electronics

JUNE · 1950

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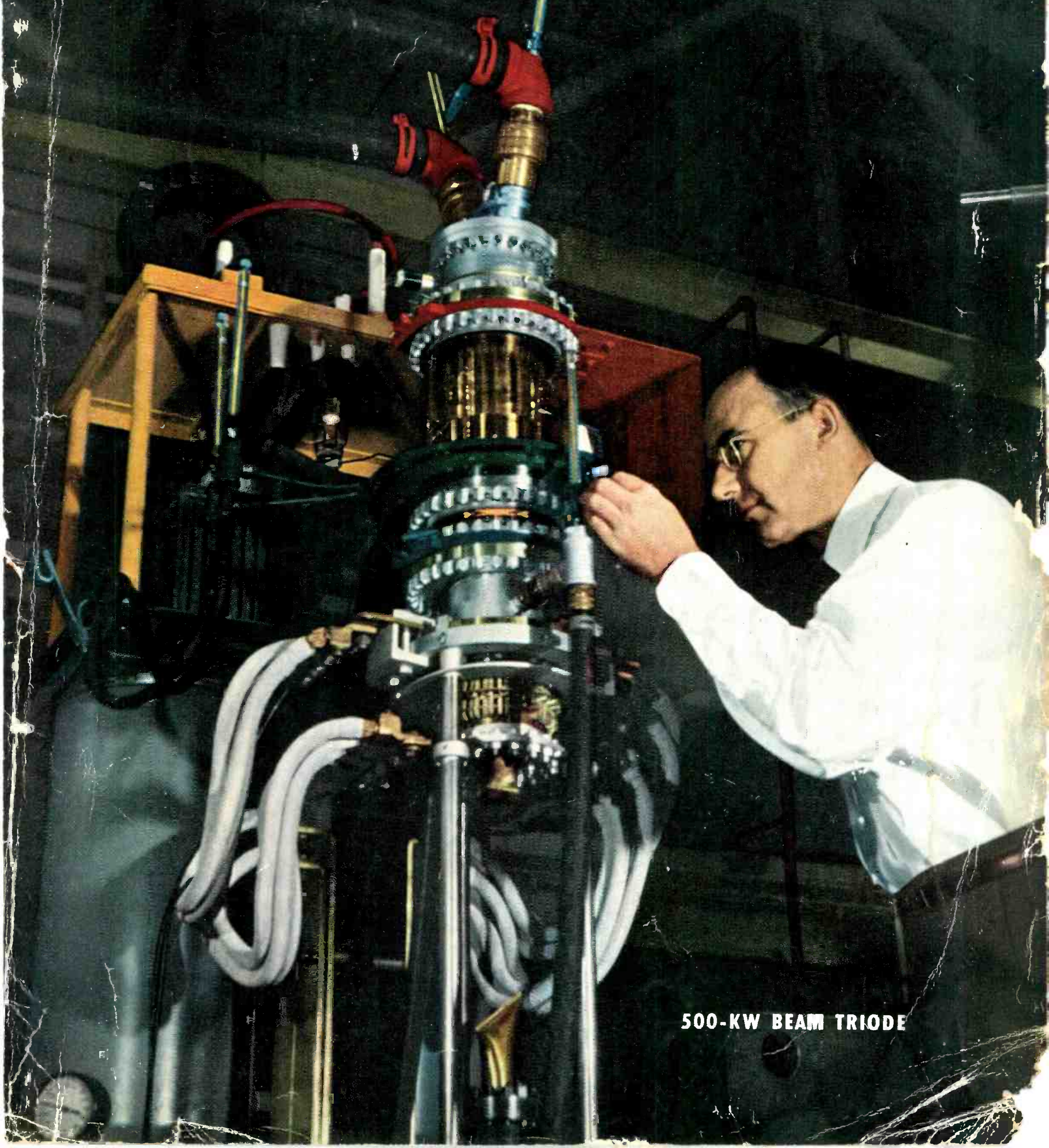
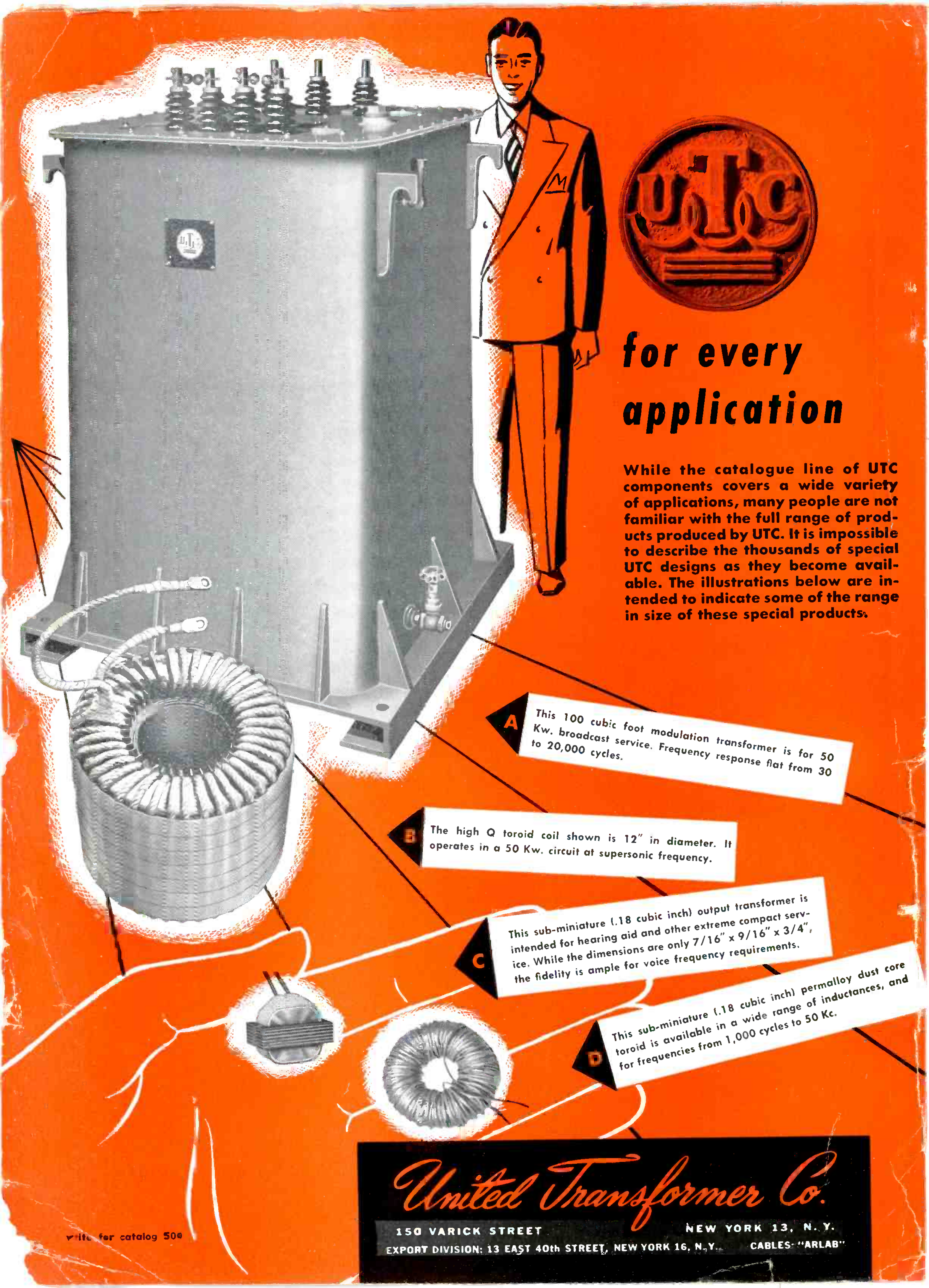


500-KW BEAM TRIODE


for every application
While the catalogue line of UTC components covers a wide variety of applications, many people are not familiar with the full range of products produced by UTC. It is impossible to describe the thousands of special UTC designs as they become available. The illustrations below are intended to indicate some of the range in size of these special products.
A This 100 cubic foot modulation transformer is for 50 Kw. broadcast service. Frequency response flat from 30 to 20,000 cycles.
B The high Q toroid coil shown is 12" in diameter. It operates in a 50 Kw. circuit at supersonic frequency.
C This sub-miniature (.18 cubic inch) output transformer is intended for hearing aid and other extreme compact service. While the dimensions are only 7/16" x 9/16" x 3/4", the fidelity is ample for voice frequency requirements.
D This sub-miniature (.18 cubic inch) permalloy dust core toroid is available in a wide range of inductances, and for frequencies from 1,000 cycles to 50 Kc.
write for catalog 500
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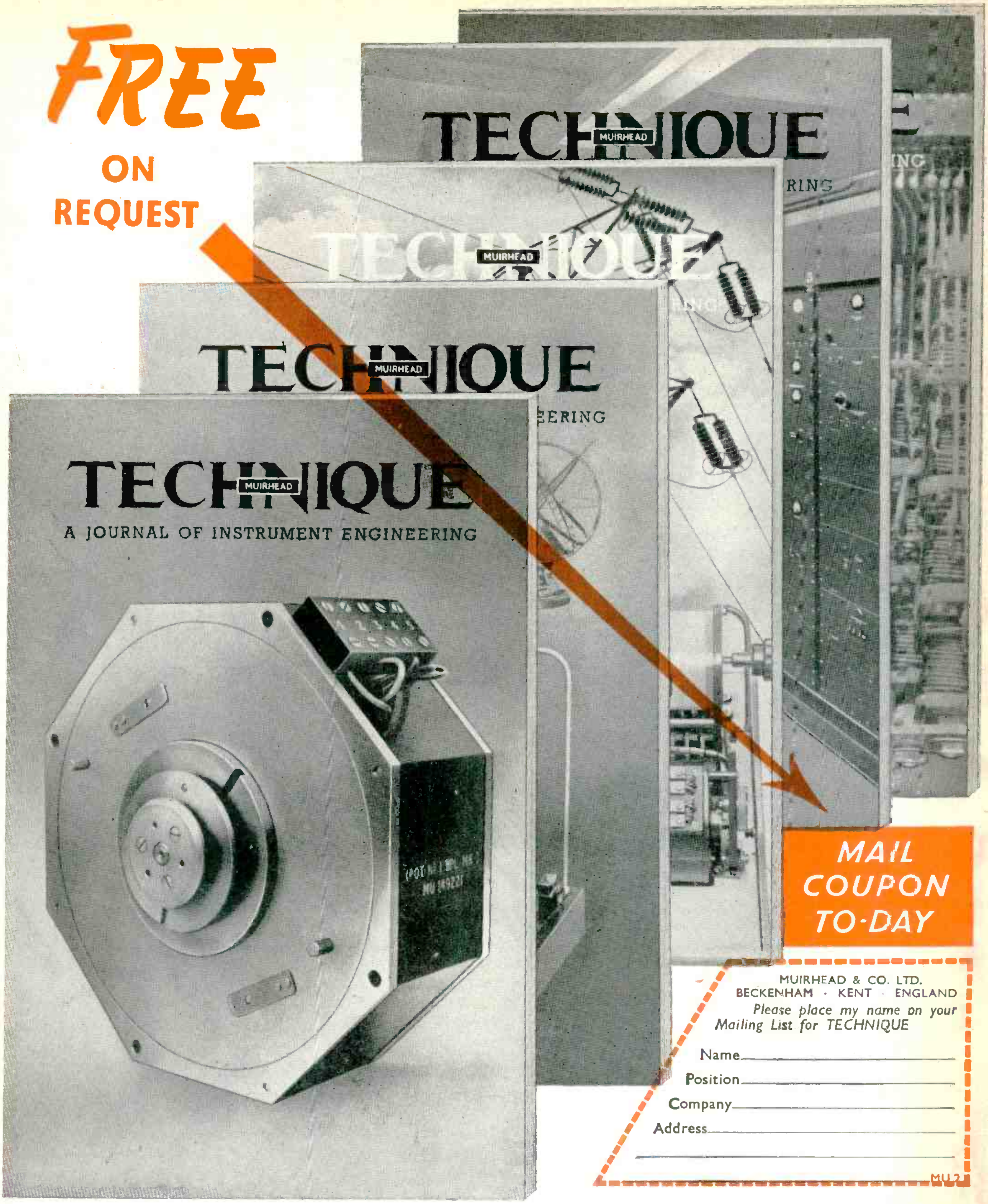

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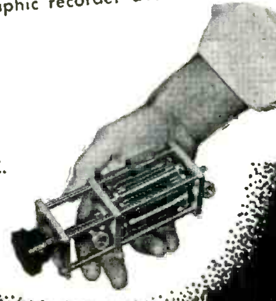

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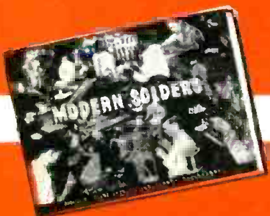

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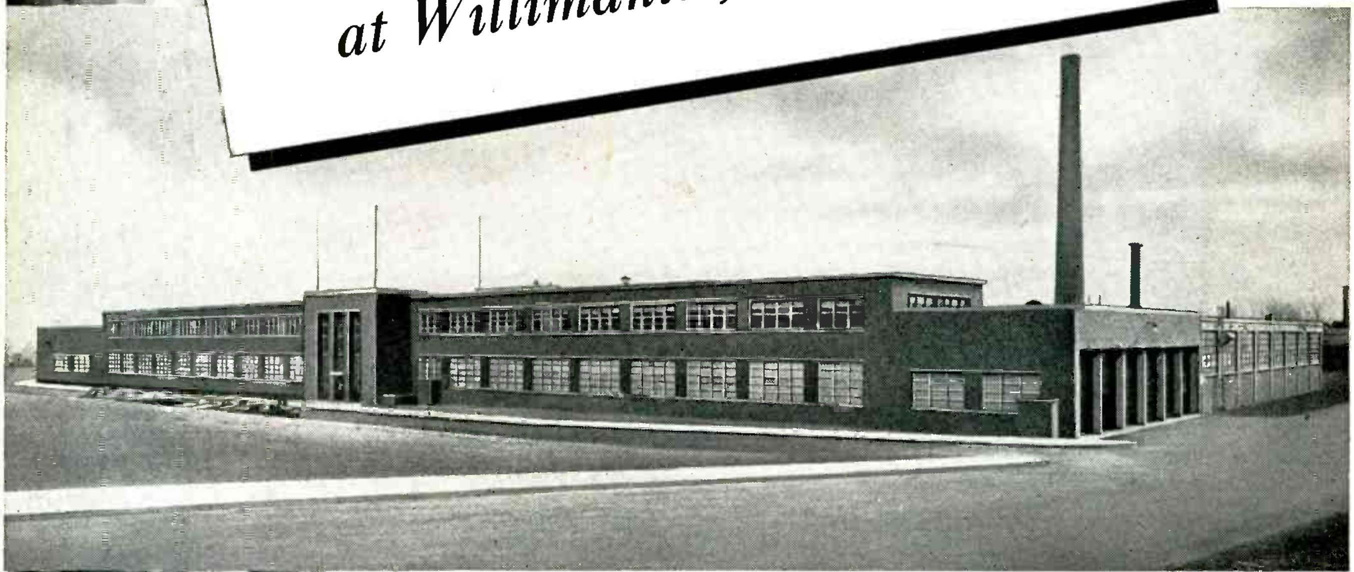

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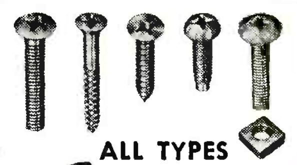

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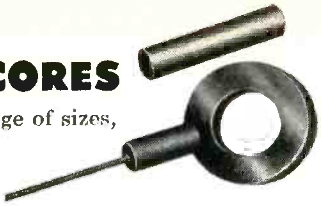

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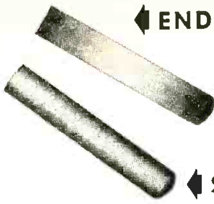

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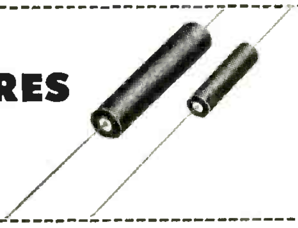

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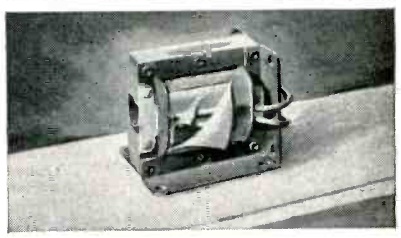

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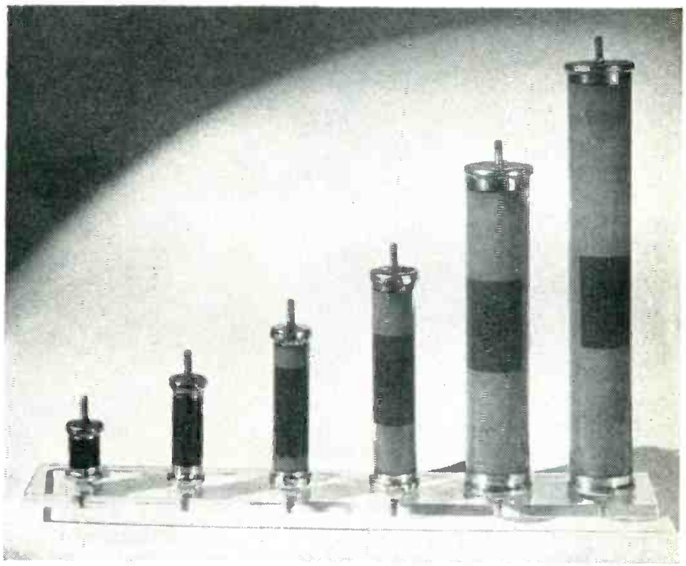

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PROBLEM: To design a 1000 mmf. capacitor rated 25000 V at 12 amperes from 500 to 1700 kilocycles. To cost less than a mica capacitor. To occupy less chassis space and less total volume without loss of efficiency or reliability.

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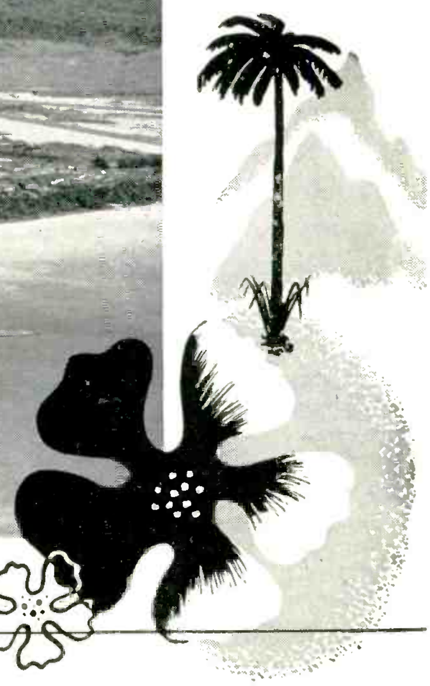

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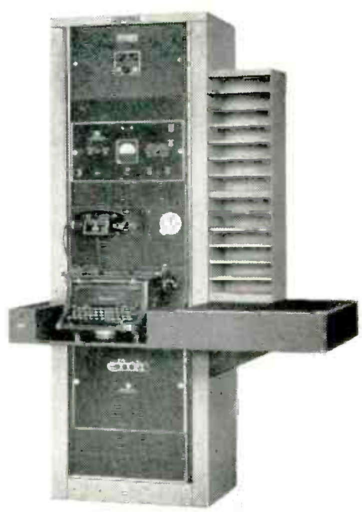

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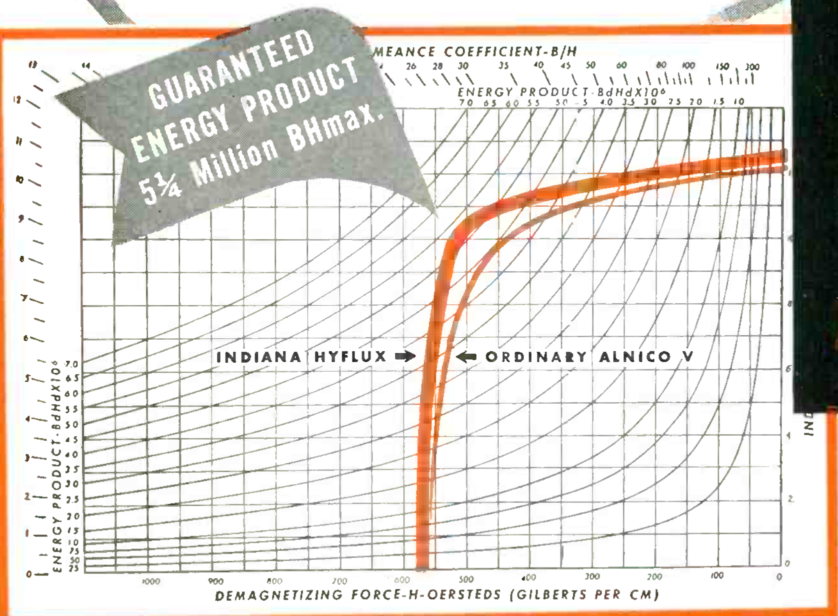

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Now it can be told! After years of research and months of field-testing, INDIANA announces exclusive new *super-strength permanent magnets* made of HYFLUX Alnico V.

The industry's highest published guaranteed energy product for standard Alnico V has been 4½ million BHmax. Now, INDIANA guarantees much greater strength—5¼ million BHmax, and the *average* energy product reaches 5½ million BHmax, or more. Yet, for these higher-energy HYFLUX magnets, you pay *not a penny* premium.

What is HYFLUX Alnico V? INDIANA HYFLUX is *not* a new alloy. It's the result of a new precision technique applied to *dependable* Alnico V . . . new procedures, controls, instrumentation, and equipment, and *precise supervision* over every step of production. Add to this the 42 years of permanent magnet experience and a long-term training program for personnel by the world's *largest* exclusive producer, and you have the background and reasons why INDIANA HYFLUX is so outstanding in *both* performance and value.

Find Out What HYFLUX Can Do! For *greater strength* . . . more compact designing . . . for the lower production costs these smaller, better magnets can bring to *your own* products, get all the facts today on amazing INDIANA HYFLUX. It's the *most important development* in permanent magnets since the introduction of Alnico V.

See what HYFLUX *does!*

When this standard R. M. A. No. 3 loud speaker magnet is INDIANA HYFLUX Alnico V with the minimum guaranteed energy product of 5¼ million BHmax, it has .7 decibels greater output than when made with 4½ million BHmax *regular* Alnico V. Similar improvements—in strength or size—apply to *all* applications. INDIANA HYFLUX is ready now to bring *you* these advantages.

For Cost-Cutting Engineering Aid, Put Your Magnet Problems up to INDIANA.

THE INDIANA STEEL PRODUCTS COMPANY
Specialists in Packaged Energy Since 1908
SALES OFFICES: BOSTON, CHICAGO, CLEVELAND, LOS ANGELES, NEW YORK, PHILADELPHIA, ROCHESTER

INDIANA PERMANENT MAGNETS

THE INDIANA STEEL PRODUCTS COMPANY
DEPT. E-60, VALPARAISO, INDIANA

Please send me all the facts on INDIANA HYFLUX. I am interested in permanent magnets for:

. . . .

. . . .

Name . . . .

Company . . . .

Street . . . .

City . . . . *Zone* . . . . . *State* . . . .

Federal

Announces

A NEW LONG-LIFE TELEVISION TUBE

High in Light Output!

Produced with the Newest and Most Advanced Type Equipment in the TV Industry

KINESCOPES BY *Federal*

Perform Better...Last Longer

Federal Kinescope Types

RECTANGULAR SCREEN: 14", 16", 17", 19"

ROUND SCREEN: 12½", 16", 19"

Here's the precisely *right* tube for TV. Here's tube design based on more than forty years' tube manufacturing experience. It's Federal's New-Day Kinescope, introducing a new high in *light* output and fine performance.

Federal's Kinescope is the new over-all advanced design embodying the ion-trap type electron gun. Magnetically focused, magnetically deflected, delivering the sharpest contrast and picture definition, it assures the user quality-first pictures, quality-first performance. For complete details, write to Dept. K413.

BACKED BY MORE THAN FORTY YEARS' TUBE MANUFACTURING EXPERIENCE

Federal Telephone and Radio Corporation

FEDERAL TELECOMMUNICATION LABORATORIES, Nutley, N. J. . . . a unit of I T & T's world-wide research and engineering organization.

VACUUM TUBE DIVISION, 100 Kingsland Road, Clifton, New Jersey
In Canada: Federal Electric Manufacturing Company, Ltd., Montreal, P. Q.
Export Distributors: International Standard Electric Corp., 67 Broad St., N. Y.

FEDERAL TELEPHONE & RADIO · FTR

AN IT&T ASSOCIATE

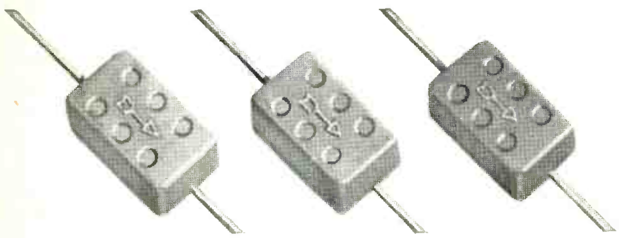
Big Chief Sangamo Says:

Little Injuns Heap Big Help!

If you need capacitors that will do a "heap big" job in a *minimum* of space to speed your production—these Sangamo Micas and Buttons are your best bet. Space problems can be easily solved without sacrifice of stability or high quality.

For detailed information on Button Micas write for Catalog No. 830. Sangamo's new Catalog No. 800 gives full information on the whole Sangamo Tribe.

Type RR Miniature Silvered Mica Capacitors



The Sangamo "Shawnee", Type RR Miniature Silvered Mica Capacitor, is designed and constructed to meet all requirements specified in the tentative JAN-C-5A specification for the CM-15 case size. Exceptionally small, the Sangamo "Shawnee" will measure up to your toughest requirements.

Type M Silvered Mica Button Capacitors

Sangamo Silvered Mica Button Capacitors are available in a wide variety of sizes and styles in capacitance ranges from 10 mmfd. to 7000 mmfd. and meet all requirements of component capacitors for V. H. F. and U. H. F. applications. Sangamo Button Capacitors are fabricated with silvered mica to provide high conductivity. They are completely sealed against humidity, and have a very low temperature coefficient.

Your Assurance of The SANGAMO Tribe PAPER·MICA·SILVER·ELECTROLYTIC CAPACITORS *Dependable Performance*

SANGAMO ELECTRIC COMPANY

SPRINGFIELD, ILLINOIS

SC50-8A

IN CANADA: SANGAMO COMPANY LIMITED, LEASIDE, ONTARIO

NEW -hp- 460A WIDE BAND AMPLIFIER

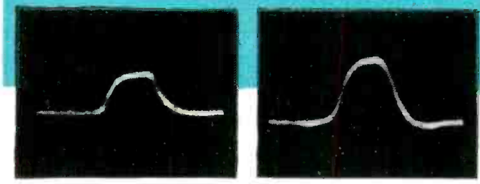


Figure 1
Actual photo of oscillograph trace showing .01 μsec pulse (left) applied direct to CRT plates; (right) through -hp- 460A.

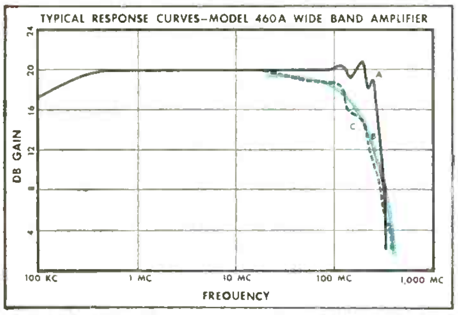


Figure 2
Typical response curves. Line A, with -hp- 410A VTVM. Line B, into 200 ohm load. Line C, Gaussian curve.

SPECIFICATIONS

Frequency Response: *High frequency* — closely matches Gaussian curve when operating into a 200 ohm resistive load. 3 db point is 140 mc.
Low frequency—when operating from a 200 ohm source and .01 blocking condenser, response off 3 db at 3 kc into an open circuit or succeeding amplifier. When operating into a 200 ohm load, off 3 db at 100 kc.
With -hp- 410A VTVM: ±1 db, 200 kc to 200 mc.

Gain: Approx. 20 db into 200 ohm load, with tubes of G_m 5,000 micromhos. (When operating into 200 ohm load.) Gain control has range of 6 db. 5 or more amplifiers may be cascaded.

Output: Approx. 8 v. peak open circuit. Output impedance, 330 ohms.

Input Impedance: 200 ohms.

Delay Characteristics: Approx. .012 μsec.

Rise Time: Approximately .0026 μsec (10% to 90% amplitude). No appreciable overshoot.

Mounting: Relay rack, 5¼" x 19" x 6" deep.

Power Supply: 115 v. 50/60 cps, self-contained.

Data subject to change without notice.

SETTING A NEW STANDARD FOR *FAITHFUL* PULSE AMPLIFICATION!

True amplification of very short pulses. Rise time .0026 microseconds; 20 db gain; can be cascaded. For oscilloscope, TV, UHF, nuclear or general laboratory work. Increases voltmeter sensitivity 10 times over 200 mc band.

The new *-hp-* 460A Wide Band Amplifier is the first instrument of its kind to offer you *faithful amplification* of very short pulses without objectionable ringing or overshoot. The rise time of the amplifier itself is only .0026 microseconds; and its response matches the Gaussian curve (transmission ideal) more closely than any other instrument yet offered.

The exactness with which the new *-hp-* 460A amplifies very short pulses can be seen in Fig. 1. Left: shows a .01 μsec pulse applied direct to plates of a 5XP11A cathode ray tube. Right: same pulse after passing through the *-hp-* 460A. Note the very short rise time and the absence of ringing or overshoot. Fig. 2, illustrates how closely the *-hp-* 460A conforms to the Gaussian ideal. As many as 5 amplifiers can be cascaded when high gain is necessary.

GENERAL AMPLIFIER

Fig. 2 also illustrates the wide frequency response of this instrument. It offers flat response up to 200 mc when used with the *-hp-* 410A Vacuum Tube Voltmeter. Sensitivity is increased 10 times. The *-hp-* 460A may also be used as a general purpose laboratory amplifier.

ACCESSORIES

Since the *-hp-* 460A Amplifier operates best at impedances of 200 ohms, *-hp-* has designed a 200 ohm coaxial system of connectors and cables. These accessories include leads with fittings, panel jacks and plugs, adapters to connect into a 50 ohm Type N system; and a special adapter for use with the *-hp-* 410A Voltmeter.

Get complete information now! See your nearest -hp- representative or write to factory.

HEWLETT-PACKARD CO.
1936-A Page Mill Road, Palo Alto, California
Export: FRAZAR & HANSEN, LTD.
301 Clay Street, San Francisco, Calif.; U. S. A.
Offices: New York, N. Y.; Los Angeles, Calif.

-hp- laboratory instruments
FOR SPEED AND ACCURACY

NEW MANUALLY-OPERATED "STICK" WINDER GETS "ELECTRICAL MANUFACTURING" DESIGN AWARD - UNIVERSAL NO. 108

A fully automatic coil winding machine pays its way only when the runs are long enough to justify the expense of the set-up time required.

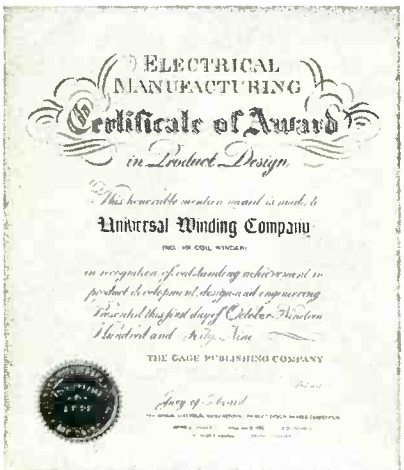
Since many coil lot sizes are small, only a portion of the market requirements can be filled economically by the use of automatic machinery.

This situation, together with the obsolete condition of many of the manually-operated winders in the electrical and electronic parts industries created the necessity for developing a manually-operated winder of *modern* design to supplement the automatic type.

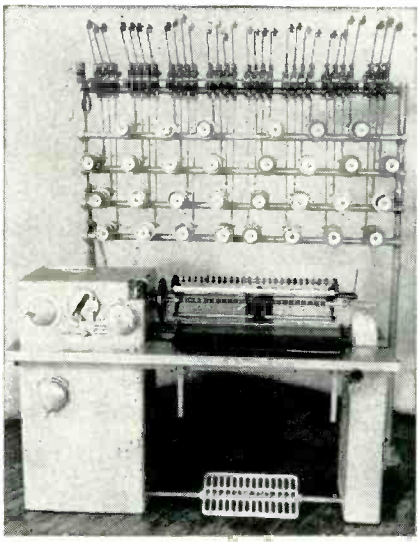
No. 108 COIL WINDER

The No. 108 Coil Winder was developed by the Universal Winding Company to meet the demand for a modern manually-operated machine to wind paper-insulated coils in multiple or "stick" form.

Its design received an Honorable Mention Award in the 11th Annual Product Design competition sponsored by "Electrical Manufacturing."


Electrical Manufacturing
Certificate of Award
in Product Design
Universal Winding Company
The Gage Publishing Company

The objective of Universal engineers was to produce an integrated unit, clean and functional, with labor-saving features which would warrant replacement of present equipment, and with a selling price low enough to be attractive to the predominantly "job shop" type of market characteristic of the ever-changing electrical and electronic parts industries.

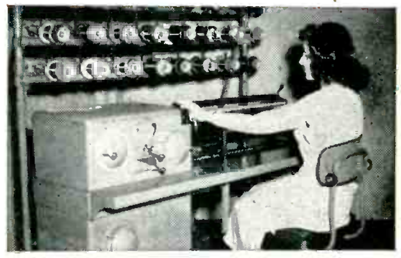


No. 108 Coil Winder.

After extensive field surveys and an analysis both of suggestions made by electrical engineers, superintendents and operators, and of their criticisms of existing machinery, our engineers determined upon the basic principles for the 108 Coil Winder that are incorporated in the following outstanding features.

Quick Set-Up All machine functions are built around the idea that quick set-up and finger-tip control are the best means of creating savings in the use of skilled labor during machine set-up.

Flexibility The machine can be adjusted quickly to accommodate changing requirements of wire size, coil length and diameter.



Note convenience of controls.

Accessibility Operations involved in preparing and finishing coils vary from job to job, but access to the coil stick is completely unhampered and all coils are readily processed. Accessibility features are also provided for ease of maintenance and adjustment.

Simplicity Since operators of this type of machine are usually women and may be disturbed by any complexity of controls and adjustments, the simple external appearance of this machine promotes confidence.

Cost Compared with an automatic machine winding the same type of coils, the cost of this machine is very modest, considering its efficiency and the high quality of its construction.

Bed The bed is a single casting, extending the full length of the machine, and is of aluminum to cut down weight. The supporting columns are made of single steel sheets, formed and welded and are braced at the bottom by steel straps which serve as feet. The left-hand one houses the motor and drive mechanism and the right-hand one is a cupboard for the operator's personal belongings.

For free literature on design features, write for "Getting the Most from Coil Winding No. 14."

UNIVERSAL WINDING COMPANY

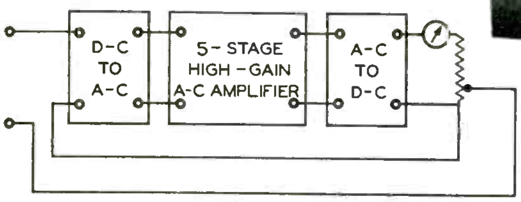
P. O. Box 1605 Providence 1, R. I.

* REG. U. S. PAT. OFF.

FOR WINDING COILS IN QUANTITY ACCURATELY . . . AUTOMATICALLY USE UNIVERSAL WINDING MACHINES

For low-level d-c measurements Use these new, triple-purpose D-C INDICATING AMPLIFIERS

stabilized for zero and gain



Voltage-balance feedback (above) and current-balance feedback stabilize gain . . . provide virtual null balance.

SPECIFICATIONS

MICROVOLT UNIT Catalog No. 9835	MICRO-MICRO-AMPERE UNIT Catalog No. 9836
FULL SCALE RANGES WITH BUILT-IN 4" METERS	
0 to 50 or —25 to +25 Microvolts; scale multipliers: 1,2,4,10, 20,40	0 to 1000 or —500 to +500 Micro-Micro-amps; scale multipliers: 1, 2, 5, 10, 20, 50, 100, 200, 500, 1000, 2000
ACCURACY	
Of amplifier: ±0.4% of reading ±0.5 Microvolt; Of meter: ±1%	Of amplifier: ±0.5 to 0.8%* of reading ±20 Micro-Micro-amps; Of meter; ±1%
STABILITY	
Zero and Gain stabilized automatically. No trimmer controls required.	
***SOURCE RESISTANCE**	
Up to 10,000 ohms.	0.1 megohm or more.
RESPONSE TIME	
2 to 3* sec.	2 to 3* sec.
OUTPUT	
For full scale input on any range: 10 millivolts at output impedance of 500 ohms for null recorder; 1 volt for 20,000-ohm external meter.	

Front panel fits standard 19" relay rack.

*Accuracy and Response Time depend on Source Resistance.

USE AS

- **DIRECT-READING MICROVOLTMETER OR MICRO-MICROAMMETER**
- **RECORDER PREAMPLIFIER**
- **NULL DETECTOR**

These new instruments are not only D-C Indicating Amplifiers but are stable, accurate measuring instruments as well. You can use them in measurements with thermocouples, strain gages, bolometers . . . bridge and potentiometer circuits . . . ionization, leakage, and phototube currents . . . almost any measurement of extremely small direct current or voltage.

Through a combination of a-c amplification and unique balanced feedback network, zero and gain stability are designed right into the instrument. Trimmer controls are designed out—eliminated.

Actually *three* instruments in one, these amplifiers can be used as—

Direct-reading instruments . . . At the turn of a scale-multiplier knob, you simply select the range in which you want to work.

Recorder preamplifiers . . . with broad flexibility. For instance, one or two degrees of temperature difference can be spread across an entire Speedomax recorder scale.

Null detectors . . . more sensitive than most reflecting galvanometers, yet with full scale response time of only 2 to 3 seconds. Leveling is unnecessary. There's no worry about shock or vibration. At the turn of a range knob, you have available a wide choice of sensitivities. External shunts are not required. And when using non-linear response, not only does the instrument stay on scale at extreme unbalance; sensitivity increases automatically as the null point is approached. For details, write to Leeds & Northrup Co., 4979 Stenton Ave., Phila. 44, Pa.

MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES

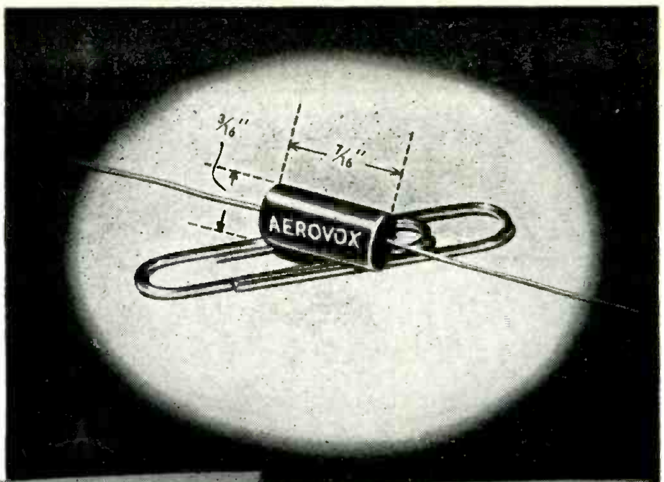
LEEDS & NORTHRUP CO.

SMALLER THAN PREVIOUS "SMALLEST"...

PREDETERMINED ACCURACY...

REMARKABLE STABILITY...

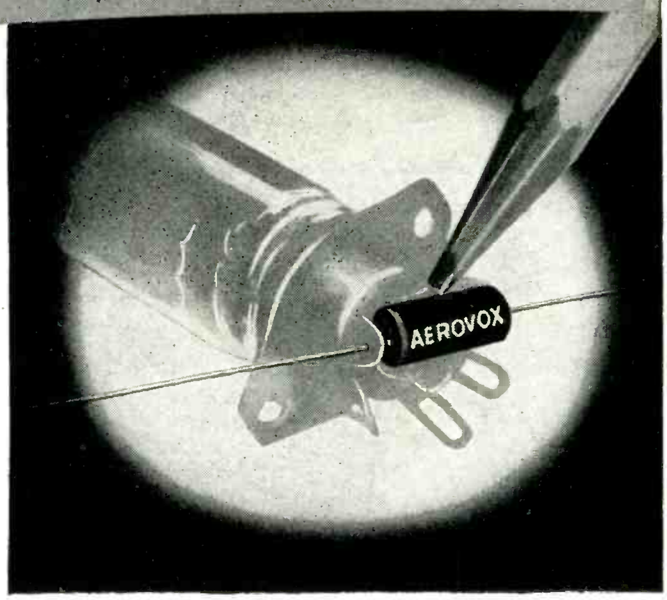
EXCEPTIONAL CHARACTERISTICS...



AEROVOX

MICRO-MINIATURES

(TYPE P83Z AEROLITE* CAPACITORS)



● Smaller than a paper clip! Only 3/16" dia. by 7/16" long! Yet rugged, accurate, stable, exceptional.

Such is the story of Aerovox Micro-miniatures (Type P83Z Capacitors). Smaller physical size directly due to radically new *metallized dielectric*—a distinct departure from conventional foil-paper and previous metallized-paper constructions. Dielectric and electrodes combined *in one element*. Smallest capacitor available for capacitance range.

Aerovox Micro-miniatures are particularly applicable to radio-electronic miniaturization calling for high-frequency and by-pass coupling.

● ***Try Aerovox Micro-miniatures in your miniaturized assemblies. Write Dept. FD-450 for engineering data, samples, quotations, and application engineering aid.***

FEATURING...

One size for all ratings—3/16" dia. by 7/16" long.

Hyvol K impregnated in humidity-resistant molded thermoplastic cases.

Operating temperature range from −15° C. to +85° C. without derating.

Power factor less than 1% when measured at or referred to frequency of 1000 cps and ambient temperature of 25° C.

Insulation resistance of 25,000 megohms or greater, measured at or referred to temperature of 25° C. Insulation resistance at 85° C., 500 megohms or greater.

Very high self-resonant frequency, due to remarkably small length of unit.

Life test: 1000 hours at 1.25 times rated voltage in ambient temperature at 85° C.

Meets humidity resistance requirements of RMA (REC-118, section 2, paragraph 2.38) for paper tubulars.

Meets RMA heat resistance test at 85° C. (REC-118, section 2, paragraph 2.39).

In 400 VDC (.0005 to .003 mfd.) and 200 VDC (.005 and .01 mfd.)

Other capacitance and voltage ratings will be made available in near future.

