtechnik*, p 527, Nov. 1938; a short description of this tube is also given in ELECTRONICS, p 132, May 1948.

(3) A. V. Haeff, A Memory Tube, ELECTRONICS, p 80, Sept 1947.

(4) L. Ridenour, "Radar System Engineering", McGraw-Hill Book Co., p 631, 1948; also Hall, "Radar Aids to Navigation", McGraw-Hill Book Co., p 253, 1948.

Reducing Transmission Bandwidth

Pulse systems that reduce the transmitted bandwidth are described. Pulse trains for two channels are superimposed and transmitted as one train at half the original rate; then separated at receiver. Reduction obtainable in system is compared to ideal reduction

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COMMUNICATION ENGINEERING has recently witnessed a rapid expansion of the theory of intelligence transmission as related to the information content of the message, signal-noise ratio, and bandwidth. The Hartley[1] law has been revised, especially by Shannon[2] to the form

$$C = W \log_B (P + N)/N \qquad (1)$$

where C is the transmission capacity of an ideal system, W is the product of the bandwidth and time that is utilized for the transmission, B is a base depending on the pulse coding system (2 for a binary code), P is the average signal power used, and N is the average noise power in the transmission medium. Shannon,[3] Tuller,[4] and Gabor[5] have indicated that transmission systems might be devised in which the transmitted bandwidth would be less than that of the input message.

Bandwidth Reduction

Equation 1 shows that bandwidth can be traded for either power or signal-noise ratio, the trade being proportional to the logarithm of the signal-noise ratio plus unity. An ideal transmission system utilizing power P_1 and a bandwidth-time factor W can be altered to transmit a bandwidth $1/n$ times the original bandwidth in the same time interval provided that a new power P_2 is utilized and is related to P_1 and the original noise power N_1 by

$$P_2 = \frac{N_1}{n}\left[\left(\frac{P_1}{N_1}+1\right)^n - 1\right] \qquad (2)$$

where it is assumed that the original noise power is reduced proportionally to the reduction in bandwidth.

Equation 2 shows that bandwidth reduction is relatively expensive of power. However, there are many cases in which the signal-noise ratios are high; for example, short cable systems and certain pulse and frequency-modulation systems. Even the usual point-to-point radio relay systems operate with high signal-noise ratios during a part of each day, and it may be desirable to reduce bandwidths at the expense of signal-noise ratio during such times to accommodate more channels.

Combining Channels

Figure 1 shows the schematic diagram of a simple bandwidth reduction transmission system based on the coding together of a pair of input message signals, called CHANNEL 1 and CHANNEL 2. The coding is accomplished by the TRANSMITTER in such a way that the same bandwidth is used for transmitting both signals simultaneously as would be required for transmitting either one alone by conventional means. A stage-by-stage description of the circuit operation will show how this result can be done.

The input wave from channel 1 is sampled by GATE 1, driven from one side of the SAMPLING MULTIVIBRATOR. This sampling is done at a frequency that is slightly higher than twice the highest frequency present in the message signal. After power and voltage amplification in the AMPLIFIER the sampled wave is quantized into one of five levels by the QUANTIZER.

The quantizer shown in the circuit consists of a group of four neon lamps arranged so that increasing voltage input to the quantizer fires increasing numbers of lamps, thus delivering increasing voltages to the load R_3. The output voltage increases in discrete steps as additional lamps fire. If individual lamps fire at an increment of 40 volts and $R_2 = R_3$, the quantized output to the DELAY GATE will be 0, 20, 40, 60, or 80 volts, depending on the amplitude of the input signal. Resistors R_1 should be much larger than resistor R_3 in order to obtain sharply quantized signals.

If a greater number of quantizing levels is required to obtain the necessary fidelity of reproduction, the number of levels may be increased by using reiterative sections in the neon-lamp network and providing a correspondingly larger voltage from the driving amplifier. Other quantizers have been described by Meacham and Peterson,[6] Reeves,[7] Goodall,[8] and Rainey.[9]

The quantized output charges the input capacitor in the delay gate by an amount proportional to the quantized amplitude of the message signal. However the delay gate does not pass this signal immediately because it is cut off by its bias.

While this sequence of operations has been proceeding, GATE 2 has sampled the signal from Channel 2. The sampled output is inverted in the EQUALIZING AMPLIFIER and fed

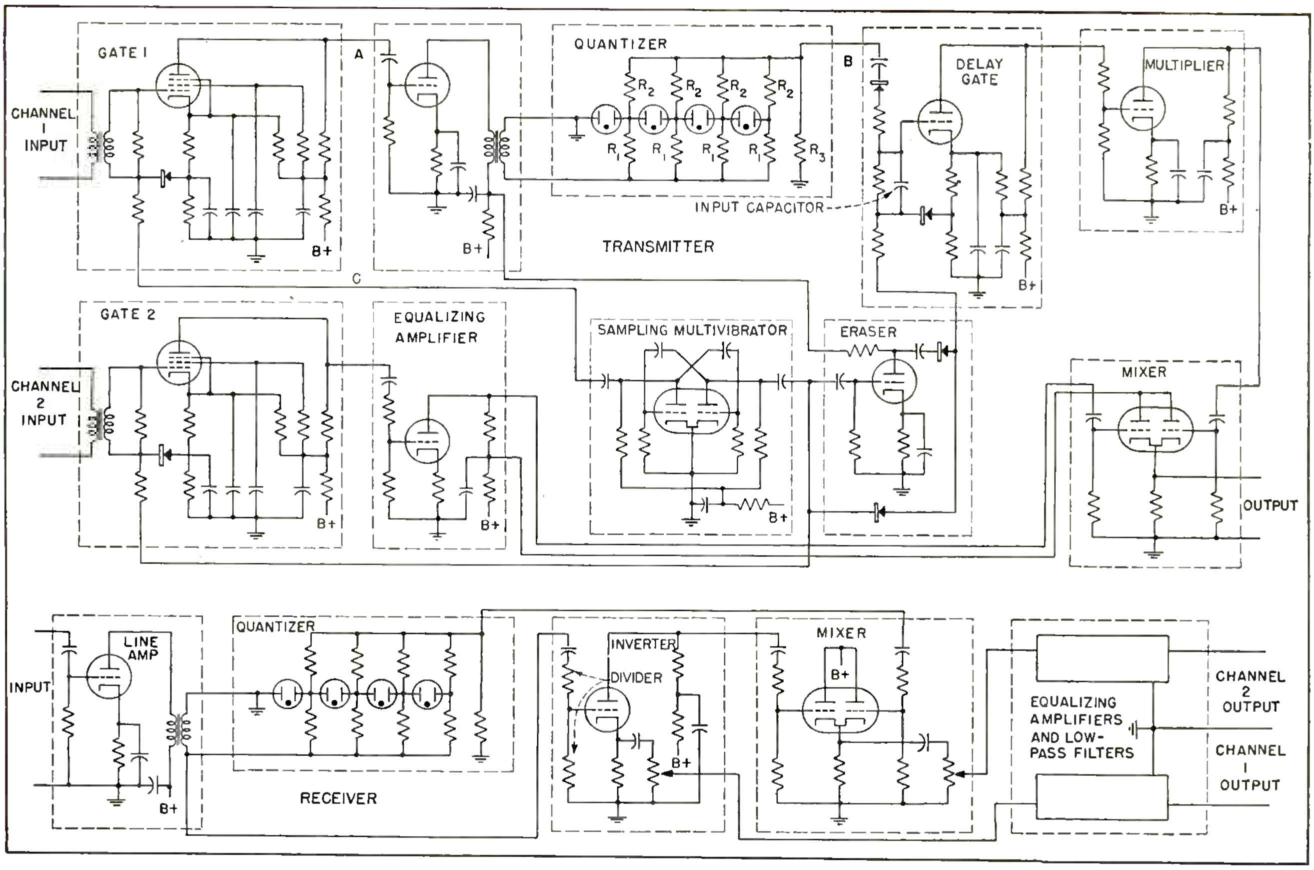

FIG. 1—Blocks show basic sequence in combining channels; detailed circuits indicate how operations can be performed

to the other input of the MIXER.

Because the sampling of the two channels is controlled from opposite plates of the multivibrator, the sampled signals will be interleaved in time. The object of this system of modulation is to transmit one pulse instead of two. Therefore the sampling square wave for channel 2 is used to actuate the delay gate at the same time that channel 2 is sampled. The output of the delay gate is then passed to the MULTIPLIER, where the signal level is raised to $2K$ times the level of the channel-2 signal appearing at the mixer grid, where K is the number of quantizing levels for channel 1, which is 5 in this case.

An ERASER is provided to remove the charge on the delay-gate capacitor after its signal has been passed to the multiplier. The erasing circuit consists of an amplifier provided with a differentiating input coupling. The square wave from the multivibrator acts through the erasing circuit to produce a very short, high-amplitude, positive pulse on the grid of the delay gate that allows the capacitor to discharge.

The pulse-amplitude modulated trains at the mixer grids are in proper polarity and time relation to be combined into a single pulse train having a repetition frequency equal to that of the sampling multivibrator. In this way the pulse rate required to transmit one channel is made adequate to transmit two or even more channels added into the same train.

A further feature of this system is that, when transmitting a high-fidelity signal having frequencies which are twice those capable of being transmitted, the signal can be separated into high and low-frequency portions, the high-frequency portion heterodyned down, and the two resulting portions fed in as channels 1 and 2. The signal will then be transmitted in half its original bandwidth.

Receiver Separates Channels

The RECEIVER first amplifies the signal from the line in its LINE AMPLIFIER to a level suitable for operating its QUANTIZER, which is the same as the one in the transmitter. The output from the quantizer is passed, with positive polarity, to a MIXER. Simultaneously, an unquantized signal is reduced in the DIVIDER by the same factor used in the multiplier of the transmitter, changed in polarity by the INVERTER, and fed to the mixer.

The quantized and the divided signals are subtracted in the mixer, giving the difference signal as the output across its cathode resistor. This signal is that of channel 2; the signal for channel 1 is obtained, within the accuracy of quantization, from the inverter cathode. EQUALIZING AMPLIFIERS feeding LOW-PASS FILTERS to remove components of the sampling frequency complete the receiver. However, if the system is used to obtain high fidelity for a single channel that has been separated into two portions, a delay-gate synchronized with the incoming pulses is needed to interleave the signals properly, and a heterodyne to translate the high-frequency portion back to its original spectrum.

In the particular encoding method described, one of the pulse signals is transmitted at a higher power level than the other. This difference leads to widely differing signal-noise ratios for the two channels.

It is assumed that only white noise affects the transmission path. That is, impulse noise is disregarded and only that noise having a uniform amplitude across the frequency spectrum is considered.

Assume that the average noise voltage at the receiver is E_N, that the number of quantizing levels is K and that the voltage levels of quantization at the transmitter are E_1 and E_2 for the two pulse trains coded together. In other words, the pulse train from the delay gate of the transmitter may have any of the voltage levels mE_1 where $m = 1, 2, 3, 4, \ldots K$, while the pulse train from channel 2 may be considered to have any of the levels mE_2 even though this channel is not quantized. Also assume that the gain in the multiplier is exactly $2K$ so that $E_1 = 2KE_2$.

Signals from the transmitter may be assumed to suffer a transmission loss represented by multiplication by a small factor L.

Under these conditions the receiver will see a composite signal consisting of two levels of quantization LmE_2 and $2KLmE_2$, and also E_N. The respective quantizing steps for the composite signals are then LE_2 and $2KLE_2$. For both these signals to be recognizable LE_2 must be greater than E_N. If it is only required to recognize the output of the stronger channel (channel 1), the requirement is reduced to $2KLE_2 > E_N$. That is, with two separate signals encoded at the transmitter into a single pulse train, the signal-noise ratio must be $2K$ times as great if both channels are to be recognized as if only the stronger channel is required. Expressed in decibels, the signal-noise ratio must be $20\log_{10}2K$ in order to use this particular method of bandwidth reduction. If we assume the noise to remain constant, the transmitter output voltage must be raised $2K$ times. However, if the signal-noise ratio was higher than required before the bandwidth was reduced, no more power may be needed.

Equation 2 states that, in an ideal transmission system, the power must be increased by a factor $1 + P_1/2N$ where P_1 is the original power, in order to halve the bandwidth-time product. This is a power increase of $20\log_{10}(1 + P_1/2N)$ decibels. The power increase for the actual system just described is considerably greater than that required in the ideal case.

The system of Fig. 1 is more efficient for signals requiring only a few quantized levels insofar as the power-bandwidth trade is concerned. If 30 quantizing levels are required, as for speech, then the signal-noise power ratio must be increased by 30 db; 10 levels would require a 26-db increase, 5 require 20, 3 require 10, and 2 levels would require only 6-db increase. These increases of signal-noise ratio are, for the most part, capable of realization on nearly all communication circuits without undue cost and may be present part of the time.

Alternative Methods

Other arrangements can be made that accomplish the same result. For example, two conventional and identical pulse-code modulators can be actuated by a common timing generator to insure simultaneous pulse outputs. The output of one modulator is amplified by the factor K and then additively combined with the output of the other modulator. Again the system transmits two channels in a bandwidth normally required for one; as many quantizing levels and as high a fidelity as are required can be used.

If $K = 1 + e$ where e is any positive number, then, at the receiver, pulses of E_R (channel 2) must be distinguished from pulses of $(1 + e)E_R$ (channel 1) in order to decode both channels. If E_N is the average noise amplitude, then $eE_R > E_N$ in order to distinguish signals from noise. If the pcm channel was working satisfactorily before the second channel was added, then making $e = 1$ should leave the signal-noise ratio the same. Making $e = 1$ means doubling the voltage of the pulses from one modulator. Adding the double voltage to the other channel gives transmitted pulses three times the original amplitude, requiring 9 times the peak power (9.5-db increase). This increase is independent of the number of quantizing levels and hence is more efficient in trading power for bandwidth for large numbers of quantizing levels than the system of Fig. 1.

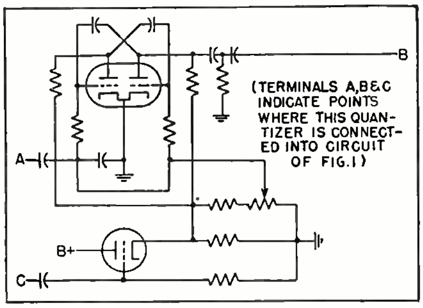

FIG. 2—Multivibrator acts as quantizer

Other circuit techniques can also be used. When many quantizing levels are required the positive-grid-counting multivibrator of Fig. 2 can be used.[10] It would be connected into the circuit of Fig. 1 at the points indicated, replacing the gas-tube quantizer. The output of gate 1 frequency modulates the counting multivibrator during the sampling of channel 1, thus causing an integral number of sharp pulses to be delivered to the capacitor in the delay gate proportionate to the amplitude of the input signal. The counting multivibrator can be made linear over a 6:1 frequency range and can be used to quantize as many as 500 levels. Center frequency of the multivibrator is adjusted by the potentiometer.

References

(1) R. V. L. Hartley, Transmitting Information, *BSTJ*, p 535, July 1928.

(2) Bandwidth vs Noise in Communication Systems, ELECTRONICS, p 72, Jan. 1948.

(3) C. E. Shannon, Information Theory, paper presented at a symposium before the National Convention of the IRE., March 24, 1948.

(4) W. G. Tuller, Bandwidth Reduction in Communication Systems, paper presented at the National Convention of the IRE., March 23, 1946. See also Theoretical Requirements for Communication Systems, ELECTRONICS, p 138, March 1948.

(5) Gabor, New Possibilities in Speech Transmission, *JIEE*, Section III, Nov 1947.

(6) Meacham and Peterson, An Experimental Multichannel Pulse Code Modulation System of Toll Quality, *BSTJ*, p 1, Jan 1948. See also Coded Pulse Modulation Minimizes Noise, ELECTRONICS, p 126, Dec 1947.

(7) A. H. Reeves, U. S. Patent 2272070, assigned to the International Standard Electric Corp.

(8) W. M. Goodall, Telephony and Pulse Code Modulation, *BSTJ*, p 395, July 1947.

(9) P. M. Rainey, U. S. Patent 1608527, assigned to the Western Electric Co.

(10) S. Bertram, The Degenerative Positive Bias Multivibrator, *Proc IRE*, p 277, Feb. 1948.

Picture-Modulated

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Control panel of the instrument and its power supply

THIS paper describes the design features and performance characteristics of a signal generator, uniquely suited for television receiver measurements in that it is capable of providing a signal of known amplitude on one of the twelve commercially allocated channels and is capable of being fully modulated by a standard RMA composite video signal. The picture-modulated generator can be used by television receiver manufacturers far removed from television broadcasting stations to test production receivers with picture signals free from noise, ghosts, and interference.

The block diagram of the generator in Fig. 1 shows the following stages:

(1) A video amplifier section whose function is to amplify a small video signal so that it has sufficient amplitude and proper polarity to operate the modulator. Multiple inputs have been provided to enable rapid selection of any one of three different video signals. The amplifier also provides a mixing channel so that synchronizing signals may be added to one or all of the video waves or two video waves may be added together for a composite display.

(2) The modulator which inserts the video intelligence on the r-f carrier in the approved fashion; that is, zero carrier corresponding to 100-percent modulation of white signals.

(3) The crystal controlled r-f oscillator which generates an unmodulated signal and precisely determines the picture carrier frequency.

(4) The multiplier chain which multiplies the oscillator frequency up to the actual picture carrier frequency.

(5) The power amplifier to amplify the modulated carrier and couple to the attenuator.

(6) The mutual inductance attenuator which provides continuously variable output from 6 db below one volt (0.5 volt) to below 120 db below one volt (1 microvolt).

(7) The output matching box which incorporates the terminating resistors and attenuator level-indicating crystal.

(8) The metering circuit, used to measure the rectified attenuator output and calibrate the attenuator.

Simplified circuit diagrams of the picture-modulated generator sections and power supply are shown in Fig. 2 to 6.

Video Circuit

The video sections, V_2, V_3, V_4, V_5, and V_6 of Fig. 2 consists fundamentally of two video amplifier stages. The selector switch S_1 setting determines which of the three first video amplifier stages V_3, V_4, or V_5, are connected through to the second video amplifier stage V_6. An additional tube V_2 is included to enable the adding of synchronizing pulses or an additional video signal to the others, if desired.

The selector switch setting also determines which gain control potentiometer R_{42}, R_{43}, or R_{44}, is effective in altering the transconductance of the sync amplifier, V_2. Since each of the four first amplifier tubes also have individual gain controls, the modulation depth and black level for each video signal can be preset, and pictures switched readily without further adjustment of any operating controls.

The two video stages are compensated by a modification of simple shunt peaking[1] to insure uniform high-frequency gain to beyond 4.5 mc. The low-frequency response of the amplifier is sufficient to transmit the vertical retrace region of the video wave with less than two-percent droop.

A parallel resonant cathode trap is included in the cathode circuit of V_6 and is tuned to 4.5 mc to attenuate the 4.5-mc video components which might otherwise appear in the sound channel and would result in undesired interference in the receiver output. The cathode trap causes a discontinuity in the amplitude and phase characteristic of the video amplifier; since this is similar to that introduced at the television transmitter or at the receiver, it produces no unusual distortion.

The type of gain control indicated was chosen with regard to the nature of the video signal desired. Where pulse-type signals, those unaffected by amplitude nonlinearity distortion, are used a screen grid voltage control is specified. This

Television Signal Generator

Circuit data and performance characteristics of a signal source for production testing of receivers at points remote from telecasting stations. A mixing pad permits the combination of picture, sound and noise signals to simulate actual conditions

control enables a large range of input signals to be employed. However, with signals where the linearity of the video amplifier must be maintained, the degenerative cathode resistor type of control is indicated. This type of gain control has limited control capabilities because of circuit capacitances and required bandwidth, in this case about 10 db of control.

Maximum gain of video amplifier channels 2 and 3 containing V_4 and V_5, is approximately 23 db (14 times) whereas the maximum gain of the other channels is about 29 db (28 times). Thus for channels 2 and 3 a minimum signal of about 0.4 volt peak to peak is required fully to cut off the modulator tube.

The input impedance of the amplifier channels was made high so that the picture-modulated generator might be connected to a terminated line without causing appreciable loading. This makes easier multiple operation of generators from a single line.

Modulator Circuit

The output of the video amplifier connects to the suppressor grid of the 6AS6 modulator tube V_9 shown in Fig. 3. The r-f signal is impressed on the control grid and the modulated energy appears in the plate circuit. The 6AS6 tube is specially designed for mixer or modulator service in that the grid-plate transconductance is capable of control by the suppressor-cathode potential in a manner which is reproducible from tube to tube. A d-c restorer diode V_8 connected to the suppressor insures

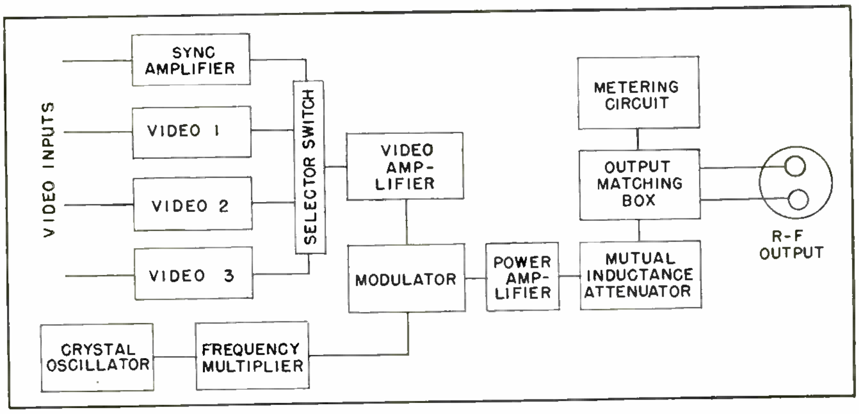


FIG. 1—Block diagram of picture-modulated generator

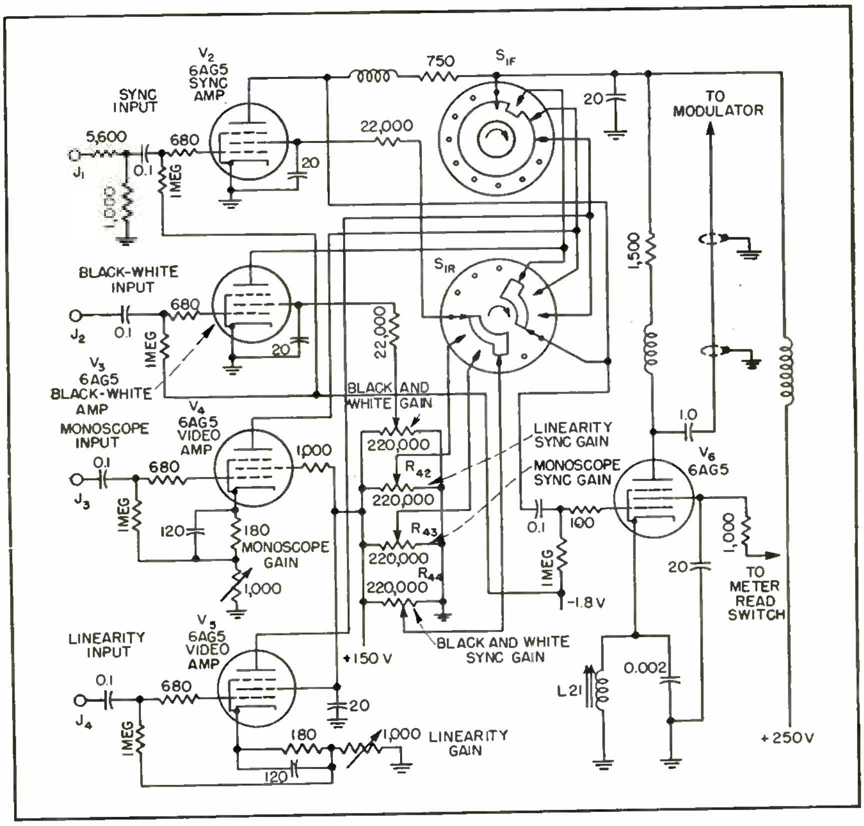


FIG. 2—Video section of the generator

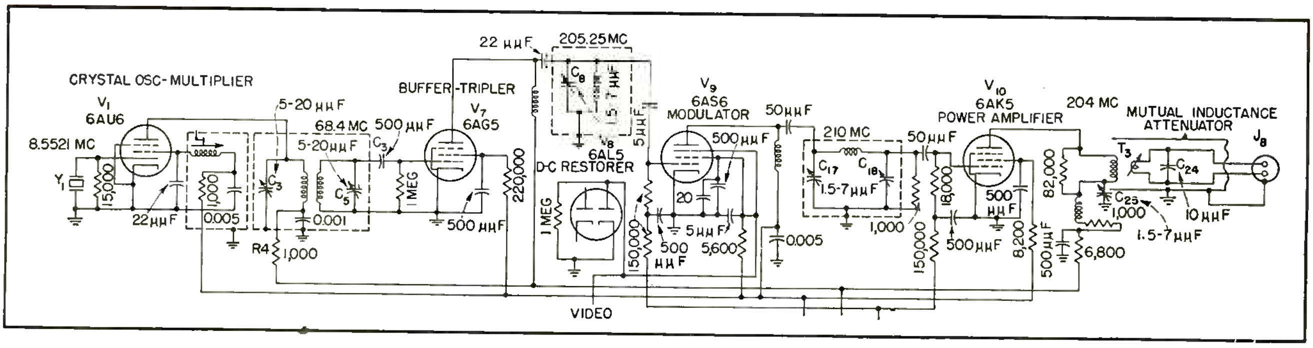


FIG. 3—Modulator and r-f circuits

that the synchronizing signal peaks are held at zero potential as illustrated in Fig. 7.

The video polarity on the suppressor grid of the modulator tube is such that sync tips produce 100 percent carrier, while the white portions of the video waveform cause reduction of the carrier to approximately 7 percent. The d-c restorer serves to clamp the sync tips to zero bias regardless of picture content. Unfortunately, this type of d-c restorer causes some degradation of the synchronizing pulse waveform during the vertical retrace interval. However, the total amount of droop during the vertical retrace interval which is due to the low-frequency characteristic of the video amplifier plus the effect of the d-c restorer diode does not exceed 5 percent.

The modulation linearity of the modulator tube is sufficiently good so that no appreciable compression of white values will occur providing the carrier level is not reduced below about 7 percent of maximum. There is, however, a small amount of clipping of the synchronizing tips by the d-c restorer. Thus a signal which contains approximately 28 percent sync, instead of the usual 25 percent, is needed to produce the standard RMA signal. If separate synchronizing signals are used in conjunction with V_9, no difficulty will be experienced. If a composite signal is fed to the video input, the amount of sync in the video waveform should be adjusted at the synchronizing generator.

Frequency Multiplier

The modulator grid is fed from the multiplier chain which develops the required r-f voltage at the picture carrier frequency. The frequency-determining element of the frequency multiplier chain is crystal Y_1 operating between 7 and 9 mc depending upon the channel desired. Tube V_1 in Fig. 3 is a combined crystal oscillator and frequency multiplier. The control grid, screen grid and cathode are connected as a triode. The plate circuit contains a highly selective, double-tuned transformer, tuned to a harmonic of the crystal oscillator. The circuits shown provide adequate multiplication and adjacent harmonic rejection for a multiplication of at least nine times.

A 6AG5 tube, V_7, is used as an additional frequency tripler on the generators which are designed for channels 7–13. For channels 1–6 this stage is used as a buffer.

Approximately one volt of r-f voltage at the picture carrier frequency appears on the modulator grid.

Output Amplifier

The modulator plate connects to a resonant circuit which is one of a stagger-tuned pair. The second circuit is the fixed coil of a mutual inductance attenuator which is resonant near the picture carrier.

The composite r-f transmission characteristic from modulator grid to the output terminals is shown in Fig. 8. for operation on channel 13. The total 3-db bandwidth is about 9 mc.

The picture carrier is situated in such a manner that the upper sidebands are faithfully transmitted whereas the lower sidebands are progressively attenuated. However, for all practical purposes for use with commercial television receivers, the picture-modulated gen-

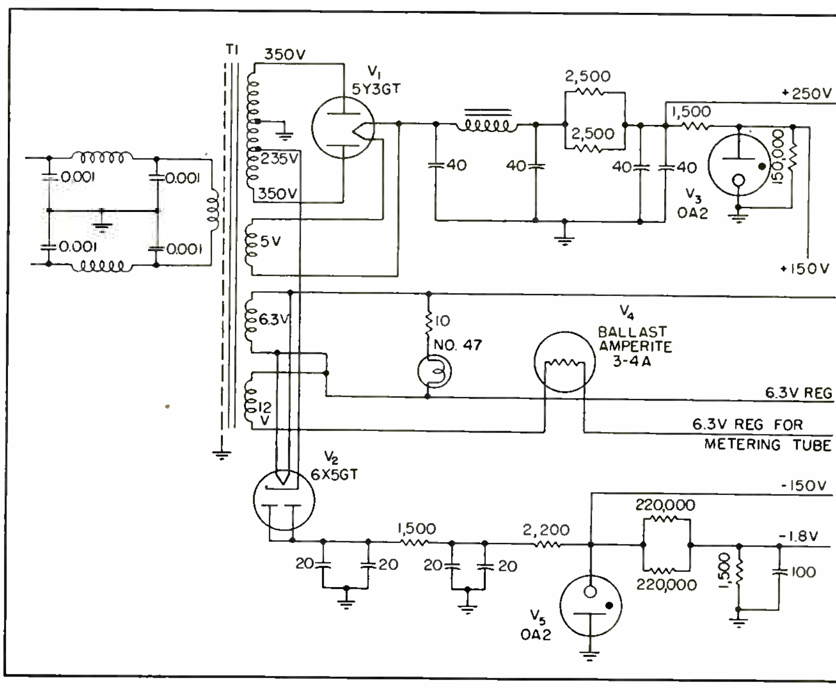


FIG. 4—Complete power supply circuit for the generator

erator is essentially double sideband. The shape of this transmission characteristic is somewhat modified when the attenuator is set for maximum output but is still satisfactory.

Power amplifier tube V_{10} couples into the mutual inductance attenuator.[2] A balanced plate circuit with C_{25} forming one of the balance capacitors and the circuit capacitance on the 6AK5 side forming the other, is used. This balanced condition is essential if the output of the attenuator is to be balanced with respect to ground.

Figure 9 shows a cross section of the attenuator indicating the position of the fixed and movable coils. The ratio of the voltage induced in the movable coil at a distance X inches from the fixed coil to that induced at a distance $(X + d/2)$ inches is 16 db. If the diameter of the cylinder is one inch, then the attenuation will be 32 db per inch of travel. Approximately 120 db of attenuation is provided in the attenuator shown.

The movable piston has a gear rack attached to it which is driven by means of a pair of split gears actuated by a shaft from the front panel. The attenuator dial is directly calibrated in db attenuation. A movable zero slider is incorporated to aid in setting the reference point.

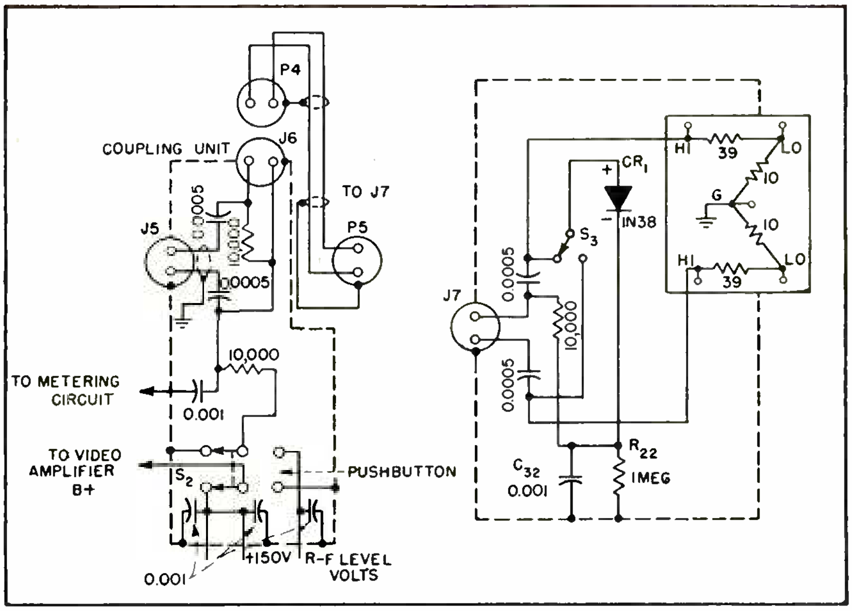
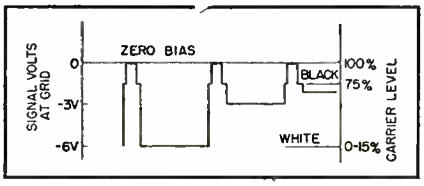
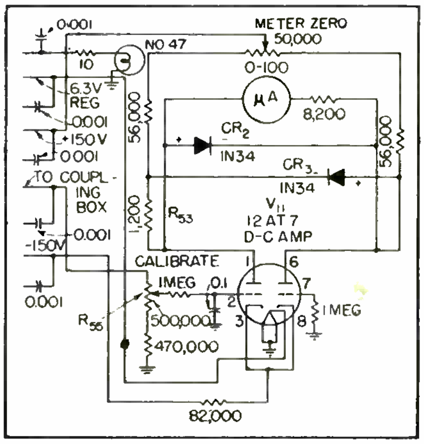


FIG. 5—Output coupling unit, left, and the output head circuit



ABOVE

FIG. 7—Waveform at suppressor grid of modulator tube showing the effect of the d-c restorer on sync tips as scene brightness varies



RIGHT

FIG. 6—Output metering circuit

Coupling Unit

By means of the output coupling unit, shown at the left of Fig. 5, the balanced signal from the attenuator cable is delivered to the r-f output jack on the front panel. Located in this unit is the METER READ SWITCH S_2 and the circuitry necessary for conducting the d-c measuring voltage of the output-level measurement system from the output lead to the output-level metering circuit. In the coupling unit and output head are the circuits for enabling both the r-f output signal and the d-c output-level measuring voltage to be carried by the same output cable.

Output Head

The output head is connected to the R-F OUTPUT JACK on the front panel by a three-foot length of RG-22U balanced twin conductor cable. The output head contains a terminating network with the following nominal output impedances: 10 ohms unbalanced to ground, 50 ohms unbalanced to ground, 20 ohms balanced, and 100 ohms balanced. The maximum output voltage across the 100-ohm output resistance is 0.5 volt rms.

Also located in the output head is a crystal rectifier CR_1, a 1N38 connected in a peak voltmeter circuit with R_{22} and C_{32}. This crystal can be connected by switch S_3 to either side of the line in the output head to indicate the magnitude of the output voltage. This enables measurement of the actual output voltage under load as well as the open-circuit voltage. The positive d-c voltage developed across R_{22} is carried by one of the conductors of the output cable to one side of the METER READ SWITCH S_2 of the coupling unit. When the switch button is depressed the video amplifier is disabled and the d-c measurement voltage is connected to the metering circuit. Thus the attenuator output level is set with no modulation on the carrier, eliminating the possible errors which might be caused by different picture content. The modulator circuits are designed so that eliminating the video signal has a negligible effect on the amplitude of the picture carrier.

Output Level Meter

The output level meter is designed to indicate the output voltage level of the unmodulated r-f carrier. As shown in Fig. 6, it consists of a cathode-coupled, balanced amplifier using a 12AT7, V_{11}. One triode section may be called the measuring tube (pins 1, 2 & 3) and

TABLE I—Oscillator and Multiplier Frequencies

Channel	Picture Carrier	Crystal Frequency	1st Multiplier	2nd Multiplier
	mc	kc		
2	55.25	9,208.3	×6	×1
3	61.25	8,750.0	×7	×1
4	67.25	8,406.3	×8	×1
5	77.25	9,656.3	×8	×1
6	83.25	9,250.0	×9	×1
7	175.25	8,345.3	×7	×3
8	181.25	8,630.9	×7	×3
9	187.25	8,916.7	×7	×3
10	193.25	9,202.4	×7	×3
11	199.25	8,302.1	×8	×3
12	205.25	8,552.1	×8	×3
13	211.25	8,802.1	×8	×3

TABLE II—Coil and Alignment Frequencies

Channel	L_1	C_3 and C_5	C_8	C_{17} and C_{18}	C_{25}
	kc	mc	mc	mc	mc
2	9,208.3	55.25	55.25	54	60
3	8,750.0	61.25	61.25	60	66
4	8,406.3	67.25	67.25	66	72
5	9,656.3	77.25	77.25	76	82
6	9,250.0	83.25	83.25	82	88
7	8,345.3	58.42	175.25	174	180
8	8,630.9	60.42	181.25	180	186
9	8,916.7	62.42	187.25	186	192
10	9,202.4	64.42	193.25	192	198
11	8,302.1	66.42	199.25	198	204
12	8,552.1	68.42	205.25	204	210
13	8,802.1	70.42	211.25	210	216

the second triode the reference tube, (pins 6, 7, 8). With no signal on the measuring tube the METER ZERO control potentiometer is adjusted until the microammeter reads zero current; in this condition the voltage difference between the two plates is zero.

If a positive d-c voltage is applied to the grid of the measuring tube the current through it will increase, and the current in the reference tube will decrease a corresponding amount. The difference of potential between the two plates is then a measure of the applied grid voltage.

To protect the meter from accidental overload of either polarity two 1N34 crystal rectifiers CR_2 and CR_3 are connected in a novel manner between the two plate circuits. Crystal CR_2 is poled so that reverse deflection of the meter is prevented. CR_3 is poled and biased by means of R_{53} so that when the meter current exceeds a certain value the crystal tends to prevent a further increase.

Potentiometer R_{55} in Fig. 6 serves only to control the magnitude of the input signal and the sensitivity of the system; hence it is labeled METER CALIBRATE on the panel. The maximum sensitivity is in the order of 0.16 to 0.20 volt for full-scale deflection.

Picture-modulated generators have been designed and constructed for channels 2 to 13 inclusive. Tables 1 and 2 indicate the frequencies involved.

Shielding and Leakage

Great care has been exercised in providing good shielding and r-f filtering to enable the use of picture modulated generators with sensitive receivers. It is possible, as a result, to attenuate completely, so that no trace of a picture signal remains on the most sensitive television receiver which has been available for test. The generators have been tested for r-f leakage through the power cables, chassis openings, and around the covers with sensitive communication receivers and have shown no discernible leakage.

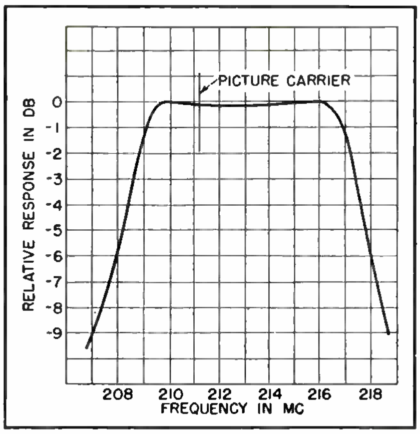


FIG. 8—Composite r-f transmission characteristic

The effective shielding has been accomplished by carefully filtering every power lead which enters or leaves the chassis in several stages. All circuits which carry r-f or have r-f fields have been carefully compartmented.

Another factor which tends toward low radiation and leakage is the absence of a high-level oscillator at the picture carrier frequency. The high-level oscillator operates between 7 and 9 mc and consequently does not affect the television receiver.

Setting Modulation Depth

The setting of the several video signal controls to obtain the standard depth of modulation can

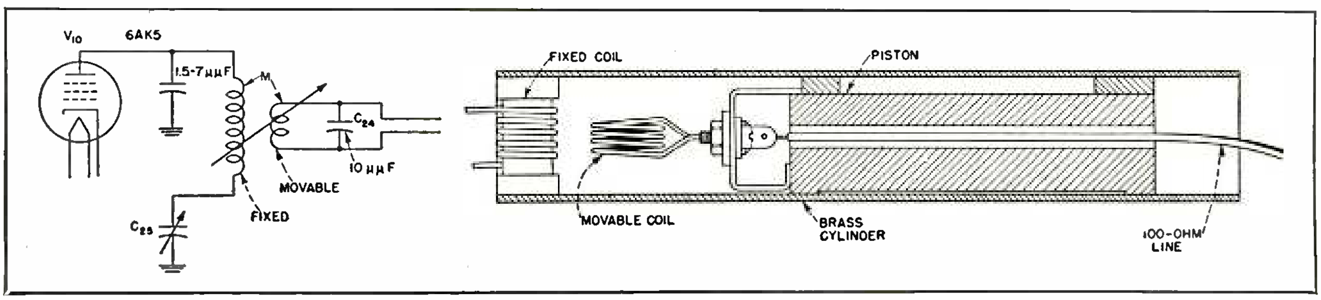


FIG. 9—Construction details of the mutual inductance attenuator

be accomplished by the following procedure. The equipment required in addition to the video source for modulating the picture modulated generator includes a wide band, high-gain oscilloscope, a mechanical buzzer-type interrupter and a crystal rectifier, video detector circuit.

The circuit and an illustration of the type of display are shown in Fig. 10. Here the rectifier circuit is connected across the output terminals of the output head. The output from the detector is connected to the vertical plates of the oscilloscope; the horizontal sweep set to 30 cps and synchronized with the power line.

The interrupter periodically short circuits the output from the detector so as to indicate the zero carrier level of the signal from the generator. The pattern on the oscilloscope appears as shown as a replica of the video modulating waveform with periodic spikes extending down to zero carrier level. In general the spikes will not be synchronous with the video signal and horizontal sweep.

To set modulation depth adjust the video and synchronizing signal gain controls until the video signal plus the sync peaks are equal to about 93 percent of the peak signal observed on the screen of the oscilloscope. The black level adjustment is made by proportioning the relative amounts of sync and video signals.

Overall Performance

The overall amplitude and phase versus frequency characteristic is shown on Fig. 11. The curves were taken with a Hazeltine phase curve tracer.[3] The swept video was connected at the video input jack and the output signal recovered across a 2,000-ohm load resistor of a crystal detector connected across the r-f output terminals. In this manner the fidelity of the entire unit including the video, r-f, and coupling circuits can be evaluated.

A resume of the performance specifications is as follows:

Operating frequency range—One channel
Output level—0.5 v to below 1 μv
Output impedance—10 ohms unbalanced; 50 ohms unbalanced; 20 ohms balanced; 100 ohms balanced
Video polarity—black positive
Video input level—0.4 v to 1.2 v peak to peak
Frequency accuracy—50 kc of nominal picture carrier
Spurious frequencies—at least 44 db below picture carrier
Attenuator balance—the unbalance to ground between two halves does not exceed 0.5 db
Power drain—110 watts at 117 v 60 cps
Modulation depth—adjustable, zero to about 93 percent

Sound Channel

The instrument has been used with standard RMA signal generators manufactured by RCA and Telequip Corp. In addition to the monoscope, several video patterns have been used, among which are: black and white signal, linearity bar pattern, step wave, camera signals and signals taken off the air by a television receiver.

In normal use of the instrument, an f-m signal generator operating on the proper sound carrier frequency is an important accessory. Figure 12 is a circuit diagram of a mixing pad which enables mixing of sound, picture and noise signals to simulate the actual television transmission. The picture input has a crystal rectifier which is used in place of the output coupling box for measurements of picture carrier level. The insertion loss of the system is approximately 9 db.

With receivers using intercarrier sound, a small amount of phase modulation of the picture carrier by the action of the modulator on the tuned circuit in its grid circuit may be observed.

The phase modulation may be reduced by means of input admittance variation compensation. This consists of an unbypassed cathode resistance in the 6AS6 cathode. The size varies between 25 and 100 ohms depending on the channel.

REFERENCES

(1) F. E. Terman, "Radio Engineers Handbook," McGraw-Hill Book Co., p 413.

(2) D. E. Hartnett and N. P. Case, The Design and Testing of Multirange Receivers, *Proc IRE*, 23, p 578, June 1935.

(3) B. D. Loughlin, A Phase Curve Tracer for Television, *Proc IRE*, 29, p 107, Mar. 1941.

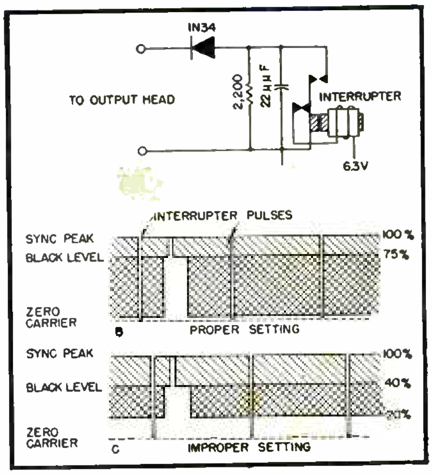


FIG. 10—Circuit of interrupter for estimating the position of zero carrier level. By adjustment of the gain controls of the generator, the modulation depth and the black level may be set according to RMA and FCC standards. Acceptable setting is shown at (*B*) and incorrect setting indicating excessive sync gain and inadequate video gain is shown at (C)

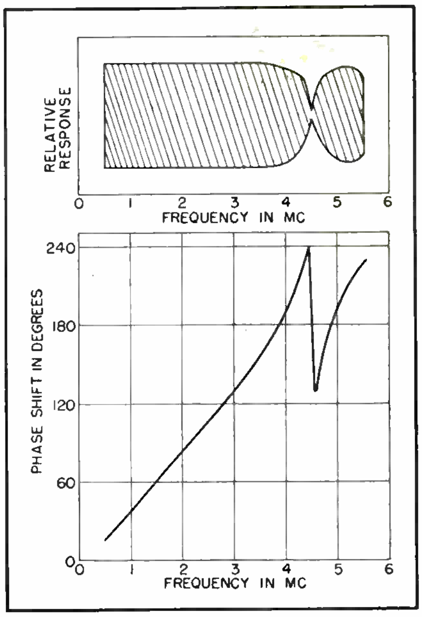


FIG. 11—Overall amplitude and phase versus frequency characteristic

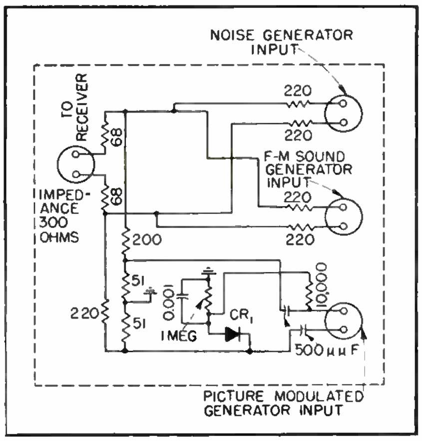


FIG. 12—Mixing pad for combining an f-m sound signal with the video channel

CERAMIC DIELECTRIC Materials

New materials, not to be confused with porcelains and steatites, have many potential uses. Dielectric constant, dissipation factor, temperature coefficient, volume resistivity and other characteristics that determine their electrical uses are discussed

Characteristic	Group A	Group B	Group C
Dielectric Constant (K) 25 C at 1 mc	30 to 95	100 to 420	500 to 6,000
Dissipation Factor (D) 25 C at 1 mc	0.0002 to 0.0005	0.0004 to 0.005	0.005 to 0.015
Temperature Coefficient (TC)	+ 100 ppm/deg C (P100) to − 750 ppm/deg C (N750)	− 1000 ppm/deg C (N1000) to − 5600 ppm/deg C (N5600)	Plots as peaked curve
Volume Resistivity 25 C	10^{11} to 10^{16} ohms per cm^3	10^{11} to 10^{16} per cm^3	10^{11} to 10^{16} per cm^3
Capacitor Applications	Temperature compensation Fixed capacitance standards By-pass and coupling Transmitting (high volt-ampere rating) Trimmers	Temperature compensation By-pass and coupling High-voltage	By-pass and coupling Filter High-voltage (dc)

FIG. 1—General characteristics of ceramic dielectrics

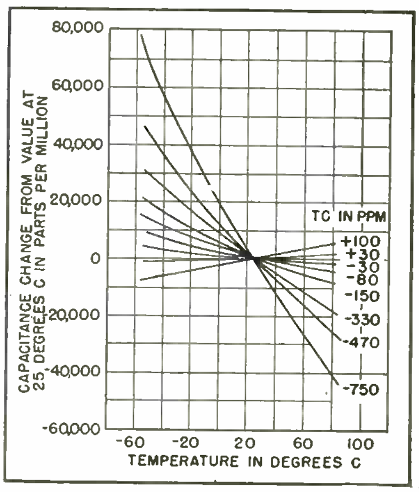


FIG. 2—Typical temperature-coefficient curves for Group-A dielectrics

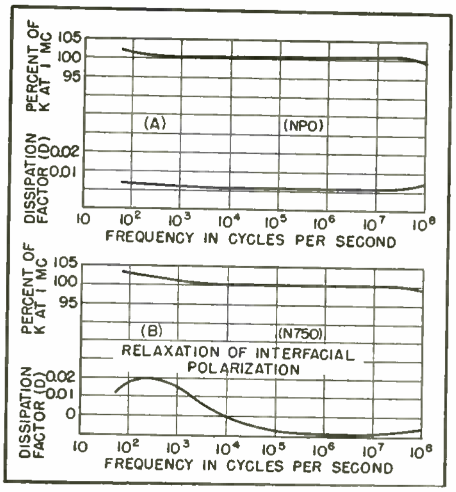


FIG. 3—Dielectric-constant and dissipation characteristics of Group-A materials

By BERT H. MARKS
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Centralab Div. of Globe-Union, Inc.
Milwaukee, Wisc.

