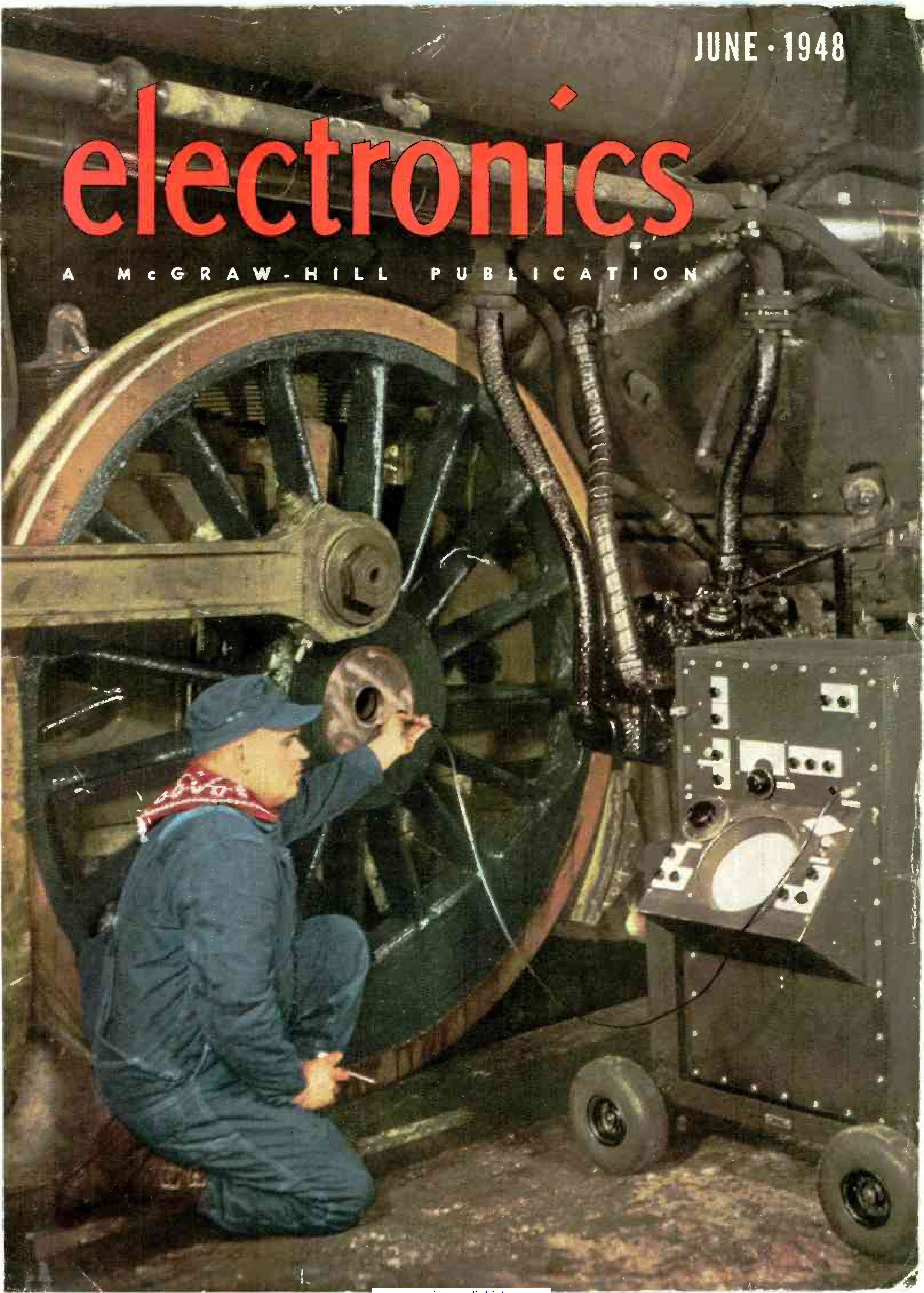
JUNE · 1948

electronics

A McGRAW-HILL PUBLICATION



for High Q Inductors...

For Maximum Stability . . .
Permalloy Dust Toroids

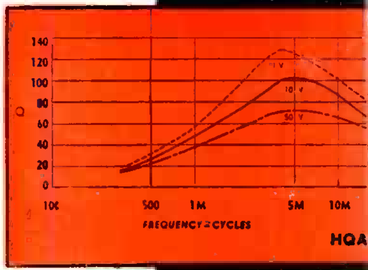
The UTC type HQ permalloy dust toroids are ideal for all audio, carrier and supersonic applications. HQA coils have Q over 100 at 5,000 cycles . . . HQB coils Q over 200 at 4,000 cycles . . . HQC coils Q over 200 at 30KC . . . HQD coils Q over 200 at 60 KC. The toroid dust core provides very low hum pickup . . . excellent stability with voltage change . . . negligible inductance change with temperature, etc. Precision adjusted to 1% tolerance.

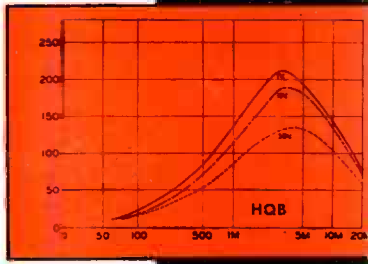
Inductance Value	Type No.	Net Price	Inductance Value	Type No.	Net Price
5 mhy.	HQA-1	$7.00	70 mhy.	HQB-3	$16.00
12.5 mhy.	HQA-2	7.00	120 mhy.	HQB-4	17.00
20 mhy.	HQA-3	7.50	.5 hy.	HQB-5	17.00
30 mhy.	HQA-4	7.50	1 hy.	HQB-6	18.00
50 mhy.	HQA-5	8.00	2 hy.	HQB-7	19.00
80 mhy.	HQA-6	8.00	3.5 hy.	HQB-8	20.00
125 mhy.	HQA-7	9.00	7.5 hy.	HQB-9	21.00
200 mhy.	HQA-8	9.00	12 hy.	HQB-10	22.00
300 mhy.	HQA-9	10.00	18 hy.	HQB-11	23.00
.5 hy.	HQA-10	10.00	25 hy.	HQB-12	24.00
.75 hy.	HQA-11	10.00	1 mhy.	HQC-1	13.00
1.25 hy.	HQA-12	11.00	2.5 mhy.	HQC-2	13.00
2 hy.	HQA-13	11.00	5 mhy.	HQC-3	13.00
3 hy.	HQA-14	13.00	10 mhy.	HQC-4	13.00
5 hy.	HQA-15	14.00	20 mhy.	HQC-5	13.00
7.5 hy.	HQA-16	15.00	.4 mhy.	HQD-1	15.00
10 hy.	HQA-17	16.00	1 mhy.	HQD-2	15.00
15 hy.	HQA-18	17.00	2.5 mhy.	HQD-3	15.00
10 mhy.	HQB-1	16.00	5 mhy.	HQD-4	15.00
30 mhy.	HQB-2	16.00	15 mhy.	HQD-5	15.00

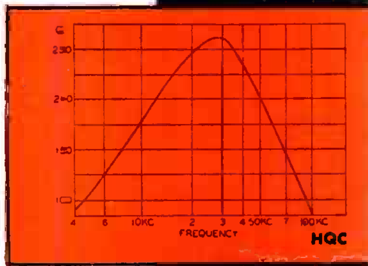
HQA, C, D
$1\frac{13}{16}$" Dia. x $1\frac{3}{16}$" High.

HQB
$2\frac{5}{8}$" L. x $1\frac{5}{8}$" W. x $2\frac{1}{2}$" H.

UNCASED TOROIDS
(Deduct $1.50 for uncased units)





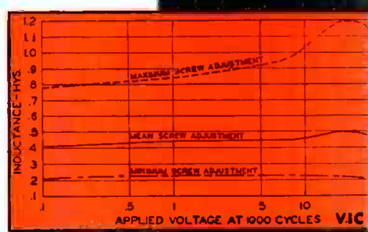


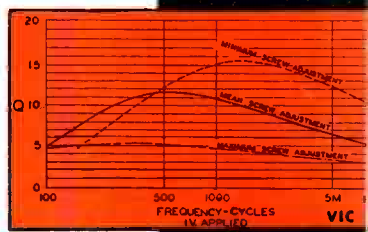
For Maximum Flexibility . . .
The VIC Variable Inductor

The set screw on VIC units permits positive adjustment of inductance to plus 90% minus 50% from rated value. Revolutionary approach for tuned audio circuits. Q and L vs. screw adjustment for a typical coil are illustrated.

Type	Mean Hys.	List Price	Type	Mean Hys.	List Price
VIC-1	.0085	$11.00	VIC-11	.85	$14.00
VIC-2	.013	11.00	VIC-12	1.3	14.00
VIC-3	.021	11.00	VIC-13	2.2	14.00
VIC-4	.034	11.00	VIC-14	3.4	14.00
VIC-5	.053	11.00	VIC-15	5.4	16.50
VIC-6	.084	11.00	VIC-16	8.5	16.50
VIC-7	.13	14.00	VIC-17	13	16.50
VIC-8	.21	14.00	VIC-18	21	16.50
VIC-9	.34	14.00	VIC-19	33	16.50
VIC-10	.54	14.00	VIC-20	52	16.50
			VIC-21	83	17.50

$1\frac{3}{8}$" L. x $1\frac{1}{4}$" W. x $1\frac{1}{2}$" H.





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JUNE • 1948

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Every demand was made by the National Company that components used in this brilliant, new receiver be consistent with their established reputation for building fine communications receivers.

The Marion Electrical Instrument Company designed a special S-Meter for the NC-183 to answer National's demand for quality . . . radio operators' demand for an accurate, dependable means of measuring and logging signals being received.

This "special" has an unbreakable plexiglass, anti-static coated window and Marion engineered dial illumination that eliminates the two principal drawbacks of conventional dial lighting . . .

A transparent lucite cavity for the bulb *seals* the delicate mechanism from dust drawn in by thermal currents and *prevents* insertion of oversized replacement bulbs which often damage the meter movement.

In addition, this "S-Meter" incorporates a special zero set in the *back*, in addition to a dust seal and other features available in all Marion Standard Electrical Indicating Instruments.

Let Marion give your product salient *selling points* . . . through "special" instruments, tailored to fit the job . . . consistent with your policy of *quality*.

THE NAME "MARION" MEANS THE "MOST" IN METERS

Write for complete information.

Also a complete line of standard electrical indicating instruments.

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Challenge "Eighty" papers are printed and washed in the same way and on the same equipment as other blueprint papers. They are available in an assortment of speeds to meet your requirements.

For 80 years, K & E instruments and materials have helped engineers and draftsmen attain precision and clarity in the designs they create. We believe that you will welcome this new "partner in creating" that insures smooth production in the blueprint room and uniformly superior prints.

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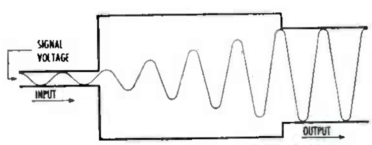
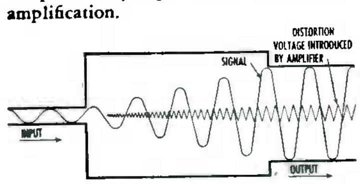
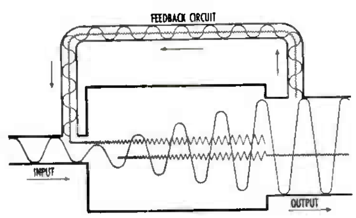
How stabilized feedback reduces amplifier distortion... keeps gain constant



(A) IDEAL AMPLIFIER existing only in theory. Output exactly duplicates input, except for amplification.



(B) AMPLIFIER WITHOUT FEEDBACK. Signal suffers distortion, shown as separate a-c voltage accompanying output signal.



(C) AMPLIFIER WITH STABILIZED FEEDBACK. Sample voltage, containing signal and distortion in same ratio as in output, is fed back in opposing phase to input. Distortion portion is amplified in opposition to distortion arising in amplifier.

LIKE many other major advances in electronics, the development of stabilized (negative) feedback was a direct outgrowth of telephone progress. To produce telephone repeaters with the necessary gain stability and low distortion, H. S. Black, of Bell Telephone Laboratories, took a sample voltage of the amplifier output and fed it back into the amplifier in *opposing* phase. Before-and-after effects are shown in simplified form in the accompanying figures.

How Feedback Reduces Distortion

Signal portion of feedback subtracts from input signal. (In practice, input receives additional amplification to maintain original output voltage.)

Distortion portion, encountering no opposing voltage in input, is amplified in opposition to distortion voltage arising in amplifier. Hence distortion voltage largely cancels itself out — output corresponds closely to input. Noise originating in the amplifier is reduced in a similar way.

How Feedback Stabilizes Gain

The relations of input, output and gain can be shown as follows:

Voltage Gain without Feedback	Total Input	Feedback Voltage (negative)	Net Input (less feedback)	Output	Overall Gain
1000	10.1	10	.1	100	9.9
500	10.2	10	.2	100	9.8

As shown, the gain of the amplifier stages incorporating feedback can drop 50 percent, with a drop in *overall* gain of only 1 percent. Hence *gain remains virtually constant*, regardless of changes in power supply or performance of components.

Users of all line and power amplifiers and all AM transmitters designed by Bell Laboratories and made by Western Electric benefit by these outstanding advantages of stabilized feedback: greatly reduced distortion and noise, virtually constant gain.

BELL TELEPHONE & TELEGRAPH CO. BELL SYSTEM AMERICAN AND ASSOCIATED COMPANIES

BELL TELEPHONE LABORATORIES

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

You get feedback at its finest . . . in Western Electric equipment

WHILE stabilized feedback is now accepted as an indispensable technique in the communications art, *actual design* of a stabilized-feedback amplifier calls for painstaking mathematical analysis and control of phase and gain characteristics over a wide frequency spectrum. *Without such control, feedback may introduce new faults more objectionable than those eliminated.* The extensive experience of Bell Laboratories engineers gives to the users of Western Electric equipment assurance that the outstanding advantages of feedback will actually be realized.

Assurance of Quality Performance

As used in all Western Electric Audio Amplifiers (except one-tube pre-amplifiers) properly applied stabilized feedback insures flatter gain-frequency characteristic and automatic suppression of noise and distortion arising from sources within the amplifier. In new loudspeaker amplifiers (which include the output coil within the feedback loop), output impedance is so low that matching to multiple loudspeakers is as simple as adding lamps to a lighting circuit.

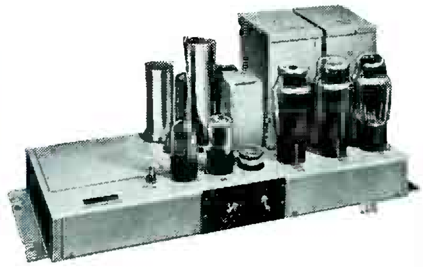
Flat Frequency Response

Flat frequency response is maintained in Western Electric AM Transmitters by stabilized feedback actuated by the final radio frequency output. Hence attenuation of high modulating frequencies is virtually eliminated. No hum suppression circuits are needed, because of reduction of noise and distortion from all sources, including final amplifiers.

Stabilized feedback, correctly applied, is just one of the factors in the outstanding performance of Western Electric Amplifiers and AM Transmitters. For *full* information on all operating features, call your local Graybar Broadcast Representative, or write Graybar Electric Company, 420 Lexington Avenue, New York 17, N. Y.

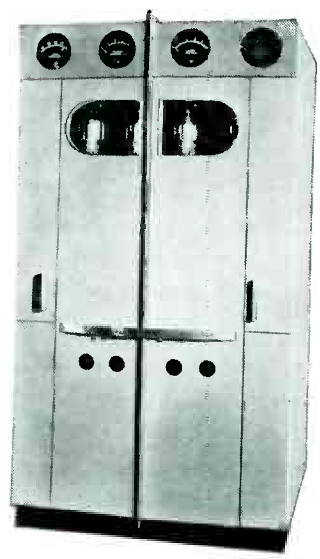
Correctly applied feedback gives you these advantages

IN AMPLIFIERS



Feedback *as you want it* keeps gain virtually constant in Western Electric Audio Amplifiers — cuts noise and distortion down to a minimum.

IN AM TRANSMITTERS



Feedback designed by Bell Laboratories does away with need for hum suppression circuits — maintains flat frequency response.

—QUALITY COUNTS—

Western Electric

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

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

GENERAL ELECTRIC FM TUNER

Engineers rave about it! Musicians acclaim it!

FM reception reaches a new high in fidelity when this new Model XFM-1 is used in conjunction with any radio receiver or amplifier designed for phono operation.

The r-f stage of this translator is unusual in a number of respects. Variable inductance tuning is employed instead of using a conventional tuning capacitor. This design has two distinct advantages. It provides a highly efficient circuit in our range (88 to 108 mc) which would not be possible with the more conventional methods of tuning and provides drift-free frequency stability.

While they last Harvey Special Price

$49.50

SPECIFICATIONS *(These specifications prove beyond doubt that this FM tuner excels . . . no other FM tuner on the market can compare.)*

CABINET:
Beautiful hand-rubbed natural walnut, 10¾" high, 11½" deep, 15¾" wide. Tuning dial is slide-rule type, wide open, with frequencies clearly marked.

ELECTRICAL RATING:
Nominal voltage, 110 at 50-60 cycles, 65 watts. Has built-in tapped transformer with selector switch for voltages: 110 (103-117); 125 (117-133); 150 (140-160); 200 (185-213); 225 (213-234); 245 (234-260).

OPERATING FREQUENCIES:
88 mc to 108 mc. 300-ohm input for folded dipole antenna. Also has built-in antenna.

TUBE COMPLEMENT:
R-F amplifier, 6AG5; Oscillator, 6AK5; Converter, 6AK5; 1st I-F amplifier, 6SG7; 2nd I-F amplifier, 6SV7; Limiter, 6SH7; Discriminator and audio amplifier, 6AQ7GT; Rectifier, 5Y3GT/G; Dial light Mazda No. 44.

The chassis has been tropicalized.

The quantity is limited and at Harvey's Special Price they won't last long. Get your order in at once to ensure delivery.

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103 West 43rd St., New York 18, N. Y.

Prices are F.O.B. New York City and are subject to change without notice.

Self Control

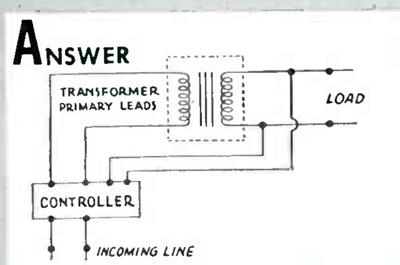
—of AC, DC or RF outputs in any one circuit, selectively stabilized over wide ranges of line and load with the new SORENSEN

ELECTRONIC CONTROLLER

Here's how the CONTROLLER answers typical regulation problems

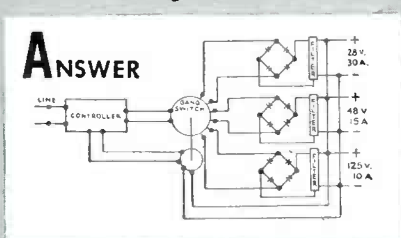
Q. An AC requirement. Can you stabilize the output of a transformer?

ANSWER



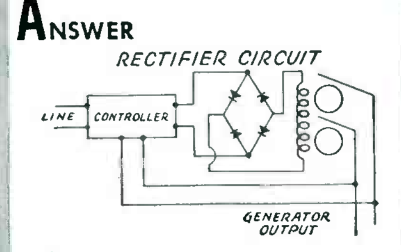
Q. Can you selectively regulate a number of DC voltages and currents?

ANSWER

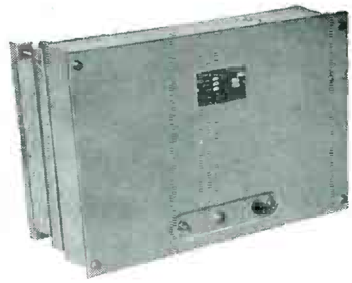


Q. Can the CONTROLLER stabilize a generator field to regulate its output?

ANSWER



The AC output of the CONTROLLER will swing between 85-145 VAC, AUTOMATICALLY adjusting the output of your unit against line and load variations. By referencing this output back to the CONTROLLER you get output regulation.



TECHNICAL SPECIFICATIONS

The controlled circuit must make available at least one watt of power to the CONTROLLER.

Input voltage range:	95-125 volts AC (50 or 60 cycles)
Load range:	200 to 2000 VA
Regulation accuracy:	0.5% at the controlled point

write today for more information on the new CONTROLLER. Arrange to have a Sorensen Engineer analyze voltage regulation requirements in your plant. He can select a Sorensen unit or suggest a special design to fit your unusual application.

Represented in all principal domestic and foreign cities.

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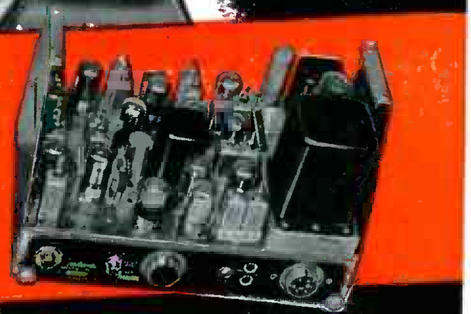
in Power Transformers



Typical Motorola FM two-way radiotelephone receiver utilizing *Sealed in Steel* Chicago Transformers.

With CT's Famous

Sealed in Steel Construction

The clean, streamlined appearance and compactness of CT's new *Sealed in Steel* construction contribute immeasurably to the trim, precision-like effect of any electronic equipment.

In addition, CT Transformers provide "steel wall" protection against atmospheric moisture, efficient magnetic and electro-static shielding, unsurpassed strength and rigidity to withstand shock and vibration, and unusual convenience of mounting.

Two base styles are available for most of the units in this catalog line, one with clearly identified solder lugs in a phenolic terminal board, the other with RMA color coded leads, stripped and tinned for easy soldering.

The design of these new power transformers assures maximum performance with minimum physical size and minimum temperature rise in accordance with RMA standards.

The wide range of carefully selected ratings achieves maximum flexibility of application, close matching with today's preferred types of tubes, and conformance with all industry standards.

Write direct for catalog illustrating, describing and listing the complete line, or contact your nearest radio parts jobber at once.

PLATE AND FILAMENT SUPPLY TRANSFORMERS

Primary 117 Volts, 50-60 Cycles

Catalog Number	HIGH VOLTAGE SECONDARY A.C. Volts	D.C. Ma.	D.C. Volts Output	FILAMENTS Rectifier Volts	Rectifier Amps.	No. 1 Volts	No. 1 Amps.	No. 2 Volts	No. 2 Amps.
For CAPACITOR INPUT SYSTEMS									
PC-55	270-0-270	55	260	5	2	6.3CT	2	......	
PC-70	335-0-335	70	320	5	2	6.3CT	3	......	
PC-85	330-0-330	85	320	5	2	6.3CT	3	......	
PC-105	345-0-345	105	320	5	2	6.3CT	3.5	......	
PC-120	375-0-375	120	380	5	3	6.3CT	4	......	
PC-150	370-0-370	150	390	5	3	6.3CT	4	6.3CT	1
PC-200	385-0-385	200	390	5	3	6.3CT	4.5	6.3CT	1
For REACTOR INPUT SYSTEMS									
PR-55	350-0-350	55	260	5	2	6.3CT	2	......	
PR-70	425-0-425	70	320	5	2	6.3CT	3	......	
PR-85	440-0-440	85	325	5	2	6.3CT	3	......	
PR-105	445-0-445	105	325	5	2	6.3CT	3.5	......	
PR-120	500-0-500	120	400	5	3	6.3CT	4	......	
PR-150	505-0-505	150	400	5	3	6.3CT	4	6.3CT	1
PR-200	520-0-520	200	410	5	3	6.3CT	4.5	6.3CT	1
PR-300	550-370-75-0-75-370-550	300	425	5	6	6.3CT	5	6.3CT	1

Also available in the *Sealed in Steel* constructions:

FILTER REACTORS with current ratings to match power transformers above.

FILAMENT TRANSFORMERS to meet a wide range of modern tube requirements.

AUDIO TRANSFORMERS—Input, Output, Driver, and Modulation—that provide uniformly high fidelity response in three frequency ranges: 30-15,000 cycles, 50-10,000 cycles, and 200-3,500 cycles.

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TUBES ARE KNOWN BY THE COMPANY THEY KEEP

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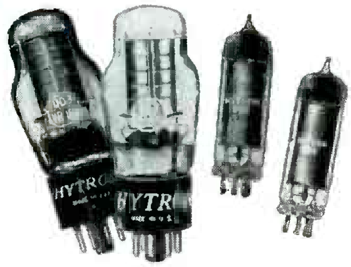

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When leaders automatically order their gaseous voltage-regulator tubes from Hytron, there must be a reason. Companies with top names can afford to select only top quality components. To have sold over 2,500,000, these Hytron OA2, OB2, OC3/VR105, and OD3/VR150 tubes must offer something special. They do! Better performance. Their advanced engineering—rigidly controlled processing and assembly — and tougher-than-JAN factory tests make these apparently simple tubes actually easy to make—better.

Yes, you are in good company if you instinctively associate V-R tubes with Hytron. Army, Navy, Air Force, AEC, famous university research laboratories — as well as industrial leaders — repeatedly order Hytron V-R tubes. Pick either the standard OC3/VR105 and OD3/VR150 or the space-saving OB2 and OA2; you, too, will prefer Hytron. That goes double, if you're "from Missouri." Find out for yourself why so many turn automatically to Hytron.

SPECIALISTS IN RADIO RECEIVING TUBES SINCE 1921

HYTRON

RADIO AND ELECTRONICS CORP.

MAIN OFFICE: SALEM, MASSACHUSETTS

NEW INSTRUMENT-TYPE DATA RECORDERS

New Instruments . . . . COOK Multichannel DATA RECORDING and INTERPRETATION UNITS

These new instruments are capable of recording and reproducing in graphical form, variable or transient data under conditions of severe shock acceleration up to 75 G's. Sectional unit design enables tape recording to be performed in moving vehicles, aircraft, guided missiles, rockets or other mobile units. Tape is then transferred to data interpretation unit and a graphical record obtained directly. Miniature magnetic recorders weighing less than 1½ lbs. or standard complete systems having any number of information channels are available.

Outstanding Features

- **ERROR SOURCES ELIMINATED**
  Conversion of datum to FM signals before transfer to tape eliminates possible sources of error.
- **HIGH ACCURACY**
  Overall data interpretation accuracy is maintained within plus or minus 2 percent.
- **WIDE SIGNAL LEVEL RANGE**
  Responsive to sensing instrument outputs as low as 0.3 volts for D.C. and 12 mv for A.C. High level signals are also usable by proper attenuation.
- **TIME BASE CHANNEL**
  Included in all type designs is a time base channel for speed and error compensation.
- **FLEXIBLE DESIGN**
  Equipment adaptable for use with customer's sensing elements or to conform to special instruments, shapes and installation requirements.

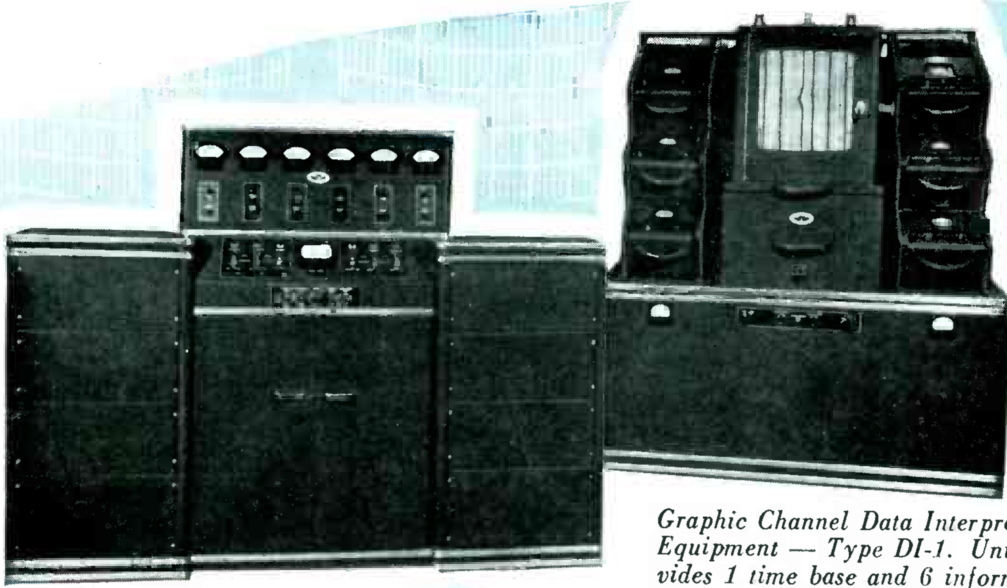
Graphic Channel Data Interpretation Equipment—Type DI-2: showing front compartment doors open for tape loading and adjustment. Unit provides 1 time base and 2 information channels.

Information Channel Magnetic Type Recorder Mechanism — Type MR-2; applicable to flight tests of engine temperatures, accelerations, strains, etc.

Information Channel Miniature Magnetic Tape Recorder Mechanism — Type MR-3; especially suited to guided missile applications.

Standard Information Channel Magnetic Tape Recorder Mechanism — Type MR-6.

PLUS A DATA INTERPRETATION SERVICE

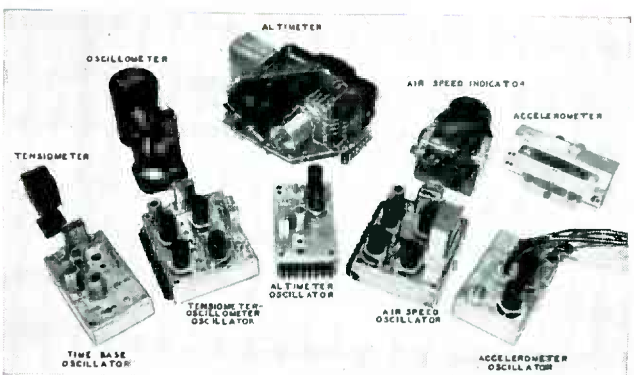


Graphic Channel Data Interpretation Equipment — Type DI-1. Unit provides 1 time base and 6 information channels.

a New Service

Typical phenomena that can be measured and analyzed include:

Pressure Variations	**Velocities**
Temperatures	**Vibrations**
Humidity	**Displacement**
Magnetic Deviations	**Decelerations**
Air Speeds	**Inertia**
Strains	**Surface Roughness**
Accelerations	**Light Intensities**



Typical set of sensing instruments and oscillators for building into the magnetic recorder equipment. Sensing instruments can be designed and manufactured to order or standard elements can be adapted to individual requirements.

Cook Research Laboratories have established a new service and now maintain a trained staff to render complete data recording and analytical services. This includes the making of permanent graphic recordings of virtually any measurement that can be made in the form of electrical impulses, over a frequency range from D.C. to 100cps. In addition, a complete mathematical analysis of the data can be made by means of:

COMPUTING MECHANISMS
AVERAGES
INTEGRATIONS
DIFFERENTIATIONS
STATISTICAL ANALYSIS

The effect on savings in man hours and increased efficiencies is obvious.

Detailed information on Cook Research data recording equipment and data interpretation service is available upon request. Please phone or write on company letterhead for Bulletin No. MR-B1.

COOK RESEARCH Laboratories

A DIVISION OF COOK ELECTRIC COMPANY
1457 Diversey Parkway Chicago 14, Illinois
Telephone: EAStgate 2424

WHAT MAKES A GOOD RECORDING BLANK GOOD* ?

STANDARDIZATION CONTROLS

Aware from the outset that the commonest disc recording complaint has always been variations from batch to batch, Soundcraft engineers determined to build disc manufacturing equipment that would not be at the mercy of such conventional ills as impurities in lacquer, inaccuracies in raw material handling, and inadequate control of the critical drying air.

To this end Soundcraft has spared no expense to safeguard the precision of each step of its disc manufacturing processes. Electronic pre-testing of lacquer batches . . . mechanical re-working of new aluminum bases . . . viscosimeter control of lacquer consistency . . . synchronous motor-control of conveyor speed . . . micrometer adjustment of coating thickness . . . automatic removal of even microscopic foreign matter in lacquer . . . electrostatic elimination of minute dust in drying air . . . automatic humidistat and thermostat control of weather-making equipment to assure constant fume absorption of drying air . . . continuous velometer test of air flow . . . all these and dozens of other double checks and inspections have made possible Soundcraft's widespread reputation as "the most consistent disc".

**Watch this space for succeeding ads in this informative series on how Soundcraft discs are made.*

No. 6 of a series

When the utmost in recording quality is needed, ask for the 'Broadcaster', a master-disc selection in instantaneous sizes at an "extra-fare" price.

•

For work-a-day broadcast-quality recordings, the Soundcraft 'Playback' offers superior cutting properties in competition with other "best-grade" blanks.

•

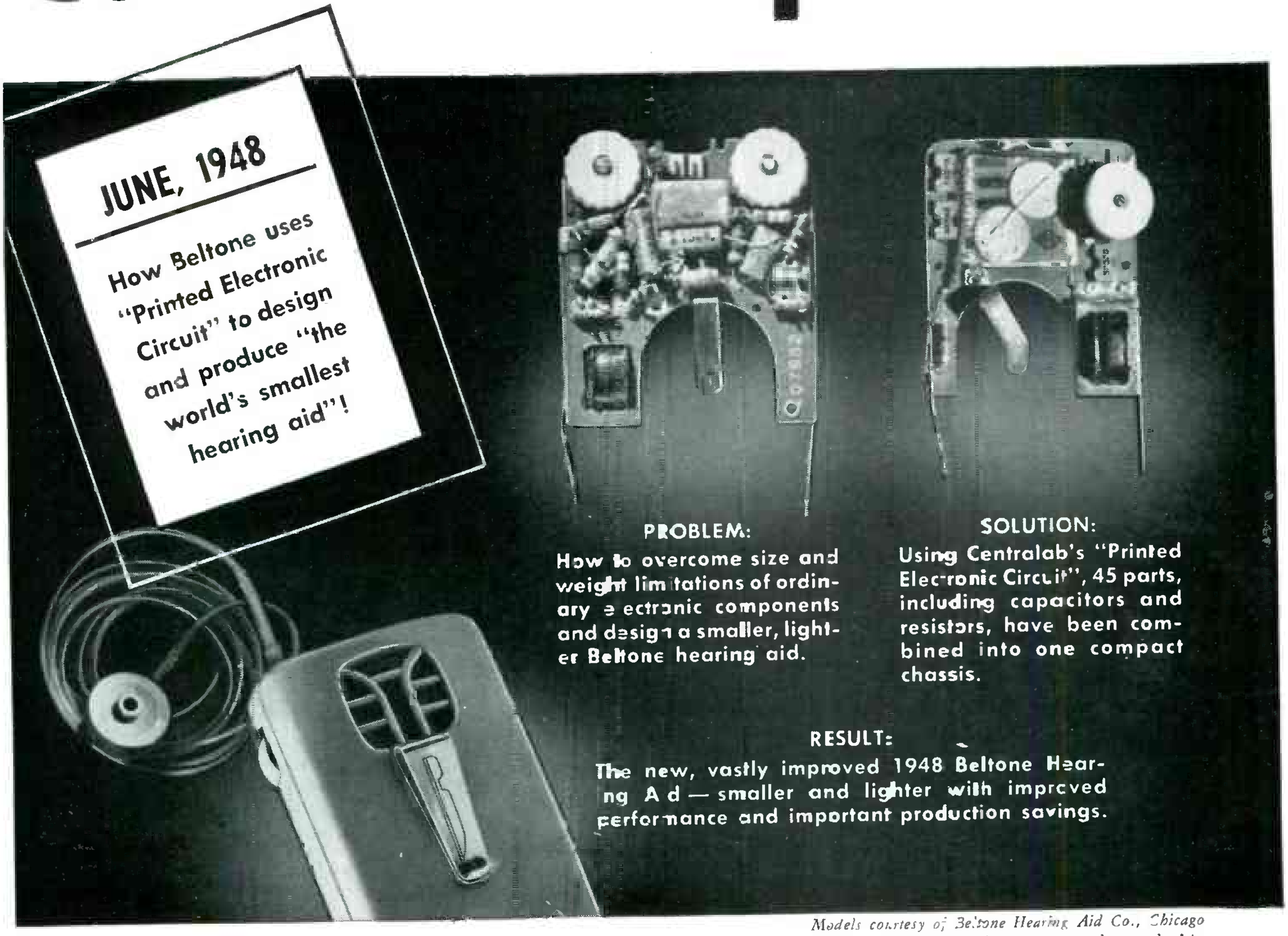
Soundcraft discs are sold by over 250 radio parts distributors in principle U. S. cities. Foreign sales by Reeves International, Inc., 10 East 52nd St., New York 22, N. Y. Cable REEVINTER.

REEVES Soundcraft CORP.

10 EAST 52nd STREET • NEW YORK 22, N. Y.

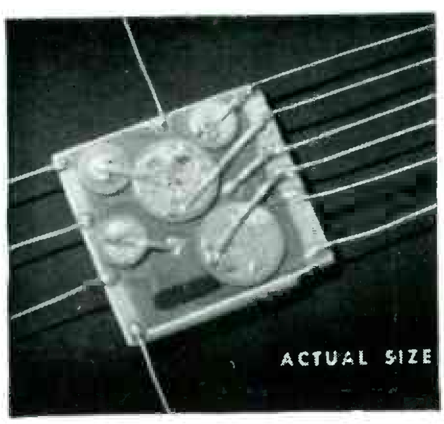
The 'Broadcaster' The 'Playback' The 'Audition' The 'Maestro'

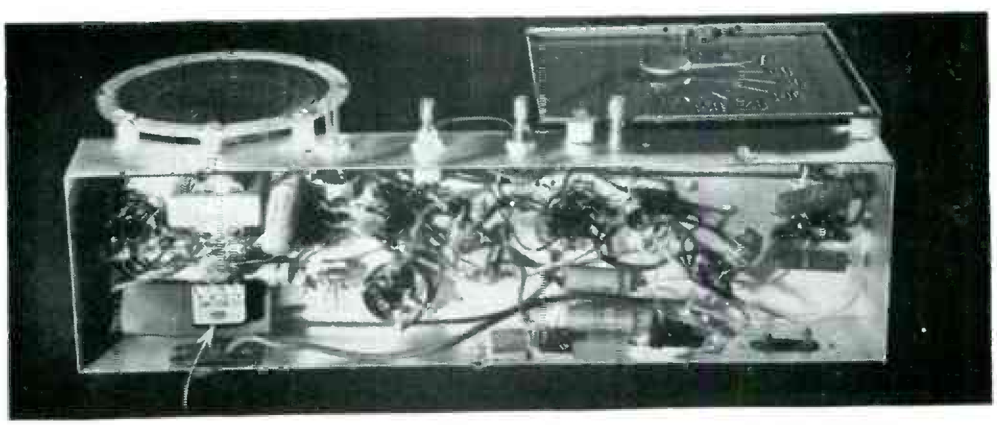
Centralab reports to



Models courtesy of Beltone Hearing Aid Co., Chicago

1 Where miniature size is of the utmost importance, nothing else combines ruggedness, dependability, and resistance to humidity and moisture in such a small unit package. That's what Beltone engineers say about Centralab's *Printed Electronic Circuit* and that's what you will say when you have seen and tested this amazing new electronic development. Working with your engineers, Centralab may be able to fit its *Printed Electronic Circuit* to your specific needs. Write us today for further information.

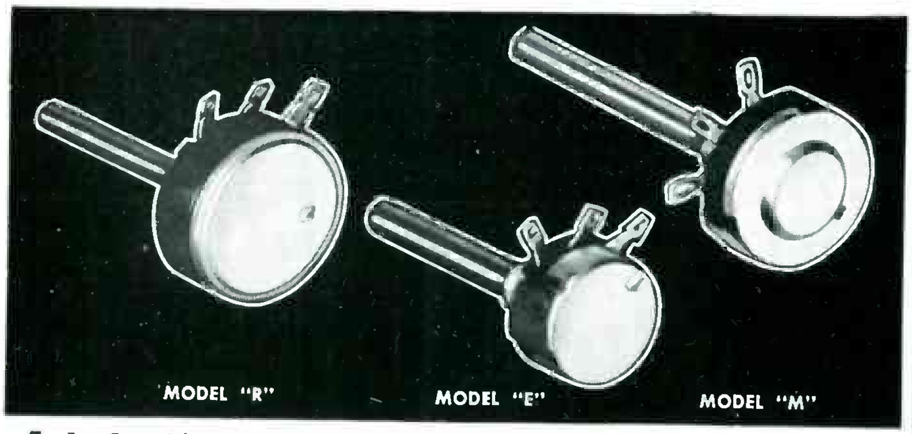




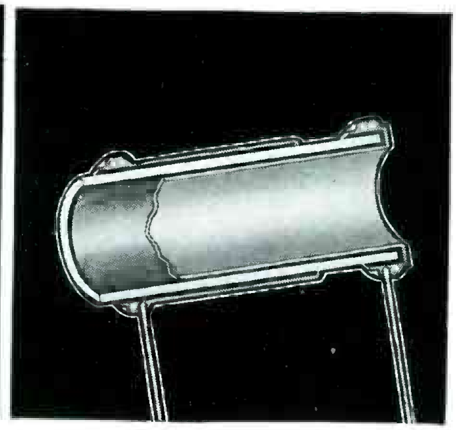
2 Rear view of Beltone-CRL unit shows integral construction — ceramic disc capacitors, "printed" silver leads and resistors (black paths).

3 Engineers of Sonora Radio and Television Corp., Chicago, use CRL's *Couplate* ("printed" interstage coupling plate) to improve manufacturing, reduce servicing. *Couplate's* long life, high efficiency, mechanical strength and resistance to humidity mean more dependable performance, simplified production for Sonora Radios.

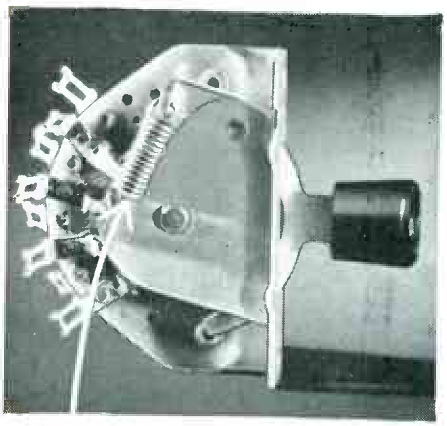
Electronic Industry



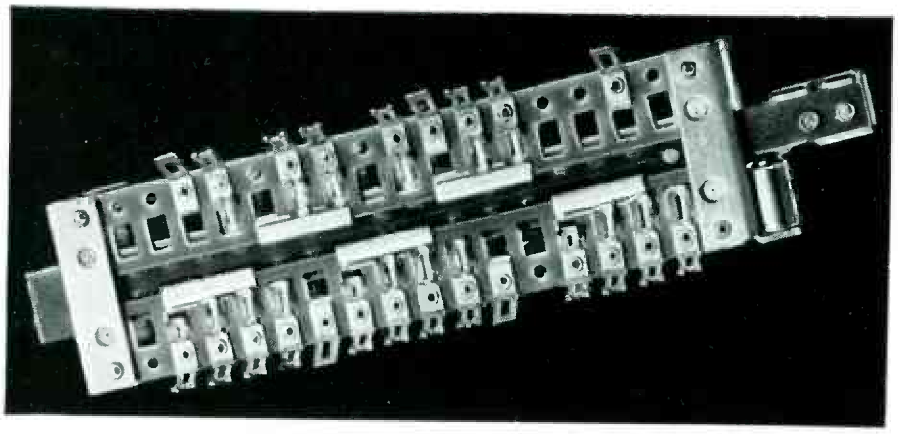
4 Let Centralab's complete Radiohm line take care of your special needs. Wide range of variations: *Model "R"* — wire wound, 3 watts; or composition type, 1 watt. *Model "E"* — composition type, ¼ watt. Direct contact, 6 resistance tapers. *Model "M"*—composition type, ½ watt. For complete information, write for Bulletin 697.



5 For quality and dependability, more and more manufacturers are switching to Centralab's line of ceramic capacitors. Order Bulletin 933.



6 In its new *Lever Switch,* Centralab guarantees a minimum life of 50,000 cycles. Reason: an exclusive, new coil spring index. Write for Bulletin 970.



7 Centralab's development of a revolutionary, new *Slide Switch* promises improved AM and FM performance! Flat, horizontal design saves valuable space, allows short leads, convenient location to coils, reduced lead inductances for increased efficiency in low and high frequencies. Rugged, efficient. Write for Bulletin 953.

LOOK TO CENTRALAB IN 1948! ***First in component research that means lower costs for the electronic industry. If you're planning new equipment, let Centralab's sales and engineering service work with you. Get in touch with Centralab!***

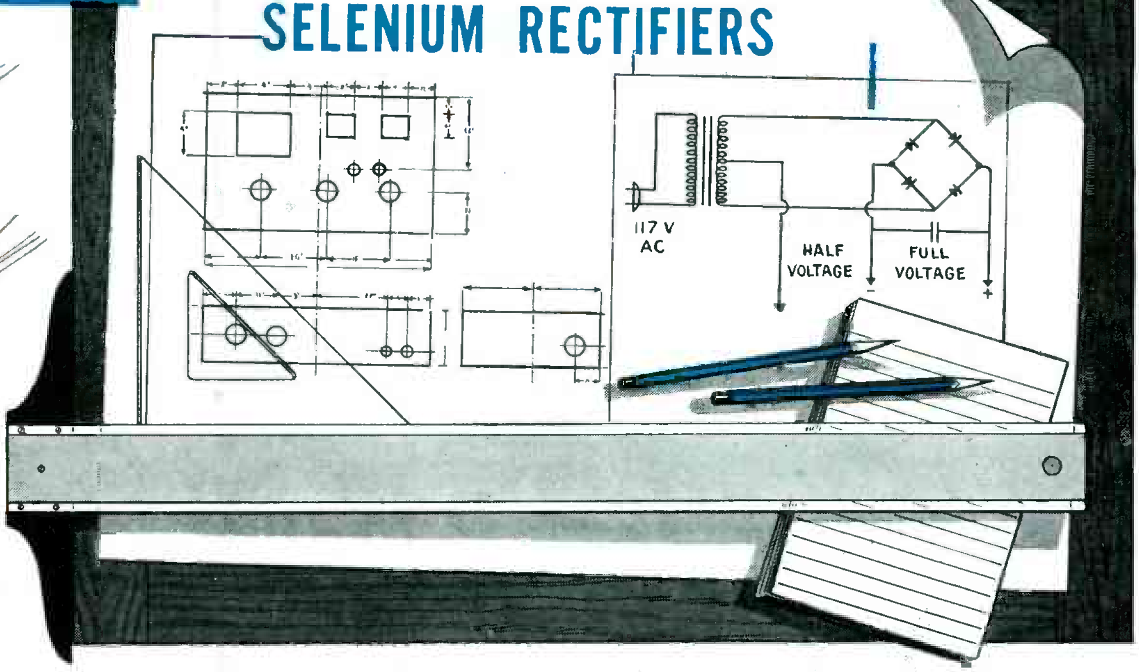
Centralab

CRL

DIVISION OF GLOBE-UNION INC., MILWAUKEE, WIS.

Federal

The FIRST NAME in SELENIUM RECTIFIERS



Gives you BETTER PRODUCT DESIGN

Electrically, Mechanically, and Thermally

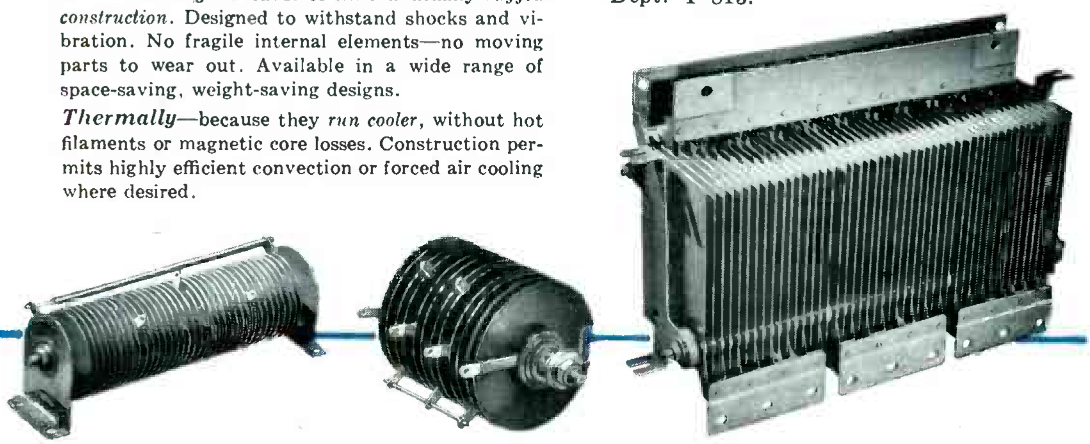
Wherever your product calls for conversion of A-C to D-C, Federal Selenium Rectifiers can simplify your design problems *three ways:*

Electrically—because of their inherent *high efficiency* and lasting characteristics. No power-consuming filaments—less wattage loss—and no time lag. D-C output is delivered instantly on application of A-C potential.

Mechanically—because of their unusually *rugged construction*. Designed to withstand shocks and vibration. No fragile internal elements—no moving parts to wear out. Available in a wide range of space-saving, weight-saving designs.

Thermally—because they *run cooler*, without hot filaments or magnetic core losses. Construction permits highly efficient convection or forced air cooling where desired.

Whatever your power conversion requirements, from milliwatts to kilowatts, there's a Federal Selenium Rectifier that will fit into your plans. And *every* Federal Selenium Rectifier is backed by the research, engineering and production skill of America's oldest and largest manufacturer of selenium rectifiers. Write Federal today for information on *your* rectifier requirements. Dept. F-813.



Federal Telephone and Radio Corporation

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.

SELENIUM and INTELIN DIVISION, 900 Passaic Ave., East Newark, New Jersey

In Canada:—Federal Electric Manufacturing Company, Ltd., Montreal, P. Q.
Export Distributors:—International Standard Electric Corp. 67 Broad St., N. Y.

Steatite SEALEX

the GUARANTEED hermetic seal!

BUSHINGS

Pressure tested, shockproof Sealed Leads and Multiple Headers

Whether your terminal problem involves vibration, temperature, hermetic sealing or ordinary lead termination, GENERAL CERAMICS Steatite Sealex Bushings and Multiple Headers offer important advantages that reduce assembly costs and improve product quality. Mounting as a single unit, they can be quickly soldered, welded or sweated to the equipment enclosure and provide perfect termination for one or as many leads as required.

GENERAL CERAMICS Sealex Bushings and Multiple Headers are available in many standard sizes and types suitable for most applications. Special types can be supplied on short notice. Hermetic sealing is absolute and each unit is individually pressure tested at 50 psi; all metal parts are hot-tinned for fast soldering. Sealex Bushings are available in sizes from 0.5 to 20 amps with flash-over ratings to 40 Kilovolts. Steatite — the insulation used in these products — has a low loss factor of only 0.7% at 1000 K.C., which recommends the use of these terminals at practically any frequency.

WRITE TODAY FOR CATALOG!

GENERAL CERAMICS engineers will gladly assist in applying Steatite Sealex terminals to your equipment, or will collaborate in developing special types for unusual conditions. An informative, fully illustrated catalog covering all General Ceramic insulators, is available free upon request on company letterhead. Write for your copy today!

GENERAL CERAMICS AND STEATITE CORPORATION — STEATITE INSULATORS

General CERAMICS and STEATITE CORP.

GENERAL OFFICES and PLANT: KEASBEY, NEW JERSEY

MAKERS OF STEATITE, TITANATES, ZIRCON PORCELAIN, ALUMINA, LIGHT-DUTY REFRACTORIES, CHEMICAL STONEWARE

Entirely New! Completely Service-Tested!

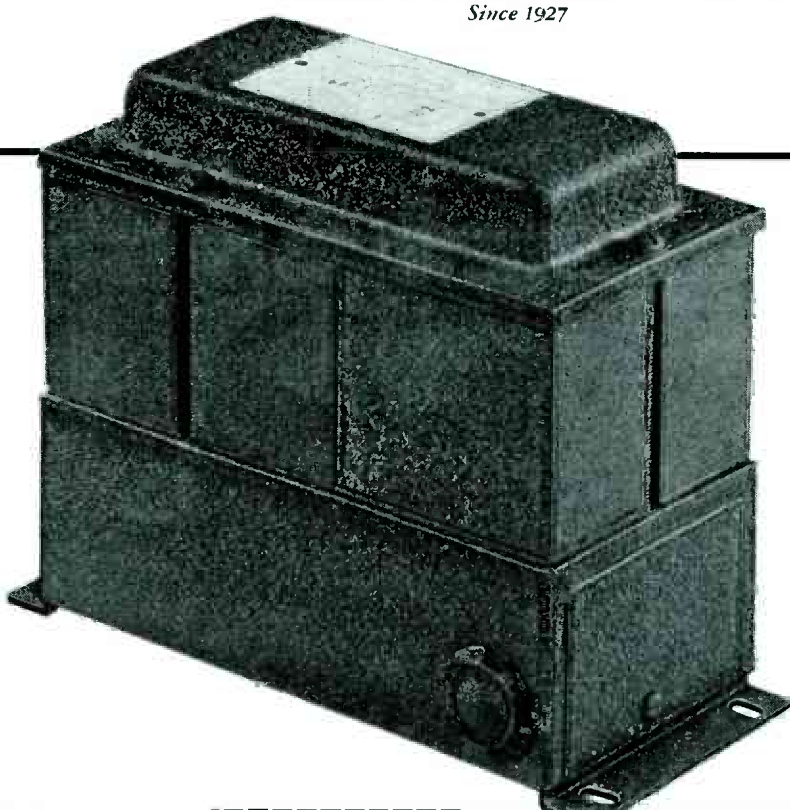
RAYTHEON Voltage Stabilizers

An Outstanding New Line of High Performance, Space and Weight Saving Models that Make It Easy to Build Enduring Accuracy Into Your Product.

The new Raytheon voltage stabilizers enable you to build voltage stability right into your electrical or electronic equipment. They come to you in neat, compact, easy-to-install packages—ruggedly built and performance-engineered for lifetime satisfaction. Choose *your* models from a wide range of standard catalog types . . . or have them custom-engineered to suit your special needs. In either case, count on Raytheon experience and skill to provide the electrical characteristics you want in the most convenient, compact and economical unit.

RAYTHEON

VOLTAGE STABILIZER HEADQUARTERS
Since 1927



Build these Advantages Into Your Equipment

- Control of output voltage to within ±½%.
- Stabilization at any load within rated capacity.
- Many designs with very low harmonic distortion of the output voltage wave *at any load.*
- Quick response. Stabilizes varying input voltage within 1/20 second.
- Entirely automatic. No adjustments. No moving parts. No maintenance.
- Wide range of designs including hermetically sealed types.

Now on the press . . . complete information

A new bulletin covering applications, performance features, operating characteristics, graphs, specifications, etc., for the entire new line of Raytheon Voltage Stabilizers.

SEND FOR IT TODAY

RAYTHEON MANUFACTURING COMPANY
Waltham 54, Massachusetts

Gentlemen: Please send me copy of your new Voltage Stabilizer Bulletin DL-V-304-A.

Name____________________

Position____________________

Company____________________

Street Address__________ Zone No.______

City__________ State______

For keeping video operations under control— from modest start to mighty operations...

DU MONT MASTER CONTROL *Equipment*

FUNCTIONS...

1. Generation of synchronizing signals conforming to RMA recommendations.
2. Distribution of sync signals.
3. Push-button selection of program sources for use by the transmitter ("on-the-air" signal).
4. Monitoring and distribution of the "on-the-air" picture signal.
5. Push-button selection of program sources next to be used as "on-the-air" signal (preview signal).
6. Monitoring and distribution of preview picture signal.
7. Monitoring of "on-the-air" and preview signal waveforms.
8. Stabilization of picture and sync signals from remote program sources.
9. Test monitoring of master control signals for maintenance purposes.
10. Exclusive Du Mont "fully automatic" lap dissolve and fade control—the standard of all Du Mont control equipment.

Split-second timing—smooth-flowing program continuity—that's the assurance the Du Mont Master Control Line offers television broadcasters.

Multiple-studio live programs, network participation, local remote pickups, films and rehearsals, are selected and integrated at will. The Du Mont Master Control Line consists of groups of integrated equipment capable of performing any desired function of television broadcasting in the professional manner long associated with sound broadcasting.

The number of functions incorporated in any one master control "package" depends on the complexity of the telecasting station. Five basic Du Mont master control "packages" meet the requirements of the smallest to the largest telecasting station. In typical Du Mont manner, you can start as small as you like and grow as large as you like, with Du Mont equipment.

DESCRIPTIVE LITERATURE ON REQUEST

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.

Presenting

DURANITE

THE SUPERIOR CAPACITOR

In several sizes. This size 1½" long by ½" diameter.

• Aerovox proudly presents a basically new capacitor designed and produced to meet today's more critical requirements.

Duranite capacitors are not to be confused with conventional molded tubulars encased in usual materials. Duranite capacitors are *entirely new*—Aerolene, the *new* impregnant; the *new* processing methods; the *new* Duranite casing—all adding up to an *entirely new* concept in the capacitor art.

Note some of Duranite's extraordinary features herewith presented! Make comparative tests! You be the judge!

• ***Literature on request. Samples available to manufacturers. Let us quote on your needs.***

TYPICAL DURANITE FEATURES . . .

- Toughest capacitors ever offered critical manufacturers and users of radio-electronic equipment.
- Positive insurance against troublesome and costly failures in the field.
- Permanent, non-varying, rock-hard casing. Smooth, clean surface. Drop them; bang them; scratch them—no damage.
- Pigtail leads firmly imbedded. Won't pull out or work loose. Wire breaks before it can be loosened.
- Really moisture-proof. Thoroughly and permanently sealed.
- Withstand high operating temperatures—no wax ends to melt. Operation from sub-zero to over 212° F. without damage.
- Temperature coefficient of capacitance comparable to wax and oil capacitors.
- Aerolene impregnant eliminates necessity of stocking and using both wax and oil capacitors. One impregnant does work of both. Results in lower inventories and manufacturing costs.
- No deterioration in stock. May be stored in advance of actual use with corresponding economy and convenience.
- Duranite does not dry out. Does not develop cracks or fissures. Stays tightly sealed.
- Smaller dimensions than usual paper tubulars.
- Standard marking; color-coding—capacitance, tolerance, voltage.

AEROVOX capacitors

FOR RADIO-ELECTRONIC AND INDUSTRIAL APPLICATIONS

AEROVOX CORPORATION, NEW BEDFORD, MASS., U. S. A.

SALES OFFICES IN ALL PRINCIPAL CITIES • Export: 13 E. 40th ST., NEW YORK 16, N. Y.

Cable: 'ARLAB' • In Canada: AEROVOX CANADA LTD., HAMILTON, ONT.

GLOBAR TYPE "CX" RESISTORS

Solving Many Resistance Problems

Excellent voltage and temperature characteristics are provided by GLOBAR Type CX Resistors. These characteristics make them especially suited for many applications including Dummy Antenna . . . Rhombic Antenna Termination . . . Parasitic current suppression . . . Voltage dropping devices . . . Induction and R. F. Heating.

An extremely small voltage and temperature coefficient together with an ability to carry loads up to 3 watts per square inch of radiating area puts these resistors in a class by themselves. When equipped with special terminals, they can be loaded to 10 watts per square inch. For immediate attention to inquiries write Dept. V-68. The Carborundum Company, GLOBAR Division, Niagara Falls, New York.

RESISTANCE RANGE AND RATING IN WATTS FOR STANDARD SIZES

TABLE I

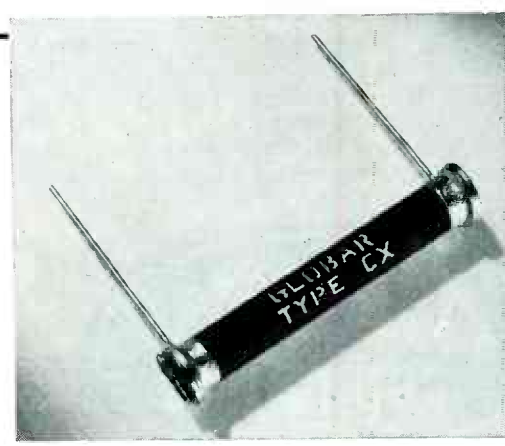
Part Number	Rating in Watts	Resistance Range*	Overall Length in Inches	Overall Diameter in Inches	Tinned Copper Wire Leads	
					Length	Diameter
997-CX	¼	1 ohm to 150 ohms	21/64	7/64	1⅛"	0.016"
763-CX	½	1 ohm to 47 ohms	⅝	7/32	1½"	0.032"
759-CX	1	1 ohm to 33 ohms	¾	¼	1½"	0.032"
766-CX	2	1 ohm to 47 ohms	1⅛	¼	1½"	0.032"
792-CX	4	1 ohm to 22 ohms	1⅞	15/32	1½"	0.040"
774-CX	6	1 ohm to 33 ohms	2⅝	15/32	1½"	0.040"

*RMA Values only, Tolerances ± 10%, and ± 20%.

TABLE II

Diameter in inches	Resistance in Ohms per Inch of Length		Length in Inches		RATING
	Minimum	Maximum	Minimum	Maximum	
½	0.10	100	2	8	Continuous duty rating is based on 3 watts per square inch of external radiating surface.
⅝	0.10	100	2	10	
¾	0.10	75	4	18	
1	0.05	50	4	18	

Type "CX" power resistors can be supplied with metallized ends of brass, copper, nickel, monel, aluminum, tinned brass or tinned copper, also with tinned copper wire (No. 14 B & S Gage) leads, approximately six inches long. Resistance tolerances are limited to ± 10% and ± 20% only.



GLOBAR

Ceramic Resistors

BY CARBORUNDUM

TRADE MARK

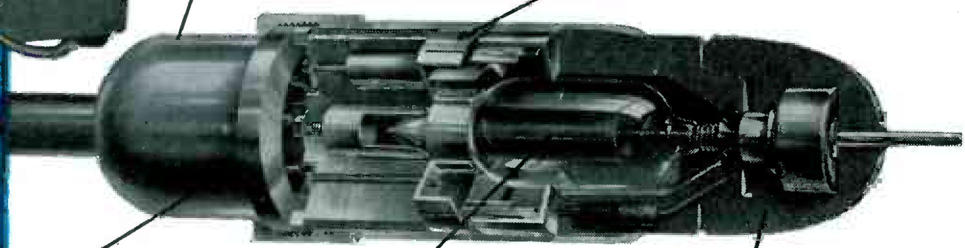
"Carborundum" and "Globar" are registered trademarks which indicate manufacture by The Carborundum Company

HERE'S FLAT RESPONSE UP TO 700 MC

-hp- 410A VACUUM TUBE VOLTMETER

with its new *-hp-* low-capacity diode probe, measures all the important radio voltages without disturbing circuits under test,

CHECK THESE FACTS ABOUT THE NEW *-hp-* PROBE*:



**Reproduced actual size*

The specially-designed diode, in combination with the *-hp-* probe design, makes possible the exceedingly flat frequency response shown graphically in Figure 1.

With this flat frequency response are combined the factors of low input capacity and high input resistance. The variation of these factors with frequency is shown in Figure 2. The input resistance and reactance are high throughout the entire range of the instrument, and thus measurements are made without appreciable detuning or loading of circuit. Maximum measuring accuracy is assured.

In addition to swiftly, easily, accurately making uhf radio measurements, this *-hp-* 410A is a convenient voltage indicator up to 3000 mc. And it serves equally well as an audio or d-c voltmeter, or an ohmmeter. A-c measurements are made in 6 ranges ...full scale readings 1 to 300 v. D-c full scale readings from 1 to 1000 v in 7 ranges. Input resistance all ranges —100 megohms. As an ohmmeter, the *-hp-* 410A measures resistances from 0.2 ohms to 500 megohms in 7 ranges.

In short, this *-hp-* 410A Vacuum Tube Voltmeter is ideal for obtaining most important parameters in radio design, manufacture, or servicing. Write today for full details. Hewlett-Packard Company, 1407E Page Mill Road, Palo Alto, California.

FIGURE 1...RESPONSE

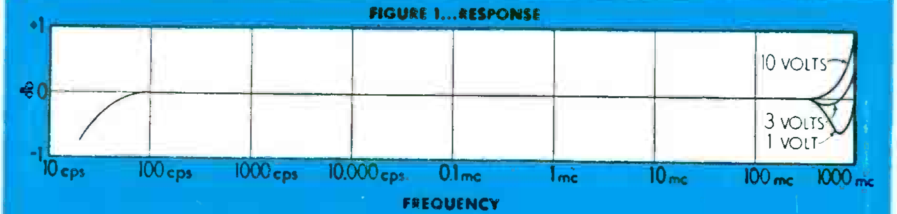
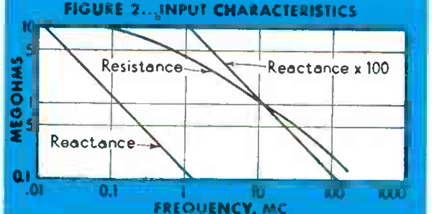


FIGURE 2...INPUT CHARACTERISTICS

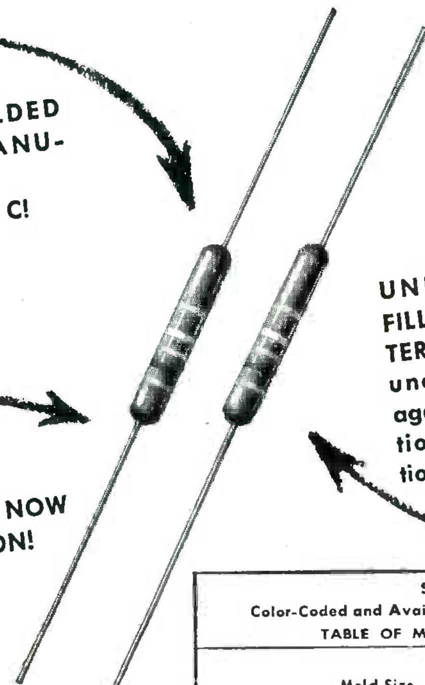


-hp- laboratory instruments
FOR SPEED AND ACCURACY

Noise and Distortion Analyzers · *Wave Analyzers* · *Frequency Meters* · *Audio Frequency Oscillators* · *Audio Signal Generators* · *Vacuum Tube Voltmeters* · *Amplifiers* · *Power Supplies* · *UHF Signal Generators* · *Attenuators* · *Square Wave Generators* · *Frequency Standards* · *Electronic Tachometers*

A QUIET REVOLUTION IN CAPACITOR DESIGN

THE SMALLEST MOLDED TUBULAR EVER MANUFACTURED!... and rated up to 125° C!



ACTUAL SIZE ILLUSTRATION TYPE 65P

UNIQUE, MINERAL-FILLED MOLDING MATERIAL! . . . Provides unequalled protection against moisture absorption even under conditions of extreme humidity!

A PROVEN PRODUCT NOW IN MASS PRODUCTION!

Seven Physical Sizes
Color-Coded and Available in 20%, 10% and 5% Decade Values
TABLE OF MAXIMUM NOMINAL CAPACITIES

	Mold Size	100V @ 125° C.	200V @ 85° C.*	400V @ 85° C.	600V @ 85° C.
65 P	.175" D. x 1-1/16"	.015	.01	.0068	.0022
	.195" D. x 1-1/16"	.022	.015	.01	.0033
	.250" D. x 1-1/16"	.047	.033	.022	.0068
	.375" D. x 1-1/16"	.15	.1	.068	—
75 P	.175" D. x 3/4"	.0068	.0047	.0033	.001
	.200" D. x 3/4"	.01	.0068	.0047	.0015
	.250" D. x 3/4"	.022	.015	.01	.0033

* alternate rating 150V @ 125° C.

NEW SPRAGUE MOLDED PROKARS*

... dependable capacitors for sub-miniature assemblies

SUB-MINIATURE PAPER CAPACITORS IN METAL CANS WITH HERMETIC, GLASS-TO-METAL SEAL

•

for the most severe applications

•

Yes, this little can houses a high quality hermetically sealed Paper Capacitor! Rated at 100 volts, D C Working, this .5 mfd. unit measures .4" x 1⅛". Presently being manufactured in quantity, variations of this sub-miniature type can be made to your specifications. Write for complete information about this and even smaller hermetically sealed units now in production as shown below.

These new molded Prokars were designed specifically to satisfy stringent military requirements. Types 65P & 75P are now in mass production and are available in a wide range of capacities—from .00047 mfd. to .15 mfd! Though higher in price than standard units, they easily justify the term "premium" in performance. Rated for —50° C to 125° C operation, these small but rugged units are ideally suited for any electrical or electronic application in which size, temperature, humidity and physical stress are dominant considerations.

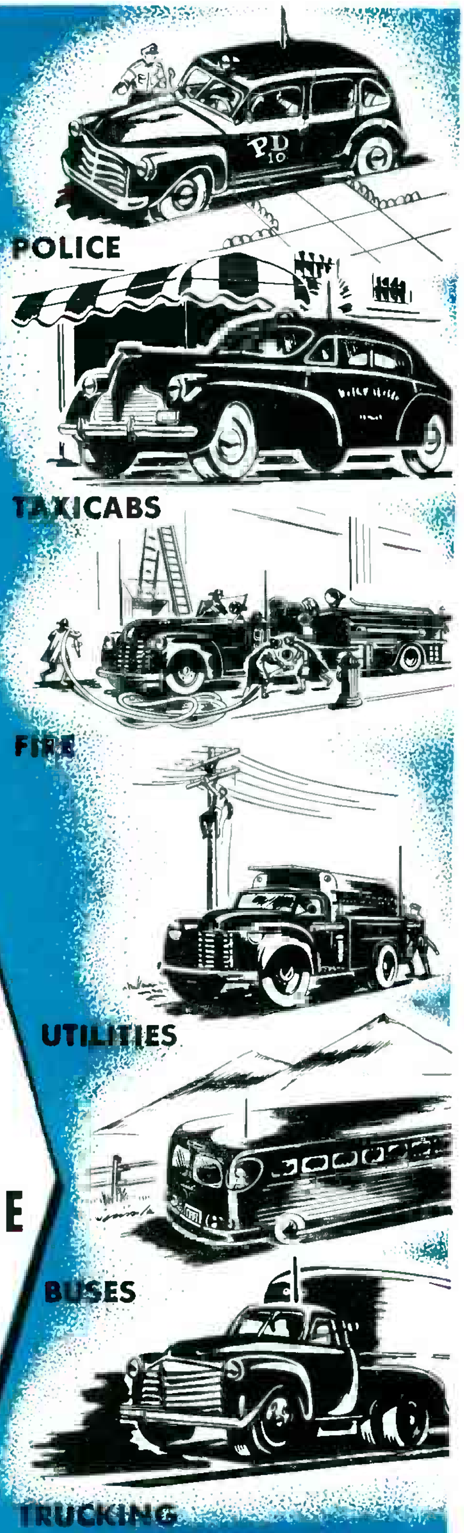
*T. M. Reg. U. S. Pat. Off.

Write for Engineering Bulletin No. 205 A

SPRAGUE

SPRAGUE ELECTRIC COMPANY, NORTH ADAMS, MASS.

PIONEERS OF ELECTRIC AND ELECTRONIC PROGRESS



Save Time and Money... Increase Operating Efficiency with PHILCO

2-WAY F-M MOBILE RADIOPHONE COMMUNICATIONS SYSTEMS

30 to 44 Mc. and 152 to 162 Mc. Sensational new developments . . . advanced engineering . . . proven reliability . . . new operating efficiency and economy for F-M Radiophone Communications Systems, permitting clear, crisp, two-way voice communications under all conditions.

PHILCO

INDUSTRIAL DIVISION

PHILADELPHIA 34 • PENNSYLVANIA

Philco Industrial Division Dep't JN2
Tioga and C Sts., Philadelphia 34, Pa.

Gentlemen:
Please send me information about the new PHILCO F-M Radiophone Communications Systems

NAME ....

ADDRESS ....

CITY ....

Millions of People Changed Our Name

You may think it strange that millions of people could have a voice in changing a company's name, but that is what has happened to The American Rolling Mill Company.

Several years after the company started operations in 1900, it adopted the trademark "ARMCO" for its special grades of steel. The ARMCO trademark—composed of the first letter in each word of the company name—has been widely advertised and appears on all the company's products. Many ARMCO customers identify their use of these special-purpose steels with this familiar trademark.

Through the years—as the original small mill grew into one of the country's great steel companies—our customers, dealers and the public alike have preferred to call the company "ARMCO." So, in recognition of this preference, the name of the company has been changed from The American Rolling Mill Company to Armco Steel Corporation.

The change is one of name only. It does not affect ARMCO management, personnel and long-established policies. It *does* emphasize more strongly the importance of the ARMCO trademark, and increases its value to those who use ARMCO Special-Purpose Steels in the things they make.

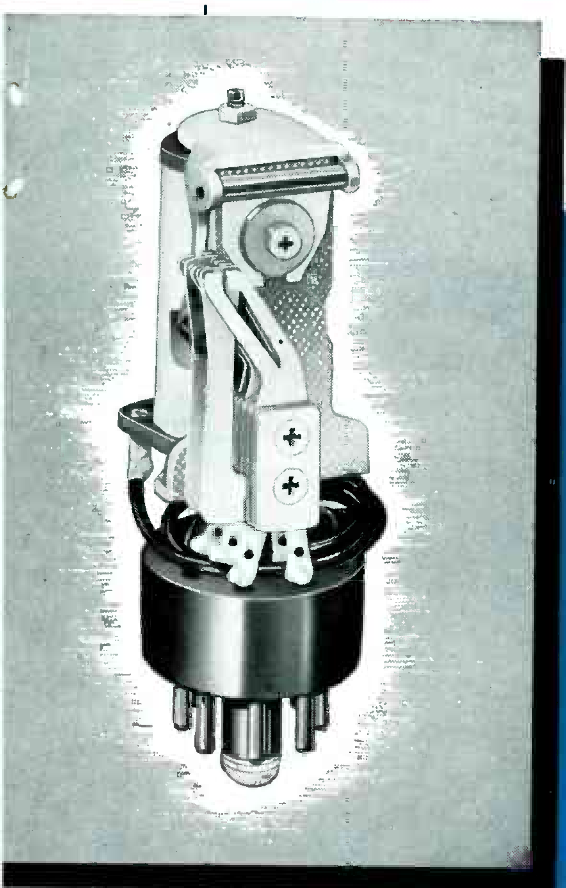
Alert research and production men who have perfected so many special-purpose grades of ARMCO Steel will continue to improve present steels while developing new ones to help manufacturers build better products for home, farm and industry. Armco Steel Corporation, Middletown, Ohio.

Export: The Armco International Corporation.

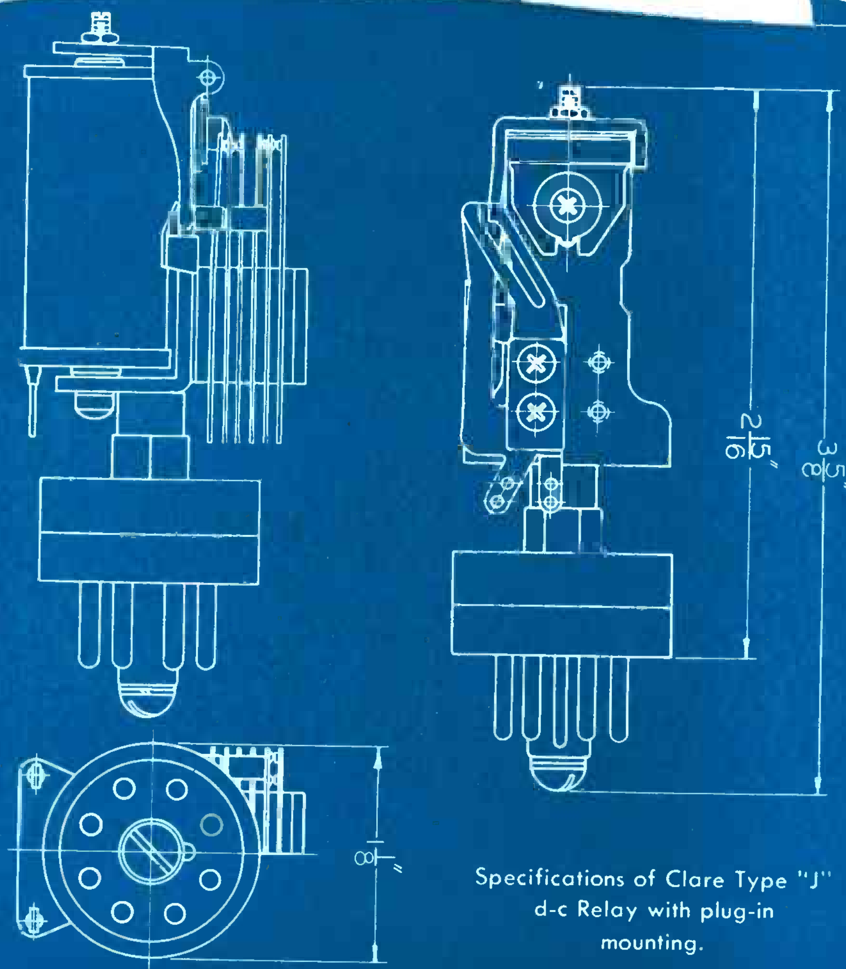
ARMCO

ARMCO STEEL CORPORATION

NOW... The CLARE Type "J" Relay can be Mounted as Conveniently as a Radio Tube!



Famous Clare Type "J" d-c Relay now available in plug-in type where quick removal or replacement is desirable



Specifications of Clare Type "J" d-c Relay with plug-in mounting.

Clare Type "J" d-c Relays combine the best features of the conventional telephone type relay with the small size and light weight which modern compact design requires.

Check these outstanding features of Clare Type "J" design which provide hitherto unheard of performance by a small relay:

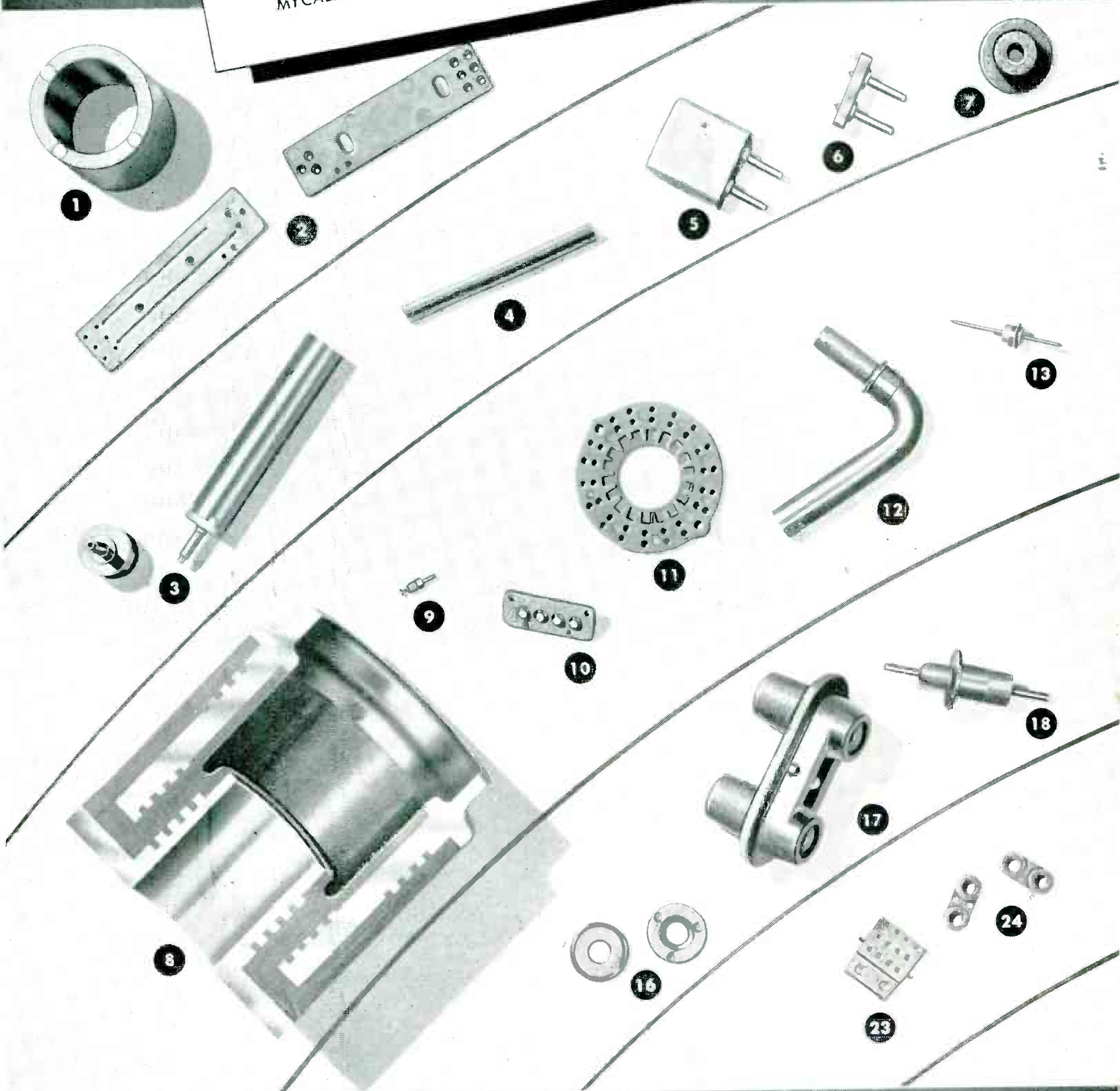
- ★ **Independent Twin Contacts**
- ★ **High Current-Carrying Capacity**
- ★ **Large Armature Bearing Area**
- ★ **Efficient Magnetic Structure**
- ★ **High Operating Speed**
- ★ **Large Contact Spring Pileups**

Clare sales engineers, with long experience in every type of relay problem, are located in principal cities. They will be glad to provide you with complete engineering data on the Clare Type "J" Relay, show you how it may be "custom-built" to meet your exact requirements.

Look for them under "Clare Relays" in your classified phone book . . . or write C. P. Clare & Co., 4719 West Sunnyside Avenue, Chicago 30, Illinois. In Canada: Canadian Line Materials Ltd., Toronto 13. Cable Address CLARELAY.

CLARE RELAYS

First in the Industrial Field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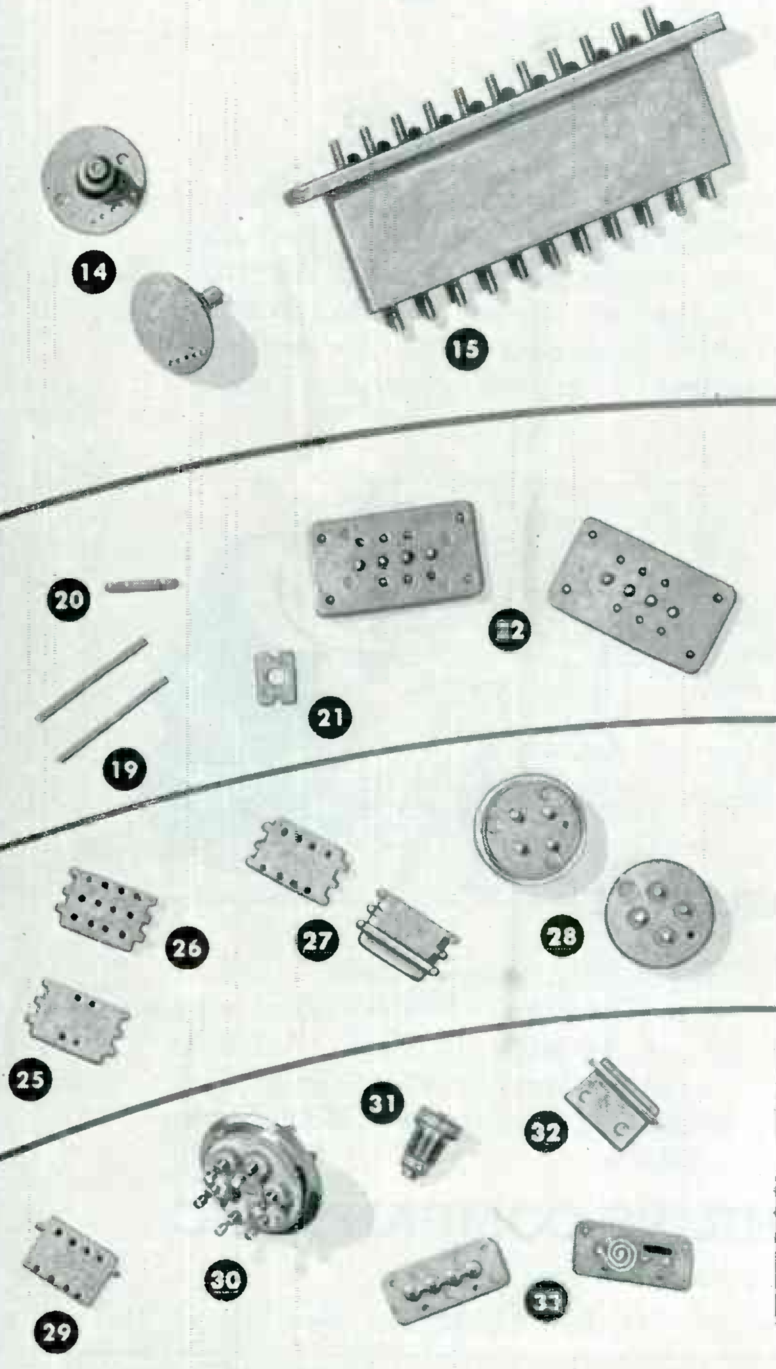
MYCALEX is today's improved insulation — designed to meet the exacting demands of all types of high-frequency circuits. MYCALEX is unusual in that it possesses a combination of peculiar characteristics that make it ideally suited for insulation in all types of electronic circuits. In tomorrow's designs for communications and industrial control equipment, MYCALEX 410 will be specified more than ever before because of its . . . Low dielectric loss · High dielectric strength · High arc resistance · Dimensional stability over wide humidity and temperature changes · Resistance to high temperatures · Mechanical precision · Mechanical strength · Ability to mold metal inserts in place. If you have any insulation problems, our engineers will be glad to help you in their solutions.

MYCALEX CORP. OF AMERICA

"Owners of 'MYCALEX' Patents"

Plant and General Offices: Clifton, N. J. Executive Offices: 30 Rockefeller Plaza, New York 20, N. Y.

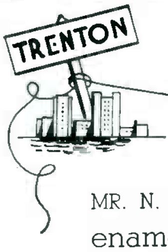
SINCE 1919 MYCALEX THE INSULATOR TRADE MARK REG. U. S. PAT. OFF.



PART NAME	APPLICATION	INSERTS	MAX. DIMEN.
1 Bushing	Motor Generator	None	1.75"
2 Insulator	Electrical Instrument	None	3.18
3 End Seal	Thermostat Shell	Stainless Steel	3.75
4 Insulator	Electrical Instrument	None	3.00
5 Hermetic Seal	Crystal housing	Nickel and Copper	0.88
6 Hermetic Seal	Crystal housing	Copper	1.09
7 Insulator	Automobile Antenna	None	1.06
8 Bushing	Ignitron	Steel	4.50
9 Stand-Off Insulator	Electronics circuit	Brass	0.56
10 Panel	Television Selector Switch	Silver	1.38
11 Switch Wafer	Television Selector Switch	None	2.31
12 Elbow	Aircraft ignition	Steel and Brass	2.75
13 Lead	Transformer	Monel	1.75
14 Insulator	Polarizing relay	None	1.09
15 Lead through block	Oscillator	Brass	4.69
16 Insulator	Telephone Transmitter	None	0.88
17 Dual Bushing	Oil Burner Transformer	None	3.00
18 Lead	Transformer	Monel	2.50
19 Actuating Bar	Telephone relay	None	1.44
20 Actuating Bar	Telephone relay	None	0.78
21 Spacer	Radio vibrator	None	0.56
22 Panel	Television Selector Switch	None	1.75
23 Spacer	Telephone relay	None	1.00
24 Spacer	Relay	None	0.91
25 Spacer	Telephone relay	None	1.00
26 Spacer	Telephone relay	None	1.00
27 Clamping Plate	Telephone relay	None	1.00
28 Electrode Mounting	Level Indicator	Brass	1.13
29 Spacer	Telephone relay	None	1.00
30 Six Terminal Header	Transformer	Monel	1.42
31 Test jack body	High Frequency Circuits	Monel	0.75
32 Clamping Plate	Telephone relay	None	1.00
33 Printed Circuit Base	Experimental	Silver	1.38

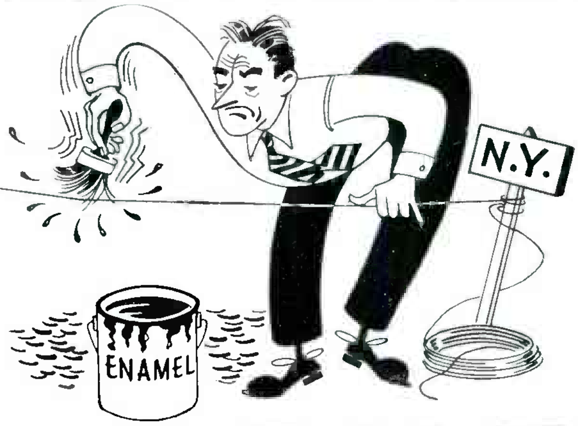
What's your problem?

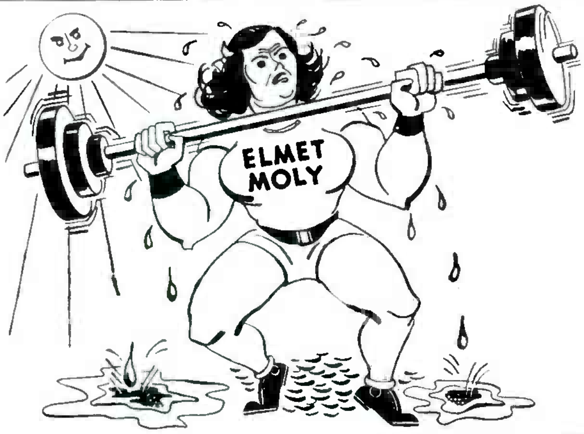
Fine Wire? Tungsten? Molybdenum?



Problem 1

MR. N. AMMELLING needed 339,000 feet of .001 enamelled copper wire. He called Fine Wire Headquarters and in good time received a one-pound package . . . his 64 miles of wire enamelled to his specifications.





Problem 2

A customer's needs called for a material with a high tensile strength at elevated temperature. He called North American Philips and received ELMET Molybdenum which performed to his complete satisfaction . . . fulfilling every requirement.

Problem 3

MR. MUST B. PLATED, who required metal-clad wire for a specific application, phoned Fine Wire Headquarters. We supplied the base material to provide the physical characteristics desired, and plated it to meet his exacting specifications for special surface qualities.

the answer

WHY not call Fine Wire Headquarters when you have a question about fine wire? We can't do the impossible, but we can do lots of things that can bring you the right fine wire for the job.

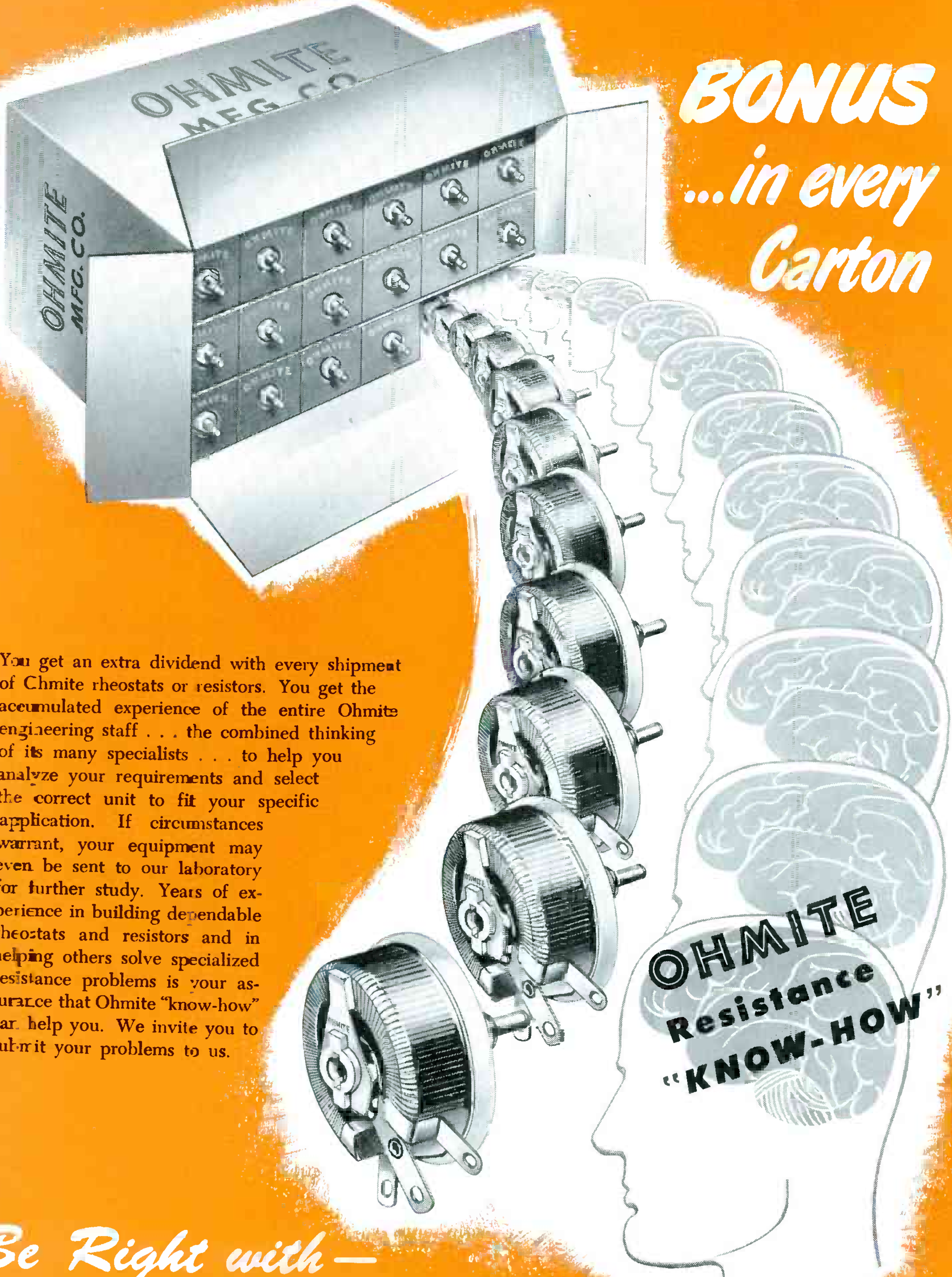
So—when you have a problem on Fine Wire, Tungsten or Molybdenum—wire, phone or write to North American Philips, makers of NORELCO Fine Wires, and ELMET Tungsten and Molybdenum products.

NORTH AMERICAN PHILIPS COMPANY, INC.

Dept. E-6, 100 East 42nd Street, New York 17, N. Y.

Export Representative • Philips Export Corporation • 100 East 42nd Street, New York 17, N. Y.

BONUS ...in every Carton



You get an extra dividend with every shipment of Ohmite rheostats or resistors. You get the accumulated experience of the entire Ohmite engineering staff . . . the combined thinking of its many specialists . . . to help you analyze your requirements and select the correct unit to fit your specific application. If circumstances warrant, your equipment may even be sent to our laboratory for further study. Years of experience in building dependable rheostats and resistors and in helping others solve specialized resistance problems is your assurance that Ohmite "know-how" can help you. We invite you to submit your problems to us.

Be Right with—

OHMITE

RHEOSTATS ★ RESISTORS ★ TAP SWITCHES

RHEOSTATS for every Need

Ten Standard Sizes—25 to 1,000 watts

● You can get a *standard* Ohmite rheostat for practically any application. The Ohmite line of standard rheostats is the most extensive available. Furthermore, six wattage sizes, in many resistance values, are carried in stock for immediate shipment. Special resistance values, tapered windings, tandem assemblies, and many other variations can be made to order quickly at small extra cost. All models are carefully engineered to give long operating life. All have the distinctive, time-proven Ohmite features—the all-ceramic construction, windings permanently locked in vitreous enamel, and smoothly gliding metal-graphite brush. Whatever your needs, Ohmite engineers can provide a rheostat of unfailing dependability to meet your exact requirements.

How to Select a RHEOSTAT

1 UNIFORM WINDING

It's easy to choose the right uniformly wound rheostat if you have certain basic data. Knowing the *resistance* required and the *maximum current* for the circuit (circuit current with rheostat shorted out), the rheostat wattage can be calculated by the formula: $W=I^2R$. A standard rheostat, the wattage of which is not less than the calculated value, can then be selected from the Ohmite catalog. If the resistance and maximum current are not known, Ohmite engineers can calculate them from various circuit information you can supply about the application.

2 TAPERED WINDING

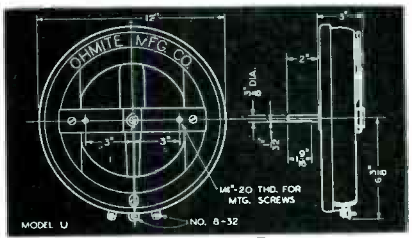
In a tapered winding rheostat the winding is made up of two to six sections of diminishing wire sizes. This construction allows a large resistance change to be "telescoped" into a small part of the winding, thus providing more uniform control and reducing over-all rheostat size.

The design of a tapered rheostat is not as simple as choosing a uniformly wound unit. Taper-wound rheostats can be selected from the standard designs listed in the Ohmite catalog for field control of generators, or Ohmite engineers will be glad to make specific recommendations.

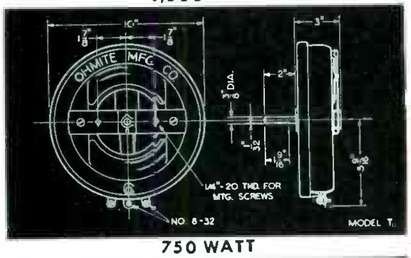
Send for Catalog and Engineering Manual No. 40

Write for this Ohmite Catalog and Engineering Manual on your letterhead. It contains the complete line plus a wealth of engineering information.

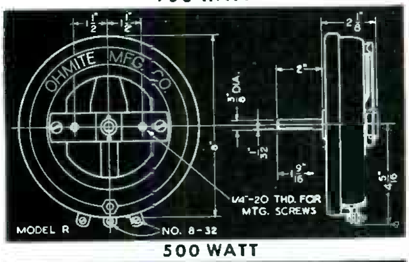
OHMITE MFG. COMPANY
4818 FLOURNOY ST.
CHICAGO 44, ILL.



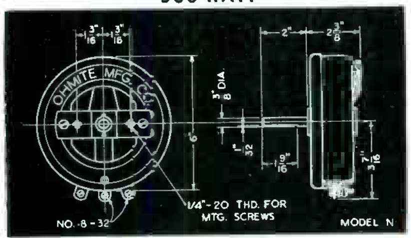
1,000 WATT



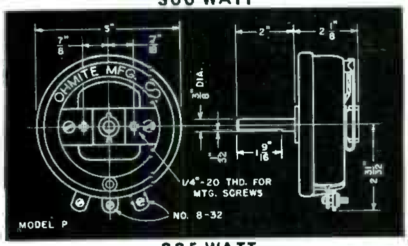
750 WATT



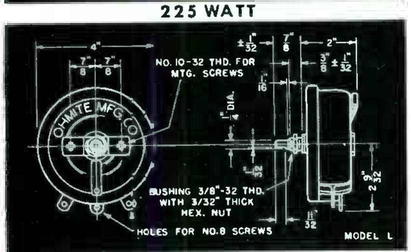
500 WATT



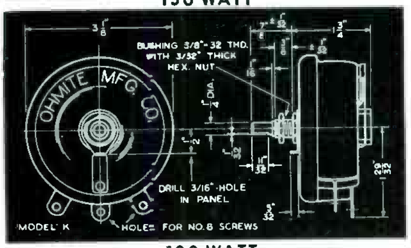
300 WATT



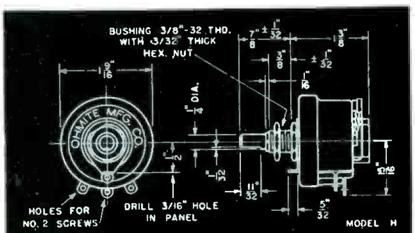
225 WATT



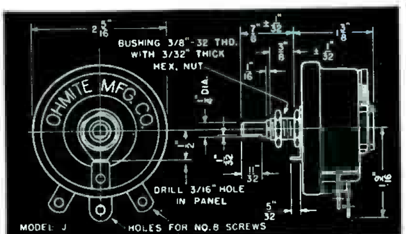
150 WATT



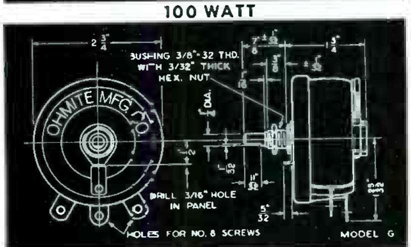
100 WATT



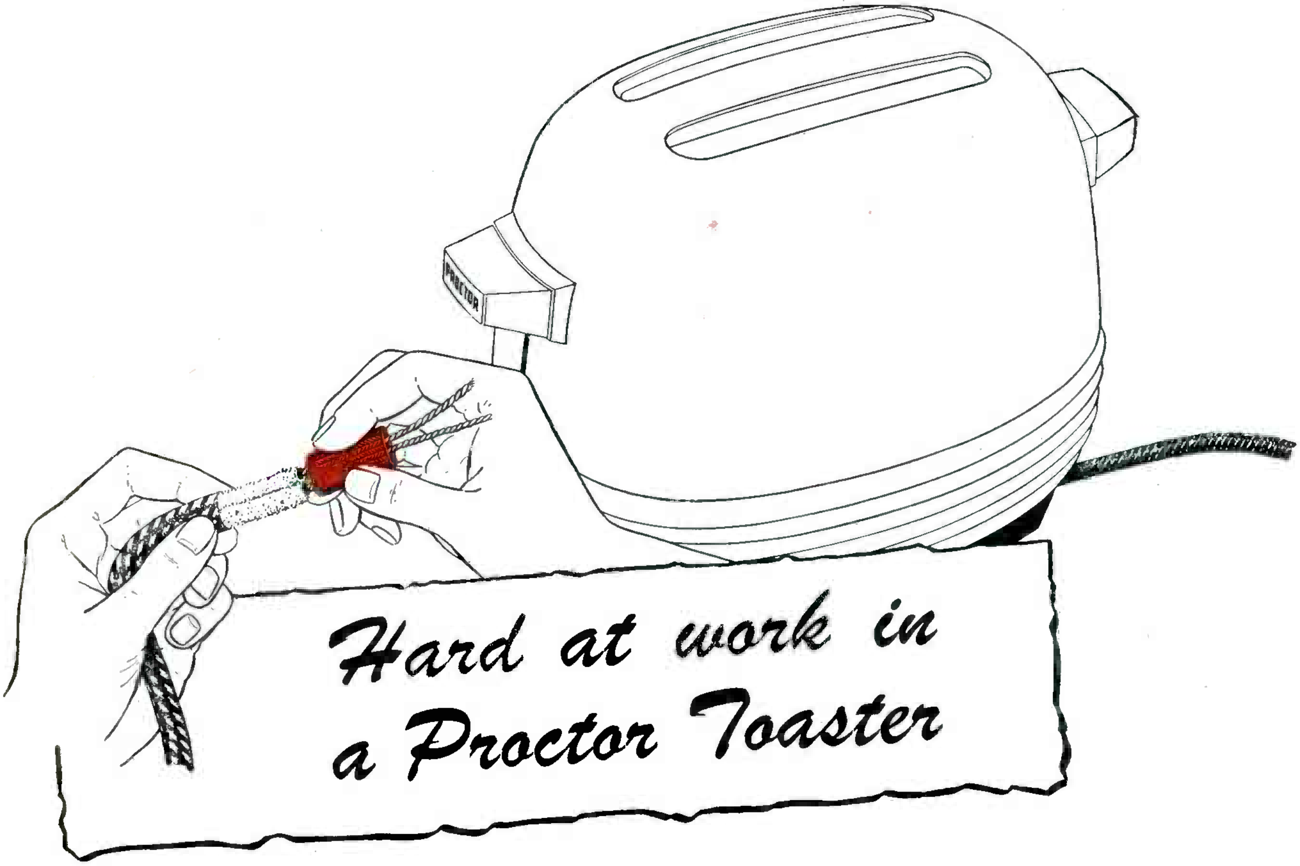
25 WATT



50 WATT



75 WATT



In the streamlined Proctor Toaster it takes a 1-inch length of BH Fiberglas Sleeving to provide supplementary insulation over the asbestos-covered leads on the built-in heater cord. With BH Fiberglas Sleeving there is no possibility of a partly uncovered braid . . . no threads to break or unravel. This extra margin of safety means trouble-free service.