*Trade-mark

CAPACITORS • VIBRATORS • TEST INSTRUMENTS

AEROVOX capacitors

For Radio-Electronic and Industrial Applications

AEROVOX CORPORATION, NEW BEDFORD, MASS., U. S. A. • Sales Offices in All Principal Cities

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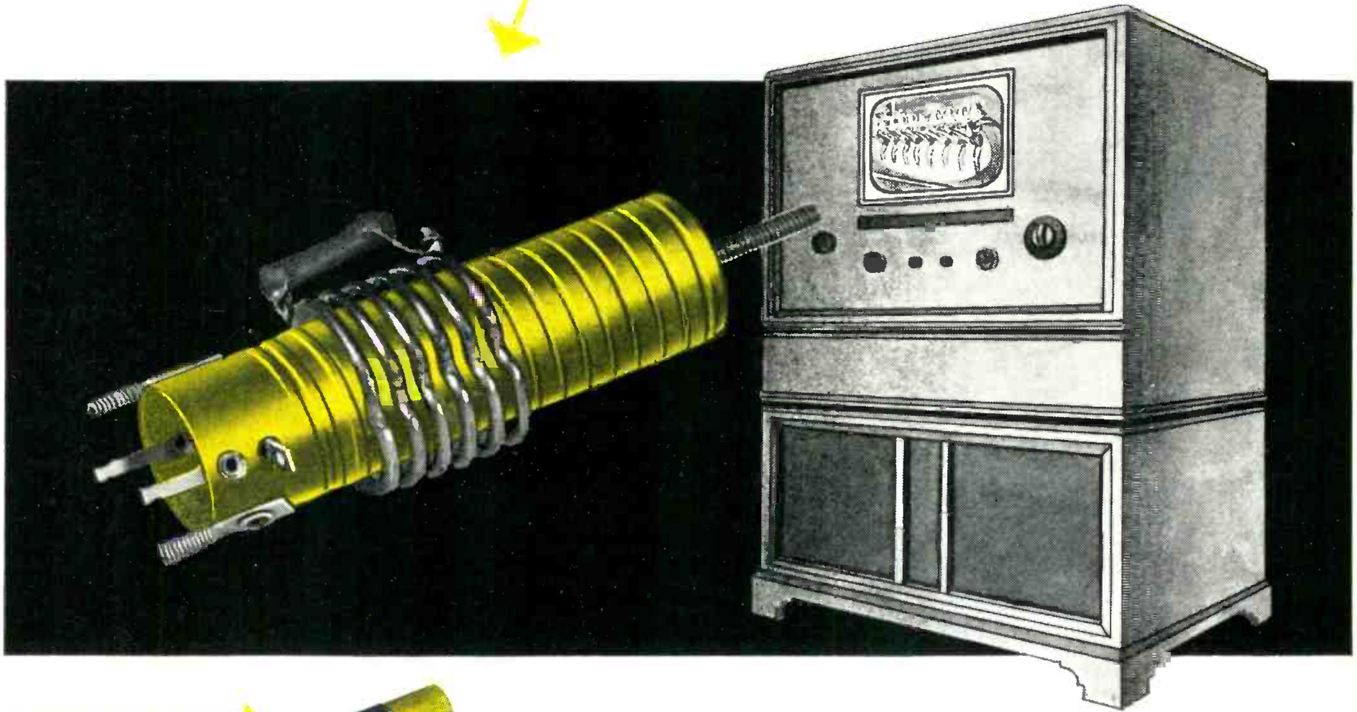
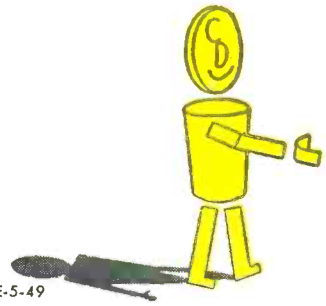
another C-D development . . .

a strong, lightweight, LOW-COST tubing for your electrical applications



Spiral Tubing—one of the many developments that have helped bring television into the mass market. Recently introduced by Continental-Diamond laboratories, it is ideal for electrical, radio, and television applications where a good dielectric tubing with high strength and lightweight is needed. It is available in a variety of sizes and grades to meet requirements for low moisture absorption, forming, riveting, drilling, tapping, etc.

It is another example of why it pays to see C-D first in your search for the right plastic. C-D Plastics provide *practical* combinations of mechanical, electrical, and chemical properties—structural strength, lightweight, moisture, heat and corrosion resistance. For fast delivery, or help with material selection problems, call your nearest C-D office, any time.



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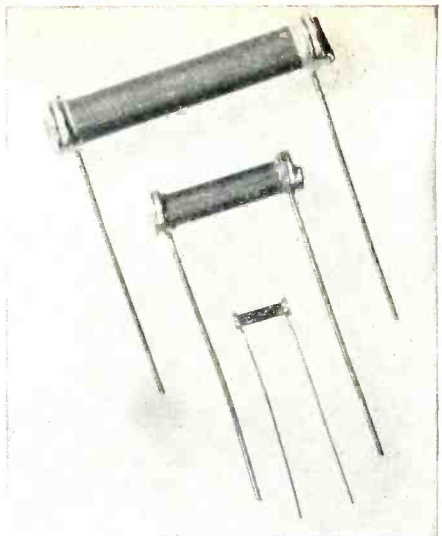
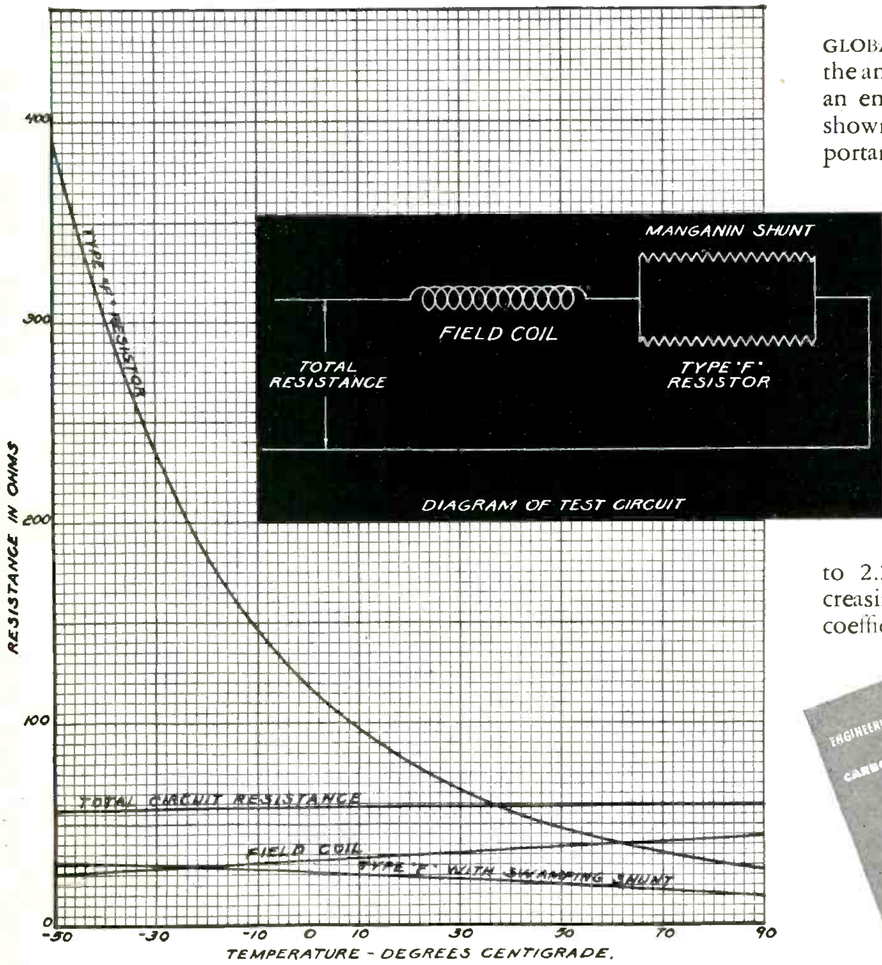
Continental-Diamond FIBRE COMPANY

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

Where Temperature Changes affect Circuit Performance...

these Resistors provide a Solution





GLOBAR brand type F resistors can often provide the answer when extremes of temperature present an engineering problem. A typical example is shown by the curves plotted here. In this important control system, a GLOBAR type F resistor is used to compensate for resistance changes due to temperature variations in coils such as generator and motor fields, measuring and control circuits.

The pronounced negative resistance—temperature characteristics of GLOBAR type F resistors makes them particularly useful for stabilizing circuits having a positive temperature coefficient of resistance.

GLOBAR type F resistors have no moving parts to wear out or get out of adjustment. They have a negative temperature coefficient ranging from 1% to 2.2% per degree Centigrade at 25°C., increasing with their resistivity, and a low voltage coefficient.

● Bulletins contain useful engineering data on GLOBAR type F resistors. Copies will be supplied immediately upon request. Write Dept. V-60, The Carborundum Company, GLOBAR Division, Niagara Falls, New York.

GLOBAR Ceramic Resistors

BY CARBORUNDUM

TRADE MARK

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

RAYTHEON

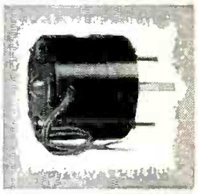
Fractional hp

MOTORS

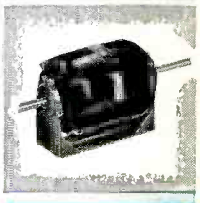
concentrated power

"Count on Raytheon to run it." That's what design engineers are saying. They're the men who appreciate the Creative Craftsmanship that goes into Raytheon fractional hp motors. Concentrated power in a small package—dependable performance at the shaft—those are the Key words in Raytheon design and engineering. When you want to *run* things, FANS, BLOWERS, HEATING EQUIPMENT, appliances or what have you—count on Raytheon motors to do the job. Call on your Raytheon motor representative for consultation on your specific application.

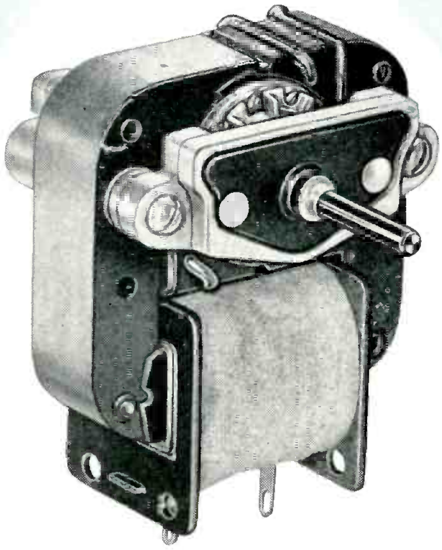
RAYTHEON TYPE 350
SHADED 2-POLE, 3000 rpm MOTOR.



RAYTHEON TYPE 330-S
4-POLE, 1/10 to 1/50 hp, 1550 rpm MOTOR.



RAYTHEON TYPE 470
SHADED 6-POLE, 1050 rpm INDUCTION MOTOR.



Type 230 Shaded 2-Pole Motor. For continuous duty without fan cooling. 1/200 to 1/50 hp at 3200 rpm. Flat Speed Torque Curve and High Starting and Pull Up Torque are characteristic of all Type 230 Raytheon motors. Efficiency is almost double the value ordinarily obtained in shaded two-pole motors of this type. Write for Data Bulletin 1000.

RUSSELL ELECTRIC COMPANY

MOTOR DIVISION OF RAYTHEON MANUFACTURING CO.

4501 So. Western Boulevard Dept. F-24 Chicago 9, Illinois

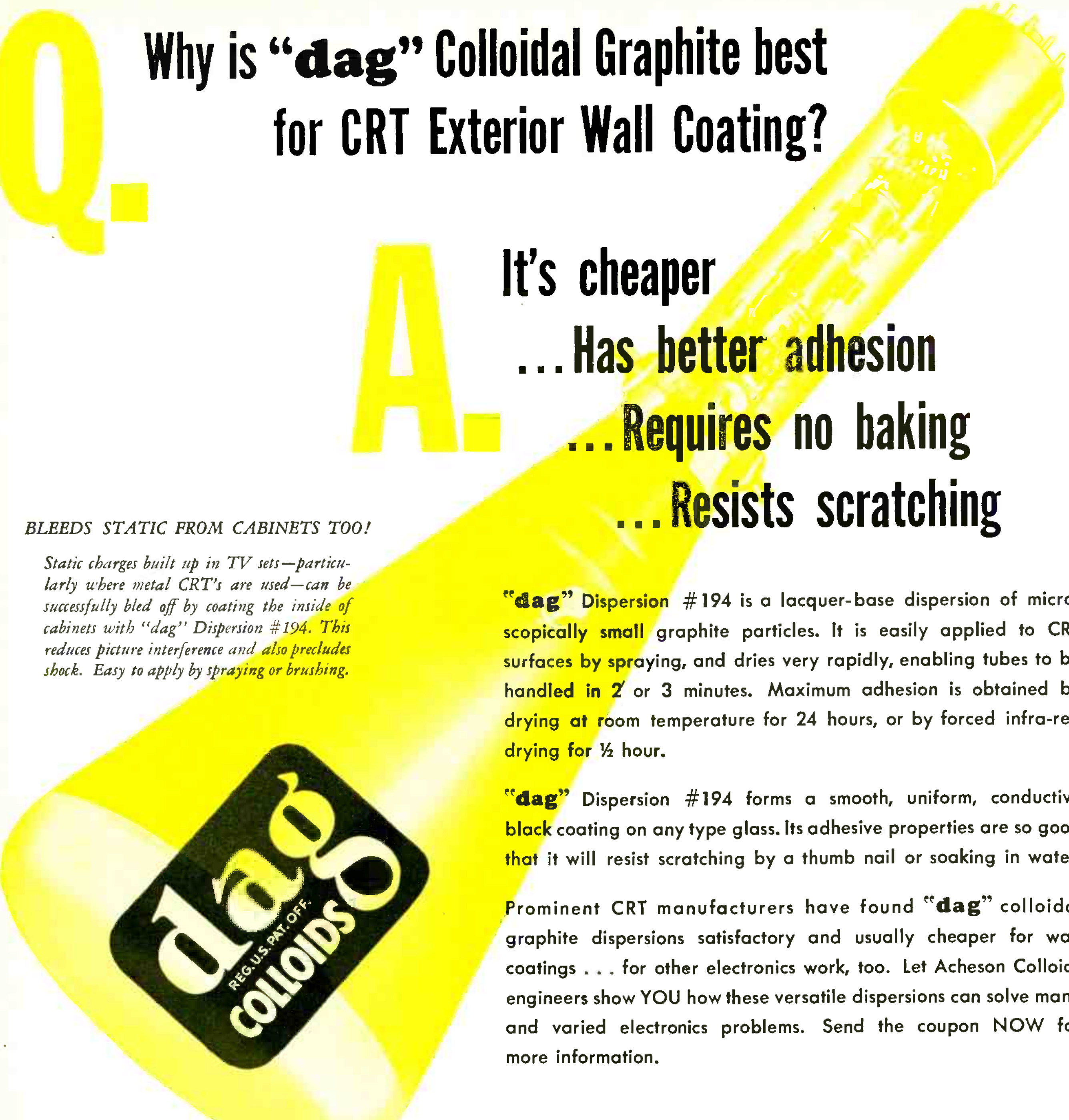
Q. Why is "dag" Colloidal Graphite best for CRT Exterior Wall Coating?

A. It's cheaper

...Has better adhesion

...Requires no baking

...Resists scratching



BLEEDS STATIC FROM CABINETS TOO!

Static charges built up in TV sets—particularly where metal CRT's are used—can be successfully bled off by coating the inside of cabinets with "dag" Dispersion #194. This reduces picture interference and also precludes shock. Easy to apply by spraying or brushing.

"**dag**" Dispersion #194 is a lacquer-base dispersion of microscopically small graphite particles. It is easily applied to CRT surfaces by spraying, and dries very rapidly, enabling tubes to be handled in 2 or 3 minutes. Maximum adhesion is obtained by drying at room temperature for 24 hours, or by forced infra-red drying for ½ hour.

"**dag**" Dispersion #194 forms a smooth, uniform, conductive black coating on any type glass. Its adhesive properties are so good that it will resist scratching by a thumb nail or soaking in water.

Prominent CRT manufacturers have found "**dag**" colloidal graphite dispersions satisfactory and usually cheaper for wall coatings . . . for other electronics work, too. Let Acheson Colloids engineers show YOU how these versatile dispersions can solve many and varied electronics problems. Send the coupon NOW for more information.

ACHESON COLLOIDS CORPORATION
Port Huron, Michigan
Send me more information on:
______ "**dag**" Dispersion #194 for Exterior Wall Coating
______ "**dag**" Colloidal Graphite in Electronics

Name..

Company Name..

Address..

City.......................... Zone.............. State..............

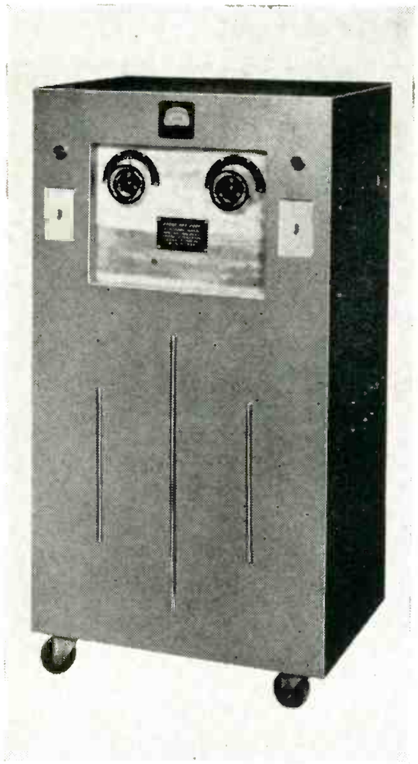
F-5

ACHESON COLLOIDS CORPORATION
Port Huron, Michigan

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

Heat Sealing Generator

KABAR MANUFACTURING CORP., 1907 White Plains Road, New York 60, N. Y. The Kabar Model No. 2500 High Frequency Generator is a versatile unit for heat sealing vinyl plastic fabrics. Indicative of the high quality of design are the KENYON Transformers used extensively.



The No. 2500 has a power supply of 220 volts, 60 cycles, single phase, output of 3 kw, output frequency of 27.12 megacycles and power consumption of 5.5 kw. Size of the compact unit is 50″ x 26″ x 18″. Weighs approximately 400 lbs. Sealing cycle is automatically controlled.

The Kabar No. 2500 is but one of many high quality applications that call upon KENYON engineering ability and know-how for transformers that are built for rugged use. Whether it be standard KENYON "T" Line or "specials" custom-built to your requirements, you are always assured of quality, dependability and sound construction.

For over 20 years, leading manufacturers and engineers in all fields specify KENYON Transformers for many industrial, communication, sound and electronic applications. KABAR, too, specifies KENYON for high quality, economy transformers!

(Advertising)

Here's the "Q" in Transformers

It's KENYON Quality

Custom-built to your Specifications

KENYON one of the oldest names in transformers, offers you high quality specification transformers custom-built to your requirements — *practically at catalog prices!* For over 20 years the KENYON "K" has been a sign of skillful engineering, progressive design and sound construction.

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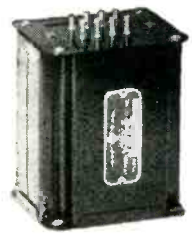
JAN APPLICATIONS	AUTOMATIC CONTROLS
BROADCAST	AUDIO AMPLIFIERS
INDUSTRIAL MACHINERY	EXPERIMENTAL LABORATORIES
RADAR	ATOMIC ENERGY EQUIPMENT

Among many others

Consult our engineering staff on any of your "special" problems at no obligation to you. Call or write *now* for our representative.



KENYON "T's"— famous line of high quality, uniform transformers are ready for immediate delivery from stock. Our standard line can save you much time and expense. For a complete story about specific ratings on all transformers, send for your copy of the latest KENYON Catalog edition *now!*

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We need "special" transformers —
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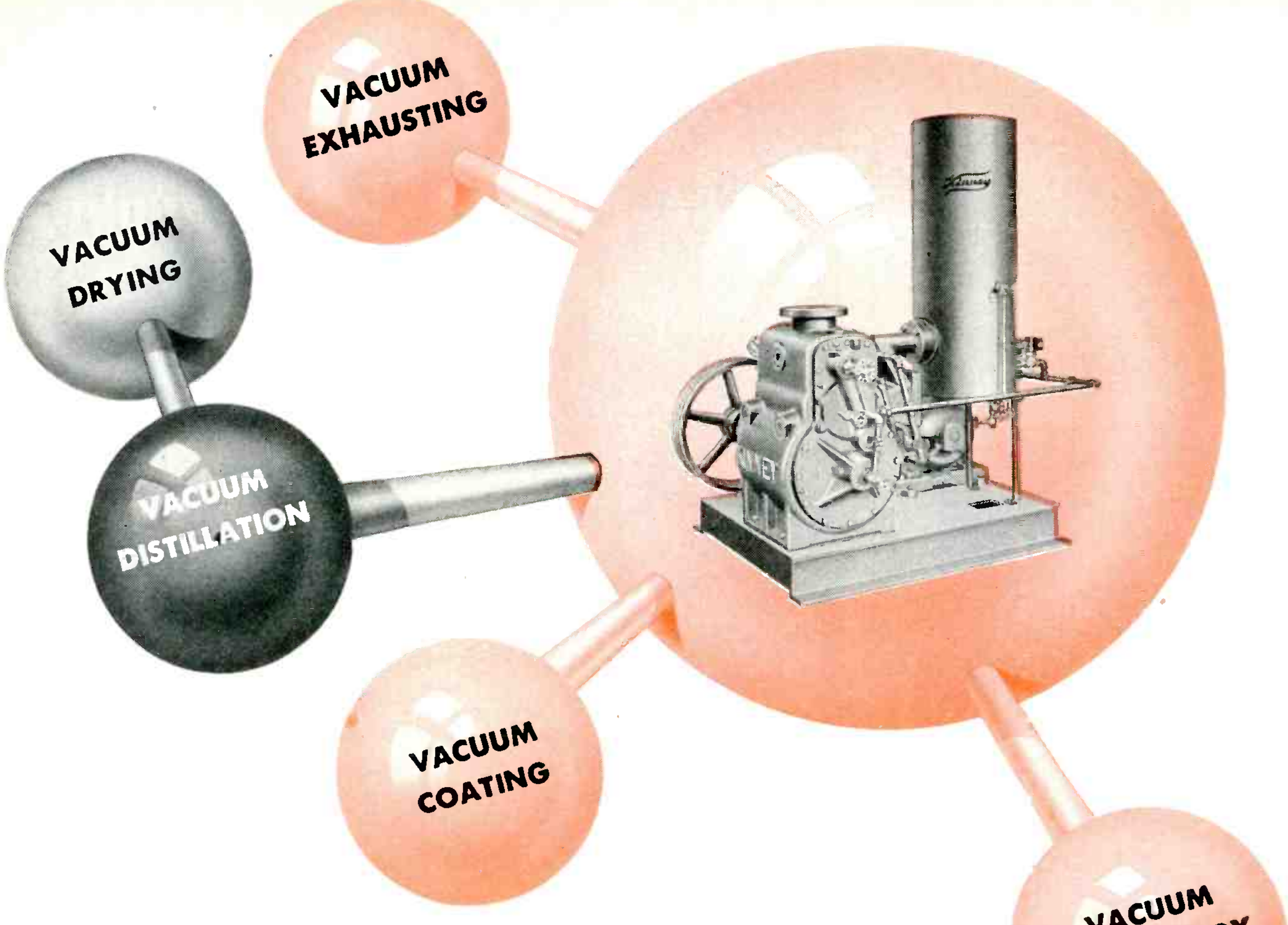


when vacuum is vital you can count on KINNEY

Kinney High Vacuum Pumps are at work in all phases of low pressure processing — in the production of television tubes, titanium, penicillin, electrical condensers, coated camera lenses, dehydrated foods, and scores of other products. Their dependability and high pumping speed have helped bring vacuum out of the laboratory and onto the production line. Kinney Pumps are establishing important records both for length of service and economy of operation. They are virtually a "production must" whenever processes require fast pump down to low absolute pressures.

Performance is the big reason why Kinney Pumps are so often specified "when vacuum is vital". Perhaps they can help speed YOUR processes or improve YOUR products. Write for Bulletin V-45, describing the complete line of Single Stage and Compound Vacuum Pumps. Kinney Manufacturing Company, 3565 Washington St., Boston 30, Mass. Representatives in New York, Chicago, Cleveland, Houston, New Orleans, Philadelphia, Los Angeles, San Francisco, Seattle.

Foreign Representatives: General Engineering Co. (Radcliffe) Ltd., Station Works, Bury Road, Radcliffe, Lancashire, England . . . Horrocks, Roxburgh Pty., Ltd., Melbourne, C. I. Australia . . . W. S. Thomas & Taylor Pty., Ltd., Johannesburg, Union of South Africa . . . Novelectric, Ltd., Zurich, Switzerland.

Making old things better
Making new things possible

KINNEY Vacuum Pumps

INDUSTRIAL TEST EQUIPMENT

SHOOT TROUBLE *on the line...* REDUCE COSTLY SHUTDOWNS!

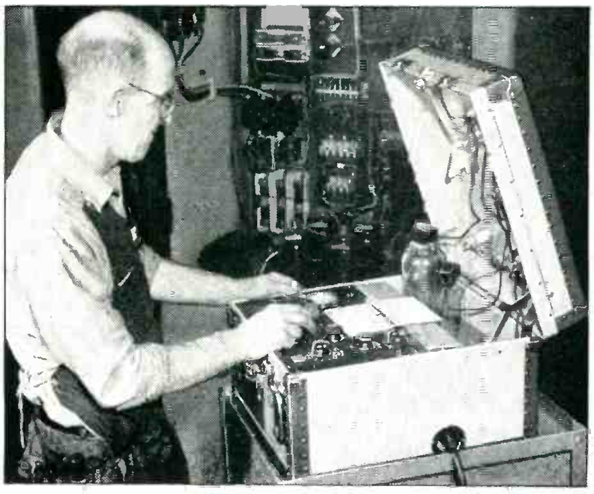
INDUSTRIAL OSCILLOSCOPE—For tracing circuit trouble in electronic-control equipment, this scope is fast, accurate, and dependable. Ideal for checking welding machines, high wave capacitor discharge panels, variable speed motor controls. Set it down anywhere—the case is insulated . . . carry it easily—weighs only 27 pounds . . . use it in many ways—tests both AC and DC.

- ☆ Tests make-and-break of relay circuits
- ★ Checks waveforms in Thyratron control
- ☆ Max. input voltage 550
- ☆ Sensitivity 0.15 volts dc/inch; 0.18 volts rms/inch.

IN WELDING OPERATIONS—USE IT TO

- ★ check "hard-starting" ignitrons
- ★ observe voltage shapes on tube elements in timing sequence circuits
- ★ check instantaneous regulation on high current welder supply line
- ★ set "full heat limit adjustment"
- ★ check relays for bounce and high resistance contactors
- ★ check "on" and "off" time in seam welders
- ★ check behavior of peaking transformers
- ★ check high frequency interference switch transients caused by other equipment

INDUSTRIAL TUBE ANALYZER—Which tubes are bad? Don't guess—check them quickly, easily with this Analyzer that pays for itself in the cost of tubes you would normally scrap. Tests Thyratrons and Phanatrons with ratings up to 100 amperes peak current. Can be operated by nontechnical personnel after brief instruction. Backs up the G-E Industrial Oscilloscope to boost your maintenance efficiency, cut your costs.



GET THIS CATALOG—IT'S FREE!

Contains specifications and price information on instruments shown here as well as other items of G-E electronic test equipment. Write: *General Electric Company, Section 460, Electronics Park, Syracuse, New York.*

GENERAL ELECTRIC

PRECISION *electronic* SPECIALTIES

HIGH-STABILITY PRECISION RESISTORS

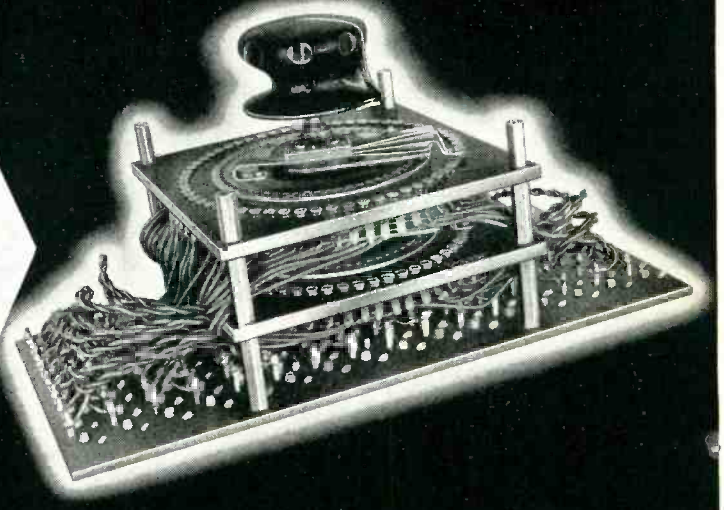
Guaranteed tolerances from 0.1% to 0.02% and stabilities as low as 0.003%.

It is one thing to make an accurate resistor, but quite another to guarantee the stability as required in computer circuits, tuning circuits, precision voltage dividers, radar range units, guided missiles and other critical uses. Not only are Shallcross Akra-Ohm resistor types 116, 196, and 193 outstanding in these respects, but they can likewise be furnished in matched pairs and sets to your tolerance and with a guaranteed stability as low as 0.003%.

MULTI-POSITION SELECTOR SWITCHES

Up to 120 contacts

As long-time specialists in custom-built rotary selector switches, Shallcross offers an extremely broad line of standard and special adaptations at attractive prices. Standard designs include up to 120 contacts per deck in shorting and non-shorting types and as many decks as may be required. Ask for Bulletin L13 and Specification Sheet 6.



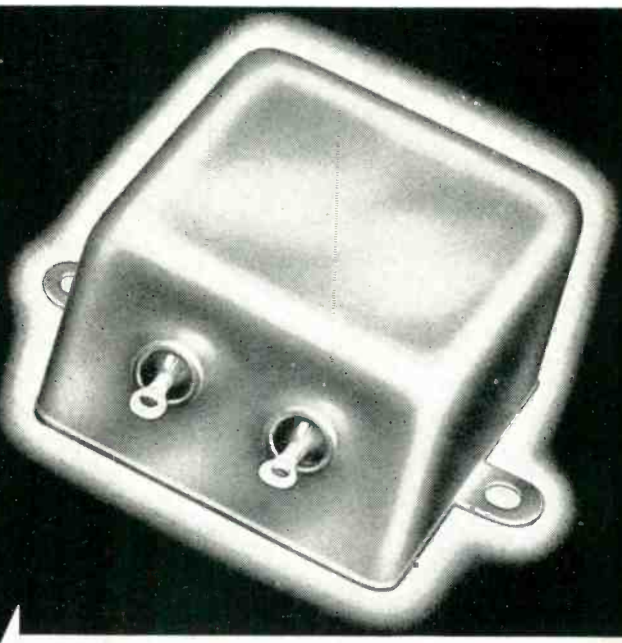
CUSTOM-BUILT SPECIALTIES

Today's complex circuits frequently call for the design, development, and production of highly specialized components, sub-assemblies, or instruments which usually fall outside the realm of standard production. Backed by a staff of electronic, electrical, instrument, mechanical, and chemical engineers and fully equipped for both research and development, Shallcross is well organized to handle such assignments. Recent developments for leading manufacturers, public utilities, and military agencies have included:

Potted Wheatstone bridge networks • High-voltage measuring equipment Potted and thermally controlled R-C networks • Precise decades and networks for computer devices • Hermetically-sealed chokes • Calibrating instruments for strain gauge bridges High resistance standards • Critical coil assemblies

SHALLCROSS MANUFACTURING

BY SHALLCROSS



HERMETICALLY-SEALED NETWORKS

Resistance • Capacitance
Bridge • Inductance

To satisfy the exacting requirements of electronic computers, delay lines, tuning circuits, phase shifters, and other devices, Shallcross is fully equipped to design and produce potted networks to meet many critical electrical specifications and space requirements. The unit shown is a hermetically-sealed potted bridge network designed to control a potential of 100 volts to within ±0.1 volt.

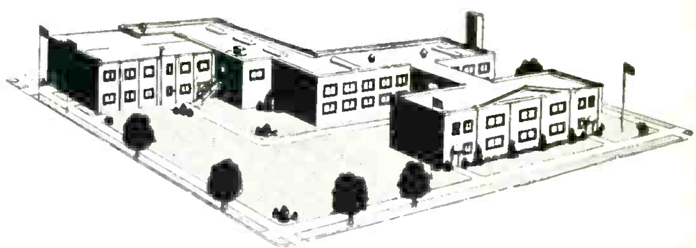
HIGH-RANGE KILOVOLT-METER MULTIPLIERS

and Voltage Dividers

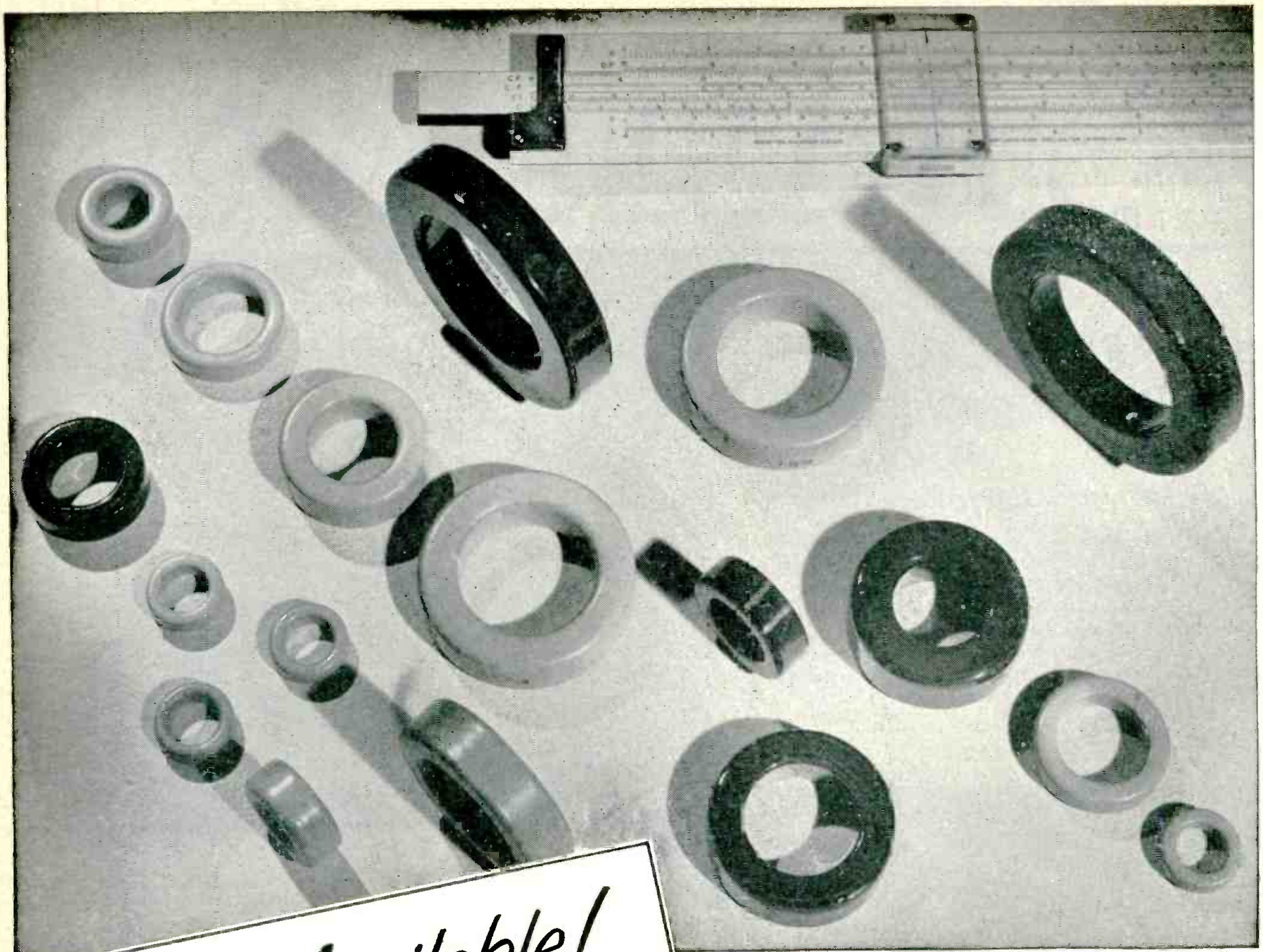
Whether for direct high-voltage measurements or for use as standards in determining the exact voltage of a portion of a high-voltage supply, Shallcross Kilovoltmeter Multipliers combine close accuracy with safety and dependability. The No. 791 Kilovoltmeter Multiplier illustrated here provides a ready means of determining a-c and d-c potentials up to 40,000 volts with outstanding accuracy. Other Shallcross types are available. For details, see Bulletin F.

HI-MEG HI-VOLTAGE RESISTORS

Special resistance elements hermetically-sealed in ceramic tubes with ferrule type terminals. With composition elements the standard tolerance is 10% and the temperature coefficient is 0.04% per degree C. Tolerances as close as 2% are available. With special wire-wound resistance elements, accuracies of 0.05% are easily obtained. A standard temperature coefficient of 0.002% per degree C holds over a wide temperature range. Three standard sizes offer resistance values from 1000 ohms to over 100 megohms. Write for Bulletin F



COMPANY Dept. E-60 **Collingdale, Pennsylvania**



Now Available!
MOLYBDENUM PERMALLOY POWDER CORES*

HIGH Q TOROIDS for use in Loading Coils, Filters, Broadband Carrier Systems and Networks— for frequencies up to 200 KC

COMPLETE LINE OF CORES TO MEET YOUR NEEDS

★ Furnished in four standard permeabilities—125, 60, 26 and 14.

★ Available in a wide range of sizes to obtain nominal inductances as high as 281 mh/1000 turns.

★ These toroidal cores are given various types of enamel and varnish finishes, some of which permit winding with heavy Formex insulated wire without supplementary insulation over the core.

For high Q in a small volume, characterized by low eddy current and hysteresis losses, ARNOLD Moly Permalloy Powder Toroidal Cores are commercially available to meet high standards of physical and electrical requirements. They provide constant permeability over a wide range of flux density. The 125 Mu cores are recommended for use up to 15 kc, 60 Mu at 10 to 50 kc, 26 Mu at 30 to 75 kc, and 14 Mu at 50 to 200 kc. Many of these cores may be furnished stabilized to provide constant permeability (±0.1%) over a specific temperature range.

** Manufactured under licensing arrangements with Western Electric Company.* W&D 2930

THE ARNOLD ENGINEERING COMPANY

SUBSIDIARY OF ALLEGHENY LUDLUM STEEL CORPORATION

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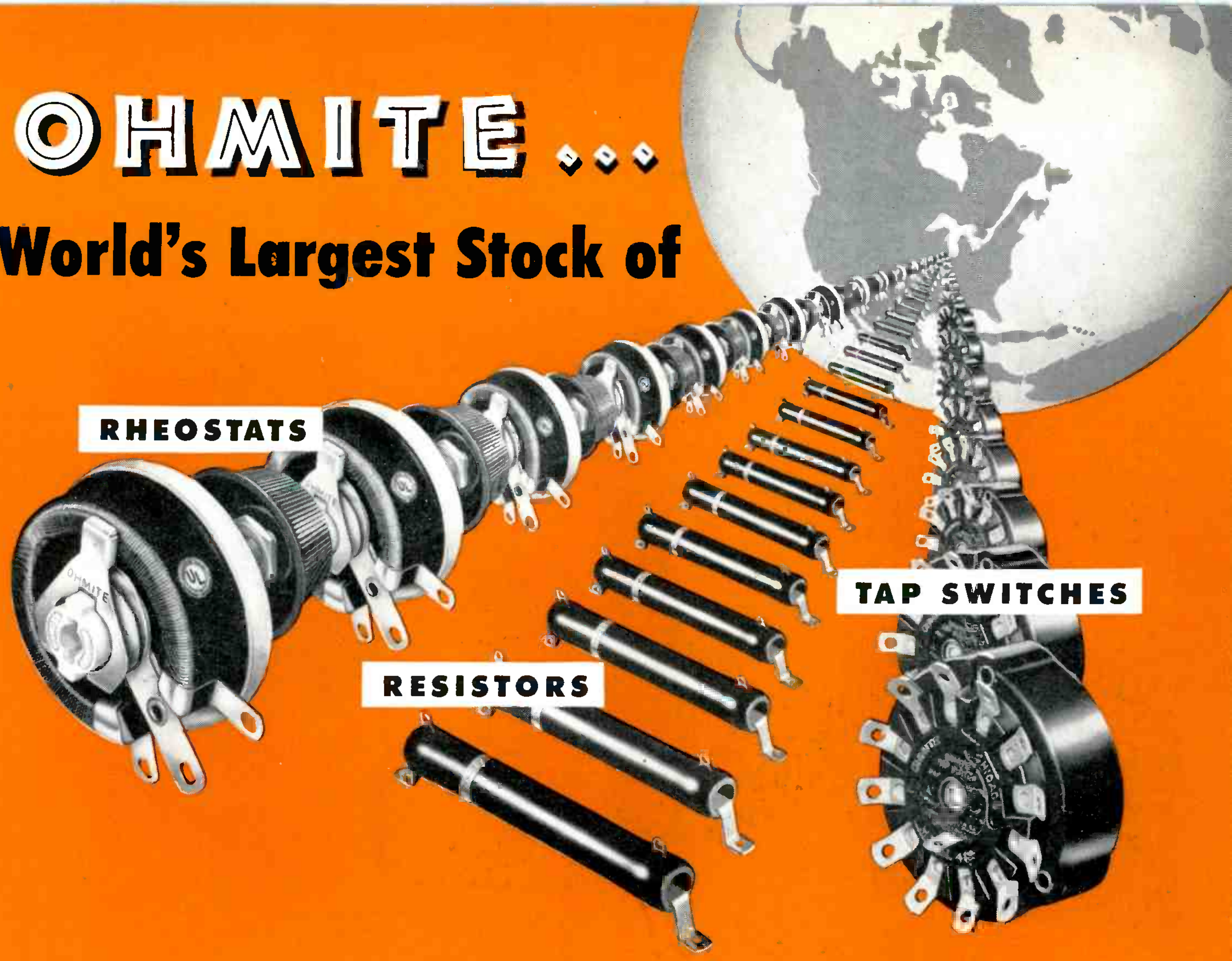

Ready for IMMEDIATE *Shipment*

For fast delivery, rely on Ohmite. Stock orders are usually shipped out the same day received. Special orders, too, are scheduled and shipped promptly.

How can Ohmite do it? First, they have developed an efficient, tightly geared order system which short-cuts red tape.

But more important is Ohmite's enormous stock of rheostats, resistors, and tap switches—believed to be the largest and most complete maintained anywhere in the world.

Specify Ohmite for Dependability . . . and *PROMPT DELIVERY!*

RUSH
SERVICE
ON SPECIAL
ORDERS, TOO

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25th Anniversary
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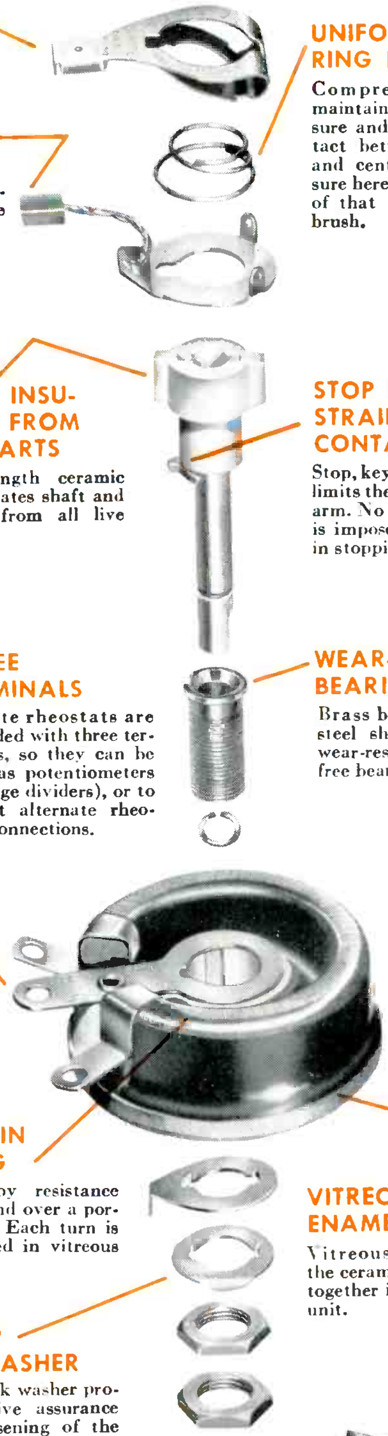
RHEOSTATS RESISTORS TAP SWITCHES

Here's Why You Get

UNFAILING DEPENDABILITY with OHMITE RHEOSTATS



UNIFORM CONTACT PRESSURE
Spring steel contact arm forms a long spring which assures uniform contact pressure at all times.