WITHIN the past decade a series of new dielectric materials has been introduced to the electronic industry in the United States. These materials are commonly known as ceramic dielectrics and are not to be confused with other electrical ceramics such as steatite and porcelain. The latter materials have dielectric constants of the order of five or six; commercially available ceramic capacitors are currently being manufactured from materials having dielectric constants ranging from 30 to 6,000.

This article describes some of the electrical characteristics of various ceramic dielectrics. Information regarding their usefulness and limitations, and notes on the test methods employed, are included.

General Characteristics

On the basis of electrical characteristics, ceramic dielectrics can be divided into the three groups indicated in Fig. 1. The values shown are typical. Since these are synthetic dielectrics, variations exist between similar materials supplied by different manufacturers. The variations are quantitative.

The materials included in Group

Manufacturing disc-type capacitors using ceramic dielectrics

A are excellent dielectrics. Except for the values of dielectric constant and temperature coefficient, their electrical characteristics are similar to those of other insulators. Introduced in temperature-compensating capacitors, they are now employed in the manufacture of capacitors for almost every circuit application. They have a small dissipation factor and a moderately high dielectric constant. For any fixed set of conditions of temperature and frequency the dielectric constant is essentially fixed, showing no change as a result of aging, temperature cycling (between −55 C and +85 C), mechanical vibration or applied voltage.

Figure 2 shows the variation in K of Group-A materials with temperature. The curves are plotted in the conventional manner, showing capacitance change in parts per million from the value at 25 C versus temperature ($\Delta C/C_{25\ \mathrm{DEG}} \times 10^6$ vs. deg C). From this type of curve it is possible to calculate the temperature coefficient over any desired temperature range. ($TC = (\Delta C/\Delta T C_{25\ \mathrm{DEG}})\ 10^6$. It is apparent that temperature coefficient is not a linear characteristic, although the portion of the curve between +25 C and +85 C closely approximates a straight line. It is the value determined on the basis of measurements at +25 C and +85 C which is taken as the nominal temperature coefficient. These values are indicated on the curves.

Figure 3 shows the changes in the magnitude of the dielectric constant and the dissipation factor of two Group-A materials, over a frequency range of approximately six decades. The overall change is three percent for the NPO (zero temperature coefficient) material and five percent for the N750 material, and is largely confined to the audio-frequency region. Figure 3B is particularly interesting because it shows what appears to be the relaxation point for interfacial polarization of the dielectric. Generally this phenomenon occurs at much lower frequencies.[1]

Temperature coefficient is not independent of frequency, but the data available on this point are not too reliable or complete. Figure 4 shows the approximate relationship between temperature coefficient and frequency. The shape of the curves indicates that in the radio-frequency region the changes are small.

That the losses in a dielectric generally increase with increasing temperature is well known. Figures 5A and 5B show the dissipation factor and insulation resistance of typical samples at various temperatures.

The Group-B materials originally represented an extension in the range of materials available for the manufacture of temperature-compensating capacitors. They are slightly poorer dielectrics than those discussed above but have larger values of temperature coefficient and higher dielectric constant. Both Group-A and Group-B materials could be classified as titanium-dioxide dielectrics.

Qualitatively, Group-B materials behave the same as the Group-A

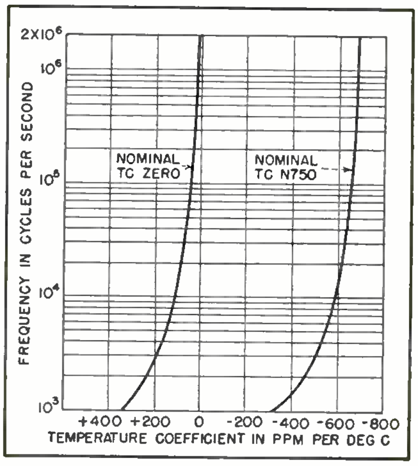


FIG. 4—Variation in temperature coefficient with frequency, Group-A materials

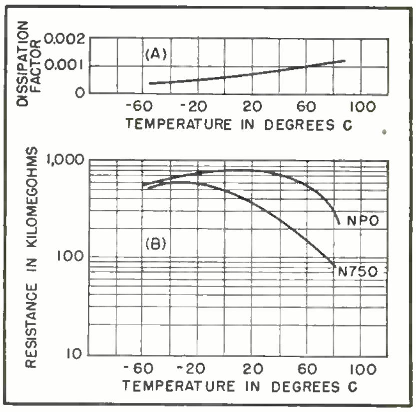
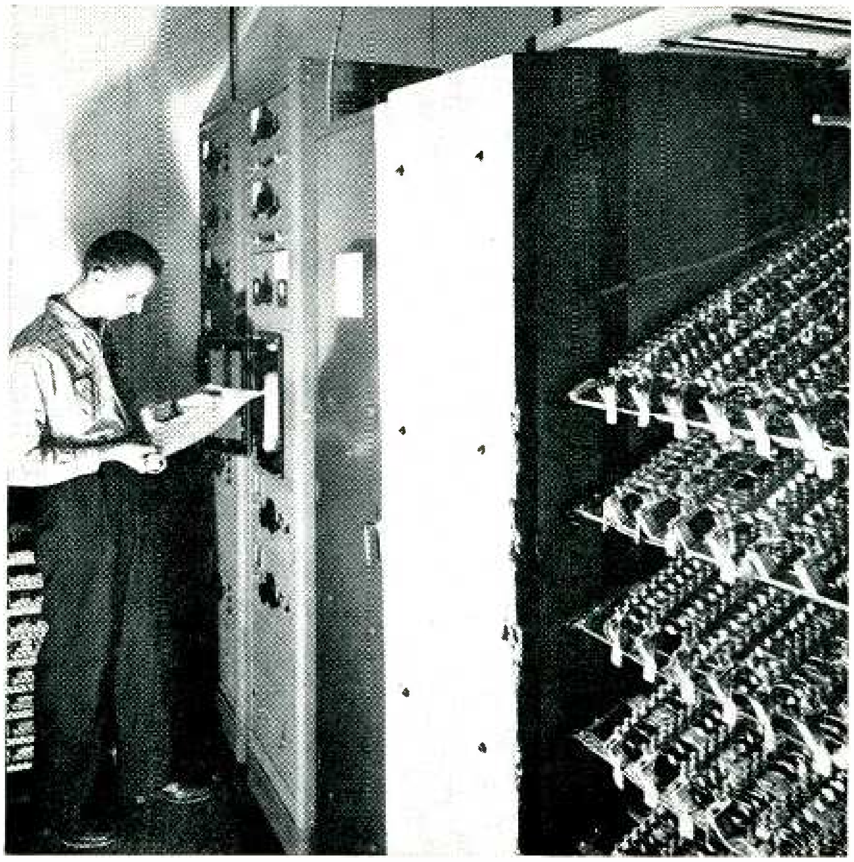


FIG. 5—Variation in dissipation factor of NPO and N750 materials with temperature (A) and variation in insulation resistance, values shown in the latter case at 1,000 volts d-c after an electrification time of one minute



Life-test equipment employed in the manufacture of ceramic dielectric capacitors

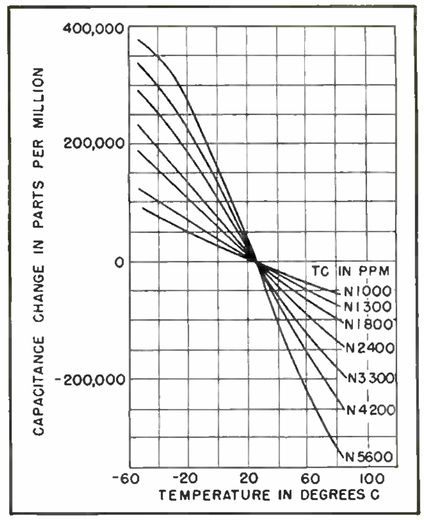


FIG. 6—Typical temperature-coefficient curves for Group-B dielectrics

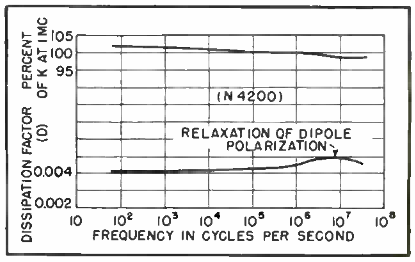


FIG. 7—Dielectric-constant and dissipation characteristics of a Group-B material

dielectrics. Figure 6 shows a family of typical temperature-coefficient curves and Fig. 7 shows a plot of the frequency-dielectric constant curve. The changes in dielectric constant with change in frequency are slightly greater than those exhibited by the previously discussed materials.

Group C

The Group-C materials cannot be classified as good dielectrics, but they are, because of their extremely high dielectric constants, very useful. They are currently used in the manufacture of bypass, coupling, blocking and filter capacitors of high-capacitance value and small physical dimensions. The resistivity of the materials is large, but the dissipation factor is quite high, thus limiting their use to applications where the applied voltage has only a small alternating component. Pressed discs (0.250 inch thick) of a material with a dielectric constant of 4,000 withstood the application of 20,000 volts d-c but were punctured by a 60-cycle alternating voltage of about 7,000 volts peak.

Several peculiarities of behavior are exhibited by the Group-C materials and, upon casual observation, the dielectric constants of the materials appear to vary at random. Investigation has revealed, however, that these variations follow a regular pattern. The dielectric constant of a Group-C material varies with time, with the magnitude of the applied voltage and in a very unusual manner with temperature.

A material common to all Group-C dielectrics is responsible for both the high value of dielectric constant and the unusual variations of this property. The material is barium titanate and its characteristics have been extensively described.[2] In its pure form it is not useable as a capacitor dielectric. Figure 8 shows the change in the dielectric constant of barium titanate with temperature. It has a high dielectric constant only over a very narrow temperature range and the steep slope of the curve indicates that a pure barium-titanate capacitor would show great changes in capacitance with temperature.

The problem of developing a capacitor dielectric from this material has been essentially one of broadening the peak of the curve, so that the changes over the working-temperature range are not excessive, and of lowering the temperature at which the peak occurs. Figure 9 shows that this has been accomplished. There is, however, a considerable decrease in the peak value of dielectric constant.

If a sample of a Group-C material is heated to a temperature of +85 C or higher for a few minutes, periodic checks of the dielectric constant after the sample has returned to room temperature show that the dielectric constant decreases with time. Figure 10 shows a semilogarithmic plot of this aging, in terms of capacitance change. The aging appears to continue indefinitely and it is known that the slope of the curve remains the same for more than a year. Each time the sample is heated and cooled it will return to its original high value of dielectric constant and the slope of its aging curve will be the same. At zero time the value of dielectric constant appears to be infinite and at infinite time the value of dielectric constant appears to be zero. The slope of the aging curve depends upon the material, and in general it is larger the higher the dielectric constant of the material.

The temperature capacitance behavior is very different from that of other dielectrics and cannot be explained in the same manner; however, it is known that, in the region of the peak dielectric constant, there is a change in the crystal structure of the material, and it is this change which appears to be responsible for the changes in dielectric constant. The material will repeat the same behavior during subsequent checks if the time after the heat treatment described above is the same. The height of the peak decreases and its shape sometimes changes with age.

The dielectric constant of Group-C materials also changes with applied voltage and the behavior seems analogous in every respect with ferromagnetic hysteresis phenomena.[8] Figure 11 gives some information regarding the magnitude of these changes, in terms of capacitance. As in the case of the temperature curve, the magnitude of the change decreases with age. At temperatures above that of the capacitance peak hysteresis it no longer occurs.

Figure 12 shows the frequency-dielectric constant curve of a material with a dielectric constant of 2,000. The sample was allowed to age for several days in order that the changes as a result of aging would be negligible.

Measurements Notes

The changes in dielectric constant discussed above are invariably associated with changes in dissipation factor and the latter changes are generally in the same direction as the former; however, these changes have not been studied sufficiently to permit a quantitative discussion at this time.

Although the unusual behavior of the Group-C dielectrics makes them undesirable for some conventional circuit applications, these same characteristics may make them valuable in others. The nonlinear resistor is a very useful circuit element. The nonlinear capacitor may prove to be of equal value.

All determinations of dielectric characteristics were made using small circular discs of the dielectric materials. The electrodes were silver paint fired on at high temperatures (approximately 1300 F). Unless otherwise noted, values indicated in the figures are those at a frequency of 1 megacycle at 25 C.

Measurements of capacitances at 1 megacycle and below were made using conventional laboratory capacitance bridges. In the range from 1 megacycle to 30 megacycles a General Radio Company Type 821-A Impedance Measuring set was employed. Corrections for residual circuit impedances were applied. Various resonant-circuit systems were employed in an attempt to obtain values at higher frequencies, but none of them seemed to yield results as consistent as those obtained at lower frequencies. One of the main difficulties here was obtaining low-capacitance samples of the materials. The standard capacitors in the various instruments were correlated to each other in order to minimize the variations due to differences between the standards.

Data on dissipation factor and insulation resistance at various temperatures were obtained by immersing the sample in a bath of dry oil of the desired temperature. The procedure was necessary, particularly at low temperatures, to prevent moisture condensation and frost formation on the samples.

The only unusual measuring system was that used to obtain the temperature-coefficient data. Here an oscillator frequency-variation system was employed. The test sample was placed in an oven, and by means of a low-capacitance, low-temperature coefficient feed-through, it was connected into the tuned circuit of a stable electron-coupled oscillator. Variations in the capacitance of the test sample caused variations in the frequency of the oscillator. The frequency va-

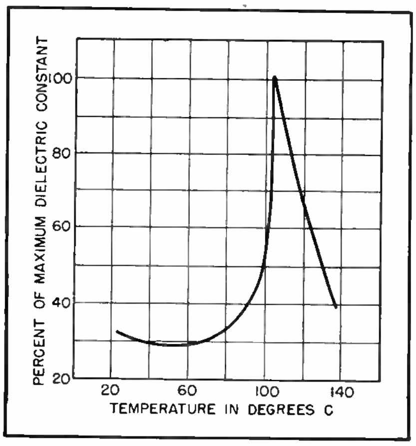


FIG. 8—Temperature-dielectric constant curve for barium titanate, where *K* is 8,000

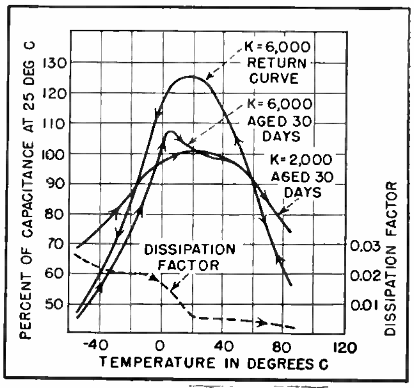


FIG. 9—Temperature characteristics of two Group-C materials

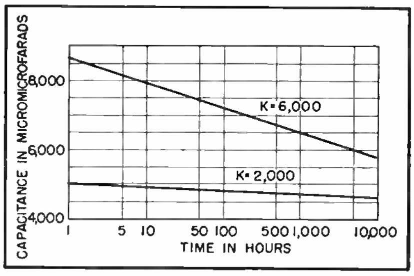


FIG. 10—Aging curve of two Group-C materials, at a test frequency of 1,000 cps

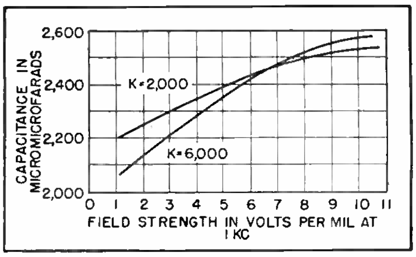


FIG. 11—Voltage characteristics of two Group-C materials

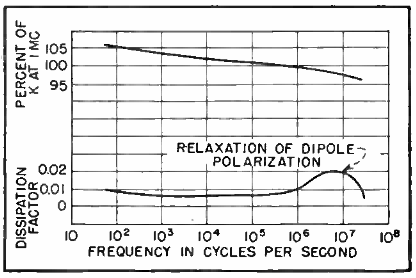
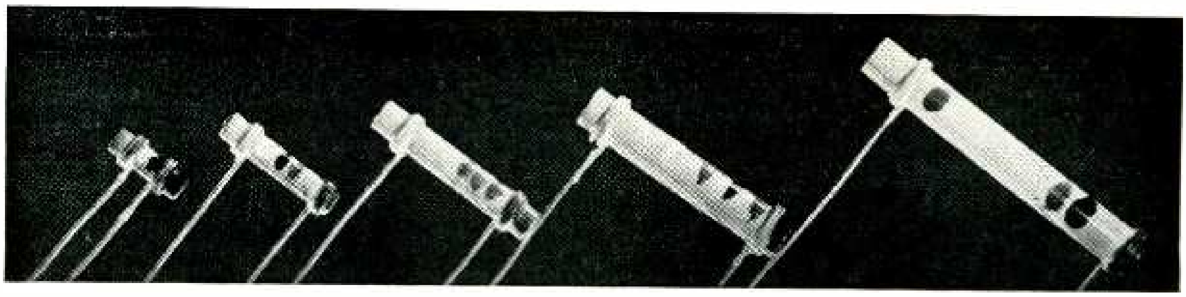


FIG. 12—Dielectric-constant and dissipation characteristics of a Group-C material



Typical tubular ceramic capacitors

riation of the oscillator was measured by beating the oscillator signal against the signal from a frequency standard. A calibrated audio oscillator and comparison oscilloscope were used to measure the beat-note frequency to within 2 or 3 cycles. From the oscillator frequency and the change in frequency, the temperature coefficient was calculated according to the formula

$$TC_{ppm} = 2\Delta FC_t/F\Delta TC_x$$

where C_x = capacitance of the test samples in $\mu\mu$f, $C_t = C_x$ + additional resonant circuit capacitances, ΔT = change in temperature in degrees C, F = frequency in mc, and ΔF = change in frequency in cycles.

Ceramic Capacitors

A ceramic capacitor in its simplest form consists of a small ceramic disc or rectangular plate with leads soldered to the silver painted electrodes on each surface. This type of capacitor is available commercially. Another style is the concentric tubular capacitor. These capacitors consist of a ceramic tube with electrodes applied to the inner and outer surfaces and leads soldered to the electrodes. Generally ceramic capacitors are not cased but are simply coated with a moisture-resistant lacquer to prevent dirt and moisture accumulation. In some cases, coatings of various phenolic resins are applied or metal or steatite housings used.

Many ceramic capacitors have been developed to meet special requirements. It is possible to obtain special *TC* curves by using paralleled plates of materials with different *TC*'s and curve shapes, and it is also possible by this means to make a capacitor which shows no measurable change in capacitance with temperature. Capacitors for use in transmitter tuned circuits are another useful development. These pieces will carry high currents and withstand high voltages but still retain a comparatively small size. High-quality, temperature-compensating trimmer capacitors are made from the Group-A materials, and high-voltage filter capacitors for television picture-tube power supplies are one of the most recent uses for the Group-C materials.

Because of their construction, the characteristics of ceramic capacitors do not vary appreciably from those of the dielectric material. This is particularly true at frequencies of the order of 10 megacycles or less. At higher frequencies, the resistance and inductance of the leads and electrodes cause some variations. The resistance of the metal parts will increase approximately as the square root of the frequency. The series inductance of leads and electrodes, though it remains constant, will cause the effective capacitance to vary from the static value by a factor so that

$$C_E = C/(1 - \omega^2 LC)$$

where C = the static capacitance, C_E = the effective capacitance, and L = series inductance.

As the natural resonant frequency of the capacitor is approached, the dissipation factor and capacitance rise sharply.

The natural resonant frequency of a small-size tubular (0.200-inch diameter 0.690-inch length) capacitor of 10 $\mu\mu$f and with $\frac{1}{16}$-inch leads has been calculated to be approximately 600 megacycles, the inductance of the electrodes being 0.004 microhenry and the total lead inductance approximately 0.006 microhenry. The natural resonant frequency varies approximately inversely as the square root of the capacitance since the inductance of tubular capacitors of the same physical size does not vary appreciably with capacitance.

More uses for the ceramic dielectric materials will no doubt be found as their characteristics become more widely known. Continuing research is almost certain to result in the development of materials with even larger dielectric constants, and though it seems doubtful that an extremely high dielectric constant material with the desirable features of the lower dielectric constant materials will be forthcoming, the new materials should be very useful. Future work in the design and manufacture of ceramic capacitors can be expected to make possible fuller use of both new and existing ceramic materials.

Acknowledgments

The writer wishes to express his thanks to H. R. Laird for his encouragement, assistances, and contributions of data on the behavior of the titanates and to acknowledge the work done by I. W. Schoeninger in the compilation and statistical analysis of voluminous data, the results of tests of ceramic capacitors. Both of these gentlemen are members of the Centralab ceramic engineering group. Mr. Schoeninger is Assistant Chief Ceramic Engineer and Dr. Laird is a physicist.

References

(1) R. F. Field, The Behavior of Dielectrics Over Wide Ranges of Frequency, Temperature, and Humidity. Paper prepared for General Radio Company, Cambridge, Mass.

(2) High Dielectric Constant Ceramics, NDRC Div. 14, No. 300, August 1944. Report by Laboratory for Insulation Research of MIT, available from Publication Board, U. S. Department of Commerce.

(3) H. R. Donley, Effect of Field Strength on the Properties of Barium Strontium Titanate, *RCA Review*, 8, No. 3, September 1947.

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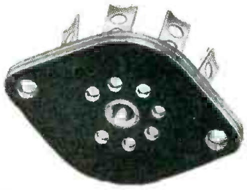

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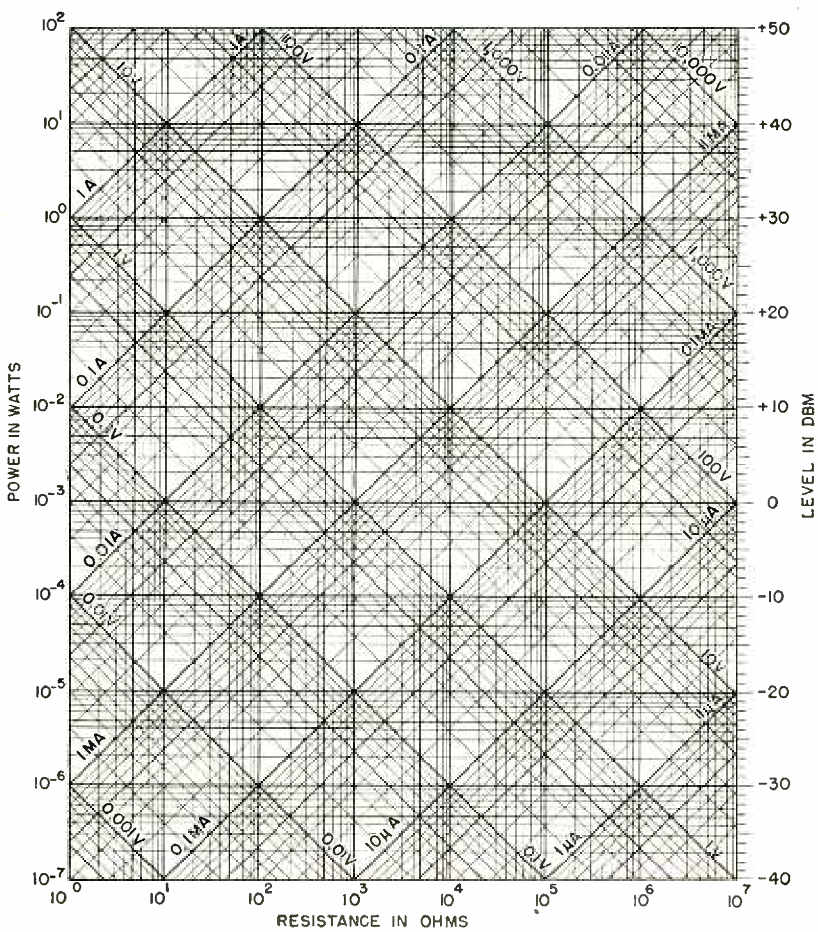
Graphical Power-Level Computations

Chart relating current, voltage, resistance and power in watts or dbm simplifies numerical calculations. Given any two of these parameters, the other two can be found directly from the chart

By **DANIEL C. NUTTING**
Seattle, Wash.



WHERE THE ACCURACY of calculations involving Ohm's laws for power and voltage need not be high the accompanying chart will save time. Typical uses include checking wattage of resistors, choosing dropping and current-limiting resistors, and comparing power levels at points of different impedances in amplifiers and other circuits.

On the log-log chart the horizontal axis represents resistance and the vertical axis represents power. Superimposed on these coordinates is a similar set of log-log coordinates drawn at 45 deg with respect to the others. These latter coordinates represent current and voltage.

The chart solves equations of the form $wx = y$ and $xy = z$ (or $wx^2 = z$ and $y^2/w = z$).

Given any two parameters, the other two are located at the intersection of the indicated coordinates. For example, if the measured potential across a 20,000-ohm load resistance is 30 volts, the chart indicates that the load consumes 0.045 watt and draws 1.5 milliamperes.

The auxiliary scale on the right-hand margin of the chart gives the power in terms of decibels with reference to one milliwatt, as is customary in communication measurements.

ELECTRONICS REFERENCE SHEET

TUBES AT WORK

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Edited by VIN ZELUFF

STL on 950-mc Band

EQUIPMENT installed as the studio-to-transmitter link for f-m station WFMI, Portsmouth, N. H., operates on 940.5 megacycles, perhaps the first permanent stl on that frequency. Because Portsmouth is only 50 feet above sea level, the broadcast transmitter is located on Saddleback Mountain, 1,180 feet high and 21 miles distant.

Studio-transmitter link equipment was designed to meet FCC requirements for f-m stations relaying their programs from the studio to transmitter in instances where, for one reason or another, wire lines are not feasible.

The basic exciter unit used in Harvey Radio Laboratories f-m broadcast transmitters has been slightly modified by the manufacturer. This unit utilizes the Phasitron system as shown in the block diagram of Fig. 1. For the stl, the normal crystal frequency of 200 kc is changed to 400 kc since the frequency stability tolerance can still be easily met and one stage of frequency multiplication is eliminated.

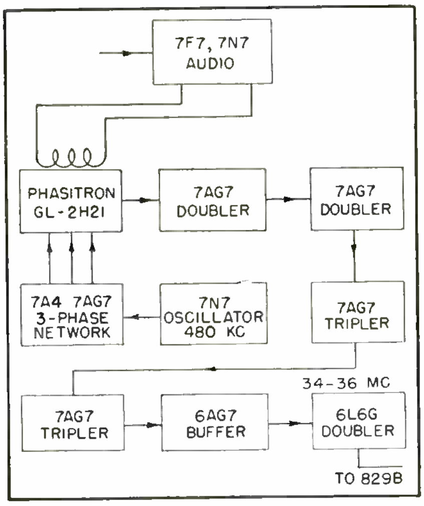

FIG. 1—Stages of the exciter unit for f-m stl transmitter

The series of doubler and tripler stages produces an output from this exciter unit at 34 to 36 mc. Conventional circuitry is used with complete metering of all circuits.

The circuit of the power tripler panel is shown in Fig. 2. This contains an 829B operating class C tripling from 34-36 mc to 102-109 mc, which drives a pair of 2C43 lighthouse triodes in push-pull tripling from 102–109 mc to 306–327 mc. The 829B stage is a conventional lumped-constant circuit. The input circuit of the second tripler is also a lumped-constant circuit but the plate circuit is tuned by parallel lines.

The input circuit of the third tripler, also a pair of 2C43 tubes, is a parallel line circuit and the plate circuit utilizes precision cavities tuned to final frequency.

The final amplifier is a grounded-grid 2C43 lighthouse tube in a tunable cavity circuit, having an output of 5 watts. The filament transformer which supplies all lighthouse tubes is controlled by a Variac and monitored by a voltmeter.

Measurements in the laboratory and in the field show that the transmitter meets the requirements laid down. The tuning range is 920 to 980 mc; frequency stability is better than the requirement—being 0.001 percent; frequency deviation is ±200 kc; f-m hum and noise level is better than 70 db below 100 percent modulation; a-m hum and noise level are more than 50 db down; the frequency response of the audio system matches the standard 75-microsecond preemphasis curve to within 1 db from 50 cps to 15 kc; a-f distortion is less than 0.5 percent between 100 cps and 7.5 kc and less than 1 percent from 50 cps to 100 cps and from 7.5 kc to 15 kc.

A block diagram of the receiver

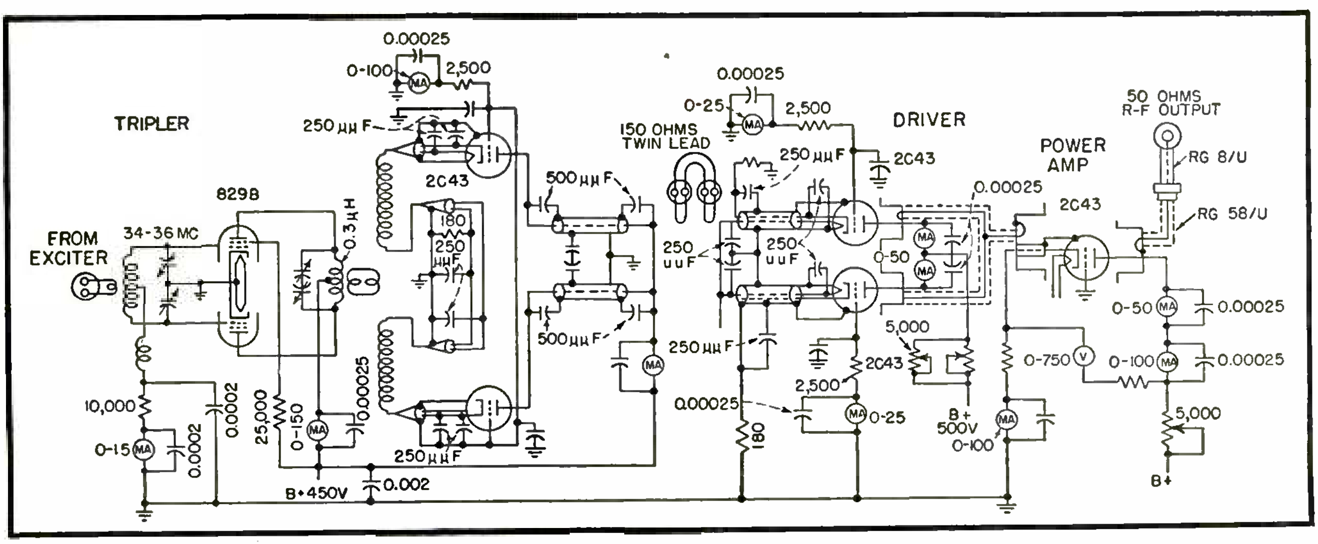

FIG. 2—Tripler stages are driven by the exciter at 35 mc and provide output on 950 mc

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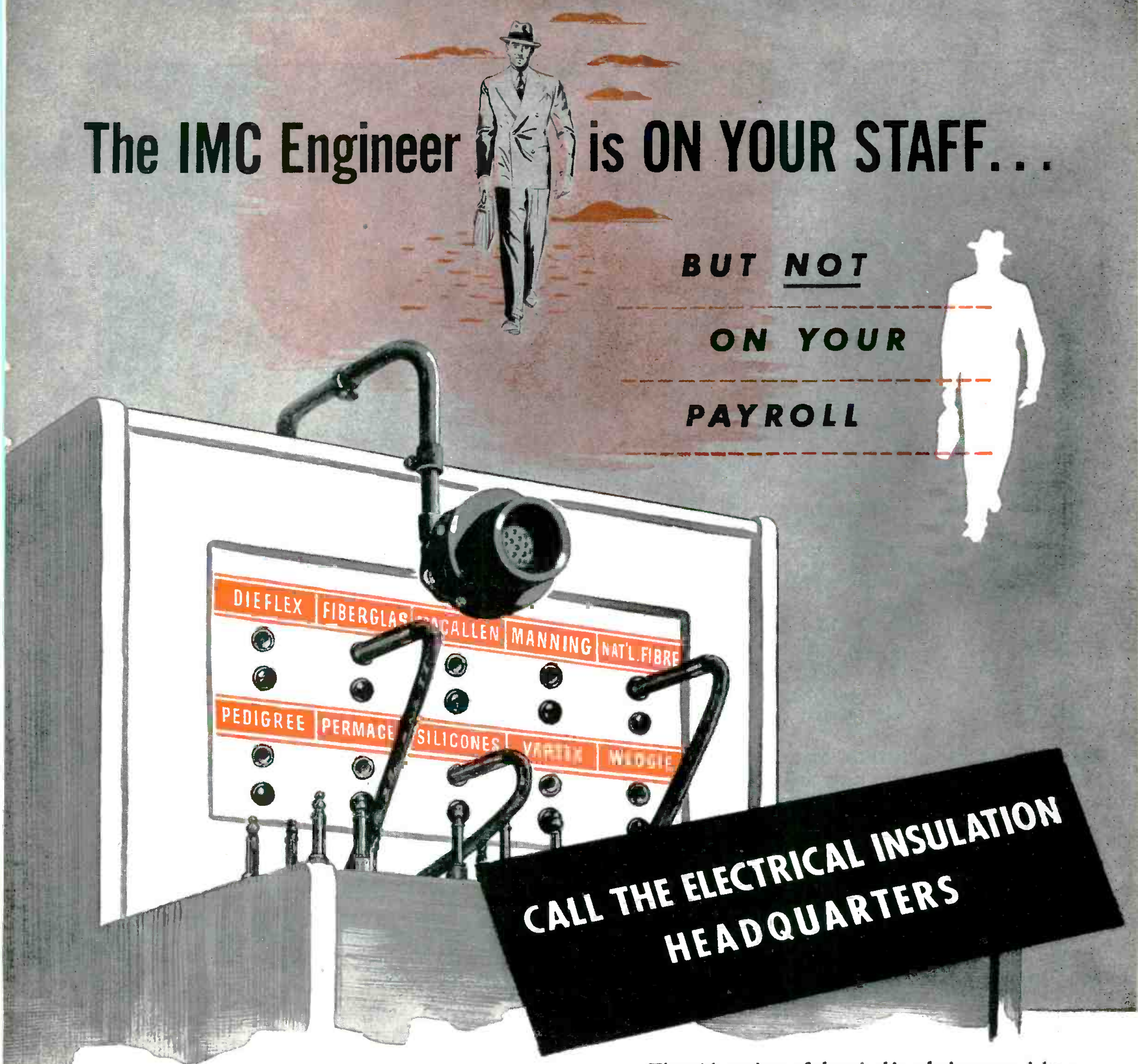

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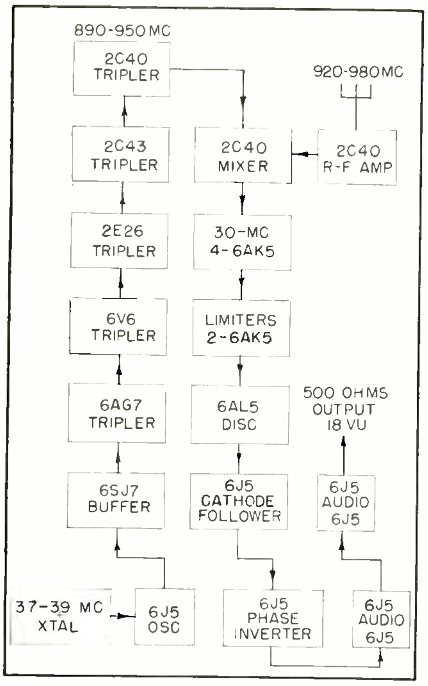


FIG. 3—Block diagram of receiver stages including the multi-stage local oscillator

is shown in Fig. 3. The i-f is 30 mc, requiring local oscillator power at 890–950 mc for reception of 920–980 mc. This frequency is obtained by the series of triplers shown.

The oscillator is crystal-controlled, using a temperature-controlled crystal in the vicinity of 3.8 mc. This circuit is provided with a vernier control to allow precise tuning to the transmitter frequency. Conventional frequency multipliers using double-tuned critically-coupled circuits for prevention of spurious radiation follow the crystal oscillator. A lighthouse tube multiplier in a parallel line circuit is used for the 100 to 300-mc tripler and the last tripler is also a lighthouse tube, in a tunable cavity circuit, providing output between 890 and 950 mc.

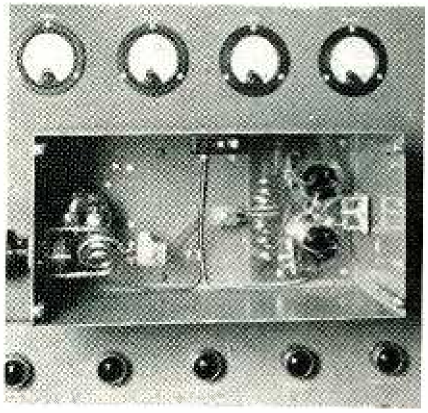
A control is provided for the d-c filament voltage which is used on the audio stages, the local oscillator, the r-f amplifier, and the mixer.

The r-f amplifier is a grounded-grid lighthouse tube in a tunable cavity circuit. Another lighthouse tube is used for the mixer, and its cavity is mounted just below the r-f stage. Adjustable local oscillator injection is provided into the mixer cavity.

The i-f amplifier is a 4-stage 30-mc amplifier using double-tuned, iron core transformers to provide a bandwith of 600 kc. The amplifier has a flat response characteristic over the bandpass.

Following the i-f, cascaded limiters feed the discriminator. A cathode follower isolates the low impedance de-emphasis circuit from the discriminator, providing loading which does not vary with frequency. A vtvm measures discriminator output, to provide a reading of kilocycles off resonance.

The audio system, shown at the upper right in Fig. 3, consists of a phase inverter followed by two push-pull stages. Triodes are used

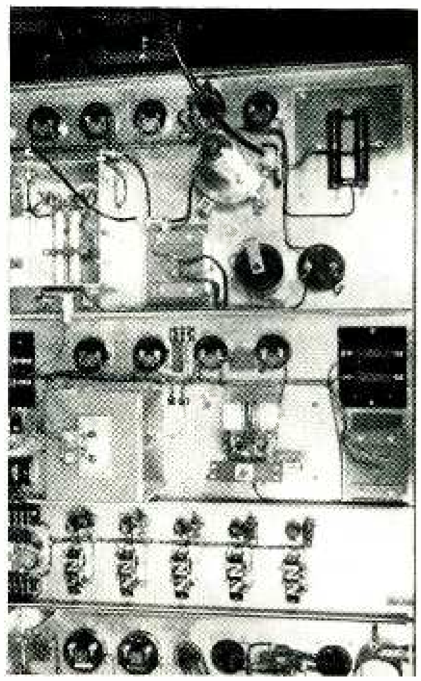


Closeup view of the 30-100 and 100-300 mc tripler stages

throughout for minimum distortion. A precision gain control having 45 steps of 1 db each is used to control the output. Maximum output is +18 vu and is monitored by a vu meter. Balanced 500/600-ohm output is provided. Audio frequency distortion is less than 0.5 percent from 50 cps to 15 kc.

Measurements in the laboratory and in the field show that the receiver is quieted by an RMA quieting signal of 3 microvolts, that its noise figure is 10 db and that the hum and noise level is more than 70 db down. Because of the high frequency stability of the receiver, it is possible to use it as a partial frequency monitor.

Either of two types of antennas are used with the stl. The corner-reflector type has a gain of 12 db and its directivity characteristics are such that at all azimuth angles greater than 30 degrees from the direction of maximum directivity, the power is down 15 db. The paraboloid antenna uses a 72-inch re-



Cavities and coupling circuits of the r-f portion of the uhf transmitter

flector which provides a gain of 23 db.

The standard corner reflector antennas are intended for use at line-of-sight distances of ten to fifteen miles. For ranges in excess of about twelve miles and up to about twenty-five miles, a paraboloid antenna at one end of the circuit will probably be necessary. For distances greater than twenty-five miles or short paths where not quite line-of-sight conditions exist, two paraboloids are recommended. Maximum distance for reliable operation is about thirty-five miles.

Resistance Deviation Bridge

Joseph C. Frommer
Electronic Engineer
Cincinnati, Ohio

THE instrument to be described was developed following the need for selecting and matching resistors in groups of ±0.5 percent. It consists of a Wheatstone Bridge containing two built-in equal arms, one pair of terminals for the resistor to be tested and one pair of terminals for any desired resistor to be inserted as a standard of comparison. The bridge is fed by 12 volts of d-c and balance is detected by a vacuum-tube voltmeter. The output of the

(continued on p 140)

YOU GET QUALITY PLUS ENGINEERING SERVICE WITH G-E PERMANENT MAGNETS

New Magnetic Focusing Assembly by G.E.'s Electronics Department

PROBLEM—
DESIGN CAST ALNICO 6 RING FOR MAGNETIC FOCUSING ASSEMBLY.

The Magnet that gives Television the new look

Now it's permanent magnets for better television reception. The permanent magnet shown above keeps electrons on the beam . . . eliminates blurring of the television picture. Once the set has been focused further adjustments are unnecessary. And, the use of a G-E permanent magnet results in greater efficiency since no heat is generated by the Cast Alnico ring magnet.

An outstanding feature of this ring magnet is the very thin wall section developed by G-E process engineers. Heretofore this was possible only with sintered magnets. Better permanent magnets as well as new applications are constantly being developed by G-E engineers.

Perhaps you can improve the efficiency of your product with G-E permanent magnets. General Electric will be glad to work with you to improve your product. Greater flexibility of magnet design is possible with the many G-E permanent magnet materials now available. All are produced under rigid quality control methods. This assures you of receiving magnets of the highest uniform quality for your application.

Clear, sharp television reception with the new G-E Magnetic Focusing Assembly.

The magnetic field set up by the assembly focuses the electron beam on the television screen. The combined effect of the G-E Cast Alnico 6 permanent magnet and a small coil produces this magnetic field axial with the tube neck. The ring magnet supplies the bulk of the magnetic flux while the coil acts as a vernier adjustment. The punched pole pieces collect the magnetic flux and direct it into a uniform radial pattern.

Outstanding advantages of this new assembly are increased efficiency and compactness. Defocusing due to line voltage fluctuation and warm-up drift is eliminated.

METALLURGY DIVISION
CHEMICAL DEPARTMENT, SECTION CM-8
GENERAL ELECTRIC COMPANY
PITTSFIELD, MASS.

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PERMANENT MAGNETS

GENERAL ELECTRIC

CD48-V8

THE ELECTRON ART

Edited by FRANK ROCKETT

Improved Material for Magnetic Amplifiers

SUCCESSFUL APPLICATION of magnetic amplifiers[1] has stimulated investigation of these devices. At a symposium on magnetic materials held in Washington, D. C., June 15, development of a suitable core material, carried out at the Naval Ordnance Laboratory, White Oaks, Md., was described by G. W. Elmen, consultant to the laboratory, and E. A. Gaugler[2], and E. Both, Squire Signal Lab; A. O. Black, of NOL, described the characteristics of electromagnetic amplifiers that could be obtained with the new core.

Frank Logan, Vickers Electric Div., Vickers Inc., reviewed development of saturable reactors and magnetic amplifiers including an experimental two-stage audio amplifier driven by a single-button carbon microphone and delivering 15 peak watts to a dynamic speaker. Otto Jensen, Rectifier Div., I.T.E. Circuit Breaker Co., showed how highly efficient electromechanical rectifiers could be built using saturable reactors.

The following material is a coordinated summary of the information presented in these several papers.

Rectangular Hysteresis Loop

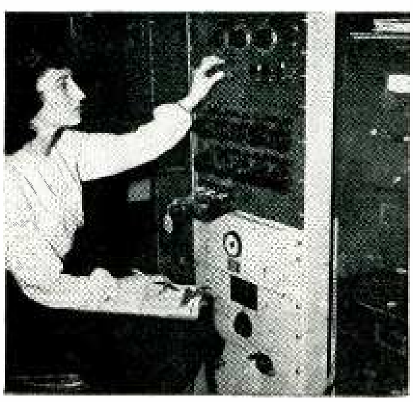
Several methods have been developed to produce materials having substantially rectangular hysteresis loops as shown in Fig. 1. A German process consists of drastic cold reduction followed by annealing in hydrogen at about 1,100 C for two hours and rapid cooling of very pure 50-50 nickel-iron alloy. At the Bell Telephone Labs 69 permalloy and some of the perminvars were found to display rectangular loops when cooled in magnetic fields. Mihara, in Japan, recently obtained similar results by cooling very pure silicon steel in a magnetic field.

The technique perfected and adapted to mass production at NOL for producing permenorm 5000-Z is a combination of cold reduction and annealing. Precautions are taken to minimize impurities introduced by both the raw materials and the melting of the alloy, which consists of equal portions of nickel and iron. Melting and casting are done under vacuum, resulting in an oxygen and carbon content below 0.01 percent. The ingots are hot rolled to 0.24 inch, then cold rolled without annealing to below 0.10 inch, resulting in 98 percent reduction. The sheets are slit into the desired tape width (0.014 inch) and finally rolled to a thickness of 0.0012 or 0.002 inch. The tape is then insulated by conventional methods and wound into spiral cores. These cores are heated in pure dry hydrogen to an optimum temperature determined magnetically from samples for each melt. After two hours the cores are rapidly cooled.

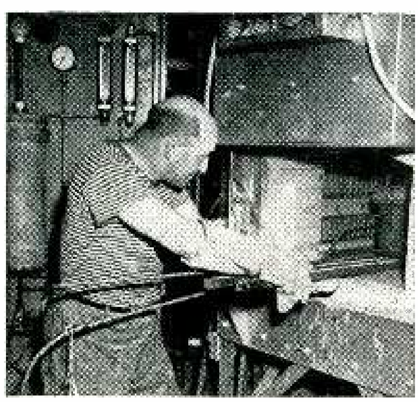
To preserve the rectangular characteristics and the sharp knee, the cores should not have air gaps, hence the uncut wound toroidal form. The magnetic field must be uniform over the entire cross section, requiring a narrow annular width relative to the mean radius. After the final heat treatment the cores should not be mechanically strained, therefore they are mounted in forms that support the windings. Because the transient time of reversals of saturation are very short in the applications of these cores, thin tape and high specific resistance are necessary.