In every industry, BH Fiberglas Sleeving gets the tough insulation jobs—where high heat, excessive current load or the possibility of insulation breakdown make extra protection a necessity.

Here is the reason. In BH Fiberglas Sleeving, no hardening varnish or lacquer is used. You can see the difference in:

(1) Remarkable flexibility . . . BH Sleeving fits snug, spreads to cover knobs or terminals. Will never harden or dry out because no varnish is used;

(2) Non-fraying qualities . . . BH Sleeving cuts clean, will not feather. It is treated to retard fraying without the use of varnish;

(3) Lasting performance . . . BH Sleeving does not disintegrate even after long use because varnish is not used.

Prove it to yourself—let us send you a sample of BH Fiberglas Sleeving 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-23, 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

HERE IT IS

NEW!
DIFFERENT!
BETTER!

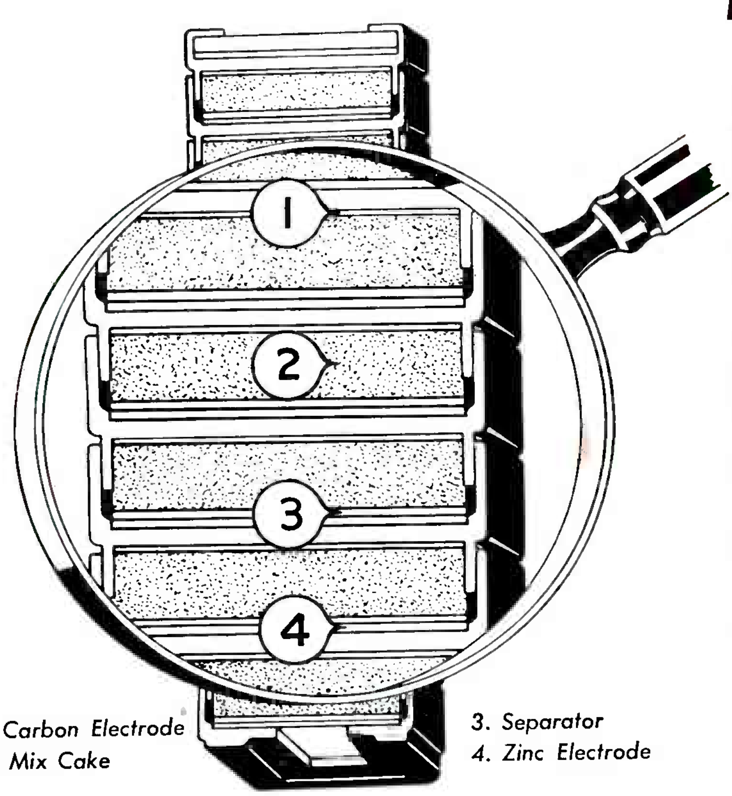
The ONLY RADIO BATTERY That Has The OLIN Interlocked Flat Cell

PLAYING HEART

Enlarged Cutaway Section Shows . . .
EACH CELL INTERLOCKS WITH ITS NEIGHBOR—
FORMS THE PLAYING-HEART OF YOUR RADIO

LOOK!

- Each Cell Holds More Power-Producing Chemicals.
- No Waste Space.
- Lasts Hours Longer.
- Costs No More.
- Already Standard Equipment with 12 Radio Manufacturers.



1. *Carbon Electrode*
2. *Mix Cake*
3. *Separator*
4. *Zinc Electrode*

EXCLUSIVE!

- Result of 5 years' Scientific Electronic Research.
- Patented U. S. Pat. No. 2416576.
- Triple-Sealed Against Power Leakage.
- No Binding Tapes.
- No Sealing Wax.
- Greatly reduces Battery Failure . . . 91% Less Soldered Connections.

Increase Your Radio Battery Sales This Summer with the *Sensational*

OLIN

Interlocked Flat Cell Battery

The demand for portable radio batteries this summer promises to be the greatest in radio history . . . estimated to be $52,000,000.

All over America, portable radio owners will be customers for this startling new electronic development that gives more hours of listening pleasure . . . yet costs no more.

Available in 2 Brands

WINCHESTER TRADE-MARK — OLIN

BOND — OLIN

Make your store headquarters for the OLIN Interlocked Flat Cell Radio Battery.

Fill in coupon below, for descriptive Catalog and get the complete Product and Sales story.

Don't Disappoint Your Customers They'll Want . . .

THE ONLY RADIO BATTERY

That has the OLIN Interlocked Flat Cell PLAYING-HEART

Olin Industries, Inc.
Electrical Division
New Haven, Conn.
Dept. C

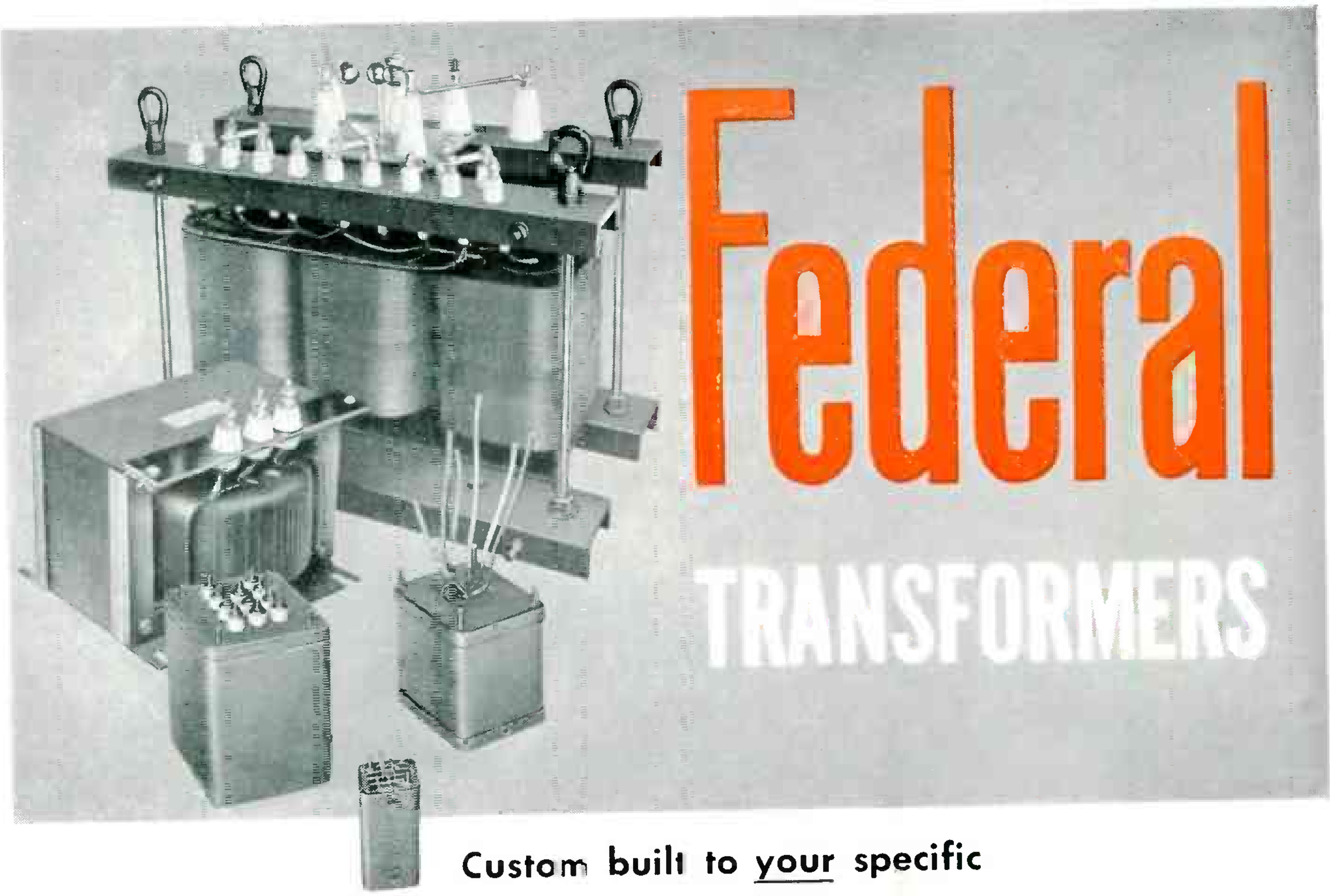
Mail me at once Descriptive Catalog ☐ Bond-Olin or ☐ Winchester-Olin. (Check brand desired.)

NAME . . . .

ADDRESS . . . .

CITY . . . . STATE . . . .

For the Industrial and Electronic Market—



Custom built to *your* specific JOB REQUIREMENTS

Where your specifications call for an *extra margin* of performance and dependability—that's a job for Federal transformers. For years, Federal has been designing and producing special transformers to meet the most exacting requirements—for Federal's own radio and electronic equipment, as well as for military and commercial service.

This engineering and production skill is at *your* service—ready to help solve your *toughest* transformer problems. Federal will design the *right* transformer for your circuit conditions, with exactly the right voltage and impedance ratios, insulation strength, load capacity, and mechanical construction. Available in sizes up to 25 kva.

For prices and data, write Federal today, outlining your design requirements. Dept. J113

This FEDERAL transformer helps to MILK COWS ELECTRICALLY

Designed for use in the pulsing circuit of an automatic milking machine, this transformer, with 115-volt input and 15-volt, 5-ampere output, provides the *right* combination of electrical, physical and thermal characteristics to assure optimum performance of the complete equipment—a typical example of a Federal transformer specially designed for a specific job.

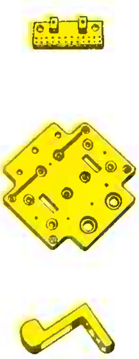
Federal Telephone and Radio Corporation

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.

In Canada:—Federal Electric Manufacturing Company, Ltd., Montreal, P. Q.
Export Distributors:—International Standard Electric Corp. 67 Broad St., N. Y.

How to Save 2 Ways with an Engineering Service that Always Gives You *Unbiased* Recommendations



First, you save production hours and dollars because you can be sure of getting electrical insulating materials that are "right for your jobs." That's because Continental-Diamond makes a complete range of products with the physicals you want. Instead of having only one, two, or three materials to recommend, C-D offers you a choice of five different insulating materials subdivided into grades or combinations of grades to fit your specific applications. Thus, you stand a much better chance of getting the one material that will reduce fabricating costs and improve product performance because it's right on the job.

Second, you save time and effort because you have a convenient, "one-stop" source for all your electrical insulating needs. To give you fast, complete shipment, large stocks of every C-D product are constantly kept on hand. And, if you request it, trained C-D technicians can give you practical, personal help that can lead to better, lower-cost applications. Save two ways, today. Call or drop us a line for anything you need in the way of top-quality electrical insulating materials.

DE-3-48

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Continental-Diamond FIBRE COMPANY

Established 1895..Manufacturers of Laminated Plastics since 1911—NEWARK 16 • DELAWARE

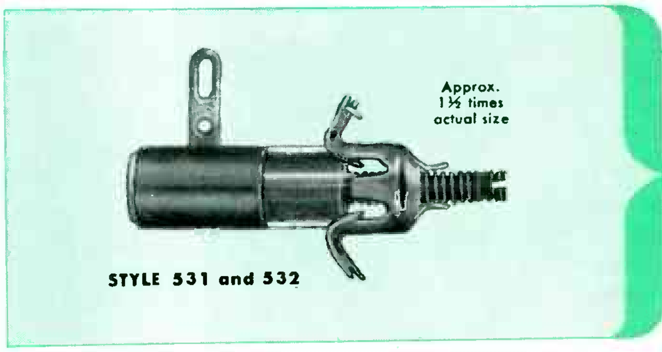
ERIE TRIMMERS

for easy assembly and dependable performance at reasonable cost

HERE are six popular ERIE Resistor trimmers, all notable for their fidelity to specifications, their rugged stability, and their straight-line capacity change throughout the total range.

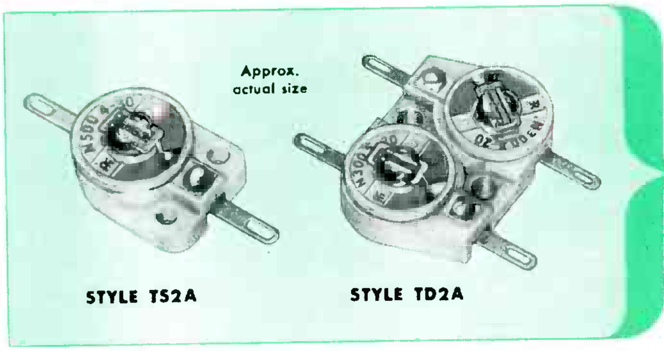
The new miniature style Tubular Trimmers and Styles 554 and 557 open up many design possibilities for added efficiency in chassis layout.

General specifications are given below. Samples will be sent to interested manufacturers on request.



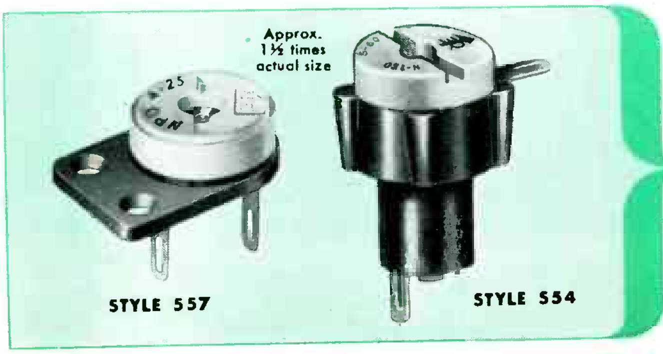
STYLES 531 and 532

Capacity Ranges: 0.5-5 MMF & 1-8 MMF
Working Voltage: 500 V.D.C.
Max. Temperature: 75°C
Q Factor @ 1 MC.: 1,000 min.
Initial Leakage Resistance: 10,000 megohms min.
Styles: 531 for panels .015" to .039"; 532 for .040" to .065"



STYLES TS2A and TD2A

Capacity Ranges:
Zero Temp. Coeff. 1.5-7 MMF & 3-12 MMF
N300 Temp. Coeff. 3-13 MMF & 5-20 MMF
N500 Temp. Coeff. 4-30 MMF & 7-45 MMF
Working Voltage: 500 V.D.C.
Q Factor @ 1 MC.: 500 min.
Initial Leakage Resistance: 10,000 megohms min.
Styles: TS2A, Single Condenser; TD2A, Dual Condenser



STYLES 554 and 557

Capacity Ranges:
Zero Temp. Coeff. 3-12 MMF & 5-25 MMF
N750 Temp. Coeff. 5-30 MMF & 8-50 MMF
Working Voltage: 350 V.D.C.
Q Factor @ 1 MC.: 500 min.
Initial Leakage Resistance: 10,000 megohms min.
Styles: 554 Mounted with Spring-Clip; 557 for Sub-panel or Bracket Mounting

Electronics Division

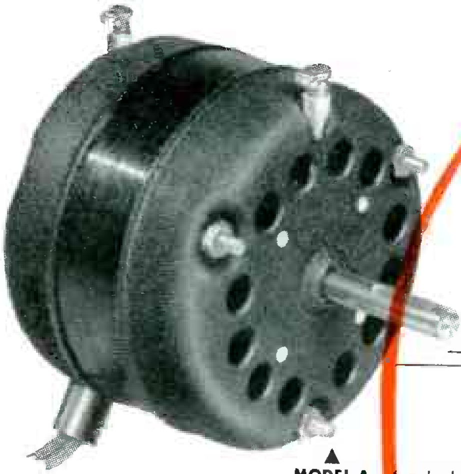
ERIE RESISTOR CORP., ERIE, PA.

LONDON, ENGLAND . . . TORONTO, CANADA

MAKE THINGS GO!

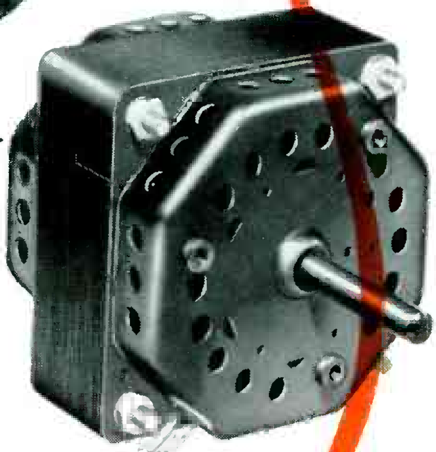
with

alliance motors



MODEL A—6-pole shaded pole induction motor • 60 and 50 cycles • Approx. 1000 R.P.M. full load speed • Size—4½″ O.D. • Length—2¾″ to 4⅝″ depending on variable stack length • Rated at approx. 1/30th h.p. • Comes semi-open or fully enclosed with or without oilers.

MODEL K—Used in all 25 cycle and some 50 and 60 cycle Alliance Phonomotors. This basic 2-pole induction type motor will adapt to any standard AC voltage or frequency. Develops up to 1/100 h.p. Drives the heavier type record changers, radio-phonograph turntables, tuning devices and operates many other controls and automatic devices.



MODEL B—New type 4-pole shaded pole fan motor made in three standard lamination stack thicknesses. Power range is from 1/100th h.p. to 1/25th h.p. Size, 3⅜″ square. Especially adapted for fans, it will drive a wide variety of mechanical devices and is ideal for sound recorders. Full load speed 1550 R.P.M.—clockwise or counter clockwise rotation—not reversible. Made for 115 volts, 60 cycles—can be wound for 50 cycles and for other voltages.

Reliable, high-speed mass production of motors at low cost—that's the big job at Alliance! Makers of mass consumer products need Alliance motors for their small load tasks. Noted for long life, they are compact and light weight. Many weigh less than a pound! Power ratings range from less than 1/400th h.p. to 1/20th h.p. Some are uni-directional—others are reversible and can be made for continuous or intermittent duty.

Practical uses for Alliance motors are to power automatic controls, switches, valves, motion displays, movie projectors, vending and business machines, toys, record players, and radio tuning devices. The newer Alliance Model A and Model B motors are especially built for driving fan blades in air circulators, room heaters, hair dryers, coolers, and air conditioning appliances. Model B is also an excellent power source for sound recorders.

Alliance Motors pack more motion and automatic action into new products!

WHEN YOU DESIGN—KEEP

alliance motors

IN MIND

ALLIANCE MANUFACTURING COMPANY • ALLIANCE, OHIO

Export Department: 401 Broadway, New York 13, N. Y., U. S. A.

outstanding advantage offered in Highest Quality Potentiometer

GIBBS MICROPOT GUARANTEES

±0.1% ACCURACY

"Integral Molding" . . . Exclusive Gibbs Engineering Development . . . Forever Locks Coiled Resistance Element and Terminals into One Integral Unit with Housing . . . Assures Unequalled and Permanent Operational Accuracy.

. . . and only the

MICROPOT

has it!

Make-ready for "INTEGRAL MOLDING" process . . .

The coiled resistance element is threaded on the molded core

Result of "INTEGRAL MOLDING" process . . .

Resistance element and terminals are one integral part of housing

OTHER IMPORTANT FEATURES OF GIBBS TEN-TURN MICROPOT

Write Today!
For engineering specifications and complete detail folder. Submit any problems to our engineering staff for recommendations. Units for immediate shipment.—1,000 to 30,000 ohm range. Special resistance values made to order.

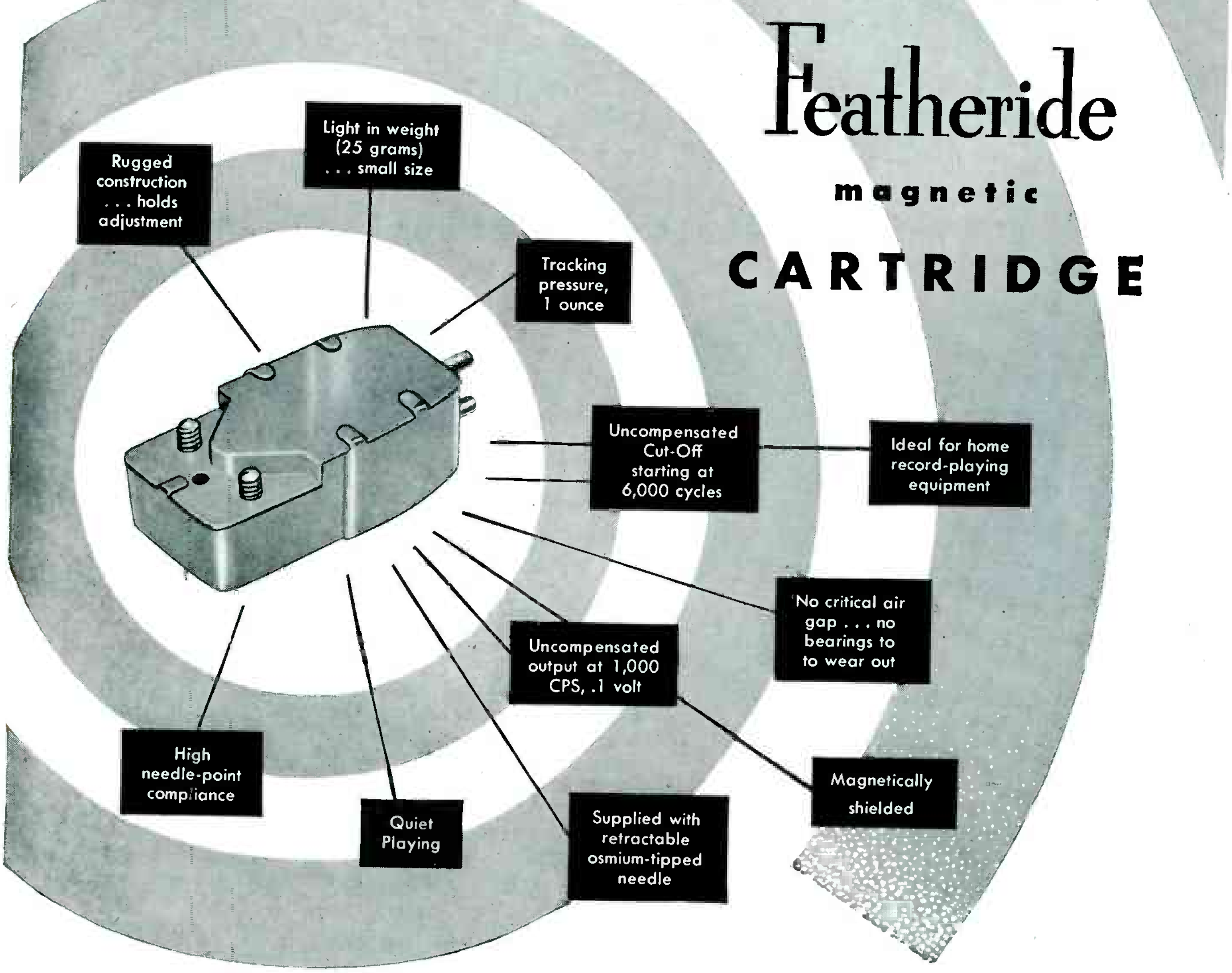
- Resistance output is directly proportional to shaft rotation through a full 3,600 degrees within ±0.1%: this linearity is carried right to the counter clockwise stop. In the Gibbs MICROPOT such results are obtained by precision manufacturing and methods.
- Precision ground, stainless steel, double thread, lead screw guides the rotating contact, *guarantees* smooth action, low uniform torque and accurate settings—*permanently*.
- Rotor assembly, supported on two bearings, assures long life and low torque.
- Ends of resistance element *soldered* to terminals *before molding*.
- Anti backlash spring in contact guide—assures you positive setting and resetting.
- The 43½" length of resistance element gives you a finer resolution.

DEPT. 34 ***GIBBS Division***

THE GEORGE W. BORG CORPORATION

Delavan • Wisconsin

The New WEBSTER ELECTRIC Featheride magnetic CARTRIDGE



The new Webster Electric "Featheride" magnetic cartridge fits universally, from a mechanical standpoint, into practically all tone arms. This will meet your requirements for tone arms you may have on hand. As shown above it has all the features for top performance . . . this is a result of sound fundamental design, careful engineering and precision manufacturing methods.

Write today to Webster Electric Co., Racine, Wisconsin for specification sheets and literature showing performance curve and all technical features.

WEBSTER ELECTRIC
RACINE WISCONSIN
Established 1909

Export Dept. 13 E. 40th Street, New York, 16, N. Y.
Cable Address "ARLAB" New York City

"Where Quality is a Responsibility and Fair Dealing an Obligation"

CREDENTIALS

of the Newest Member of the Belden Magnet Wire Family

Celenamel magnet wire—newly developed by Belden—is copper wire insulated with a film of cellulose acetate combined under heat with other resinous materials. The film so produced is tough, flexible, continuous, and of high dielectric strength.

• • •

Celenamel is practically impervious to the action of hot coal tar as well as petroleum naphthas. The properties are such that Celenamel meets and in some respects exceeds industry standards for oleo-resinous enameled magnet wire.

• • •

In soldering operations it is unnecessary to remove the Celenamel insulation. Soldering of leads is accomplished by dipping in a low-temperature lead-tin bath or direct application of a soldering iron. A flux of rosin-alcohol should be used.

• • •

Celenamel films are produced with insulation additions that have closer and more uniform tolerances than have heretofore been available. The film withstands the usual temperatures encountered during coil impregnation and baking.

• • •

Celenamel insulation possesses very good aging qualities. Celenamel magnet wire produced several years ago still exhibits its original mechanical and electrical properties.

Celenamel is available in sizes 41 and finer.

Belden

WIREMAKER FOR INDUSTRY

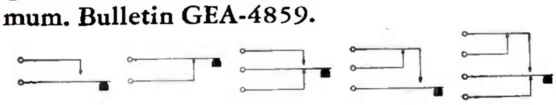
ELECTRONICS

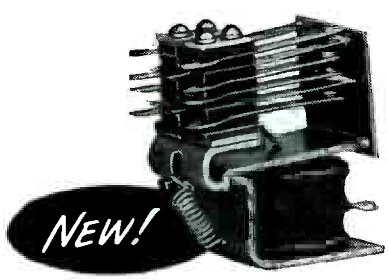
Designers

RELAYS . . . for any duty, any duty cycle

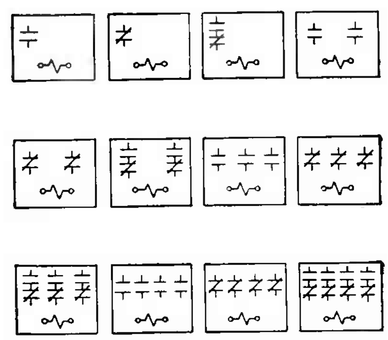
COMMUNICATIONS AND SIGNALING Designed specifically for use in industrial electronic equipment, communications and signaling equipment, this General Electric telephone-type relay has a service life measured in many millions of operations. Working from five basic contact arrangements, combinations can be stacked to satisfy intricate circuit switching requirements.

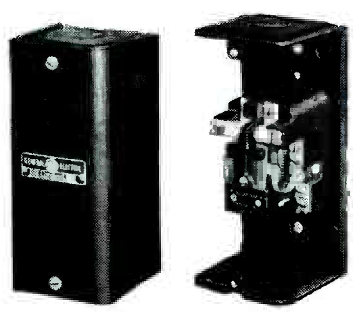
Welded-crossbar palladium contacts, new-type molded insulation and stainless steel bearings contribute to this d-c relay's longevity. Coils rated 1 to 250 volts, 0.1 to 26,000 ohms; contacts 3 amps maximum. Bulletin GEA-4859.





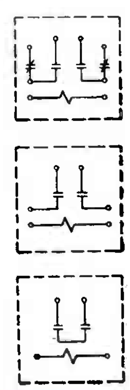
VENDING MACHINES AND DISPENSERS Designers of coin changers, coin-operated phonographs, drink dispensers, and similar automatic devices will soon be familar with G.E.'s new appliance relay, an inexpensive multi-contact unit. Featuring quiet operation, reliability and compactness, the CR2790G relay is available in ratings of 24 and 115 volts a-c, 24 volts d-c, 5 amps continuous. Bulletin GEA-4864.





HEAVY-DUTY GENERAL-PURPOSE Three contact arrangements—spst, dpst, and dpdt—plus four mounting arrangements give the CR2790E real versatility. Mounting arrangements available are the enclosed form shown here, open form, back-connected form for panel mounting, and a plug-in form for use in process control equipment.

Its heavy silver contacts are rated 10 amps continuous at 115/230 volts, 60 cycles; normally open contacts will make and break 45 amps, normally closed contacts 20 amps. Bulletin GEC-257 gives full details.



GENERAL ELECTRIC

Digest

TIMELY HIGHLIGHTS ON G-E COMPONENTS

DYNAMOTORS FOR QUICK DELIVERY!

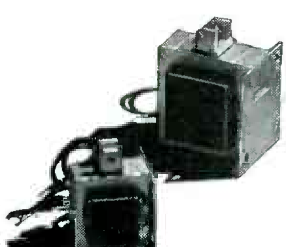
Shopping for fractional-hp dynamotors? General Electric can now supply you on a short-shipment basis! Production has finally caught up on these d-c

to a-c converters for communications service. Standard dynamotors are available in ratings of 200 and 500 volt-amperes, 60 cycles, continuous duty. Specials are also available, but on a slightly longer shipment. For more complete information on these fhp equipments, contact your G-E representative or write Fractional-horsepower Motor Div., General Electric Co., Fort Wayne, Indiana.

MORE PULL IN LESS SPACE

You'll find these new, small, all-welded solenoids useful in any application where a straight-line thrust is required... they're a natural for vending machines. The small unit requires only three cubic inches of space, and develops 0.26 pounds pull at ½-inch stroke; its "big brother" produces 3.7 pounds at ¾-inch stroke.

Brazed-in pole shader increases efficiency, insures quiet operation. Varnish-impregnated coil provides high resistance to shock, splashing water, oil. Check Bulletin GEA-4897.



SHOW IT, THEN THEY'LL KNOW IT

If your organization has an educational program underway, or plans one, ask your G-E representative to show you the Industrial Electronics Training Course. Rated tops in visual training by the nation's industrials, schools and institutions now using it, the complete kit contains twelve half-hour slide films with records, individual lesson guides keyed to the film, and a manual for the course instructor.

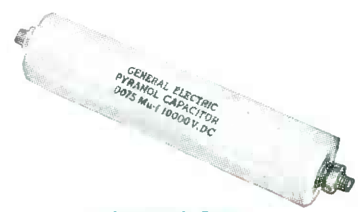
Everything from fundamental electronics to up-to-the-minute electronic

production tools are forcefully described and explained in this easy-to-take visual course. Check Bulletin GES-3303.

NEED SOMETHING SPECIAL IN CAPACITORS?

Here's a new .0075-muf, 10-kv d-c capacitor for television, precipitation, and similar electronic equipment requiring filtering in high-voltage power supply. Other capacitances (.0005 to .01 muf) and voltages (3 to 30 kv) can be supplied.

Ceramic container acts as insulator, simplifies mounting, cuts size (volume) to 1/5th without lowering quality in any way. Ingenious internal hermetic silicone seal eliminates solder. Pyranol filled. Contact your G-E representative or write Transformer Div., General Electric Co., Pittsfield, Mass., for quotation.



LOOKING FOR PERMANENT MAGNET DATA?

These two new bulletins are packed full of application and design information to help you build magnets into your electronic equipment. CDM-1 covers "Permanent Magnets"; CDM-2 describes "Cast and Sintered Alnico Magnets." Coupon below will bring this valuable information to your desk quickly. Check it now.

GENERAL ELECTRIC COMPANY, Section E-642-17
Apparatus Department, Schenectady, N. Y.

Please send me the following bulletins:

- ☐ GEA-4859 Telephone-type Relay
- ☐ GEA-4864 Appliance Relay
- ☐ GEC-257 General-purpose Relay
- ☐ GEA-4897 Solenoids
- ☐ GES-3303 Electronics Training Course
- ☐ CDM-1 Permanent Magnets
- ☐ CDM-2 Cast & Sintered Alnico Magnets

Name ....

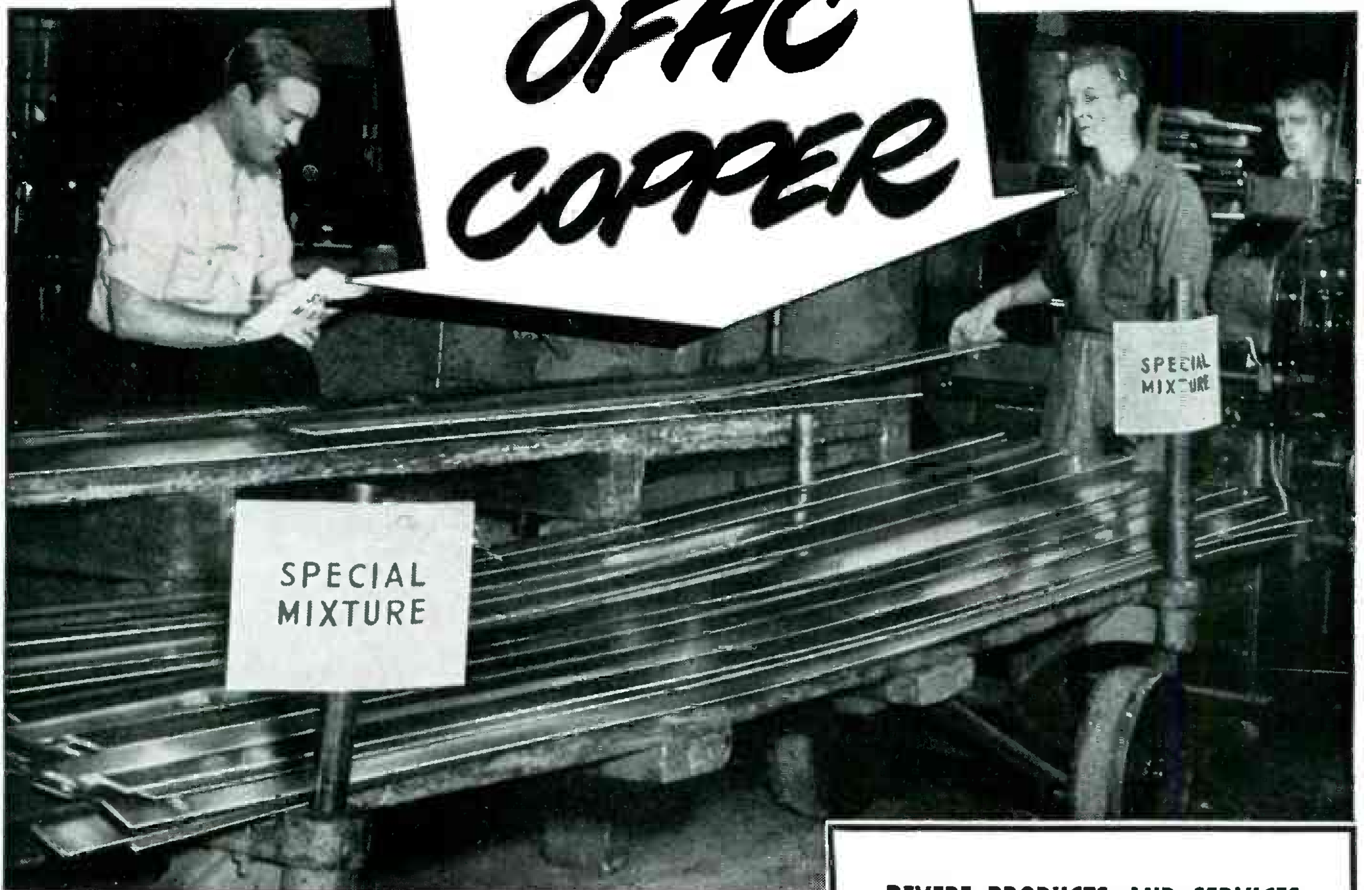
Company ....

Address ....

City .... State ....

PERSONALLY CONDUCTED THROUGH THE REVERE MILLS

OFHC COPPER



BECAUSE OFHC Copper looks like any other copper, Revere takes great pains to identify it throughout processing, to see it is not lost track of or mixed up with other types. The obvious thing is to mark each piece, which is done, but markings are obliterated by operations such as rolling, and so Revere goes to the length of assigning special personnel to follow each lot of OFHC Copper from one operation to another, watching carefully to be sure each load is kept intact.

In addition, Revere takes full cognizance of the fact that OFHC Copper for radio purposes must have special qualities. In making anodes, it must be deep drawn, and for the feather-edge seal, it must be capable of being rolled or machined down to .002″/.010″. By carefully controlling mill processing, grain size is kept at or below permissible limits. Freedom from oxygen, and from voids, is guaranteed by the method of casting the bars from which we roll the forms required. In addition, there is an operation which results in Revere OFHC Copper being not just commercially free but *nearly absolutely free* of internal and external defects. This great care in producing copper for radio and radar purposes probably accounts for the fact that Revere is a preferred source of supply.

REVERE PRODUCTS AND SERVICES

All Revere Metals are processed with the care and attention required to assure that they meet all metallurgical and physical specifications. Revere supplies mill products in non-ferrous metals and alloys, and also electric welded and lockseam steel tube. An important part of our service to industry is the Revere Technical Advisory Service, which will gladly collaborate with you on specifications and fabrication methods.

REVERE

COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

230 Park Avenue, New York 17, New York

• • •

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

Sales Offices in Principal Cities, Distributors Everywhere

SMALLER DIMENSIONS...
HIGHER CURRENT RATINGS...
HIGHER EFFECTIVE VOLTAGE RATINGS...

IN THE NEW
LAPP GAS-FILLED CONDENSERS

PREVIOUS MODEL
1000 mmf, 21 Kv peak, 40 amps RMS

NEW MODEL
1000 mmf, 23 Kv peak, 70 amps RMS

The new Lapp Gas-Filled Condensers save about 30% of space requirements as compared with previous units. Current paths are only one-third as long, with consequent lower losses. Current ratings, effective voltage ratings and safety factors have been increased. On variable models the tuning shaft is at ground potential, which eliminates need for special insulated tuning shafts. Puncture-proof. Constant capacitance without need for "warm-up." Lapp Gas-Filled Condensers are a source of proved dependability for capacitance at high voltages or high currents for radio or industrial electronic circuits. Write for bulletin No. 265.

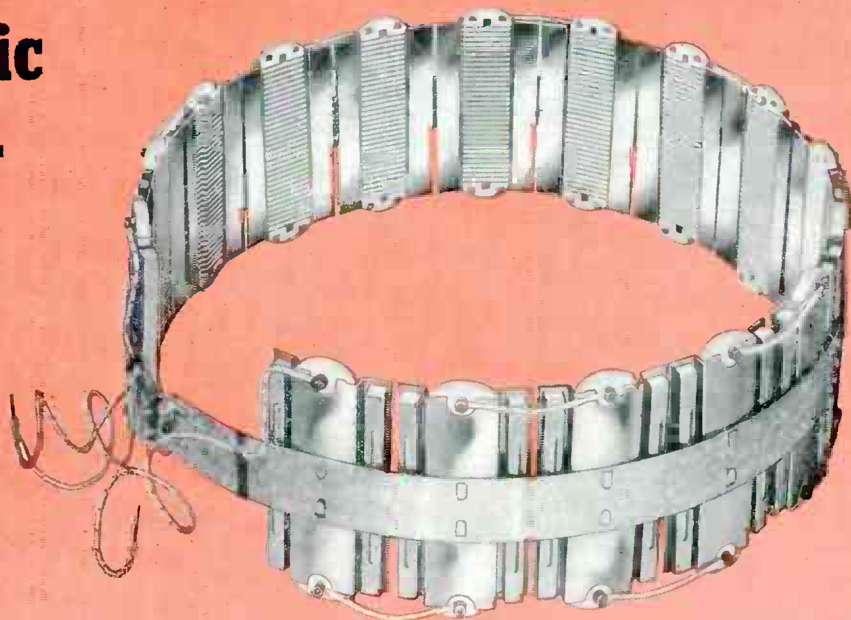
Lapp

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


Sign of Transformer Reliability
KENYON
For over 20 years, the KENYON "K" has been a sign of transformer reliability. Ever since the cat's-whisker, crystal-set days, KENYON has pioneered high quality transformers. Skillful engineering, progressive design and sound construction have resulted in dependable, conservatively-rated transformers with an enviable record for minimum field rejections. Cut engineering and replacement costs. Improve products. Insure repeat business. Specify KENYON!
Consult KENYON
About Your Transformer Problems
KENYON TRANSFORMER CO., Inc.
840 BARRY STREET
NEW YORK 59, N.Y.

ELECTRIC "LIFE BELTS"

for domestic hot water heaters



When water in municipal systems contains dissolved minerals and chlorine, it becomes a fairly efficient electrolyte.

To avoid electrolytic corrosion which may occur if dissimilar metals are in contact with the water, the Toastmaster Water Heater employs "LIFE BELT" heating elements attached to the outside of the tank. In such an application, the ability of the elements to give long, trouble-free, economical service rests solely upon the quality of the electrical resistance material used. To assure top-level performance for a lifetime, the McGraw Electric Co., maker of the Toastmaster Water Heater, specifies Nichrome.*

The tank of the Toastmaster Heater is further protected by McGraw's new "Ionodic" system of corrosion prevention, where a magnesium rod anode, immersed in the water, saves the cathodic material of the tank from electrolytic attack.

Thus the manufacturers are able proudly to state: "We guarantee the Toastmaster Electric Water Heater for 10 years, and we deem this to be a conservative commitment. Many water heaters made by this company are still in daily use after several times this length of service, and elements in the old water heaters show little wear and no loss of efficiency."

Profit by the example of the McGraw Electric Co. and specify Nichrome. And remember, Driver-Harris manufactures over 80 alloys designed to fill the numerous requirements of the Electrical and Electronic industries . . . fully described in our catalog R-46.

Nichrome is Manufactured only by

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

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.

Physical Properties of Insulation

No. 7

in a series on properties of electrical insulation. Previous advertisements stressed understanding of dielectric strength; in this discussion emphasis is shifted to physical properties of electrical insulation.

PHYSICAL PROPERTIES OF INSULATION VITAL IN ELECTRICAL EQUIPMENT DESIGN

Dielectric strength values are probably the most useful *single* criterion of the behavior of electrical insulation for specification, comparison and design purposes.

The behavior of insulating materials under electrical stress is, however, only one of many factors to be considered in its selection. Just as electrical insulation is the only means of isolating electrical circuits, so it provides the only mechanical support for electrical conductors. It is thus the "keystone" which locks equipment elements into proper relative position and supports them, electrically and mechanically. It often requires careful judgment to secure the proper balance of properties in a material for a specific application, since the electrical and mechanical environments may frequently demand performance characteristics which are at variance with each other.

Therefore, the engineer must know not only the electrical properties of an insulating material, but also how it will react physically to high temperatures, vibration, abrasion, compression, shock and tensile stresses in operation *and* in fabrication and assembly.

Values for the physical properties of electrical insulation, as determined by methods standardized by the American Society for Testing Materials, should be interpreted with the same caution as dielectric strength values. For physical characteristics may vary with the thickness of the material and its temperature and moisture content.

IMPACT TESTS

ASTM Designation D256-47T sets up methods for determining the relative toughness or resistance to shock of electrical insulating materials. Impact values are indicated by the energy expended by the machine in fracturing a standard sample of material, ½" x ½" square, with a notch approximately .100" deep, so that thickness of the sample to the notch is exactly .400".

Two methods are used. *Method A* employs a Cantilever Beam (Izod Type) Impact Machine in which the specimen is clamped at one end as a cantilever beam (Figure 1). *Method B* employs a Simple Beam (Charpy Type) Impact Machine which is similar except in the design of the impact head, and in that the test sample is supported at both ends. The pendulum is released from such a height that linear velocity of striking edge at impact is about 11 fps.

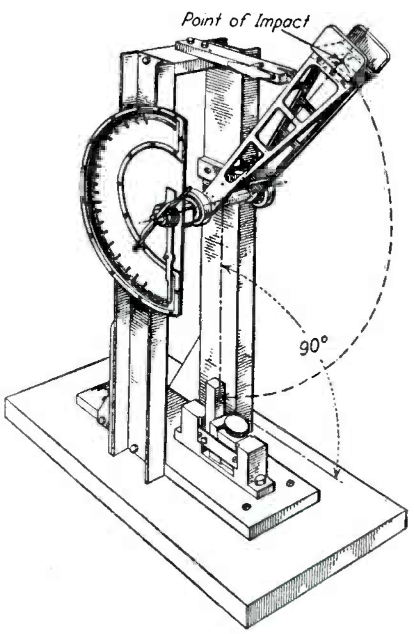


Figure 1—Cantilever Beam (Izod Type) Impact Machine used in testing impact resistance of electrical insulating materials.

Test reports include: (1) specimen size, (2) method of test, (3) conditioning, (4) direction of testing (sheet materials), (5) whether samples were cut lengthwise or crosswise from the sheet, (6) value of energy expended in breaking sample, expressed in ft-lb per inch of notch, (7) average thickness of sample and (8) number of such samples broken in each operation of the machine.

LAMICOID SHEETS—
MINIMUM IMPACT STRENGTH

NEMA Grade		Izod Impact Strength Ft-lb/in. notch (Flatwise)	(Edgewise)
X	*(Paper Base)*	1.3	0.50
P	*(Paper Base)*	*	0.50
XX	*(Paper Base)*	1.0	0.40
XXP	*(Paper Base)*	*	0.40
XXX	*(Paper Base)*	0.80	0.35
XXXP	*(Paper Base)*	*	0.30
C	*(Canvas Base)*	3.2	2.0
CE	*(Canvas Base)*	2.3	1.3
L	*(Linen Base)*	2.5	1.2
LE	*(Linen Base)*	1.8	1.0
A	*(Asbestos Paper Base)*	1.8	0.80
AA	*(Asbestos Fabric Base)*	3.5	3.0

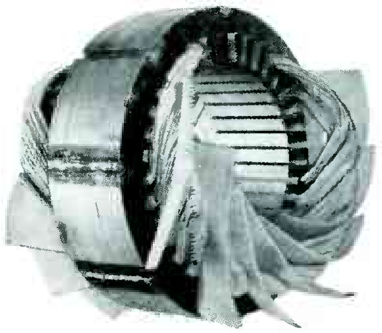
*Flatwise tests are applicable only to sheets having a thickness of ½" or over. No flatwise values given as these grades are not available in thicknesses exceeding ¼".

MICA

Vital in Electrical Equipment Design

MICA PRODUCTS OFFER WIDE RANGE OF PROPERTIES

Mica Insulator Company manufactures a highly diversified line of insulating materials which afford many combinations of physical and electrical properties. Longer life and better performance have been built into many different products through careful selection and application of materials possessing the proper balance of characteristics.



EMPIRE ARMATITE SLOT INSULATION

tough, flexible, easily-formed combinations of fabric and paper, provides relatively high dielectric strength and more compact finished insulation. It is used together with high-strength Lamicoid slot wedges and Empire cloth for phase insulation in this wound stator for a squirrel cage motor. Physical and dielectric properties complement each other in providing insulation dependability.

POST-FORMING LAMICOID

ideal for deep drawing and forming, is used to advantage by RCA as an antenna case and insulating part for the 66BX portable radio. In addition to its high dielectric strength and low power factor, this fabric-base laminated plastic has the advantages of high impact resistance and compressive strength, and is stable under varying atmospheric conditions.

FIBERGLAS-BASE LAMICOID

impregnated with Melamine resin, finds wide use where fire, arc and temperature resistance and high impact strength are important, as in terminal and panel boards, slot sticks, pole collars and coil spacers. It possesses very high dielectric strength and very low moisture absorption.

Over 50 years of experience have gone into the development and manufacture of Mica Insulator Company electrical insulation products. The accumulated knowledge of material properties and specialized experience in the problems of electrical insulation application is at your disposal. Consult our Technical Service Department on your insulation problems.

MICO ELECTRICAL INSULATION

Trade-mark

Mica Insulator COMPANY

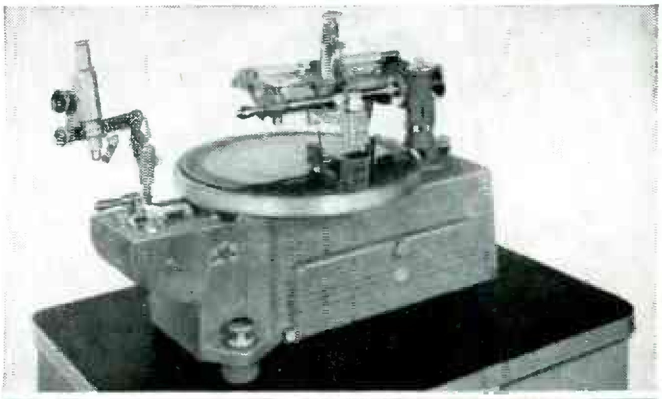
SCHENECTADY 1, NEW YORK

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

Always room for something *NEW* and *BETTER*

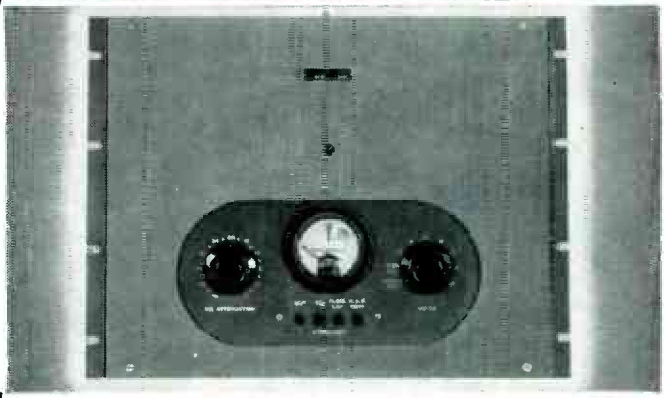
NEW ▸ ▸ ▸
Presto 8D-G Recorder

Extreme accuracy . . . designed for the finest instantaneous and master recordings. A special feature is the direct gear drive with separate motors for 33⅓ and for 78.26 rpm. Overhead driven independently of the turntable and has a choice of seven different feed pitches in each direction.



NEW ▸ ▸ ▸
Presto 92-A Recording Amplifier

Sixty-watt amplifier especially designed for high-fidelity recording. Vertically mounted chassis. Removal of front panel gives access to all circuits. Output stage has four 807's in push-pull parallel. Selector switch and meter provide both output level indicator and plate current readings for all tubes. Response: 20-17,000 cps.

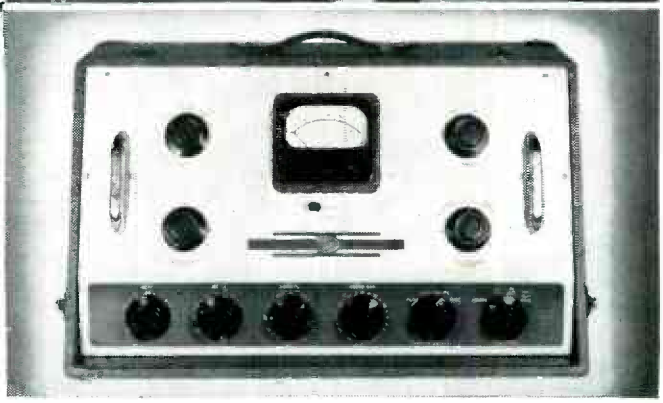


NEW ▸ ▸ ▸
Presto 64-A Transcription Unit

Directly gear-driven at both 33⅓ and 78.26 rpm, with two separate motors, one for each speed. Instantaneous speed selection by turning mercury switch, without damage to mechanism. Speed: Total speed error is zero. Noise: At least 50 db below program. Starting: Table on speed in less than ⅛ revolution at 33⅓ rpm.

NEW ▸ ▸ ▸
Presto 90-A

Complete portable recording console. Three low-level input channels with mixers, master gain control and variable high and low frequency equalizers. Four fixed characteristics: Flat between 30 and 15,000 cps, NAB recording, 78 rpm recording, and playback complementing NAB recording.



For further information about any of this new equipment, write or wire

PRESTO RECORDING CORPORATION, Paramus, New Jersey
Mailing Address: P. O. Box 500, Hackensack, New Jersey

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

Specify HI-Q COMPONENTS for PRECISION . . .

Precision standards are set in the laboratory.

Accurate performance of your product is limited by the precision of its component parts. It is only through selection of precision components that superior performance can be assured. Hi-Q Ceramic Capacitors, for example, can be held to a minimum tolerance of .25 MMF. Constant surveillance throughout every stage of manufacture . . . from raw material to finished product . . . is responsible for this uniformly high quality of all Hi-Q components. Specify Hi-Q components . . . your assurance of precision performance.

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.

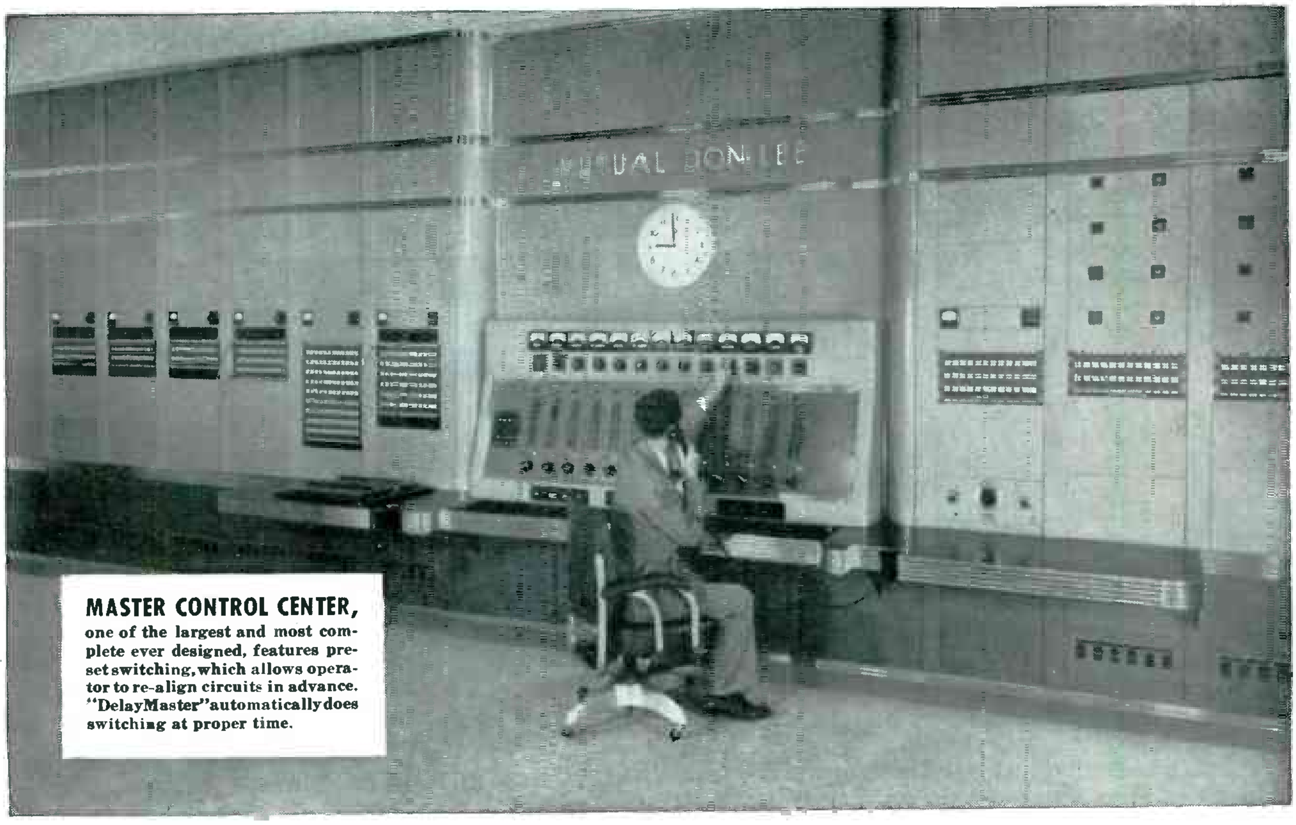
DEPENDABILITY Interpret this factor in terms of your customers' satisfaction . . . Year after year of trouble-free performance. Our Hi-Q makes your product better.

SPACE SAVING 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. — JESSOP, PA.
Sales Offices: BOSTON, NEW YORK, PHILADELPHIA, DETROIT, CHICAGO, LOS ANGELES

New Mutual-Don Lee Studios



MASTER CONTROL CENTER, one of the largest and most complete ever designed, features pre-set switching, which allows operator to re-align circuits in advance. "DelayMaster" automatically does switching at proper time.

MUTUAL-DON LEE'S brand new 3 million dollar Hollywood studios serve as the heart of the network's West Coast AM-FM-TV activities. The block-square building is as modern as tomorrow, and its audio facilities are unexcelled anywhere in completeness and flexibility.

The impressive Master Control—custom-built by Western Electric—is one of the world's largest and most complete control centers. It contains equipment for simultaneous multiple dispatching to 10 outgoing networks and 4 recording channels of programs originating in the 12 studios, 3 announce booths, 96 remote pick-up lines and 7 incoming networks. Many extra circuits are provided to handle special requirements and a complete monitor system makes all programs available to managerial, sales, and public rooms. Through the use of pre-set program control with automatic switching, only one master operator is required.

Besides the Master Control equipment, Western Electric supplied for the studios 14 custom audio desks of the three types shown on the opposite page.

The "king size" of this installation is indicated by the number of components in Master Control and the 14 desks: 212 amplifiers, 67 rectifiers, 996 relays and 6,999 jacks, joined by 145,500 feet of wire with 108,074 soldered connections.

Western Electric and Bell Laboratories engineers are experts in the design and construction of custom-built audio and switching systems for stations of every size—as simple or complex as you require. For details see your Graybar Broadcast Representative, or write to Graybar Electric Company, 420 Lexington Avenue, New York 17, N. Y.

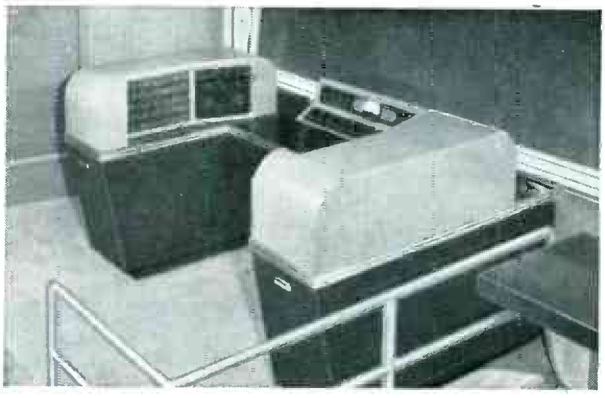
—QUALITY COUNTS—

Distributed by GraybaR OFFICES IN 95 PRINCIPAL CITIES

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

Western

Custom Equipped by Western Electric



STUDIO CONTROL CONSOLES—Eight of these serve the auditoriums and drama studios in the new Mutual-Don Lee headquarters. Each console provides for six microphone inputs, a reverberation circuit, two transcription inputs and a remote input channel.

STUDIO-TYPE TRANSCRIPTION CONSOLES
Three of these are used in the smaller studios for handling commentary and round-table discussion programs, disc jockey shows, and the playback of delayed broadcasts with facility for cut-in announcements.

ANNOUNCE-TYPE TRANSCRIPTION CONSOLES—Three of these provide facilities in the KHJ network and FM announce booths for fading into and out of programs, giving identification and spot announcements and playing transcribed commercials and recorded fills.

Mutual-Don Lee's new $3,000,000 block-square Hollywood home.

Electric

3 sensitive ALLIED RELAYS

FOR A LIMITED POWER SUPPLY OR PRECISE OPERATING CHARACTERISTICS

TYPE B
ALLIED RELAY

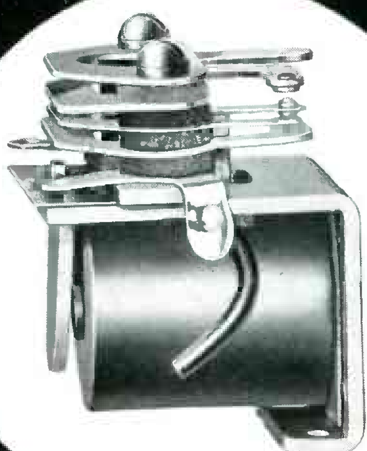
SENSITIVITY: 9 MILLIWATTS

Supplied with contact arrangements up to 2-pole double-throw. Standard silver contacts rated at 1 ampere at 24 volts DC or 110 volts AC non-inductive. Coil rating 9 milliwatts up to 38 volts DC and 0.12 volt-amperes up to 110 volts AC. Dimensions: 1¾" x 2⅜" x 2¾".

TYPE BG
ALLIED RELAY

SENSITIVITY: 11 MILLIWATTS

Contact arrangements, single-pole double-throw. Standard silver contacts rated at 2 amperes at 24 volts DC or 110 volts AC non-inductive. Coil rating 11 milliwatts up to 25 volts DC. Coils available for DC operation only. Dimensions: 1¼" x 1¾" x 1⅜".



TYPE F
ALLIED RELAY

SENSITIVITY: 80 MILLIWATTS

Supplied with contact arrangements up to 2-pole double-throw. Standard silver contacts rated at 2 amperes at 24 volts DC or 110 volts AC non-inductive. Coil rating 80 milliwatts up to 31 volts DC. Coils available for DC operation only. Dimensions: 1⅜" x 1³⁄₁₀" x 1⅜".

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

AL-128

ALLIED CONTROL COMPANY, INC.

2 EAST END AVENUE, NEW YORK 21, NEW YORK

ASTATIC BRINGS YOU A TRULY REVOLUTIONARY DEVELOPMENT

THE MAGNETO-INDUCTION PICKUP

Yes, this is it! An entirely new concept in record-reproduction engineering. A radically new pickup cartridge that opens broad new vistas of listening pleasure . . . offers unchanging faithfulness and quality of reproduction that is stable and trouble-free.

The Astatic Magneto-Induction Pickup represents the first clean break with traditional principles, employed in the manufacture of magnetic type reproducers, since the introduction of such devices in early phonographs. Discarded now by this amazing development is the need for delicately spaced "air gaps," which collect lint and dust, and thereby become a prime source of trouble in other type magnetic pickups. Their elimination in the Magneto-Induction cartridge is all the more revolutionary . . . a newly opened door to greater record enjoyment . . . to a peak fidelity of reproduction that LASTS, even under the most consistent service or adverse climatic conditions.

MODEL MI-1, Code ASAKA — **Standard Housing**

MODEL MI-2, Code: ASALZ — **Mumetal Housing***

**Provides increased shielding effect for maximum reduction of hum*

Two Equalizer-Amplifier models available:

Model EA-1, compact unit designed for installation in radio sets and audio amplifiers having insufficient gain for operation of Astatic Magneto-Induction Pickup Cartridges. Provides "bass boost."

Model EA-2, self-powered, provides adjustable "bass boost," adjustable treble "roll-off," and selection of "turnover frequency."

Here are the OUTSTANDING FEATURES . . .

1. No "Air Gaps."
2. Necessity for delicate handling eliminated.
3. No troublesome, costly armature balancing problems.
4. Longer-lived, troublefree performance without distortion or changes in characteristics.
5. Transcription quality reproduction.
6. Velocity response flat to 12,000 cycles.
7. Output is 100 millivolts. This is approximately 20 db. greater than most previously available, light-weight magnetic pickups.
8. Needle pressure, 1 oz.
9. Impedance, 7,500 ohms at 1,000 c.p.s.—110,000 ohms at 10,000 c.p.s.
10. Interchangeability: Physical dimensions of this cartridge are such that it can be employed with a majority of present day standard pickup and transcription arms.

Now Available

THE **Astatic** CORPORATION
CONNEAUT, OHIO
IN CANADA: CANADIAN ASTATIC LTD., TORONTO, ONTARIO

Manufactured under Massa Laboratories License

When the circuit calls for "Q" . . .

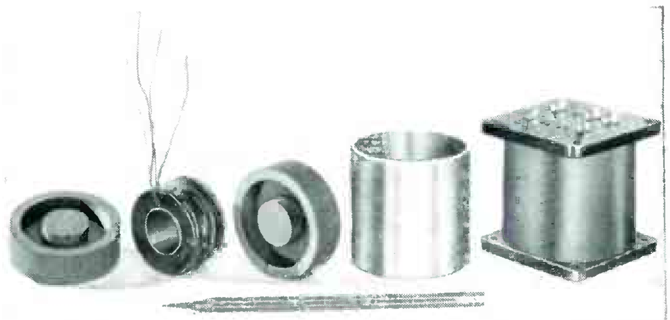
STACKPOLE CUP CORES

save space • reduce costs improve performance

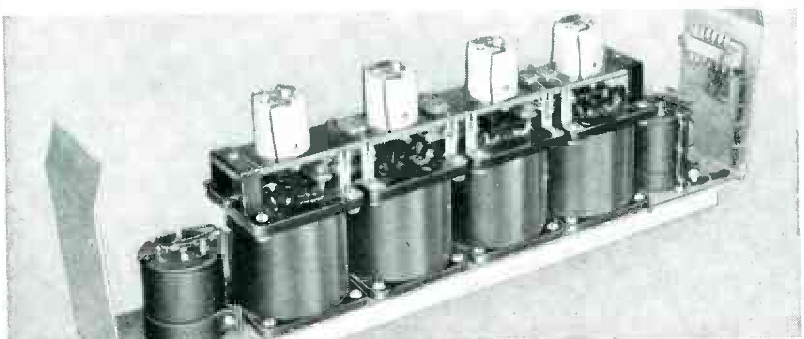
Stackpole iron powder molded cup cores are ideally suited to save valuable space and to make important contributions to high "Q" circuits. They are compact, efficient; may be mounted close to the chassis or any other metal part.

Stackpole offers a broad range of shapes and types—and, where required, can produce special cup cores to the most exacting specifications. Write for samples. State your specifications and probable quantities required.

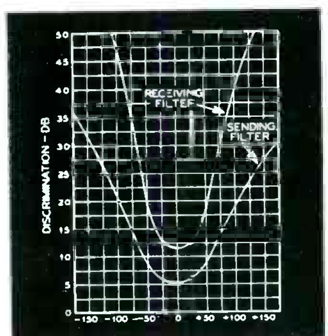
The laminated steel core coil requires about three times as much space as the newer powdered-iron core coil.



Above is a still further refinement of the loading coils shown at left. This coil may be wound more easily, and at less cost than the toroid type.

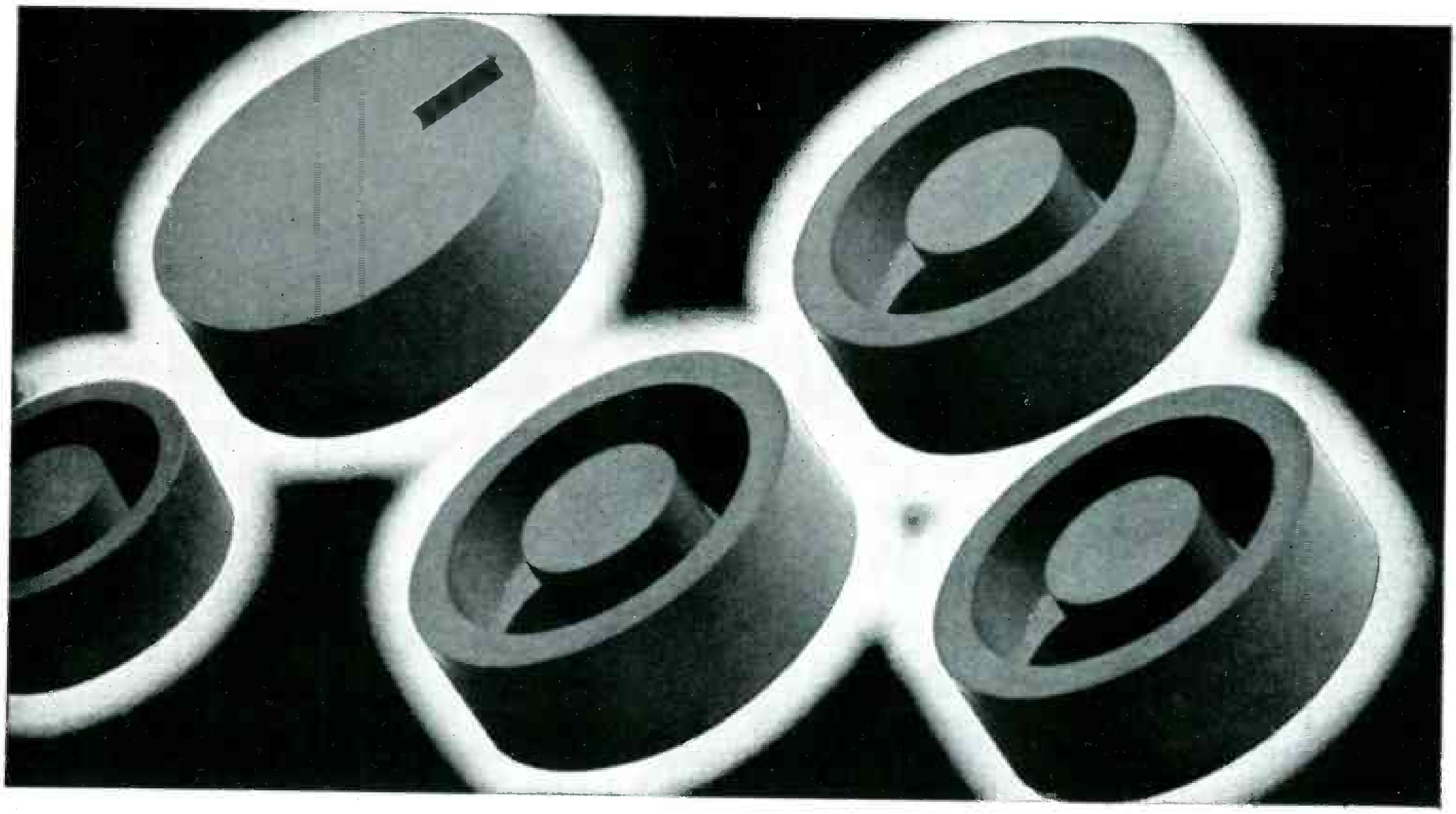


The neat, compact unit above is a Western Union carrier filter featuring four Stackpole powdered-iron cup-core type inductors. Imagine the space required if only toroid or laminated core coils, as shown in the first illustration, were available.



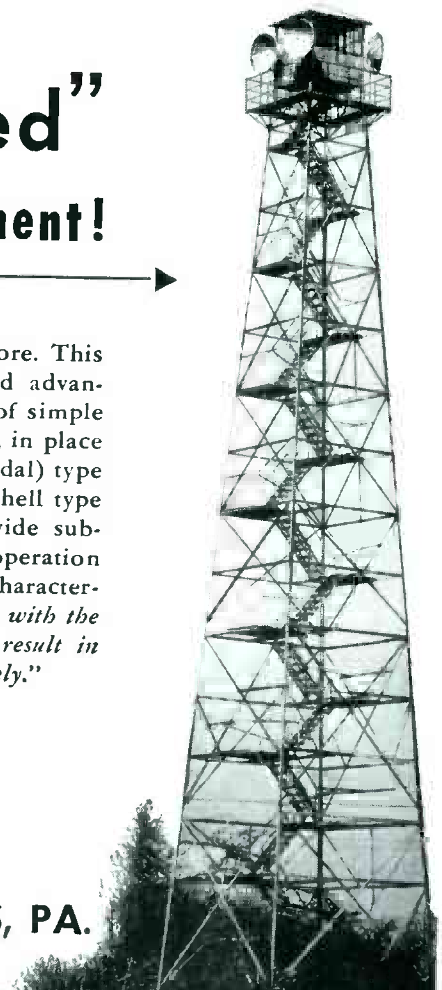
In Western Union carrier telegraph systems, Stackpole cup cores contribute to the performance shown above.

IRON CORE



"Tested and Approved"

in Western Union Radio Beam Equipment!



Made by Stackpole to meet rigid requirements of Western Union design, Powdered-Iron Cup Cores are a relatively recent development. Western Union Radio Beam and Carrier Systems Equipment engineers have taken full advantage of the many space and labor-saving possibilities they offer. Since 1942, progressive design improvements resulted in the pictures shown at the left.

Part of a recent Western Union report reads, "Subsequent research work has resulted in a new shell type of core. This form of core possesses marked advantages in that it permits the use of simple coils, wound on a plastic spool, in place of the laboriously wound (toroidal) type previously necessary. . . . The shell type powdered-iron cores also provide substantial improvement in carrier operation due to improved attenuation characteristics. *These advantages, together with the reduction in cost, will doubtless result in shell type coils being used extensively.*"

Get All the Up-to-Date Information on Stackpole Cup Cores—Write for Bulletin RC-7B

STACKPOLE

STACKPOLE CARBON COMPANY • ST. MARYS, PA.

H E A D Q U A R T E R S

Only a Prosperous America Can Be Free

DURING May 50 million American workers will get from the Congress of the United States a real incentive to work.

This incentive is called a tax cut. Beginning May 1, the withholding tax on incomes will be reduced, giving everyone a much-needed increase in take-home pay.

But the tax cut will have a far more important effect. It may be literally a life-saver for American employment and production – and, hence, for the stability of the world. It will help to do two things which must be done if our economy is to continue to furnish good jobs and good earnings.

1. *It will generate part of the private funds for investment in common stocks – the "risk capital" which we need to sustain prosperity.*

2. *It will provide part of the incentives necessary to make American business management still more effective.*

These two predictions are not advanced as matters of opinion. They are based on facts reported by McGraw-Hill field editors.

These facts show why the reductions in upper bracket income tax rates are most significant for our continued prosperity. For the first time in more than twenty years the tax burden on people who can afford to risk their savings has been lightened. To find out what this will mean to the economy, McGraw-Hill field editors all over the nation asked a group of business executives making $15,000 a year or more how they will use the money which the tax cut gives them. Here is what they said:

1. They plan to save – not spend – three-fourths of the money they keep as a result of tax reduction.

2. They plan to invest one-half of these savings in common stocks. If all persons making over $15,000 follow this pattern, they will make available about a half billion dollars of risk capital for American industry.

WHAT THE TAX CUT WILL DO

What will upper bracket taxpayers do with their tax savings?
What can business expect as a result?

TO ANSWER THESE QUESTIONS, McGraw-Hill field editors interviewed a carefully selected sample of business executives earning $15,000 a year or more. Here, for the first time, are solid facts that show how tax reduction will effect the supply of risk capital and business incentives. These are the results:

1) How much of your tax reduction will you save?	74%
2) How much of your tax savings will you invest in common stocks?	52%
3) Will lower taxes lead you to switch some of your investment in bonds to stocks?	Yes 28%
4) Have you passed up an opportunity to invest in a new business in the last five years because the return after taxes did not justify the risk?	Yes 40%
5) Will lower taxes make you more inclined to take a risk on a new business?	Yes 80%
6) Have you turned down the opportunity to take a bigger job in the last five years because taxes would take too much of the additional income offered?	Yes 13%
7) Do you know of actual cases of executives who have turned down bigger jobs or more work because of taxes?	Yes 38%
8) Will lower taxes make you more inclined to take on a bigger job or more work?	Yes 59%

3. They also will switch some of their present savings from bonds and bank accounts to common stocks. This might easily add a billion dollars or more to the supply of risk capital.

The one-half billion dollars of tax savings and the funds switched from other investments into common stocks is not enough to end the shortage of risk capital. But it is a start.

Before passage of the tax law, risk capital had been growing increasingly scarce.

One measure of the scarcity is that last year only four-tenths of 1% of national income went into new common stocks. In 1925, a year of normal prosperity, almost 3% of national income was invested in new common stocks.

Another measure is that between 1940 and 1947 people actually reduced their holdings of corporate stocks and bonds by nearly a billion dollars. During the same period, people salted away almost $150 billion in such safe havens as cash, bank deposits, and government bonds.

This drought of risk capital hit us just when we need a vastly increased flow of risk capital to finance the expansion and improvement of our American productive machine. We need risk capital to search for new oil fields and to build new pipelines and refineries. We need capital to expand our over-loaded electric and gas utilities. We need it to finish re-equipping our airlines and railroads and bus lines. We need it to modernize our textile production. We need it to keep pace in the magical, booming chemical industries. We need it to launch the new industry of television.

We need capital for all this work and for much more besides. And we must do all this work if we are to keep the United States dynamic and if we are to create new and better jobs.

The tax cut comes just in time. As the last editorial in this series showed, the flow of risk capital must double or triple if we are to avoid a cutback in industrial expansion next year. A major reduction in industrial expansion because of a shortage of risk capital would menace our prosperity. Whenever capital expansion has sagged, the whole economy has sagged. That is the record. That is why every American has a crucial interest in breaking the shortage of risk capital.

The tax reduction now going into effect helps relieve that shortage. In my opinion, we need still other tax changes to assure enough risk capital for healthy industry and healthy employment.

We should encourage the rapid depreciation and replacement of plants and equipment to keep America efficient.

We should eliminate the double taxation of stockholders' incomes.

We should permit full averaging of good years and bad in calculating income tax payments.

We should cut tax rates again as soon as we can.

The tax cut of 1948 will prime the flow of capital. We must keep it flowing.

The tax cut also encourages our successful men and women to work harder and more effectively.

The McGraw-Hill editors collected some solid facts to show how seriously heavy taxes have discouraged business leaders. Here they are:

1. One out of seven persons the editors questioned said that they had turned down positions with greater responsibilities because heavy taxes would take most of the greater pay that went with the harder job.

2. Six out of ten executives would be more inclined to accept a more responsible job now that taxes will let them keep more of the added pay such a job would bring.

We all have a stake in incentives which make men work harder, especially talented men. The more we each work, the more we all have.

The tax reductions so far made will leave the government more than enough revenue to meet all its expenses, including the proposed defense expenses, and still reduce the national debt. If more defense money becomes necessary, vigorous economy on less essential government expenses will make possible both stronger military defenses and a better tax system. We need both.

Only a prosperous America can be strong enough to remain free—and to help keep the rest of the world free.

James H. McGraw, Jr.

President, McGraw-Hill Publishing Company, Inc.

THIS IS THE 67TH OF THE SERIES

Here's the loudspeaker line that rocketed to stardom!

755A—8" direct radiator. 8 watts, 70-13,000 cycles.

756A—10" direct radiator. 20 watts, 65-10,000 cycles.

728B—12" direct radiator. 30 watts, 60-10,000 cycles.

754 TYPE—12" high-efficiency direct radiators. 60-10,000 cycles; 15 watts indoor service, 50 watts outdoor.

757A—dual unit system. 30 watts, 60-15,000 cycles.

IN just a few months after deliveries started, the Western Electric line of high-quality, wide range speakers has won a position of undisputed leadership wherever the ultimate in sound reproduction is desired.

All of these speakers combine, to a unique degree, unmatched realism in reproduction with exceptionally small space requirements and ease of installation. With their range of power capacities, you can select just the speaker you want for every sound radiation requirement.

Have you ordered some? Call your local Graybar Broadcast Representative, or write Graybar Electric Co., 420 Lexington Ave., New York 17, N.Y.

THESE ARE AMONG THE BROADCAST STATIONS THAT ARE USING THE NEW WESTERN ELECTRIC LOUDSPEAKERS

ALABAMA
WAFM Birmingham

ARIZONA
KOY Phoenix
KPSC Phoenix
KTSC Tucson
KYSC Yuma

ARKANSAS
KFPW Fort Smith
KWHN Fort Smith

CALIFORNIA
KBMT San Bernardino
KCRA Sacramento
KFAC Los Angeles
KFRC San Francisco
KGFN Grass Valley
KIEM Eureka
KIEV Glendale
KOWL Santa Monica
KRE Berkeley
KSJO San Jose
KUSC Los Angeles
KUSN San Diego
KWIK Burbank

FLORIDA
WALT Tampa
WCNH Quincy
WDAE Tampa
WDBO Orlando
WKAT Miami Beach
WQAM Miami
WSUN St. Petersburg
WTAL Tallahassee

GEORGIA
WCON Atlanta
WGST Atlanta
WNEX Macon
WSB Atlanta

IDAHO
KFXD Nampa
KWEI Weiser

ILLINOIS
WBBM Chicago
WFRL Freeport
WHBF Rock Island
WIND Chicago
WKRS Waukegan
WMBD Peoria
WOAK Chicago
WSOY Decatur

IOWA
KCBC Des Moines
KDEC Decorah
KDTH Dubuque

KANSAS
KIMV Hutchinson
WREN Topeka

KENTUCKY
WGRC Louisville

LOUISIANA
WAFB Baton Rouge
WCLA Baton Rouge
WTPS New Orleans

MASSACHUSETTS
WBZ Boston
WLYN Lynn
WNAC Boston

MICHIGAN
WELL Battle Creek
WHRV Ann Arbor
WJBK Detroit
WKAR Lansing
WWJ-TV Detroit

MINNESOTA
KAUS Austin
KBTR Minneapolis
KSTP Minneapolis
WCCO Minneapolis
WEBC Duluth
WMIN Minneapolis
WTCN Minneapolis

MISSISSIPPI
WLOX Biloxi

MISSOURI
KHMO Hannibal
KWK St. Louis
KWTO Springfield
WIL St. Louis

MONTANA
KIYI Shelby
KOJM Havre
KPRK Livingston

NEBRASKA
KFAB Omaha
KOWH Omaha

NEW JERSEY
WPAT Paterson

NEW YORK
WJZ New York

NORTH CAROLINA
WDNC Durham
WFMY Greensboro

NORTH DAKOTA
KVOX Fargo

OHIO
WADC Akron
WEWS Cleveland
WHIZ Zanesville
WHIO Dayton
WHK Cleveland
WHKC Columbus
WHKK Akron
WJW Cleveland
WOSU Columbus
WSPD Toledo
WSRS Cleveland Heights

OKLAHOMA
KGLC Miami
KOMA Oklahoma City
KSIW Woodward
KSPI Stillwater
WKY Oklahoma City

OREGON
KALE Portland
KGW Portland
KPFM Portland
KUIN Grants Pass

PENNSYLVANIA
KDKA Pittsburgh
WCAE Pittsburgh
WCRO Johnstown
WHJB Greensburg
WHOD Homestead
WJAS Pittsburgh
WJSW Altoona
WKJF Pittsburgh
WKRZ Oil City
WMBS Uniontown
WMCK McKeesport
WMGW Meadville
WPGH Pittsburgh
WPIC Sharon
WBVP Beaver Falls

RHODE ISLAND
WEAN Providence

SOUTH CAROLINA
WIS Columbia

SOUTH DAKOTA
KELO Sioux Falls
KSDN Aberdeen
KSOO Sioux Falls

TENNESSEE
WHIN Gallatin
WMAK Nashville

TEXAS
KABC San Antonio
KCMC Texarkana
KLEE Houston
KMAC San Antonio
KRLD Dallas
KTRM Beaumont
WBAP Fort Worth
WFAA Dallas

VIRGINIA
WRVA Richmond

WASHINGTON
KBRC Mt. Vernon
KBRO Bremerton
KOMW Omak
KONP Port Angeles
KRSC-FM Seattle
KTBI Tacoma
KVNI Spokane

WEST VIRGINIA
WAJR Morgantown
WCOM Parkersburg
WLOG Logan
WLOH Princeton
WMMN Fairmont
WPDX Clarksburg
WPLH Huntington

WISCONSIN
WATK Antigo
WCLO Janesville
WEAU Eau Claire
WIBA Madison
WJMC Rice Lake
WJPG Green Bay
WKBH La Crosse
WMIL Milwaukee
WOBT Rhinelander
WTAQ Green Bay
WWCF Poynette

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

Distributed by GraybaR
OFFICES IN 95 PRINCIPAL CITIES

Western Electric

—QUALITY COUNTS—

BUSINESS BRIEFS

By W. W. MacDONALD

Biggest Customer for many RMA member-companies in 1947 was Uncle Sam. Here's the way communications equipment sales (exclusive of home receivers) broke down, most of the volume covering transmitters and associated apparatus:

U.S. Government	$48,548,676
Broadcast Stations	25,868,781
General Users	9,631,332
Aviation	3,591,633
Marine	292,389

Uncle was first by a wide margin on electronic navigation equipment, including radar and sonar:

U.S. Government	$81,320,455
Aviation	2,823,571
Marine	769,743

And Uncle bought $4,601,257 worth of our laboratory and test equipment.

Movie People, now very conscious of the competition presented by home television, are out of the talking and into the doing stage. Paramount recently relayed a spot news event into a New York picture palace, transferred it to a film and ran the film thirty seconds later. The audience, not told about the stunt at the box office, took the program for granted.

Watch for more of this sort of thing, without benefit of cooperation from broadcast stations.

Multiple-Screen Tele, an idea broached some time ago in this column (p 68, March), appears to be taking hold. Commercial installations involving one set and several remotely-operated cathode-ray tubes have been made in taverns in the New York area. Adaptation of the scheme to home sets appears certain to follow.

Indoor Tele Antennas are badly needed, thought many dealers attending *Televiser's* recent show at the Hotel New Yorker. It seems that thousands of apartment-house families are number-one prospects for sets but, for various reasons, see little chance that they can be connected to outdoor or master antenna systems for years to come.

Things that the public want have a habit of coming true, despite technical difficulties. One possible solution of the indoor tele antenna problem involves a compact directive array positioned to catch signals on the second or third bounce off building walls, in conjunction with a preamplifier. Any other ideas floating around out there?

Major Impression gained at a recent meeting in Philadelphia attended by tube manufacturers and designers of industrial electronic equipment is that it is silly to put a $1 tube in a $1,000 control attached to a $10,000 machine unless the tube is completely suited to the application.

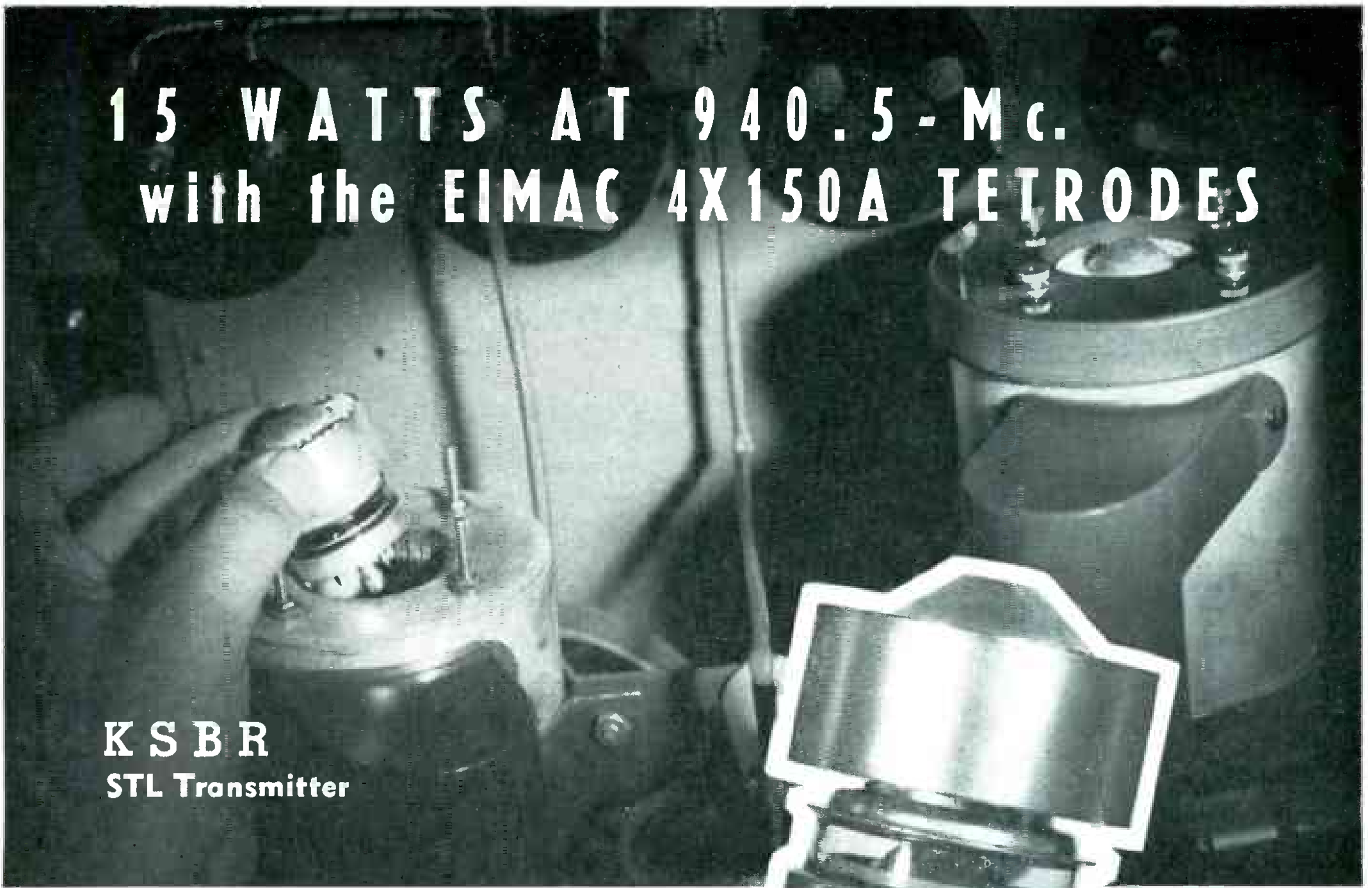
Makers of controls, it seems, are willing and anxious to spend more for tubes that have predictable life, particularly if they can be sure such tubes will be available on a long-term basis.

Miniature Tubes are in such demand that occasional shortages are anticipated. At least one manufacturer is urging equipment designers to play safe by (1) using types available from three or more suppliers, (2) planning chassis layouts readily convertible to octals and, (3) arranging to use miniatures having either of two base layouts.

Prediction by one tube maker is that by 1950 miniatures will represent 60 percent of receiving-type production, metal 20 percent and conventional glass 20 percent.

We Hear That Sperry Gyroscope has just received a contract from the U. S. Coast Guard for 20 loran sets. Some 40 sets were bought back in June of last year. Several aid weather ships to keep on their stations.

Just About Everything is used in the field of electronics. The other day we saw a camera set up to take pictures of oscilloscope



FREQUENCY UP 6X, (156.75-Mc. to 940.5-Mc.)
POWER UP 7X (2 watts to 15 watts)

Eimac **4X150A**

Here's a STL transmitter that's in operation on the new 950-Mc. band, fulfilling all the FCC requirements and powered by Eimac 4X150A tetrodes. It's a part of the studio-transmitter-link between the San Bruno studios and the 250 Kw FM transmitter of station KSBR high atop 3849-foot Mt. Diablo some 33 miles away.

REL MODULATOR → 2 WATTS 156.75-Mc. → EIMAC 4X150A TRIPLER → 15 WATTS 470.25-Mc. → EIMAC 4X150A DOUBLER → 15 WATTS 940.5 Mc.

The R-F amplifier was specifically designed for the KSBR application by Eimac engineers. It is driven by an REL modulator delivering 2 watts output at 156.7-Mc. to one Eimac 4X150A in a tripler stage, which in turn drives a single 4X150A in a doubler stage, providing 15 watts useful output at 940.5-Mc.

The Eimac 4X150A is ideally suited for this application because of its high power gain at relatively low plate voltages, ability as a frequency multiplier without loss of amplification, low grid drive requirements, and a high ratio of transconductance to capacitance. It also has the advantage of being physically small and functionally designed for simple installation.

Complete data on the Eimac 4X150A for STL and other UHF applications is available by writing direct.

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

EXPORT AGENTS: Frazar & Hansen—301 Clay St.—San Francisco, Calif.

ESSENTIAL DATA
KSBR STL TRANSMITTER

REL MODULATOR, MODEL 694
EIMAC 4X150A, R-F AMPLIFIER

Useful Output Power	15 watts
Frequency	940.5 Mc.
Frequency Stability	.002%
Audio Frequency Response. Substantially flat	50 to 15,000 cycles
Distortion	.5% Max.
Noise Level - 70 db below 100% modulation	± 100 Kc. deviation

Eimac 4X150A
General Characteristics

Heater voltage	6.0 volts
Heater current	2.8 amps.
Minimum heating time	30 secs.
Grid Screen amplification factor	4.5
Direct interelectrode capacitance (Average)	
Grid-Plate	0.02 μμf
Input	14.1 μμf
Output	4.7 μμf

Maximum Ratings

D-C Plate voltage	1000 volts
D-C Plate current	250 ma.
Plate dissipation	150 watts
D-C Screen voltage	300 volts

Follow the Leaders to
Eimac TUBES
The Power for R-F

traces, and the darn thing was held in position by Erector-set parts.

Receiver Sales by RCA licensees during 1947 totalled 20,174,370 units, worth $702,798,118. Here's the way the total broke down:

TYPE	UNITS	DOLLARS
Electric		
Table (under $12.50 billing price)	2,206,472	$23,331,200
Table (over $12.50 billing price)		
A-M	7,873,379	150,553,298
A-M/F-M	201,366	10,702,645
F-M (including converters)	72,654	1,840,705
Consoles		
A-M	132,804	13,581,187
A-M/F-M	42,898	5,412,652
Table-Radio-Phonos		
A-M	1,302,491	63,554,888
A-M/F-M	3,581	619,549
Console-Radio-Phonos		
A-M	953.356	96,566,151
A-M/F-M	765,780	123,570,950
Battery		
PortableA-C/D-C	2,427,613	54,565,628
Table	513,536	10,866,683
Consoles	4,014	599,014
Auto	2,862,466	87,120,288
Television		
Converters	.....	.....
Radio Table Models	103,673	22,528,406
Radio Consoles		
Direct viewing	18,551	6,420,776
Projection	10,795	6,175,514
Radio Phonos		
Direct viewing	17,400	7,724,026
Projection	372	613,521
Phonographs		
Phono only	467,605	10,033,767
With radio attachment	74,271	2,100,013
Without Cabinets		
A-M	101,810	2,577,098
A-M/F-M	17,436	1,725,391
Television	47	14,588
TOTAL	20,174,370	$702,798,118

Panel Instruments having 270-degree scales were developed during the war to simplify the reading of necessarily compact types. Now we note with interest that the idea is coming into more widespread use in power instruments both large and small. It seems to us that spreading out of scales is particularly important in the field of electronics, and that the idea merits extension to our kind of apparatus.

Radar Rat Trap promoted by an outfit up in Rochester intrigues us no end. If we were a betting man we'd offer two to one that while the thing may catch rodents it doesn't detect their presence by reflected radio waves.

Philco Sales in 1947 broke down as follows: refrigerators, freezers and air conditioners 32 percent; radio-phonographs and television receivers 30 percent; radio sets 24 percent; tubes, parts, dry batteries, accessories and miscellaneous products 9 percent; government and industrial business 5 percent.

Stromberg-Carlson's 1947 sales were split three ways: radio 65 percent; telephone 31 percent; sound 4 percent.

Allen B. DuMont manufacturing division sales in 1947: television receivers $7,774,000; cathode-ray tubes $1,846,000; cathode-ray oscilloscopes $1,702,000 and television transmitters $517,000.

Vernier Dial designed by one of our readers (p 68, April) appears to interest quite a few manufacturers looking for new things to make, and we have forwarded their inquiries to the designer. Anyone else out there we can help in a similar manner?

Magnet Wire produced in 1947 totalled 300 million pounds, according to the best estimates we have been able to obtain. About one third of this wire went into electronic apparatus.

Best Argument cathode-ray tube makers have for limitation of the number of television types is the cost reduction that can be obtained by mass production. Many students of the current trend toward lower-priced sets believe that savings that might be achieved by variations in tube design at this time are minor by comparison.

Highest Priced item ever offered by GE for use in the home is a new a-m and f-m phono-radio and television set listing at $2,100.

Government Specs cover over 4,000 tube types.

Norm Krim of Raytheon says it costs at least $50,000 to develop a really new tube.

New To Us is an expression heard the other day in a laboratory. We arrived in the middle of an obvious flurry of excitement. Questioned regarding the cause, one of the engineers replied, quite casually, that he thought it was just a *"routine emergency."*

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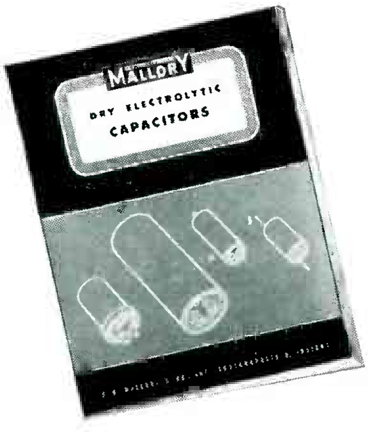
We recently tested capacitors for several customers* who had shelved them for up to six years. All proved ready to use without re-aging. None took more than seven minutes to reach the leakage limit of new units. All characteristics were within the limits of new-unit inspection.

Such quality is added protection for the man who specifies Mallory Capacitors. Such quality is invariably built into Mallory Approved Precision Products.

**Names on request.*



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CROSS TALK

▶ **INTERCARRIER** . . . One of the tempests raging in the television field is that around the intercarrier method of receiving the sound. In this system (see ELECTRONICS, Jan. 1947, p 102), the picture and sound carriers are amplified together in the picture i-f amplifier, developing a 4.5-mc beat frequency (the separation of picture and sound carriers) at the picture tube grid. This beat note is frequency modulated by virtue of the f-m on the sound carrier and hence may be passed through a limiter, frequency detector and audio amplifier to the loudspeaker. At first this idea sounded attractive principally on the grounds of economy, since no sound i-f amplifier is needed. Soon the economy idea was replaced by recognition of advantages relating to the shortcomings of the local oscillator in a standard receiver. The intercarrier system is highly tolerant of drift, microphonics and hum modulation in the local oscillator, since these affect the carriers in the same degree and hence do not disturb the 4.5-mc beat note. An intercarrier receiver would, in fact, require no fine tuning control.

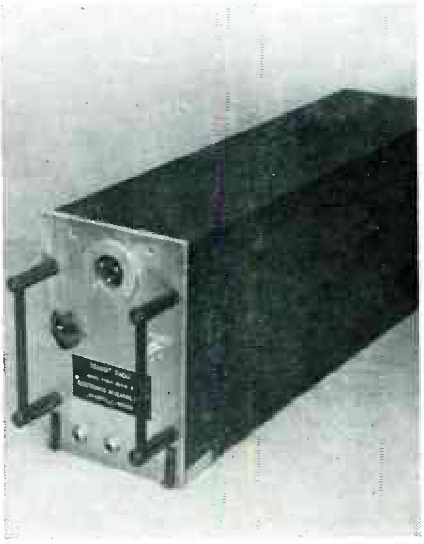
Then a manufacturer was so brash as to bring out an inexpensive video receiver using the intercarrier system. Brash, because mutterings had been heard from the first that the system would fail if the picture carrier was frequency modulated to any extent by the picture waveform. Then a low pitched (60-cps) rattle which could not be separated from the sound modulation would appear at the loudspeaker. To be sure, interference of this type was soon discovered, particularly when the picture modulation was heavy, but the effect was not pronounced and certainly was tolerable in an inexpensive receiver. At least so it seemed on the low-band stations then on the air.

So the inexpensive sets continued to sell, and the mutterings of the transmitter manufacturers continued to be heard, and action to recommend to the FCC standards which would safeguard against excessively heavy picture modulation continued to be deferred. Then a station on channel 13 opened up in the New York area. This channel, on 210–216 mc, was expected to give the most trouble from unavoidable frequency-modulation of the picture carrier. But when listening tests were carried out, the intercarrier sets seemed to do as well, or nearly, as on the low band stations. The conventional receivers, for the most part, gave considerably inferior performance, due to hum modulation, microphonics and drift of the local oscillator, in the order named.

Thus often is confidence misplaced. The transmitter men had done better than they thought; the receiver men had done worse. The argument is not over yet. But the inexpensive receivers continue to sell and the recommended standard continues to be deferred. Our guess is that when enough of the intercarrier receivers are sold, the transmitter designers will have to lick incidental frequency-modulation of the picture or lose customers, and the broadcasters will have to monitor modulation or lose a good part of their audience. We don't argue for such de facto engineering, based on sales figures, but we recognize its power.

▶ **DECISION** . . . Since we commented in February on the care with which marine radar must be used as an anti-collision device, a Canadian court has ruled, in another case, that the use of radar does not free the master of a vessel from the established rule of the sea, namely that he must operate at such speed as to be able to stop within a distance not greater than one-half the range of visibility. Visibility here means the distance the lookout can see with human, not radar, vision. If this decision establishes a precedent in admiralty law, the utility of radar in the marine field will be sharply restricted. No captain would dare run through fog at high speed with radar guidance if by so doing he placed himself and his owners in the position of being legally responsible for any collision which might occur, regardless of other circumstances. Before the courts can be expected to take a more liberal view, an impressive record of safe operation of radar-equipped vessels must be amassed. That drives the point home: radar is a safety aid only when it is properly installed, adequately maintained and intelligently used.