UNIFORM SLIP-RING PRESSURE
Compression spring maintains uniform pressure and electrical contact between slip ring and center lead. Pressure here is independent of that at the contact brush.

METAL-GRAPHITE BRUSH
Assures perfect contact with negligible wear on the wire.

SHAFT INSULATED FROM LIVE PARTS
High-strength ceramic hub insulates shaft and bushing from all live parts.

STOP PREVENTS STRAIN ON CONTACT ARM
Stop, keyed to the shaft, limits the rotation of the arm. No torsional strain is imposed on the arm in stopping.

THREE TERMINALS
Ohmite rheostats are provided with three terminals, so they can be used as potentiometers (voltage dividers), or to permit alternate rheostat connections.

WEAR-RESISTANT BEARING
Brass bushing for the steel shaft provides a wear-resistant, wobble-free bearing.

LOCKED-IN WINDING
Special alloy resistance wire is wound over a porcelain core. Each turn is firmly locked in vitreous enamel.

VITREOUS ENAMEL BOND
Vitreous enamel bonds the ceramic core and base together into one integral unit.

BEND-UP LOCK WASHER
Bend-up lock washer provides positive assurance against loosening of the assembly nut.

Years of field experience emphasize the underlying soundness of Ohmite rheostat design. These rheostats are constructed entirely of ceramic and metal—contain nothing to char, burn, shrink, or deteriorate. Ceramic parts insulate the shaft and mounting. The resistance winding is permanently locked in place by vitreous enamel. Every turn is contacted by the smoothly gliding metal-graphite brush, assuring smooth, gradual, close control.

OHMITE MANUFACTURING CO.
4818 Flournoy St.
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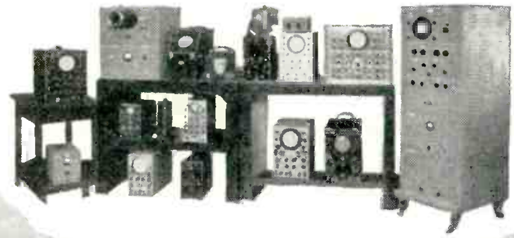
Write on Company Letterhead for Catalog and Engineering Manual #40.

RHEOSTATS • RESISTORS • TAP SWITCHES

25th Anniversary
1925-1950

DUMONT *Oscillography..*



. . . the outstanding heritage of another great performer

DEFINING THE OSCILLOGRAPHIC SPECTRUM **from 10 cps. to 15 megacycles**

THE NEW DU MONT TYPE 294 CATHODE-RAY OSCILLOGRAPH

The Type 294 is an extremely versatile cathode-ray oscillograph combining high-voltage operation with precise high-frequency circuit design, extending its general-purpose utility to meet the specialized needs of high-speed transient study.

Stable operation of the high-gain, wide-band amplifier of the Y axis over the entire frequency range from 10 cps. to 15 megacycles includes the performance of a signal-delay line built into the Y-axis circuit to insure full display of short-duration pulses. An input pulse rise time of 0.01 μs. will be reproduced with a rise time not exceeding 0.03 μs.

Available undistorted deflection of both symmetrical signals and unidirectional pulses of either positive or negative polarity exceeds the usable vertical scan of the cathode-ray tube. A built-in high-voltage unit supplies 12 kv. accelerating potential to the Du Mont Type 5XP- cathode-ray tube; rear-panel selection of a lower potential may be made for increased sensitivity and deflection.

A flexible sweep circuit provides continuously variable driven and recurrent sweeps with sweep calibration being provided by internal timing markers applied through the Z-axis amplifier.

• • •

Permanent records of phenomena studied with the Type 294 may be made with either the Du Mont Type 271-A or 314-A Oscillograph-record Camera.

GENERAL SPECIFICATIONS

Cathode-ray Tube . . . . . Du Mont Type 5XP-
Accelerating potential . . . . . 12,000 volts
. . . . . . 7,000 volts

Y-axis Amplifier
Frequency response
10 cps. to 15 megacycles
Sensitivity . . . . . 0.15 rms volt/in. at 7 kv.
. . . . 0.20 rms volt/in. at 12 kv.
Rise time . . . . 0.03 μs. from 10% to 90%

Signal Delay . . . . 0.25 μs.

X-axis Amplifier
Frequency response . . . . 2 cps. to 700 kc.
Sensitivity . . . . . . 0.4 rms volt/in. at 7 kv.
. . . . . 0.5 rms volt/in. at 12 kv.
Rise time . . . . . . 0.5 μs. from 10% to 90%

Driven Sweep Range . . . . . . 0.1 sec. to 2 μs.

Recurrent Sweep Range . . 10 cps. to 150 kc.

Z-axis Amplifier
Polarity selection—3 volts peak to blank trace of normal intensity.

Timing-Marker Intervals
100 μs., 10 μs., 1 μs.

Trigger Generator
Repetition rate . . . . 200 to 3600 p.p.s.
Output amplitude . . . . 50 volts peak
Output polarity . . . . positive or negative

Physical Specifications
Indicator Unit
24½" d.—15¾" h.—12¾" w.—62 lbs.
Power Supply
19¾" d.—15¾" h.—12¾" w.—100 lbs.

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ALLEN B. DUMONT LABORATORIES, INC., *INSTRUMENT DIVISION*, 1000 MAIN AVENUE, CLIFTON, NEW JERSEY

ANNOUNCING... 5 *New* UNITS

Making available a wider choice of
ARMA Induction Motors

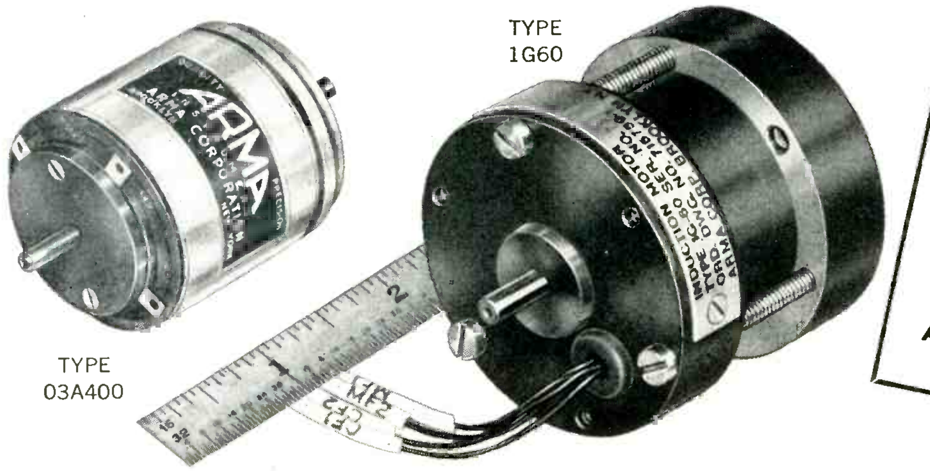
Designed specifically for high performance servo applications

TYPICAL SPECIFICATIONS

	TYPE	DWG. No.	FREQ.	FIELD VOLTAGES			(Min.) NO LOAD SPEED R.P.M.	MAX. WATTS OUTPUT at R.P.M.	STALLED TORQUE (Min.) Oz. In.	ROTOR INERTIA Oz. In.²	WEIGHT lbs.
				PHASE	MAIN	CONTROL					
New	03A60	715758-1	60	2	24	24	1600	0.55 at 875	1.3	0.040	0.25
New	03B60	715758-2	60	2	24	24	3000	1.0 at 2000	1.0	0.040	0.25
	1A60	213377-2	60	2	40	40	3100	1.5 at 1750	1.7	0.030	0.8
	1B60	213251-1	60	2	115	115	3000	2.4 at 2000	3.0	0.25	1.4
	1D60	213251-2	60	2	115	115	3000	6.5 at 2000	8.0	0.25	1.4
New	1F60	64913	60	3	115		3200	13.0 at 2000	16.	0.048	1.5
New	1G60	65016 (715759)	60	2	115	40	1500	1.0 at 750	3.0	0.051	0.56
	5A	213079-1	60	2	75	90	3000	6.3 at 1800	8.0	0.32	4.0
	5C	213261-1	60	2	90	75	3000	7.5 at 2000	8.0	5.51	4.3
	6	213069-1	60	2	115	90	3000	18.0 at 2000	16.5	1.38	9.8
New	03A400	715640-1	400	2	24	24	10,000	1.8 at 6000	0.7	0.036	0.25

FEATURES

Low Bearing Friction • Rapid Response to Applied Voltage • Symmetrical Rotor Design • Quiet Operation • High Mechanical Accuracy • Double Ended Shafts.



TYPE 1G60

TYPE 03A400

INDUCTION MOTOR BOOKLET JUST PRINTED GIVES COMPLETE DETAILS

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ARMA PRODUCTS RELEASED FOR PRIVATE INDUSTRY

ARMA ELECTRICAL RESOLVERS* • ARMA SYNCHROS • ARMA INDUCTION MOTORS • ARMA INDUCTION GENERATORS • ARMA MECHANICAL DIFFERENTIALS • ARMA ALTERNATING VOLTAGE COMPARATOR • COMPUTING MECHANISMS • INDUSTRIAL CONTROLS • STABILIZATION DEVICES • NAVIGATIONAL EQUIPMENT • LIMITRON AUTOMATIC INSPECTION SYSTEM

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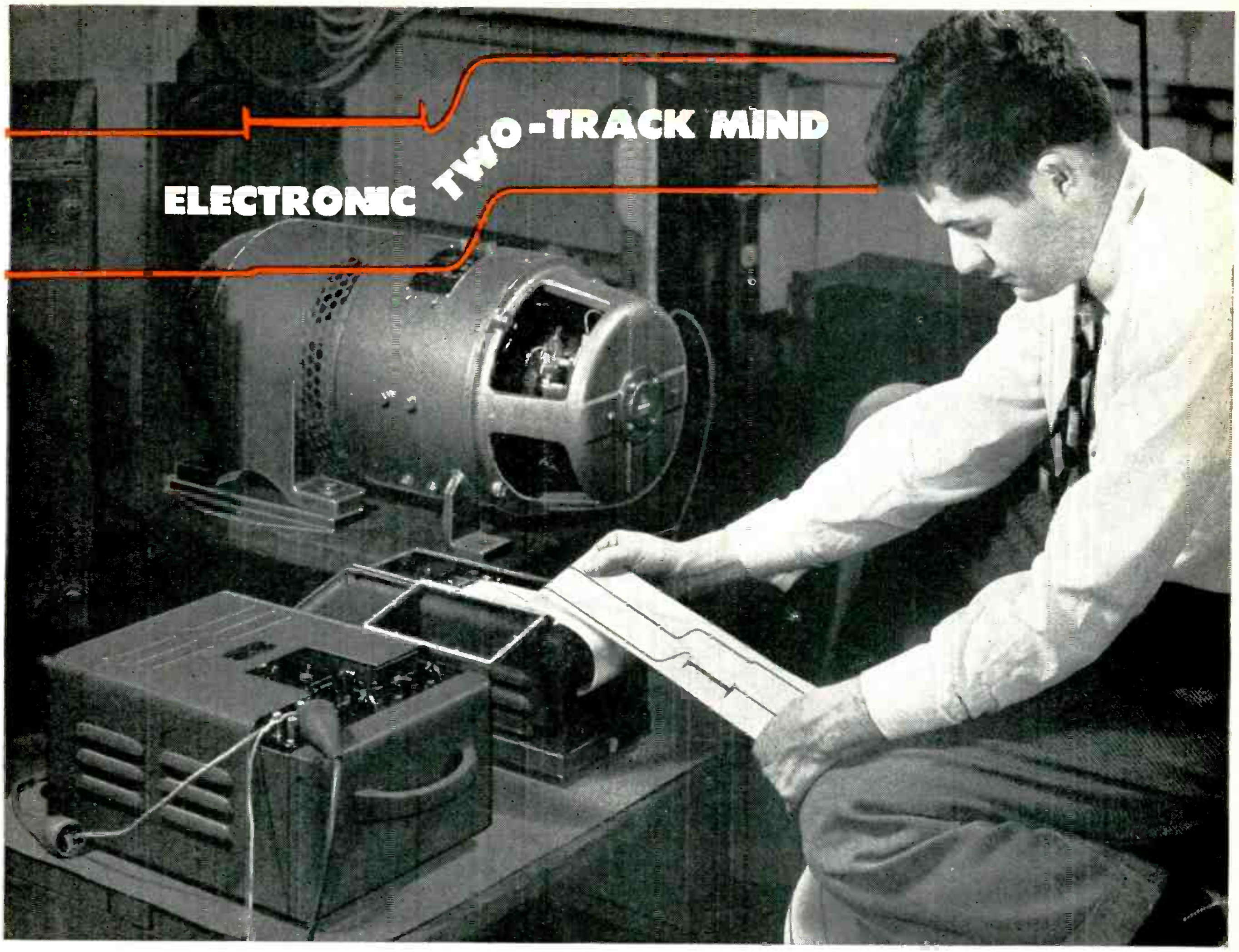
QUALITY ARMA INSTRUMENT PRECISION



New BRUSH Dual Channel DC Amplifier simplifies current-voltage studies

To measure and record two phenomena simultaneously, Brush introduces the new Model BL-928 Dual Channel Direct Coupled Amplifier for use with the Model BL-202 Dual Channel Magnetic Oscillograph. These Brush instruments, shown above, are being used in the test laboratory of Hertner Electric Company, Cleveland, Ohio to study the characteristics of motor-generators. In this particular test, they are recording generator voltage and field current time-curves for plotting a saturation curve and studying build-up of voltage. This requires only a few minutes . . . compared to the hours needed for conventional plotting methods.

These Brush dual-channel instruments can simplify the study of many other variables such as battery characteristics, photo cell outputs, line voltage and current values and electric phenomena having amplitudes of 40 millivolts or more and frequency components from zero to 100 cycles per second. Write for Form 732 which gives further details.

THE *Brush* DEVELOPMENT COMPANY
3405 Perkins Avenue, Cleveland 14, Ohio, U. S. A.

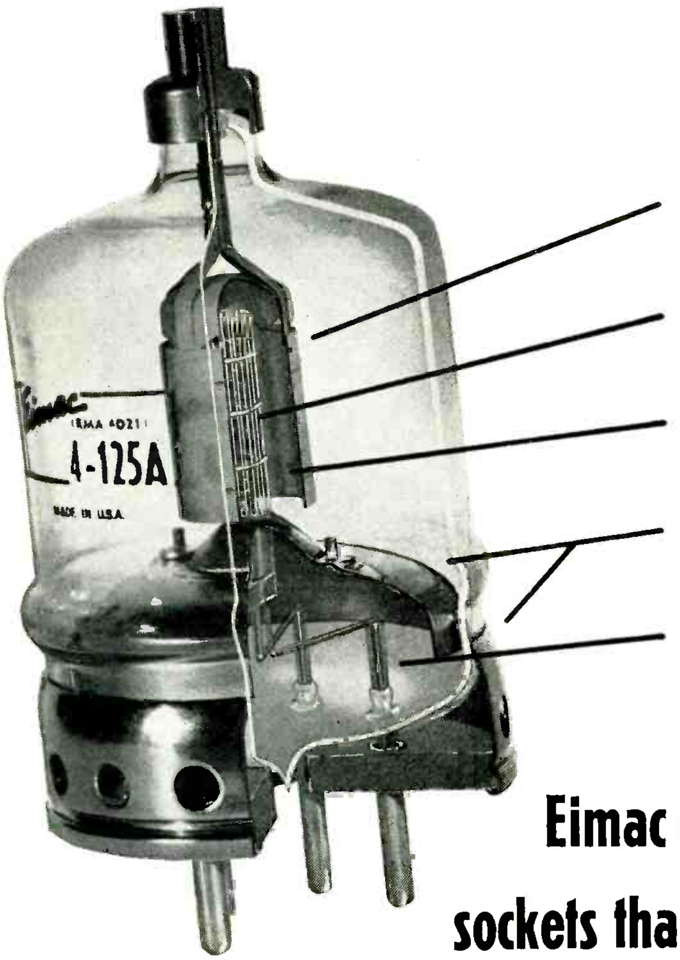
Canadian Representatives: A. C. Wickman (Canada) Ltd., P. O. Box 9
Station N, Toronto 14, Ontario

Put it in writing with a

BRUSH RECORDING ANALYZER

STRAIN ANALYZERS • SURFACE ANALYZERS • CONTOUR ANALYZERS • UNIVERSAL ANALYZERS • UNIFORMITY ANALYZERS

Because Of 5 Outstanding Features



Eimac 4-125A tetrodes fill more key sockets than any other 125-watt tetrode.

The Eimac 4-125A is the heart of modern radio communication systems. Its dependability-of-performance has been proved over years of service in many thousand transmitters. It will be to your advantage to consider carefully the economy and circuit simplification the Eimac 4-125A offers.

As an example of Eimac 4-125A performance, two tubes in typical class-C telegraphy or FM telephony operation with less than 5 watts of grid-driving power will handle 1000 watts input; or, two 4-125A's in high-level modulated service will handle 750 watts input.

Take advantage of the engineering experience of America's foremost tetrode manufacturer . . . Eimac. Write for complete data on the 4-125A and other equally famous Eimac tetrodes.

EITEL-McCULLOUGH, INC.
San Bruno, California
Export Agents: Frazar & Hansen, 301 Clay St., San Francisco, California

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

The 4-125A is another Eimac contribution to electronic progress.

they
may
look
alike,
but:
there
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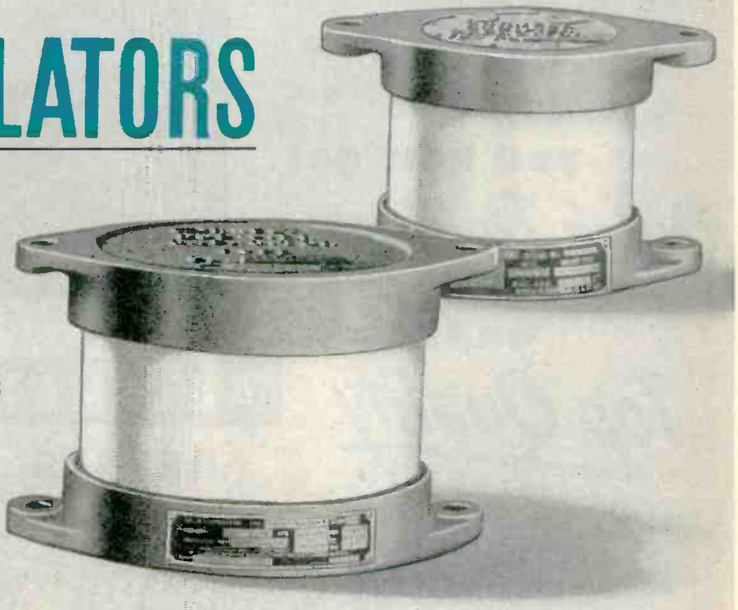
C-D

THE STANDARD IN THE FIELD OF HIGH POWER OSCILLATORS



type 50 series

C-D HIGH POWER MICA TRANSMITTER CAPACITORS

Typical of the many C-D firsts are the type 50 mica capacitors. Only C-D micas can point to a record of dependable service of over forty years. Here's why:

Series mica stack—C-D first to use and patent this construction. Affords uniform voltage gradient!

India-ruby mica—Sheets *individually* tested for uniform thickness and dielectric strength!

Special exclusive high melting point low loss filler—Reduces stray field losses; protects against humidity!

Vacuum impregnated assembly—Assures high insulation resistance; low losses; eliminates air voids!

High pressure maintained on stacks—Results in high Q; good capacity stability.

Cast-aluminum end caps—Low-resistance, wide-path, positive-contact terminals for series, parallel or series-parallel connection. Speedy, space-conserving installations!

Every unit tested under long, continuous overload—Assures maximum reliable service.

Type 50 capacitors are available in all commercial capacity and voltage ratings. For complete description of these and Faradon type transmitter capacitors, write for catalog. CORNELL-DUBILIER ELECTRIC CORPORATION, Dept. K-6-0, South Plainfield, New Jersey. Other plants in New Bedford, Brookline and Worcester, Mass.; Providence, R. I.; Indianapolis, Ind., and subsidiary, The Radiart Corp., Cleveland, Ohio.

C-D Best by Field Test!

40TH ANNIVERSARY · CORNELL-DUBILIER CAPACITORS · 1910 1950

CONSISTENTLY DEPENDABLE
CORNELL-DUBILIER
CAPACITORS · VIBRATORS · ANTENNAS · CONVERTERS

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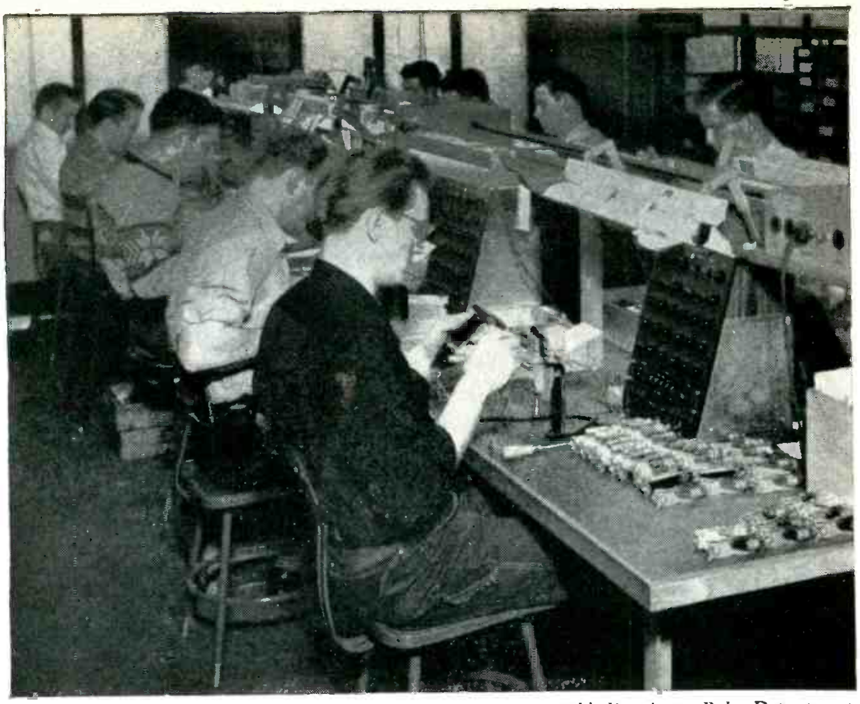
you now get
Quick Delivery
on these
Top Quality



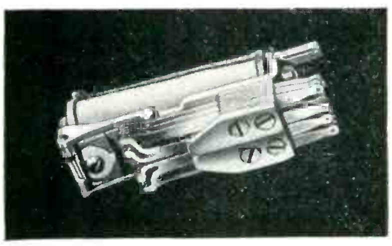
One of the assembly lines in our Relay Department

AUTOMATIC ELECTRIC

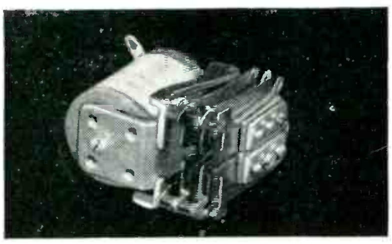
RELAYS **SWITCHES**

This special—*and separate*—department has but one function . . . to process *your* orders promptly and accurately. Here, stocks of all standard parts are maintained, ready for expert assembly in accordance with your specific requirements. "Engineering Samples" are shipped within 10 to 14 days after receipt of order (for hermetically sealed relays, allow 10 days more). Quantity shipments can start within 30 to 60 days on schedules to meet your requirements. With high-geared volume production, thousands of these superior components are being delivered quickly.

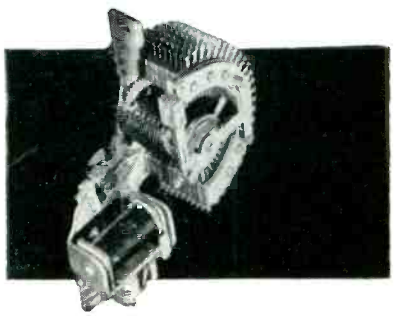
WHEREVER DEPENDABILITY COMES FIRST:—*The men who know insist upon Automatic Electric Relays and Switches for top quality. Here are a few examples:*



CLASS "B" RELAYS—For requirements up to 26 terminals—greater sensitivity, contact pressure, compactness, versatility. And here's dependable long life even under extremely high speed operation. Hermetically sealed, where desired, to maintain highest performance standards.



CLASS "S" RELAYS—For aircraft and other applications requiring small size, light weight, and hermetic sealing, if desired. Astonishing power in small space. Unaffected by extreme vibration, temperature changes, high humidity. Supplied with coils up to 10,000 ohms or more.



TYPE 45 ROTARY SWITCH—Up to 10 or more bank levels, adaptable to 25- or 50-point operation. Speed to 70 steps a second. Simpler . . . only one field adjustment. For d-c service or completely self-contained for a-c service to suit a wide variety of control applications.

For help on your control problems, call one of our field engineers, or write for literature. Address AUTOMATIC ELECTRIC SALES CORPORATION, Chicago 7, Illinois. In Canada: Automatic Electric (Canada) Ltd., Toronto.

RELAYS **SWITCHES**

AUTOMATIC ELECTRIC

CHICAGO

HERE'S YOUR ANSWER to the problem of **HIGH** INSULATION PERFORMANCE at **LOW** cost:

IRVINGTON
Style OW
VARNISHED FIBERGLAS*

Look to Irvington for the right combination to boost performance, improve quality, cut cost . . . of *your* products! Latest in Irvington's line of leadership is Style OW Varnished Fiberglas Class B insulation, which has *proved* its value in core wrappings, field coils, punchings, similar tough spots.

Irvington Style OW Varnished Fiberglas utilizes a new weaving principle that permits the glass fabric to carry more insulating varnish. Black or yellow, 36″ wide, .007″ to .012″ thick, 25 or 50 yds. long, this new insulation may provide the answer to your design problem. Write today for test reports, further details, samples.

Look to Irvington

for Insulation Leadership

*T.M. Reg. Owens-Corning Fiberglas Corp.

STANDARD OF THE WORLD — IRVINGTON INSULATION — TRADE MARK REG. U.S. PAT. OFF.

IRVINGTON
VARNISH and INSULATOR COMPANY

Irvington 11, New Jersey

YOU CAN BE **SURE**.. IF IT'S

Westinghouse

These are just three of the many sizes and types that are made available to you in Westinghouse Portable Instruments—the most complete matched line in the Industry. For all your portable instrument requirements, refer to Westinghouse Catalog Section 43-100—ask your nearest Westinghouse Representative.

Get more for your instrument dollar!

1. The most complete matched line

in the industry . . . for every portable requirement.

2. Shipments in 10 days!

Shipments can be made for practically every requirement for portable electrical measuring instruments within 10 days of receipt of order at factory.

3. Assured A.S.A. standards.

Every Westinghouse Portable Instrument is designed and built to meet the rigid standards of the American Standards Association.

AND . . . you get the famous Westinghouse *controlled quality* that assures you of permanently white dials, springs that remain constant for life, magnets that remain stable, low-friction pivots, high overload capacity and uniform scale distribution.

Westinghouse Instrument Specialists are available at all times to assist you with *your* electrical measuring problems. Their nationwide experience enables them to solve instrument application problems of *all* types. Phone, write or wire your nearest representative. For the complete story on portable instruments, ask for C. S. 43-100. Westinghouse Electric Corporation, 95 Orange Street, Newark, N. J.

J-40392

Specify Westinghouse and be SURE of all three!

Westinghouse INSTRUMENTS

WESTINGHOUSE W

Watch Master

Frequency Standards

GUARANTEED ACCURACY
1 part in 100,000
(.001%)

Uses

Time bases, rate indicators, clock systems, chronographs, geo-physical prospecting, control devices and for running small synchronous motors.

Features

1. **Bimetallic, temperature-compensated fork, no heating or heat-up time is required.**
2. **Fork is hermetically sealed, no barometric effects on frequency.**
3. **Precision type, non-ageing, low coefficient resistors used where advantageous.**
4. **Non-linear negative feedback for constant amplitude control.**
5. **No multi-vibrators used.**
6. **Synchronous clock simplifies checking with time signal.**

Specifications

Accuracy—1 part in 100,000 (.001%).
Temperature coefficient—1 part in 1,000,000 per degree centigrade (or better).
Outputs—

1. **60 cycles, sine wave, 0-110 volts at 0 to 10 watts (adjustable).**
2. **120 cycle pulses, 30 volts negative.**
3. **240 cycle pulses, 30 volts positive and negative. Pulse duration, 100 micro-seconds.**

Type 212

TERMINATION
Front and Rear
CONSTRUCTION
Standard 8¾" x 19" Panel
HOUSING
8¾" x 19" x 8" Metal Cabinet
WEIGHT
25 pounds

American Time Products, Inc.,
580 Fifth Ave., New York 19, N. Y.
Gentlemen:
Please send descriptive folder, No. 212

Name....................

Company....................

Address....................

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

product of

AMERICAN TIME PRODUCTS INC.

580 Fifth Avenue **New York 19, N. Y.**

Operating under patents of the Western Electric Company

In medieval times, a coat-of-arms had an importance that could not be overestimated. It was granted as a personal badge, signifying the attributes and accomplishments of its proprietor—and as such was respected thruout the civilized world. It had no duplicate.

In turn, the emblem imposed upon its owner a responsibility for maintaining an enviable reputation—a condition which stimulated general confidence in him.

Times have changed, but not *all things*. The sense of sanctity of an emblem is prevalent today as it was hundreds of years ago. That is why we take such pride in our trademark: NICHROME.

It is evidence of our accomplishment; our unique, personal badge — respected everywhere. Granted solely and wholly to us by the United States Patent Office over forty years ago, it symbolizes a series of superb electrical heat and corrosion-resistant alloys (developed and produced *only* by Driver-Harris Company) which today is serving industry all over the world.

Yes, there are other excellent heat and corrosion-resistant alloys, but *only one* NICHROME—the product of exclusive Driver-Harris knowledge and techniques.

We are well aware of our obligation to maintain its reputation, both here and abroad. In fact, such obligation is an inspiration to give of our best—now, tomorrow, and always.

Nichrome* is manufactured only by

Driver-Harris Company

HARRISON, NEW JERSEY

BRANCHES: Chicago, Detroit, Cleveland, Los Angeles, San Francisco,

Manufactured and sold in Canada by
The B. GREENING WIRE COMPANY, LTD., Hamilton, Ontario, Canada

**T.M. Registered in United States Patent Office by Driver-Harris Company August, 1908*

No Other Porcelain Offers the Superior Advantages of

ZIRCON PORCELAIN

in Electrical, Technical and Mechanical Applications

The increasing number of uses for Zircon Porcelain in a long list of diverse applications focuses interest on the expanding potential of this material. Its excellent combination of properties is widely applied in the low-frequency power field, in high-frequency and ultra-high frequency equipment, and in special installations where effective resistance to thermal shock or high mechanical strength is required at both normal and elevated temperatures.

TAM has pioneered this and many other developments in which Zirconium compounds are used.

Characteristics of Zircon Porcelain

1 Formed by any conventional method.
2 Readily produced in uniform, high quality.
3 Long firing range.
4 One-fire process.
5 High abrasion resistance.
6 Strong mechanically.
7 Chemical resistance.
8 High thermal conductivity.
9 Thermal shock resistance.
10 Low electrical loss factor.
11 High electrical resistivity and dielectric strength at normal and elevated temperatures.
12 Raw material, of closely controlled properties, readily available from TAM.

TAM PRODUCTS
Registered U. S. Pat. Off.

TAM is a registered trademark

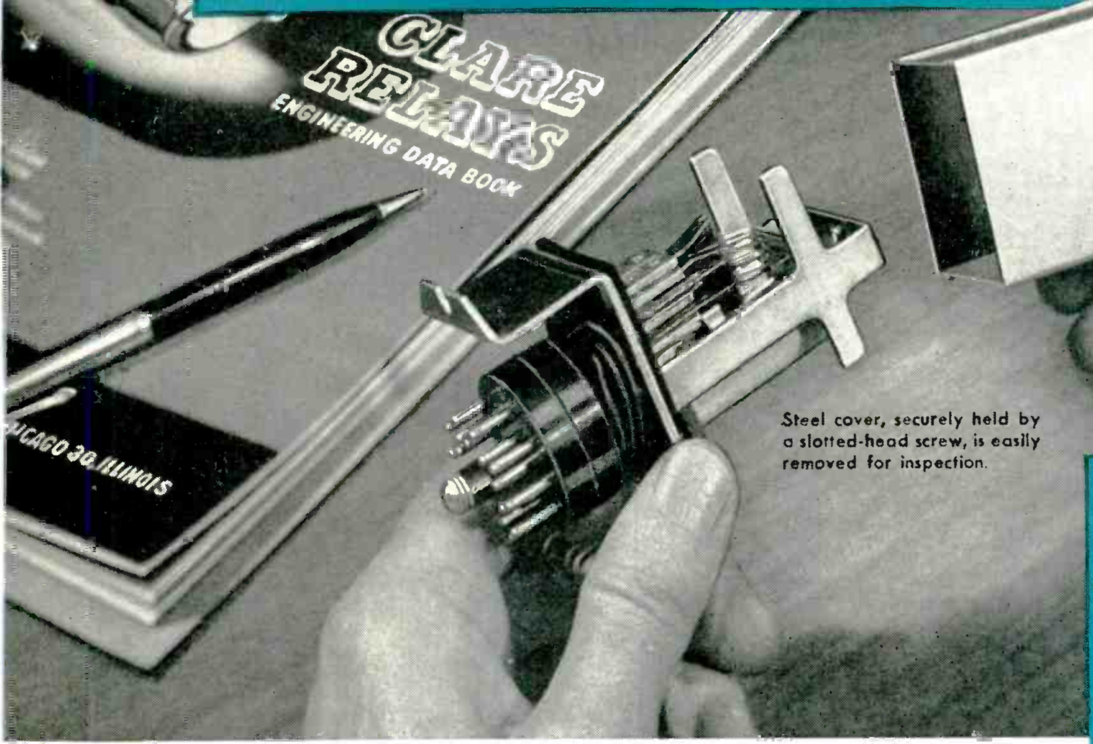
TITANIUM ALLOY MFG. DIVISION
NATIONAL LEAD COMPANY

Executive and Sales Office: 111 BROADWAY, NEW YORK CITY • General Offices, Works, and Research Laboratories: NIAGARA FALLS, N. Y.

New Dust-Tight Plug-in Enclosure for

CLARE TYPE "J" TWIN CONTACT RELAY

To Meet Severe Operating Conditions



Steel cover, securely held by a slotted-head screw, is easily removed for inspection.

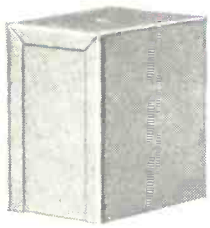
This new CLARE dust-tight plug-in enclosure for the small Type "J" Relay offers designers a number of unusual features for installation on industrial equipment.

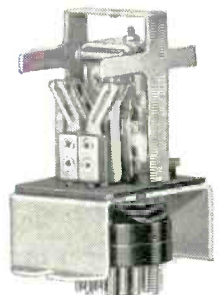
Entrance of dust is prevented by the steel cover and by use of a Neoprene gasket which is closely fitted at the factory to the relay terminals. The dust-tight cover is easily removed for inspection. Use of standard radio plug simplifies installation and cuts wiring costs. Base is secured to chassis to prevent plug from being jarred or accidentally pulled from its socket.

Exclusive design of the CLARE Type "J" Relay allows the twin contacts to operate independently of each other. One contact is sure to close, reducing contact failure to the practical limit. This relay combines all the best features of the conventional telephone-type relay with small size and light weight. It provides unusually high current-carrying capacity, large contact spring capacity, extreme sensitivity and high operating speed.

This new dust-tight enclosed relay is one of many outstanding CLARE contributions in the development of new and better relay components for industry. CLARE Sales Engineers are located in principal cities to consult with you on your relay problems. Call them direct or write: C. P. Clare & Co., 4719 West Sunnyside Avenue, Chicago 30, Illinois. Cable Address: CLARELAY. In Canada: Canadian Line Materials Ltd., Toronto 13.

Write for Bulletin No. 108





Neoprene gasket, closely fitted at factory to relay terminals, between base and cover, effectively occludes dust.

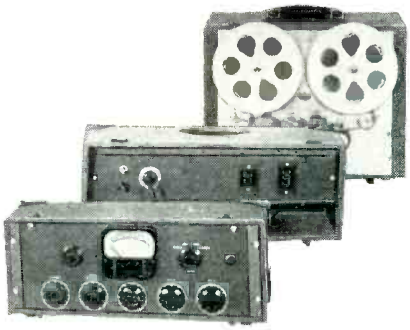
Plug is standard radio-type plug. Standard finishes are silver lustre lacquer for cover, cadmium for base. Retaining screws hold base securely to panel.

CLARE RELAYS

First in the Industrial Field

no matter **how** you **record**...

tape or disc

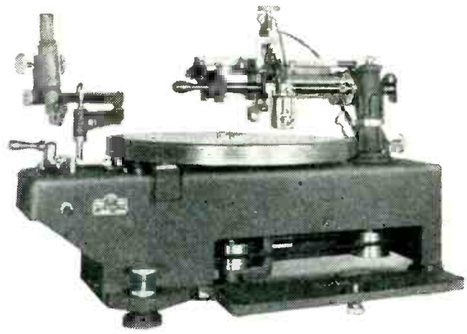


PRESTO portable tape recorder PT-900

Packs easily into two portable cases, but sets up into complete broadcast-quality machine. Three heads . . . erase, record, reproduce. Separate recording and monitoring amplifiers. Available in either 15"/sec & 7½"/sec or 7½"/sec & 3¾"/sec. Three microphone input.

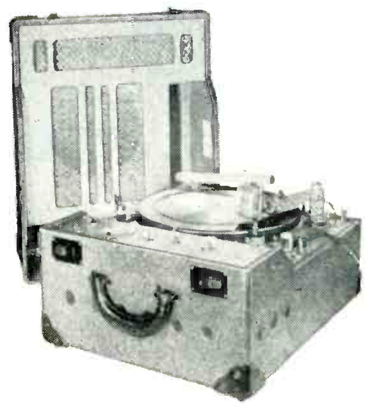
PRESTO console tape recorder SR-950

The finest studio-type tape recorder available. Operation by push-button control. Three motors, three heads. Frequency response: 30 to 15,000 cps at 15"/sec. Signal to noise ratio more than 52 db at 1½% distortion. Cabinet designed for rapid maintenance.



PRESTO precision disc recorder 8-D

Designed for extreme accuracy and ease of operation. Available in either rim drive (8-D) or gear drive (8-DG). Frequency response 50 to 10,000 cps. Heavy overhead cantilever cutting mechanism requires no contact with record. Double motor drive on 8-DG. 33⅓ and 78 rpm.



PRESTO portable disc recorder K-10

Records and plays microgroove and standard records at 33⅓ rpm (45 rpm available at slight additional cost). Two interchangeable pickup arms. 12" turntable accommodates 13¼" disc. Detachable dynamic speaker, sturdy portable cases. Frequency response: 50-8000 cycles.

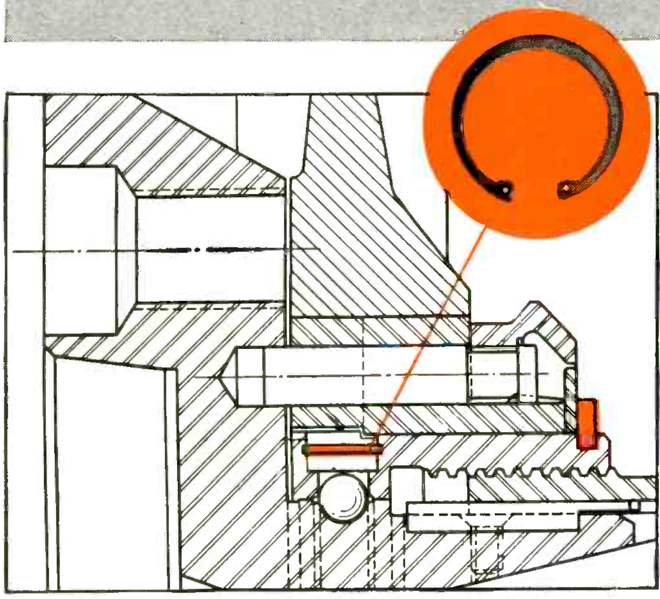
PRESTO equipment gives BETTER results

Well-informed engineers read
THE PRESTO RECORDER
every month
Is *your* name on our free distribution list?

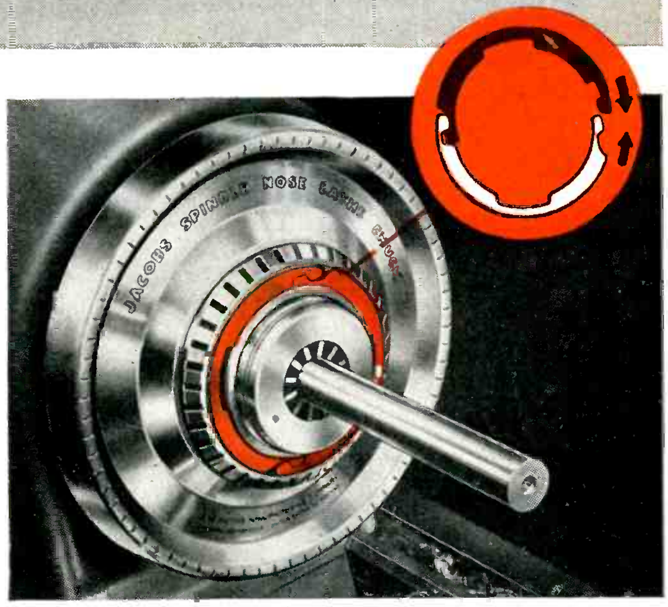
PRESTO RECORDING CORPORATION
Paramus, New Jersey

IN CANADA: Walter P. Downs, Ltd., Dominion Square Bldg. Montreal, Canada
OVERSEAS: M. Simons & Co., Inc., 25 Warren Street New York, N. Y.

2 Waldes Truarc Rings Save Space ...cut costs...Lock entire chuck



INTERNAL RING: Used instead of a shoulder screw, Truarc internal ring #5000-37 locks disc over ball loading hole. Saves 1/8 inch in overall diameter. Eliminates tapping. Withstands machine vibration and vibration from impact device within chuck. Used with Truarc pliers, it facilitates assembly and disassembly.