Magnetic Amplifiers

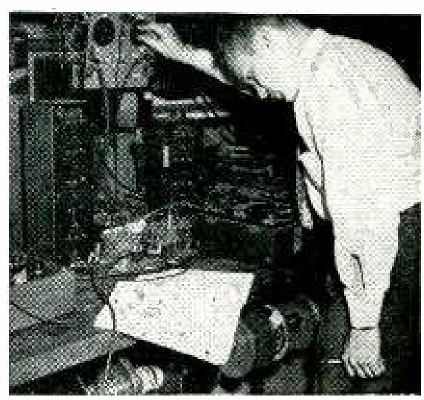
Although numerous attempts have in the past been made to develop magnetic amplifiers, these devices have had limited application. With an understanding of



At Naval Ordnance Lab materials are measured to find those best suited for magnetic amplifiers



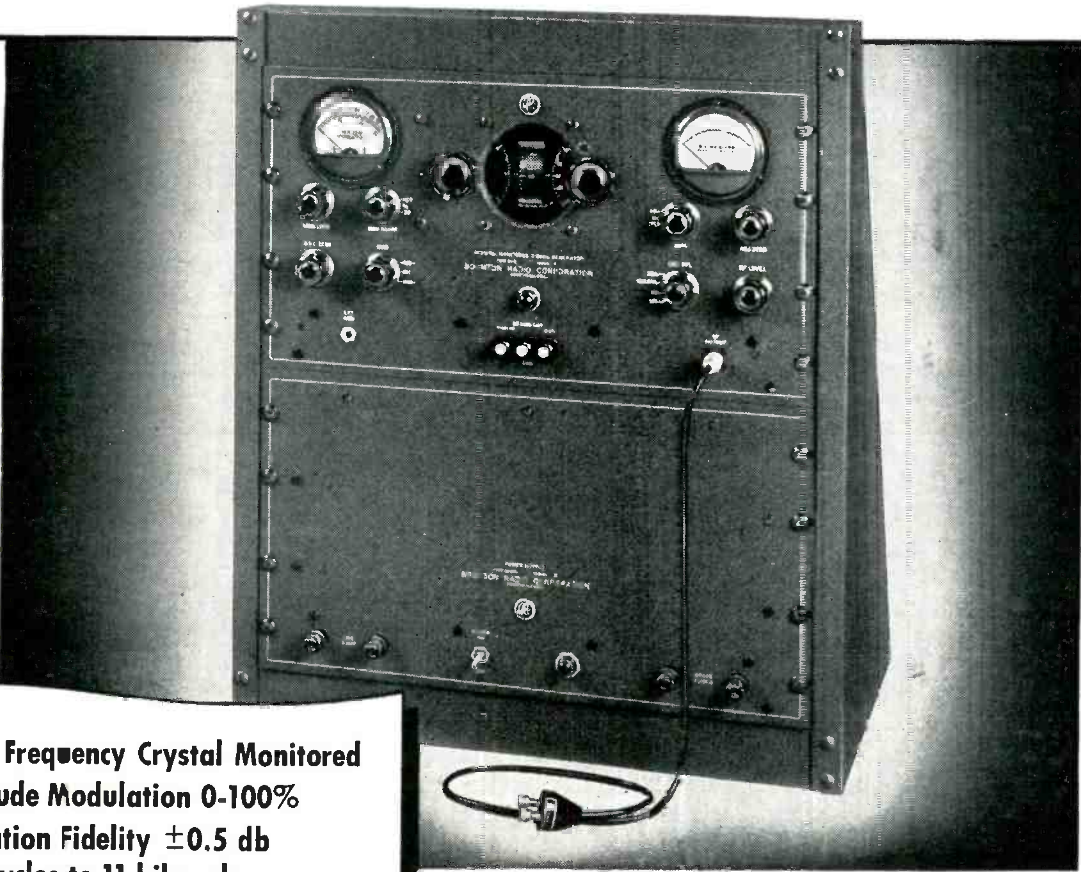
Properties of new core material depend on its being annealed under carefully controlled conditions



Magnetic amplifiers produce power gains of several thousand per stage, twice that previously possible

A NEW AMPLITUDE MODULATED SIGNAL GENERATOR

Type 211-A • Frequency Range 88-140 Megacycles



Output Frequency Crystal Monitored
Amplitude Modulation 0-100%
Modulation Fidelity ±0.5 db
30 cycles to 11 kilocycles
Negligible Spurious FM

SPECIFICATIONS

FREQUENCY RANGE: Master Oscillator: 88-140 megacycles in one range. Vernier frequency dial has 100 divisions and is coupled to the main tuning capacitor through a 120:1 gear drive. Each vernier division is equivalent to a 10 kc. change in frequency.

Crystal Controlled Frequencies: Either of two crystals 110.100 mc. and 114.900 mc., accurate to ±0.0035%, may be selected by a switch for use individually or in combination with the master oscillator to standardize its output frequency.

AMPLITUDE MODULATION CHARACTERISTICS: Two amplitude modulation ranges, 0-30% and 0-100%, are provided for use with the internal oscillator or a low distortion external oscillator. Distortion is 5% or less at 95% amplitude modulation.

Internal Audio Oscillator: Two modulating frequencies, 400 and 1000 cycles.

Modulation Amplifier: The internal modulating amplifier has the following characteristics:

Uniform response within ±0.5 db. 30 cycles to 11 kc.
Uniform response within ±0.1 db. 90 cycles to 150 cycles.
Uniform response within ±0.1 db. 9500 cycles to 10.5 kc.

Phose Distortion: (up to 60% omplitude modulation.)

Less than 0.25 degrees at 30 cycles.
Less than 10 degrees at 11 kc.

AUDIO TEST VOLTAGE: This instrument contains a demodulator or detector which supplies to front panel terminals a portion of the demodulated carrier.

SPURIOUS FM: Less than 1 kc. at 60% AM.

OUTPUT ATTENUATOR: Single ended piston type, adjustable from 0.2 volt to 0.1 microvolt. Output impedance as seen looking in at terminals of output cable is 26.5 ohms.

The Type 211-A Signal Generator is specifically designed for the testing and calibrating of omni-range radio receiving equipment. It is also well suited for laboratory and development work where a precision type amplitude modulated R.F. signal source is required.

Careful consideration has been given to the location of panel controls with respect to function and degree of use. The main frequency dial is located in the center of the panel, with the vernier dial to the left in close proximity, utilizing the same fiducial for simplicity and ease of operation. Symmetrically located to the right of the frequency dial is the output attenuator dial, directly calibrated in microvolts. The center panel enclosure embodies those controls which the operator will have the greatest occasion to use, permitting rapid, accurate settings to be made with maximum convenience.

The calibration accuracy of the frequency dial settings is ±0.25% at any point; however since crystal controlled frequencies are also available within the instrument, zero beats may be obtained from which the output frequency may be standardized to an accuracy of about ±0.025% by slipping the vernier frequency dial with respect to the main frequency dial. This feature permits the identification and checking of channel frequencies differing by as little as 100 kc.

Write today for complete details!

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FREQUENCY MODULATED SIGNAL GENERATOR · BEAT FREQUENCY
GENERATOR AND OTHER DIRECT READING INSTRUMENTS

BOONTON RADIO *Corporation*
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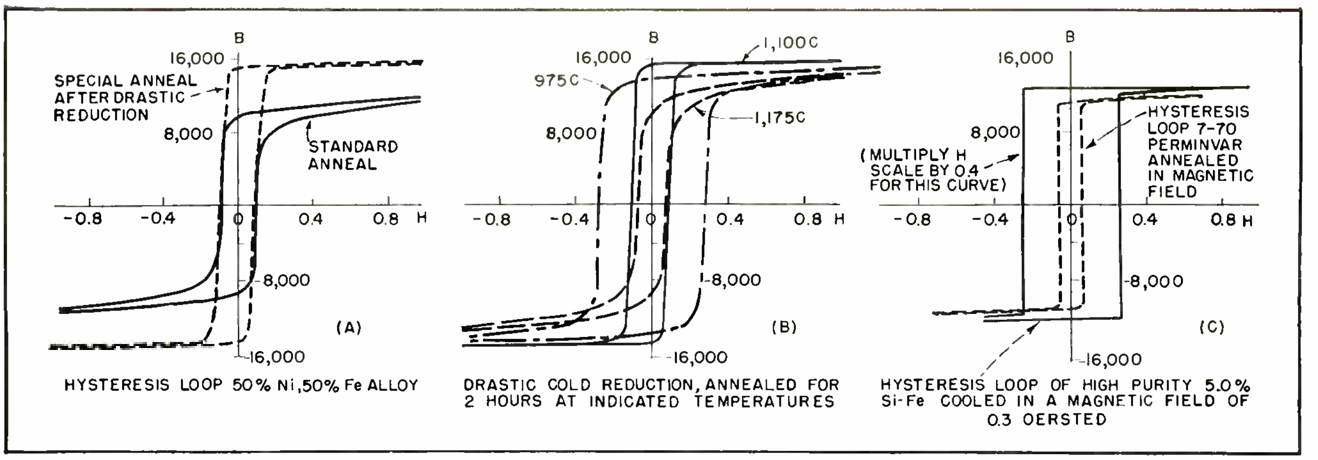


FIG. 1—Hysteresis loops are made rectangular by (A) special annealing which must be done at a critical temperature (B), or by annealing in a magnetic field (C)

the theory of their operation,[3] engineers in Europe have produced successful units.[4] Development of improved magnetic core material opens the possibility that these amplifiers can be used more widely, especially in rugged industrial control equipment that must require little maintenance.

Operation of a magnetic amplifier can be followed from the series of curves shown in Fig. 2; the action is similar to that of a thyratron. Consider a simple reactor having two windings, one carrying the alternating current that is to be controlled, the other carrying the direct control current. With zero control current the reactor presents high impedance at all values of applied alternating voltage so that negligible power is developed in the load. With a slight amount of control current the core is saturated at the peak of the load current cycle; it then presents low impedance and power is momentarily developed across the load. Hysteresis causes the power pulse to be unsymmetrical. The portion of the cycle during which load current can flow is increased as the control current is increased.

The core size and ampere-turns are so proportioned for the power to be controlled that at zero control current the core does not become saturated and at full control current the core is saturated during the full positive half cycle. To obtain the optimum range of output for a given reactor and control signal the maximum flux density at cutoff is adjusted so that the hysteresis loop is symmetrical and shows a total excursion of flux density just less than twice the saturation flux density of the material. For high power capacity the knee of the hysteresis curve should occur at high density. For high amplification the magnetizing force at the knee should be small. These design requirements can be realized readily with the new core material.

For practical operation two reactors, or their magnetic equivalent, are used. The control windings are so arranged that the fundamental component of the a-c induced into them by transformer action cancels, and so that full-wave operation can be obtained. Figure 3 compares the results obtainable with permenorm 5000-Z and standard electrical steel.

Electromechanical Rectifier

Efficient high-current rectifiers are needed in the chemical and transportation industries to convert a-c to d-c. Although mercury arc and similar electronic rectifiers are widely used in this application, mechanical rectifiers have also been used. Figure 4 shows the elements of such a unit. To prevent destructive arcing, commutation should take place at zero phase current. However, a sinusoidal alternating current is changing most rapidly at zero so that it is difficult to time

(continued on p 164)

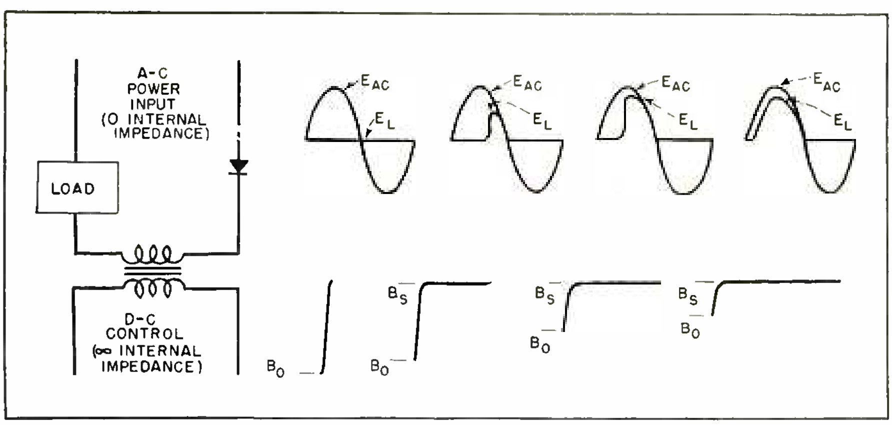


FIG. 2—Bias current serves to regulate portion of cycle during which reactor permits voltage to develop across load

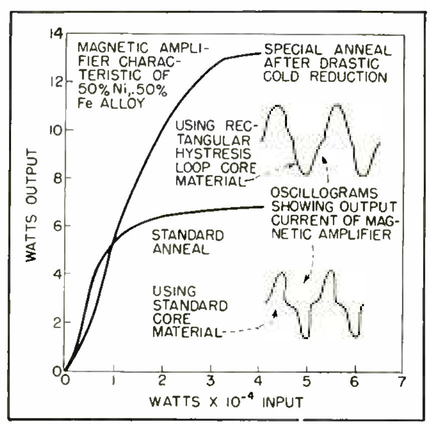
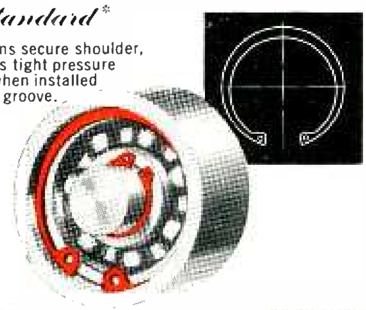


FIG. 3—Comparison of amplifiers using differently treated cores

Send for new 28-page data book on Waldes Truarc Retaining Rings

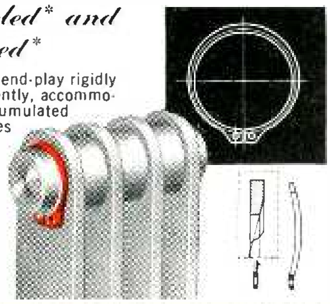
Standard*

Forms secure shoulder, gives tight pressure fit when installed in a groove.



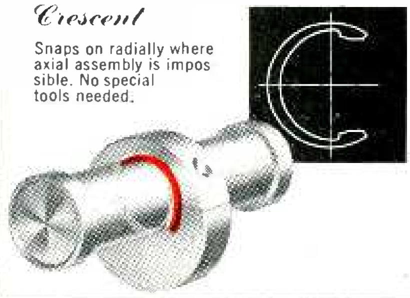
Beveled* and Bowed*

Take up end-play rigidly or resiliently, accommodate accumulated tolerances.



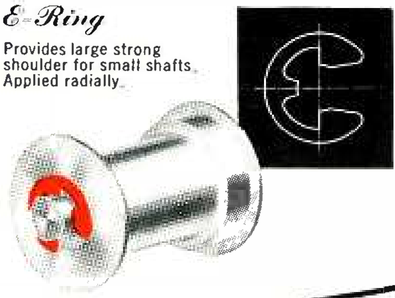
Crescent

Snaps on radially where axial assembly is impossible. No special tools needed.



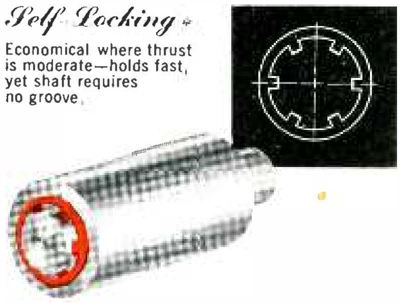
E-Ring

Provides large strong shoulder for small shafts. Applied radially.



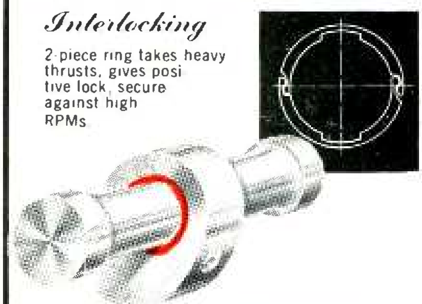
Self-Locking*

Economical where thrust is moderate—holds fast, yet shaft requires no groove.



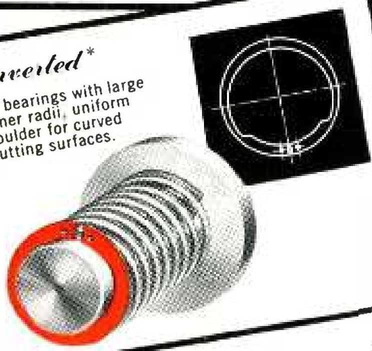
Interlocking

2-piece ring takes heavy thrusts, gives positive lock, secure against high RPMs.



Inverted*

For bearings with large corner radii, uniform shoulder for curved abutting surfaces.



COMPLETE ENGINEERING SPECIFICATIONS AND DATA, with 28 pages of charts for all standard types of Truarc rings, now available upon request. Data includes ring dimensions; housing and shaft dimensions; groove dimensions; thrust load capacities; materials; tensile strengths; types of finishes. There are charts supplying engineering recommendations and Truarc ring specifications for standard ball bearing assemblies.

Here is everything you need to know to use and specify time and money-saving Truarc rings. You will find there's a Waldes Truarc precision-engineered retaining ring to answer every positioning and fastening need. Send for your free copy of this data book today.

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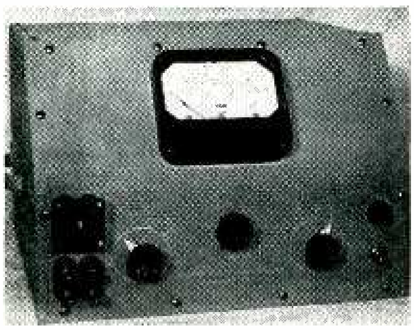
NEW PRODUCTS

Edited by A. A. McKENZIE

New equipment, components, tubes, testing apparatus and products closely allied to the electronics field. A review of catalogs, handbooks, technical bulletins and other manufacturers' literature

Wide-Range Wattmeter

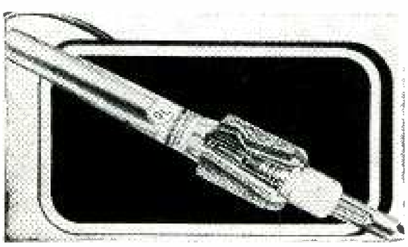
ANDERSON-FLUKE ENGINEERING Co., Box 815A, Springdale, Conn. Model 101 VAW meter measures volts, amperes and watts over a frequency range of 20 to 200,000 cps. Eight voltage ranges from 0.1 to 300v and ten current ranges 0.001 to 30 amp. provide power readings from 100 microwatts to 9 kw. Input resistance is 1 megohm



in parallel with 25 micromicrofarads. Powered by 117 volts at 60 cps, the electronically regulated power supply and feedback amplifiers make for stable calibration. Literature is available on request.

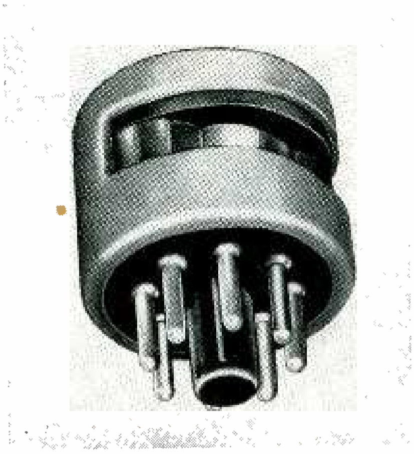
Soldering Pencil

UNGAR ELECTRIC TOOL Co., Los Angeles 54, Calif. A new soldering pencil with interchangeable tips operates from socket power and heats to 600 degrees in 90 seconds. The pencil is 7 inches long and has a maximum diameter of 1 inch.



Tape Recorder Heads

WEBSTER ENGINEERING Co., 421 Sinclair Ave., S. E., Cedar Rapids, Iowa. Plug-in magnetic tape recorder heads can be used in any



octal tube socket and are furnished in a variety of coil and impedance arrangements. Both playback and erase heads have steel covers.

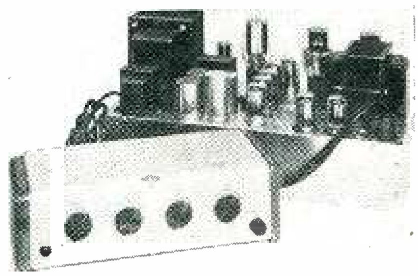
Tape Recorder Chassis

MAGNEPHONE DIVISION, AMPLIFIER CORP. OF AMERICA, 398-7 Broadway, New York 13, N. Y. The Twin-Trax tape recorder chassis has an attainable frequency response of 50 to 9,000 cycles ±3 db. An automatic switch and solenoid instantly reverses direction of tape travel at the end of the reel. Facil-

ities are available for the use of a turntable and phono-pickup for disc record playback, or for copying records onto tape. Twin-channel stereophonic recording for 3-dimensional effect is possible.

Remote-Control Amplifier

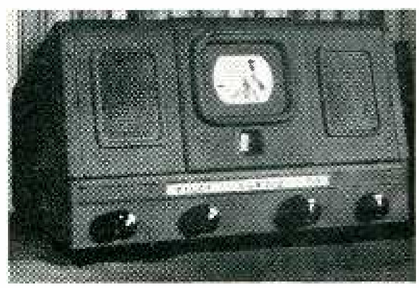
BROOK ELECTRONICS INC., 34 De-Hart Place, Elizabeth 2, N. J., has a new remote-control model 10C3 amplifier designed essentially for custom-built radiophonographs. The smaller of the two chassis shown contains the preamplifier



stages, input jacks and operating controls. The larger contains the 30-watt power amplifier and power supply. Frequency response is flat within 0.2 db from 20 to 20,000 cycles.

Miniature Televiser

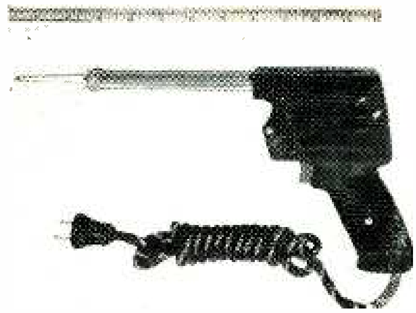
PILOT RADIO CORP., 37-06 Thirty-Sixth St., Long Island City, N. Y. The Candid-TV home television receiver employs a new 3-in. cathode ray tube and weighs 15 pounds.



Continuous tuning of all bands with conventional components helps to keep the retail price at $99.50.

Soldering Gun

WELLER MFG. Co., Easton, Pa. The new 12-inch soldering gun is designed for particularly long-reach requirements such as telephone



multiple maintenance. Dual heat at 100 and 135 watts is provided, with operation on 115 volts at 60 cycles. Like the other models it has five-second heating, built-in transformer, prefocused spotlight and trigger switch.

Sound Level Meter

HERMON HOSMER SCOTT, INC., 385 Putnam Ave., Cambridge 39, Mass. Type 410-A sound level meter has a range 34 to 140 db above the ASA

reference level and has standard weighting characteristics. The microphone can be used on an extension cable if desired. Net weight is about 2 pounds.

R-F Oscillator

TECHNOLOGY INSTRUMENT CORP., 1058 Main St., Waltham 54, Mass. Type 410-A r-f oscillator is a general-purpose laboratory instrument and a signal source for r-f bridges. It is provided with output voltmeter and a continuously adjustable level control. Frequency range is 100 kc to 10 mc in six bands. Internal modulation at 1,000 cycles is provided. Output impedance is approximately 50 ohms. In the May issue of this magazine the manufacturer's name was erroneously given.

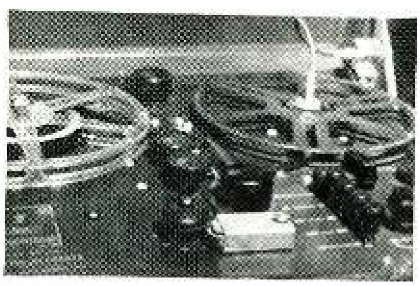
Ultrasonic Tester

SPERRY PRODUCTS, INC., 1505 Willow Ave., Hoboken, N. J. Type SR05, a new Supersonic Reflectoscope, is used for nondestructive

testing of metals and other materials for internal defects. The unit measures 14 × 16 × 23 inches, is portable, and weighs about 85 pounds.

Tape Accessory

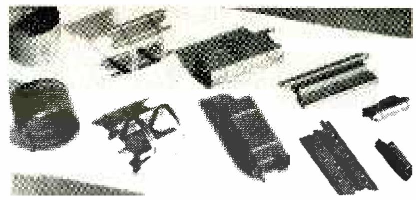
INLAND SALES INC., 622 N. Monroe St., Spokane 11, Washington. An accessory that improves performance of the Brush Soundmirror, designated Tru Speed Pressure Roller, is available. The illustra-



tion shows method of mounting. The roller can be swung away from the capstan for tape threading but locks in position when the machine is in operation.

Aluminized Steel

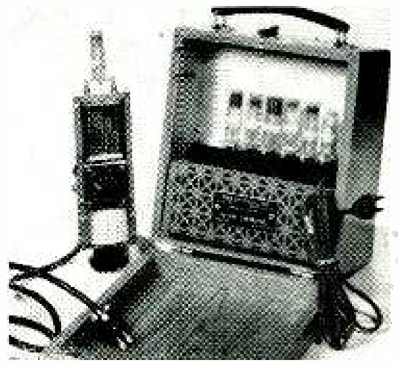
SYLVANIA ELECTRIC PRODUCTS INC., Emporium, Pa. A new type of aluminized steel provides a surface with heat-radiating properties 85 percent of the perfect black body. It evolves a minimum of gas when



used in the manufacture of vacuum tubes. Finished strip is ductile, has a black finish, and is 0.005 inch thick.

Grid Dip Oscillator

DE VINE LABORATORY, Madison, N. J. Model 70 Grid dip oscillator covers the range from 2 to 200 megacycles, using 7 coils. Operated

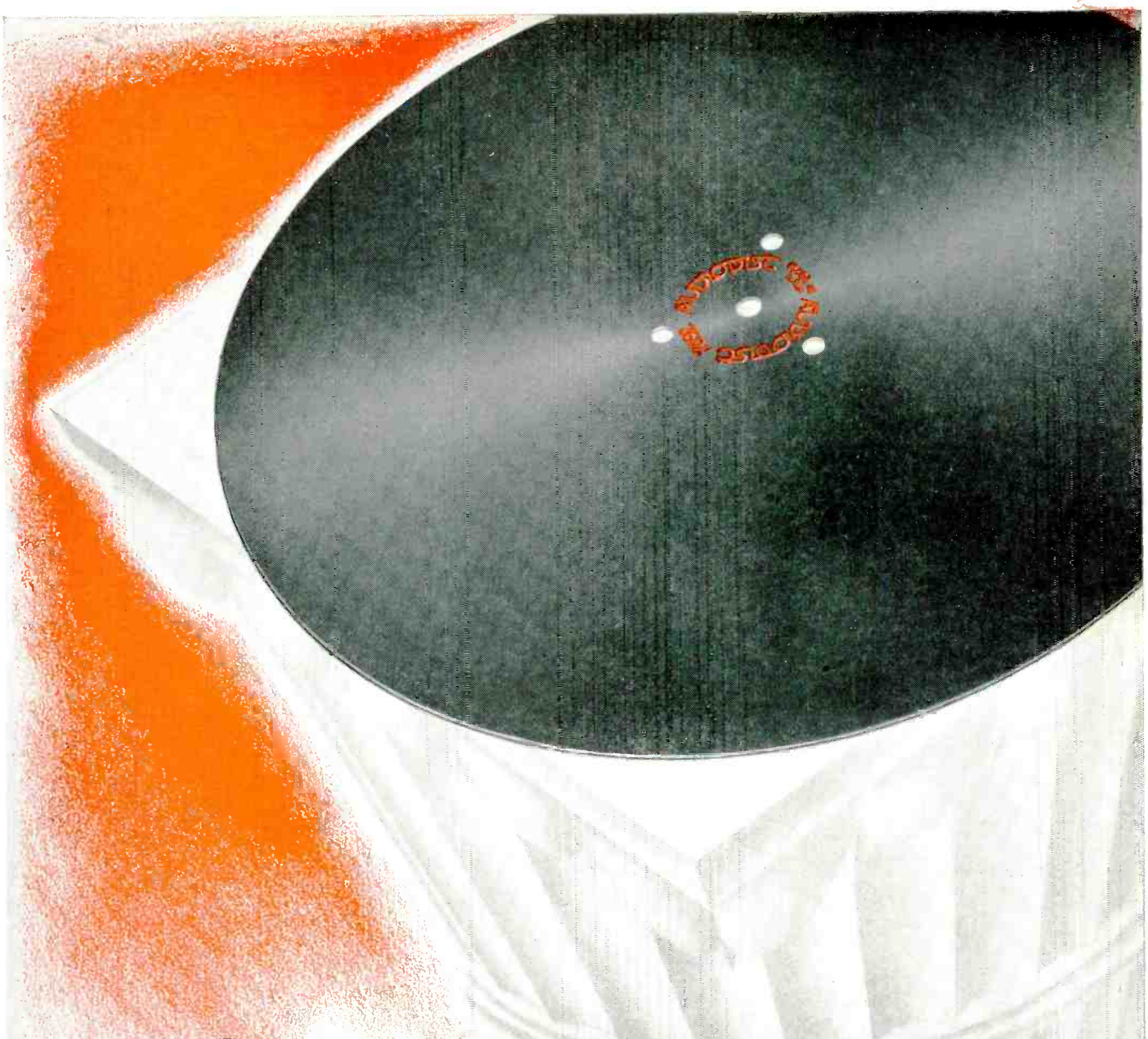


without plate voltage, the unit acts as an absorption type meter with indicating meter. Batteries can be substituted for the a-c power supply unit.

Tape Recorder

DORMITZER ELECTRIC & MFG. CORP., 782 Commonwealth Ave., Boston, Mass. Three motors are used in a new magnetic tape recorder that

(Continued on p 176)



TEN YEARS OF LEADERSHIP

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During this decade AUDIODISCS have been rated first in every field of sound recording . . . radio broadcasting, commercial recording studios, the phonograph record industry, motion picture studios, educational institutions, home recording, research laboratories and governmental agencies. In every country throughout the world, AUDIODISCS are regarded as the true standard of recording quality.

At first the output of AUDIODISCS was measured in tens of thousands, then in hundreds of thousands and later in millions per year. Today this highest rate of production is being maintained and the quality is the finest yet achieved.

AUDIO DEVICES, INC., 444 Madison Avenue, New York 22, N.Y.

Export Department: Rocke International Corp., 13 E. 40th Street, New York 16, N. Y.

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THEY SPEAK FOR THEMSELVES

they speak for themselves **audiodiscs**

NEWS OF THE INDUSTRY

Edited by JOHN MARKUS

Largest television hookup; low-powered f-m is authorized by FCC; 65 scientists receive awards; reviews of 12 new books

Commercial Facsimile

FACSIMILE service on a commercial basis can now be rendered by commercial f-m broadcast stations, as a result of a recent FCC decision. Simplex facsimile transmissions will be limited to one hour between 7:00 a.m. and midnight. Multiplex facsimile may be transmitted for a maximum of three hours during the same period.

The Commission at the same time amended its Engineering Standards to incorporate the following definitions:

The *index of cooperation* as applied to facsimile broadcasting is the product of the number of lines per inch, the available line length in inches, and the reciprocal of the line-use ratio. (Thus, 105 × 8.2 × 8/7 = 984).

The term *line-use ratio* as applied to facsimile broadcasting is the ratio of the available line to the total length of scanning line.

The term *available line* means the portion of the total length of scanning line that can be used specifically for picture signals.

The term *rectilinear scanning* means the process of scanning an area in a predetermined sequence of narrow straight parallel strips.

The term *optical density* means the logarith (to the base 10) of the ratio of incident to be transmitted or reflected light.

The following standards apply to facsimile broadcasting:

1. Rectilinear scanning shall be employed, with scanning spot progressing from left to right and scanned lines pro-

Preferred List of Army-Navy Electron Tubes

Filament Voltage	Diodes	Diode Triodes	Triodes	Twin Triodes	Pentodes: Remote	Pentodes: Sharp	Converters	Klystrons	Power Output	Tuning Indicators	Rectifiers	Miscellaneous: Cathode Ray	Miscellaneous: Crystals
1.4	1A3			3A5	1T4	1U4 1U5	1R5		3A4 3S4 3V4		1Z2 1B3GT/8016	2BP1 3DP1A 3JP(1,7,12)	1N21B 1N23B 1N25
5.0											5U4WG* 5Y3GT	5CP(1A,7A,12) 5FP(1A,7A,14) 5JP1 5SP(1,7)	1N26 1N31 1N32 1N43
6.3	2B22 6AL5W*	6AT6 6BF6	2C40 6C4 6F4 6J4 6N4	2C51 6AS7G 6J6 6N7GT 6SL7W* 6SN7W* 12AT7 12AU7 12AX7 5687	6BA6 6BD6 6SG7 6SK7 9003	6AC7W* 6AG5 6AN6 6AK5W* 6AS6 6AU6 6SH7 6SJ7W* 5656	6BE6 6SB7Y	2K22 2K48 2K26 2K50 2K28 2K54 2K29 2K55 2K41 6BL6 2K45	2E30 6AG7 6AK6 6AN5 6AQ5 6B4G 6L6WGA* 6Y6GT 6Y6G	6E5	6X4 6X5W*	7BP7A 10KP7 12DP7A **Voltage Regulators** 0A2 0B2 0A3/VR75 0C3/VR105	**Photo-tubes** 1P30 1P37 1P39 1P40 927
25 or over									25L6GT		25Z6GT	0D3/VR150	
Only types for 28 volts anode supply operation		26C6				26A6	26D6		26A7GT				

* Where the ruggedized version (W suffix) cannot be procured, a JAN prototype may be used, provided direct interchangeability is assured.

Triodes	Tetrodes	Twin Tetrodes	Pulse Modulation	Magnetrons	Rectifiers: Vacuum	Rectifiers: Gas	Rectifiers: Grid Control	Clipper Tubes	Gas Switching: ATR	Gas Switching: TR
2C39A 450TH 2C43 811 6C22 880 9C21 889RA 9C22 893A 100TH 893AR 250TH	4D21 5D22 807W* 4X150A	829B 832A	3D21A 3C45 3E29 4C35 5C22 6C21 715C	2J30–34 4J50 2J48 4J51 2J51 4J52 2J58 4J54–59 2J60 4J78 2J61A–62A 5J26 3J21 5586 5657	2X2A 3B24W 371B 5R4GY 836 1616 8020	0Z4A 857B 3B28 869B 4B26 1005 4B32 1006 6C 5517 16B	2D21 C6J 6D4 393A 394A 884	3B29 4B31 719A	1B35 1B36 1B37 1B44 1B51 1B52 1B53 1B56 1B57	1B26 1B27 1B32 1B50 1B60

Receiving types are listed in upper section, transmitting types below. This preferred list, dated May 7, 1948, supersedes the previous lists dated Jan. 28, 1947 and Jan. 28, 1948. The purpose of the list is to effect an eventual reduction in the variety of tubes used in Service equipment. It is mandatory that all tubes to be used in all future design of new equipments under the jurisdiction of the Army laboratories or the Navy department be chosen from this list. Provisions are made for certain exceptions, however. For permission to use other tubes in Army equipment, write to the Army Laboratory concerned with such equipment; for Navy equipment, write to Electronics Division, Bureau of Ships, Code 930-A, Navy Department, Washington, D. C.

High Voltage and HIGH KVA

CERAMICONS* *by Erie Resistor*

TELEVISION HIGH VOLTAGE FILTER CERAMICON

The newly developed Erie Type 410 Ceramicon provides a new high standard of dependability for high voltage filtering. Retaining the inherent high flashover protection of the original Erie Double-Cup design of the dielectric, extra safety factor has been added by a low-loss molded bakelite case designed to provide longest possible creepage path between terminals.

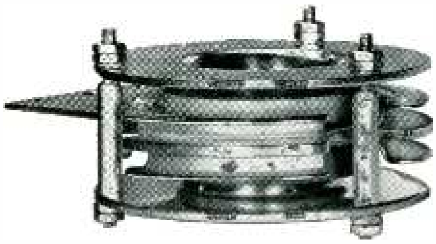
Specifications: Flash test—22,500 Volts; Life test—15,000 Volts at 85°C for 1,000 hours; Capacity, 500 MMF, ±20%.

9,000 VOLT BY-PASS CERAMICON

This new ceramic dielectric by-pass condenser is rated at 10,000 RMS test and 7 KVA load. Maximum operating temperature is 100° C. Type 2344 Erie Ceramicon is available in 1,000 MMF capacity. Size approximately 4 1/8" high.

200 AMP. FEED-THRU BY-PASS CERAMICON

Erie Type 2373 Ceramicon is ideal for power line terminals to by-pass radio frequency currents on industrial heating and similar equipment. Conservatively rated at 1,000 Volts DC. operated with current carrying capacity of 200 Amps. overall length 4½" Standard capacity ranges, 250 MMF, 650 MMF, 1,000 MMF, and 10,000 MMF.



10,000 VOLT, 20 KVA CERAMICON

This plate-type ceramic condenser combines ratings of 20 KVA and 10,000 Volts DC. with compact size, only 4⅜" dia. x 2-5/16" height. With forced air circulation rated load is above 50 KVA at 15 MC. Type 3688 Ceramicon is made in 500 MMF and 1,000 MMF capacities.

* Ceramicon is the registered trade name of silvered ceramic condensers made by Erie Resistor Corporation

Electronics Division

ERIE RESISTOR CORP., ERIE, PA.

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MEETINGS

AUG. 20-29: All-Electrical Exposition, Pan-Pacific Auditorium, Los Angeles, Calif.

AUG. 24-27: AIEE Pacific General Meeting, Spokane, Wash.

SEPT. 4-6: ARRL Convention, Milwaukee Auditorium, Milwaukee.

SEPT. 6-11: International television meeting, with exhibition Sept. 2 to 15, Swiss Federal Institute of Technology, Zurich. Address inquiries to Secretariat, International Television Meeting, Gloriastrasse 41, Zurich 6, Switzerland.

SEPT. 13-17: Third Instrument Conference and Exhibit, Convention Hall, Philadelphia, Pa.

SEPT. 20-23: Annual meeting, Associated Police Communication Officers, Inc., Rice Hotel, Houston.

SEPT. 27-OCT. 1: Third National Plastic Exposition, Grand Central Palace, New York City.

SEPT. 29-OCT. 2: Pacific Electronic Exhibition and IRE west coast Annual Convention, Biltmore Hotel, Los Angeles, Calif.

OCT. 5-7: AIEE Middle-Eastern District Meeting, Washington, D. C.

OCT. 11-12: FM Association Second Annual Convention, Sheraton Hotel, Chicago.

OCT. 12-16: Fifth National Chemical Exposition, Coliseum, Chicago, Ill.

OCT. 23-29: Annual convention, American Society for Metals, Benjamin Franklin Hotel, Philadelphia.

OCT. 25-28: Annual Fall meeting of the Institute of Metals Division, American Institute of Mining and Metallurgical Engineers, Hotel Adelphia, Philadelphia.

OCT. 25-29: National Metal Exposition, Commercial Museum and Convention Halls, Philadelphia.

OCT. 25-29: Annual Convention, American Welding Society, Bellevue-Stratford Hotel, Philadelphia.

OCT. 25-29: 64th semiannual convention, Society of Motion Picture Engineers, Hotel Statler, Washington, D. C.

OCT. 27-28: Annual Convention, Society for Non-Destructive Testing, Hotel Adelphia, Philadelphia.

NOV. 4-6 National Electronics Conference, Edgewater Beach Hotel, Chicago.

gressing from top to bottom of subject copy.

2. The standard index of cooperation shall be 984.

3. The number of scanning lines per minute shall be 360.

4. The line-use ratio shall be ⅞, or 315 deg. of the full scanning cycle.

5. The ⅛ cycle or 45 deg. not included in the available scanning line shall be divided into three equal parts, the first 15 deg. being used for transmission at approximately white level, the second 15 deg. for transmission at approximately black level, and the third 15 deg. for transmission at approximately white level.

6. An interval of not more than 12 seconds shall be available between two pages of subject copy, for the transmission of a page-separation signal and/or other services.

7. Amplitude modulation of subcarrier shall be used.

8. Subcarrier modulation shall normally vary approximately linearly with the optical density of the subject copy.

9. Negative modulation shall be used, i. e., maximum subcarrier amplitude and maximum radio-frequency swing on black.

10. Subcarrier noise level shall be maintained at least 30 db below maximum (black) picture modulation level, at the radio transmitter input.

New Experimental Television Station

RADIO frequencies above 500 mc will soon be explored by RCA as a medium for the expansion of television broadcasting. A new experimental station will be installed at the Wardman Park Hotel in Washington, location of NBC's commercial television station WNBW. Simultaneous operation of the two stations on 67 mc and 510 mc will give engineers an opportunity for the first time to compare the service possibilities of uhf frequencies with those of the present lower-band commercial frequencies.

Transmitting equipment for the tests has been completed and installation awaits only the FCC authorization. The transmitter will produce an effective radiated power up to 25 kilowatts. With this power engineers can make field strength surveys of a 500-mc broadcast service under all conditions and over all kinds of terrain.

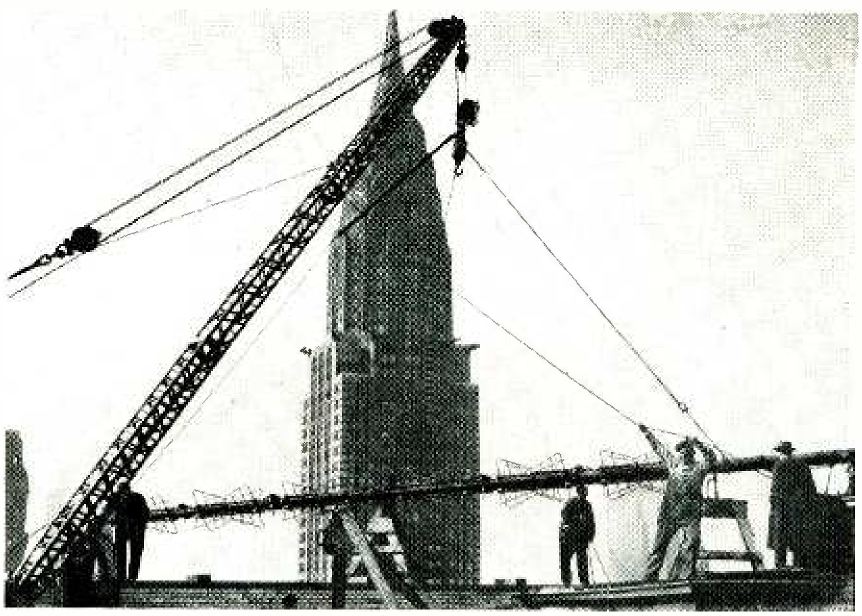
Should the experiments prove these frequencies are practicable for television, a simple adapter can be provided for present television sets to enable them to receive programs broadcast on the higher frequencies.

Station WPIX Tower Completed

CONSTRUCTION of New York City's fourth television station, WPIX, was recently completed with the erection of a 287-foot tower 36 stories above street level atop the Daily News building.

The television tower has a 10-foot high base section 35 by 58 feet square. The second section is 207 feet high, tapering from 30 feet square to five feet square. Next comes a 28-foot pylon section 20

(Continued on page 204)



Raising the RCA antenna for television station WPIX from street level to the roof of the 36th floor

A GENERAL CHEMICAL RESEARCH DEVELOPMENT

From Elemental Fluorine

SULFUR HEXAFLUORIDE

A STABLE DIELECTRIC GAS

Formula: SF_6
Molecular Weight: 146.06
Melting Point: —50.8°C
Sublimation Temperature: —63.8°C
Critical Temperature: 45.6°C
Critical Pressure: 540 p.s.i.a.
Vapor Pressure:

Temp. (°C)	Pressure (p.s.i.a.)
—80	5
—50	34
—20	102
10	240
40	481

DIELECTRIC CONSTANTS AT 27.5°C:

Pressure, P_{mm}	Diel. Deviation, δ	Diel. Const., ϵ^1
708	1.91	1.00191
704	1.90	1.00190
590	1.58	1.00158
457	1.23	1.00123
369	0.98	1.00098
216	0.57	1.00057
131	0.34	1.00034

$$\epsilon^1 = 1 - 10^{-3}\delta$$

Reference
Fuoss, J. Amer. Chem. Soc., *60*, 1633 (1938)

COEFFICIENT OF EXPANSION—LIQUID SF_6:
0.027 (for interval —18.5 to 30°C)

Reference
Prideaux, J. Chem. Soc., *89*, 323,376 (1906)

MEAN DIELECTRIC COEFFICIENTS AND POLARIZATION:

Gas	$E^{25°}_{0\text{-}1}$	$E^{25°}_{0}$	$E^{-80°}_{0}$	P^{25}
Air	528	528	—	4.31
N_2	538	538	—	4.39
SF_6	2049	2026	2018	16.51
SiF_4	1702	1690	1681	13.78

$E^{25°}_{0\text{-}1}$ —values which would be obtained by actual measurement at 25°C for a pressure range of 0-1 atmosphere; actual measurements at slightly different temperature.

$E^{25°}_{0}$ —limiting values of E at zero pressure if gases were perfect.

$E^{-80°}_{0}$ —limiting values at -80°C.

P^{25}—polarization as calculated from

$$P = \frac{\epsilon - 1}{\epsilon + 2} \cdot \frac{m}{d} = 0.008155E_0$$

Reference
Watson, Rao, and Ramaswamy, Proc. Roy. Soc. (London), *431*, 558 (1934)

BASIC CHEMICALS FOR AMERICAN INDUSTRY

In Sulfur Hexafluoride, General Chemical Research makes another important contribution to fluorine chemistry. This stable dielectric gas was the first commercial chemical produced from elemental fluorine to be offered Industry . . . and is the forerunner of many similarly made fluorine compounds awaiting introduction.

Discovered by Moissan and Lebeau in 1900 as the product of combustion of sulfur in fluorine, it has been found to be remarkably inert and to possess exceptional thermal stability. These characteristics, together with its splendid electrical properties, have led to its present use as a gaseous dielectric in high voltage equipment.

The physical data presented here may suggest other applications worthy of prompt investigation for your products and processes. For commercial quantities, experimental samples, or more detailed technical information, write or phone:

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40 RECTOR STREET, NEW YORK 6, N. Y.

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TUBES AT WORK
(continued from p 126)

vtvm is read on a meter calibrated in ± percent deviation.