Loudspeakers above the aisle of this Portland, Oregon trolley bus provide music for riders



Fixed-tuned f-m broadcast receiver for bus radio service

Car-Card Radio

THE BANNS have been proclaimed for an interesting four-way marriage of transportation, f-m radio broadcasting, the riding public, and advertising. Proponents of the scheme claim that all the participants gain.

The Basic Idea

Predicated upon the fundamental premise that riders of a transportation system are captive during the period of their travel, the advertiser can be assured of a measured number of listeners to his sales talk for any given day and time of day. In return, the rider gets free music and news. Bus systems feeling the pinch of increased operating costs will welcome any device that supplements revenue from the sometimes provocative but as yet unvocal "car cards". And the station that keys its programs to the new advertising medium can be expected to reap some additional revenue at a time when f-m broadcasting needs it.

The broad contractual aspects of the system are simple. The f-m station enters into an agreement with the local transit company that provides exclusive rights for the broadcaster to install receiving equipment in the vehicles. The radio station pays a monthly fee to the transit company for each radio-equipped vehicle, in the manner of recompense for car card advertising. Another contract is made between the broadcaster and the organizing agency that provides for purchase of receiving units and all accessories (currently selling for about $141) and the appointment of the agency as exclusive advertising representative.

Taking the narrow view (the small city bus line) the suggested system of transportation radio looks simple; but ad men thinking in terms of the broad golden field are already causing engineers some worry. For example, interest has already been shown by certain railroads.

While the bus can get along with a normally sensitive, single-channel receiver, the railroad car must be equipped to pick up weaker signals at greater distance on a receiver that can be tuned from one frequency to another as the train progresses from one service area to another along its route. There is then nothing to insure that the receiver is tuned to the program desired by the sponsor of the service. Length of time that a given station will be heard satisfactorily depends not only upon transmitted power from the antenna but also upon such diverse factors as speed of the train and terrain between the transmitter and the moving receiver.

Planes are a special and more difficult problem.

Programming Problems

Transportation authorities are already discussing contracts that insure a minimum amount of advertising material, both as to length and frequency. Programs can't be all boogie-woogie or all Shostakovitch. The idea of a sports broadcast is enough to make any transportation executive's hair

Table 1—Announcement and Time Rates for 400 Receivers

	1 Time	13 Times	26 Times	52 Times	104 Times	260 Times	500 Times	1,000 Times
Announcements								
Class A (23,000 riders) 7–9 am 4–6.30 pm	$20.00	——	$19.00	$18.00	$17.00	$16.00	$15.00	$14.00
Class B (8,200 riders) 6–7 am 9 am–4 pm	10.00	——	9.50	9.00	8.50	8.00	7.50	7.00
Class C (4,400 riders) 6.30 pm–midnight 12–12 Sunday	6.00	——	5.70	5.40	5.10	4.80	4.50	4.20
Time Rates								
6.30 pm–midnight								
1 hour	40.00	38.00	36.00	34.00	32.00	30.00	——	——
1/2 hour	24.00	22.80	21.60	20.40	19.20	18.00	——	——
1/4 hour	15.00	14.25	13.50	12.75	12.00	11.25	——	——

Radio programs keyed to a captive listening audience in buses, trolleys, and trains constitute a new advertising medium and source of revenue for the f-m broadcaster

curl. What if the bell rings at the count of nine just as the bus pulls into the terminal! At the same time, the radio station can not afford to key its entire production into a transportation receiving system. There is, of course, the possibility of turning bus receivers on or off with an ultrasonic tone. Broadcasters turn pale when the riders' radio scheme is compared to the Muzak system of music supplied by wire to restaurants and other public places where music is designed, as are the murals or the drapes, as a backdrop for more important activity. The system is no source of revenue if the riders' consciousness is not pricked. And the Federal Communications Commission would undoubtedly view with disfavor a broadcasting system using conventional f-m frequencies to concentrate a narrow type of program material in the manner of point-to-point communication. Quite aside from the strictly legal aspects, the broadcasters realize that concentration on transportation radio to the exclusion of the greater potential audience would knock the whole business flat on its face.

Because there are inherently few technical problems that can not some how be overcome by competent engineers, the greatest potential impediment to adoption of car-card radio would seem to be the rider himself. Judging from the surveys that have so far been publicized, the public can be expected to lap it up. Better than 95 percent of those queried have indicated that recently broadcast test programs of music and news were not only acceptable but enjoyable. Of 2,626 interviews completed among the riders on five different lines in or near Cincinnati between the hours of 9 am and 6 pm, 2,514 indicated enjoyment, 84 did not enjoy the program, and 28 maintained a neutral attitude.

Although the idea of car-card radio is spreading rapidly and negotiations are in progress in a number of cities, the only firm rates available at the time of this writing were furnished by Louis E. Schaefer of Transit Radio, Inc. for WCTS-FM, Cincinnati, Ohio. This station operates on 101.9 mc (Channel 270) with an effective output power of 12.6 kw. Under a contract with Transit Radio, Inc., there are to be 400 single-frequency f-m receivers placed on vehicles of the Cincinnati Street Railway Co., the Covington, Cincinnati and Newport Railway Co., and the Dixie Traction Co. The audience is estimated at 380,000 riders per day. Guaranteed average circulation has been divided into three classes, the rates for which are shown in Table I. Announcements must not exceed 35 words. Three-minute news periods and sports summaries in which the total commercial time must not exceed 50 words is charged for at the announcement rate plus 50 percent. Weather reports and time signals are handled at special rates. The time rates for programs in excess of 3 minutes are covered only in the second Class C category.

Equipment

Under the normal conditions so far encountered, adequate signal has been obtained using a dipole antenna mounted horizontally above the front windshield (so as not to interfere with conveyor-type bus cleaning operations). A 50-ohm line connects the antenna to the receiver installed under one of the passenger seats.

The receiver itself is a crystal-controlled, fixed-tuned superheterodyne with eleven miniature tubes. Frequency response is within ± 2 db from 50 to 10,000 cycles, with an audio output of 8 watts. Ordinarily six 6-inch permanent magnet speakers mounted along the ceiling of each bus are adequate. Two volume controls are provided; one a master that is locked into place at the time of installation; the other a vernier control for adjustment over a 6-db range. Power is supplied from a dynamotor operating from the vehicle's battery. At 12 volts input the drain is less than 8 amperes. The receiver is shock mounted and any component weighing over 5 grams is tightly fastened to a terminal board so as to avoid breakage from vibration or jarring.—A. A. McK.

Engineering the Schematic Diagram

Step-by-step procedure for preparing intricate diagrams so that major circuitry stands out clearly, with stages arranged according to mechanical groupings of equipment yet still in logical order. Diagrams for APS-3 radar serve as examples

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THE IDEAL schematic diagram should present the features of a circuit in a form which is suitable for ready analysis in the fashion of the flow-of-function outline, exemplified by the organization chart, the production-line flow, the chemical-process diagram and other systematized arrays of information.

Diagramming with lines which show only circuit components and their interconnecting copper wires, without a scheme, produces an impenetrable labyrinth when extended without refinement to modern complex electronic equipment. The scheme is the essence, and effective schematic diagrams should display clearly:

(1) A readily discernible pattern or general framework of the system that stands out boldly from a background of accurate but subordinate detail.

(2) The sequence of events or operations, such that cause is plainly related to effect, and the directions of flow of power, signals, impulses and functions.

(3) The relative importance of components or units.

(4) The roles that individual components play in circuit operation.

(5) Certain broad mechanical features of grouping of construction.

(6) The physical points of ready access to the circuits where tests may be applied, measurements made, or results obtained.

(7) The controls as to name, physical position, how the adjustment is made mechanically, how the controls are related to other controls and to the influences they exert.

(8) Copious annotations, including electrical values of components.

Careful planning of a clear, rich schematic calls for the expenditure of time, thought, and ingenuity to achieve clarity and smoothness. It must be sketched again and again, rearranged and sketched over. A good schematic cannot be drawn casually. It must be done by one who knows thoroughly the operation and purposes of the equipment.

FOR SIMPLIFIED MAINTENANCE

Increasing ingenuity in developing electronic devices today demands that a correspondingly high order of skill be devoted to lucid recording of their circuitry.

The techniques described here for enhancing the clarity and value of intricate schematic diagrams were successfully used during the War throughout the Massachusetts Institute of Technology Naval Radar School.

Extra time spent in planning and execution of diagrams for commercial radar, communication and industrial electronic control equipment will more than pay for itself in simplification and speedup of maintenance and servicing

The Block Diagram

The positions on the paper of all parts of the drawing should conform to a general framework or plan which shows the flow of function. This bare framework is called a block diagram. It should first be sketched out in as ideally simple and straightforward a manner as possible. The flow begins with the primary motivation of the equipment, generally at the left of the sheet. As the activating impulse or signal is carried through successive operations, such as amplification, reshaping, phasing, and the like, heavy black flow lines should be drawn toward the right, passing through these operators or modifiers sketched in as unit-function blocks without regard to their physical locations in the equipment.

By unit-function block is meant a whole circuit operating as a unit, such as an amplifier, multivibrator, or oscillator. The path may branch and proceed through parallel paths or it may be joined by paths of impulses coming in from blocks above or below the main flow. For eye appeal, consecutive order, and readability, the flow should be kept moving in smooth unbroken streams from the cause, on the left, to the effect on the right.

Having sketched an ideally smooth flow, as illustrated by the diagram of an APS-3 radar equipment shown in Fig. 1, it will be necessary to modify this to some

* Formerly with Massachusetts Institute of Technology Naval Radar School.

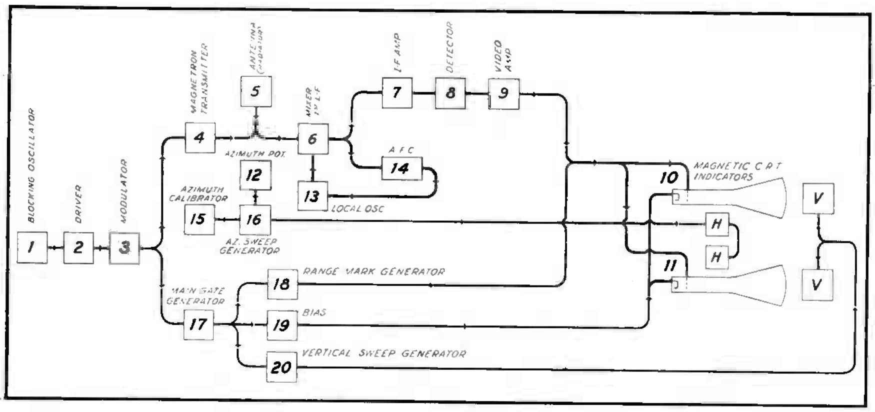

FIG. 1—First draft of block diagram, showing idealized flow of functions for APS-3 radar

extent to conform to the actual physical locations of the unit-function blocks in the equipment.

By moving these blocks up or down it will be possible to collect, in one general group on the sheet, those which are located in the same mechanical unit or box. Such a step is illustrated in Fig. 2. This will require the flow lines to dip downward or upward from the original ideal path. Any rearrangements which result in straighter flow lines or emphasis upon the relative importance of the paths should be used. This will often require related units to be above each other.

The blocks related by physical location are enclosed by a larger dashed outline, boldly drawn, designating the frame, unit, or box which contains them. Within this outline the blocks may be shifted about to preserve straight flow lines and to eliminate as many crossovers of paths as possible. From the schematic viewpoint these outlines may be rectangles, long, short, horizontal, vertical, notched, or otherwise shaped to accommodate blocks, without regard to similarity to the actual box shape in the equipment.

Frequently it is desirable to prepare the entire schematic so that it can be separated into individually complete numbered pages. This arrangement is particularly useful for instruction book or text book purposes. The appropriate section of the entire drawing may also be secured inside covers or doors of the individual apparatus boxes or cabinets. When the worker studies the overall system schematic drawing, he encounters the same familiar diagram patterns which he finds in the covers of the individual units. To provide this page sectionalization, additional rearrangements of the drawing may be required so that reasonable divisions can be made. In general this is not too difficult once the mechanical grouping of unit-function blocks has been determined.

Figure 3 illustrates a rearrangement of the material of Fig. 2 into four separate quadrants or pages. Helpful general details have been filled in to form the complete block diagram as finally developed. The quadrant or page numbers refer to detailed drawings, one of which is shown in Fig. 4. Note the very close correlation between the patterns of the heavy flow lines on Fig. 3 with their counterparts on the detailed drawings of Fig. 4. For the reader, this preservation of the pattern simplifies the mental transition from block diagram to individual page. It is also a powerful assistance to the memory.

The Detailed Sheet

The positions of the unit-function blocks having been roughly determined by the layout of the block diagram, it becomes necessary to develop the detail within each block. This detail comprises resistors, capacitors, coils, tubes, etc, whose wiring must fit into the general scheme.

To achieve smoothness, it may be necessary to draw and redraw the circuitry of blocks top for bottom or right for left to conform to the straightforward block diagram. It should always be kept in mind that each block is a subsidiary link in the branching chain-of-function flow.

The component resistors, capacitors, and tubes should be so disposed with respect to each other that the circuit behavior and purpose is made clear. This may require readjustment of the block diagram as space requirements become defined. Where voltage divider chains of resistors provide graduated voltages, they should be arranged in the simple straight line or row with the high voltage impressed across the ends. Successively lower-voltage taps come out from it like steps in a ladder. A convenient concept is a potential gradient of the tapping wires:

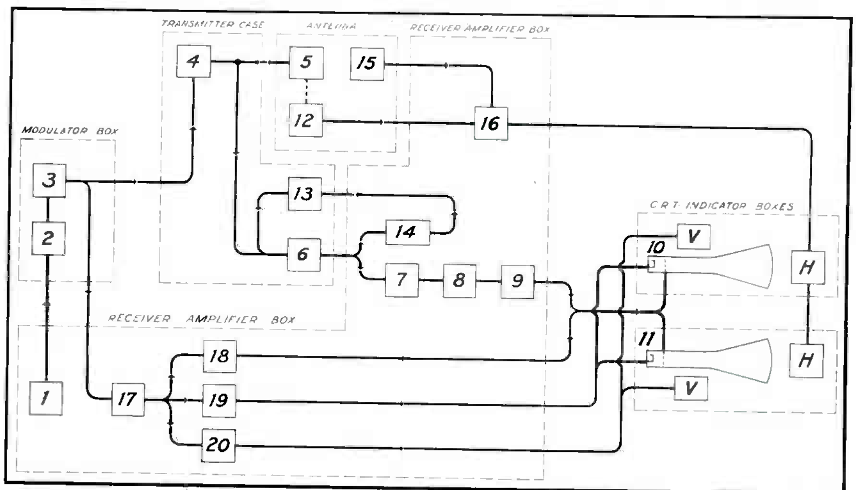

FIG. 2—Regrouping of unit-function blocks of APS-3 radar diagram to conform to mechanical divisions and minimize crossovers

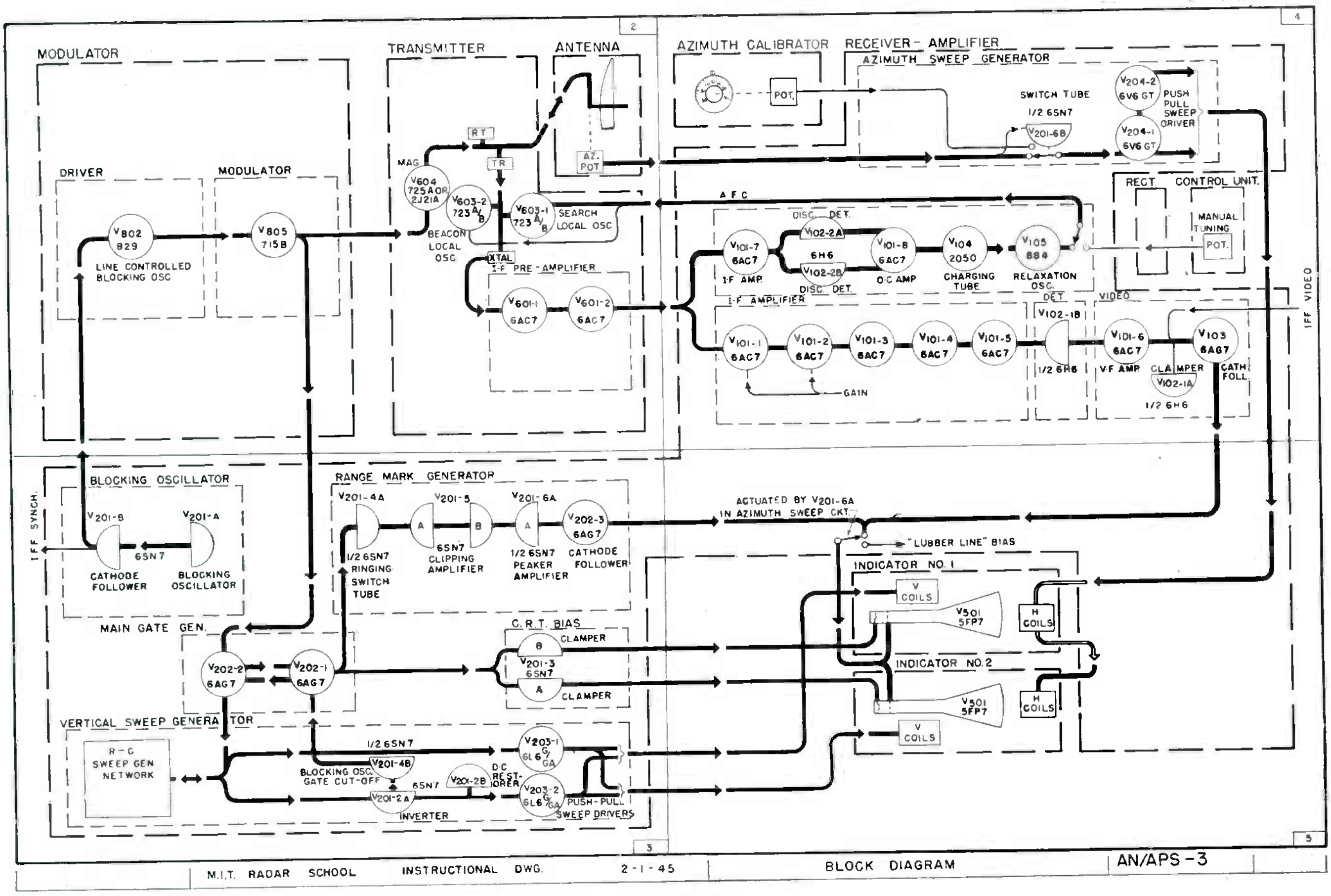

FIG. 3—Final block diagram of APS-3 radar, with helpful detail filled in. Arrangement in four quadrants permits comparison with the four schematic diagram sheets, one for each quadrant, that are drawn next

highest near the top, lowest toward the bottom.

Bridge circuits should be drawn to look like a bridge. If the plate impedance of a vacuum tube is part of an arm of the bridge, it should be drawn in one of the sides of the diamond and oriented to match. This will immediately assist the reader to understand what the designer expected the tube to do.

When networks might require the application of Thevenin's or Kirchhoff's principles for analysis, the link elements, meshes, and junctions should be drawn to stand slightly apart from other circuits and be arranged so that the appropriate principle is apparent.

Electrical symmetry as exemplified in balanced circuits should be expressed as graphical symmetry. Symmetry of general function should also be so shown where appropriate. It should be emphasized that graphical symmetry should not be employed for the sake of pictorial composition when no such real electrical symmetry exists.

Electrical similitude should be emphasized, when valid, by graphical similitude. A group of R-C chains, selectable by a switch, all similar in principle but differing only in time constant, should be grouped; all pairs of resistors should be placed at the same level and the attitudes of one R-C combination repeated for all. Once the reader has decided what one is for, he can plainly see that all fulfill the same purpose. Such an R-C group should stand apart from other similarly appearing R-C links whose function is not immediately related to them.

Where cables connect one outlined unit to another, the sides of such units should be arranged to be adjacent and the elements so arranged within that the cable can be shown as a family of straight wires, free of cross-overs, running between the units. Some cable wires will carry the chain-of-function flow, standing out boldly and becoming part of the general framework of the diagram.

Too often the simple circuitry of primary power distribution involving on-off switches, fuses, automatic overload cut-outs, interlocks, time delays, gate and battle switches, can become woven into a complex web of advanced wiremanship that would defy Maxwell himself, though he be armed with the finest of volt-ohmmeters. These primary circuits are usually set up sequentially: that is, the one most remote from the main fuses depends upon the functions of numerous devices preceding it. The diagram of this web should be drawn as branching chains of influence flowing across into rungs of a ladder whose rails are the two primary power leads. From the diagram it should be instantly apparent, without wire tracing, which units are controlled by a given switch and which chains of influence would be put out of commission by a blown fuse or open gate switch. The drawing should be deliberately set up so the man with the volt-ohmmeter can see immediately what

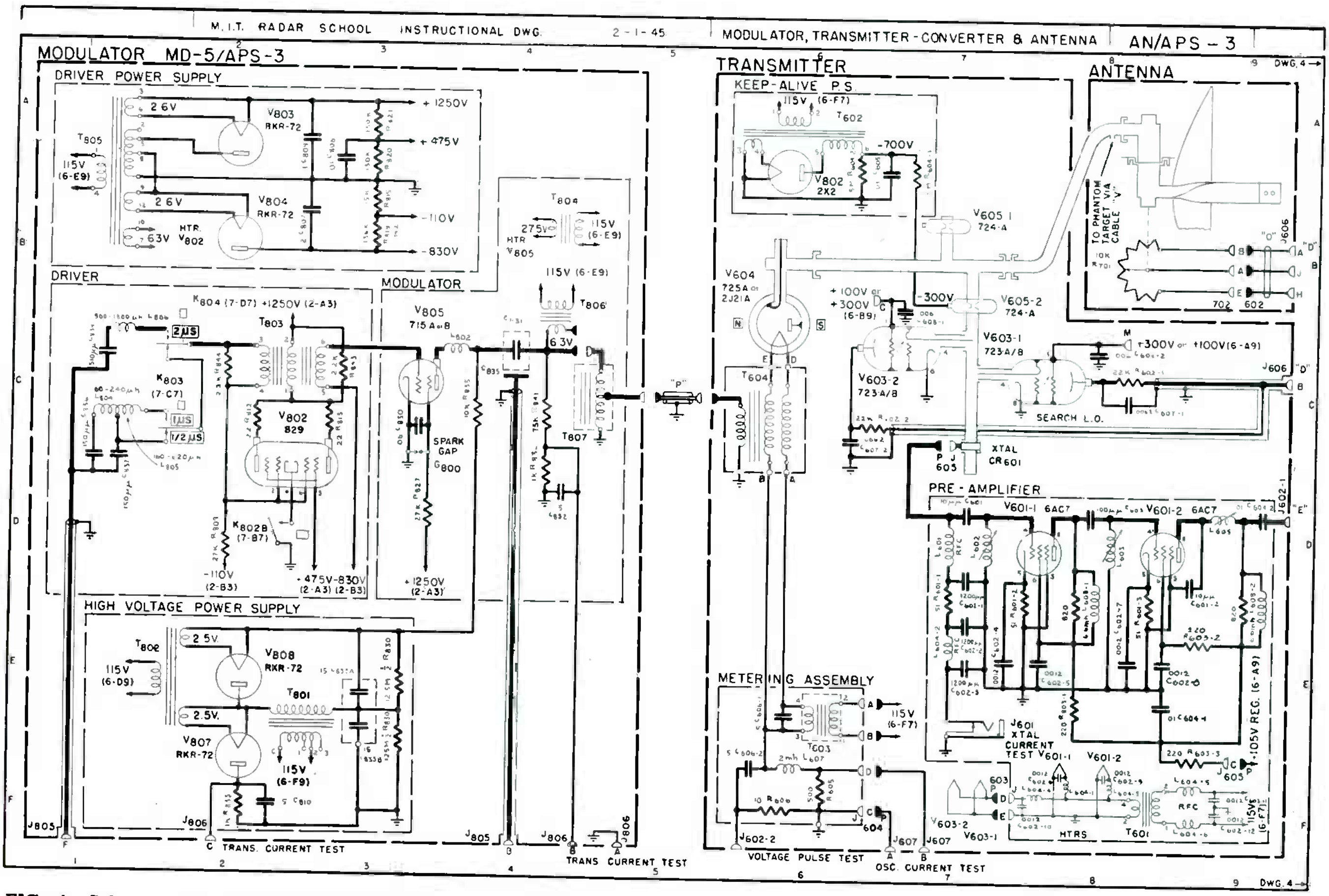

FIG. 4—Schematic diagram for upper left quadrant of Fig. 3, as drawn before standardization of symbols by ASA. Use of several weights of letters and lines improves effectiveness and eye appeal, but takes longer to draw

voltage or resistance he might normally expect to encounter in making a measurement at any point.

Designations and Markings

The schematic drawing should carry identification of every resistor, capacitor, tube, and switch. This means a designation (or part) number together with the circuit value or type number. It should make unnecessary the usual frequent and aggravating reference to the parts list.

All pin numbers on all tube sockets should be shown. All jacks, plugs, terminals, fanning strips and cables should carry their designations and actual numbers. All supply voltages should be shown where appropriate.

To eliminate many conventional leads from the drawing, a system of margin coordinates on each numbered page of the drawing makes it practical to show an arrow head on the end of a lead with a simple legend giving the drawing page number and coordinates where the other end of the lead may be picked up. This is used principally for plate supply voltage leads or similar common sources. Thus, in Fig. 4, drawing 2, the screen supply for the modulator tube has the legend + 1,250 V (2-A3). The 2 refers to the drawing sheet and A3 are the coordinates on drawing 2 where the screen supply source will be found.

Each control for adjustment, calibration or operation should be marked with the name it actually carries on the panel. This name (abbreviated) is usually enclosed in a box to designate that it is so marked.

It is desirable to designate by simple, appropriate symbols whether it is a screw-driver adjustment or a knob and whether it is accessible from the front panel or is within the chassis. Although the drawing examples printed herewith do not show the latter features, extensive and very helpful use was made of such designations in later drawings.

The several weights of letters and lines shown in the accompany- illustrations are the minimum found effective in providing the desired emphasis of flow and subordination of detail.

In the large amount of work done on drawings of this kind it has proved most satisfactory to standardize on 17" x 22" tracing cloth sheets for original ink drawings. This is a convenient scale for the draftsman and reduces to 8½" x 11" individual sheets in a 2 to 1 reduction. The examples shown here suffer unavoidably from a reduction somewhat more than this.

The authors wish to acknowledge the inestimable contributions of Richard L. Bliss of the MIT School of Architecture, who learned electronics for the sole purpose of producing the drawings described above and who wrestled with the fatiguing routines of countless redrawings to produce truly engineered schematics.

LIGHT METER
for Electric Flash Lamps

Battery-operated phototube-amplifier-meter circuit integrates incident light produced at subject to be photographed by capacitor-energized electric flash lamps. Meter is calibrated to read directly in aperture numbers for correct color or black-and-white exposures

By **HAROLD E. EDGERTON**
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Cambridge, Mass.

THE photoelectric light-integrating meter described here was developed for measuring the incident light from repeating electric-flash photographic light sources that are energized by discharge of a capacitor. The object of most light measurements of this nature is to determine the camera aperture, and for this purpose the meter can be calibrated to read directly in aperture numbers that will result in properly-exposed photographs for both color and black-and-white film.

The person most interested in the use of this meter is the one who is to take color photographs. He will place the meter at the subject and direct the phototube opening at the main light. A pushbutton will flash the key light or all the lights and the meter will indicate a given reading if the correct camera aperture for the type of film selected has been pre-set on the optical attenuator. The photographer can then adjust the camera aperture to the value indicated by the meter, or modify the distance to the key light to obtain some desired aperture.

As a next step, the fill-in light, background lights and spots can be measured and the light-to-subject spacing arranged so that the ratio of the key light to these others will produce the desired photographic effect.

A further use of the meter is to check the output of electric-flash lighting equipment, by comparing meter readings for standard and unknown lamps and power units. Also, the effectiveness and angular distribution of light from reflectors can be evaluated.

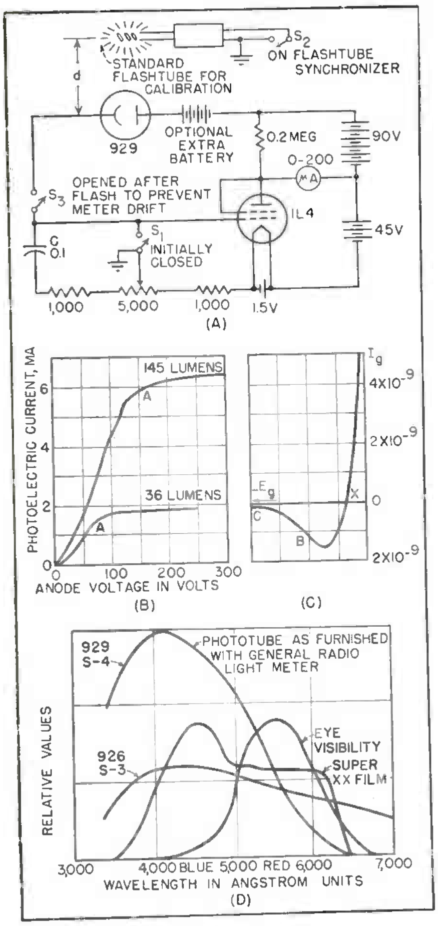


FIG. 1—Circuit and characteristic curves of photoelectric light-integrating meter for capacitor-discharge electric flash lamps

Design Data

The measurement of the quantity of light produced by a flash from an electric-flash lamp involves the integration of instantaneous values of light over the duration of the flash. A circuit that accomplishes this under certain conditions is given in Fig. 1A. The measurement of light requires that the phototube current and instantaneous light be proportional, so that $i = KF$, where K is a constant relating phototube current i and light flux F.

Figure 1B shows the general shape of the volt-ampere characteristics of an RCA Type 929 vacuum phototube with strong illumination. Note that the current and luminous flux can be proportional only for voltages above the knee (point A).

Should the instantaneous variation of luminous flux exceed that corresponding to the knee during a short, intense flash of light, the equation $i = KF$ will not be satisfied and the meter indication will not be a true measure of the integrated light. Gas-filled phototubes cannot be used since, because of the effects of the gas, the current may not be proportional to flux. The curves of Fig. 1B show that about 100 volts is required on this phototube if 36 lumens is the greatest instantaneous illumination that is to be experienced. For 145 lumens, the voltage should be about 200 volts. From this limited number of data it appears that the saturation current is approximately a function of the square of phototube voltage.

A voltage proportional to the integrated light and thereby proportional to exposure is obtained across an integrating capacitor C if the phototube current flows ino the capacitor. The voltage is

$$e_c = \frac{1}{C}\int_0^\infty i\,dt = \frac{K}{C}\int_0^\infty F\,dt \qquad (1)$$

A vacuum-tube voltmeter with an indicating meter M is used to record the voltage without discharging the capacitor at a rate which interferes with the reading of the meter after the flash. The drift of the indicating meter after a flash reading will depend upon the grid current of the vacuum tube, the leakage current of the phototube,

Light meter is held at position to be taken by subject and is aimed at flash lamp, which is tripped remotely by pushbutton on end of cord

and the leakage of the circuit. The size of capacitor C must be increased to such a value that the drift is inappreciable unless some method is provided to adjust the drift, such as grid current compensation.

In the practical design of an integrating light meter the capacitance for an uncompensated circuit is usually about 0.1 μf when the meter drift is limited to less than a full-scale deflection in about 30 seconds.

From the equation $i_c = C(de/dt)$, the time to drift to full scale, if the grid and leakage currents are assumed constant, can be given by $t_d = Ce_c/i_c$, where e_c is input voltage to produce a full-scale deflection, t_d is the time required for the meter to drift from zero to full scale, and i_c is the current that causes drift in the integrating capacitor C. Thus the drift time is a function of the grid and leakage currents and the integrating capacitor once an amplifier design has been selected.

The grid current curve of a typical three-electrode vacuum tube appears in Fig. 1C. For most tubes the crossover point X of zero grid current is about −1 volt with respect to the negative end of the cathode. It is inadvisable to operate on the right-hand side of the crossover point since the grid current increases rapidly due to electrons that arrive at the grid with energy obtained from thermal processes at the cathode. Positive ion currents are responsible for the negative slope of the grid current curve between the points B and C since the number of positive ions is directly a function of the plate current. To the left of point C the plate current is cut off and the tube serves no useful function. Therefore the portion of the characteristic that can be used falls between C and X.

Point C as well as the entire curve depends upon plate voltage. A plate voltage is selected that is as low as possible, but still ample to produce plate current that is several times that of the maximum reading of the meter. The usual practical value of grid bias is well to the left of point X for all operating conditions.

The type 1L4 tube connected as a triode with the screen and plate tied together can be used with 45 volts on the plate, a plate current of 0.5 ma and a grid bias of −1.3 volt. A 200-microampere meter is used as an indicator. Under this condition the grid current is less than 10^{-9} ampere for selected tubes that have been aged for two days with 90 volts on the plates.

Self-Bias Connection

Amplifiers with self-bias resistors have voltage calibrations that are relatively independent of the tube constants. This independence of calibration is gained at the expense of sensitivity in the conventional circuit design. However, for this special type of amplifier with a floating input capacitor, as used for light measurement, the advantages of self-bias can be gained without a loss of sensitivity. As long as the product of capacitance C and the voltage necessary for full-scale deflection e_c is constant, the light necessary for full-scale deflection of the meter and the drift time will not be changed. The drift time is also proportional to the same product.

A suitable design with degeneration by means of a cathode resistor is one that reduces the gain by a factor of five; this is provided by the circuit of Fig. 1. Such a design will decrease the influence of tube characteristics by a factor of about the same value.

Testing the Instrument

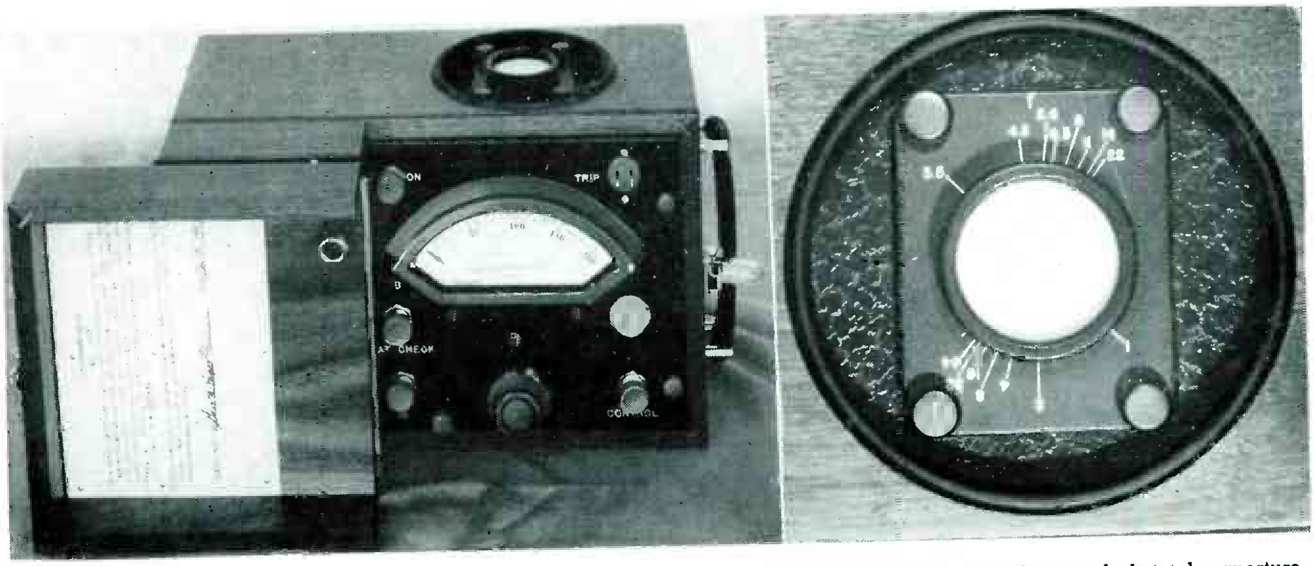
Should the phototube voltage be less than that required for saturation the meter will read low. A simple test of the meter, with any flashing light source of known duration, is to vary the phototube voltage and record the resultant meter reading. If the meter reading is constant as the voltage is increased, there is ample voltage on the phototube. The limiting phototube voltage can be found by decreasing the phototube voltage until the meters begin to drop.

If a flashtube with a shorter flash is used, but with the same quantity of light, the break will occur at a higher phototube voltage.

Shortest Allowable Flash

The duration of most flashtubes ranges from 50 to 1,000 microseconds. As a general rule, the duration is longer for the more powerful lamps.

The limiting time of flash can be calculated approximately as follows: Assume that the flash of light is of rectangular form providing F



Complete battery-operated photoelectric light-integrating meter as made by General Radio Co., and closeup of phototube aperture containing Polaroid attenuator

lumens on the phototube cathode for T seconds duration. The quantity of light is

$$Q = \int_0^T F\,dt = FT \tag{2}$$

or

$$e_c = \frac{1}{C} KFT = \frac{i}{C} T \tag{3}$$

The phototube current is KF amperes, and $i = Ce_c/T$. From this it can be seen that the peak current through the phototube is a direct function of the integrating capacitance and the voltage required for full scale on the deflecting meter. Likewise, the required phototube current for full-scale deflection increases inversely with change in duration of the flash. A short flash will require a larger phototube current and a higher phototube voltage if a full-scale reading without error is to result.

A phototube circuit with 100 volts on the 929 phototube and with a peak flux of 36 lumens will produce a photoelectric current of 1.7 ma, as shown by the lower curve of Fig. 1B. With $C = 0.1$ μf and $e_c = 2.5$ volt (sufficient for a full-scale deflection of a 200-microampere meter), $T = Ce_c/i = 147$ microseconds, assuming a rectangular pulse of light. The actual pulses of light from electric-flash tubes rise sharply to a peak and then decay with a form resembling an exponential.

With 200 volts on the phototube the current can be about four times greater and the time similarly decreases to 36 microseconds. By similar reasoning, a half-scale reading can be made with an 18-microsecond pulse with 200 volts on the phototube.

An approximate general expression for the necessary phototube voltage required to give an accurate integration of a rectangular pulse of light of duration T can be obtained if the phototube saturation current i is taken to be a squared function of the phototube voltage E. The expression is $i = AE^2$, where A is a constant. This current, when substituted for the integrator capacitor voltage previously given, results in the following expression for the required phototube voltage

$$E = \sqrt{Ce_c/AT} \tag{4}$$

As a numerical example, the required voltage calculated for a one-microsecond flash is 1,150 volts. This might cause a flashover in the phototube. If it is necessary to measure microsecond pulses, a more sensitive amplifier or a smaller integrating capacitor should be used. Such a modification requires a smaller grid current in order to keep the meter drift time at a reasonable value. The phototube voltage becomes 240 if $e_c = 0.1$ volt and $C = 0.1$ μf. These are reasonable values that can be obtained with a two-stage amplifier with grid current compensation.

Some care is required in selecting a suitable integrating capacitor since some capacitors have leakage and others have absorption effects that are serious. It has been found that polystyrene and mica capacitors have very desirable characteristics. Certain types of oil capacitors can be used with success as integrating elements.

The light-meter calibration is made with a specific phototube (type 929) which is a vacuum-type tube with an S-4 surface. If other types are used, the calibration will not hold. The S-4 surface has a peak sensitivity in the blue portion of the spectrum, at 4,500 A. The sensitivity decreases from this peak to the cutoff value which is in the orange. Very little red light is measured. Thus the meter measures mainly the blue light. This is not a serious disadvantage since most photographic film, even the panchromatic types, also has a sensitivity peak in the blue.

For color photography the flash-tubes that are used are mainly filled with xenon gas at high pressure for high-efficiency use. The meter should then be calibrated experimentally with a xenon lamp under conditions that are known to produce a suitable color-photograph result. Fortunately xenon flash-tubes are of about the same color temperature regardless of the energy loading, and therefore the light meter can be used for comparison purposes with success even if only sensitive to blue light.

Figure 1D shows the spectral sensitivity of two types of photoelectric surfaces as well as the standard eye visibility curve and film response. A different phototube, type 926 (S-3 surface), has a sensitivity curve that covers the entire visual range as well as some of the infrared, but has a lower overall sensitivity than the 929.

The Corning Glass Works can make on special order a filter composed of two kinds of glass that will correct the 926 phototube spectral characteristic to correspond to the visibility curve. A filter composed of glasses 3304 and 4784 gives a suitable combination. An accurate match can be made to any particular phototube at two wavelengths (6,400 and 4,800 A) by adjusting the thickness of the two glasses.

The phototube in the light meter will respond to the light from any kind of light source. However, the meter output cannot be expressed in lumen seconds per square foot unless the spectral distribution is the same as that of the xenon flashtube that is used for calibration. All xenon flashtubes, to a first approximation, have a comparable spectral distribution and therefore the meter readings can be given in terms of lumen seconds.

Maximum Meter Sensitivity

The example given previously (e_c = 2.5 volt, C = 0.1 μf) will have a maximum reading of the meter corresponding to 36 lumens for 147 microseconds when a phototube voltage of 100 volts is used. This reading corresponds to $36 \times 147 \times 10^{-6} = 0.0053$ lumen-second with a tungsten source having a color temperature of 2,850 Kelvin. Xenon lamps have an equivalent color temperature of from 6,000 to 9,000 and because of the proportionally greater blue light, require less than half as much visual light in lumen-seconds to produce the equivalent phototube current in the 929 phototube. For this reason a xenon flashtube will produce a full-scale reading of the meter with about 0.0026 lumen-second of incident light.

The projected area of a 929 phototube cathode is about 0.5 square inch, so the phototube cathode has a light density of about 0.005 lumen-second per square inch when used to measure the light from axenon flashtube. We will now calculate the distance from a standard flashtube that will give this deflection for calibration purposes. A standard FT-214 flashtube (General Electric Co.) flashed from 30 μf at 2,000 volts emits some 2,000 lumen-seconds and has an intensity I of 200 horizontal candlepower-seconds with a duration of about 150 microseconds. The number of lumen-seconds per square inch at a distance d in inches is $L = I/d^2 = 0.005$ lumen-second per square inch, from which $d = I/L = 200$ inches $= 16.7$ feet.

Calibration of the meter can be accomplished directly by this method, using a standard flashtube operated under specified conditions. Thus a full-scale meter reading corresponds to $U = 200/16.7^2 = 0.715$ lumen-seconds per sq ft.

The reading of incident phosage in lumen-seconds per square foot can likewise be calculated from $U = kRM$ lumen-seconds per square foot, where M is the meter reading, R is the polaroid attenuation ratio as read on the front of the meter, and k is a constant of the instrument. The light transmission of the uncrossed Polaroids at the 1 setting of the instrument is about 30 percent and this influences the value of k.

A diffusing disc is shown on the attenuator, which also acts as a calibrator to make the meter direct-reading in lumen seconds per square foot; for this case k equals 1. With the diffuser removed, the value of k for most instruments is 0.015 with a 200-microampere meter, with 200 as the full-scale meter reading.

The beam-candlepower-second output of a given flashtube and reflector combination is $kRMd^2$ or Ud^2, where d is the meter-lamp distance in feet.

Neutral-density filters can be used to extend the scale range. Thus a 1/10 transmission filter would give a multiplying factor of 10. Neutral-density filters are available in decimal, logarithmic and percentage steps.

The meter has an angular acceptance ratio depending upon the diffusion disc and other factors. With the disc, the meter reading decreases to half value when the meter is swung 25 degrees from the meter-lamp axis. This angle decreases to 15 or 20 degrees without the diffuser. Any type of diffuser can be used in the filter adapter ring on the instrument.

Determining Camera Apertures

Preliminary experiments show that about 100 incident lumen-seconds per square foot (U) are required to expose daylight Kodachrome properly with a CC15 filter at an aperture of f/3.5. The aperture f is then equal to $\sqrt{0.122U}$, where phosage U is in lumen-seconds per sq ft. Values of average incident light U required for various apertures are as follows:

Aperture f	Phosage U
1.0	7.85
1.5	18.5
2.0	32.6
2.5	50.8
3.5	100
4.5	165
5.6	256
6.3	326
8	520
11	986
16	2,080
22	3,940
32	8,380

As an example, suppose the lights are fixed and the meter is to be used to determine the aperture. Guess at an aperture such as f/3.5 and make a reading. If the meter reads 100, the guess was correct. If it reads 200, the light is double that needed at f/3.5. Therefore the aperture should be increased one stop to f/4.5. Likewise, if the meter reads 50, the correct stop is f/2.5.

Eventually tables of suitable values of incident lumen-seconds per square foot for all types of photographic emulsions and for different flash durations will be available from the film manufacturers.

The meter has an aperture scale on the Polaroid attenuator to read camera aperture directly. The aperture marks have been placed so that they correspond to a meter reading of $U = 100$ for the correct lighting condition for the indicated aperture with daylight Kodachrome. These readings require the calibrated diffusing disc on the attenuator that is furnished with the meter. This disc also makes the meter direct-reading in lumen-seconds per square foot.

Facsimile Modulator Tube

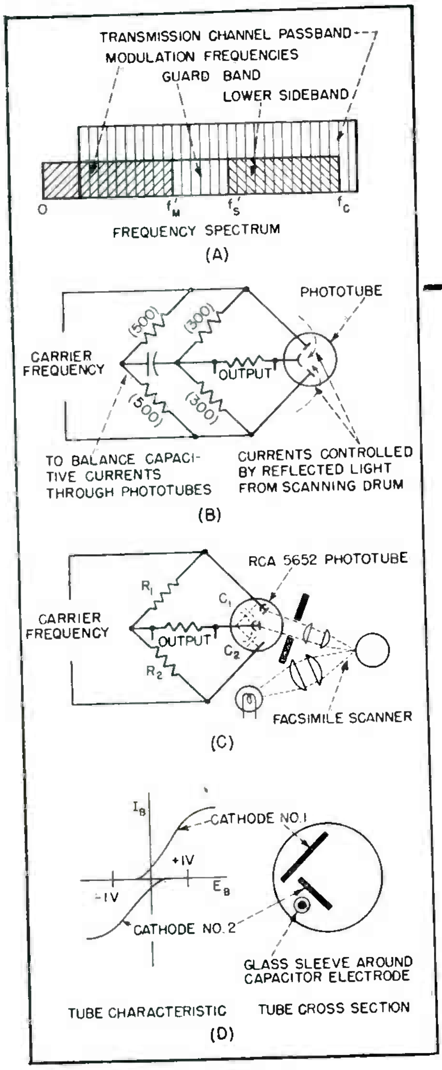


FIG. 1—**Basic considerations in design of bridge modulator for fascimile**

By J. R. SHONNARD

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HIGH RESOLUTION facsimile signals are transmitted over existing communication facilities by amplitude-modulated low-frequency carriers. A new type phototube and bridge modulator have been developed that enable light from the facsimile scanner to produce the modulation directly without generating frequencies that have to be eliminated by costly filters. The tube and circuit may simplify other systems in a similar manner.

Facsimile Transmission

Before describing the phototube and its action in the circuit, it is best to review the modulation problems that lead to its development. In many communication systems, facsimile being a typical example, the lowest modulation frequency is zero cps, corresponding in this case to a picture area of uniform density. The highest frequency is limited by what can be transmitted by the channel. Modulation currents as such cannot be transmitted over existing facilities because they are essentially interrupted d-c. To transmit them without introducing excessive distortion the channel would have to be repolarized from transmitter to recorder thus requiring d-c amplifiers.

The solution to the problem has been to transmit the signal as an amplitude-modulated low-frequency carrier of frequency f_C. Under such condition the highest modulating frequency f_M' is limited to half the carrier frequency, assuming that filters with ideal cutoffs are available. Therefore the highest possible carrier should be used. In practice, the upper frequency limit is determined by the top of the channel passband. The carrier frequency is thus selected near this limit. Only the lower sideband of the amplitude-modulated carrier can then be transmitted, but this is all that is necessary for faithful reproduction and provides an efficient way to use the available channel. The manner in which these frequencies occupy the channel spectrum is shown in Fig. 1A.

The modulation frequencies f_M produce lower sideband frequencies f_S extending from the carrier f_C to the lowest sideband frequency $f_S' = f_C - f_M'$. When $f_M' = f_C/2$, $f_S' = f_M'$. If a higher modulation frequency is used the modulation band overlaps the lower sideband producing extraneous frequencies. Under such conditions filters cannot be used to prevent modulation frequencies from reaching the transmission circuit. If $f_S' = f_M'$, ideal filters could separate the modulation and sidebands and 50 percent of the transmission band would be used. Actually sufficient guard band must be left between modulation and sideband frequencies so that realizable filters can be used. If filters that do not have such sharp cutoffs as to introduce transient distortion are employed, the maximum use ratio of the channel is only 30 percent.

Phototube Modulator

The conventional type phototube bridge modulator shown in Fig. 1B produces both the modulation frequencies contained in the impinging light beam and the sideband frequencies of the modulated carrier in its output. The circuit is balanced for reactive and resistive currents. Light on the phototube upsets the resistive balance to produce the modulation.

When the RCA 5652 phototube, which has been designed for this service, is used, the output contains only the modulated carrier and sidebands. The signal can be connected directly to a conventional amplifier that is reasonably flat over its passband; filters are unnecessary. The phototube has two flat cathodes arranged at approximately right angles to each other. When both plates are illuminated, one acts as a cathode and the other as an anode, depending on the polarity of the

Phototube having two plates each acting alternately as cathode and anode simplifies bridge modulator. Because tube conducts alternately in one direction and then in the other, only desired modulated carrier and side bands appear across the output

potential applied between them. If the applied potential is alternating, equal current pulses flow in both directions with equal light on both plates. The average current is then zero. Even a flash of light for the duration of one cycle of the carrier causes equal but opposite pulses to flow so that the effective current remains zero up to modulating frequencies of half the carrier frequency. Contrasted to this action, the current flow in a conventional phototube in a modulator circuit is unidirectional.

As used in the modulator, the new phototube is a variable impedance, the two cathodes being connected as an arm of an a-c bridge. Capacitive current is balanced, preferably by an electrode built into the phototube and completely covered with a dielectric. The capacitance between this electrode and one cathode is made approximately equal to the capacitance between cathodes.

For modulation by this tube the bridge circuit can be arranged as in Fig. 1C. If no light reaches the tube and $R_1 = R_2$ and $C_1 = C_2$, there is no voltage output. As reflected light reaches the phototube, conduction takes place in the direction governed by the polarity of the carrier. Both electrodes are photoelectric and therefore act alternately as cathodes and as anodes.

The amplitude of the applied carrier is limited by saturation of the cathode current in this circuit. The phototube operates on the linear portion of its characteristic curve, shown in Fig. 1D, for a given range of light values. In the case of high definition facsimile the maximum light is in the order of 4×10^{-4} lumens. The elemental area of illumination at the scanning drum is about 5×10^{-5} square inches. The carrier potential applied to the bridge is about 0.7 rms volt. If the bridge is balanced with the light source off, when the light is turned on the output voltage will be undistorted modulated carrier proportional to the instantaneous light intensity reflected from the rotating scanning drum; only carrier and sidebands will be present.

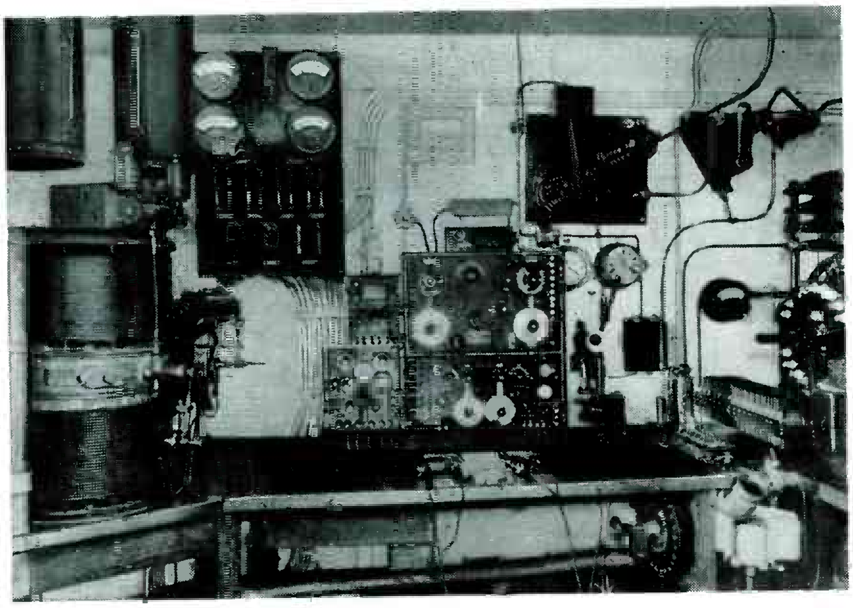
Operating Circuit and Tests

For convenience and ease of adjustment the circuit that is used has balancing controls. In addition, a diffusing plate is placed over the aperture to overcome two difficulties. First, a sharply focused image can cause uneven illumination of the two cathodes and thus produce occasional d-c keying components in the output. Second, the light beam passing through the aperture covers too small an area on the photocathodes for ease of adjustment when balancing the bridge to eliminate the modulation frequencies from the output, unless the optical system is very long. The diffusing plate defocuses the beam without sacrificing resolving power.

In operation, the output voltage varies from a maximum between 0.005 and 0.010 rms volt to a minimum controlled by the noise from the balanced bridge with the light off. The noise level of the bridge and the first stage of the amplifier is equivalent to 25 to 50 microvolts at the grid of the first stage. The load resistor, which also serves as the grid resistor of the first amplifier tube, can be from 1 to 20 megohms depending on the compromise that must be made between high sensitivity and stability against humidity, stray fields and input noise. The phototube noise does not seem to be a problem. The useful voltage ratio for light variations is therefore from 40 to 50 db.

When the scanner observes a 1.6-reflection density photographic black, the output rises about 10 db above the noise level. This level determines the minimum useful signal. When the scanner observes a bright white, the output rises an additional 30 to 35 db. However, such a range is beyond the capabilities of an average transmission channel. Therefore, after amplification, the signal is compressed to a range of about 20 db, within the limits of most channels.

Resolving power of any equipment with a given carrier frequency can be determined roughly by reducing the size of print being transmitted until the copy reproduced at the receiver is just illegible, assuming the receiver to be linear above the carrier frequency. A better but more complicated method is to select a type face and size that has a line width greater than is necessary to block light to the phototube. It is then certain that full interruption of the light to the phototube will be produced regardless of scanning velocity. Increasing the scanning velocity at both transmitter and receiver with a given carrier frequency will determine the maximum resolving power, and therefore the maximum usable modulation frequency for a given system. With the new phototube, 50-percent utilization of the channel can be realized and thus good resolution can be obtained.



Radio room of Army transport about 1918. The 5-kw arc transmitter is at left

Radio in the Merchant Marine

Survey of ship communications for message handling and safety of life at sea. Basic radio law and changing legal requirements are reviewed as background in the evolution of technical equipment to meet specifications. Current trends are analyzed

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HISTORICALLY, it was the maritime mobile service that first adopted commercial radio communication and demonstrated its value to the world. Radio has maintained a brilliant record in the saving of life and property at sea from a period more than a decade preceding that fateful night in 1912 when the distress call from the stricken *Titanic* dramatized its usefulness. But in spite of the impetus which this highly successful application gave to the radio industry during its infancy, technical progress in the marine field has been along conservative lines following, rather than leading, shore developments.

The first shipboard radio installations (circa 1901) utilized the discharge of a large spark coil across a straight gap into a tuned antenna system to radiate energy. A coherer, or rudimentary form of a multiple-point-contact rectifier, connected to an inker was used to record the received signals. Thus, it is to be noted that the first shipboard radio installations employed automatic recording and visual presentation of information! Within a short time the oscillatory discharge of a capacitor across a synchronous or quenched gap was adopted as an improved method of setting up oscillations in a large antenna system. Radio energy in the form of broad, highly damped waves, usually modulated at a convenient audio frequency, was radiated at frequencies in the order of 100 to 200 kilocycles. The received signal was demodulated by a magnetic detector. A significant improvement in receiver effectiveness was realized when the unilateral characteristic of mineral crystals was discovered and applied to signal rectification. Although some voltage gain was obtained from the rather low-Q tuned antenna primary and secondary circuits, the audio component effective in the magnetic-type reproducer was low. Range, even under conditions of moderate signal-to-noise ratio, was restricted and reliability of both receiver and transmitter not always of the highest order.

An improvement in system selectivity, increased range, lower antenna insulation requirements, and better signal note were some of the advantages gained through the introduction of the Poulsen arc type of continuous wave transmitter prior to World War I. The arc oscillator, however, was limited by

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Views expressed in this article are the author's and do not necessarily represent those of the U. S. Maritime Service.

Typical shipboard installation of distributed type. Shown from left to right are the main transmitter, coil rack, emergency crystal receiver, intermediate and high-frequency receiver, high-frequency transmitter, and emergency transmitter

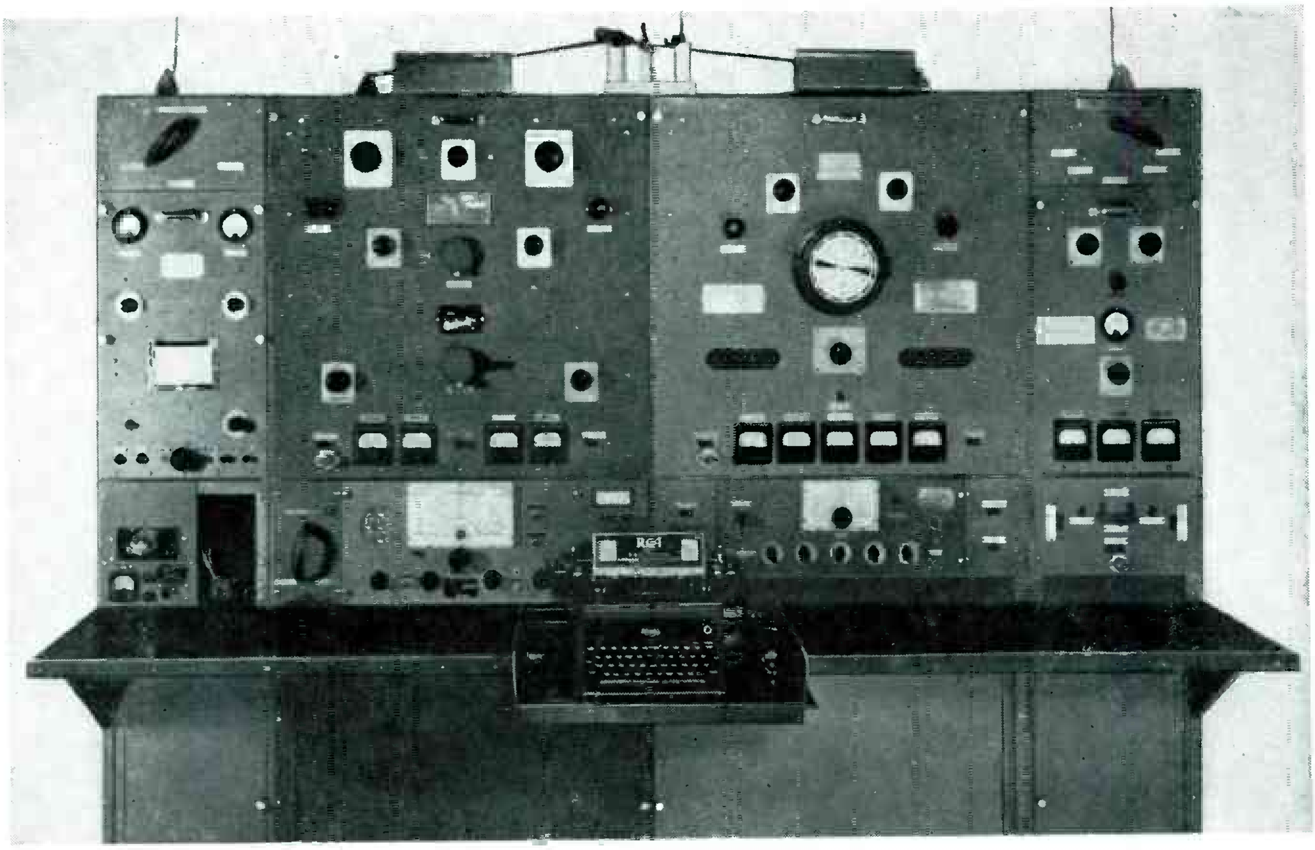
an inherent inefficiency to wavelengths longer than 1,000 meters (300 kc) and found its most useful application on wavelengths as high as 18,000 meters (17 kc). Rapid extension of the vacuum-tube oscillator to marine use and unsuitability for radiophone (A3) modulation were the important contributing factors to the eventual obsolescence of the arc transmitter. Nevertheless, standard 2-kw arcs remained as supplementary equipment on many ships throughout the 1930's and high-power installations of several hundred kilowatts were used in commercial and government coastal and transoceanic stations for many years.

Although the spark, arc, Alexanderson alternator (for land stations), and vacuum tube were concurrently or successively employed as oscillators during the three decades ending in 1930, the superiority of the tube eventually forced its acceptance by the marine industry. Early tube transmitters were usually of the converted spark type; that is, the oscillatory circuit of the shipboard spark equipment was replaced by one or two electron tubes with appropriate changes in circuit and power supply. Primary and secondary tuned circuits were left intact. Either c-w (A1) or tone modulated c-w (A2) emission was provided. Later tube equipments were designed especially for marine use. Some form of master-oscillator power-amplifier lineup furnished a choice of several working frequencies centering around the two international marine calling frequencies of 143 and 500 kc.

Improvements

During the period 1930–40 the replacement of early v-t transmitters by improved types incorporating crystal control, and the almost complete disappearance of arc and spark equipment occurred. Tuned-radio-frequency and superheterodyne receivers, designed for exclusive marine application, were adopted as standard. However, many merchant ships did not discard obsolete equipment until the late 1930's.

Other innovations in this decade were: (1) the rapid expansion of high-frequency communication facilities and the production of several types of well-designed marine transmitters for this work; (2) the increasing use of low-powered marine radiotelephone, particularly on the smaller vessels and communications involving safety or ship's business; (3) the mandatory installation of an automatic alarm, capable of giving visual and audible indication of impending distress or safety information, on all merchant



Typical packaged shipboard installation including automatic alarm (with keyer unit), high-frequency transmitter and receiver, intermediate-frequency transmitter and receiver, emergency transmitter, antenna switch, and charging panel. Motor generators are in lower section

ships over 1,600 tons where a continuous radio watch is not feasible; (4) the requirement for a battery-operated transmitter-receiver unit in motor lifeboats of certain classes of passenger vessels to reduce the hazard involved in ship abandonment.

Perhaps the most outstanding advance during the recent war was the development and production of the packaged shipboard radio station; that is, one unit containing three v-t transmitters, three receivers, automatic alarm, main and emergency power motor-generator sets, and all switching and control circuits. This package could be disassembled for handling and reassembled aboard the ship. Installation time was reduced from days to hours.

Hand-cranked, portable and semi-portable lifeboat transceivers, high-frequency facilities on nearly every U. S. ocean-going vessel, and a keen but discriminating interest in the value of new electronic navigational aids were other evidences that postwar applications of radio in the marine industry would expand. Thus the modern shipboard installation, the mobile end of the communications loop, is the end product of a 47-year old sporadic evolution and includes most of the technological advances made during the prewar and wartime years.

Shipboard Radio Station

Every ocean-going passenger vessel and cargo vessel of 1,600 tons or over (certain government vessels and ships of the armed forces excluded) must have, upon leaving any U. S. port, an efficient, properly licensed radio installation in operating condition and manned by competent operators. Similar requirements are enforced by the administrations of other maritime nations. A continuous radio watch must be maintained at all times the vessel is being navigated outside harbors or ports. However, cargo vessels in lieu of additional operators may employ the automatic alarm device to monitor the safety and distress frequency (500 kc) during periods when the operator is off duty.

The minimum prerequisites for an efficient radio installation, aboard compulsorily equipped vessels, are specifically fixed by law. However, equipment design, provided certain essential performance is assured, is not specified except in cases where the use of obsolete techniques would cause undue interference to other services.

Each shipboard radio station must have: (1) main transmitter and receiver; (2) emergency transmitter and receiver; (3) emergency source of primary power independent of ship supply, capable of 6 hours continuous service; (4) other ancillary equipment contributing to efficiency, such as a clock, and bridge communication. A normal range of 200 miles is required for the main transmitter and 100 miles for the emergency. Although at one time the low-frequency band between 100 and 200 kc carried the larger part of message traffic in the maritime mobile service, today nearly all work is done on medium or high frequencies. Most shipboard stations provide several working frequencies in the band between 350 and 515 kc, inclusive. The international calling and distress frequency of 500 kc is used to make initial contact. Where supplementary high frequency is installed, it must comply with statutory regulations as to performance and use.

Regulatory performance specifications for marine radio equipment are not difficult to meet. There are, however, special considerations incurred by the stringent conditions of marine service. Ruggedness, compactness, part-replacement accessibility and protection against moisture and spray are some of the essential construction features. Efficient, well-standardized circuitry capable of easy and stable adjustment must be used throughout. Reliability must be of the highest order. It is necessary that operating controls be kept to the minimum consistent with good performance and that such controls be arranged conveniently. Provision for rapid one-control frequency shifting, simplified tuning, A1 or A2 emission at will of operator, use of 110 volts d-c as a primary power supply, or 12-volt storage batteries as an alternate emergency source, optional use of crystal control on medium and high-frequency transmitters, and a break-in system that will permit the operator to receive during keying intervals are features included in modern marine radio equipment.

Main and Emergency Transmitters

Power output of modern shipboard transmitters ranges from 50 watts for the emergency set to 500 watts for the main, medium-frequency equipment. Average power outputs of 150 to 200 watts are typical. From five to eight working and calling frequencies within the band from 350 to 515 kc are provided. Shifting frequency is accomplished rapidly by a ganged switch and antenna retuning.

The oscillator is conventional and usually has eight pretuned iron-core circuits, or ganged tapped inductances for easy switching. Provision for crystal control on all or any one of the frequencies can be obtained by substitution of appropriate crystal for a removable input capacitor. An alternative mopa lineup uses a self-excited oscillator, buffer, and paralleled-tube power amplifier. Antenna loading and tuning is accomplished typically by means of a tapped variometer. Plate modulation for A2 emission at 500 to 1,000 cycles originates in the power-supply motor generator which also supplies a high d-c voltage, or a low a-c that is increased and rectified for the plates.

Special precautions are taken to suppress harmonics and parasitics by complete shielding, oscillator-amplifier isolation, and r-f grid isolation. Primary, or some form of grid keying is used for carrier interruption in telegraphy.

Equipment Characteristics

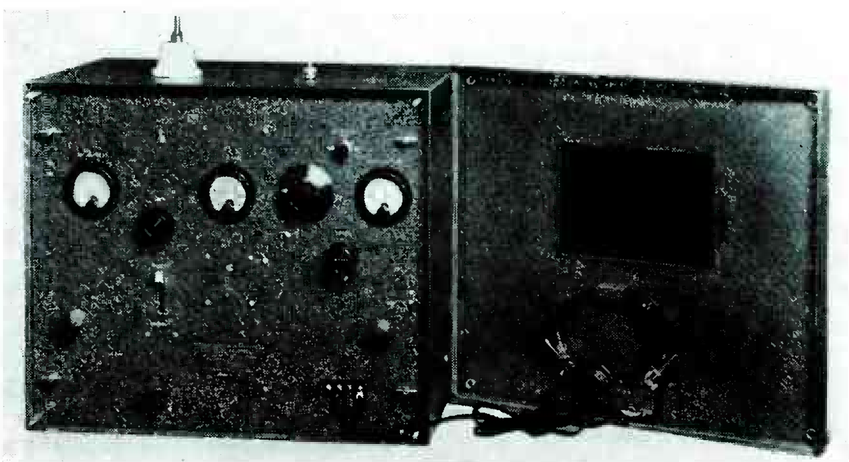
The emergency transmitter, as an independent unit, has an output power of about 50 watts into a standard shipboard antenna, or single-wire (against ground) radiator of approximately one-quarter wavelength, end or center-fed. Antenna characteristics vary between 500 to 1,500 $\mu\mu$f and 4 to 10 ohms. Modulated c-w (A2 emission) often due to raw a-c on plates, is frequently used. All power for the emergency transmitter is supplied from storage batteries through a motor-generator set of appropriate rating. Some main transmitters are so designed that they may be operated on reduced power from batteries, thus serving as emergency equipment.

Well-designed, rugged, dependable high-frequency transmitting equipment, specially built for shipboard use, is presently available. Power outputs of 150 to 200 watts, choice of A1 or A2 emission, provision for optional master oscillator or crystal control of eight frequency bands in the region 4.14 to 22.14 mc, are features of this equipment. Additionally, several working frequencies are included in each band. A stability percentage of ± 0.05 for master oscillator, or ± 0.02 for crystal oscillator is readily maintained under widely varying operating conditions. Oscillator circuitry is conventional. However, a form of temperature compensation is used by one manufacturer to insure the stability of a self-excited type. Convenient, rapid resetting of oscillator and doubler controls is provided for facile operation. Simultaneous cathode or grid-block keying of all tubes, and the use of the beam-power tubes in the power amplifiers is almost standard. For economy it is necessary that the high-frequency and main transmitters use the same motor generator through a suitable switching arrangement which permits alternate, but not simultaneous, operation.

Marine Radio Receiver

The receiver is a vital complement to the shipboard installation. A typical station includes three or four such adjuncts: (1) main receiver for the vlf, l-f, and m-f regions; (2) emergency receiver for the medium frequencies; (3) high-frequency receiver. For a standby watch on 500 kc while working on another medium frequency, an additional set is sometimes used.

The main receiver, although of straightforward design and construction, has special features for



Transmitter-receiver used in motor lifeboats carried by passenger vessels marine radiotelegraph application. The trf type with regenerative detector is standard in the marine medium band. Band switching, or plug-in coils, for substantially continuous coverage from 16 to 600 kc gives considerable versatility. One or two stages of r-f, a regenerative detector, and two stages of audio amplification is a lineup commonly used. Designed primarily for reception of A1 or A2 emission, bandwidth considerations permit high gain and selectivity per stage. Response to modulated signals is still further improved in a receiver of one manufacturer by employing audio transformers peaked in the 500 to 1,000-cps region. A storage battery for heater supply and dry batteries for plates make the main receiver independent of the ship's power line.

The emergency receiver is a crystal-rectifier type as required by law. It covers a range from 350 to 515 kc and will respond to A2 or type-B (spark) emission.

Although special high-frequency receivers have been built for shipboard service, they possess few, if any, points of superiority over any standard, high-quality communications set. Generally, they use the superheterodyne principle and are engineered for ruggedness, reliability, and compactness rather than maximum performance and flexibility.

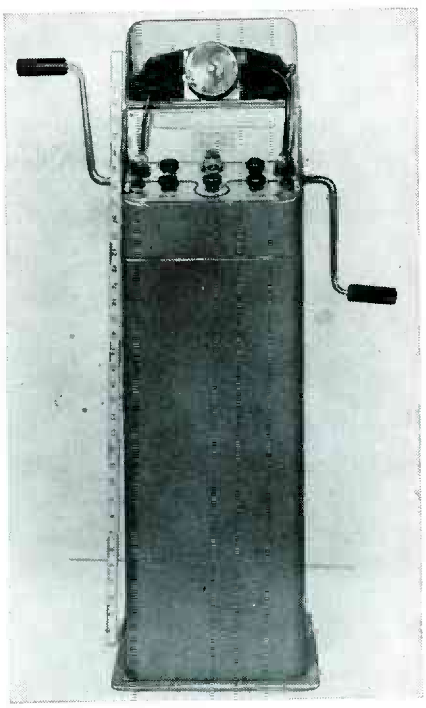
Automatic Alarm

Radio laws of the U. S. require that every ocean-going passenger vessel and every ocean-going cargo vessel of 1,600 tons or over shall maintain a continuous radio watch while at sea. However, cargo vessels, in lieu of additional personnel may use an automatic alarm device during the time operator is not on watch to guard the international distress and safety frequency of 500 kc. The automatic device must be capable of responding exclusively to an international alarm signal consisting of twelve dashes of four seconds length, spaced one second apart. To actuate, a minimum of 500 μv at the receiver input is specified. The alarm signal must precede all distress calls and may be used for urgent hydrographic or meteorological broadcasts.

Automatic alarms in use on U. S. ships are of two general types: one employs a superheterodyne receiver with an electronic selector; the other uses a sensitive trf receiver with a square-law detector and mechanical selector. Both instruments give audible indication when a true alarm signal is received and audible or visual notice or both when the alarm becomes inoperative owing to circuit failure or unusual external noise or interference conditions. Variable receiver gain permits a setting of sensitivity within the range 200 to 50,000 μv, thus allowing optimum adjustment for prevailing noise conditions. One equipment has auxiliary contacts that key the main transmitter to send out an alarm signal. A very recent development is an alarm responding directly to a specific ship's call letters or to an SOS call, thus expediting more immediate action in emergencies. Very few ships, however, are equipped with this device.

Lifeboat Radio Installation

International regulations make it mandatory that ocean-going passenger vessels maintain a complete radiotelegraph installation in one motor lifeboat where the number of lifeboats exceeds 13 and two such installations where the number exceeds 19.



A balloon-supported antenna is used on this lifeboat equipment. When cranked it automatically sends out SOS

The lifeboat transmitter and receiver unit are packaged together and mounted rigidly within a protective housing, usually in the bow. A fixed frequency of 500 kc is determined by a Colpitts oscillator arranged in a self-rectified, full-wave circuit. Modulation at 1,000 or 1,600 cps for A2 emission is obtained from a dynamotor of 110-volt, 500 or 800-cycle output. The primary source of transmitter plate and all filament power is two 12-volt, high capacity storage batteries; receiver plate voltage being furnished by dry batteries. An antenna of approximately 50 feet long, supported on collapsible masts gives a minimum reliable range of 50 miles. Power capacity must be such as to permit continuous operation for 4 hours.

Another type of lifeboat transmitter, an outgrowth of the Gibson Girl unit used in sea-air rescue work during the war, is frequently seen on merchant ships now. This equipment may be portable or semiportable and often incorporates a signalling facility only. Power is supplied by a hand-cranked generator integral with the equipment. Although the regulations requiring the installation of this device have been suspended, many merchant ships carry one or more as a means of extending the signalling area of a lifeboat.

Marine Radiotelephone

An increase in the convenience and economy in ship-to-shore, shore-to-ship, and intership communication has been effected through the establishment of medium-range marine radiotelephone networks. On the ten available frequencies in the 2-to-3 mc region a vast amount of information is exchanged. Through complementary coastal harbor stations connection can be made into the land-line telephone system.

Although certain large passenger vessels have complete facilities for long-distance radiotelephone communication open to public correspondence, equipment on most vessels is limited in range to coastal waters within coverage of harbor stations. Smaller vessels, such as tugs, yachts, fishing boats, pilot boats, or those whose routes do not justify the expense of a radio telegraph station, have found the marine radiotelephone an invaluable aid to piloting or in transacting ship business.

Shipboard radiotelephone equipment, in addition to meeting the standard requirements of ruggedness, compactness, operational simplicity, and weatherproofing has, in its highest development, several features which increase its convenience and effectiveness. Since it is ordinarily installed on the bridge or in a chart room, it is operated by nontechnical personnel.

Crystal control on all frequencies is standard. A change in carrier frequency is accomplished by one switch and antenna retuning. A choice of the method of carrier interruption (for listening-in purposes) can be made by an operator using a button on his handset which can be released for listening, or automatic operation of a Vodas relay actuated by speech air pressure on handset transmitter diaphragm.

The radio receiver allows selection of pretuned, spot frequencies corresponding to transmitter settings. An automatic selective ringer can be installed to permit signalling of an individual ship by transmission of coded impulses from harbor stations. Separate control units for operation of equipment on a preset frequency from a remote shipboard position can be furnished.

The marine radiotelephone is invaluable in cases of distress. The Coast Guard maintains a listening watch on 2,670 kc on the Great Lakes and the coasts.

A postwar development of great significance is the growing popularity of f-m radiotelephone in the 157 and 162-mc bands. Use of certain frequencies in this region in conjunction with harbor-approach radar is expected to facilitate movement of traffic in high-density areas.


Modern radiotelephone for marine use in pilot or chart room

Basic Radio Law

World-wide regulation of radio communications in the maritime mobile service is based on the Articles of the Convention for the Safety of Life at Sea, London, 1929, and the International Telecommunications Convention of Madrid, 1932, with annexed Radio Regulations. Except for the Radio Regulations, the United States is signatory to both these agreements. The recent Telecommunications Conference at Atlantic City, under auspices of the International Telecommunications Union, revised many extant regulations and made certain frequency re-allocations.

Statutory supervision of all communications in the United States is pursued under authority of the Communications Act of 1934 which created the Federal Communications Commission. As amended in 1937, this Act includes provisions of the Safety Convention for ship radiotelegraph stations.

Business Administration

Coincident with the development of marine mobile communications there has been a comparable growth of commercial companies specializing in the administration of the technical, legal, and business aspects of marine radio. In the United States four of the larger radio service companies, Tropical Radio & Telegraph, Radiomarine Corporation of America, MacKay Radio & Telegraph, and Globe Wireless, Inc., maintain extensive facilities for servicing and operating radiotelegraph and telegraph stations ashore and afloat.

Many steamship companies maintain their own radio organizations.

Today, for the ships of all nations, there exists a standardized, world-wide, radiotelegraph network made up of many systems but coordinated by the various administrations into a well-integrated, highly cooperative facility. There are few places on the high seas where a merchant ship need remain out of touch with its home port for more than a few hours at a time. However, since there can be no lessening in efforts to improve safety of life and property at sea, expedite ships' business, or improve public convenience in communications, progress in the marine radio field will continue.

Future Trends

Certain trends are already discernible; the next decade should see the following adjuncts widely accepted:

(1) Universal adoption of crystal control on all working frequencies of high and medium-frequency equipment.

(2) Replacement of many distributed-type shipboard radio stations by packaged, one-unit installations.

(3) Widespread use of some form of call-signal and SOS-responder device for supplementary watch-standing on all merchant ships.

(4) Greater use of the marine radiotelephone, particularly the vhf f-m type. Extension of present a-m radiotelephone ranges and use of vhf f-m in conjunction with navigational aids.

(5) Increased popularity of high-frequency bands for normal ship-radio traffic.

(6) Installation of radio facsimile on many passenger vessels.

(7) Limited use of television for public entertainment on the larger passenger vessels.

(8) Closer coordination of radio communication facilities, on shore and aboard ship, with sea and air safety and rescue work and with radio or electronic navigational systems.

The author wishes to thank the Radiomarine Corporation of America, 75 Varick Street, N. Y., and the MacKay Radio & Telegraph Co., Inc., Marine Division, 345 Hudson Street, N. Y., for supplying photographs accompanying this article.

Soldering

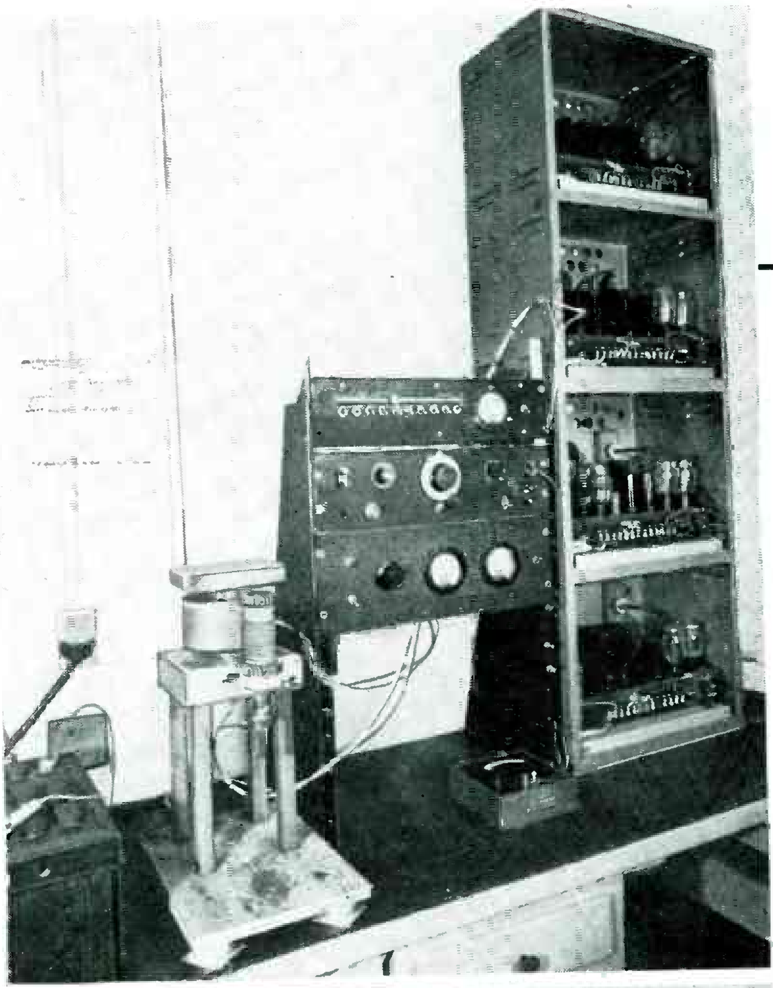


FIG. 1 — Experimental sonodizing setup. Left to right: 24-volt polarizing battery; magnetostriction transducer and soldering iron; unit containing oscillator, loading capacitors, and controls; four 50-watt amplifiers

THE TINNING of aluminum alloys presents problems tending to limit applications of soldering. Experiments indicate that some of these problems can be solved by vibrating solder at an ultrasonic rate while applying it to the work.[1] By this method the oxide coating is disrupted and alloying of the metals occurs before re-oxidation of the aluminum can take place.

The tinning of aluminum and its alloys through the application of magnetostrictive forces to a soldering iron is called sonodizing. Although sonodizing eliminates the use of a flux, if wide enough differences of surface potential exist between the metallic boundaries corrosion susceptibility exists and precautions must be taken commensurate with the conditions of exposure.

Transducer Selection

In order to establish satisfactory procedures for fluxless tinning, it was first necessary to select a vibration generator that could be readily modified to serve as a soldering iron. Selection of suitable equipment required analysis of the characteristics of several types of

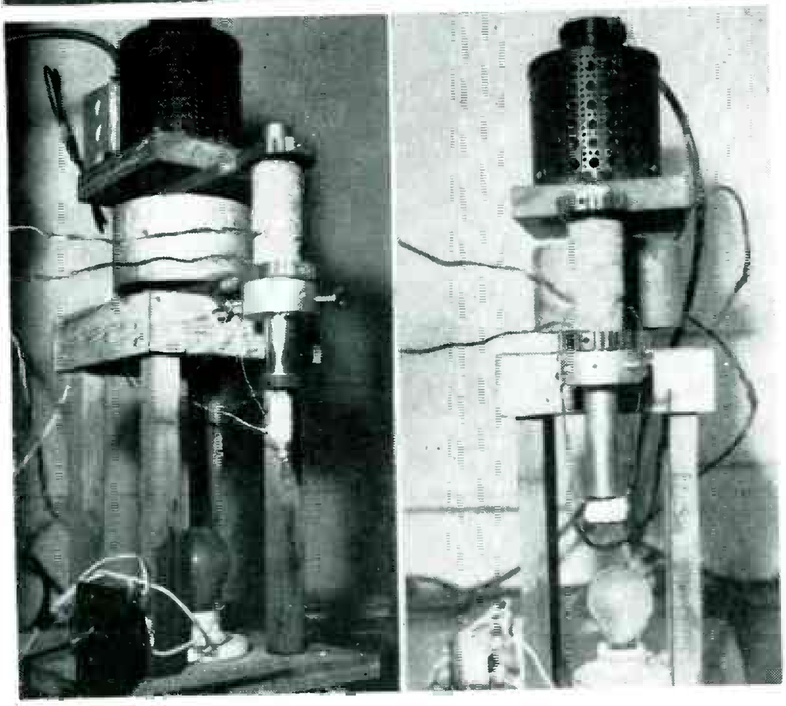


FIG. 2—Magnetostriction transducer with solid tinning tip and (right) with brush-type tip

Aluminum Alloys

Work is accomplished experimentally by vibrating the iron tip at an ultrasonic frequency by means of a vacuum-tube driven magnetostriction oscillator, to remove surface oxidation. Method is also applicable to stainless steel, chromium-plated and other hard-to-solder surfaces

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existing generators. The four types considered were: (1) magnetostriction, (2) electromagnetic, (3) gas, and (4) quartz crystal.

The deciding factor which influenced the selection of the magnetostriction unit was the ease with which the magnetostrictive element could be modified and equipped with a suitable tip. Such a transducer can, in fact, be fabricated so that the vibrating element itself is capable of withstanding direct immersion in molten metals and can be used directly as a soldering iron.

Transducer Characteristics

A magnetostriction generator of the type described by Pierce[2] has an effective frequency range of 1 to 50 kc. Amplitudes of 0.0001 to approximately 0.001 cm, which is the rupture point of nickel, can be obtained. Power up to 10,000 watts may be used. Less than 15 watts acoustic output is impractical where mechanical vibration is the objective. Transducer efficiency, which is the measure of coil output available as mechanical power or acoustic energy, seldom exceeds 15 percent. Operating temperature of the magnetostrictive tube within the coil is limited by the Curie point of the metal (300 F for Invar), but tip temperature of 800 F can be maintained for short intervals.

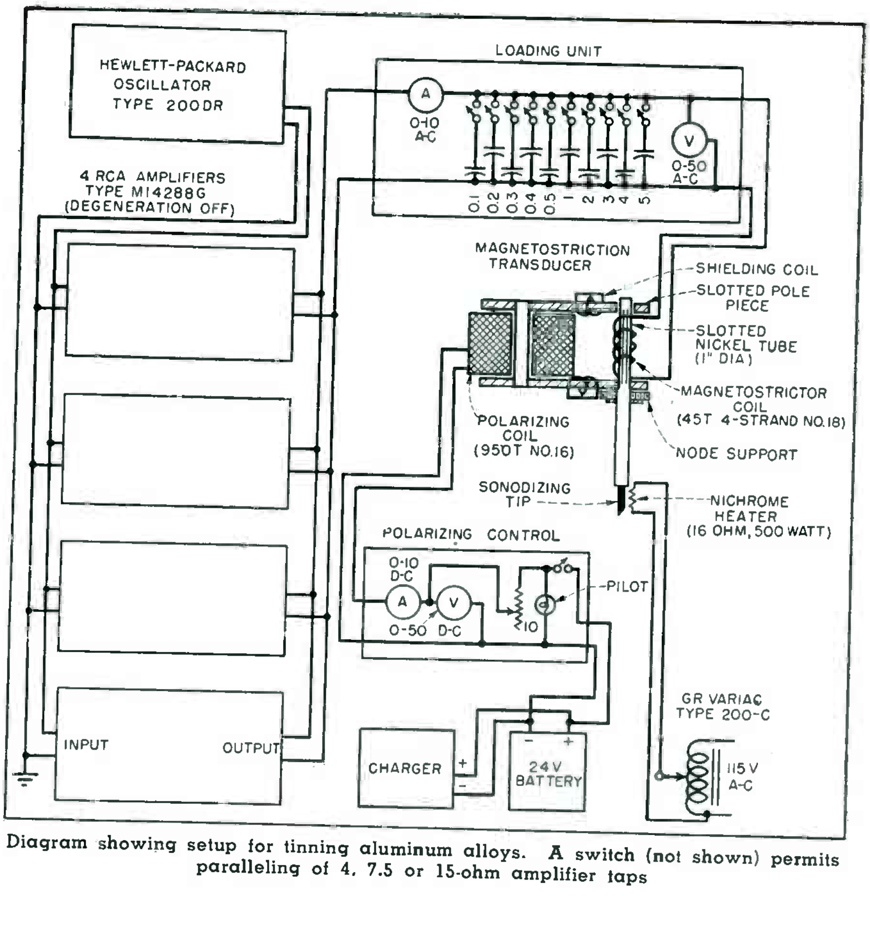

Diagram showing setup for tinning aluminum alloys. A switch (not shown) permits paralleling of 4, 7.5 or 15-ohm amplifier taps

The electromagnetic generator[3] is simpler and less costly than the magnetostrictor, but it is applicable mainly to low-frequency work with large volumes of fluid on a continuous basis. Similarly, a generator such as the Galton whistle[4] has some desirable features but it has a transducer efficiency of only 5 percent and is not as readily con-

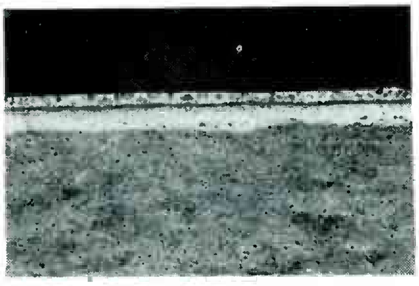

FIG. 3 — Photomicrograph showing (bottom) alloy, aluminum cladding, and (top) solder

trolled as electronic devices. Again, the quartz-crystal oscillator is suitable for work requiring precise control, but unsuited at present to sudden temperature changes required in fluxless soldering. Fracture of the crystal is likely to occur.

The magnetostriction generator constructed by the authors with the assistance of Richard W. Powell of Lockheed, and Bodine Sound Drive, is pictured in Fig. 1 and has four component parts: (1) four paralleled 50-watt amplifiers, including an output meter and a switch for selection of various amplifier output taps; (2) a capacitor loading unit; (3) an oscillator tunable from 7 to 70 kc and a magnetostriction unit, the essential components of which include the magnetostrictor coil consisting of a helix of 45 turns of 4-strand no. 18 Formex-insulated copper wire wound in two layers on a Micarta frame. The coil is 3¼× 1½-inches inside diameter and was designed to operate one-half of the metal transducer element, thus freeing the lower half of the nickel tube.

Polarizing Coil

Because magnetostriction is independent of the sense of the magnetic field, a polarizing coil consisting of 950 turns of no. 16 insulated copper wire was required. The solenoid is mounted between two soft iron plates to form a magnetic circuit. The arms of the pole pieces are shielded by wrapping with copper to prevent interaction between the magnetostrictor and polarizing coil.

The nickel tube, supplied by the International Nickel Co., is 9 inches long, 1 inch outside diameter, and has a 1/32-inch wall thickness. Nine longitudinal slots 1/32 inch long were cut in the tube along the section enclosed in the energizing helix to reduce heating. The soldering tip consists of a ¼-inch stainless-steel rod, 4 inches long, silver soldered to the end of the nickel tube. A Nichrome heater coil is wound on a tube which maintains a loose sliding fit on the tip so that unnecessary mechanical loading is avoided.

The transducer is pictured in Fig. 2. The oscillator helix is mounted so as to cover one half of the transducer element. Iron arms enclosing the polarizing coil support both units. The magnetostrictor tube is supported at its center of mass in the dural holder shown in Fig. 2. The control equipment is mounted in two separate racks (Fig. 1).

Equipment Operation

To operate the system the power-amplifier, oscillator and polarizer-coil circuits are energized. The oscillator is tuned to give maximum vibrational intensity, activating the metal tube at resonance. The capacitance across the magnetostrictor coil is adjusted to give maximum deflection of the ammeter in this circuit. Amplifier impedances are adjusted for maximum output. Power is controlled by adjusting gain on the amplifier bank. Field strength of the polarizer coil is altered to give maximum magnetostrictive effect.

After the circuit is stabilized, the Variac is set to give proper tip temperature and the solder is applied and allowed to flow around the tip and onto the metal to be tinned. The operation produces an intense hissing and chattering noise which can be used by the operator to gage working efficiency. When the work under the tip area reaches the temperature of melting solder, two or three rapid passes of the tip generally produce satisfactory tinning.

As the metal surface does not ordinarily need cleaning, pre-etching or fluxing, corrosion is not a factor in the operation. An iron-wire brush tip was found to work well in some instances, with the added advantage that it more readily reaches inaccessible areas, scaled spots and scratches. Goggles and respirator are worn by the operator as the tendency of the

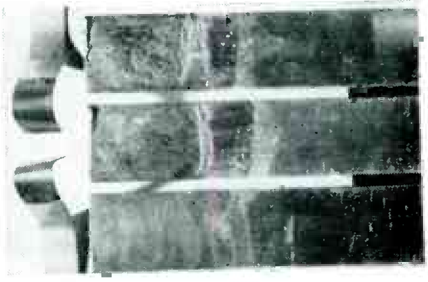

FIG. 4—Tinned dural panels

brush or tip to throw metal constitutes a hazard.

With the apparatus operating at 8 kc, tests have been made on aluminum and its alloys, notably 25ST and 75ST, as well as stainless steel, chromium-plated surfaces and anodized and dyed aluminum. Typical results are shown in Fig. 3 and 4.

Stainless steel tinned easily when a small amount of cadmium was added to the solder as a wetting agent. The same was true with chromium-plated surfaces. Phenolic strips were metallized with zinc, lead, cadmium and aluminum. Castolin eutectic 19B solder was used. Anodized and dyed aluminum tinned satisfactorily, but required a longer time than bare alloy surfaces. Ferrous metals such as 1010 and 4130 steel do not tin readily, requiring greater energy output and greater solder wettability. Aluminum aircraft-generator cable tips and lugs were tinned and then sweated together, resulting in very low contact-resistance.

Tested applications include the following:

Joining dural tubing — *Test samples showed average strength of 3,000 psi.*

Assembly of dural chassis for electrical units—*Flat panels satisfactorily joined.*

Hot-air duct assembly—*Initial tests on 0.064-inch and 0.020-inch dural satisfactory.*

Replacement for metal-to-metal adhesives—*Indicated success, but not yet thoroughly investigated.*

Airfoil smoothing — *Scratched and gouged aluminum surfaces satisfactorily filled.*

Anodized dural surfaces—*Heavily anodized and dyed dural surfaces were tinned directly.*

Other applications will no doubt be disclosed by continuing experimental tests.

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(4) J. Alexander, "Colloid Chemistry, Vol. 5." Reinhold Pub. Co., 1944.

Rocket-Engine Tester

Photoelectric unit utilizing Polaroid discs to generate sine wave checks speed of fuel pumps operating at 40,000 rpm and measures torque required to overcome drag

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ROCKET-POWERED ENGINES of one particular type employ two kinds of fuel. To feed these two propellants to the engine a turbo-driven pump having an impeller at each end is used.

A seal is required at each end of the pump-turbine shaft, which is driven at speeds up to 40,000 rpm. In order to determine the life of the seals during development it was necessary to measure both speed and torque. This had to be accomplished without adding external torque, and the following description explains how it was done electronically.

Principle of Operation

As shown in the diagram, a rotating Polaroid disc and a stationary Polaroid disc, in combination with a system of light sources, lenses, and phototubes, comprise the sine-wave generator of the test device.

The rotating Polaroid disc is mounted on the pump driveshaft. Directly in front of it two light sources and lenses are mounted on a stationary bracket. In back of the rotating Polaroid disc are the stationary Polaroid disc and two phototubes. These are spaced 90 degrees apart to produce similar electrical phase-shift.

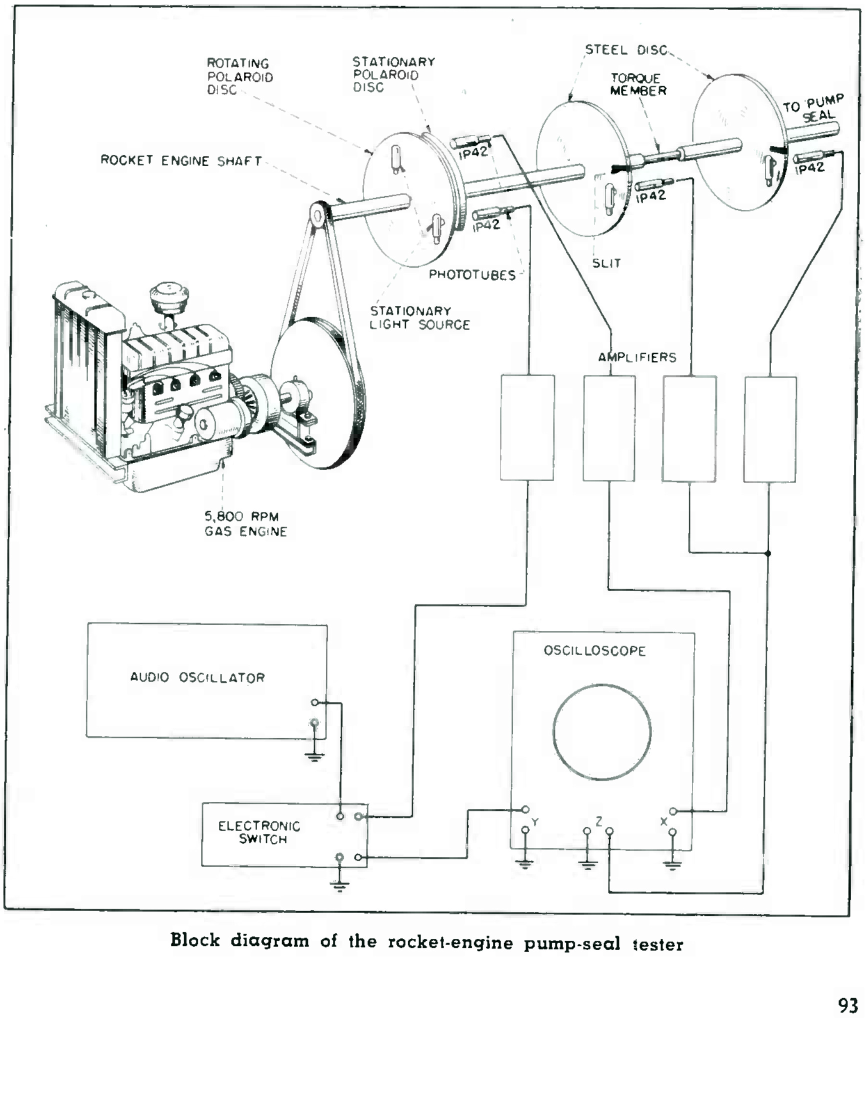
The output of the phototubes is fed to two voltage amplifiers. One of these amplifiers is connected to the X axis of an oscilloscope. The output of the other amplifier is connected to the input of an electronic switch, and the output of the electronic switch is connected to the Y axis of the oscilloscope. To the other input of the electronic switch an audio oscillator is connected.

A circle of 4-inch diameter is produced on the oscilloscope screen when the audio oscillator is tuned to the frequency of the Polaroid generator. The frequency of the audio oscillator multiplied by thirty gives the revolutions per minute of the shaft when the Polaroid generator provides two cycles per revolution.

Also mounted on the pump driving shaft is an opaque disc with a slit 0.008 inch wide and ⅜″ long, cut on the outer periphery. A light source, lens and phototube system much the same as that used in the Polaroid sine-wave generator is employed. Phototube output is fed through voltage amplifier to the Z axis of the oscilloscope. A dark spot appears on the circle developed by the Polaroid generator. An identical arrangement is used on the torque end of the shaft. This produces another spot on the circle, superimposed directly upon the first spot.

Method of Measurement

The spot remains true as long as no load is applied on the torque side of the pump. However, when loads are applied this produces an angular displacement of the torque member, which moves the superimposed spot an equivalent angle. The angular displacement is measured between the stationary spot and the moved spot, by placing a polar-coordinate chart in front of the oscilloscope tube.



Block diagram of the rocket-engine pump-seal tester

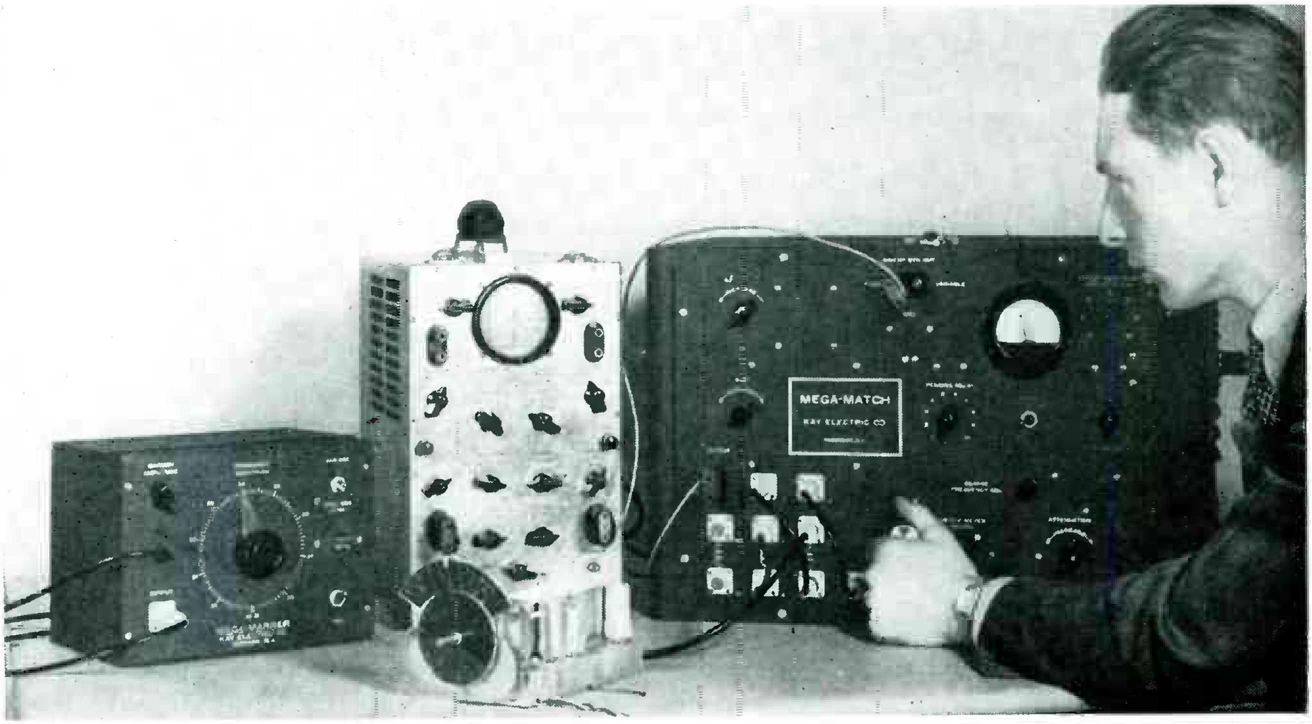


FIG. 1—Frequency-scanning vhf impedance meter in use, with conventional oscilloscope used as indicator

Frequency-Scanning VHF Impedance Meter

IMPEDANCE MEASUREMENTS can be made at radio frequencies by several methods and techniques, using such instruments as the radio frequency bridge, the slotted line, the Q meter and the combination of a calibrated signal-generator with standardized r-f ammeter, voltmeter or reference impedance. Each of these methods has its own particular type of utility. However, in determining the impedance-versus-frequency curve of a particular device, all require tedious point-by-point measurements.