INTERLOCKING RING: Used instead of a locknut, Truarc interlocking ring #5107-343 locks handwheel assembly securely on impact sleeve of Jacobs chuck. Saves 7/32 inch in overall length. Eliminates tapping. Chuck's top speed: 5000 RPM; Truarc ring is dynamically balanced to withstand 50,000 RPM's. Services easily with a screwdriver.

2 Waldes Truarc Retaining Rings secure the entire mechanism of new spindle nose lathe chuck for Jacobs Mfg. Co., Hartford, Conn. Truarc gives Jacobs a finer, more compact product, and at lower cost than possible with any other fastening device.

Wherever you use machined shoulders, nuts, bolts, snap rings, cotter pins, there's a Truarc Ring that does a better job of holding parts together.

Truarc Rings are precision-engineered. Quick and easy to assemble, disassemble. Always circular to give a never-failing grip. They can be used over and over again.

Find out what Truarc Rings can do for you. Send your drawings to Waldes Truarc Engineers for individual attention, without obligation.

2 TRUARC RINGS GIVE 6 BIG ADVANTAGES

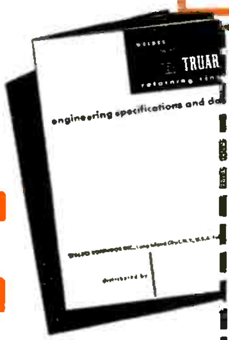
- **Cut overall length 7/32 in.**
- **Cut overall diameter 1/8 in.**
- **Eliminate cost of tapping**
- **Withstand up to 50,000 RPM's, give a factor of assurance of 10**
- **Withstand machine vibration**
- **Facilitate assembly, disassembly**

WALDES TRUARC REG. U. S. PAT. OFF.

RETAINING RINGS

WALDES KOHINOOR, INC., LONG ISLAND CITY 1, NEW YORK

WALDES TRUARC RETAINING RINGS ARE PROTECTED BY U.S. PATS. 2,302,948; 2,026,454; 2,416,852 AND OTHER PATS. PEND.



Waldes Kohinoor, Inc., 47-16 Austel Place E-062
Long Island City 1, N. Y.

Please send 28-page Data Book on Waldes Truarc Retaining Rings.

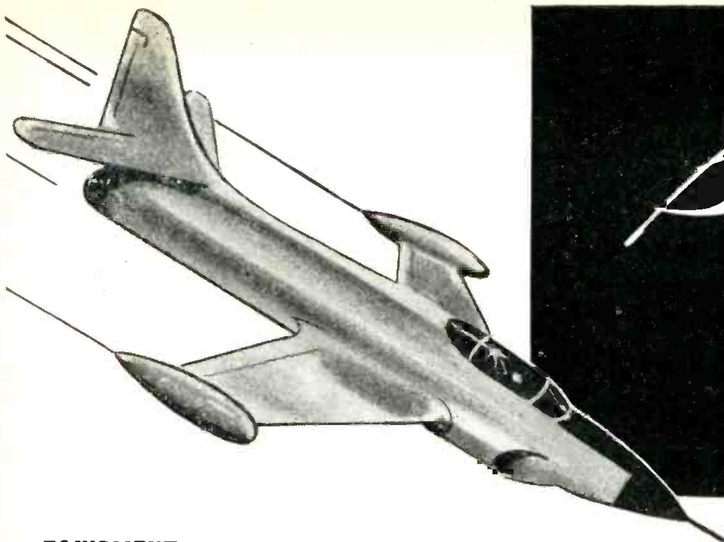
Name__________

Title__________

Company__________

Business Address__________

City______ Zone____ State______



Sorensen

ELECTRONIC EQUIPMENT FOR *AVIATION*

SORENSEN: offers the Aviation field three principal types of product:

EQUIPMENT: Sorensen equipment (400 cycle line voltage regulators, Inverters, Regulated DC supplys, Frequency changers and Phase Adapters) are lightweight, designed for conformity to JAN specifications.

TEST EQUIPMENT AIDS: Sorensen's voltage regulating equipment (400 cycle Line Regulators, DC supplys or "Nobatrons") can facilitate the use of test equipment by providing regulated AC or DC power.

COMPONENTS: Sorensen has a wide range of products which can be used to great advantage in aviation manufacturers' equipment. Chief among these are the 400 cycle variable auto transformers, the Saturable Core reactors and other power components. Equipment units can be designed to meet JAN specifications.

FOSTERITE: In airborne units, Sorensen seals its wound components against humidity by the Fosterite process, a method which adds little to weight or size, and is, therefore, ideal in aircraft electronic design.

TYPICAL SORENSEN AIRBORNE UNITS

400 CYCLE REGULATOR
± 0.5% regulation; 400 cycles ± 10%; 5% distortion; 50 VA to 3 KVA capacities.

ELECTRONIC INVERTER
Inverters and Frequency changes under development. Specifications on request.

DC SUPPLY
0-325 VDC; 0-500 VDC; 300-1000 DC regulated ± 0.5%; 125, 300, 500 ma.

NOBATRON
6-12-28-48-125 VDC from 5-350 amperes; regulated ± 0.25%; 60 or 400 cycles input.

400 CYCLE AUTO TRANSFORMER
0-130 VA; 400 Cycles 5 and 15 amperes.

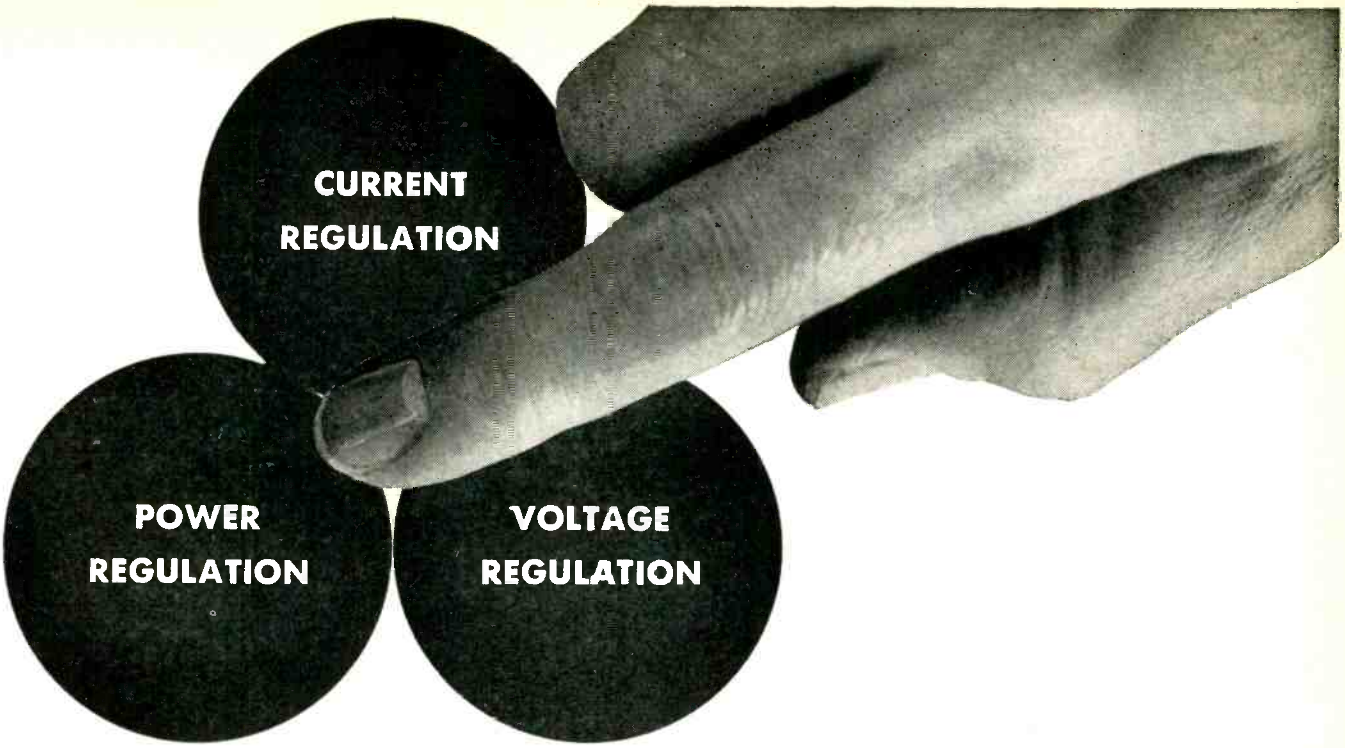
SATURABLE CORE REACTOR
For magnetic amplifier circuits. Request data book.

LITERATURE: The following literature is available on request: Catalog A 1049 (AC regulators); Catalog B 1049 (Nobatrons and DC supplys); Catalog C 1049 (wound components and fosterite); Saturable Core Reactor Technical Data sheets; "Aircraft" issue of "Currently."

POWER controlled converted

Sorensen **and company, inc.**
375 FAIRFIELD AVE. • STAMFORD, CONN.

MANUFACTURERS OF AC LINE REGULATORS, 60 AND 400 CYCLES; REGULATED DC POWER SOURCES; ELECTRONIC INVERTORS; VOLTAGE REFERENCE STANDARD; CUSTOM BUILT TRANSFORMERS; SATURABLE CORE REACTORS



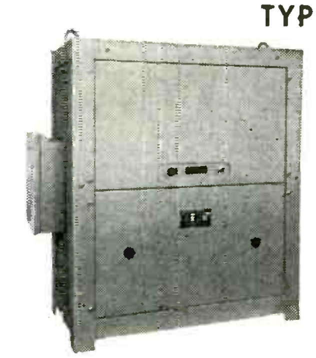
can you put your Finger on the TROUBLE?

● If you can, a SORENSEN Electronically controlled, magnetic amplifier regulating circuit can solve it!

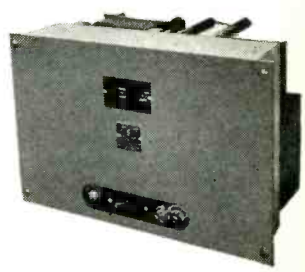
Sorensen's *new line* of Electronic AC Voltage Regulators is the *most accurate* and *most economical* line of Electronic Voltage Regulators on the market today. Standard specifications offer Accuracy to within ±0.1% and Distortion as low as 2%. Load range from zero to full load. All models are temperature Compensated and can be supplied hermetically sealed or fosterited. And the Sorensen line uses *less tubes* than other electronic type regulators.

● *Sorensen Engineers* are always at your service to solve unusual problems and give you the benefits of years of experience. Describe your needs and let a Sorensen Engineer suggest a solution. It will save you time and money to try Sorensen first.

TYPICAL AC REGULATORS



Model 5000-2S—high power
Input 95 to 130; distortion 3%; load 0-5000 VA;
Accuracy ±0.1% against line or load; 50-60 cycles



Model 3000S—medium power
Input 95 to 130; distortion 3%; load 0-3000 VA
Accuracy ±0.1% against line or load; 50-60 cycles

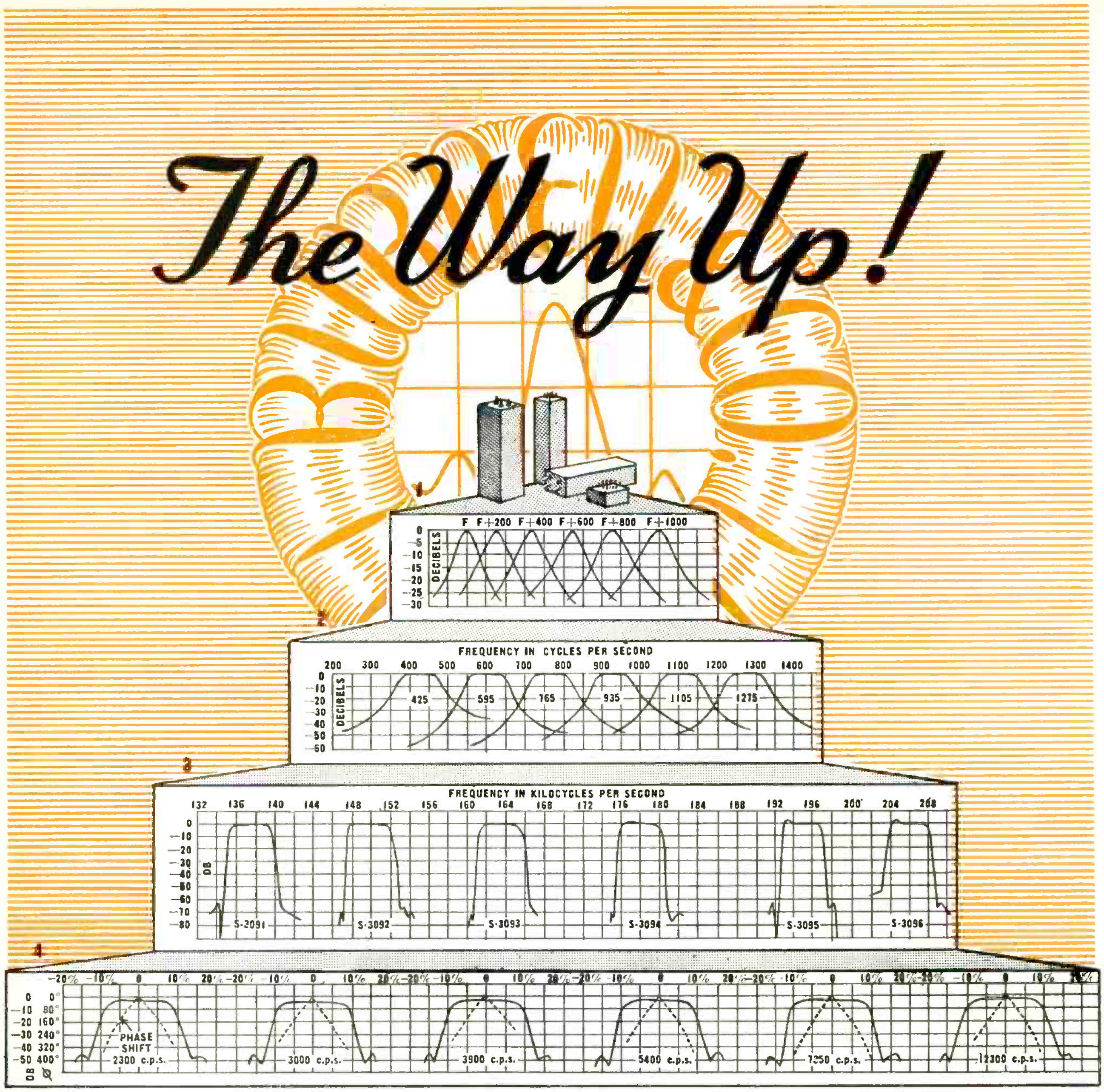
Model 500S—low power
Input 95 to 130; distortion 3%; load 0-500 VA;
Accuracy ±0.1% against line or load; 50-60 cycles

CATALOG A1049 DESCRIBES COMPLETE LINE

POWER controlled converted

Sorensen and company, inc.
375 FAIRFIELD AVE. • STAMFORD, CONN.

MANUFACTURERS OF AC LINE REGULATORS, 60 AND 400 CYCLES; REGULATED DC POWER SOURCES; ELECTRONIC INVERTORS; VOLTAGE REFERENCE STANDARD; CUSTOM BUILT TRANSFORMERS; SATURABLE CORE REACTORS



1 SUB-MINIATURE "GUIDED MISSILES" FILTERS

For security reasons details of this development in miniaturization must be omitted. It can be told, however, that all six channels are contained in a total volume of 18 cubic inches or 3 cubic inches per channel.

2 TONE CHANNEL FILTERS

Available for either 170 or 340 cycles spacing between channels. These filters have received wide acceptance and are extremely popular among manufacturers of carrier telegraph equipment. In addition to the many standard types of tone filters we are supplying, special characteristics can readily be incorporated into designs to suit your application.

3 CRYSTAL ELEMENT CHANNEL FILTERS

These extremely sharp wide band filters employing crystals and toroidal coils, were so compact that they were substituted in Air Force equipment for ordinary I.F. transformers. Result was tremendous improvement in selectivity and signal to noise ratio. We derived great satisfaction from this achievement.

4 TELEMETERING FILTERS

Among the earliest to be employed in the improved telemetering system now in general use. Particular attention has been paid to linearity of phase shift and good transient suppression as well as high inter-channel attenuation in order to eliminate distortion in telemetering reception.

WRITE FOR TECHNICAL INFORMATION

Burnell & Company
YONKERS 2, NEW YORK
CABLE ADDRESS "BURNELL"

ALL INQUIRIES WILL BE PROMPTLY HANDLED

Exclusive Manufacturers of Communications Network Components

Unsurpassed!

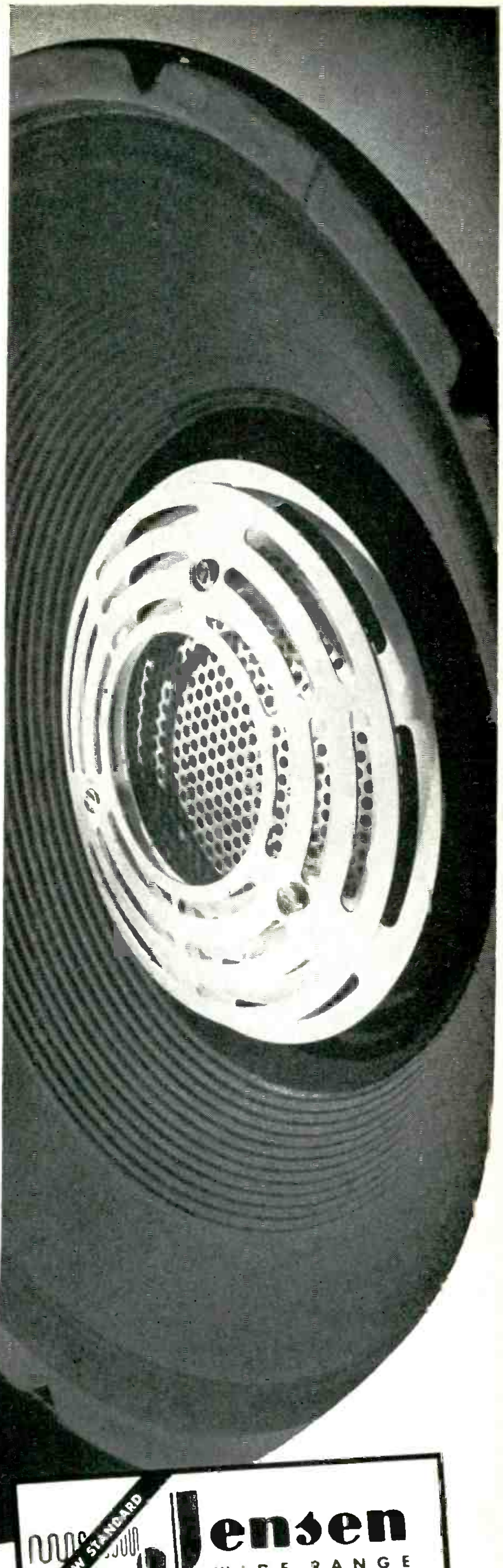
Jensen Model 510

Coaxial Speaker

With its new high frequency driver . . . new high frequency horn . . . new low frequency unit . . . plus the new Jensen Acoustic Lens—all skillfully engineered into a coordinated unit, the H-510 gives you reproduction unsurpassed by any integral two-way system regardless of price!

Comparative tests have proved this time after time. Why? Because you instantly recognize the unusually satisfying, smooth, clean high fidelity performance . . . the easy-to-live-with quality that makes you *know* you want to own it *now*.

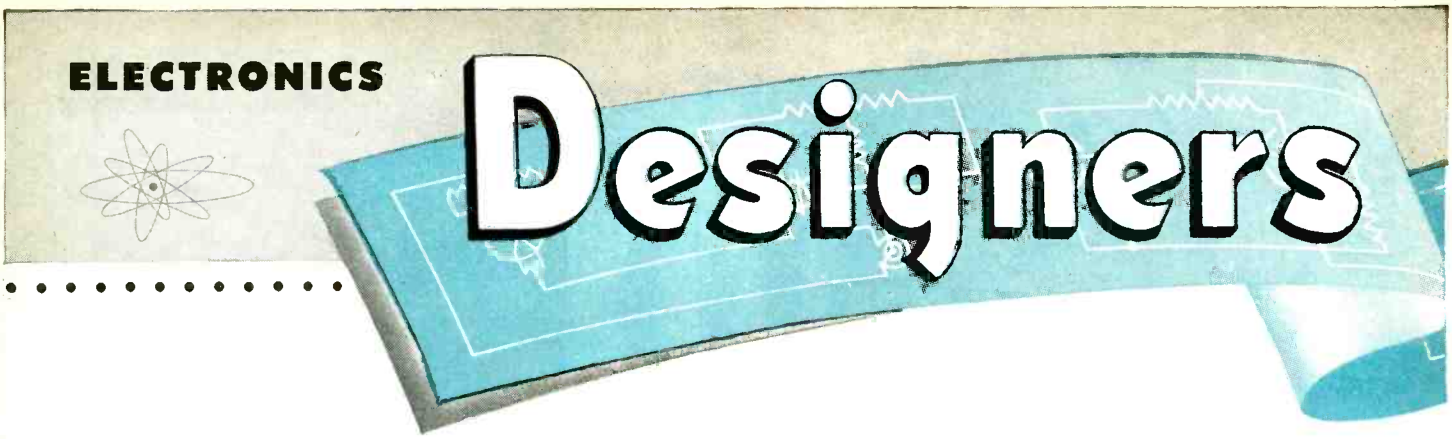
Ask for free booklet "Let Music Come to Life" and Data Sheet 152.

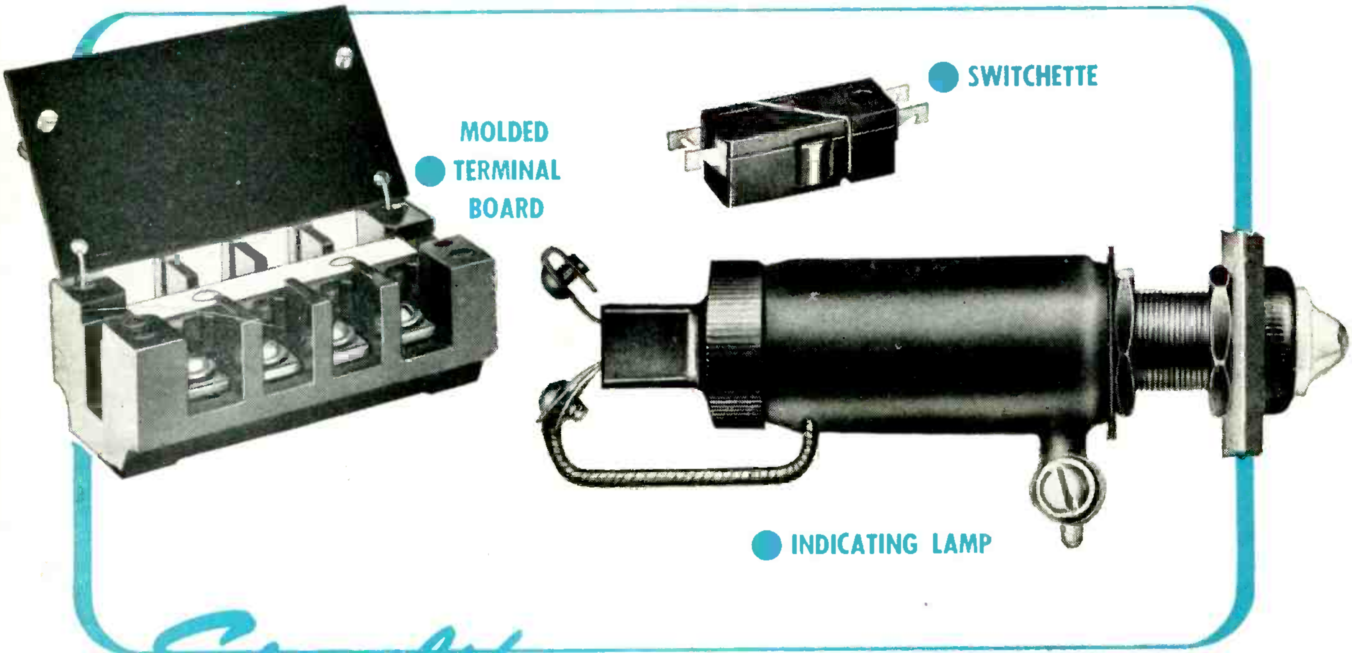


NEW STANDARD Jensen W'DE RANGE

JENSEN MANUFACTURING COMPANY *DIVISION OF THE MUTER COMPANY*

6607 South Laramie Avenue, Chicago 38, Illinois • ***In Canada: Copper Wire Products, Ltd., 351 Carlaw, Toronto***





Simplify YOUR CONTROL CIRCUITS WITH THESE G-E COMPONENTS

● **MOLDED TERMINAL BOARDS**—Designed to give positive electrical connection without soldering lugs, these sturdy terminal boards are built of molded Textolite® with reinforced pole barriers. Hinged protective covers protect wiring; marking strips are reversible—white on one side, black on the other. Boards are available with 4 to 12 poles; are 2 inches wide, 1¼ inches long. See Bulletin GEA-1497.

● **"SWITCHETTES"**— Use them in tight places; depend on them for long life. They're available in single- or two-circuit, normally open or normally closed circuits; have momentary or maintaining contacts; are equipped with screw terminals, soldering lugs or quick-connect lugs. They're corrosion-proof, vibration-resistant, and have low r-f noise output. Ratings up to 10 amps at 230 vac. Size: 1¼ x ½ x ½. See Bulletin GEA-4888.

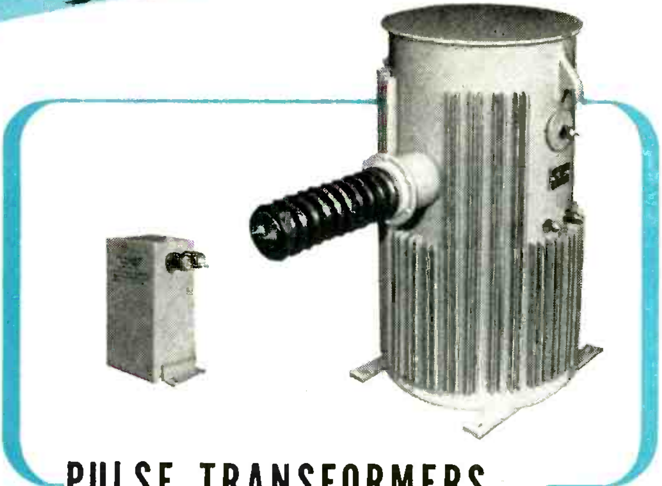
● **INDICATING LAMPS**—You can see from any angle whether these lamps are off or on. Color caps—made from a special translucent compound—are clear, green, red, yellow, white, or blue. Available for 24, 48, 125, 250, or 660 volts d-c; 125, 220, 440, or 550 volts a-c. Mount on panels up to 2 inches thick. All units include built-in series resistors, to insure long lamp life and eliminate the need for fuses. Size: about 5 inches long. See Bulletin GEA-3643.

GENERAL ELECTRIC

667-6

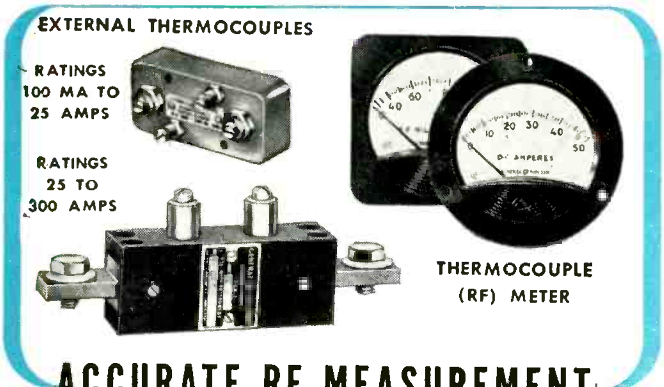
Digest

TIMELY HIGHLIGHTS ON G-E COMPONENTS



PULSE TRANSFORMERS... MIDGET OR GIANT

A six-inch midget and two-foot giant, both are examples of G.E.'s family of oil-insulated, hermetically sealed pulse transformers. General Electric has built units with peak voltage ratings of from 10 to 100 kv and over, peak power ratings up to 30 megawatts, for pulse durations of from .05 to 20 microseconds and repetition rates up to 10,000 pps. Oil filled units have also been used for lower voltages to minimize internal corona. Typical applications: pulse voltage step-up or step-down, impedance matching, phase reversing, and transmitter plate-current measurement. What is your requirement? Write, giving complete details, to Power Transformer Sales Division, General Electric Co., Pittsfield, Mass.



ACCURATE RF MEASUREMENT

100 MA to 300 AMPS

The new, sturdy, and easy-to-read G-E panel instruments are available for measuring r-f from 100 ma or less to 300 amps. R-f meters are usually supplied with internal thermocouples, but for applications where remote location of thermocouple is required, or for measuring extremely high currents (over 20 amps), external units are available. For complete data on these or other G-E panel instruments for a-c, d-c, or a-f, see Bulletin GEC-368.

New! FOR COMPACT DESIGNS MINIATURE RECTIFIER CELLS

Here's a new series of rectifier cells that can help you fit your circuit into a smaller space. These new "K-type" cells may be used to replace tubes for dual-diode, voltage-doubler, and blocking applications.

The cells are built with a new G-E evaporation process which makes for long life and stable output. Forward resistance and back leakage are low. Standard cells are moisture resistant, special units are hermetically sealed. All have a $\frac{7}{16}$-inch diameter and can be mounted as easily as an ordinary resistor. Circuits: half-wave, center tap, or bridge. Ratings: as high as 40 RMS volts input, 56.5 maximum inverse peak volts at 10 d-c ma. Data in Bulletin GEC-655.

General Electric Company, Section A667-6
Apparatus Department, Schenectady 5, N. Y.

Please send me the following bulletins:

Indicate for reference only ✓	☐	GEA-1497	Terminal boards
	☐	GEA-3643	Indicating lamps
	☐	GEA-4888	Switchettes
for planning an immediate project X	☐	GEC-368	Panel instruments
	☐	GEC-655	Rectifier cells

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Company..........

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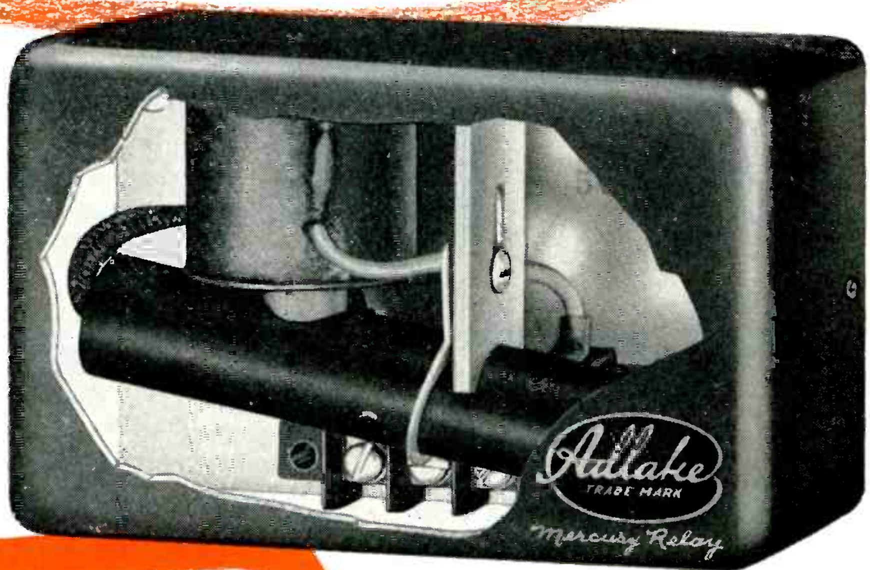
SPECIALLY DESIGNED FOR USE WITH

SENSITIVE

THERMO-REGULATORS

New ADLAKE No. 5000 Mercury Relay



Because of its amazingly high load-input ratio, the No. 5000 relay operates at 115 volts 60 cycles on *only 0.007* ampere—a fraction of the current consumed by any other type of mercury relay!

It is ideally suited for use in electronic tube circuits where the output of the tube is limited. With its low amperage operating the coil, the contacts will handle 5 amperes at the same voltage—and tests indicate the No. 5000's life to be over 30 million operations!

It can be used as a pilot relay operating from a very sensitive thermo-regulator—serves equally well for high and low temperature control—and functions perfectly with either mercury-and-glass or bi-metal regulators.

FOR FULL INFORMATION on this sensational relay, write The Adams & Westlake Company, 1107 N. Michigan, Elkhart, Indiana. No obligation, of course.

Every ADLAKE Mercury Relay offers these advantages:

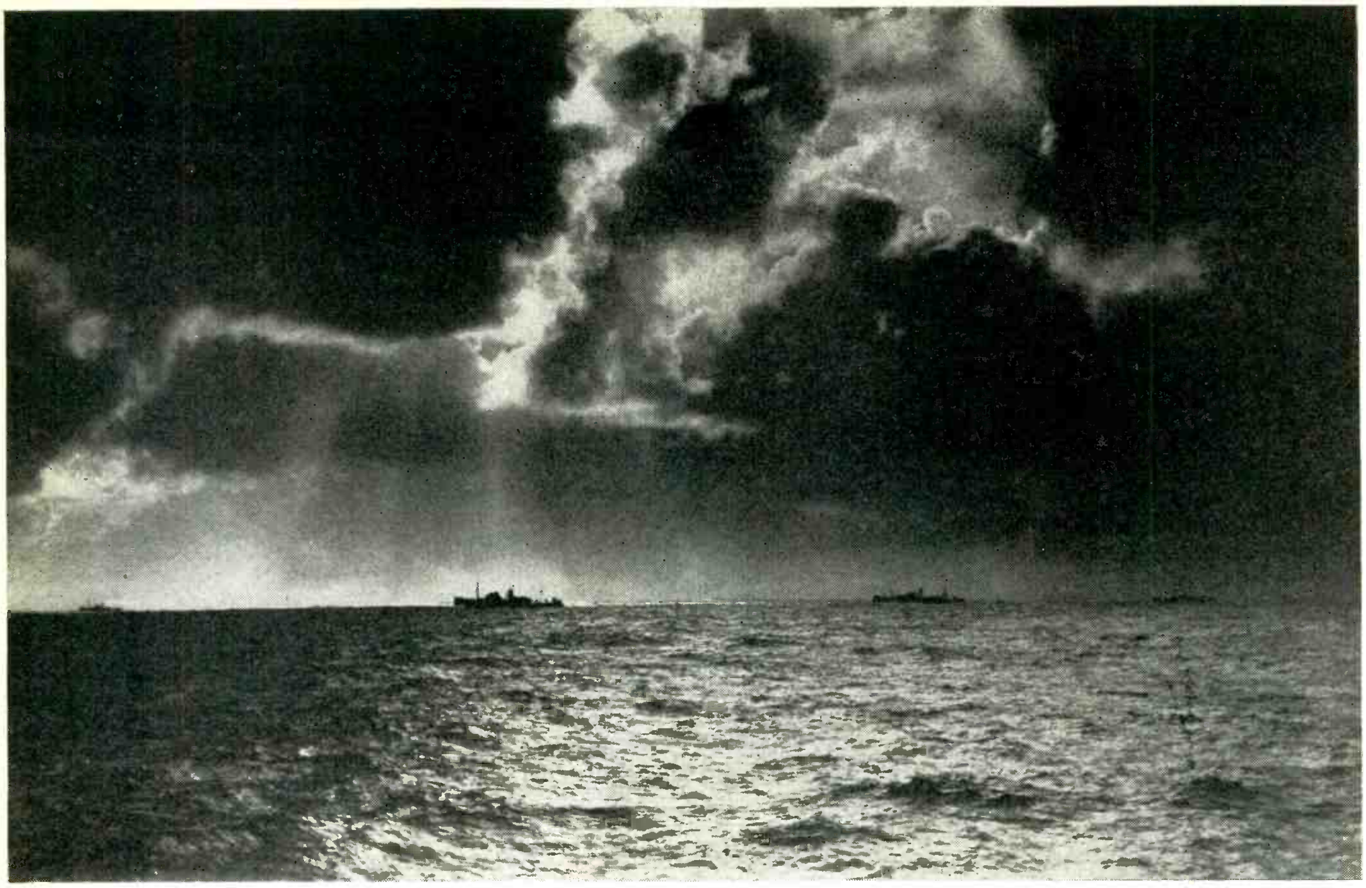
- **Hermetically sealed—(dust, dirt, moisture, oxidation and temperature changes can't interfere with operation)**
- **Silent and chatterless**
- **Requires no maintenance**
- **Absolutely safe**

Manufacturers of
Hermetically Sealed Mercury Relays for Timing, Load and Control Circuits

THE
Adams & Westlake
COMPANY

Established 1857 ELKHART, INDIANA New York • Chicago


HAYDU
INDUCTION OSCILLATORS...
the complete line for industry...
HAYDU BROTHERS' answer to your problem in brazing, annealing and hardening — where localized heating is important — can be solved with these machines of infinite uses. One of its important functions is the heat treatment of internal metal parts of electron tubes.
The induction oscillators can be built to any power specifications to meet individual needs.
Maintenance difficulties are overcome easily in these moderately priced induction oscillators as William G. Klinder, with his many years of experience in Electronics, gave every consideration to make each part readily accessible.
Prompt delivery on standard sizes.
Our plant will accept job welding work assignments.
HAYDU BROTHERS
PLAINFIELD NEW JERSEY
HB



Official U. S. Coast Guard Photo

weather... *and the unknown*

The perils of the sea can be summed up quite easily as being the Weather and the Unknown—the mystery of hitting something or being hit by something which can't be seen below the surface.

There is little which we at Edo have been able to do about the weather but new, improved electronic equipment, which our engineers and skilled craftsmen have designed and built, is doing much to take the Unknown out of what's below the waves.

Sonar equipment for charting the ocean's bottom with improved accuracy, instruments which show the shape of the harbor floor, and other underwater detection equipment are among the electronic devices being designed and perfected at Edo for added safety at sea.

SEEING THE SHAPE
OF THE OCEAN FLOOR!

The Contour Bottom Scanner developed and manufactured for the U.S. Navy by Edo combines Sonar with a cathode ray tube to give an instantaneous and accurate picture of the shape of a channel or harbor floor both below and to either side of a ship, an instrument of great potential use for navigation in shallow waters.

The C.B.S. is but one of a wide variety of electronic devices developed, perfected and manufactured by Edo's staff of highly qualified electronics engineers who have behind them Edo's Twenty-Five years of diversified experience in engineering, precision manufacturing, research and development.

For a complete picture of Edo's activities, you'll enjoy reading our Twenty-Fifth Anniversary booklet. Write to Dept. ES-2, Edo Corporation, College Point, N. Y., for your copy today.

1925 · 1950 Edo 25TH ANNIVERSARY

EDO CORPORATION · COLLEGE POINT, N. Y.

G-E RECTIFIER TUBES

BASIC IN BROADCASTING

They're dependable!

YOUR supply of d-c power ranks high among requirements for signal power and continuity. By installing rectifier tubes that serve reliably, you've taken a big step toward peak transmitter output with minimum time off the air. *Assure tube reliability by choosing General Electric!*

Here are products pre-tested for quality (built of selected materials by the most modern manufacturing methods, with inspection at every stage), and pretested for performance in two important ways: (1) as tubes, after manufacture, (2) as types, by use in broadcast stations from coast to coast, where G-E tubes enjoy a none-better record.

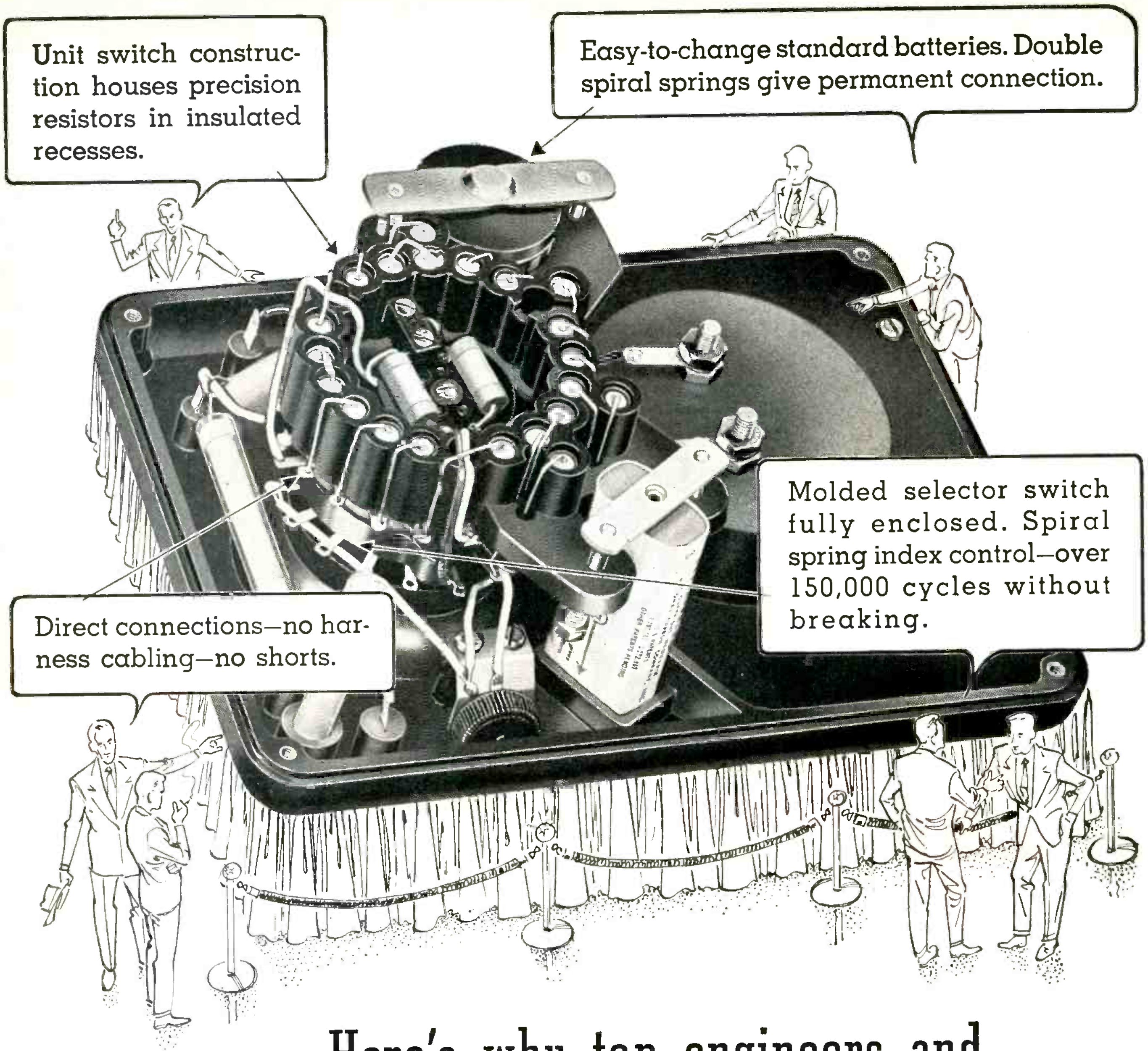
General Electric also brings you constant design improvements. *Example:* the straight-side bulbs of the GL-8008 and GL-673 give an increased temperature margin of safety, make these tubes easier to handle and install. *Example:* future heavy AM-FM-TV power requirements are anticipated by new G-E tube developments such as the GL-5630 ignitron, which will supply direct current in impressively large amounts.