When there is no resistor across the *unknown* terminals, the percentage deviation is infinite and would cause the pointer to jump off scale. For protection against such abuse between insertion of successive resistors to be tested (without the use of a hand-operated switch that would slow down operation) a relay automatically disconnects the meter whenever the bridge

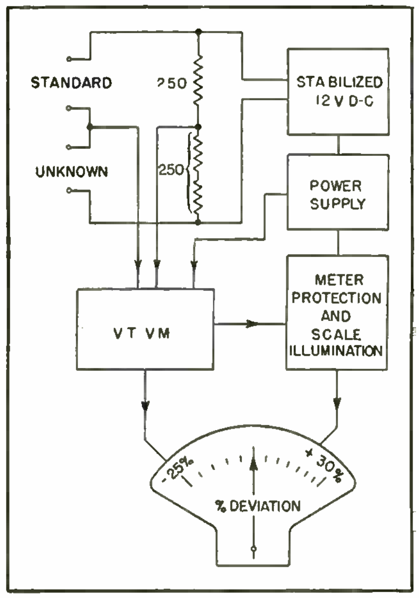


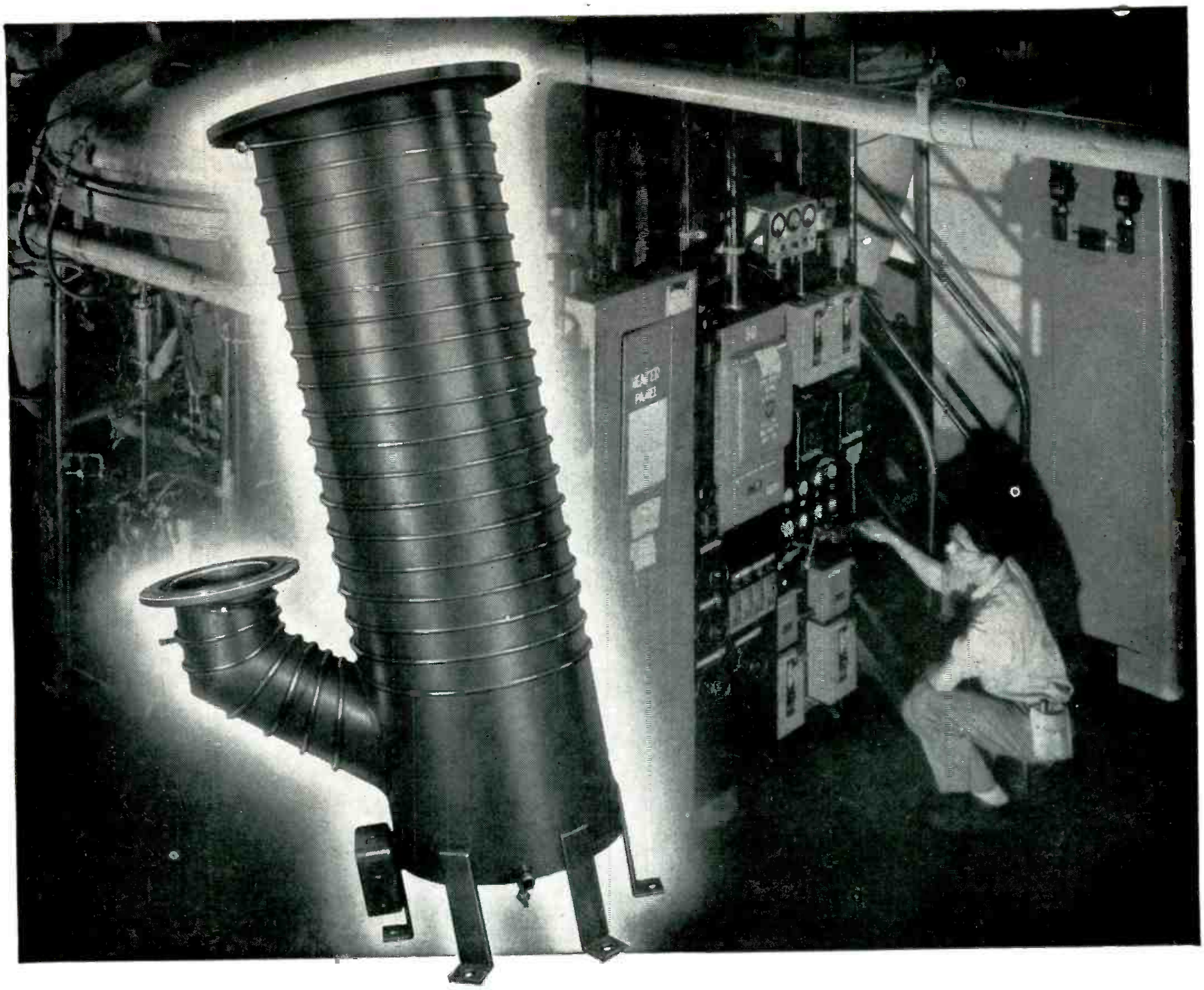
FIG. 1—Block diagram of instrument for sorting resistors into groups of one percent apart

output exceeds adjustable predetermined limits.

Whenever the *unknown* terminals are empty, the meter stays in its zero position. If a resistor that falls within the preset limits is inserted, the meter is automatically connected and indicates the percentage deviation from the standard. To have a definite indication of whether the meter is active or not, the dial is lit up by two panel lamps whenever the meter is active. A block diagram of the instrument is given on Fig. 1.

Bridge

The bridge contains two equal ratio arms one of which is tapped and delivers the resistance ratio for full scale calibration. The other two arms are formed by the standard (fastened to a pair of screw terminals) and the unknown X to be inserted under a pair of spring terminals. These terminals consist of



slotted phosphor-bronze lips pressing against perpendicular phosphor-bronze blades that can enter into these slots. The pigtails of resistors are held firmly between the edges of these blades and the flats of the lips. The small contact area between pigtail and the blades pressing down perpendicularly on it assures high contact pressure per unit area and still allows insertion and removal of the resistors with a minimum of effort.

The circuit of the vtvm is shown in Fig. 2. It is of the conventional type comprising one pair of preamplifier triodes and one pair of triodes forming a second stage to feed the meter movement. Both stages

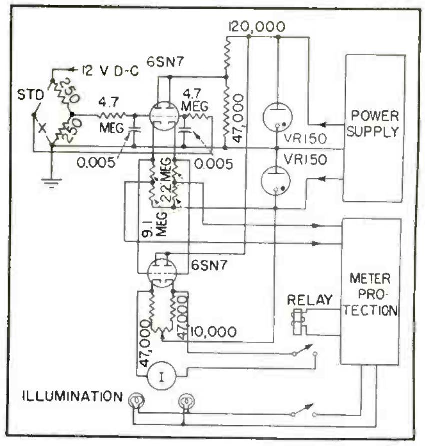


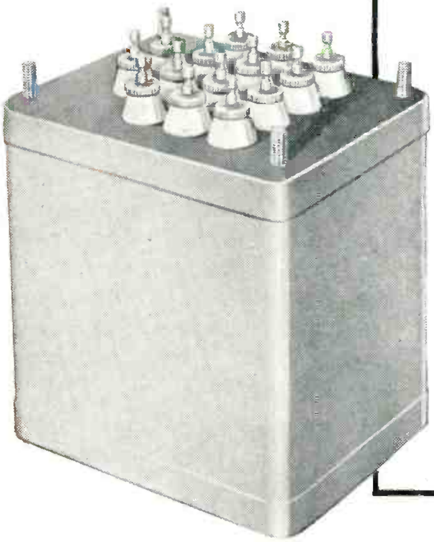
FIG. 2—Circuit of vacuum-tube voltmeter used as detector of bridge output

are connected as cathode followers. Both positive and negative side of the B supply are stabilized to prevent zero drift or change of sensitivity with variation of line voltage.

The circuit data of the first stage were chosen to assure lowest possible grid leakage. To this effect the plate current is held around 15 microamperes and the plate voltage at 34 volts. At this plate voltage the voltage between cathode and grid will assume −2 volts for average tubes and never fall below −1.5 volt, which is a safe value for emission from cathode to grid. The plate voltage is low enough to cause no gas current in properly evacuated tubes.

The second stage is designed to keep the cathode current of each system amply above the 0.5 ma necessary to give full deflection to the meter in either direction. This keeps the working point far from the curvature of the characteristics

You need all these quality factors if you use HERMETICALLY SEALED TRANSFORMERS



Uniform Characteristics
Correct Termination
Vacuum Impregnation
Infra-Red Pre-heating
Vacuum Filling
Induction Soldering
Vacuum Immersion Testing
Mechanical Strength
Continuous Inspection

AmerTran Hermetically Sealed Transformers have all the quality factors listed in the above panel. And that's not all. All along the line, in the fabrication of parts and in assembly our employees are alert to turn out only the best in workmanship. For they know that nothing less than the best insures customer satisfaction.

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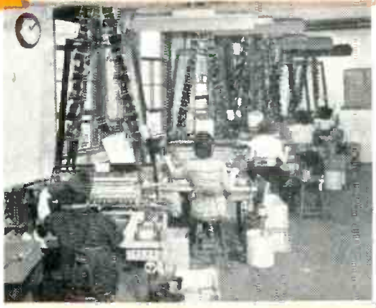
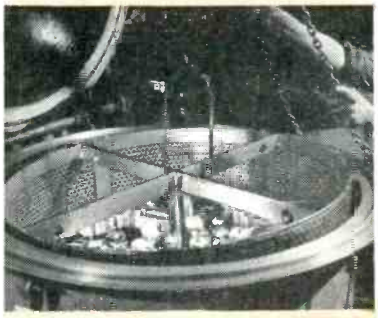
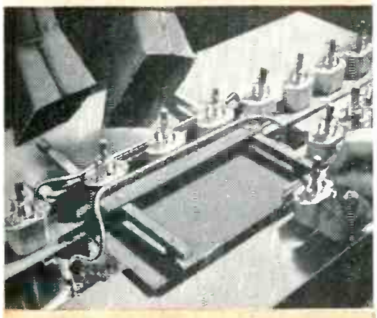


Winding Coils



Vacuum Impregnation



Induction Soldering

Immersion Vacuum Testing

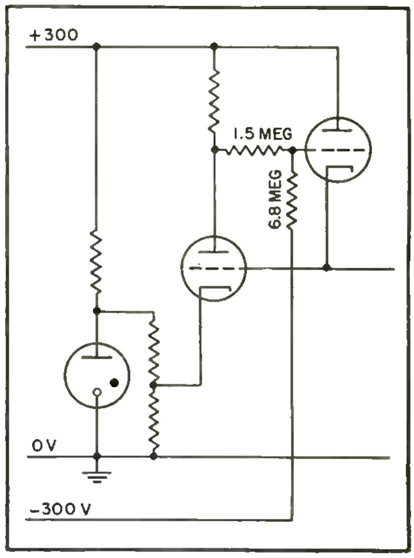


FIG. 3—Stabilizer circuit for low d-c voltage

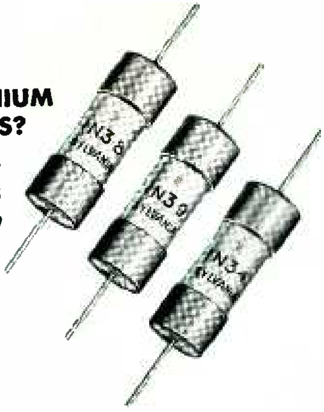
and insures linearity of response. Accordingly the scale could be calculated and no correction was necessary for increase or decrease of mutual conductance of the triode systems with increase and decrease of plate current within the range of the instrument.

Stabilizing Circuit

The voltage output of a Wheatstone bridge depends only on the applied voltage and on the resistance ratio of its arms but not on the actual resistance if, as is the case with vacuum-tube amplification, no current is drawn from the output.

The instrument gives percentage deviation from any standard without readjustment, if the applied voltage is kept constant. The conventional types of regulated voltage supplies are not suitable for such low voltages, because the cathode of the power tube has to be held at a voltage substantially above the cathode of the preamplifier tube, to permit the plate of this latter to drive the grid of the power tube sufficiently negative. By connecting two conventional systems in series with each other in such a way that their output voltages are subtracted from each other, any low output voltage can be obtained, but such a system involves many components, heavy losses and a relatively high percentage of variation of the small difference voltage even for relatively low percentage variations of the two large voltages

If it's a question of crystal diodes...



GERMANIUM DIODES?
1N34
1N38
1N39

DUO-DIODES?
1N35

VARISTORS?
1N40
1N41

SILICON DIODES?

1N21B	1N25
1N21C	1N26
1N22	1N31
1N23B	1N32

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Silicon crystal diodes for first detectors in microwave receivers, high level video detectors, microwave instrument use . . . germanium crystal diodes, duo-diodes and varistors for a multitude of AM, FM and television applications . . . you'll find them all in the Sylvania line. Keep abreast of Sylvania research on new crystal diode applications. The coupon at right will place you on the mailing list for Sylvania's new series of Engineering News Letters.

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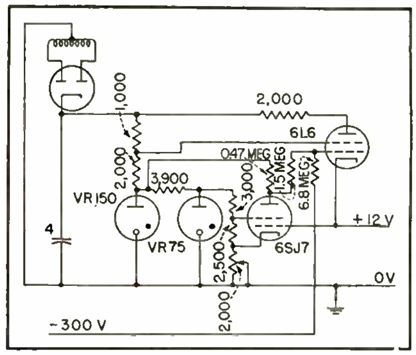

FIG. 4—In this detailed circuit of the voltage stabilizer, two stabilized stages are connected in cascade. The resistor in the plate circuit of the 6L6 is used to reduce plate dissipation

that are subtracted from each other.

The voltage regulating system of Fig. 3 and Fig. 4 allows regulating of any low output voltage down to zero by the simple means of connecting the grid of the power tube to a voltage divider between the plate of the preamplifier and a substantially negative potential (say −300 volts). Then the grid of the power tube will assume a voltage substantially below the voltage on the plate of the preamplifier and still follow the voltage variations of the former.

Meter Protection

The meter is disconnected by a relay whenever the *unknown* terminals are empty or if the resistor across them is outside preset limits. This operation could be accomplished by a sensitive relay connected in series with the movement and shorting it out at overcurrents. But such relay would have to operate on very low currents in either direction and it would be hard to have it act quickly enough before the meter would overswing.

To provide for the limit of relay action to be adjustable in either direction of overload, the circuit of Fig. 5 was provided. The bridge output, after it had passed the first cathode follower, is applied to the grids of the 6SL7, amplified and applied to the grids of the 6SN7. In balance both sides of this tube are cut off, the limit of unbalance in which either side will conduct being adjusted by the grid potentiometers. By using a voltage divider circuit similar to that employed in the voltage-stabilizer portion of the instrument it is possible to use d-c amplification with the

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Many of these uses were problems that just couldn't be solved until permanent magnet materials were developed to do the job—a work of pioneering to which Arnold contributed a heavy share. Many other applications were those where permanent magnets supplanted older materials because of their inherent ability to save weight, size and production time, as well as greatly improve the performance of the equipment.

To these advantages, Arnold Permanent Magnets add another very important value—standards of quality and uniformity that are unmatched within the industry. Arnold Products are 100% quality-controlled at every step of manufacture. What's more, they're available in all Alnico grades and other types of magnetic materials, in cast or sintered forms, and in any shape, size or degree of finish you need. ● Let's get our engineers together on *your* magnet applications or problems.

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W&D 1296

second stage having its cathode at a potential below the grid of the first stage.

Limitations and Performance

The range of the instrument is limited at the low end by the current available from the regulated supply and at the high end by the ability of the first tube to work at high grid impedance. The low limit can be transgressed by using an outside battery, if the standard and unknown will both stand the wattage developed in them.

The maximum power appearing in a standard of 100 ohms in case of short circuit across the unknown terminals is 1.44 watt; the maximum power that can be delivered across the unknown terminals if a 100-ohm resistor is inserted in the *standard* terminals is 0.36 watt. If the battery voltage is not exactly 12 volts, the *full-scale* adjustment has

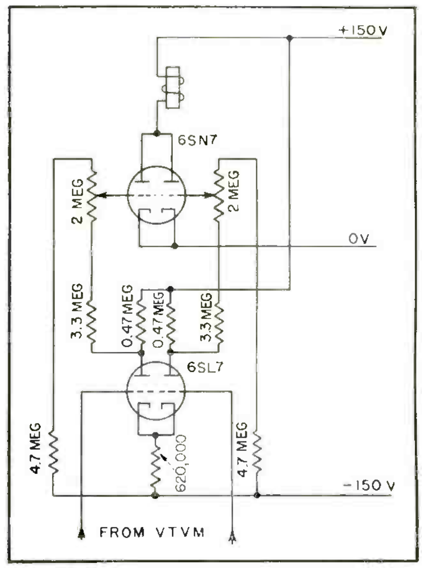
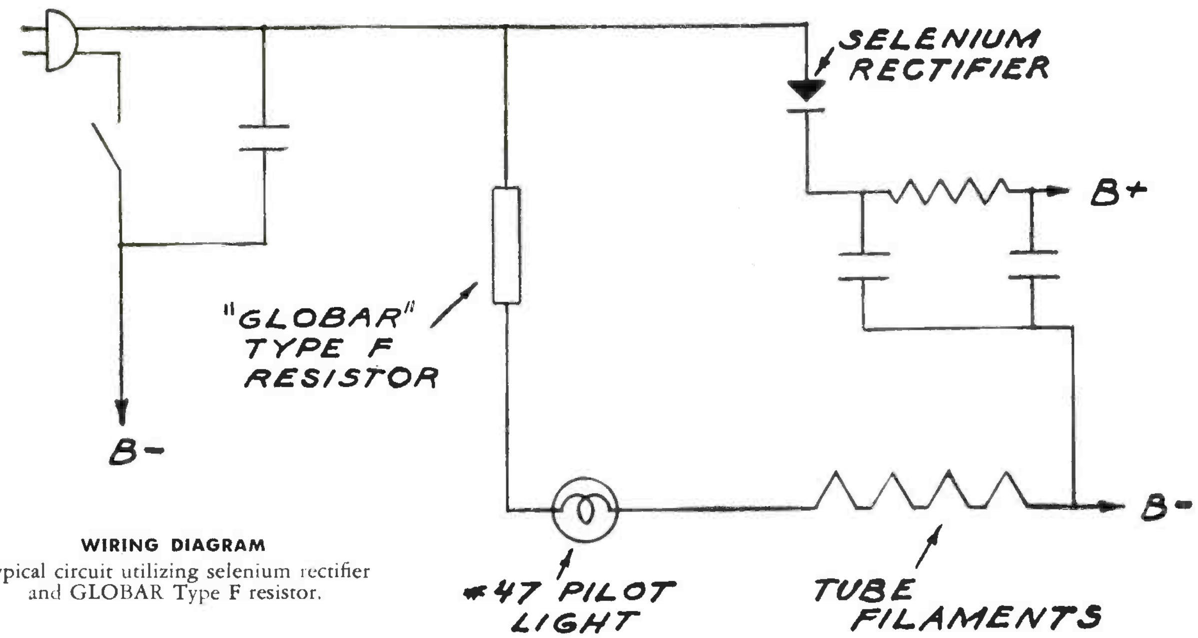


FIG. 5—If the vtvm is overloaded in either direction, one triode of the 6SN7 energizes the relay

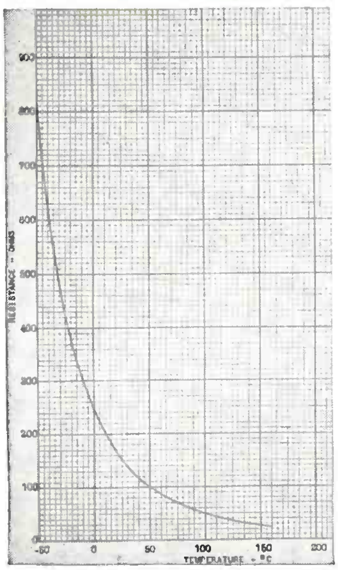
to be readjusted and the readings will be as accurate as with the stabilized voltage.

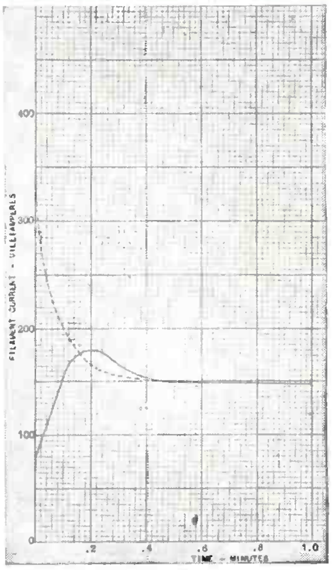
Best use of the instrument can be made for sorting resistors in groups of one-percent apart. In this service 600 pieces per hour can be easily sorted out. One unit has been in continuous use in the Clippard Instrument Laboratories (makers of the instrument) for two years. Readjustment of zero or full-scale adjustment was not necessary for stretches of many weeks. On all instruments shipped not a single complaint or request for re-

Boosting Performance of AC-DC Radio Receivers



WIRING DIAGRAM
Typical circuit utilizing selenium rectifier and GLOBAR Type F resistor.





TEMPERATURE CHART (above left)—Note the extreme temperature sensitivity of the GLOBAR Type F resistors pointed up in the steepness of this typical curve.

FILAMENT CHART (above right)—This chart, illustrating the shock absorbing quality of GLOBAR Type F Resistor, shows how both pilot lights and tubes are protected from the sudden inrush of current when the set is turned on. This protection insures longer life from the tubes; moreover, the tubes retain their original performance characteristics.

THIS wiring diagram illustrates a simple and practical method of building big set performance into conventional AC-DC receivers. The accompanying charts help explain how this is accomplished with selenium rectifiers and GLOBAR Type F Resistors. Selenium rectifiers provide a source of low loss DC power and GLOBAR temperature sensitive resistors compensate for the positive resistance-temperature characteristic of radio tubes and pilot light filaments. The high initial resistance of GLOBAR Type F resistors prevents sudden inrush of high currents which shorten tube life and burn out pilot lights, thus insuring continuous maximum tube performance.

Of many benefits reported, five are particularly significant.

1. **Protection against premature failure of pilot lights and radio tubes.**
2. **Undistorted audio output multiplied.**
3. **Manufacturing and service costs reduced.**
4. **Wiring circuits simplified.**
5. **Quality and efficiency of receiver increased.**

A good way to check these claims is to run tests in your own plant. We will be glad to supply sample resistors. Merely send us a diagram of your test circuit so we may send you resistors of correct specifications. There is no obligation, of course. We want you to prove to your own satisfaction that the use of GLOBAR resistors and selenium rectifiers will improve receiver performance at lower cost. The Carborundum Company, Globar Division, Niagara Falls, New York.

GLOBAR Ceramic Resistors

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pair or servicing has been obtained. Patent protection is sought.

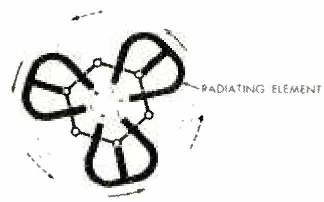
F-M Radiator

POWER gains ranging from 1.5 to 9 in easy steps can be obtained by using the required number of 14.5 foot sections of the Western Electric 57A antenna, similar to the Cloverleaf but having three loops instead of four.

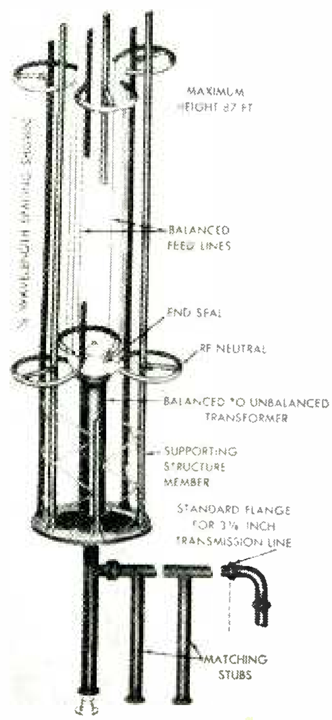
The antenna may be used with any number of radiating units from one to 19, depending on frequency. Half wave or full wave spacing of elements may be employed.

Half wave spacing gives wider vertical beam and also provides increased service area coverage over full wave spacing. Full wave spacing means half as many radiating units with resultant lower cost—and lower gain.

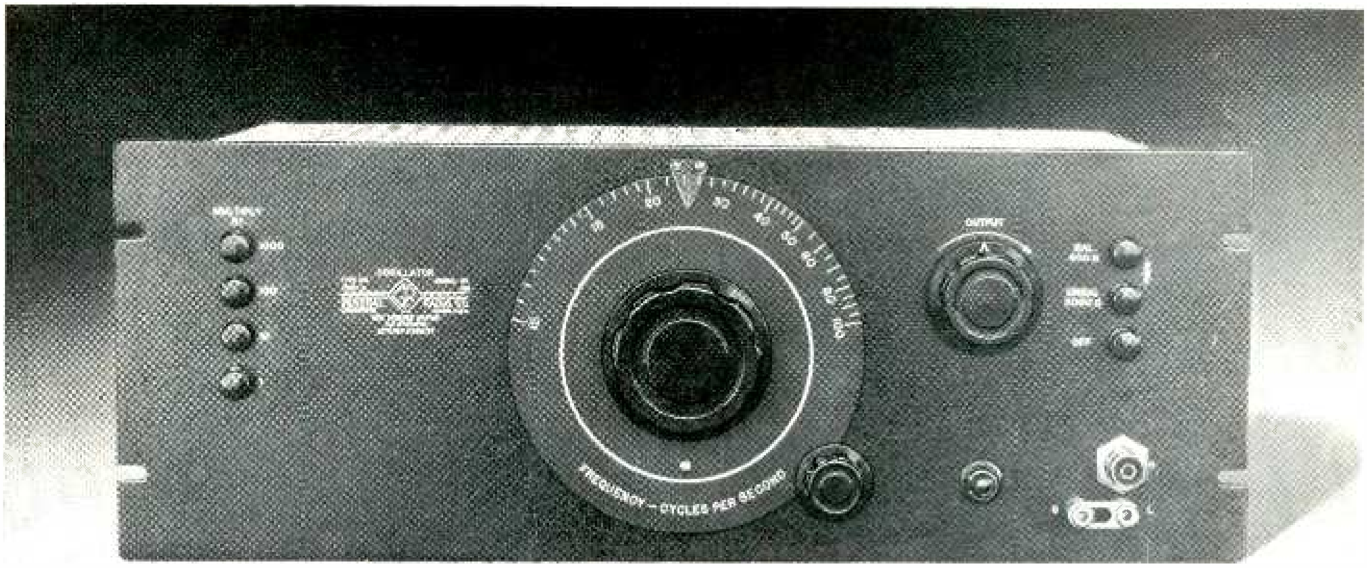
Mechanical arrangement of the



ANTENNA CURRENT DIAGRAM OF 57A



Mechanical arrangement and current diagram of the f-m antenna



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57A is shown in the drawing. The antenna is fed from the coaxial transmission line at the lower right, and is matched to the transmission line by use of the matching stubs. A conventional balanced-to-unbalanced transformer at the base of the antenna connects the coaxial transmission line to the six-wire balanced line. A single end seal for the coaxial line is employed at this point. The six-wire line runs vertically up the inside of the antenna to feed the radiating elements with the polarity as shown in the antenna current diagram.

For half-wave spacing, adjacent radiating units are mounted on alternate legs of the tower to compensate for the phase reversal. As the middle of each radiating element is a neutral point, the radiating elements are firmly attached to the grounded structure members at that point.

The structure is designed to support a television antenna. The television antenna may be fed from transmission lines fastened to the supporting structure members on the inner side of the 57A where they will not disturb the radiated f-m pattern.

Polyphase Power Synchroscope

BY E. B. KURTZ AND R. H. BURKHARDT
The State University of Iowa
Iowa City, Iowa

THE ELECTRONIC polyphase power synchroscope to be described indicates the state of synchronism of two polyphase power systems. It not only shows the correct moment for closing a switch connecting two generators in parallel or a generator to a power line, but also gives a continuous indication of the relative voltages, frequencies and phase rotations. The application of a cathode-ray tube employing a polyphase deflection system eliminates all moving parts and permits the inspection of all phases simultaneously.

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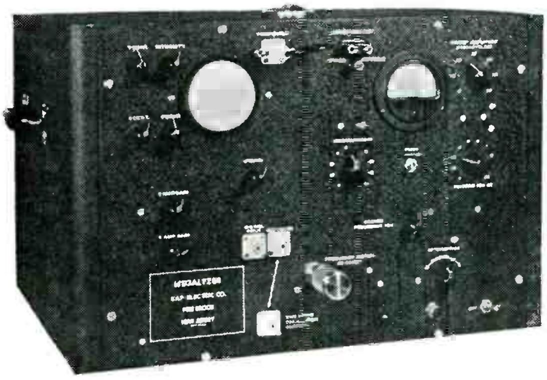

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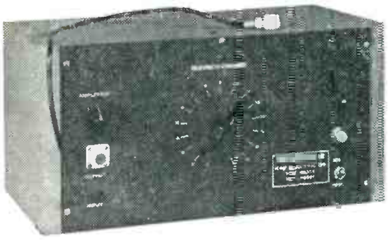

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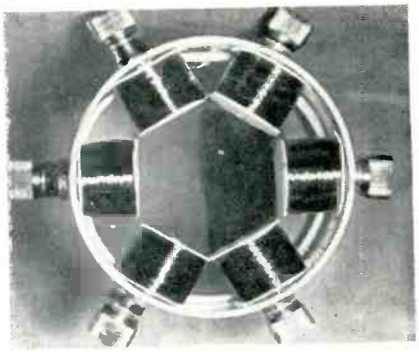

FIG. 1—Three-phase magnetic deflection system for a three-inch cathode-ray tube

the voltages obtained from the machines to be synchronized cause deflections along as many axes as there are phases. An example of a three-phase magnetic deflection system is illustrated in Fig. 1 and 2. The position of magnetic deflection coils placed around the cathode-ray tube for a three-phase synchroscope is shown in Fig. 3 and 4.

When a single set of deflection coils is used, two connections to the systems to be synchronized, straight and crossed, are possible The straight connection for three phases is shown in Fig. 5.

When the straight connection is used, a circle of variable magnitude is obtained on the screeen. The diameter is determined by the voltages of the two systems and the phase angle between them. When the two systems have slightly different frequencies, the relative phase angle will be continuously changing which will cause the circle diameter to vary at a rate depending upon this difference.

If the voltages are exactly equal and in such phase position as to oppose each other, a circle of zero diameter, or spot, is observed on the screen. If a switch connecting the two systems is closed at this instant, no voltages will be present

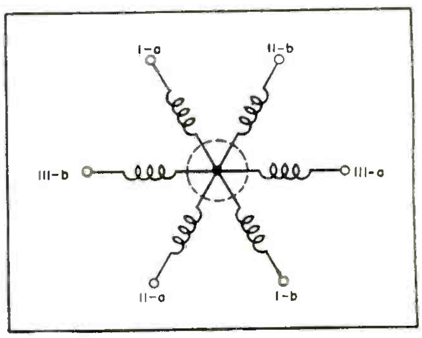

FIG. 2—Schematic of three-phase deflection system

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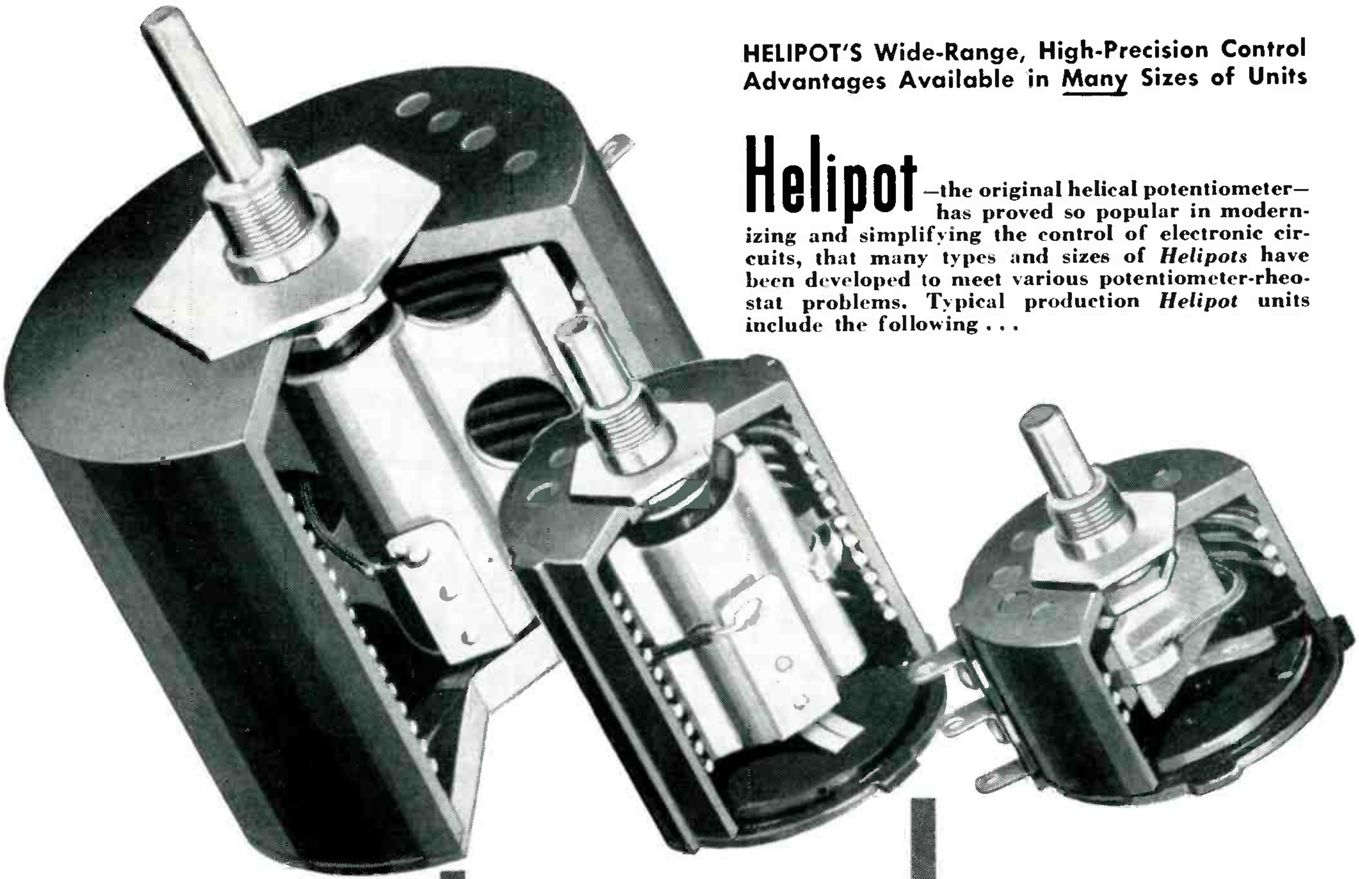

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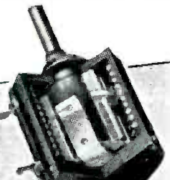
MODEL A—Case diameter—1.8"; Number of turns—10; Slide wire length—46½"; Rotation—3600°; Power rating—5 watts; Resistance ratings—10 to 50,000 ohms.

MODEL C—Case diameter—1.8"; Number of turns—3; Slide wire length—13.5"; Rotation—1080°; Power rating—3 watts; Resistance ratings—5 to 15,000 ohms.



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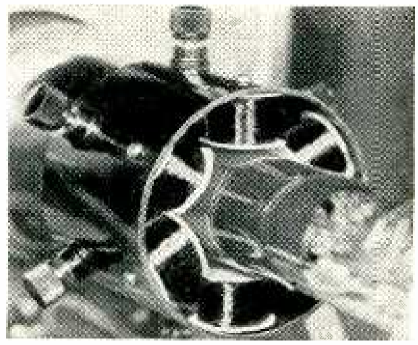

FIG. 3—Set of deflection coils mounted on a cathode-ray tube

to cause circulating currents. When the rms voltages of the two systems are not exactly equal, the rms voltage between them will never be zero. The minimum diameter of the circle then indicates the difference of the voltages.

The condition of maximum voltage between the two systems is indicated by a circle of maximum diameter. The voltage at this instant is the sum of the voltages of the two systems and may be determined by measuring the circle diameter which is directly proportional to the applied voltage. If the directions of phase rotation are not the same, a line or narrow ellipse instead of a circle will be indicated on the screen.

The usual straight connection of lamps for indicating synchronism shows a direct relation between the brilliancy of the lamps and the diameter of the circle on the screen. The oscilloscope method gives a better indication for two reasons: First, the action of the oscilloscope is instantaneous, since it is dependent for operation upon the instantaneous value of the voltage rather than upon a heating effect. Second, a small residual circle indicating unequal voltages is easily

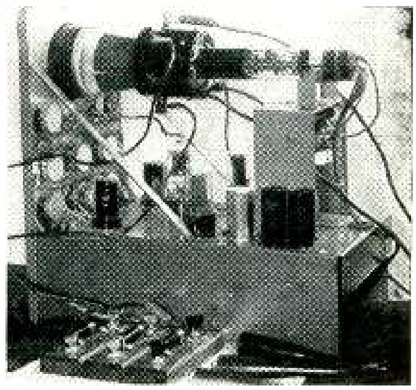

FIG. 4—Magnetic coils mounted on an oscilloscope

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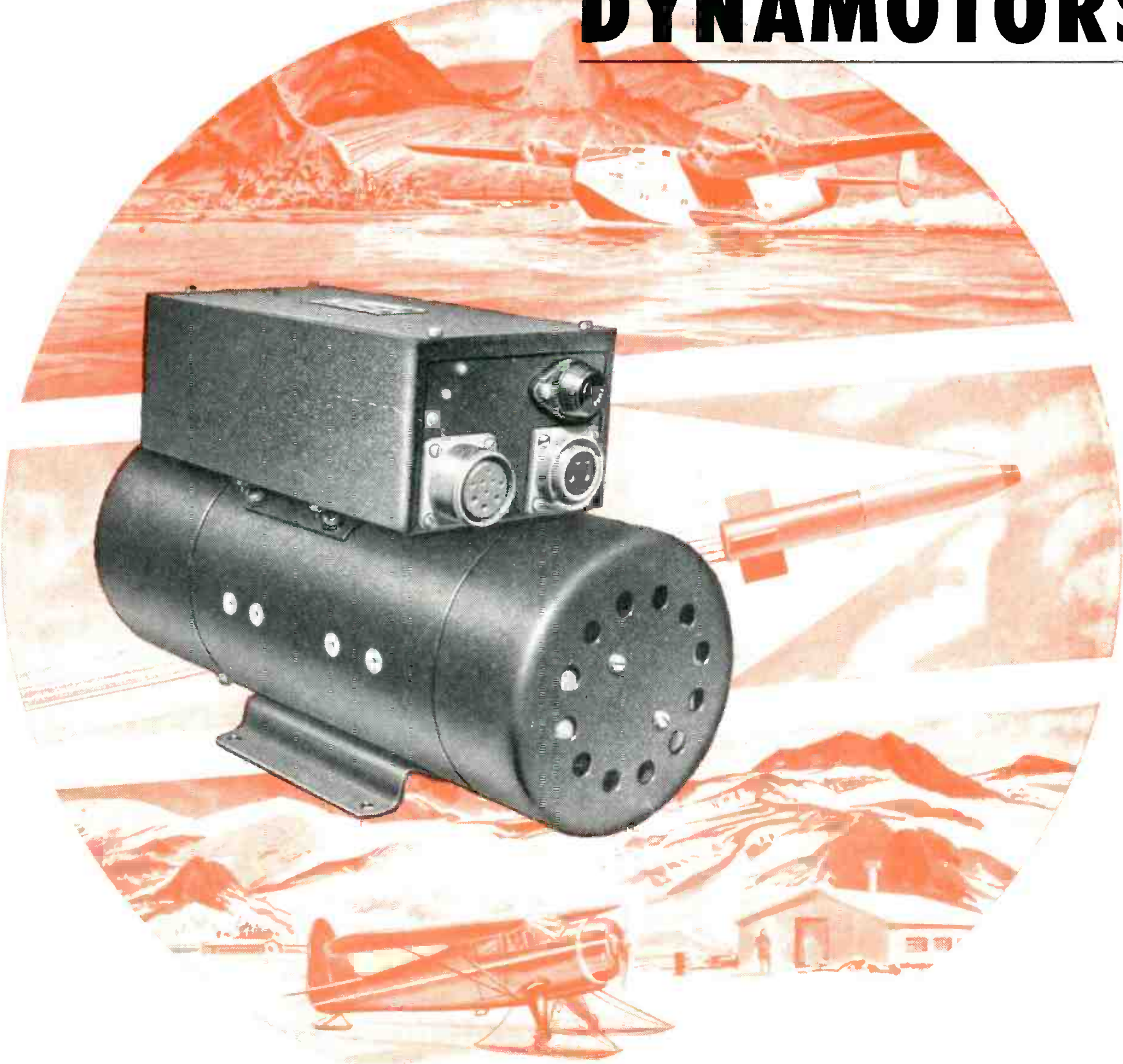

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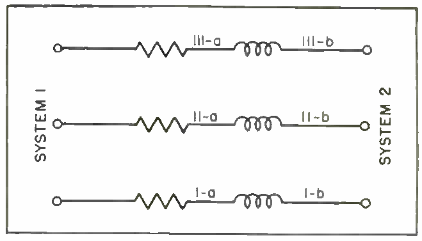

FIG. 5—The straight connection for three phase

seen on the oscilloscope, while the lamps may be dark even though a small voltage difference exists.

Crossed Connection

The other synchroscope connection which may be used with a single set of coils is the crossed connection shown in Fig. 6. This is equivalent to reversing the phase rotation of one of the systems. A straight line is obtained on the screen with this connection when

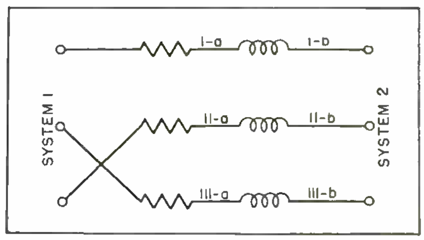

FIG. 6—Crossed connection for three phase

the phase rotations are the same and the voltages are equal. The slope of the line is determined by the relative phase position of the incoming voltages and may be made to assume any desired position at the proper instant for synchronizing by proper orientation of the set of coils.

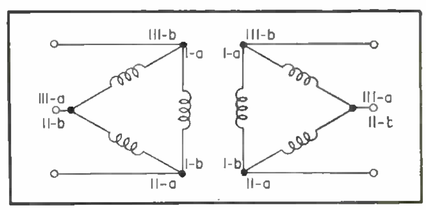

FIG. 7—Deflection using two sets of coils

The sum of the voltages is indicated by the length of the line. Any voltage difference causes a separation of the line into an ellipse which has a width proportional to the difference. If the phase rotations of the systems are not the same, a circle instead of a straight line will be obtained with this connection. Differences in frequency are indicated by rotation of the

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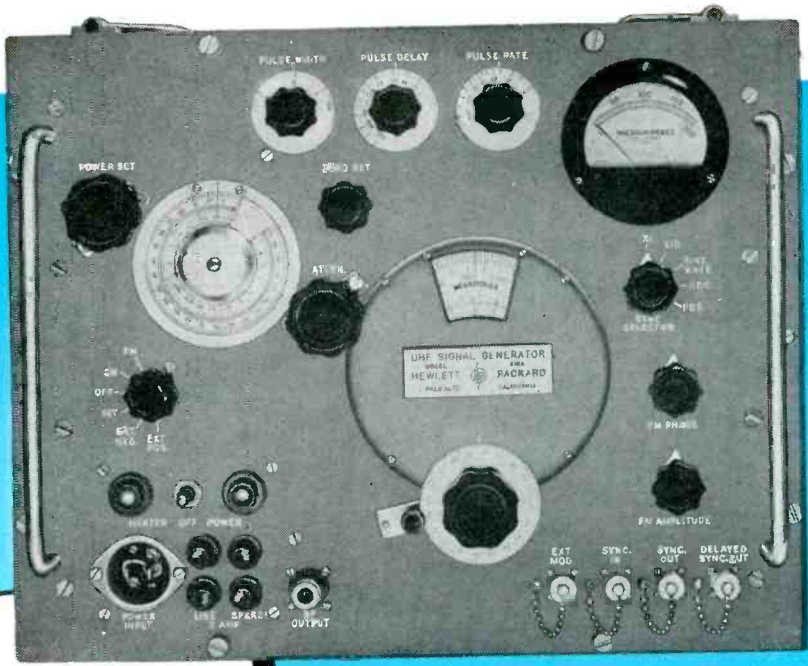

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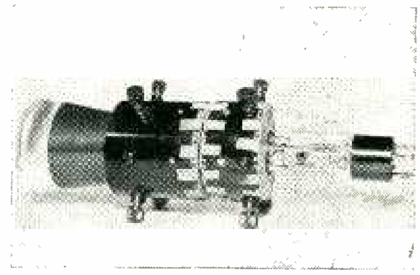

FIG. 8—Two sets of coils mounted on a c-r tube

line. The direction of rotation indicates which frequency is higher, and the rate of rotation indicates the order of the frequency difference.

Two Sets of Coils

Two sets of deflection coils may also be used in the synchroscope if desired by connecting one set to each system as shown in Fig. 7 and 8. When the directions of rotation are the same for both coils, a circle of variable diameter similar to that of the straight connection previously described is obtained. However, the diameter at the time of closing the switch may be adjusted for minimum, maximum, or any intermediate value simply by rotating one of the coils. Opposite phase rotation of one of the systems gives a line instead of a circle.

Reversing the rotation for one of the sets of coils can be done to obtain a rotating line similar to the one obtained for the crossed connection.

If it is desired to obtain a spot or a straight line as with the single set of coils, the deflection sensitivity of the two sets must be made equal. Multiplier resistors may be used to adjust the voltage sensitivity.

In all cases of the use of a single set or two sets of coils, an open line in one of the systems causes a changing figure instead of a continuous circle or line.

Theory of Operation

When balanced polyphase voltages are applied to a set of deflection coils as described, a revolving magnetic field of constant magnitude is set up. The spot on the screen then traces a circle.

Consider first the case of the straight connection. The two generators may be considered to be in series, each independently produc-

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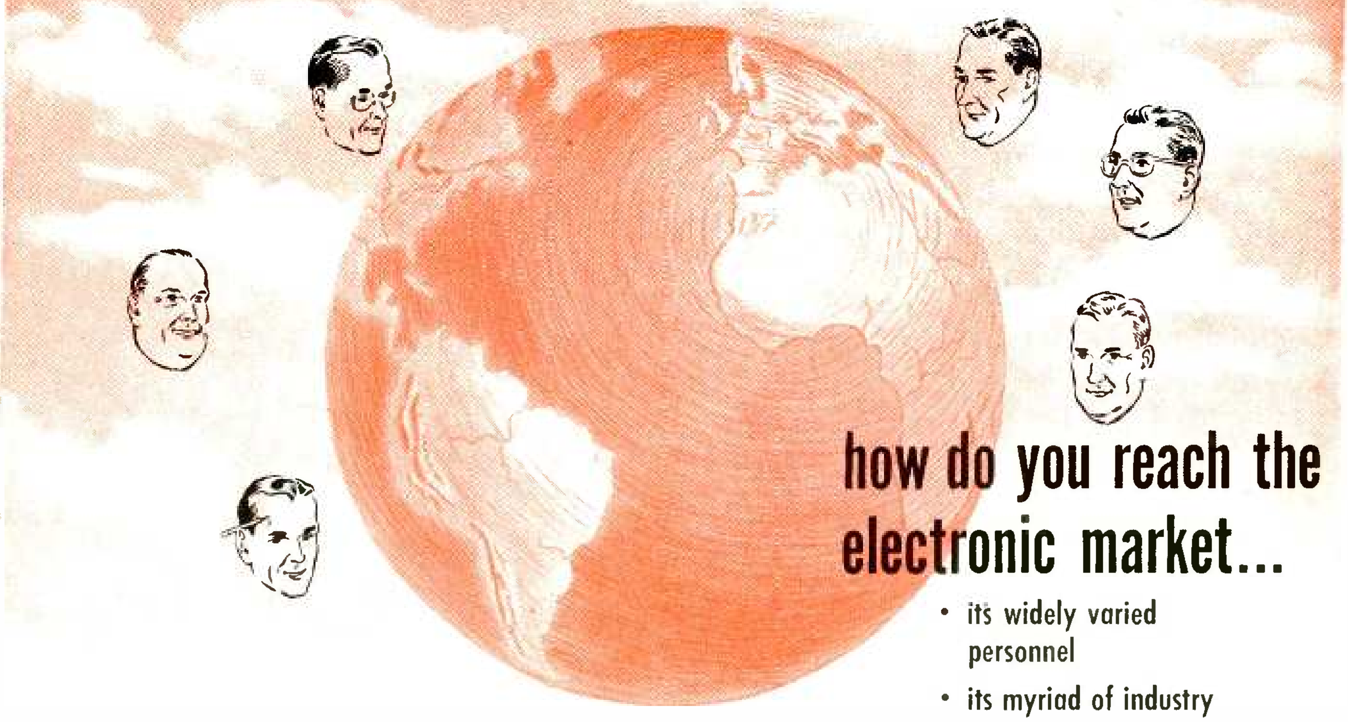

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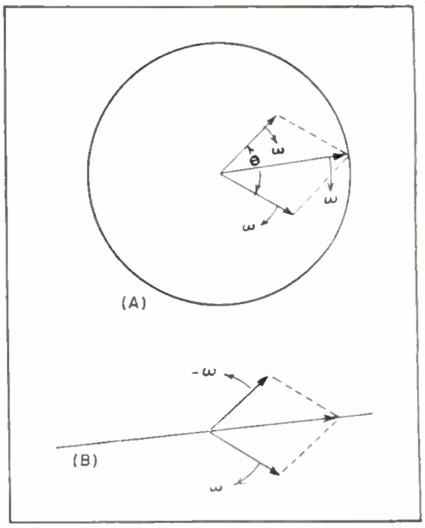

FIG. 9A—Production of the circle pattern. At 9B, the straight-line pattern

ing its own current and its own revolving field. If the directions of rotation of the two fields are the same and the frequencies are the same, a resultant revolving field of constant magnitude depending upon the relative phase position is formed. See Fig. 9A.