A new instrument has been developed which provides an instantaneous and visually-presented determination of impedance versus frequency. The design of the instrument is such as to enable it to handle almost all of the devices encountered by the radio engineer in the design and development of present-day vhf and h-f equipment. The instrument is a frequency-scanning reflection meter designed for operation anywhere in the range from 10 to 250 megacycles. At any frequency within this range it will rapidly scan a bandwidth of up to 30 megacycles. Its output signal, suitable for use with any oscilloscope, is proportional to the amount of energy reflected from the end of a transmission delay line to which the device or system under test has been connected.

Principle of Operation

The instrument, shown in Fig. 1 and 2, embodies a principle originally used in the terrain clearance meter.[1] It consists essentially of a wide-range sweeping oscillator[2] which is arranged to propagate a frequency-modulated signal through a transmission system of finite propagation time. This propagation time is such that at any instant the reflected energy received back from the far end of the system will be of a measurably different frequency from that being fed into its input.

The pitch of the beat note produced by combining the incident and reflected waves in an internally-contained detector circuit is proportional to the rate at which the frequency is being varied and to the propagation time of the transmission system. The amplitude of

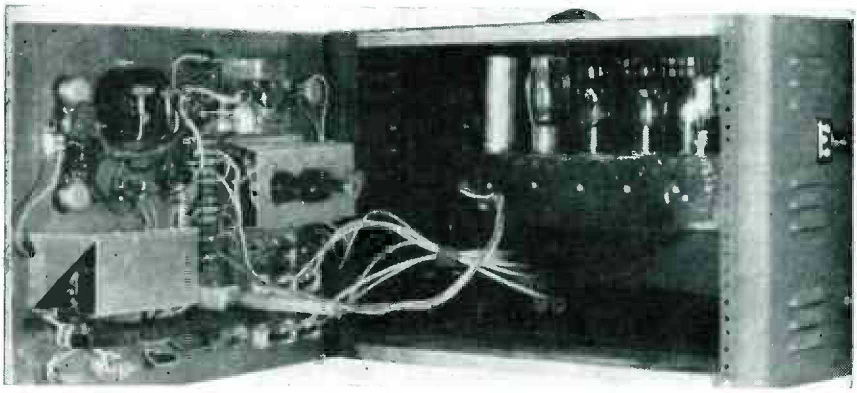


FIG. 2—Inside view of the instrument

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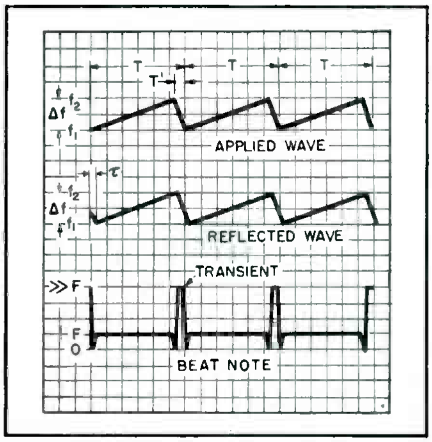

FIG. 3—Frequency vs time relationships existing at the beat-note detector

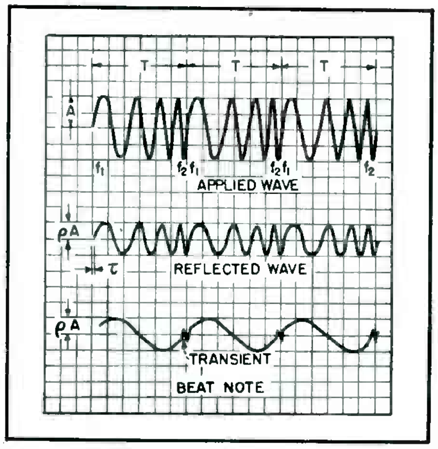

FIG. 4—Amplitude vs time relationships existing at the beat-note detector

Instrument using principle similar to that employed in aircraft f-m terrain-clearance indicators scans bandwidths up to 30 mc in the range between 10 and 250 mc. Details of design are given and the method of operation is described, using termination of an r-f transmission line as an example

the beat note is proportional to the amplitude of the reflected wave.

With reference to Fig. 3 and 4, the conditions which prevail are as follows:

(1) An r-f voltage of amplitude A is linearly frequency-modulated between the limits f_1 and f_2 by a sawtooth waveform of period T.

(2) This voltage is applied to a transmission line whose terminating impedance Z_L does not equal its characteristic impedance Z_o.

(3) The reflected energy due to this inequality is received back at the input after a delay time τ equal to twice the propagation time along the transmission line.

When attenuation in the transmission line is assumed to be negligible and ρ is taken as the transmission-line reflection factor equal to $(Z_L - Z_o)/(Z_L + Z_o)$ the voltage amplitude of the reflected wave will be ρ times the amplitude of the applied wave. The total frequency excursion Δf of the reflected wave will be the same as that of the applied wave. The frequency of the beat note is given by

$$F = \frac{\tau}{T}(f_2 - f_1) = \frac{\tau}{T}\Delta f \qquad (1)$$

The beat note exists for a length of time equal to $T - T'$, where T' is the time of the return sweep. At the end of this time, for the brief interval T', a transient frequency is set up as the applied wave snaps back from f_2 to f_1 to repeat the sweeping sequence.

To a first order of magnitude, it is necessary that the beat-note frequency be such that at least one full cycle of the beat note is completed during the time interval T. As is apparent from Fig. 4, this condition must be fulfilled if a closely sinusoidal beat-note waveform is to be obtained. Therefore

$$T \geqq 1/F \qquad (2)$$

For the case where $T = 1/F$, substituting for T in Eq. 1 gives

$$\Delta f = 1/\tau \qquad (3)$$

In order, therefore, to secure at least one full cycle of beat note, the total frequency deviation must equal the inverse of the total propagation time outward and back through the transmission line. The amount of frequency excursion during one cycle of beat note will determine the frequency resolution of a particular reflection measurement.

Description of Instrument

In the instrument, a band-pass audio amplifier with variable gain is used in conjunction with the beat-note detector. This combination results in high sensitivity of measurement of reflected energy. In order to reach the best compromise between high gain, good stability and low susceptibility to disturbance from unwanted signals, the amplifier is designed with a pass band of from 300 to 6,000 cycles per second. The beat-note detector is a silicon-crystal diode and the frequency-sweeping signal generator is an oscillator[2] plus an auxiliary 2,000-cps sawtooth modulator of the phantastron type. Three fixed lengths of RG-58/U coaxial transmission line are included internally to provide a suitable transmission delay for most of the applications generally encountered. The propagation velocity along this type of line is about 660 feet per microsecond.

The diagram of Fig. 5 shows the essential elements of the frequency-scanning reflection meter. The portion within the dotted line is the oscillator with its normal 60-cps sawtooth frequency modulation applied to the high-level (local) oscillator. The frequency excursion can be adjusted to as high as 30 megacycles or more. The adjustable output of the 2,000-cps sawtooth modulator is applied to the low-level (signal) oscillator, permitting sweep excursions of up to 5 megacycles. The 60-cps sweep rate is intended for very-high-frequency (30 to 250 megacycles) broadband work, whereas the 2,000 cps sweep rate is designed for high-frequency (10 to 50 megacycles) medium and narrow-band work.

With the various combinations of transmission line lengths included in the instrument, total delay times of 0.2, 0.4, 0.6, 0.8 and 1.0 microseconds are available. From Eq. 3 the respective sweep widths for obtaining one complete cycle of beat note output are 5.0, 2.5, 1.67, 1.25 and 1.0 megacycles. For the condition of two full cycles of beat-note output per sweep, the above sweep widths are doubled; for three full cycles of beat note, the sweep widths are tripled; and so on. This permits operation of the instrument under a wide variety of conditions, using either the high-frequency sweep rate or the low-frequency sweep rate as the individual case may dictate, and patching in suitable lengths of internal or external transmission line as required.

Applications

One typical use of the instrument is described in the following paragraphs.

Suppose it is necessary to evaluate the impedance of a coaxial-sleeve broad-band vertical dipole antenna designed for operation in the 50 to 60 megacycle region from 53.5-ohm coaxial transmission line. The antenna is mounted on an elevated support about 80 feet from the point at which the test instrument is most conveniently located, and an attached 100-foot length of 53.5-ohm coaxial cable is brought down to the test location. It is desired to observe visually the reflected energy from this antenna over the frequency range of 40 to 70 megacycles, and this information is desired with a frequency resolution of about 2 megacycles.

The ratio of total sweep width to desired frequency resolution is $30/2 = 15$, so that 15 full cycles of beat-note output per sweep are required. Hence, modifying Eq. 3 for this case.

$$\Delta f = 15\,(1/\tau) \tag{4}$$

so that

$$\tau = 15/30 = 0.5 \text{ microsecond} \tag{5}$$

The same figure may be arrived at by noting that the 2-megacycle resolution requirement is equivalent to saying that the applied frequency must shift at the rate of 2 megacycles per beat-note cycle. It then follows directly from Eq. 3 that $\tau = \frac{1}{2}$ microsecond.

A two-way delay of 0.5 microsecond requires a one-way length of solid-dielectric coaxial cable of 166 feet. Since the 100-foot feeder cable is already available externally, it is only necessary to add a single 66-foot length of internal cable from that available in the instrument to make up the necessary transmission system. The setup is as follows:

A patching cable is connected between connectors P_1 and P_2. Another patching cable is connected between P_3 and P_4. The feed cable from the antenna is connected to P_5. The sweeping output is set up for a center frequency of 55 megacycles, with the 60-cps sawtooth generator set for 30 megacycles of total sweep width (the 2,000-cps sweep is set to zero for this particular application). The 60-cps sawtooth-sweep output terminals are connected to the horizontal sweep input of any commercial oscilloscope, and the output of the band-pass audio amplifier is connected to the vertical input of the oscilloscope.

The visual pattern of the desired data will resemble the sketch of Fig. 6. The 15 complete beat-note cycles, swept every 1/60 of a second (F = 900 cps), are modulated by

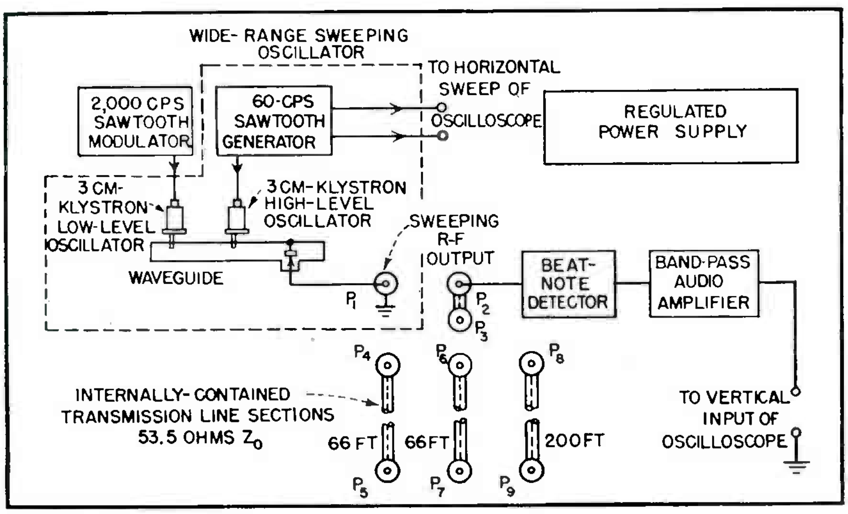

FIG. 5—Block diagram of the frequency-scanning vhf impedance meter showing lengths of transmission line available within the instrument

an envelope whose amplitude represents the amount of reflected energy as a function of instantaneous frequency. As can be seen, the reflected energy approaches zero in the region of 55 megacycles, at which point the antenna impedance closely matches the characteristic impedance of the transmission line. At either extreme of the frequency excursion the reflected energy approaches that which would be obtained if the transmission line were terminated in an open circuit. It is thus possible to tell at a glance just how effectively a given antenna matches its transmission line, and over how wide a frequency band it does so.

Transmission-Line Attenuation

Since attenuation is present to some extent in all practical transmission systems, the amplitude of the reflected voltage wave as received back at the beat-note detector is not strictly equal to ρ times the voltage amplitude of the applied wave, but is $\eta^2\rho$ times this amplitude, where η is the voltage attenuation ratio suffered by the wave in traversing the length of the line one way. However, it remains true that the amplitude of the reflected wave received back at the beat note detector is proportional to the magnitude of the reflection factor. For an open-circuited or short-circuited termination of the transmission line the magnitude of ρ is always unity. For an arbitrary terminating impedance it is possible to evaluate the magnitude of the reflection factor, and hence the magnitude of the terminating impedance, by the following procedure:

First, the transmission line to be used is terminated in a short-circuit, corresponding to a reflection factor of amplitude unity, and the amplitude of the resultant beat note is adjusted to any convenient reference value, such as two inches peak-to-peak. Then the arbitrary terminating impedance is connected across the transmission line in place of the short-circuit and the peak-to-peak height of the resultant beat-note wave displayed on the oscilloscope screen is measured. The ratio of the height at any particular frequency to the two-inch reference height is then the magnitude of the reflection factor at that frequency. The phase angle of the reflection factor may be obtained by comparing the phase of the beat-note wave at any particular frequency to the phase of the two-inch reference wave. With this information, the terminating impedance may then be calculated with the aid of the Smith Chart.

From the above description it is apparent that a knowledge of the transmission-line attenuation is not essential to the operation of the instrument. However, excessive transmission line attenuation is to be avoided since there is a

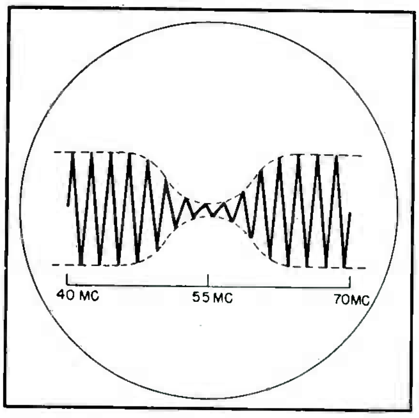

FIG. 6—Typical visual presentation of reflected energy on an oscilloscope screen

practical limit even in the most carefully manufactured delay cable or transmission line to the uniformity of characteristic impedance with length. The minute irregularities in Z_o which exist cause small reflections to occur early in the line which may completely mask the reflection due to the terminating impedance when the cable attenuation per unit length is high and the line length large. It is fortunate that for vhf applications, where the transmission line attenuation is rather high, it is generally satisfactory to work with frequency resolutions of the order of about three megacycles.

Transmission-line lengths of the order of 100 feet may then be employed without excessive total attenuation. For frequencies below the vhf range the transmission-line attenuation is conveniently low, so that longer lengths may be used to achieve the finer absolute frequency resolution which is usually desired here. A relative frequency resolution of from 2 percent to 5 percent of the center frequency is satisfactory in most cases. The sum of the lengths of cable contained within the instrument provides a minimum absolute frequency resolution of about one megacycle. For narrower resolutions than this, the addition of a suitable length of external transmission line is required. Similarly, if resolutions of less than about 2 megacycles are desired in the upper portion of the vhf band it will probably be necessary to use a suitable length of lower-loss transmission line than that contained within the instrument.

Operation With Balanced Circuits

For measurement of balanced impedances two methods have proved satisfactory. The first method involves the use of coaxial transmission line in conjunction with a suitable balanced-to-unbalanced transformer to connect the impedance to be measured to the line. The second method makes use of an external length of balanced transmission line of the twin-lead type developed for use with present-day television and f-m receivers. This transmission line may be set up in the laboratory by stringing a suitable length back and forth between pegs located on the walls in such positions that the sections of line thus formed are spaced two or three feet from each other. The balanced impedance to be measured may then be connected to one end of this line, while the other end of the line is connected to the coaxial output connector of the instrument.

Tests have shown that this type of balanced transmission line arrangement then acts as its own balanced-to-unbalanced conversion system to a satisfactory degree. Futhermore, tests have also shown that transmission-line impedances of from 50 to 300 ohms may be used without encountering trouble from second-time reflected waves.

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SOFAR

A hyperbolic position-determining system that depends upon propagation of sound from a bomb exploded at a 4,000-foot depth in the ocean. Accuracy of fixes is within five miles at 2,000-mile range. Continuous monitoring equipment used to time arrival of impulse is described

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SOFAR, from the initial letters of the words SOund Fixing And Ranging, is the code name of a position-determining system. The sound transmissions on which it depends have been heard all the way from Dakar to the Bahamas. The system was designed specifically as a rescue measure in locating castaways at sea or survivors from a ditched plane.

In operation, the castaway drops a bomb weighing 1 to 4 pounds into the water. The bomb has been set to explode at a depth of about three-quarters of a mile. Observers at each of three or more continuously operating receiving stations time the instant of arrival of the peak sound pressure to the nearest tenth of a second. The bomb is then located on one of a family of hyperbolas confocal to a pair of receiving stations. Any two of the three observation points constitutes a pair and the fix, or actual location in terms of latitude and longitude, is the point at which two lines of position cross. The lines of position are generated by the differences in time of arrival of the underwater signal.

The geometry is comparable to that of navigational systems like loran except that the transmitting and receiving stations are interchanged. .ccuracy of a fix is within five miles at a range of 2,000 miles.

Sound Channel Effect

The sofar system is based on a phenomenon in the field of sound physics which was verified experimentally during the war. This phenomenon, which has been called the sound channel effect, is the result of refraction of sound waves by layers of water. Practically speaking, because of these refraction effects, there is a horizontal channel deep down in the ocean through which the sound of an explosion can travel for thousands of miles.

Sound waves, like light waves, are bent as they travel through media in which the velocity of propagation varies. Such refraction, caused by velocity changes in the water, is accountable for the sound channel effect.

In the open sea, the velocity of sound is dependent primarily on temperature and pressure. The velocity decreases with decreasing temperature and increases very slightly with increasing pressure. Generally speaking, temperature decreases with depth. At the same time, the hydrostatic pressure increases. The two effects, therefore, work in opposition. This effect can be seen graphically in Fig. 1, which was prepared from studies of the North Atlantic Ocean by the Woods Hole Oceanographic Institution.

At depths of less than about 4,000 feet (this critical depth varies from ocean to ocean), the variation in temperature is relatively more important than the change due to pressure variation. Below this depth, there is practically no change in temperature, but because of increasing pressure the velocity increases. The 4,000-ft level, therefore, becomes a stratum

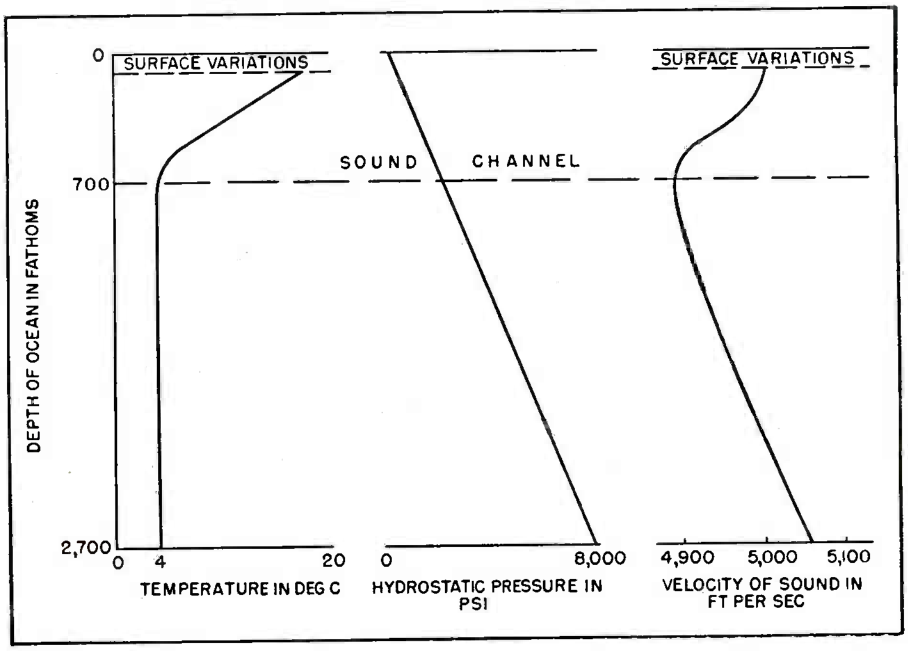


FIG. 1—Graphic explanation of the sound channel effect upon which the sofar system depends

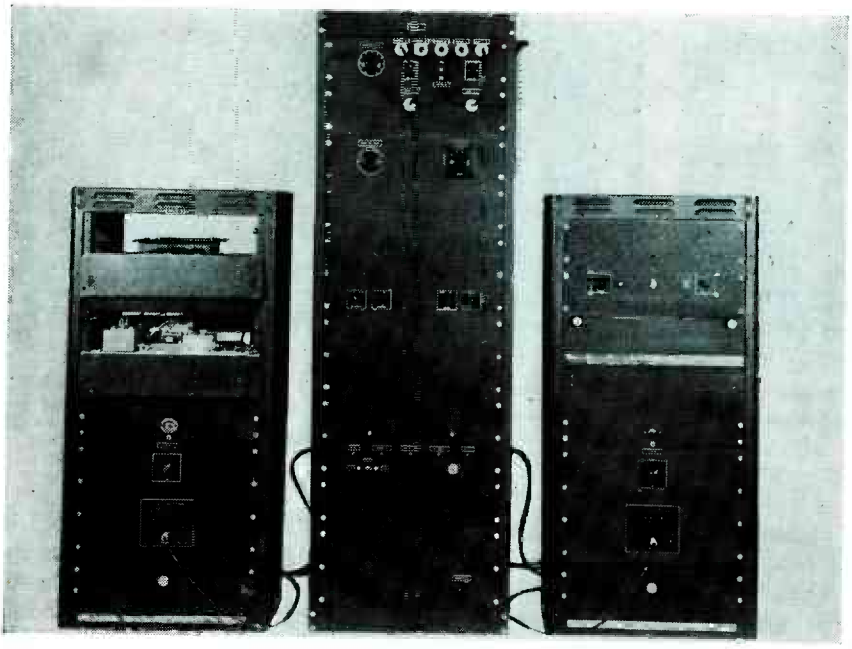


FIG. 2—Experimental sofar receiving station. Recorders and timing equipments are in smaller racks. Center cabinet contains controls, amplifiers and power

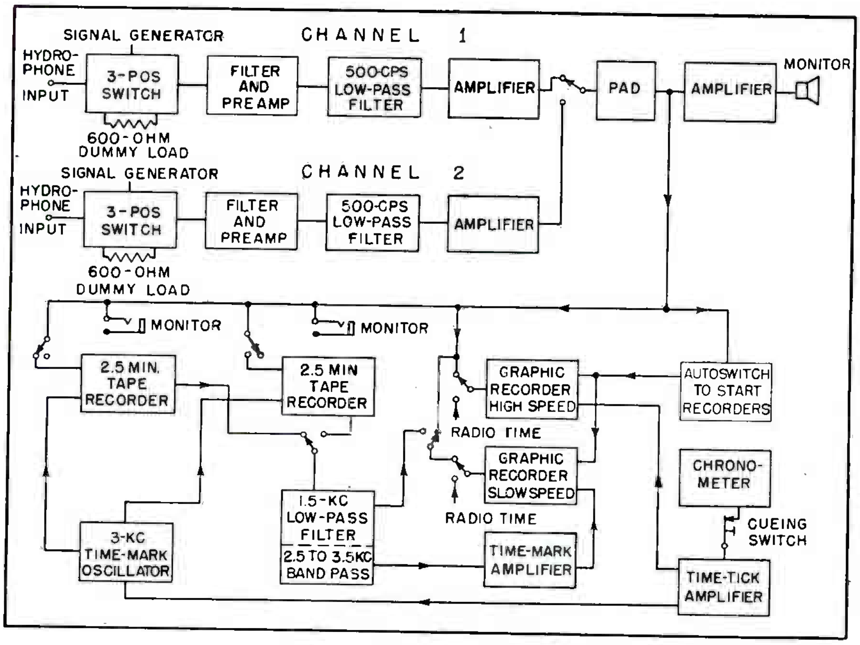


FIG. 3—Simplied block diagram of more important elements making up a complete monitoring station

of minimum sound velocity. Sounds originating at this depth are refracted downward from above and upward from below. As a consequence, sounds are horizontally channeled.

Sounds originating at a depth of 4,000 ft spread horizontally within the sound channel in much the same way in which sounds in air go echoing down a canyon. This phenomenon has a number of rather interesting effects on the characteristic of the sound wave as it is received at some great distance from the source. For example, a sound ray leaving the source at an inclination to the horizontal has a tendency to cross and recross the horizontal layer indefinitely until it is finally attenuated below the ambient noise level.

As a consequence, sound may theoretically travel by an infinite number of different paths between the source and the receiving pickup —particularly if the separation between sound source and pickup is very great, for example, of the order of several hundred miles. Furthermore, the most direct route, that is, the horizontal path from source to pickup, is also the slowest; because those ray paths inclined from the horizontal lead into strata of higher sound velocity which then bend back some of the rays and produce the phenomenon described above as a crossing and recrossing of the axis of the sound channel.

Multipath Effect

It was found rather early in the series of experiments to determine the nature of sound channel transmission that sounds arriving at the receiving element commence at a low intensity, gradually building up to a loud crescendo with a very sharp cutoff—an effect which has been described as the kettledrum. The cutoff occurs, it is believed, when the sounds which have traveled by the slowest route (and at the same time the route of most nearly constant depth) arrive. The cutoff is so sharp that there is practically no possibility of mistaking it, and the instant at which it occurs can be determined to within 0.1 second. The buildup time of the sound wave received after spreading is about 1.2 seconds per 100 miles. Furthermore, the character of a sound-channel explosion is so distinct that it cannot be confused with stray explosions at other depths.

Design Considerations

Experimental work demonstrated that the primary specifications for sofar monitoring equipment should include:

(1) sensitive response from 30 to 300 cycles;

(2) self-noise of the amplifiers at an absolute minimum;

(3) provision for switching quickly from one hydrophone to another, with, at the same time, some means for introducing a signal generator for equipment calibration and maintenance;

(4) suitable means for indexing actual arrival time of the signal

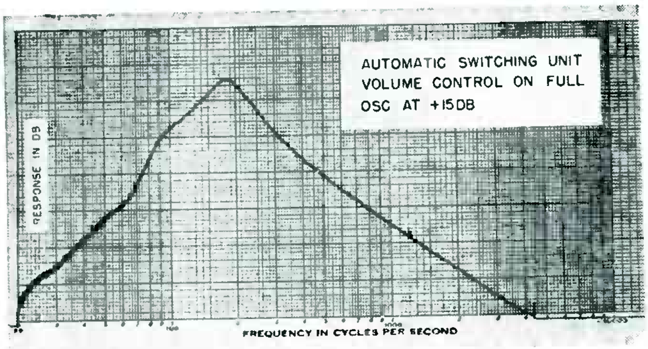


FIG. 4—Response of the automatic switching unit that turns on recorders when bomb signal starts arriving. The device triggers at 175 cycles

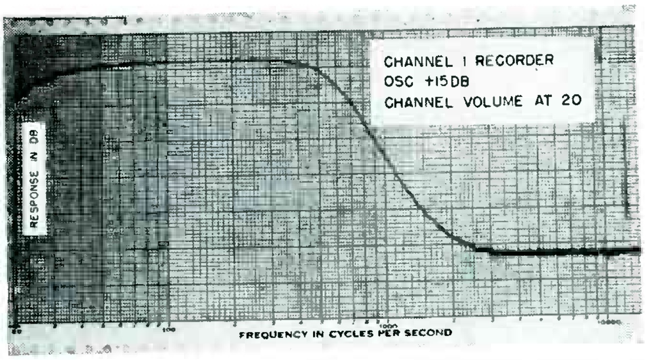


FIG. 5—Response of an amplifier channel incorporating a 500-cycle low-pass filter. Overall noise is 27 db below that of typical amplifier

(to 0.1 second) and means for obtaining chronometer correction by introducing WWV time signals.

In order to expedite delivery of the intial group of monitoring station equipment, it was decided to utilize readily available commercial equipment modified as required, supplementing this with those units which required special design or treatment. Figure 2 is a front view of the three racks which house all the apparatus for each station except the bass reflex speaker used for aural monitoring. This equipment provides integrated receiving, recording and timing units for each network station. The equipment is built to operate continuously, day after day, although the incident that it is designed to note and report to the operator takes only a few seconds and may not occur for months at a time.

Figure 3 is a block diagram of the receiving station. Several hydrophones located in the sound channel are connected by submarine cable (sometimes 12 to 15 miles long) to the hydrophone input receptacles at the top of Rack 1, center of Fig. 2. One hydrophone is patched into the operating amplifier channel.

The hydrophone amplifier circuits terminate in a system bus, contained in a unit identified as the Chronometer Time Control and Phone Monitor. The functions of this unit are: to act as a distribution center for the amplified signal from the hydrophone to the recording components; to distribute the time indexing pulses from the circuits controlled by the break-circuit chronometer; to separate the 3-kc tone pulses from the signal when the magnetic tape is reproduced; and to amplify and rectify these 3-kc pulses as a driving source for the paper tape time index relay on reproduction from the magnetic tape.

Recording Data

The recording units, which consist of a dual installation of a graphic sound level recorder and a magnetic tape recorder, are housed in separate cabinets, Rack 2 and Rack 3 (left and right in Fig. 2) cable-connected to the main rack. A time indexing and auto-start, as well as selective input control and monitoring position were added to the basic graphic recorder. In the magnetic tape recorders the speed was made adjustable from one minute normal to a maximum duration of 2.5 minutes without sacrificing the frequency response below 500 cycles.

The automatic switching unit also is housed in Rack 2. It is the function of this unit to switch on the supply circuit to the graphic level recorder motors and the time indexing control relay when a sound channel shot signal arrives at the monitoring station. Figure 4 shows the response of this unit. It is designed to trigger a 2050 thyratron at 175 cycles. Rack 3, in addition to its recording units, also contains the break-circuit chronometer which initiates the timing circuit pulses.

Figure 5 shows the response of a typical amplifier unit with a 500-cycle low-pass filter incorporated in the circuit. With input energy of the order of a microvolt over a narrow pass band from 30 to 300 cycles, the normal undistorted voltage gain is 107 db. At maximum gain with input terminated in 600

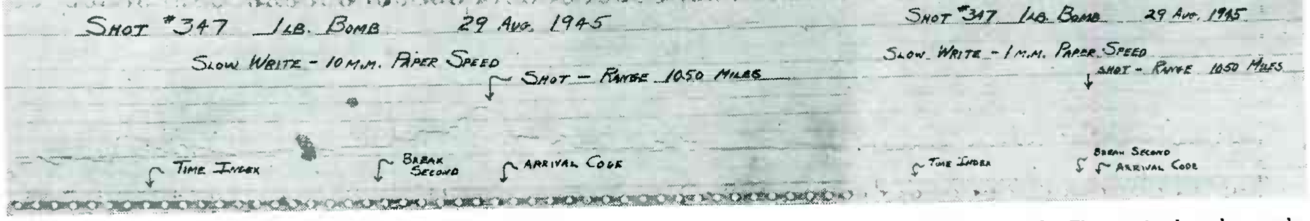


FIG. 6—Slow and fast graphic recordings of bomb signals from 1,050 miles. This record has been made from a replaying of the magnetic tape record. Point of maximum energy is timed to an accuracy of 0.1 second. The arrival code mark is made by the observing operator when he hears the maximum signal arrive and is chiefly useful in identifying the peak

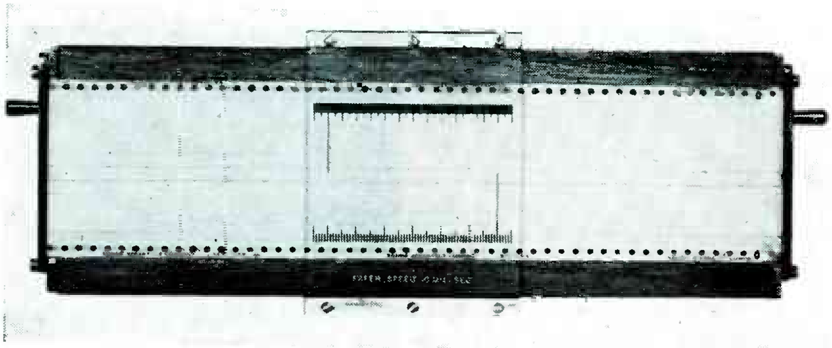


FIG. 7—Shot arrival time evaluator for two different recorder speeds. The long vertical line is placed over the maximum signal and tenths of seconds read off to the nearest chronometer time mark

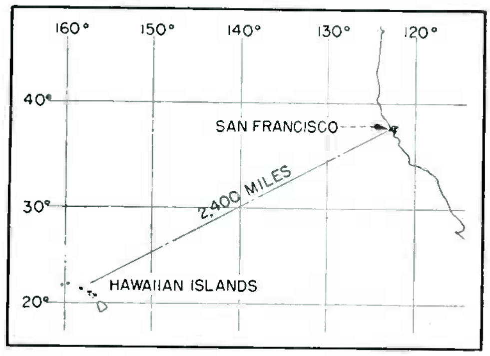


FIG. 8—Pacific Ocean Air-Sea Rescue network showing experimental stations in California and the Hawaiian Islands

ohms the overall self-noise of a typical amplifier channel as measured on a vtvm (terminated in 600 ohms) is 27 db below 1 volt.

In normal operation the equipment listens continuously. One of the magnetic tape recorder units continuously records the sounds picked up by the hydrophone and erases automatically two and a half minutes later.

With the arrival of energy from a sofar bomb, the visual recording equipment is triggered by the buildup of the amplitude of the received signal, and the station operator is alerted by means of a suitable warning device. Inasmuch as the signal comes in rather slowly, building up to a crescendo before the cutoff, the gating circuit is actuated with ample time for the operator to process the shot reception. First he must press the cue switch which breaks the chronometer control circuit, thus providing a secondary timing mark on the visual tape as well as a 3-kc tone pulse on the magnetic tape recorder. This cue mark, labeled "arrival code" in Fig. 6, enables ready identification of the time to the nearest minute and second.

The operator switches the operating magnetic tape recorder to an inoperative condition. He then turns on the stand-by magnetic tape recorder to record and switches it to the system bus. After restoring the automatic switching unit to stand-by the listening operation of the station continues, and the operator is free to observe the arrival time of the signal just received and recorded. Since this signal has also been recorded on the magnetic tape recorder, the operator can play back this recording and reproduce it on the stand-by graphic level recorder in order to obtain another trace of the received signal.

Normal visual tape speed is 5 mm per second. However, on playback from the magnetic recorder, the operator can adjust the paper tape speed of the recorder to 10 mm per sec to increase the resolving power by a factor of two.

Timing Circuit

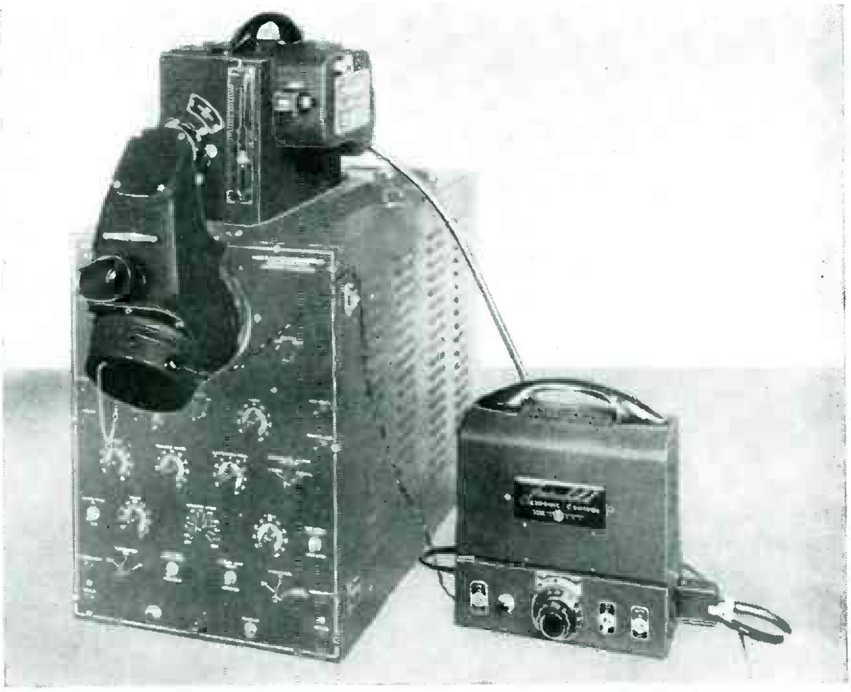
A standard Navy break-circuit chronometer is connected to each of the d-c amplifiers which actuate recorder paper indexing styli. This chronometer breaks the circuit once each second, except the 59th in every minute. The break-second mark appears clearly on the transcriptions shown in Fig. 6. One of the two amplifiers keys a 3-kc oscillator which feeds a signal into the magnetic tape recorders, allowing 3-kc pulses to be recorded on the tape in synchronism with the chronometer.

When the magnetic tape recording is played back to the sound level recorder, the 3-kc pulses are separated from the signal by a bandpass filter, are rectified and are switched to the sound level recorder paper indexing stylus. By the use of the code mark, the sound level recorder paper for a particular shot as originally recorded can be lined up with the sound level recorder paper of this same shot as recorded from the magnetic tape recorder. In this way is afforded an alternate graphic level record of the complete signal, showing the dynamic range. An accurate measure of the time of arrival can be obtained from it. The picture of the shot arrival time evaluator, Fig. 7, shows a typical trace lined up for measurement.

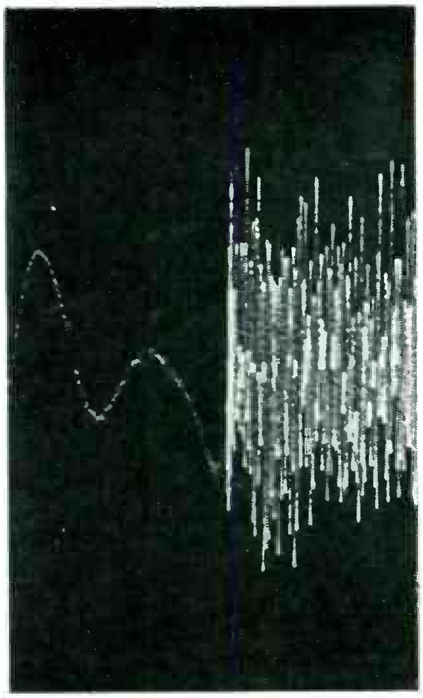
Plans are now well under way for the installation of the first permanent three-station network. The primary responsibility for completing the installation of this network, carrying out the operational tests, and conducting additional sofar research, is being prosecuted by the U. S. Navy Electronics Laboratory in San Diego. One station has been established in Hawaii and tested satisfactorily by means of bombs dropped off the California coast, 2,000 miles distant. The other two will be on the west coast, located in positions suitable for covering the California-Hawaii air routes.

Acknowledgement

Credit for experimental verification of the sound channel effect belongs to the Woods Hole Oceanographic Institution, at Woods Hole, Massachusetts, where Dr. Maurice Ewing was the principal scientist involved in the cooperative enterprise with the U. S. Navy Underwater Sound Laboratory. Among the many who contributed much to this task are J. L. Worzel, J. E. Peoples, R. J. McCurdy, W. S. Latham, W. B. Watkins, and R. E. Maxwell.



Camera mounted on oscilliscope, and electronic film-speed control unit



Example of film acceleration

An Oscilloscope Camera

Continuous recordings of oscilloscope patterns are made on film or paper at speeds from one inch per minute to five feet per second, a range of 3,600 to 1, using electronic motor control. Either film motion or the oscilloscope sweep can be employed as the time base

MOST oscilloscope pictures are made with cameras designed for general photographic purposes and not particularly suited for recording oscilloscope patterns.

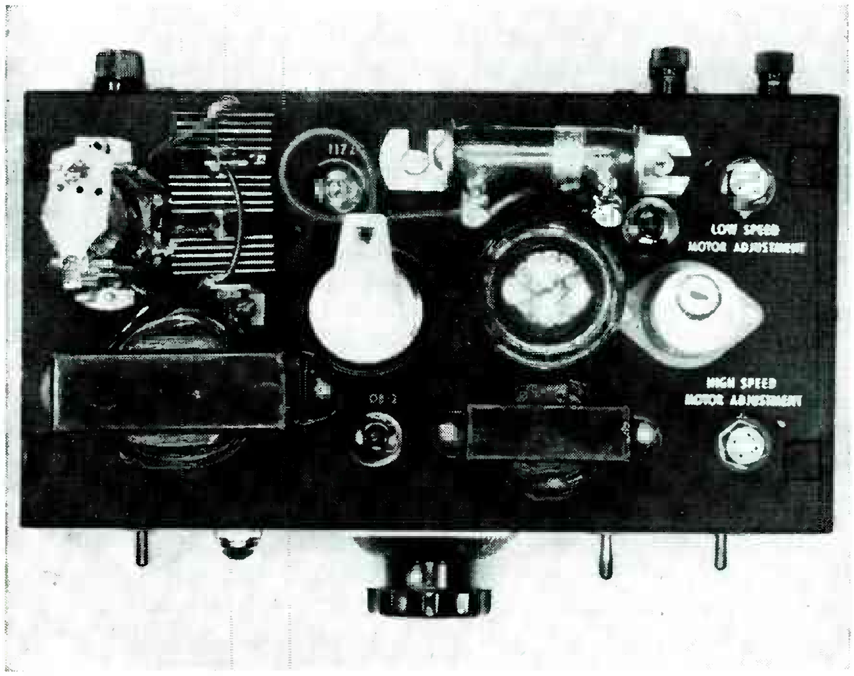
The camera to be described is designed for both still and continuously moving film photography. For still photography of stationary patterns, single transients or data records, a shutter with speeds of 1 second to 1/400 second, plus time and bulb, is provided. This shutter must be kept open when making continuous recordings, so an interlock is provided to prevent any possibility of running the film through with the shutter closed or inadvertently leaving it open while taking a series of still pictures.

For continuous recordings, a speed range of 3,600 to 1, from 1 inch per minute to 5 feet per second, is provided by means of a specially designed electronic control and a two-speed clutch. The electronic control provides smooth, uniform speed continuously variable by means of a single-dial control from 1 inch per minute to 60 inches per minute, or 1 inch per second to 60 inches per second, depending upon the position of the clutch.

The clutch is shifted by a simple push-pull knob which inserts or removes a 60-to-1 gear ratio. It may be operated while the camera is running, so that it is possible to set up for a recording on low speed and shift to high at the desired instant, giving extremely fast acceleration of less than 0.01 second to reach maximum speed.

Many types of mechanical drives were tried in the development of this camera, including change gears, cone pulleys and variable cone, but it was found that the electronic control not only gave better performance but was cheaper to produce. Furthermore, the electronic control gave a continuously variable speed control which maintains any set speed without fluctuation due to variations in load and line surges. Such precise control is absolutely essential to be sure that any variation in the recorded pattern is due to actual changes in the oscilloscope pattern and not due to fluctuations in film speed.

To give an accurate record of the exact rate of film movement, a small neon lamp is mounted so it will record along the edge of the film when fed suitable voltage.



Top view of motor speed-control chassis

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When taking still pictures, the film is advanced manually by means of a lever provided with an adjustable stop which permits advance of ¼ to double a standard 35-mm frame height (5 to 39-mm). However, if it is desired to take a large number of stills in succession the continuous film drive can be used by adjusting it to a speed which will separate successive pictures by the desired amount and by blanking out the screen with Z-axis modulation except during the interval when recording is desired. The blanking signal can be removed by the transient to be recorded, or by a relay or snap-action switch.

The camera is mounted on top of the oscilloscope with a reflecting mirror system in a light-tight housing to bring the scope image up to it. This periscope type of mounting gets the camera out of the operator's way, and provision for simultaneous viewing and recording is easily provided by a port over the lower mirror.

A filter excludes most extraneous light which would affect the film when the port is open for viewing, and a guillotine shutter closes the port entirely at other times. A rubber ring at the lower end of the periscope fits up against the cathode-ray tube to exclude all light and at the same time locates the mount accurately so that no focusing is required. The camera is prefocused at the factory.

Data Record

An illuminated data card mounts on the front of the periscope by means of spring clips, when not in use. Handwritten data may be put on the finely ground Lucite surface with an ordinary pencil and removed with a pencil eraser.

The camera uses standard 35-mm film or paper, and has an internal capacity of 100 feet, with provision for mounting a 1,000-foot magazine externally. With the 100-foot reels, the camera will operate from 20 seconds at the maximum speed to 20 hours at the minimum speed; with a 1,000-foot magazine it will operate from 3⅓ minutes to 8⅓ days, respectively.

A footage indicator shows the number of feet exposed regardless of whether 100-foot reels or 1,000-foot magazines are used, or whether the film is advanced manually or by the motor. The camera may be loaded or film removed in daylight.

A coated f/2.8 lens is supplied as standard equipment but an f/1.5 lens is optional. With the f/2.8 lens and accelerating potentials of 3,000 volts on a type 5CP11A cathode-ray tube, writing rates up to 0.8 inch per microsecond can be recorded. With a type 5RP11A tube and 29,000 volts accelerating potential, rates up to 70 inches per microsecond can be recorded. The corresponding writing rates with the f/1.5 lens are 3 and 270 inches per microsecond respectively.

Electronic Control

The circuit used in the electronic speed control of the Oscillo-Record Camera is shown in Fig. 1. A type C1B thyratron supplies the armature voltage to the motor. The control voltage is obtained from a 117Z3 rectifier with an OB2 voltage regulator used to eliminate line-voltage fluctuation effects. Bias voltage is obtained from a selenium rectifier and two other selenium rectifiers supply the motor field. A second OB2 maintains constant bias voltage. Current in the field of the motor is maintained constant with a current-regulating tube. The 117Z3 also supplies a time-delay relay which prevents application of power to the thyratron until it has had sufficient time to warm up.

In addition to the d-c applied to the grid of the thyratron to control the speed of the motor, a small amount of a-c is superimposed on it. With the d-c alone, the smallest portion of a cycle during which the thyratron can fire, if it fires at all, is ¼ cycle, with a maximum of ½ cycle.

By superimposing a small amount of a-c properly phased it is possible to cause the firing to occur much later in the cycle so that current is passed during only a very

Data record photographed from pencilled note on illuminated card

small fraction of a cycle when the power requirements are low. In this way, in place of the motor receiving a large slug of power followed by several cycles with no power, a small amount of power is supplied to it each cycle. This practically eliminates speed fluctuations which would otherwise cause uneven film speed. It also provides excellent speed control over a much wider range of speed and load conditions than would otherwise be possible.

Methods of Recording

The fundamental recording techniques possible with the camera are: single-frame exposure on stationary film, continuous-motion photography employing the film motion as a time base (which we shall refer to as the first method), and continuous-motion photography employing the oscilloscope sweep as a time base, transversal to the motion of the film (which we shall refer to as the second method).

A paper written in 1944 thoroughly discusses the various factors generally involved in oscilloscope photography.[1] In this paper, the relationships between the luminescent-spot writing rate, the lens aperture and optical-magnification ratio were derived and methods of calculating exposure were given. A Du Mont camera specifically designed for single-frame exposure photography only has recently been placed on the market. The Oscillo-Record Camera also has provision for this type of recording in addition to its primary use as a continuously moving film camera.

This method of recording can be used for the photography of either highly repetitive phenomena or single-transient phenomena where the duration of the transient is not longer than the longest sweep of the oscilloscope used, unless one wishes to photograph only individual parts of the long transient.

In photographing repetitive phenomena, the camera shutter speed should be set so that it opens for at least the duration, and preferably longer, than the time of one complete cycle of the oscilloscope sweep. The exposure, of course, should be sufficient to obtain useful negative density for the highest writing-rate components of the signal.

To photograph single transients, the camera shutter is best set at bulb or time, opened before the transient occurs, and closed after the transient has disappeared. For this purpose, an oscilloscope having a triggered sweep and automatic beam control is preferred. With such an instrument, the screen of the cathode-ray tube is blank before the transient occurs. When the sweep is initiated by the transient, the trace is blanked in for the duration of the sweep, and there is no fogging of the film by a luminescent spot or line before or after the transient.

When very long exposures are to be used with high-speed panchromatic film, fogging of the film may result due to a very weak glow coming from the heater of the cathode-ray tube. The fogging can be prevented by the use of a blue filter in front of the cathode-ray tube screen.

Film Speed Time Base

An example of the method of recording that uses the film travel as a time base is shown at the top in Fig. 2. The two pulses which appear recurrently are seen to have constant spacing, indicating the constant speed of the film. To make such a recording, the signal must appear as a horizontal deflection of the spot on the cathode-ray tube screen since the motion of the film in the Oscillo-Record Camera is vertically upward. This is best accomplished by reversing the horizontal and vertical deflection plate connections to the tube or by rotating the cathode-ray tube clockwise through 90 degrees. By doing this, rather than just feeding the signal into the X amplifier, the signal may be observed before the recording is started, using the oscilloscope sweep. Then, when all adjustments are made, the sweep is switched off and the camera motor is started.

This method of recording is useful where the signal to be photographed occurs too slowly for an observer to study, even on a long-persistence screen, or when the signal consists of a non-uniform recurrent phenomenon, or if the signal occurs at random.

At the maximum camera speed (60 inches per second), the highest frequency which can be recorded is limited by the resolution of the film and the luminescent spot size. With high-speed film emulsions, such as Eastman Kodak Linograph Ortho and Linagraph Pan, the limit frequency for this method of recording is about 10,000 cycles.

For a particular cathode-ray tube screen, the frequency limit due to persistence, for continuous motion recording, is known as the blurring limit. This limit is approximately 200 kilocycles for a P11 screen and is therefore well above the resolution limit at 60 inches per second. When a time reference is desired, a signal voltage of known frequency may be connected to the small neon bulb in the camera; a narrow time-marker track is then recorded at the edge of the film.

The second method of recording, that of recording the oscilloscope sweep across the width of the film, is illustrated by the bottom trace in Fig 2. The pulses shown are the same as at the top and were obtained by differentiating a sawtooth wave. Both oscillograms were made on the same strip of film by running the film through the camera twice; recording once by the first method, with the beam positioned to one side of the cathode-ray tube screen, and then recording by the second method, with the beam positioned to the other side of the screen.

Although the film was run at the same speed in both cases, the distance between pulses at the bottom in Fig. 2 is much greater and, had the signals been more complex, this additional space would have been necessary. As stated previously, it is only necessary to run the film at a rate of speed sufficient to provide some separation of the successive sweeps and the signals imposed thereon. The angle at which the sweep base-line appears is determined by the ratio of the oscilloscope sweep speed and the film travel speed. When the film speed and sweep speed are equal, the base line records at a 45-degree angle, and when the sweep speed is much greater than the film speed, the base line is essentially perpendicular to the film length.

The film speed at which the successive sweeps, and the signals imposed on them, are just separated, can be calculated from the formula

$$S = f_s h/6$$

where S = the necessary film speed, f_s = the sweep frequency, h = the height of the signal peak appearing on the cathode-ray tube screen.

The factor, 1/6, is the optical-reduction-ratio of the camera lens. In many cases where the signals appear immediately below one another the film can be run slower than S, so that one signal appears inside the other or interlaces without overlapping (as in Fig. 9).

When the signal being recorded is a sine wave or any other pattern having negative as well as positive amplitudes, and the peaks of the signals on the successive sweeps do not interlace, then h will have to be taken as the peak to peak amplitude. The highest frequency that may be recorded by this method is limited only by the maximum sweep speed available and the maximum photographic writing rate of the oscillograph. (Maximum photographic writing rate is defined as the maximum writing speed of the luminescent spot on the cathode-ray tube screen, which produces a recording density of 0.1 above film fog at an optical object: image ratio of $M = 1$ with a lens aperture of f/1 and with a high sensitivity film emulsion processed in a high contrast developer.)

Occasionally, certain phenomena are observed which have extremely rapid variations at the beginning and then undergo a slow rate of change with a duration many times longer than the initial transient. To record such phenomena completely, with sufficient detail for analysis, it would be necessary to run the film at extremely high speeds. Besides being uneconomical, this procedure would make it difficult to study the latter part of the signal which, since it has a slow rate of change, would be spread over a great length of film.

It may be possible in a few cases, by watching the pattern through the camera's viewing eyepiece, to switch the film speed from high to low by means of the speed-change clutch but this is usually impractical. The second method of continuous-motion recording might then be used, but the continuity of important parts of the phenomenon may be lost due to the many successive sweeps.

For Transients

In a third method of continuous-motion recording, a single driven-sweep of the oscilloscope is used to rapidly deflect the spot vertically upward at the start of the phenomena, as the film in the camera moves slowly in the same direction. The signal is impressed horizontally on the spot; at the end of the single sweep the spot is not blanked out but remains in position. The effective speed of the time base during the sweep is equal to the vector sum of the optically-reduced sweep speed and the film speed and, after the sweep, is equal to the film speed alone. Sweep and film speeds should be chosen to provide optimum spread of the rapid transient and the slow rate of change part respectively Only one time-base discontinuity then exists at the end of the sweep travel. Even this discontinuity can be avoided by the use of an exponential sweep rather than a linear sweep. That is, the exponential curve of the sweep rate can be made asymptotic to the film speed. Where a number of high-speed transients occur at random during an otherwise slow rate-of-change phenomenon, the oscilloscope sweep could be made to trigger off only during the transients and rapidly fly back to the original position to record the slow part. The use of timing markers is mandatory to achieve the proper time perspective when studying the recording.

The effects of a heavy load on the performance of a synchronous motor is shown in Fig. 3 and 4. The oscillograms show the starting current in the motor from the in-

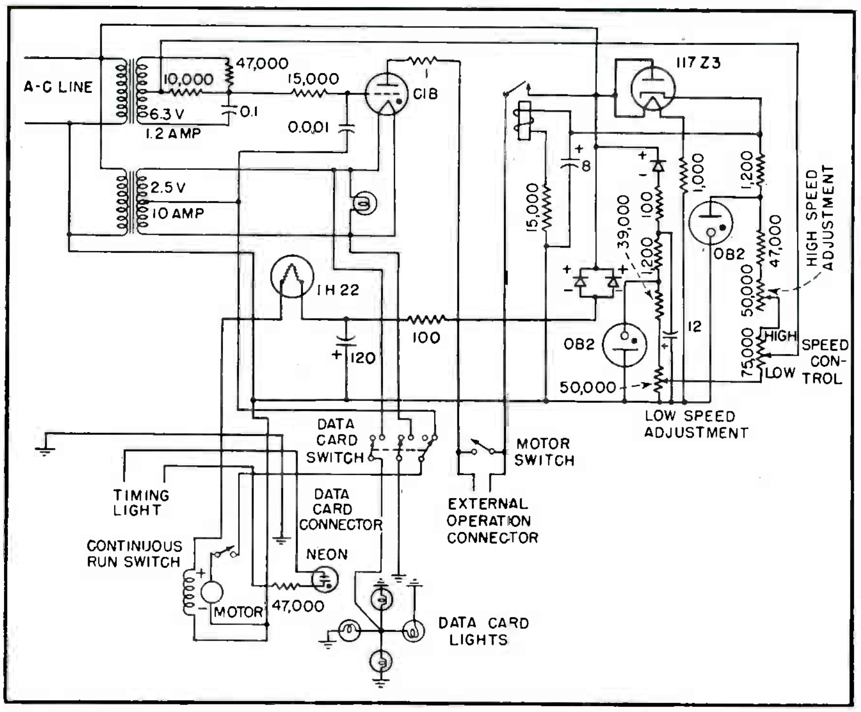

FIG. 1—Circuit of electronic variable-speed-control for the camera motor

FIG. 2—Top trace—use of film travel as time base. Bottom trace—time base across width of film

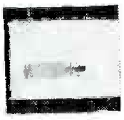

FIG. 3—Motor start

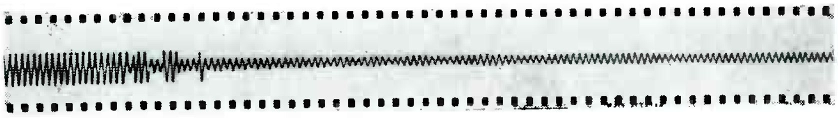

FIG. 4—Motor starting current

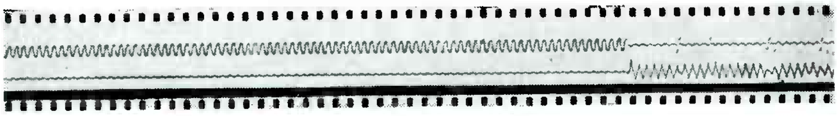

FIG. 5—Top trace—voltage across fluorescent tube. Bottom trace—current through circuit

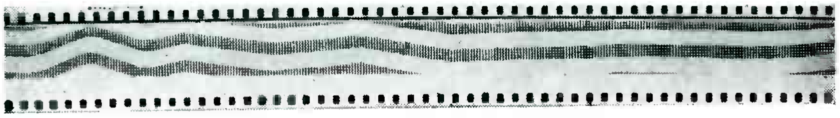

FIG. 6—Oscillator frequency drift

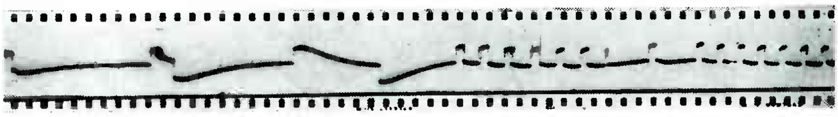

FIG. 7—Output of OB2 with varying load

FIG. 8—Output of Geiger-Muller counter

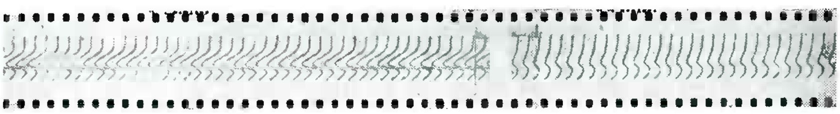

FIG. 9—Potential of frog sciatic nerve

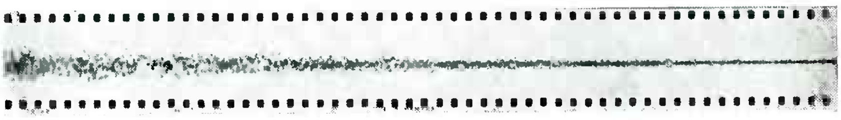

FIG. 10—Reverberation of sharp sound in closed room

stant the switch is turned on to the time that the motor has reached its synchronous peed.

Figure 3 is a single-frame photograph and, although the oscillogram provides some indication of the transients that occur, it is not possible to analyze the phenomenon unless a series of pictures of sections of the overall characteristic is taken.

The oscillogram of Fig. 4, made by the first method of continuous-motion recording, clearly shows the heavy starting current and the automatic switching from starter winding to running winding. This switching and subsequent hunting, visible as a modulation of the motor-current amplitude as the motor builds up enough torque to carry the load, can easily be timed. Timing markers are unnecessary since each current cycle represents 1/60 of a second. Figure 4 shows that the motor switches to the starting winding 4 times in ½ second because of the heavy load. After the last switching occurs, the motor armature hunts for approximately 3 more seconds before stability is reached. The total elapsed time from the instant of switching on the motor to the time of stability is approximately 4 seconds.

Fluorescent Lamp Analysis

Another application of the oscilloscope and continuous-motion camera in the electrical industry is illustrated in Fig. 5. This oscillogram shows the starting voltage and current characteristics of a fluorescent lamp fixture. The simultaneous recording of voltage and current was obtained by the use of a 5SP dual-beam cathode-ray tube. In Fig. 5, the upper trace represents the voltage across the fluorescent tube and the lower trace represents the total current drawn by the fixture. Again, film motion provides the time base.

The two luminescent spots on the tube screen were positioned in a horizontal line to obtain the proper time relationship between voltage and current in the recording. When the switch is turned on, a voltage immediately appears across the tube and a small amount of current is drawn by the entire fixture. The lamp fixture contains the fluorescent tube, a series-inductive ballast, a gas-filled starter containing a bimetal element, and a capacitor which is connected in parallel with the starter and tube. At first the current is limited by the resistance of the starter, the ballast, and the filaments at the end of the fluorescent tube. After approximately 1.4 seconds, (determined from number of 60-cycle peaks) the voltage across the tube suddenly drops, while the current drawn by the fixture rises to a high value. This is caused by the heated, bimetal starter short-circuiting the capacitor. The current is now limited only by the filaments and the inductive-ballast.

The filaments rapidly heat up as the bimetal in the starter cools.

After another 1/10 of a second, the bimetal cools sufficiently to contract and unshort the capacitor. This causes the current through the inductive ballast to drop, and the collapsing magnetic field causes a resonant voltage surge to appear across the capacitor and tube, as indicated by the first voltage surge-transient in the oscillogram.

During the next ½ second, about 5 more voltage transients occur, corresponding to flickers in the tube, until the fluorescent tube finally starts and remains on. The end of the recording shows a constant voltage being maintained across the tube, and the current, which is limited now by the ballast and the resistance of the gas in the tube. The slope of each peak of the voltage characteristic is the result of the charging and discharging of the capacitor during each cycle.

Such a recording provides the lamp manufacturer with an excellent means of evaluating the action of the gaseous starter, the tube characteristics and the optimum constants for the ballast and capacitor. Since the life of a starter and fluorescent tube depends to a great extent on the number of times that starting occurs, it is of advantage to be able to study these transients in detail.

Frequency Drift

A method of recording oscillator drift by time is shown in Fig. 6. The oscillogram was obtained by a variation of the second method of continuous-motion photography. The recurrent sweep of the oscilloscope was locked to a standard frequency and the output of a drifting oscillator was connected to the Z-amplifier input. The sweep appears as a line across the film with a portion blanked out by the drifting oscillator signal.

If the oscillator frequency and phase are constant with respect to the standard frequency, the blanking will occur at the same point and appear as a straight path along the length of the recording. Notice how the oscillator drifts rapidly at first and then becomes relatively stable. A frequency-drift record such as this can be extended to over eight days on a 1,000-ft. magazine.

The camera provides a means of obtaining voltage time curves of power lines, power supplies, voltage stabilizers and regulators. The output voltage of an OB2 gas regulator tube is shown in Fig. 7. This characteristic was obtained by rapidly varying the load on a regulated supply from 0 to 10 milliamperes. From a curve such as this, the voltage recovery time of a voltage regulator may be determined for either rapid or slow charges in load.

Nuclear Physics

One of the simplest applications of the camera and oscilloscope is to record the output of a particle counter tube. Figure 8 shows an oscillogram of the output pulses of a gamma-ray counter connected to an oscilloscope. The random nature of the pulses and the apparent showers of cosmic rays is recorded. By running the film faster or by using the oscilloscope-sweep recording method, the pulses can be further separated, and the number during any time interval can be counted by using a time-marker track.

Biology and Physiology

Figure 9 is a typical biological recording showing the action potential of a frog's sciatic nerve in response to electrical stimulation at a repetition rate of 100 per second. An electrical-pulse stimulator was used to stimulate the nerve and simultaneously initiate the driven sweep of an oscilloscope at a pulse repetition rate of 100 per second. The film was run at about 3 inches per second, each successive reaction occurring beneath the other. At the start of the recording a portion of the nerve had been dipped into a powerful nerve poison and the reaction of the nerve to the stimuli gradually diminished.

The bottom portion of the recording shows the diminished response caused by poisoning of the nerve. Actually, the entire recording occupied about 100 feet of film so only small portions of the beginning and end are shown. The trailing edge of the stimulating pulse can be seen at the left of each sweep. The recording was obtained at the Columbia Medical Center in New York City with the permission and kind assistance of Dr. H. Grundfest.

Applied Acoustics

Recently, methods have been tried to teach the deaf to see sounds by sight-reading of patterns on luminescent screens. An extension of this method to record these patterns on photographic paper is an obvious consideration and perhaps this will some day lead to musical libraries for the deaf.

With an oscilloscope and continuous-motion camera, acoustics design engineers now have a new means of observing the location and measuring the duration of sound reflections from walls or objects in auditoriums or sound studios. Measurement of reverberation time is one of the difficult problems with which the acoustics designer must cope.[2] Usually the reverberation time is calculated mathematically by measuring the absorption surfaces of every unit in a room and applying acoustical absorption coefficients to these measurements, including them all in a formula. Some designers make use of tables and nomographs to simplify these calculations.[3]

A continuous recording showing the reverberations in a closed room caused by a sharp sound impulse is shown in Fig. 10. The complete sound decay is not shown because of lack of space. As applied to the problems of acoustic design the reverberations may be picked up by a very directional microphone, and the recording would then show the amplitude and location of the source of most echos. Proper placement of sound damping materials is then facilitated and an over-all reverberation time recording may be made.

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Designing INDUSTRIAL

Electronic computer is adjusted to simulate an industrial operation and its control. Engineer then manipulates system to determine optimum design. To simplify computer construction and increase speed very fast time scales are used in computing circuits

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USE OF ANALOGS makes it possible to experiment readily with devices or phenomena under changes of scale or after transformation of their variables. All models, whether they are the small-scale replicas used by civil engineers, model airplanes in the wind tunnels of aerodynamic engineers, miniature boat hulls in the towing tanks of naval architects, or the equivalent circuits used by acoustical engineers to study microphones, are analogs. Dynamic analogs can be highly complex assemblies such as differential analyzers, abstractions such as mathematics itself, or direct simulations of the process.

The great advantage of analogs as devices for solving engineering problems is that they are simple. Electrical analogs of mechanical, thermal, or other systems can be assembled and adjusted quickly and easily. For example, in designing a pneumatic control, the analogous electrical network of resistors and capacitors of Fig. 1A was built. As a suitable design evolved from experiment a more formal network was constructed. Finally, after experience in the laboratory under many control circumstances, the actual pneumatic control of Fig. 1B was built. Much time and costly machining were saved using the easily modified electrical analogy.

To facilitate making electrical analogies and to perform the broader functions of analog computers in problems dealing with automatic controllers, the Analaut has been developed. It is a flexible electronic instrument for study and demonstration of regulatory systems such as industrial process controls, servomechanisms or position followers, navigational controls, and stabilizers for power plants.

Designing Controllers by Analogs

As long as a process remains in the steady state its analysis is relatively simple. About two decades ago engineers in the process industries, particulary those concerned with instrumentation, became concerned with the dynamic nature of their processes and equipment, especially under automatic operation. Owing to the complexity of such problems, early studies were empirical. Mathematical analyses and syntheses of idealized systems were made. Hydraulic analogs of thermal systems were built from which transient behavior could be studied readily by direct measurement.

Beginning in 1936 the writer developed a complete computational Automatic Control Analyzer based on interconnected high-speed models of both process equipment and its associated controller, which took the form shown in Fig. 2A. Different masks depicting the processes and controls being studied were superimposed on the panel to facilitate visualizing the system; the in-

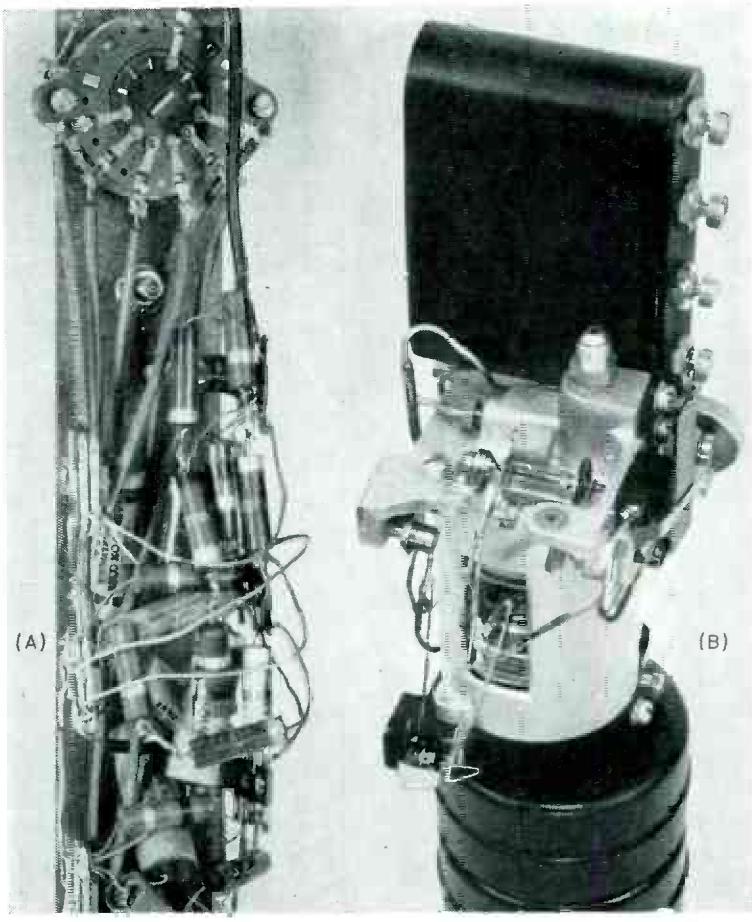

FIG. 1—Electrical analog (A) simplifies design of pneumatic controller (B)

CONTROLLERS By Analog

strument is still in use. The same basic technique, developed to a higher degree, is employed in the modern instrument shown in Fig. 2B. It is used for designing controls and also for predicting the necessary type of control for a proposed installation and the adjustment for optimum performance of complex systems.

Whereas controllers can be designed by mathematical analysis provided the system is not prohibitively complex or by testing in the completed plant if adjustments to the system can be made safely and economically, it is simpler to represent the closed control-process loop by an analog. The heavy lines of Fig. 3A show the loop whose properties are to be studied; the rest of the diagram shows the elements of the analog analyzer. The control manipulates the plant input m in recognition of the unbalance u so as to cause the regulated variable v to follow its desired value v^*, thus reducing the absolute value of the unbalance u to a minimum near zero. All the variable and parameters in the analog are the counterparts of those in the actual plant.

In the analog computing system, the controller and the plant are represented by electronic model assemblages, a basic circuit of which is shown in Fig. 3B. The essential loop variables are transformed into measurable voltages, each of which can be related to the corresponding plant variable by an appropriate scale factor such as pounds per square inch per volt (to convert to pressure in a pneumatic control).

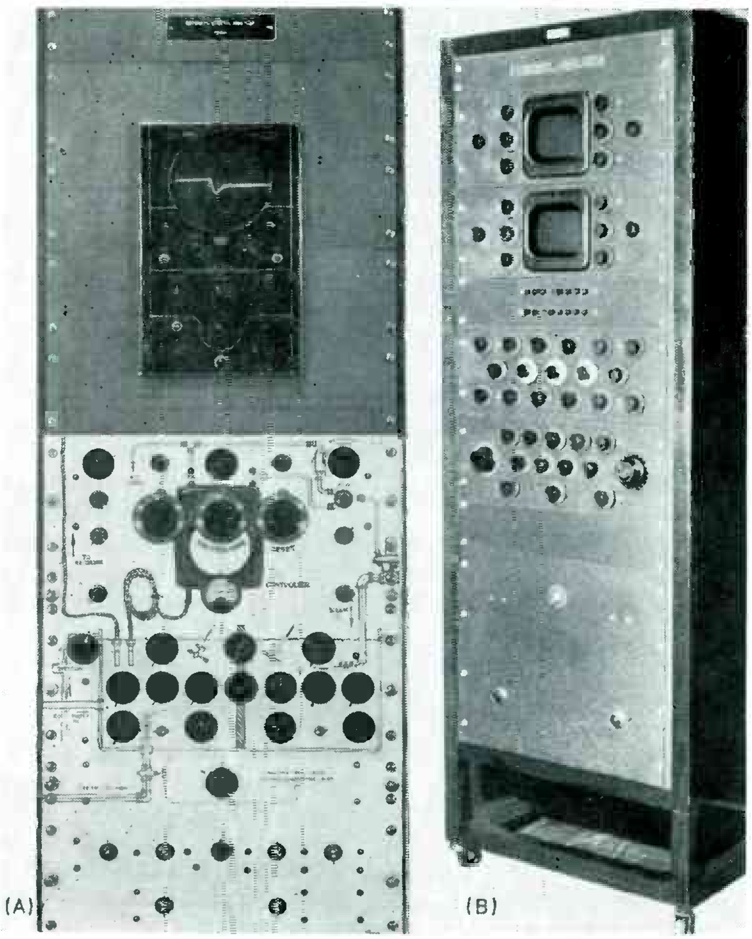

FIG. 2—Circuits of analog computer simulate plant and controller

For repesenting the desired value there is a manually adjustable steady component and an optionally inserted variable component for disturbing the system. The flexibility of the instrument permits comparing controlled and uncontrolled responses of the simulated system, studying hysteresis and excursion limit effects, inserting conventional regulating functions with proportional, derivative, integral, and second integral effects, and inserting special features from external circuits. Response of the analog is determined by disturbing it with a recurrent pulse and observing the transient on an oscilloscope. The time scale of the analog is made short so that the loop will have returned to equilibrium before the next pulse and so that the computing elements, especially the capacitors, can be conveniently small. The disturbance can be inserted at any desirable point in the loop.

Usually the variations around the simulated loop are displayed as functions of time on the oscilloscope, with suitable timing markers if necessary. However, by plotting one variable against another parametric plots of great interest can be obtained. Figure 4 shows curves plotted against time, and a parametric curve (for a more complex system) by way of comparing the two types of displays. The parametric method shows the stability and phase relations among significant loop variables.

With such an analog of the process an analog of the appropriate controller can be developed and its suitability observed from the transient response obtained. By manipulating plant or control parameters that are likely to vary during operation, critical conditions can be found and evaluated. With this information the control is practically designed. The fast operating time of the analog permits observing the complete transient response as an adjustment is made, so that a complete study of a system can be completed quickly.

Basic Circuit

For special purposes the analog might be arranged differently than the one described here, but the same basic circuit can be used. Most of the complete analog system is based on conventional electronic techniques and so need not be reviewed. However, it should be pointed out that, of the possible mediums for building analogs, the convenience and flexibility of electronic circuits makes them excellent for experimental purposes. If one stays well above the noise and drift thresholds, there is no practical limit to the precision that can be obtained if the needs justify the effort. At the opposite exreme, tube noise can be employed for random excitations where statistical evaluations are to be made.

Figure 3B shows a useful general-purpose circuit for use in electronic analogs. Considered as an amplifier, the circuit is directly coupled for handling direct current but can operate to frequencies that are high compared to the fundamental frequency employed in the disturbance. The input impedance as seen from e_1 is very high. The internal impedance of the circuit is also relatively high so that for reliable results substantially no current can be drawn from the output by the load. Thus, because no current can be drawn at the output e_2, the circuit is usually followed by another of the same kind.

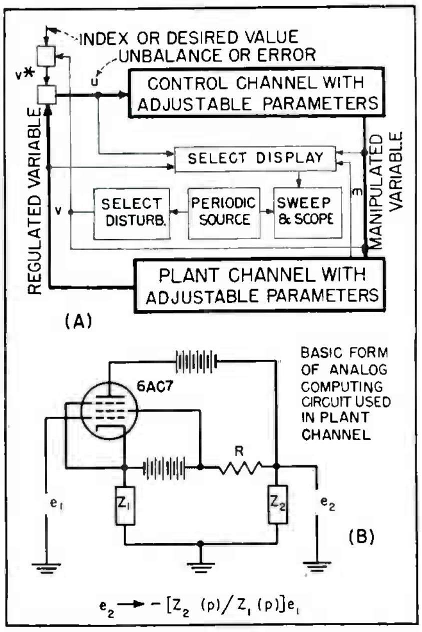

FIG. 3—(A) Block diagram of automatic control computer, and (B) basic circuit of used in the analog computer elements

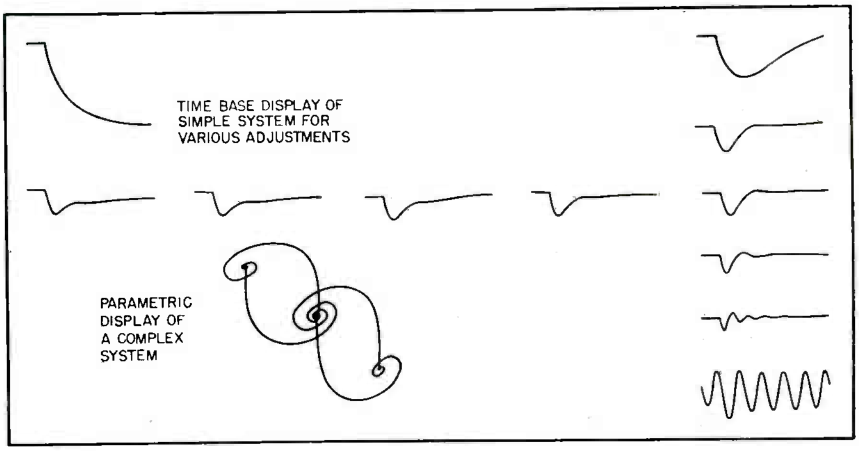

FIG. 4—Reproduction from oscilloscope tracings show how optimum response of plant can be determined by systematic adjustment of various controller adjustments

A fixed source of screen excitation is provided, giving constant gain to zero frequency. The same voltage source provides a reverse current mode of operation in the computing portion of the circuit. Dropping-resistance R is chosen near the average effective d-c plate resistance of the tube. A peculiarity of the circuit is that there are no paths from the tube electrodes to ground other than those through the elements Z_1 and Z_2, thus the currents through these elements are equal and opposite. As the grid voltage approaches cutoff, current circulates through Z_1 and Z_2 in that order, making the output e_2 positive. At the opposite extreme, the current circulates in the reverse direction making e_2 negative. Because the voltage across Z_1 follows e_1, the output e_2 is dynamically related to e_1 in a manner dependent almost entirely on the values of Z_1 and Z_2.

If Z_1 is purely resistive, the current in Z_2 corresponds to the input voltage e_1. This property is useful in various ways; for example, Z_2 can be the input terminals of a four-terminal filter, in which case the current into the filter is directly manipulable with no expenditure of input energy.

If Z_2 is also purely resistive and equal to Z_1, reversal of sign or "minus one" operation results. With Z_1 and Z_2 replaced by a single linear potentiometer, a distortionless inverting amplifier having a useful adjustment is obtained. With the tap in the center, the gain or transfer function is nearly unity. Deflection of the tap in one direction gives a transfer or gain of G and an equal deflection in the other direction gives a gain of $1/G$.

With Z_1 still purely resistive, if Z_2 is purely capacitive, the circuit is a reasonably good integrator with a time constant R_1C_2. In the control analog computer for which this circuit was developed, the computing interval is typically four milliseconds, so that the time constant of the integrator can be made long compared to the computing time using components of reasonable size. If the elements are reversed the circuit is a differentiator. In fact there are numerous dynamic characteristics that can be obtained using different combinations of impedances for Z_1 and Z_2. The nominal equation for the circuit is given in Fig. 3B.

In operating the circuit, care must be taken to prevent saturation of the tube or components. For example, a typical fast integrator will integrate to a limit in a millisecond with one volt remaining on the input. However, such a device can be tested and calibrated by applying a square wave of about five volts amplitude to the input, with an additive adjustable d-c bias. The bias can be set to bring the effective input level to zero and will keep the output within the limits of saturation. Under these conditions a sharp and straight sawtooth will be produced in the output by a sharp square wave at the input; the amplitude of the output will be dependent

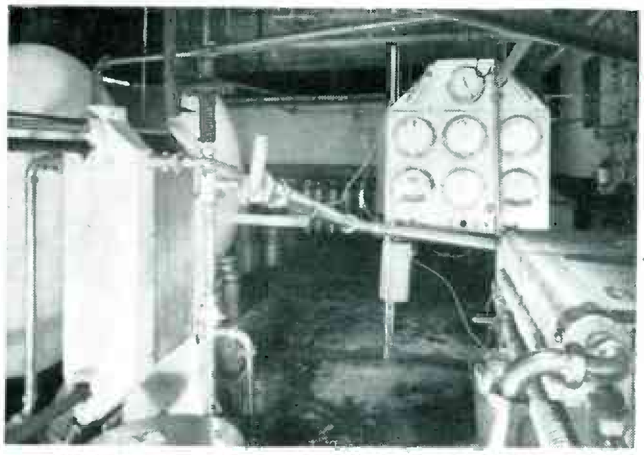

FIG. 5—Control for heat exchanger in this pasteurizing plant was designed by means of electrical analogs

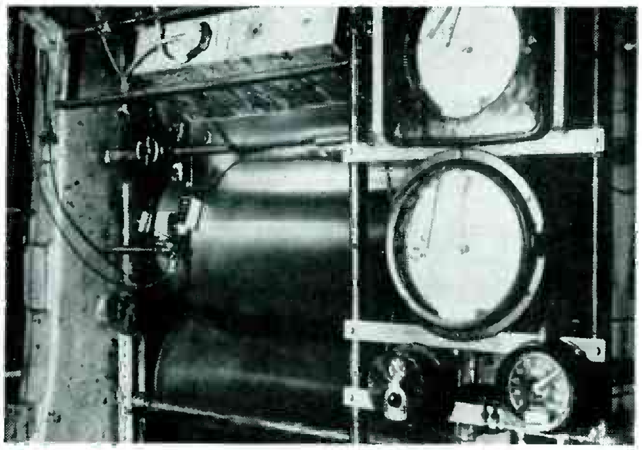

FIG. 6—Floating thermometer head on plastic calendering roller actuates automatic process controller

on the amplitude of the input, its period, and the time constant of the integrator. Other types of computing networks require other techniques for calibration and adjustment, but this example illustrates the simplicity of the methods.

The combinations possible with this basic circuit provide a powerful general technique for constructing computers and control analogs. Most dynamic conditions can be reproduced with this circuit and combinations of passive networks. For a small project, or for initial experimentation, the basic circuit using batteries is especially appropriate because well-regulated power supplies are unnecessary. As used in the control analog computer, common power supplies and auxiliary switching and calibration circuits are necessarily added to the basic circuit.

Industrial Applications

The first step in using the analog computer for designing an automatic control for an industrial plant or process is to reduce the actual system to its elecrical model. In many processes it is possible to recognize the electrical analogs from the equipment and to compute parameters from known data or by simple tests. Distributed parameters can usually be represented to useful accuracies with a few lumped sections.

As mentioned above, if a direct approach is not feasible the dynamic response of the plant can be determined by introducing a known disturbance at the input or manipulated variable and observing the disturbance produced at the output or regulated variable. The plant must remain in a sufficiently undisturbed condition, aside from the intentional disturbance, or the measurement must be repeated often enough to eliminate random effects. Where the response depends on the condition of the load or there are other nonlinearities, a series of tests may be necessary. The record of plant response is then duplicated to a much faster time scale on the control computer, with especial attention to duplicating delay and the initial portions of the response. Once the plant response has been provided in the analyzer, the appropriate control can be quickly determined.

Two typical problems illustrate more specifically how the analog method of designing controllers is carried out in practice. Figure 5 shows a portion of a high temperature pasteurizer; the main heat exchanger is at the right and the instrument panel in the near background. Several interlocking controls are included in the plant to assure holding every drop of milk at a maximum temperature for a minimum interval, avoiding overheating. The crucial regulation problem is to control the hot water temperature in the final milk heater stage at a point chosen for its significant relation to the milk temperature by manipulating a steam valve elsewhere in the system. Under manual operation with water replacing the milk to avoid accidents, a record was made of the temperature variations resulting from a sudden known change of the steam valve. From this information the settings for a proportional derivative-integral control were determined on the analog computer. High performance was obtained from the predicted settings and further adjustments were unnecessary.

In another type of problem the crucial regulated variable was the surface temperature of the central roll of a plastic calender. The temperature was measured electronically by the floating head shown in Fig. 6 and recorded on a self-balancing capacitor bridge instrument. The manipulated variable was steam pressure under control of an auxiliary or cascaded regulator. By making a manual change in the steam pressure, the plant response was obtained on the temperature recorder. The analog of the plant was then set to duplicate this response and several control methods studied. The best type control mechanism thus determined was installed and set to the predicted dynamic adjustments, giving satisfactory control immediately.

Besides providing a design and operating tool in the field of automatic control, this type of analog has also proved useful in instructing plant personnel and as a college lecture room demonstrator and laboratory test set. Acknowledgement is made to the engineers of The Foxboro Company for whom the early developments of these techniques were made, and to Prof. J. A. Hrones of MIT for encouragement in their application to the pedagogy of automatic controls.

Electron Diffraction for Film and Surface Studies

Crystalline structures of thin films can be determined by diffraction patterns produced when electrons are directed through the material. Surfaces of materials are studied by patterns of reflected electrons. Applications and equipment for the technique are described

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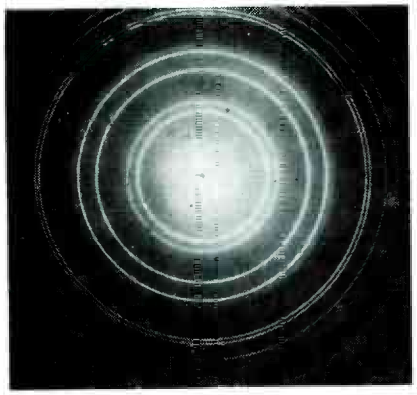


Although oxidation of a magnesium disc was not visible, this reflection electron pattern shows the surface presence of magnesium oxide

Aluminum mounted on a Formvar film to give a total thickness less than 500 Angstrom units produced this transmission electron diffraction pattern

THE ELECTRON diffraction instrument is a research tool designed to aid physicists in observing and measuring conditions on surfaces, or in thin layers, of materials such as metals, ceramics, and plastics. In it a beam of electrons is directed at the material being studied and the resulting diffraction pattern is observed visually on a phosphorescent plate or photographic records are made. This pattern consists of rings, the diameters, intensities, and sharpnesses of which indicate composition, orientation, and atomic arrangement of crystalline material.

Types of Applications

The electron diffraction technique is used for investigating corrosion, catalysts, lubricants, surface deposits, pigments for paints, inks, dyes, graphite, and many phases of metallurgy. The diffraction patterns are similar to those produced by x-ray diffraction. The essential difference is that diffraction patterns resulting from reflecting electrons from the test samples indicate conditions only on surfaces of samples, while diffraction patterns from electrons projected through test samples indicate internal conditions of thin films. X-ray diffraction indicates the condition throughout the entire specimen.

Comparison may be made between electron diffraction patterns obtained by various users of electron diffraction equipment, or with the card index of x-ray diffraction patterns maintained by the American Society for Testing Materials.

The electron diffraction instrument is used in research developing better filaments. It is now generally known that primary and secondary electron emission is a function of the surface conditions. The instrument has been used in the General Electric Research Laboratory in the study of better material for secondary emission. In this case, a magnesium-silver alloy was heated, after which the surface was examined by the electron diffraction instrument and found to be magnesium oxide, which is good for secondary emission.

In studying the cause and prevention of corrosion, it is essential to determine its nature in very early stages. Electron diffraction will detect minute changes and thus will help to identify chemical changes before they are visible under a microscope. By studying corrosion resistance of alloys in different atmospheres, the instrument has aided in selecting the best material for gas-turbine buckets.

Patterns can be observed visually or photographic records can be made

Catalytic action is a surface phenomenon. Electron diffraction photographs reveal the presence of the very thin layer of material responsible for this action. Lubrication is a function of the surface film. Hence the electron diffraction instrument is important in determining good lubricating films and in controlling processes for their production. In addition, it is useful for studying surface changes on bearings and engine cylinder walls.

Method of Operation

The instrument is mounted on a portable table. The major components are an electron gun that produces the electron beam, an apertured anode that accelerates and positions the beam, a magnetic lens for focusing and positioning the beam on the specimen, the specimen chamber with manipulator for adjusting the position of the specimen, a mechanical shutter for controlling exposures and provided with a fluorescent coating for visual indication of focus, a camera box with fluorescent screen for viewing the diffraction pattern and with space for five 4 by 5 inch photographic plates for recording the pattern, the evacuating system, and the power supply.

Either of two apertured anodes, which are grounded and thus maintained at a positive potential relative to the filament, can be brought into position and adjusted mechanically for proper positioning of the electron beam. One aperture admits a beam of 0.002-inch diameter, the other 0.008-inch diameter.

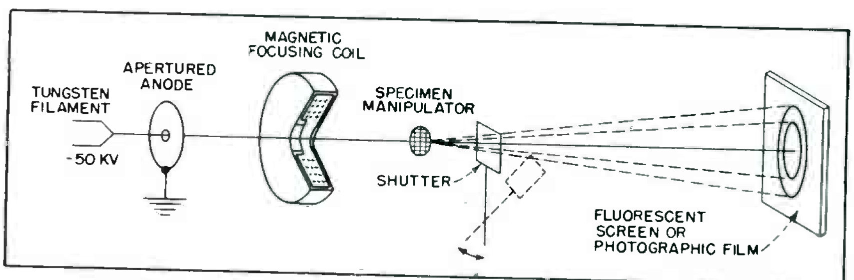
The specimen chamber is about 6.5 inches square by 8 inches deep. Samples are admitted through a door 6 inches in diameter. Three of the faces of the chamber are provided with glass ports 3.5 inches in diameter. These glass windows are interchangeable with metal plates or other accessories. One accessory, a specimen manipulator, is normally mounted on the top port. Another accessory that can be mounted on the front port when required, is an auxiliary electron gun for neutralizing charges that collect on certain specimens.

The specimen, the surface characteristics of which are to be studied, is mounted on the specimen holder. After vacuum has been established and electrons are passing through the apertured anode to form a beam, the operator focuses the beam on the shutter by means of the magnetic lens until, by adjustment of the apertured anode, the unfocused and focused beams coincide. Specimen adjustments are made with the manipulator until a diffraction pattern is obtained on the fluorescent screen. The distance of the specimen from the screen is determined by an accessory telescope, which can be mounted on the specimen chamber.

When a photograph of the pattern that has been focused on the fluorescent screen in the camera box is desired the beam is interrupted by the shutter. A photographic plate is lowered from the upper plate holder by actuating a push button. The shutter is then opened long enough for the exposure. Then the plate is dropped into the lower plate holder by operating another push button.

The evacuating system consists of a mechanical pump and an oil diffusion pump, separately mounted beneath the assembly. A valve seals the chamber from the pumps during specimen changes or loading and unloading of the camera. Vacuum is measured by a thermocouple gage. Time-delay relays prevent premature application of voltage.

The power supply, furnishing accelerating potential to the main electron beam, is adjustable from 20 to 50 kilovolts and is stabilized and ripple-free to better than 0.1 percent. A high-frequency supply furnishes current for the filament of the electron gun. A zero-center instrument indicates any variation of the high potential greater than 0.05 percent.



Elements of electron diffraction instrument show its operating principle

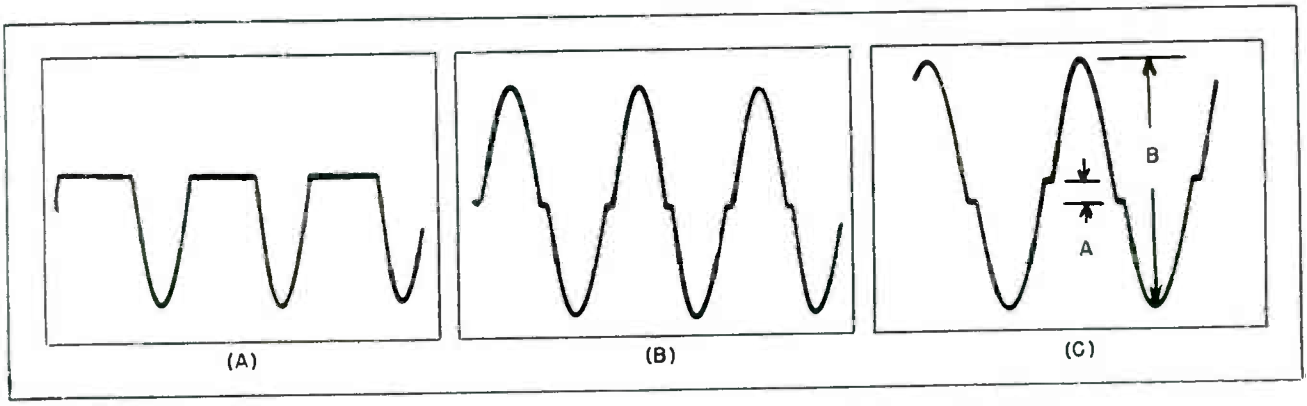


FIG. 1—Clipped sine wave (A); double clipped sine wave (B); double clipped sine wave showing phase shift (C)

Technique for Distortion Analysis

Modification of clipped sine waves by circuits under observation is displayed on a cathode-ray oscilloscope for quick analysis of audio response. Typical patterns are given, and a simple equipment comprising biased crystal rectifiers is described

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DISTORTION in a linear circuit can be separated into two general categories: nonlinear distortion; and frequency distortion. Nonlinear distortion is caused by impedances that are functions of current or voltage. A sine wave introduced in such an impedance will be distorted in waveform because of the harmonics generated. These nonlinear impedances are generally resistive, like those encountered in a tube or crystal.

A sine wave introduced in a circuit containing only reactance will not be distorted in waveform, but may be changed in phase and amplitude. This phase shift and amplitude change may also vary with frequency. Harmonics are not generated in this kind of a circuit, though they may be selectively diminished or accentuated.

Circuits in general have both nonlinear distortion and frequency distortion. The amount and kind of distortion that can be tolerated in a circuit depends on its use. Communication circuits, in which intelligibility is paramount, can have considerable distortion, whereas broadcast circuits should have negligible distortion.

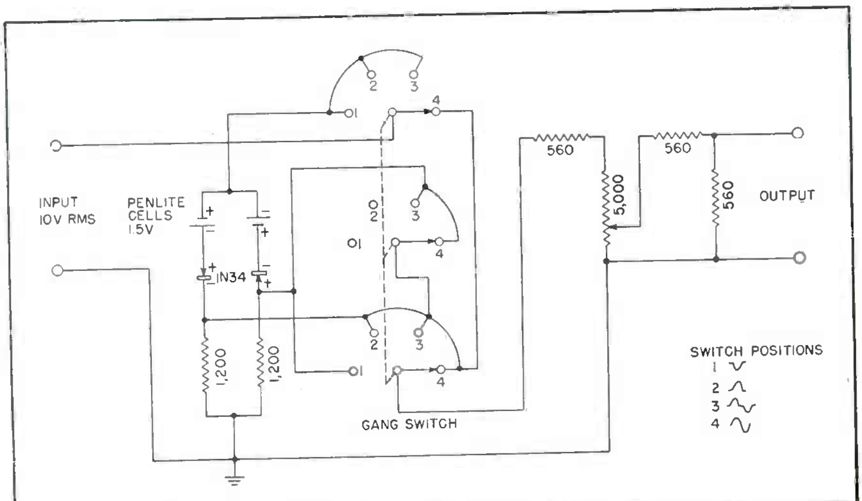

FIG. 2—Circuit diagram of a sine wave clipper with output waveforms for various switch positions indicated

Measurement of Distortion

There are various ways of determining distortion in a circuit in order to indicate its suitability for a particular application. One well-

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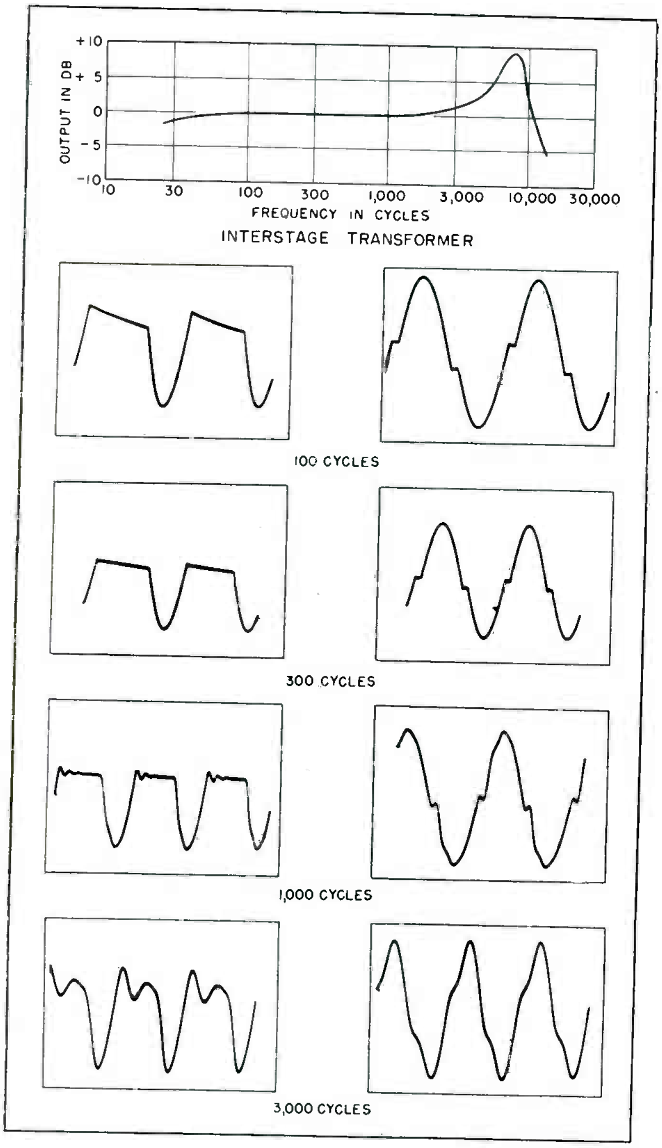
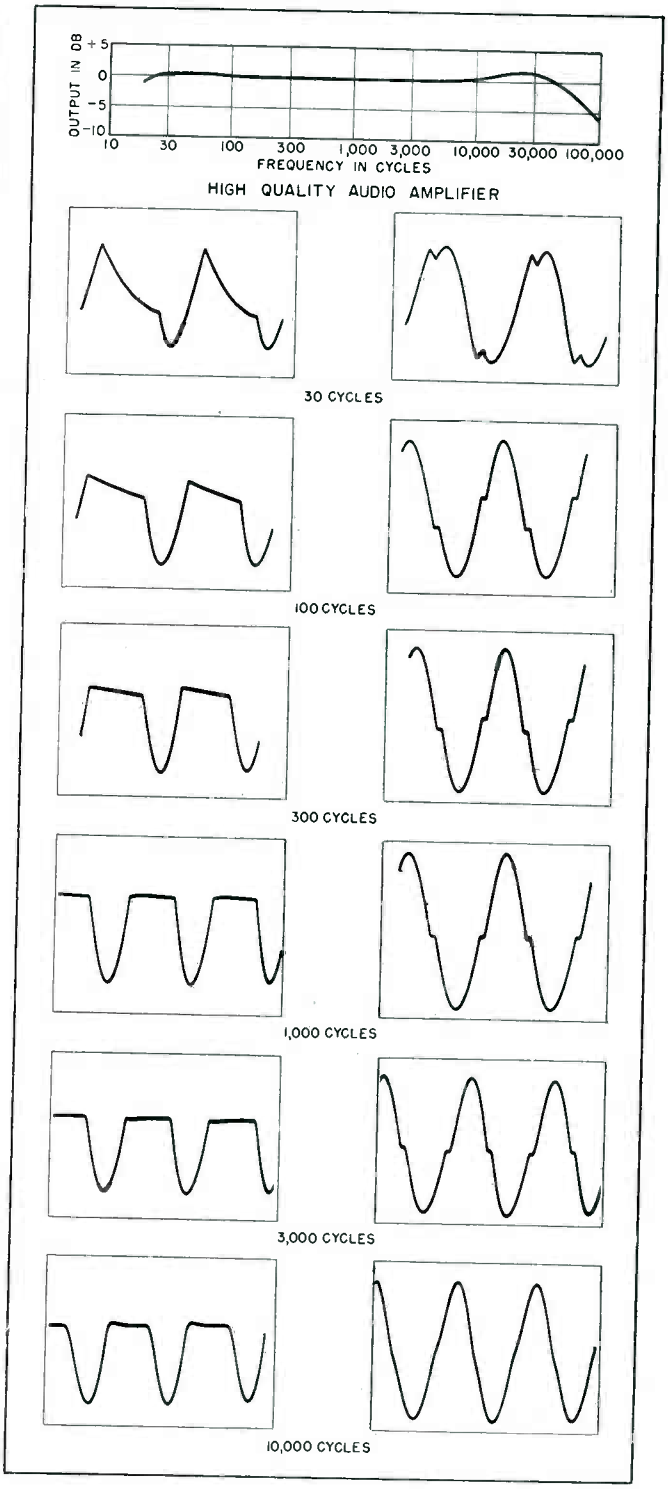


ABOVE

FIG. 3—Response of an interstage transformer in conventional graphic form and by means of clipped, and double clipped, sine waves

RIGHT

FIG. 4—Graph of high quality audio amplifier characteristics with clipped (left) and double clipped (right) oscillograms of response at spot frequencies



known method utilizes the circuit response to a sine wave. Nonlinear distortion is measured by noting the percentage of harmonics generated in the circuit for various frequencies and amplitudes. The effect of reactance is measured by the variation in gain as the frequency is varied.

The interdependence of the two kinds of distortion is not always clearly stated. The harmonics generated by nonlinear distortion will be influenced by the frequency characteristic, so that the sine wave analysis is correct only if either the nonlinear, or the frequency distortion is found to be negligible.

The sine wave analysis is of great utility however, in that definite and reproducible quantities are obtained. In experimental, and developmental work it is sometimes tedious and time consuming.

Standard Waveform Method

A quick and simple qualitative anlysis of a circuit can be made by noting the change in shape of certain standard waveforms. Waveforms with a high harmonic content are particularly suitable for investigating the effect of frequency distortion in wide-band circuits. One example is the square wave, which is of great utility in the investigation of video circuits. The square wave can be considered to simulate an extreme case of the kind of signal the circuits are required to handle.

Most signals encountered in audio circuits are complex in that they are composed of a fundamental and its harmonics. A test waveform that simulates such a signal, and that has been particularly useful in audio circuit analysis is shown in Fig. 1A. It is a portion of sine wave and is therefore called a clipped sine wave. Two such clipped sine waves can be placed back to back, as shown in Fig. 1B. This waveform has been termed a double clipped sine wave.

Clipped Sine Wave

One great advantage of the clipped sine wave is in the economy and simplicity of its generator for which the circuit diagram is given in Fig. 2. A sine wave of the proper amplitude, is fed into the unit and clipping is done by means of biased crystal rectifiers.

The frequency range of the driving voltage is determined by the kind of equipment being tested. For high quality circuits, the frequency range may be approximately 100 to 10,000 cycles. For communications circuits, it can be 300 to 3,000 cycles. The frequency range need not be continuously variable. For most purposes, the discrete frequencies of 100, 300, 1,000, 3,000, and 10,000 cycles will suffice.