If you build or design transmitters, phone your nearby G-E electronics office for expert counsel on rectifier tubes. If you are a station operator with tube replacements in mind, your G-E tube distributor will be glad to serve you promptly, efficiently, out of ample local stocks. *Electronics Department, General Electric Company, Schenectady, 5, New York.*

GENERAL ELECTRIC

180-J4

Type	Cathode voltage	Cathode current	Anode peak voltage	Anode peak current	Anode avg current
GL-866-A	2.5 v	5 amp	10,000 v	1 amp	0.25 amp
GL-8008	5 v	7.5 amp	10,000 v	5 amp	1.25 amp
GL-673	5 v	10 amp	15,000 v	6 amp	1.5 amp
GL-869-B	5 v	19 amp	20,000 v	10 amp	2.5 amp
GL-857-B	5 v	30 amp	22,000 v	40 amp	10 amp



Here's why top engineers and technicians use Model 630

Features like those shown above are what make this popular V.O.M. so outstandingly dependable in the field. The enclosed switch, for instance, keeps the silvered contacts *permanently clean*. That's rugged construction that means stronger performance, longer life. And tests show that the spiral spring index control, after more than 150,000 cycles of switch rotation, has no disruption or appreciable wear! Investigate this history-making Volt-Ohm-Mil-Ammeter today: 33 ranges, large 5½" meter.

ONLY
$37.50
AT YOUR DISTRIBUTOR

FOR THE MAN WHO TAKES PRIDE IN HIS WORK

Triplett

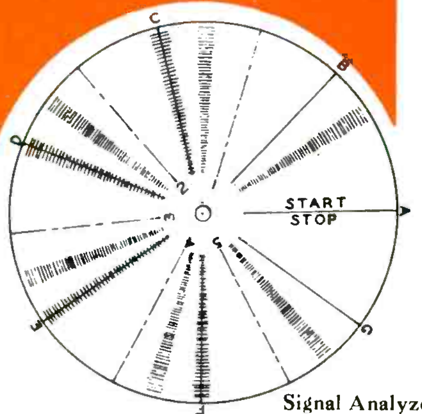
TRIPLETT ELECTRICAL INSTRUMENT COMPANY • BLUFFTON, OHIO, U.S.A.

BUNNELL SIGNAL ANALYZER

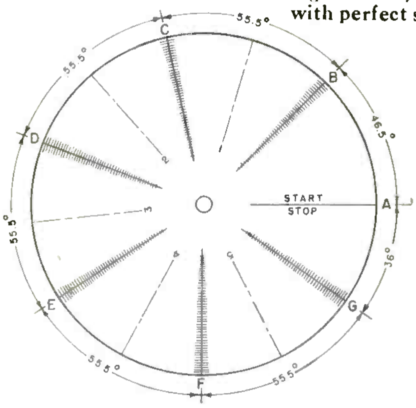
Dimensions: 9" x 6" x 8"
Weight: 18 lbs.

THE ONLY CARRY-ABOUT

TELEGRAPH TROUBLE-SHOOTER SOLD *that provides* A PERMANENT RECORD *of Transmission Quality*



Signal Analyzer chart indicating signal error



Signal Analyzer chart with perfect signals

Checks Transmission Quality

Indicates any type of signal irregularity in 7-unit or 7.4-unit code start-stop telegraph circuits. Records distortion on every individual signal pulse as it is received. Can be used to determine condition of signals from transmitting keyboards or regenerative repeaters. Useful in checking operation of receiving printers. Helps assure high transmission quality and continuity by detecting incipient troubles before printing failure occurs.

Time-Saving . . . Economical

Saves circuit time by helping to correct error quickly. Saves time of operating, service and maintenance personnel.

Provides Permanent Record

Records signals permanently on paper chart for detailed analysis, quantitative measurement and future reference or comparison. Permits observation of distortion on working circuits and quick identification of sources of error. Useful in alignment and trouble-shooting.

Portable . . . Easy to Use

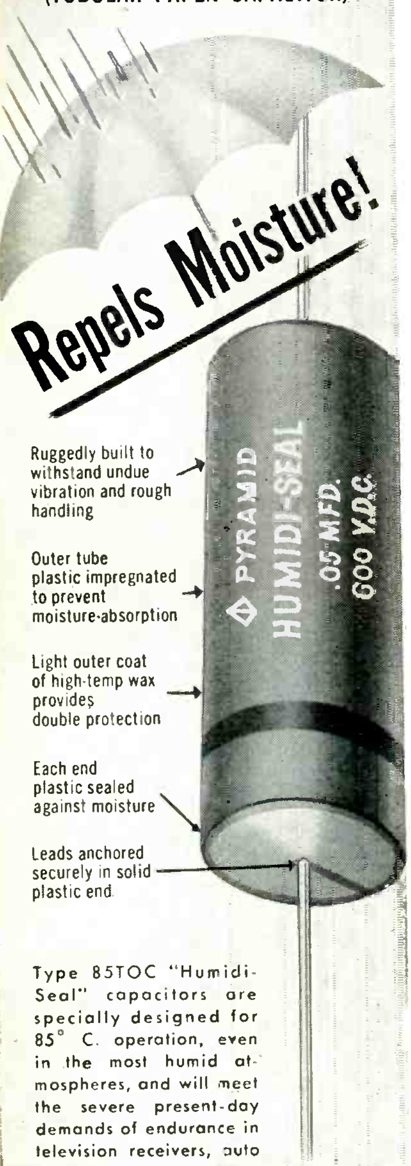
Light, simple and compact in design and construction. Can be moved easily from place to place as needed. Easy to connect, easy to operate. No adjustments or complicated connections required—just plug in and turn on.

J. H. BUNNELL & Co.

81 Prospect Street, Brooklyn, N.Y., Dept. 15

BUNNELL—a key word in communications equipment ▶ **Research, Engineering, Production and Testing Facilities For Electronic and Communications Equipment.**

the New
PYRAMID
"Humidi-Seal"
(TUBULAR PAPER CAPACITOR)



Type 85TOC "Humidi-Seal" capacitors are specially designed for 85° C. operation, even in the most humid atmospheres, and will meet the severe present-day demands of endurance in television receivers, auto radios, etc.

WRITE FOR COMPLETE LITERATURE

Representatives and Distributors throughout the U.S.A. and Canada

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155 Oxford Street
Paterson, N. J., U.S.A.
TELEGRAMS: WUX Paterson, N. J.
CABLE ADDRESS: Pyramidusa

BUSINESS BRIEFS

By W. W. MacDONALD

Third-Quarter Outlook for American business in general now looks good, and most economists who predicted a healthy first-half earlier this year but refused to stick their necks out further have since extended their optimism through September. In the field of electronics, specifically, things look particularly healthy. Most manufacturers we have talked to recently anticipate good business right through the fourth-quarter.

Auto Radio Business, second only to television in radio industry importance at the moment, is booming. Car manufacturers working into a backlog of orders developed during recent strikes expect to turn out between 6 and 6½ million automobiles in 1950 if no further shutdowns occur. Return to more normal market conditions in 1951 should support the production of between 4½ and 5 million new cars.

Shortage of ceramic-and-powdered-iron cores that have proven especially efficient in television-receiver sweep-circuit coils is currently troubling some set makers. Manufacturers of such cores are increasing production to meet the unexpectedly heavy demand but from where we sit it seems doubtful that they will be able to catch up until Fall at the earliest.

Informal Poll of RMA Directors produces an estimate of 5,350,000 tv sets in 1950, the high guess about production being 6,500,000 and the low 4,500,000. The estimate in a similar poll taken last February was 4,500,000.

TV Interference caused by oscillator radiation is reduced by the use of RMA-recommended 40-mc i-f in some makes and models now reaching the market.

Three-Color RCA television-picture-tube screen employing triangularly grouped dots of different phosphors is produced by an almost unbelievably accurate printing technique. And we of the printing business are not easily moved to superlatives concerning color registry.

Television Shipments by RMA members totalled 2,227,973 in 1949. Here's the breakdown:

Albany	27,032
Albuquerque	758
Atlanta	14,242
Baltimore	62,175
Birmingham	5,679
Boston	143,669
Buffalo	41,201
Charlotte, N. C	7,031
Chicago	230,845
Cincinnati	73,890
Cleveland	75,411
Dallas	14,802
Davenport, Ia	6,684
Detroit	109,307
Erie, Pa	4,240
Greensboro, N. C	1,862
Houston	6,862
Huntington, W. Va	2,650
Indianapolis	14,270
Jacksonville	3,160
Kansas City, Mo	25,076
Los Angeles	196,941
Louisville	9,250
Memphis	5,356
Miami	6,228
Milwaukee	34,335
Minneapolis	29,440
Nashville	342
Newark	152,080
New Haven	29,801
New Orleans	7,239
New York City	368,655
Oklahoma City	8,423
Omaha	10,381
Philadelphia	206,073
Phoenix	2,166
Pittsburgh	48,958
Portland, Ore	1,041
Richmond	8,753
St. Louis	45,328
St. Petersburg	284
Salt Lake City	4,218
San Antonio	4,690
San Francisco	29,705
Seattle	9,038
Syracuse	15,937
Toledo	25,988
Tulsa	7,191
Washington, D. C	57,551
Unallocated	31,732

Certain printed-circuit techniques now coming into vogue are similar, believe it or not, to a process suggested in 1888 for the marking of tombstones.

Industrial Users of small radio-receiving-type tubes contacted in our continuing study of the need for types having longer life invariably say they are willing to pay more for a substantial improvement. But when it comes to actually laying extra dough on the line there is naturally some quibbling.

Just what is a "substantial improvement?" How much is "more?" Tube makers tell us that refinements run costs up sharply. And the cost problem is further

uniformity

Not a foot out of step, not a figure out of line. That's uniformity! Karp Products, too, are always "in line," following the most exacting and precise specifications. That means a saving of time and money on your assembly line. "Uniformity" brings greater efficiency into your production.

Our new 70,000 square foot plant has extensive facilities, including an accumulation of dies and jigs which permits us to fabricate at minimum cost, whether your job is a single unit or a large quantity.

Twenty five years' experience has given our craftsmen a "know how" which is reflected in Karp's quality and accuracy. And you can have this service at competitive prices.

Let us quote on your next requirement of metal cabinets, consoles, chassis, and enclosures. Write today for your FREE copy of our illustrated data book.

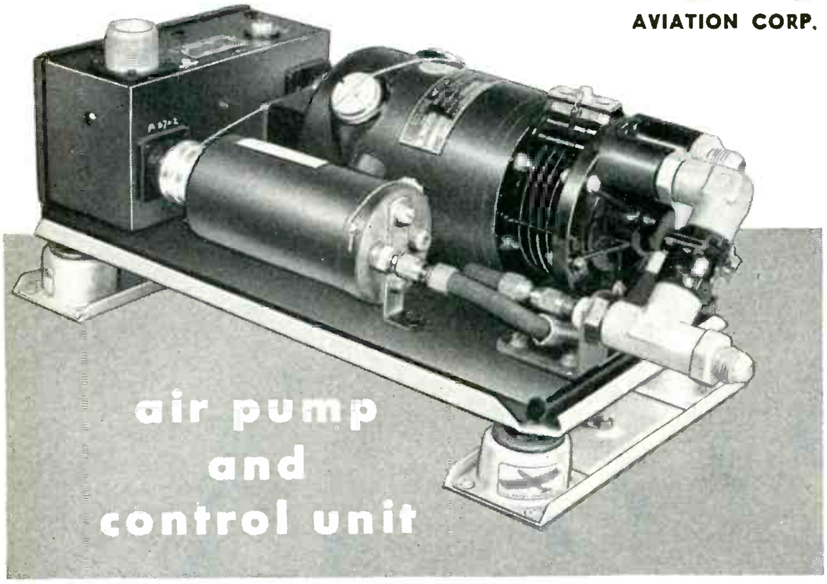
KARP METAL PRODUCTS CO., INC.

215-63rd Street, Brooklyn 20, New York

SHOCK AND VIBRATION NEWS

ECLIPSE-PIONEER

DIVISION OF Bendix AVIATION CORP.



uses

AIR DAMPED BARRYMOUNTS

FOR ASSURED CONTROL of SHOCK and VIBRATION

At high altitudes, the performance of aircraft radar, radio, ignition, and fuel systems depends on pressurization by this Eclipse-Pioneer unit whose sensitive aneroid switch mechanism must be guarded against shock and vibration.

For this critical task, air-damped BARRYMOUNTS were chosen by Eclipse-Pioneer engineers after tests proved they isolate vibration with no snubber contact at any frequency — even at resonance.

The Eclipse-Pioneer unit is shown on a BARRY standard mounting base assembly which permits rapid installation or removal of the pump and control unit.

Free Catalogs give dimensions and load ratings of stock BARRYMOUNTS. Catalog 502 covers aircraft applications. Catalog 504 covers industrial and general-purpose mountings. WRITE TODAY to

THE BARRY CORP.

Main Office 177 Sidney St. ● Cambridge 39 Massachusetts

New York Rochester Philadelphia Washington Cleveland Dayton
Chicago Minneapolis St. Louis Los Angeles Toronto

complicated by the fact that the demand for small industrial tube types is still materially less than for comparable communications types.

Certainly there can be no close comparison of the price of large-volume radio-receiving tubes and smaller-volume longer-life industrial tubes. The economic desirability of the latter has to be judged on the basis of reduced industrial apparatus down-time.

Machlett Labs furnishes the following examples of industrial economies effected by the use of induction heating:

Connecticut Instrument Manufacturer

Product	Previous Unit Cost	Induction Unit Cost
Thermocouple wells, brazed	$ .068	$ .037
Spring, tempered	.024	.007
Well for recorder, soldered	1.70	.59
Lever, brazed	.025	.014
Vat fitting, brazed	68	.20
Damping magnet, brazed	1.18	.17
Connector, soldered	.061	.034
Flange, soldered	1.36	.051

Wisconsin Gear Manufacturer

Furnace Heat		Induction Heat	
Heat-treat	$.53	Broach clutch	$1.06
Grind	.64	Induction-harden	.03
Finish clutch	.11	Broach gear	.13
Heat, press, grind	.77	Induction-harden	.13
	$2.05		$1.35

Washington Hatchet-Head Manufacturer

Flame Tempering (per hour)		Induction Tempering (per hour)	
Fuel	$.90	Oscillator power	$ .135
Two men, machine	1.90	Control power	.04
Labor, cleaning	.90	One man	1.00
Power, conveyor	.04	Cooling water	.108
Naphtha, cleaning	.05	Tube replacement	.10
	$3.79		$1.383

Electronic Equipment Manufacturer

	Torch-Braze Unit Cost	Induction-Braze Unit Cost	Production Increase
Cylinder assembly	$.567	$.095	605%
Pivot elbow	.190	.119	160
Tube head	8.49	1.78	475
Hose assembly	.150	.086	174
Conductor-plug assembly	.094	.054	174
Push-rod assembly	.035	.021	166
Echo-box cap boring	.100	.074	135

We're wide open for more examples.

One Unhuman Bridge between the wiggling meter pointer (or squiggling c-r spot) and the printed or punched-card output of a business-type machine is Metrotype Corporation's automatic data recorder, called to our attention as one answer to our *Business Briefs* plea (March, p 60) for something to help man digest the voluminous data being gathered today by electronic measuring and telemetering gear.

This particular robot takes in voltages (into which most any other quantity can be converted) and uses a step voltmeter to generate a number of pulses proportional to the voltage being measured. From there we go into a myriad of electronic counters, memories, number mixers and suchlike that in the end make an appropriate teletypewriter character sock paper at an appropriate position. Perhaps not quite that simple—the gear fills a tall relay rack—but it works, without human attention or human errors; best of all, results come out in simple arithmetic right in the same room or hundreds of miles away over a two-wire phone line.

Here's one long step in the right direction.

A Friend Of Ours owns a small plant devoted to the repair and installation of marine electrical and electronic equipment and the manufacture of marine telephones. He's looking for an additional line, something not too remote from his business and not too tough to make and sell.

We hear about lots of firms in this position and will be glad to pass along to them the names of readers who have ideas, particularly if design work is fairly well advanced.

Radar will be in use aboard 202 Great Lakes freighters, or 64 percent of the total number, by the end of the year, predicts C. M. Jansky, consultant for the Lake Carriers Association. Some 1,200 radiophones will be in use aboard U. S. and Canadian vessels plying the same waters.

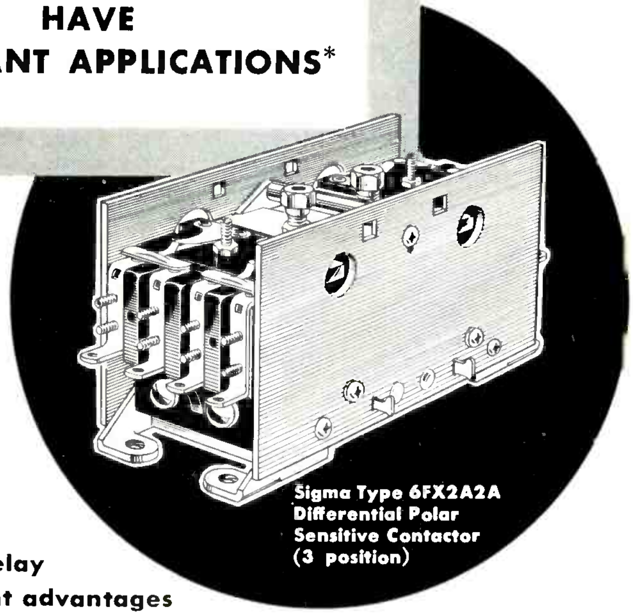
Summer Complaint apparently permeates all strata of society.

While passing through an experimental tube laboratory the other day we noted faint wisps of smoke coming from a transparent hydrogen furnace but, peer as we would, there was no trace of the object being heated. A young lady longingly looking outdoors at the birds, bees and flowers and apparently in charge was questioned and took one startled look.

"My God," she said, "I forgot to put the work in there!"

servos

OF THE CONTACTOR TYPE— HAVE IMPORTANT APPLICATIONS*



Sigma Type 6FX2A2A Differential Polar Sensitive Contactor (3 position)

This Sigma Relay has significant advantages as the output device

Gain—Besides obvious advantages in reduction of complexity of principal circuits, capacity and weight of power supplies, etc., additional gain afforded by any link in a closed loop system permits enhanced stability through more feedback; greater system sensitivity and accuracy; less droop and faster response. These advantages may be taken in various combinations.

Standard Sigma Series 6-X contactors will control from one to four circuits each rated 5 Amps at 110v ac at a differential power sensitivity of 16 milliwatts per pole — *power gain, 34000: 1.*

Type 6FX2A2A (above) has two double-break normally open switches on each end; with two 12000 ohm windings it operates at 1.6 ma differential current, either way depending on polarity.

Self Balance—In a servo requiring correction in either of two directions, this Sigma relay replaces two conventional relays corresponding to the two directions. In a typical push pull "DC" amplifier circuit it eliminates all concern over magnitude of plate currents at "null." With one of its windings in each plate circuit it responds *only* to differential current.

Its balanced armature can assume either of two operated positions (depending on polarity of signal) or a neutral, and it has *positive detent in all 3 positions.*

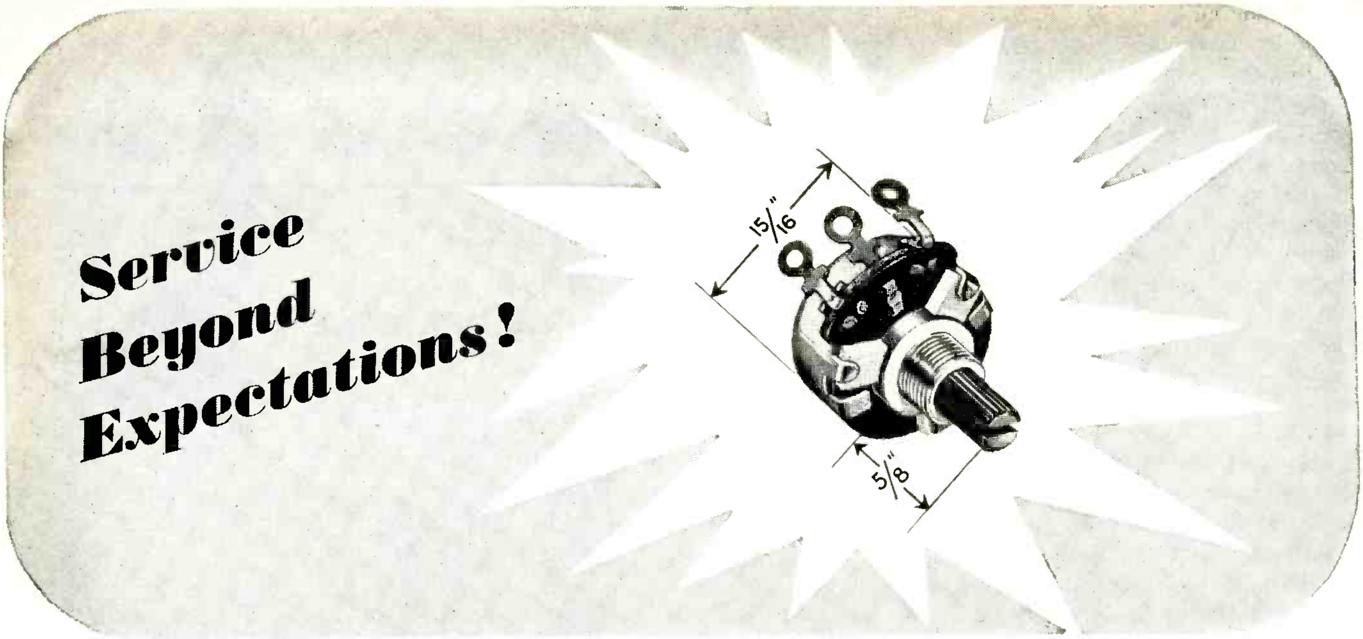
Adverse Environment — Combination of an almost perfectly balanced armature and substantial operating forces with rugged box-like structure produces high immunity to shock and vibration. Choice of materials and processes is suitable for service from —55° to —85° and up to 95 % R.H. Hermetic Sealing is also available.

Speed of Response — Although the unit in question is by no means the fastest of relays, its dynamic efficiency is such that in many circuits it will respond in less than 10 milliseconds. Such response occurs when the coil circuit has relatively high source impedance.

Our general catalog, which describes many other useful types lists a large group of available standard coil and contact combinations for the SIGMA SERIES 6 relays.

*See our advertisement in this space, May Issue.

SIGMA Instruments, Inc.
SENSITIVE RELAYS
62A Ceylon St., Boston 21, Mass.



New Development In Mallory Midgetrol* Minimizes TV Drift!

THE 15/16" MALLORY MIDGETROL

(Power rating ½ watt)

Electrical characteristics specially designed for critical applications in television, radio and other circuits. Insulated shafts are knurled for ease in adjustment. Shaft and current-carrying parts provide 1500 volt insulation . . . 15/16" diameter saves space. Precision-controlled carbon element provides smooth tapers, quiet operation, accurate resistance values, less drift in television applications.

The Mallory Midgetrol now embodies a new technique in variable resistor manufacture . . . providing precise control of drift under high humidity conditions. It involves a new treatment of the carbon element, assuring uniform dispersion of talcum-fine particles over a special phenolic base with an extremely low factor of moisture absorption. As a result, drift is held within very close limits... well within the requirements for TV picture stability. *This feature will obviously eliminate a troublesome source of field service problems.* It is an important addition to the desirable characteristics described at the left.

That's service beyond expectations!

Mallory's electronic component know-how is at your disposal. What Mallory has done for others can be done for you!

Television Tuners, Special Switches, Controls and Resistors

P. R. MALLORY & CO., Inc.
MALLORY

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

SERVING INDUSTRY WITH

Capacitors
Controls
Rectifiers
Special Switches
Contacts
Resistors
Vibrators
Power Supplies
Resistance Welding Materials

*Trade Mark

CROSS TALK

▶ **CPB** . . . A month or two ago (on another network, *Proceedings IRE*, March, 1950, p 227), we held forth as a guest editorialist concerning the importance of radio engineers in advising the government, placing particular emphasis on the RTPB, JTAC, NTSC type of organization. Since then has come word of the formation by President Truman of the Communications Policy Board (April issue, p 130) which is to undertake a sweeping review of the basic communications needs of the country, and to study the conflicts and inequities which beset the use of the radio spectrum. The five members of the board are the presidents of MIT, Caltech, and West Virginia University (Drs. Killian, DuBridge and Stewart), a former president and current board member of the IRE (Dr. Everitt), and a man thoroughly familiar with military communications requirements (Mr. O'Brien). They are asked to study the use of radio and wire facilities by government and non-government agencies and to recommend to the president, by October, 1950, a sound communications policy, in the national and international spheres. Certainly the board members are qualified, by position and experience, to accomplish this enormously important task competently and equitably. Considering the number of special, vested, and highly-vocal interests who have an important stake in the outcome of their deliberations, their task is not to be envied.

Inevitably they will compare the modus operandi of the FCC, which regulates the use of radio by non-government users (all of which must justify the use at length) with that of the IRAC, which regulates government users (without a comparable justifying procedure). Surely also they must come to grips with the problem of spectrum space reserved for future use but not used at present, the problem of point-to-point channels occupied 50 percent or more of the time with the repetition of call letters, with the general waste of a precious public domain. Many, in fact, are the heads that must be knocked together before the spectrum is equitably and fully put to use. The good wishes of the radio profession go to the CPB.

▶ **LANDLORD** . . . The tendency of "the management" to interfere with engineering progress is a common complaint. Now comes an example in reverse.

For years, f-m and tv broadcast engineers have urged that several stations should occupy jointly the best transmitting site in a given locality. Major Armstrong hung six arms on his Alpine f-m tower with this philosophy in mind. This system not only provides strong signals but also maintains the adjacent signal ratio near unity throughout the service area, with benefits to all concerned. But the disinclination of broadcasters to share a good thing with the competition is understandable. So, since 1930 or thereabouts, NBC has been the sole broadcasting occupant of the Empire State tower.

Now all this is changed. WJZ-TV has moved to Empire State alongside WNBT. WCBS-TV has announced plans to move, as soon as the new 200-foot antenna tower is ready, as have stations WPIX and WABD. And the Empire State people feel that they may be able to make room for all seven stations now assigned in the New York area.

This is indeed progress. We would like to report that this progressive step could be traced to the impassioned pleas of engineers of the competing networks, and the gracious assent of the NBC engineers. But no. The credit goes to management. Whose management? The owners of the Empire State Building. And what did it? An outsize increase in the rent, gentlemen. That's what did it.

Seriously, all concerned are to be congratulated. By 1951, New York should have by all the odds the best television service, technically speaking, in the world. And there's no patent on the idea. Boston, Philadelphia, Chicago, San Francisco and Los Angeles papers, etc, please copy.

▶ **TAPE APLENTY** . . . Howard Chinn's suggestion for recording television transcriptions on magnetic tape (*Crosstalk*, February, 1950) has called forth a masterly analysis of costs by John Boyers of Magnecord. Mr. Boyers' letter (*Backtalk*, this issue) points out that, on reasonable assumptions, a 15-minute video tape program would require about 37,500 feet of tape, at a list price of $1,375! Impractical on the face of it but, says Boyers, "I am sure the job will be done before too long."

Plastic-

By WILLIAM R. CUMING
Emerson & Cuming Company
Boston, Mass.

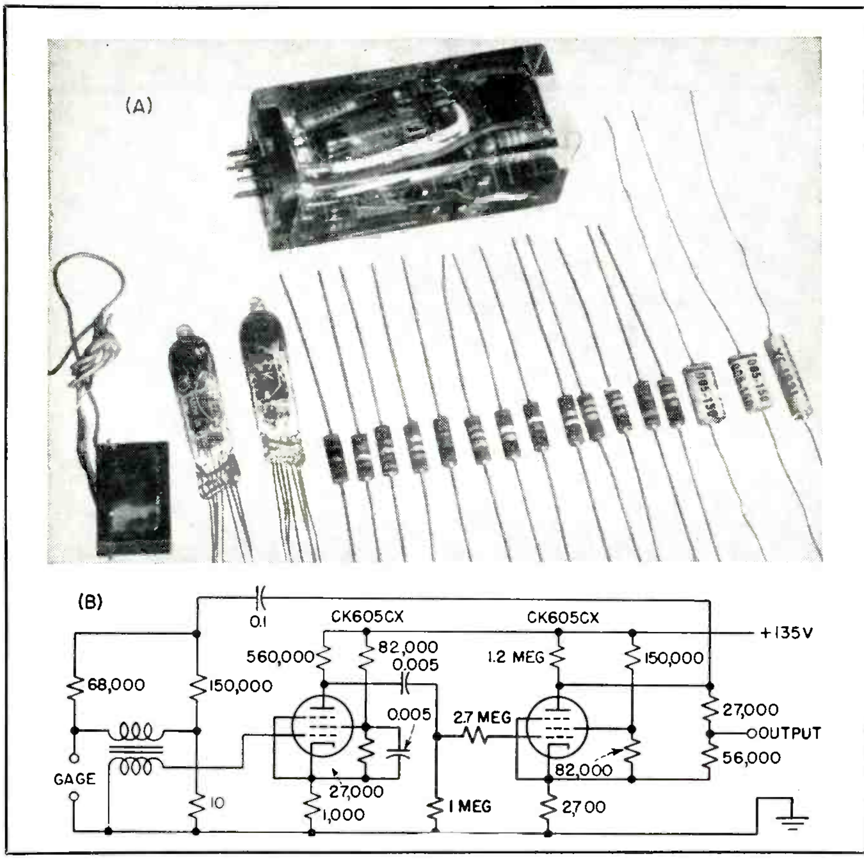


FIG. 1—(A) Plug-in oscillator for vibrating-wire-type pressure gage used for guided-missile telemetering application and, in foreground, the component parts embedded therein. (B) Circuit of the oscillator

Considerable interest has developed within the electronics industry concerning the embedment of circuits and components in rigid plastic materials. The technique is sometimes referred to as casting.

In brief, it consists of: (1) preparing a mold of the proper size and shape, (2) setting the circuit or component in the mold, (3) pouring a prepared liquid resinous material into the mold, and (4) polymerizing the resin into a rigid solid. The mold is then removed.

Embedment materials with excellent physical and electrical properties are available. For example, it is possible to embed in essentially pure polystyrene, a plastic notable for its electrical properties. Moreover, materials with made-to-order properties may be formulated for specialized applications. Materials may be transparent or opaque. Coloring possibilities are almost unlimited.

Applications for plastic-encased units are increasing rapidly. A few of the benefits derived from embedment are:

(1) Hermetic sealing.
(2) Ruggedization and shockproofing.
(3) Elimination of mountings.
(4) Use of bare point-to-point wiring for rapid circuit assembly.
(5) Miniaturization and utilization of plug-in subassemblies.
(6) Stabilization of electronic operation.

Suitable Materials

The coating and potting of electrical components in waxes or resinous materials has been done for many years. Often a container is used to hold the component and the potting compound. However, in general the potting compounds of the electrical industry are not suitable for electronic applications. High-frequency, high-impedance circuits require materials of superior electrical properties. Sensitive electronic components can not be subjected to the high temperatures needed to make most potting compounds pourable.

In some instances, embedment has been accomplished by using conventional injection or compression-molding methods. High temperatures and pressures, however, limit the usefulness of this technique. In addition, the capital outlay for equipment has generally confined molding to large-volume units.

For many years, a few concerns have embedded objects in methyl methacrylate (Lucite and Plexiglas) by a low-pressure casting process. This technique has largely been limited to objects used for display purposes. Methyl methacrylate, although unsurpassed for its optical properties, is not particularly good with respect to electrical properties.

In 1947 the National Bureau of Standards announced the development of a casting resin termed NBS Resin. This material had excellent electrical characteristics and was widely used as an embedment medium in electronic laboratories. It is expensive and not plentiful.

In recent years a good deal of work has been done in chemical laboratories on materials which can be polymerized, that is, transformed from the liquid to the solid state by a low-pressure, low-temperature process. In the course of these investigations materials and techniques which permitted casting and polymerization right in the mold were developed.

Polymerization denotes a chemical reaction wherein distinct molecules react with one another to form a larger molecule. For example, styrene, a liquid hydrocarbon, polymerizes to form polystyrene. Styrene is referred to as a monomer (single molecular structure) whereas polystyrene is the resulting polymer. In cases where two distinct chemical compounds enter into a reaction it is often referred to as copolymerization. The latter is the reaction which most commonly-used embedment plastics undergo.

It is well known that certain chemicals catalyze (or hasten) polymerization and copolymerization reactions even when used in very

Embedded Circuits

Casting of component parts within materials suitable for electronic applications eliminates chassis, permits bare point-to-point wiring and provides miniaturized and stable plug-in units. Here is how it is done

small proportions. The most important of these catalysts are organic peroxides, benzoyl peroxide for example. In addition, other compounds, notably heavy metal salts and tertiary amines, activate the catalyst to give even more rapid polymerization. These compounds have been termed accelerators. Heat may also be applied to speed the reaction. The choice of a catalytic system for a particular application is not a simple matter.

Currently popular embedment compounds are polyesters. Polyesters are the resinous reaction products of organic unsaturated acids and alcohols. They may be used as such for embedment but are most commonly diluted with styrene. A wide range of physical and electrical properties in the copolymerized plastic is achieved by selection of the appropriate polyester or combination of polyesters and the proportion of styrene used. Further modification is possible by the use of fillers and plasticizers. Fillers include mica dust, milled glass filaments and cotton linters. Plasticizers are normally liquid additives, used to increase flexibility, particularly for low-temperature operation.

Polystyrene may be used in embedment applications where the optimum in electrical characteristics is desired. One completely polymerized polystyrene casting resin has the electrical properties indicated in Table I.

Table I—Typical Polystyrene Casting Resin (*Stycast*)

Frequency	Dissipation Factor	Dielectric Constant
100 cycles	0.00098	2.596
1 kc	0.00062	2.595
10 kc	0.00047	2.592
100 kc	0.00096	2.588
1 mc	0.00084	2.582

Characteristics

Dependent upon the application, there are many specific requirements placed on an embedment plastic. The difficulty of combining all of the best characteristics in a single compound is evident. Fortunately all are seldom, if ever, required simultaneously for any single application.

In order to give a general idea of properties which can be expected of a typical unfilled polyester-type resin, Table II is included. Properties refer to only one resin. It is possible to modify them greatly.

A few of the more important properties of embedment plastics are discussed briefly below.

Electrical Properties—Polystyrene is the most satisfactory material with respect to general electrical properties. It is a thermoplastic material and will, therefore, soften at approximately 80 C. It should not be used as an embedment medium at temperatures below —10 C because of brittleness.

High Temperature—Resins with high polyester content and mineral filler are best suited to high-temperature applications. The polyester resins are thermosetting. They do not flow at high temperatures. Decomposition or degradation of the plastic will, however, result from excessive temperature operation.

The temperature reached at hot spots within an embedment depends upon a number of factors associated with the heat-generating and heat-transmission path. Careful physical design of circuitry and use of a high heat-conductivity resin consistent with satisfactory electrical properties are good approaches to this problem.

Mineral-filled polyesters have

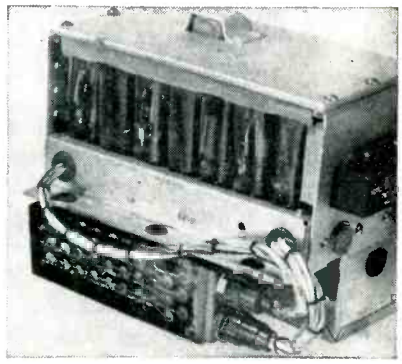


FIG. 2—Missile-borne telemetering system employing the technique

been subjected to hot-spot temperatures (at embedded vacuum-tube surfaces) of 300 C for half-hour periods without ill effects. Under prolonged operation hot-spot temperatures should be limited to 160 C. Some embedment compounds now under development indicate that this temperature limit will be raised.

Recent data on resistors embedded in one-inch cubes of resin with thermal conductivity of 2.3×10^{-4} gm-cal per cm^2 per sec per deg C per cm indicates that the surface temperature of the resistors will be 35 to 45 C above the ambient-air temperature when operated at normal rated dissipation. Operating at half rated dissipation will approximately halve the temperature rise.

Low-Temperature Operation — The use of plasticizers and reenforcing-type fillers is effective in permitting operation at low temperatures. Embedments suitably prepared have been taken down to temperatures as low as —80 C with no adverse effects. These same embedments will withstand operation at least to 110 C.

High Thermal Conductivity — High thermal conductivity may be achieved by the use of high-conductivity fillers; even metallic fillers are possibilities. Achieving good thermal properties is always a compromise with electrical properties. Embedment of cooling fins has also been used effectively.

Thermal Expansion Coefficient—Thermosetting embedment resins with high mineral-filler content have been prepared to have expansion coefficients below 20 parts per million per degree C. It is sometimes desirable to use a resin with the same coefficient as the embedded object. Within limits this may be done by proper blending of the resin mix.

Shrinkage — Shrinkage during copolymerization is roughly 8 percent by volume. The total volumetric change, however, is not effective in causing pressure on the embedded units. This is due to the fact that during copolymerization the density of the resin increases while it is still liquid. At a later point a weak semi-solid gel forms. Shrinkage from this point is only a few percent. The use of polymerized resin dissolved or dispersed in the liquid resin is effective in minimizing shrinkage effects.

Optical Properties—These plastics may be water-white. By the use of selected dyes and pigments opaqueness and colors in infinite variety are obtainable. Identification tabs may be enclosed in transparent units. Lettering may be cast on the surface of an embedment or may be finally engraved or printed.

Adhesion—The adhesion to glass, metal or ceramic surfaces depends upon (a) the resin used, (b) the physical configuration of the embedment, and (c) the condition of the surface. Certain resins show excellent adhesion. However, if a resin is selected on the basis of other characteristics, adhesion may usually be accomplished by use of another resin for a priming coat. It is best to have shrinkage take place toward the surface to which adhesion is desired. Rough, clean surfaces are superior to smooth surfaces upon which foreign matter is present.

Embedment Method

A step-by-step procedure for the embedment of a simple circuit in the resin whose properties are listed in Table II is given below for illustration.

Components are wired together in accordance with a circuit diagram. Maximum use is made of bare point-to-point wiring. Components which dissipate heat are located in such a manner as to minimize heat concentration. In general, miniature components may be used to achieve maximum space saving. A small connector is used for mounting. Upon completion of wiring, and before embedment, the circuit is checked for proper operation.

The mold is made of metal, plaster-of-paris or cardboard. Normal mold-making principles, such as clearance and taper, are adhered to. A means of supporting the circuit is provided. The inside of the mold is coated with an appropriate parting agent such as silicone oil. The circuit is placed in the mold.

The needed quantity of resin is weighed out. A measured amount of peroxide catalyst is added and stirred in. This will be of the order of one percent of the resin weight. An accelerator may also be added at this time. The prepared resin is poured into the mold. Entrapped air bubbles will rise and can be completely removed by subjecting the unit to vacuum.

The unit is set aside to copolymerize. Placing in an air oven at about 55 C will hasten this process. Rapid copolymerization increases the danger of cracking in the finished unit. In critical situations copolymerization is sometimes accomplished under refrigeration. A final brief oven cure completes the reaction. Removal from the mold, cleaning and polishing (if desired) yields the plastic packaged unit.

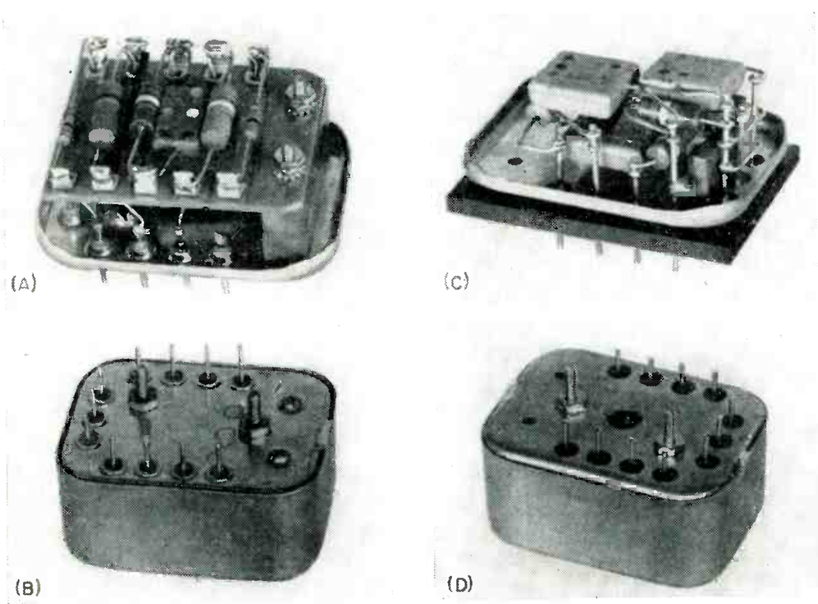


FIG. 3—Old and new techniques employed in assembling an industrial instrument subassembly, the former shown at (A) and (B) and the latter at (C) and (D)

Practical Examples

A few examples will serve to illustrate embedment possibilities.

At Massachusetts Institute of Technology, project Meteor, a guided-missile development, has the problem of miniaturizing and ruggedizing a complex electronics system. Moreover, the system may sustain long periods of inactivity, but must function precisely when called upon. Hermetic sealing is thus a necessity. The use of individual plug-in subassemblies is desirable so that repairs can be made rapidly and accurately.

Figure 1A shows a typical unit. The components which are assembled into the unit are shown below it; the circuit diagram is shown in Fig. 1B. This particular unit is an oscillator for a vibrating-wire-type pressure gage. The finished unit has a volume of approximately one cubic inch.

A missile-borne telemetering system is shown in Fig. 2. The major chassis contains 28 embedded plug-in units. These are oscillators, multivibrators and clippers. In the foreground is an embedded matrix

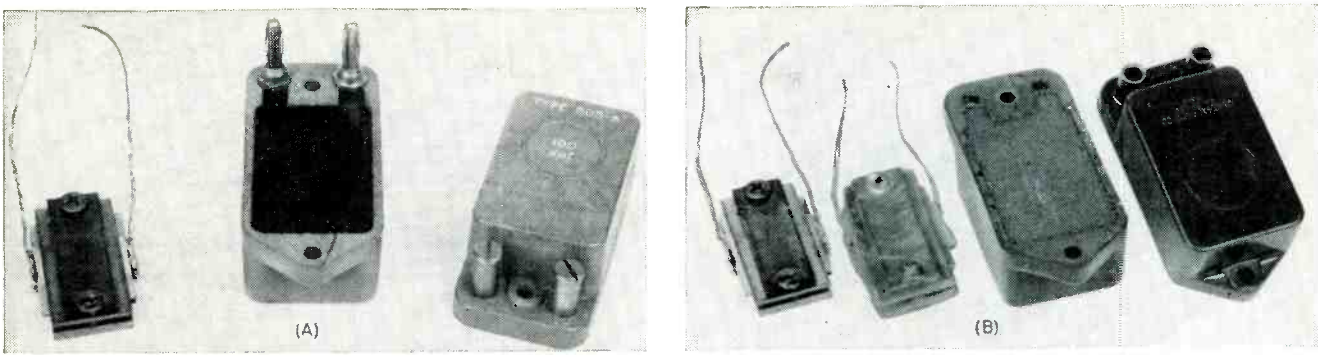


FIG. 4—Precision capacitor made by two methods, the case filled with silica gel, ground cork, paper and wax at (A), and dipped in wax and embedded in plastic within the case at (B)

consisting of 30 germanium diodes and associated components.

Two bleeder embedments are used in high-voltage cathode-ray tube power supplies. The embedments were made for Edgerton, Germeshausen and Grier. They consist of eleven 4-megohm, 2-watt resistors connected in series, with appropriate taps brought out. The bleeder has 22,000 volts applied across the end terminals and operates continuously with a current of 0.5 mil. The major advantages over conventional construction are space conservation, elimination of possible corona and mounting ease.