As the phase position changes, the diameter of the circle changes. If the rotations are opposite, a straight line results. See Figure 9B.

The method using two sets of deflection coils may be explained similarly except that the two fields are produced independently in separate coils and the deflection is a resultant of the two fields.

HIGH INTENSITY continuously operating gas discharge lamps are being studied by Dr. J. N. Aldington at Siemens Ltd. (Lancashire, England). Lamps from 100 to 20,000 watts have been produced for television and photographic studio applications. The lamps have hot tungsten electrodes containing thoria sealed in quartz bulbs and completely water cooled. The arc, established in xenon, although krypton has been used also, gives light of the same quality as sun light. The arc current is 100 amperes, giving several hundred amperes per square centimeter of arc section and an efficiency of 25 to 35 lumens per watt.

THE ELECTRON ART

(continued from p 130)

the commutation accurately enough to avoid destructive arcing in this manner. Furthermore, for efficient rectification of three-phase power, only the phase having the highest voltage at that instant should be operating.

The sequence of contact timing is made such that the next phase is closed just before the conducting one is opened. In this way an opposing circulating current is established through the transformer secondaries and the contact that is to be opened, giving a resultant current of zero at some point in the building up of the circulating current. This action makes it possible to open a phase before it passes through zero and thus to draw current from each phase only during the peak portion of its cycle.

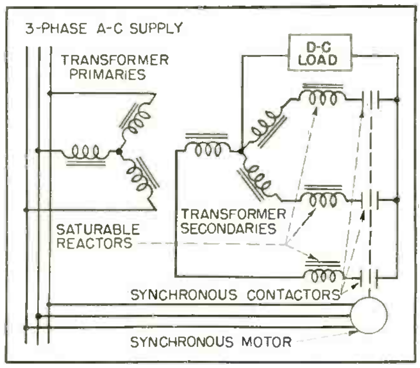

FIG. 4—Elements of three-phase synchronous contacting type rectifier

To prolong the interval of zero current through the contacts, saturable reactors are placed in series with them. As long as the current is high, the reactors are saturated and present low inductances. However, when the current approaches zero in the phase about to be opened, the reactor is no longer saturated; its inductance is then high. Hence during this interval the current is very low. The advantage of permenorm 5000-Z is that the transition from low inductance (saturation) to high inductance is abrupt and complete. There is negligible voltage drop in the commutating reactor during the active portion of the cycle so that efficiencies over 97 percent can be obtained with mechanical rectifiers having capacities of 10,000 amperes at 400 volts d-c.

(1) W. E. Greene, Application of Mag-

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DUMONT *First with the Finest in Television*

ALLEN B. DU MONT LABORATORIES, INC. • TELEVISION EQUIPMENT DIVISION, 42 HARDING AVE., CLIFTON, N. J. • DU MONT NETWORK AND STATION WABD, 515 MADISON AVE., NEW YORK 22, N. Y. • DU MONT'S JOHN WANAMAKER TELEVISION STUDIOS, WANAMAKER PLACE, NEW YORK 3, N. Y. • STATION WTTG, WASHINGTON, D. C. • HOME OFFICES AND PLANTS, PASSAIC, N. J.

netic Amplifiers, ELECTRONICS, p 124, Sept. 1947; also Electromagnetic Amplifiers, ELECTRONICS, p 190, Jan. 1948.

(2) G. W. Elmen and E. A. Gaugler, Development of High Permeability Iron, conference paper presented at the Winter General Meeting of the AIEE, Pittsburgh, Pa., Jan. 1948.

(3) H. B. Rex, The Transductor, *Instruments*, p 1102, Dec. 1947; bibliography of 213 entries, *Instruments*, p 332, April 1948.

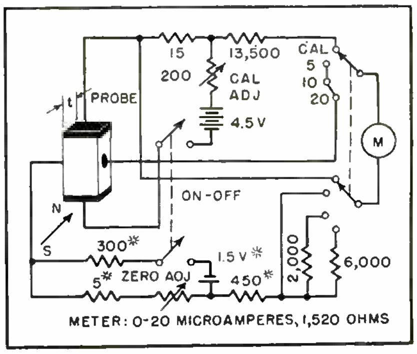
(4) S. E. Tweedy, Magnetic Amplifiers, *Electronic Engineering*, p 38, Feb. 1948; discussion p 168, May 1948.

Nonmagnetic Magnetometer

FIELD STRENGTHS between 100 and 8,000 gauss can be measured to an accuracy of plus or minus two percent with a simple magnetometer using a germanium probe as the sensing element. The probe depends on the Hall effect for its action and gives a direct-reading indication.

If a thin rectangular conductor is oriented perpendicularly to a magnetic field, a current passing between opposite sides of the plate will be made to flow in a curved path, thus producing a potential difference between the two edges of the plate. The magnitude of this potential in volts is $V = RIH/t$ where I is the current in amperes, H the magnetic field strength in gauss, t the thickness of the plate in centimeters, and R is the Hall coefficient in volt-centimeters per ampere-gauss of the plate material. Type N germanium (in which conduction is by electrons, as distinguished from the P type in which conduction is by holes) has the very large Hall coefficient of 8×10^{-5} and a specific resistance of 5.7 ohm-centimeters, both at 25 C. (For comparison, the corresponding values for copper are 5.2×10^{-13} and 1.7×10^{-6}.)

Thin slabs of germanium 0.040 in. thick (0.004 in. for use in very



Probe of direct-reading magnetic field strength meter is germanium slab

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Look for the Stackpole Minute Man — your guarantee of highest quality in molded components.

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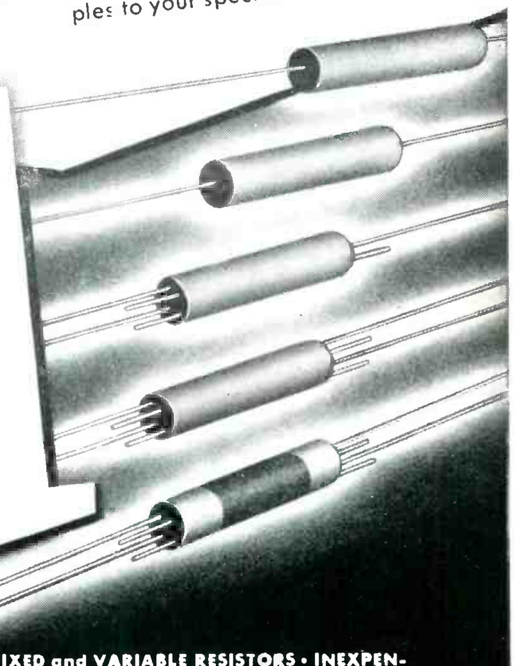
You can save money, speed production and increase the efficiency of your equipment by using Stackpole Molded Bakelite Coil Forms as mechanical supports for coil windings. They take less space and require a third fewer soldered connections. Coils may either be wound directly on the forms or wound separately, then slipped over the forms.

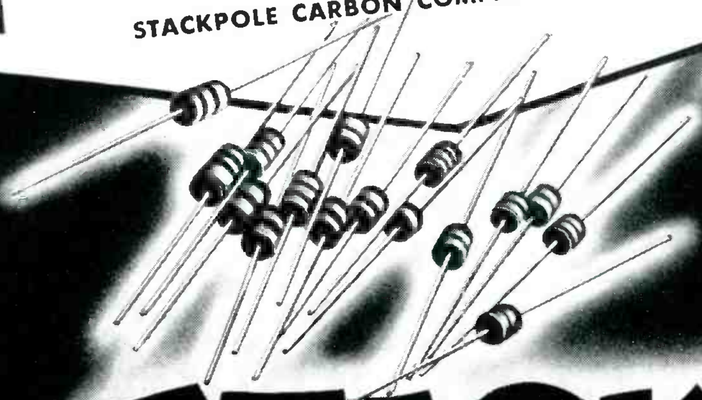
Standard types include forms for universal winding, solenoid winding, tapped universal winding, antenna or coupled winding, iron cored universal winding, iron cored I-F transformer or coupled coils and many others. Molded iron center sections can be provided on forms where required. Write for details or samples to your specifications.



... with STACKPOLE "GA" LOW-VALUE CAPACITORS

When assembly time is considered, Stackpole GA Low Value Capacitors may actually cost less than "gimmicks" formed by twisting insulated wires together—*and are many times more efficient*. Q is much improved, insulation resistance better, breakdown voltage higher, mechanical construction far superior. GA Capacitors are sturdily molded. Leads are anchored and tinned. Standard values include 0.68; 1.0; 1.5; 2.2; 3.3 and 4.7 mmfd. Tolerances are ± 20%. Write for details.

Electronic Components Division
STACKPOLE CARBON COMPANY, St. Marys, Pa.



FIXED and VARIABLE RESISTORS • INEXPENSIVE SWITCHES • IRON CORES • POWER TUBE ANODES • SINTERED ALNICO II PERMANENT MAGNETS • RHEOSTAT PLATES and DISCS • ANODES and ELECTRODES, etc.

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narrow gaps), 0.5 in. long and 0.2 in. wide, to which are soldered copper leads, are used as probes. A microammeter is used to indicate the current produced across the probe by the Hall effect. Calibration of the instrument is adjusted by varying the current supplied to the probe. A bucking potential in the detecting circuit is necessary to adjust the zero, and multipliers in the meter circuit can be used to control the range. The starred values of components may have to be adjusted from probe to probe. (G. L. Pearson, Magnetic Field Strength Meter Employing the Hall Effect in Germanium, *RSI*, p 263 April 1948.)

Multifrequency Synchronizer

By Robert K-F Scal
National Bureau of Standards
Washington, D. C.

Pulses repeating at multiples or fractions of the input signal frequency are produced by a versatile synchronizing unit that is useful for calibration and measurement in a variety of control and laboratory applications. The unit can be driven by the power line or by an external oscillator at a frequency in the subsonic, sonic or ultrasonic range. For example, the equipment has

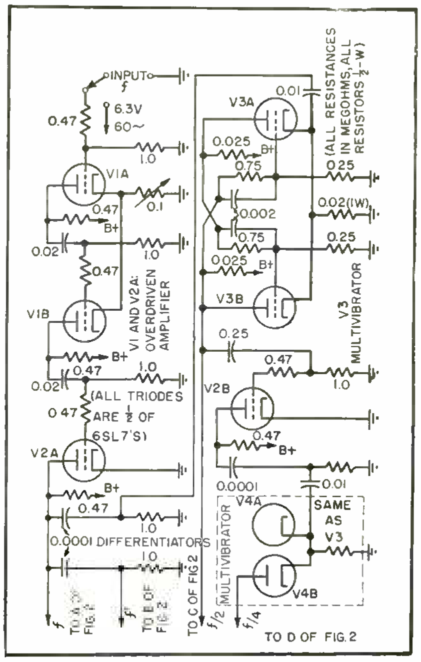


FIG. 1—Input and divider portions of synchronizer; second multivibrator is same as first; connections go to correspondingly marked leads of Fig. 2

been used to produce range markers. It delivers an output that can be adjusted in amplitude and made to have a rectangular, square, or impulse waveform.

Straightforward Circuit

The circuit uses only resistance and capacitance, hence there can be no frequency drift as there might be if resonant circuits were used. Triodes are used throughout; almost any type is suitable, but the high-gain dual type is preferable. The circuit values shown here are for a 60 cps input; they are not particularly critical.

Functionally the unit consists of four sections: the input, the multiplier, the divider, and the output. Figure 1 shows the input and divider; Fig. 2 shows the multiplier and output. Although the circuit shown provides five output frequencies (the fundamental, its second and third harmonics, and its second and third subharmonics), the circuit can be extended, or restricted, to any required range.

The input consists of an overdriven amplifier (V1A, V1B and V2A) which converts the input to a rectangular or square wave depending on the adjustment of the

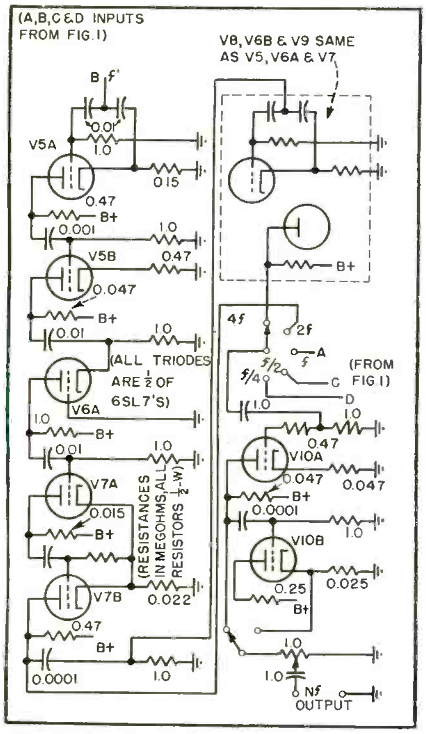


FIG. 2—Leads A, B, C and D come from corresponding leads of Fig. 2. Multipliers (one shown in detail) and output portions of synchronizer are shown here

cathode resistor. If a fixed input voltage is used, this resistor can be fixed at the value giving the required waveform. One volt input is sufficient to drive the clipper; if higher voltages are available, fewer stages can be used. The frequency-dividing circuit consists of a cathode-coupled half-shot multivibrator (V3A and V3B) fed from a differentiating circuit. This multivibrator produces an output of half the frequency of its input. To further divide the synchronizing frequency, the output from this multivibrator is fed through another differentiating circuit to a second multivibrator (V4A and V4B). If, as in this circuit, the output between dividers is to be used, an over-driven amplifier (V2B) should be used between them. When the unit is first put into operation the dividing circuits may need adjusting to assure that they are not triggered by stray pickup. The circuit can be laid out and adjusted so that the tubes need not be shielded, but if the equipment is to be used near apparatus producing strong pulses, shielding from external pickup is essential.

Frequency Multiplier

The novel multiplying circuit shown in Fig. 2 is an alternate-pulse inverter that inverts only the positive pulses of a wave train consisting of alternate positive and negative pulses. Pulses shown in Fig. 3 are applied to both grid and cathode of the inverter (V5A), which is effectively self-biased practically to cutoff. A positive input pulse affects the grid, producing a negative pulse in the plate circuit. A negative pulse affects the cathode, also producing a negative pulse in the plate circuit. The following two stages (V5B and V6A) eliminate positive pulses appearing in the plate circuit and shape the negative pulses. Because a grounded-grid amplifier (V6A) is used in this shaping circuit, the pulses out of it are positive.

To obtain a rectangular or square wave at the multiplied rate, the output pulses can be fed to a multivibrator. If further multiplication is required, the pulse output is fed through a differentiator to another alternate pulse inverter

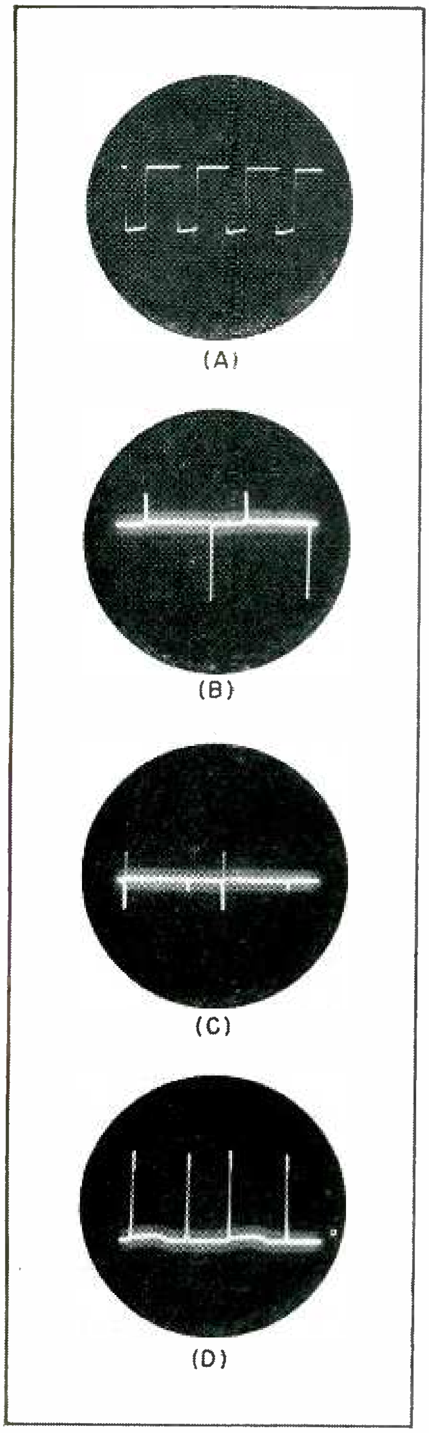


FIG. 3—Oscillographs show waveforms at critical portions of synchronizer. (A) output of overdriven amplifier, (B) input to alternate pulse inverter, (C) output of alternate pule inverter, and (D) output of shaping amplifier

(V8, V6B, and V9). A buffer and shaping amplifier (V7A and V7B) is advisable if the output from the first multiplier is to be used externally as well as for driving another multiplier. The grid circuit of the output (V7B) is adjusted to give the required wave shape.

As shown here the unit provides

only one frequency at a time. If several frequencies are to be used, additional switching and output amplifiers can be added to obtain all frequencies simultaneously if desired. The single output amplifier used here consists of an overdriven stage (V10A) to limit the voltages of all frequencies to the same level. The output switch selects rectangular or square waves from the output of this amplifier, or pulses produced by feeding the signal to the cathode follower (V10B) through a differentiator. Additional circuits can be used to improve the waveform if desired.

Spacing of the output pulses from the alternate pulse inverter is the same as the input spacing. If the inverter is used to drive a single-shot multivibrator, it will be necessary to adjust the multivibrator to obtain the required output; for example, to obtain a symmetrical square wave. Although the dividing and multiplying circuits are not sensitive to frequency, the coupling circuits of the multipliers are; they will have to be adjusted if the input frequency is changed. A unit employing an input frequency equal to the highest required frequency and using only dividers is, therefore, more versatile than one using both dividers and multipliers.

Power requirements for the unit are small. The maximum output voltage is dependent on the B+ voltage, which can be from 250 to 300 volts for the 6SL7's or higher if 6SN7's are used. A 5Y3-GT/G or selenium rectifier can be used with a single-section filter. A regulator may be desirable because the output is sensitive to supply voltage. Transients on the B+ line may trigger the multivibrators. Therefore, if, as is most likely, an electrolytic filter is used across the output of the power supply, it should be bypassed with either a small paper or mica capacitor to offer low impedance to high frequencies. If an external power supply is used, the capacitors should be across the B+ at the synchronizer to by-pass stray pulses picked up from the supply line, even if it is shielded.

This synchronizer was developed by the author while at Stamford University, Calif., for use with the

Stamford University Multifrequency Ionosphere Recorder operated under contract with the Bureau of Standards, Commerce Dept., Washington, D. C.

Indoor Television Antenna

By John H. Newitt
J. H. Newitt & Associates
Development Engineers
East Orange, N. J.

Receiving antennas do not readily cover such wide frequency ranges as the television band. By analyzing the operation and limitations of a dipole, the requirements for a wideband antenna can be deduced. From such an analysis a wideband indoor antenna that meets these requirements has been developed.

Characteristics of a Dipole

Most receiving antennas for very high frequencies are based on the dipole. Both the energy induced into a dipole and its terminal impedance are functions of frequency. Furthermore, parasitic elements (reflectors and directors), although they improve the directed sensitivity of the antenna, make it more frequency selective. Such directional arrays are properly used to eliminate ghosts, but are efficient only over a ten-percent frequency range.

To obtain some semblance of wideband response from dipole type antennas, they are resonanted near the middle of the band to be covered and purposely mismatched to the transmission line. Thus, as the efficiency of energy transfer

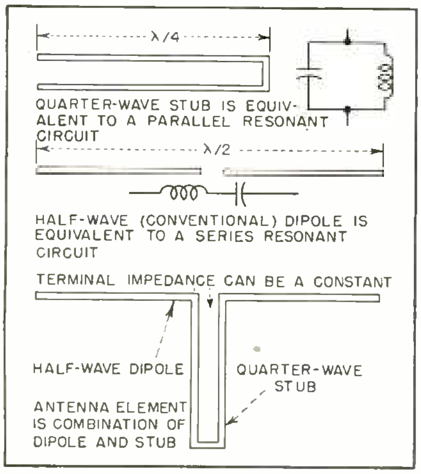


FIG. 1—Basic components of antenna

from radio wave to antenna decreases, the efficiency of energy transfer from antenna to transmission line increases. A fairly constant, but low efficiency is obtained over a portion of the television band with a dipole, whose terminal impedance varies between about 2,000 ohms at the limits of its useful band to 72 ohms at resonance, coupled into a 300-ohm line. A better match is obtained from a folded dipole.

A common method of providing wideband reception is to couple several antennas, whose resonant frequencies are spaced throughout the band, to the transmission line. The bandwidth can be extended by increasing the radiator surface area by using thick tubes in place of thin rods for the dipole. However, to cover the entire television band this method is impracticable: The rods have to be so thick. A cone operating on the same principle would require a base to height ratio of about 1:1; it would be resistive over a very wide frequency range (about 2:1).

Impedance Compensation

The basic components of an antenna that presents a nearly constant terminal impedance to its transmission line, and therefore preserves its efficiency of energy transfer to the line, are shown in Fig. 1. The quarter-wave stub is a parallel resonant circuit presenting a high terminal resistance at resonance, a capacitive impedance above resonance and an inductive impedance below resonance. The half-wave dipole is a series resonant circuit presenting a low terminal resistance at resonance, an inductive impedance above, and a capacitive impedance below. When these two impedances are properly pro-

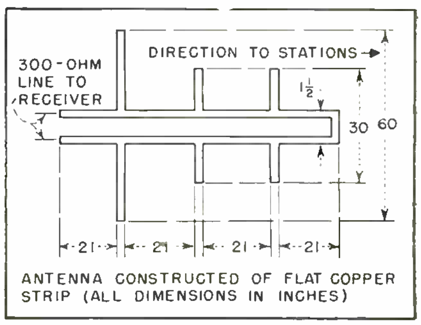


FIG. 2—Wideband end-fire array (dimensions are for an experimental version used under a rug indoors)

portioned and combined, they can be made to present a nearly constant resistive impedance over a wide band.

The principle can be used in an array consisting of receivers of different lengths to improve the sensitivity throughout the entire band, giving a system such as that of Fig. 2. The array presents a low impedance and maintains its sensitivity over a wide range. The impedance matching section was found to improve the performance.

The system is an end-fire array; its high directivity provides discrimination against ghosts. Any number of elements can be used, the directivity increasing with the number of elements. In designing the array, both factors (wave sensitivity and impedance matching) should be given equal attention to obtain optimum results. Several such arrays can be combined to further improve the performance.

Industrial Magnetron

DIELECTRIC HEATING depends on developing high power at high voltage across the material to be heated. However, the voltage is limited by arcing across the work. Hence continuous power is required for this application. The pulsed magnetron previously described briefly (ELECTRONICS, p 194, Dec. 1947) was developed by the British Thomson-Houston Co. for radar, not dielectric heating.

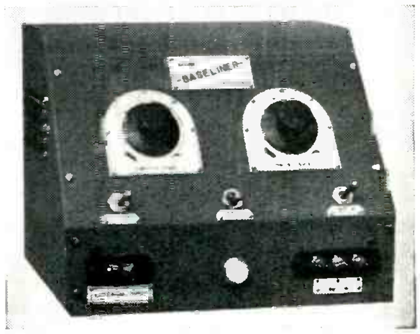
SURVEY OF NEW TECHNIQUES

MULTITRACK RANGE (MTR), developed in Australia as a modification of Gee, simplifies the equipment in an airplane. With hyperbolic tracks, as produced by such systems as Gee, either the navigator or the airborne navigation equipment must perform a computation to convert the indication into a radial track. With MTR the tracks are practically straight radials at distances beyond 10 miles from the master and slave station pair. This pair, operating on 200 mc, are only 10 miles apart. Because pulses are used the system is unaffected by reflections, however, it has two blind regions 180 deg apart.

12,000 cps and noise reduction more than 25 db. It has a 10-watt power output.

Baseline Generator

GLOBE PRODUCTS CORP., 870 Maplewood Ave., Bridgeport 5, Conn. The Baseliner is a recently developed device that provides a baseline in



visual alignment systems by restoring the cro amplifier to its zero input operating condition for 180 degrees of the modulation cycle.

Signal Generator

BOONTON RADIO CORP., Boonton, N. J. Type 211-A signal generator is designed for testing and

calibrating omnirange radio receiving equipment operating in the range from 88 to 140 megacycles. The equipment comprises an r-f assembly, modulator and oscillator, panel and meter, and external dual regulated power supply.

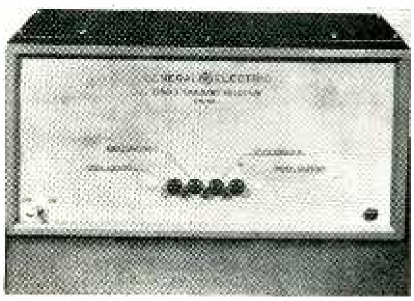
Evaporation Plater

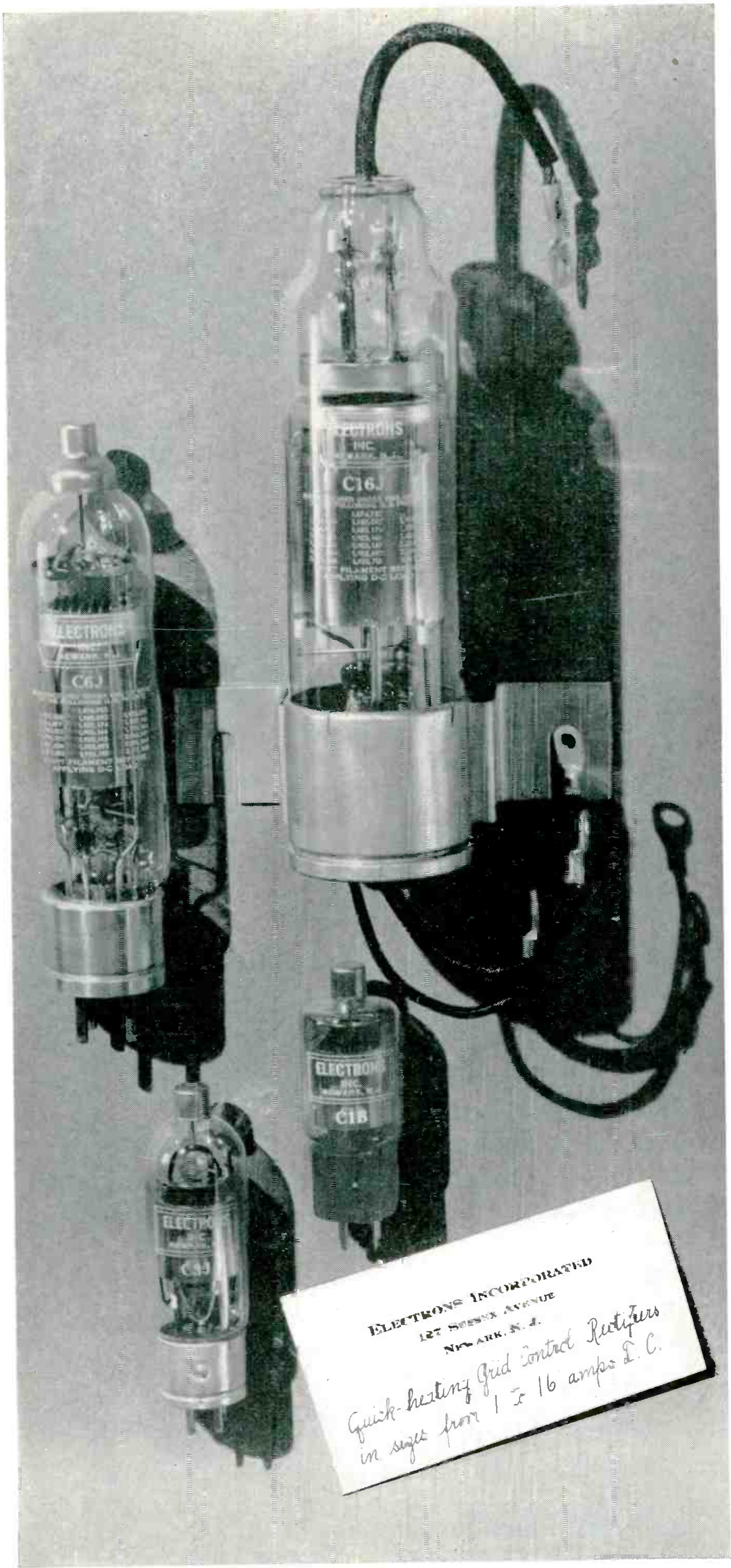
L. L. CONSTANTIN & Co., 253 Crooks Ave., Clifton, N. J. The machine illustrated is used for plating metals and metal fluorides in a

vacuum by evaporation. It finds application in base plating quartz, mica, and ceramics. Production of crystal oscillators to frequency is better than 180 units per hour.

Single-Sideband Selector

GENERAL ELECTRIC Co., Syracuse, N. Y. Type YRS-1 single-sideband selector was designed to provide improved reception in crowded amateur and communications radio bands without affecting quality of received signal. The device has four pushbuttons, one for dual-sideband reception with reinforced carrier, one for normal reception and one for selection of each sideband. It is intended for use with

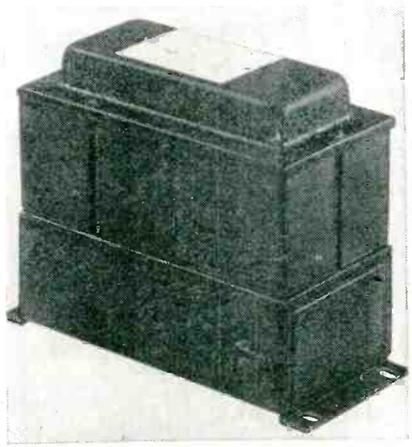




any receiver having an intermediate frequency of about 455 kc and operates on 105 to 125 volts, 50 or 60 cycles power at 60 watts.

Voltage Stabilizers

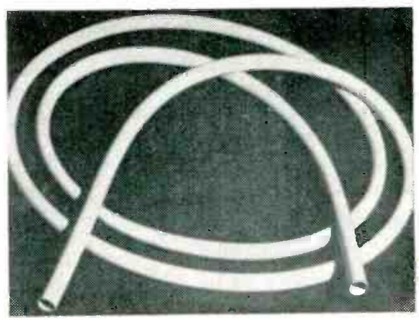
RAYTHEON MFG. CO., Waltham, Mass., introduces the VR-6000 line of automatic a-c line voltage stabilizers. The units are designed to



stabilize fluctuating voltage to within 0.5 percent. Varying input voltage can be stabilized within 0.05 second. The line can be procured in standard catalog models or custom-engineered designs.

Plastic Tubing

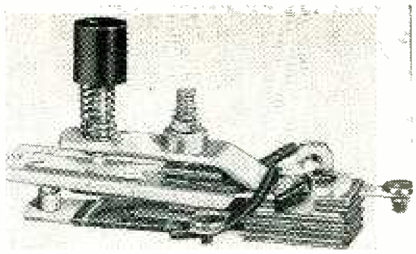
WILLIAM BRAND AND CO., 276 Fourth Ave., New York 10, N. Y. A new thermoplastic tubing type



Rel-16-A can be used continuously at 105 C. Porosity has been reduced to a minimum.

Thermal Timer

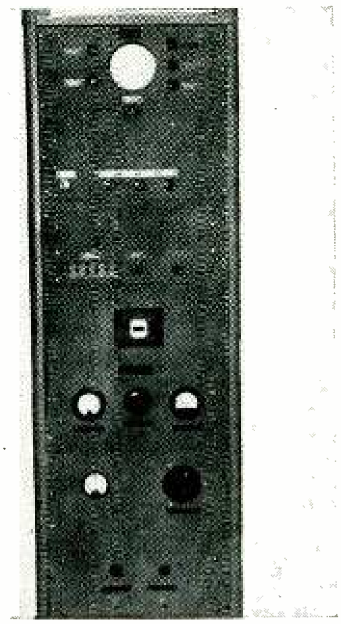
GEORGE ULANET CO., 414 Market St., Newark 5, N. J., has added a new manual reset thermal timer to its



line of electric heat control products. The unit is activated by a heater element which is wound on the bimetallic strip. Timing range is from 20 seconds to 3 minutes. Suggested applications are standby power plants, process control panels, and the like.

Microwave Generator

LERU LABORATORIES, INC., 360 Bleecker St., New York 14, N. Y. Designed for use in schools and training programs the 60-kw, 3-cm magnetron generator has a switch selection of six different pulse rates.



Also featured is a built-in c-r scope and a selector switch for coding pulses.

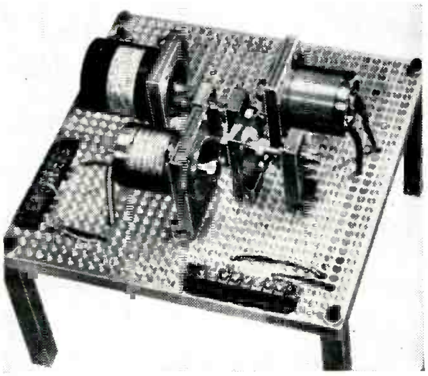
Control Console

ALLEN B. DUMONT LABORATORIES, INC., 42 Harding Ave., Clifton, N. J. Type TA-129-A television transmitter control console features a 12-inch picture monitor and power supply, line and frame waveform monitors, station monitor re-

ceiver, visual frequency monitor and all necessary visual and aural meters. It can be adapted for use with any make or model transmitter.

Breadboard Servo

SERVOMECHANISMS, INC., 142 Mineola Boulevard, Mineola, N. Y. The apparatus illustrated allows quick and accurate trials of various servo



systems. Shafts, gears, spacers, and other components are described and priced in a catalog just issued.

Television Rehearsal Equipment

TELEVISION PROJECTS, INC., 24 Walnut St., Newark, N. J. Type 148-C television studio rehearsal equipment illustrated comprises camera,

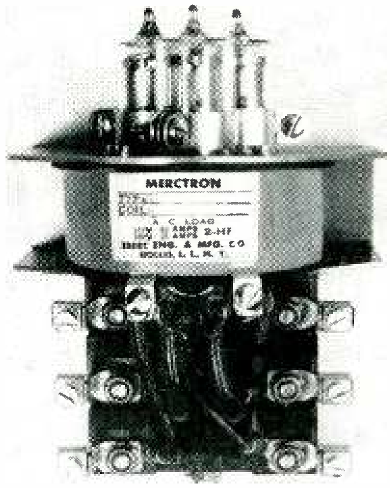
studio control console, and all necessary circuits for school demonstration, or program planning use. A brochure is available.

End-Window Counter

INSTRUMENT DEVELOPMENT LABORATORIES, 229 W. Erie St., Chicago 10, Ill. Model D31 Geiger tube has an all-glass envelope with a mica window at the end, and is a symmetrical cylinder either with or without a socket which can be provided if desired. It has a plateau from 1,100 to 1,300 volts, with a slope of 3 percent per hundred volts.

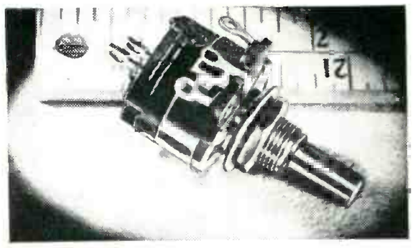
Mercury Relay

EBERT ENGINEERING & MFG. CO., 185-09 Jamaica Ave., Hollis 7, L. I., New York. The three-pole normally-open or normally-closed mercury relay illustrated will handle loads up to 10 hp at 440 v a-c.



Small Volume Control

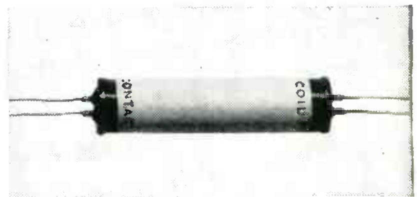
CLAROSTAT MFG. CO., INC., 130 Clinton St., Brooklyn, N. Y. A



small compact carbon volume control can be obtained with or without switch. Standard units are available in 0.25, 0.5, 1.0 and 2.0 megohm values, with the Z audio taper.

Resonant Relays

STEVENS-ARNOLD CO., 22 Elkins St., South Boston, Mass. The new hermetically-sealed resonant relays are used in low-level circuits where a change in leakage resistance



might be important. They operate only when energized at a predetermined frequency. Catalog 116 gives description and specifications.

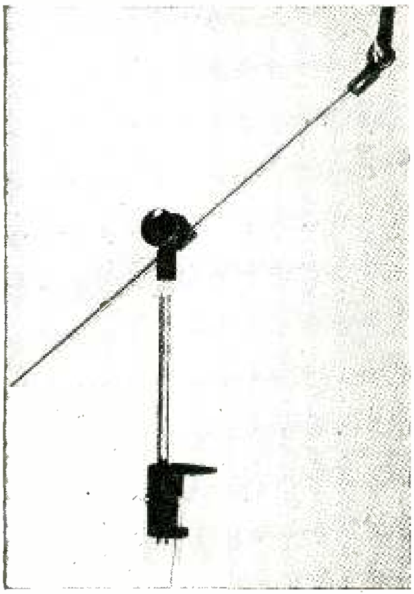
VTVM

HEWLETT-PACKARD CO., 395 Page Mill Road, Palo Alto, Calif. Model 400C vacuum tube voltmeter provides readings from 0.1 millivolt to 300 volts in the frequency range from 20 cycles to 2 megacycles. A special output terminal permits

use of the new device as a stabilized amplifier. Full details are available.

Pulpit Mike Stand

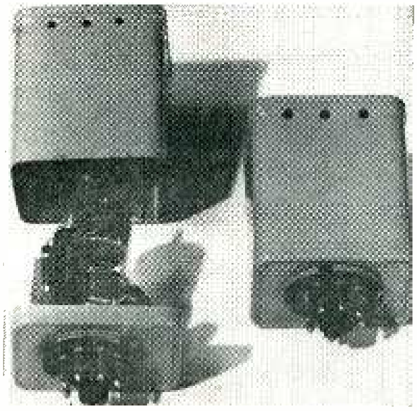
SPECIAL PRODUCTS CO., Silver Spring, Md. A new model portable adjustable microphone stand can be attached to pulpit or table. The top underside of the clamp is felt-



lined and an upright rod, held in position by a thumb screw, is adjustable up to ten inches. The universal joint in the center permits a 2-foot horizontal boom extension with locking at any angle selected. Price is $13.95 list.

Pickup Amplifier

COLLINS AUDIO PRODUCTS CO., INC., P. O. Box 368, Westfield, N. J. Model 1-A amplifier can be used with a variety of types of magnetic pickup cartridges. It consists of a



small metal shield can with an octal-plug base measuring $1\frac{7}{8}$x2x$2\frac{1}{2}$ inches in which is wired the complete equalizing circuit including vacuum tube. The unit requires no long cable but may be plugged into a tube socket. Requirements are 0.3 amp at 6.3 v, 2 ma at 250 v. Output averages 0.5 to 1.0 volt.

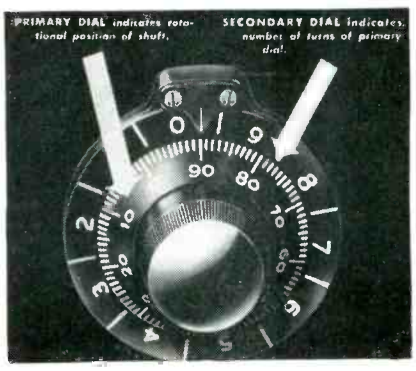
Millivolt Meter

MILLIVAC INSTRUMENTS, Box 3027, New Haven, Conn. Model MV-17A vacuum tube millivoltmeter for d-c has a magnetic modulator that converts the incoming signal to a 120-cycle wave that is then amplified.

Lowest range is 0 to 1 millivolt with 6 megohms input impedance. Top range is 0 to 1,000 volts with 60 megohms input impedance. Bulletin II-105 gives details of this equipment that opens up new measurement techniques.

Multiturn Dial

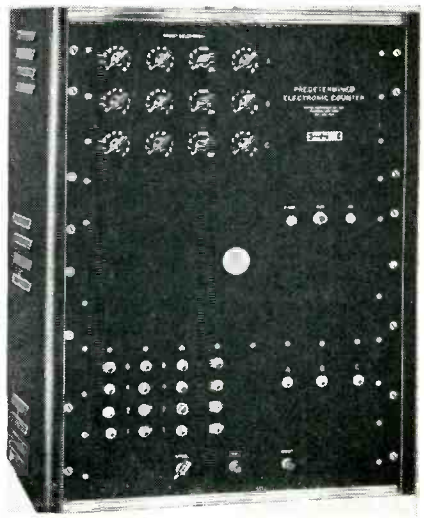
THE HELIPOT CORP., 1011 Mission St., South Pasadena, Calif. The Duodial is a multiturn dial devel-



oped for use with helical potentiometers but having other applications as well. It consists of a primary knob-dial geared to a concentric turns—indicating secondary dial and requires a panel space only two inches in diameter.

Predetermined Counters

POTTER INSTRUMENT CO., INC., 136–56 Roosevelt Ave., Flushing, N. Y. A new line of multiple-sequence counters use four-tube counter decades and are designed to predetermine any number of selected counts occurring in se-



quence. Pictured here is the three-sequence unit which will predetermine three different counts that occur in sequence, each of which can be any number from 1 to 10,000. Output consists of three high-speed mercury-type relays.

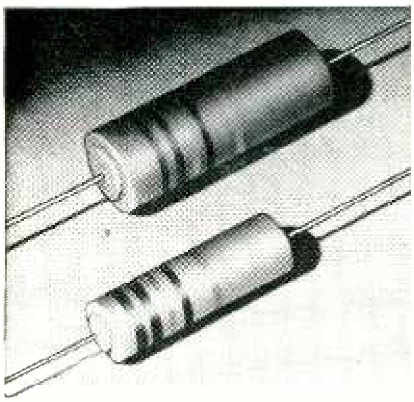
Disc Recorder

REK-O-KUT CO., INC., 38-01 Queens Boulevard, New York, N. Y. A new 12-in. disc recorder, illustrated, has a dual speed turntable,

overhead feed mechanism, and self-contained 8-in speaker.

Paper Tubulars

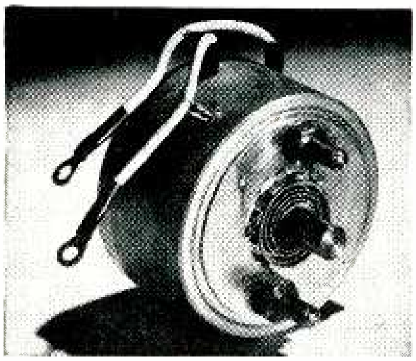
AEROVOX CORP., New Bedford, Mass. The recent paper tubular capacitors feature new design,



Aerolene impregnant and Duranite casing. The line is moisture-proof and designed for climatic extremes.

Rotary Solenoids

G. H. LELAND INC., 118 Webster St., Dayton 2, Ohio. The Ledex no. 7 and no. 8 rotary solenoids were designed to produce torques of 25 and 50 pound-inches, respectively. A choice of wire sizes from no. 13 to no. 35 represents d-c



operation from 6 to 550 volts. Rectifiers can be supplied, as accessories, for solenoid operation on a-c.

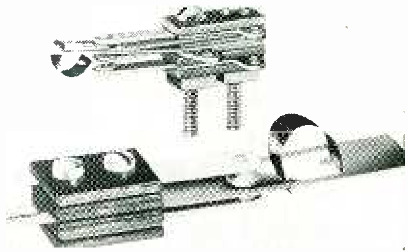
Regenerative Preselector

BABCOCK RADIO ENGINEERING, INC., 6164 Sepulveda Blvd., Van Nuys, Calif. Model P2A regenerative preselector has a 4-band range of

10, 11, 15 and 20 meters; and general coverage is from 13 to 40 mc. It uses miniature 6AU6, 6J6 and also VR150 tubes. Net price is $27.50.

Snap Action Switch

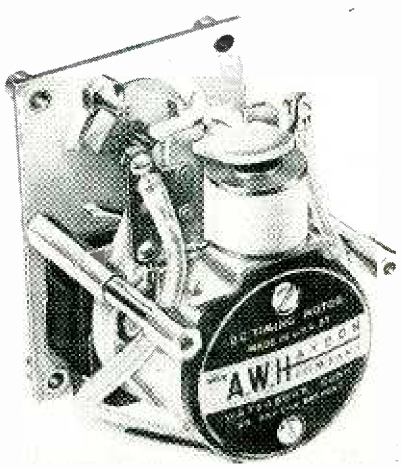
ACRO ELECTRIC CO., 1316 Superior Ave., Cleveland 14, Ohio. Snap-



action switches rated by Underwriters Labs at 15 amp, 125 volts, or 7.5 amp, 250 volts a-c are available in two sizes as shown.

D-C Timing Motor

A. W. HAYDON CO., Waterbury, Conn. Series 6400 d-c and 11400 a-c time delay relays have a planetary differential and capstan-type clutch mechanism which is designed to drive the switch actuat-



This little

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saves money

ECONOMY in building television sets is *important* and the General Electric Focus Coil points the way to *important* savings in manufacturing.

1 The G-E Focus Coil requires less current—permitting the use of lower-priced power supplies.

2 It is a combination of the new G-E Alnico 6 permanent magnet and an electro-magnet.

3 It is simple to install. Forming a single assembly with the deflection yoke and centering device, the entire assembly is mounted with one bracket.

4 It is small, compact, lightweight—giving set designers more space to utilize.

When your sets are placed on the market—be sure they're equipped with this little G-E Focus Coil with the four big features.

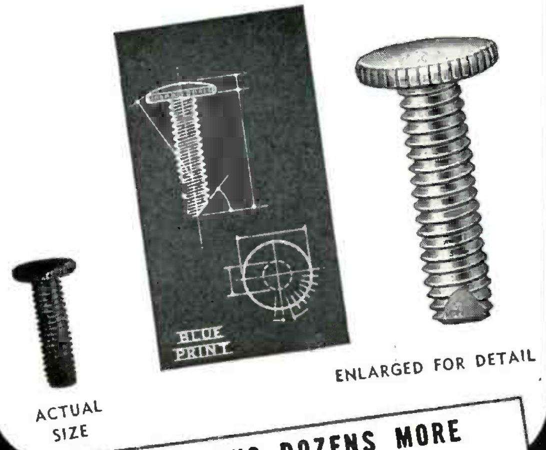
For complete information on Television Components write: General Electric Company, Electronics Park, Syracuse, N. Y.

168-G7

GENERAL ELECTRIC

ANOTHER SPECIAL BY PROGRESSIVE

QUALITY PROMCO BRAND



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Special heads, threads and finishes on any metal or alloy adapted to cold upset. Weekly output: 25,000,000 pieces. Many specials, suggesting production savings for you, illustrated in latest catalog. Includes weights per 1M standard pieces, dec. equivs. of fractions, other purchasing and engineering helps. Write for Catalog 19.

The **PROGRESSIVE MFG. CO.**

_0 NORWOOD ST. TORRINGTON, CONN

New DUMONT

TYPE P8 125 °C *Silicone* OIL CAPACITORS

SOLVES THE HIGH HEAT CONDENSER PROBLEM

Send for Literature

- New silicone oil capacitors for continuous A/C-D/C up to 125° C.
- Made in ceramic or bakelized tubes.
- Cap. — .00005 to 1.0 M.F.D. From 100 volts to 20000 volts.

DUMONT ELECTRIC CORP.

MFR'S OF CAPACITORS FOR EVERY REQUIREMENT

308 DYCKMAN ST., NEW YORK, N. Y.

ing arm when the clutch holds the third element of the differential stationary. Weight is approximately one pound and the unit may be modified to specifications for individual applications.