From Fig. 1A it is seen that the clipped sine wave is composed of successive flat portions with sharp corners, interconnected by portions of a sine wave. Analysis of this wave shows it to be the fundamental plus an infinite series of harmonics with the even harmonics predominating.

The flat portion and the sharp corners of the clipped sine wave are similar in shape to a half square wave, and the effect of a circuit on this portion of a clipped sine wave is similar to the effect on the square wave. Square wave experience can therefore be transferred almost intact to analysis with the clipped sine wave.

The asymmetry of the clipped sine wave is of great help in avoiding mistaken analysis due to amplitude saturation. Amplitude saturation is easily noted by a flattening of the peaks of the sine wave portion. Asymmetrical amplitude saturation can be investigated by reversing the polarity of the clipped sine wave. This feature has been useful in the investigation of class-B amplifiers. For the analysis, it is sometimes advantageous to reduce the duration of the sine wave portion by decreasing the ratio of driving voltage to back bias.

Double Clipped Sine Wave

The double clipped sine wave is useful in determining phase shift at low frequencies. It is composed of the fundamental and an infinite number of harmonics, with the odd harmonics predominating. This waveform, (Fig. 1B), is seen to be a sine wave with a small step at the points of zero voltage. Phase shift in a circuit is indicated by a vertical displacement of these steps, as shown in Fig. 1C. The approximate phase shift can be calculated from the following formula

$$\phi = \sin^{-1} (a/b)$$

where ϕ is phase shift; a is the vertical displacement of step por-

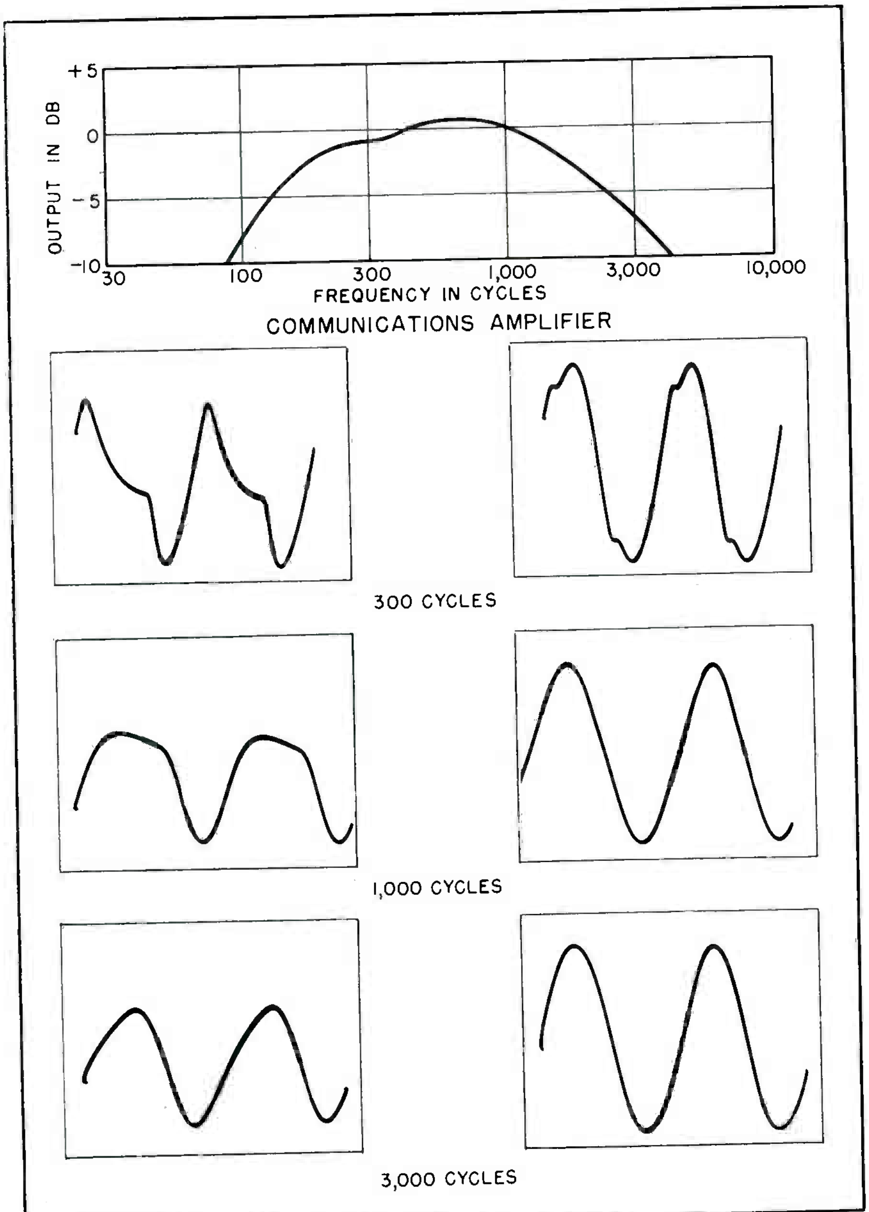


FIG. 5—Response of a communications amplifier. Oscillograms at left show effect on clipped sine waves and, at right, on double clipped waves

tions; and b is the peak to peak amplitude.

It is possible of course, to formulate and plot the effect of various circuits on the clipped sine wave and the double clipped sine wave. For qualitative analysis, however, it is practical to illustrate the effect of several typical circuits on these test waveforms by means of oscilloscope displays.

Interstage Transformer

The frequency characteristic of an inexpensive interstage transformer is shown at the top of Fig. 3. This transformer is essentially flat from 30 to 3,000 cycles, but with a large peak in the response at 8,000 cycles. The effect of this transformer on the clipped sine wave is shown at the left. At 100 cycles, there is sufficient high-frequency response to keep the corners sharp. At 300 cycles, a transient has become evident, becoming larger at 1,000 cycles.

The flat portion of the clipped sine wave is slightly less than a half period. Estimating the number of half waves of the transient on the flat portion and multiplying by two gives the approximate ratio of the transient frequency to the driving frequency. In this case it is estimated to be seven half waves for a 1,000-cycle half period, giving an approximate frequency of 7,000 cycles for the transient. It is interesting to note the correspondence of the transient frequency to the point of high gain on the frequency characteristic. The 3,000 cycle clipped sine wave indicates that the transient frequency has been more closely approached.

In Fig. 3 at the right are shown the effects of the transformer on the double clipped sine wave. The transient is beginning to be evident on the flat portions at 300 cycles. The 1,000-cycle wave is appreciably distorted by the transient, and the steps are practically obliterated at 3,000 cycles owing to dropping high-frequency response.

High Quality Amplifier

The graph in Fig. 4 shows the frequency characteristic of a high quality, multistage, resistance-coupled amplifier. This amplifier is essentially flat between 20 and 50,000 cycles. The series of oscillograms at the left shows the effects of this amplifier on the clipped sine wave. At 30 cycles, the slope of the flat portion illustrates the effect of phase shift. The sharpness of the corners indicates the presence of higher order harmonics. At 100 cycles, the phase shift has decreased and the high-frequency response is still good. The oscillogram for 300 cycles is a good replica of the clipped sine wave, as it is at 1,000 cycles. At 3,000 cycles the effect of high-frequency attenuation is beginning to make itself felt, while at 10,000 cycles high-frequency cutoff has rounded the corners appreciably. The important feature in this analysis is the gradual change in shape of the clipped sine wave over the frequency range. There are no distinct resonant circuits or sharp discontinuities indicated, nor would they be expected in high-quality circuits.

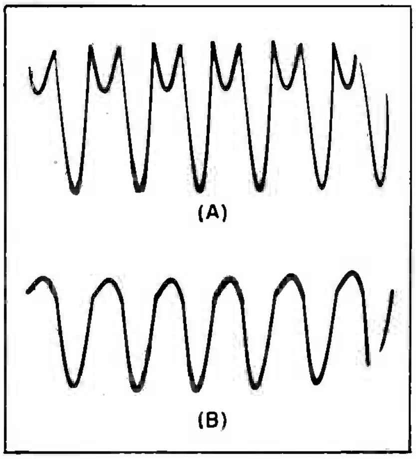


FIG. 6—Clipped sine wave with fundamental partially suppressed (A); and with fundamental partially accentuated (B)

The effect of this amplifier on the double clipped sine wave is shown in the oscillograms at the right. Phase shift, as indicated by the displaced flat portions, is evident at 30 cycles. This characteristic decreases with increasing frequency until it is negligible at 1,000 cycles. At 3,000 cycles the phase shift has reversed direction. Above 3,000 the lack of sufficient high-frequency response tends to obliterate the steps, as shown in the oscillogram for 10,000 cycles.

Figure 5 shows the frequency characteristics of an amplifier used for communication purposes. The response of this amplifier is maximum at approximately 700 cycles. It is down 1 db at 300 cycles, up 1 db at 700 cycles and down more than 7 db at 3,000 cycles. Zero level is taken at 1,000 cycles.

Communications Amplifier

The oscillograms of the effect of this amplifier on the clipped sine wave are shown at the left in Fig. 5. At 300 cycles, phase shift is indicated by the slope of the flat portion, and the lack of high-frequency response by the blunted corners. The oscillogram for 1,000 cycles shows a rise in gain at somewhat less than 1,000 cycles, and the corners are further obliterated. At 3,000 cycles, the effect of a poor high-frequency response is evident. It is interesting to note in this amplifier also, the lack of any tendency toward transients. The clipped sine wave analysis indicates a broadly resonant circuit, with maximum gain at less than 1,000 cycles, and no significant frequency discontinuities outside the pass band.

To the right are the oscillograms showing the effect of this amplifier on the double clipped sine wave. The large phase shift at 300 cycles is shown by the vertical displacement of the flat portions. These steps are increasingly obliterated by the lack of high-frequency response at 1,000 cycles and 3,000 cycles.

Tuned Circuit at Driving Frequency

The examples just given illustrate the ordinary use to which one may put the clipped and double clipped sine wave. The effect of a circuit tuned to the fundamental frequency of the clipped sine wave was not clearly exemplified, and is therefore illustrated. Fig. 6A shows the shape of the clipped sine wave with the fundamental partially suppressed, and (B) with the fundamental partially accentuated. The flat portions have now become concave in A and convex as in B.

When the driving frequency is shifted slightly from that of the tuned circuit these convex and concave portions will be displaced to one side. An example of this effect is shown in Fig. 5 (1,000 cycles, at the left) illustrating the effect of a communications circuit on the clipped sine wave.

Multivibrator Design by Graphic Methods

Simple graphic method permits accurate design of free-running multivibrator circuit, eliminating tedious and repeated calculations. Curves are given for commonly used tubes. All phenomena determining circuit operation are taken into account

By A. E. ABBOT

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THE equation for the semiperiod of the free-running zero-bias multivibrator shown in Fig. 1, as derived from its equivalent circuit, is

$$\tau_1 = \left(R_{g1} + \frac{R_L r_p}{R_L + r_p}\right) C_1 \ln\left(\frac{E_b - E_m}{E_x}\right) \qquad (1)$$

where τ_1 = semiperiod of multivibrator
R_{g1} = grid resistance
R_L = load resistance
r_p = plate resistance
C_1 = coupling capacitance
E_b = plate-supply voltage

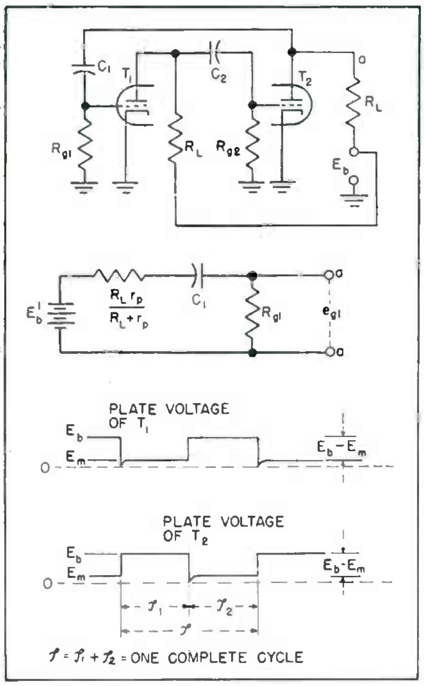


FIG. 1—Basic zero-bias free-running multivibrator, equivalent circuit, and typical time and voltage relations at the plates of the tube

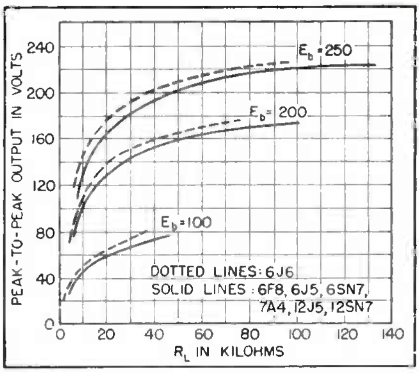


FIG. 2—Variation of output voltage with load resistance for tubes commonly used in multivibrator circuits

E_m = minimum alternating voltage on the plate
E_x = cutoff voltage corresponding to E_b

The subscript 1 denotes those factors pertaining to tube T_1. The various time and voltage relationships in the wave produced are shown also in Fig. 1. In Fig. 2 is given the output voltage E_o of the multivibrator in peak-to-peak volts as a function of load resistance.

The buildup time of the multivibrator, τ_B, is given on the A scales of the nomograph in Fig. 3. This nomograph is based on

$$\tau_B = 4\,(R_L + r_p)\,C \qquad (2)$$

The value of τ_B obtained here covers the period required for the voltage wave to reach 98 percent of its peak value.

In Fig. 4 it is assumed that

$$\alpha = \frac{E_b - E_m}{E_x} \qquad (3)$$

and α is plotted in this graph against various values of R_L and E_b. Figure 4, therefore, gives a value of α that can be multiplied by the time constant to give the semiperiod. Therefore, Eq. 1 reduces to

$$\tau_1 = \left[R_{g1} + \frac{R_L r_p}{R_L + r_p}\right] C_1\,\alpha \qquad (4)$$

Figure 5 is a period-versus-frequency chart, which is included to facilitate the determination of the whole period τ when the frequency is given. This enables a simple calculation of fractional periods in the case of an unsymmetrical multivibrator (Fig. 1):

$$\tau = \tau_1 + \tau_2 \qquad (5)$$

where τ_1 and τ_2 are the fractional periods.

In Fig. 6 and 7, it is assumed that

$$\beta = \frac{R_L r_p}{R_L + r_p} \qquad (6)$$

Therefore, Eq. 4 further reduces to

$$\tau_1 = (R_{g1} + \beta)\,C_1\,\alpha \qquad (7)$$

In Fig. 6, it is also assumed that

$$\gamma = \frac{R_{g1}}{R_{g1} + \beta} \qquad (8)$$

When plotted against R_g, the factor γ permits an evaluation of the effect of the load and plate resistances on the grid resistance. For the value of R_L selected, if R_g is made so high that $\gamma > 0.9$, then it can be assumed that $\beta = 0$. When $\gamma > 0.9$, there is approximately a 10-percent error in the calculation of τ_1; this falls to 5 percent when $\gamma = 0.95$.

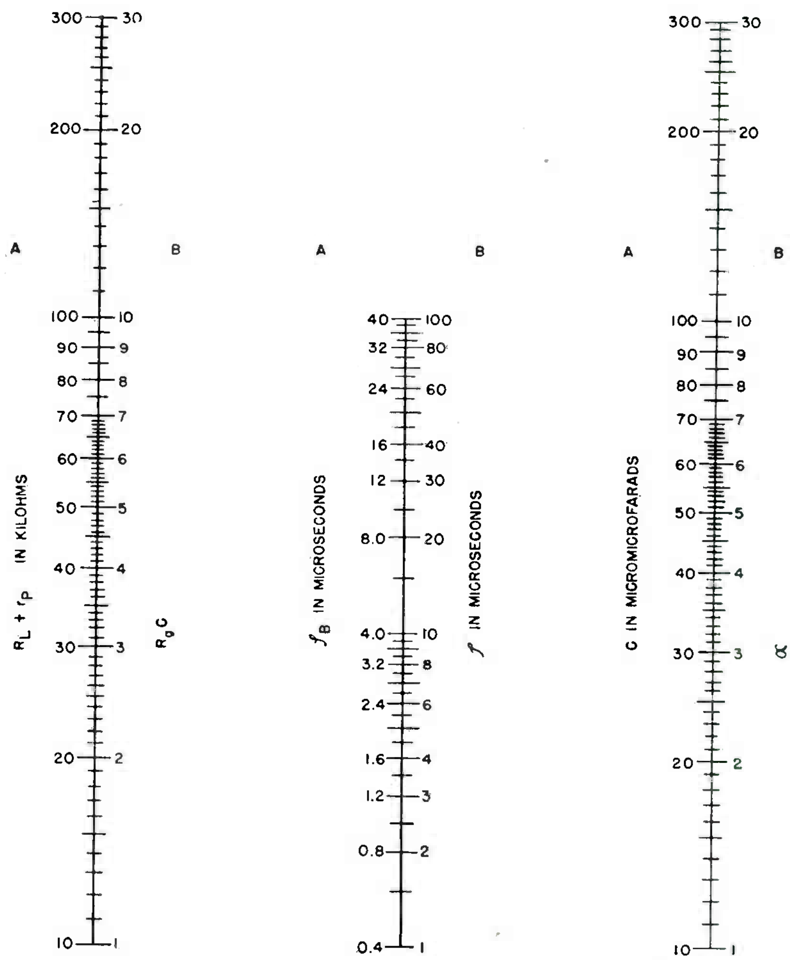


FIG. 3—Nomograph interrelating the various factors involved in multivibrator construction. The plate resistance value may be taken as 9,300 ohms for 6F8, 6J5, 6SN7, 7A4, 12J5 and 12SN7 tubes, as 10,000 ohms for the 6C5, and as 7,100 ohms for the 6J6

Equation 7 reduces to a simple equation

$$\tau_1 = R_{g1}\, C_1\, \alpha \qquad (9)$$

The B scales of Fig. 3 are a plot of Eq. 9, and enable a simple calculation of the fractional period from the time constant and α.

If the conditions of the problem are such that $\gamma << 0.9$ it will be necessary to include the effect of β and use Eq. 7 rather than Eq. 9.

Figure 7 gives the value of β for different load resistances. The r_p selected in this calculation is an average value. With a given voltage swing, there will be a maximum deviation of 11 percent between any possible r_p and this average value.

Example 1

It is desired to design a multivibrator, using a 6SN7 tube, that will have a peak-to-peak output of 190 volts and will operate at a frequency of 30 kc. The pulse width required for triggering purposes is 10 microseconds. The plate supply is 250 volts.

Then E_b = 250 volts, f = 30 kc, E_o = 190 volts peak to peak, and τ_1 = 10 microseconds.

Step 1 (see Fig. 2): When E_o = 190 volts and E_b = 250 volts, R_L = 35 kilohms.

Step 2 (see Fig. 4): When R_L

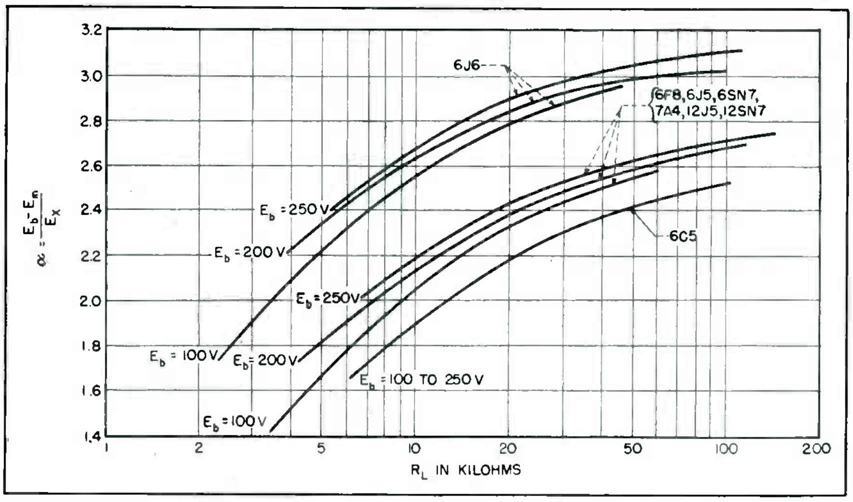


FIG. 4—Curves giving value of α in terms of load resistance and plate voltage for several types of tubes

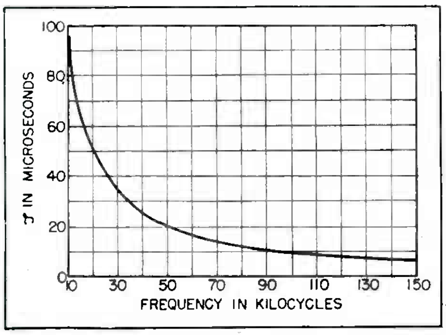


FIG. 5—Time-frequency relationship

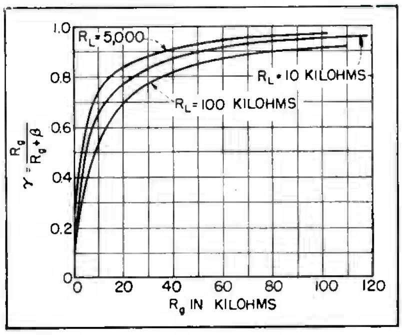


FIG. 6—Load resistance curves

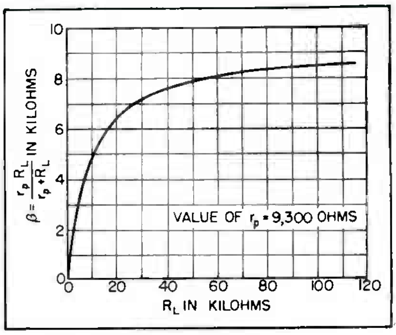


FIG. 7—Effect of load resistance

$= 35$ kilohms and $E_b = 250$ volts, $\alpha = 2.563$.

Step 3 (see Fig. 5): When $f = 30$ kc, $\tau = 34$ microseconds. Then $\tau_1 = 10$ microseconds and $\tau_2 = 24$ microseconds.

Step 4: When $R_L = 35$ kilohms and $R_{g1} = R_{g2} = 0.1$ megohm, $\gamma = 0.93$. Then $\beta = 0$. Using scales B of Fig. 3: When $\tau_1 = 10$ microseconds $\tau_2 = 24$ microseconds, and $\alpha = 2.563$, $R_{g1}C_1 = 10/2.563 = 3.9$ microseconds, and $R_{g2}C_2 = 24/2.563 = 9.35$ microseconds.

Step 5: When $R_{g1} = 0.1$ megohm and $R_{g1}C_1 = 3.9$ microseconds, $C_1 = 40$ μμf. When $R_{g2} = 0.1$ megohm and $R_{g2}C_2 = 9.35$ microseconds, $C_2 = 95$ μμf.

Step 6 (see Fig. 3, scales A): When $R_L = 35$ kilohms and $C_1 = 40$ μμf, $\tau_B = 7$ microseconds.

A multivibrator was constructed according to the above calculations, with resistor and capacitor values accurate to within 1 percent. Calculated and experimental values of the semiperiod were identical, and E_o differed by only 2 volts.

It is desired to improve the buildup time of the multivibrator output in Example 1 at the expense of output voltage. The conditions of the problem remain the same, except that a lower value of R_L is selected.

Example 2

Let $R_L = 10$ kilohms. Then, by consulting the curves in the same order as in Example 1, it is found that $E_o = 132$ volts, $\alpha = 2.205$, $R_{g1} = R_{g2} = 0.1$ megohm, $\gamma = 0.93$, $R_{g1}C_1 = 10/2.205 = 4.54$ microseconds, $R_{g2}C_2 = 24/2.205 = 10.88$ microseconds, $C_1 = 45.4$ μμf, $C_2 = 108.8$ μμf, and $\tau_B = 3.51$ microseconds.

The multivibrator was again constructed, using resistor and capacitor values accurate to within 2 percent; results again were in close agreement.

Example 3

It is desired to design a 25-kilocycle multivibrator with a buildup time of 2 microseconds and a pulse width of 15 microseconds.

Step 1 (see Fig. 3, scales A): When $C = 31$ μμf and $R_L = 8$ kilohms, $\tau_B = 2$ microseconds.

Step 2 (see Fig. 2): When $R_L = 8$ kilohms and $E_B = 250$ volts, $E_o = 119$ volts.

Step 3 (see Fig. 4): When $R_L = 8$ kilohms and $E_B = 250$ volts, $\alpha = 2.11$.

Step 4 (see Fig. 5): When $f = 25$ kc, $\tau = 40.1$ microseconds. Then $\tau_1 = 15$ microseconds and $\tau_2 = 25.1$ microseconds.

Step 5 (see Fig. 3, scales B): When $R_{g1}C_1 = 15/2.11 = 7.11$ microseconds, and $C_1 = 31$ μμf $R_{g1} = 0.228$ megohm. When $R_{g2}C_2 = 25.1/2.11 = 11.9$ microseconds and $R_{g2} = 0.1$ megohm, $C_2 = 120$ μμf.

Limitations

The results of tests on a multivibrator of this design, using resistors and capacitors accurate to within 2 percent, are interesting because they illustrate one of the limitations of the method. The calculated value of τ_1 is 15 microseconds, while the measured value of τ_1 is 13 microseconds. The discrepancy is caused by the low value of coupling capacitance used (31 μμf). At this value, the stray capacitance becomes an appreciable fraction of the total. For extremely accurate results, it would be necessary to subtract the tube and wiring capacitance from the calculated value.

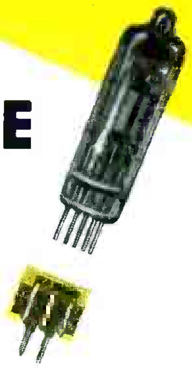
Another solution to the problem would be to use a smaller value of grid resistance, thus permitting a correspondingly larger coupling capacitance. When a high value of coupling capacitance is used, as in the calculation for τ_2, the experimental results are very close to the calculated one.

Another somewhat hidden cause for errors in predicting the semiperiods of a multivibrator is the permanent change in the value of a resistor with temperature. To determine the order of this change, each lead of a ½-watt resistor of 102,600 ohms was heated with a soldering iron for a half minute. The resistor was then cooled and the measured resistance was found to be 148,000 ohms, a change of 45 percent. Each lead of five ½-watt, 0.1-megohm resistors was then heated for fifteen seconds. The average resistance change, after they had cooled for a long period of time, was 17 percent. Thus, the process of soldering resistors into a circuit may change the value of the resistor permanently and, consequently, affect the semiperiod of the multivibrator.

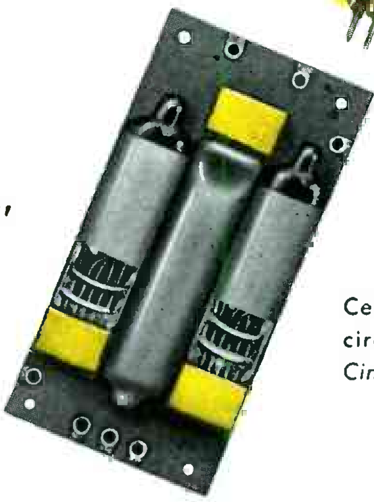
To evaluate the cause of the discrepancy in Example 3, the following experiment was made: The 31-μμf capacitor was replaced by a variable mica trimmer capacitor, which was adjusted until the semiperiod was exactly 10 microseconds. The capacitance value under these conditions was 27 μμf. Thus, a 4 μμf error caused by wiring and tube capacitance is responsible for the 3-microsecond error in the pulse width.

The results obtained with the new value of capacitance were: $\tau_1 = 10$ microseconds, $\tau_2 = 26$ microseconds, $\tau_B = 3$ microseconds, and $E_o = 110$ volts.

NOW THE TUBES ARE REMOVABLE...



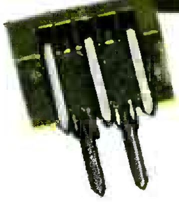
IN THE "PRINTED ELECTRONIC CIRCUIT"



Centralab's "*Ampec*" printed circuit amplifier using new *Cinch* socket.

Another Cinch First!

SUB-MINIATURE SOCKET for "printed electronic circuit"



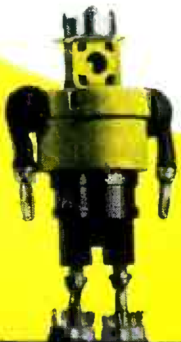
. . . insert contact tails through holes in insulation and bend over — socket is mounted, tube lies horizontal to chassis, soldering tails positioned on back of chassis for wiring. These newly designed "self attaching" sockets will revolutionize conventional wiring in chassis applications.

Sub Miniature Socket No. 54 A 13124 *(Reproduced here twice size)*

PATENT PENDING

Co-ordinated with the extensive and exhaustive research of Centralab, CINCH engineering experience now contributes **a perfected socket for** the "printed electronic **circuit." The new sub**-miniature socket takes **no additional space . . .** holds tubes securely **in place with high tension** contacts of new design . . . **permits easy main**tenance and **replacement of tubes; low loss** bakelite provides **maximum insulation and mini**mum high frequency **loss. Tube is inserted from** either side, the **width of the socket equals the** length of leads **in the tube itself.**

Samples and **further details on request.**



AVAILABLE AT LEADING ELECTRONIC JOBBERS . . . *everywhere*

CINCH MANUFACTURING CORPORATION 2335 W. VAN BUREN ST. CHICAGO 12, ILLINOIS

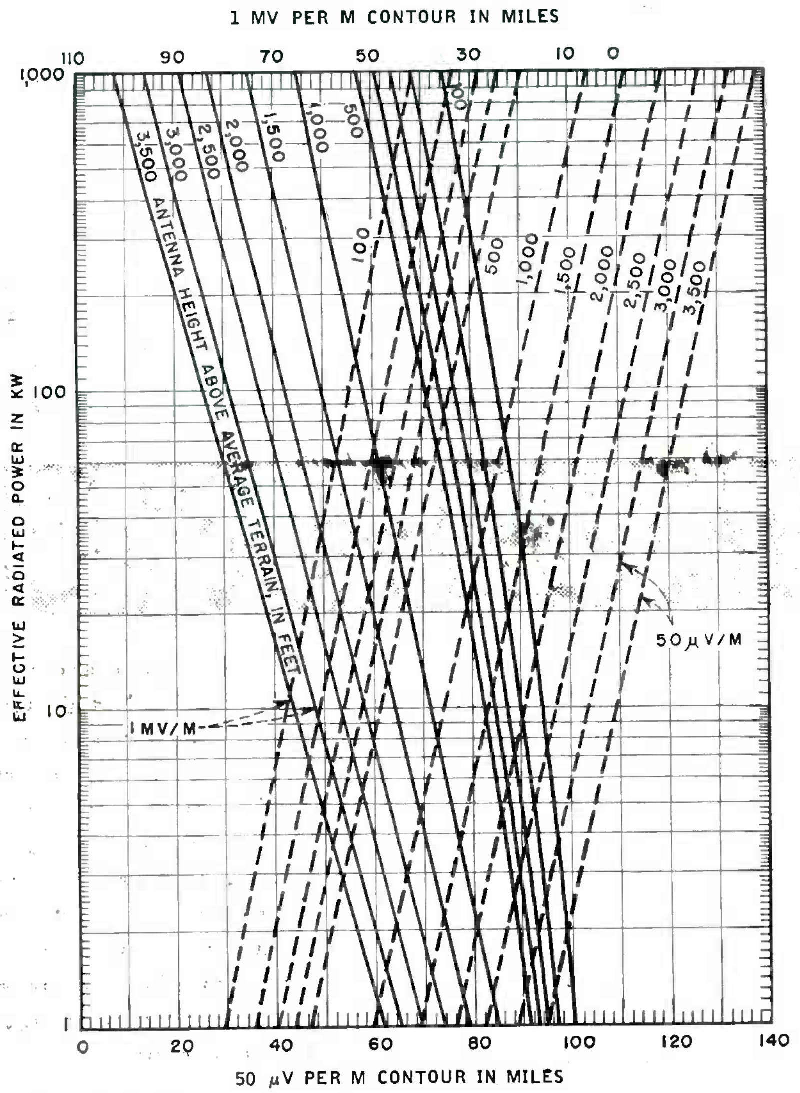
Subsidiary of United-Carr Fastener Corporation, Cambridge 42, Mass.

F-M Service Areas

Chart shows approximate distance to 1-mv/m and 50-μv/m contours for effective radiated powers between 1 and 1,000 kw and transmitting antenna heights from 100 to 3,500 feet above average terrain

BY JOHN H. BATTISON

Allocations Engineer
American Broadcasting Co., Inc.
New York, N. Y.



THE accompanying chart, based on FCC data, provides a quick means of determining the approximate service areas of a transmitter operating on any channel between 88 and 108 mc. Distance to the 1 mv-per-meter contour (solid lines) is shown by the upper scale and distance to the 50 microvolt-per-meter contour (dashed lines) by the lower scale, for various effective radiated powers and transmitting antenna heights. Receiving antenna height is assumed to be 30 feet above average terrain.

Using the Chart

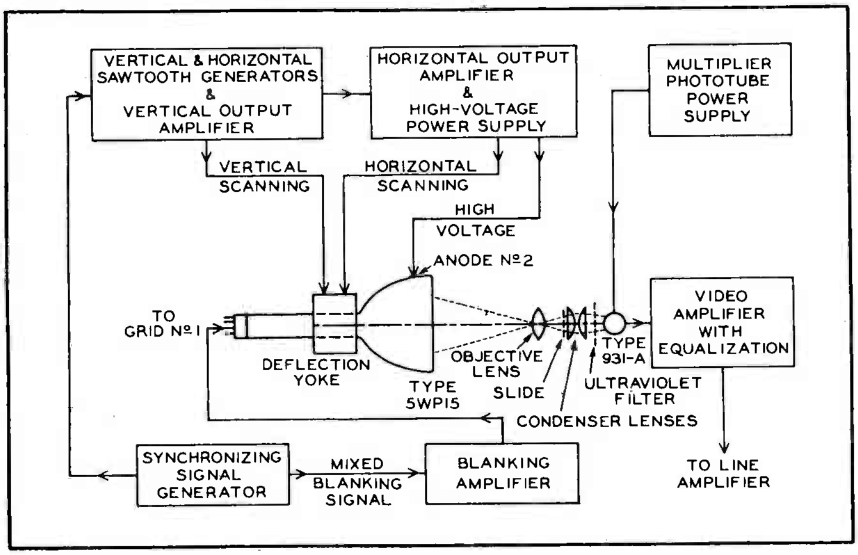
To determine the distance to the 1 millivolt-per-meter contour with a transmitting antenna height of 2,000 feet and 20-kw of effective radiated power, enter the chart at the left and, at the point where the 20-kw horizontal line intersects the solid diagonal line labelled 2,000′, read on upper scale 57 miles. To determine distance to 50 microvolt-per-meter contour follow the same procedure but use the dashed diagonal line labelled 2,000′ and read the lower scale.

If coverage is desired at a given distance, with a known transmitting antenna height, the effective radiated power required may be read to the left of the point of intersection of appropriate distance and height lines. Similarly, should it be necessary to determine the transmitting antenna height required to provide a certain contour with a given power the chart may be entered from the left and the bottom, and the height read from the appropriate solid or dashed line.

TUBES AT WORK

Including INDUSTRIAL CONTROL

Edited by VIN ZELUFF



Video signal generator system for slide transparencies, using the RCA Flying Spot tube

Flying-Spot Video Generator

A NEW cathode-ray tube allows television stations to construct a video-signal generator which permits transmission of station call letters and test patterns from interchangeable slide transparencies or opaque surfaces.

The tube, RCA5WP15, furnishes a small, rapidly moving spot of radiant energy (hence the name) for scanning. It has an extremely short persistence phosphor having a large component of its energy emission in the near-ultraviolet region. The persistence of the ultraviolet radiation is so short that the amount of equalization needed in the video amplifier to minimize trailing in the reproduced picture is small and can be supplied by a single network. As a result, circuits and adjustments are relatively simple.

A video-signal generator using the tube would consist essentially of the Flying-Spot tube with associated power supplies, deflection yoke, and scanning circuits; a lens to project the raster on the subject to be scanned; the subject, a slide transparency, motion picture film, or opaque object; a multiplier phototube with associated power supply to intercept the radiation transmitted or reflected by the subject, and convert it into video signals; and a video amplifier.

The tube makes possible unusual video effects, such as double images —one produced by a slide, the other by modulating the beam of the tube. A block diagram of a video-signal generator arranged for use with a slide transparency is shown. For best results, the objective lens should be a high-quality enlarger type designed for low magnification and preferably corrected for use with ultraviolet radiation.

Suitable filters for absorbing the visible and passing the ultraviolet radiation of the screen are available. The choice of filter is affected by a compromise between the permissible loss of signal output through absorption by the filter and the amount of trailing which can be tolerated, or the extent of equalization needed.

Trailing results from the lag in buildup and decay of output from the screen. As the flying spot moves across a boundary from a light to a dark area of the subject being scanned, the persistence of energy output from the screen results in continued input to the phototube from the light area during the time the dark area is being scanned. Thus, the light area trails into the dark area in the reproduced picture.

Similarly, as the flying spot moves from a dark area to a light area, the lag in buildup of the screen output causes the dark area to trail over into the light area. As a result of these effects, the reproduced picture has an appearance similar to that produced by a signal deficient in high frequencies. It is, therefore, necessary to enhance the high-frequency response of the video amplifier by introducing equalizing networks with suitable time constants. Sufficient equalization should be provided to give the desired square-wave response.

The decay characteristics of most standard phosphors are such as to require considerable equalization provided by networks with different time constants in several stages of the video amplifier. Their relatively long decay generally results in appreciable reduction of the useful signal-to-noise ratio.

The persistence of the P15 phosphor is comparatively so short that less equalization is needed. If used without an ultraviolet filter, less equalization is required than for other standard phosphors but a complex network is nevertheless needed because the decay characteristic is not a simple exponential curve but a curve of a complex function. When used with a filter to pass only the ultraviolet radia-

tion, the P15 effectively has a persistence so extremely short that the small amount of equalization needed can be supplied by only one network. As a result, circuits and adjustments are simplified and substantially the same signal-to-noise ratio is obtained, in spite of filter absorption, as will the arrangement using the total radiation from the phosphor.

Resolution of better than 700 lines at the center of the reproduced picture can be produced by the 5WP15. To obtain such resolution in the horizontal direction, it is necessary to use a video amplifier having a band-width of about 10 megacycles.

Soft x-rays are produced when the 5WP15 is operated with an anode No. 2 voltage above approximately 20,000 volts. These rays can constitute a health hazard unless the tube is adequately shielded. Relatively simple shielding should prove adequate.

MULTIPLE BABY SITTING

Six children in adjoining student-veteran homes at Camp Shanks are monitored while their parents are out. Major Jean L. Wood and his wife use separate microphones, amplifiers and labeled loudspeakers for each baby channel, with a clock at each microphone to warn if any channel fails

Versatile Power Supply

BY WILLIAM B. MILLER
Standards Engineer
Bardwell & McAlister Inc.
Burbank, California

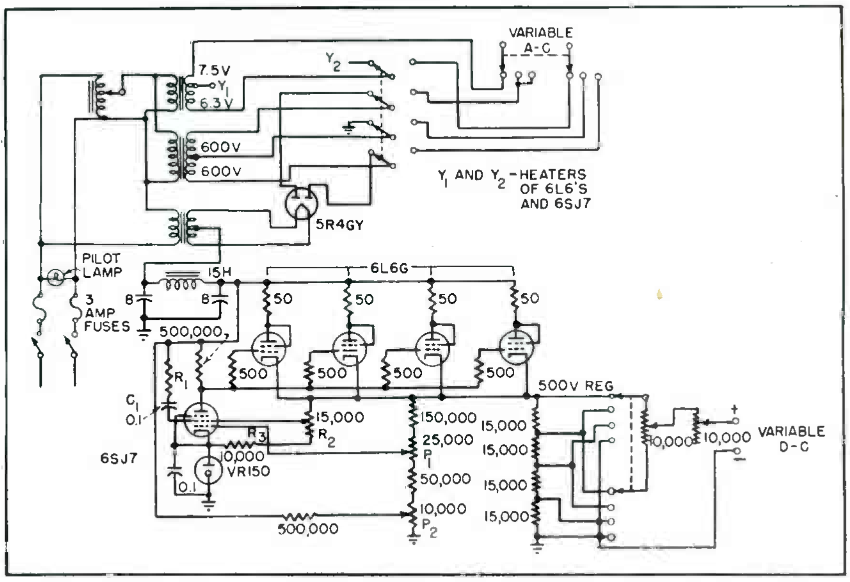
BOTH direct and alternating voltages for meter testing are provided by the circuit shown. The a-c output is continuously variable from 0 to 1,200 volts and the maximum d-c output is fixed and regulated at 500 volts. Lower d-c voltages are obtained by means of a variable voltage divider which allows smooth control down to zero volt.

Low ripple was not a factor in the design and only ordinary filtering was used. However, the action of the regulator section and a small amount of feedback resulted in a measured ripple of 0.4 millivolt. Regulation was important and is quite good. After the output was set at 500 volts, it held with no perceptible change, with a line variation from 90 to 125 volts and a load variation of from 0 to 200 milliamperes.

Four 6L6G's, triode connected, are used in parallel as the series regulators, and a 6SJ7 as the amplifier. Resistors in each plate lead of the 6L6's equalize the current distribution, and resistors in each grid lead help stabilize and limit the grid current. A total of 200 ma may be safely drawn from this combination.

The 6SJ7 control amplifier was considered as an r-f tube and care in wire placement was used to eliminate erratic operation and unwanted oscillations. Resistors R_2 and R_3 supply the screen voltage and also the keep-alive voltage for the VR150, the current through the latter being about 15 ma with no load on the supply. The divider network across the output supplies the control grid voltage for the 6SJ7 and also feeds the grid any fluctua-

(continued on p 140)



Up to 1,200 volts a-c and 500 volts d-c are available from the power supply

THE ELECTRON ART

Edited by FRANK ROCKETT

Motion Picture Television Projected from Film

EXPERIMENTAL television pictures of boxing contests were projected onto the 18 by 24 foot screen of the New York City Paramount theater as the event took place. The technique will be used to provide practically simultaneous showings in theaters of local news events. When network facilities become available it may be extended to an intercity basis, independently of television broadcasting networks. The film from which the picture is projected can be stored, edited, and reused.

Television picture is recorded on 35 mm film, which is then completely processed in 66 seconds, by the equipment that Paramount's vice-president Pcul Raiborn is inspecting

Section of experimental film (not the one shown publicly) shows clarity of picture; note variable density sound track also recorded onto film from audio relayed over some uhf

The experimental equipment with which the system was demonstrated in April consisted of a DuMont image orthicon pickup camera, two pairs of 7 kmc microwave RCA relays (to transmit the signal from the Brooklyn Navy Y.M.C.A. to the Manhatten Paramount building via the N. Y. Daily News building), and terminal equipment developed by Paramount engineers. The terminal equipment reproduces the television picture at 30 frames a second and electronically blanks it to permit recording on film at 24 frames a second. The film is completely processed (developed, fixed, washed, and dried—no trouble being encountered from grain or soft geliten), and feed directly into the projector. The process can be operated so fast that a frame is projected 30 seconds after it is exposed. However, at such a rate, sludge tends to collect on the film; a 66 second processing interval has been found most satisfactory.

Because of the extreme sensitivity of the image orthicon (greater than that of film), this technique, in addition to offering quicker projection, is superior to that of using a motion picture camera to obtain news reels under adverse lighting conditions. Not only was the showing experimental in that the terminal equipment had only been completed 10 days before the showing (it was the first time the engineers had seen the picture projected onto the screen of the main theater), it was also experimental in that the audience was not apprised of the showing until it took place; they applauded at the conclusion of the 15 minute showing. The picture was as sharp as direct film news shots and had a remarkably long tonal range.

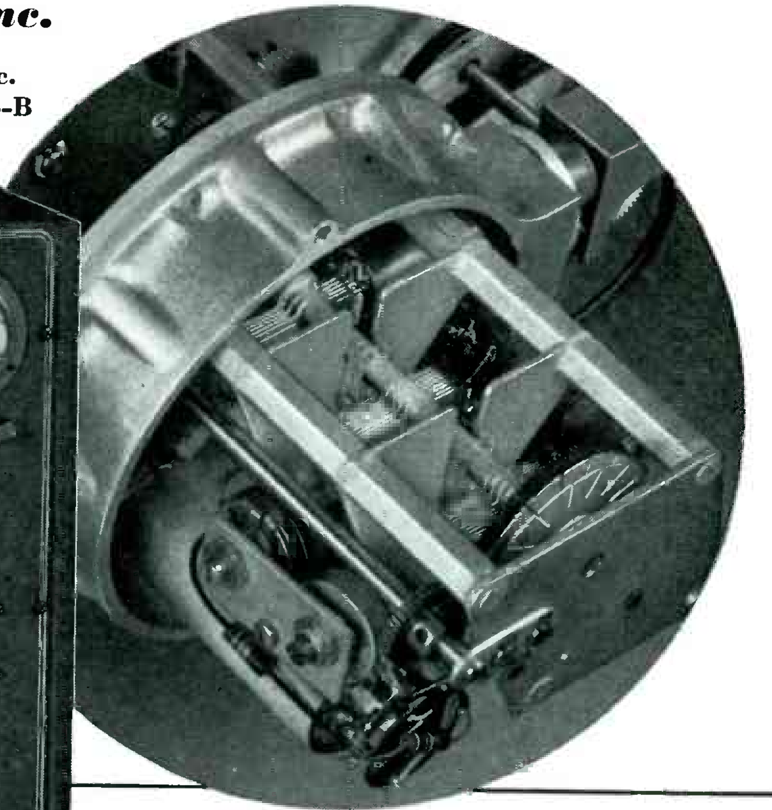
Crystal Diodes in Computers

LARGE scale digital computers using many electronic tubes dissipate a great deal of heat. To reduce the amount of heat that must be removed by the air conditioner for the computer, and to reduce the operating power and mechanical size of the computer, germanium

FM SIGNAL GENERATOR

Type 202-B 54-216 mc.

Additional coverage from 0.4—25 mc.
with accessory UNIVERTER Type 203-B



Shown above is an interior view of the 202-B Signal Generator RF assembly with shield cover removed. Heavy aluminum castings form the mounting base of this RF unit resulting in a compact and highly rigid structure. Girder type condenser frame construction, multiple rotor shaft grounding contacts, and welded interstage shield plates are but a few of the many design features of this unit which give added circuit stability.

Designed to meet the exacting requirements set forth by leading FM and television engineers throughout the country, the 202-B FM Signal Generator has found widespread acceptance as the essential laboratory instrument for receiver development and research work.

Frequency coverage from 54 to 216 megacycles is provided in two ranges, 54 to 108 megacycles and 108 to 216 megacycles. A front panel modulation meter having two deviation scales, 0-80 kilocycles and 0-240 kilocycles, permits accurate modulation settings to be made.

Although fundamentally an FM instrument, amplitude modulation from zero to 50%, with meter calibrations at 30% and 50%, has been incorporated. This AM feature offers increased versatility and provides a means by which simultaneous frequency and amplitude modulation may be obtained through the use of an external audio oscillator.

The internal AF oscillator has eight modulation frequencies ranging from 50 cycles to 15 kilocycles, any one of which may be conveniently selected by a rotary type switch for either amplitude or frequency modulation.

The calibrated piston type attenuator has a voltage range of from 0.1 microvolt to 0.2 volt and is standardized by means of a front panel output monitor meter.

The output impedance of the instrument, at the terminals of the R.F. output cable, is 26.5 ohms.

AVAILABLE AS AN ACCESSORY

is the 203-B Univerter, a unity gain frequency converter which, in combination with the 202-B instrument, provides the additional coverage of commonly used intermediate and radio frequencies.

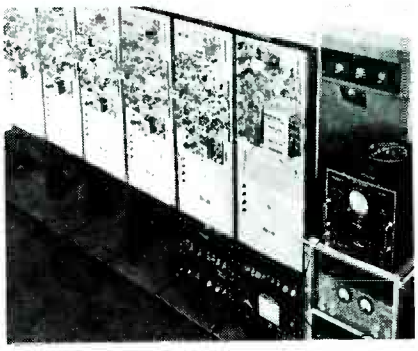
- R.F. Range: 0.4 mc. to 25 mc.
- R.F. Increment Dial: ±250 kc. in 10 kc. increments.
- R.F. Output: 0.1 microvolt to 0.1 volt. Also approximately 2 volts maximum (uncalibrated).

For further information write for Catalog E

UNIVERTER
Type 203-B

BOONTON RADIO *Corporation*
BOONTON·N·J·U·S·A·

DESIGNERS AND MANUFACTURERS OF THE "Q" METER . . . QX-CHECKER . . . FREQUENCY MODULATED SIGNAL GENERATOR . . . BEAT FREQUENCY GENERATOR . . . AND OTHER DIRECT READING TEST INSTRUMENTS crystal diodes can be used in the switching circuits. When the potential across a diode is negative, it presents a high impedance; when the voltage is positive, it presents a low impedance. Thus the diode constitutes a convenient voltage sensitive switch. Because it consumes power from the control or switching channel, that channel should have low internal impedance. Computers using such switching networks, like that illustrated here, have large capacity but are relatively compact.



High speed computer developed at the Servomechanisms Laboratory of M.I.T. uses germanium diodes, performs arithmetical operations using five-place binary numbers, and indicates solution by neon lamps

Time Expansion of Periodic Waves

By LI-YEN CHEN
Transmission Engineer
Ministry of Communication, China

MANY METHODS have been proposed for reducing bandwidth required to transmit a certain message. Preliminary tests conducted at Polytechnic Institute of Brooklyn with a wave-expanding system show that periodic waves can be transmitted over less bandwidth than is normally required.

Signal Sampling and Expanding

A periodic wave consists of several identical cycles of a particular waveshape. To transmit this wave all that is needed is to transmit the characteristics of one cycle and knowledge of the rate at which the cycle repeats itself (waveform and frequency). Waveform can be transmitted by gating out a single cycle and elongating it in the time scale. The bandwidth required to transmit the elongated wave is reduced in proportion to the elongation. Furthermore, if the elongation has a predetermined fixed relation to the original wave, the system design incorporates knowledge of the number of cycles to be reproduced at the receiver for each transmitted cycle, and hence no additional bandwith need be used to convey this information.

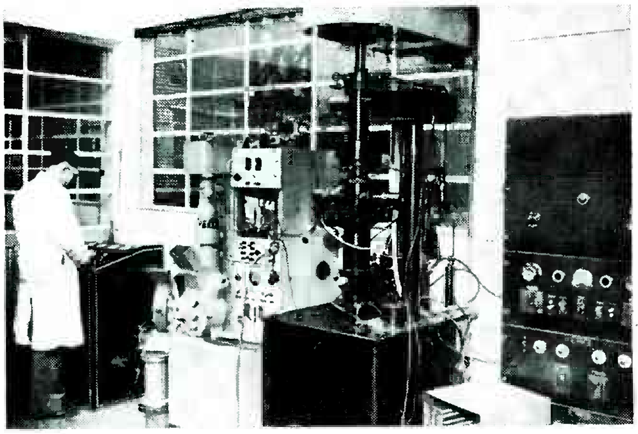
An experimental technique for expanding a wave has been developed and tested. Using a 1,000-cps frequency, the wavelength was doubled (frequency halved) and the signal transmitted as a 500-cps frequency. The wave reconstructed at the receiver of the original 1,000-cps frequency had practically the waveform of the initial signal. Whereas a technique such as recording the signal at a fast rate and playing it into the transmitter at slow speed produces a similar increase in the time scale, this sampling and expanding method produces the increased time scale without changing the elapsed duration for transmitting the complete signal.

Pulse Methods Perform Expansion

Figure 1 shows the general principle of the expander. Information

(continued on p 170)

Research Stimulates Electronic Applications in Science and Industry

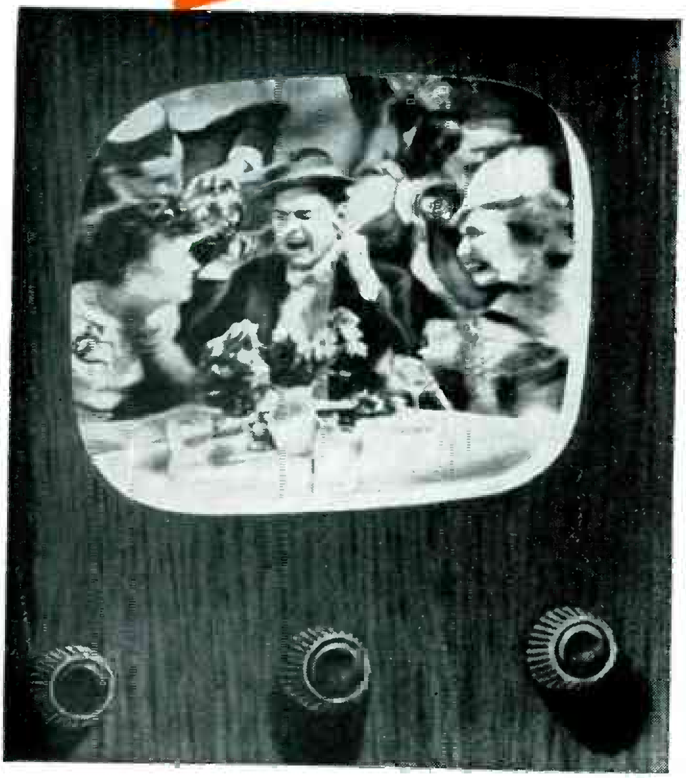


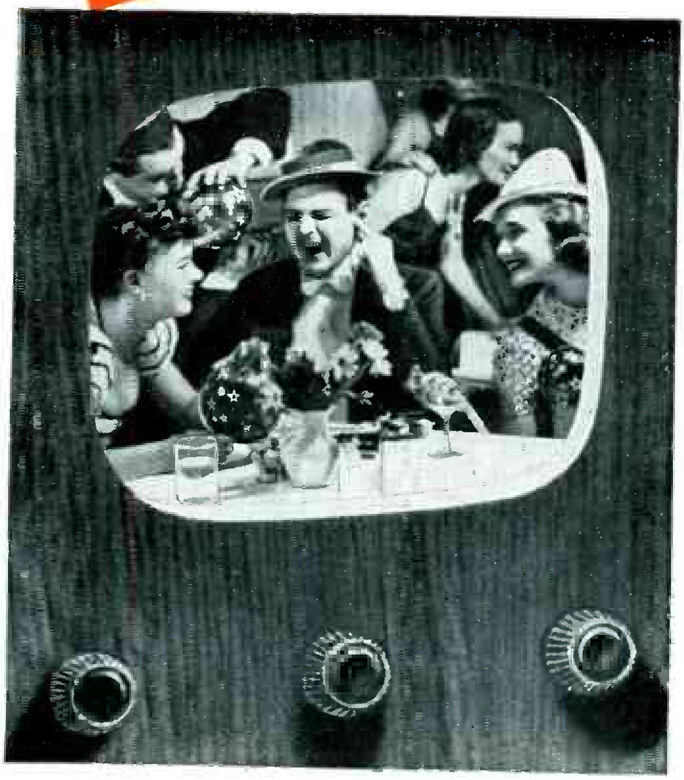
Cathode-ray oscillograph equipment is used to study transients in the high-voltage and insulation research laboratory

Scientists working on vacuum tubes such as x-ray generators for therapy; an assembled synchrotron doughnut is in foreground

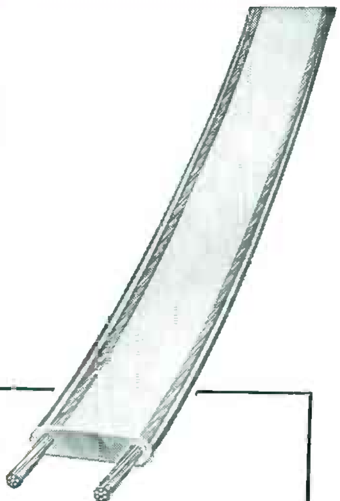
Experiments leading toward physical, biological, medical, and industrial applications of electronics are being conducted at new and extensive laboratories in Staffordshire, England. Included in the equipment of the English Electric Company's Nelson Laboratories are a three million volt generator for testing transformers, a thirty million electron volt synchrotron that is being developed for the government's laboratory at Harwell, and a 140 million volt machine that is planned for cancer research. Electronic laboratories are developing television receivers, industrial controls and scientific instruments.

CONFUSING? OR AMUSING?





Lead-In Lines Play an Important Part in Television Reception



The effects of attenuation and impedance mismatch on FM and Television reception are minimized by Anaconda Type ATV* lead-in lines.

The satin-smooth polyethylene insulation of Type ATV line sheds water readily, thus avoiding subsequent impedance discontinuities. This material also has exceptionally high resistance to corrosion. 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. 47430

**An Anaconda Trade-Mark*

A Type ATV Lead-In for Every Need

Anaconda offers a complete selection of Type ATV lead-in lines for 75, 125, 150 and 300 ohms impedance unshielded and 150 ohms shielded. For an electrical and physical characteristics bulletin, write to Anaconda Wire and Cable Company, 25 Broadway, New York 4, N. Y.

ANACONDA WIRE AND CABLE COMPANY

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

Frequency Standard

AMERICAN TIME PRODUCTS, INC., 580 Fifth Ave., New York 19, N. Y. Type 2121A frequency standard is designed to provide an accuracy of one part in 100,000. Power output is up to 110 volts, 10 watts, at 60 cycles; power input is 110 volts, 45

watts, at 50 to 400 cycles. Net weight of the unit with cabinet is 25 lb.

Wall Speaker Cabinet

JENSEN MFG. CO., Chicago 38, Ill. Two new wall mounting enclosures, model H-81 for 8-inch speakers and model J-61 for 6-inch speakers, have been announced. Pictured here is the model H-81, a bass reflex sector cabinet which may be

mounted singly, in pairs, or in clusters of four around a post to obtain wide-angle distribution of sound.

Barretter Mounts

SPERRY GYROSCOPE CO., Great Neck, N. Y. These instruments are type-N holders for sensitive barretter elements used with suitable wattmeter bridges to measure absolute

microwave power within ±5 percent accuracy. Maximum average c-w power that can be measured directly is limited to 10 milliwatts. This range can be extended to 100 watts or higher by using a suitable directional coupler or attenuator. Four models are available.

Magnetic Tape Recorder

AMPLIFIER CORP. OF AMERICA, Magnephone Division, 398-7 Broadway, New York 13, N. Y. Model SP850 high-fidelity magnetic tape recorder is a self-contained unit consisting of tape-pulling mechanism, recording amplifier with ultrasonic

bias and erase oscillator, playback amplifier, monitor amplifier and speaker. Bias frequency range is adjustable from 30 to 80 kc with a total recording and playback distortion under 3 percent at 400 cycles.

Sideband Selector

JAMES MILLEN MFG. CO., INC., Malden, Mass. Type 92105 single sideband selector employs the McLaughlin circuit which has two crystals and four tubes. The unit provides advantages of single side-

band reception on all signals rather than only to those with suppressed carrier. The unit is readily connected to any standard communications receiver.

Vacuum Capacitors

DOLINKO & WILKENS, INC., 101 Hazel St., Paterson 3, N. J., has a new line of high-current vacuum

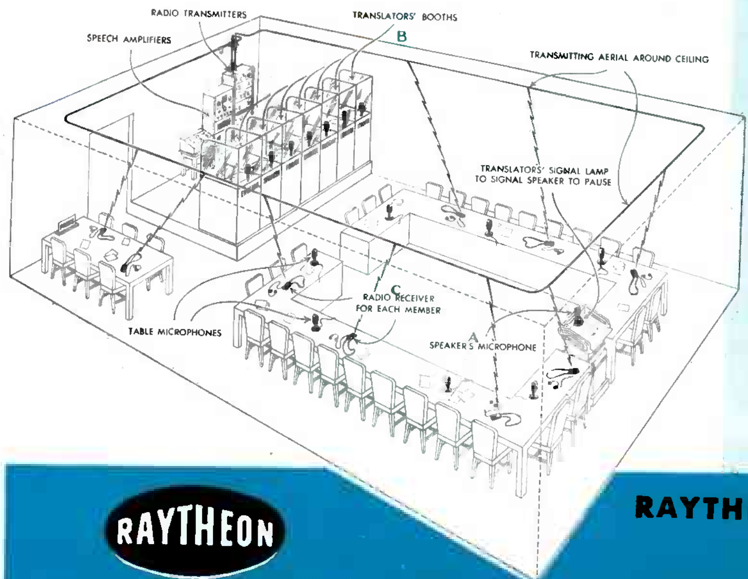
(Shown two-thirds actual size)

RAYTHEON SUBMINIATURE TUBES

TRANSLATE QUALITY, DEPENDABILITY AND CONVENIENCE INTO THE PRODUCT

IBM WIRELESS TRANSLATING SYSTEM, EMBODYING FILENE-FINLAY PATENTS, EMPLOYS RAYTHEON TUBES

Here's How It's Done—The words of the speaker (A) are transmitted to interpreters (B) who are working at microphones. As each interpreter hears the speech he immediately makes the translation in his particular language. All the translations are conveyed to the listeners (C) who select, by dial, the language they wish to hear.



This is the lightweight receiving set, with aerial in the shoulder strap for complete freedom of movement while listening. It contains three RAYTHEON Subminiatures, two 2E42s and one 2E36. Two stages of radio amplification are provided, diode detector with automatic volume control, and a pentode output section connected to the headphones. The set measures 1⅝ x 4⅛ x 5½ inches and weighs only 1½ pounds. There is excellent speech tone with ample volume, sensitivity and selectivity between the channels that deliver any one up to seven languages.

Why International Business Machines Corporation and other manufacturers of high grade electronic equipment use RAYTHEON Subminiature Tubes.

1. **Reduced Product Size... Increased Product Salability.** Raytheon filamentary Subminiatures are flat. Batteries can be tiny because of extremely low filament drain.
2. **Plug Into Standard Sockets.** All Raytheon Subminiatures can either be soldered in or plugged into readily available sockets.
3. **Raytheon Reliability**—the result of unique methods and nine years continuous production of long-life Subminiature Tubes.
4. **Readily Available From Stock**—over half a million on tap at all times. Over 30 types. Standard throughout the world.
5. **At Your Local Distributor's**—over three hundred Raytheon Special Purpose Tube Distributors ready to serve you quickly and intelligently.

Write for Data Sheets on Raytheon Subminiature Tubes

RAYTHEON
Excellence in Electronics

RAYTHEON MANUFACTURING COMPANY
SPECIAL TUBE SECTION
Newton 58, Massachusetts

RADIO RECEIVING TUBES • SUBMINIATURE TUBES • SPECIAL PURPOSE TUBES • MICROWAVE TUBES

capacitors rated at 32,000 volts. The units are available in capacitances of 6, 12, 25, 50, 75, 100 and 250 micromicrofarads.

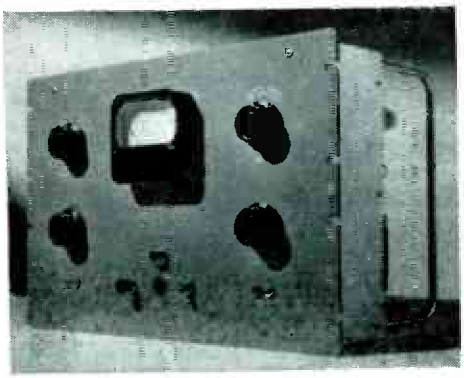
Ultrasonic Weld Tester

SPERRY PRODUCTS, INC., 1505 Willow Ave., Hoboken, N. J. The new angle-beam transmitter illustrated

is used with the Supersonic Reflectoscope to inspect welds. The weld itself will not constitute a reflecting interface, but any voids or inclusions will reflect a part of the energy.

Noise Suppressor

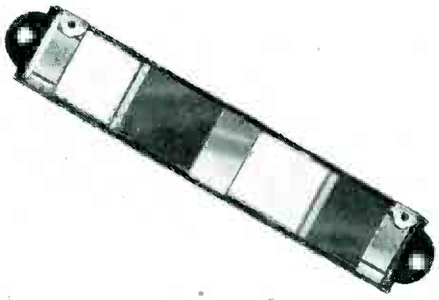
HERMAN HOSMER SCOTT, INC., 385 Putnam Ave., Cambridge, Mass. Type 910-C is the new and improved noise suppressor which functions on the exclusive dynamic-bandpass principle. Compared to previous



models, the new type features improved control circuits, extended frequency range, a continuous suppression control and more flexible remote control facilities.

Strip Selenium Rectifier

STANDARD ARCTURUS CORP., 54 Clark St., Newark 4, N. J. The Kotron strip selenium rectifiers



were designed to replace thermionic rectifiers in many circuits. Available in 75, 100 and 200-ma units they mount easily and conserve chassis space. The units can be used in combinations as full-wave rectifiers or voltage doublers.

Flying Spot C-R

RADIO CORP. OF AMERICA, Harrison, N. J. The new flying-spot cathode-ray tube, tube type 5WP15 will find use in television studios for show-

ing slides or opaque objects. It will not only produce a repetitive picture similar to that obtained with the usual monoscope, but will permit change of picture at will. It is described in an 8-page brochure.

Marine Radiotelephone

GENERAL ELECTRIC CO., Syracuse, N. Y. Type MS-1-A marine radiotelephone offers four-channel operation in the marine 2 to 3-mc band,

and is completely housed in one cabinet with handset attached. The receiver delivers 2.5 watts of power to the speaker, operation being from a 6-volt battery with a current consumption of 7.5 amperes. Power output of the transmitter is 5 watts of r-f carrier.

Plug-In Relay

C. P. CLARE & CO., 4719 West Sunnyside Ave., Chicago 30, Ill. Type J small d-c relay is now avail-

able in plug-in type. Overall length of relay and octal-base plug is 3⅝ inches. Independent twin contacts and high current carrying capacity are featured.

Test Instrument

MCMURDO SILVER CO., INC., 1249 Main St., Hartford 3, Conn. The model 905A Sparx is a supersensitive aural dynamic signal tracer with an 18-watt universal output

(continued on p 194)

NEWS OF THE INDUSTRY

Edited by JOHN MARKUS

IRE plans for professional groups; Audio Engineering Society launched; new microwave relay chains; 19 new books reviewed

Broadcast Operator License Proposal Amended

IN AUGUST 1947 the FCC proposed a change in rules applying to operator licenses for the broadcast service. After considering all available comments and information from interested parties the Commission recently modified its proposal as follows:

A new group of commercial operator licenses, to be known as the Broadcast Operator Group, will be established: (a) limited broadcast operator license; (b) broadcast-technician operator license; (c) broadcast-engineer operator license.

New examination elements will be added to presently existing elements 1 through 6, as follows:

(7) Practical Broadcast Operation. Provisions of law, rules and regulations governing the operation of standard and f-m broadcast stations, and procedures involved in normal operation (including minor transmitter adjustments) to insure compliance therewith.

(8) Technical Broadcast Theory and Practice. Intermediate electronics theory and practice as applied to the operation, adjustment and maintenance of standard and f-m broadcast stations, technical regulations, and standards of good engineering practice regarding the operation of all classes of broadcast stations and of the equipment permitted or required.

(9) Advanced Broadcast Theory and Practice. Advanced technical theory and practice applicable to the operation, adjustment and maintenance of a-m, f-m, television and other classes of broadcast stations and associated equipment, including special antenna systems.

Examination requirements for the licenses in the new broadcast operator group will include, in addition to satisfactory ability to understand the English language and to receive and transmit spoken messages in English, the following written examination elements:

Limited broadcast operator license—1, 2, and 7.

Broadcast technician-operator license—1, 2, 7 and 8.

Broadcast engineer-operator license—1, 2, 7, 8 and 9.

The scope of authority of licenses of the new broadcast operator group will be substantially as follows:

Limited broadcast operator license—Holders of this class of license may operate any standard broadcast station having a maximum licensed power of not more than 1 kw and not employing a directional antenna system, or any f-m broadcast station having a maximum licensed effective radiated power of not more than 1 kw, or any remote pickup or standard broadcast station, provided (1) that one or more holders of a radiotelephone first class operator license, broadcast technician-operator license, or broadcast engineer-operator license is regularly employed on a full-time basis by that station, and (2) that holders of the limited broadcast operator license are prohibited from making any repairs or adjustments beyond the protective interlocks of the radio station transmitter, except in the presence and under the direction of a person holding one of the higher classes of licenses.

Broadcast technician-operator license—Holders of this class of license may operate any class of broadcast station, provided that (1) in the case of a standard broadcast

BROADCASTERS SOLVE FLOOD PROBLEM

Radio station WKYW, Louisville, Ky., now has a water-borne transmitter near the Ohio River. In the path of frequent floods, it was installed on a barge and rises with the river. The barge is held by steel cables

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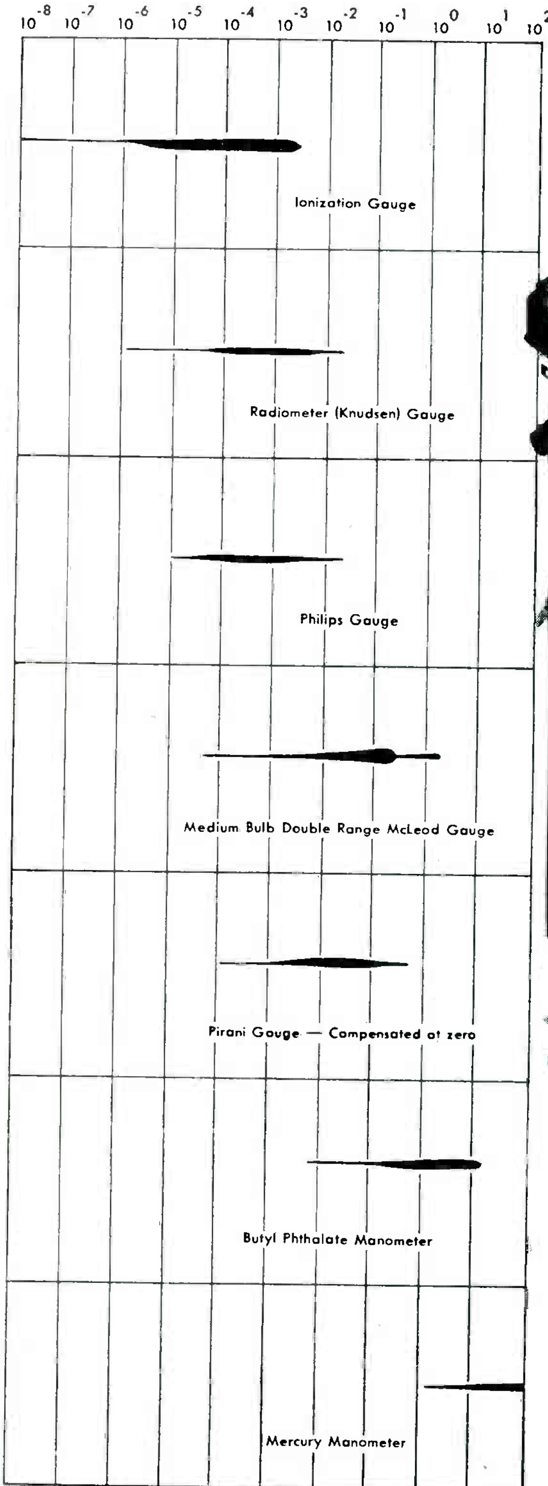

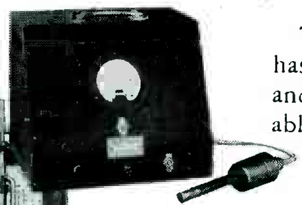

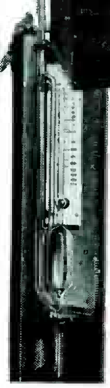

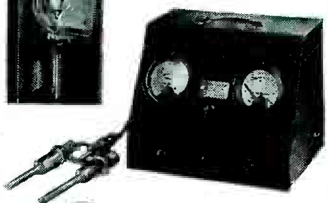

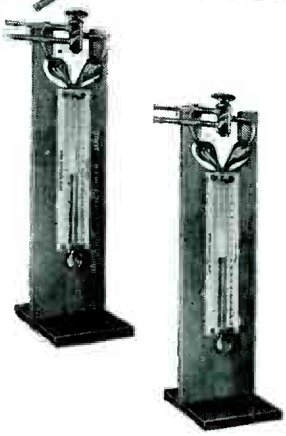

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To fit this wide range of applications, DPI has designed and produced more than 35 types and sizes of high-vacuum pumps, and also suitable controls, gauges, valves and accessories. **Seven fine gauges to provide accurate readings of high vacuum are shown on this page.** Each has a different range of maximum sensitivity—thus each is best fitted for a particular range of operation.

The accompanying charts indicate the full range of each instrument. The Range of Maximum Sensitivity is indicated by the widest portions of that line.

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station having a maximum licensed power in excess of 1 kw or using a directional antenna system, or (2) in the case of an f-m broadcast station having a maximum licensed effective radiated power in excess of 1 kw, or (3) in the case of an international, facsimile, or television broadcast station, one or more holders of a broadcast engineer-operator license is regularly employed on a full-time basis by that station.

Broadcast engineer-operator license—Holders of this class of license may operate any class of broadcast station.

MEETINGS

JUNE 10-12: Symposium sponsored by Armour Research Foundation and the Physics Department of the Illinois Institute of Technology, at Stevens Hotel, Chicago. Papers and planned discussion will cover instrumentation, techniques and application of electron and light microscopy.

JUNE 21-25: 51st annual meeting of the American Society for Testing Materials, at Detroit, Michigan.

JUNE 21-25: AIEE Summer General Meeting, Mexico City.

JULY 14-16: International symposium on noise, held by the Acoustics Group of the Physical Society and the Roger Institute of British Architects, at the Royal Institute, Portland Place, London, W. 1.

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. 13-17: Third Instrument Conference and Exhibit, Convention Hall, Philadelphia, Pa.

SEPT. 27-OCT. 2: Third National Plastic Exposition, Grand Central Palace, New York City.

SEPT. 30-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.

NOV. 4-6: National Electronics Conference, Edgewater Beach Hotel, Chicago.

Audio Society Launched

AT a meeting April 13 in New York City attended by over 125 members, the constitution and bylaws of the Audio Engineering Society were formally adopted. C. J. Lebel, chairman of the meeting, announced that membership was already over 500 and growing steadily.

Adoption of the constitution marks the launching of a new national technical society serving the field of electronics. Provisions are made for establishment of local or regional sections when authorized by the Board of Governors of the national society.

The committee entrusted with formulation of the constitution was headed by Harry N. Reizes and composed of Isabel Capps, R. J. Stier, C. R. Sawyer, A. A. Pulley, C. G. Brodhun, D. L. Richter, C. J. McProud, C. J. Lebel, A. Cezar and J. Daniels.

Classes of membership provided for are as follows:

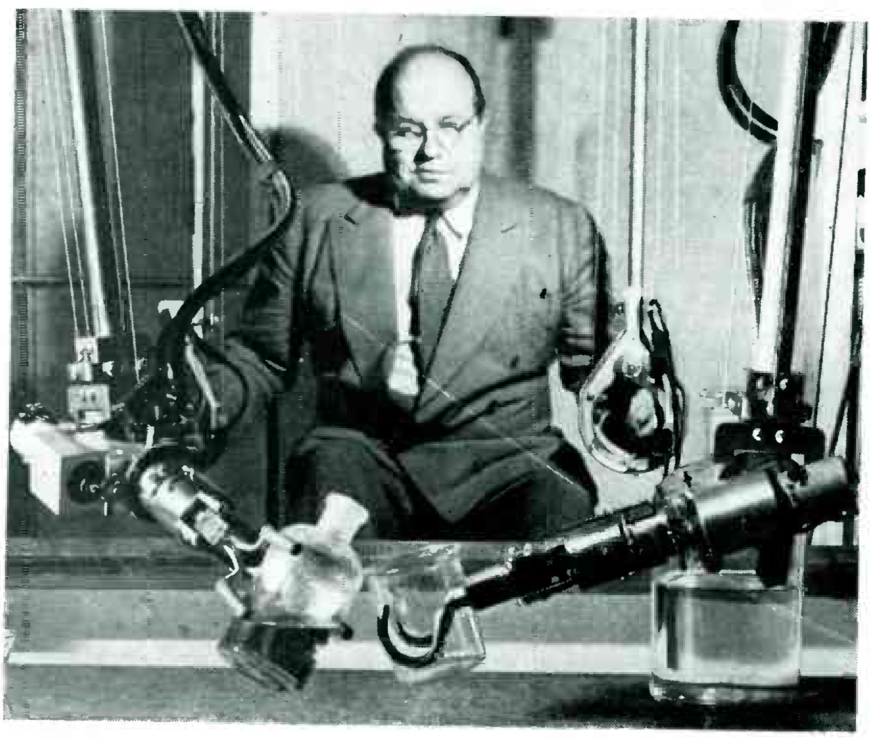
(1) *Honorary Members:* — A person of outstanding repute and eminence in the science of audio engineering or any of its allied arts, may be elected to honorary membership by the board of governors and thus become entitled to all the rights and privileges of the society.

(2) *Fellows:* — A member who has rendered conspicuous service, or is recognized to have made valuable contribution to the advancement in or dissemination of knowledge of audio engineering, or the promotion of its application in practice, may be elected a fellow of the society.

(3) *Members:*—Any person active in audio engineering who has an academic degree, or its equivalent in scientific or professional experience in audio engineering or in a closely related field or art, shall be eligible for election to membership in the society and upon election shall be entitled to all the

(continued on p 227)

MECHANICAL HANDS FOR RADIOACTIVE AREAS



A remote-control manipulator using mechanical hands can perform chemical experiments or operate machine tools in radioactive areas. In actual use the hands would extend over a protective 8-ft wall into the area while operated from an outside room. General motion of the robot corresponds to that given the handles by the remote operator but wrists, rotated electrically by the use of synchros, can be twisted around completely any number of times. The device is used at the Knolls Atomic Power Laboratory near Schenectady, N. Y., and was developed by John Payne of the Atomic Power Division of the G. E. Research Laboratory

(continued from p 126)

tions in the output voltage. The amplifying action of this tube provides the regulating effect. Any change on the grid of the 6SJ7 is amplified and transmitted as bias to the 6L6's, which changes their series resistance in the proper direction to counteract the fluctuation.

By varying P_1, the output voltage is brought to the exact value desired. The divider was calculated to put the grid 5 volts above the cathode, or 155 volts; P_1 has a range of about 50 volts. Potentiometer P_2 helps in reducing ripple, as it feeds the unregulated voltage to the regulated side and any ripple will be partially cancelled due to the 180-degree phase difference between the two.

Resistor R_1 and capacitor C_1 aid considerably in ripple reduction. A 500,000-ohm potentiometer was used for R_1 and adjusted for minimum ripple voltage. If the supply is used where the load changes rapidly, a 4-μf 600-volt oil-filled capacitor across the output helps in maintaining regulation.

A-C Output

The change from d-c to a-c is accomplished by means of a 4-pole double-throw relay. When the relay is energized, it disconnects the high-voltage windings from the rectifier tube and makes them available by means of a switch. The Variac, connected to the primaries of one filament transformer and the plate transformer, controls the a-c output. When the switch selects the filament transformer, a-c from 0 to 7.5 volts is available at the terminals. With half of the plate winding switched in, up to 600 volts may be had. With the full winding, 1,200 volts are available; each range being continuously variable. The Variac is turned down whenever a change is made to prevent arcing at the relay contacts.

The resistance network across the output divides the 500 volts d-c into four ranges, each range being approximately a 125-volt step, depending on the current being drawn. Thus for the first range the voltage is 0 to 125, the second from 125 to 250, the third from 250 to 375 and the last from 375 to the full 500. The arrangement of the

potentiometers gives a very smooth control between ranges and allows voltages as low as 0.05 to be easily obtained. The two 10,000-ohm potentiometers are General Radio type 314A, rated at 8 watts.

Phase Meter

By E. O. VANDEVEN
General Electric Co.
Schenectady, New York

THE PHASE METER is a device that measures the phase angles of a low or high frequency polyphase voltage supply. Essentially this is accomplished by developing on the screen of a cathode-ray oscilloscope a circular sweep at the polyphase supply frequency. Each phase voltage of the polyphase supply is then separately amplified, clipped, differentiated and again amplified.

In the output of each phase amplifier are pulses which are established in time by their respective phase voltage. These pulses are mixed and applied to the Z-axis amplifier of the oscilloscope to intensity modulate the circular trace, causing a dark or bright spot to appear for each phase voltage. The angular displacement between the spots is then a measure of the angular displacement between corresponding phase voltages. The phase angles can be read by calibrating the oscilloscope screen radially in degrees.

A block diagram of the phase meter is shown in Fig. 1. One phase

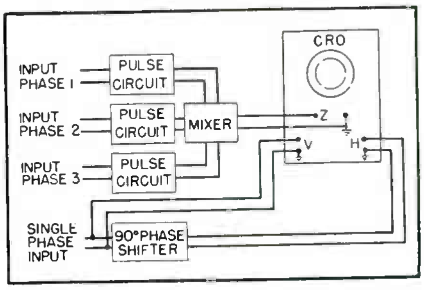


FIG. 1—Block diagram of phase detector

of the three-phase supply is applied to a device which shifts the phase by 90 degrees. This is done, since to obtain a circular sweep it is necessary to apply to the horizontal and vertical amplifiers voltages of the same frequency but separated in phase by 90 degrees. The pulse forming and mixing circuits are also indicated.

The phase meter was developed

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RATINGS

FILTERED

Code Number	A-C Input Volts	A-C Input Phase	A-C Input Cycles	D-C Output Volts	D-C Output Amps.
1 FTR 3093-AS	115	1	60	12	3
2 FTR 3128-BS*	115	1	60	22-30	10
3 FTR 3246-BS	115	1	60	6	10
4 FTR 3138-BS	115	1	60	12	5
5 FTR 3185-AS	115	1	60	12	7.5

*Filtered and regulated

UNFILTERED

Code Number	A-C Input Volts	A-C Input Phase	A-C Input Cycles	D-C Output Volts	D-C Output Amps.
6 FTR 3300-DS	115	1	60	2-32	50
7 FTR 1342-AS	115	1	50/60	6	4
8 FTR 3341-AS	115	1	50/60	28	5
9 FTR 3339-BS	115/230	1	50/60	6-24	18
10 FTR 3340-BS	115	1	50/60	5-70	12
11 FTR 3352-BS	115	1	50/60	5/10	20/10

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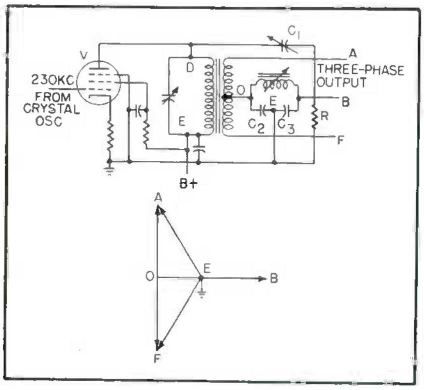

FIG. 2—Single-phase to three-phase transformation circuit and phase diagram

for work with the 2H21 phasitron tube, used to generate crystal-controlled f-m. The phasitron has three-phase r-f applied to the deflector electrodes. A crystal oscillator at approximately 230 kilocycles is the signal source. This single-phase voltage is transformed to three-phase by employing a modified Scott transformer connection.

The single- to three-phase transformation circuit, with the associated phase relationships, is shown in Fig. 2. Amplifier tube V supplies a transformer load, the secondary of which is center tapped. Secondary voltage, AF, is shown vectorially on the phase diagram. The OB vector, displaced 90 degrees from AF, is obtained by shifting the phase of the primary voltage DE by 90 degrees. Since DE and AF are in phase, vector OB is then 90 degrees from AF.

Resistor R is essentially connected from B to E which is part of a tuned circuit. Therefore by detuning the tuned circuit slightly from the resonant point the reactance from B to E can be made to appear inductive. This inductive reactance is in series with C_1, and by proper adjustment of these two parameters the voltage BE will be displaced from the supply voltage DE by 90 degrees. By properly establishing the ratio of C_2 to C_3, the point E is selected along the OB vector. Point E is grounded providing a neutral point for the balanced three-phase system.

For the phasitron to operate with minimum distortion it is necessary that the exciter supply phase voltages of equal magnitude and angular displacement. The phase meter was developed to facilitate the adjustment of the exciter supply for perfect three-phase output.

Circular Sweep

Figure 3 shows the circuit used to obtain circular sweep. The single-phase, 230-kc signal feeds a pentode amplifier. The amplifier plate circuit has a tuned transformer which, when resonated, gives a 90-degree phase shift between primary and secondary. Proper adjustment of the secondary tuning

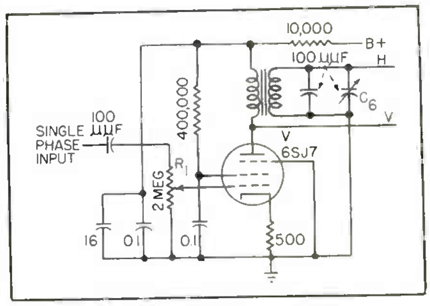

FIG. 3—Circuit of circular sweep generator

capacitor is accomplished by observing the pattern on the c-r tube. When this capacitor, and the horizontal and vertical gains, are correctly set, the result will be a circular trace on the cro screen.

The pentode amplifier is run class A and with an unbypassed cathode resistor. This is to minimize distortion of the voltages applied to the vertical and horizontal amplifiers. The cro amplifiers must also have low distortion, or it will be impossible to obtain perfect circular sweep. Circle size is controlled by R_1.

One of the pulse-forming circuits is shown in Fig. 4. Phase voltage is applied to V_{1A}, a cathode follower. This tube transforms from high-impedance input to low-impedance output across L_1.

Operation

Accuracy of the meter depends more than anything else on the coupling circuit between V_{1A} and V_2, and the operation of V_2. The voltage developed across L_1 is at least 30 volts rms. Therefore the grid of V_2 swings from minus 50 volts to 50 volts plus, less the drop across R_3C_3. The tube begins to conduct when the input voltage rises to approximately −4.5 volts. When it

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- **G-E RING SEAL construction gives generous terminal-contact areas.**

RATINGS

Filament voltage	6.3 v
Filament current	240 amp
Grid-plate transconductance	11,000 micromhos
Interelectrode capacitances:	
Grid-filament	24 micromicrofarads
Grid-plate	15.7 micromicrofarads
Plate-filament	0.5 micromicrofarads
Type of cooling	water and forced air
Plate ratings per tube, Class B r-f power amplifier (video service, synchronizing peak conditions):	
Max voltage	5,000 v
Max current	2 amp
Max input	10 kw
Max dissipation	5 kw
* Useful power output, typical operation (at 4,000 v and 1.7 amp, band width 5 mc)	3.4 kw
Plate ratings per tube, Class C r-f power amplifier (key-down conditions without modulation):	
Max voltage	6,500 v
Max current	2 amp
Max input	12 kw
Max dissipation	5 kw
* Useful power output, typical operation (at 6,000 v and 1.3 amp)	6.4 kw

*Includes power transferred from driver to output of grounded-grid amplifier.

TODAY'S better pictures, in many cases, owe a debt for sharpness and quality to the superior signal put on the air by General Electric's great power triode, GL-9C24. Newest transmitters with finer video performance, use GL-9C24's in push-pull for final output over both low and high-band channels.

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When applied in a properly designed grounded-grid amplifier circuit, *no neutralization is necessary.* Lead inductance is extremely low.

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If you build transmitters and wish to benefit from the proved brilliant performance of Type GL-9C24, your nearby G-E electronics office gladly will give you further details.

If you are a station operator or engineer, needing replacement tubes *of any type*—FM, television, or AM—see your local General Electric tube distributor or dealer for alert service! Besides showing the way in tube design, G.E. gets tubes to you fastest when you need them. *Electronics Department, General Electric Company, Schenectady 5, N. Y.*

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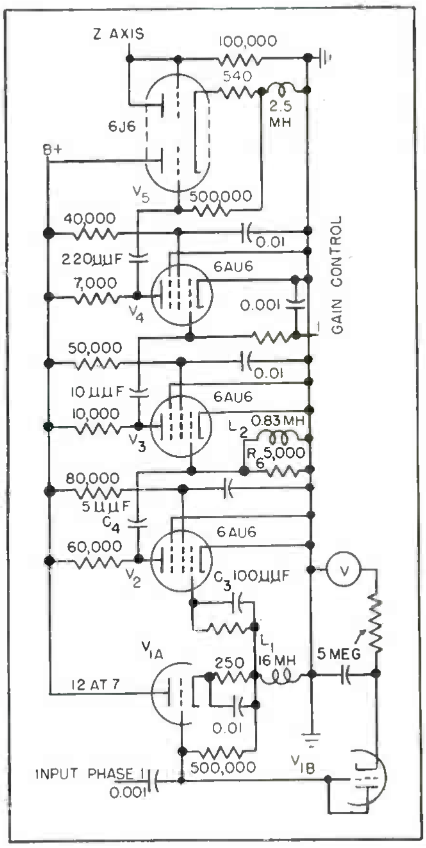


FIG. 4—Pulse generator for one phase

reaches zero volts, grid current begins to flow, resulting in a voltage drop across the grid resistor.

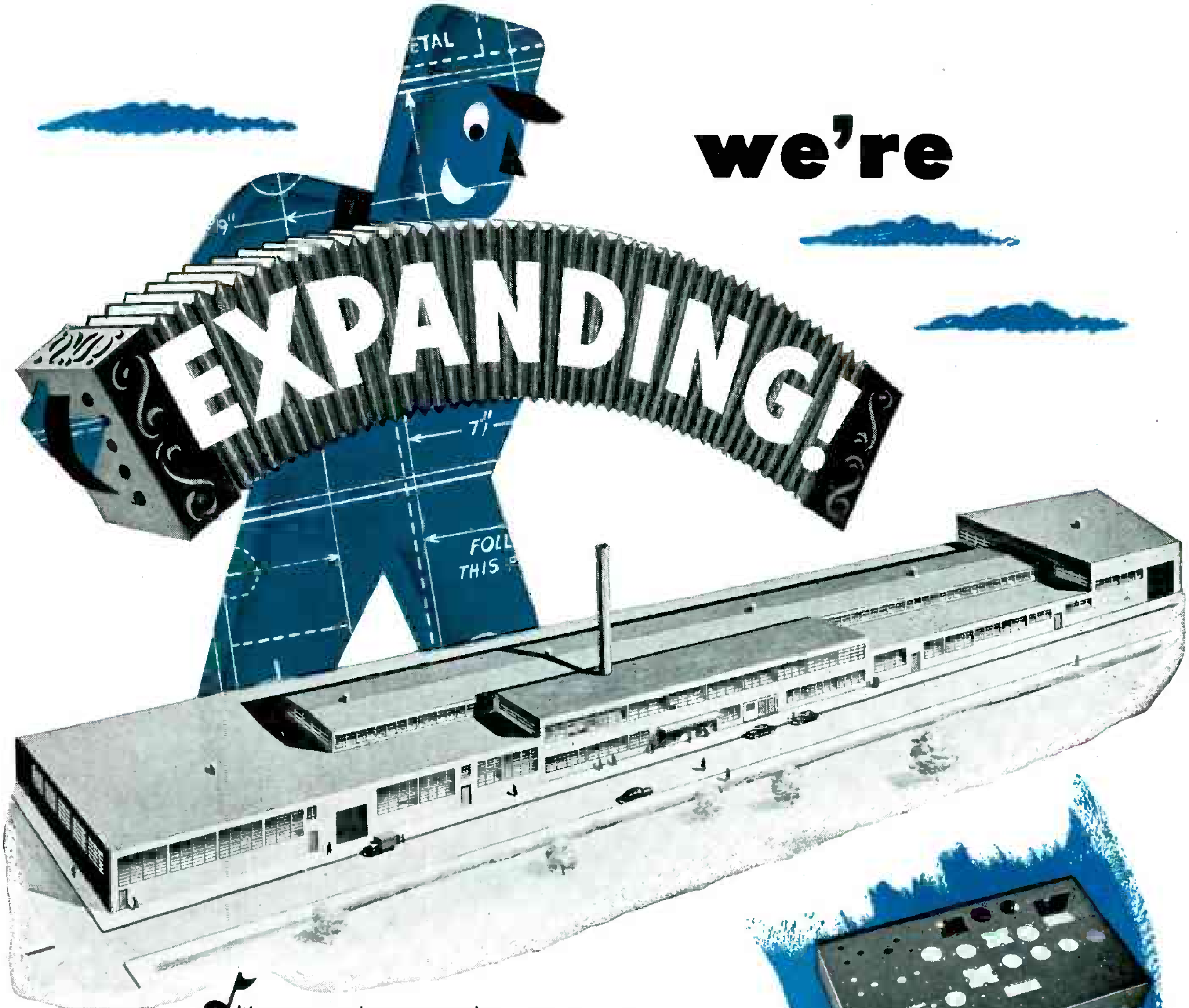
The output of V_2 therefore is a pulse whose leading edge is very steep. It is important that this leading edge be definitely established in time with respect to the phase input voltage.

Tube V_2 is directly coupled to L_1, since a blocking capacitor would have a discharge time constant which would develop grid bias on V_2 and change its operating point with respect to the phase input voltage. Filter R_3C_3 has a time constant which is short compared to the period of one cycle. Thus, as the voltage across L_1 rises from its peak negative value, V_2 should begin to conduct at a point determined entirely by its cutoff potential.

If the magnitude of the phase voltage is varied, this point will shift slightly, which is part of the inherent error of the device. If all phase voltages are varied by the same amount however, no net error should result. All operating points will have shifted by the same amount and in the same direction.

C_4 and R_6L_2 constitute a differentiating circuit, the voltage on V_3

we're



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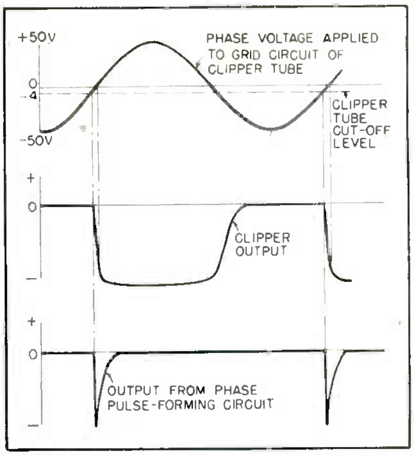

FIG. 5—Phase relations in pulse-forming circuit

grid consisting of narrow positive and negative pulses. Since V_3 is zero biased, its grid presents low impedance to the positive pulses and high impedance to the negative ones. In the output, positive pulses predominate.

Tube V_4 is an amplifier-inverter, biased beyond cutoff. The pulses are also narrowed in this stage. Output of V_4 is applied to V_5, a cathode follower. The negative pulses developed across the cathode-follower load impedance cannot be fed to the Z axis input directly. If this were done the cathode-follower loads of all phase circuits would essentially be in parallel. When one cathode follower were pulsing the remaining two would present excessive loading. The result would be insufficient pulse output voltage.

Circuit Isolation

Therefore the second section of V_5, is diode connected. Under these circuit conditions, the cathode load impedances of the inoperative cathode followers are isolated from the load impedance of the one that is operating.

Tube V_{1B} is diode-connected to form part of a peak-reading voltmeter circuit. The meter is calibrated to read rms phase voltage.

Figure 5 shows the phase relationship between the sine wave input to the phase circuit and the output pulses appearing at the Z-axis input to the cro. The leading edge of each pulse is determined by the cutoff point of the first clipper tube in the corresponding phase circuit.

Other possible uses of the phase

THE RCA WV-84A ULTRA-SENSITIVE DC MICROAMMETER is a battery-operated vacuum-tube instrument capable of measuring currents from 0.001 to 1000 microamperes. The instrument has six ranges and can read currents in either direction by a simple switching operation. Accuracy is ± 5% of full-scale reading in the 0.01 range, ± 4% on all other ranges.

In addition to its usefulness in measuring small currents, the RCA WV-84A may also be employed as an extremely high-resistance voltmeter by the addition of external multipliers, or it may be used for the measurement of very high resistance values.

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THE RCA WV-75A HIGH-FREQUENCY VOLTOHMYST employs a push-pull dc vacuum-tube voltmeter circuit that provides excellent linearity and stability. It will measure dc resistances up to 1000 megohms, ac and dc voltages up to 1000 volts. A newly developed diode probe and internal circuit permits readings of both positive and negative peak voltages at frequencies up to 250 Mc.

In addition, the RCA WV-75A possesses all the outstanding characteristics of its well-known predecessor, Type 195-A.

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THE RCA WV-73A AUDIO VOLTMETER is a sensitive high-impedance VTVM capable of readings from 0.001 to 1000 ac volts over a range of 20 to 20,000 cycles. Logarithmic scale and overlapping attenuator assure accuracy even when pointer is at either end of scale.

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Using Audio Voltmeter with rectifying probe to detect standing waves in wave guide.

For complete details, see your RCA Laboratory Measuring Equipment Distributor, or write RCA, Commercial Engineering, Section FY40, Harrison, New Jersey.

RCA

RADIO CORPORATION of AMERICA

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

meter principle include the measurement of phase shift through amplifier circuits.

R-F Heating for Cabinets

By CHARLES DUSENBURY

Engineering and Service Department
Westinghouse Electric Corp.
Atlanta, Georgia

WHEN Gavan Woodcrafter Inc. began the manufacture of radio cabinets, a method was needed that would eliminate human error in gluing, holding and setting. In addition they were limited in time and floor space. The solution was found in radio-frequency heating.

The production line cabinet fabrication set up contains five Westinghous generators, one 5 kw, 5-mc set, two 5 kw, 15-mc sets, and two 2 kw, 15-mc sets. Three of these units are equipped with two position switches to permit one jig to be heated while the other is loaded. The other two units are connected directly to the presses. The jigs and presses are constructed of plastic-impregnated wood and cost has been quite low.

With radio-frequency glue line heating and setting, cabinet construction does not rely on nails, cleats, or hand clamps to hold the cabinet together for a long glue-setting period. The various parts are coated with glue, placed in the jig and held for a few seconds during the r-f heating cycle, which sets the glue sufficiently so that they can be removed immediately for finishing. This gives a product without nails, and thus a finer finished cabinet.

The entire process consists of six steps: five gluing and heating operations and the final assembly. In forming the curved front section of the cabinet, two plys of birch or

In this jig, small blocks for the sides of the cabinet are glued and placed in slots having electrodes on each side so that r-f current passes through the glue line

Oil Cooled POWERSTATS

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The immersion and mounting of a POWERSTAT variable transformer in oil can substantially increase its rating above normal air operation. The increased power is dependent upon the type of POWERSTAT, quantity of oil, area of wetted surface and type of container. In addition, POWERSTATS mounted in oil are ideally suited for use in hazardous areas such as powder mills, gas reduction chambers, oil and gas refineries and similar locations where a small arc or spark could cause an explosion.

Most POWERSTATS can be adapted for oil mounting, but since applications vary, only single phase types are available as standard. However, The Superior Electric Company can provide in quantity specific oil-cooled POWERSTAT requirements.

Oil-cooled POWERSTATS are quality manufactured and ruggedly designed to stand the severest usage, providing precision control with added power and safety for dependable, accurate service.

Any problems regarding the use of oil-cooled POWERSTATS should be referred to The Superior Electric Company's staff of experienced voltage control engineers. Use their specialized knowledge.

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Request Bulletin 547, a completely illustrated voltage control engineering data catalog.

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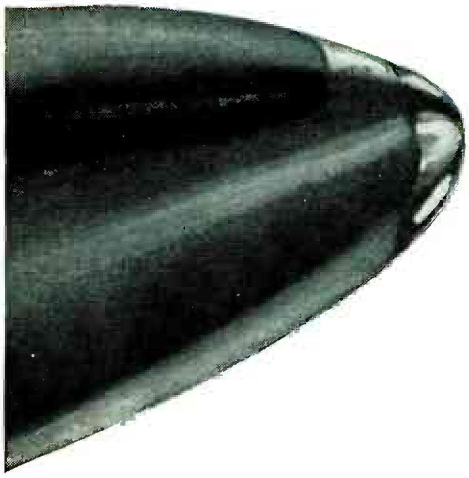

JANUARY 1, 1948 — **"We need a greatly enlarged air force, right now."** — *President's Air Policy Commission*

FEBRUARY 9, 1948 — **"U. S. policies must remain continually adjusted to the requirements of total air power."** — *Air Co-ordinating Committee*

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FORTY BILLION DOLLARS . . . that's the amount of money required to rebuild U. S. air supremacy in the next five years. Our Administration, our Congress, our military and aviation leaders agree that we must do this if America, as the leading world power, is to maintain world peace and order.

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The impact of $40 billion of aviation spending will affect every business in this country. Your planning, beginning now, must embrace the effect on your business of the innumerable product and service requirements of aviation.

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Aviation Week was specifically designed to serve the information needs of *all* men in the aviation business. Its editors report every important development in the science of aeronautics and assess its effect upon all activities within the industry. Its editors also recognize the need for the greatest possible speed in the communication of aeronautical intelligence.

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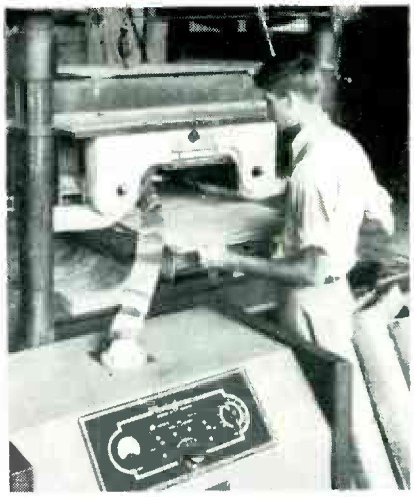

Two plys of birch or poplar and one of mahogany are glued together to form the cabinet front. A 5-kw, 5-mc Westinghouse generator is used

poplar and one ply of mahogany are used to form a three-ply section. The middle ply is painted with glue and the section placed in the press. Approximately 200 lb per square inch pressure is applied to the ply section and the 5-kw, 5-mc generator is then applied for a period of 120 seconds.

After the heating cycle, the panel is split into quadrants to form four cabinet front panels. One man applies glue, operates the press, and splits the panels and turns out 100 sections or 400 front panels in an eight-hour day. Production can be increased in the future by the addition of a glue spreader.

Inside Gluing

After the front panels are cut by an automatic saw, stiffening or loudspeaker boards and six small blocks are glued to the inside. This is done by a 2-kw, 15-mc generator. This unit can be used for a second heating operation while the loading is going on. The second operation is the gluing of two small blocks and a strip on the record changer mounting board. These operations respectively require 30 and 20 seconds heating time and 20 to 30 seconds loading time. The generator is adjusted so that no change is necessary when changing jigs.