The Foxboro Company, manufacturer of precision industrial instruments, seals certain critical networks into metal cans. Figure 3 is a before-and-after photograph-series of one such network. At (A) and (B) is the former design. Components are rigidly mounted on a phenolic strip, the strip is mounted on the base of the metal can and is then wired to glass bead terminals which provide external connection.

This network has now been redesigned for embedment and is shown at (C) and (D). A reusable jig supports the terminal leads. The phenolic strip and glass beads are eliminated. The cover of the can serves as the mold for the resin.

Component Application

Applications for the embedment technique in the component field are indicated by the experience of General Radio. Early experiments indicated that components embedded within a relatively-thin plastic coating were impervious to 100-percent relative humidity under prolonged exposure. Moreover, the plastic coat presented a hydrophobic (non-wetting) surface to moisture. Plastic was superior to heavy wax coatings in physical properties. Electrical properties were satisfactory for some of the most exacting applications.

In Fig. 4A is a 100-$\mu\mu$f mica capacitor. It is made up of multiple layers of selected mica and foil. These are bound together by a brass clamp, with a heavy spring to give the proper degree of pressure preloading. Under standard procedure the component is next mounted in a low-loss phenolic case, surrounded by silica gel and ground cork, covered with paper and sealed with wax.

When applying embedment technique to this capacitor it was found that a light hydrocarbon wax-dip coating prevented liquid resin from entering the mica-foil pile and changing capacitance. A styrene-methacrylate molded case was chosen since the embedment plastic makes a perfect bond to this material. Experimental work produced a resin formulation and polymerization procedure which added a minimum and constant capacitance to the final product. A large number have been made up for testing under 100-percent relative-humidity conditions. After 1,000 hours no moisture had penetrated the capacitor shown in Fig. 4B.

Completely cast capacitors have been formed. One experimental model is in opaque and the other in clear plastic. Molding methods for this type of unit which would be practical on a production basis are now under investigation.

Plastic embedment of electronic parts is no longer untried. When the process is established and controlled by competent electrical and chemical engineers it is one of electronics' most useful design tools.

Table II—Properties of Typical Polyester-Type Embedment Resin *(Resin 40)*

(Polyester content—65%, Styrene content—35%)

Specific Gravity	1.24
Tensile Strength (psi)	9,000
Compressive Strength (psi)	19,000
Izod Impact, (ft-lb/ in. of notch)	0.3
Rockwell Hardness (M scale)	110
Coefficient of Linear Expansion (cm/cm/deg C	50×10^{-6}
ASTM Heat Distortion Under Load (deg C)	110
Thermal Conductivity (BTU/ft^2/hr /deg F/in.	1.5
Water Resistance (Gain 25 deg C, in 24 hr, in %	0.2
Dielectric Constant (at 60, at 1,000 and 10^6 cps)	3.1
Power Factor 60 cps	0.008
Power Factor 1,000 cps	0.005
Power Factor 10^6 cps	0.017
Dielectric Strength (v/mil, 100-mil sample)	500
Resistivity (ohm-cm)	10^{12}
Optical Properties	clear, water white when polymerized
Machineability	excellent

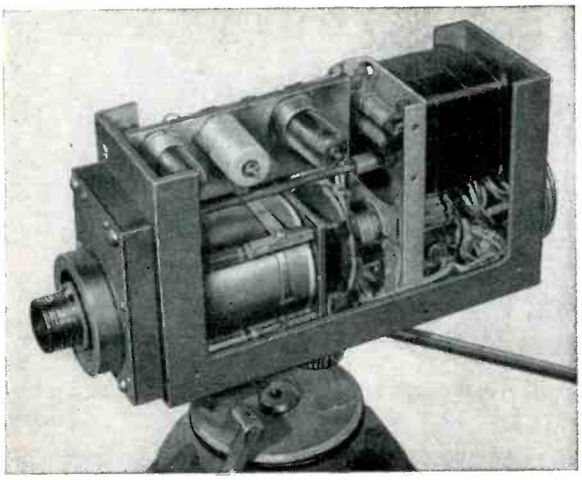


FIG. 1—Vidicon camera unit contains two miniature tubes and the picture tube

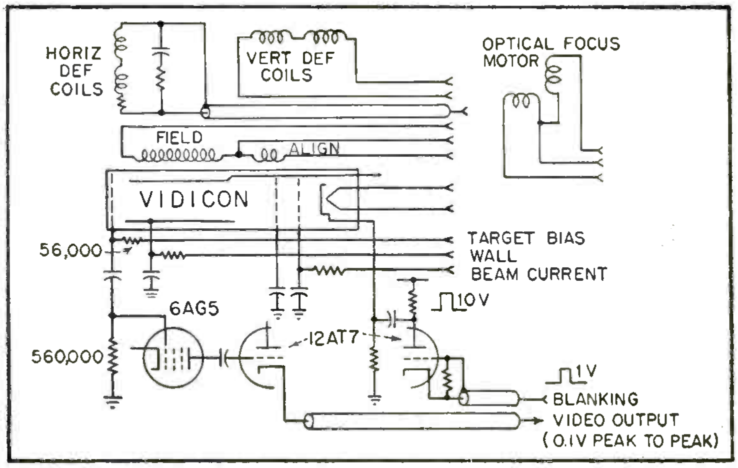


FIG. 2—A standard 24-conductor cable connects the camera and control units

Simplified TELEVISION

System uses recently introduced vidicon camera tube. Synchronizing signals follow RMA standards to allow use of commercial-broadcast tv receivers as monitors. Two units contain total of 48 tubes, including vidicon and monitoring scope

INDUSTRIAL television installations usually employ a multiplicity of camera units and a common centrally-located viewer, in contrast to broadcast television where a handful of cameras is used to serve many thousands of receivers. The most logical approach to cutting the cost of industrial television equipment is to reduce the cost of the camera units and to make them usable with commercial broadcast viewing equipment, which has already undergone substantial price reduction.

There are other basic requirements for industrial television equipment besides low cost. It should be compact and light in weight for portability. It should require a minimum of servicing and be capable of dependable operation over long periods of time.

Such a system is described here. A significant reduction in camera cost has been made possible by the recent introduction of the vidicon tube, which was described in ELECTRONICS last month.[1] The advantages of this photoconductive camera tube include operational simplicity, low cost, good resolution, freedom from spurious signals and high light sensitivity.

Vidicon System

The system consists of a small pickup camera and a master unit. These units are connected by a standard 24-conductor television camera cable, which may be up to 500 feet in length.

The camera shown in Fig. 1 with its cover removed is 10 inches long, 3¼ inches wide, 5 inches high, and weighs approximately 8 pounds. A typical 16-mm lens in a remote focusing mount permits optical focus adjustment by remote control from the front panel of the control unit along with the other camera adjustments.

The vidicon pickup tube can be seen extending inside of the focusing-coil—deflection-yoke assembly and the electron-gun alignment coil. The motor and gear assembly for operation of the remote focusing mechanism is located in the rear of the case and the video amplifier stages extend from the front of the camera toward the rear.

As shown in Fig. 2 the camera has been kept as simple as possible, containing only the pickup tube and those elements intimately connected with it. Scanning currents for both vertical and horizontal deflection coils are sent in over the cable along with the d-c currents for the focusing field and alignment coil as well as the operating potentials for various electrodes in the vidicon. A one-stage video preamplifier followed by a cathode-follower prepare the signals from the target electrode for transmission over the coaxial cable back to the master unit. In order to establish black level it is necessary to blank the target of the vidicon during the scanning return time and this is most conveniently done by applying a positive ten-volt blanking pulse to the cathode. Since a ten-volt pulse on a 52-ohm line represents a very sizeable current it was found more economical to transmit a one volt

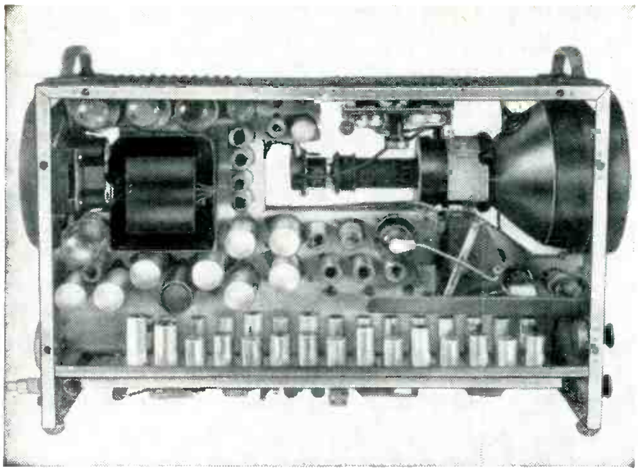


FIG 3—Left-side view of control unit shows video strip and cooling fan

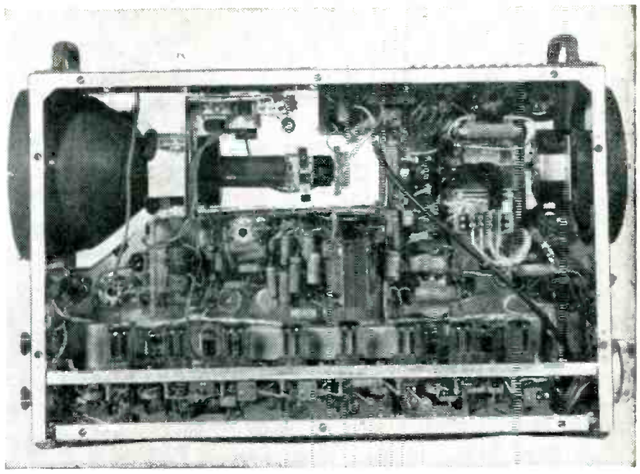
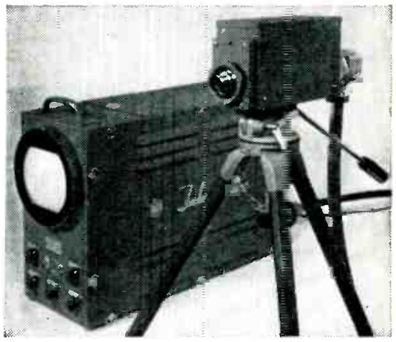


FIG. 4—Right-side view shows frequency-division chain and high-voltage circuits

For INDUSTRY



Complete industrial television system draws a total of 350 watts

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pulse and amplify it in the camera just before application to the vidicon cathode.

Views of each side of the master control unit are shown in Fig. 3 and 4.

In order to operate standard broadcast television receivers from a system of this kind it is necessary to establish substantially the same scanning rates as those used in commercial broadcasting. Certainly it is necessary to transmit an interlaced signal because otherwise the resolution in the vertical direction will drop to approximately 250 lines. It was therefore decided to establish the same scanning rates for the industrial system as those standardized by the RMA for commercial broadcasting, namely 525 lines, 30 frames interlaced.

Simplified Sync

One of the basic elements of the simplified synchronizing signal generator used in this equipment is an oscillator, which resembles the familiar multivibrator.[2]

This basic oscillator is illustrated in Fig. 5A. Before the plate voltage is applied to the circuit, C is uncharged and the grid of V_2 is at ground potential. As soon as plate voltage is applied, the grid of V_1 is raised to some positive potential determined by the series of resistors. The plate resistor of V_1 is low and consequently a relatively large current can be drawn by that tube down through the common cathode resistance, which raises the cathode of both of the tubes to some positive voltage E_K. With the cathode of V_2 highly positive with respect to its grid, the plate current in that tube is cut off and C is free to charge through R toward B+ according to the logarithmic curve shown in Fig. 5B.

If nothing were to prevent it, C would charge up to a value $(1 - 1/\varepsilon)$ of B+ in RC seconds. However, as the potential on the grid of V_2 increases as C charges, it will reach the shaded region below E_K that represents the negative bias range for which V_2 will be conductive. As soon as V_2 begins to conduct, the plate current flowing through its plate resistor lowers the potential of the grid of V_1 and that tube is quickly biased off. However, since it was largely the heavy current drawn in the left-hand tube that supported the cathode potential at the value E_K, this potential will now drop to a very low value and the grid of V_2 will find itself highly positive with respect to its cathode. Capacitor C then discharges through the diode formed by the grid and cathode of V_2 and the length of time required for the discharge to occur is determined by the value of C and the effective resistance of the diode and the cathode resistor.

Having discharged C to a low value the circuit is ready to restart the cycle. Thus a saw-tooth voltage waveform is available across C and a narrow pulse can be obtained from the plate resistor of V_1. The exact frequency of oscillation of this circuit depends upon several factors including the value of the plate supply voltage, which is carefully regu-

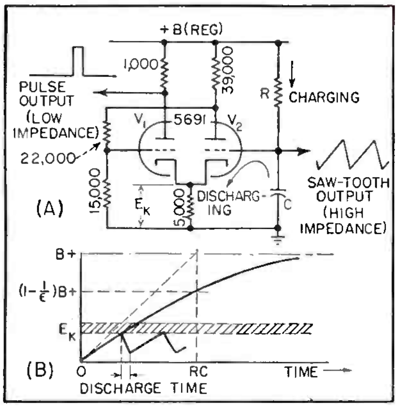

FIG. 5—Basic oscillator-counter operates at twice horizonal scanning frequency

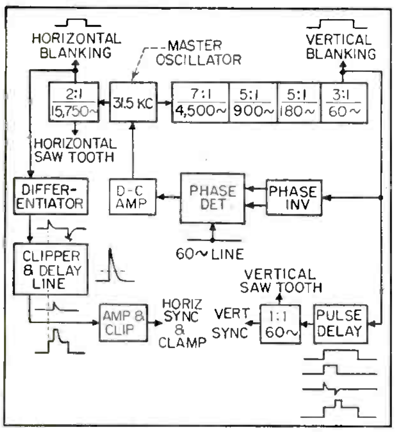

FIG. 6—Vertical and horizontal sync, scanning and blanking voltages are produced by this frequency-division and pulse-shaping network

lated. It depends primarily upon the values of R and C, and the voltage E_K, and it has been found to be stable enough over long periods of time for this application.

The oscillator is susceptible to being synchronized to external signals. A positive pulse added to the capacitor voltage can precipitate entry into the conduction region periodically, or a negative pulse added to E_K or to the left-hand grid will do as well. A circuit of this kind is especially useful in a television synchronizing generator since use can be made of the square-topped pulse output as well as the nearly ideal saw-tooth wave.

Frequency Division

The positive pulse out of the master oscillator is added to the capacitor voltage of the next stage below, which is an identical oscillator but set to run free at 1/7 or 1/5 the master frequency, as shown in Fig. 6. In this way the two oscillators are locked rigidly together and a third can be locked to the second and so on down to any submultiple frequency.

Seven of these oscillators are used in the synchronizing-signal generator. In order to obtain the half-integral relationship required between the horizontal and vertical scanning rates to produce odd-line interlacing, it is necessary to start with a master oscillator at 31.5 kc, which is double the horizontal rate of 15,750 cycles. Subdivision of the master frequency by the numbers 7, 5, 5 and 3 yields the vertical scanning rate of 60 cycles. The vertical blanking pulse is taken from the 60-cycle oscillator that is made to have a discharge time approximately 5 percent of the vertical period (V) by choice of the time constants governing that oscillator. A sample of the vertical blanking signal is taken through a phase inverter to a phase detector where it is compared to the power-line frequency. The afc signal thus developed is applied to the master oscillator to synchronize it with the power frequency.

The horizontal frequency generator is synchronized at ½ the master frequency and is adjusted to produce a horizontal blanking pulse width that is approximately 15 percent of the horizontal period. The saw-tooth output of this stage is also used as a scanning waveform.

Horizontal sync is made from blanking by differentiating the blanking pulse, clipping the leading pulse and sending it through a delay line to produce a front porch of about 2 percent of the horizontal scanning period H. The pulse is later amplified and clipped to produce a sync pulse with a steep front edge and a duration of approximately 5 percent H. The horizontal sync and blanking pulses are thus similar to the RMA standard waveforms.

The vertical sync pulse, which is quite unorthodox, is produced by allowing the front edge of vertical blanking to key a pulse delay tube into operation. After a time interval, determined by time constants in the delay circuit, the delay tube falls out of its conductive condition having produced a pulse that is a fraction of the length of the vertical blanking period.

This pulse is then differentiated, and the pip corresponding to the trailing edge of the delay pulse used to synchronize a second 60-cycle saw-tooth oscillator. The discharge time or equivalent pulse width from this oscillator is made to be no greater than approximately ½ of the time for one horizontal line in order that a short vertical sync pulse can be slipped in just ahead of one horizontal sync pulse and just after another one in the odd and even fields. Thus 10 tubes have been used to produce all of the waveforms required for the entire system.

The composite waveform is shown in Fig. 7. Although the vertical sync pulse is only about 10 times as long as the horizontal pulse no difficulty has been experienced in tests with commercial receivers in obtaining sufficient vertical sync signal. Furthermore, the signal in an industrial system is always noise free since it will be fed over closed circuits.

The scanning system used is shown in the block diagram of Fig. 8A. A single vertical deflection

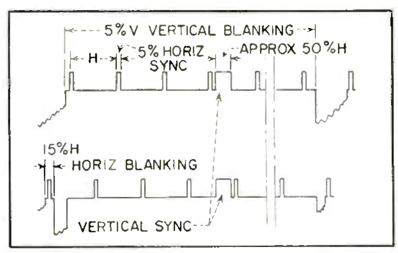

FIG. 7—Composite waveform for the industrial television system

amplifier is common to both the monitor kinescope and the camera since the power requirements are small and ordinary cable pairs are satisfactory for transmission out to the camera. The horizontal scanning and second anode voltage supply for the monitoring kinescope are combined in one conventional unit of the type normally used in home receivers.

The horizontal scanning for the camera is quite unconventional, however, since it is necesary to send the current to the camera through several hundred feet of 52-ohm coaxial cable. The method of accomplishing this can best be understood from Fig. 8B.

The parallel-resonant circuit comprising C and L with R_1 and R_2 connected serially in each arm is known to be antiresonant at all frequencies for the singular condition where $R_1 = R_2 = \sqrt{L/C}$. The terminal impedance Z, looking into the network is a pure resistance equal to $\sqrt{L/C}$ ohms at all frequencies. Such a constant resistance network as this makes an ideal termination for the transmission line and since it includes the horizontal deflection coil as one element it should be possible to produce any desired current waveform in the coil by impressing the proper voltage waveform upon the line. Ringing of the resonant circuit formed by the deflection coil and any capacitance that may be associated with it is very undesirable in the presence of the impulse waveforms used in television scanning. The condition for critical damping of a resonant circuit requires that the total resistance around the series loop must be at least equal to $2\sqrt{L/C}$, a condition that coincides exactly with the foregoing.

Synthesis of the required voltage waveform is accomplished as shown in Fig. 8C. The voltage across the inductance during the scanning period must be $L\,di/dt$ which for a constant rate of change of current is a small constant negative voltage. During retrace time the current change is in the opposite direction and many times faster, hence, the voltage required across the coil is of the form of a positive pulse. The voltage drop iR_2 across R_2 due to the saw-tooth current is of saw-tooth waveform as shown. The sum of these two voltages gives the required waveform that must be impressed upon the line to produce the ideal current saw-tooth in the coil.

Perfection of the scanning linearity depends entirely upon the accuracy with which this complex waveform is produced. It was fortunate that both the saw-tooth waveform and its companion pulse were available from the horizontal frequency stage in the synchronizing-signal generator since it was then only necessary to mix the two waveforms with appropriate amplitude adjustment to obtain the required shape.

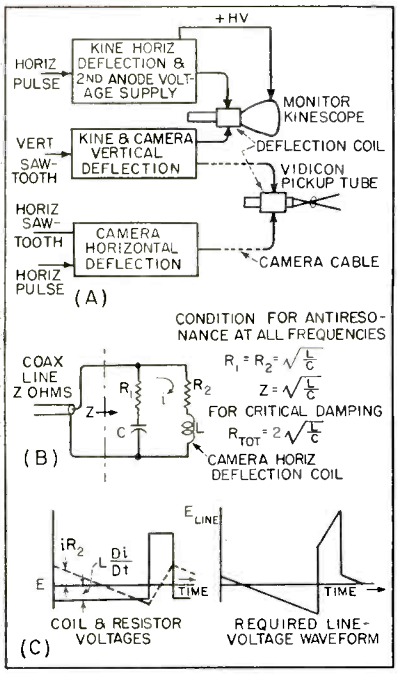

FIG. 8—Block diagram of scanning circuits. (B) and (C) explain operation

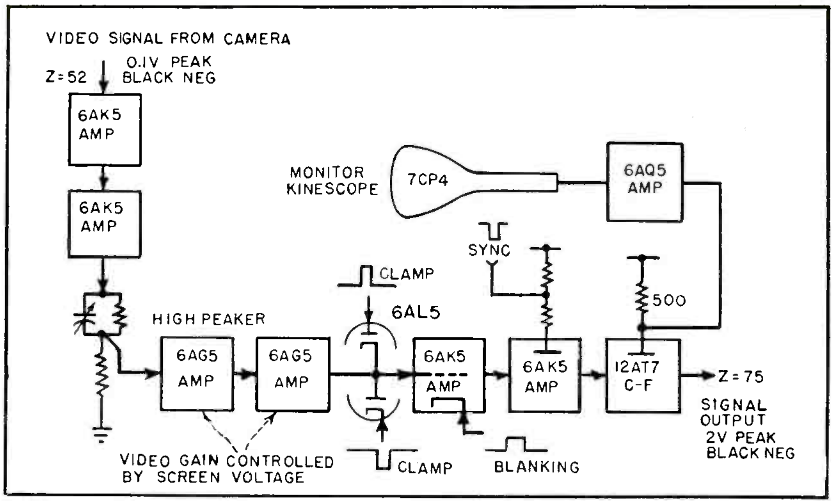

FIG. 9—Video path is similar to that used in broadcast transmitters

Video Amplifier

The video amplifier is almost identical to those used in broadcast equipment. As shown in Fig. 9, the signal goes through two stages of amplification before reaching the conventional high peaker.

Video gain is controlled by varying the screen voltage of the 6AG5's. Black level is established by means of a conventional driven clamp circuit; the clamping pulses are made from horizontal sync. Blanking is inserted in the cathode of the d-c setter and sync signals are mixed with video in the following stage. The composite signal is then sent to the external 75-ohm signal lines by means of a cathode-follower output stage. The output signal is polarized with blacks negative and is 2 volts peak to peak.

Signal for the internal kinescope is taken from a sampling resistor in the output stage and fed through a one-stage amplifier to the kinescope grid.

The gain in the kinescope loop is not adjustable and thus the kinescope serves as a rough monitor of the signal level on the outgoing line in addition to its other uses for black level setting, camera focus and beam adjustments, as well as a check on sync generator operation.

The television instrument described could easily be mass produced and sold within the price range of other business machines of comparable size and complexity. It will produce a sharp, steady picture of useful quality, and the pickup tube is sensitive enough to permit use of the equipment under the illumination levels normally encountered in industrial operations.

The authors are indebted to Dr. V. K. Zworykin of the RCA Laboratories for much helpful encouragement and guidance during the development of this project.

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(1) Paul K. Weimer, Stanley V. Forgue and Robert R. Goodrich, The Vidicon—Photoconductive Camera Tube, ELECTRONICS, p 70, May 1950.

(2) Kurt Schlesinger, Patent No. 2,383,822 (RCA).

Highest fidelity, least noise and longest wear are obtained by using needles having different tip characteristics for slow-speed and for high-speed records. Convenience and less costly associated equipment, however, are creating considerable interest in compromise types, several of which are described here

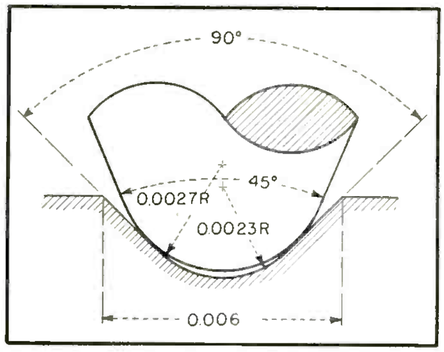

FIG. 1—Profile of typical 78-rpm groove and standard 2.7-mil radius needle

All-Purpose

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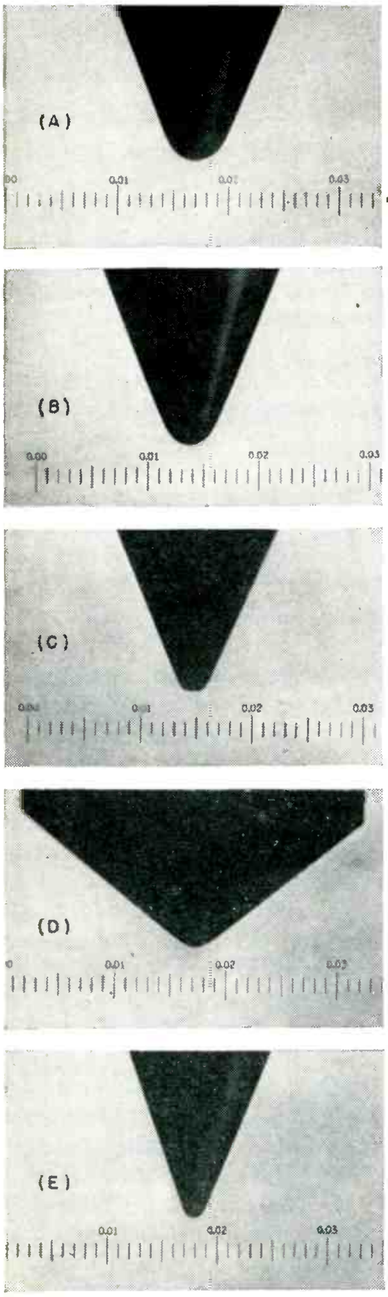

Contours of five types of needles in use today. (A) Standard 2.7-mil radius needle for 78-rpm discs. (B) All-purpose needle with 2-mil tip radius. (C) All-purpose Unipoint. (D) All-purpose wide-angle needle. (E) Standard 1-mil radius needle for fine-groove records

AMONG the problems confronting the designer of phonographs as a result of the introduction of $33\frac{1}{3}$ and 45-rpm records is the need for separate needles for the 78-rpm and the slow-speed records. For best reproduction it is desirable to use a needle with a 2.7-mil tip radius (1 mil = 0.001 inch) for the 78.26-rpm records, and one with a 1-mil tip radius for the $33\frac{1}{3}$ and 45-rpm records.

The requirement of employing dual-needle pickups, together with the mechanism for placing the proper needle in position, adds to the cost and complexity of the record player. It is not surprising, therefore, that work began on needles that would be capable of playing both the conventional and the fine-groove records when the latter were introduced by Columbia in the spring of 1948.

At this writing, a number of manufacturers are beginning to market phonograph players and record changers employing single-needle pickups for use with all records. In addition to eliminating the changing of needles, these players use the same low needle force of 7 to 10 grams for all types of records, resulting in further simplicity of operation. It is quite likely, therefore, that a substantial number of phonographs employing all-purpose needles will make their appearance in the near future. It is the purpose of this paper to review the performance of various commercially available all-purpose needles.

To begin the examination of the problem, it is well to review the relationship which exists between conventional phonograph grooves and needles. In Fig. 1 is shown in cross-section a typical groove and needle of a conventional 78-rpm record. The groove is 6 mils wide; it has a 2.3-mil bottom radius and sidewalls inclined at 45 deg.[1] The needle accepted as standard by the RMA has a 45 deg ± 5 deg included angle and a radius of 2.7 mils. The objective generally desired is to allow the needle to be supported by the sidewalls, rather than by the bottom of the groove, as in this manner the needle has a positive engagement with the groove and can be driven laterally without lost motion.

In Fig. 2 is shown in cross-section a typical groove and needle found in $33\frac{1}{3}$ and 45-rpm records. Data issued by record manufacturers would indicate that the width of the grooves of $33\frac{1}{3}$ rpm records should lie between the limits of 2.7 mils and 3.0 mils, and that of 45-rpm records between the limits of 2.5 and 3.0 mils. Measurements made by the writer and his associates on a number of fine-groove records selected at random indicate

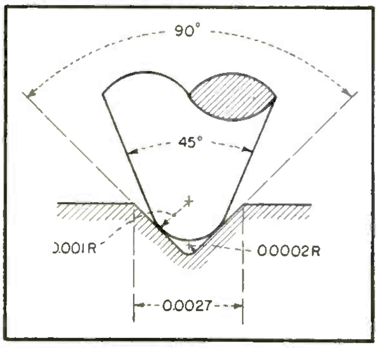

FIG. 2—Profile of typical fine-groove and standard 1-mil radius needle

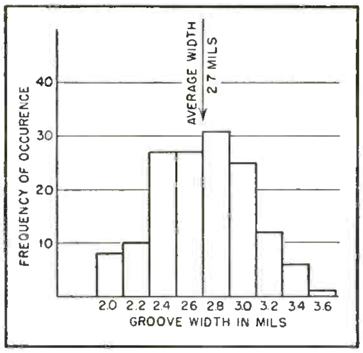

FIG. 3 — Distribution of groove widths of 147 fine-groove records

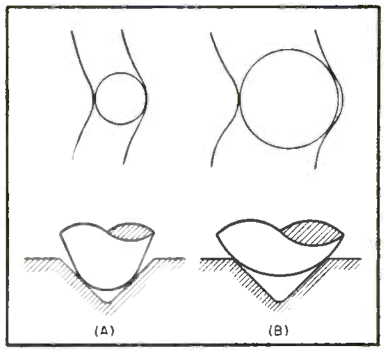

FIG. 4—(A) 1-mil radius needle in a modulated fine-groove. (B) 2-mil needle

PHONOGRAPH NEEDLES

that these limits are not being commercially maintained. The bar chart in Fig. 3 shows the distribution of groove widths of 147 fine-groove records of all types, selected at random. It is seen that, on the average, unmodulated fine-grooves have a width of 2.7 mils, and a substantial number of fine-groove records have unmodulated grooves only 2 mils wide. As a result of pinch effect, the modulated groove width is narrowed considerably, and upon occasion approaches 1.7 to 1.8 mils.

Performance Criteria

The evaluation of an all-purpose needle with respect to design problems and the satisfaction to the ultimate user constitute a complicated problem which does not have a single, simple solution.

An important factor to be considered is the quality of reproduction, which is intimately connected with freedom from distortion and surface noise. Low distortion depends upon the ability of a needle to trace a modulated groove accurately and it is determined in part by the radius of the needle at the point of contact with the record.[2] This can be seen from Fig. 4. This figure depicts two needles placed in a fine-groove, one of the needles having a radius of 1 mil and the other having a radius of 2 mils. The 1-mil needle is shown passing through the crest of a modulated wave having a radius of curvature somewhat larger than 1 mil. The 1-mil needle will follow this modulation without a discontinuity, as shown in Fig. 4A. A 2-mil needle placed in the same groove will hit a corner at the crest of the wave, causing a discontinuity accompanied by severe distortion. Therefore, one might conclude that for the best quality reproduction a needle should have the smallest possible radius.

On the other hand, there is also a low limit below which a needle radius cannot be diminished without causing another type of distortion known as skating. This effect is illustrated in Fig. 5. Here is shown a 1-mil radius needle placed in a 78-rpm groove. The needle is not properly supported and cannot be driven laterally in a positive manner. When playing a modulated groove, such a needle will skate from one sidewall to the other, resulting in distortion and a characteristic swishing type of surface noise.

Another factor which has a great deal of practical importance to the user of a phonograph is needle wear. A small needle point offers less contact area with the surface of the groove than does a large one, resulting in more rapid wear of the needle and the record. When a needle (which is initially a surface of revolution) develops sizeable flats because of wear the result is a substantial loss in fidelity, since the needle is no longer capable of faithfully following the groove modulations.[3] It is important to note that the reduction of needle force achieved with lightweight pickups for fine-groove records has been offset by smaller needle area in contact with the groove, and consequently the needle wear problem has not been lessened thereby.

In considering needle contour, one must be especially cautious of needles which are permitted to contact the upper edges, or corners, of the groove. These corners frequently have ridges (or horns)[4] which cause an increase in surface noise and popping noises when allowed to contact the playback tip. Also, after moderate playing time, the groove edges tend to wear shoulders in the surface of the needle, allowing it to rest partially on the land between the grooves. This results in a considerable increase in distortion. The effect can be minimized by keeping the needle force low and by using long-wear materials for the needle tip.

A third factor has become important as a direct consequence of lower needle forces employed with fine-groove records: the ability of a needle to pull the pickup across the record, that is, its traction, has become substantially lessened, often resulting in inability of the pickup to remain in the groove against the forces of pivot friction, side thrust, unbalanced gravity, or the drag of the trip mechanism of the record changers. Traction force can be measured approximately by applying a lateral force to the side of the pickup (while playing a record) with a spring scale such as the Western Electric relay adjusting scale 70F until the needle is ejected from the groove. To cancel the effect of side thrust caused by tracking angle[5], it is necessary to perform this operation both inwardly and outwardly, and to average both readings. Pivot friction must be low to minimize frictional errors.

A small amount of mathematics will suffice to demonstrate that the traction force is equal to the vertical pickup force multiplied by the trigonometric tangent of the angle between the horizontal plane and the tangent line to the needle at the point of contact with the groove. Because of this factor, large-radius needles which rest upon the upper edges of the groove exhibit greatly lowered traction when they are new as compared to small-radius needles.

With these considerations in mind, we may proceed to examine

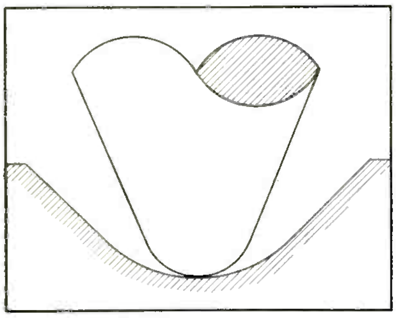

FIG. 5—Profile of 1-mil needle placed in a 78-rpm groove

some of the all-purpose needles commercially available at this time.

Spherical-Tip Type

One of the earliest all-purpose needles to which consideration was given had a spherical point and a radius selected to lie between the standard 1-mil and 2.7-mil radii. A large amount of experimental work was done in the Shure laboratories to ascertain the most favorable size of spherical-tip needle for all-purpose use. These tests indicated that sufficiently satisfactory performance for many applications is obtained with a needle having a

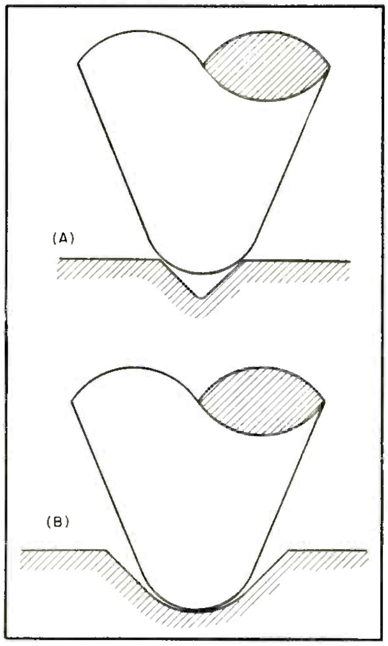

FIG. 6—(A) Profile of 2-mil radius needle in a fine groove. (B) Profile of needle in 78-rpm groove

radius maintained closely at 2 mils.

The manner in which this type of needle fits into the two types of grooves is shown in Fig. 6. In the case of a typical fine groove, the needle contacts the upper edges of the groove as seen in Fig. 6A. Because these edges are apt to be damaged by scratching or scuffing, and because of horns, a 2-mil radius needle reproduces more surface noise than a standard 1-mil radius needle especially designed for use in fine grooves. A 2-mil needle will cause an increase in distortion in fine-groove records because of the relatively large radius in contact with the modulated groove. This fact becomes especially noticeable on highly modulated inside grooves of 33⅓ rpm records. Likewise, the wear of 2-mil needles on fine-groove records is considerable. Figure 7 shows a photograph of a 2-mil osmium-tip needle which had been played 21 hours on Columbia microgroove records. Under the conditions of test, the shoulders produced by the groove edge allow the needle to rest upon the land, resulting in noticeable distortion. A similar needle having a sapphire tip will last several times as long as the osmium-tip needle before reaching this condition.

Traction of 2-mil needles on fine-groove records is initially rather low, ranging from approximately 50 percent to 70 percent of needle force (depending upon the exact needle radius and width of the groove). It follows, therefore, that the mechanics of pickup and changer have to be carefully determined to insure reliable operation.

From Fig. 6B, it is seen that in a typical 78-rpm groove, the 2-mil-radius needle rides at, or close to, the bottom of the groove. In actual practice the needle tip presses into the bottom of the groove under the influence of the pickup force, and therefore it exhibits fairly satisfactory engagement with the modulated sidewall. The bottom portion of the groove impresses a greater amount of noise upon a laterally responsive pickup than does the sidewall, resulting in increased surface noise from shellac records. In the instances of records with grooves having large bottom radius, skating is often clearly discernible.

On first thought, it might appear that a needle of this type would not provide satisfactory reproduction. Fortunately, distortion and noise which might be extremely annoying in a wide-range system often become tolerable in a system with a high-frequency cut-off beginning at 3 to 4 kc. It is a well-established fact that the majority of non-technical listeners will accept a substantial attenuation of high-frequency response in order to achieve a comparative freedom from distortion and surface noise.[6] This object is accomplished in our P81 pickup cartridge, which has been especially designed for use with all-purpose needles, and which has been found

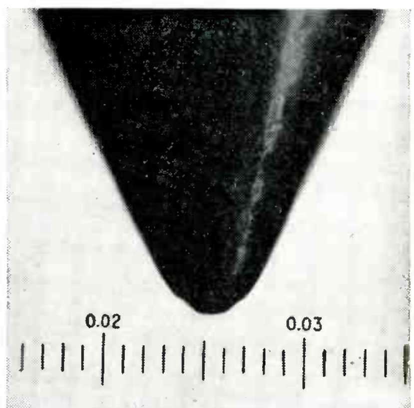

FIG. 7—Photograph of a 2-mil osmium all-purpose needle after 21 hours of wear on fine-groove records

well suited for use in the home. The frequency response characteristic of this cartridge is shown in Fig. 8.

The Unipoint Needle

A considerable amount of experimental work has been performed on a special needle having generally conical sidewalls and a truncated tip. This needle has been named the "Unipoint." A typical outline of the needle in relation to the average 78-rpm groove and the average fine groove is shown in Fig. 9. The engagement of the needle with the average fine groove is shown in Fig. 9A. The needle rides well within the groove and is in contact with the sidewalls, therefore traction is good and noise is low. However, because the radius at the point of contact is greater than that of a 1-mil radius needle, this needle produces greater distortion than a standard 1-mil needle (but less than a 2-mil needle). The profile after 43 hours of wear is shown in Fig. 10. Because of the absence of shoulders, the needle illustrated will still perform tolerably well on fine-groove records, but will exhibit noise and skating on 78-rpm records. A sapphire type will last several times as long as an osmium type.

It is seen in Fig. 9B that the needle is in contact with the sidewalls of the standard groove close to the bottom of the groove. Therefore, an increase in surface noise is inevitable as compared to a standard 2.7-mil spherical point. However, the two-point contact helps to promote a more positive driving by the sidewalls, especially when the needle presses into the groove as a result of vertical pickup force. On some records where a 2-mil needle exhibited noticeable skating, very little skating was perceived with a Unipoint.

There is considerable evidence that the needle offers advantages over a 2-mil radius needle, especially to the user principally concerned with the playing of fine-groove records. These advantages are offset by certain disadvantages. Because of its more complicated contour, the needle is not easy to control in production with regard to dimensions. Also, one which is played constantly on fine-groove records becomes less satisfactory with time for use on 78-rpm discs. (The same is also true of 2-mil radius needles, but to a lesser degree.) One may generalize by saying that a 2-mil needle favors 78-rpm records, while the Unipoint favors fine-groove records.

Wide-Angle Needle

Early cutoff at high frequency is needed when employing a Unipoint needle with 78-rpm records, but it is not essential when playing fine-groove records. Satisfactory cutoff may be obtained with an R-C network connected as shown in Fig. 11. The switching circuit for inserting the network for the 78-rpm records may be mechanically coupled to the speed-changing lever of the record changer. In Fig. 11 is shown the frequency response characteristic of our P71 extended-range pickup employing the new needle, with and without the network.

Still another form of all-purpose needle was described by J. Reid of the Crosley Corporation at the May, 1949 meeting of the Acoustical Society of America. This needle is shown in profile in Fig. 12, together with the outlines of 78-rpm and fine grooves. Basically it consists of a cone having an included angle of approximately 108 deg to 118 deg and a bottom radius of approximately 1.6 mils. The intention is to choose an angle and tip radius large enough to avoid touching the bottom of 78-rpm grooves. If these conditions are met, the needle is capable of fitting the groove by remaining in contact with the upper edges of grooves of all sizes.

Because of the large radius at

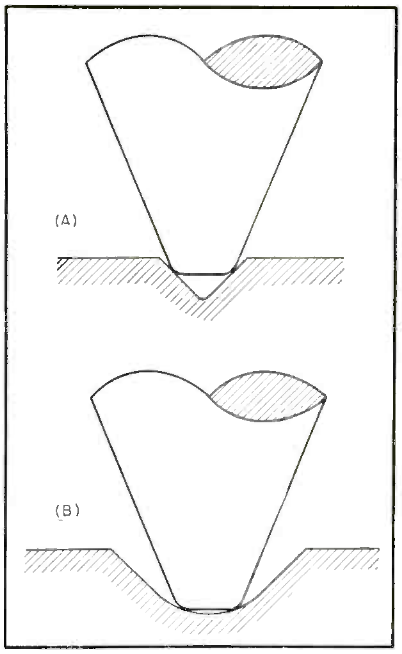

FIG. 9—(A) Profile of Unipoint needle in a fine groove. (B) Profile of needle in a 78-rpm groove

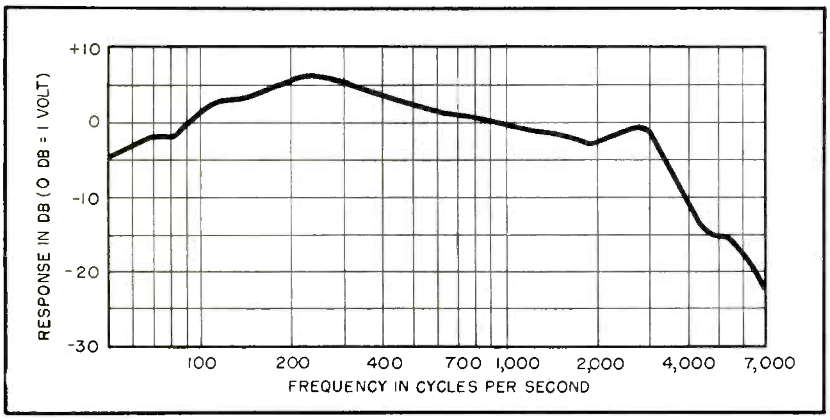

FIG. 8—Response-frequency characteristic of Shure P81 pickup cartridge terminated with 1 megohm, with all-purpose 2-mil radius needle on Auditone record. High-frequency response is attenuated by means of an internal mechanical filter

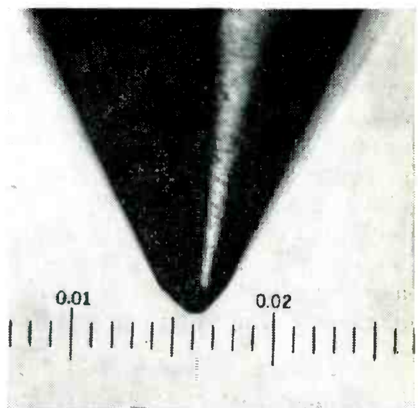

FIG. 10—Photograph of osmium Unipoint needle after 43 hours of wear on fine-groove records

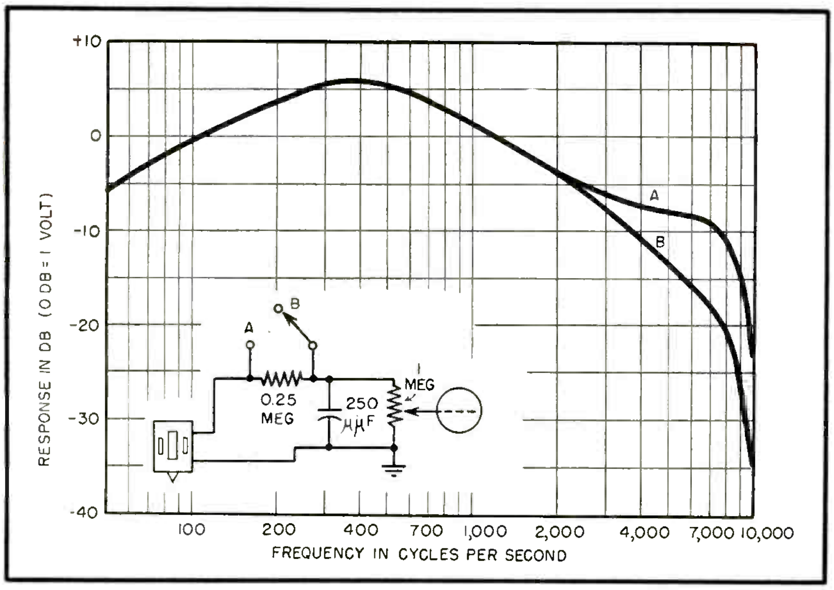

FIG. 11—Switching circuit for selecting (A) extended frequency range, or (B) early cutoff when using a pickup with a Unipoint needle on fine-groove records and 78-rpm records respectively. Response-frequency characteristic measured on RCA 12-5-31-record

the point of contact with the groove, the tracing distortion is increased, although the effect of this distortion may be diminished on both 78-rpm and fine-groove records by curtailing the upper frequency range of sound reproduction, as with previous needles. Again, attenuation of highs helps to eliminate noise residing at groove edges caused by horns and scuffed records. The advantages claimed by Mr. Reid for this needle are the same as those claimed for the large-radius needle described some years ago[7].