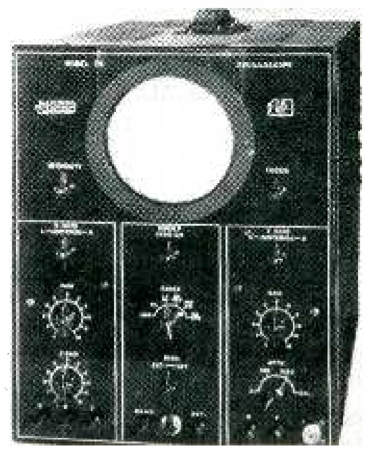
Master Switch

General Control Co., 1200 Soldiers Field Road, Boston, Mass., announces the TC-58-M master switch which has centralized fingertip control for the entire trim-

tab system of an airplane. All switch elements of the unit are of the snap-action type, able to handle a 10-ampere noninductive load at 24 volts d-c.

Wide-Range Scope

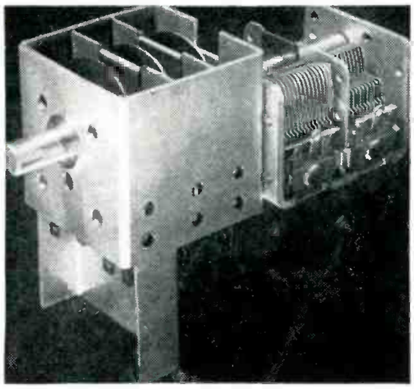
Electronic Development Laboratory, 2655 W. 19th St., Chicago, Ill. Model 75 wide-range oscilloscope has a vertical amplifier response of ±2 db from 10 cycles to 5 megacycles, permitting study of television signals and all waveforms with high harmonic contents. It features a self-contained



voltage calibrator with ±5-percent accuracy. Information is also available on the model 49-A 5-inch scope.

Vane Tuner

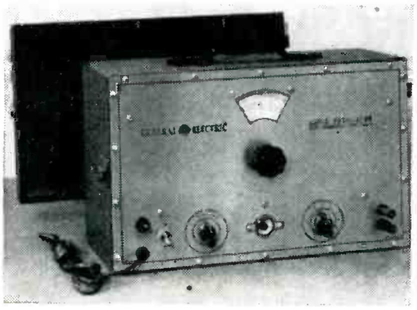
MODULATION PRODUCTS CO., 509 23rd St., Union City, N. J. The new a-m and f-m tuning device mounts on the shaft of any tuning capacitor. The unit is supplied



either as a two or three gang vane tuner mounted on an a-m tuning capacitor or as a complete r-f chassis for a-m or f-m design.

Audio Oscillator

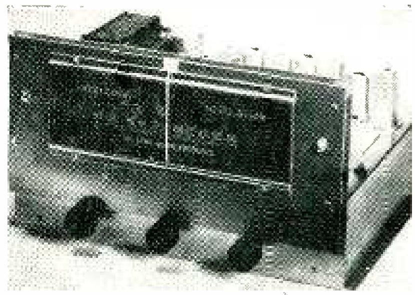
GENERAL ELECTRIC CO., Syracuse, N. Y., has announced the type YGA-4 audio oscillator, developed primarily for the serviceman. A stable bfo circuit enables the unit



to deliver a low distortion output voltage which remains constant within ± 1 db over the 50 to 15,000 cycle range.

F-M Tuner

COLLINS AUDIO PRODUCTS CO., INC., P. O. Box 368, Westfield, N. J. The new f-m tuner includes the 6AL7-GT tuning indicator, three i-f stages and two cascade limiters. It



has a 10-microvolt sensitivity. A total of 11 tubes is included in the compact unit.

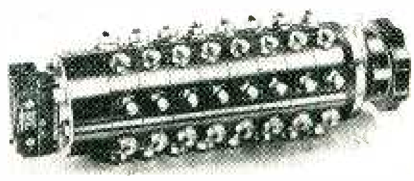
Life-Size Television

CORTLEY TELEVISION CORP., 15 W. 27th St., New York 1, N. Y., has developed a new type television receiver capable of throwing a picture varying in size from several

inches up to 6 × 8 feet onto a screen. Featured are a tilt adjustment for different height screens, a highly regulated power supply and an automatic cutout relay.

Rotary Tap Switch

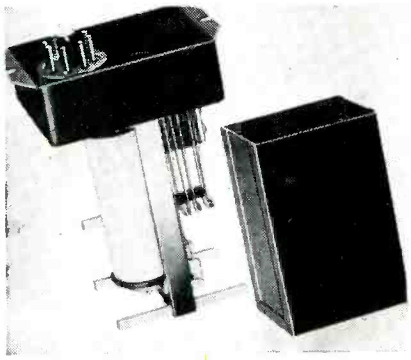
EASTERN SPECIALTY CO., Philadelphia 40, Pa., has developed the new rotary tap switch for intricate circuits. Each section with 7 active positions and one off position is rated at 50 amperes continuous duty, with an overload capacity of



75 amperes. It is designed so that twelve switch sections may be operated in parallel to handle a maximum current of 600 amperes.

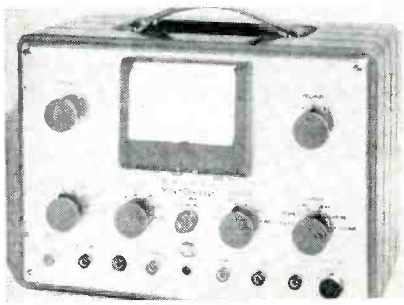
Relay Protection

C. P. Clare & Co., 4719 W. Sunnyside Ave., Chicago 30, Ill., has developed a dust-tight plug-in relay base and cover for use in plants where dust conditions may affect operation of unprotected relays. Write for complete specifications.



Tester

Radio Corp. of America, Camden, N. J. The new Master Voltohmyst measures capacitance from 5 μμf to 1,000 μf; current from 1 μa to 10 amp; r-f voltage at frequencies up to 250 megacycles; as well as performing other customary measurements expected of the standard test equipment.



Literature

Scientific Instruments. American Instrument Co., Silver Springs, Maryland, has just issued a 274-page catalog describing instruments for use in chemical, biological, physical, metallurgical, and other laboratories. Available to laboratory workers requesting it on business stationery.

Blowers. Rotron Div., Jenckes Knitting Machine Co., 180 Weeden St., Pawtucket, R. I. Catalog sheets describing a new line of blowers designed for tube cooling and similar uses in radio and electronic equipment.

Shock Mounts. Barry Corp., 179 Sidney St., Cambridge 39, Mass. A 14-page catalog describes the heavy equipment mountings and engineering services available from the company.

Television Antennas. The Workshop Associates, Inc., 66 Needham St., Newton Highlands 61, Mass., has just released two brochures on ways of obtaining optimum television signals in all bands. A new biconical antenna for f-m and television is constructed of corrugated board covered with aluminum foil (for attic installation) and lists at $19.95.

Mobile Microphones. Electro-Voice, Inc., Buchanan, Michigan. Bulletin 140 gives helpful information, data and prices on the complete line of carbon, dynamic and differential carbon Mobil-Mikes for aircraft, police, fire, taxi, marine, utility, forestry and similar services.

Resistors and Rheostats. Ward Leonard Electric Co., Mount Vernon, N. Y. Catalog D-130 is a 24-page reference guide fully describing and illustrating a comprehensive line of resistors, rheostats and radio amateur relays. List prices are included.

Equipment Pamphlet. Clark Electronic Laboratories, Palm Springs, Calif. Bulletin 117 is a 12-page pamphlet treating of selenium rectifier tubes and tanks, acyclic generators and multispeed selenium motor controls.

Antenna Equipment. J. F. D. Manufacturing Co., Inc., 4109-4123 Ft. Hamilton Parkway, Brooklyn 19, N. Y. A 16-page catalog presents the Super-Beam line of television and f-m antennas which includes over 27 arrays. Also described and illustrated is a wide assortment of accessories, brackets and wire.

Resins and Plastics. Bakelite Corp., 300 Madison Ave., New York 17, N. Y. A handsomely illustrated booklet describes the many forms in which Vinylite resins and plastics are produced and fabricated. The last four pages are devoted to tables for technical assistance.

Flow-Rate Meters. Brooks Rotameter Co., P.O. Box B-53648, Lansdale, Pa. A new catalog describes the full line of rotameters for flow-rate measurement and control. Capacity chart, data sheet and dimension prints of each type meter are given.

Timing Motor. The R. W. Cramer Co. Inc., Centerbrook, Conn. Bulletin 10A is a 4-page folder dealing with the type SX self-starting synchronous timing motor. This unit is intended for industrial applications in the instrument and control field to fill the gap between the low-torque clock motor and the fractional h-p group. A table on the back page gives a large choice of standard output speeds.

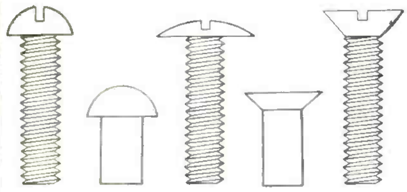
Flexible Tubing. Titeflex, Inc., 410 Frelinghuysen Ave., Newark 5, N. J., recently published a 24-page catalog illustrating and describing a line of all-metal flexible tubing. Included are specifications for standard fittings and illustrations of typical assemblies with these fittings.

High-Range Ohmmeter. Radio City Products Co., 152 W. 25 St., New York 1, N. Y. Bulletin No. 133 is devoted to the model 450 series high-range ohmmeters. Included are six different units in open face models and in portable types which make resistance measurements of 50 to 1,000 megohms.

Transformer Catalog. Standard Transformer Corp., Dept. S, Elston, Kedzie, and Addison Sts., Chicago 18, Ill. The 24-page catalog 140-H lists over 400 stock items

PROMPT DELIVERY!

Stainless Steel MACHINE SCREWS and Rivets



SCREWS, nuts, washers, pins — Allmetal carries the largest stock in the country of stainless steel fasteners and screw machine parts. Our complete facilities for heading, tapping, drilling, reaming, slotting, turning, stamping, broaching and centerless grinding make possible prompt delivery of specials, too. Write for our free 83-page catalog today.

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Cap Screws	Nuts	Taper Pins
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PRECISION POTENTIOMETERS

Toroidal and Sinusoidal

For use in computing and analyzing devices; generation of low frequency saw tooth and sine waves: controls for radio and radar equipment; position indicators; servomechanisms; electro medical instruments, measuring devices—telemetering; gun fire control where 360° rotation, high precision and low noise levels are essential.

The type RL14MS sinusoidal potentiometer is illustrated. It is wound to a total resistance of 35,400 ohms and provides two voltages proportional to the sine and cosine of the shaft angle. It will generate a sine wave true within ±.6% Overall dimensions are 4⅜" diameter x 4 11/32 long plus shaft extension ¼" diameter x 1¼" long.

Write for Bulletin F-68

THE GAMEWELL COMPANY
Newton Upper Falls 64, Massachusetts

MIGHTY MITES OF RECORDING!

For cutting—

Brilliantone RECORDING NEEDLES

For cutting direct on all coated aluminum, paper, or glass base discs. Machine-lapped to insure a mirrorlike finish . . . a clean, quiet-cut groove.

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Actone TRANSCRIPTION NEEDLE 100% SHADOWGRAPHED

Made to fit the groove cut by the Brilliantone Recording Needle. Used by top radio stations and transcription companies.

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For New Catalog and Current Price Lists, write to: Advertising Division

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COOLER OPERATION

KOTRON STRIP-TYPE SELENIUM RECTIFIERS

PATS. PEND.

100 MA. UNIT

- Max. A. C. line input 130 volts rms
- Max. inst. peak current 1000 Ma.
- Max. inverse peak voltage 360
- Average operating temp. 105°F
- Dimensions: 4-1/16" x 1-1/16" x 5/32"
- Other Sizes: 75 Ma. and 200 Ma.

Kotron's metallic rectifying elements are mounted in one plane. Plates cannot contribute heat to each other. Result—Cooler Operation . longer life . . . increased circuit efficiency. Wafer-thin Kotron saves space, mounts easier.

Write for Complete Technical Data, Prices and Delivery

ARCTURUS "KNOWN THE WORLD OVER"

STANDARD ARCTURUS CORPORATION
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including audio and power transformers and reactors, power packs, volt adjusters, radio transmitter kits and television components.

Timer and Control Data. Electronic Controls, Inc., 44 Summer Ave., Newark 4, N. J. Several models of timers and switches are covered in a four-page loose-leaf perforated folder. Description, application and technical data for each are given.

Aircraft Instruments. Fredric Flader, Inc., North Tonawanda, New York. Two recent bulletins treat of Teleflight accelerometers and pressure transmitters which are specially designed for use in aircraft and missile applications. Mechanical drawings, principles of operation and prices are included.

Components Catalog. Stackpole Carbon Co., St. Marys, Pa. Catalog RC7 covers a line of electronic components including fixed and variable resistors, iron cores, line and slide switches, choke forms and capacitor units. The publication is replete with illustrations, mechanical diagrams and charts.

Sapphire Gages. Sapphire Products Division, Elgin National Watch Co., Aurora, Ill. A four-page color circular gives description and prices on sapphire plug gages, ring gages and micrometers. The Tipt-type gage, featuring hardened steel leader, is fully covered.

Carrier System. Lenkurt Electric Co., 1116 County Road, San Carlos, Calif. Folder CX39A is an eight-page illustrated publication giving a complete treatment of the Type 32 three-channel carrier system. Particular emphasis is laid on filter engineering which gives the system in effect, a fourth channel.

Isotope Chart. General Electric Co., Schenectady 5, N. Y. A new chart giving the latest data concerning isotopes of the chemical elements is being distributed. Printed on heavy paper, 26 × 50 inches, it is divided into three overlapping sections for convenience. In the form of a long diagonal checkerboard, each square contains the chemical symbol, atomic weight and other data on the isotope, along with empty spaces to keep the chart up to date. Copies may be had on request.

Wire & Cable Handbook. Rockbestos Products Corp., New Haven 4, Conn. The new No. 10-F catalog and handbook gives a cross-section of the complete line of more than 125 different heat and flame resistant wires.

Maintenance Catalog. General Cement Mfg. Co., 919 Taylor Ave., Rockford, Ill. Catalog 150 is a 64-page well-illustrated description and price list of a wide variety of chemicals, parts, materials, tools and equipment necessary for the maintenance of radio and electronic equipment.

Klystrons. Sperry Gyroscope Co., Great Neck, New York. A small, simply-written, folder discusses klystrons and their operation and lists many possible applications. The further use of klystrons in industry is advocated.

Battery Replacement Guide. Burgess Battery Co., Dept. RG, Freeport, Ill. The 1948 guide contains the latest replacement battery information, listing over 1600 sets made by 100 radio manufacturers and the correct batteries for each set.

Timing Devices. The A. W. Haydon Co., Waterbury 32, Conn. A new catalog covers a variety of timing motors, relays, switches, and indicators for both a-c and d-c use. Illustrations and specifications are included.

Miniature Bearings. New Hampshire Ball Bearings, Inc., Peterborough, New Hampshire. Technical bulletin No. 48 contains much information on extra-small bearings of several designs. Tolerances, mounting and selection of bearings are treated.

NEWS OF THE INDUSTRY
(continued from page 138)

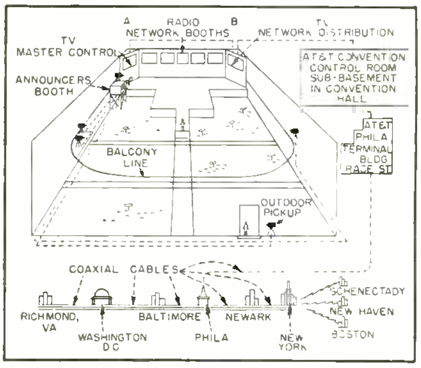
inches in diameter, topped by an RCA six-bay batwing antenna.

The entire project, including acoustically isolated studios, was built by the Turner Construction Company for the Daily News.

Convention Coverage Via TV

EIGHTEEN television stations from Boston, Mass. to Richmond, Va.—the largest video hookup to date—covered the recent Republican and Democratic national conventions. In addition to direct telecast from the scene, television broadcasters filmed the proceedings and flew them to stations in the midwest and west coast where no cable or microwave relay facilities are as yet available for direct transmissions.

To accomplish the feat a general television committee for pooled coverage was created several months ago, composed of personnel from ABC, CBS, DuMont and NBC, to organize the telecasting for all stations situated along the



Sketch shows camera setup and route followed by television pooled pickup of national political conventions

coaxial cable and microwave relay route of the American Telephone and Telegraph Co. on the eastern seaboard.

Five television cameras were set up, each equipped with a turret of four lenses, making possible 20 different views. The televised images were fed by cable from the cameras to a master control room to the left of the Convention Hall stage, where a producer-director selected for transmission the picture best depicting the proceedings. The selected picture was then routed via

Vital Aids TO

MANUFACTURERS OF MINIATURE TUBE RADIOS AND EQUIPMENT

★ Star Miniature Socket Wiring Plugs for accurate alignment of miniature socket contacts during wiring. Precision cast of zinc base alloy—pins of stainless steel. #JE-9 (9 pin); #JE-10 (7 pin).

★ Star Miniature Tube Pin Straighteners (with stainless steel insert) to obtain a perfect fit when the tube is placed in the equipment. #JE-15 (9 pin); #JE-13 (7 pin).

Scientifically designed — Precision made
Immediate Delivery in Any Quantities

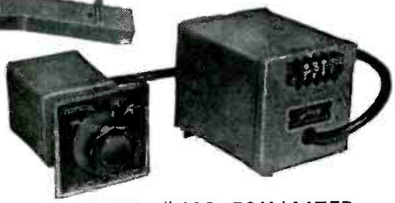
★STAR EXPANSION PRODUCTS CO., INC.
147 CEDAR STREET, NEW YORK 6, N. Y.

The Combination of

GRAY TRANSCRIPTION ARM, #601 4-Position EQUALIZER and SELECTED GE CARTRIDGE . . .

. . . *is receiving* WIDE ACCLAIM

Developed in collaboration with the COLUMBIA BROADCASTING SYSTEM for finer lateral reproduction, it is now standard equipment in two major networks.



GRAY TRANSCRIPTION ARM

This, the only modern arm for lateral reproduction, greatly extends the life of stylus and recordings. Adjustable stylus pressure, accommodates all modern cartridges. Ideal for **Micro-Groove** reproduction. Many other new features. Arm, less cartridge, $35.00.

GRAY #601 EQUALIZER for GE CARTRIDGE

Optimum Performance, Economy of Operation and Quality Workmanship. Matches pickup to microphone channel. Complete, $42.50.

Write for more details (including Gray Selected GE Cartridges with Diamond Styli, and Micro-Groove reproduction).

GRAY RESEARCH & DEVELOPMENT COMPANY, Inc.
Factory: Hartford, Conn. • Sales: 565 FIFTH AVENUE, NEW YORK 17

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New!

REAR PROJECTION PLASTIC TELEVISION SCREENS

The screen surface consists of a conglomerate arrangement of microscopic plastic crystals that "Pin Point" the projected image providing unexcelled angular viewing with a minimum loss of projected light. It is estimated that there is a loss of approximately 10% of light viewing the image at 45 degrees off center.

Light transmission percentages are controlled to obtain the maximum efficiency of the television optical projection system. The percentage of 80% of transmission has been determined as that providing maximum efficiency. Stock sheets are available from 3 x 4 feet down. Specify inside dimensions of screen desired. If larger sizes are required, they can be made to order.

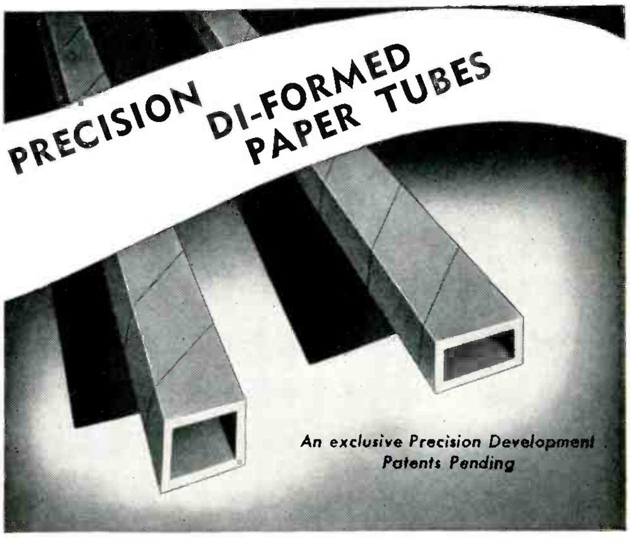
The special construction of this screen material permits its use in places where even direct light falls on the screen. The screen is designed to give maximum black and white quality when used with a new 5TP4 Tube.

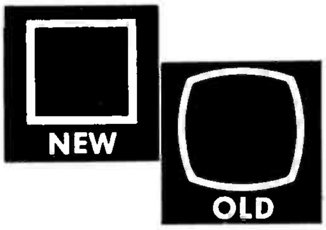
Net price of Rear Projection Screen, per sq. foot.............. **$3.00**

25% With Order, Balance C.O.D.

Pioneers in Projection Television
SPELLMAN TELEVISION CO., INC.
130 WEST 24th STREET • NEW YORK 11, N. Y.

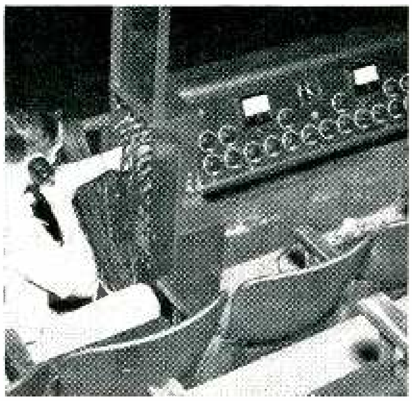
NEW PROCESS CUTS COIL WINDING COSTS 4 WAYS





At no extra cost, all Precision tubes are now Di-Formed under heat and pressure. This means 1) Greater strength at no increase in weight. 2) Automatic stacking made possible. 3) Coils need not be formed after winding. 4) Cores can be engineered closer. The saving in wire, labor, extra operations; and the greater coil efficiency can readily be seen. Send for samples of Di-Formed tubes, and new Mandrel List.

PRECISION PAPER TUBE CO.
2041 WEST CHARLESTON STREET CHICAGO 47, ILL.
Plant #2 • 79 Chapel St. • Hartford, Conn.



Special RCA custom-built microphone control and mixing console shown being installed in Philadelphia Convention Hall in the center of the first balcony overlooking the arena. It controls a sound system having an output of approximately 1 kw, one of the world's largest amplifier installations

cable to a network distribution booth to the right of the stage. This booth provided feeds to the individual control rooms of each of the networks on the scene, and also to the control room of the AT&T from which point they were sent via coaxial cable to the Bell System's terminal on Race St., Philadelphia. From there they were transmitted by coaxial cable to the stations.

In New York City the images were fed via AT&T microwave to Boston, Mass., via G-E's microwave relay to Schenectady, N. Y., and over DuMont network's relay to New Haven, Conn.

Low-Powered Educational F-m

THE FCC has proposed to amend its rules and regulations so that low-powered (10 watts or less) educational f-m broadcasting would be authorized in the 88 to 92 mc band now allocated to the noncommercial educational broadcast service. Indications are that such a station could get on the air for an expenditure of a few hundred dollars and could cover distances of from two to five miles.

Licensing of low-power f-m transmitters for school systems is advocated by the U. S. Office of Education. Syracuse and DePauw Universities are applicants for $2\frac{1}{2}$-watt noncommercial educational f-m stations, and other institutions have expressed interest. Syracuse U. has conducted an experimental station of this nature for the past year, using G-E equipment.

Scientists Decorated

In recognition of outstanding services to the armed forces, the award of the Medal for Merit was bestowed on 65 scientists and engineers of the wartime office of Scientific Research and Development. The following were the recipients:

Leason H. Adams of the Geophysical Laboratory, Carnegie Institute of Washington; Roger Adams of the Department of Chemistry, University of Illinois; Homer B. Adkins of the Department of Chemistry, University of Wisconsin; Henry B. Allen of Franklin Institute, Philadelphia; Luis W. Alvarez of the Department of Physics, University of Calif.; Bennetth Archambault of M. W. Kellogg Co., New York, N. Y.; James G. Baker of Harvard College Observatory; Edward L. Bowles of MIT; John E. Burchard of MIT; John S. Burlew of the Geophysical Laboratory, Carnegie Institute; Samuel H. Caldwell of MIT; Harris M. Chadwell of Rockefeller Foundation, N. Y.; Robert D. Coghill of Abbott Laboratories, Chicago; Edwin J. Cohn of Harvard University; Ralph A. Connor of University of Pennsylvania; Alphonse R. Dochez of Columbia University; Lee A. DuBridge of Calif. Inst. of Technology; Melville Eastham of General Radio Co.; Alexander Ellett of Zenith Radio Corp.; Raymond H. Ewell of California Research Institute; Horace S. Ford of MIT; William A. Fowler of Calif. Institute of Technology; Ivan A. Getting of MIT; Lars O. Grondahl of Union Switch & Signal Co., Pittsburgh; Paul M. Gross of Duke University; Albert B. Hastings of Harvard; Clarence N. Hickman of Bell Telephone Laboratories; Hoyt C. Hottel of MIT; Frederick L. Hovde of Purdue University; Walter S. Hunter of Brown University; Herbert E. Ives of Bell Labs; Zay Jeffries of General Electric Co., Pittsfield, Mass.; Charles S. Keefer of Boston University; Paul E. Klopsteg of Northwestern University; Edward F. Knipling of U. S. Dept. of Agriculture, Washington, D. C.; Irving Langmuir of General Electric Co., Schenectady; Warren K. Lewis of MIT; Alfred L. Loomis of Loomis Laboratories, Tuxedo Park, New York; Stanley P. Lovell of Beckwith Mfg. Co., Boston, Mass.; Duncan P. MacDougall, Los Alamos, New Mexico; Max Mason of Calif. Institute of Technology; Robert R. McMath of McMath-Hulbest Observatory, University of Michigan; Edward L. Moreland of MIT; William A. Noyes, Jr. of the University of Rochester; Brian O'Brien of the University of Rochester; Linus C. Pauling of Calif. Institute of Technology; Isidor I. Rabi of Columbia University; Harold B. Richmond of General Radio Co.; Louis N. Ridenour of the University of Illinois; Richard B. Roberts of the Carnegie Institute; Hartley Rowe of United Fruit Co., Boston, Mass.; Bruce H. Sage of Calif. Institute of Technology; James A. Shannon of E. R. Squibb and Sons, N. Y.; Thomas K. Sherwood of MIT; Homer W. Smith of the College of Medicine, New York University; Earl P. Stevenson of Arthur D. Little, Inc., Newton, Mass.; Irvin Stewart of the Univ. of West Virginia; Chauncey G. Suits of General Electric Co., Schenectady, N. Y.; Frederick E. Terman of Stanford University; Roger S. Warner, Jr. of the U. S. Atomic Energy Commission, Washington, D. C.; Alan T. Waterman of the Office of Naval Research, Washington, D. C.; Warran Weaver of Rockefeller Foundation; Clyde E. Williams of the Battelle Memorial Institute, Columbus, Ohio; Carroll L. Wilson of the U. S. Atomic Energy Commission, Washington, D. C.; Edgar B. Wilson, Jr. of Harvard University.

In addition to the above named, the Medal for Merit with oak leaf

President Truman presents Medal for Merit with oak leaf cluster to James B. Conant (right) and Vannevar Bush (left)

cluster was bestowed upon Vannevar Bush and James B. Conant for their contributions to atomic research.

BUSINESS NEWS

ALLEN B. DUMONT LABORATORIES, INC. has purchased from WAA a 56-acre former Wright Aeronautical plant in East Paterson, N. J., and will use it to triple the present 3,000-per-month television receiver production. The property must be maintained in such a manner that it may be reconverted to its original use within 120 days.

TELECTRAD CO., New York, N. Y., has been formed to specialize in supplying capacitors to manufacturers and laboratories.

SERVO CORP. OF AMERICA, manufacturers of servomechanisms and computers, have acquired space in the Eric Wedemeyer Building, New Hyde Park, L. I., New York. The newly leased area will house the servomechanisms laboratory and general offices.

CONTROL ENGINEERING CORP., manufacturers of precision electromechanical instruments and control systems, has purchased a 14,000-foot modern laboratory building in Canton, Mass.

GENERAL ELECTRIC CO. will devote its entire receiver building (capable of housing three football fields) at Electronics Park to television set production by the end of the year.

ELECTRON MICROSCOPE SOCIETY OF AMERICA has set up a placement service for the mutual benefit of its

members and potential employers. Inquiries should be directed to C. S. Burton of the American Cyanamid Co., Stamford, Conn., who is secretary of EMSA.

TRIODE RADIO, INC., Brooklyn, N. Y. has set up engineering and development laboratories specializing in high-frequency communications and high-fidelity audio systems.

SANGAMO ELECTRIC CO., Springfield, Ill., recently finished construction of its new plant at Marion, Illinois, which provides complete facilities for the manufacture of mica, paper and electrolytic capacitors.

PERSONNEL

JOHN BALLANTYNE was appointed chairman of the board of directors of Philco Corporation. He had served as president since 1943, and during the war acted also as vice-president in charge of operations, directing the company's conversion to war work.

WILLIAM B. LODGE, wartime associate director of OSRD's Airborne Instrument Laboratory and since 1944 director of general engineering at CBS, was named vice-president in charge of general engineering for the Columbia Broadcasting System.

W. B. Lodge

R. D. Huntoon

ROBERT D. HUNTOON, assistant chief of the Atomic Physics Division, National Bureau of Standards, has received a distinguished achievement award from the Washington Academy of Sciences for "the advancement of electronics and its application to other sciences and to modern ordnance."

HENRY H. HAUSNER, who during the war developed hermetic seals for electronic equipment, was appointed a member of the staff of the Metallurgical Research and Development Laboratories of Sylvania Electric Products Inc., Bayside, N. Y.

J. H. LUDWIG, formerly with Philco, RCA Victor and Raytheon, is now president and treasurer of the newly formed Control Engineering Corp., Canton, Mass.

W. A. JONES, recently with Raytheon Mfg. Company as project engineer on gyro design, is now vice-president of Control Engineering Corp., Canton, Mass.

ROBERT W. CLARK, NBC New York television operations supervisor, has been transferred to the same position for the network's Hollywood division.

T. KEITH GLENNAN, director of the Navy's Underwater Sound and Detection laboratory at New London, Conn., in 1942, was recently inducted as president of Case Institute of Technology, Cleveland, Ohio.

A. V. ASTIN, assistant chief of the Electronics Division, National Bureau of Standards, has been awarded His Majesty's Medal for Service in the Cause of Freedom in recognition of work in England from Sept. 1944 to March 1945 as representative of the National Bureau of Standards and of Division 4, NDRC, involving the use and evaluation of the proximity fuze. As government officials are not permitted to accept foreign decorations, the medal will be held in custody until his retirement.

WINSTON L. HOLE was recently appointed assistant to the director of the Ohio State Research Foundation. He was previously coordinator of engineering development for North American Phillips Co., and served as a technical aide with NDRC.

SAMUEL BOUSKY, president of the Cleveland Section of the Instrument Society of America, has joined Horizons Inc., as chief of the physics division. Previously he was employed by Jack & Heintz Inc., in the development of special electronic instruments for aircraft.

NEW BOOKS

Ultrahigh Frequency Transmission and Radiation

By Nathan Marchand. *John Wiley & Sons, New York,* 1947, 322 *pages,* $4.50.

The basic principles of the radiation and transmission of electromagnetic waves are presented, using a mathematical approach coupled with a detailed analysis of the result. The book should appeal to all engineers, scientists and students for whom mathematics is a useful tool. Partial differential equations are used in many of the basic developments.

Covered in turn are Transmission Lines, Elements of Vector Analysis, Fundamental Electromagnetic Equations, Plane Electromagnetic Waves, Radiation, Antenna Arrays, Wave Guides and Complex Transmission Line Network Analysis. A few problems are appended to each chapter, which will aid in making the book useful as a text.

The final chapter presents some useful ideas on the combination of circuit equations with transmission line networks to a conventional transmission line circuit. Such devices as a balanced shielded loop antenna and conversion transformers are treated with the aid of equations involving Kirchhoff's current law. Some errors in sign in this presentation appear rather generally, but the intent is clear and the results are quite useful.—G. B. Hoadley, *Brooklyn Polytechnic Institute.*

Fundamental Electronics and Vacuum Tubes

By A. L. Albert, *Professor of Communication Engineering, Oregon State College. The MacMillan Company, New York, N. Y.,* 1947, 510 *pages, price* $6.50.

This is a revised edition of Professor Albert's popular text, which appeared first in 1938. As everyone knows, electronics has moved ahead in the intervening ten years, and this new edition is a response to the changes that have occurred. It has been completely revised and reset. Material on certain aspects of the art which were not very apparent in 1938 has been brought into the

book. A matter of considerable value for use as a text in class or for the man who studies alone is the inclusion of problems and questions at the end of each chapter.

One noteworthy feature of the book is the large size of the illustrations, making them exceptionally easy to see, to read and to understand.

The book is aimed at junior or senior college students taking their first general course in electronics and, therefore, can be adapted to courses preliminary to a more intensive study of communication engineering or power generation and use.—K. H.

Klystron and Microwave Triodes

EDITED BY D. R. HAMILTON, J. K. KNIPP AND J. B. H. KUPER. *Volume 7 of the MIT Radiation Laboratory Series. McGraw-Hill Book Company, Inc., New York, N. Y.*, 1947, 533 *pages*, $7.50.

AN advanced theoretical analysis of microwave triodes and klystrons is presented in this volume. Second order effects and an analysis of large-signal conditions are included as well as the more familiar small-signal first order theories. In order to present this amount of theoretical material, it has been necessary to exclude descriptive material. As a result, the book will be most useful to tube designers and experts in the field and will prove to be difficult reading for the person desiring an introduction to the subject.

The book is divided into three sections. Part I includes an introduction and a thorough treatment of the interaction between electrons and electric fields. This material is basic in character and applies equally well to triodes and klystrons. Triodes are considered specifically in Part II, and the third section on klystrons analyzes these tubes as amplifiers, frequency multipliers and oscillators.

Almost half of the book is devoted to the analysis and discussion of reflex klystron oscillators. Nonideal reflectors, hysteresis effects, output load characteristics, modulation, and noise are considered in this section. The other sections are equally complete in their treatment

of advanced problems and second order effects. The triode analysis is limited to the small-signal case, but space charge effects, large transit angles and noise are treated in considerable detail. Space charge debunching and large-signal conditions are included in the chapter on electron bunching.

The book will be a valuable addition to the material on microwave tube types. References to outside sources are given more frequently than in some of the other volumes in this series, and the use of cross references has made the book free of repetition.

In some cases the presentation of the material could be improved considerably. For example, the factors included in the input resistance R_1 of a grid-separation amplifier are not clearly defined when the term is introduced, and mention of the usual low-frequency value of $R_1 = 1/g_m$ occurs eight pages later. The tendency to depend upon equations being self-explanatory makes the book difficult to follow, but the wealth of material which has been included as a result of that editorial policy adds to its usefulness as a reference text.—A. E. HARRISON, *Princeton University.*

Microwave Transmission Design Data

BY THEODORE MORENO. *McGraw-Hill Book Co., New York, N. Y.*, 1948, 248 *pages*, $4.00

PRACTICAL design data for microwave transmission components are presented in this book. The general topics covered are: transmission line theory as applied to microwave components; coaxial lines and flexible cables; wave guides, giving practical design data for structures, bends, tees, transformers, obstacles, windows, and couplings; wave guides filled with dielectric material both completely and partially; and cavity resonators.

This book is a revision and expansion of an earlier Confidential volume of the same name published by Sperry Gyroscope Co. during the war. Although this book is only thirty pages longer than the original volume, it actually contains a much greater proportion of new

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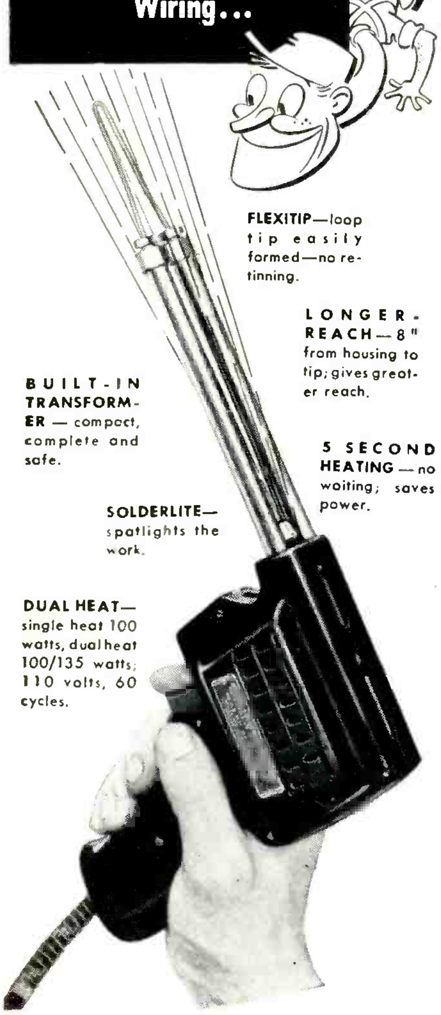

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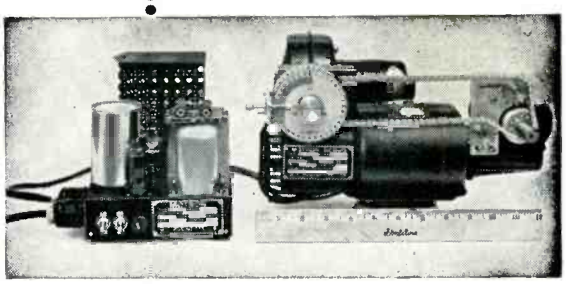

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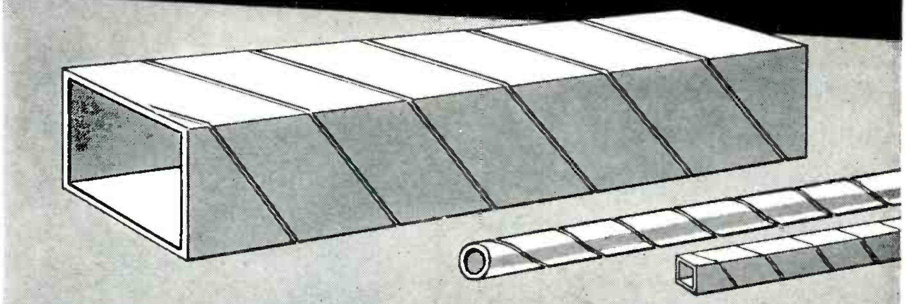

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material inasmuch as the illustrations and graphs have been reduced to from one-half to one-quarter size. Although the curves are not as easy to read and in many cases the fine calibration lines have been omitted, they are still adequate. The illustrations themselves have lost nothing in the reduction.

Enough theoretical discussion is included in the new volume to allow the use of the data without a previous background in many of the specialized subjects. In addition to the expansion of theoretical discussion, this latest volume also contains many new and expanded subjects such as equivalent circuits for many configurations, coaxial to wave guide transformers, magic tees, the ring bridge, and an expanded dielectric constant and loss table.

The usefulness of this volume, like its predecessor, lies in the great abundance of curves and equations leading to actual dimensions and construction data for microwave components.—NATHAN MARCHAND.

Ultra and Extreme Short Wave Reception Principles, Operation and Design

BY M. J. O. STRUTT. *D. Van Nostrand Company, Inc., New York, N. Y.*, 1947, 387 *pages*, $7.50.

THIS book contains a comprehensive treatment of receiver problems in the 3 to 30,000-mc range. It assembles in one place descriptions of circuits and phenomena that represent the post-war trend in receiver design and analysis. Because of the large amount of material covered by the volume, the treatment is concise, and it will probably not be very useful as a textbook for the beginner. It is, however, an excellent source book for the practicing engineer.

Each of the seven chapters starts with a brief, but sufficient, review of the pertinent background material, and then proceeds with a thorough application of the principles so established to the specific problem discussed. In general, emphasis is placed upon quantitative results, and extensive use is made of graphical methods for the presentation of data. At appropriate places in the text material,

numbers are given that apply to a list of 409 references alphabetically arranged by author's name at the back of the book. This list includes both domestic and foreign publications.

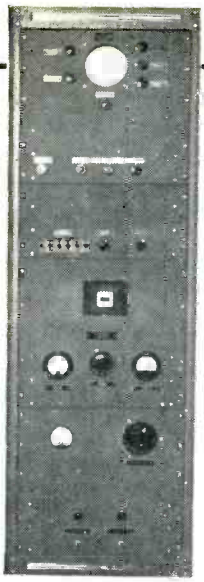
The first chapter is introduced with a review of electromagnetic theory. This theory is then applied to the various propagation phenomena associated with the frequency range considered. The absorption and refraction problems of interest to all communication engineers, and the special reflection problems of the radar engineer, are covered. The chapter concludes with a condensed explanation of amplitude modulation, frequency and phase modulation, and the various types of pulse modulation.

The second chapter considers in detail the characteristics and sources of noise associated with receiver circuits, and the various ways in which the noisiness of a receiver can be expressed. Included are five theorems, called properties by the author, relating to the possibility of reducing noise by feedback.

The third chapter begins with a review of radiation theory applicable to antennas. The author then applies this theory, with a minimum dependence upon mathematics, to single-wire antennas, loops, arrays, and to special types, such as the rhombic and V-shaped antenna. Brief consideration is given to parabolic reflectors and metal lenses. Noise picked up and generated by the antenna is covered. The chapter is concluded with a consideration of the antenna as a circuit to which the receiver must be adjusted for optimum operation.

In the fourth chapter, properties of parallel-wire and coaxial transmission lines, and wave-guides, are discussed and applied to the use of these devices as wave conductors and matching elements. Lumped-constant resonant circuits and cavities are considered as coupling devices.

The fifth chapter contains an excellent treatment of high-frequency measuring equipment for receiver testing. Of special interest is the section on high-frequency shielding and attenuators. Included are graphs showing the variation of input and output resist-



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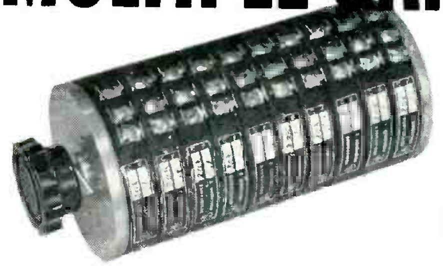

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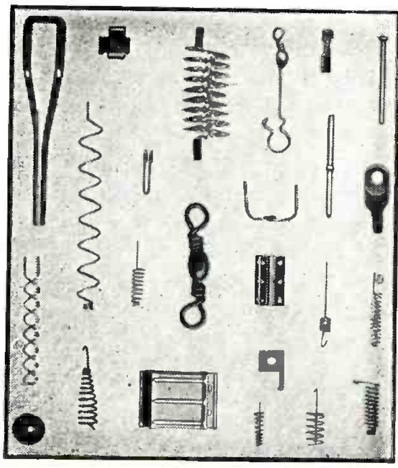

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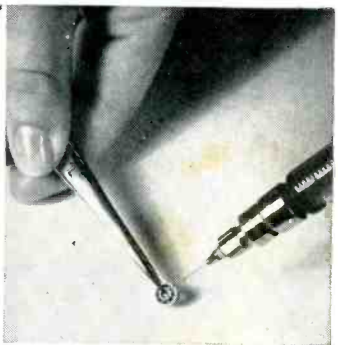

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ances and capacitances of vacuum tubes with frequency.

The input stages of high-frequency receivers are treated in detail in the sixth chapter. The chapter begins with a discussion of the various types of amplifier circuits used, and their inherent noise properties. There follows a consideration of noise-reducing and neutralizing circuit connections. Next, mixer stages are covered and both tube and crystal types are considered. In the local-oscillator section brief treatment is given to triodes, reflex-klystrons, light-house tubes, and magnetrons. Automatic-frequency control is discussed briefly. Brief treatment is also given to special detection methods, such as superregeneration.

The concluding chapter covers the remainder of the receiver and includes the i-f amplifier, second detector, and video or audio stages. This treatment is conventional except in certain parts where special test methods are discussed, such as measuring the microphonic level of a receiver. Frequency modulation, impulse modulation, single-sideband, and radar receivers complete the material of the chapter.

All in all, the book is a valuable and timely contribution to the growing list of publications in its field. It is unfortunate that a companion book is not available covering the problems of transmission in the concise manner that this covers the problems of reception.—MARTIN W. ESSIGMANN, *Northeastern University.*

FM Transmission and Reception

BY JOHN F. RIDER AND SEYMOUR D. USLAN. *Published by John F. Rider Publisher, Inc. New York* 16, *New York*, 1948, 409 *pages, cloth-bound* \$2.70, *paper* \$1.80.

THIS book represents a vast amount of material on f-m transmitters, including most of the commercial broadcast types, as well as examples of those used in amateur and police radio work. Receivers, reactance tubes, limiters, discriminators, locked oscillators and ratio detectors are described in detail.

Antenna systems for transmission and reception are included, as

well as a rather good chapter on servicing f-m receivers and a fairly complete bibliography.

Some of the discussion material is confusing and occasionally terminated with incorrect conclusions. The authors have a particularly rough time trying to prove that phase shift type modulators produce only a deviation in phase but not in frequency of the modulated wave, unless a corrector is included.

The book assumes only a basic working knowledge of radio on the part of its readers, and is well illustrated with wiring diagrams and graphs.—GLENN H. MUSSELMAN, *Columbia University.*

Introduction to Modern Physics

By F. K. RICHTMYER, *Late Professor of Physics at Cornell University, and* E. H. KENNARD, *Formerly Professor of Physics at Cornell University, McGraw-Hill Book Company, Inc., New York, N. Y., Fourth Edition,* 759 *pages,* $6.00.

F. K. RICHTMYER was a productive experimental physicist, who himself played an important role in advancing the frontiers of his science through those exciting years when classical theories of the atom were forced to give way to the new ideas of Planck, Einstein, Bohr, and Schrodinger. To him the appearance of the initial signs of weakness of the classical theory, the birth, the growth, and the final triumph of the quantum theory were a living drama whose most exciting chapters unfolded before his own watchful eyes and in part through his own experiments. His book "Introduction to Modern Physics" which appeared in 1928 was a stirring account of these developments cast against the background of the history of physics from its earliest beginnings, and built around the central theme that progress is made only when authoritarianism is cast aside and theories are accepted only to the extent that they can be tested in the laboratory.

In the first edition, written by Professor Richtmyer himself, the plot unfolds like a narrative and all subject matter contributes to the central theme in a manner which the author is careful to point out. There are no loose ends, no incomprehensible gaps in the argument, and few digressions. The book was intended as an introduction to guide and to direct the interests of students into modern physics and to indoctrinate them in its philosophy. It was not a reference book, not an encyclopedia of dry and unrelated factual data. To use a commercial expression, it was written when physics was being taught in a buyer's market.

In view of the success of Professor Richtmyer's book and its usefulness as a textbook in first year graduate teaching, it is not surprising that some one of his students or associates would attempt to revise it and bring the story up to date, as E. H. Kennard has now done. Had the author lived, he probably would have done this himself, and his revision would undoubtedly have included, as Kennard's revision does, a complete account of the development of the modern quantum theory, an enlarged chapter on nuclear physics and a new chapter on cosmic rays. Admirers of the first edition would probably have preferred that these revisions had taken the form of a sequel in which continuity of thought and interest were preserved, rather than that of an abridged modification which can still be crammed into one course in the curriculum.

Because of the tremendous volume of new material which has been added in the revised edition, adherence to the original style of exposition would have required at least twice the number of pages. It is, therefore, no fault of the author, but rather a characteristic of modern physics, that the new edition resembles a syllabus of important results more than it does an introduction for the uninitiated.
—THOMAS H. JOHNSON, *Brookhaven National Laboratory.*

Loudspeakers: The Why & How of Good Reproduction

BY G. A. BRIGGS. *Published by Warfdale Wireless Works, Idle, Bradford, England,* 1948, 87 *pages,* 5/.