The next operation is the gluing of five blocks to each side of the cabinet. Glue is applied and the blocks placed in various slots which have electrodes on each side so that the r-f current passes through

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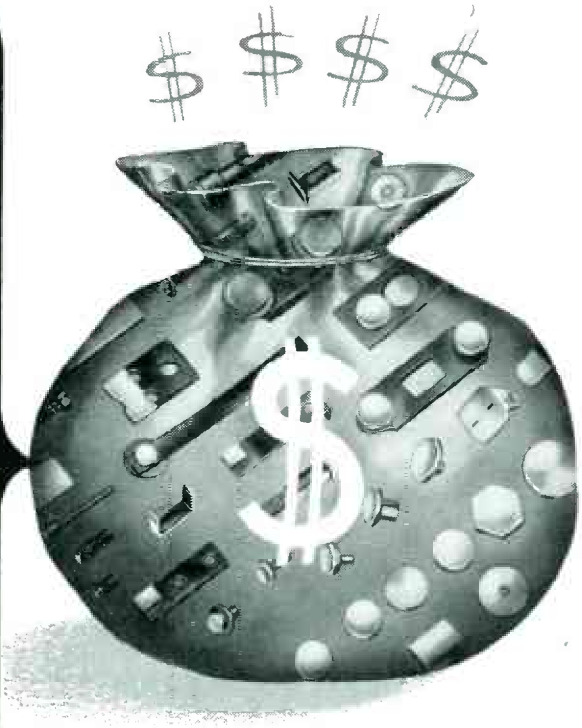

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A loudspeaker mount board and several small blocks are glued simultaneously in about 30 seconds with this jig

the glue line. When the blocks are in position, they are pushed under a press lowered by an air cylinder that applies pressure to the blocks during the heating cycle. A 5-kw, 15-mc generator with a time cycle of about 20 seconds completes the operation.

The fifth operation is heating the glue lines of the radio cabinet top. The two curved side pieces and the triangular strengthening pieces plus the front and back pieces are glued on in this case to form a top which is free from nails and is always square. The heating cycle for this operation with a 2-kw generator is about 45 seconds and the loading cycle is about the same.

Transfer Switch

The plant is laid out so that the parts flow from one operation to the next and eventually end up at the final assembly jigs. Dual presses are used for the final assembly, a transfer switch being mounted on top of the 5-kw, 15-mc generator. Two cabinets are heated at the same time in about 110 seconds. During this heating time the operators are loading the second two jigs and as soon as the first heating cycle is completed the power is transferred to the second set of jigs so that the generator is utilized about 90 percent of the time.

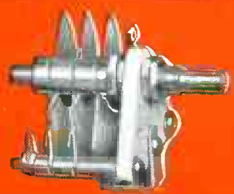
The cabinet must be kept square

JOHNSON OFFERS

A Condenser To Fit Every Need!

TYPE C & D — Sturdily constructed to give trouble-free operation under the most severe service, JOHNSON Type C and D Condensers cost less than any other quality condensers. Features include sturdy construction, heavy aluminum plates .051" thick, Steatite insulation and center rotor contacts on all dual models. Both front and rear shaft extensions permit ganging.
Available in 52 different models, single or dual sections, with spacing varying from .175" to .500" and maximum capacities from 50 to 1,000 mmfd.

TYPE E & F — Rugged and compact, JOHNSON Type E and F Condensers for medium and low power transmitters have more capacity per cubic inch and occupy less panel space for their rating than any other condenser on the market. Features include Steatite insulation, stator mounted above to reduce capacity to ground, front and rear shaft extensions that permit ganging.
Available in 45 different models, single or dual sections, spacing .045" to .125", and maximum capacities from 35 to 500 mmfd.



TYPE G — The JOHNSON Type G Condenser is widely used as a neutralizing condenser for medium and low power stages. It's equally famous for its outstanding performance in grid and plate tuning at high and ultra high frequencies. Features include front and rear shaft extensions and universal mounting bracket and locking nut.
Available only in single sections with single end plate. Seven models from which to choose. Capacities from 3.5 to 52 mmfd. Plate spacing from .045" to .225".

TYPE H — Combining minimum weight with small size, JOHNSON Type H Condensers are designed especially to withstand heavy vibration. Steatite end plates prevent any possibility of "short circuit loops" and permit panel mounting with both rotor and stator insulated from ground. Aluminum plates are .020" thick. End plates are 1½" square.
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TYPE J — A midget condenser with big condenser characteristics, Type J has wider spacing than most small types, yet occupies little more space. It is ideal for oscillator and low power stages. Universal type mounting brackets make possible a variety of mountings including chassis, panel or inside tube socket type inductors. Steatite end plate.
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SINGLE TYPE — Available in four models: 1.55 to 5.14 mmf, 1.73 to 8.69 mmf, 2.15 to 14.58 mmf. and 2.6 to 19.7 mmf.
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TYPE N — When space is limited, yet you need extremely high voltage rating, fine adjustment with uniform voltage breakdown rating throughout the full capacity range, the JOHNSON Type N Neutralizing Condenser is the perfect answer.
Available in three different models. Capacity range in each type is approx. 1.5 mmfd. to 10.5 mmfd., peak RF breakdown ratings at 2 MC ranges from 8,500 with the N125 to 14,500 for the N375.

JOHNSON ... *a famous name in Radio*

E. F. JOHNSON CO., WASECA, MINNESOTA

with pressure applied from side to side and from front to back. Two cams plus an aircraft clamp are used to accomplish this. Two operators or loaders and two assistants who apply the glue and assemble the cabinets can reach the desired production rate, slightly over 350 cabinets each day.

Since these jigs are made of heavy material with two sides and the bottom square, the resulting cabinets must be square. This eliminates one of the greatest difficulties of handmade cabinets where a complete jig is not available. An improved method of applying glue has been devised for small parts using a small rubber

Phonoradio cabinet glued together with r-f heating is free of nails and always square

bulb type syringe with a small plastic nozzle. With this, glue can be applied without excess that might cause arcing and lost time in cleanup.

Advantages

When animal glue and nails are used the cabinets must be stacked for a period of probably twenty-four hours before sanding and finishing can be accomplished. This, of course, requires floor space and additional handling, eliminating the possibilities of a production line type of assembly. Furthermore, it requires a considerable outlay for clamps, and the possibility of nails alone not holding the cabinet tight enough during the

TO MEASURE

- RESISTANCE
- INDUCTANCE
- CAPACITANCE
- STORAGE FACTOR
- DISSIPATION FACTOR

IN

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Over the major portion of its ranges this bridge is accurate for the majority of routine measurements in any laboratory. The ranges are:

RESISTANCE: 1 milliohm to 1 megohm

INDUCTANCE: 1 microhenry to 100 henrys

CAPACITANCE: 1 micromicrofarad to 100 microfarads

STORAGE FACTOR (X/R): .02 to 1000

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The bridge includes built-in standards, batteries, a 1000-cycle tone source for a-c measurements, a zero-center galvanometer d-c null detector, and terminals for a headset for 1000-cycle detection. Provision is made for use of an external generator for measurements over a wide range from a few cycles to 10 kilocycles. Direct-reading dials add greatly to the ease and rapidity with which measurements can be made.

TYPE 650-A IMPEDANCE BRIDGE $240.00

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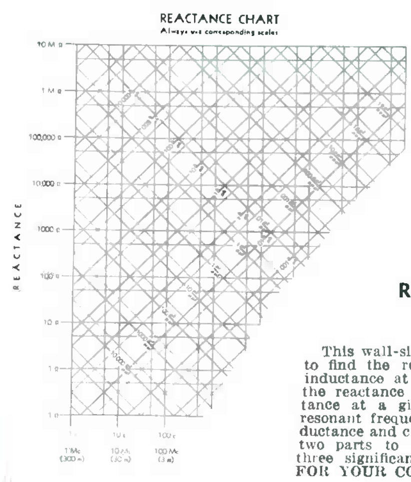

WRITE FOR THIS REACTANCE CHART

This wall-size chart is designed to find the reactance of a given inductance at a given frequency; the reactance of a given capacitance at a given frequency; the resonant frequency of a given inductance and capacitance. It is in two parts to be read to two or three significant figures. WRITE FOR YOUR COPY.

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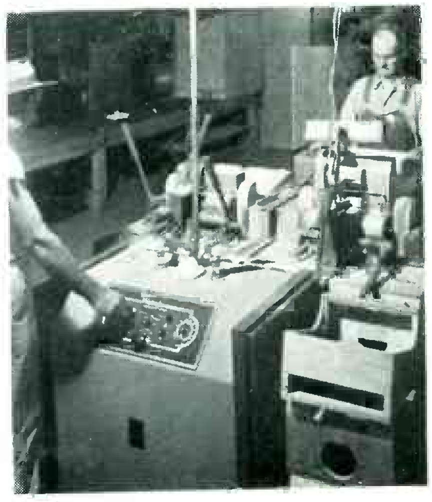


Various parts of the cabinet are assembled into one unit in two minutes at this station served by a 5-kw, 5-mc generator

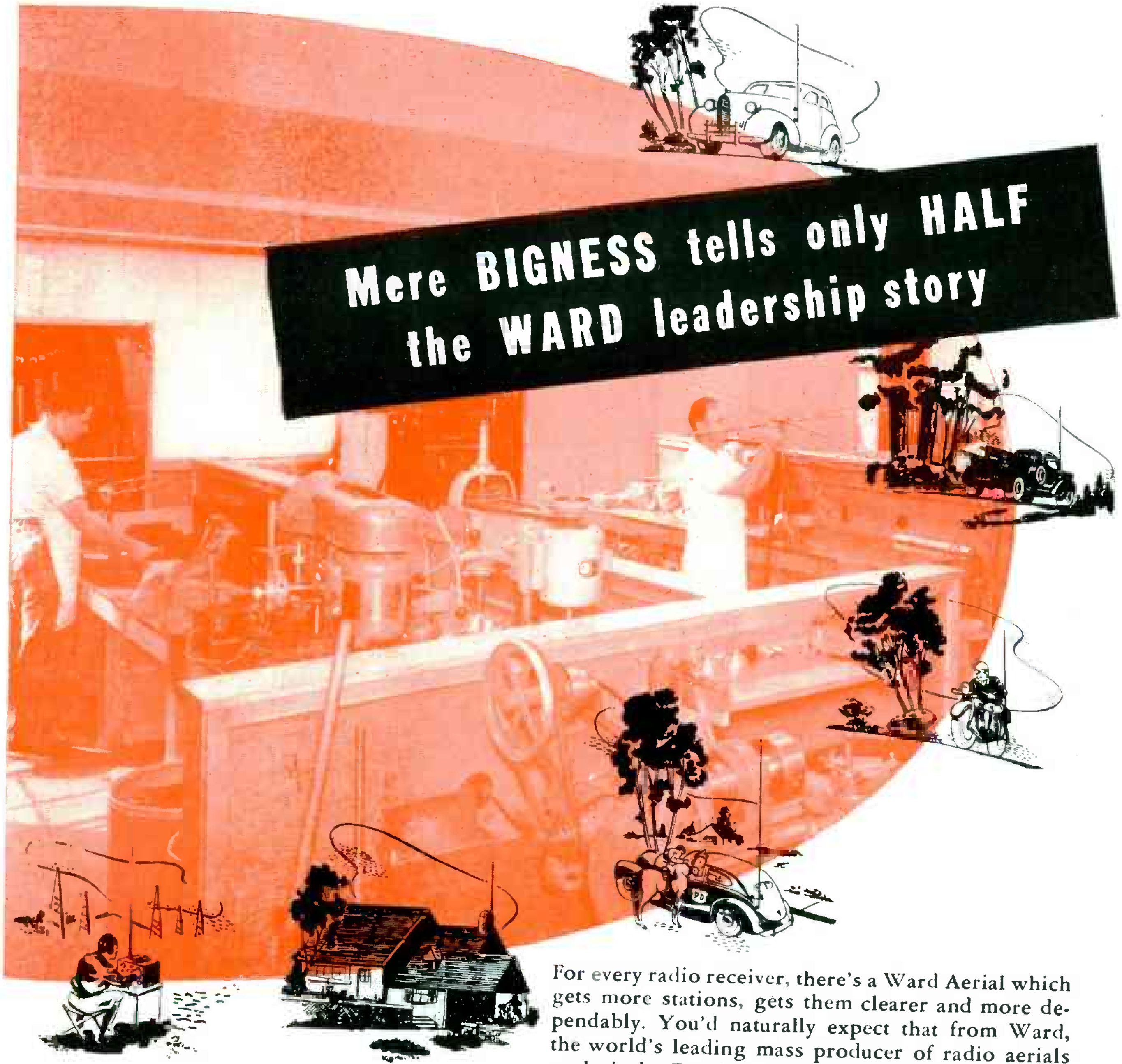
glue setting period is always present.

The production line layout with radio-frequency heating saves handling and consequently gives a better product at lower cost. The fact that a man cannot apply a great deal of pressure when nailing a cabinet, unless it is in a jig, means that the parts have to be much more accurate when hand assembly and nails are used. However, the final assembly is arranged so that it draws up the material and takes up a great deal of misalignment which could only be tolerated under these conditions. Therefore, the labor required in the cutting operations need not be quite as highly skilled, nor the machines as accurate.

Carrier Shift Check Meter

By J. W. Whitehead
Central High School
Leeds, Yorkshire, England

During the second World War a requirement arose for a simple and convenient means of checking the setting up of a transmitter working on a carrier-shift teleprinter circuit. Continuous indication of shift was not required. The method adopted is to set a stable oscillator to the transmitter *space* frequency. The beat frequency obtained between this oscillator and the transmitter when on its *mark* frequency is then equal to the carrier shift, and by comparing the note thus produced with that generated by a stable audio frequency oscillator set to the required frequency, an



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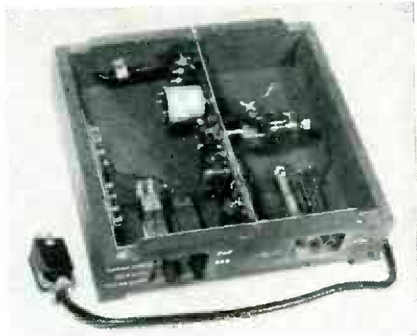


Constructed in this fashion, the carrier shift check meter fits under a BC-221 frequency meter

indication of the error in the transmitter shift tuning is obtained and can be corrected.

The circuit layout is shown schematically in Fig. 1. It contains three main items—a stable r-f oscillator, a stable a-f oscillator, and the comparison unit or mixer.

A useful, but not essential, source of r-f is an oscillating wavemeter which is provided with a crystal check, such as the U. S. Army frequency meter type BC-221. By using this meter as a basis of the scheme, it is possible to provide, at the same time, a convenient check on the transmitter carrier frequency.

For the a-f generator, a cathode-tap oscillator was found to be a convenient form, using as a resonant circuit a fixed capacitor and one winding of a transformer. Output is taken from a second winding on the transformer and fed to the mixer unit. An attempt made to carry out the final adjustment by means of d-c through a third winding was unsuccessful, and units are individually tuned by strapping further capacitors across the tuned winding.

The output from the audio oscil-

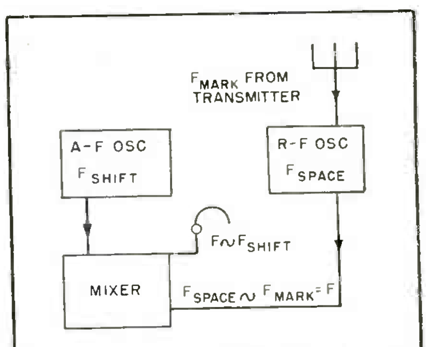
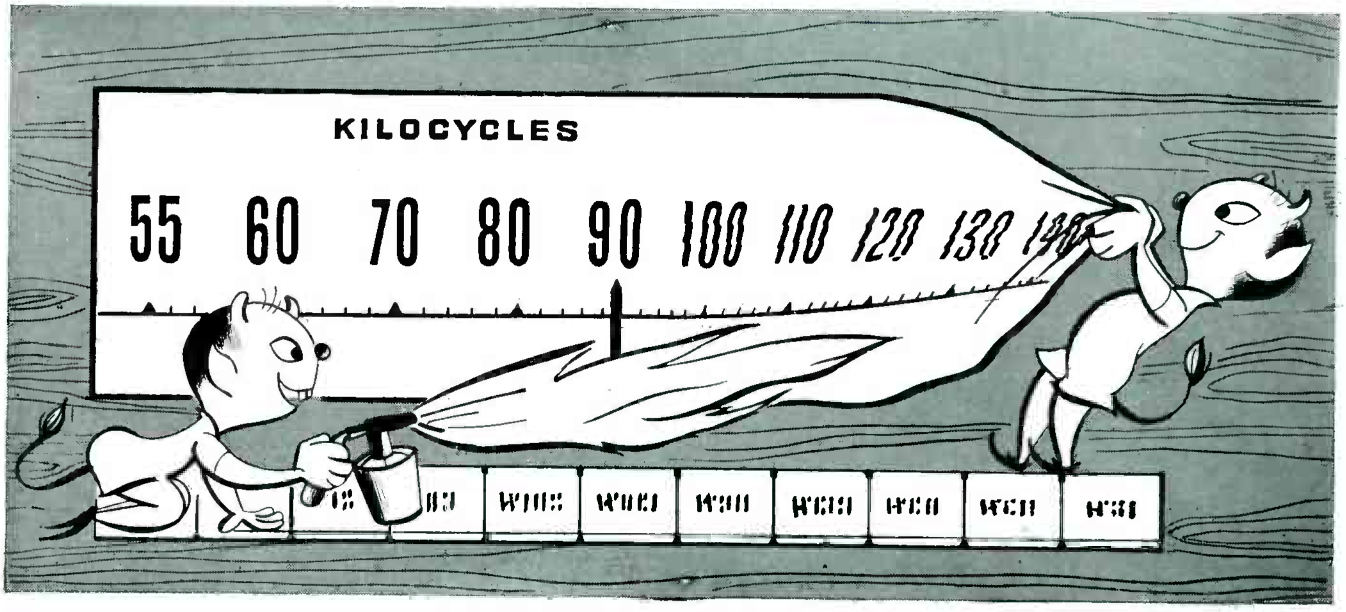


FIG. 1—Essential stages of a system for checking carrier shift



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These powders, made by G. A. & F.'s exclusive, patented carbonyl process, have a *unique* degree of temperature stability, and in direct comparison tests proved themselves superior to all other magnetic powders.

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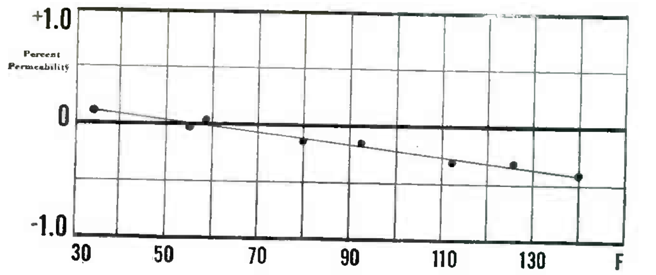

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Spheres of small size	Low eddy current losses; usable for high frequencies
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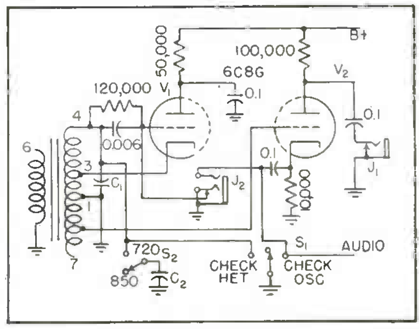


FIG. 2—Audio oscillator and mixer circuit. The center position of switch S_1 is the normal position

lator is taken to the grid-filament circuit of the mixer tube, the cathode circuit of which is fed with the audio output from the oscillating frequency meter. This latter tone is generated by heterodyne action within the meter between the *space* frequency produced by the meter and the carrier shift transmitter on its *mark* frequency. The audio signal resulting in the plate circuit of the mixer is applied to phones, and the beats heard allow accurate setting of the transmitter *mark* frequency.

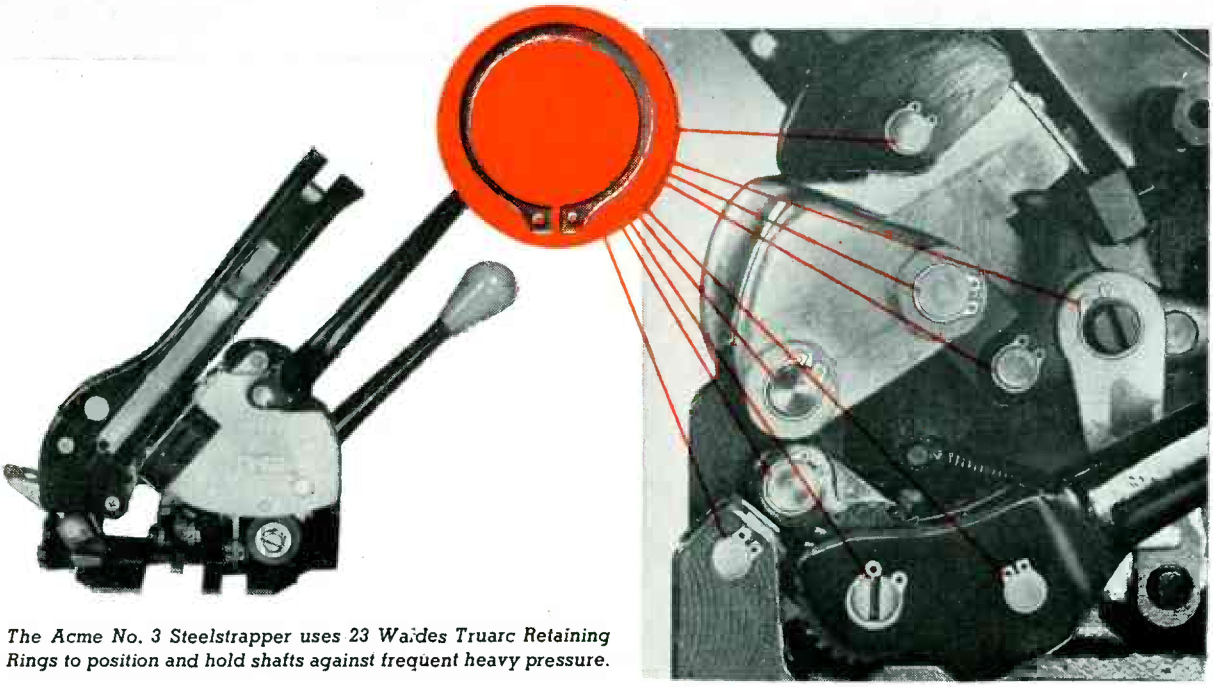
Mixer

For simplicity of construction it was considered desirable to use one tube for the two necessary circuits, and the double triode 6C8G was selected. Each section of this tube has its separate cathode, a fact which allows virtually complete isolation of the two circuits, thus making for enhanced frequency stability of the oscillator.

Referring to Fig. 2, the winding of transformer between terminal 4 and earth is tuned by means of fixed capacitors at C_1, strapped across it to produce the desired frequency. The precise values of these capacitors varies from unit to unit, and each must therefore be individually tuned. The scope of the instrument may be increased by providing switch S_2 to bring in further capacitors C_2 in parallel with the first bank to secure a second audio frequency. (The two frequencies in use were 850 and 720 cps respectively). Terminal 3 on T_1 is a tap on the tuned winding taken directly to the cathode of V_1, and terminal 4 connects with the grid of this tube via a parallel r-c combination.

Output from the a-f oscillator is

23 Truarc rings permit changeover to centerless grinding savings



The Acme No. 3 Steelstrapper uses 23 Waldes Truarc Retaining Rings to position and hold shafts against frequent heavy pressure.

"The use of Truarc Retaining Rings permits centerless grinding of pins instead of plunge-grinding. This eliminates the problem of taper and reduces the required tensional tolerances of these parts," reports Acme Steel Company of Chicago. "Furthermore, use of Truarc rings gives the Steelstrapper smoother lines by eliminating unsightly projections. This results in a more streamlined housing, a definite sales advantage."

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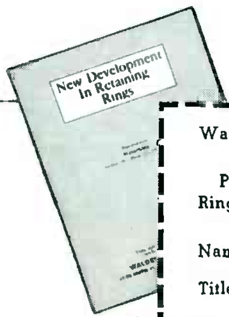

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City__________ Zone______ State______

taken from T_1 and applied to the other section of the 6C8G, V_2. The audio output from the frequency meter is applied across the cathode resistor via the capacitance. Across the plate load, therefore, appears the beat note resulting from the superposition of the two audio frequencies, and it is reproduced in the phones which are plugged in at J_1.

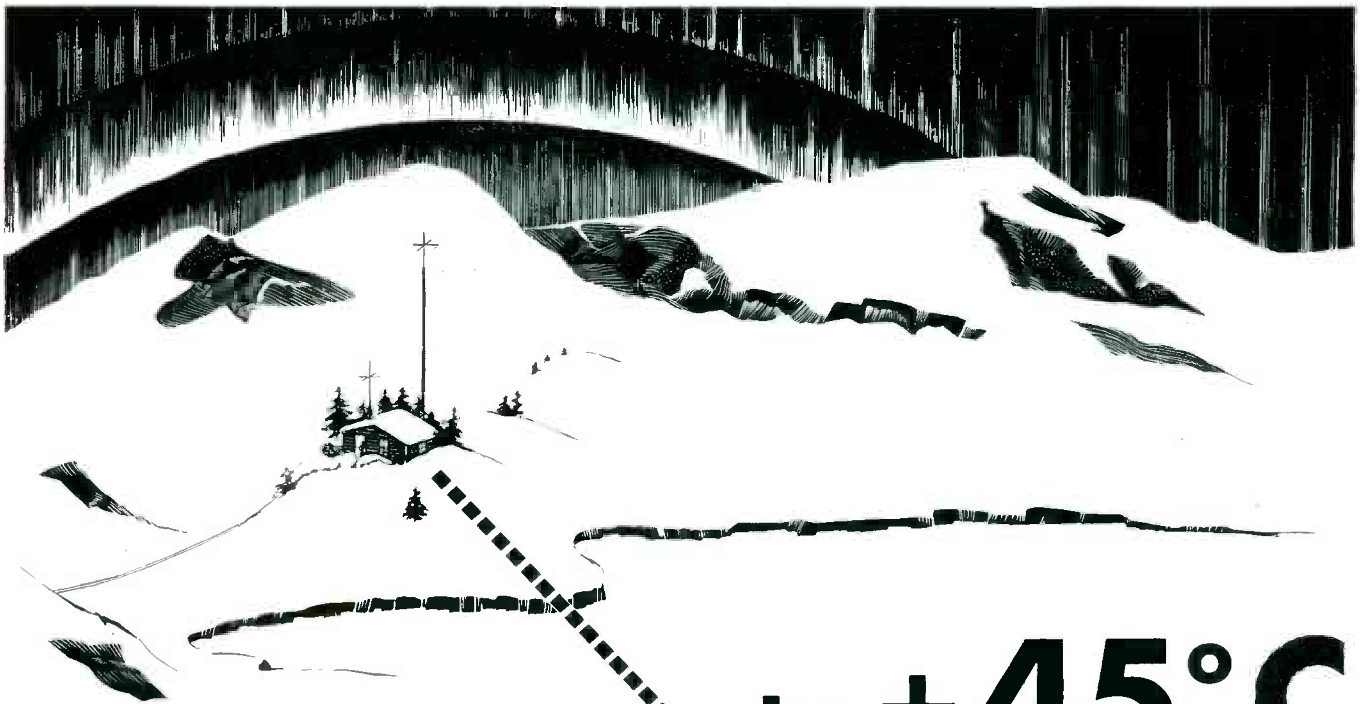
It was found convenient to tune the frequency meter to zero beat on *space* without switching off the a-f oscillator, and for this purpose a second jack J_2 is provided. This jack is connected across the audio input from the frequency meter, and has an additional contact which is arranged to short the grid of the audio oscillator to ground when the jack is in use, thus stopping that tube from oscillating and avoiding the complication of having a continuous additional note in the phones while tuning to zero beat.

It may be possible for an inexperienced operator to obtain an apparent tuning point when the two tones are harmonically related. A three-position nonlocking key is therefore provided to enable the two tones to be heard independently, thus ensuring that they are of exactly the same frequency.

The original prototype was calibrated against a standard tone generator to an accuracy of ± 1 cycle, and this was used as a standard against which further models were checked. During a long period of use the stability of all the models has been good and the results have been eminently satisfactory.

The particular model illustrated in the photographs was designed to fit beneath frequency meters of the U. S. Army type BC-221. This accounts for its somewhat unusual shape.

RADIATION indicators are used by Australian Customs authorities to detect thorium in bags of mineral-bearing sand exported from the east coast of Australia. The thorium occurs in monazite sands, and exports of mineral sands containing more than a certain proportion of monazite are banned by the Commonwealth Government.



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Aerocom's new V.H. frequency AM radiotelephone transmitter is designed and built to operate amid ice and snow or steaming jungles, and what's more, this fine transmitter will give long trouble free efficient service with low maintenance and operating costs. Built in two models VH-200 and VH-50 to meet your communications needs.

Model VH-200

The model illustrated (VH-200) operates on one Crystal Controlled frequency (plus one closely spaced frequency) anywhere in the range 118-132 Mcs. or 132-165 Mcs., A-2 (with accessory unit) or A-3 AM. Nominal carrier power 200 watts up to 132 Mcs., reduced power up to 165 Mcs. Low temperature operation using gas filled rectifiers. Normal temperature operation using mercury vapor rectifiers. Relative humidity up to 95%. Model VH-50 has similar characteristics except nominal carrier power is 50 watts. Complete technical data on both models on request. *Aerocom* builds other radiotelegraph and telephone transmitters with accessories, and invites your inquiry if you have a communications problem.

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(continued from p 130)

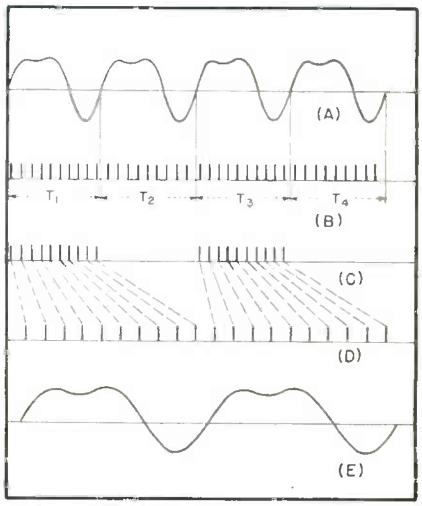

FIG. 1—Basic wave-expanding technique

of the waveshape of the input periodic wave (A) is stored in the modulated pulses (B). Because of the periodicity of the wave, the pulses in group T_1 are identical to those in group T_2. Only one group need be transmitted without reducing the information that will be conveyed (to a receiver adjusted to the system). Alternate pulse groups are therefore omitted (C) and the remaining pulses rearranged to occupy the entire time scale (D). Demodulation of these rearranged pulses gives the elongated wave (E). The bandwidth occupied by this wave (E) is half that occupied by the original one (A).

The system, comprising an arrangement of relatively common circuits, that accomplishes this novel result is shown in Fig. 2. Pulse position modulation is used to store information of the incoming wave. The repetition rate of the pulses is 10,000-cps so the system is capable of faithfully transmitting frequencies up to 3,500-cps.

A square wave of half the frequency of the input wave is obtained by a divider. This square wave gates the pulse-selecting circuit for passing pulses of alternate cycles of the signal wave, giving an intermediate signal of the general form shown in Fig. 1C.

A number of delay circuits are used to convert the pulses to the expanded time scale. The first delay circuit delays its pulse for 150 microseconds, the second circuit delays its pulse for 250 microsec-

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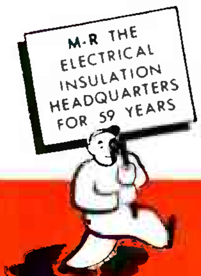

The formula of 1366EX CAPACITOR END SEAL is typical of the detailed data published in this important reference book. 1366EX has unusual characteristics and is one of the latest developed by Mitchell-Rand. It embodies the advantageous combination of high cold flow temperature with low viscosity, also good impact strength and good adhesion to cardboard are inherent and desirable qualities.

1366EX

Cold Flow	238/243° F
S. P. (R&B)	250/255° F
Pouring Temp.	350/400° F
Color	Tan
Adhesion	Satisfactory
Penetration 77/100/5	0
*Chloride Free	Yes
Spec. Grav.	1.35
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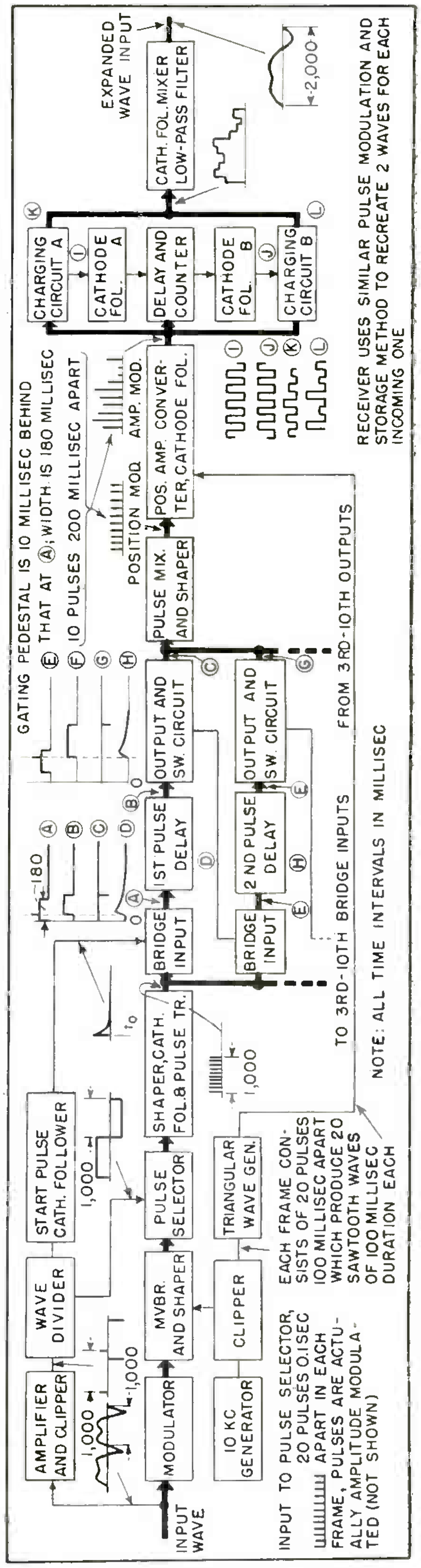

FIG. 2—Experimental wave expander

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FEATURES:

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- *Lightweight tone arm and minimum needle pressure for longer record life.*
- *Automatic shut-off after last record is played.*
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Build added appeal into your radio-phonograph combinations with the Model "R" — Seeburg's new record changer.

Combining compactness with quality . . . style with performance—the Model "R" offers every convenience essential to the modern console instrument. Beyond dependable, quiet operation, this new mechanism possesses such important convenience features as the automatic shut-off . . . lightweight tone arm . . . four-position control for automatic play, manual play, record rejection.

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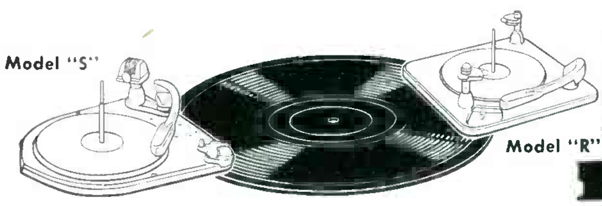

Seeburg

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microseconds instead of the initial 100 microseconds. The modulation displacements of the individual pulses are unaffected.

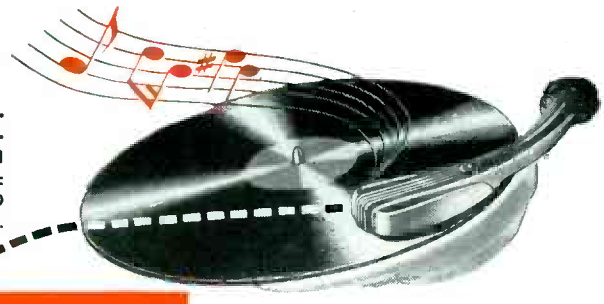
Because the number of pulses in each group may differ from the norm by ±1, the time interval between each delayed pulse group may be 200 ± 100 microseconds, and a special method of demodulation is required. The position-modulated pulses are converted to amplitude-modulated pulses by superimposing them on a 10,000-cps triangular wave. A capacitor charging circuit is used to gate and hold a charge corresponding to the amplitude of each pulse. Two charging circuits are used to avoid the gap created by discharging the capacitor. Switching actions of the charging circuits are actuated by two cathode followers controlled by a counter. Each incoming pulse trips the counter, which routes it to one capacitor and discharges the other. The expanded wave is obtained from the output of a low-pass filter.

Special Circuit Techniques

Because most of the circuit elements are conventional, it is unnecessary to describe their details. However, some of the design and adjustment techniques that are peculiar to this particular application should be mentioned.

In the pulse modulator, which is essentially a one-shot multi-vibrator tripped by the negative pulse from a 10,000-cps source, the position of the tail edge of the pulse is position-modulated by the incoming signal, giving a ±6-microsecond displacement for a ±2-volt input signal. A differentiating circuit and shaper circuit transform the modulated edge into the leading edge of a pulse. Push-pull output for the bridges of the delay circuits is obtained from a pulse transformer that delivers a 5-microsecond pulse with a peak amplitude of 40 volts.

The pulse delay circuit is also a one-shot multivibrator delivering a pulse a preset interval after being tripped by one. A bridge is connected between each pulse delay circuit and the pulse source. Normally the bridges are balanced so that no pulses can reach the delay



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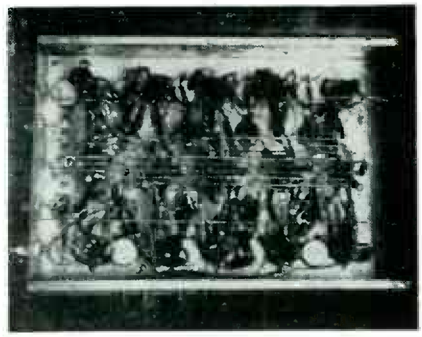
multivibrators. An incoming wave train initiates the action by producing a pulse that opens (unbalances) the first bridge circuit. The first pulse is thus received and delayed by the first circuit, and 10 microseconds later the bridge to the second delay is opened. The systematic switching continues routing successive pulses to delays in order. The unbalanced condition for each bridge exists for only 180 microseconds; the relay action stops when the incoming signal ceases.

Demodulation of the amplitude-modulated pulse train is complicated by the variation of the interval between pulse groups. Two charging circuits are used alternately to hold a charge that is proportional to the pulse amplitude. The charging circuits are controlled by square waves 180 degrees out of phase so that only one circuit can operate at a time. The surge of charging current in one circuit ignites a gas tube that discharges the other circuit. The pulse that controls the charging is delayed 10 microseconds and then passed to a counter to cause the square wave to reverse. The two capacitors of the charging circuits are connected to the grids of two cathode followers having a common load, and thus the capacitor with the larger voltage will control the output. The cathode voltage thus follows the envelope of the amplitude-modulated pulse train; the demodulated signal is obtained from a low-pass filter.

Ten delay circuits with their input bridges and the pulse mixer are on the upper chassis. Coaxial cables connect to the lower chassis containing the rest of the experimental system for reducing bandwidth

Limitations and Applications

The experimental equipment for



Parallel bars on the underside of the top chassis are used to minimize wiring capacitance to ground, thus improving the pulse response of the circuits. On the lower chassis shielded leads carry pulses to minimize interference

demonstrating the wave expanding principle has many limitations. The repetition rate limits the upper frequency that can be passed, while the number of pulses in a cycle limits the lower frequency. If the repetition rate of modulated pulses per second is r, and the lowest frequency to be transmitted is f_1, the maximum number of pulses in a cycle will be $N = r/f_1$ (inasmuch as fractions of pulses cannot be realized, the next largest integer value must be used for N). The experimental equipment used only ten delay circuits so that the fundamental frequency of the wave to be expanded could be no lower than 1,000-cps. Because the expanding circuit uses pulse position modulation it is subject to some small distortion.

To extend the lower frequency to 100-cps (the fundamental frequency of the average male voice) so that the technique could be used for telephony, another method of pulse delay that would use fewer tubes would be desirable. To avoid distortion in the delay circuits, amplitude-modulated instead of position-modulated pulses might be used. Mercury delay lines might provide the solution. If the terminal equipment can be simplified, this method of transmission is a powerful means of providing more channels on existing wire lines and of solving the problem of frequency congestion in radio transmission.

The Polytechnic Institute of Brooklyn supplied the materials for building the test equipment. The author is also indebted to G. B.

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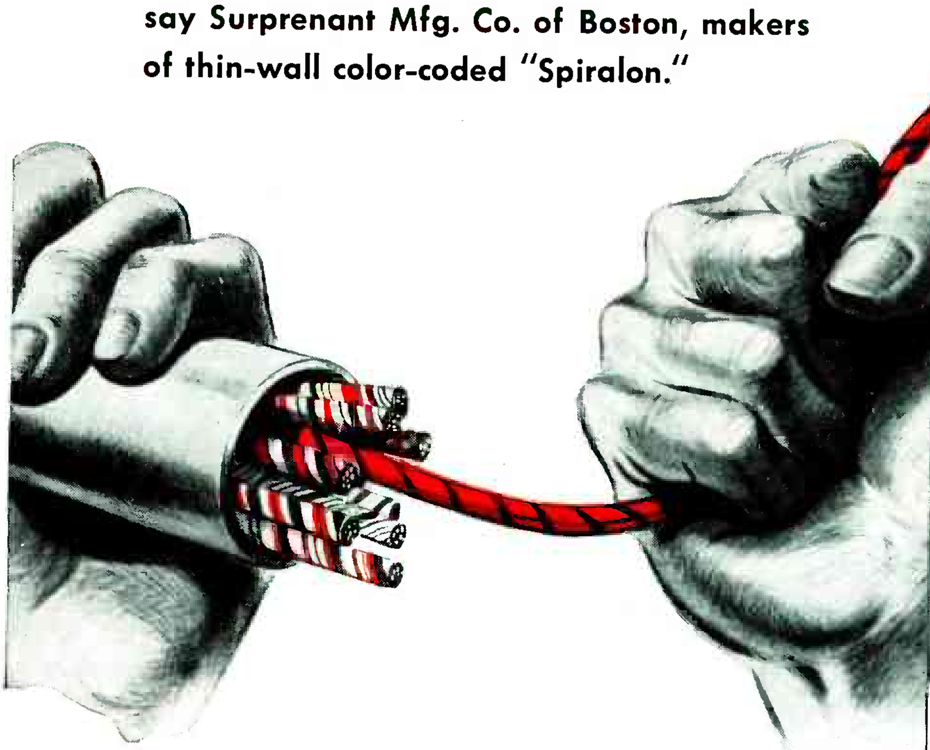
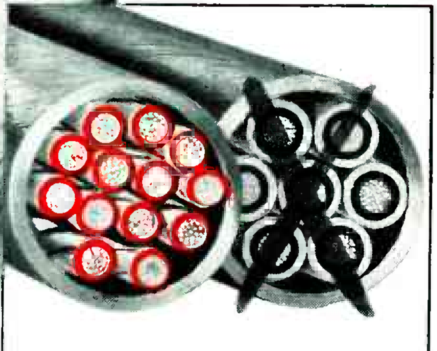
say Surprenant Mfg. Co. of Boston, makers of thin-wall color-coded "Spiralon."





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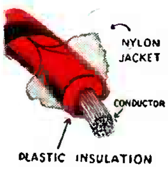

"Our new 'Spiralon' wire is available in many thousands of distinct color combinations, making identification easy even in the most complex installations," report Surprenant Manufacturing Company. "It consists of a conductor, color-coded plastic insulation, and a transparent protective jacket of Du Pont nylon. The nylon cover can be applied easily and rapidly. It's *extra smooth.* It's tough and long lasting. It resists heat, oils, many chemicals, abrasion, and flexing. And nylon helps us produce a wire with *smaller diameter* and *lighter weight.* We feel it is unsurpassed as a thin-wall extruded covering."

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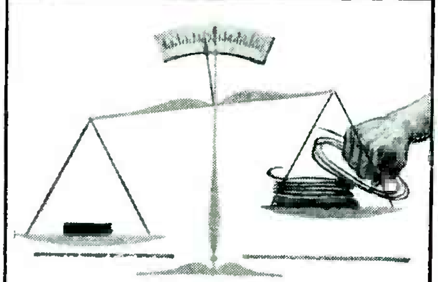

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Hoadley and W. R. MacLean for their advice during the project.

Reproducing Handwriting

BY HUGH LINEBACK
Assistant Professor
Oklahoma A & M
Stillwater, Okla.

A NOVEL application of the cathode-ray oscilloscope is the reproduction of handwriting. Inspiration for the device to be described came from a demonstration at the Naval School, Harvard University. Description of a similar device for writing "LORAN" (*Radio News*, Feb. 1946) attracted the attention of a dealer who asked for a unit that would reproduce his letterhead as a novelty display while giving demonstrations of electronic equipment.

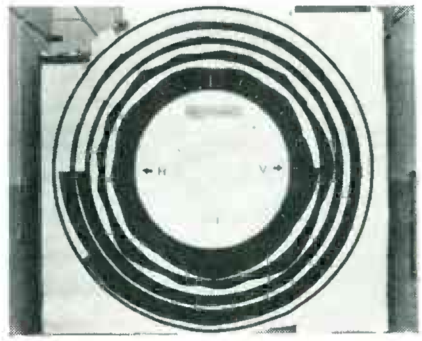


FIG. 1—Polar plot of handwriting

To reproduce the letterhead, it was enlarged on rectangular graph paper, using a projector and pantograph. Two hundred and forty points in each word were plotted in polar coordinates on a thirteen-foot circle, using separate tracks for vertical and horizontal components; Fig. 1 shows the result. A photographic transparency of this pattern was made and mounted on a motor shaft. The tracks were scanned by light beams with phototubes receiving the modulated light. The voltages developed by the

FIG. 2—Original and reproduction

"Coming in with stalled car," radios tow truck operator. A mobile two-way FM radiotelephone permits instant communication with dispatcher.

Lock-In tubes in *Motorola* equipment maintain smooth flow of traffic on famous bridge

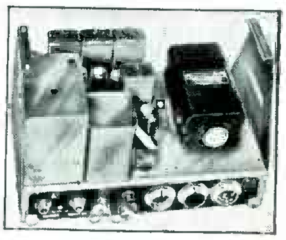
Motorola radiotelephone enables the dispatcher at microphone to direct movements of any mobile unit instantly.

THE famous San Francisco-Oakland Bay Bridge must be free of stalled cars at all times. A smooth flow of traffic is maintained with the aid of Motorola FM Radiotelephone equipment.

Tow cars, emergency roadside service trucks, electrician trucks, fire units and traffic engineer's sedan constitute the radio fleet. By means of this efficient system, a flow of 70,000 cars per day rolls with minimum delay over the great bridge.

Securely locked in position in the Motorola equipment are *Sylvania Lock-In Tubes*, depended upon day and night to give superlative service under all conditions!

For full information about Sylvania Lock-Ins see Sylvania Distributors or write Sylvania Electric Products Inc., Radio Tube Division, Emporium, Pa.



High frequency 160,000 kilocycle FM two-way Motorola radiotelephone equipment permits 100% radio coverage regardless of electrical interferences or steel enclosing structure. Sylvania Lock-Ins handle very high frequencies with ease. Have short, direct connections, fewer welded joints . . . no soldered joints — less loss; getter located on top; shorts eliminated by separation of getter material from leads! Cannot be dislodged from sockets no matter how rough the way.

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MAKERS OF RADIO TUBES; CATHODE RAY TUBES; ELECTRONIC DEVICES; FLUORESCENT LAMPS, FIXTURES, WIRING DEVICES; ELECTRIC LIGHT BULBS phototubes were applied to the two channels of the oscilloscope. Figure 2 shows the original letterhead and the reproduction produced on the oscilloscope. Actually only one word is reproduced at a time so that the letters can be as large as possible on the face of the cathode-ray tube. In use, either word can be selected or they can be made to alternate by an automatic relay.

Capacitor Counting Circuit

By Bradford Howland
U. S. Naval Research Laboratory
(Author now at the Graduate School of Arts and Sciences, Harvard University, Cambridge, Massachusetts)

Conventional capacitor counting circuits represent the count by a voltage stored on a capacitor. The circuit to be described operates on this principle but has in addition N stable states of electrical equilibrium and can store the count indefinitely. Because of this property of long time stability the circuit is well adapted to counting random events or at a low rate. A simple form of the circuit using crystal diodes is described.

Essentially the circuit consists of (A) a network of diodes and resistors, the complexity of which determines the number of equilibrium voltages, (B) an impedance sensitive feedback circuit that stabilizes the voltage across the capacitor at any one of the equilibrium voltages determined by the diode network, (C) means for stepping the capacitor voltage up or down one increment for each count, and (D) means for resetting the circuit to zero each time it has counted N events.

Basic Diode Charging Network

Figure 1 shows the basic two-terminal counting circuit composed of diodes, resistors, and batteries arranged for an N of 5. The resistances are large. Normally current flows from the high bias voltage through them and the bottom row of diodes. When a voltage of the polarity indicated is applied to the terminals of the network, the currents through the resistors will switch successively to the top row of diodes as the applied voltage exceeds the individual voltages to which the lower diodes are connected. This action results in the

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3.5% of 0.1 Milliamperes Load

LOW-CURRENT, HIGH-VOLTAGE D-C POWER SUPPLY IS COMPACT, LIGHT IN WEIGHT—HAS PREVIOUSLY UNOBTAINABLE FEATURES

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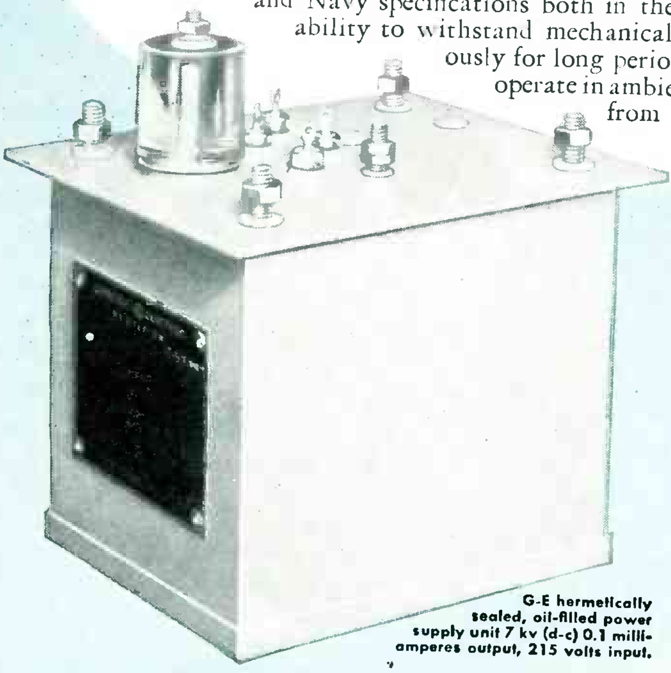
The unit shown here (Cat. 8317502) will supply 7 kv at 0.1 milliamperes d-c output. The regulation does not exceed 3.5% per 0.1 milliamperes load, and 15% at 0.5 milliamperes maximum load. The ripple on the output voltage is less than 1%. This unit is manufactured for 215 volts, 10,000 cycles, a-c input. An additional pair of terminals is provided to supply 45 volts a-c when 215 volts are applied to the input terminal.

This completely self-contained hermetically sealed rectifier will meet Army and Navy specifications both in the matter of design, and as to its ability to withstand mechanical shock and operate continuously for long periods of time. It is designed to operate in ambient temperatures ranging from −40 C to +60 C.



G-E hermetically sealed, oil-filled power supply unit 7 kv (d-c) 0.1 milliamperes output, 215 volts input.

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- Selenium elements
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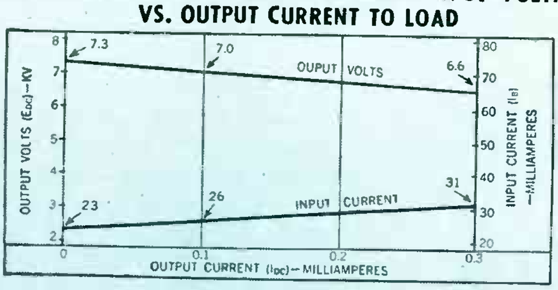
- Filter has low energy storage
- Readily mounted
- Oil filled for strength
- Hermetically sealed
- Can be used as tank circuit of an audio oscillator*

*An unusual feature of this unit is that it may be used as the tank circuit of an audio oscillator. The input terminals are connected to the plate circuit. The 45-volt output terminals are connected as the grid feed back. The oscillator tube normally used is a 6V6. The operating frequency is 10,000 cycles.

INPUT CURRENT TO OSCILLATOR AND OUTPUT VOLTAGE VS. OUTPUT CURRENT TO LOAD



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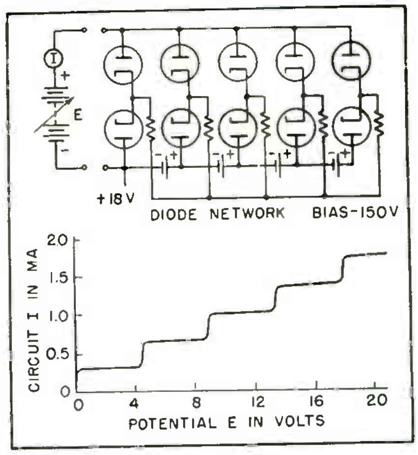


FIG. 1—Basic diode stepping circuit

current-voltage characteristic also shown in Fig. 1. This curve is based on measurements made with 1N34 crystal diodes, 470,000-ohm resistors, and a bias of −150 volts.

The characteristic of the network, as shown by its response curve, is such that its dynamic or a-c resistance, which is the reciprocal of the slope of the characteristic curve, is low near points of transition and high between them. At the transitions the resistance is about 700 ohms, between them it is approximately 50,000 ohms depending on the applied voltage and the back resistance of the diodes. It is this marked variation in a-c resistance of the network that is used by auxiliary circuits to stabilize the voltage across the capacitor.

Impedance Sensitive Circuit

The stabilizing circuit responds to changes in dynamic resistance of the network and controls the voltage across a capacitor at or near the value for which the network presents low impedance. One such circuit is shown in Fig. 2. A small r-f voltage is applied to the grid of an amplifier. The cathode of the amplifier tube is connected to ground through a high a-c impedance in parallel with the network. If the network presents a low a-c impedance, the cathode will be bypassed to ground and a large r-f output will be produced at the plate of the tube. If the network presents a high a-c impedance, the cathode degeneration will produce a small r-f output at the plate. In general this action is obtained only if the peak-to-peak r-f voltage is small enough to limit the voltage swings in the network within one

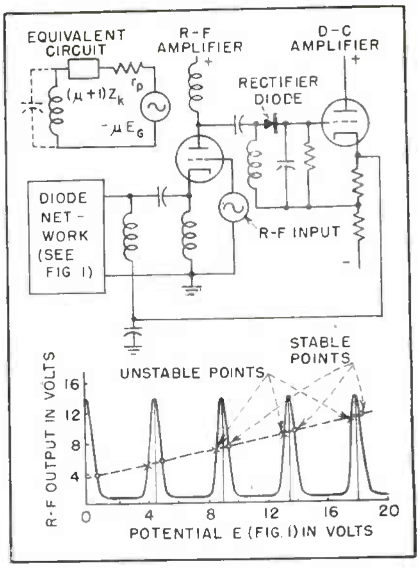


FIG. 2—Circuit stabilizes voltage

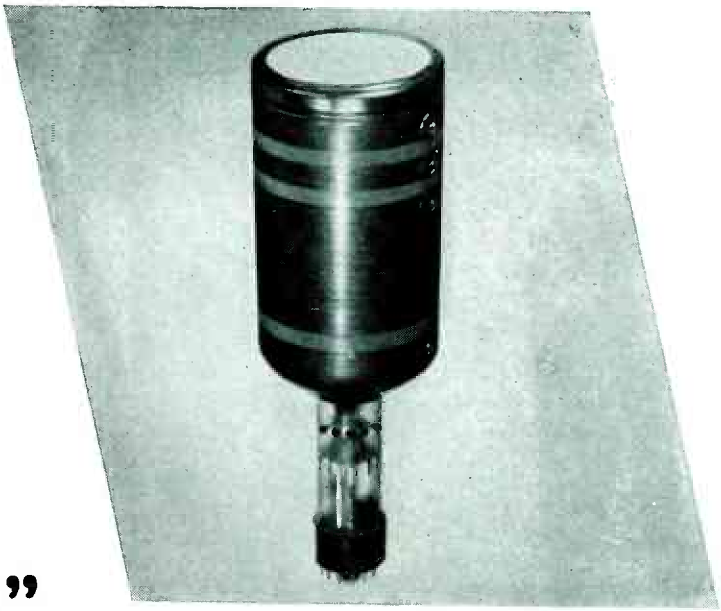
step of its dynamic characteristic.

The r-f output at the amplifier plate can be calculated by means of the equivalent circuit also shown in Fig. 2. The cathode impedance is Z_K. The curve in Fig. 2 shows this variation of plate r-f voltage with voltage applied to the network. This r-f voltage is rectified (by a crystal diode) to give a positive potential that is amplified and fed back to the capacitor to maintain whatever voltage is across it.

To discuss specifically how the stabilization operates, assume that the capacitor is charged to 9.5 volts. Should this potential decrease, the output from the r-f amplifier will increase, the grid of the d-c amplifier will be driven positive, and the voltage across the capacitor will be restored to its initial value. The action is actually quite complex and a minimum capacitance is required to obtain stable equilibrium points. There is, in addition, a stable condition when the capacitor voltage is negative, in which case the d-c amplifier is cut off; this state is not usually used in counting circuits.

Stepping and Reset Circuits

To step the voltage across the capacitor in performing the counting operation, an increment of charge is either added or subtracted; the stabilizing circuit then brings the capacitor voltage to the next equilibrium point. The points of unstable equilibrium on the stabilizing circuit characteristic are the dividing voltages between stable states. To drop the voltage



Courtesy Allen B. DuMont Laboratories, Inc.

CRT Wall Coating . . . Another use for a "**dag**" colloidal graphite dispersion!

In Cathode-Ray Tubes, such as the one above, **"dag"** CRT Wall Coating—a colloidal graphite dispersion—serves as a conductor and as an accelerating electrode...excludes external light...and reduces light reflection from the filament.

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FF 5

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40th Anniversary Year

across the capacitor to the next lower stable state the charge must be forcefully reduced to bring the voltage below the adjacent unstable point; to lift the voltage the charge must be increased to bring the voltage above the next unstable point before it will be driven into stability by the control circuit. The volt-

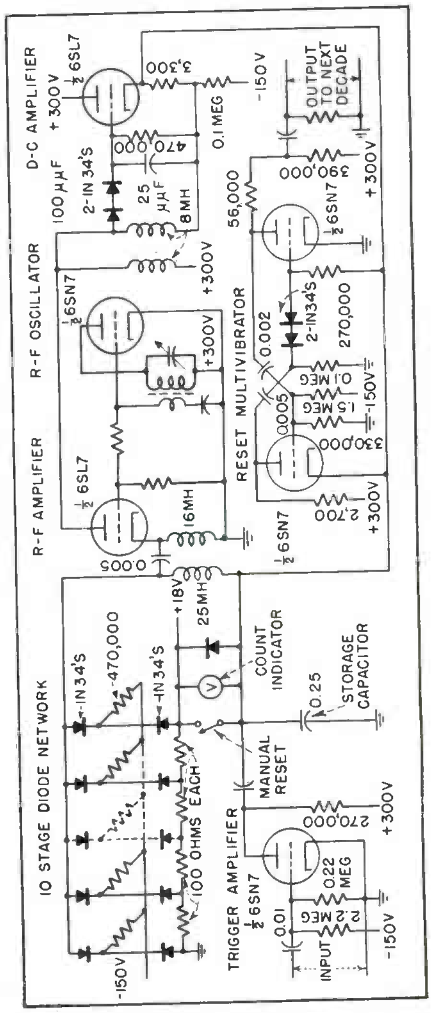


FIG. 3—Complete decade counting circuit

age across the capacitor is most easily stepped down as the drop to trigger the circuit to its next equilibrium is then small.

If the circuit is to count large numbers it must be reset to zero each time it has counted its limit of N pulses. A multivibrator or blocking oscillator that is triggered each time the voltage across the capacitor is stepped beyond its lowest (or highest) equilibrium can restore the circuit to zero. The output from the reset circuit is used to operate another counting circuit.

A complete decade counter using these elements is shown in Fig. 3. The network uses twenty 1N34

crystal diodes, or 6AL5 vacuum diodes can be used equally well. Taps at 2-volt intervals along a low-impedance divider determine the ten equilibrium voltages. The number of steps that can be obtained in a single network is limited by the minimum voltage required per step (about 1 volt) and by the safe inverse voltage of the diodes. The control circuits require six triodes (three dual triode tubes). The r-f oscillator can be used in common by several other counting stages.

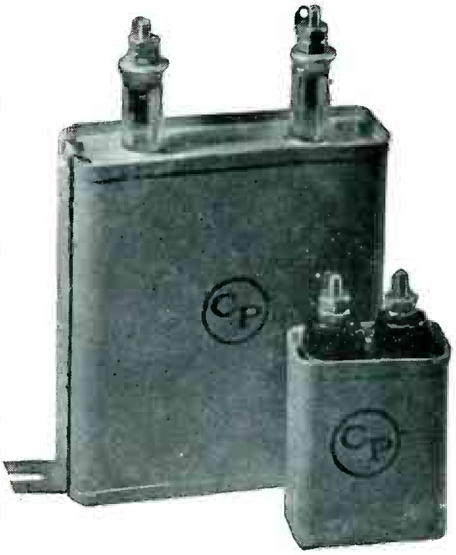
The oscillator frequency was chosen to make the plate circuit of the r-f amplifier resonate, and in this case is 600 kc. The inductance shunting the network was chosen to resonate with the stray capacitance to assure a high r-f impedance between stable states.

Positive pulses that are to be counted are applied to the storage capacitor through a trigger amplifier. The stored voltage is thus stepped down one 2-volt increment by each input pulse. The size of the coupling capacitor is not critical. The reset multivibrator is triggered each time the capacitor voltage goes negative. Upon being triggered the multivibrator passes a high current for a predetermined interval that restores the highest equilibrium voltage across the capacitor, limited at this value by the clipping diode. A positive output pulse from the multivibrator operates succeeding counting decades.

The count is indicated by a high-impedance voltmeter. A manual reset enables the circuit to be cleared. This circuit counts satisfactorily at any rate up to 1,500 events a second, the upper limit being determined by the reset time. The reset time, in turn, depends on the size of the storage capacitor and on the current that can be carried by the reset tube. The circuit of Fig. 3 does not represent an optimum design; it is believed that with further refinement the upper limit of counting speed can be considerably increased.

SURVEY OF NEW TECHNIQUES

INDUSTRIAL AND SCIENTIFIC problems dealing with the flow of heat are solved by a specialized calculat-



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CAPACITORS—

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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.
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MANUFACTURERS of GLASSMIKE CAPACITORS and HIGH VOLTAGE POWER SUPPLIES.

ing machine developed at the Columbia University School of Engineering. The heat and mass flow analyser laboratory consists of extensive resistance-capacitance networks and associated meters and power supplies. Thermal properties of materials are concentrated into individual electrical circuit elements by lumping their electrical analogs. Problems that would be impractically time consuming are solved readily by the machine, and accelerated action is obtained by changing the time scale of the analog. During the six years that the laboratory has been developing, problems dealing with solidification of metal and glass castings, heat losses in furnaces, deicing airplane wings at high altitudes, and heat generated by brakes on trains have been solved. The laboratory, headed by Dr. Victor Paschkis and Prof. C. F. Kayan, is operated as a consulting agency for industry and also engages in developing general physical data. It is sponsored by a number of industries concerned with heat transfer problems.

HIGH-VOLTAGE POWER SUPPLIES, for military infrared detectors, were developed by Dr. Carl Bosch, physiist for the Allgemeine Elektrizitats-Gesellschaft, Germany. The rotary electrostatic generator patterned after the well known Wimshurst machines used for classroom demonstration, weighs less than a pound and is 4.5 inches in diameter; it replaces a 20-pound transformer and vacuum tube power supply, and gives a d-c output of 12,000 volts. The basic design, illustrated in the May 1947 *Science Progress* (U. S. Dept. of Commerce), can be adapted to power supplies for x-ray, cathode-ray, and other high-voltage tubes.

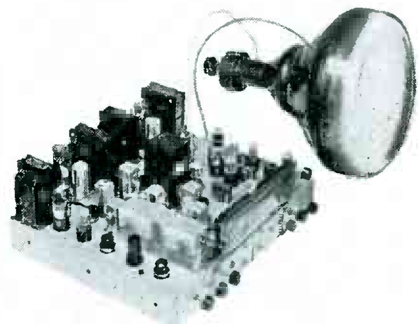
PENCILE mark sensing method, developed by International Business Machine Corp., is replacing punched holes in cards for some applications. Conductance provided by a heavily drawn short pencile line across a particular box on a file card is sufficient to actuate the circuit between fine fingers under which the card passes. The pencile mark is simple to make and the sensing permits high speed operation of the accounting machine.

NEW PRODUCTS
(continued from p 134)

transformer and test speaker which may be used separately. Two panel switches and chart establish any one of 30 desired transformer primary impedances from 325 through 70,000 ohms, single and push-pull.

Television and F-M Receiver

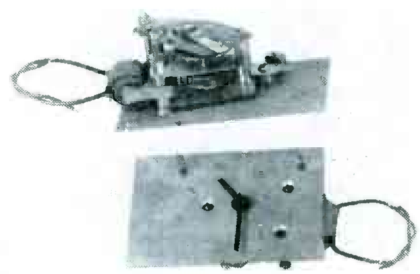
DUVAL RADIO & TELEVISION CORP., 423 Grove Street, Jersey City 2, N. J. Model 15C is a complete



wired and tested unit, less cabinet. The receiver tunes continuously from 44 to 216 mc and a switch is provided to turn off sweep and high-voltage circuits when f-m reception alone is desired.

Timer

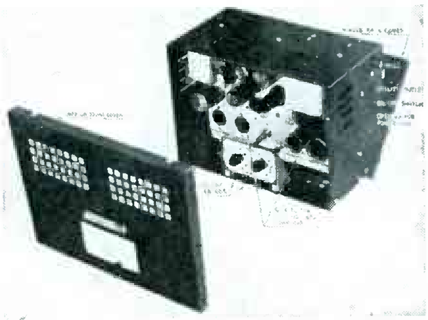
THE ARNOLD CLOCK CO., 136 W. 52nd St., New York, N. Y. The new precision timer has a single-circuit double-throw switch with a



capacity of 500 watts and can be used to turn any electrical unit either off or on. The electric switch has positive action that permits predetermined timing at any 15-minute interval.

Audio Amplification

LANGEVIN MFG. CORP., 37 W 65th St., New York 23, N. Y. Type 122 is an audio amplifier unit featuring plug-in channel adaptors which



provide it with eight applications. It has an output power of 8 watts with less than 3-percent total harmonic distortion from 50 to 15,000 cycles. An electrical characteristics chart will be supplied on request.

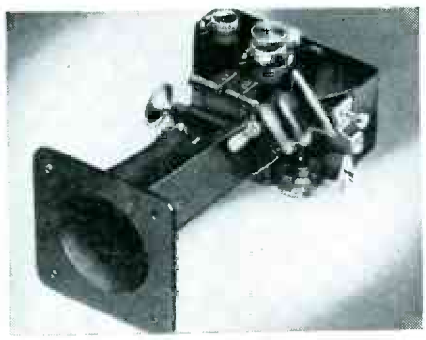
Counter Chronograph

POTTER INSTRUMENT CO., INC., 136-56 Roosevelt Ave., Flushing, N. Y. Model 450 interval timer will measure intervals in steps of 0.625

microsecond, corresponding to a frequency of 1.6 megacycles which is that of the crystal oscillator used as the time base. The instrument registers intervals up to 1 second. Longer periods are recorded by using an external counter.

Oscilloscope Camera

AMERICAN BRITISH TECHNOLOGY, INC., 57 Park Ave., New York 16, N. Y., distributors for Furzehill Laboratories, Ltd. Type 1684J oscilloscope camera uses unperforated



I-T-E Oval Resistor Assemblies are especially designed to meet the exacting and changing needs of the fast-growing electronics industry.

They are distinguished by their high unit-area wattage ratio which is due in part to the heat dissipation qualities of the mounting brackets. An oval resistor, or assembly of oval units, has a much higher wattage rating than that of a conventional round resistor of comparable size. This quality enables them to meet the requirements of limited space, and makes them particularly suited to compact aviation, sound, radio, and other modern electronics applications.

Oval Resistor Assemblies are part of I-T-E's complete line of wire-wound Power Resistors. Only the highest grade materials are used in their manufacture, and they are given the same thought in design, the same care in fabrication that the most complicated unit of switchgear receives.

No matter what your resistor problem calls for—compactness, long life, dependability, or exact tolerances—be sure to investigate I-T-E Oval Resistor Assemblies, the *modern* wire-wound Power Resistors. Complete technical information, as well as valuable application data, is contained in the new I-T-E Resistor catalog. Send for it today.

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"

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35-mm film. Equipped with an f/1.9 lens, the camera can be converted to a continuous film type.

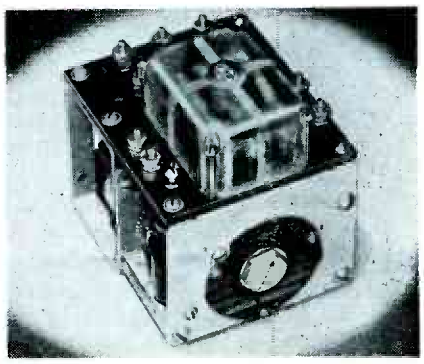
Bidirectional Microphone

TURNER Co., Cedar Rapids, Iowa. Model 87 velocity microphone uses a single element ribbon generator

supported in an Alnico V magnet. Response is within plus or minus 5 db from 80 to 10,000 cycles. Level is 62 db below 1 volt per dyne per square centimeter at high impedance. A switch allows use into 50, 200, or 500 ohms.

Timing Relay

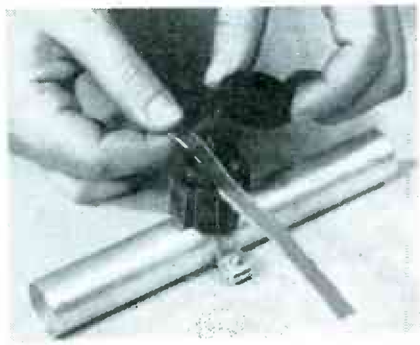
WARD LEONARD ELECTRIC Co., Mount Vernon, N. Y., announces development of the Bulletin 362 mo-



tor driven time delay relay with composite connections. The unit is designed for use in control equipment or systems where an adjustable time delay is required for proper remote, automatic or sequential operation.

Lightning Arrester

RADIO CORP. OF AMERICA, Camden, N. J., has developed a lightning



arrester designed to fit into television and f-m receiver installations. The device features a new method of attaching the transmission line which avoids cutting and splicing.

Regulated Dynamotor

BENDIX AVIATION CORP., Red Bank, N. J., introduces a regulated dynamotor which permits constant out-

put with as much as 25-percent variation in input voltage. The unit is available in various sizes and voltage ratings.

Audio Frequency Meter

BARKER & WILLIAMSON, INC., 237 Fairfield Ave., Upper Darby, Pa. Model 300 audio frequency meter makes direct measurements of unknown audio frequencies up to 30,-

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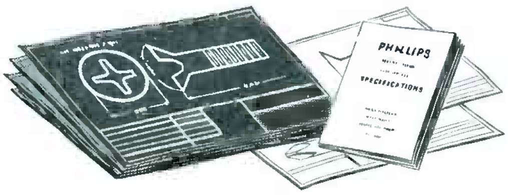
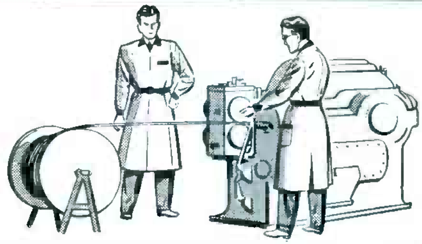
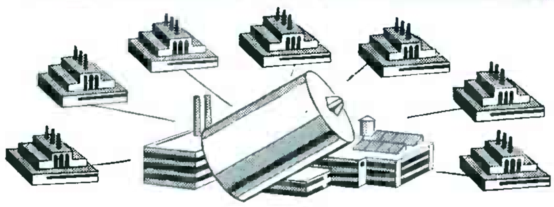
OFFER DIMENSIONAL UNIFORMITY INSURED BY CLOSE ENGINEERING CONTROL



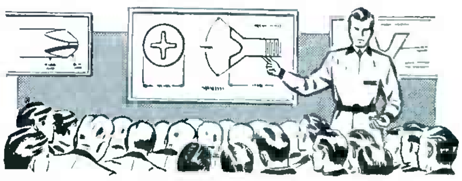
ESTABLISHED STANDARDS . . . Every manufacturer of Phillips Cross Recessed Head Screws is supplied with complete engineering and production data which prescribes precise dimensions and tolerances.



CENTRALIZED PRODUCTION TRAINING . . . And, before production is started on Phillips Screws, each plants' supervisory staff puts in an extended training period with Phillips engineers.



COMMON SOURCE OF RECESS FORMING TOOLS . . . Punches for forming the Phillips Cross Recess in all types and sizes of Phillips Screws are formed from master types at one plant. The manufacture of gauges for maintaining uniformity of Phillips Drivers and Bits are similarly centralized.



ENGINEERS' MEETINGS . . . Standards carefully established at the very beginning are rigorously maintained through meetings of "Phillips Recessed Head Standards Committee". Engineers from all plants meet to exchange ideas, discuss problems and learn about recent developments.

All these precautions to secure absolute dimensional uniformity are just part of the care taken to produce Phillips Cross Recessed Head Screws that give users *all* the advantage of a cross recess engineered for practical production.

Speed and ease of driving in production assembly demands that the driver and recess fit smoothly, perfectly, the same way every time, all the time. With Phillips Screws, you can depend on it.

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

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

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National Lock Co.
National Screw & Mfg. Co.
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Parker-Kalon Corporation
Pawtucket Screw Co.
Pheoll Manufacturing Co.
Reading Screw Co.
Russell Burdsall & Ward Bolt & Nut Co.
Scovill Manufacturing Co.
Seaboard Screw Corp.
Shakeproof Inc.
The Southington Hardware Mfg. Co.
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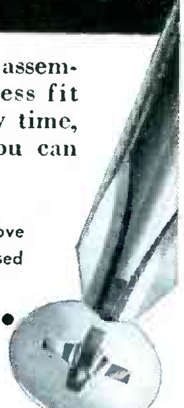
GET THIS NEW BOOKLET of facts that prove the top value, top economy of Phillips Recessed Head Screws. It's free . . . use the coupon.



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Send me the new booklet—"How to Select Recessed Head Screws for Practical Production Driving".

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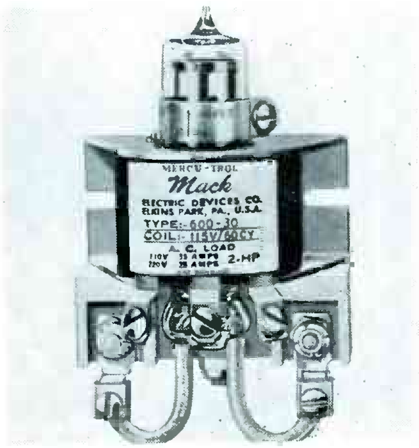
000 cycles. Six ranges are required for the complete coverage of this spectrum. The meter will operate on any waveform with peak ratios of less than 8 to 1, and requires a minimum input of 0.5 volt.

Power Relays

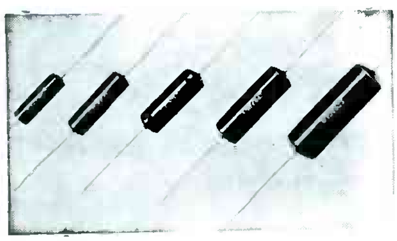
MACK ELECTRIC DEVICES, INC., 30 Glenside Ave., Wyncote, Pa., has developed the Mercu-Trol power



relays with 3-coil terminals and featuring a replaceable tube which is hermetically sealed with the contacts, having mercury-to-mercury make and break in inert gas. Contact ratings and coil data may be found in bulletin 410.

Molded Tubular Capacitors

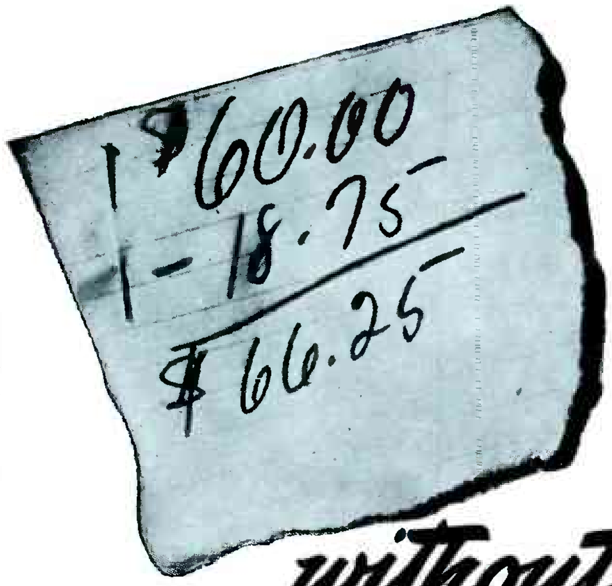
SPRAGUE ELECTRIC CO., North Adams, Mass. Available in all popular capacitance values in 200 to 1,600-



volt types, new phenolic molded tubular capacitors are rated for operation from minus 40 to plus 85 C. They are described in Bulletin 210.

Automatic Washing Unit

RAYTHEON MFG. CO., 60 E. 42nd St., New York 17, N. Y. The new automatic washing unit for use on industrial precipitators washes and



How 19,000 companies up take-home pay *without upping payrolls*

Can you deduct $18.75 from $60.00 and get $66.25? *Yes.* And the way you can do it is mighty important to your company—and to the nation!

You start with $60, representing someone's weekly take-home pay. You deduct $18.75 for the purchase of a U.S. Savings Bond. That leaves $41.25. But $41.25 isn't what the worker takes home. He takes home $41.25 *plus a $25 Savings Bond.* Total (assuming he holds the Bond till maturity): *$66.25.*

WHAT 19,000 COMPANIES HAVE LEARNED

In the 19,000 companies that are operating the Payroll Savings Plan for the regular purchase of Savings Bonds, employees have been more contented in their jobs—absenteeism has decreased—even accidents have been fewer!

Those are the "company" benefits the Plan provides, in addition to extra security for individual employees.

But the Plan has other, far-reaching benefits of basic importance to both your business and the national economy...

SPREADING THE NATIONAL DEBT HELPS SECURE YOUR FUTURE

The future of your business is closely dependent upon the future economy of your country. To a major extent, that future depends upon management of the public debt. Distribution of the debt as widely as possible among the people of the nation will result in the greatest good for all.

How that works is clearly and briefly described in the free brochure shown at the right. Request your copy—*today*—from your State Director of the U. S. Treasury Department's Savings Bonds Division.

ACTION BY TOP MANAGEMENT NEEDED

The benefits of regular Bond-buying are as important today as ever—but war-time emotional appeals are gone. Sponsorship of the Payroll Savings Plan by a responsible executive in your company is necessary to keep its benefits *advertised to your employees.*

Banks don't sell Savings Bonds on the "installment plan"— which is the way most workers prefer to buy them. *Such workers want and need the Payroll Savings Plan.*

Those are the reasons why it's important to make sure that the Plan is adequately maintained in your company.

The State Director will gladly give you any assistance you wish.

"The National Debt and You,"

a 12-page pocket-size brochure, expresses the views of W. Randolph Burgess, Vice Chairman of the Board of the National City Bank of New York—and of Clarence Francis, Chairman of the Board, General Foods Corporation. Be sure to get your copy from the Treasury Department's State Director, Savings Bonds Division.

The Treasury Department acknowledges with appreciation the publication of this message by

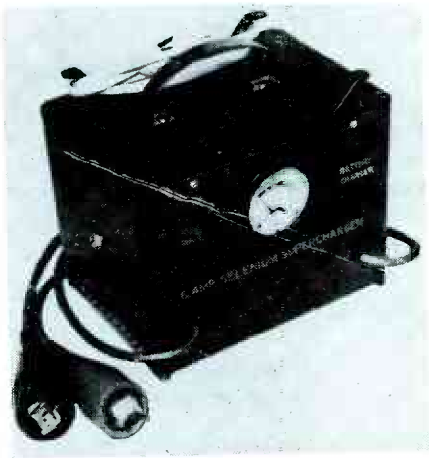
ELECTRONICS

This is an official U.S. Treasury advertisement prepared under the auspices of the Treasury Department and the Advertising Council

dries all ionizers and collector plates, reapplies the adhesive and shuts off automatically. Units are available in two sizes: 1,200 to 1,500 cfm and 1,800 to 2,250 cfm.

Battery Chargers

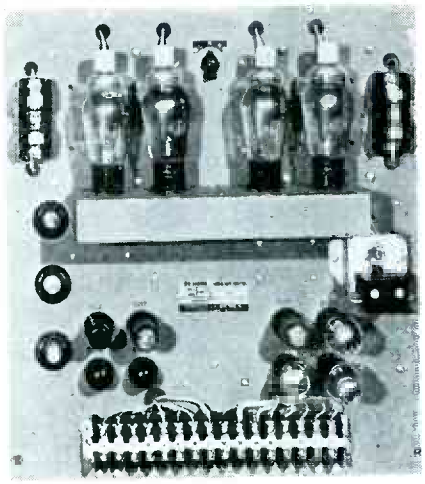
RICHARDSON-ALLEN CORP., 15 West 20th St., New York, N. Y., has introduced a new line of small, light,



portable battery chargers. Each unit features a direct-reading meter, circuit-breaker protection and selenium rectification. They operate on 110 volts, 50 to 70 cycle a-c current.

Adjustable-Speed Control

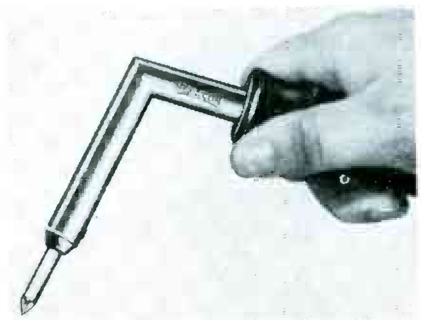
RELIANCE ELECTRIC & ENGINEERING CO., Cleveland, Ohio. An electronic excitation control system has been designed for closely controlled speed regulation. Functionally it is comparable to a 2-circuit, motor operated rheostat with a servomechanism, preset speed device controlling the output voltage



of a constant potential rotating exciter. A single-phase half-wave rectifier with a back rectifier is recommended for use with the unit. Output voltage can be varied from 0 to 230 volts.

Light Soldering Iron

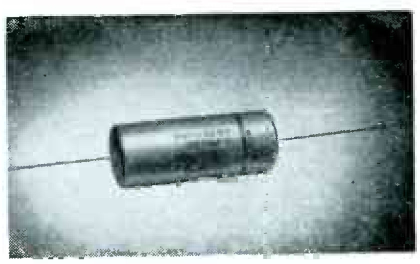
HEXACON ELECTRIC CO., 130 W. Clay Ave., Roselle Park, N. J. The new soldering iron weighs only 5½ ounces less cord, and requires no



transformer for operation. It works from any regular 110 or 220-volt line circuit a-c or d-c. Designated as catalog No. 30H, list price is $5.00.

Television Capacitors

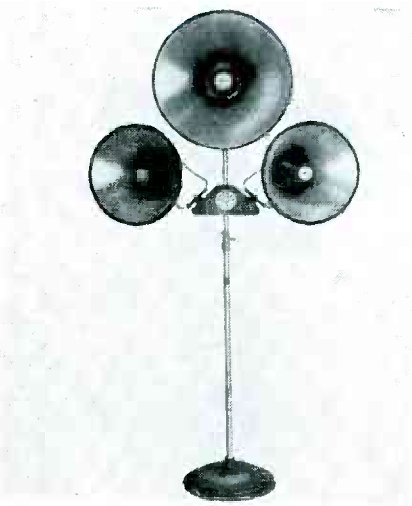
CORNELL-DUBILIER ELECTRIC CORP., South Plainfield, N. J. The DSTH television capacitors are oil-impreg-



nated and wax-filled. Size range is from $\frac{1}{2}$-inch diameter by $2\frac{1}{8}$-inch length up to $1\frac{13}{16} \times 4\frac{3}{4}$ inches; d-c voltage from 3,000 to 6,000.

Sound Projector

ATLAS SOUND CORP., 1443 39th St., Brooklyn 18, N. Y. This stand and mounting fixture permit the illus-



trated sound projector to be easily directed in any vertical or horizontal angle and permanently locked in the desired position. A complete catalog description is available on request.

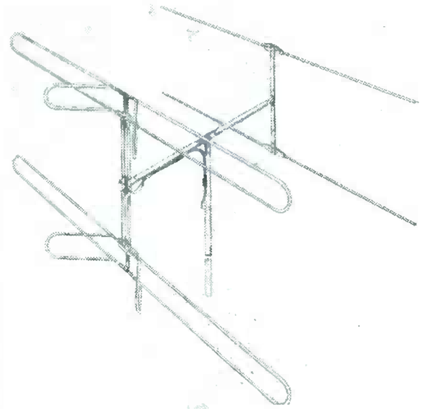
Portable Microammeter

RADIO CORP. OF AMERICA, Camden, N. J. Type WV-84A is an ultra-sensitive, portable, battery-oper-

ated microammeter for measuring d-c currents ranging from 0.001 to 1,000 microamperes. The instrument can also be used as a high-range ohmmeter when connected to a suitable power supply.

Antenna Conversion

J. F. D. MANUFACTURING CO., INC., 4109-4123 Ft. Hamilton Parkway, Brooklyn 19, N. Y. A new line of f-m and television antennas with



conversion kits has been assembled. In all there are 22 different types ranging from the single straight dipole to the double-stacked folded dipole with high-frequency lobes, as illustrated. The line covers the 44 to 216-mc range, channels 1 to 13 and f-m bands.

Tap Switch Rectifier

RICHARDSON-ALLEN CORP., 15 West 20th St., New York, N. Y., announces a new series of selenium

rectifiers with 36-position tap switch controls. The units are standard up to 27-kw capacity.

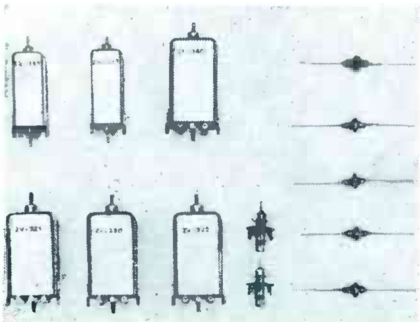
Auto-Radio Vibrators

AMERICAN TELEVISION & RADIO CO., 300 E. Fourth St., St. Paul 1, Minn., announces a complete line

of auto-radio vibrators designed for use in standard vibrator-operated auto and household radio receivers. The new line, featuring ceramic stack spacers, is covered in the recently released Vibrator Guide which is available free of charge.

Television Transformers

HILLBURN ELECTRONIC PRODUCTS CO., 1 Worth St., New York 13, N. Y. Series ZV video and sound trans-



formers are stagger tuned, have a 4-mc bandwidth, with sound rejection of 150 to 1 and adjacent channel rejection of 100 to 1.

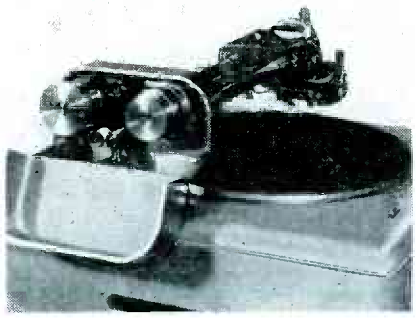
Miniature Socket

CINCH MFG. CORP., 2335 W. Van Buren St., Chicago 12, Ill. A new type miniature socket features a contact construction which insures continuous and consistent mainte-

nance of critical dimensions and holding tension of the contact. It is available in 1-inch and $1\frac{5}{16}$-inch mounting centers, plain or shielded, and in grounded types with seven or eight contacts.

Professional Recorder

ROBINSON RECORDING LABORATORIES, 2022 Sansom St., Philadelphia 3, Pa., introduce the new lathe type recorder for professional work in radio stations and recording studios.



Wow factor is reduced to 0.01 percent by use of a new belt drive and dynamically balanced components. The unit also features a ground thread feed screw which eliminates the feed screw pattern.

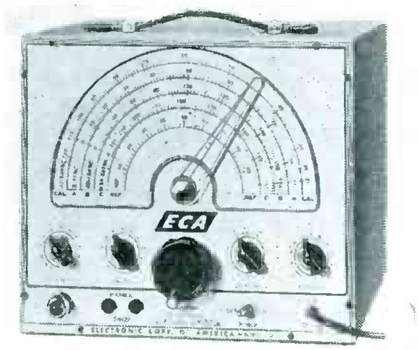
Loudspeaker

RADIO-MUSIC CORP., Port Chester, N. Y. The new Hyper-Mag loudspeaker features a parabolic projector and frequency range from 50

to over 10,000 cycles at low distortion. It is fully described in Bulletin HS-1.

Sweep Signal Generator

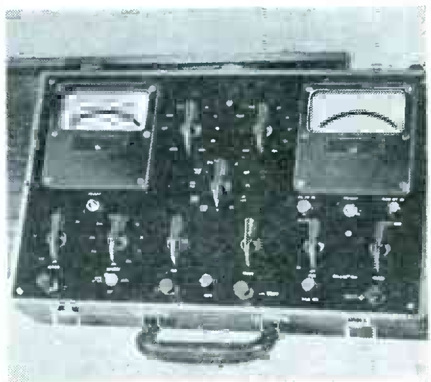
ELECTRONIC CORP. OF AMERICA, 170 53rd St., Brooklyn 32, N. Y. New York, N. Y. An f-m and television signal generator featuring a sweep



width of 500 kc to approximately 10 mc with a 60-cycle horizontal sweep output, has a frequency range of 2 to 227 mc in three bands. Price is $34.95 complete.

Testing Multimeter

M. C. MILLER, 1142 Emerson Ave., W. Englewood, N. J. Model No. 5 is a multi-combination meter designed for electrolysis and corro-



sion investigations and cathodic protection testing both in field and laboratory. It provides all of the instrumentation required to cover the wide range of d-c current and potential measurements necessary in this field. The unit weighs about 23 pounds.

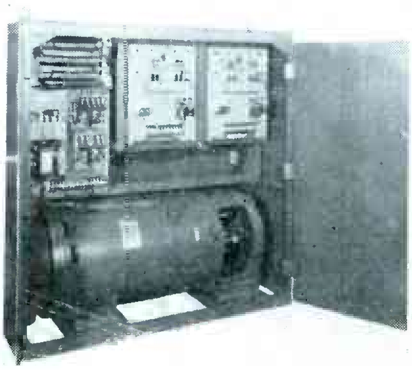
Synchronizing Generator

ALLEN B. DU MONT LABORATORIES, INC., 42 Harding Ave., Clifton, N. J. Type 5030-A is a portable

television synchronizing generator useful for testing transmitters, experimental development and laboratory work. Only a-c power is required. Half-line driving pulses are provided for using differential delay techniques necessary for long camera cable hookups. The instrument weighs about 50 lb.

Synchronizing Speed Control

RELIANCE ELECTRIC & ENGINEERING CO., Cleveland, Ohio. The Short Stroke Dancer Roll Control is designed for synchronizing the speed



of independently driven machines used in paper finishing, rubber extrusion and other continuous process operations. The unit has been designed for 230 volt d-c service and a maximum current of 2 amperes.

Audio Amplifiers

SETCHELL CARLSON, INC., 2233 University Ave., Saint Paul 4, Minnesota. Model PA722 master amplifier and model B422 booster are illustrated. As many as ten boosters can be used, each one providing its own 25-watt output with separate gain control. The booster units are

mechanically attached to the base of the amplifier by means of concealed tiebolts.

Gauss Meter

GENERAL ELECTRIC CO., Schenectady 5, N. Y. The new direct-reading gauss meter, with a probe diameter

of 0.052 inch, permits measurement of flux in small-gap magnets of standard or irregular shape. Also available is a triple kit combining three meters of different ratings in a single carrying case. Ask for bulletin GEC-238.

Literature

Laboratory Instruments. Technology Instrument Corp., 1058 Main St., Waltham 54, Mass. A new bulletin describes and illustrates types 410-A r-f oscillator and 310-A Z-Angle meter. Specifications and simplified circuit diagrams are included.

Snap-Action Switches. Micro Switch, Freeport, Ill. Microtips, the first issue of a new publication, promises to tell in following issues how plant engineers and electrical maintenance men are using snap-action switches. The pamphlet is punched for a standard 3-ring binder so that each copy may be filed for ready reference.

Magnetic Iron Powders. C. K. Williams & Co., Metallurgical and Electronic Division, 2001 Lynch St., East St. Louis, Ill., offers a brochure filled with data and a price list on a variety of IRN magnetic iron powders. Also available is the condensation of an article on the effective permeability of h-f iron cores.

Terminals. Shakeproof Inc., Division of Illinois Tool Works, 2501 North Keeler Ave., Chicago 39, Ill. Catalog A-S-51 contains dimensional data and general information to simplify selection and specification of proper wiring terminals for designers and draftsmen of radios and electrical devices. Working drawings of each part are included.

Crystal Units. Standard Piezo Co., P. O. Box 164, Carlisle, Pa. Eleven types of crystal units are pictured in a 4-page folder. Chief features are outlined and ordering information is given.

Miniature Speed Changers. Metron Instrument Co., 432 Lincoln St., Denver 9, Colorado. Bulletin No. 100 shows three types of miniature speed changers with a table giving all of the standard integral ratios. Power is transmitted either way for ratios below 230 to 1.

Coaxial Frequency Meter. Frequency Standards Corp., 237 Lafayette St., New York 12, N. Y. A loose-leaf perforated folder points out the prominent features of model 315A frequency meter which covers the 300 to 1500-mc range in four overlapping bands.

Portable Wire Recorder. Precision Audio Products, Inc., 1133 Broadway, New York 10, N. Y. Two sides of a single sheet show

DESIGNED FOR DISCRIMINATING MANUFACTURERS

Leakproof

ENAMELED MAGNET WIRE

A product, resulting from many years of research in the field of fine wire manufacture, that meets the most rigid requirements of radio and ignition coils.

A new coating method gives a smooth, permanently - adherent enameling, and mercury-process tests guarantee perfect uniformity. Great flexibility and tensile strength assure perfect laying, even at high winding speeds. If you want reduction in coil dimensions without sacrificing electrical values, or seek a uniform, leakproof wire that will deliver extra years of service, this Hudson Wire product is the answer.

QUALITY

UNIFORMITY

SERVICE

Also manufacturers of high grade cotton and silk covered wires, cotton and silk coverings over enamel coated wires, and all constructions of Litz wires. A variety of coverings made to customers' specifications, or to requirements determined by our engineers. Complete design and engineering facilities are at your disposal; details and quotations on request.

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Studio Quality AMPLIFIERS

WITH CUSTOM-BUILT FEATURES

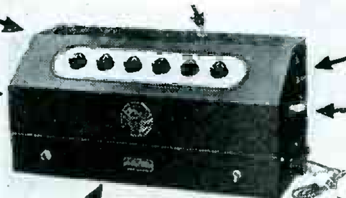
Design of Bardwell & McAlister's New Commercial Amplifiers embodies the principles which have been proven in custom-built units developed in the Motion Picture Industry, where quality is requisite. Fully licensed.

12w. models operate up to 8 indoor speakers, effectively cover outdoor audience of 2500.

25w. models operate up to 16 indoor speakers, effectively cover outdoor audience of 8000.

Designed & fabricated by manufacturers of high quality Sound & Recording Equipment for the Motion Picture Industry. Union made.

2 to 4 high gain input channels and 2 to 4 high or low gain radio or phonograph input channels.



With or without professional "T" type bass and treble equalizers.

High fidelity reproduction at any setting of volume controls up to full rated output with less than 4% distortion.

Frequency response flat within ½ db from 50 to 10,000 cycles.

Output impedances 500, 250, 16 & 8 ohms. Overall gain 105 db. Hum level 85 db below full output.

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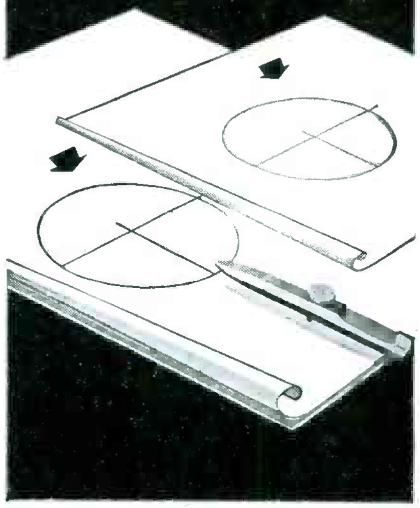

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the outstanding features and technical specifications of the Wiremaster, a portable wire recorder. Frequency range is from 40 to 10,000 cps and the unit has separate listening and recording volume controls.

Laboratory Monitor. Tracerlab, Inc., 55 Oliver St., Boston 10, Mass. Model SU-3 was developed for use as a routine contamination monitor in radioactivity laboratories. Bulletin No. 9 gives a 12-page description of the instrument complete with diagrams.

Vacuum Melting. National Research Corp., 70 Memorial Drive, Cambridge 42, Mass. The new brochure on high-vacuum furnaces outlines equipment for metallurgical melting and casting in the micron pressure range. Components are sketched and described, and a bibliography is included.

Sound Reproduction. Terminal Radio Corp., 85 Cortlandt St., New York 7, N. Y. Amplifiers, microphones, loudspeakers, and wire recording equipment are described and illustrated in an eight-page catalog. Prices for individual items are listed.

Receiving Tube Reference. Radio Corp. of America, Harrison, N. J. The latest edition, form 1275-D, is a compact and informative booklet on receiving tubes for television, f-m and standard broadcast. Price is ten cents.

Sound Recorder. Sound Apparatus Co., 233 Broadway, New York 7, N. Y. Literature is now available on the newly designed model HPL high speed recorder and requests for the bulletin "Sound Advances" will be promptly filled.

Portable C-R Scope. Tektronix, Inc., 1516 S. E. Seventh Ave., Portland 14, Oregon. A recent 4-page folder on the type 511 cathode-ray oscilloscope gives a general description of the portable unit along with a thorough treatment of its vertical and horizontal deflection systems. Characteristics and other pertinent data are covered.

Components. Hugh H. Eby, Inc., 4741 Stenton Ave., Philadelphia, Pa., announces publication of a 48-page loose-leaf catalog showing a complete line of components. Pertinent dimensions of sockets, plugs, connectors, jacks, terminal strips and a wide variety of binding posts in many models and sizes are given.

Microwave Supplies. The Waveguide Mfg. & Equipment Co., Inc., 125 E. 23rd St., New York 10, N. Y. A recently issued catalog illustrates and describes a variety of microwave test equipment, assemblies and components.

Service Manual. Clarostat Mfg. Co., Inc., 130 Clinton St., Brooklyn 2, N. Y. The new 127-page manual is a compilation of all standard type radios in current use, based on a survey by leading compilers of service data. Price is 50 cents per copy.

Precision Switches. Micro Switch Corp., P. O. Box 561, Freeport, Ill. Temporary data sheet 41 gives characteristics, diagrams and prices of skeleton switches. Also available is a loose-leaf descriptive sheet showing a switch in actual operation.

Electronic Timers. Radio Corp. of America, Harrison, N. J. Application Note AN-131 describes the use of type 2D21 or 2050 thyratrons in electronic timer circuits.

Television Antenna System. Workshop Associates, Inc., 66 Needham St., Newton Highlands 61, Mass. Television reception by means of multiple antennas and a coaxial selector switch is the latest practical slant on a difficult problem. Literature is now available.

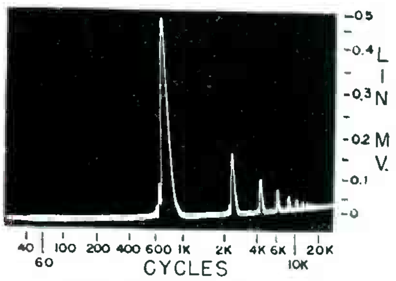
Cathode-Ray Equipment. Allen B. DuMont Laboratories, Inc., Clifton, N. J. The Oscillographer is a bi-monthly loose-leaf perforated publication with information on different types of c-r tubes, polar-

FASTER, SIMPLER
AUDIO ANALYSIS
with Model AP-1

PANORAMIC SONIC ANALYZER

Reduce time, complexity and cost of making audio measurements with the unusual advantages offered by the Panoramic Sonic Analyzer. By resolving a complex audio wave into a spectrograph showing the frequency distribution and voltage amplitude of the components, Model AP-1 . . .

• Eliminates slow point-by-point frequency checks • Provides a quick overall view of the audio spectrum • Enables determination of changes in waveform content while parameters are varied • Furnishes simple presentations for production line testing.



Panoramic Sonic Spectrograph of 750 cps square wave.

Use Model AP-1 for analyzing . . .
• Harmonics • Intermodulation • Vibration • Noise • Acoustics • Materials

Features . . . Continuous scanning from 40-20,000 cps in one second • Wide input voltage range • Linear and log voltage scale • Closely logarithmic frequency scale • Built-in voltage and frequency calibrator • Simple operation.

WRITE for detailed specs, price and delivery.

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The ultimate in microphone quality, the new Amperite Velocity has proven in actual practice to give the highest type of reproduction in Broadcasting, Recording, and Public Address.

The major disadvantage of pre-war velocities has been eliminated—namely "boominess" on close talking.

- *Shout* right into the new *Amperite Velocity*—or *stand 2 feet away*—the quality of reproduction is always excellent.
- *Harmonic distortion is less than 1%* (Note: best studio diaphragm mike is 500% higher).
- *Practically no angle discrimination* . . . 120° *front and back*. (Best studio diaphragm microphones—discrimination 800% higher).
- One Amperite Velocity Microphone will pick up an entire symphony orchestra.

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Velocity Microphones
for Public Address
Models RBHG, RBLG
List $42.00

P. G. Dynamic
Models PGH, PGL
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STUDIO VELOCITY, finest in quality; ideal for broadcasting and Recording.
Models R80H, R80L. List $80.00

There is an Amperite Microphone for every requirement.

WRITE FOR ILLUSTRATED 4-PAGE FOLDER giving full information and prices.

"Kontak" Mikes
Model SKH, list $12.00
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If it concerns heat and age resistance, we're specialists and have been for twenty years. Whether it is dropping excessive voltages—maintaining higher than ambient temperatures in equipment—high current conductors—heating element leads in crystal temperature control ovens — if it's got to be tough to continually withstand wear and tear . . .