Because of the wide angle, the traction ability of the needle is diminished. This necessitates reasonable care in the design and adjustment of the tripping mechanism for reliable operation of record changers. Likewise, the ability of the needle to follow the groove modulation is somewhat lessened, necessitating the use of somewhat higher compliance in pickups, or conversely, a greater needle force for proper operation.

Wear data is not available on this needle; however, information furnished by Mr. Reid indicates it has a long life and is rugged and not easily damaged by careless use.

Design Orientation

Listeners' satisfaction with all-purpose needles is subject to such a degree of variation that definitive conclusions cannot be drawn at the present time to cover all conditions. However, a number of generalized conclusions can be stated.

In instruments capable of high-quality, wide-range reproduction, all-purpose needles offer less fidelity and less listener satisfaction than do the standard 1-mil and 2.7-mil needles. The use of all-purpose needles results in an increase in distortion and surface noise. As stated previously, these effects may be rendered less perceptible by attenuating the high-frequency response of the system. As a general rule, therefore, users of all-purpose needles have found it expedient to employ reproducing systems which have a significant attenuation in the frequency range above aproximately 2½ to 4 kc. This type of response characteristic does not permit taking advantage of the very best quality of reproduction available from fine-groove records; the advantage of simplicity and low cost which is gained, however, is often considered sufficient to warrant the use of such needles in the home. Because the majority of all-purpose pickups have a replaceable needle, the user can readily substitute in its place one of the standard needles if he chooses to build a library of 78-rpm or slow-speed records only.

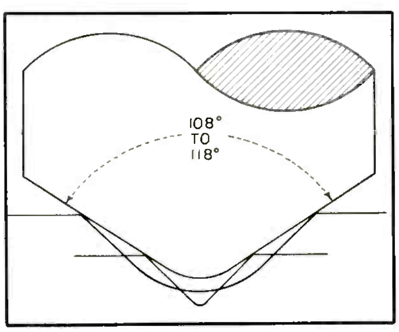

FIG. 12—Wide-angle needle shown with the outlines of a 78-rpm groove and a fine groove

Since the performance of all-purpose needles is greatly impaired by wear, it is desirable to specify the longest-life tip material available, consistent with cost limitations. The best long-wear metal tips presently available for all-purpose needles are probably useful for 20 to 50 hours of wear—depending upon numerous conditions, including listener's tolerance. Sapphire tips should generally last three to four times longer. All of the wear tests previously mentioned were performed with a vertical needle force equivalent to 7 grams (¼ ounce) upon the record. All-purpose needles should be employed with the lightest-weight pickups only, and certainly not with needle forces equivalent to more than 10 to 12 grams.

In choosing a pickup and needle system for multi-purpose phonographs, the designer must weigh the elements of fidelity, convenience and cost of the pickup, as well as that of the associated tone arm, record changer, and circuit. The choice of system will further depend upon the buying habits and preferences of the potential group of customers.

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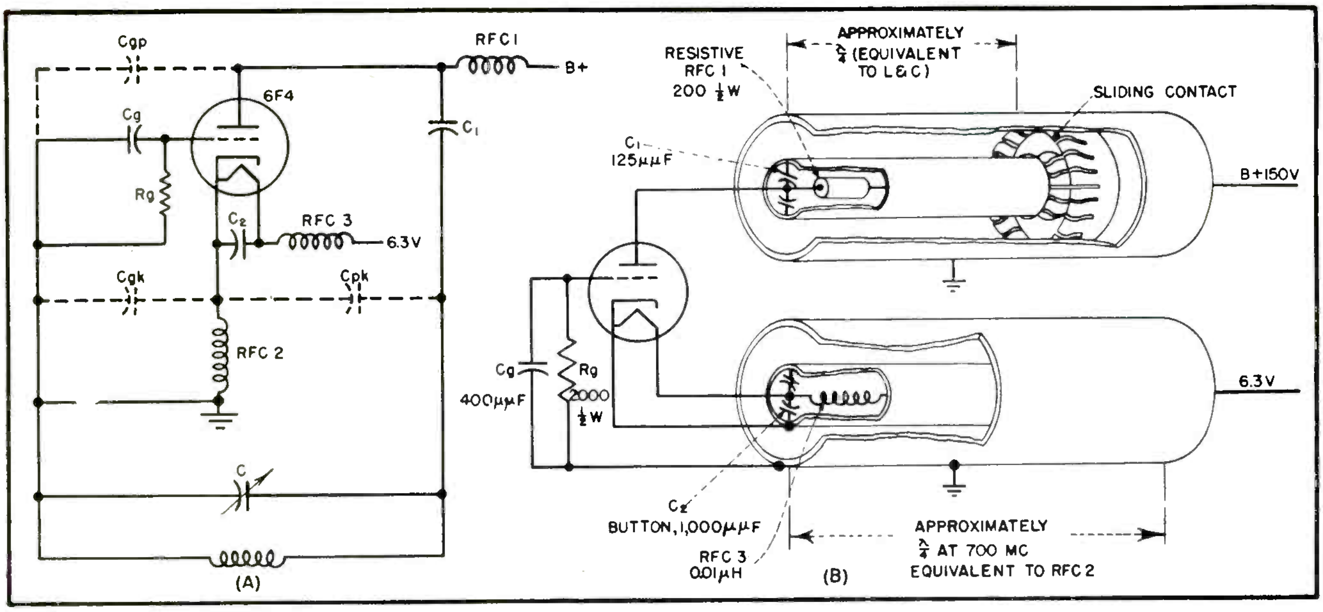

FIG. 1—Basic oscillator circuit and coaxial-line equivalent

UHF Sweep-Frequency Oscillator

Measurements and tests in the proposed new uhf television band are facilitated by the equipment described. Maximum sweep of 30 mc from 470 to 890 mc, at a rate synchronized with the power line, is provided by a motor-driven capacitor plate rotated at the high-impedance end of a resonant cavity

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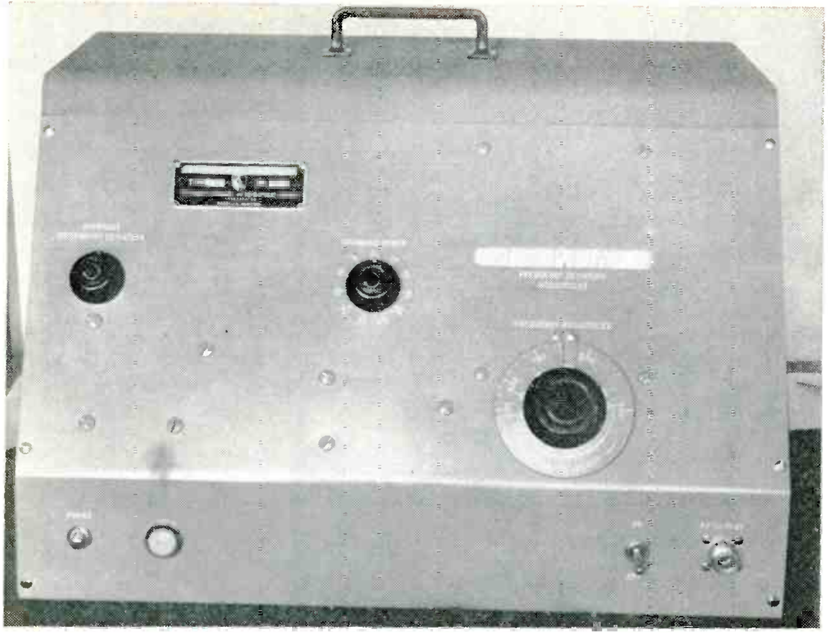
IN DEVELOPING a sweep oscillator for the new uhf television band, a choice exists in attempting to frequency-modulate a fundamental oscillator directly or to resort to a mixing method involving either the frequency addition of two lower-frequency oscillators or subtraction of two higher-frequency oscillators.

An output of the order of several volts across 50 ohms is available using a 6F4 triode as a fundamental oscillator, whereas any simple mixing method using two oscillator tubes will result in a maximum output about 10 to 20 db down from this level. The larger output of the fundamental-frequency oscillator is useful in many applications. Since the use of a swept fundamental-frequency oscillator offers much greater ease and simplicity of operation and greater freedom from harmonic output, this type of oscillator is more desirable provided the problem of obtaining satisfactory frequency sweeping does not become too complex.

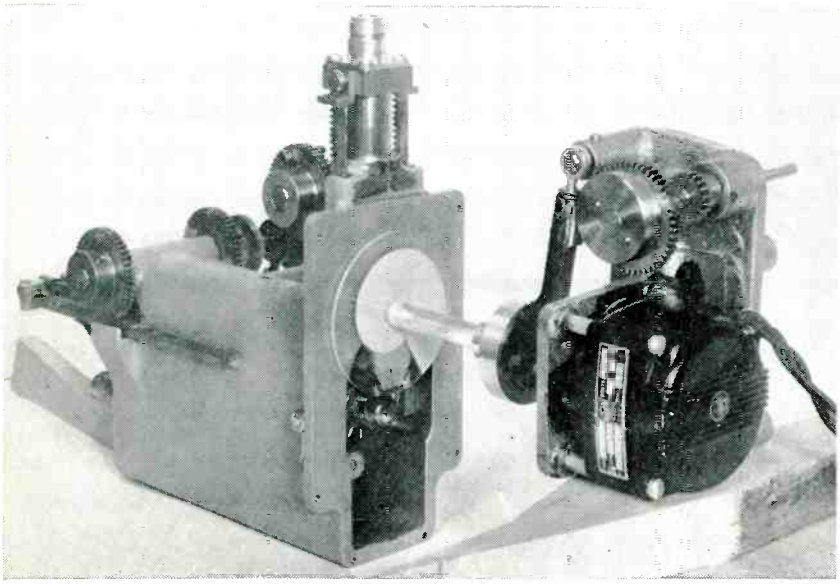
The sweep oscillator to be described covers a range from 470 to 890 mc with a maximum sweep of at least 30 mc at a rate synchronized with the power line. At least 2 volts across 50 ohms is available at any frequency within the specified band, and this voltage can be continuously attenuated by a front panel control to a value of 90 decibels below the maximum output.

At any fixed setting of the attenuator, the output does not vary by more than 1.5 db from the average output at that setting over the entire specified frequency band. Leakage from the oscillator has been minimized by use of completely enclosed coaxial line circuits.

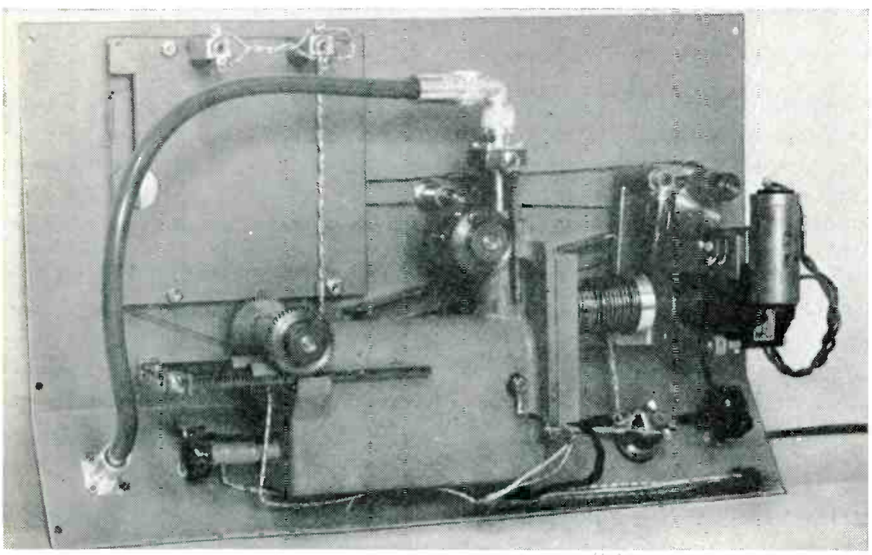
The modified Colpitts oscillator circuit shown in Fig. 1A was selected as best suited for the pur-



Magnitude of the frequency sweep is shown automatically through a panel slot as the oscillator frequency is varied



Closeup of specially shaped capacitor and its motor drive system



A standard rack-and-pinion drive is used on both tuning plunger and attenuator

pose in this television application.

Resonance is obtained between the plate and grid of the 6F4 acorn triode while the plate-to-cathode and grid-to-cathode interelectrode capacitances form a well-proportioned capacitive voltage-dividing network to complete the Colpitts arrangement. Both the cathode and filament circuits are choked to minimize their shunting effect across the grid-to-cathode interelectrode capacitance.

Since adequate shielding is of great importance, the oscillator was constructed in a self-shielding coaxial line. A coaxial line equivalent of the basic oscillator circuit is shown schematically in Fig. 1B.

A cutaway view showing the mechanical construction of the coaxial line oscillator is shown in Fig. 2.

The main body of the oscillator is made from a single bronze casting. The glass body of the oscillator tube is recessed in an indentation in the center conductor to provide a low-impedance connecting line between the resonant circuit and the tube elements. This low-impedance connecting line is necessary to obtain a satisfactory tuning rate at the high-frequency end of the band.

The coaxial-line section used to choke the filament is chosen in length to offer maximum impedance at the center-band frequency. Sufficiently high impedance is obtained at the band edges to give good performance.

Output power is capacitively coupled from the oscillator tank cir-

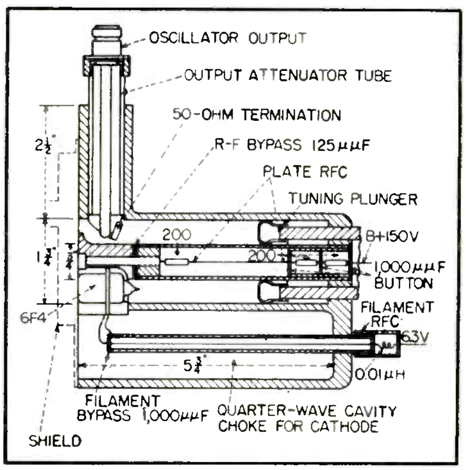


Fig. 2—Physical construction of coaxial-line oscillator

cuit through a coaxial line connected close to the high-voltage point of the resonator as shown in Fig. 2. The harmonic content at this point is small. The output line is terminated in a 50-ohm resistor to provide a reasonably well matched output impedance.

The output is attenuated by withdrawing the pickup line from the axis of the resonant cavity. As the center conductor of the output line is withdrawn the coupling is obtained through the intervening section of tubing which acts as a circular waveguide operated below its cutoff frequency.

The rate of attenuation through a waveguide used under these conditions is almost linear and constant over a wide range of frequencies which makes it possible to have a calibrated attenuator control. Typical power output characteristics for the oscillator are shown in Fig. 3.

Mechanism for Sweeping

Frequency sweeping is accomplished by varying the capacitance between the high-impedance end of the cavity and ground. There are a number of ways of varying this capacitance but the two most straightforward approaches consist of either vibrating a metallic strip in reed-like fashion against the end of the cavity or employing a motor drive to vary the capacitance by rotating a specially shaped capacitor plate. In either case, the motions have to be synchronized with some convenient standard such as the 60-cycle line so that a stationary picture can be obtained on a viewing oscilloscope.

The vibrating capacitor presents certain problems that involve difficult electronic or electromechanical solutions. A driven reed has a motion that includes harmonic components of the driving frequency. A reed driven by a sine-wave power source should be viewed on an oscilloscope with a sine-wave sweep to preserve the frequency linearity of the base line. A sine sweep, however, requires perfect synchronism so that the return trace may exactly coincide with the forward trace. The presence of mechanical harmonics prevents this.

This problem can be circumvented by electronic means. The reed could be driven with a sawtooth wave form and the return portion of the sine sweep could be blanked, but a solution for the second or rotating approach is simple and direct.

One photograph shows the mechanical arrangement used for the rotational method of sweeping the frequency. A synchronous motor is used to rotate a specially shaped capacitor plate which is sprayed on the face of a plastic disc. The ideal shape of the capacitor plate when a sawtooth sweep is used on the oscilloscope is one that will allow the frequency of the oscillator to vary linearly with angular rotation of the driving motor. The magnitude of the sweep is varied by changing the spacing between the plate and the end of the resonator.

The sweep capacitor spacing is controlled by the angular rotation of an eccentrically mounted circular cam. The cam follower is spring loaded and the front panel control is coupled to the cam through a conventional gear train having a 4 to 1 rotational ratio. This ratio is desirable since the entire cam throw occurs in only 180 degrees of rotation.

The synchronous motor used has the property of locking in on any one of four points on the cycle of the input 60-cycle power source. Phasing between the similarly locked internal sawtooth sweep on the viewing oscilloscope and the rotating motor can be roughly adjusted to any one of the four motor positions by momentarily breaking the motor circuit and allowing the motor armature to slip one position. Fine adjustment in phase is made with controls on the oscilloscope.

Dial Details

A curve of the sweep characteristics of the complete oscillator is shown in Fig. 4. This shows that the magnitude of the frequency sweep for a given capacitor plate spacing is not constant over the frequency range. This is corrected through the use of a dial arrangement which automatically shows the magnitude of the frequency sweep as the frequency is varied.

To accomplish this, the dial consists of a chart on which is plotted curves for constant frequency sweep with the tuning plunger position as the ordinate and the angular knob movement, which controls the capacitor spacing, as the abscissa. This chart is viewed through a slot in the panel and is arranged to move past this slot as the oscillator frequency is varied.

A pointer travelling along the slot is mechanically connected to the sweep capacitor. The chart is drawn so that the end of this pointer indicates directly the magnitude of the frequency sweep at any oscillator frequency and at any capacitor plate setting.

Two simple cord and pulley systems are used to drive the pointer and chart in the frequency sweep indicating system. The pointer is connected to the sweep magnitude control and the chart position is coupled to the tuning plunger position.

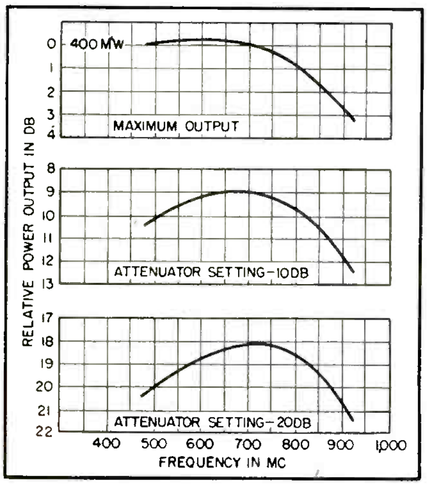


FIG. 3—Power output plotted against frequency for several attenuator settings

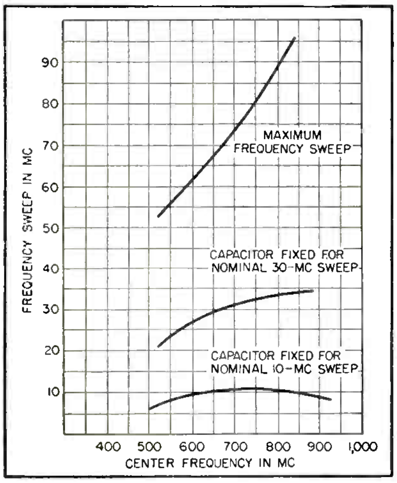


FIG. 4—Frequency sweep versus frequency for several capacitor settings

VHF LINKS at Manila

Line-of-sight f-m linsk in 160-mc band provide over 150 speech, telegraph, printer and control circuits between new CAA control station and remote transmitting and receiving stations. Details of special circuits are given

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At Manila International Airport, formerly Nichols Field, CAA has designed and is finishing construction of one of the world's most extensive and complete aeronautical communications networks.

From Manila point-to-point and air-ground communications circuits radiate toward Australia, Java, Malay States, French Indo-China, Japan, and the United States. In addition, interisland radio printer and c-w circuits connect Manila with numerous island cities for dissemination of aeronautical and weather information.

For a number of years CAA has been studying the relative dependability and cost of wire-line and radio-control links between the control stations and antenna sites at its overseas communications stations. In the Philippines, new factors affected the design of the control links. Permanent wire-line facilities in the Manila area were largely devastated during the war, and the risk of service breakdown through landline pilferage made still another strong argument for the use of radio to connect remotely located transmitting and receiving stations with the master control station at the airport.

Circuit Requirements

The types of control circuits required at Manila are similar to those of all CAA overseas communications stations. Remotely located radio transmitters and receivers must be controllable from the airport to maintain communication with aircraft in flight and with other overseas aeronautical terminals. Weather information must be gathered and disseminated to aircraft in flight as well as to many fixed points in the area. Information necessary to the operation of the many airlines concerned must be exchanged over six point-to-point radio printer and telegraph circuits out of Manila.

Communication to aircraft in flight uses both c-w telegraph and radiotelephone. Multichannel transmitters and tunable receivers are used. For control circuits pertaining to air-ground communication, circuits are arranged so the operator can make a dial selection of the transmitter frequency desired at any one of seven remote air-ground operating positions. In addition, the operator is provided with control circuits enabling him to voice-modulate or manually key the transmitters. These control functions

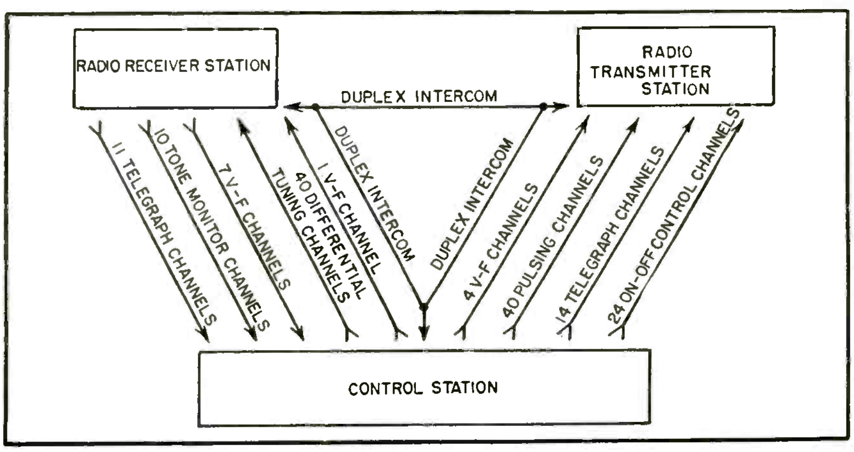


FIG. 1—Each arrow represents one of the vhf links used in lieu of wire lines between control station at airport and the two remotely located antenna sites. Numbers and types of carrier-derived channels provided by each link are indicated

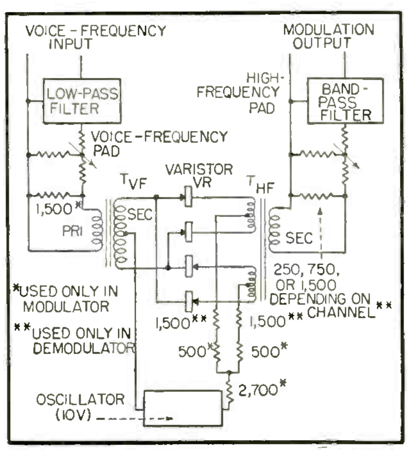


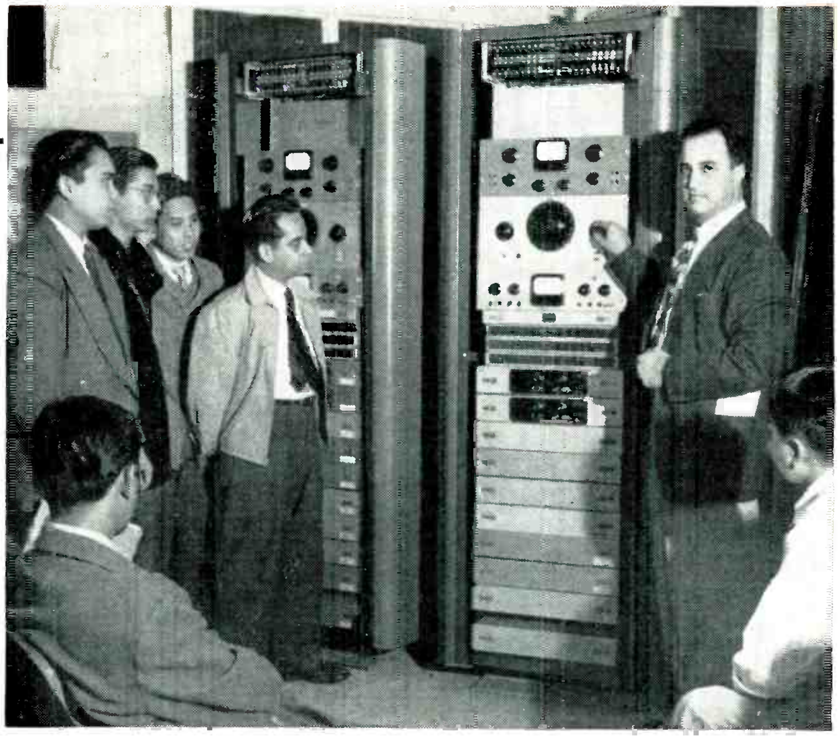
FIG. 2—Basic modem circuit that can be used either as a modulator for producing sidebands or as a demodulator

Airport

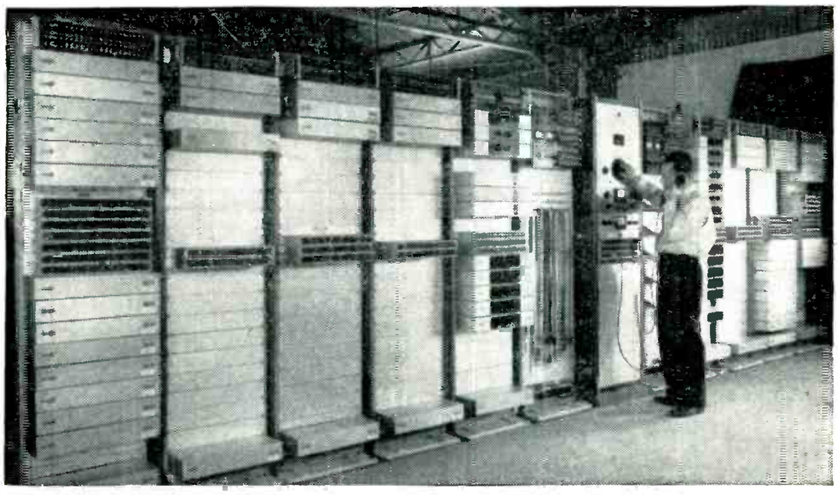
are obtained through carrier-derived voice channels. An associated tone-channeling system is used to apply power to the remote transmitters, to deliver transmitter dialing impulses, and to allow manual keying with semiautomatic telegraph keys.

When receiving transmissions from aircraft in flight, the audio output of the remote receivers is transmitted over vhf carrier-derived voice channels which pass frequencies in the range of 200 to 2,800 cps. For the c-w output of receivers, a much wider bandwidth must be transmitted so that the operator can receive transmissions from aircraft whose transmitters are slightly off frequency.

A monitoring-modulator control circuit is included to permit simultaneous monitoring of all signals in the output of a communications receiver with a bandwidth of 16 kc and selection of the particular signal required. Control of the beat-frequency oscillator and r-f sensitivity is secured with small reversible motors attached to the receivers. Angular position of the remote shaft is indicated to the operator.



Demonstrating Lenkurt equipment to group of Philippine trainees for operating and maintenance duties at Manila CAA installations



Carrier equipment racks for control station of aeronautical communications network

Carrier Equipment

Point-to-point radio communication is carried over both manual radiotelegraph and frequency-shift radio printer circuits. For printer signals the control circuits provide tone channeling on carrier-derived voice channels which transmit 75 or 150-wpm impulses between stations. Radio circuits are for duplex, duplex-diplex, and simplex operation. Thirteen operating positions are devoted to point-to-point, weather, and auxiliary printer services.

Control and speech signals are transmitted over line-of-sight distances between radio transmitter and receiver stations and the control station by vhf f-m radio links operating in the 160-mc band. The channels provided by each link are indicated in Fig. 1. The usable modulation frequency range of each vhf link is 300 to 28,000 cps, with a r-f power output of 10 watts. Corner reflector antennas are used.

The control station is in its own building at the airport, with wire connections to the airport control tower. The other two stations are in their own buildings at separate remote sites chosen for optimum antenna effectiveness.

Operation of the carrier equipment associated with each radio link is essentially the same for all links. A low-pass high-pass filter divides the 300 to 28,000-cps modulation band of the radio link into two bands—300 to 3,000 and 4,000 to 28,000 cps. The lower band is used directly for transmission of voice frequencies. The upper band is for derivation of six carrier voice channels which can be used for speech, voice-frequency signaling, or voice-frequency telegraph.

Modulator-demodulators or modems, when used as modulators, combine modulating and limiting actions on the carrier voice-frequency channels. The same equipment panel can be used as a demodulator. This equipment, when combined with a suitable oscillator, modulates a 0 to 3,000-cps voice band to produce one of these sidebands: 5 to 8 kc—channel 2; 9 to 12 kc—channel 3; 13 to 16 kc—channel 4; 17 to 20 kc—channel 5; 21 to 24 kc—channel 6; 25 to 28 kc—channel 7. For future expansion of the system, additional sidebands as high as 45 to 48 kc can be produced.

The basic modem circuit is shown in Fig. 2. Following a low-pass filter and an attenuation pad, the voice-frequency signal is impressed on one winding of transformer T_{VF}. Oscillator voltage is applied between the midpoint of the other winding and the paralleled midpoints of two windings of transformer T_{HF}.

The carrier-frequency (oscillator) voltage exceeds the voice-frequency voltage in T_{VF} to such an extent that the carrier voltage always controls the polarity of the combined voltage across varistor *VR*. The audio voltage merely increases or decreases the instantaneous magnitude of the carrier voltage at the audio frequency. When polarity of the carrier voltage is such that T_{VF} is positive with respect to T_{HF}, current flows through *VR* and through both transformers, with the secondary of T_{VF} in series with one primary of T_{HF}. When carrier voltage reverses, current flows through the secondary of T_{VF} in series with the other primary of T_{HF}. Thus *VR* acts as a switch to reverse the T_{HF} windings at the carrier frequency. In doing this the oscillator current divides at the center tap and flows in opposite directions through the two

Traffic control tower at Manila International Airport, near control station

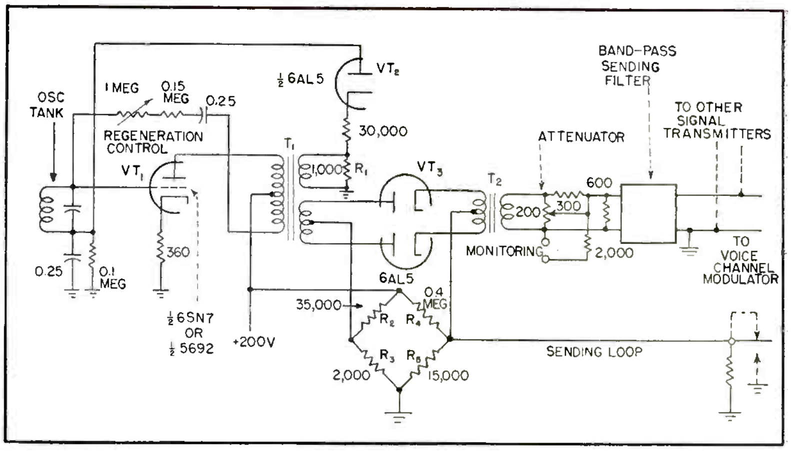


FIG. 3—Typical universal signal transmitter circuit. In use these are paired to utilize the other sections of the first two tubes

halves of each winding of T_{HF}.

The direction of balanced current flow through the transformer windings is controlled by the oscillator, while variation in the amount of unbalanced current flow is controlled by the voice-frequency signal. These unbalanced variations in T_{HF} induce sideband frequencies in the opposite winding in a manner identical to the means of deriving upper and lower sidebands from a conventional balanced modulator circuit utilizing electron tubes. These sideband frequencies are attenuated to proper level in the high-frequency pad and applied to the bandpass filter, through which only the lower sideband passes to the modulation output terminals. This modem output is parallel-connected to other modems and to the high-pass side of a line filter.

In service as a demodulator, the action described above is reversed, with the result that voice frequencies are produced from a carrier-frequency sideband.

Signaling Equipment

All signal pulsing up to 30 cps, except telegraphy, is handled from the sending end by a universal signal transmitter that can provide signaling pulses on either an on-off or differential-level basis under control of an external pulse circuit. One type of transmitter has nine units for 18 signal circuits spaced 120 cps between 420 and 2,460 cps, capable of 14 pps. Another transmitter has four units for eight circuits at 240-cps spacing from 780 to 2,460 cps, at 28 pps.

A typical signal transmitter circuit is shown in Fig. 3. One section of dual triode VT_1 functions in a stabilized oscillator circuit at the signal frequency. Adjustable regeneration is fed back to the grid from one half of the primary of the oscillator output transformer T_1 to provide for oscillator level variation.

Diode VT_2 contributes a rectified negative voltage from the oscillator output as a portion of the oscillator grid bias, thus opposing any change in oscillator output. Another output-stability measure is resistor R_1, which loads the oscillator enough to dissipate several times the power of the used signal. Thus the change in oscillator loading produced by keying represents only a fraction of the total load.

The portion of oscillator output used for signaling is fed in a balanced circuit to the plates of dual-diode VT_3. Conduction through VT_3 depends on its cathode bias, which is under control of the local sending loop. Plate and cathode d-c voltages are obtained from voltage-divider networks formed by R_2 and R_3 for the plates and R_4 and R_5 for the cathodes. These are proportioned so VT_3 is normally nonconducting. Shorting R_5 to ground through the sending loop makes VT_3 continuously conducting. Grounding R_5 through various amounts of resistance in the sending loop makes VT_3 conductive for various intermediate portions of each cycle. The effect is to make the output vary in level. When VT_3 is conducting, signal from the oscillator passes

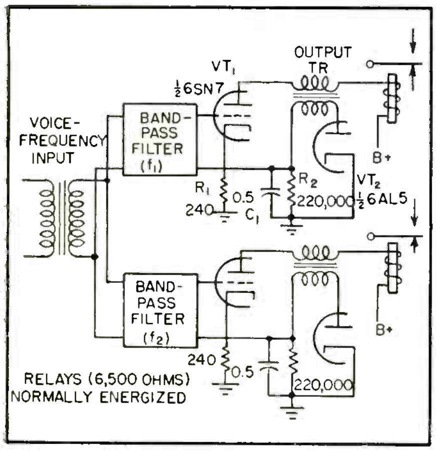


FIG. 4—Double receiver used for on-off control over a radio link

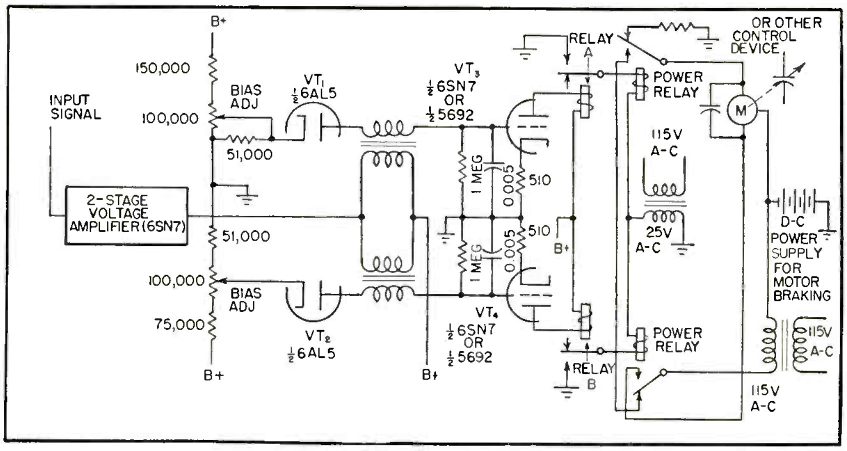


FIG. 5—Differential signal receiver circuit used to control reversible motor over radio link between airport station and remote station

through transformer T_2, a variable attenuator and a bandpass sending filter to the line. Thus, depending upon the kind of sending-loop equipment used, the diode can be keyed from off to full on or to various sending levels at very high speeds.

Receivers

Various types of receivers are associated with the universal transmitter described, depending on the service requirement. For the on-off control of heavy-current circuits such as primary power, a double receiver like that in Fig. 4 is used. This is capable of operating two circuits at a rate not to exceed 1 pps. Up to 18 such circuits can be operated on a single voice channel between 420 and 2,460 cps. Input from the voice-frequency circuit goes to the primary of an input transformer whose secondary feeds two bandpass filters, each of which selects one frequency. One of the two frequencies, say f_1, goes to the grid of triode section VT_1. The plate of this section is in series with the related output transformer and relay coil. Cathode-bias resistor R_1 is such as to permit enough d-c to flow in the plate circuit to operate the relay with no signal.

When a signal of proper frequency is received, it is amplified in VT_1 and appears across the secondary of the output transformer. It is then rectified by one section of VT_2 and applied through network R_2C_1 and the bandpass filter as a negative bias on the grid of VT_1. This reduces the d-c plate current of VT_1 and allows the relay to release. Both front and back contacts are provided on this relay so it can be connected either normally-open or normally-closed.

For dial control and manual telegraph keying, another type of receiver is used. These units handle pulsing at rates up to 28 pps, depending upon the filters used. The input transformer and bandpass filters are arranged as in Fig. 4 but each filter is followed by a two-stage resistance-coupled limiter amplifier using a 6SL7. When an incoming signal is strong enough to drive the grid of the first stage positive, grid-circuit clipping takes place to produce limiting. Amplifier output is rectified by one diode section of a 6AL5, which impresses a negative bias on the grid of a triode output section (half of a 6SN7). This section, a d-c amplifier, receives its plate voltage through the relay coil. Without signal, plate current is high enough to energize the relay. Negative bias created by a received signal drives the output triode to plate-current cutoff and releases the relay, which thus follows the signal.

Motor Control

Primarily designed for operation of a reversible motor over a radio control circuit, the differential signal receiver of Fig. 5 is actuated by three discrete signal amplitudes: nominal level, —10 db from nominal, and no signal. Up to 18 of these motor-control circuits are obtainable between 420 and 2,460 cps at 120-cps spacing.

The received signal is amplified and fed to separate diode rectifiers VT_1 and VT_2 in Fig. 5. The outputs of the rectifiers drive d-c triode amplifiers VT_3 and VT_4, which respectively control relays *A* and *B*. A received signal of proper frequency and above a median level, which is adjustable for relays *A* and *B*, releases the relays.

When no signal is being received, grid bias on triode sections VT_3 and VT_4 is such that plate current flows, operating both relays as shown. With signal high enough to override the bias of either diode, rectification takes place, developing negative grid bias on the corresponding triode section and either reducing or cutting off plate current, depending on the value of the developed bias. Plate current below the range of 2.5 to 4 ma releases the relays. Differential bias adjustment on the two rectifiers causes the two relays to operate at different signal levels.

With power relays and a reversible motor connected as in Fig. 5, either forward, reverse or stationary operation is obtained respectively from nominal, 10 db below nominal, or absence of tone. Serious fading or failure of the radio link will not cause rotation of actuated controls.

Identically geared, reversible a-c motors are used for both indicating and controlling purposes. A special arrangement places d-c on the windings when a-c is removed. This brakes the motor rapidly to a standstill and is necessary to keep the lightly loaded indicator motor in step with the heavily loaded controlled motor.

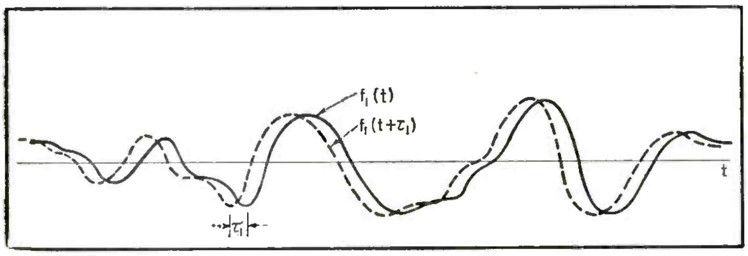


FIG. 1—Time functions used for determining the autocorrelation function of a stationary random process

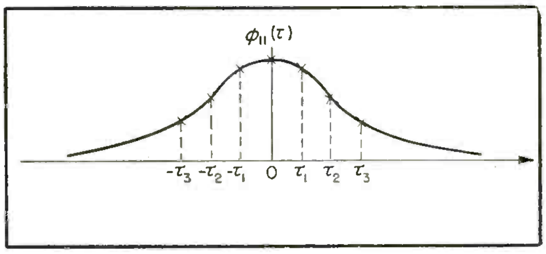


FIG. 2—Autocorrelation function of random time function that can represent a voltage or current

Correlation Functions and Communication Applications

A RECENT ADVANCE in communication engineering which has attracted considerable attention is the development of a new communication theory based on the statistical concept of information. Norbert Wiener, in his work entitled "The Extrapolation Interpolation and Smoothing of Stationary Time Series" which first appeared as an NDRC Report in 1942, disclosed his statistical prediction and filtering theory which has served as a starting point for much of the recent work by other investigators.