WRITTEN for domestic high-fidelity addicts, this pithy pamphlet presents the essentials for intelligent selection and evaluation of loudspeakers. The author has drawn liberally from books on music, acoustics, and circuits to illustrate points, thus providing the nontechnical reader with highlights from these works and an excellent short bibliography for those wishing to delve deeper into the subject.

The short sections into which the book is divided include material on requirements of quality, frequency response and power, loudspeaker design and performance, loudspeaker and cabinet resonances, types of baffles and their effects, room acoustics, transients, and coupling networks. Representative commercial speakers and housings are shown in an appendix. Many of the points are documented with data obtained by the author in developing loudspeakers. His experience has been that the frequency of bass resonance of good loudspeakers decreases with age.

The author admits that some of his statements are influenced by his opinion, but then what constitutes faithful reproduction is mostly a matter of opinion. Others may take exceptions to some of the statements, especially the experts, but in this reviewer's opinion this booklet accomplishes its objective of informing the critical listener of the technicalities of reproduction. It is a pleasure to see the Doppler effect correctly presented as a trivial problem.—F.H.R.

Essentials of Radio

BY MORRIS SLURZBERG AND WILLIAM OSTERHELD. *McGraw-Hill Book Co., Inc., New York*, 1948, 806 *pages*, $5.00.

THE AUTHORS of the long-popular "Electrical Essentials of Radio" have presented here at an intermediate level the principles of operation of the basic circuits and circuit elements used in conventional radio receivers, as essential background knowledge for understanding electronic circuits. Although mathematics is quite definitely used in connection with the explanations, along with vector diagrams and graphs, the extent of use is such that serious students studying radio in a junior college, trade school, or the more technically-inclined high school should be able to master most of the material. The book is also well suited for independent study at home.

Examples are used liberally throughout the text to illustrate equations and procedures. Each chapter is followed by a bibliography, an average of about fifty questions, and an average of about forty problems. An eighteen-section appendix provides sufficient reference data so that all problems may be solved without resort to other books.

The authors are to be commended for their use of standard ASA symbols throughout, along with consistent and simplified handling of such abbreviations as a-c, r-f, and avc. A minor deviation occurs in their use of pm rather than p-m in connection with dynamic loudspeakers.

This book can well be the answer to McGraw-Hill's long-felt need for a book competitive to Keith Henney's "Principles of Radio" published by Wiley. The scope and treatment are similar, though of course the new book is much the larger of the two. Instructors who like to pick and choose their assignments, in line with personal preferences and for tailoring to the number of classroom hours available, may well prefer the larger book; those who have neither the time nor inclination to do this will undoubtedly still prefer the book that for two decades has been the unchallenged leader in radio textbooks at the intermediate level.—J.M.

• • •

Books Received for Review

THE ELECTRON MICROSCOPE. By D. Gabor. Chemical Publishing Co., Brooklyn, N. Y., American edition, 1948, 164 pages, $4.75. Development, performance and future possibilities of resolution in the electron microscope. (For comments on British edition see ELECTRONICS, p 294, Aug. 1946.)

THE THEORY OF MATHEMATICAL MACHINES. By Francis J. Murray, Assoc. Prof. of Mathematics, Columbia University. King's Crown Press, New York, N. Y., Revised Edition, 1948, 139 pages spiral-bound, $3.00. Revision of first edition (see ELECTRONICS, p 284, May 1947), with errors corrected, Part I expanded, discussion of trigger circuits in Part II altered and augmented, and new chapters on Electronic Digital Computers and on Noise, Accuracy and Stability added to Part III.

DIRECTORY OF ENGINEERING DATA SOURCES. Southeastern Research Institute, Inc., 5009 Peachtree Road, Atlanta, Ga., 63 pages paper-covered, $2.50. Names, addresses, price information and other data on four types of information sources: Government Printing Office and federal agencies; universities, colleges and state agencies; scientific, technical, and trade organizations; commercial publishers of periodicals and books.

considerably if a standard frequency, transmitted continuously by a governmental agency such as the Bureau of Standards in much the same manner as they now operate WWV, were used for control. A transmission of this type would be necessary in each center where the Citizens Radio Band were in active use.

Although this standard frequency could be used in several ways, its utility can be illustrated by a single example. To control the transmitter frequency, the receiver associated with it would pick up the standard transmission. This standard would be heterodyned against a local low-frequency crystal oscillator to produce the carrier.

With the problem of frequency stability thus solved, designing equipment for the Citizens Radio Band should be simpler.

M. F. MELVIN
Electro-Mechanical Research Dept.
P. R. Mallory & Co., Inc.
Indianapolis, Indiana

Ruggetron?

DEAR SIRS:

YOUR article in the April issue on "Rugged Electron Tubes" prompted me to comment on this use of the word "rugged" and its poor relatives "ruggedize," "ruggedized," and "ruggedization."

The latter three do not even appear in an unabridged dictionary and for "rugged" the following meanings are given: Having a rough uneven surface, not smooth, irregular, not neat or well kept, uneven, unkempt, rough with bristles or hair, shaggy, hard, harsh, austere, rude uncivil, fierce and turbulent.

None of these applies to an electron tube. The final meaning given is vigorous, robust, strong, sturdy, hardy; said of health, physique, as in: rugged common sense.

Would not "sturdy" be a better word? As most commonly used, it is defined as: "Characterized by physical strength or force, strong, lusty, robust; also stiff, stout, firm . . . . " The verb form "sturdied" is also mentioned as used in Scotland.

"Rugged" as a tube characteristic, however, is probably too well entrenched now to be changed. Each month when I pick up the

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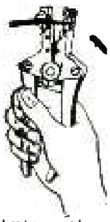

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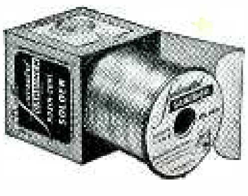

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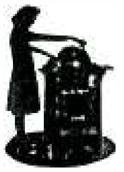

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latest issue of ELECTRONICS, I expect to find an announcement of the latest tube type—the Ruggetron.

W. C. WHITE
Research Laboratory
General Electric Co.
Schenectady, New York

Electronism

DEAR SIRS:

IN Mr. Fleming's letter (BACKTALK, March 1948) he suggests that in electronic patents it is unusual to use the expression "electronic tube" in claims, and that the normal expression is "electronic discharge device."

Both expressions are certainly used before the Canadian Patent Office, and a glance at any group of modern U. S. Patents shows that both seem to be used in Washington as well. Two very recent U. S. patents, Numbers 2,436,398, and 2,436,677 have claims using the expression "electron tube" or "electronic tube." Other expressions are also used: "vacuum tube," U. S. Patent 2,435,579.

It would seem that no particular expression can be described as unusual, among those referred to above.

In my letter criticized by Mr. Fleming (BACKTALK, January 1948) I was not advocating any particular expression to denote a radio tube in a patent claim, but was dealing with quite a different matter—the use of the word "electronism" as denoting the electrical counterpart of "mechanism"—a colorful addition to scientific language.

WILLIAM R. MEREDITH
Barrister-at-Law
Ottawa, Canada

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(Continued on opposite page)

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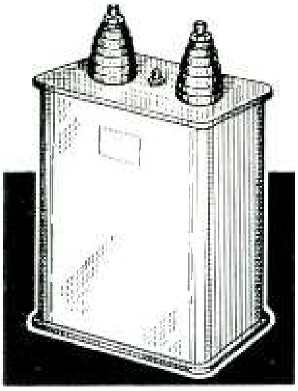

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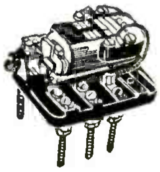

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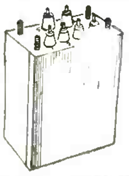

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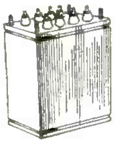

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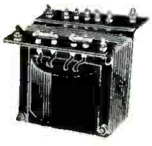

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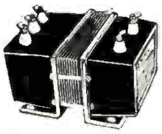

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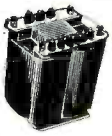

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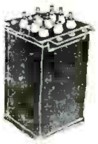

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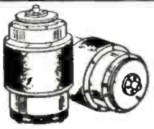
CLOSE  OUT

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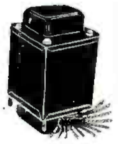


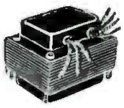
This transformer designed for heavy duty television service. Primary 115 V. 60 cy.

Sec. #1 325-0-325V. @ 400 ma.
Sec. #2 5 V. 3 amps
Sec. #3 12.6 C. CT. @ 10 amps
Sec. #4 6.3 V @ 7 amps

List price $40.00. Your cost.....

$18.25

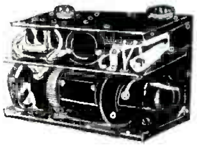
SMALL POWER TRANSFORMER



Pri. 115 V 60 cy
Sec. #1 750 V. CT @ 80 ma
Sec. #2 6.3 V. @ 5 amps

$2.95

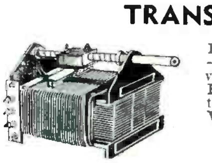
PE 94 28 VOLT DYNAMOTOR



Designed for 522—delivers:
300 Volts @ 250 ma DC
150 Volts bias
12 Volts @ 10 amps DC ....

$8.75

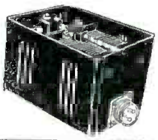
TRANSTAT



Input 115 volts 60 cy —Output 90 to 130 volts @ 17.5 amps. Here is the answer to that low line voltage. Very few left..........

$24.95

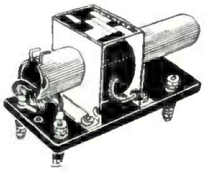
400 Cycle TRANSTAT



110 V. 400 cy input— 90 to 135 V. output @ 10 amps.............

$14.50

ADLAKE Type 1040-80

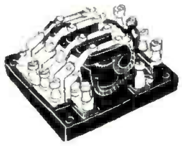


No. R-4012 Mercury Time Delay Relay Normally Open, Closes in 5 seconds, Opens in .3 seconds. . . .

$8.75

No. R-4602

DUAL RELAY



2 110v 60 cy Relay Mounted on one frame. Both relays double pole. One single throw. One double throw. Coils can be paralleled or used independently.

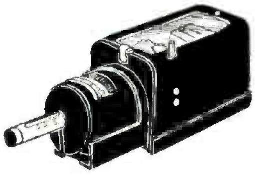
$2.20 each

No. R 474

KEYING RELAY

Here is a keying relay made to mount in a tube socket. Double pole Double Throw relay—sealed in vacuum 300 ohm coil. Will follow 100 words a minute. Stock up now....... **$2.00**

PBC GENERAL ELECTRIC OVER CURRENT RELAY

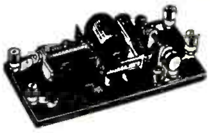


No. R - 4010 Adjustable from 1.5 to 3.0 amperes. 110 volt. 60 cyc. Reset ......

$24.95

No. R-3001

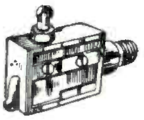
OVERCURRENT RELAY



Automatic reset—Overload coil is 3000 ohms —Can be shunted for any current simply—Protect those expensive final amplifier tubes, to reset simply press a button. Reset coil is 110 v. 60 cycles **$2.49**

No. SS 101

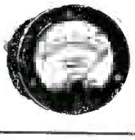
MICRO SWITCH



Single pole single throw aircraft type, rugged for outside use—can be used for stopping beam rotation so as not to foul up feed line cable.... **$1.25**

No. M-462

3½ INCH "S" METER



Used in a Bridge Circuit will give you accurate readings on your surplus receiver or receiver not equipped with meter. Uses light for lighting meter face.

$4.95

No. M-248

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Bakelite cased meter—27 ohms. Basic resistance may be used wherever a small 1 mil movement is needed for S-Meter in receiver or basic meter in test equipment. A steal at

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Hi Volt MICA CONDENSERS
.007—5000 V—1.75
.005—8000 V—2.25

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2500-0-2500 V @ 500 MA
or
2000-0-2000 V @ 500 MA
(oil-filled Xformer from BC610)

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- 2—Plate Caps for 872A
- 2—Sockets for 872A

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PRIMARY 440/220 VOLTS
SECONDARY 230/115 VOLTS
.600 KVA
$14.95

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Full Wave Bridge Type

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up to 18v AC	up to 12v DC	½ Amp.	$0.98
up to 18v AC	up to 12v DC	1 Amp.	1.95
up to 18v AC	up to 12v DC	3 Amp.	3.45
up to 18v AC	up to 12v DC	5 Amp.	4.45
up to 18v AC	up to 12v DC	10 Amp.	7.45
up to 18v AC	up to 12v DC	15 Amp.	9.95
up to 18v AC	up to 12v DC	30 Amp.	14.95
up to 36v AC	up to 28v DC	1 Amp.	3.45
up to 36v AC	up to 28v DC	5 Amp.	7.45
up to 36v AC	up to 28v DC	10 Amp.	12.45
up to 36v AC	up to 28v DC	15 Amp.	18.95
up to 115v AC	up to 100v DC	.25 Amp.	2.95
up to 115v AC	up to 100v DC	.6 Amp.	6.95
up to 115v AC	up to 100v DC	5 Amp.	19.95
up to 115v AC	up to 100v DC	3 Amp.	12.95

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NATIONALLY ADVERTISED BRANDS

All Ratings, D. C.

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.5mfd.	600v	.35	4mfd.	2000v	3.75
1mfd.	600v	.35	15mfd.	2000v	4.95
2mfd.	600v	.35	2mfd.	2500v	2.49
4mfd.	600v	.60	.1mfd.	2500v	1.25
8mfd.	600v	1.10	.25mfd.	2500v	1.45
10mfd.	600v	1.15	.5mfd.	2500v	1.75
3x.1mfd.	1000v	.45	.05mfd.	3000v	1.95
.25mfd.	1000v	.45	.1mfd.	3000v	2.25
1mfd.	1000v	.60	.25mfd.	3000v	2.65
2mfd.	1000v	.70	.5mfd.	3000v	2.85
4mfd.	1000v	.90	1mfd.	3000v	3.50
8mfd.	1000v	1.95	12mfd.	3000v	6.95
10mfd.	1000v	2.10	2mfd.	4000v	5.95
15mfd.	1000v	2.25	1mfd.	5000v	4.95
20mfd.	1000v	2.95	.1mfd.	7000v	2.95
24mfd.	1500v	6.95	3mfd.	4000v	6.95
.1mfd.	1750v	.89	2mfd.	3000v	3.45
.1mfd.	2000v	.95	2x.1mfd.	7000v	3.25
.25mfd.	2000v	1.05	.02mfd.	12000v	9.95
.5mfd.	2000v	1.15	.02mfd.	20000v	11.95

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Frequency Range—100-156 Mc
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Type	Price
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10CP4A	42.20
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726A	23.50
800	2.25
801A	.98
802	2.95
803	8.95
804	9.95

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811	2.25
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865	.98
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878	2.49
879	.89
884	.98
889	.98
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923	.98
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950	1.06
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955	.75
956	.75
957	.75
958A	.75
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1613	.75
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1622	1.75
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1626	.49
1627	7.95
1629	.69
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1636	5.95
1638	.98
1641	.79
1642	.98
1654	1.98
1665	.98
1851	1.25
1852	1.06
1853	1.06
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Type	Price
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HY24	1.50
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HY75	1.25
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MR4	90.00
QK59	39.50
QK60	39.50
QK61	39.50
QK62	39.50
REL21	4.25
RK12	1.95
RK21	3.95
RK22	4.95
RK25	2.95
RK33	.98
RK34	.59
RK59	3.95
RK60	.79
RK69	49.50
RK72	1.95
RK73	3.95
RX120	10.00
T20	1.95
TZ40	2.95
UX6653	3.95
V700	6.95
VR75	.98
VR78	.75
VR90	.75
VR91	1.49
VR92	.75
VR105	.75
VR150	.98
VT127A	3.00
VU111	1.19
WL460	14.95
WL468	14.95
WL532A	4.95
WL562	150.00
WL616	105.00
WL619	49.50
Z225	1.95
OY4	.99
OZ4	.99
OZ4G	.99
1A3	.81
1A4P	1.54
1A5GT	.67
1A6	1.20
1A7GT	.81
1B3/8016	1.89
1B4P	1.54
1B5/25S	1.20
1C5GT	.81
1C6	1.20
1C7G	1.20
1D5GP	1.54
1D7G	1.20
1D8GT	1.54
1E5GP	1.62
1E7G	1.54
1F4	.99
1F5G	.99
1F6	1.54
1F7G	1.54
1G4GT	.99
1G5G	.99
1G6GT	.99
1H4G	.81
1H5GT	.67
1H6G	1.20
1J5G	1.20
1J6G	1.20
1J6GT	1.20
1L4	.81
1LA4	1.20
1LA6	1.20
1LB4	1.20
1LC5	1.20
1LC6	1.20
1LD5	1.20
1LE3	1.20
1LH4	1.20
1LN5	1.20
1N5GT	.81

Type	Price
1P5GT	.99
1Q5GT	.99
1R4/1294	1.20
1R5	.81
1S4	.99
1S5	.99
1T4	.81
1T5GT	.99
1U4	.81
1U5	.99
1V	.81
2A3	1.20
2A4G	1.54
2A5	.81
2A6	.99
2A7	.99
2B7	.99
2E5	.99
3B7/1291	1.54
3D6/1299	1.54
3LF4	1.20
3Q4	.81
3Q5GT	.99
3S4	.81
3V4	.81
5T4	1.54
5U4G	.62
5V4G	.99
5W4	.99
5W4GT	.62
5X4G	.67
5Y3GT	.39
5Y4G	.57
5Y4GT	.57
5Z3	.67
5Z4	.99
6A3	1.20
6A4/LA	1.20
6A6	.99
6A7	.81
6A8	.81
6A8G	.81
6A8GT	.81
6AB5/6N5	.99
6AB7/1853	1.20
6AC5GT	.99
6AC7/1852	1.20
6AD7G	1.20
6AF6G	.99
6AG5	1.20
6AG7	1.20
6AH6	1.62
6AK6	.99
6AL5	.81
6AQ5	.81
6AQ6	.81
6AT6	.67
6AU6	.81
6AV6	.67
6B4G	1.20
6B5	1.62
6B6G	.81
6B7	1.20
6B8	1.20
6B8G	1.20
6BA6	.81
6BD6	.81
6BE6	.81
6BF6	.67
6BG6G	1.89
6BH6	.81
6BJ6	.81
6C4	.67
6C5	.67
6C5GT	.67
6C6	.81
6C8G	1.20
6D6	.67
6D8G	1.20
6F5	.81
6F5	.81
6F5GT	.67
6F6	.81
6F6G	.67
6F6GT	.67
6F7	1.20
6F8G	1.20
6G6G	.99
6H6	.67
6H6GT	.67
6J5	.62
6J5GT	.62
6J6	1.20
6J7	.81
6J7G	.81
6J7GT	.81
6J8G	1.20
6K5GT	.99
6K6GT	.62
6K7	.67
6K7G	.67
6K7GT	.67
6K8	.99
6K8G	1.20
6K8GT	.99
6L5G	.99
6L6	1.54
6L6G	1.20

Type	Price
6L7	.99
6L7G	1.20
6N7	.99
6N7GT	.99
6P5GT	.99
6Q7	.81
6Q7G	.81
6Q7GT	.67
6R7	.99
6R7GT	.81
6S7	.99
6S7G	1.20
6S8GT	.99
6SA7	.67
6SA7GT	.67
6SB7Y	.99
6SC7	.81
6SC7GT	.81
6SF5	.67
6SF5GT	.81
6SF7	.81
6SG7	.81
6SH7	.81
6SH7GT	.81
6SJ7	.67
6SJ7GT	.67
6SK7	.67
6SK7GT	.67
6SL7GT	.99
6SN7GT	.99
6SQ7	.62
6SQ7GT	.67
6SR7	.67
6SR7GT	.81
6SS7	.81
6ST7	.99
6SZ7	.81
6T7G	1.20
6U5/6G5	.81
6U6GT	.81
6U7G	.67
6V6	1.20
6V6GT	.81
6W7G	.99
6X4	.67
6X5	.99
6X5GT	.62
6Y6G	.99
6Z7G	1.54
6ZY5G	.81
7A4/XXL	.81
7A5	.81
7A6	.81
7A7	.81
7A8	.81
7B4	.81
7B5	.81
7B6	.81
7B7	.81
7B8	.81
7C5	.81
7C6	.81
7C7	.81
7E6	.81
7E7	.99
7F7	.99
7F8	1.20
7G7/1232	1.20
7H7	.99
7J7	1.20
7L7	.99
7N7	.99
7Q7	.81
7R7	.99
7S7	1.20
7V7	1.20
7W7	1.20
7Y4	.81
7X7/XXFM	1.20
7Z4	.81
10	1.62
12A7	1.20
12A8GT	.81
12AH7GT	.99
12AL5	.81
12AT6	.67
12AU6	.81
12AU7	.99
12AV6	.67
12AW6	1.20
12AX7	.99
12BA6	.81
12BD6	.81
12BE6	.81
12C8	1.20
12F5GT	.67
12H6	.67
12J5GT	.62
12J7GT	.81
12K7G	.81
12K7GT	.67
12K8	.99
12K8GT	.81
12Q7GT	.67
12SA7	.67
12SA7GT	.81
12SC7	.81
12SF5	.67

Type	Price
12SF5GT	.67
12SF7	.81
12SG7	.81
12SH7	.81
12SJ7	.67
12SJ7GT	.67
12SK7	.67
12SK7GT	.67
12SL7GT	.99
12SN7GT	.99
12SQ7	.62
12SQ7GT	.67
12SR7	.81
12SR7GT	.81
12Z3	.99
14A4	1.20
14A5	1.62
14A7/12B7	.99
14AF7/XXD	.99
14B6	.99
14B8	.99
14C7	.99
14E6	.81
14F7	.99
14H7	1.20
14J7	1.20
14N7	1.20
14Q7	.99
14R7	.99
15	1.20
19	1.20
24A	.81
25A6	1.20
25L6	1.20
25L6GT	.67
25Z5	.62
25Z6	.81
25Z6GT	.62
26	.67
27	.62
30	.81
31	.99
32	1.20
32L7GT	1.54
33	1.20
34	1.20
35/51	.81
35A5	.81
35B5	.81
35L6GT	.67
35W4	.52
35Y4	.99
35Z3	.81
35Z4GT	.57
35Z5GT	.52
36	.99
37	.67
38	.81
39/44	.99
41	.67
42	.67
43	.67
45	.67
45Z3	.67
45Z5GT	.67
46	.99
47	.99
49	.99
50	1.62
50A5	.99
50B5	.81
50L6GT	.67
50Y6GT	.67
53	.99
55	.81
56	.67
57	.81
58	.81
59	1.20
70L7GT	1.62
71A	.81
75	.67
76	.67
77	.67
78	.67
79	.99
80	.47
81	1.54
82	.99
83	.99
83V	1.20
84/6Z4	.67
85	.81
89	.81
117L7/M7GT	1.62
117N7GT	1.62
117P7GT	1.62
117Z3	.81
117Z6GT	.99
6AJ5	.99
6AK5	.99
IAB5	1.06
RK75	6.25
RK65	24.95
2x2	.69
2v3G	1.10
6J4	3.95
6AL7	1.06

ATTENTION!

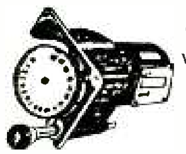
All Tubes guaranteed, except for open filaments, shorts and broken glass, for which we check before shipment.

Please specify how to ship, ie: Parcel Post, Railway Express, etc.

RADIO HAM SHACK Inc.

63 DEY STREET • NEW YORK 7, N. Y.

MICROWAVE TEST EQUIPMENT



W. E. I 138 A. Signal generator, 2700 to 2900 Mc range. Lighthouse tube oscillator with attenuator & output meter. 115 VAC input, reg. Pwr. supply. With circuit diagram $50.00
TS-238 GP. 10 cm. Echo box with resonance indicator and micrometer adjust cavity. 2700 to 2900 Mcs calibrated....$85.00
3 cm. wavemeter: 9200 to 11,000 mc transmission type with square flanges....$15.00
3 cm. stabilizer cavity, transmission type...$20.00
Direct reading VSWR meter. Complete with amplifier, bolometer input—AC crystal—DC crystal connections....$45.00
3 cm. Wavemeter. Micrometer head mounted on X-Band guide. Freq. range approx. 7900 to 10,300 Mc....$75.00

PULSE EQUIPMENT

APQ-13 PULSE MODULATOR. Pulse Width .5 to 1.1 Micro Sec. Rep. rate 624 to 1348 Pps. Pk. pwr. out 35 KW. Energy 0.018 Joules....$49.00
TPS-3 PULSE MODULATOR. Pk. power 50 amp, 24 KV (1200 KW pk.); pulse rate 200 PPS, 1.5 microsec; pulse line impedance 50 ohms. Circuit—series charging version of DC Resonance type. Uses two 705-A's as rectifiers. 115 v. 400 cycle input. New, with all tubes....$49.50

PULSE NETWORKS

G.E. #25E5-1-350-50P2T. 25 KV, 5 sections, "E" circuit, 1 microsecond pulse length, 350 PPS, 50 ohms impedance....$45.00
G. E. #6E3.5-2000-50P2T, 6KV, "E" circuit, 3 sections, .5 microsecond, 2000 PPS, 50 ohms impedance....$6.50

PULSE TRANSFORMERS

W.E. # D166173 Hi-Volt input transformer, W.E. Impedance ratio 50 ohms to 900 ohms. Freq. range: 10 kc to 2 mc. 2 sections parallel connected, potted in oil....$12.00
W.E. KS 9800 Input transformer. Winding ratio between terminals 3-5 and 1-2 is 1.1:1, and between terminals 6-7 and 1-2 is 2:1. Frequency range: 380-520 c.p.s. Permalloy core....$2.00
G.E. # K2731 Repetition Rate: 635 PPS, Pri. Imp: 50 Ohms, Sec. Imp: 450 Ohms, Pulse Width: 1 Microsec. Pri. Input: 9.5 KV PK, Sec. Output: 28 KV PK. Peak Output: 800 KW. Bifilar 2.75 Amp....$19.50
G.E. K2450A Will receive 13KV. 4 micro-second pulse on pri. secondary delivers 14KV. Peak power out 100W GE....$15.00
W.E. # D169271 Hi Volt input pulse Transformer $9.95
G.E. # K2748A Pulse Input, line to magnetron.$12.00
Utah Pulse or Blocking Oscillator Transformer Freq. limits 790-810 cy-3 windings turns ratio 1:1:1 Dimensions 1 13/16 x 1¼" 19/32....$1.50

PULSE TUBES

705-A—$1.95 715-B—$8.50
Ceramic Sockets for 715-B, 705-A ea. $.69

POWER EQUIPMENT

STEP DOWN TRANSFORMER: Pri: 440/220/110 volts a.c. 60 cycles, 3 KVA. Sec. 115 v. 2500 volt insulation. Size 12"x12"x7"....$40.00
PLATE TRANSFORMER. Pri: 117 v, 60 cy. Sec. 17,000 v. @ 114 ma, with choke. Oil immersed. Size 26"x29"x13". Amertran....$65.00
Fil. Transformer: Pri: 220 v.a.c., 60 cy; .05KVA. Sec. 5 v.c.t., 34,000 v. test....$24.50
Fil. Trans. UX-6899. Pri: 115 V, 60 cy. Sec: Two 5V, 5.5 Amp Wdgs. 29KV Test....$24.50
Plate Transformer: Pri: 115/230 v.a.c., 50-60 cy. Sec: 21,000 v. 100 ma....$145.00

LINE VOLTAGE REG Pri 92-138v 57/63 cy 1ph15A Sec. 115v 7.15A .82 Kw 96% PF....$99.50
VOLTAGE REG. "Transtat" Amertran Type "RH" 2 Kva Load. Input: 90/130 v 50/60 cy. Output 115v....$40.00
TRANSTAT VOLTAGE REG, 11.5 KVA. 0-115 vac. 60 cy 100 amps....$75.00
ITE Circuit Breaker. 115 amps, 600v....$15.00

400 CYCLE TRANSFORMERS

PLATE XFMR: Pri: 115 v. 400 cy. Sec: 9800 v or 8600 v @ 32 ma dc....$12.50
#12033, Plate Xfmr: Pri: 115 v, 800 cy. Sec: 4500 vct. 250 ma....$4.50
KS 9445. Pwr. Xfmr. Pri: 115 v, 400-2400 cy. Sec: 592 vct. 120 ma. 6.3v. 8 amp; 5v, 2 amp....$3.50
PLATE XFMR. Pri: 115 v, 400-2400 cy. Sec: 4500 v. 6 ma....$6.50
#7143. Pri: 115 v, 400 cy. Sec: 6.3 v, 7 amp, 8.3 v, 8.8 amp; 6.3 v, 1.3 amp....$2.50
KS 9584. Pri: 115 v, 400 cy. Sec: 5000 v, 290 ma, 5v. 10 amp....$15.00
PLATE XFMR: Pri: 115 v, 380-2800 cps. Sec: 2200 v. 350 va....$3.95
PLATE XFMR: Pri: 115 v, 400 cy. Sec: 1150-0-1150 v. 40 ma....$1.75

INVERTERS

PE 206-A. Input: 28 VDC @ 38 amp. Output: 80 volts @ 500 volt-amps. 800 cycles. Leland. New, complete with enclosed relay, filter, instruction book....$12.50
PE 218: Input: 25-28 VDC @ 92 amps. Output: 115 volts @ 1500 volt-amps, 380-500 cycles. Poor physical but good running condition....$12.50

WATER COOLED TUBES

GL697 GL623 GL562 ML100
Guaranteed—New ....$75.00 EA

MICROWAVE ANTENNAS

AN MPG-1 Antenna. Rotary feed type high speed scanner antenna assembly, including horn, parabolic reflector. Less internal mechanisms. 10 deg. sector scan. Approx. 12'L x 4'W x 3'H. Unused. (Gov't Cost—$4500.00)....$250.00
APS-4 3 cm. antenna. Complete. 14½" dish. Cutler feed dipole, directional coupler, all standard 1" x ½" waveguide. Drive motor and gear mechanisms for horizontal and vertical scan. New, complete..$65.00
AN/TPS-3. Parabolic dish type reflector approx. 10' diam. Extremely lightweight construction. New, in 3 carrying cases....$89.50
RELAY SYSTEM PARABOLIC REFLECTORS: approx. range: 2000 to 6000 mc. Dimensions: 4½' x 3', rectangle, new....$85.00
TDY "JAM" RADAR ROTATING ANTENNA. 10 cm. 30 deg. beam. 115 v.a.c. drive. New......$100.00
SO-13 ANTENNA. 24" dish with feedback dipole 360 deg. rotation, complete with drive motor and selsyn.
New ....$75.00 Used $45.00
DBM ANTENNA. Dual, back-to-back parabolas with dipoles. Freq. coverage 1,000-4500 mc. No drive mechanism....$65.00
AN/128A ANTENNA. Two Vertical dipoles working against a square reflector apx. 3' x 4'. Range: 140-200 mc....NEW $40.00

30 FT. MAST SETS

Heavy duty rugged plywood. Crated in 3 sections with coupling material. Two masts for ideal flat-top antenna. Unused....$40.00 per set

5J30

THE NEWEST THING IN UHF. 10-350 MC. MAGNETRON IN GLASS ENVELOPE. NEW, COMPLETE WITH DATA SHEET $39.50

Tube	Frq. Range	Pk. Pwr. Out	Price
2J31	2820-2860 mc.	265 KW.	$15.00
2J21A	9345-9405 mc.	50 KW.	$25.00
2J22	3267-3333 mc.	265 KW.	$15.00
2J26	2992-3019 mc.	275 KW.	$15.00
2J27	2965-2992 mc.	275 KW.	$15.00
2J32	2780-2820 mc.	285 KW.	$15.00
2J38 Pkg.	3249-3263 mc.	5 KW.	$25.00
2J39 Pkg.	3267-3333 mc.	8.7 KW.	$25.00
2J55 Pkg.	9345-9405 mc.	50 KW.	$25.00
3J31	24,000 mc.	35 KW.	$17.00
700A	680-710 mc.	100 KW.	$35.00
714AY			$15.00
720BY	2800 mc.	1000 KW.	$25.00

KLYSTRONS: 723A/B $7.75 707B, W cavity $20.00

MAGNETS

For 2J21, 725-A, 2J22, 2J26, 2J27, 2J31, 2J32, and 3J31....Each $8.00
4850 Gauss, ⅝" bet. pole faces, ¾" pole diam $8.00
1500 Gauss, 1½" bet. pole faces, 1⅝" pole diam....$8.00
1000 Gauss, electromagnet, adjustable 2⅜" to 3" bet. pole faces, 2½" pole diam....$12.00

TUNABLE PKG'D "CW" MAGNETRONS

QK59 2675-2900 Mcs. QK61 2975-3200 Mcs.
QK60 2800-3025 Mcs. QK62 3150-3375 Mcs.
New—$45 each New—$55 each

LABORATORY ACCESSORIES

REACTOR: .01HY, 2.5 amp. 1500 v ins "Kenyon" $3.50
BROAD BAND S THRU X thermistor mount with type "N" input....$8.00
SPERRY KLYSTRON TUNER Mod. 12....$2.00
SINE POTENTIOMETERS, GE-#251 X 96 or W.E. #KS 15138 LO1....$3.50
CG 27, TYPE "N" CABLE ASS'Y, 3' long, male to female....$2.50
PH-SHIFTING CAP., 180 deg. W.E. #D-150734 $2.50
KLYSTRON SOCKETS for 723 A.B. and similar types, 2 for....$1.00
10 CM. McNALLY CAVITY TYPE SG. Ea....$3.50
LINE INSERTION ATTENUATOR, type OAX-1. 20 Db. attenuation, with 3-contact plug and socket (amphenol 168-5)....$2.25
TS 115/APS-2F 10 CM ANTENNA in lucite ball, with type "N" fitting....$4.50
OAJ NAVY TYPE CYT66ADL, ANTENNA in lucite ball, with Sperry fitting....$4.50
10 CM. FEEDBACK DIPOLE antenna, in lucite ball, for use with parabola....$8.00

THERMISTORS ($.95 ea.)	VARISTORS $.95 ea.
D-167332 (Bead)	D-167176
D-170396 (Bead)	D-170225
D-168392 (Button)	D-168687
D-166228 (Button)	D-171121
D-167018 (Tube)	D-171631

"PPI", ROTATING YOKE TYPE, complete with all necessary oscillator circuits, CR tube 5FP7, complete with tubes. Used with SO radar....$100.00
RT39/APG-15. Transmitter-receiver. 2200-2700 mc APX. Complete with 2C43 lighthouse plumbing. TR, 30 mc, I.F., all enclosed in compact pressurized housing. New, less tubes....$100.00
CP 14 APS-15A COMPUTER. Compiles slant range-ground range against altitude....$15.50
CURSOR DIAL ASSEMBLY for 7" CR tube. Azimuth calibrated to 360 deg. Roller bearing mechanism $12.50
CONDENSER DRIVE ASS'Y. Rotates any coupled condenser by means of motor thru 90 deg. at rate of 5 deg. per min. Operates on 55-110 vac, 60 cy. Manual knob permits rough adjustment. WE = B401020-G1. New, complete with cover and 0-90 deg. indicator scale....$12.50
BC 701-A RADAR RECEIVER, Part of SCR 521 and ASE eqpt. 176 mc operation, receives bilobed search and homing patterns. Complete with tubes and antenna switching motor....$37.00

APS-15

"X" BAND: Compl RF head and modulator, incl. 725-A magnetron & magnet, two 723A/B klystrons (local osc & beacon), 1B24 tr. rcvr-ampl, duplexer, HV supply, blower, pulse xfmr, Pk Pwr out: 45 KW apx. Input: 115V, 400 cy. Modulator pulse duration .5 to 2 microsec. apx. 13 KV. PK. pulse. Compl with all tubes, incl. 715 B, 829 B, RKR 73, two 72. Compl. pkg. new....$210.00
Complete Pkg. as above, less modulator..$150.00

CERAMIC CAPACITORS

$7.50 per 100....$50 per 1000

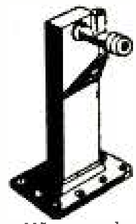
3 mmf	±5%	60 mmf	±3%
5 mmf	±5%	67 mmf	±20%
4 mmf	±.5 mmf	100 mmf	±5%
8.5 mmf	±.5 mmf	115 mmf	±2%
11 mmf	±5%	240 mmf	±3%
15 mmf	±2.5 mmf	250 mmf	—
48 mmf	±2%	500 mmf	+15—30%
50 mmf	±20%	1000 mmf	±5%

SILVER-MICA BUTTON CAPACITORS

$9.50 per 100....$80 per 1000

185 mmf....±2.5mmf
175 mmf....±2.5mmf
500 mmf....±10%

MICROWAVE PLUMBING



10 CENTIMETER

WAVEGUIDE to flexible coax coupler (RG 18/U), with flange Gold plated. App. 10" high....$17.50
MAGNETRON TO WAVEGUIDE coupler with 721-A duplexer cavity, gold plated....$45.00
10 CM WAVEGUIDE SWITCHING UNIT, switches 1 input to any of 3 outputs. Standard 1½" x 3" guide with square flanges. Complete with 115 vac or dc arranged switching motor. Mfg. Raytheon. New and complete....$135.00
721-A TR CAVITY WITH TUBE. Complete with tuning plungers....$5.50
WAVEGUIDE SECTION, MC 445A, rt. angle bend. 5½ ft. OA. 8" slotted section....$21.00
10 CM OSC. PICKUP LOOP, with male Homedell output....$3.50

⅞" RIGID COAX—⅜" I.C.

RIGHT ANGLE BEND, with flexible coax output pick-up loop....$8.00
SHORT RIGHT ANGLE bend, with pressurizing nipple....$2.00
30 FT. FLEXIBLE SECTION, ⅞ rigid to ⅞ rigid $7.50
RIGID COAX to flex coax connector....$3.50
STUB-SUPPORTED RIGID COAX, gold plated. 5' lengths. Per length....$5.00
RT. ANGLES for above....$2.50
⅞" COAX. ROTARY JOINT....$8.00
RT. ANGLE BEND 15" L. OA....$2.00
FLEXIBLE SECTION, 15" L. Male to female....$4.25
⅞" RIGID COAX, bead supported....$1.20/ft.
MAGNETRON COUPLING to ⅞" rigid coax ⅜" IC line, less "M" nut, with TR pickup loop, gold plated....$7.50

3 CM. PLUMBING

(STD. 1" x ½" GUIDE UNLESS OTHERWISE SPECIFIED)

TR CAVITY for 724-A TR tube, transmission or absorption types....$3.50
724-A TR tube (41-TR-1)....$2.50
WAVEGUIDE SECTION, CG 251/APS-15A, 26" long choke to cover, with 180 deg. bend of 2½" rad. at one end....$4.00
ROTARY JOINT with slotted section and type "N" output pickup....$8.50
WAVEGUIDE SECTION, 12" long choke to cover, 45 deg. twist & 2½" radius, 90 deg. bend....$4.50
STABILIZER CAVITY feeding waveguide section, with filtered output and attenuating slugs....$20.00
SLUG TUNER/ATTENUATOR, W.E. guide, gold plated....$3.75
TR/ATR DUPLEXER section with iris flange....$4.00
RIGHT ANGLE ELBOW, 5½" choke to cover, 2½" radius E or H plane....$5.00
TWIST, 90 deg., choke to cover....$5.00
WAVEGUIDE SECTIONS 2½" long, silver plated, with choke flange....$4.50
WAVEGUIDE, 90 deg. bend E plane, 18" long....$4.00
ROTARY JOINT, choke to choke....$6.00
ROTARY JOINT, choke to choke, with deck mounting....$6.00
S-CURVE WAVEGUIDE, 8" long cover to choke..$2.50
DUPLEXER SECTION for 1B24....$10.00
3 CM. WAVEGUIDE, 1" x ½" I.D. per ft....$1.50
CIRCULAR CHOKE FLANGES, solid brass...... .55
"T" SECTION (TR-ATR) choke to choke, supplied with circ. or sq. flanges....$3.50
DIRECTIONAL COUPLER CG 124 APS-15A on 16" section cover to cover 15 deg., bend....$5.00
FEEDBACK DIPOLE with 90 deg. twist. 7½"...$3.50

2K25/723AB, X band local oscillator mount with (1) choke coupling to beacon reference cavity; (2) choke coupling to TR and receiver; (3) Iris coupling with AFC attenuator to antenna waveguide; (4) Radar AFC crystal mount; (5) Receiver crystal mount; (6) Attenuating slugs. Mfg. DeMornay Budd....$22.50
TR/ATR Duplexer section for above....$4.00

2½" FLEXIBLE SECTION, cover to cover....$4.00
SHORT ARM "T" section, with additional choke output on vertical section....$4.00

1.25 CENTIMETER

WAVE GUIDE Section 1" cover to cover....$2.00
T SECTION choke to cover....$4.50
MITRED ELBOW cover to cover....$3.00
MITRED ELBOW and "S" sections choke to cover $3.50
FLEXIBLE SECTION 1" long choke to choke....$3.00
K-BAND ROTARY JOINT....$45.00

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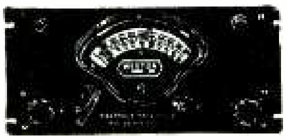
DAVEN AUDIO FREQUENCY METER Model 837E



Direct reading from 0-30 KC in 4 separate ranges on 6" Weston Model 271 Fan Meter. Built-in voltage regulated power supply operates from 115 volts 60 cycles, has high input impedance. With pick-up can be used to determine frequency in vibration tester. With suitable mixer can check deviation of R.F. carrier from standard. Mounts of 8¾"x19" rack panel. Complete with tubes. Slightly used but perfect. Only............$59.50

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2' GE 0-30 amps. D.C.	2.95
2" GE 0-1 amp RF (internal thermo)	2.95
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2" GE 0-1.2 ma (0-100 scale)	2.49
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2" Gruen 0-3V DC (1000 ohms per volt)	2.45
2" Weston 150-0-150 Microamps	3.49
3" Westinghouse 0-75 amp AC	4.95
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3" Westinghouse 0-150 volts AC Rectifier type (Linear)	5.95
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4" G.E. 0 to 50 Microamps	9.95
4" GE 1-0-1 ma DC (Blank scale)	3.95

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5 Watt type AA, 20-25-50-200-470-2500-4000 ohms	.09 ea.
10 watt type AB, 25-40-84-400-470-1325-1900-2000-4000 ohms	.15 ea.
20 watt type DG, 50-70-100-150-300-750-1000-1500-2500-2700-5000-7500 10000-16000-20000-30000 ohms	.20 ea.
30 watt type DI, 100-150-2500-3000-4500-5300-7500-18000-40000 ohms	.24 ea.

1% PRECISION RESISTORS

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200-2500-5000-8500-10000 ohms	$.39 ea.
50000-95000 ohms	.49 ea.
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In portable wood case 6" x 6" x 10" (including cover not shown). Has Weston 0-150 volt A.C. meter 60 cycle, 2 switching circuits. Complete with line and test cables. A bargain at only $3.95.

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1.5 to 7 MMF—.24
5 to 20 MMF—.24
4 to 30 MMF—.24
7 to 45 MMF—.24
10 to 110 MMF—.39

"A POWERFUL BABY"

This plate transformer built to rigid Signal Corps spec. Input 118 volts, 25 to 60 cycles. Has 2 separate 118 volt primaries and can be used on 110 or 220 volts. Secondary 800 volts center tapped at 775 mills. Exceptional regulation even when loaded to 900 mills! Fully cased—4 mtg holes. 37 lbs. net wt. 6½ x 6½ x 7⅛. Peak value at 7.95. 10 for $70.00

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Two separate 118 volt, 25 to 60 cycle primaries. Can be used on 110 or 220 volts. Secondary 5 volts at 15 amps. Built to Signal Corps specs. Fully encased. 5 x 4¼ x 5⅝. Net wt. 10 lbs. $3.75 each. 10 for $30.00.

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These transformers have many uses—filament, isolation, stepdown, bias, etc.
All have 2 separate primaries for 110/220 volt 25-60 cycle operation. Primaries. Can be used in series or parallel.
3 Choices of Secondaries:
Type 504—115 volts 500 mills and 6.3 volts 5 amps.
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Fully encased—4 mtg. holes. 5⅛ x 4¼ x 5⅛.
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Hammerlund MC 320S 320 mmf	.79
Hammerlund APC 100 100 mmf	.39
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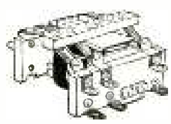

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12 Mfd. 450 V.D.C. Tubular	44¢
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Industrial Instruments Model L2AU 110/220 volts 60 cycle input. Direct reading from 0-100000 megohms on 4" meter. Can be extended to 500000 megohms with external supply. Sloping hardwood cabinet 15"x8"x10". Brand new with tubes plus running spare parts including extra tubes. Great value only $69.95.