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coordinate indicators, h-v power supplies, oscillographs and like equipment.

Speakers. Altec Lansing Corp., 250 W. 57th St., New York 19, N. Y., gives response curves and data on four of its outstanding speaker designs in a recently issued 6-page folder.

Synthetic Sapphire. Sapphire Products Division, Elgin National Watch Co., Aurora, Ill. An 8-page pamphlet explains the uses and properties of synthetic sapphire in industry.

Wire Recorder. Electronic Sound Engineering Co., 4344 Armitage Ave., Chicago 39, Ill., has a brochure describing the Polyphonic Sound recorder model PS179. Frequency range of the system is 30 to 15,000 cycles.

Metal-Backed Screen. General Electric Co., Syracuse, N. Y. A new 10-inch metal-backed direct-view television picture tube that gives better pictures at more normal ambient light levels has recently been announced.

Communications Equipment. Browning Laboratories, Inc., Winchester, Mass. A 4-page brochure describes the line of tuners, frequency meters, capacitance alarm, and other devices.

Instrument Catalog. Electro-Tech Equipment Co., 117 Lafayette St., New York 13, N. Y. Catalog 48 illustrates and describes a line of instruments of many manufacturers from A battery eliminators to Wheatstone bridges in 65 pages.

Carbon-Graphite. Stackpole Carbon Co., St. Marys, Pa. Tube anodes, battery carbons, ground rods, electrical contacts, and spectrographite are among the many carbon products discussed in a new 44-page booklet.

Measuring Frequency. General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass. Volume XXII No. 9 of the Experimenter describes the type 1141-A audio-frequency meter as well as the 1231-B amplifier and null detector. Illustrations, schematic diagrams and characteristic curves of both units are also shown.

Miniature Iron. Television, Inc., New Rochelle, N. Y. The Soldetron miniature soldering copper operates from a storage battery or 6-volt transformer and is described in a sheet recently issued.

Plastic Bulletin. Fabri-Form Co., 100 Seneca St., Byesville, Ohio. Some of the newest ways to use plastics are shown in a new 12-page bulletin. Over fifty drawings and photographs illustrate detailed parts in a manner that is simple to the layman.

H-F Conductor. Titeflex, Inc., 591 Frelinghuysen Ave., Newark 5, N. J. Water-cooled, flexible leads for use in conducting high-frequency currents are described in a folder just issued. List prices are included.

Timing Motors and Devices. Haydon Mfg. Co., Torrington, Conn. Of value to engineers and designers is the 16-page, 2-color catalog No. 320 on synchronous timing motors, timing devices and clock movements.

Miniature Tubes. Tung-Sol Lamp Works Inc., Newark 4, N. J. Actual sizes, advantages and applications of a line of miniature electron tubes are discussed in a six-page pamphlet.

Molded Metal Products. Keystone Carbon Co., 1935 State St., Saint Marys, Pa. A four-page circular covers powder metallurgy parts, motor and generator brushes, and negative temperature coefficient resistance units. Various types of each line are illustrated.

Radio and Recorder Catalog. Hoffman Radio Corp., Los Angeles, Calif., has published a 16-page catalog of its 1948 line. The brochure, specially featuring the

Wirecord and Musicord, is spiral bound, profusely illustrated and printed in three colors.

Pins and Leads. The Bead Chain Mfg. Co., Mountain Grove and State Streets, Bridgeport 5, Conn. Multiswage contact pins are constructed with a hole through the entire length to facilitate threading lead wires. The contact pins are used for radio tubes, panel-mounted terminals, jacks, and leads for miniature and other radio tubes.

Insulating Material. General Ceramics and Steatite Corp., Keasbey, N. J. Catalog 3000 shows various methods of producing steatite insulators. Different types and shapes are discussed with mechanical drawings given throughout.

Test Instruments. General Electronic Distributing Co., 98 Park Place, New York 7, N. Y. Several models of tube and set testers, volt-ohm-milliammeters, signal generators and tracers are described in an 8-page catalog. Specifications and price of each are given.

Phase-Shift Modulator. Radio Engineering Laboratories, Inc., 35-54 36th St., Long Island City 1, N. Y. Bulletin 5030 contains a description of characteristics, functions and technical specifications of the Serrasoid phase-shift modulator for f-m broadcasting.

Metered Variable Transformers. Standard Electrical Products Co., 400 Linden Ave., Dayton 3, Ohio. A four-page folder describes a new line of Adjust-A-Volt metered variable transformers, including isolated primary transformers with secondary voltages of 0 to 140 volts and autotransformers with the same output voltage.

Radio Service Encyclopedia. P. R. Mallory & Co., Inc., Indianapolis, Ind. The sixth edition of this reference book of useful service information contains 25 percent more listings than the fifth edition. A reference to Rider's Manual, volume and page number for each receiver, is shown. The encyclopedia is available at a net price of $2.00.

Revolving Antenna. Kings Electronics, 372 Classon Ave., Brooklyn 5, N. Y. A looseleaf-perforated folder gives the chief features and prices of several models of Roto Beam dipole rotating antennas for the elimination of ghosts and weak stations in television reception. Typical installations are shown.

Loud Speakers. Magnavox Co., Fort Wayne 4, Ind., has just issued a complete compilation of all pertinent engineering data with illustrations and dimensional information covering all current models of loudspeakers available to manufacturers.

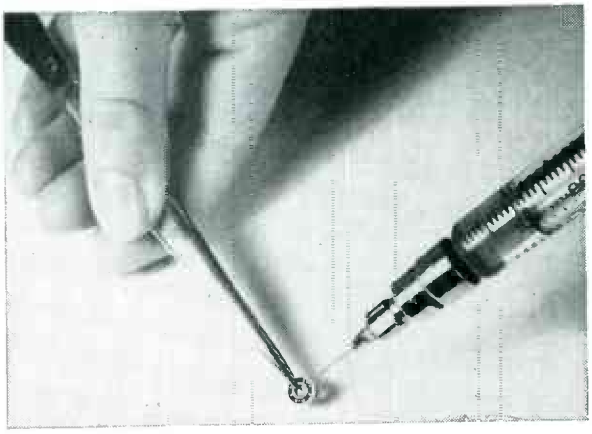
Oscillograph Photography. Fairchild Camera and Instrument Corp., 88–06 Van Wyck Blvd., Jamaica 1, N. Y. The Oscillo-Record camera is designed for recording cathode-ray oscillograph images. A complete description along with specifications, accessories and catalog listings can be found in a recent 12-page booklet.

Connecting Devices. Howard B. Jones Div., 2460 W. George St., Chicago 18, Ill. Catalog 16 lists various types of electrical connecting devices together with photographs and sketches of the products to facilitate ordering.

Resistors. Precision Resistor Co., 336 Badger Ave., Newark 8, N. J., has issued a 4-page bulletin setting forth a variety of inductive and noninductive resistors. The latest catalog covering wirewound resistors in full detail may be had on request.

Remote Control. Eclipse-Pioneer Div., Bendix Aviation Corp., Teterboro, N. J. An 8-page bulletin 711–21 illustrates a remote torque control system. The control comprises a transmitting synchro, amplifier, and the torque unit.

FOR THE
FIRST TIME IN THE U. S.



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New Hampshire MICRO Ball Bearings are *ground*, on all ten functional surfaces.

Radial	Chrome steel
Radial-thrust	Stainless steel
Self-aligning	Beryllium copper
Pivot	

Bulletin on Request

NEW HAMPSHIRE BALL BEARINGS, INC.
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CRYSTAL CONTROLLED AUDIO FREQUENCY STANDARDS

- Frequencies **1**.0000 to **20,000** cycles per second.
- Sine wave outputs over 40 cycles.

Our Audio Frequency Standards possess all of the stability inherent to the quartz controlled oscillator plus special performance features exclusive to our patents and manufacturing skill developed in many years of experience. Unit illustrated is one of our many designs. Our service includes design and adaptation of special units for various applications . . . custom built in small quantities or produced for large orders on a production basis. Write for information.

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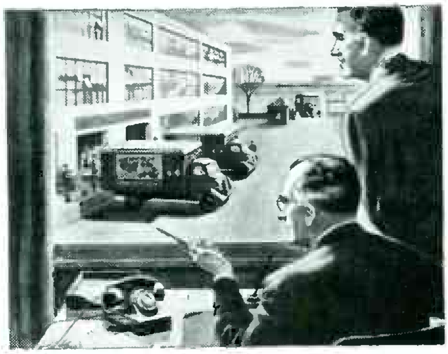

"NOT ON MY PAYROLL... BUT WORKING FOR ME!"

Railway Express is part of everyone's business, *always* ready to go to work for you just where and when you need it, whether you use its nation-wide shipping facilities daily or only occasionally.

Now available to Railway Express—and to *your* business—are 500 new, high-speed, passenger train-equipped cars. New motor vehicles, too, are part of the constructive Railway Express effort to offer you better service.

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NATION-WIDE RAIL-AIR SERVICE

(continued from p 139)

rights and privileges of the society.

(4) *Associates:*—Any person interested in the objectives of the audio engineering society shall be eligible to election to associate membership in the society and shall upon election become entitled to all the rights and privileges of the society, except the right to vote or to hold office or chairmanship of standing committees However, associates of record at the institution of the society shall have the right to vote as long as membership shall be continuous and maintained.

(5) *Student Members:*—A student interested in audio engineering and enrolled in a recognized school, college or university may apply for student membership in the society. Upon election, however, a student member shall not be eligible to vote or for membership on committees except in his local student chapter.

(6) *Sustaining Members:*—Any person, corporation or organization annually contributing substantially to the Society shall be eligible for election to sustaining membership in the society.

Regular meetings will be held on the second Tuesday of each month except during July and August, with an annual meeting each October. The annual dues shall be as follows: honorary member, none; fellow, $7.50; member, $7.50; associate member, $6.00; student, $3.00.

IRE Plans Group System

TWO TYPES of professional groups will soon be formed within the IRE: (1) vertical—illustrated by the broadcast engineering group and (2) horizontal—as in the audio, video and acoustic group. Each group will elect a chairman, vice-chairman and executive committee, to look after its own interests.

Other groups are anticipated to provide a further integration of the vastly expanded fields of communications and electronics into areas of special technical interests. An individual group can be instituted by petition from 25 or more members of the Institute. Each group may activate its own committees, special conferences, and meetings, and may expect to take charge of one or more programs at sessions of National and Regional conventions, as well as provide for limited distribution of papers of special interest. Correspondence regarding the formation of groups should be addressed to L. G. Cumming, technical secretary of the IRE, 1 East 79th St., New York City.

Coffin Awards Bestowed

SIX MEMBERS of General Electric's Electronics Department have received the Charles A. Coffin award, highest honor bestowed by the company, for outstanding work during 1946 and 1947 on transmitting and broadcasting developments. The recipients are as follows:

William F. Goetter, Ross A. Lash and Henry P. Thomas of the transmitter division at Syracuse, N. Y., for their efforts in the design and development of a new line of f-m broadcast transmitters.

Robert B. Dome of the receiver division at Syracuse, N. Y., in

W. F. Goetter

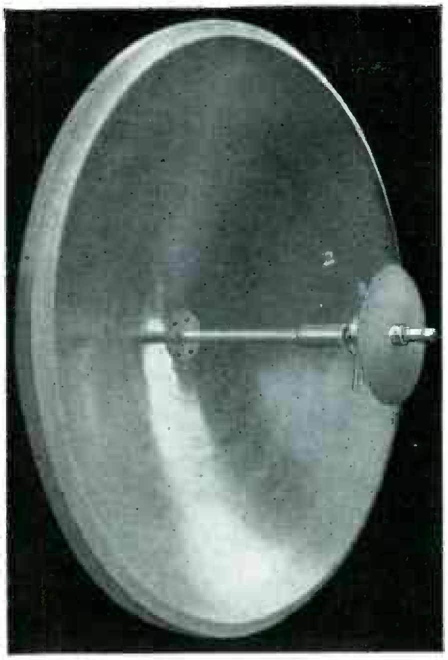
R. A. Lash

H. P. Thomas

R. B. Dome

R. P. Watson

K. C. DeWalt



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- Research and Development Laboratories

The Workshop can supply parabolic antennas in a wide range of types, sizes and focal lengths, plus a complete production and engineering service on this type of antenna.

Workshop test equipment and measurements for the determination of antenna characteristics is outstanding in the industry. These facilities, coupled with the wartime experience of its engineers on high frequency antennas, assure exceptional performance.

PARABOLAS — Precision-formed aluminum reflectors. Can be supplied separately, if desired.

MOUNTINGS — Various types of aluminum reinforced mountings can be supplied with all antennas.

R. F. COMPONENTS — Precisions machined and heavily silver plated. Critical elements protected by low-loss plastic radome.

PATTERN AND IMPEDANCE DATA — A series of elaborate measurements of both pattern and impedance are made to adjust the settings for optimum performance. Pattern and impedance data is supplied with each antenna.

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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

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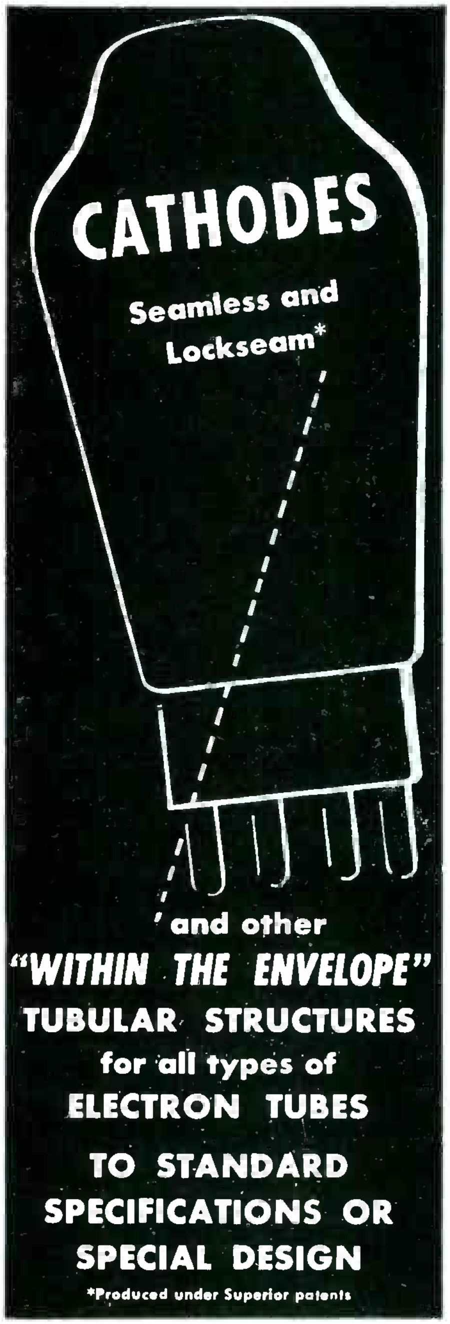


recognition of his invention of a new circuit system for communications equipment.

Robert P. Watson and F. M. Bailey of the tube division at Schenectady, N. Y., a joint award for work in developing the phasitron.

Kenneth C. DeWalt of the tube division, for transmitter-tube production accomplishments, especially in connection with the Manhattan District.

Marine VHF Service

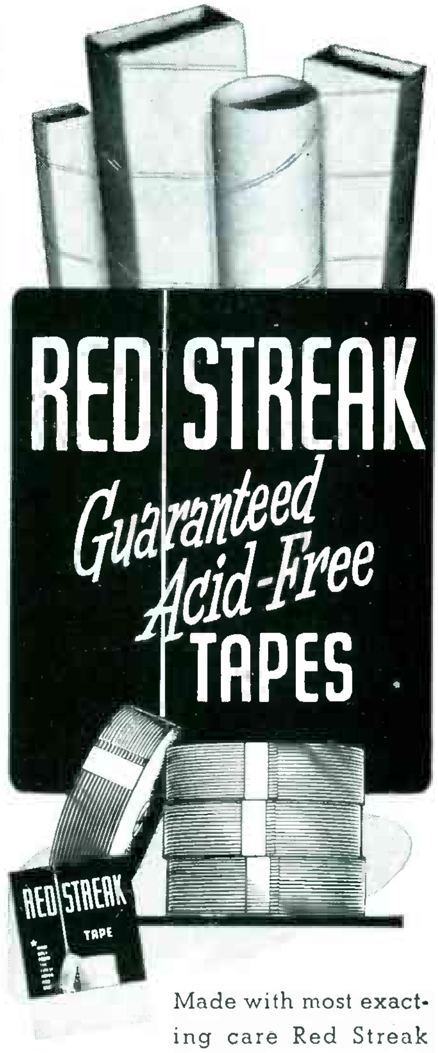
THE FCC has announced its decision to establish a vhf radiotelephone maritime mobile service on a regular basis for the operational and business needs of ships. In this connection, class 2 experimental applications have already been granted for certain land radiotelephone stations and associated stations aboard tugboats. These are of an interim character prior to the formulation of rules for the regular service. Further interim grants will be made to eligible applicants, but will not be for use on a common carrier basis. Common carrier experimentation can continue on the one duplex channel now being used.

New Technical Society

FORMATION of a new technical organization, the Standards Engineering Society, was recently announced. Its purpose is to remove barriers that tend to isolate various fields of engineering. Members may be any type of engineer—mechanical, industrial, electrical—so long as their work is concerned with standardization.

Stanley Zwerling of the Army-Navy Electronics and Electrical Standards Agency, Eatontown, N. J., was elected president, and serves on the steering committee along with Harold R. Terhune of RCA Victor, George Burnett of Sperry Gyroscope Co., P. K. McElroy of General Radio Co., and Karl Geiges of the Underwriters' Laboratories, Inc.

Due to present lack of office space, membership is now limited to the several thousand doing standards work in or near New York. A bulletin, to be published after each bi-monthly meeting, will be avail-



able to anyone interested, and the society's president anticipates formation of similar groups throughout the country.

New Microwave Chains

THE FCC HAS authorized the American Telephone and Telegraph Co. to construct two experimental microwave relay chains—one between Chicago and Milwaukee and the other linking Detroit and Toledo—to provide common carrier service including television transmission. Equipment and services proposed are similar to those now in effect in the New York-Boston microwave chain. Construction is to be completed by June 15, 1949 at an estimated cost of $1,400,000.

Name NEC Officers

THE NATIONAL ELECTRONICS CONFERENCE, INC., which will hold its annual technical forum Nov. 4, 5 and 6 at the Edgewater Beach Hotel, Chicago, Ill., has named W. C. White of General Electric Co., Schenectady, N. Y., as chairman of the board of directors for 1948.

Other officers elected are:

President—E. O. Neubauer of Illinois Bell Telephone Co.

Executive vice-president—G. H. Fett of the U. of Illinois.

Secretary—R. R. Buss of Northwestern Technological Institute.

Treasurer—O. D. Westerberg of Commonwealth Edison Co.

Vice-president in charge of arrangements—Karl Kramer of Jensen Mfg. Co.

Vice-president in charge of program—H. A. Leedy of Armour Research Foundation.

Vice-president in charge of publicity—L. G. Killian of Cook Research Laboratories.

Vice-president in charge of publication—A. H. Wing of Northwestern Technological Institute.

Chairman of exhibits committee—J. A. M. Lyon of Northwestern Technological Institute.

Chairman of hotels committee—R. K. Metcalf of Illinois Bell Telephone Co.

Oak Ridge to Have Graduate School

A GRADUATE engineering practice school for training in atomic energy plant work will be established in July at Oak Ridge, Tenn., by the Massachusetts Institute of Technology. The production plants of the Atomic Energy Commission at Oak Ridge will be utilized in the work. These include the gaseous diffusion and electromagnetic plants and the Oak Ridge National Laboratory.

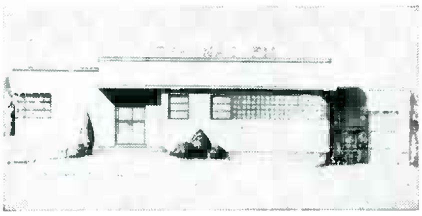
Courses (five months each) will be open only to United States citi-

zens who are graduate students of the MIT engineering departments and who have been cleared by the Atomic Energy Commission. No compensation will be paid students, but academic credit will be given for work done. The major objective will be to help prepare graduate engineers for responsible posts in the atomic energy field.

BUSINESS NEWS

SUPREME, INC., Greenwood, Miss., a new corporation, has acquired the manufacturing rights, facilities and assets of the Supreme Instruments Corp., manufacturers of test equipment and meters, and will soon occupy its new air-conditioned plant.

YANKEE NETWORK'S new WNAC-TV-FM transmitter is under construction in Medford, Mass. Both the television and f-m antennas will



Architect's sketch of WNAC-TV-FM Transmitter building

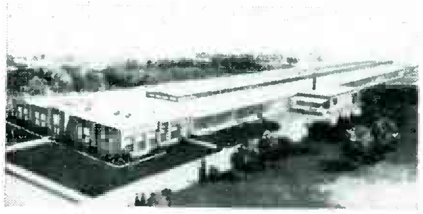
be mounted on the same pole atop a 467-ft tower. Effective radiated power of the television antenna will be 32.7 kw.

LOCKE INCORPORATED is the new name for the Locke Insulator Corporation of Baltimore, Md. Having enlarged its design and development engineering staffs, the company will produce all types of ceramics and hardware for the electronic field.

PHILCO CORP. will design and produce fixed-station and mobile radiotelephone facilities for 21 cities throughout New England and New York, for rental by the U-Dryvit Auto Rental Co., Inc., Cambridge, Mass. along with its vehicles. At present, U-Dryvit operates a 100-

unit system in the Boston area under FCC limited common carrier radiotelephone authorization.

EMELOID CO., INC., makers of plastic products such as radio dials, electronic parts and name plates,



New Emeloid plant

recently moved to a new 40,000-sq ft plant in Hillside, N. J.

LINDBERG ENGINEERING CO. of Chicago, Ill., manufacturers of industrial heat treating and melting furnaces, has acquired the assets of the Electronics Division of Illinois Tool Works, and will continue to produce and sell h-f induction and dielectric heating equipment.

THE HAYS CORP., Michigan City, Ind., has added a new building to its manufacturing plant to provide for production of industrial electronic control instruments.

STANDARD ARCTURUS CORP. recently moved to a new plant in Newark, N. J., thus increasing plant capacity for tube development and

New Arcturus plant at 54 Clark St. in Newark

production and providing expansion space for its affiliates.

ROWE ENGINEERING CORP., Chicago, Ill., is the newly formed organization of the Rowe Radio Research Laboratory Co. Rowe Radio will continue to operate simultaneously until completion of several government contracts. The new organization specializes in consulting engineering and design and development projects covering electronics and nucleonics.

WESTERN ELECTRIC CO. will erect a new building covering an area equal to four entire city blocks in New York City to consolidate its headquarters organization.

ECKERT-MAUCHLY COMPUTER CORP. has moved to new and larger quarters in the Spring Garden Building, Broad and Spring Garden Sts., Philadelphia, Pa.

RADIO CORP. OF AMERICA recently began construction of a new building at its Lancaster plant as part of a million-dollar expansion program to increase c-r television picture tube production.

Artist's sketch of RCA's expanded tube plant at Lancaster, Pa.

GRAY RESEARCH AND DEVELOPMENT CO. INC., makers of recording and transcription equipment, have moved to a larger factory in Hartford, Conn., to expand manufacturing facilities.

SPELLMAN TELEVISION INC., manufacturers of 30-kv h-v power supplies and other projection television components, have moved to larger quarters at 130 W. 24th St., New York City.

UNITED TELEVISION MFG. CORP., Boston, Mass., has been established to build home, restaurant and hotel television receivers.

ARNOLD B. BAILEY CORP., Scotch Plains, N. J., has announced the Bailey f-m transmitter which uses a highly stable f-m crystal operating at frequencies up to the limit

of crystals now available. This newly formed concern will specialize in development of electronic communication equipment.

GARSTANG-MAY CO., Indianapolis, Ind., representatives of radio and electrical manufacturers, was recently formed by the former president and general manager and the vice-president in charge of manufacturing, respectively, of Electronic Laboratories.

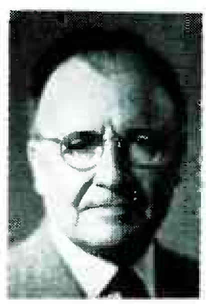
WESTINGHOUSE ELECTRIC CORP. has purchased additional manufacturing facilities at Hahntown, near Irwin, Pa. The new plant, with 125,000 sq ft of floor space, will be occupied by the mica-processing section of the transportation and generator division.

WESTERN SOCIETY OF ENGINEERS moved to new headquarters at 84 East Randolph St., Chicago, Ill.

PERSONNEL

MELVILLE EASTHAM, chief engineer of General Radio Co., Cambridge, Mass., recently received the New England Award for outstanding professional contributions to the industry, given annually by the Engineering Societies of New England, Inc. He founded General Radio in 1915, was its president until 1944, and was responsible for the development of Loran at MIT.

M. Eastham



J. H. Dellinger

J. HOWARD DELLINGER, chief of the Central Radio Propagation Laboratory of the National Bureau of Standards, recently retired after 40 years of government service. He initiated radio research at the

Bureau in 1911 and discovered the simultaneous occurrence of solar eruptions and radio fadeouts, since called the Dellinger Effect. In the advisory field he organized the Interdepartmental Radio Advisory Committee which assigns all radio frequencies used by Federal agencies.

MARCUS A. ACHESON was appointed chief engineer for the radio tube division of Sylvania Electric Products Inc. He has been with the company since 1934 and during the war he directed the Sylvania development of proximity fuze tubes for the Navy Bureau of Ordnance.

M. A. Acheson

A. C. De Napoli

A. C. DE NAPOLI, previously with Western Electric Company and Films, Inc., has been named chief engineer of SoundScriber Corp., New Haven, Conn., manufacturers of electronic disc dictating equipment.

ANTHONY WRIGHT, recently appointed chief television engineer of The Magnavox Company, previously held the same position at RCA Victor.

NORMAN WUNDERLICH is now vice-president and divisional chief of Lear Radio, Inc., Chicago, Ill.

MAXWELL K. GOLDSTEIN, at one time head of NRL's radio direction finder activity, recently joined the staff of the research division of the Office of Naval Research as electronics consultant.

KENNETH V. CURTIS, application engineer in Raytheon's marine department since 1945, has been

NEWS OF THE INDUSTRY (continued)

named product manager of the commercial products division at Raytheon Mfg. Co., Waltham, Mass. From 1943 to 1945 he was in the radar design section of the Bureau of Ships, USN.

FRANK G. MARBLE has been appointed sales manager of the Kay Electric Co., of Pine Brook, N. J. He was recently in charge of instrumentation activities at Pratt and Whitney Aircraft. During the war he was associated with the Bell Telephone Laboratories in connection with radar activities.

F. G. Marble

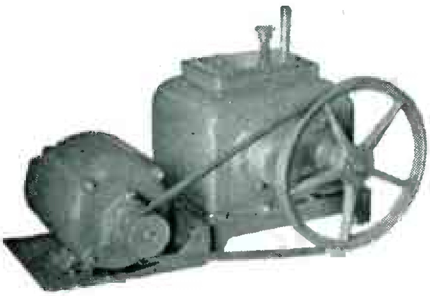
R. K. McClintock

R. K. MCCLINTOCK was named assistant to the chief engineer at Sylvania Electric's radio tube division. He has been with the company since 1936 and was instrumental in the development of the proximity fuze.

R. E. MATHES, previously associated with RCA Laboratories, with radar countermeasures in the Bureau of Ships, and until recently chief engineer of Finch Telecommunications, is now chief engineer at Gray Research and Development Co., Inc., Elmsford, New York.

NOEL L. KEEFER, for the last 12 years chief installation and service engineer on the Pacific Coast for General Electric Co., has been appointed chief engineer of KMGM, Metro-Goldwyn-Mayer's f-m station in Los Angeles.

WILLIAM H. LYON, former service engineer, has been appointed service manager at SoundScriber Corp. During the war he was an associate engineer in the Interior Communications Section of the Bureau of Ships.



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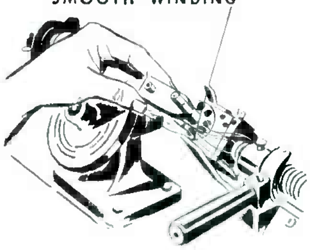
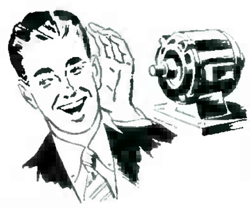


SMOOTH OPERATION



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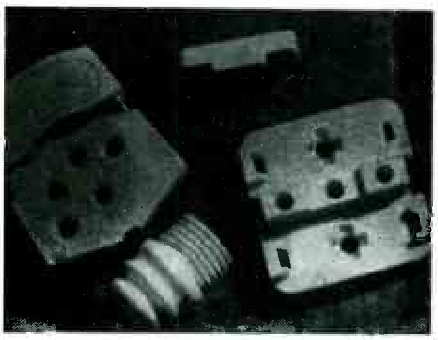

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Modulus of Rupture	20,000 lbs. per square inch
Dielectric Strength	235 volts per mil
Dielectric Constant	6.42 } Frequency of 1 megacycle
Loss Factor	7.90 }
Power Factor	4.46 }
Bulk Specific Gravity	2.664%
Density (from above gravity)	0.096 lbs. per cubic inch
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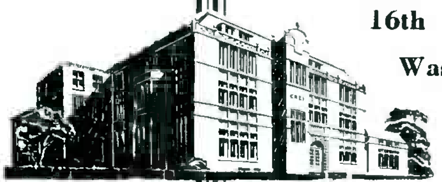

Home Study and Residence Courses in Practical Radio-Electronics and Television.
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NEW BOOKS

Hearing Aids

By H. Davis, S. S. Stevens, R. H. Nichols, Jr., C. V. Hudgins, R. J. Marquis, G. E. Peterson and D. A. Ross. *Harvard University Press, Cambridge, Mass.*, 1947, 197 *pages*, $2.00.

This book describes work done at Harvard University during the war on the adaptation of hearing aids to individual users. The work had two original objectives: (1) the determination of frequency-response patterns in a hearing aid which would give best performance for people with various types of hearing loss and (2) the development of rapid and reliable methods for testing hard-of-hearing people.

The principal item of physical equipment used in the research was a "master hearing aid", which consisted of a laboratory-type microphone, amplifier, receiver, and controls.

The method of testing was concerned primarily with the intelligibility of speech as determined by the use of word lists. Tone quality and ease of listening were not considered in the merit rating.

The tests were conducted on a group of eighteen hard-of-hearing men and women with hearing losses ranging from moderate to severe.

The articulation tests on the word lists were conducted both to determine types of frequency patterns as related to hearing losses shown in audiograms for different individuals and also to determine desirable loudness and methods for limiting loudness.

The principal conclusion drawn on the first of these items is that practically all hard-of-hearing persons can be properly fitted with either a flat frequency response or with a response which has a simple and uniform rise with increasing frequency.

With regard to the second item it was concluded that it is desirable to limit maximum loudness for any individual and that this limiting may best be done by compression amplification, although peak clipping is also acceptable.

This report is a valuable summary of specific work done in the hearing aid field by a group of scientists. The validity of its general conclusions is impaired by the small number of different persons tested and the fact that the criteria is based solely on articulation without regard to satisfactorily pleasing tone quality. The latter item is of great importance since experience shows that hard-of-hearing people will not wear a hearing aid continuously if the tone quality is annoying, no matter how good the articulation may be.

The danger of generalization on the basis of only eighteen users as well as on the somewhat questionable standard of articulation only is illustrated by data taken from the files of the Sonotone Corporation. From these records we have examined one thousand successive audiograms without selection and have compared them with the fittings on instruments which were found to give best longtime results. These data show that 48 percent of the one thousand individuals were fitted with frequency characteristics lying within the range of the Harvard recommendations; 52 percent were better fitted by frequency patterns lying outside the recommendations of the Harvard report.

The excessive emphasis given to this one generalization with regard to frequency fitting and the undue publicity given to this statement tend to discredit an otherwise worthwhile report on a valuable study of hearing aid problems.—L. GRANT HECTOR AND FRED W. KRANZ, *Sonotone Corp., Elmsford, N. Y.*

Patent Notes for Engineers

PUBLISHED BY RCA REVIEW, *RCA Laboratories Division, Radio Corporation of America, Princeton, N. J.*, 1947, 151 *pages*, $2.50.

WHILE published primarily for use within the RCA organization, the contents of this book will appeal to all engineers, scientists, and attorneys who have to deal with patent matters. Many of the questions which naturally arise in the minds of technical people will be found answered within its pages.

The original manuscript was prepared by C. D. Tusks, director of RCA's patent department, but the book also draws upon other members of the patent group.

Within the eight major chapters will be found explanations of what constitutes an invention, what can be patented, how to keep appropriate records of one's technical work that may lead to a patent application, the preparation of the application, its amendments, the whole question of interference, and finally, the ownership, use, and licensing of patents.

Copious examples from the patent literature point up the discussion, making the book more effective as a working tool and more interesting, even to one who may never make an invention. The entire technique of carrying matters through from the original concept to the use of an issued patent is covered.—K.H.

Radio Engineering

BY FREDERICK EMMONS TERMAN. *McGraw-Hill Book Co., New York,* 1947, *Third Edition,* 969 *pages,* $7.00.

"ELECTRICAL circuits and vacuum tubes behave according to exact laws, which in the main are simple and easily understood, and which can be used to predict the performance of radio circuits and radio apparatus with the same certainty and accuracy that the performance of other types of electrical equipment, such as transformers, motors, and transmission lines, is analyzed. It is this ability to reduce a problem to quantitative relations that predict with accuracy the performance to be expected or explain the results already obtained that represents a real mastery of the subject such as the radio engineer is expected to possess." So reads a portion of the Preface to the First Edition. That it appears some fifteen years later in a much expanded Third Edition may be a hoary tradition of the publisher's routine, but it is none the less alive and, one suspects, a reaffirmation of the author's creed.

For all his uncompromising approach to the fact that there can be no royal road, nor primrose path either, to engineering, Professor Terman has managed to keep the presentation of information in his books clear and simple, so that "Terman says . . ." has become a natural preamble in classroom or laboratory. Although his scholastic attainments have brought him the title of Dean of the School of Engineering at Stanford University, he is probably better known as past

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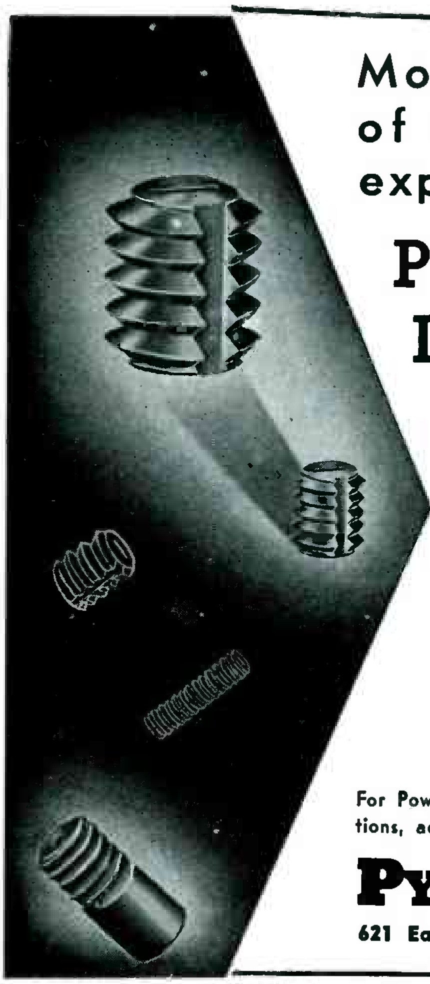

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president of the Institute of Radio Engineers. No mere pedant, he served his country with distinction at the MIT Radiation Laboratory, from whence he moved his group to found the Radio Research Laboratory at Harvard.

We are dealing here with a college text that will not necessarily please everyone. It is not a handbook with a quick answer for the man who suddenly wishes to know all about a new electronic aid to navigation, nor is it a loose-leaf booklet into which one slips dope sheets on the latest equipment for the production of frequency modulation.

The text as a whole has been brought up-to-date by the inclusion at appropriate points of such information as that on klystrons, magnetrons, lighthouse and traveling wave tubes. In addition, a completely new chapter has been added that describes circuits with distributed constants and serves to orient the reader on microwave phenomena. It would be hopeless to attempt a complete catalog of contents and additions, particularly since there are already at least 105,000 readers who are familiar with the general philosophy and presentation of the original work.

Fifty-odd pages of questions from the separate chapters have been collected at the back of the volume where they are more conveniently found than in earlier editions.—A.A.McK.

Microwave Mixers

Volume 16 of the MIT Radiation Laboratory Series, By Robert V. Pound. *McGraw-Hill Book Co., New York*, 1948, 381 *pages*, $5.50.

The present state of the art in microwave mixer circuits and components is well covered in this volume. Although the microwave superheterodyne receiver and crystal rectifiers are themselves subjects of other volumes in the series, sufficient introductory material is presented here to permit the reader to study microwave mixers and their use without recourse to the other volumes.

Because of their wide usage, crystal mixers are the major topic of this text. Simple, multiple-function and balanced mixers are considered. The local oscillator is considered not only with regard to noise generation but to frequency control as well. A chapter by Eric Durand discusses various local oscillator frequency stabilization methods, including constant frequency difference and constant absolute frequency schemes.

The completeness of the text, its use of but lack of dependence on mathematics, the large number of practical design problems considered and the detailed drawings and data presented make this text very useful. Anyone desiring to know more about this field of microwave techniques would do well to read this book.—JOSEPH KAUFMAN, *National Radio Institute, Washington, D. C.*

Techniques in Experimental Electronics

BY C. H. BACHMAN, *Associate Professor of Physics, Syracuse University. John Wiley & Sons, New York,* 1948, 252 *pages*, $3.50.

IN this short book the author, formerly with G-E, describes the equipment and methods used in laboratory vacuum systems, especially with electronic discharge devices. Liberal comparisons and evaluations of the methods discussed make the book a useful guide; practice is stressed rather than theory.

About the first two-thirds of the book is devoted to vacuum systems: pumps, traps, baffles, gages, valves and controlled leaks, demountable joints, glass blowing, leak detection, glass systems, and metal systems. The last third of the book discusses electronics: cathodes and sources of charged particles, control, and assembly and processing in the laboratory. Two chapters, one on controls and gadgets and one on hints and techniques, contain many suggestions based on experience that can save others the need for learning the hard way.

As a comprehensive discussion of the subject, the book is especially valuable for the specific mentions of materials and equipment that have proved suitable under various conditions. The treatment is well adapted to the needs of the beginning experimenter concerned with simple vacuum and electronic problems, such as the graduate student. It should be supplemented with works on the theory of gases and electronics, naturally. The book is a utilitarian manual.—F.H.R.

Crystal Rectifiers

Vol. 15 of the MIT Radiation Laboratory Series, EDITED BY HENRY C. TORREY AND CHARLES A. WHITMER. *McGraw-Hill Book Company, New York*, 1948, 443 *pages*, $7.50.

EARLY in the development of microwave radar it was found that the old familiar crystal rectifier, in suitably modernized form, offered considerable promise as a high-sensitivity mixer crystal. With further development, improvement in sensitivity, stability and ruggedness resulted in a reliable component, superior in performance to any vacuum tube, which was universally used in microwave radar mixers. It is not surprising, therefore, that an appreciable percentage of the total research and development effort of the microwave radar program was devoted to crystal rectifiers.

The MIT Radiation Laboratory not only carried out a broad research program in all aspects of the crystal rectifier but also coordinated the simultaneous research programs of many university and industrial laboratories. The purpose of the book is "to present the fund of knowledge on crystal rectifiers that accumulated during the course of World War II".

Although the main application was that of mixer crystals, the low-level video rectifier for microwave beacon systems was of considerable importance. Crystals were also widely used in laboratory measurements, particularly for wavemeter resonance indication and relative power measurements.

After a discussion of the properties of semi-conductors from the present theories of the solid state, a summary is given of the most recent theories applicable to the semi-conductor point-contact rectifier. A major portion of the book is devoted to the crystal converter and includes thorough treatment of the crystal characteristics of conversion loss, noise, r-f and i-f, impedances and burnout properties. The remainder of the book is devoted to special types including the video detector crystals. Representative manufacturing techniques are given for the various

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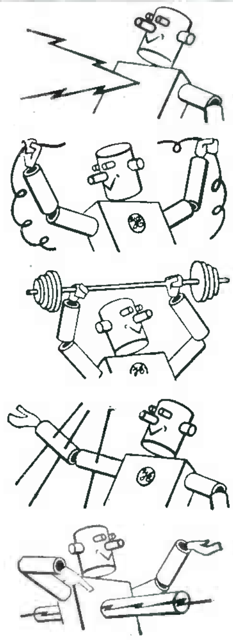

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crystal types as well as a discussion of the various measurement techniques. This includes both laboratory methods for comprehensive measurements and detailed descriptions of standardized test equipment for production testing of crystals for the most important frequency bands.

Probably the most outstanding development in this field was the discovery during the war by Benzer, of Purdue University, of the high-inverse-voltage germanium rectifier. Although developed too late for application during the war, this rectifier has already attained considerable commercial importance in communication and electronic equipment.

Summarizing as it does the entire field of crystal rectifier development during the war, this authoritative book may be highly recommended to physicists interested in the theory of semi-conductors and point-contact rectifiers and to microwave and communication engineers interested in the properties and applications of crystal rectifiers.—H. HEINS, *Sylvania Electric Products Inc.*

Books Received for Review

DICTIONARY OF GERMAN ELECTRICAL SYMBOLS. Office of Technical Services, Department of Commerce, Washington 25, D. C., 120 pages (printed), $3.00. Approximately 1,200 symbols used to designate components of German communication systems, each identified according to conventional American designation. Includes symbols for switches, relays, tubes, radar components, etc.

MODERN COLLEGE PHYSICS. By Harvey E. White. D. Van Nostrand Co., Inc., New York, N. Y., 1948, 802 pages, $5.00. Designed for use as standard required one-year college physics course. The entire last quarter of the book is devoted to electronics as well as atomic and nuclear physics. The book is intentionally too big for a one-year course, and is divided into many chapters so instructors can pick and choose.

MODERN PHYSICS. By G. E. M. Jauncey. D. Van Nostrand Co., Inc., New York, N. Y., 1948, third edition, 561 pages, $6.00. Intermediate between first-year course in college physics and advanced undergraduate physics courses. Revisions serve chiefly to cover advances made in physics since publication of the second edition in 1937.

UNITED STATES NAVY SYNCHROS—Description and Operation. Ordnance Pamphlet No. 1303, 15 Dec. 1944, available from Superintendent of Documents, Government Printing Office, Washington 25, D. C. as catalog No. N 18.7:1303, price 50 cents, 166 pages. Paper-covered manual intended for technicians who maintain and repair Synchro systems, called Selsyns by G-E, Teletorque by Kollsman and Autosyn by Bendix. Covers fundamentals, motors and generators, a

complete Synchro system, Synchro differential, control transformer, use of capacitors, fusing, characteristics of standard synchros, standard connections, zeroing synchros, lubrication, troubleshooting, interior communication units, step by step systems, and converters.

FREQUENCY MODULATION, Volume I. Published by RCA Review, Princeton, N. J., 1948, 515 pages, $2.50. Reprints of papers by RCA authors covering the period 1936-1947, in four sections: General; Transmission; Reception; Miscellaneous. Additional papers are included in summary form or are listed in the bibliography at the end of the book. Cloth-bound.

ELEMENTARY RADIO SERVICING. By William R. Wellman. D. Van Nostrand Co., Inc., New York, N. Y., 1947, 260 pages, $3.00. Troubleshooting and repair, for vocational school students and others who have already studied radio and mastered some of the principles of receiver construction. Forty job sheets at ends of chapters give step-by-step instructions for carrying out laboratory experiments. No mathematics, and minimum theory.

THE LOG LOG SLIDE RULE. Written and published by Edward C. Taylor, Woodstock, Vermont, 24-page booklet, $1.00. Advanced instruction pamphlet telling how to use the log log rule for solving practical problems in which exponentials, natural logarithms, decimal powers and hyperbolic functions have to be evaluated numerically.

ELECTRIC RESISTANCE WELDING. Published by Harold S. Card, 850 Euclid Ave., Cleveland 14, Ohio, 22 pages, $1.00. Nearly 650 articles published in 49 magazines from 1936 to June 1947 are listed chronologically by publication. An index provides a subject key to the bibliography.

TABLES OF SPHERICAL BESSEL FUNCTIONS, VOL. II. Mathematical Tables Project, National Bureau of Standards. Columbia University Press, New York, 1947, 328 pages, $7.50. This volume extends the range for $\pm\nu$ from 29/2 to 61/2, Vol. I having covered the range from 1/2 to 27/2, for the Spherical Bessel Function $(\pi/2x)^{1/2}J_\nu(x)$.

DISSOCIATION ENERGIES AND SPECTRA OF DIATOMIC MOLECULES. By A. G. Gaydon. John Wiley & Sons, Inc., New York, 1947, 239 pages, $5.00. American edition of a British book covering this aspect of molecular spectroscopy. Final chapter gives numerical data for about 250 diatomic molecules. Electron impact methods are covered in chapter VII.

BRITISH RADIO COMPONENTS. Radio Component Manufacturers' Federation, 22 Surrey St., Strand, London WC2, England, 1947, 184 pages, 21 shillings. Addresses of members, achievements of British radio industry, classified index of British-made radio components, advertisements of manufacturers and list of trade names.

STANDARDS ON RADIO RECEIVERS—Methods of Testing Frequency-Modulation Broadcast Receivers. The Institute of Radio Engineers, New York 21, N. Y., 1947, 15 pages, 60 cents. Sequel to 1938 report dealing with a-m receivers, limited to broadcast f-m receivers designed to operate at carrier frequencies between 88 and 108 mc.

RADIO DATA BOOK. By W. F. Boyce and J. J. Roche. Boland and Boyce, Inc., Publishers, Montclair, N. J., 1,148 pages, $5.00. Handbook format, presenting 200 pages of basic circuits without values of components, a hundred pages on test equipment, and sections on measurements, antennas, sound systems and sound recording. Tube data fills 325 pages; the remaining 263 pages cover formulas, graphs, tables, symbols, codes, 64 pages of complete circuit diagrams of radio equipment with values, an abridged dictionary of terms, and a glossary of radio books.

Backtalk

This department is operated as an open forum where our readers may discuss problems of the electronics industry or comment upon articles which ELECTRONICS has published.

Phantastron Decimal

DEAR SIRS:

IN Table 2 of the article in the April issue of ELECTRONICS on phantastrons, all the values of delay in microseconds should be divided by ten; that is, 50 instead of 500, 250 instead of 2500, etc. This inadvertent misplacement of a decimal point would be somewhat embarrassing if a person built a phantastron using the values of the table and expected a delay ten times longer than they would get.

The values in the first column are for a circuit which worked. However, for circuits which have a small value of maximum delay time, the circuit is somewhat critical since the value of the grid condenser C_g, is beginning to approach the value which one might expect for stray capacitance in a badly laid-out circuit.

MATTHEW T. LEBENBAUM
Engineer
Airborne Instrument Laboratory
Mineola, New York

Audio Noise Reduction

DEAR SIRS:

HARRY F. OLSON'S statement (ELECTRONICS, Dec. 1947, p 120) that he separates signal and noise on the basis of amplitude is misleading.

It is true that the system he describes will discriminate against any amplitude below a certain threshhold level—*but only when said amplitude is present alone* (or with other sufficiently small amplitudes).

If a small noise voltage below the threshhold level and a signal voltage of such a magnitude as to make the sum of the signal voltage plus the noise voltage greater than the threshhold level are simultaneously present, no separation of signal and noise will occur.

The statement that if the threshhold level "corresponds to the maximum amplitude of the noise, the noise will not be reproduced" is accordingly incorrect, except under special conditions not usually attained.

There can be no improvement in signal to noise ratio by use of the system he describes except during intervals when the sum of the signal plus the noise is less than the threshhold level—which is of course a trivial consideration.

HENRY E. SINGLETON
New York, N. Y.

Rebuttal

DEAR SIRS:

I am glad that Henry E. Singleton has called attention to some parts of my paper that were not clear because it provides me with an opportunity for additional explanation and clarification.

It is impossible in a discussion or in an article describing the system to present the complete theory of electronics involved and all the characteristics of speech and music which conspire to make the system effective in reducing noise. Since the elements of sound reproduction, such as, for example, time-frequency distribution of the components in speech and music, masking of noise by tones, threshold and ambient noise, integrating characteristics of the ear, are known to those interested in sound reproduction, it appeared superfluous to present these in the article. Rather I tried to present the physical action of the system.

Of the above characteristics, there is one outstanding one, namely, the transient nature of speech and music that makes it possible to reduce noise by threshold system. If the frequency range is divided into octave frequency bands, it will be found that, in general, there are relatively long intervals in which there is no signal amplitude. However, the noise is always present.

Under these conditions, in the threshold noise reducing system,

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when there is no signal, the noise will not be reproduced. Furthermore, when the noise and signal are of small amplitude there will be a reduction in noise. This is certainly separation of noise and signal on the basis of amplitude. Obviously, when the amplitude is several times the noise level the reduction is small. However, under the latter conditions, the signal masks the noise and noise reduction is not necessary. It may be mentioned in passing, that none of the existing noise-reducing systems are capable of reducing noise under full signal operation.

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HARRY F. OLSON
Radio Corporation of America
RCA Laboratories Division
Princeton, N. J.

Stagger Tuning

DEAR SIR:

I wish to disclaim responsibility for the captions accompanying the diagrams in my article "Stagger-Tuned Amplifier Design" in the May 1948 ELECTRONICS. In particular, Fig. 4 and 6 are interchanged, the numerical values in the caption of Fig. 2 are erroneous, and the word "flat" must be omitted in the phrase "flat staggered-pair" of the caption to Fig. 5.

HENRY WALLMAN
Massachusetts Institute of Technology
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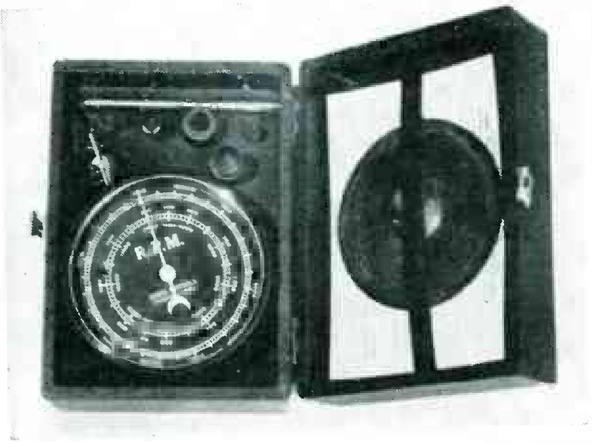
PORTABLE TACHOMETER



This unit is of the centrifugal mechanical type and is designed to show **INSTANTANEOUSLY and CONTINUOUSLY THE SPEED OR CHANGE IN SPEED** of any revolving shaft or surface. No stop watch or other mechanism required.

- Three ranges in R.P.M., and three ranges in F.P.M.
  Low Range . . 300-1,200 (Each division equals 10 R.P.M.)
  Medium Range 1,000-4,000 (Each division equals 20 R.P.M.)
  High Range 3,000-12,000 (Each division equals 100 R.P.M.)
- Large open dial 4" diameter.
- Ruggedly constructed for heavy duty service.
- Ball bearing and oilless bearings — require no lubricatioan whatsoever.
- Readily portable—Fits neatly into palm of hand.
- Gear shift for selecting low, medium and high ranges.
- Greatest accuracy—meets Navy specifications 18-T-22, Type B, Class A.
- Complete with the following accessories:

1—Steel tip
1—Conical Rubber tip metal mounted
1—Rubber lined metal cone tip
1—Peripheral Rubber wheel 1 ft. in circumference
1—Extension Rod
1—Small size convex rubber tip, metal mounted
1—Operating instruction

Made by Jones Motrola, Stamford, Connecticut. Comes complete in blue velvet lined carrying case; 7⅛" L x 4" H x 5" W. **List Price $75.00**—Surplus—New—Guaranteed.

Your Cost $24.50 fob N. Y.

D. C. MILLIAMMETERS

MINIATURE MILLIAMMETER 1.35 M.A. 500 MV mvt. Black scale calibrated—.1 to + 1.25 G.E. 1¾" Square flush metal case........$2.50
1 MA **Simpson** 125 2½" Rd fl bake case....$3.50
1 MA **G.E.** DW-51 100 MV mvt, sc cal 0.50 Ma 2½" rd fl bake case........................$3.50
50 MA **G.E.** DO-41 black scale, 3½" rd fl bake case..............................$3.25
50 MA **Weston** 506 2½" rd fl bake case........$3.95
150 **Gruen** 508 2½" rd fl bake case..........$3.00
200 **Gruen** 511 2½" rd fl bake case..........$3.00
200 MA **W.H.** NX-35 3½" rd fl bake case...$3.95
50-0-50 MA **Westinghouse** NX-35 3" rd fl bake case..............................$3.95

RADIO FREQUENCY AMMETERS

250 MA **G.E.** Dw-52 black sc. sc cal 0-5 mkd "Antennae Current" 2½" rd fl bake case..$3.50
1 A **G.E.** DW-44 2½" Rd fl bake case........$3.50
1 A R.F. **G.E.** DW52 2½" metal case........$3.00
2 A **Simpson** 135 2½" rd fl bake case........$3.50
3 A **G.E.** DW-52 black scale 2½" rd fl bake case..............................$2.95
4 A **G.E.** DW-44 black scale 2½" rd fl bake case..............................$2.95
6 A **G.E.** DW-44 black scale 2½" rd fl bake case..............................$2.50
8 A **G.E.** DW-44 black scale 2½" rd fl bake case..............................$2.95
8 A **Simpson** 135 2½" rd fl bake case........$3.50
20 A **G.E.** DO-44 3½" Rd fl bake case........$4.95

A. C. AMMETERS

30 A—**Triplett** 331-J.P.—3½" Rd fl bake case.$4.00
50 A **G.E.** AO-22 3½" Rd fl bake case......$4.50
60 **Simpson** 3" sq. fl bake case..............$3.50
75 A **Triplett** 331-J.P.C. 3½" Rd fl bake case $3.50

D. C. AMMETERS

15 A **Triplett** 0321-T 3½" Rd fl bake case...$4.00
30-030 A **G.E.** DW-51 2½" Rd fl metal case..$3.50
50 A **Hoyt** 2½" Rd fl metal case............$2.95
200 A **Weston** 506 Comp with ext 50 MV shunt 2½" rd fl bake case......................$7.50

D. C. MICROAMMETERS

150 Microampere McClintock No. 2001 approx 740 ohms resistance black scale 2½" rd fl bake case..............................$3.50
D.C. MICROAMMETER 0-200 UA movement 500 ohms resistance 4" x 4½" Rectanglar case, knife edge pointer. Scale calibrated to 200 megohms & 20,000 ohms. Caption Insulation Tester. Superior Instruments Co. ....@ $7.50
500 MICROAMPERE UNDAMPED MOVEMENT W.H. RX-35 scale calibrated 0-25 Watts 3" Sq. fl bake case.
Supplied with paper VOMA scale.........$4.95

HIGH ALTITUDE ALTIMETER
Radio Set SCR-518

This item consist of a complete set of apparatus for installation on aircraft for use in determining the height above the terrain. The nominal range of the equipment is from 0 to 20,000 feet, but is inoperative to an altitude of approximately 30,000 feet. The complete set of main components when equipped with tubes and fuses, with cable interconnections, with antenna arrays, and primary power source connections, properly made, constitutes a complete and operative equipment. All necessary voltages, other than the primary source, are generated within the equipment. The source of power is an aircraft d-c supply of 24 to 28.6 volts. The total power consumed is approximately 300 watts. Operates at approximately 515 Megacycles.

The set consists of 6 major separate component items. **Receiver, Transmitter, Power unit, Indicator, Control Box & Junction box.**

This equipment comes complete with antennae, connecting cords, brackets, connectors and 29 tubes as supplied by the manufacturer. Brand New—in original cartons. Made by RCA-govt. cost approximately $900.00. Complete with OPERATING INSTRUCTIONS & CIRCUIT DIAGRAMS

Can be used, as is, for use as an altimeter, or for adaptation to radar for marine use, protective or police systems, television etc.

The many valuable parts in this set alone are well worth many times this low price of Only $24.50

Shipping weight approximately 150 lbs. f.o.b. N. Y.

(For detailed particulars of individual components see our advertisement in the May 1948 issue of "Electronics")

Manufacturers and Exporters!

Can you use these items"

We have quantities of these units available and can offer them to you at attractive prices.

PRECISION RESISTORS

± 1% Accuracy, Wire Wound—Non Inductive

1.0 Meg 1.0 K.V.
1.0 Meg 1.0 K.V.
1.5 Meg 1.5 K.V.
1.5 Meg 1.5 K.V
1.5 Meg 1.5 K.V
2.5 Meg 2.5 K.V.
2.5 Meg 2.5 K.V.
3.5 Meg 3.5 K.V.
4.0 Meg 4.0 K.V.
20.0 Meg 20.0 K.V.
20.0 Meg 20.0 K.V.

TERMINAL BOARDS

4—**Terminal Connections** 3¼" L x 2" W x 1½" H with cover, G.E.
6—**Terminal Connections** 4½" L x 2" W x 1¾" H no cover, G.E.
8—**Terminal Connections** 5½" L x 2" W x 1½" H with cover, G.E.

THERMAL CIRCUIT BREAKER

120 Volt, 15 Amp. A.C. Double pole, Single throw, Curve D. By Heineman Circuit Breaker Co. Catalog #0322.

A. C. VOLTMETERS

15 V. **G.E.** AO-22 3½" Rd fl bake case....$3.95
75 V. **Weston** 517 2" Rd fl ring mounted metal case..............................$2.95
150 V. **Weston** 476 Calibrated for use from 25 to 500 cycles 3½" rd fl bake case..........$6.50
150 V. **Burlington** 32XA 3" Sq. fl bake case..$4.00
300 V. **Weston** 517 2½" rd fl metal case......$6.00

D. C. VOLTMETERS

5 V **W.H.** NX-33 200 ohms per volt 2½" bake case..............................$3.50
10 V **Sun** 2 AP458 100 ohms per volt 2½" rd fl bake case..............................$2.50
15 V **Gruen,** GW505 2½" Rd fl bake case.....$3.50
20 V **Weston** 506 1000 ohms per volt 2½" Rd fl bake case..............................$3.50
50 V **W.H.** NX-35 200 Ohms per volt 3½" rd fl bake case..............................$3.95
200 V **W.H.** NX-35 200 Ohms per volt 3½" Rd fl bake case..............................$3.95

SPECIAL METERS

Simpson, 25 SIGNAL STRENGTH "S" METER 3½" rd fl bake case. Use this on the plate circuit of your receiver to show the relative strength of incoming signals. Sc. calibrated—6 to 100 DB above 1 microvolt. 5 MA Zero right mvt with translucent sc. for internal sc. illumination from rear of meter. Comp. with socket, lamp and leads. For further details refer to Radio Amateur's Handbook $4.50
DECIBEL METER—Westinghouse RC-35 — 10 to + 6 DB 3" Sq. fl bakelite case 6 M.W. 500 Ohms zero DB = 1.732 volts. Full scale = 3.45 volts $5.95

All items are Surplus-New-Guaranteed. C.O.D.'s not sent unless accompanied by 25% Deposit. Orders accepted from rated concerns, public institutions, etc., on open account. We carry a complete line of surplus new meters suitable for every requirement, such as portable, panel, switchboard, recording instruments, laboratory standards, etc. Over 50,000 Meters in Stock. We also stock various surplus components, tubes, parts, and accessories and can supply large quantities for manufacturers, exporters, etc. Send for free circular Manufacturers, Exporters, Dealers—We invite your inquiries.

MARITIME SWITCHBOARD

338 Canal Street — Worth 4-8216-7-8-9 — New York 13, New York

TELL US—TELL OTHERS—SAY YOU SAW IT IN ELECTRONICS!

"VIBROTEST" RESISTANCE AND VOLTAGE TESTER

Resistance Range 0-200 Megohms (at 1,000 volts test potential) 0-2000 Ohms

Voltage Range 150-300-600 Volts D.C.
150-300-600 Volts A.C.

Push button action for resistance readings. Operates from internal power supply off two #6 dry cells. Large 4" meter and knife edge pointer insure accurate readings. Complete with batteries, test leads & instructions in metal carrying case. Associated Research Inc. Model # 204.

Net Price $60.00 f.o.b. N. Y.

WESTON MODEL 311 PORTABLE POTENTIAL TRANSFORMER

To be used to extend the range of any precision laboratory standard 150 Volt A.C. meter.

Maximum potential ratio of 1500 and 750 volts to 150 Volts.

Normal potential ratio of 1150 and 575 volts to 115 Volts.

Frequency rating from 25-125 cycles. Maximum secondary burden of 15 volt-ampere. Ratio accuracy is within 1/5 of 1% when used with model 310 or 326 meters. Complete in polished oak case with removable cover, lock and carrying strap.

List Price $247.50

Net Price $90.00 F.O.B. N. Y.

WESTON MODEL 461-4 PORTABLE CURRENT TRANSFORMER

This unit can be used with any precision 5 Amperes A.C. Meter to extend the ranges of the meter to 50, 100, 200, 250, 500 or 1000 Amperes A.C. Accuracy within ¼ of 1%; Normal Secondary Capacity = 15 Va; Binding Posts for 50 Ampere tap; Inserted primary for 100, 200, 250, 500 and 1000 Amperes; Insulated for use up to 2500 volts.

List Price $98.00

Net Price $35.00 f.o.b. N. Y.

PANEL METER COMBINATION OFFER

150 Volts A.C. Meter, Triplett 331-JP 3½" Rd fl. bakelite case.

30 Ampere A.C. Meter. Triplett 331-JP 3½" Rd. fl. bakelite case.

Both Meters for $7.95

MULTI-RANGE PORTABLE A.C. VOLTMETER

Weston Model 433. 150/300/600 volts AC. Accuracy within ¾ of 1% from 25 to 125 cycles. Hand calibrated Mirror scale 4.04" long with 150 scale divisions: Knife edge pointer. Moving iron Band type. Magnetically shielded. Dimensions 6"x6"x3½" .... **Net $47.50**

Voltage Polarity Phase Rotation Tester, Triplett 337 AVP, Checks 115, 220 and 440 line voltage; locates open circuits, blown fuses, damaged wiring, etc., Indicates whether A.C. or D.C. and polarity of D.C.; Checks phase rotation to determine direction of rotation of motors, operation of controls, etc.; Consists of a 3" square meter and a small polarized vane movement in a small handy sized case. Complete with 36" leads with test prods. @ **$8.50**

Portable (Chronometric) TACHOMETER

Jaeger Watch Co. Model #43A-6

- Can be used for speeds up to 20,000 R.P.M.
- Can be used for lineal speed measurements to 10,000 F.P.M.
- Ideally suited for testing the speeds of motors, particularly of fractional horse power, generators, turbines, centrifugals, fans, etc.
- Very small Torque—requires practically no power to drive.
- Unequalled Readability 2" Open face dial—each division on large dial equals 10 R.P.M.; each division on small dial equals 1,000 R.P.M.
- Greatest Accuracy—meets Navy specifications—guaranteed to be within ½ of 1%.
- Results of test reading remain on dial until next test taken.
- Push button for automatic resetting.
- Complete with the following accessories:

1—Large pointed rubber tip
1—Large hollow rubber tip
1—6" circumference wheel tip
1—Operating Instructions
1—Temperature Correction chart

The combination of the above features will give accurately, within a few seconds, by direct reading, the R.P.M. of shafts or the lineal speeds of surfaces without any accessories or timing of any kind. Each unit comes complete in a red velvet lined carrying case 5" x 3½" x 1½" (case and accessories not illustrated). **Net List Price, $75.00**—Surplus—New—Guaranteed.

Your Cost $24.50 fob, N. Y.

CODE TRAINING SET AN/GSC-T1

Made by T. R. McElroy, Boston

Operates off 6, 12, 24 or 110 V D.C. or 110 V or 230 Volt, 60 cycle.

An excellent unit for schools or clubs for code training. This unit is designed for group training of telegraph code to students whereby each student sends a message from any prepared text to the instructor. It provides a visual signal through a blinker or an audible signal through a monitoring speaker. Has volume control, variable frequency oscillator, a phone jack for a monitoring headset, pitch and tone control, rotary switch for selecting the operating voltage and power supply.

Complete with spare fuses, power cord and battery adapter; 10 Telegraph Keys with 10' line each, 1 #6x5 tube and 2 #6AG6 tubes.

Complete in chest 10½" x 17" L x 13½" H—Net wt. 49 lbs.

Can be used anywhere—batteries A.C. or D.C. Durable—Good for a lifetime of Service! NET fob, NY $24.50

PORTABLE A. C. AMMETER WESTON MODEL 528

DUAL RANGE 0-3 Amp. and 0-15 Amp. full scale for use on any frequency from 25 to 50 cycles. The ideal instrument for all commercial, industrial, experimental, home, radio, motor and general repair shop testing. Comes complete with a genuine leather, plushlined carrying case and a pair of test leads. A very convenient pocket sized test meter priced at less than 50% of manufacturers list. Your cost .... **ONLY $12.50**

WESTON MODEL 528 PORTABLE A. C. VOLTMETER

DUAL RANGE 0-15 and 0-150 Volts for use on any frequency from 25 to 125 cycles. Complete with plushlined leather carrying case and a pair of test leads. This Voltmeter, with the matching model Ammeter above, makes an ideal pair of test meters for any mechanic to carry around in his tool box.

ONLY $9.50

COMBINATION OFFER: 528 Voltmeter—528 Ammeter—**BOTH FOR $21.00**

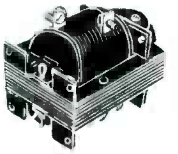
All items are Surplus-New-Guaranteed. C.O.D.'s not sent unless accompanied by 25% Deposit. Orders accepted from rated concerns, public institutions, etc., on open account. We carry a complete line of surplus new meters suitable for every requirement, such as portable, panel, switchboard, recording instruments, laboratory standards, etc. Over 50,000 Meters in Stock. We also stock various surplus components, tubes, parts, and accessories and can supply large quantities for manufacturers, exporters, etc. Send for free circular Manufacturers, Exporters, Dealers—We invite inquries.

MARITIME SWITCHBOARD

338 Canal Street **Worth 4-8216-7-8-9** **New York 13, New York**

TELL US—TELL OTHERS—SAY YOU SAW IT IN ELECTRONICS!

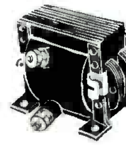
GENERAL ELEC. SOLENOID



No. R-4242 115 V. 60 Cyc. Type CR 9503-209F Complete with Armature $1.25 each

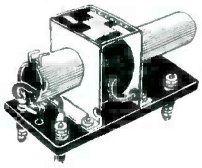
SPECIALS ← OF → THE MONTH

GENERAL ELEC. SOLENOID



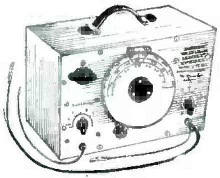
No. R-4243 120 V. 60 Cyc. Type CR 9503-208L Complete with Armature $1.00 each

ADLAKE Type 1040-80



No. R-4012 Mercury Time Delay Relay Normally Opens, Closes in 5 seconds, Opens in .3 seconds. $8.75

SWEEP SIGNAL GENERATOR



McMurdo Silver Co., Model 909 FM and Television Sweep Signal Generator with a frequency range of 2 mc. through 226 mcs. with true electronic FM sweep variable from 40 kc. to 9 mc.

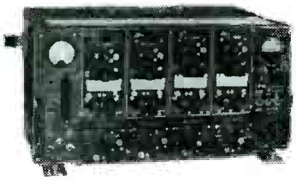
Power required is 105/125 v., 50/60 cycles a.c. at 35 watts, with this new unit one can visually align FM and TV receivers quickly and perfectly with simple but complete instructions supplied for FM and TV servicing.

Priced at Only $48.50

TRANSMITTER BUY OF 1948

MODEL ATD AIRCRAFT TRANSMITTER

Built to Rigid Navy Specifications



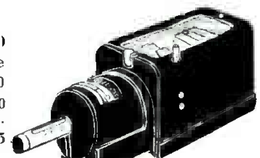
This unit covers 540 Kc. to 9050 Kc. C W. or fone, designed for Dynamotor Operation. Power supply requirements are 380 volts and 1000 volts DC.

Separate Ant. Tuning units covering the following frequencies:
540—1500 Kc.
1500—3000 Kc.
3000—9050 Kc.

Tube line-up as follows: RF Osc. 6L6-RF Amp. 814—Audio—6SL7 Pre Amp. into 6L6 driver and side tone amplifier with pair of 6L6 modulators, screen oscillator tube, regulated with VR 150 tube. All circuits are metered.
$10\frac{1}{2}$" high, $12\frac{1}{4}$" deep, $21\frac{1}{2}$" long. Shipping weight 100 lbs. Price, F.O.B. New York City.

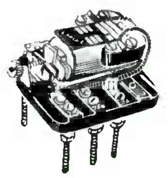
FOR QUICK SALE—COMPLETE.... **$49.50**

PBC GENERAL ELECTRIC OVERCURRENT RELAY



No. R-4010 Adjustable from 1.5 to 3.0 amperes. 110 volt. 60 cyc. Reset. $24.95

WHEELOCK RELAY



No. R-4013 Double Pole Double Throw 115 Volts 60 cyc. Coil 5 amp. contacts. $2.65

LAST CHANCE

Going Like "Hot Cakes"
At This Greatly Reduced Price
New-Standard Brand

304 TL'S

This may be your last opportunity to stock up on spares at this price—and you fellows who plan to build a kilowatt rig in the near future—here is a golden opportunity to still get in on this "all time new low price."

This is a single tube easy to drive for full kw power with 3000 v. plate, actually 4-75 T's in one envelope.

"Filaments checked before shipment"

SPECIAL $1.98

HI-VOLTAGE POWER SUPPLY

Hi & Low Voltage Rectifier Power Supply Model C F T—20169 formerly used with the DAQ Direction Finder. This power supply contains 2500 v. at 3 mils—325 v. at 100 mils. Also contains a sweep amplifier, voltage regulated from 110 v. 60 cy AC. source.

Power Supply can be used to power a television receiver or perfect power supply for an Oscilloscope, or General Lab. use. Unit is mounted in a cabinet with all controls including pilot lights & switches on front panel. Wt. approx. 40 pounds.

$29.95

LIMITED QUALITY

MAGNETIC DEFLECTION YOKES

MAGNETIC DEFLECTION YOKES for Television or large scope applications—for use in RCA TRK—120 and similar television receivers

Catalog #	Deflection Angle	Horizontal Inductance	Vertical Inductance	Overall Length
DY-1S	55°	5 mh. Price $14.75	19 mh.	2-⅝"
DY-2L	40°	5 mh. Price $15.75	22 mh.	3-7/16"
DY-4L	40°	1.5 mh. Price $15.75	45 mh.	3-7/16"

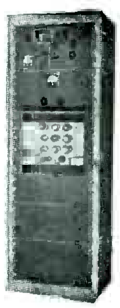
FIXED FERRUL TYPE CONDENSER

No. C-2614 Size $5\frac{1}{4}$" long x ¾" in Diameter. 800 MMF. @ 8 K.V.D.C. $1.49 each

MASTER OSCILLATOR MI-19427-B

This unit was built for R.C.A. Add a final—becomes a complete transmitter with signal shifter. Perfect for Television sweep circuits for field or station use or wherever 300 v. must be maintained under varying load conditions—

COMPLETE (less tubes) **$225.00**



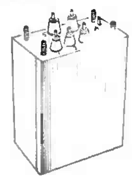
TECHNICAL SUMMARY

ELECTRICAL CHARACTERISTICS
- Output Frequency .... 2 to 20 megacycles
- Output Level, Buffer-Amplifier....Sufficient to drive an RCA-807
- Modulation Frequency .... 650 cycles ± 150 cycles
- Frequency Deviation (maximum) .... ±500 cycles
- Power Consumption .... 200 watts
- Power Supply .... 115 230 volts, 50/60 cycles
- Oscillator Filament Current .... 0.05 ampere d-c
- Amplifier and Tone Generator Filament Voltage....... 6.3 volts a-c

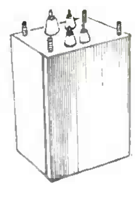
TUBE COMPLEMENT
- Electron-Coupled Oscillator 2 RCA-3Q5-GT
- Buffer-Amplifier 1 RCA-807
- Tone Generator 1 RCA-6AB7, 1 RCA-6F6
- Regulated Power Supply .... 2 RCA-5U4-G, RCA-6Y6-G; 1 RCA-1852, 2 RCA-VR-150 30

MECHANICAL SPECIFICATIONS
- Dimensions...Height, 66 9 10 in.; Width, 22 in.; Depth, $17\frac{1}{8}$ in.

TYPICAL PERFORMANCE DATA — Frequency Change
- Line voltage change ± 10 per cent .... 0.0005 per cent
- Temperature change, per degree Fahrenheit .... 0.0007 per cent
- Relative humidity change of 1 per cent over the range of 30 to 95 at a dry bulb temperature of 110 degrees F .... 0.0003 per cent
- Drift from cold start, first reading taken within 1 minute after applying power:
- Frequency deviation at the end of the first hour: a negative drift of 100-400 cycles (measured at 7 mc)

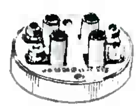


FILAMENT TRANSFORMER—Hermetically sealed 115 v. 60 cyc. primary-sec. #1-6.3 @ 3 amp. sec. #2 2.5 volts @ 2 amps. Western Electric D spec. #161917 insulated for high voltage inverse peaks—designed to light scope tube and 2x2 tube Stock #T4106—$5\frac{1}{4}$" high x $2\frac{3}{4}$" x $4\frac{1}{2}$" $3.95



SCOPE or TELEVISION TRANSFORMER — Western Electric Spec. #D161913—2500 Volts @ 4 MA. Hermetically sealed with ceramic terminals out bottom. prim. 115 v. 60 cycs. Stock #T4105—$5\frac{1}{4}$" high x $3\frac{5}{8}$ x $4\frac{1}{2}$" $6.95

4 PIN GIANT SOCKET



No. S 407 For 304TL or 304 TH Very few left in surplus. Get yours NOW $1.00

20% DEPOSIT WITH ORDERS UNLESS RATED

NIAGARA RADIO SUPPLY CORP.

160 GREENWICH STREET — NEW YORK 6, N. Y.

Phone DIgby 9-1132-3-4
All Prices F. O. B. N. Y. C.

"TAB"

That's A Buy

- TRANSFORMERS 115V/60cy INPUT 7500V or 15000V DOUBLER/35ma ... $15.95
- 10800VCT or 21000V DOUBLER/95ma ... 19.95
- 1320V&375VCT/110ma,5V/3A,2.5V/3.25A& 6.3V/2.75A Cased HV insltd ... 7.95
- 1350VCT/150ma,6.3V/5A,5V/2A ... 6.95
- 640VCT&1250V/250ma $4.95@ ...2 for 8.95
- 500VCT/60ma,6.3V/4A HmtcllyCased ... 1.29
- 1100VCT/212ma $5.95; 10V/8A/12KV ... 6.95
- 5V/115Amp $10.95; 2.5V/10A/10KV ... 3.95
- 1000VCT/45ma,795VCT/80ma,3x5V/3A & 6.3VCT/1A,6.3V/.3A HV/Hmtclly CSD ... 4.95
- 872A's COMBINATION TRANS sockets ... 12.00
- 866A COMBINATION Tubes,sockets,Xtormer.. 5.95
- 570VCT/180ma,5V/3A, 12V/4A CSD ... 3.95
- 510VCT/125ma,5V/2A,6V/4A CSD ... 3.25
- TRIPLETT TUBE CHECKER TRANSF ... 2.95
- 220 to 440V-or-110 to 220V/250Watt ... 4.95
- AUTO TRANSF 6V/2A,150V/1.6A,35V/1.2A ... 3.95
- SEL RECT TR/115/60c,42.5V/2A ... 4.25
- GE Hermetically CASED USN Transf's 880 VCT/125ma,6.3V/2A,6.3V/3A&5V/3A delivers 250ma on hiV ... 4.45
- 6.3VCT/4Adelivers6.3VCT/6.8Amp ... 1.69
- 6.3VCT/.7A HV insltd 2Xcurrent ... 1.80
- 330VCT/10ma & 330VCT/10ma ... 2.49
- 2000V/10ma H'sealed USN ... 3.95
- 5V/60Amp KENYON HV insltd ... 6.95
- WE PPinput&PPdriver transfs 6V6/805 ... 6.95
- 90-80-70V/2Amp GE USN ... 3.49
- 840VCT/110ma,540VCT/21ma,5V/3A,5V/3A& 6.3V/1A, 6.3V/.6A USN CASED 2Xsafety factor ... 4.95
- 2.5V/40Amp GE insltn 25KV ... 7.95
- 6800V or V.C.T/1Amp/17KVinsltn,208to251V inpt ... 95.00
- 3400V or V.C.T/1Amp/17KVinsltn,107to126V inpt ... 95.00
- 115 or 230V/10Amp/2KW TRANSFORMER .. 19.95
- 115 or 230V/8Amp/1.8KW AUTOTRANSF ... 16.95
- 90,100,115,120or230V/1.6KW TRANSF ... 16.95
- 5V/6.5Amp/36KV insltn & socket UX ... 6.95
- 7.5VCT/6.5A, 6.3VCT/3A ... 3.75
- 700VCT/150ma,10V/3.25A,2.5V/10A & 6.3VCT/2A,5V/3A,HV insltd CASED ... 5.95
- 1100VCT/150ma,6.3V/3A,5V/3A HV ins ... 4.50
- 10V/8A/12KV or 2x5V/8A/12KV ins ... 6.95
- 1000VCT/200ma,90V. bias,6.3V/5A,5V/6A& 18V/.55A, CASED ... 4.95
- 1000VCT/150ma,300Vbias,6.3V/5A,5V/3A& 2x6.3V/.65A,6.3V/1.25ACSD50-800cys& pri taps 0-80-115VAC Hmt sealed ... 4.50
- 7.5V/12A/HV$4.95; 4x6.3V/4A&3x5V/4A ... 4.50
- 10VCT/10A/220Vin or 5VCT/10A/110Vin ... 4.95
- 5VCT/20A/220Vin or 2.5VCT/20A/110Vin ... 5.95
- 10VCT/10A,12VCT/.7A,3x6V/1A,2x6V/2A ... 7.95
- 3x5V/3A,2.5V/1.75A,6.4V/12A,6.4V/10A ... 4.95
- 6.3V/3A,5V/4A,5V/8A HV insltd ... 5.50
- 14or20V/12A/220V or 7or10V/12A/110Vin ... 4.95
- 772V/2.5ma, 2.5V/3A ... 3.95
- 1200VCT/300ma $4.50@ ...Two for 9.98
- 3200VCT/200ma & 780VCT, 12VCT/.5A ... 12.95
- 1400VCT/300ma,6VCT/4A,2.5V/3A, 5V/4A ... 9.95
- 700VCT/120ma,115V/100ma,6.3V/2A& 6.3V/2A,5V/2A CASED HVinsltd ... 3.25
- 700VCT/125ma,6.3V/1.2A,5V/3A ... 2.95
- Universal Vibrator Transf 6,12,24,115VDC& 115&230VAC/50-60cy,420VCT/85ma,6.3V/3A ... 2.49
- 500V/3A$10@ 2for$19; 7.5V/24A/220Vin ... 3.95
- 2240VCT/500ma, Pri105to250V/50-60cy inpt& 2.5V/10A,12V/4.5A,19V/2.5A $24.95@ 2 for 47.00
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- 750VCT/375ma & Tap 500V wndg ... 5.25
- 2.5VCT/15A inpt210-250V/HVins Collins ... 4.50
- 250VCT/60ma,6.3V/1.5A Small ... 1.49

CHOKES

- 13.5Hy/1Amp/42ohm/17KVinsl ... 90.00
- 15-29Hy/150ma Swinging Cased ... 2.95
- 12Hy/300ma $3.95; 3Hy/40ma ...3 for 1.00
- 15Hy/400ma or 20Hy/300ma/12KV ins ... 7.95
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- 8Hy/150ma new UTC crckd Bklte T'Bd...2 for 2.25
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- 8Hy/125ma HVins $1.69; 51Hy/100ma ... 1.29
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- 12Hy/200ma $2.95; 2x12Hy/150ma ... 2.95
- .35Hy/2.5A $2.95; 10Hy/125ma ... 1.25
- 10Hy/45ma, 3 for $1.49; 12Hy/60ma ... .85
- 2x30Hy/50ma 98c; .01Hy/2.5Amp ... 1.49
- HV SCOPE CHOKE 12Hy/85ma CSD ... 1.98
- OUNCER PLATE IMP 300Hy ... 1.49
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- PP6L6 Hifi outpt2.5,6,5,15.5,62,250 ohm ... 3.95
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- AUDIO BAND PASS FILTER 60,90&150cys Cased & shielded $2.25 each @ ...3 for 5.95
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- PP6V6's to tap line or V.C. ... 1.39

- CW3 RCVR & COILS 5.1to10mc's NEW ... $16.95
- HAMMARLUND SUPERPRO & PWR SUP USED ... 125.00
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- BC456 MODULATOR less tubes&Dyn LN* ... 1.69
- SCR274/ARC5 CONTROL BOX LN* ... 1.95
- AVT112 RCA 6L6 XTAL XMTR LN* ... 12.95
- TA12 COLLINS XMTR USED LN* ... 39.95
- SC2 RADAR RCVR & INDCTR 175-225mc's .. 198.50
- TAJ NAVY XMTR 175-600kc/500Watt LN* .. 595.00
- TBK NAVY 2to18.1mc's/500Watt XMTR LN* . 695.00
- BC319 XMTR 4to13.4mc's/300W&PWR LN* .. 395.00
- BC620 RCVR & XMTR & DYNMTR LN* ... 49.95
- COLLINS ART13 SPEECH AMPLIFIER & parts to convert to peak clipper&data ... 8.25
- VOLTAGE REGULATOR NEW RAYTHEON 95-130V/60cy, Outpt 115V/60Watt ... 10.95
- V'REGULATOR SAME 198-242Vinpt/50-60cy outpt 220V/500Watts/.5% Regltn ... 35.00
- DYNMTR 28Vin/out540V/250ma used LN* ... 2.50
- DYN 12&24Vin/275V/110ma/PMagnet ... 1.95
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- DYNMTR 28Vin/out250V/60ma ...2 for 1.98
- WRENCHES ELECTRICAL HARDENED 9/32" & 11/32; 15/64 & ¼" OPEN END @ 20¢ 2 for .30

HiPOWER VARIABLE ANTENNA MATCHING NETWORK #1001A BRAND NEW 1500 to 7000 KC

1KW-RF easily Converted to hi freqs. PiNetwork adjustable in&outpt. CASED. 5"x15"x23" Relay Rack Mtg. Contains hvy edgewise Ribbon coil & 250mmf/7000V Variable Condsr Johnson&RF mtr thermocouple 0-8Amp/3"Sq. With TECH manual. Will match & load majority ANTENNAS. STURDY CONSTRUCTION. Wgt. 45 lbs. Excellent for Police, Airport, Broadcast & Amateur stations.

TAB SPECIAL ... $12.95

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SAME UNIT LESS ANTENNA COIL includes Housing, VAR CONDSR RF meter, insulators, dials TECHmanual. NEW.

TAB SPECIAL ... $8.95

AIRCRAFT INSTRUMENTS USED LN*

- GTD PIONEER REMOTE INDICATING A100 COMPASS MAGNESYN ... $ 3.95
- PIONEER TRANSMITTER MAGNESYN REMOTE COMPASS TO A100 IND ... 8.95
- WESTON L&R COMPASS 602 METER ... 3.95
- GE RADIO ALTITUDE 0-4&0-40 RANGE ... 7.95
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- TEMPERATURE CARBURETOR OIL&AIR WESTON 606 RESIST THERMOMTR —30+50°C ... 2.98
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- TEMP. RESISTANCE THERMOMETER WESTON —50to+150°C/12&24VDC/DYNAMOMTR ... 4.95
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- FUEL GALS 55/150/150/8DJ3 GE ... 4.95
- IND AUTOSYN DUAL 3500RPM/26V ... 4.95
- IND TACH 4500RPM/8DJ13A/GE ... 6.95
- IND ASSM 10000RPM/656 KOLLSMAN ... 6.95
- PRESSURE DUAL 25lbs AN5772 ... 1.98
- PRESSURE 2000lbs AC-E4 ... .98
- PRESSURE 200lbs USGCO ... .98
- PRESSURE D-10/10-75" MERCURY ... 1.98
- GE LIQUID LEVEL TRANSMITTER NEW .. .98
- BANK&CLIMB GYRO CONTROL MK4USN AUTOMATIC PILOT NEW ... 19.95
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"TAB" MONEY BACK GUARANTEE $5. MIN. ORDER F.O.B. N.Y.C. ADD SHIPPING CHARGES & 25% DEPOSIT. C'TABOGRAM. WO 2-7230.

RECTIFIERS BRIDGE TYPE

INPUT	OUTPUT	CURRENT	PRICE
0–18V	0–14	1.35Amp	$2.25
0–18V	0–14	5Amp	4.85
0–36V	0–28	320ma	1.49
0–36V	0–28	1.1Amp	2.39
0–36V	0–28	1.5Amp	2.89
0–36V	0–28	5Amp	7.50
0–64V	0–54	220ma	3.49
0–64V	0–54	5Amp	16.95
0–90V	0–80	150ma	2.85
0–135V	0–116	3Amp	14.95
0–126V	0–110	150ma	2.95
0–144V	0–125	150ma	2.95
0–350V	0–300	40ma	.85

FULL WAVE CENTER TAP

460VCT	0–110V	1.6Amp	6.95
460VCT	0–110V	220ma	3.49
460VCT	0–110V	3.5Amp	14.95
600VCT	0–256V	2.4Amp	12.95
650VCT	0–272V	150ma	2.95

HALF WAVE TYPES*

0–28V	0–12	150ma	.59
0–72V	0–36	300ma	.98
0–130V	0–100V	100ma	.98
0–216V	0–144	75ma	1.75

*USE WITH CAPACITOR any VDC at 2Xoutput.

CAPACITORS

- 6000mfd/15WV $2.98; 500mfd/60WV ... $ .98
- 2000mfd/50WV $1.98; 500mfd/200WV ... 1.49

CAPACITORS OIL RATED WVDC

- TAPPED 2.8mfd/200VDC oil ...15 for 1.50
- 2mfd/330VAC/1000WVDC oil ...5 for 1.98
- 5mfd/600WVDC/220VAC&Brkts oil ...2 for 1.80
- 7mfd/600V 99¢; 10mfd/600V ... 1.39
- 3.3mfd/225VAC $1.25; 4mfd/600V ... .89
- 20mfd/600V/$2.75; 4mfd/330VAC/1000VDC .. 1.39
- 15mfd/330VAC/1000VDC&2000VDCIntermnt.. 4.50
- 3mfd/2000VDC $4; 4mfd/3000VDC ... 5.95
- 2mfd/2000VDC $2.49; 2mfd/5000VDC ... 10.00
- 4mfd/5000VDC $16; 2mfd/2500VDC ... 28.00
- 1mfd/2500VDC $95; 1mfd/4000VDC ... 3.75
- 00025mfd/25KV ... 4.95
- 2x1mfd/400V 12for$1; 3x1mfd/400V ...10 for 1.00
- 1mfd/400V 12for$1; 2mfd/400V ...5 for 1.00
- .5mfd/500V 10for$1; 1mfd/500V ...8 for 1.00
- 05mfd/600V 30for$1; 2x.05mfd/600V ...25 for 1.00
- 3x.05mfd/600V 15for$1; 3x.22mfd/600V ..12 for 1.00
- 3x.25mfd/600V 5for$1; .5mfd/600V ...8 for 1.00
- 3x.1mfd/600V 8for$1; 2x.25mfd/600V ...6 for 1.00
- .1mfd/1000V 4for$1; .25mfd/1000V ...4 for 1.20
- .2mfd/500V $2.25; 1mfd/3600V ... 3.25
- .2mfd/5000V $2.25; 1mfd/3600V ... 3.25
- VACUUM CONDSRS GE 50MMF/7500V ... 2.95

MICA CONDENSERS RATED

600 WVDC. rated in MFD Capacity

.0001	.00055	.0012	.004
.0002	.00085	.003	.006
.00036			.008

EACH 30¢@ ... 10 for $2.50

.01	@45¢	.026	@92¢	.04	@$1.60
.015	@65¢	.03	@$1.00	.05	@$1.90
.02	@71¢	.039	@$1.20		

1200WVDC Rated in MFD Capacity

.0001	@28¢	.004	@64¢	.01	@$1.12
.00025	@28¢	.0051	@70¢	.013	@$1.20
.001	@36¢	.0062	@70¢	.03	@$1.80

2500WVDC Rated in MFD Capacity

00045	@36¢	.0025	@90¢	.005	@$1.32
00082	@55¢	.0039	@$1.26	.006	@$1.38
002	@90¢	.004	@$1.26	.01	@$1.64
0022	@90¢	.0043	@$1.26	.015	@$1.78

3000WVDC Rated in MFD Capacity

.00005	@54¢	.0001	@72¢	.0007	@90¢
.005	@$1.45				

3500WVDC Rated in MFD Capacity

.002	@$1.00	.003	@$1.20

5000WVDC Rated in MFD Capacity

.00003	@$2.25	.00025	@$2.70	.0015	@$2.70
.00009	@2.70	.0005	@$2.70	.005	@$2.70
.00015	@$2.70				

8000WVDC .01MFD @$16.00

10000WVDC .003 @$12.00 .0015 @$13.00

- 10000WVDC 25MMF @98¢ ...10 for 7.50
- 10% DISCOUNT ON MICAS ON 10 of a# C "TAB" for JAN PARTS & PRICES
- VARIAC 200C/860Watt/0-130VAC ... 16.95
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- EXT CORD HVY DUTY SJ 16', M&F PLUGS .98
- AUTOSYNS AY1&AY5/24V/60&400cy ... 3.95
- REENTRANT TRUMPET & DRIVER 35WATT 29.95
- WE 35to55Watt PM DRIVER $11.95@ ..2 for 21.95
- WE BEACHMASTER 250Watt TRUMPET ... 125.00
- WE DYNAMIC MICROPHONE & CABLE ... 7.95
- AUTOSYN TYPE 5 SYNCHRO LN* ... 8.95
- AUTOSYN TYPE 5 DIFFERENTIAL LN* ... 4.95
- PE157 VIBRAPACK, SPKR, BAT & CHGER 7.95
- VIBRAPACK 6VDC/425V/110ma ... 12.95
- WE TELETYPE PWR SUPPLY KS5825 inpt 115-230V/50-60cy, Outpt 0.4Amp/115VDC .. 39.95
- TBY new VIBRAPACK & Storage Battery 4V/40AH Outpt 7.5V/20ma, 156V/30ma, 3V/375ma, 1.5V/200ma ... 14.95
- DYNMTR DM4in12&24V/220/100ma&440V/200ma ... 5.95
- DYNMTR DA3A P/o PE94 New less Relays ... 4.95
- DYNMTR PE94 for SCR522 NEW ... 9.95
- BC412 OSCILLOSCOPE NEW ... 69.95
- APN4 RECEIVER & OSCILLOSCOPE LN* ... 79.95
- APN4 RECEIVER LN* ... 39.95
- SN8APW5B SYNCHRONIZER NEW ... 39.95
- USN 10 STATION MASTER INTERCOM LN* 39.95
- GE AMPLIFIER NEW 22RELAYS, 4SENSITIVE & One 10pos 2pole latching. DL4W158 AG2AMP ... 14.95

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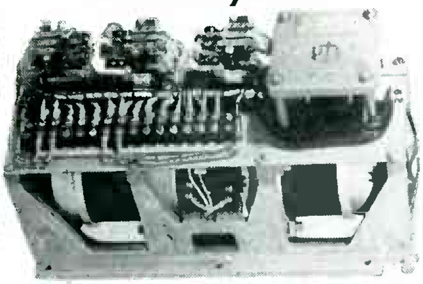
NEW GUARANTEED • • • CORNER CHURCH & LIBERTY STS., ROOM 200 • • • ELECTRONIC PARTS

FLASH! SENSATIONAL BARGAINS IN SURPLUS EQUIPMENT

BIG SAVINGS *at* ELECTRO SALES CO.

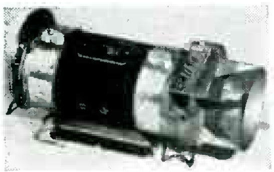
Deviation Alarm System



Consisting of one Ford instrument syncro motor, operating at 115 volts, 60 cycles, single phase, and one Ford Syncro Generator Mark IV, used in conjunction with three 115 volt relays and one 110 volts, A.C. buzzer. Comes completely connected and mounted on a cast iron frame.

Brand New **SUPER VALUE** **$14.75**

Winco Dynamotor

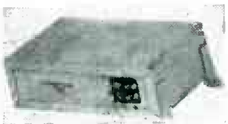


Brand New

$1

Manufactured by the Windcharger Corp. Specifications: Input Voltage; 18 Volts, D.C. Output Voltage; 450 V. - 150 MA fan cooled, ball bearings. Has short extended staff to permit use as motor. Length - 9¼"; Width - 4". Base mounting.

Western Electric Filter Assembly



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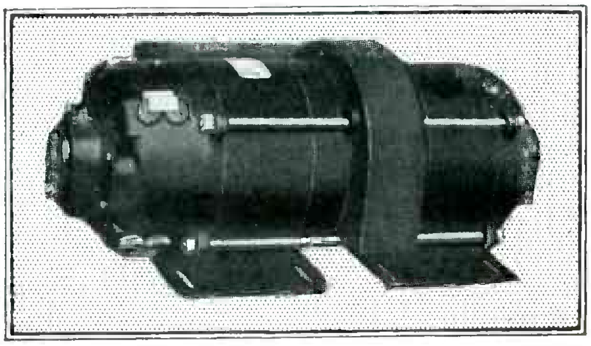
Complete filter network contained in a single well-shielded unit measuring 6½" long, 3¾" wide, 1⅞" deep. A dual section low pass filter with high Q components. The response is flat from .175 - 1500 CPS. This network has a "Q" of 65 at 1000 CPS with 600 OHM output impedance. The DC resistance is 1.56 ohms. **95c**

General Electric Amplidyne



BRAND NEW!

MODEL 5AM73AB76

INPUT 440 volts, 3 φ, 60 cycles, 2.1 amps.

OUTPUT 250 volts, 3 amps. 750 watts; cont. duty, 3450 RPM; 45 C.—Temp. Rise.

Special Price **$85.**

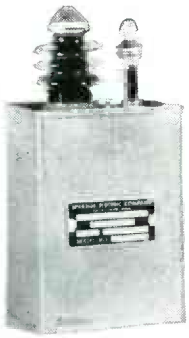
MODEL 5AM49AB3
INPUT: 440 volts, 3 φ, 60 cycles, 1 ampere
OUTPUT: 250 volts, 1.5 amps. 375 watts, cont. operation, 40 c.—Temp. Rise. 3450 RPM.

Special Price $53.50

MODEL 5AM45DB20
INPUT: 115 volts, 1 φ, 60 cycles, 5 amps.
OUTPUT: 250 volts, .6 amp. 150 watts, cont. duty. 40 C.—Temp. Rise 3450 RPM.

Special Price $53.50

SPRAGUE PULSE FORMING NETWORK



Size of Case, Exclusive of High Tension Insulators, 8 x 4 x 4 Inches.

Consists of Chokes & Condensers 15,000 Volts Oil-Filled 19 Micro-Sec.

$4.95

STANDARD BRAND
RHEOSTATS

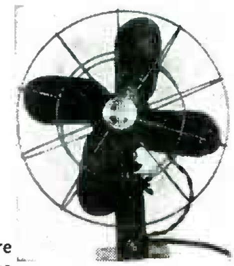
Consist of four 13" plates, circular contacts, 100 ohms and 8—2 amperes, connected in series and assembled for back of board mounting or can be employed for floor or table operation.
BRAND NEW. Packed in individual cartons.

These rheostats were made to sell for $82.50. **$19.75** each

New 112 Page Catalog

—listing scores of bargains. Write for it on your company's letterhead.

Direct Current Fans



Manufactured by Westinghouse. These fans are the standard 12" type for desk or wall mounting.
The wall type is illustrated

These fans are not new but have been reconditioned by us with new cords and connectors. Fully guaranteed to be perfect.

SPECIAL PRICE $6.50

Hollow Capacitors

Made by leading manufacturers. Rated at 1.0 Mfd. 120 Volts, DC **100 for $1.75**

Battery Chargers

BRAND NEW! Compact unit plugs into any wall socket operating at 110 Volts, 60 cycles and supplies 6 Volts, 6 amperes. Has handle for carrying and cord and insulated battery clips. Complete, guaranteed. Dimensions 7½" x 4½" by 4¾". Special **$8.25**

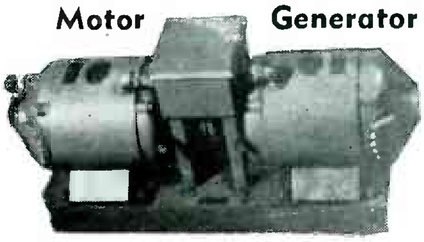
All prices F.O.B. Boston. Orders accepted from rated concerns on open accounts. Net 30 days.

ELECTRO SALES COMPANY

Dept. E-6, 110 PEARL STREET, BOSTON 10, MASS.

SURPLUS SAVINGS at ELECTRO SALES CO.

MARATHON Motor Generator



Rebuilt like new. Two separate units coupled together on a common bed plate. MARINE TYPE with voltage regulator and frequency controller. Operable at 110 volts DC and supplying 110 volts AC, single phase, 60 cycles, 500 va.

SPECIAL PRICE $65

Same unit as above with 32 volt, DC motor and 300 va. output..... $54

Complete Motor and Pump Assembly

Operating at 21 Volts, DC 70 amperes. Can be used on 32 Volt systems with resistance bank. Motor rated at ¼ HP. Can be used for pumping water or oil. Original cost to government was over $150.00. We have a limited quantity of these units, sold on a money-back basis. Special.................. $19.50

Motor Rated 2½ HP

Operative at 440 Volts, 3 phase, 60 cycles. Can be reconnected for operation on 220 v, 60 cy. 3 ph. 1750 RPM. Double Shaft. Ball Bearings. Marine Duty, 30 minutes. A sturdy motor for any application, at a never before offered price. Brand New! Fully guaranteed. Original cases. $28.50

Bosch Magnetos

with Pump Assembly, completely enclosed. Brand New! Original cartons. Special $7.85

General Electric Motors

Flange Mounted. Rated 1/20 HP operative at 60 volts, DC. Shaft is 3/16", 1" long. Model 5PS56HC18. SPECIAL $2.85

G. E. Rebuilt Rotary Converters,

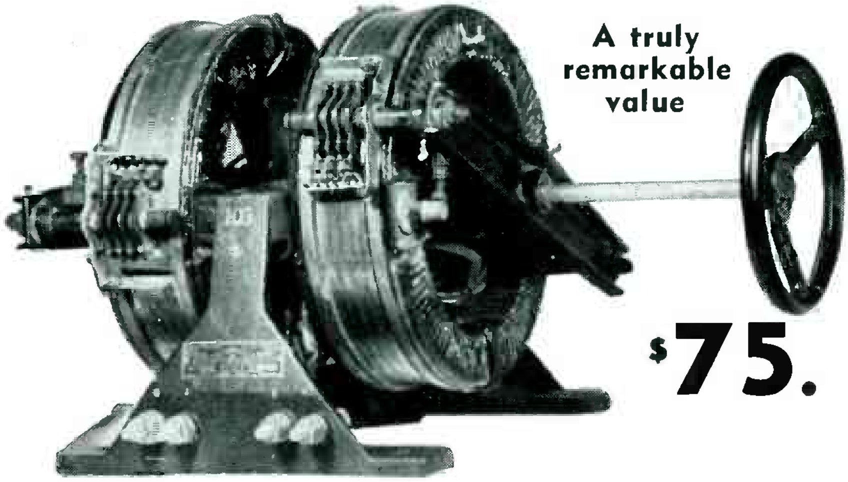
Input: 110 Volts, DC; Output: 70 Volts, AC, single phase, 60 cycles. 100 Watts Special $4.40

NEW 112 Page Catalog

Packed from cover to cover with thousands of amazing values in a $500,000 stock. Distribution must be limited to requests on company letterheads. Address Dept. E.6

"TRANSTATS" Amertran Voltage Regulator (Variable Transformer)

A truly remarkable value



$75.

11.5 KVA; Fixed Winding; 115 Volts; Commutator Range 0-115 Volts, Maximum Amperage 100. Can be reconnected for 230 volts with maximum amperage of 50. Blueprint of connections supplied.

BRAND NEW, in original factory cases

Raytheon Rectichargér

The output voltage of the Raytheon Charger is 48 Volts at 3 amp. This charger has control for increasing or decreasing the trickle charge rate. Will charge up to 23 cells at one time. Can also be used as a battery eliminator and for operation of signalling equipment.

A Voltmeter—reading from 0 to 100 Volts, DC indicates the charging Voltage. Completely mounted and wired for operation in a gray finished sheet steel cabinet measuring 11" x 17" x 21¼". Each unit is brand new and packed for export in cases 16 x 18 x 30. Weight when packed 236 pounds. Spec. W-3826.

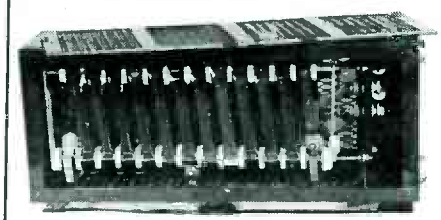
NEW! Specially Priced $23.

HELIPOTS, Model A

Case diameter 1.8"; Number of turns 10; slide Wire Length 46½"; Rotation 3600 Degrees; Power rating 5 Watts; Resistance rating 20,000 ohms. ....

SPECIAL PRICE $4.50

Resistor Assembly



National Brand Manufacturer. 150 amperes, 0.088 ohms, 13.2 volts, 25" long, 9" wide and 12" high.

OUR SPECIAL PRICE $3.89

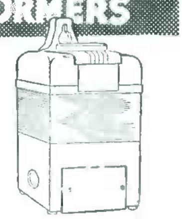
Janette Type CS13F Rotary Converters

BRAND NEW! Input: 12 volts, DC Output 110 volts, single phase, 60 cycles; .212 KVA, 85% P.F. Ball Bearings. With filter for use on radio equipment.