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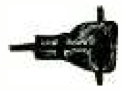

9200 volts peak. 8 amps. Used as antenna switch in Collins ART 13. BRAND new $1.75

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Micomold .005 2500 W.V. type 4	.69
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N.Y.T. 8 henry 160 ma. 140 ohms D.C.	1.39
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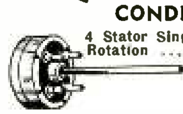

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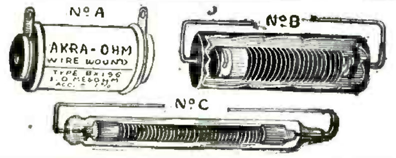

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.42	182	684	2635	14000
.425	182.4	689	2700	14400
.607	199	697	2850	14440
.7	200	700	2860	14460
1.01	209.4	733	2900	14500
1.3	216	750	3000	15000
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3	220.4	806	3290	16500
3.83	225	854	3384	17000
4	230	900	3500	17500
4.35	235	910	3509	18000
5	240	917	3700	18380
5.025	245.4	946	3730	18500
6	250	978	3760	19000
6.25	260	1000	4000	19500
7	271	1030	4200	20000
7.5	275	1056	4280	20520
7.8	280	1060	4300	21000
7.9	286	1100	4314	21500
8	289	1110	4440	22000
10	299	1150	4444	22500
10.38	300	1155	4500	22990
10.48	310	1162	4720	23000
11.25	311.5	1175	4750	23150
12	320	1200	4850	23325
13.52	325	1225	4885	23400
14.2	340	1250	4900	24000
14.5	350	1260	5000	24600
15	366.6	1322	5100	25000
16	370	1350	5210	25200
16.37	375	1355	5235	25400
17	380	1400	5200	26600
20	390	1495	5500	27500
21	400	1500	5600	29000
25	410	1510	5730	29500
26	414.3	1518	5910	29900
30	418.8	1600	6000	30000
37	425	1640	6140	31000
45.1	426.9	1646	6200	33000
48	427	1650	6300	35000
50	440	1670	6495	37000
51.78	450	1680	6500	38140
55	452	1710	6840	38500
56.7	470	1712	6990	39500
60	475	1740	7000	40000
63	478	1770	7500	43000
68	480	1800	7700	47000
71.4	487	1818	7930	48000
74	500	1830	8000	48660
75	520	1865	8250	49000
80	525	1900	8500	50000
81.4	540	1910	8700	52000
89.8	550	1960	8992	54000
90	575	2000	9000	56000
95	580	2045	9445	60000
100	600	2080	9500	61430
101	607	2095	9710	62000
105	612	2142	10000	64000
105.7	625	2145	10430	65000
107	633	2160	10500	68000
113.1	640	2195	10600	70000
120	641	2200	11000	72000
121.2	649	2250	11400	75000
125	650	2300	11500	80000
147.5	657	2400	11690	84000
150	665	2450	12000	90000
160	669	2463	12600	91000
165	670	2485	13220	95000
170	673	2490		
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125000	185000	268000	422000	654000
130000	201000	275000	458000	750000
135000	220000	294000	478000	761300
140000	225000	307500	500000	800000
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1 Meg	2 Meg	3.5 Meg	4.23 Meg	10 Meg
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SEALED, 10 or 12Meg/10KV/9W, $1.35@ 10for $10.00
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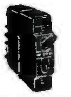

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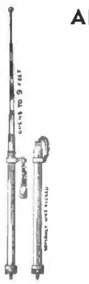

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30cm/12"lgth&
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WILLARD BR18/BB52/5oz
Miniature dsgnd portable
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'MODELS', .3/11/16x1-7/16Wx29/32H"
SPECIAL $1.49 @, 6 for $10
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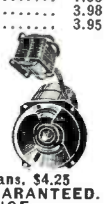
WSTGHSE 0-150VAC/25-125cys 3.98
GE GALVOMTR 2.5&25/Octr/3 1/2 2B'C....... 3.95
BLOWER 28VACDC/100cfm... $4.95
With Transf 115VAC......... 6.25
BLOWER 115VAC/125cfm 7.95
BLOWER 28VACDC/250cfm & twin outlet 'ORD' dsgnd, TURBINE Impeller ball bearing, Continuous duty 300 hour test & Transf 115VAC operation 10.95



BLOWER LR #2/28 VDCAC 2.98 & Trans, $4.25
*LN—Like New Used GOOD GUARANTEED.
PRICES SUBJECT TO CHANGE

"TAB" MONEY BACK GUARANTEE. $3 MIN. ORDER F.O.B. N.Y.C. ADD SHIPPING CHARGES & 25% DEPOSIT $3 MIN. ORDER. W08-7230

RECTIFIERS BRIDGE TYPE

INPUT	OUTPUT	CURRENT	PRICE
0–18V	0–13	1.35 Amp.	2.49
0–18V	0–13	3.25 Amp.	3.20
0–18V	0–13	5 Amp.	4.45
0–36V	0–28	320 ma.	1.40
0–36V	0–28	1.1 Amp.	3.25
0–36V	0–28	1.5 Amp.	3.95
0–36V	0–28	3.25 Amp.	6.50
0–36V	0–28	5 Amp.	7.40
0–64V	0–50	220 ma.	3.49
0–64V	0–50	1.5 Amp.	2.89
0–64V	0–50	3.25 Amp.	12.95
0–64V	0–50	5 Amp.	15.95
0–90V	0–72	150 ma.	2.85
0–126V	0–110	150 ma.	2.95
0–135V	0–116	3.25 Amp.	16.95
0–250V	0–200	40 ma.	.80

"TAB" STANDARD 'JAN' TUBES

OA4G	$1.00	6SC7	.71	955	.45
OZ4	.85	6SG7	.71	956	.49
1B3/8016	2.00	6SH7	.38	957	.49
1B24	2.95	6SJ7	.58	958A	.45
1B27	2.95	6SJ7G	.58	991	.35
1E7G	.98	6SK7	.58	1613	.69
1L4	.70	6SL7	.87	1614	1.50
1LC6	1.00	6SN7	.75	1616	1.87
1LH4	1.00	6SN7GT	.68	1619	.25
1LN5	1.00	6SQ7	.54	1622	1.49
1P5G	.79	6SS7	.71	1624	.70
1P24	2.95	6V6GT	.71	1625	.39
1R4/1294	1.00	6U7G	.58	1626	.45
2AP1A	2.85	6X4	.53	1629	.58
2C26	.39	6X5	.53	1635	1.90
2C34/RK34	.49	6Y6G	.88	1641	.75
2C40/446	.73	6Z4/84	.74	2050	.88
2D21	.75	7BP7/1813	2.90	2051	.48
2E22	1.45	9JP1	3.95	7193	.38
2J21/725	12.49	10Y	.59	8005	3.25
2J26	14.95	12A6	.34	8012	3.95
2J32	16.95	12AH7	.87	8013A	4.95
2J49	35.00	12AR7	.95	8020	4.95
2J55	24.95	12DP7	12.95	9001	.49
2J61A	39.95	12GP7	12.95	9002	.59
2K25/	5.90	12SA7	.58	9003	.49
2K29	6.95	12SH7	.71	9004	.49
2V3G	.98	12SK7	.58	9006	.45
2X2	.49	12SQ7	.58	C6J	4.95
3A4	.49	12X3	.95	CE206	3.95
3B7/1291	.95	15E	1.45	CE215	5.95
3B24	.95	25Z5	.53	CK1005	.30
3BP1	1.00	35L6	.58	F127A	12.00
3BP1A	2.95	35Z5	.45	FG104	14.95
3C23	4.95	37	.78	FG105	16.95
3D6/1299	.88	41	.58	FG166	49.00
3FP7	2.98	50L6	.58	434/7C29	7.90
3JP12	2.95	80	.52	HK24/3C24	.59
3S4	.55	83V	.88	RX215	9.95
4J47	35.00	205B–VT2	3.95	T200	12.00
5AP1	2.75	211	.79	VR90	.74
5BP1	1.45	215	2.95	VR92	.45
5BP4	2.95	250TH	17.49	VR105	.74
5CP1	2.95	250TL	18.00	VR150	.74
5D21	19.00	304TH	4.95	WL468	9.95
5FP7	3.95	304TL	1.98	WL530	49.50
5HP1	3.95	307A/RX95	3.75	WL531	9.95
5R4G	1.00	388	2.95	WL619	20.00
5T4	1.25	393	5.95	UX6653	2.95
5U4G	.53	450TL	32.95	TUNGAR*	
5V4	.87	527/1000S	.65	20X672*	2.95
5W4	.87	631P1/SN4	3.75	199698*	2.95
5Y3	.38	703A	4.95	289881*	2.50
5Z3	.59	707B/2K28	9.95	MAZDA PL**	
5Z4	.88	710A/8011	2.90	49**Box	.60
6AB7	.98	717A	.69	64**Box @	.07
6AC7	.72	722/287A	9.95	S6/T4**	
6AG5	.88	723AB	4.95	Box	1.40
6AG7	.98	726A	6.95	100W/	
6AJ5	.98	802	1.95	20V** @	.39
6AK5	.69	803	7.95	313/	
6AL5	.98	804	6.70	28V** @	.10
6B4G	1.04	805	3.74	323/100**	
6B8G	.98	807	1.24	qty	10.00
6C4	.39	808	1.95	AVIATION	
6C5	.51	810	5.75	LGTS	
6C6	.71	811	1.94	4522/250W	1.49
6C8G	.98	813	5.95	4560/600W	3.50
6D4	.59	814	2.98	NEON BULBS†	
6D6	.59	815	2.25	NE2†/100	
6E5	.71	816	1.15	qty	4.50
6F6/1613	.69	826	.49	NE16&	
6F8	1.04	828	10.00	991 @	.25
6G5/6U5	.95	829B/3E29	3.95	NE51/	
6G6	.86	832A	2.75	20.100	6.00
6H6G	.48	836	1.10	SOCKETS	
6H6	.59	837	2.25	2X2HV	.30
6J4	5.25	WL632A	12.95	705/715	.69
6J5	.49	845	3.95	803/304T	.90
6J6	.65	860	2.49	807	.24
6J7	.70	864	.67	813	.69
6K5GT	.86	865	1.00	829/832	.25
6K6GT	.49	866A	1.00	866	.24
6K7	.59	868	1.00	872/211	.49
6K8	.86	GL872A	2.49	Acorn 6 for	1.00
6L6	1.24	884	.89	Diheptal	.69
6L6G	1.04	918/CE1C	1.20	Maginal	.69
6L7	.87	922	1.40	TUBES GTD	
6N7	.87	923	.49	except open Fil.	
6S7	.87	931A	3.49	& breakage	
6SA7	.54	954	.45	Write Qty Price	

VOLTAGE REGULATORS NEW RAYTHEON
95-130V/60cy outpt 115/60watt new...........10.95
198to242Vinpt/50-60cys, Outpt 220V 500 Watts/5% Regltn NEW........................ 35.00
VOLTAGE REGULATOR SOLA 95-220V 50-60cy/2000Watt/17.4Amn LN* 149.50
PHOTOFLASH KIT & POWER SUPPLY includes all parts 12VDC or 115VAC& 2-STROBOFLASH LAMPS & REFLECTORS 59.95
STROBOFLASH LAMPS & reflectors....2 for 21.00
STROBOFLASH CONDSRS 8mfd/3000Vint.. 3.95
15mfd/2000Vint, $4.50; 16mfd/3000Vint...... 7.95
25mfd/2000Vint, $7.95: 4x8mfd(32mfd)3000Vint 11.95
BC1162A p/o RC150 WAVEMTR(150-210mcs) incl 8-15mc Freq mtr Synchronizer, tuneable coax cavity & cnnctr unit & pwr supply readily convertible Xmtr, RCVR Citizens band NEW............................ 23.95

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CORNER CHURCH & LIBERTY STS., ROOM 200

STEPDOWN TRANSFORMERS

Input: 115V.-60 cycles.
Output: 20 V., at 10 amps.
Also tapped at 6V., for pilot light. Ideal for Selenium Rectifier Applications, etc.
Brand New $2.45

SELENIUM RECTIFIER

Bridge Type
Input: 36 V. AC
Output: 28 V. DC., 1.1 Amps.
Brand New $2.75

APPROACH INDICATORS

Type ID-24/ARN-9
Brand New $3.95

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Type AN/APN-1 Complete, brand new in original cartons with instruction books
$49.50

KOLLSMAN COMPASSES

Type B-16 Brand new and complete with spare pilot lamp.
$9.75

SOLAR ELIMOSTATS

Line filters, 20 amps. capacity
Brand New $3.95

INSTRUMENT LAMPS

Mazda #323
$10.00 per Hundred

SOLA VOLTAGE REGULATORS

Cat. No. 30807—Pri. 95-125 V. 60 Cy. Output 115 V. 2.18 amps. VA. 250.
$39.50

RADAR EQUIPMENT

All Brand New Material!

ANTENNA ASSEMBLIES

SO-1 (66AGE) $125.00
SO-3 (NMT-2062) $120.00
SO-8 (66AGD) $120.00
TDY (NMT-2062 . . . . $ 95.00

SPARE PARTS

Complete Set SO-3 Tender Spares
$2500.00
10 CM Flatwise Bend 90° Bronze Elbows
$20.00
Complete spare parts in stock for Type SG 1 Radar

ALSO

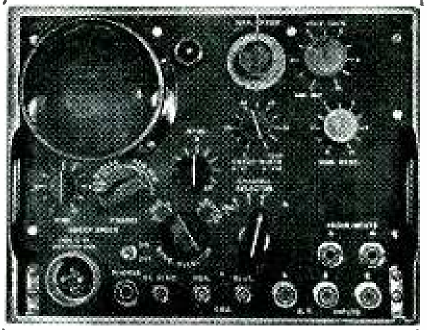
SO-Radar Repeater Adapters CBM-50AFO, PPI units, SO-11 Modulators, Remote Indicators, SO Receiver Transmitter Units, Antenna Unit Controls, etc.
Large Stock. All Brand New Material!

RADAR TUBES IN STOCK

Types—4C35, 2J62, 3B24, 3C45, 7BP7

PAN-OSCILLO-RECEIVER

Ideal for laboratory, television and general service work



Model AN/APA 10

Performs work of four units

1. **PANORAMIC ADAPTOR:** For use with any receiver with I.F. frequency of 405-505 kcs., 4.75 to 5.75 mcs., and 29-31 mcs.
2. **OSCILLOSCOPE:** Visually checks received signals, monitors transmitter output — percentage modulation, carrier wave-shape, etc.
3. **SYNCHROSCOPE:** External inputs provide synchroscope action.
4. **RECEIVER:** Three inputs provide facilities for use with convertors to cover wide range of frequencies to 10,000 mcs.

FEATURES:

* 3" scope tube
* 21 tubes
* Variable sweep 35-40,000 cy
* Transformer built in for 110 V. 60 cycle operation.
* 2 I.F. stages—double conversion.
* 2 Video stages in push pull to vertical plates.
* Pentode output audio monitor.
* Multi-Vibrator horizontal sweep (radar type).
* Horizontal sweep amplifiers P. P. to horizontal plates.

Surplus equipment tested and guaranteed in perfect operating condition. We have sold hundreds of these units to leading schools, laboratories, amateur operators all over the world.

$129.50

(Mail $3.50 for 80 page Technical manual and instruction book)

SOUND POWERED CHEST SETS

No batteries required
Ideal for television installers, or any antenna measurement work. Leaves hands free to make adjustments. Set consists of microphone and headset as illustrated.

Brand New **Per Set $19.50**

W. E. TYPE D-168479 MERCURY CONTACT RELAY

For applications in all types of high speed switching devices. Long service life, high operating speeds. Large current and voltage handling capacity, uniform and constant operating characteristics under adverse atmospheric conditions. Hermetically-sealed mercury-wetted contacts in gas-filled glass envelope. Free from moisture, dirt, corrosion and atmospheric pressure.

1000 hours life at 60 operations per second. Two coils of 700 ohms, and 3300 ohms. Operating current, coils, series aiding—6.6 mils. Release current, coils series aiding—5.2 mils. Four page Technical Data on request.

Brand New in Original Cartons **$4.75**

MOTOR GENERATORS

Brand new. Built by Allis Chalmers to rigid specifications of the U. S. Navy

K.V.A. output 1.250	R.P.M. 3600
K.W. output 1.	Cont. Duty Ph. Single
P.F. 80	Cycles 60
Volts input 115 D.C.	Volts output 120 A.C.
Amps input 14	Amps. output 10.4

Length 26"; width 12⅞"; height 13". Compound accumulative A.C. and D.C. fields. Centrifugal starter. Splashproof covered. Frequency adjustable to load, plus or minus five cycles.

PRICE $125.00
Identical Machine, but 230 volts D. C. Input, $125.00
Set of Replacement Spare Parts for Either Machine $29.50

DYNAMOTORS—500 Watts Navy Type CAJO-211444

Input: 105-130 Volts D.C., 6 amps. Output 13 or 26 Volts D.C. (26 V. at 20 amps. in series or 13 V. at 40 amps. in parallel). Designed for radio use, fully R.F. filtered, complete with separate Square D line switch box.

BRAND NEW $59.50

SYNCHROS (Selsyns, Antosyns, etc.)

G. E. types 2J5FB1, 2J5S1. Ford Inst. types 5SDG Bendix types 1-1, 11-2, X. CAL. 18300 Electrolux type XXI Diehl type IV, 78414. Navy ordnance types 5G, 5DG, AY101D, and many other types in stock.

POSITION TRANSMITTERS

General Electric type 8TJ9 continuously variable potentiometer tapped every 120 degrees with two sliding contacts 180 degrees opposed. 500 ohms resistance each, 120 degrees. Used in 24 volt D.C. Selsyn systems.

Brand New $3.95

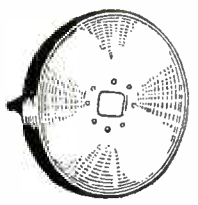
G. E. AMPLIDYNES

Type 5AM21JJ7, NEW $49.50
Type 5AM45DB20, NEW 89.50

G. E. SERVO AMPLIFIERS

Type 2CVICI, New $19.50

PARABOLOIDS



Spun magnesium dishes.
Ideal for microwave experimental work.
Dia. 17½". Depth 4".
Reinforced perimeter.
Two sets mounting brackets on rear. Open center hole 1½" x 1⅝".

Per Pair, Brand New $8.75

TRANSMITTING EQUIPMENT

B C-325 B Transmitter. Freq. range 1.5 to 18 mcs. Output 400 watts C. W. or 50 watts phone. 110 V. 60 cycle, 1 ph. Complete with tubes. Used, but in good operating condition **$295.00**

MD1/FRC Modulators. Part of T-4/FRC and T-5/FRC. Complete in enclosed metal racks. Each unit consists of a dual modulator channel, each of 300 watts audio output (2-810's in push-pull). Complete from microphone input jack to modulation transformer output terminals for connection to Class "C" final amplifier R.F. stage. Brand new **$275.00**

SA-2/FRC Switch Panels **$10.00**

All prices quoted subject to change. 20% deposit on C.O.D.s fob. Tuckahoe, N. Y. About 20 miles N. of N.Y.C.

ELECTRONICRAFT INC.

All merchandise guaranteed. Immediate delivery, subject to prior sale.

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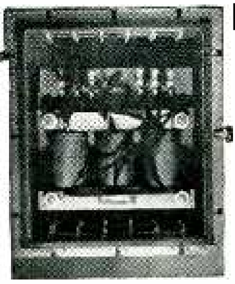
BIG VALUES IN SURPLUS

G. E. Motor Starting Reactors



Type 11K2840G2

Rated at 440 Volts, 3 Phase, 60 Cycles, 16.8 Amperes. 15-20 HP. Waterproof steel case. 17" x 15" x 10". Brand New in original factory cases.

$9.90

General Electric Plunger Relays

Type PAC

GE Bulletin GEF2337JY

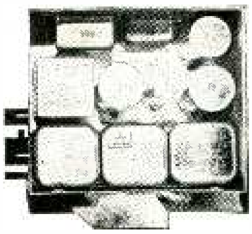
Adjustable from 1.5 to 5.0 amperes. 110 volt. 60 cy. Reset type.

BRAND NEW BIG VALUE

$10

Vibrator Power Supply

PE-204A



Input Voltage:
12 Volts DC
Output Voltages:
Two windings 4.3 VDC @ 50 MA
Two windings 45VDC @ 0.5 MA
Two windings 85VDC @ 5.0 MA

Parts alone worth double the money.
BRAND NEW **$1**

Gear Reduction Assembly

Incorporates a train of 10 gears arranged so that different ratios can be obtained. Ideal for beam antenna or any device employing speed reducer. Reduction from 2:1 to 40:1 and other ratios possible.

6¼" L x 5½" W x 4¼" H
Brand New in Original Cases

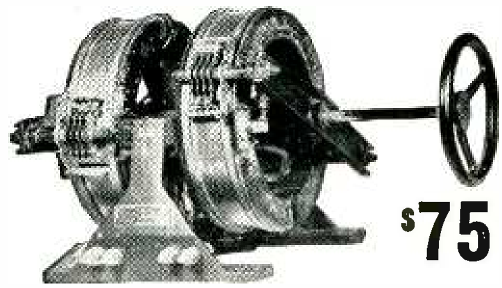
$2.79

"TRANSTATS"

Amertran Voltage Regulator

11.5 KVA; 50/60 cy. Commutator Range 0-115 V. Max. Amp. 100. Can be reconnected for 230 volts @ 50 MA.

BRAND NEW



$75

ALL ITEMS LISTED BELOW ARE "BRAND NEW" UNLESS OTHERWISE SPECIFIED

SYNCHRO'S

Ford Instrument Synchro Generator, 7G, MK111 Mod. 3 115/90 Volts 60 Cycles......Price $16.50

Arma Corp. Synchro Differential Generator, Type 5DG MK4 Mod. 1 90/90 Volts 60 Cycles Price $7.95

Diehl Synchro Transmitter, Type C78414 115 Volts 60 Cycles..................Price $4.35

Control Instrument Synchro Motor, Type 5F MK4 Mod. 3 115/90 Volts 60 Cycles....Price $26.25

Sperry Gyroscope Voltage Receiver, 76166, 115 Volts 60 Cycles..................Price $4.35

Delco Synchro Transmitter, C79331, Type I-4, 115 Volts, 60 Cycles..............Price $4.35

MOTORS AND GENERATORS

Western Electric Motor, KS8624, 20 VAC, 200 Cps, 2 ph. 9000 RPM.............Price $4.95

Oster Shunt Motor, Type E-7-5, 27½ Volts DC, 1/20 HP 3650 RPM ....Price $7.50

Oster Series Motor, Type C-2BP-1A, 27.5 Volts DC, 1/100 HP 7000 RPM...........Price $2.50

Universal Electric Shunt Motor, KS5603L02, 28 Volts, .6 Amps. 5000 RPM..........Price $2.00

Westinghouse Series Motor, 1171391, 27 Volts 6.5 Amps. ¼ HP 5800 RPM...........Price $5.00

Elinco AC Generator, Type F-16 2 phase, 1.3 Volts per 100 RPM..............Price $7.95

Elinco DC Generator, Type PM-2, 1.75 Volts per 100 RPM ....Price $5.75

G. E. Permanent Magnet Generator, 5BY9E8, 140 Volts DC .025 Amps. 1800 RPM Price $5.50

G. E. Motor, Mod. 5BA10AJ18D, 27 Volts 0.7 Amps. 1 oz/ft torque 110 RPM....Price $1.00

Emerson Electric Motor, Style 1610212, 24 Volts 160 oz/ft 27 Amps. 100 RPM.........Price $8.95

Electric Specialty Co. AC Motor, Type BF51R, 440/3/60cy. 2.5 HP, 1750 RPM......Price $28.50

G. E. Motor, Type BC 115 VDC 1/6 HP 1725 RPM Comp. wound Rebuilt...........Price $9.50

G. E. Series Motor, Mod. 5PS56HC18, 60 VDC 1/20 HP, 1.4 A. 5500 RPM.........Price $2.85

G. E. Motor, 230 Volts DC, 6.75 HP, 1100 RPM flange mounting ....Price $50.00

General Industries Phono Motor, 23200, 115 VAC, 60 cy. 0.5 A. 80 RPM.............Price $5.75

General Industries Phono Motor, 23200, 115/220 VAC, 60 cycle, 0.5 Amps. 80 RPM...Price $6.35

Universal Electric Co., 115 VDC, 500 RPM, .12A Price $4.50

G. E. 115 VDC, 1/30 HP, 1750 RPM Shunt wound. Rebuilt ....Price $4.00

INVERTERS AND DYNAMOTORS

PE103 Ballentine Dynamotor, input 6-12 Volts, output 500 Volts, 160 Ma. without filter. Price $9.95

PE206 Inverter, input 27 Volts DC, output 80 Volts, 800 Cycle, 500 VA..........Price $9.95

PE218 Inverter, input 27 Volts DC, output 115 Volts, 400 Cycle, 1500 VA Rebuilt Like New Price $22.50

Dynamotors for SCR-522, input 28 Volts DC, output 13-150-300 Volts. Rebuilt Like New Price $3.25

G. E. Dynamotor, 5D48B8A, input 14 Volts DC, output 1000 Volts at 350 Ma. complete with filter ....Price $5.00

MG-132A Inverter, input 11.5 Volts DC, output 140 Volts AC, 1.2 Amps. 350 Cycle, 1800 RPM, 100% PF ....Price $19.95

METERS

Bristol Pyromaster Potentiometer Type 440MFI, 115 Volts, 60 Cycles, Range 0-2000° F. Used but Guaranteed ....Price $125.00

Hoyt Portable Ammeter, Mod. 515, 0-15 Amperes DC, complete with test leads..Price $4.95

G. E. Voltmeter, Mod. AB-13, 0-150 Volts AC, 400 Cycle, 4½" sq. complete with external resistor ....Price $14.95

MAGNETRONS

2J26 2992-3019 mc 275 KW..........Price $10.00
2J27 2965-2992 mc 275 KW..........Price $10.00
2J31 2820-2860 mc 285 KW..........Price $15.00
2J61 3000-3100 mc 35 KW..........Price $25.00
700 A, B, C, D, West. Elec. 100 KW...Price $25.00
720 AY, GY, West. Elec. 1000 KW...Price $25.00
728 AY, BY, CY, DY, EY, FY, GY, 300 KW Price $25.00

KLYSTRONS

Westinghouse, Type 417A.............Price $9.00
Westinghouse, Type 723A/B...........Price $5.00

TRANSFORMERS

Stepdown Transformer 575/230/115, 60 cycle, 100 VA, air-cooled..............Price $3.10

Westinghouse Transformer Primary 110 Volts, 60 cycle, Secondary 20 Volts, 200 watts Price $3.95

BATTERIES

8 Volt Dewar Wet Cell Battery, 15 amp.-hours. Complete with electrolyte and filler syringe. May be used as four 2 volt batteries. Price $8.00

2 Volt Willard Battery, replacement for G. E. portable radio model LB530........Price $1.50

4 Volt Searchlight Battery, 80 Ampere hours Price $10.65

(all batteries shipped dry)

BLOWERS

Redmond Single Blower, Type L, 115 Volts 60 Cycles, single phase 50 CFM......Price $14.95

Redmond Double Blower, Type L, 115 Volts 60 Cycles, single phase 100 CFM....Price $19.95

Oster Single Blower, 6 Volts DC, 5000 RPM, Torrington Blower size 1½..........Price $4.50

AMPLIDYNES

G. E. Amplidyne, Mod. 5AM45DB20, input 115 Volts, single phase, 60 Cycle 5.0 Amps. output 250 Volts, 0.6 Amps. 150 watt, 3450 RPM, continuous duty ....Price $53.50

G. E. Amplidyne, Mod. 5AM21JJ7, input 27 Volts DC, 16 Amps, 4600 RPM, output 60 Volts, 2.5 Amps. 150 watt ....Price $9.95

VOLTAGE REGULATORS

Eclipse Voltage Regulator, Type 1001, set at 115 Volts AC ....Price $3.25

Eclipse Voltage Regulator, Type 1002, set at 27.7 Volts DC ....Price $1.75

Leland Voltage Regulator, 11651, set at 18 volts Price $1.29

NEW 112 PAGE CATALOG PACKED WITH BARGAINS IN EQUIPMENT. WRITE FOR IT ON YOUR COMPANY'S LETTERHEAD.

All prices F.O.B. Boston. Orders accepted from rated concerns on open accounts. Net 30-days.

ELECTRO SALES COMPANY

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Remote Indicating Compass System

Kollsman Remote Compass Transmitter and Indicator—with Pioneer inverter. 24 v. DC operation. Stock #SA-22A. **Price $25.00 each.** 14 v. DC system—Stock #SA-22B **Price $30.00 each.**

400 Cycle Inverters

Pioneer—12116-2-A, 12116-5-A, 12123-1-A.
Holtzer Cabot—MG-149F, MG-149H single phase—and MG-153F (3 phase).
General Electric—5D21NJ3A, 5AS131JJ11A.
Leland—10563 and PE-218.

INVERTER—Wincharger PU-7/AP—Input 28 v. DC at 160 amperes. Output 115 v. 400 cy @ 21.6 amps. Voltage and frequency regulated. Cont. duty. Wt. 75 lbs. Stock #SA-164. **Price $99.50 each.**

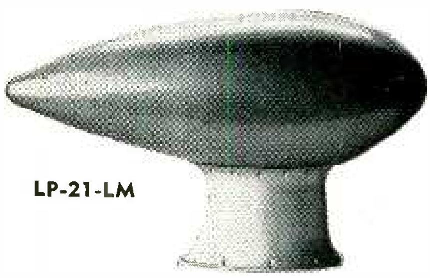
WESTINGHOUSE FL BLOWER

115 v. 400 cy. 17 c.f.m. Includes capacitor. Stock #SA-144. **Price $6.75 each.**

Tachometer Generator

Elinco PM-2
2.0 v. DC per 100 rpm. Use to 2000 rpm. Stock #SA-53. **Price $7.50 each.**

Radio Compass Loop



Stock #SA-99. **Price $9.50 each.**

NULL TYPE SYNCHRO INDICATOR

Precision position indicator. Uses Bendix size 5 Selsyn, rectifier tube, transformer, magic eye tube and illuminated 0-360° dial. Ideal for Hams, labs and experimenters. May be used with size 5 generator SA-43. Stock #SA-119. **Price $7.95 each.**

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Use as transmitter or receiver on 26 v. 400 cy. or 6-12 v. 60 cycles. 2⅜" diam. x 2¼" lg. ⅝" shaft ext. with 0.1245 diam. Stock #SA-57. **Price $3.75 each.**

DC MOTORS

Synchron 10 RPM Timing Motor—24 V. Hanson Mfg. Co. Stock #SA-110. **Price $3.75 each.**

G.E. Reversible—5BC26AC134. 1/20 H.P. 24V @ 3.4 Amps. Shunt wound. Cont. duty. 4½" diam. x 6½" lg. 1¾" shaft extension, ⅜" diam. 2¼" sq. 1" conduit box mounted on motor. Explosion proof. Stock #SA-143. **Price $12.50 ea.**

G.E. 10 RPM—5BA10FJ12—40 lb/in. 24 V. 1.1 amps. **Reversible.** Stock #SA-17. **Price $8.75 each.**

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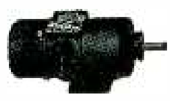
Constant Speed DC Motor—G.E. 5BA25MJ-24. 24V DC 7100 rpm. RC noise filter. Stock #SA-100. **Price $8.50 ea.**

250 RPM. Delco 5067127—27 V. PM field. 1¼" diam. x 3¼" lg. 42 tooth ⅝" pitch diameter pinion on 0.250" shaft. Stock #SA-108. **Price $2.95 each.**

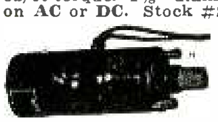


DELCO CONSTANT SPEED MOTOR A-7155

1/30 hp. 3600 rpm. Cont. duty. 2½" diam. x 5½" lg. ⅞" shaft extension, 5/32" diam. 4 hole base mounting. Stock #SA-94. **Price $6.50 each.**

110 RPM MOTOR

G.E. 5BA10AJ18D. 27 V. # 0.7 amps. 1 oz/ft torque. 1⅝" diam. x 3½" lg. Operates on **AC** or **DC**. Stock #SA-98.



Include 15¢ for P.P. and handling
Price $2.95 ea. net

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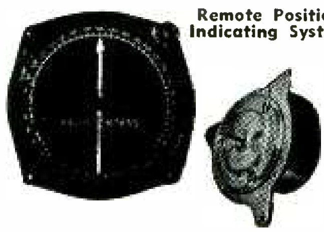
A-5 Directional Gyro
A-5 Vertical Gyro
Westinghouse Rate Gyro
Pioneer 12800 Gyro Servo

All Prices F.O.B. Paterson, N. J.

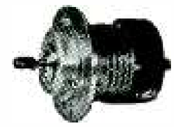
Remote Position Indicating System



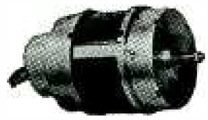
Ideal for Ham Beam Position Indicator or industrial uses. 6-12 volts 60 cycles. 5-inch indicator with 0-360° dial. Heavy duty transmitter. Stock #SA-115. **Price $9.95 per system.**

Phase Shift Capacitor—4 stator single rotor. 0-360° phase shift. Stock #SA-114. **Price $4.75 ea.**

Servo Motor



Pioneer Type CK-2. 2 phase 400 cycle. Fixed phase 26 V., var. phase. 49 V. max. 1.05 oz/in. stall torque. Stock #SA 97. **Price $4.75 ea. net.**



Size 5 Synchro Generator

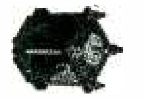
Similar to Navy Ordnance type 5G with shaft detail per Army Ordnance Dwg. C-78414. 115 v. 60 cy. Stock #SA-43.

MAGNESYNS Pioneer CL-3

6 power Magnesyn. Use as transmitter or receiver. 26 v. 400 cy or 52 v. 800 cy. Stock #SA-6. **Price $3.75 each.**

HAM SYNCHRO SPECIAL

W.E. Co. KS-5950-LT.
115 v. 400 cy. or reduced 60 cycle excitation. Stock #SA-182. **Price $4.75 each.**



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Magnavox #XC-260046-G1

Hi-speed ball bearings. Silver plated coaxial type capacitor. Use in sweep generator. 5-10 mmf. Stock #SA-167. **Price $2.75 each.**

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AS-217A/APG-15B. 12 CM dipole and 13 inch parabola housed in 16" weatherproof Radome. DC spinner motor for conical scan. Shipping weight 70 lbs. Stock #SA-95.

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FM Mobile Transmitter-Receiver operates from 6 volt vibrapack, 20.0 to 27.9 Mc; easily converted to 10-meter freq. 28-29.7 Mc.

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R-89/ARN-5

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Transmitter .... **$2.95 ea.**
Set **$6.95**

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L & N: 4223 Precision Resistor; 7655 Portable Indicator and Standard Cell.
Millen: P4E Synchroscopes.
Western Electric: RA 90A High Voltage Power Supplies; SID 353384 VT Regulated Power Supplies; TS/5AP Range Calibrator (Sweep Marker Generator); 15154, D 152213 Modulator Oil Units; TS9/APQ-5 Range Calibrator Modulator; 157A Output Transformers; Breakdown Testers, 500 volt.
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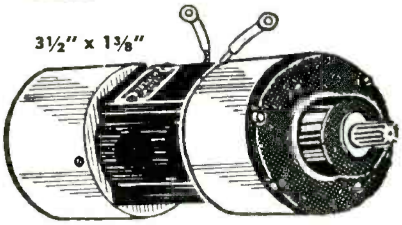

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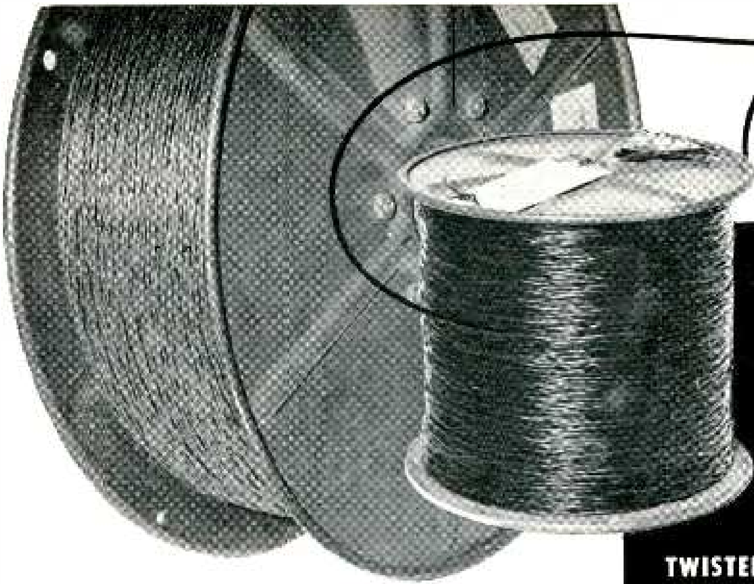

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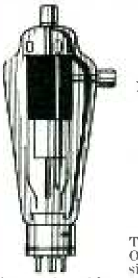

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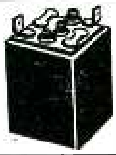

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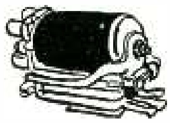

No. R30 3500 ohm 6MA SPDT 3a cont...89¢ ea.
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G.M. Relay No. R16 240 ohms 24v 4PDT 10A cont ....98¢ ea.
No. R31 40 ohms 12v SPST N.O..........39¢ ea.

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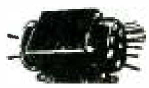
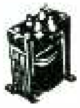


Pwr Trans: 1500v C.T. at 150ma, 6.3v 2.5a, 6.3v 1.6a, 5v 3a, 115v 50-60c pri G.E. ....$5.25 ea.



Fil Trans: 6.3v 8a, 115v 50-60c pri G.E. ....$1.95 ea.

3 hy 5ma 325 ohms 1 9/16"d x 1¼" h ....25¢ ea.

20hy 15ma 975 ohms G.E. Herm Sealed 2¼" x 1⅞" x 2¼"..29¢ ea.

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VIBRATORS 115v DC to 90cy AC 115v OAK No. V6429 6 prong..........................59¢ ea.

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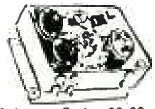
⅜" dia. x ½" wndg. Lgth 1 ⅛" lg. form. R-F = 6 turns #.17 silver wire 24¢. 2 for 25¢.



Ant trans ass'y MN 26 & ARN-7 Stk #3CK-1084C-24 ....$1.75 ea.

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GOVERNMENT INSPECTED AND APPROVED FOR BENDIX, WESTERN ELECTRIC AND OTHER NATIONALLY KNOWN MANUFACTURERS.

TYPE DA-3A 28V — SPECIAL! **$9.95**

INPUT 28VDC	10.5 AMPS	
Hi VOLT OUTPUT	300VDC	.260 AMPS
MED. VOLT OUTPUT	150VDC	.010 AMPS
LOW VOLT OUTPUT	14.5VDC	5.0 Amps
Temp. Rise 40° C	Duty Continuous	RPM 4700

Made for Bendix By Webster of Chicago

MODEL D-104 12V

INPUT #1	INPUT #2	OUTPUT #1	OUTPUT #2
12VDC	12VDC	225VDC	440VDC
RPM-4700	DUTY CONT.	.100AMP	.200AMP

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MODEL 5053
DC INPUT 28V, 1.40AMPS — DC OUTPUT 250V, .060AMPS — **$3.95**
CONTINUOUS DUTY RATING WESTERN ELECTRIC KS-5868 LO3

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Electrolytics, Capacitors, Micas, Pots, Rheostats, Wire, Trimmers, Special Purpose Tubes and many other hard to get items. All Nationally Known Brands.

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Centralab 50 mmfd threaded ceramic feed thru capacitors and 300 mmfd silver button mica disc type feed thru capacitors

1000 lengths of aluminum alloy conduit, flexible shielded with tinned copper braid, ID ½", 88" long, male and female couplings

1600 lengths of stranded aluminum flexible shielding, ID ¾", 7 ft. long

7000 feet of stranded aluminum flexible shield conduit, ID ⅜"

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Sold! "Please discontinue our ad in 'Searchlight' as we have sold the equipment through this advertising."

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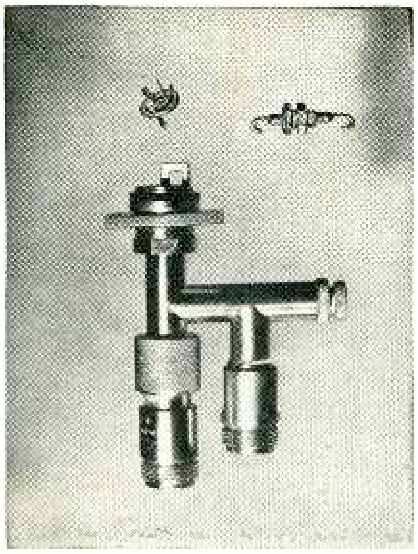

CRYSTAL MIXER ASSEMBLY, S band, type N fittings, variable oscillator injection coupling, **$5.00.**

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TRANSFORMERS, 115 volts 60 cps primaries:

2. 6250, 3250, and 2000 volts, tapped primary, **$14.00.**
2. 6250 volts 80 ma. ungrounded, G. E. **$12.00.**
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Varistors WE D171528, D171628, D-161871-A. **75¢ ea.**

0-350 volts, 1000 ohms per volt meter, Westinghouse NX 35, **$4.50.**

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Red Bank 6-4247

PORTABLE D. C. AMMETER

HOYT TYPE 515

RANGE 0—15 AMPS

$3.95

10 for $35.00

Mirrored scale 3½" long, knife-edge pointer. Molded bakelite case dimensions 4¼" x 5¼" 2¼". Snaps in place in black wrinkle-finished steel case 5¼" x 6" x 2⅜". Furnished with 3 ft. color-coded rubber insulated clip leads.

Basic movement—approximately 12.5 ma. Shunt readily replaced permitting conversion to lower range scale.

Individually packaged in moisture-vaporproof packing.

G.E. type FG-172 **Thyratrons** **$16.00**

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Hydraulic servo controls for remote rotation of ASB antenna (Transmitter and Positioner)—set **$20.00**

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THE FOLLOWING:

15000 Selenium Rectifiers 75 mils 110 volts .... **$ .25**

5000 Electrolytic Condensers 3000 mfd. 3 volts metal can 1¾" x 1" .... **$ .10**

1000 Non-Polarized Electrolytic Condensers Cap. 20 + 10 mfd. 350 v and +5 +5 mfd. @ 150 v, in metal can.... **$ .39**

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30 M #44 G.E. and Tungsol Pilot bulbs @ .... **$35.00 per M**

Large quantities of mica condensers in all sizes at low prices

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● Standard size and type. Surplus Black Bakelite. Low-impedance mike, 3000-ohm receiver. 6-ft. cord with two plugs. Brand New. In original factory-sealed cartons ...... $2.85 ea. net.

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25-Watt P-A Re-Entrant Speakers - Brand New!!

● 9-pound magnet. 13" bell. 21" long. UTC line-matching xmfr. 250, 500, 1000, 2500 ohms. Our best seller. Few left. Surplus Item. Original Cartons. $21.60.

VACUUM CAPACITORS

● Surplus. Brand New. Original Boxes. 17,000 peak volts up to 50uuf sizes; 10,000 peak volts for larger sizes. 6uuf. $2.80; 12uuf. $3.50; 50uuf. $4.50; 100uuf. $7.65; 150uuf. $11.60; 200uuf. $14.60; 250uuf. $17.30.

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This instrument was developed by the Boonton Radio Corp. to permit checking at VHF; Capacitance, Inductance and complete Resonant Circuits. Ideal for Television and FM Tuners, Quality control, etc. Four Frequency Ranges. Available for immediate delivery.

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COMPUTER CONDENSERS

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Made by well known Mfg.

FS-4879, Electronics

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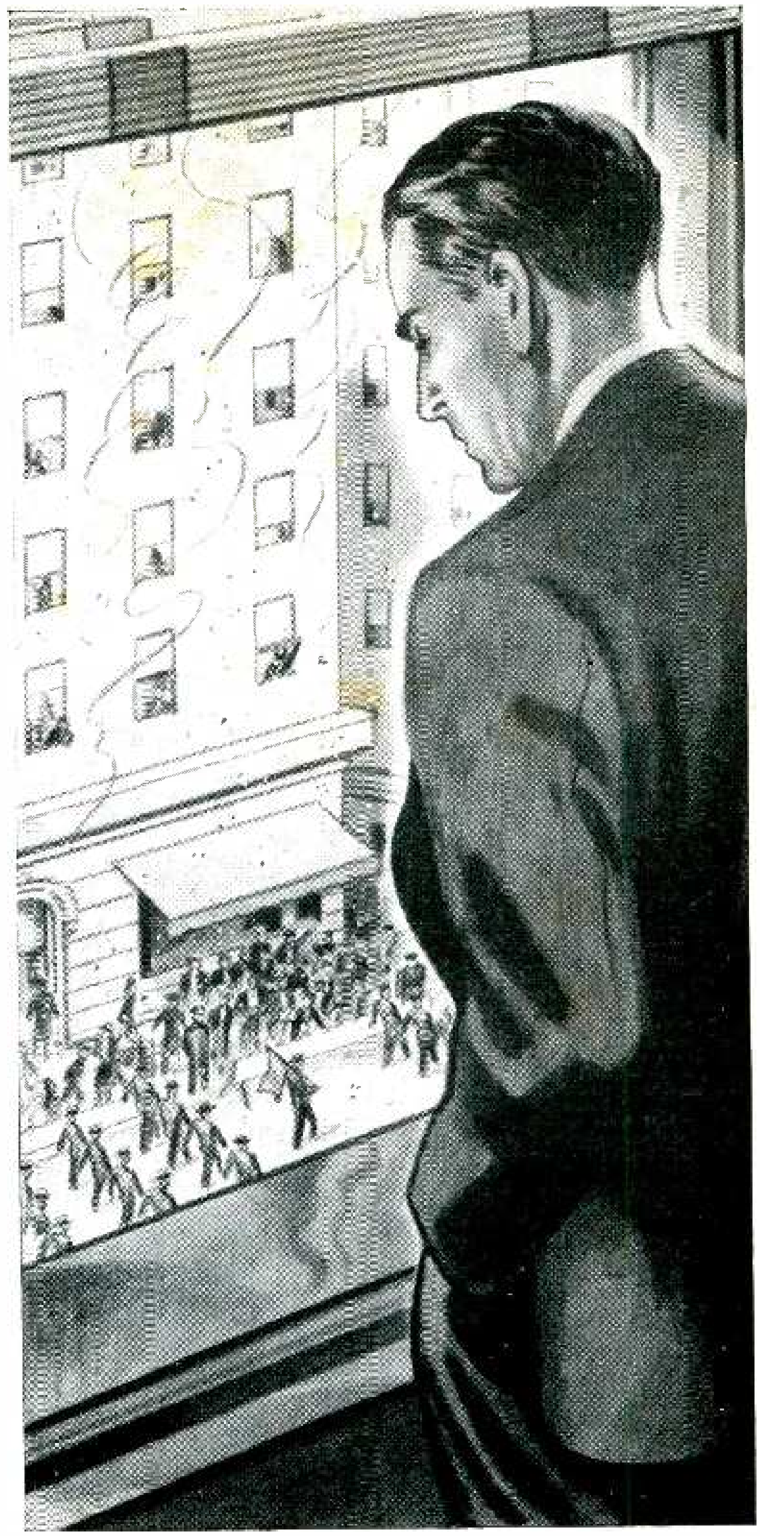
MEMO TO PRESIDENTS WHO WATCHED THE BAND GO BY!

HERE'S ONE parade that isn't "all over but the shouting" after the band has passed. It's the Payroll Savings Plan for the regular purchase of U.S. Security Bonds by employees.

Though the formal spring campaign to sell Bonds is over, any company can still move forward with the parade. Right now thousands of companies are putting *additional push* behind their Payroll Savings Plans. Managements of many companies that have not yet participated are *now installing* the Plan.

It's a "look-ahead" plan, that benefits employee, company, and nation. Every $3 invested in Bonds pay $4 at maturity. Personnel records in the plants with active P.S.P. programs show improved employee attitudes—evidenced by less absenteeism and fewer accidents—as the individual's sense of security grows with Bond purchases. And every Security Bond dollar built up in the Treasury retires a dollar of the national debt that is potentially inflationary. It means less bidding-up of prices. Moreover, Bond buyers are better citizens because they have a tangible stake in the nation's future.

It's just as easy to take action now as when the campaign was at its height. Just call your Treasury Department's State Director, Savings Bonds Division, and ask for the material that helps to get a Payroll Plan started or to keep it rolling.



The Treasury Department acknowledges with appreciation the publication of this message by

ELECTRONICS

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INDEX TO ADVERTISERS

PRECISION IN PRODUCTION

Many people realize and take advantage of the fact that "the tough ones go to UTC." Many of these "tough ones," while requiring laboratory precision, are actually production in quantity. To take care of such special requirements, the UTC Laboratories have a special section which develops and produces production test equipment of laboratory accuracy. The few illustrations below indicate some of these tests as applied to a group of units used by one of our customers in one production item of equipment:

The component being checked here is a dual saturable reactor where the test and adjusting conditions necessitate uniformity of the complete *slope* of the saturation curve. The precision of this equipment permits measuring five widely separated points on the saturation curve with saturating DC controllable to .5% and inductance to .5%.

Servomechanisms and similar apparatus depend, to a considerable degree, on phase angle operation. The transformer adjusted in this operation requires an accuracy of .05 degrees phase angle calibration under the resonant condition of application. With wide change in voltage and temperature range from −40 to +85 degrees C., the phase angle deviation cannot exceed .2 degree. To effect this type of stability, specific temperature cycling and aging methods have been developed so that permanent stability is effected.

This test position involves two practical problems in a precision inductor. The unit shown is adjusted to an inductance accuracy of .3%, with precise (high) Q limits. It is then oriented in its case, using a test setup which simulates the actual final equipment so that minimum inductive coupling will result when installed in the final equipment.

The hermetic sealing of transformers involves considerable precision in manufacturing processes and materials. To assure consistent performance, continuous sampling of production is run through fully automatic temperature and humidity cycling apparatus. It is this type of continual production check that brings the bulk of hermetic sealed transformers to UTC.

United Transformer Co.

150 VARICK STREET NEW YORK 13, N. Y.

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The world's most modern tube plant . . .

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by automatic mass production at RCA, Lancaster

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Today this highly automatic equipment—unique in the tube manufacturing industry—is turning out *better* 10-inch kinescopes at the unprecedented rate of more than one a minute!

Now, in anticipation of television's continued growth, RCA is embarked on a million-dollar expansion program at Lancaster that will *double* present kinescope output . . . another step in RCA's continued leadership in the development and manufacture of high quality tubes at low cost.

THE FOUNTAINHEAD OF MODERN TUBE DEVELOPMENT IS RCA

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TUBE DEPARTMENT

RADIO CORPORATION of AMERICA

HARRISON, N. J.