SPECIAL $51

GENERAL ELECTRIC TRANSFORMERS

Brand New!
1 KVA.
460-230
230-115



$19

All prices F.O.B. Boston. Orders accepted from rated concerns on open account. Net 30 days.

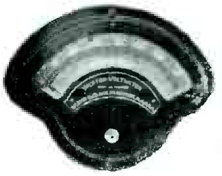
ELECTRO SALES COMPANY

Dept. E.-6, 110 PEARL STREET, BOSTON 10, MASS.

SURPLUS BARGAINS!

WESTON MODEL 271

Large Fan Shaped Microammeter



Another of the famous Weston fan shaped line. Very large scale 5.8" long. These meters were made by Weston to General Radio specifications, with special mirrored scale and knife edge pointer. Accuracy 1%.

0—600 Microamps
170 M.V.
Coil Res: 250 Ohms

Your Price **$12.50**
10 for **$100.00**

TRANSTATS—3 K. V. A.

Type RH Input: 115 V. 10%. Output: 115 V. Max. Amps: 26 A. Made as a line voltage corrector 10% of input voltage, or can be connected to give plus 20% or minus 20% of input. Can also be reconnected to be used as an isolated type stepdown with variable secondary. Input: 115 V. Output: 0-30 Volts at 30 Amps. No Knob.

A Real Buy at ***$18.00***

(same type, but .25 KVA. Input: 103-126 V. Output: 115 V.-2.17 A.)

Price $6.50

STEPDOWN TRANSFORMER

Made by General Electric. Heavy duty stepdown transformer, with considerable overdesign. Ideal for rectifier applications, low voltage heating, general laboratory use, etc. Open frame type.

Input: 115 Volts—60 Cycles
Output: 15 Volts (at full load)
Capacity: 180 V.A.
Size: 3½" x 3½" x 4".

Your Cost $3.75

Quantity prices available

HEAVY DUTY STEPDOWN TRANSFORMERS

Input: 115 V. (with 8 taps in primary).
Output: from 16 to 10.5 V. (in 8 steps).
Capacity: 1.25 KVA—Sec. Amps: 100.
Size: 13"x10"x5". Approx. Weight: 30 Lbs.
Open Frame Construction.

Your Cost **$12.50**
10 for **$100.00**

POWER TRANSFORMER

Pri—440/220 V 60 Cy Sec—125/115/105 V Rating .8 KVA RCA Open construction. Bracket mounted, pri & sec terminal boards. Overall dimensions: 5¾"H x 7½"W x 8"D. Mounting dimensions: 6⅞"x5⅞". Price **$12.50**

STRUTHERS-DUNN RELAYS

D.P.S.T., Normally open, 115V, 60 Cycle, A.C. coil, 30 Amp contacts, fibre base with 4 holes for mounting. Dimensions, 4½" L x 3" W x 2¾" H.

A Real Buy At **$2.50**

OHMITE POWER TAP SWITCH

Non-Shorting, Model 312, Cat. #312-10, 25 Amps A.C., 10 taps, without knob, Dimensions: 3¼" Diam. x 3¼" Deep.

Your Price **$1.50**

HEINEMAN CIRCUIT BREAKER

For use with low voltage, D.C., 100 Amps, Dimensions: 3¼"H x 4"D x 1" W...... $1.75

A. C. VOLT-AMMETER SET

Westinghouse RA-37—4" Sq. 0-300 Volts AC Scale: 300/600 Volts A.C.
With Potential Transformer for 600 Volt Range $10.00
Westinghouse RA-37—4" Sq. 0-5 Amps AC. Scale: 75/150 Amps A.C.
With Donut Current Transformer for Double Range 75/150 to 5 .... $10.00
Price: **for ALL 4 PIECES** $17.50

PORTABLE A. C. AMMETER

WESTON #528

Double range ammeter. 0—3 Amps and 0—15 Amps. Two of the very useful ranges for your Lab. or shop. Complete in genuine leather case with test leads.

Your Price **$12.25**

D. C. AMPS & MILLS

0-1 Ma 2" G.E. DW41 (special scale)	$2.95
0-1 Ma 2" Weston 506	3.75
0-2 Ma 2" Sun 1AP525-5	2.25
0-1 Ma 2" Weston 506 with metal case	1.85
0-5 Ma 2" Dejur S-210	1.95
0-25 Ma 2" G.E. DW41	2.95
0-30 Ma 2" G.E. DW41	2.95
0-35 V. 2" Simpson (metal case)	2.95
0-100 Ma 2" sq. Simpson 127	2.95
0-500 Ma 2" G.E. DW41	3.25
0-1 Ma 3" G.E. DO-41	4.95
0-15 Ma 3" Westhse NX-35 (scale: 15/150/300)	2.95
0-10 A. 3" Simpson #25	4.50
0-30 Ma DC G.E. DO-58, 4½"x4" (Black or White Scale)	4.95
30-0-30 A. 3" Simpson 25	4.50
0-30/120/600 Ma Weston Portable Model 280—Precision Type	5.95
0-300 A. 3" Roller-Smith (fl. bake Type TD-50 MV) (with ext. shunt)	4.95
0-300 A same as above (without shunt)	2.25

D. C. VOLTS

0-15 V. 2" Westhse BX-33 (Black scale)	2.75
0-20 V. 2" Weston 506 (1000 Ohms per Volt)	2.95
0-40 V. 2" Weston 506	2.95
0-150 V. 3" G.E. DO-41	4.75
0-150 V. 4" Weston 643 (Black scale—flush—metal)	6.75

A. C. VOLTS

0-10 V. 2" G.E. AW-42	$2.95
0-10 V. 3" G.E. AD 25	3.75
0-150 V. 2" Simpson 155 (metal case)	2.95
0-150 3" G.E. AO-41	4.50

A. C. AMPS

0-1.5 A. 2" Weston 507 (RF)	$3.50
0-3 A 3" Westhse NA-35 (scale: 120 A.)	3.95
0-30 A. 3" Triplett (metal)	2.95
0-5 A 4" sq. Triplett 431A (scale: 150/300)	2.95
0-75 A, 4" Weston 642 (Surface Metal Case)	6.75

All meters are white scale flush bakelite case unless otherwise specified.

HEAVY DUTY RHEOSTAT

10 ohms — 9.2 Amps — 9.2 Amps (Not tapered). 14" Dia. Complete with handle and legs for rear of panel mounting.

Your Cost . . **$5.95**

SELENIUM RECTIFIER STACK

New — Manufactured only 3 Months Ago

Full Wave Bridge. Input Max. 24V AC. Output 18V @ 10A, continuous duty.

A Real Buy at
$7.85

RECTIFIER TUBES

6 Amp. (Tungar type) for battery chargers, rectifiers, etc.

Your Cost **$1.50**
(minimum order of 10 tubes)

RHEOSTAT, OHMITE MOD. N,

300 Watts, 150 Ohms, 1.41 Max. Amps, 6" Diam., Weight 2¾ lbs., without knob.

Price **$5.25**

RHEOSTAT, OHMITE MOD. R,

500 Watts, 250 Ohms, Tapered, 2.5-.51 Amps, 8" Diam., Weight 4 lbs., without knob.

Price **$7.50**

SELENIUM RECTIFIERS

Full Wave Bridge

Approximate Rating

Federal Type #	Input Max.	Output Max.	Amps.	Price
10B1CV1	18 V.	14 V.	.5	$.98
10B2CV1	36 V.	28 V.	.5	1.50
4B3CV2	48 V.	36 V.	.5	2.75
5B2AV1	36 V.	28 V.	1.6	4.25
5B2AV5	36 V.	28 V.	8	11.75
11BA6AM1	120 V.	100 V.	1.6	11.95
9DO612R	150 V.	115 V.	1.6	14.50

CAPACITORS

Cap. Mfd.	Volts D.C.	Height Weight Length	Price
10	1000	5-7/8 x 1-3/4 x 3-7/8"	$1.85
4	1000	5-7/8 x 2-3/4 x 1-1/4"	.85
1	1000	3-5/7 x 2 x 1-1/16"	.50
1	500	2" x 1-1/4" x 1-1/16"	.25
.25	1000	1-1/2 x 1" x 3/4"	.25

CAPACITORS

.001 Mfd.—50 K.V. DC.—5⅛"x7¾"x4" $12.50
Insulators 4" Dia. x 7" High.
.1 Mfd.—25 K.V. DC.—13"x7"x4" $9.85

FREQUENCY METER

Range 350-450 Cycles, Weston 637, aircraft type, 3½".

Complete $4.95

All meters are white scale flush bakelite case unless otherwise specified.

ALL PRICES INDICATED ARE FOB, OUR WAREHOUSE, NEW YORK, N. Y.

Shipments Transportation Charges Collect Will Be Made Via Railway Express Unless Sufficient Postage Is Included, Or Other Instructions Issued. We Will Refund Excess Postage In Stamps.

POWERTRON Electrical Equipment Co.

117 LAFAYETTE STREET *Phone:* **WOrth 4-8610** **NEW YORK 13, N. Y.**

SPECIALIZED ELECTRONIC MATERIAL

HIGH QUALITY • LOW PRICE • IMMEDIATE SHIPMENT

TRANSTAT VOLTAGE REGULATORS

Manufactured by Amertran, three Models are available

Model #TH 2½B
Fixed Winding 230/130
Commutator range 0-260 Volts, .65 KVA.
Max. amp. 2½
Price $19.95

Model #29144
Fixed Winding 115 Volts—60 cycles
Commutators range 103-126 Volts
Maximum output .25 KVA
Housed in shielded case 5" x 6" x 6"
Price $6.95

Type RH
Fixed Winding 115 Volts—400 cycles
Commutator range 75-120 Volts
Load — .72 KVA
Housed in Shielded case 5½" x 6" x 6½"
Price $1.95

RELAYS

Allied Control #B06D35 D.P.D.T. Coil 26 Volts D.C. Contacts 10 amps. A.C. at 115 Volts **Price $ .95**

Allied Control #BOY-X5 Coil 6 Volts D.C. Contacts D.P.D.T. plus SPST N.C. Heavy contacts **Price $ .95**

Aircraft-type Starter Relay Hermetically sealed coil 12 Volts 18 ohms. Very heavy contacts **Price $ .75**

Aircraft-Type Starter Relay Leach type #7220-3-24 Coil 24 Volts D.C. Res. 132 Ohms. Very Heavy Contacts .... **Price $ .75**

Isolantite Relay D.P.D.T. Heavy Contacts Coil 100 ohms. 12 Volts D.C. .... **Price $ .75**

Weston Mod. 705 Relay—meter type. Requires only 7½ microamperes (plus or minus) to close contacts. Coil resistance approximately 50 ohms. Solenoid reset coil—400 ohms at 18 volts D.C. Limited quantity. .... **Price $3.95**

Price Bros Co. Miniature type TB-302 SPST plus DPST N.O. Isolantile spacers Coil 300 ohms. 24 volts D.C. .... **Price $ .95**

Telephone Type Relay #D4544 D.P.S.T. Coil 1000 ohms 12 Volts D.C. .... **Price $ .95**

G.M. Relay D.P.D.T. plus S.P.S.T. Normally open coil 30 ohms 6 V. D.C. .... **Price $ .65**

G.E. 2 circuit: coil 10 volts DC contacts 50/20 amps 115 volts AC .... **Price $ .85**

G.E. #D106F3, coil 180 ohms. 24 volts DC Double Pole, Double throw .... **Price $ .65**

Allied #73B60. miniature type 26 volts Double Pole, Double throw, isolantite spacer **Price $ .95**

Clare #814680—Miniature, 300 ohms, 24 volts DC Four Pole—two throws .... **Price $ .95**

Leach #1054, coil 260 ohms. 24 volts DC Heavy contacts, two pole single throw .... **Price $ .95**

RCA Vacuum Relay, Relay contacts will break 3000 volts and carry 10 amperes Solenoid resistance 200 ohms, 24 volts DC—Excellent as R.F. antenna relay .... **Price $ .95**

Clare #818062—2 Pole single throw. Miniature type. Resistance 140 ohms. Will operate from 10 volts DC or 20 Volts AC .... **Price $ .95**

RELAYS

Telephone Type Relay #D161984 Dual Contacts Six Pole Double Throw Coil 700 ohms 24 Volts D.C. **Price $1.25**

Telephone Type Relay #DB28091 Dual Contacts 4 P.S.T. Normally open Dual Winding Coil 175 ohm and 180 ohm 12 V. D.C. .... **Price $ .95**

Miniature Relay #D4913 S.P.D.T. Coil 300 ohms 24 V. D.C. .... **Price $ .55**

Relays Allen Bradley Bulletin-810 Magnetic Overload Relay Dashpot type 28 amps continuous adjustable range 15-43 amperes. S.P.D.T. N.C. 600 Volts Max. .... **Price $1.95**

Allen Bradley Bulletin-810 Magnetic Overload Relay Dashpot type .15 amps. continuous adjustable range .095-.29 amps. D.C. Resistance 300 ohms S.P.S.T. N.C. 600 Volts Max. .... **Price $1.25**

Western Electric Stepping Selector Relay #86522 20 position indicating switch. Coil resistance 20,000 ohms .... **Price $6.25**

Struthers Dunn S.P.D.T. Relay 36 Volt coil—20 ma. Contacts 2 amps at 115 V.A.C. ... **Price $ .95**

Relay—D.P.D.T. Heavy contacts Coil 6 volts D.C. 18 ohms .... **Price $ .95**

Leach type 1154 D.P.S.T. Heavy contacts Coil 50 Volts 50/60 cycles .... **Price $1.25**

Leach type 1054-32 D.P.S.T. Heavy contacts Coil 32 volts D.C. 675 ohms. .... **Price $ .75**

Struthers Dunn #61BXX104 D.P.S.T. Coil 12 Volts D.C. Contacts 25 amperes at 12 Volts D.C. **Price $ .95**

Allied Control #D0X8 4 Make 4 Break. Heavy Contacts Coil 18 turns #10 enamelled wire **Price $ .75**

Relay S.P.S.T. WE Co. #D163781 unit encased in vacuum tube shell with octal base. 2 pins term for coil, two for switch, 2500 ohm 10 V.D.C. Operating current 4.3 ma. release current 2.5 ma. cont. rating 1 amp. Switching speed up to 200 cycles .... **Price $1.95**

Switchboard Relay, WE Co. #D164816 3 windings **Price $2.95**

TIME DELAY RELAYS

Thermal vacuum type
S. P. S. T. 100 ohm coil
24 Volts AC/DC
90 second delay .... **Price $ .95**

Cramer Time Delay Relay—#44SF3 N.L. Motor 115 Volts—60 cycles—Two Pole Switch 115 Volts at 10 amps—One circuit closes at 4 seconds, other circuit closes at 40 seconds. **Price only $4.95**

400 CYCLE TRANSFORMERS

Brand New, Surplus, Standard Manufacturers

Filament—Primary 115 Volts 400 cycles, Secondary 6.3 volts 2.5 amps. overall dimensions 2" Sq. x 2.5" .... **Price $ .75**

Scope Transformers — Primary — 115 Volts 400 cycles. Secondary 3300 Volts 5 MA 2.5 Volts 1.75 amps, overall dimensions 4" x 5" x 5" **Price $2.45**

HIGH FIDELITY INPUT TRANSFORMERS

Ferranti #4794 Balanced winding, shielded type. Description—Turns ratio step-up 2/1 primary inductance 133 Henrys ± 1 DB 60-9000 cycles. Can be used to match any single or push-pull plates to any single or push-pull grids—overall dimensions 2¼" x 3" x 2½" .... **Price $1.75**

TUBES

(New surplus priced for quick sale)

Type	Price	Type	Price
2C46	4.95	954	.45
2J55	9.75	957	.45
3B24	.55	9002	.35
3B25	.55	9003	.18
3C23	2.45	9006	.35
4B27	2.95	50	1.25
5D21	9.95	VR90	.75
4C33	2.95	VR105	.75
6AC7	.65	1626	.65
6E5	.60	1629	.25
6F8	.95	1R4	.65
6H6	.45	1631	.65
6SJ7	.45	1632	.25
6Y6	.65	1633	.65
23D4	.35	1644	1.25
45	.55	7193	.45
RK60	2.95	866 A	.95
VR78	.45	28D7	.45
HY114B	.45	724B	1.95
350B	4.95	3FP7	.95
388A	4.95	5FP7	.95
394A	2.95	RK72	.75
801	$ .45	RK73	.45
Sylvania 3 D6/1299			.75
GE VU1110E146			.45
Raytheon CK1005			.85

RADIO NOISE FILTERS

These line noise filters are available in large quantities and priced for quick sale.

Mallory NF 12-6EG—Housed in a bathtub type container and rated at 7 amps. 50 volts D.C. Solder lug terminals .... **Price $ .35**

Mallory NF7-3A—Housed in silver-plated rectangular case 3¾" x 1⅞" x 2½" with male and female amphenol AN3108 plugs .... **Price $ .95**

Mallory NF7-4—Housed in rectangular case 3" x 1½" x 7½". Internal screw terminals. Rated at 12 amperes—35 V.D.C. .... **Price $ .95**

Mallory NF2-2—Housed in square case 3¾" x 2½" high—Rated at 50 amperes 35 volts .. **Price $ .95**

General Electric Noise Filter—Housed in square case 4¼" by 3" high. Rated at 200 amperes at 50 volts .... **Price $ .95**

Mallory NF2-1—100 amps, 35 volts—Housed in shielded container 3¾" square x 2½" high screw terminals .... **Price $ .95**

Solar Elim-D-Stat—Type EA105—50 amps at 50 Volts—**$ .95.** Type EA109—50 amps at 35 volts. Both units are housed in container similar to Mallory NF2 .... **Price $ .95**

Bendix—model 3937—Generator Filter—50 amps. 120 Volts D.C.—Housed in shielded containers 4" x 3¾" x 8" .... **Price $1.25**

Line Noise Filter—Unshielded and mounted on a bracket Suitable for use on regular power lines—Consists of two .01 molded condensers and 140 turn solenoid choke coil .... **Price only $ .10**

4000-6000 VOLT LOW CURRENT DC SUPPLY

These units have been designed for use with television, cathode ray, electron multiplier and other types of equipment requiring high voltage with currents up to 1 milliampere. Brand new completely wired and tested. Ready to operate from 115 volt power line. D.C. output is filtered.
Price Complete $12.50

2000-3000 Volt D.C. Supply, similar to above, but with lower output voltage. Ready to operate from 115 Volt power line. **Price Complete $7.95**

Write for Descriptive Catalog Listing a Large Variety of Electronic Components

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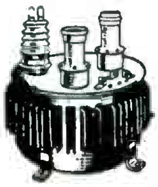
Telephone: WOrth 4-1169
NEW YORK 6, N. Y.

PULSE TRANSFORMERS



GE #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. PWR Out: 800 KW. Bifilar: 2.75 Amp. $19.50
Type G.E. K2450A Will receive 13KV, 4 micro-second pulse on pri., secondary delivers 14KV Peak power out 100KW GE..... $15.00
WE #D169271 hi Volt input pulse Transformer $9.95
GE #K2748-A Pulse Input, line to magnetron... $12.00
Pulse Xfmr. KS 9948, Imp ratio 700 to 50 ohms, 13 KVDC, unpotted, uncased $6.50
Pulse transformer for 725-A magnetron.... $12.65
Utah Pulse or Blocking Oscillator Transformer Freq. limits 790-810 cy-3 windings turns ratio 1:1:1 Dimensions 1 13/16x1¾x19/32...... $1.50
705-A Rectifier Tube, with Ceramic Socket. $1.25
WE #D166173 HI-Volt input transformer. Impedance ratio 50 ohms to 900 ohms. Freq. range: 10 kc to 2mc. 2 sections parallel connected, potted in oil $12.50
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

PULSE NETWORKS

GE #25E5-1-350-50P2T. 25 KV, 5 sections, "E" circuit, 1 microsecond pulse length, 350 PPS, 50 sections, .5 microsecond pulse, 2000 PPS, 50 ohms impedance $45.00
G.E. #6E3-5-2000-50 P2T. 6KV, "E" circuit, 3 ohms impedance $6.50
APQ-13 Pulse modulator. Pulse width, .5 to 1.1 micro sec, repetition rate 624 to 1348 PPS, pk pwr. out35 KW. Energy 0.018 Joules.... $49.00

MICROWAVE SPECIALS

"X" BAND RF HEAD, AN-APS/15B. Complete with all tubes, magnetron, duplexer section, receiver section, mixer section, blower, pulse transformer, HV rectifier. New and complete. $150.00
10 CM. RF Package. Consists of: SO Xmtr.-receiver using 2J27 magnetron oscillator, 250 KW peak input. 707-B receiver-mixer... $150.00
Modulator-motor-alternator unit for above.. $75.00
Receiver rectifier power unit for above...... $25.00
Rotating antenna with parabolic reflector. New $75.00
"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. 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. Controls: sweep phasing, range, altitude. 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
10 cm. waveguide switch, for switching 1 input to any of 3 outputs. Standard 1½" x 3" sq. flanges. Complete with 115 v. ac or dc arranged switching motor. New, complete $260.00
BC 701-A RADAR RECEIVER, Part of SCR 521 and ASE eqpt. 176 mc operation, receives bi-lobed search and homing patterns. Complete with tubes and antenna switching motor.. $37.00
BC 704-A SCOPE, part of SCR 521 and ASE equipment. "L" scope with linear range sweep upward from bottom. Suitable for search, homing, on beacon or target. With all tubes, including 5BP1 .... $17.50

MICROWAVE TEST EQUIPMENT

W. E. I 138 A. Signal generator, 2700 Mc range. Lighthouse tube oscillator with attenuator & output meter. 115 VAC input, reg. Pwr. supply. With circuit diagram $50.00
10 cm oscillator cavity for 2C40 lighthouse tube, with attenuator, thermistor, pickup loop. Heavy silver-plated casting $50.00
TS-238 GP. 10 cm. Echo box with resonance indicator and micrometer adjust cavity....... $85.00
3 cm. wavemeter: 9200 to 11,000 mc transmission type with square flanges. (Also available in absorption type with square and circular flanges) $15.00
3 cm. stabilizer cavity, tunable transmission type. Model 1551 (TFX 11GA) $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 10,000 Mc. $75.00

COAX CABLE

RG 18/U, Armored, 52 ohm imp....... Per ft. $ .51
RG 24/U, Twin Coax, 125 ohm imp. Armored Per ft. $ .51
RG 28/U, 48 ohm imp. .... Per ft. $ .51

CONNECTORS

UG 254/U .... $ .75
UG 255/U, Adapts UG 254/U to Amphenol low loss series .... $ .85

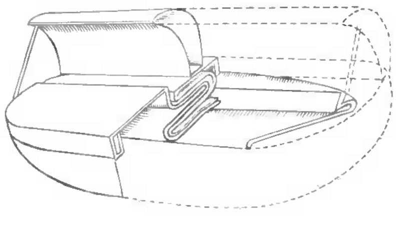
AMPHENOL "83" SERIES

831R chassis receptacle .... $ .35
831SP male connector .... $ .35
831AP, right angle adapter .... $ .35

EXPERIMENTAL EQUIPMENT

"Communications"

RADAR
AIRCRAFT
INDUSTRIAL



AN MPG-1 Antenna. Rotary feed type high speed scanner antenna assembly, including horn parabolic reflector, as illustrated. Less internal mechanisms. 10 deg. sector scan. Approx. 12'L X 4'W X 3'H. Unused................. $250.00
(Gov't Cost—$4500.00)
AS 125/APR Cone type receiving antenna. 1000 to 3200 megacycles. New $4.50
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
140-600 MC. CONE TYPE ANTENNA, complete with 25' sectional steel mast, guys, cables, carrying case, etc. New...................... $49.50
SO-13 ANTENNA. 24" dish with feedback dipole 360 deg. rotation, complete with drive motor and selsyn. New........... $75.00 Used.......... $45.00
AS 69/APT, TRANSMITTER JAMMING ANTENNA. Consists of 4 radiators, polarized for hor. and vert. radiation. Type "N" input. $18.50
DBM ANTENNA. Dual, back-to-back parabolas with dipoles. Freq. coverage 1,000-4500 mc. No drive mechanism $65.00

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. @ 144 ma, with choke. Oil immersed. Size: 26"x29"x13". Amertran $65.00
PLATE TRANSFORMER. Pri: 220 v, 60 cy. 3 phase, 30 KVA. Sec: 6150, 5620, 5050, 4500 volts. Oil filled. 89 gal. Size: 54"x32"x23". Amertran. Approx. wt. 1500 lbs......... $250.00
Plate Transformer: Pri: 115/230 v.a.c., 50-60 cy. sec: 21,000 v. 100 ma.................... $145.00
Plate Transformer: Pri: 115 v.a.c., 400 cy. Sec: 9800 or 8600 v. @ 32 ma. dc........... $12.50

REGULATORS

LINE VOLTAGE REG 2 KW Saturable reactor type Pri 95-130 v 60 cy Sec 115 v 60 cy. 17.4 A 2 Kw 100% PF $160.00
LINE VOLTAGE REG Pri 92-138v 57/63 cy 1ph15A Sec 115v 7.15A .82 Kw 96% PF.. $135.00

OIL CONDENSERS

.25 mfd @ 20,000V. DC..................... $17.50
.1 mfd @ 10,000 KVDC, 14F191............. $15.00
.0016 mfd @ 15 KVDC, # 26F700............. $8.45
.015 mfd @ 16 KVDC, # 25F835.............. $7.50
.005—.005—.01 mfd @ 10 KVDC, GEPYR #26F344 .... $6.95
.06 mfd @ 15 KVDC, 25F585-G2 .... $8.70
2X.1 mfd @ 7,000 vdc, 25F774 .... $3.95
Precision condenser: #D-166602, 16 mfd @ 400 vdc, temp comp—50 to 85 deg C. $7.50
Precision condenser: D-161270, 1 mfd @ 200 vdc, temp comp —40 to plus 65 deg. C. $5.00

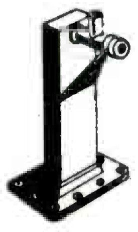
MICA

STANDARD BRAND

.08 mf @ 1500 VDC, MX60 .... $11.50
.03 mf @ 2000 VDC, 551A-50................ 12.75
.045 mf @ 2000 VDC, G1 .... 12.75
.00015 mf @ 20 KV, 1970-404................. 25.00
.0001 mf @ 20 KV, G3......................... 25.00
.0051 mf @ 15 KV, G4......................... 25.00
.006 mf @ 10 KV, G3......................... 17.50
Isolating Capacitor. PL 1417, 406-110 mmf @ KV AC (peak) Each.................. 3.50

MICROWAVE PLUMBING

10 Centimeter



Sand Load (Dummy Antenna) wave guide section with cooling fins. app. 23" high.... $28.00
Waveguide to flexible coax coupler (RG 18/U), with flange Gold plated. App. 10" high (as shown) $17.50
Magnetron to waveguide coupler with 721-A duplexer cavity, gold plated $45.00

10 CM PLUMBING

721-A TR cavity with tube. Complete with tuning plungers $5.50
Line Stretcher complete with remote control cable in standard guide with square flanges.... $50.00
Waveguide section, MC 445A, rt. angle bend, 5½ ft. OA, 8" slotted section............. $15.00

⅞" RIGID COAX—⅜" I.C.

Right angle bend, with flexible coax output pickup loop $3.00
Short right angle bend, with pressurizing nipple $2.00
30 ft. flexible section, ⅞ rigid to ⅞ rigid... $7.50
Rigid coax to type "N" adapter.......... $5.00
Stub-supported rigid coax, gold plated. 5' lengths. Per length $5.00
Rt. Angles for above........................ $2.50
⅞" coax, rotary joint........................ $8.00
Magnetron coupling to ⅞" rigid coax......... $4.00
⅞" coax, rt. angle bend 15" L. OA.......... $2.00
Slotted section, 10" long.................. $5.50
Flexible section, 15" L. Male to female. Pressurized $3.25

⅞" RIGID COAX—¼ I.C.

Short right angle bend..................... $2.05
Rotating joint, with deck mounting......... $5.00
Rigid Coax Slotted Section, CU 60-AP...... $5.00

3 CM. PLUMBING

(Standard 1" x ½" guide unless otherwise specified)

TR cavity for 724-A TR tube, transmission or absorption types $3.50
724-A TR tube................................. $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" radium, 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 wavemeter iris flange $4.00
CG/APS-3, straight waveguide section. 10" choke to cover $1.75
Right angle elbow, 5½" choke to cover, 2½" radius, E or H plane................................ $5.00
Twist, 90 deg., 6" choke to cover............ $5.00
Waveguide sections 2½" long, silver plated, with choke flange $3.50
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, 1⅛" x ½" ID 1/16" wall per ft. $1.25
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
Waveguide to Type "N" Coax Adapter...... $6.50
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

RADAR SETS

RC 145 IFF SET. Consists of BC 1267 xmtr-rcvr, remote antenna controller and indicator I-221, power supply RA 105-A, 1 kw. pulse oscillator operates on 154-186 mc. Operates from 117 v., 60 cy. New $190.00

THERMISTORS
($.95 ea.)
Standard Brand
D-167332 (Bead)
D-170396 (Bead)
D-168392 (Button)
D-168391 (Bead)

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CROSS POINTER INDICATOR
Two 0-200 microampere movements, 3" case, many applications $2.50

STANDARD BRAND CONDENSER
1 MFD 600 VOLTS DC
152 IN BOX
$2.00 PER BOX

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SPECIALS OF THE MONTH

HASH FILTER CHOKES FOR MERCURY VAPOR TUBES
CARRIES 500 MA LOAD
59c pr.—2 pr. $1.00

STEP DOWN TRANSFORMER

PRIMARY 440/220 VOLTS
SECONDARY 230/115 VOLTS
600 KVA
$14.95

SELENIUM RECTIFIERS
Full Wave Bridge Type

INPUT	OUTPUT		
up to 18v AC	up to 12v DC	1 Amp.	$1.95
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 54v AC	up to 36v DC	.25 Amp.	.98
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

OIL CONDENSERS
NATIONALLY ADVERTISED BRANDS
All Ratings, D. C.

2x.1mfd.	600v	$0.35	1mfd.	2000v	$0.95
.25mfd.	600v	.35	3mfd.	2000v	2.75
.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
.25mfd.	2000v	1.05	2mfd.	3000v	3.45
.5mfd.	2000v	1.15	2x.1mfd.	7000v	3.25

HIGH CAPACITY CONDENSERS

2x3500 mfd.—25 WVDC $3.45
1000 mfd.—15 WVDC .... .99
100 mfd.—50 WVDC .... .49
4x10 mfd.—400 VDC .... .89

CODE KEYER TG-10

This practice Code Keyer contains a 7 tube 110 volt 60 cycle Amplifier plus an electric eye tube. It also contains a 110 volt 60 cycle motor which runs your code tape through at the rate of 5 to 25 words per minute. The amplifier would make an excellent P.A. system and the motor would turn a timetable very nicely.

NEW—$24.95
(Less Tubes)

R5/ARN-7 RADIO COMPASS RECEIVER

Three bands 200 to 1750 K.C. Complete with 17 tubes required. This set is ideal for conversion to home broadcast Receiver, addition to ham shack, etc. A Receiver that would be hard to pick up at this price.

Only $31.95—NEW USED—$17.95

BC 733 RECEIVER

A Western Electric 10 tube Receiver cover 100-120 Mc. Complete with 10 tubes, crystals, etc.

New **$12.95**
Used .... **$ 7.95**

PERMALLOY SHIELDS for CATHODE RAY TUBES

3" Shield $1.49
5" Shield 1.98

TUBES (*Brand New*)
Standard Brands

1N21	$0.39	F-127A	$22.50
2AP1	2.25	371B	5.95
2C40	1.19	450TH	39.95
2D21	.89	703A	7.95
2V3G	1.25	715B/C	12.95
2X2	.84	721A	4.35
3AP1	3.00	723A/B	23.50
3BP1	2.95	726A/B	23.50
3E29	2.95	801	1.49
3GP1	3.95	802	1.98
5BP4	4.94	803	8.95
5CP1	3.95	804	9.95
5JP1	11.95	805	4.95
5LP1	11.95	806	14.95
5R4GY	.98	807	1.15
5Y3	.39	808	2.95
6AB7	1.20	809	1.50
6AC7	1.20	810	6.95
6AG5	1.20	811	1.95
6AG7	.99	812	3.15
6AJ5	.99	813	8.95
6AK5	.90	814	4.45
6AL5	.81	815	3.95
6AQ6	.81	829-A-B	3.95
6AR6	1.29	832	2.25
6B4G	1.20	833A	39.50
6C4	.67	836	1.75
6C5	.67	837	2.50
6D4	.99	838	3.95
6F6	.81	861	69.50
6F6G	.67	866	.75
6J4	1.50	872A	2.50
6J5	.62	884	.98
6J6	.89	885	.98
6L6G	1.20	902P1	8.45
6L7	.98	954	.75
6N7	.99	955	.75
6SH7	.81	956	.75
6SL7	.91	957	.75
6SN7	.91	958	.75
6SR7	.67	959	.75
7A4/XXL	.81	1005	.69
7F7	.99	1616	2.94
7L7	.99	1619	.75
10Y	.98	1622	1.98
15E	1.50	1624	.90
HK24G	1.75	1625	.75
28D7	.98	1626	.75
30	.31	8001	6.49
35T/TG	3.50	8005	4.95
VR75	.99	8011	3.75
VR90	.75	8016	1.65
VR105	.75	8025A	4.95
VR150	.75	1654	1.98
100TH	12.95	9001	1.15
100TS	3.00	9002	.98
211	1.25	9003	.98
75T	2.95	9004	.98
250TH	17.50	9005	.98
257B	6.49	9006	.98
304TH	9.95	F-128A	75.00

GLIDE PATH RECEIVER R-89/ARN-5

Glide Path Receiver used in the Instrument Landing System covering the frequency range 332 to 335 mc; complete with the following tubes: 7—6AJ5, 1—12SR7, 2—12SN7, 1—28D7, including three crystals 6497KC, 6522K, 6547KC.

Brand New **$14.95**
Used .... **$ 9.95**

TRANSFORMER—115 V. 60 Cyc.
HI-VOLTAGE INSULATION

3710v @ 10 ma.; 2x2½v @ 3A	$9.95
2500v @ 15 ma	6.50
2500v @ 4 ma.; 2½v @ 2A. 6.3v @ 1 amp	7.95
2150v @ 15 ma	5.50
1750v @ 4 ma.; 6.3v @ 3A	6.50
1600v @ 4 ma.; 700v CT @ 150 ma.; 6.3v @ 9A	7.95
1200v CT @ 400 ma.; 10v CT @ 10A	9.95
550-0-550 @ 150 ma.; 5v @ 3A; 2x6.3v @ 5A CT	7.95
525-0-525v @ 60ma.; 925v @ 10ma.; 2x5v @ 3A; 6.3v @ 3.6A; 6.3v @ 2A; 6.3v @ 1A	7.95
520-0-520v @ 120ma.; 5v @ 2A; 6.3v CT @ 2A	1.98
500-0-500v @ 25 ma.; 262-0-262v @ 55 ma.; ma.; 6.3v @ 1A; 2x5v @ 2A	4.49
500-0-500v @ 100 ma.; 5v CT @ 3A	4.95
400-315-0-100-315v @ 200 ma.; 2.5v @ 2A; 5v @ 3A; 6.3v @ 9A; 6.3v ; 9A	6.50
400-0-400v @ 200 ma.; 5v @ 3A	4.95
375-0-375v @ 400 ma	4.95
350-0-350v @ 150 ma.; 5v @ 3A; 6.3v @ 6A; 78v @ 1A	4.95
350-0-350v @ 45 ma.; 675v @ 5 ma.; 2½v @ 2A; 2x6.3v @ 1A; 6.3v @ 2½A	4.95
350-0-350v @ 80 ma.; 6.3v @ .6A; 6.3v @ 3.75A; 2x5v @ 3A	3.98
385-0-385-550v @ 200 ma.; 2½v @ 2A; 5v @ 3A; 3x6.3v @ 6A—PRI. 110/220	7.95
350-0-350v @ 150 ma.; 5v @ 3A; 6.3v @ 7.5A; 6.3v @ 3A	4.95
350-0-350v @ 35 ma	1.49
340-0-340v @ 300 ma.; 1540v @ 5 ma	5.95
335-0-335v @ 60ma.; 5v @ 3A; 6.3v @ 2A; 0-13-17-21-23v @ 70 ma.—PRI. 110/220	4.95
325-0-325v @ 120 ma.; 10v @ 5A; 5v @ 7A	3.49
300-0-300v @ 65 ma.; 2x5v @ 2A; 6.3v @ 2½A; 6.3v @ 1A	3.49
250-0-250v @ 100 ma.; 2x6.3v @ 4A; 6.3v @ 5A; 6.3v @ 1A	4.95
120-0-120v @ 50 ma	.98
80-0-80v @ 225 ma.; 5v @ 2A; 5v @ 4A	3.95
24v @ 6A	3.5
13.5v CT @ 3.25A	2.95
3x10.3v @ 7A; CT	9.95
12.6v CT @ 10A; 11v CT @ 6.5A	7.95
6.3v @ 10A; 6.3v @ 1A	3.50
6.3v @ 1A; 2½v @ 2A	3.45
6.3v @ 21½A; 6.3v @ 2A; 2½v @ 2A	5.95
6.3v @ .25A; 6.3v @ 3A; 5v @ 12A; 6.3v CT @ 9A	4.95
5v—190A .... 17.50 / 6.3v @ 1A	.98
5v—115A .... 14.95 / 8v CT 1A	.98
220v to 110v @ .75 kv	2.98
6.3v CT @ 3A; 5v CT @ 4A	4.25

FILTER CHOKES
HI-VOLTAGE INSULATION

10 hy @ 400 ma	$4.95	325 hy @ 3 ma	$3.49
8 hy @ 300 ma	3.95	1 hy @ 800 ma	14.95
25 hy @ 160 ma	3.49	10 hy @ 250 ma	2.49
12 hy @ 150 ma	2.25	10 hy @ 200 ma	1.98
12 hy @ 100 ma	1.39	10/20 @ 85 ma	1.59
30 hy @ 70 ma	1.39	15 hy @ 125 ma	1.49
.05 hy @ 15 amps	7.95	15 hy @ 100 ma	1.39
.1 hy @ 5 amps	6.95	3 hy @ 50 ma	.29
4 hy @ 600 ma	5.95	30 hy Dual @ 20 ma	1.49
200 hy @ 10 ma	3.49	8/30 hy @ 250 ma	3.50
600 hy @ 3 ma	3.49	10 hy @ 100 ma	1.29

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RELIANCE SPECIALS

RG 8/U

NEW-UNUSED

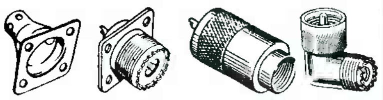
52 OHM

COAXIAL CABLE

500-2500 feet	$30.00 per M
3000-5000 feet	27.50 per M
5500-10.000 feet	25.00 per M
10,000-20.000 feet	22.50 per M
over 20,000 feet	20.00 per M

No charge for reels.

COAXIAL FITTINGS



Hood 10¢ Socket 40¢ SD 239 83-1R Plug 40c PL 259 83-1SP Angle Adaptor 40c M-359 83-1AP

PL259A, 83-1SPN, 83-1AP, UG21U, CUF 49190 (83-ISP with small hole for RG59U Coaxial Fittings UG255U (Adaptor, takes 83-ISP one side & UG88U other), UG85U Baby "N" plug, UG87U Baby 'N' socket, UG27U.............40c each

83-22SP, 83-22R, 83-22J, 83-22AP...50% off current list price.

UNIVERSAL JOINT

ALUMINUM

1 1/8" lg. x 1/2" OD

1/4" ID 35¢

BC 1072A IFF X'MITTER

in MAPLE CHEST — 150 to 200 Mcs, 115 V., 60 Cyc.

POWER SUPPLY gives: 0-5000 v.d.c. (variac control) 312 v.d.c., 700 v.d.c., 6.3 vac. Also contains: 11 tubes (6J5, 826, 6SN7, 5U4G, etc.). 5 KV meter, Blower, Condensers and many other useful parts too numerous to list. Shipping Wt. 245 lbs.

Only .... (used) $22.50

TUBULAR PAPER CONDENSERS

.0015 mfd	800V 6¢	.1	600V	9¢
.0025	1000V 8¢	.25	400V	12¢
.01	400V 6¢	.25	600V	15¢
.02	400V 6¢	.5	50V	5¢
.05	400V 8¢	.5	200V	8¢
.1	200V 6¢	1	200V	15¢
.1	400V 8¢			

METERS (3½" diameter)

TOTAL HOURS—0 to 10,000 hrs. Measured in tenths.

11 V., 60 cyc.—$5.00 0–15V. AC —$4.20
0–8 RF amp. —$3.50 0–350V. DC—$4.20
0–7.5V. AC—$4.00

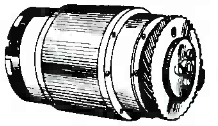
TACHOMETER MAGNETO

Model 44A

Weston

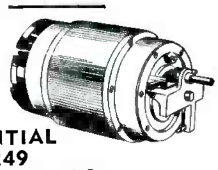
ONLY $37.50

SELSYNS



ONLY $7.25 pair

115 V., 60 Cyc., 3¼" dia. x 1½" body SELSYN #C78248
Also 50 V., 50 Cyc. $4.75 pair. Used in Pairs for Remote Control.



ONLY $2.25 ea.

SELSYN DIFFERENTIAL #C78249

115 V., 60 Cyc.

Used between two #C78248 as dampener. Can be converted to a 3600 RPM Motor in 10 Minutes. Instruction sheet supplied.
Also 50 V., 50 Cyc. $1.25 ea.

400 MA CHOKE

12 H., 90 ohm DC 12 lb. net, 4½"x5⅜"x 4¼" high, four ¼" mtg. holes, hermetically sealed.

Only $3.85

95¢ CHROMALUX STRIP HEATER

115 V. 750watt

20" x 1½"

ALLEN SET SCREWS

2-56x1/16	6-32 x1/8	8-32x3/8
4-40x1/8	8-32x1/8	1/4 20x1/2
4-40x3/16	8-32x3/16	3/8-16x7/16

All sizes .... $1.50 per C
Wrenches .... 2¢ each
(2-56 size out of stock)

BALL BEARINGS

	ID	OD	
FAFNIR 33K5	3/16"	1/2"	35¢
XA 134RPP	1/4"	5/8"	35¢
FAFNIR 38K	5/16"	1-3/64"	35¢

NEEDLE BEARINGS

		I.D.	O.D.	
B88	1/2" wide	1/2"	11/16"	25¢
B108	1/2" wide	5/8"	13/16"	30¢
GB34X	1/4" wide	3/16"	11/32"	25¢

PRECISION RESISTORS

¼ WATT—30¢

OHMS	Tol.	OHMS	Tol.	OHMS	Tol.
6.68	¼%	14.98	¼%	220.4	¼%
10.48	¼	16.37	¼	301.8	¼
10.84	¼	20.	1	366.6	¼
11.25	¼	62.54	¼	414.3	¼
11.74	¼	79.81	¼	705	1
12.32	¼	105.8	¼	2193	¼
13.02	¼	123.8	¼	3500	10
13.52	¼	125	¼	10,000	1
13.89	¼	147.5	¼	59.148	¼

½ WATT—30¢

OHMS	Tol.	OHMS	Tol.	OHMS	Tol.
.250	1%	125	¼%	2850	1%
.334	1	180	1	3427	¼
.502	1	210	1	4,000	2
.557	1	235	2	4,000	2
.627	1	235	2	4,000	1
.76	1	235	1	4,300	2
1.01	½	260	1	4,451	¼
1.53	1	270	1	5,000	1
2.04	1	298.3	¼	5,000	1
2.25	1	320	.1	5,900	1
11.1	1	400	1	6,500	1
13.15	1	400	1	7,000	1
20	1	400	1	7,000	1
46	1	723.1	¼	7,300	2
52	¼	900	5	7,500	1
55.1	1	1500	1	7,500	1
66.6	5	2500	1	8,000	1
75	1	2500	1	8,000	1
97.8	¼	2500	1	8,500	1

½ WATT—35¢

OHMS	Tol.	OHMS	Tol.	OHMS	Tol.
10,000	1%	25,000	1%	100,000	1%
10,000	1	30,000	1	100,000	1
14,825	¼	37,000	1	100,000	5
15,000	1	50,000	2	150,000	½
15,000	1	50,000	2	150,000	½
15,750	1	50,000	1	180,000	5
17,000	1	68,000	5	500,000	3
20,000	1				

1 WATT—30¢

OHMS	Tol.	OHMS	Tol.	OHMS	Tol.
.5	2%	5.21	1%	1250	1%
1.01	1	10.1	1	3300	1
2.58	1	10.9	1	5000	1
5	1	100	1	7000	1
3.39	1	270	1	9000	1
5.05	1	420	2		

1 WATT—35¢

OHMS	Tol.	OHMS	Tol.	OHMS	Tol
12,000	2%	50,000	10%	68,000	5%
18,000	1	50,000	1	70,000	1
20,000	1	55,000	1	75,000	1
30,000	1	56,000	10	84,000	2
		65,000	1		

1 WATT—45¢

OHMS	Tol.	OHMS	Tol.	OHMS	Tol.
100,000	1%	160,000	1%	522,000	½%
120,000	1	180,000	1	522,000	½
125,000	1	250,000	1	525,000	1
128,000	1	250,000	1	600,000	1
130,000	1	320,000	1	700,000	1
158,000	2	470,000	1	1 meg	5

1 WATT—75¢

OHMS	Tol.
1 meg	1%

Any order for
100 pieces or more—10% off
Any order for
1000 pieces or more—20% off

OIL FILLED CAPACITORS

.1 mfd	7500 V. DC	$1.95	2 mfd	750 V. AC (2200 V. DC)	$ .55
.1–.1 mfd	7000 V. DC	2.45	4 mfd	2000 V. DC	3.90
.1 mfd	7000 V. DC	1.95	1 mfd	2000 V. DC	.80
.02–.02 mfd	7000 V. DC	1.65	4 mfd	1000 V. DC	1.00
.1 mfd	6000 V. DC	1.65	3 mfd	1000 V. DC	.90
.02–.03 mfd	6000 V. DC	1.60	1 mfd	800 V. DC	.40
.03–.03 mfd	6000 V. DC	1.65	1 mfd	600 V. DC	.35
.01 mfd	6000 V. DC	1.45	4 mfd	600 V. DC	.69
.4 mfd	2500 V. DC	3.50			

TUBES (brand new)

1A5 GT	$.69	6AC7	$.77	6X5 GT/G	$.60
1A7 GT	.80	6AG5	.83	6V6 GT/G	.55
1H5 GT	.69	6AJ5	.90	12Q7 GT/G	.70
1L4	.65	6AK5	.86	12SA/7 GT	.60
1LC6	1.29	6B8 G	.79	12SH7	.47
1LH4	1.29	6C4	.29	12SQ7	.70
1LN5	1.29	6C5	.61	25L6 GT	.70
1N5 GT	.75	6F6	.61	35Z5 GT	.50
1R5	.70	6H6	.47	117Z6 GT	1.10
1S5	.75	6J6	.69	826	.99
1T4	.50	6K6 GT	.65	2050	.82
2D21	.58	6K7	.60	9001	.69
2X2/879	.69	6K8	.95	9002	.69
3A4	.61	6L6 GA	.98	9003	.69
3C24	.98	6Q7 GT	.90	9004	.69
3Q4	.60	6SF5 GT	.80	9006	.69
3Q5 GT/G	.85	6SF7	.80	VR105	.70
3S4	.65	6SG7	.70	VR150	.70
5U4	.73	6SH7	.38	VT62	.47
5W4 G	.80	6SJ7	.69	VT76	.70
5X4 G	.72	6SK7	.55	75	.70
5Y3 GT	.43	6SL7 GT	.80	77	.70
5Z4	.85	6SN7	.83	78	.70
6A7	.80	6SR7	.70	C5B	4.95
6AB7	1.10	6SQ7	.70	FG41	49.50

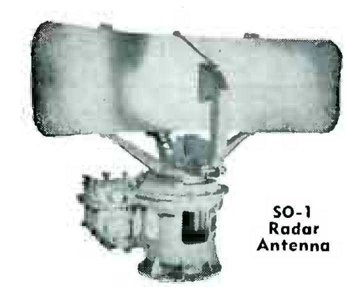
RELIANCE *Merchandizing Company*

Arch St. Cor. Croskey, Philadelphia 3, Pa.

Telephone RIttenhouse 6-4927

f.o.b. PHILA., PA.

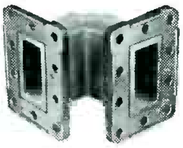
MINIMUM $3 ORDER



SO-1 Radar Antenna

RADAR ANTENNAS

Type SO-1—$125.00
Type SO-8—$120.00 Type SO-13—$70.00
TDY—$95.00



10 CM WAVEGUIDE

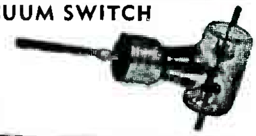
90 degree elbow—Bronze—Brand New

Price $20.00

RIGID COAX ASSEMBLIES

9/16" dia. Brass Couplings at each end—24" lengths .... $.90
9/16" dia. Brass Couplings at each end—30" lengths $1.05
9/16" dia. Brass Couplings at each end—48" lengths $1.80

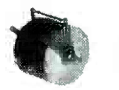
SPERTI VACUUM SWITCH



Used in Art 13 Transmitter

Price $1.75

SELENIUM RECTIFIER



Bridge Type: Input 36 volts—Output 28 volts, 1.1 amps.

Price $2.75

STEPDOWN TRANSFORMERS

Input: 115 V.-60 cy. Output: 20 V., at 10 amps. Also tapped at 6V., for pilot light. Ideal for Selenium Rectifier Applications.

Price $2.45

STROBOTRONS

Type SS501
Brand New
Price $6.45

W.E. TYPE D-168479 MERCURY CONTACT RELAY

Brand New War Surplus in Original Cartons

For application 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.

Price $4.75

KOLLSMAN MAGNETIC COMPASSES

(Brand New)

Type B-16

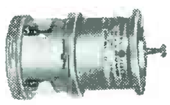
Price $9.75

HIGH PRECISION 100 KC CRYSTALS

Price $3.95 each

(No C. O. D.'s. Please include 25c for postage and handling.) Brand New Surplus at about 1/10 Gov't. cost. An ideal Frequency Standard for Amateurs, Servicemen, Laboratories, etc.

Exceptional Frequency Stability ± 15 cycles from —50° to + 80° c. (.0015) 10 G Vibration Test. Calibrated at 30° c. Brand New. Mounted in Sealed Cases as Shown.



SELSYN GENERATOR

Type 2JIF3—115 volts—400 cycles. Brand New.

Price $1.95

Also large stock of other types of Synchros as follows:
5B, 5G, 5SF, 5SDG, 5DG, 6DG, 7G, C78414, C78863, 2J5FBI, CAL 18300, C78411, AY101D, etc.

PANORAMIC ADAPTER TYPE AN/APA-10

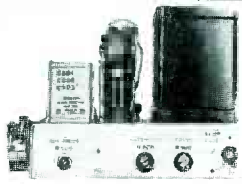
Total 21 tubes including 3" scope tube. Converted for operation 115 v. 60 cycles. Tested and guaranteed in perfect operating condition. **$97.50**

VOLTAGE REGULATOR CHASSIS AN/APA-10

Consists of 3 filter capacitors, choke, 2-VR150 tubes, etc. Can be used to regulate any 300 volt power supply and provides 300 and 150 volt regulated taps. Complete as shown.

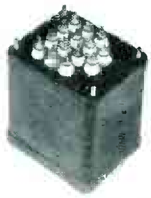
Price $5.75

AN/APA-10 POWER SUPPLY



Input:
80 or 115 volts, 400 to 2600 cycles

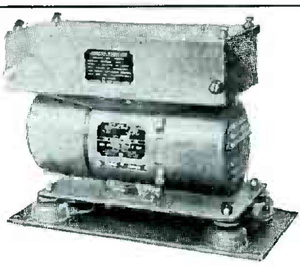
Output:
1200 volts D.C. at 1.5 MA.
400 volts D.C. at 130 MA.
6.4 A.C. volts at 0.8A (ins. for 1500 v. D.C.)
Includes tubes: 1—5R4GY, 1—2x2, 1—6AK5, cathode ray tube socket, resistance capacitance filter, two focus controls, an intensity control and 6AK5 reinserter circuit.
Brand new. Complete $13.75



AN/APA-10

400-2600 cycle POWER TRANSFORMER

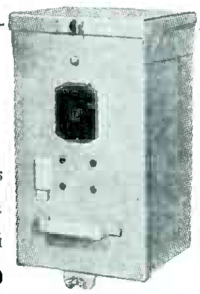
As used in Power Pack Described Above $4.75

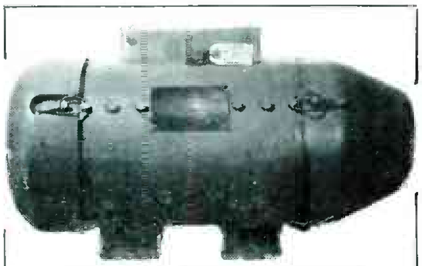


U. S. NAVY TYPE CAJO-211444 DYNAMOTOR and SWITCH BOX

Input: 105/130 V.DC at 6 amps.
Output: 13 V.DC at 40 amps or 26 volts at 20 amps.
Designed for radio use. Fully R.F. filtered. Complete with Square "D" switch box, spare fuses, brushes, etc. Brand New, packed in original wooden cases.

Price $59.50





MOTOR GENERATORS

Brand New War Surplus Machines built by Allis Chalmers Co. to U. S. Navy Specifications.

Input: 115V. D.C. at 14 amps., 3600 rpm. Output: 120 V. A.C., 60 CY, 1 ph. at 10.4 amps., 1000 Watts continuous duty. Ball bearings. Splashproof. Fully enclosed. Centrifugal starter. Frequency adjustable to load. **Price $97.50.**

Same machine but for 230 V. D.C. input. Price $125.00. Spare parts kit with extra brushes, brush-holders, field coils, bearings, etc., for either machine, **$29.50.**

400 CYCLE INVERTERS

Pioneer type 12123-1-A. Input: 24 V.DC. 12 amps. Output: 115 V., 400 cy., 3 ph. Capacity 100 va. New .... Price $79.50
Pioneer Type 12121-1-A. Input: 24 V.DC., 18 amps. Output: 115 V., 400 cy., 3 ph. Capacity 250 va. New .... Price $89.50

G. E. AMPLIDYNES

Type 5AM21JJ7 .... Price 49.50
Type 5AM45DB20 .... Price 89.50

All prices quoted are fob Tuckahoe, N. Y. (About 20 miles N. of N. Y. C.)

ELECTRONICRAFT, INC.

All merchandise guaranteed. Immediate delivery, subject to prior sale.

5 WAVERLY PLACE PHONE—TUCKAHOE 3-0044 TUCKAHOE 7, NEW YORK

Finest of surplus at a fraction of cost

PEAK ELECTRONICS CO.

Industrials
Schools - Labs

3 METER BARGAINS FOR THIS MONTH

$2.95 EACH
10 FOR $24.75

- 2" GE 0-1 Amp RF (Internal Thermo)
- 2" GE 0-30 Amps DC (Internal shunt)
- 2" Sun 0-1 MA Basic (Volt Scale)

METER SPECIALS

1½" GE 0-1 MA Basic	$3.95
2" GE 0-5 ma (amp scale)	1.95
2" GE 0-1.2 ma (0-100 scale)	2.49
2" Weston type 507 0-120 ma RF	4.95
2" GE 0-1 ma (volt scale)	2.95
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
3" Weston—10 to 14 DB	5.45
3" Weston—10 to +14 DB	5.95
3" Westinghouse 0-50 amps AC	4.95
3" Triplett 0-75 amps AC	3.95
3" WE 0-80 ma DC	2.95
3" GE 200-0-200 volts DC	2.95
3" McClintock 0-1 ma	3.95
3" Westinghouse 0-2 ma DC	3.95
3" Westinghouse 0-20 ma DC	3.95
3" GE 0-15 ma DC (square)	3.95
3" Westinghouse 0-150V AC	3.95
3" Westinghouse 0-150 volts AC Rectifier type (Linear)	5.95
3" WE 0-50 microamps	9.95
3" GE Running Time Meter	7.95
4" GE 1-0-1 ma DC (Blank scale)	3.95

WIRE WOUND RESISTORS

Standard Make

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

Standard Make

200-2500-5000-8500-10000 ohms	.39 ea.
50000-95000 ohms	.49 ea.
100000-750000-1 meg	.89 ea.

S. C. TEST SET—1-114

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

U. H. F. COAX. CONNECTORS

UG12U—831R—831J—UG21U—831AP—831SP
.39 ea.

Large stocks of Coax, and A/N connectors.

VARIABLE CERAMICON TRIMMERS

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

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 on 8¾"x19" rack panel. Complete with tubes. Slightly used but perfect. Only $59.50

MEGOHM METER

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

MIDGET VARIABLE BARGAINS

Hammarlund MC 250S 250 mmf	$ .69
Hammerlund MC 320S 320 mmf	.79
Hammarlund APC 100 100 mmf	.39
Bud MC 913 Dual 35 mmf. D.S.	1.25
Hammarlund HF 15 15 mmf	.39
National TMS 150 mmf	.79

"A CLOSEOUT" AMERTRAN TRANSTAT or Stepdown Transformer

110/220 volts 60 cycle input. Output variable plus or minus 10% of 115 volts at 8.5 amps. Also can be connected to give different voltage combinations. Brand new .... only $12.95
Limited Quan.

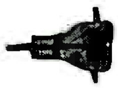
AMERTRAN VOLTAGE REGULATOR

130/230 volts 50/60 cycles input. Output variable from 0—260 volts. 1.3 KVA, single phase. Used but good $19.50

OIL CONDENSER

11 mfd 250 vac— .85
5 mfd 150 vac— .49
1 mfd 600 vdc— .29
2 mfd 600 vdc.— .39
4 mfd 600 vdc— .59
3/3 mfd 600 vdc— .79
10 mfd 600 vdc— .95
14 mfd 600 vdc—1.35
2 mfd 1000 vdc— .79
4 mfd 1000 vdc— .95
15 mfd 1000 vdc—2.95
2 mfd 1500 vdc—1.25
1 mfd 2000 vdc—1.45
2 mfd 4000 vdc—5.50
3 mfd 3000 vdc—3.95
1 mfd 5000 vdc—4.50
.15/.15 mfd 6000 vdc—1.95
.1 mfd 7500 vdc—1.95
.15/.15 mfd 8000 vdc—2.75
4 mfd 8 kv dc—19.95
.01/.01 mfd 12 kv dc—5.75
.005/.01 mfd 12 kv dc—5.50
.03 mfd 16 kv dc—5.75
.65 mfd 12,500 vdc—12.95
.75/.35 mfd 8/16 kv—12.95
.1 mfd 25 kv dc—17.50
.02 mfd 20 kv dc—7.95

SPERTI RF VACUUM SWITCH



9200 volts peak, 8 amps. Used as antenna switch in Collins ART 13. BRAND new $1.75

MISCELLANEOUS SPECIALS

2-11 mmf. Butterfly with ball bearings	$ .59
G.E. S.P.D.T. Relay 10000 ohm coil	.59
Heineman Circuit Breaker 5 amp. 110V. A.C.	.89
G.E. Solenoid W/Microswitches 24 V. D.C.	.69
25 ohms 25 watt Rheostat	.39
Microswitch 10 amps. (Interlock)	.59
C.H. Bat Handle Switch—D.P.S.T. ½ H.P.	.95
Veeder Root Counter	.95
4 Quadrant Phasing Condenser	1.95
Trim Commercial Phones (High Imp)	4.50

Tremendous stocks on hand. Please send requests for quotes. Special quantity discounts. Prices f.o.b. N Y. 20% with order less rated, balance C.O.D. Minimum order $3.00.

"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

"BRUTE FORCE"

This fully encased choke 6 Henry at 550 mills. 28 ohms dc resistance. Built to rigid Signal Corps specs. Net weight 16 lbs. 5⅛ x 4¼ x 5⅝. A great buy at $4.95 each. 10 for $40.00.

FILAMENT TRANSFORMER

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 lb. $3.75 each. 10 for $30.00.

VERSATILE POWER

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 250 mills and 6.3 volts 5 amps.
Type 505—115 volts 500 mills and 6.3 volts 2 amps.
Type 502—0-70-75 volts at 1.5 amps.

Fully encased—4 mtg. holes. 5⅛ x 4¼ x 5⅛.
Your cost any type .... $1.95 each
10 for $17.00. 100 for $150.00

STEPDOWN TRANSFORMER

220/110 volts. 100 watts. Fully encased. 5⅛ x 4¼ x 5⅛ .... $2.49 each

HIGH VOLTAGE MICAS

CD .001 600 W.V.	$ .19
CD .01 600 W.V.	.29
CD .027 600 W.V.	.49
CD .0005 5000 W.V.	.79
C.D. .002 2500 W.V. 5000 V.T. type 9	.49
C.D. .002 3500 W.V. 7500 V.T. type 9	.69
Micamold .005 2500 W.V. type 4	.69
Solar .005 10 KV. D.C. 11 amp. 3000 K.C.	7.95
C.D. .006 6 KV. D.C. 20 amp 400 K.C.	5.95
R.C.A. .02 2000V. D.C. 10 amp. 300 K.C.	1.75
Sangamo (F2L) .015 2000V. D.C.	1.50
C.D. (6H) .0013 5000V. D.C.	1.00
C.D. (6H) .005 5000V. D.C. 11 amp. 1000 K.C.	2.50
R.C.A. .0002 2500 W.V. 5000 V.T.	.30

CHOKE BARGAINS

WE 4.3 hy 620 42 ohms	$ 4.95
N.Y.T. 8 henry 160 ma. 140 ohms D.C.	1.39
C.T.C. 1.5 henry 250 ma. 72 ohms	.60
R.C.A. 50 henry, 680 ma high voltage	19.50

POWER PLANT (PE 197)

4 cylinder Hercules Gas driven engine. Output 110 volts 60 cycles, voltage regulated. 5KW-6.3KVA at 80% Pwr. Ftr. Single phase, complete with running spare parts, meter panel, battery, tools, remote cable, etc.

Weight 1200 lbs. Export Packed. Excellent for emergency power. Brand new $575.00

Scope Transformer hermetically sealed 1,800 volts, 4 ma, 6.3 volts, .9 amp. 2½ volts, 2.5 amps., 5 x 3¼ x 3¾ $5.95

FEDERAL SELENIUM RECTIFIER

Full wave. 36 volts input. 28 volts output at 6.1 amps. Brand new $7.95

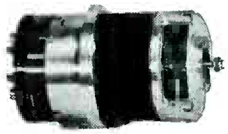
Phone Cortlandt 7-6443

PEAK ELECTRONICS CO.
188 Washington St., New York 7, N. Y.

DEPARTMENT EA
SEND FOR BULLETIN

NEW GUARANTEED SURPLUS!!

SYNCHROS




NAVY TYPES

1G, 1CT, 5G, 5CT, 5DG, 5SG, 5SF, 5HSF, and others.
Pioneer Autosyns—AY-1, AY-14, AY-20, AY-30, AY-54, AY-101D, 851, etc.
Kollsman—775-01
G. E. — 2J1F1, 2J1G1, 2J1H1, 2J5HA1, 2J5FB1, 2J6F3, etc.

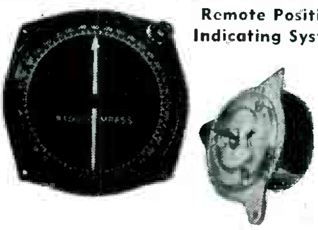
Size 5 Synchro Generator
Similar to Navy Ordnance type 5G with shaft detail per Army Ordnance Dwg. C-78414. 115 v. 60 cy. Stock #SA-43. **Price $9.50 ea.**

NULL TYPE SYNCHRO INDICATOR

Precision position indicator. Uses Bendix size 5 Selsyn, rectifier tube, transformer, magic eye tube and illuminated 360° dial. Ideal for Hams, labs and experimenters. Use with SA-43 Synchro listed above. Stock #SA-119. **Price $6.95 each.**

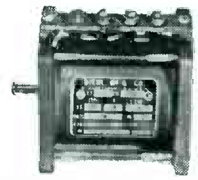
Minneapolis - Honeywell Stabilized Aerial Camera Mount. Complete with amplifier, inverter, and carrying case. Stock #SA-9. **Price $125.00 ea.**
DC Selsyn System—24 V. DC transmitter and indicator. Indicator calibrated for flap position. 360° dial easily added. Stock #SA-129. **Price $9.50 per system.**
Pioneer Magnetic Amplifier Assembly. Saturable core type output transformer. 400 cycle. Operates from plates of 6SN7 to supply 1 phase of servo motor. Stock #SA-44. **Price $8.75 ea.**

Remote Position Indicating System



Idle 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.**

SERVO MOTORS




Pioneer—CK-2 and 10047-2-A for 400 cycles.
Diehl—FP-25-3, **FPE-25-11** (CDA-211052) **and ZP-105-8** (CDA-211-377) for 60 cycles.

400 Cycle Motors

E.A.D. J33. 115 V. 3 phase. Synchronous. 8000 rpm. 2" x 3". Stock #SA-59. **Price $6.75 ea.**
E.A.D. J-72B. 115 V. 2 phase induction motor. 4700 rpm. Stock #SA-140. **Price $9.75 ea.**

Westinghouse Type FL Blower

115 V. 400 cy. 17 C.F.M. Includes capacitor.

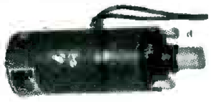
Stock #SA-144 **Price $6.75 ea.**

DC MOTORS

John Oster. Series wound. 27 V. 7,000 rpm. 1/100 H.P. Stock #SA-30. **Price $2.75 ea.**
Westinghouse 1171391. 27 V. 6.5 amps. Series-fan cooled. 3" diam. 4½" lg. ⅛ H.P. Cont. Duty. Stock #SA-156. **Price $6.75 ea.**
Delco 5069370. 27.5 V. Alnico field. 10,000 rpm. Similar to S-65 but has straight shaft extension. Stock #SA-16. **Price $4.75 ea.**
DC Timing Motor—Haydon ½ rpm. 29 volts, 100 mills. Stock #SA-157. **Price $3.75 each**
Constant Speed D.C. Motor—G. E. 5BA25MJ24. 24 V. D.C. 7100 rpm RC noise filter. Stock #SA-100. **Price $8.50 ea.**
G.E. 5BC26AC134. 1/20 H.P. Cont. Duty. Reversible. 24 V. @ 3.4 amps. Explosion proof housing. 4½" diam. x 6½" lg. ⅜" shaft, 1¾" lg. Stock #SA-143. **Price $12.50 ea.**

110 RPM Aircraft Motor

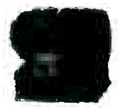
G.E. 5BA10AJ18D. 27 V. @ 0.7 amps. 1 oz/ft torque. 1⅜" diam. x ½" lg. Operates on AC or DC. Stock #SA-98. **Price $2.95 ea.**



Include 15¢ for P.P. and handling.

ALL PRICES F. O. B. CLIFTON, N. J.

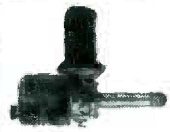
INVERTERS




Pioneer — 12116-5-A, 12117-2-A, 12123-1-A.
Holtzer Cabot—MG-149F, MG-149H, MG-153F.
General Electric—5D21NJ3A.
Leland—10563, PE-218.
Wincharger—PU-7/AP.

Radio Compass Loop LP-21-LM. Stock #SA-99. **Price $9.50 ea.**
Phase Shift Capacitor—4 stator single rotor. 0-360° phase shift. Stock #SA-114. **Price $4.75 ea.**
Magnesyn—Pioneer CL-3. 6 power. Transmitter or receiver. Stock #SA-6. **Price $3.75 ea.**

ACUATOR



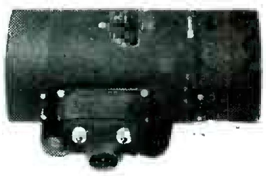
Foote Bros. 10801. 1/6th H.P. 24 V. @ 11.5 amps. 5 inch linear travel. Limit Switches.

Stock #SA-161. **Price $12.50 ea.**

60 CYCLE AC MOTORS

G.E. Reversible. 1/150 H.P. Shunt wound. 40 volts 5000 rpm. Split field. Stock #SA-18. **Price $4.75 ea.**
Stock #SA-19. Similar to above but not split field. **Price $2.75 ea.**
Barber-Colman. 0.001 H.P. wound shaded pole type. Reversible by relay or s.p.d.t. switch. Stock #SA-27. **Price $3.75 ea.**
Timing Motor—Haydon 1 rpm. 115 V. A.C. Stock #SA-133. **Price $2.85 each.**

AMPLIDYNES



G.E. Aircraft

5AM31-NJ18A. Input 27 V. D.C. @ 44 amps. Output 60 V. DC @ 8.8 amps. max. 530 watts. Stock # SA-111. **Price $14.50 ea.**
60 cy. G. E. Amplidyne—5AM45-DB-15. Input 115 v. Output 250 v. DC at 0.6 amps. Cont. Duty. Stock #SA-147.

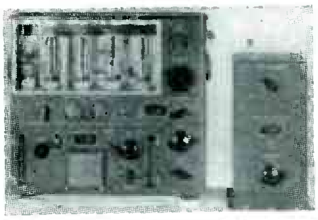
Write or call for complete listing.

SERVO-TEK PRODUCTS CO.
INCORPORATED
Surplus Division

Open account shipments to rated concerns, others may order C.O.D.

247 CROOKS AVE. ARmory 4-2677 CLIFTON, N. J.

RADIOMEN'S HEADQUARTERS ✻ WORLD WIDE MAIL ORDER SERVICE ! !



GENERAL ELECTRIC 150 WATT TRANSMITTER

Cost the Government $1800.00 • Cost to You— BRAND NEW—$67.50

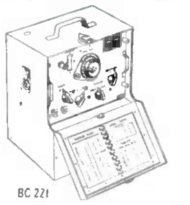
This is the famous transmitter used in U.S. Army bombers and ground stations, during the war. Its design and construction have been proved in service, under all kinds of conditions, all over the world. The entire frequency range is covered by means of plug-tuning units which are included. Each tuning has its own oscillator and power amplifier coils and condensers, and antenna tuning circuits—all designed to operate at top efficiency within its particular frequency range. Transmitter and accessories are finished in black crackle, and the milliammeter, voltmeter, and RF ammeter are mounted on the front panel. Here are the specifications: FREQUENCY RANGE: 200 to 500 KC and 1500 to 12,500 KC. (Will operate 10 and 20 meter band with slight modification). OSCILLATOR: Self-excited, thermo compensated, and hand callibrated. POWER AMPLIFIER: Neutralized class "C" stage, using 211 tube, and equipped with antenna coupling circuit which matches practically any length antenna. MODULATOR: Class "B"—uses two 211 tubes. POWER SUPPLY: Supplied complete with dynamotor which furnishes 1000V at 350 MA. Complete instructions are furnished to operate set from 110V AC. SIZE: 21½x23x9¼". Total shipping wgt. 200 lbs., complete with all tubes, dynamotor power supply, seven tuning units, antenna tuning unit and the essential plugs.

RT1655. An 11 tube crystal controlled superhet receiver for 24-28V DC operation. Beautiful chassis and cabinet. Uses latest tube types including 7 miniature 6AJ5's. Tubes and schematic supplied. Only a few available at $14.95.

1948 MODEL OUTBOARD MOTOR AT DEALER WHOLESALE PRICE!!

Powerful deluxe twin cylinder outboard motor with automatic starter (no fumbling for a rope), a positive cooling unbreakable water pump, and an improved magneto for sensationally quick starts as well as smooth, efficient operation at slowest trolling speed or with the throttle wide open. Dozens of additional outstanding features are provided, such as corrosion resistant aluminum alloy castings, to protect the engine and give the unit a sleek, streamlined appearance; hardened alloy steel connecting rods with roller bearings, and a rugged, perfectly balanced crankshaft. Delivers a full 7.5 H.P. as rated by the Outboard Boating Club of America. Net weight-52 lb. Gross shipping weight including free steel storage stand-100 lb. For a limited time we are selling this motor, which is produced by the world's second largest maker of outboards to sell for more than $30.00 above our price—for only $139.00, brand new, FOB Buffalo.

BC-221 FREQUENCY METERS with calibrating Crystal and calibration charts. A precision frequency standard that is useful for innumerable applications for laboratory technician, service man, amateur, and experimenter at the give away price of only $36.95.



BC 221

Auto Radio Dealers! Attention!

Nationally advertised brand of 1948 car radio which will fit practically any car and every pocketbook. Six tube superheterodyne with three gang condenser and 6½" speaker. **$32.20 for sample, or Dealer price $29.97 each, in lots of two or more.**

Here is an item that no serviceman who repairs auto radios should be without. Nationally advertised ATR battery eliminator that supplies perfectly filtered 6 VDC at 14 amps, from 110 AC.............. $36.00

CONDENSERS—PAPER TUBULAR 600 WV—.001, .002, .005—8c; .01, .05—9c; .1—10c; .25—23c; .05—35c; **ELECTROLYTICS**; 8mfd 200v—20c; 10mfd 35v—20c; 30mfd 150v—23c; 20/20mfd 150v—35c; 30/20 150v—46c; 50mfd 150v—43c; 8mfd 475v—34c; 16mfd 350v—65c; **OIL CONDENSERS**: 4mfd 600v 49c; 2mfd 600v—29c; 3X.1mfd 600v—29c.

SPEAKERS—These PM speakers are the finest that are available. All have heavy overside Alnico V magnets.

3½"		$1.15	6 for $6.60
4"		$1.15	6 for $6.60
5"		$1.10	10 for $9.50
6"		$1.50	6 for $8.70
7" (Car Radio Size)		$4.50	6 for $21.50
8"	10 ox.	$3.95	6 for $20.50
8"	21 oz.	$4.95	6 for $26.50
10"	21 oz.	$5.50	6 for $30.00
12"	21 oz.	$7.95	6 for $42.00

MIDGET 1 WATT RIG supplied complete with polystyrene coil forms for 3 ham bands. Size overall 3"x1"x2½" high. Includes practically all necessary parts. Details on page 62 of January 1948 QST. Your cost $1.50
Battery pack for the 1 watt transmitter supplying 90 volts "B" and 1.5 volts "A".......... $1.50
110 V. AC power supply kit for the 1 watt transmitter.......... $3.50

GENERAL ELECTRIC RT-1248 15-TUBE TRANSMITTER-RECEIVER

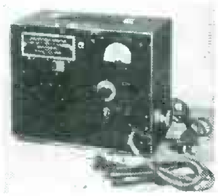
TERRIFIC POWER—(20 watts) on any two instantly selected, easily pre-adjusted frequencies from 435 to 500 Mc. Transmitter uses 5 tubes including a Western Electric 316 A as final. Receiver uses 10 tubes including 955's, as first detector and oscillator, and 3—7H7's as IF's with 4 slug-tuned 40 Mc. IF transformers, plus a 7H7, 7E6's and 7F7's. In addition unit contains 8 relays designed to operate any sort of external equipment when actuated by a received signal from a similar set elsewhere. Originally designed for 12 volt operation, power supply is not included, as it is a cinch for any amateur to connect this unit for 110V AC, using any supply capable of 400V DC at 135 MA. The ideal unit for use in mobile or stationary service in the Citizen's Radio Telephone Band where no license is necessary. Instructions and diagrams supplied for running the RT-1248 transmitter on either code or voice in AM or FM transmission or reception, for use as a mobile public address system, as on 80 to 110 Mc. FM broadcast receiver, as a Facsimile transmitter or receiver, as an Amateur Television transmitter or receiver for remote control relay hookups, for Geiger-Mueller counter applications. It sells for only $29.95 or two for $53.90. If desired for marine or mobile use, the dynamotor which will work on either 12 or 24V DC and supply all power for the set is only $15.00 additional.

AT LAST YOU CAN AFFORD A LABORATORY STANDARD MICROVOLTER

The famous Measurements Corp. Model 78E, 5 Tube Laboratory Standard Signal Generator (that sold new, FOB, Boonton, N. J., for $310.00 net), is available in perfect condition for 25 to 60 cycles, 115V AC operation. Until now this is the sort of top-flight lab equipment that discriminating buyers have only vainly hoped would be released at a bargain price. Worth every cent the manufacturer asks, but available FOB Buffalo while our limited supply lasts for only $79.95.

Such companies as Admiral Corp. and John Meck, Inc., have ordered from us and repeated many times on these 78 generators for use in their labs and production line testing.

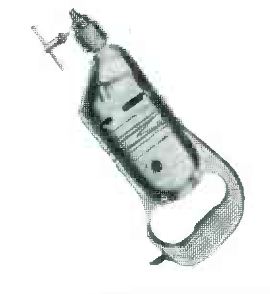
Uses 1,9002, 1-7Y4, 1-VR 150-30, 1-7C7, and 1-7C5 tubes. Output continuously variable from 0 to 100,000 Microvolts.



78E Standard Signal Generator. 50 to 70 Mc. Unmodulated or with 400 cycle modulation.

RT 1463 7 tube amplifiers containing 3—7F7, 1—7Y4, 3—7N7, 4 potentiometers, numerous resistors, filter and bypass condensers, filter chokes, power and audio transformers, and six sensitive plate relays. A military development that provided amazing stepless control proportional to correction required for ailerons, rudder and elevator, in the original application. A control amplifier of the ordinary type would deflect the rudder by some arbitrary amount when the ship was blown off the course to port or starboard. The result would either be that the correction was insufficient and the plane continued off course, or the correction would be too great, starting a series of tackings and would greatly increase fuel consumption and elapsed time in reaching the objective. This phenomenal unit, with its 3 amplifiers and six 5000 ohm, relays in bridge circuits, will accurately control any 3 operations, related or unrelated, in minutely adjustable uniquely quantitative variations in either forward or reverse directions, 9"x7"x8" black crackle aluminum case. Brand new in original carton, $12.95, or used $9.95.

TERRIFIC VALUE— PORTABLE ELECTRIC DRILL

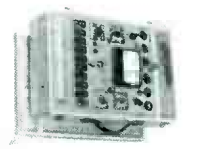


(Sold at less than established factory price so we cannot mention brand name)

Only $19.95 equipped with ¼" Jacobs Geared Chuck and Key. Not an intermittent duty drill, but a full size rugged tool.
Most convenient type switch, natural grip handle, and balance like a six shooter.
Precision cut gears—turbine type cooling blower—extra long brushes.
No stalling under heaviest pressure because of powerful 110 Volt AC-DC motor and multiple ball thrust bearing.
Other bearings self-aligning lifetime-lubricating Chrysler Oilite type.
Made for toughest year-in and year-out service in plant or on construction jobs.
Amazing perpetual factory guarantee assures you of a lifetime of trouble-free use.
25% deposit on C.O.D.'s. Full refund (you pay transportation) if not pleased with drill after trial.

RECORDING AMPLIFIER, 3 stage, 110 V, 25 or 60 cycle high gain amplifier built by recently bankrupt manufacturer specifically for recording use. Transformer for low impedance wire recorder head or magnetic cutter included on chassis. Tone and volume controls and switches on chassis for playback, recording or use as public address amplifier. Complete with tubes-$9.95 Speaker-$2.40 Beautiful original portable case $5.95. Mike Stand $5.95.

BENDIX SCR 522—Very high Frequency Voice Transmitter-Receiver—100 to 156 MC. This job was good enough for the Joint Command to make it standard equipment in everything that flew, even though each set cost the Gov't $2500.00. Crystal Controlled and Amplitude Modulated—HIGH TRANSMITTER OUTPUT and 3 Microvolt Receiver Sensitivity gave good communication up to 180 miles at high altitudes. Receiver has ten tubes and transmitter has seven tubes, including two 832's. Furnished complete with 17 tubes, remote control unit, 4 crystals, and the special wide band VHF antenna that was designed for this set. These sets have been removed from unused aircraft and are guaranteed to be in perfect condition. We include free parts and diagrams for the conversion to "continuously variable frequency coverage" in the receiver.
The SCR 522 complete with 24 volt dynamotor sells for only $37.95. The SCR 522 is also available with a brand new 12 volt dynamotor for only $42.95.



1948 MODEL MUTUAL CONDUCTANCE TUBE TESTER $49.95

No possibility of good tubes reading "Bad" or bad tubes reading "Good" as on dynamic conductance testers or other ordinary emission testers. Attractive panel and case equal to any on the market in appearance . . . Large 4½" meter . . . Calibrated micromho scale as well as a Bad-Good scale . . . Front panel fuse . . . Individual sockets for all tube base types—voltages from .75 volts to 117 volts and complete switching flexibility allow all present and future tubes to be tested regardless of location of elements on tube base . . . Indicates gas content and detects shorts or opens on each individual section of all loctal, octal and miniature tubes including cold cathode, magic eye and voltage regulator tubes as well as all ballast resistors. Name of the nationally known manufacturer withheld because of special price offer.
Model "C"—Sloping front counter case.......... $49.95
Model "P"—Handsome hand-rubbed portable case.......... 54.95
Built-in roll chart with either of above $5.00 extra.

SELENIUM RECTIFIERS. The new miniature rectifier that more and more manufacturers are using. Order some of each type so you will be ready when these receivers require servicing. Make extra money by installing them in old sets. All types are rated at 130 V.A.C.

25 MA	$ .45	10 For	$ 4.00				
75 MA	.70	10 For	6.50	50 For	$31.00	100 For	$60.00
100 MA	.75	10 For	7.00	50 For	32.50	100 For	59.00
150 MA	.80	10 For	7.50	50 For	35.00	100 For	65.00
200 MA	1.05	10 For	10.00	50 For	47.50	100 For	90.00
250 MA	1.25	10 For	12.00	50 For	57.50	100 For	110.00

DO NOT ASSORT TO MAKE QUANTITY

Cable Address: BUFRAD

Minimum order $3.00—All prices subject to change—25% deposit with COD orders.

BUFFALO RADIO SUPPLY, 219-221 Genesee St., Dept. 6-E BUFFALO 3, N. Y.

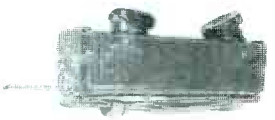
HDQRS. FOR ALL TYPES TRANSMITTERS

TELEMARINE

SELECTED ELECTRONIC SURPLUS

FOR MARINE, AVIATION AND COMMERCIAL USE

SCR-536 HANDY-TALKIES

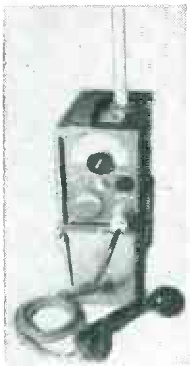


We have just a few hundred of these popular Handy-Talkies, and they won't last long. All are in very excellent condition, and complete with crystals (receiving and transmitting) and batteries. All are in top operating condition, and preset at various operating frequencies ranging from 3.5 to 6.0 mc. We will supply units with matched frequencies as long as quantity permits. First come, first served!

PRICE, EACH $50.00

Extra Set Batteries (A&B) .. $3.00

5-Meter Walkie-Talkie



Model BC-322 Transceiver: simple, popular communications unit. Freq. range 52-65 mc. Uses only two tubes, types 33 and 30. Includes a 5 MC crystal in a crystal calibrator circuit. Range 5 to 150 miles, depending upon location and altitude. Operates from single battery block (not supplied) available from mfr., or other sources. Supplied with telescoping antenna and handset, almost new condition.

PRICE, EACH $24.95

FREQUENCY METER TS-69/AP

Frequency range 400 mc to 1,000 mc continuous. Black-crackle finished metal case, dim: 6"x6"x22", contains variable length coax resonating cavity with crystal rectifiers and 0-200 microammeter. Veeder-Root counter and calibration charts insure extreme precision. Telescopic antenna, and coax line probe, with metal carrying case for entire equipment. All New Equipment.

COMPLETE, EACH $42.50

50 WATT RADIOTELEPHONE; MODEL ATD

Designed for airplane installation. 4 channels. Useful also for ship, shore, or ham installation. Conservatively rated at 50 watts output, A1, A2, and A3. Instant selection of any one frequency in 3 bands, 540 to 1500, 1500 to 3000, and 3000 to 9050 Kc. Complete with 24 to 28 v.d.c. dynamotor, remote control, channel indicator unit, plug connectors, spares, instruction book. Uses high-level plate modulation for A2 and A3. **PRICE COMPLETE EACH $110.00**

32 VDC 110 AC CONVERTER

Mfd. by Kato Engineering, for marine or farm installation. Rotary type, compact and ruggedly built for continuous duty. Rubber shock mounting on filter case, with complete input and output filtering. Output-110 volts, 60 cycles AC, .225 KVA, but will operate efficiently on loads up to 300 watts. New units only.

PRICE, EACH $39.95

Quantities, 10 or more, Each $34.95

RADAR EQUIPMENT

Navy Model SF, NEW and Complete with all spares and accessories. **Price, Complete Set....$2,500.00**
SCR-717-B. Army-Bomber Type, PPI, New and Complete with all spares and accessories. **EACH $850.00**
Radar Transmitter Type CRV-52AAY, for SD-3, excellent condition but less tubes. **EACH..$150.00**
Model YJ Automatic-Respondor Radar Beacon, RF and Power Supply Units only (transmitter) with tubes. Good condition..**PRICE EACH....$150.00**

RADIO TRANSMITTERS

Immediate Delivery from Stock

2-KW Hi-Frequency Transmitter; 4-Bands, 2 to 18 mc. Model H-2000, mfd by Radio Laboratories, Inc. Consists of P.A. unit using 2—833A tubes, in cabinet 36x36x74¼" high, and Power Supply using 4—872A and 2—866 tubes, in cabinet 24"x36"x74¼" high. Operates from 110 or 220 volts, 50-60 cycles, 1-phase AC. Driving power required, 70-125 watts. New, with tubes. **COMPLETE $2,100.00**

BC-325 Transmitter, 400W.-A1, 100 W.-A2 & A3. 1.5 to 18.0 mc. M.O. or X'tal control on 6 frequencies. **Operates from 110/220/1/60c. AC.** With tubes, in excellent condition. **Price, each $700.00**

BC-447, 300 W. A1, 2-Channel Transmitter. Complete and self-contained in one cabinet, 36x29x72" H., includes RF sections, power supplies, and control equipment. Freq. range 4.0 to 13.4 mc. Operates from 110/220V/1/50-60 c. AC. With tubes. Excellent condition. **PRICE EACH $600.00**

Model 600-B, 600 Watt Radiotelephone transmitter, mfd. by Temco for the Navy (shore station). 600 watts on phone, 1 KW on CW; frequency range 1.5 to 20.0 mc. Provision for multi-channel operation. Includes separate Remote Control and Speech Amplifier unit. Operates from 220 volts, 1-phase, 50-60 cycles AC. With tubes—no spares. **Price $2,000.00**

Collins 75 Watt Autotune Transmitter. Model TCB, 10-channels instantly available by dial-telephone selection at transmitter or remote position. A1, A2, or A3 emission. Freq. range 1.5 to 12.0 mc. Operates from 110 volts, 1-phase, 50-60 cycles AC. Complete with all spares (tubes, capacitors, etc.), remote operating unit, handsets, etc. Excellent condition. Priced way below cost at....... **$600.00**

X'MTTNG X'FORMERS CHOKES, ETC.

Inca Heavy Current Plate X'former, has tapped primary to 240 volts, 50/60 cycles AC, and 2200 volt secondary center-tapped. Output 3000 VA. Model 035499. Shpg. wt. 300 lbs. New condition. **PRICE EACH $74.95**

Amertran Filter Choke. Type W, 0.04 henries at 2.4 amps dc. rms test 10 kv, dc resist. 0.24 ohm. NEW. **PRICE EACH $4.95**

Adlake Time-Delay Relay. Model 902-72-1, 220 volts 50-60 cycles, normally open, seconds operate —30 (max), release—5 (max). New. **PRICE EACH $4.95**

Adlake Time-Delay Relay, Type 1040-65-4, 110 volts 50-60 cycles AC, normally open, operate min. 30 secs., max. 40 secs., release 0.3 secs. New. **Each $3.10**

All Prices F.O.B. N.Y.C. All Material Offered Subject to Prior Sale.
Prices Quoted Supersede Previous Advertised Prices, and Effective Until Next Issue Only.

TELEMARINE COMMUNICATIONS COMPANY

Phone—Watkins 4-7021 533 W. 24th St., N. Y. 11, N. Y.

SIGNAL GENERATOR for the range of 1000-4000 megacycles, used by producer of the APR-4 tuning units, uses a 1000-3000 megacycle cavity & 2C40, below cutoff attenuator, crystal and 50 microamp meter at output connector, TFS-5 coaxial wavemeter, sine wave modulation, 115 v. 60 cps.

HARMONIC GENERATOR, good output in range of 300 to 2000 megacycles. uses 000-1000 mc butterfly, 703 A tube, and distorter crystals, waveguide below cutoff attenuator, used, 110 v 60 cps.

TEST SET TS-278/AP. for AN/APS 13, synchronized, delayed pulse signal generator, 400-430 megacycles, calibrated waveguide below cutoff attenuator, synchronized marker generator, 115 v 60 cps. new and complete.

TUNING UNITS for APR-4 and APR-1 receivers, TN-19 975-2100 mc and TN-54 2100-4000 mc, new.

WAVE ANALYZER, General Radio type 636-A.

RANGE EXTENSION FILTER, Gen. Radio 732-P1.

SIGNAL GENERATOR, G.R. 605 B, good working order.

SIGNAL GENERATOR MEASUREMENTS 78 B and Ferris 18 B, good working order.

X BAND S.W.R. Test Sets, TS-12/AP, new.

X BAND POWER METER, TS 36/AP, new.

X BAND WAVE METER, TS 33/AP, new.

X BAND POWER LOAD, TS-108/AP, new.

SYNCHROSCOPE, TS-34/AP.

TYPE N CONNECTORS, UG-10, 12, 21, 22, 24, 25, 27, 30, 59, 83, 86, 190, 201, 245, and UHF connectors SO 239, PL 259 83 1AP. UG 266, complete with center contacts, immediate delivery.

CRYSTAL MIXER ASSEMBLY, 10 cm, type N fittings.

COMPACT RADAR RECEIVER TRANSMITTER AND INDICATOR, AN/APG-13A, 2400-2700 mc, 115 v 400 cps, new, export packed **$125.00.**

RADAR TRANSMITTER, BC 947-A, 10 cm, 115 v 60 cps, less HV supply, **$40.00.**

COMPLETE MARINE RADAR, Navy SD 3,220 megacycles, 115 v 60 cps. new. export packed.

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MARINE RECEIVER MACKAY 128-AW, 15-650 kc, 115 v 60 cps, **$50.00.** 5

MARINE RECEIVER ARB-1, 15-600 kc, **$50.00.**

TRANSFORMERS, 115 volts 60 cps primaries:

1. 7500 volts 35 ma, ungrounded Thordarsen, **$15.00.**
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3. 2 secondaries at 500 volts 5 amps each, wt 210 pounds, **$50.00.**

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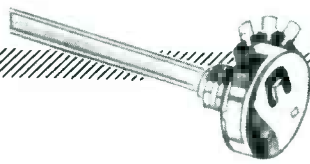
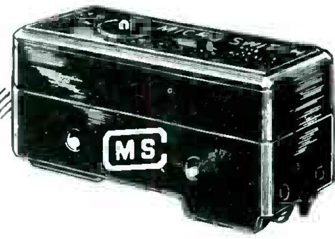


MICRO-SWITCHES



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TYPE MX-9E

BRAND NEW!

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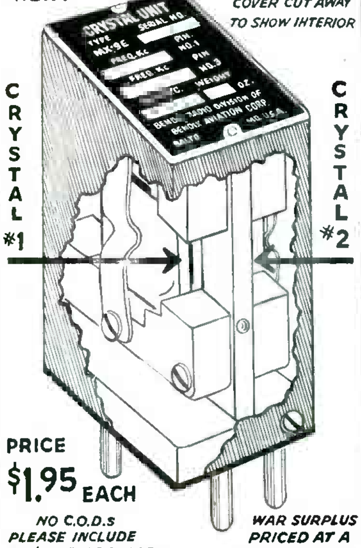

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WAR SURPLUS PRICED AT A FRACTION OF GOV'T COST

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All above units are brand new, individually packed with frequencies marked on containers and with manufacturer's inspection tags attached. Quantities available to large users.

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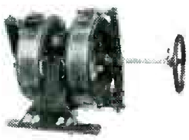
INDUSTRIAL & ELECTRONIC POWER SUPPLY EQUIPMENT

TRANSFORMERS



T-103—Voltage regulator Transtat, American Transformer Co. Spec. 29145 Max. KVA output 11.5, 50/60 cyc. 0-115 V. 100 amps or 230 V. 50 amps. $75.00 Net Wt. 134 lbs. Dim. 25" W x 16" D x 17½" H (Encl. 8" shaft ext.)

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Nationally advertised brands. Capacitors 1.0 mid. 25,000 V. D.C. ..... $36.00 Net Wt 65 lbs. Dim. 14½" Wx8½" Dx15" H. O. A.

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RC-117—Westinghouse Time Delay Current Relay, Type SC-M .2 to 1 amp A.C. or D.C. .8 amp continuous rating. Rating 20-40% drop out ratio $12.95 Net Wt. 3 lbs. Dim. 3" W x 5" D x 5⅝" H.

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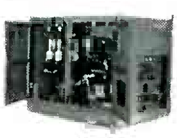
M-140AB—Weston Model 476—3" A.C. Ammeter, 3 amp full scale, calibrated 0-120 amps, flush mounting, with 40/1 current trans. .... $8.50 Net Wt. 3 lbs.

M-143AB—Weston Kilovoltmeter—3", Model 301, 20 KV. @ 1000 ohms per volt, flush type, calibrated for steel panel mounting, with 20 meg. 20 KV Weston resistor complete with clips and standoff insulators .... $18.00 Net Wt. 4 lbs.

HEATERS

H-149—Chromolox strip heaters, 300 W., 115 V. (¼x1½x12") $1.00

POWER SUPPLY



(RA-38) 115 V., 60 cyc. input, adjustable output 0-15,000 V. A.C. or D.C. @ 500 Mils. Shipping weight 2100 lbs. $200.00

Can be furnished to deliver 0-7,500 V. @ 1.0 amp for $250

All merchandise in "as new" condition. Add approximately 20% to net weights for estimated shipping weights. Terms are 30% with order, balance C.O.D. All prices f.o.b. Los Angeles Warehouse.

Write for additional detailed information on any of the above items and for special quantity discounts.

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Used for illuminating Meters, Compass Dials, and Airplane Instruments.
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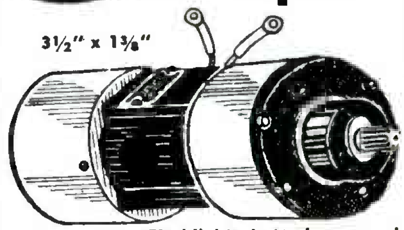

Operates on Flashlight batteries, speed depending on the voltage. Fairly strong on 6 volts, full power and speed on 27 volts. Designed to be used in bombsights, automatic pilots, etc., 250 RPM. FEW MORE at **$5.00**

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25-Watt P-A Re-Entrant Speakers - Brand New!!

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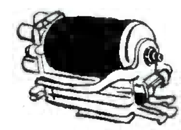

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No R13 200 ohms 24v SPST M.O. $20/c
No R58 150 ohm 12v DPDT & SPST Norm clsd 3a cont $45/c

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No 66 150 ohms 12v DPST N.O.......$45/c
G.M. Relay No R16 240 ohms 24v 4PDT 10A cont $60/c
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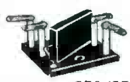
Close Tolerance Silver Micas 1500 MMF± 1% $50/M

Close Tolerance Silver Micas 125MMF±1 MMF ..$50/M



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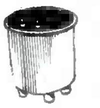
20hy 15ma 975 ohms G.E. Herm Seald 2¼" x 1⅞ x 2¾" $22.50/c



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B1-1X5	1.5 AMP.	2.95
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B1-10	10 AMP.	9.95
B1-15	15 AMP.	13.95
B1-20	20 AMP.	15.95
B1-25	25 AMP.	20.95
B1-30	30 AMP.	23.95
B1-40	40 AMP.	27.95
B1-50	50 AMP.	32.95
B1-60	60 AMP.	36.95

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Type#	Current	Price
B2-150	150 MA.	$.98
B2-220	220 MA.	1.25
B2-300	300 MA.	1.50
B2-450	450 MA.	2.25
B2-600	600 MA.	2.95
B2-1	1 AMP.	3.95
B2-2	2 AMP.	4.95
B2-3	3 AMP.	6.95
B2-5	5 AMP.	9.95
B2-6	6 AMP.	10.95
B2-7X5	7.5 AMP.	13.95
B2-10	10 AMP.	15.95
B2-15	15 AMP.	24.95
B2-20	20 AMP.	27.95
B2-30	30 AMP.	36.95

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B6-250	250 MA.	2.95
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B6-600	600 MA.	5.95
B6-800	800 MA.	7.95
B6-1X2	1.2 AMP.	9.95
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B6-5	5 AMP.	24.95
B6-7X5	7.5 AMP.	32.95
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3B13-6	6 AMP.	81.50
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C1-20	20 AMP.	12.95
C1-30	30 AMP.	17.95
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All Primaries 115VAC 50/60 Cycles

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TXF36-2	36	2	2.95
TXF36-5	36	5	4.95
TXF36-10	36	10	7.95
TXF36-15	36	15	11.95
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All TXF Types are Tapped to Deliver 32, 34, 36 Volts.

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CF-2	2000 MFD.	15 V.D.C.	1.69
CF-3	1000 MFD.	25 V.D.C.	1.69
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CF-5	1500 MFD.	30 V.D.C.	2.49
CF-6	4000 MFD.	30 V.D.C.	3.25
CF-7	3000 MFD.	35 V.D.C.	3.25
CF-8	100 MFD.	50 V.D.C.	.98
CF-9	200 MFD.	150 V.D.C.	1.69
CF-10	500 MFD.	200 V.D.C.	3.25
CF-11	100 MFD.	350 V.D.C.	2.25
CF-12	125 MFD.	350 V.D.C.	2.49

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HY3	.03 Hen. at 3Amp.	2.95
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HY12	.125Hen. at 12Amp.	12.95

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Type#	Capacity	Voltage	Price
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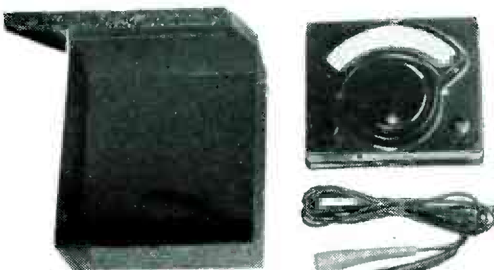

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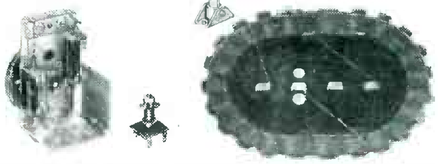

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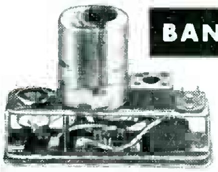

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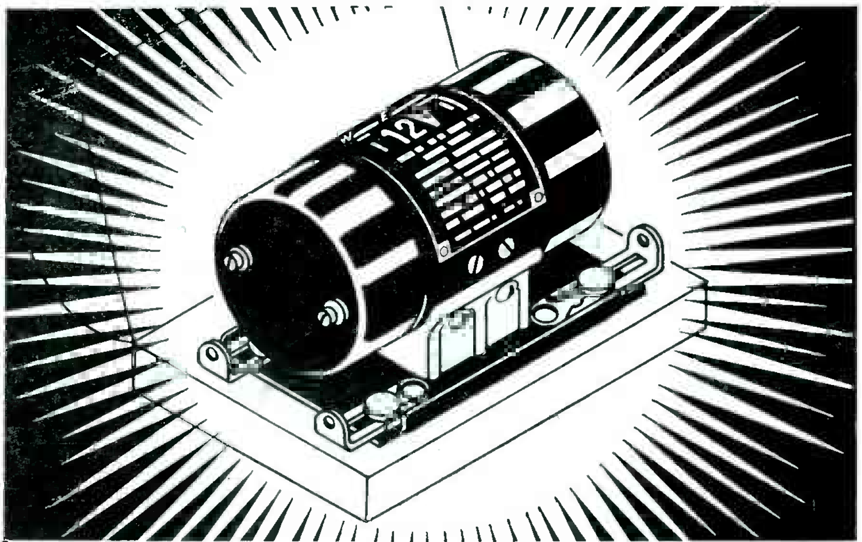

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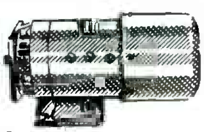

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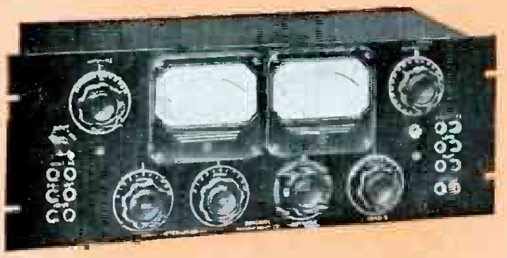

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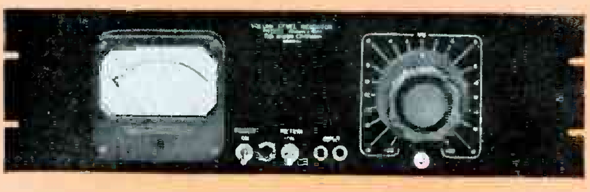

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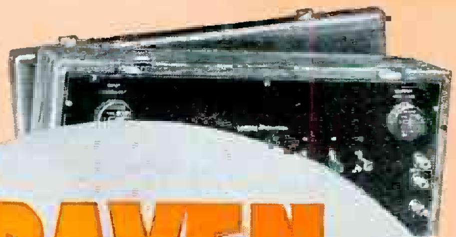

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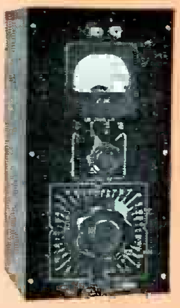

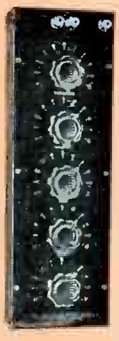

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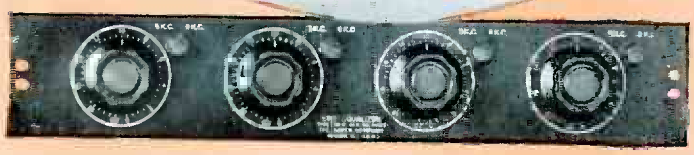

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