On the more general problem of control and communication, not only in the machine but the animal as well, Wiener has expounded the theory in his book "Cybernetics." Here the theory of information received a rigorous treatment. Independently, but at about the same time, C. E. Shannon in his papers appearing in the *Bell System Technical Journal* arrived at essentially the same conclusions concerning the theory of information.

It is not the purpose of this article to delve into information theory or prediction theory or any other portion of the new communication theory. We are primarily interested in bringing to the attention of the reader certain functions and techniques, arising from the new development, which have proved to be of considerable importance and effectiveness in the solution of a number of problems. Interesting applications of these techniques have been and are being made. These functions enter in one way or another, with varying degree of importance, in the various problems that are subject to the new statistical approach. The functions concerned are known as correlation functions.

Messages and Noise

Correlation functions are related in a quite natural way to time functions (or time series), which carry information. Instead of plunging into a quantitative and precise definition of an information-carrying function, let us consider qualitatively some of the features of this type of function. For our present purpose this will suffice.

If a time function carries information, and the flow of information is uninterrupted, it is essential that the function be of such a nature that its variations from instant to instant are at least incompletely predictable as far as the receiver is concerned. For if complete specification of the function by the receiver is possible, it is no longer a message in the true sense of the word and should not be sent over the transmission system in its entirety. For the identification of this particular message only a code number need be transmitted instead of all of its details.

Clearly a message should not be represented by a sinusoidal wave whose past and future are completely determined once its amplitude, phase and frequency are known. When information concerning these quantities is given to the receiver, continuation of the transmission of the sinusoid brings no further information.

A message need not be confined to those derived from spoken or written words. It may be any continual fluctuation, which does not follow a simple law of variation due to the complexity of the actuating mechanism, of a part of a system or the property of such a part carrying information needed for the control of other components in the functioning of the system. Thus the path of an airplane in a fire-control system, temperature

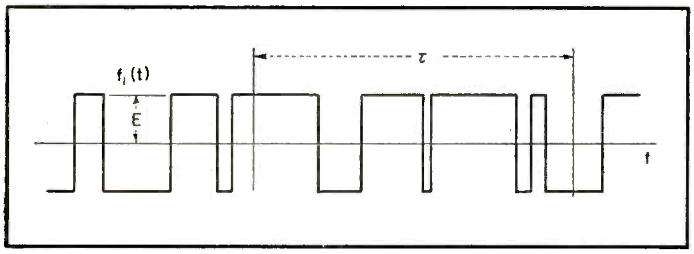


FIG. 3—Time function having random zero crossings following the Poisson distribution law

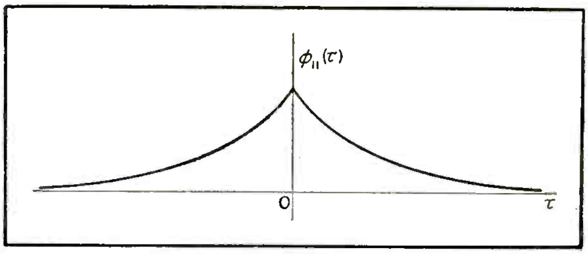


FIG. 4—Autocorrelation graph for random-width pulses of Fig. 3

How messages and other continuous information-carrying functions can be described in terms of statistics and probability. Required measurements are easily made with an electronic correlator. Engineering applications described include detector providing 30-db gain for signal that is 15 db below noise level

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changes in an industrial process, impulses in the nervous system and wind gusts on an airplane with automatic control are examples of messages.

When fluctuations cause a disturbance in a system over which a message is being transmitted they are known as noise. Broadly speaking, a noise need not be classified as such because of its sound, for if two messages are sent through a common channel the undesired message at one receiver is a noise to be eliminated while the reverse is true at the other receiver.

In the analysis of messages and noise or in the design of systems for their transmission or elimination, it is reasonable that we consider an ensemble of messages and an ensemble of noise. Generally we are not interested in the properties of a single message and we do not design a system for the transmission of a particular message. Furthermore, certain idealizations have to be made in regard to the fluctuating phenomena that we deal with for the simplification of the analytical work.

One assumption we make is that the time functions are physically of considerable duration so that theoretically they extend from the infinite past to the infinite future. Another assumption is that the statistical properties of these functions are invariant under a shift in the time origin. In other words, they are stationary in time. These assumptions are easily justified for a large number of practical situations.

Messages and noise are regarded as stationary random processes and are described and characterized in terms of statistics and probability. A stationary random process is defined in terms of probability distribution functions. For the general case, the definition requires a complete set of joint probability distribution functions together with the simple amplitude distribution. Most of these distribution functions are difficult to determine both theoretically and experimentally. However, this difficulty has not substantially hindered our progress in the application of the new theory. One reason is that in most of the applications we are able to make at present, not all of the distribution functions are necessary. The more important reason is that in these applications direct measurements of distribution functions are unnecessary. Other characteristics which are dependent upon the distribution functions are actually preferable and readily measured experimentally. We refer, of course, to the correlation functions.

Autocorrelation

For a large number of physical applications, the most useful characteristic of a stationary random process is its autocorrelation function. One method of expressing this function involves the use of only the first joint distribution function of the process just referred to. Another method of defining this function which avoids the use of the joint distribution function calls for the consideration of a member function of an ensemble, which represents the random process, instead of the entire ensemble. Thus, if $f_1(t)$ represents the member function in question, the autocorrelation function is defined as

$$\varphi_{11}(\tau) = \lim_{T\to\infty} \frac{1}{2T}\int_{-T}^{T} f_1(t)\, f_1(t+\tau)\, dt \quad (1)$$

In a general sense the correlation function shows the degree of dependence of one value in a time

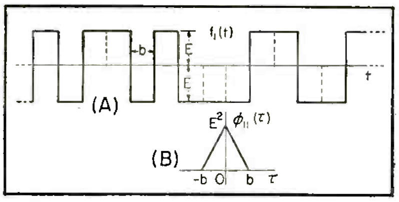

FIG. 5—Random distribution of equal-length positive and negative pulses, corresponding to tossing a coin heads or tails, and triangular autocorrelation function obtained

series to another at a different time. As indicated by the equation, to obtain a point on the autocorrelation curve for a value of $\tau = \tau_1$, $f_1(t)$ which represents a message or a noise as the case may be is given a displacement τ_1 for all values of t, obtaining $f_1(t + \tau_1)$. Then the product $f_1(t) f_1(t + \tau_1)$ is formed for all t. The integral of the product is then taken over the entire duration of the function, which theoretically is infinity. However, practically, a sufficiently long duration is considered and the resulting integral is divided by the duration for the mean value which is represented by $\phi_{11}(\tau_1)$. The steps of operation are indicated in Fig. 1.

From geometric considerations, it is clear that the same value is obtained if the shifting of $f_1(t)$ is now done in the other direction. In other words $\phi_{11}(\tau_1) = \phi_{11}(-\tau_1)$. A continuation of the process determines the whole curve which is even in the variable τ.

A sample autocorrelation curve in this elementary graphical determination is shown in Fig. 2. We observe that the value of $\phi_{11}(\tau)$ at $\tau = 0$ is obtained from the mean of the square of the given function and should be a value which cannot be exceeded by any other value of the curve. If the function represents a voltage or a current and a load of one ohm is assumed, the point $\phi_{11}(0)$ gives the mean power of the function.

The expression in Eq. 1 for the autocorrelation function of a member function of a random process is known as a time average for $\phi_{11}(\tau)$. The expression of the autocorrelation function in terms of the first joint distribution, called the ensemble average, is not given here because it is not essential for our purpose in the present discussion. It is sufficient to point out that the two expressions are equivalent for stationary random processes, according to an important theorem in random processes known as the Ergodic Theorem. In effect the theorem states that the autocorrelation function obtained from a member function—of sufficiently long duration—of a random process is the same as that obtained from the process as a whole. In short, a time average is equivalent to an ensemble average for a stationary random process.

Crosscorrelation

In a manner similar to the definition of Eq. 1, the crosscorrelation between two functions $f_1(t)$ and $f_2(t)$ is defined as

$$\varphi_{12}(\tau) = \lim_{T \to \infty} \frac{1}{2T} \int_{-T}^{T} f_1(t)\, f_2(t + \tau)\, dt \quad (2)$$

When the functions $f_1(t)$ and $f_2(t)$ originate from different sources, as for example speech and resistor noise, we expect their crosscorrelation (obtained on the basis of a long duration $2T$) to be the same for every value of the displacement τ. The crosscorrelation value becomes zero for this case if the mean of either $f_1(t)$ or $f_2(t)$ is zero.

When the crosscorrelation function for two functions is a constant or zero, the functions are said to be incoherent. This case is common, but there are situations in which $f_1(t)$ and $f_2(t)$ are dependent though not identical so that their crosscorrelation is a good measure of their coherence.

Periodic Functions

A point of considerable importance is that the definitions in Eq. 1 and 2 for the autocorrelation and crosscorrelation of stationary random processes may also be applied to periodic functions. Frequently a random process has a hidden periodic component and it becomes important in many practical problems to separate the periodic and random components. The fact that correlation functions are applicable to both types of functions and their operations on them produce results of markedly different characteristics, renders these functions particularly important in problems of this type.

For a periodic function, we need not consider the ensemble average, and the duration over which the function is considered need be only one complete cycle of the function. Hence Eq. 1 for a periodic function $f_1(t)$ reads

$$\varphi_{11}(\tau) = \frac{1}{T_1} \int_0^{T_1} f_1(t)\, f_1(t + \tau)\, dt \quad (3)$$

and Eq. 2 for periodic functions $f_1(t)$ and $f_2(t)$ of the same fundamental frequency reads

$$\varphi_{12}(\tau) = \frac{1}{T_1} \int_0^{T_1} f_1(t)\, f_2(t + \tau)\, dt \quad (4)$$

in which T_1 is the complete period of $f_1(t)$ and $f_2(t)$.

Let us put

$$f_1(t) = A_1 \cos(\omega_1 t + \theta_1) \quad (5)$$

and evaluate its autocorrelation function. By application of Eq. 3 the autocorrelation function is

$$\varphi_{11}(\tau) = \frac{A_1^2}{2} \cos \omega_1 \tau \quad (6)$$

For the general case of an arbitrary periodic function

$$f_1(t) = \frac{a_0}{2} + \sum_{n=1}^{\infty} a_n \cos(n\omega_1 t + \theta_n) \quad (7)$$

the autocorrelation function becomes

$$\varphi_{11}(\tau) = \frac{a_0^2}{4} + \frac{1}{2} \sum_{n=1}^{\infty} a_n^2 \cos n\omega_1 \tau \quad (8)$$

From these results we obtain the following general properties of the autocorrelation function of a periodic function:

(1) The autocorrelation function is periodic with the period of the given function.

(2) The autocorrelation function is a cosine series dropping all

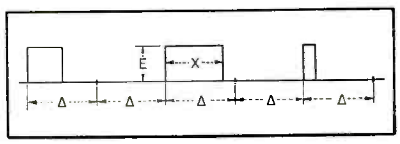

FIG. 6—Duration-modulated pulses, characterized by equally-spaced leading edges

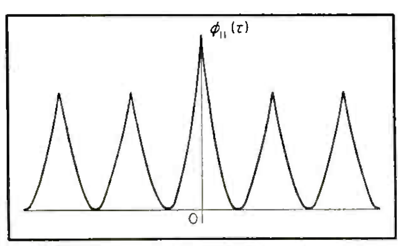

FIG. 7—Autocorrelation function for duration-modulated pulses

phase angles in the harmonics of the original function.

(3) The amplitudes of the harmonics in the autocorrelation function are obtained from the corresponding harmonic amplitude by squaring and multiplying by the factor ½.

Random Processes

The actual computation for the autocorrelation function of a random process involves more background material than we have presented here. We shall not attempt any detailed exposition of the process of computation but simply state the results which are known for some idealized cases. The case of the flat-top wave of alternating positive and negative pulses of varying duration as shown in Fig. 3 is interesting. The assumption made in this problem is that the distribution of the zero-crossings follows the Poisson Law which states that if the average number of zero-crossings per second is k, the probability $P(n,\tau)$ that there are n zero-crossings in any duration τ of the wave is given by the formula

$$P(n,\tau) = \frac{(k\tau)^n}{n!} e^{-k\tau} \qquad (9)$$

On this basis the autocorrelation function may be shown to have the simple form

$$\varphi_{11}(\tau) = E^2 e^{-2k|\tau|} \qquad (10)$$

A graph of this function appears in Fig. 4.

A series of rectangular pulses of the same size appearing consecutively each with equal probability of being positive or negative, as the sketch in Fig. 5A illustrates, may be experimentally formed by the tossing of a coin whose heads indicates a positive pulse and tails a negative one. The autocorrelation function for such a series may be obtained from consideration of probability and has the form of a triangle as Fig. 5B shows. Autocorrelation functions have been found analytically for a number of cases having varying degrees of complexity. Some of these results have been useful in practical application, particularly in problems on noise and interference.

A random process where a hidden periodic component exists is found in the transmission of messages by pulse-duration modulation and similar types of pulse-modulation. For the typical pulse-duration modulation signal shown in Fig. 6 the leading edges of the pulses are spaced an interval of 2Δ. For reason of simplicity in computation, let us assume that the pulse duration varies independently between the limits of zero and Δ with a uniform distribution. With this simplifying condition, we may show that the autocorrelation function is of the form shown in Fig. 7. Separating this function into its periodic and nonperiodic components, we find that they appear as in Fig. 8A and 8B.

Since a periodic function produces a periodic autocorrelation function, we consider that the periodic autocorrelation function of Fig. 8A results from the hidden periodic component in the original pulse-duration modulation wave. The remainder in Fig. 8B, which is nonperiodic, is the result of the random component in the wave. This remarkable property of autocorrelation finds several interesting applications concerning which we shall have a further discussion.

Wiener's Theorem

A theorem of great importance both theoretically and physically relates the autocorrelation function to the power density spectrum of the random process. This theorem has been given a rigorous treatment by N. Wiener and generally bears his name. It states that if $\Phi_{11}(\omega)$ represents the power density spectrum of a random process whose autocorrelation function is $\varphi_{11}(\tau)$ then the following reciprocal relations must hold:

$$\varphi_{11}(\tau) = \int_{-\infty}^{\infty} \Phi_{11}(\omega) \cos \omega\tau \, d\omega \qquad (11)$$

$$\Phi_{11}(\omega) = \frac{1}{2\pi}\int_{-\infty}^{\infty} \varphi_{11}(\tau) \cos \omega\tau \, d\tau \qquad (12)$$

In other words, the autocorrelation function and power density spectrum of a stationary random process are determinable one from the other by a Fourier cosine transformation. Let us illustrate one application of this theorem by an example.

Referring to the flat-top wave of Fig. 3, which we regard as representing a voltage fluctuation with a load of one ohm, we wish to know the spectrum of the fluctuating voltage. If only Fourier series and Fourier integral theories for periodic functions and transients are at our disposal, we are not sufficiently equipped to solve a problem of this sort. The reason is simply that these theories, as they stand, are not applicable to functions which are specified in terms of statistics and probability and are not representable by specific analytic expressions giving their precise values for all values of the independent variable. However, the extension of the Fourier

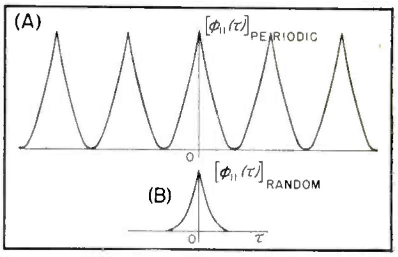

FIG. 8—Periodic and random components of autocorrelation function for duration-modulated pulses

theories to the harmonic analysis of random processes through the medium of correlation functions has enabled us to obtain a solution to our problem with surprising ease. Thus, applying Wiener's theorem we find that the power density spectrum in watts per radian per second of the fluctuating voltage is, as Eq. 12 states,

$$\Phi_{11}(\omega) = \frac{1}{2\pi}\int_{-\infty}^{\infty} E^2 e^{-2k|\tau|} \cos \omega\tau \, d\tau$$

$$= \frac{E^2}{\pi} \frac{2k}{4k^2 + \omega^2} \qquad (13)$$

In this calculation we have made use of the autocorrelation function in Eq. 10.

Measurement of Correlation Functions

Due to the fact that every point of a correlation curve should represent the result of a large number of observations made on the random function so as to ensure its close approximation to the true value, the calculation of the correlation curve from experimental data by the method briefly described in conjunction with Fig. 1 and 2 is often slow and tedious. Various mechanical and electrical devices are being developed in a number of research laboratories for the rapid and accurate determination of correlation curves. One method applying electronic techniques has been in use in the Research Laboratory of Electronics, MIT. The method avoids the difficulties of continuous multiplication required in the defining Eq. 1 for the autocorrelation function by an application of the theory of sampling. In this electronic correlator, the random function as it is fed into the device is sampled at regular intervals as indicated in Fig. 9 so that the values $a_1, a_2, a_3, \ldots$ are obtained.

While this sampling is in progress a second set of values $b_1, b_2, b_3, \ldots$ are taken, each trailing a corresponding value of the first set by a time τ_1. The order of taking the samples is as indicated in the figure so that they appear in the order $a_1, b_1; a_2, b_2; a_3, b_3; \ldots$ From these pairs of values a series of pulses is formed in such a manner that their heights are proportional to the values $a_1, a_2, a_3, \ldots$ and their durations to the values $b_1, b_2, b_3, \ldots$ as shown. An integrating circuit gives a voltage corresponding to the sum of the products of the pairs of sampled values of the random function.

It may be shown that the autocorrelation function at the point τ_1 is given by the approximate formula

$$\varphi_{11}(\tau_1) \cong \frac{K}{N} \sum_{n=1}^{N} a_n b_n \Big|_{\tau_1} \qquad (14)$$

where K is a factor of proportionality. Repetition of this process

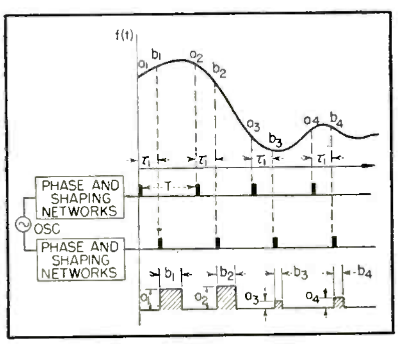

FIG. 9—Method of sampling a random function at regular intervals with an electronic correlator

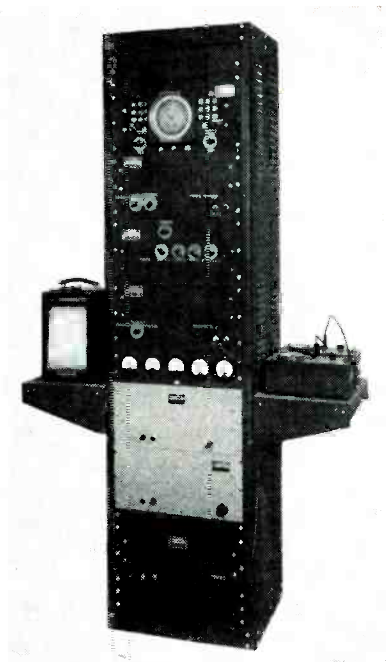

FIG. 10—Electronic correlator built at MIT for obtaining complete autocorrelation curve of a random function automatically on recorder at left

for other values of τ determines the autocorrelation curve. The operations required for obtaining the complete curve are automatic. The correlator is shown in Fig. 10. A sample autocorrelation function for filtered noise is given in Fig. 11.

Power Spectrums

In connection with the Wiener theorem for autocorrelation functions, we have already shown the effectiveness of spectrum calculation through the medium of correlation. It is generally true that the spectrum of a stationary random process is most readily found by this method if the problem is simple enough for solution. As further examples of spectrum calculation let us point out that the power density spectrum of the random series shown in Fig. 5 is simply the cosine transform of the autocorrelation curve in Fig. 6. Similarly the cosine transform of the nonperiodic autocorrelation curve in Fig. 8B is the power density spectrum of the random component in the pulse-duration modulation wave of Fig. 6.

The spectrums of a large variety of stationary random processes under simplifying conditions are not difficult to determine. These spectrums have been useful in noise problems. Some nonlinear cases have also been attacked with success. An example of such cases is the spectrum of noise through a rectifier.

On the experimental side, the correlation method of finding a spectrum has also proved its effectiveness. With adequate equipment, experimental determination of a complete correlation curve should be simpler and often more accurate than the determination of a complete spectrum by use of filters.

An example of the experimental evaluation of the spectrum through the correlation process is given in Fig. 12. Here the autocorrelation curve for random noise from a gas tube is obtained by the use of the electronic correlator. The cosine transformation required to produce the spectrum is performed by an electronic differential analyzer developed at MIT.

The fact that it is possible to measure correlation curves for very small and comparatively, very large values of τ without excessive demands on the size and accuracy in the equipment, means that a nearly complete spectrum curve is not difficult to obtain. On the other hand, if the spectrum is to be obtained from frequency measurements, we may encounter some difficulties at low frequencies because requirements in equipment at these frequencies are not conveniently met.

Detection

In giving an example on the autocorrelation of a random process, as illustrated in Fig. 6, 7 and 8, we have noted the interesting fact that autocorrelation is capable of separating the periodic and random components in the process. Let us further consider the case of a mixture of random noise $f_N(t)$ and a periodic function $f_S(t)$. By our assumption that the noise has no periodic component it is obviously true that $f_N(t)$ and $f_S(t)$ are incoherent. Let the mixture be written as

$$f_1(t) = f_N(t) + f_S(t) \qquad (15)$$

According to Eq. 1, the autocorrelation function of $f_1(t)$ is

$$\varphi_{11}(\tau) = \lim_{T\to\infty} \frac{1}{2T}\int_{-T}^{T} \Big[f_N(t) + f_S(t)\Big] \Big[f_N(t+\tau) + f_S(t+\tau)\Big]\, dt \qquad (16)$$

which simplifies to

$$\varphi_{11}(\tau) = \varphi_{NN}(\tau) + \varphi_{SS}(\tau) \qquad (17)$$

the crosscorrelation terms having been dropped because of incoherence between $f_N(t)$ and $f_S(t)$. Our result states that the autocorrelation function of the sum of the noise and periodic function is the sum of their individual autocorrelation functions.

In Fig. 13 we have illustrated the correlation curves for the case of $f_S(t)$ being a sinusoid. Let us consider the behavior of the curves at comparatively large values of the variable τ. Theoretically the noise autocorrelation curve approaches the square of the mean value of the noise as τ becomes large; that is, $\phi_{NN}(\tau)$ is a constant (or zero, if the mean is zero) for large τ. On the other hand, since the autocorrelation function of the sinusoid is another sinusoid, its behavior is the same irrespective of the magnitude of τ.

We see that if autocorrelation is performed on a random noise at reasonably large values of τ, so that in the absence of a periodic wave the result is a constant, the presence of a periodic wave in the noise will result in a periodic curve instead of the constant (or zero). Theoretical considerations show that a periodic wave in random noise, however small, may be detected by this method. However, errors in measurement and finite time of observation set a limit to what we can physically accomplish.

The power of this method in detection has been demonstrated in the laboratory. Reproduced in Fig. 14 is a set of curves obtained from the electronic correlator mentioned earlier for various input signal-to-noise ratios. The comparatively flat portions of the curves are obtained with only random noise at the input. As soon as the sinusoid was introduced into the noise the sinusoidal form of the output became evident. One of the curves in Fig. 14 shows that for an input signal-to-noise ratio of nearly −15 db the output signal-to-noise ratio appears to be about +15 db, so that the net gain is approximately 30 db. In a problem of detection of weak periodic signals in noise a gain of this magnitude is definitely an achievement.

The numerical values given here do not indicate practical limits, for still greater improvement in signal-to-noise ratio is possible by lengthening the time of observation and improving the accuracy of the equipment. Furthermore, when the frequency of the periodic signal is known, a local sinusoidal (or some other simple periodic form) voltage of the known frequency may be used for the purpose of crosscorrelating it with the incoming noise and signal mixture. By the application of crosscorrelation an additional substantial gain may be achieved.

In several respects this new method of detection is superior to the use of narrow-band filters. The correlator operates in the time domain to achieve a result that an extremely narrow-band filter could produce in the frequency domain. But while the correlator separates a sinusoid from random noise irrespective of its frequency as long as it is within the bandwidth for which the correlator is designed, a narrow-band filter, as its name implies, does not have this advantage. Because of this and other reasons the search for a periodic signal in random noise by the method of correlation is by far a simpler, more effective and more economical method than filtering.

Optimum Linear Systems

Correlation functions occupy an important position in the statistical prediction and filter theory of Wiener. The reason for their prominence may be readily traced to the criterion for system design in the theory. Let us illustrate by considering the problem of statistical filtering. In very general terms, the filter problem requires that the instantaneous output of the filter to be designed should be, on the average, as nearly as possible the same as the desired message when the input of the system is the corrupted message. In formulating this problem Wiener takes as a measure of error in the design the mean of the square of the difference between the actual output $f_o(t)$ and the desired output which is, in the case of filtering, the message itself $f_M(t)$ with possibly a delay α. Therefore the error expression is

$$\epsilon = \lim_{T \to \infty} \frac{1}{2T} \int_{-T}^{T} \left[f_0(t) - f_M(t - \alpha) \right]^2 dt \qquad (18)$$

The output $f_o(t)$ is expressible in terms of the system characteristic and the input to the system. The adoption of this measure of error, with the consequential criterion that the design of the best system should reduce the mean-square error to its minimum, introduces into the design problem correlation functions. This fact becomes clear when the mean-square error expression of Eq. 18 is expanded according to the square law and simplified. As a matter of fact, the specific correlation functions required as basic data in the predic-

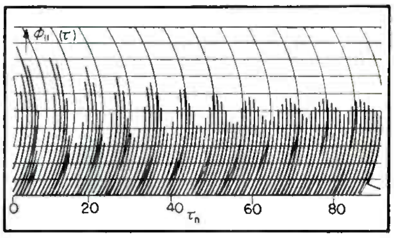

FIG. 11—Example of autocorrelation function for filtered noise, as recorded by correlator

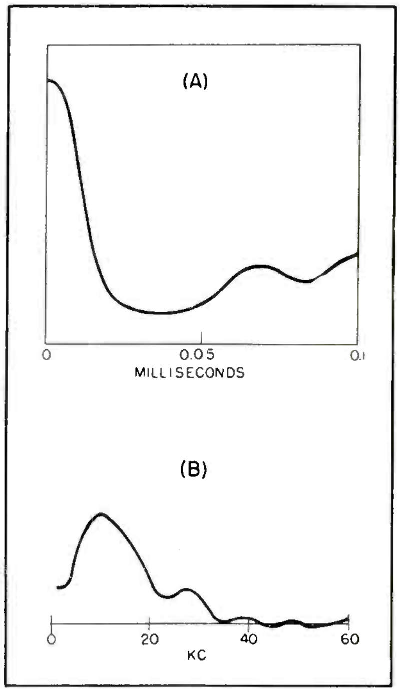

FIG. 12—Correlation function (A) for noise from a type 884 gas tube, as obtained with electronic correlator, and corresponding power spectrum obtained by making cosine transformation of function with an electronic differential analyzer

tion and filter theory are the autocorrelation function of the input and the crosscorrelation function of the input and the desired output. We shall not go into details here but should emphasize the fact that in the theory of optimum linear systems all input and output functions are completely characterized by their correlation functions, when the design criterion is the least-mean-square-error criterion.

Impulse Response

The correlator may be used to determine the impulse response of a linear system such as an electrical network or an acoustical transducer. It can be shown that if the network is excited by a white noise source; i.e. one whose spectrum is flat over a frequency range that exceeds the pass band of the device being tested, the crosscorrelation between the input and output is the impulse response of the system, for in general the crosscorrelation between input and output is given by the integral

$$\varphi_{i0}(\tau) = \int_{-\infty}^{\infty} h(t)\, \varphi_{ii}(\tau - t)\, dt \qquad (19)$$

where $h(t)$ is the system response to a unit impulse and $\phi_{ii}(\tau)$ is the autocorrelation of the input signal. If the input signal is a white noise as assumed, Eq. 19 simply becomes

$$\varphi_{i0}(\tau) = h(\tau) \qquad (20)$$

This measurement technique has considerable advantage over standard impulse amplitude measurement methods when it is necessary to work against large noise backgrounds, or in cases where it is desired to use small input signals. The system function of the circuit can be obtained by taking the Fourier transform of $\phi_{i0}(\tau)$ in the manner previously indicated.

It is easy to see physically that the crosscorrelation function should be the impulse response, for if the input signal is really a white noise it consists of a series of independent pulses, and the crosscorrelation measures the relationship between an input pulse and the effect it has on a circuit an arbitrary time τ later. The impulse response is just the response at any time τ after $\tau = 0$ to an impulse input. The crosscorrelation measures the average of a large number of such input pulses to form a value for $\phi_{i0}(\tau)$.

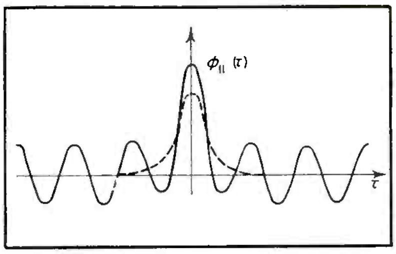

FIG. 13—Autocorrelation function of additive mixture of random noise and sine wave

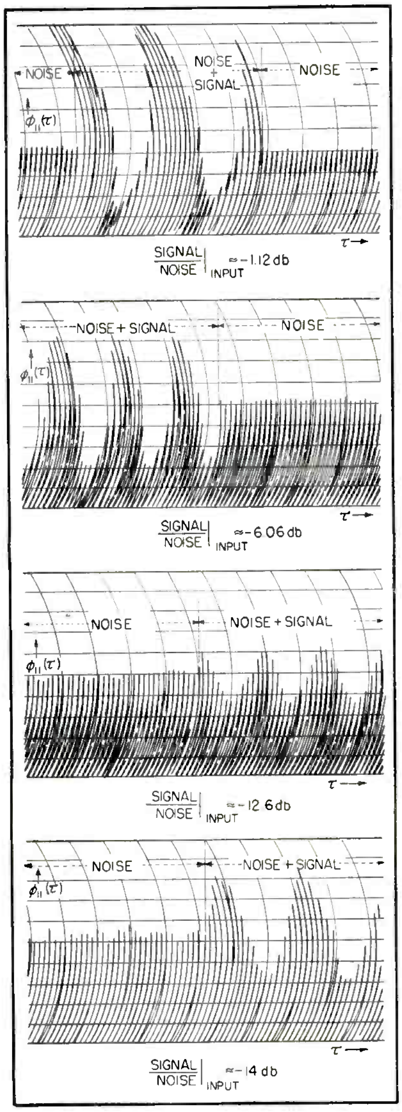

FIG. 14—Experimental results obtained by using electronic correlator to detect pure 8-kc sine-wave signal at four different levels below that of random noise. Sinusoidal output is clearly evident in each case

If one is only interested in the amplitude of the system function, it may be obtained from the output autocorrelation. If the input to the system is a white noise the autocorrelation is the Fourier transform of the amplitude function squared.

Measuring Crosstalk

In multichannel communication systems it is often desirable to make a measurement of the crosstalk induced from one channel to another. In most systems the amount of crosstalk is dependent not only upon the signals present in the two channels being investigated, but also upon signals in the other circuits of the system. An example of this is the cross-modulation in a frequency-division multiplex system in which several modulated carriers of different frequencies are mixed together and transmitted through the amplifiers of a single radio or wire circuit. Nonlinearity in the amplifier results in intermodulation and distortion products which are a function of the signals in all channels.

Normally it is difficult to load all of the circuits and still measure the effects due to a single channel. However, if each of the channels is fed by an independent noise generator so that the crosscorrelation function taken between any two noise sources is zero, then the amount of noise introduced into a given channel by means of any other channel can be obtained by measuring the crosscorrelation between the input to the offending channel and the output of the circuit being studied. The system can be calibrated by supplying known amounts of the offending channel noise into the circuit being measured. The value of the crosscorrelation obtained under these conditions provides an accurate calibration.

Numerous attempts have been made to measure the information transferred by a linear system. Such measurements have precise meaning when applied to servomechanism systems and radar systems but are often not important as applied to human communication systems, because the properties of the human transducers, eyes and ears, which are left out of the computation, are the governing factors in controlling information rate.

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Producing The 5820 Image Orthicon

Many special techniques are involved in the manufacture of the 5820, with its extremely high sensitivity and its close adherence to the spectral response of the human eye. This paper describes and illustrates the various steps in its production

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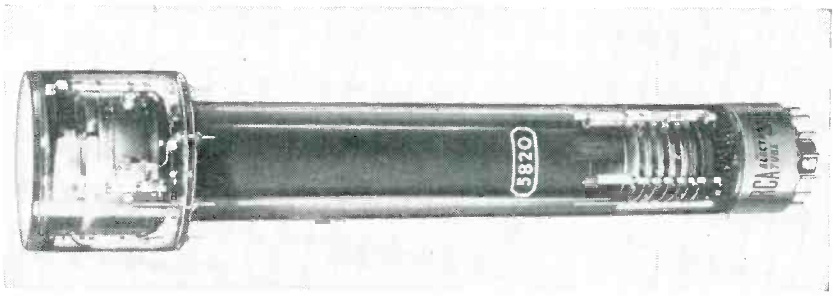
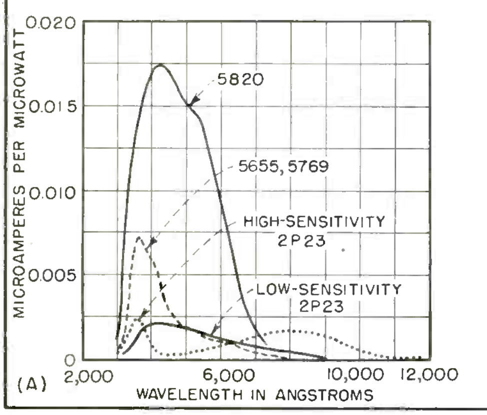
THE IMAGE ORTHICON, cornerstone of modern tv broadcasting, has undergone many improvements since its introduction in 1946. Among the important refinements are: better resolution, higher sensitivity and color response more closely matching that of the eye. These trends are illustrated by four models of the image orthicon, known as types 2P23, 5655, 5769, and 5820.

The type 2P23 was introduced in 1946 for remote pickup use.[1] Since this tube had unheard-of sensitivity, compared to the earlier iconoscopes and standard orthicons, it was widely adopted despite poor resolution and excessive infrared response. The resolution and sensitivity were increased, without change in type number, but the poor tonal rendition in the presence of infrared remained.

A year later, type 5655 was announced for studio use.[2] The stricter requirements of studio work were met by a new photosurface with less infrared pickup, and by improved signal-to-noise ratio made possible by a new target structure having higher target capacitance. The 5655 was not highly sensitive, however, and illumination of the order of 200 to 300 footcandles (incandescent) or 150-200 footcandles (fluorescent) was needed to provide adequate depth of focus. The improved color rendition was so important, however, that in 1948 type 5769, combining the features of types 2P23 and 5655, was introduced. This tube covered a wide range of illumination, in addition to good color response and better sensitivity, but greater sensitivity was needed for incandescent light. What was



Type 5820 image orthicon television camera tube



PHOTOSENSITIVITIES

TUBE TYPE	MICROAMP/LUMEN (2870°K TUNGSTEN)
5820	40
HIGH-SENSITIVITY 2P23	20
LOW-SENSITIVITY 2P23	8
5655,5769	6

(B)

FIG. 1—Comparative spectral responses and overall sensitivities of the four types of image orthicons

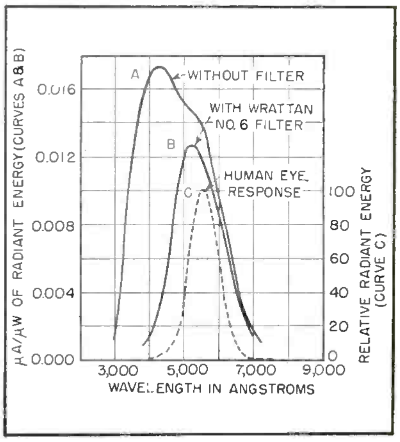


FIG. 2—Comparison of 5820 spectral response with that of human eye

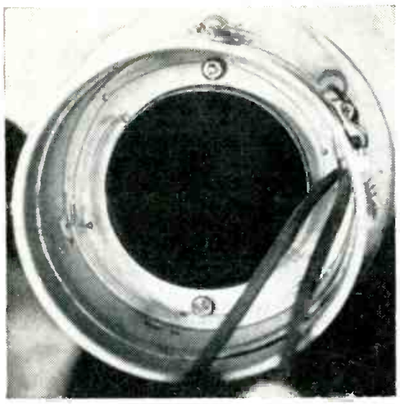


FIG. 3—Image section of the 5820. Evaporators are being welded in place

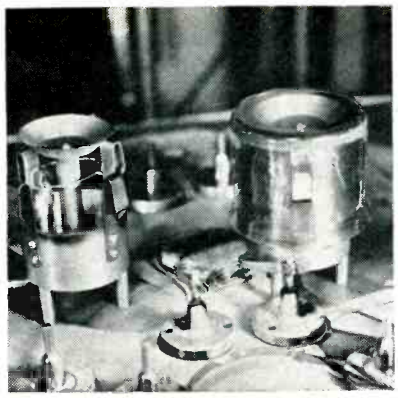


FIG. 4—Image-section glass caps are aluminized in an evaporating system

FIG. 5—The glass target section is cut from a carefully-blown glass bubble

needed was a tube with much higher sensitivity throughout the visible range, matching the eye response curve as closely as possible. This need has recently been met, in the type 5820, by the introduction of a new type photosurface, the production of which is described in this paper. The target structure of the new tube is like the older 2P23 and 5769.

Figure 1 shows the comparative spectral responses and overall sensitivities of the four types of image orthicons. The curves are plotted on an absolute basis, giving the output current in terms of a microwatt of radiant power at each wavelength shown. It will be noted that the latest tube, type 5820, not only has exceptionally high sensitivity but possesses its principal response almost entirely in the useful region, in the visible range from 4,000 to 7,000 angstroms. Figure 2 shows the close relationship between the type 5820 spectral response when fitted with a Wratten No. 6 filter and response of the eye.

Using the type 5820 a usable picture can be obtained with 1 or 2 footcandles of illumination, although 20 to 30 footcandles should be used to provide good depth of focus and to reproduce properly the dark tones in the gray scale. When used in outdoor pickups, the tube is so sensitive that neutral-gray filters may be required. On very bright sunny days a filter transmission of 5 percent is satisfactory, whereas on bright cloudy days (500 to 1,000 footcandles), the filter transmission should be about 10 percent. More detailed operating characteristics have been described in a recent publication[3].

To give a clearer picture of the problems involved in manufacturing the image orthicons, a series of photographs of some of the more complicated assemblies is shown.

Figure 3 is a photograph of the image section of the tube taken from the photocathode end. The evaporators which hold the material for forming the photocathode are being welded into position. These evaporators are the chief reason for the high sensitivity of the 5820. After the tube has been pumped and outgassed, the evaporators are heated to put a definite amount of evaporated material on the inside surface of the face plate.

During manufacture, many precautions are needed to keep the tubes free from any impurities that might affect the sensitivity of the photosurface. To avoid any contamination, evaporated aluminum is used for the metal coating necessary to connect the photosurface to a contact. Figure 4 shows the glass caps which will be sealed over the image section, set up in an evaporating system just prior to being aluminized.

Target Section

Next to the problem of making photocathodes of high sensitivity, the mesh target section of the tube is probably the most difficult fabrication problem. The target is a flat piece of glass only a little over 0.0001-inch thick sealed to a metal ring. The glass, originally in the form of tubing, must meet a number of specifications. Its coefficient of expansion must be fairly close to that of the metal ring; its electrical resistivity must be in a fairly narrow range; and its optical quality must be quite good.

The diameter and wall thickness of the tubing are selected for convenience in blowing the desired bubble from which the target section is cut, as shown in Fig. 5. This section is then placed on top of the target ring. After its thickness is checked by a hand spectroscope, the bubble and its ring are placed in a small metal box which, in turn, is placed in an oven held at an elevated temperature.

As the bubble begins to reach proper temperature, it seals itself to the ring and also tightens up so that it is flat. At this point, the box is removed from the oven and allowed to cool. The last step is to remove the excess glass from the outside of the target ring. The target, after being rechecked for thickness and freedom from defects, is ready for mounting in the mesh target assembly.

Figures 6, 7 and 8 show three of the steps in the manufacture of the 50-mesh copper screen which is mounted close to the glass target. A description of this process is given in a paper[4] by H. B. Law. The glass master, which is the heart of the process, consists of a glass plate which has been cross ruled with 500 lines per inch. After proper cleaning, the glass master is placed in a sputtering system, as shown in Fig. 6, and a thin layer of metal is sputtered over the entire ruled surface. Sputtering has the advantage over evaporation in that the tightness of the metal coating can be more easily controlled.

The next step is to remove the

FIG 6—Glass master is placed in sputtering system to form 500-mesh screen

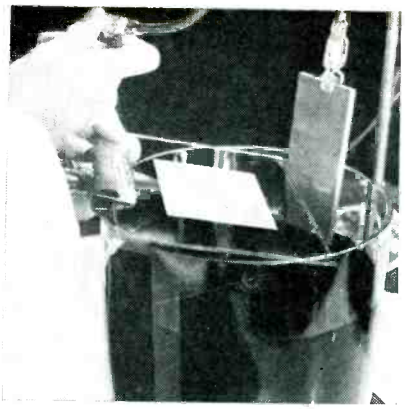


FIG. 7—Completed 500-mesh screen and master being removed from bath

FIG. 8—Copper mesh is carefully removed from master and then inspected

metal from the surface but not from the bottom of the rulings. This part of the process calls for the right type of groove shape in the master, the proper thickness and tightness of the metal coating, and a special material for the rubbing. After the surface metal is removed, the master is placed in a plating bath so that copper will be deposited in the rulings.

Figure 7 shows the master being removed from the plating bath with the mesh completely formed. Figure 8 shows the mesh being removed from the master. After drying the mesh is examined for defects.

The mesh is now ready for mounting close to the glass target. Figure 9 shows the complete mesh-target assembly ready for insertion in a tube.

Curing Smudge

The solution of one particularly troublesome problem in connection with the mesh-target assembly is of interest. In the early image orthicons an effect which received the name smudge was very troublesome. The smudge showed up mainly in high lights when the camera was picking up a flatly lighted scene. Some areas of the picture would then be lighter or darker than others. If the border between these areas was sharp, this effect could be very troublesome, especially when the camera was panned.

The cause of smudging was finally traced to a difference in contact potential between different parts of the copper mesh on the side which faced the target. This difference in contact potential led to a variation in the true potential between the target and mesh in different areas. In the 5820, smudge has been greatly reduced by evaporating a metal such as aluminum onto the target side of the mesh before the mesh and target are assembled together.

Although much of the sensitivity of the image orthicon is due to the high photosensitivity of its photocathode and to the gain at the target, the signal multiplier also is a large contributing factor, especially at low light levels. Figure 10 is a photograph of one of the multiplier wheels with its vanes being assembled into a complete multiplier. Figure 11 shows a complete multiplier gun assembly being checked for possible shorts. The manufacture of multiplier parts requires much care to make sure that the tubes produced have good multiplier gains and are free from defects.

Many groups have contributed to the success of these new tubes. In the Tube Department at Lancaster, the authors wish to acknowledge the help of L. Young, A. D. Cope and J. K. Johnson in the fabrication and processing of the tubes, A. A. Rotow for his extensive testing, and C. T. Lattimer for the photographs.

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FIG. 9—Complete mesh-target system ready for insertion in the tube structure

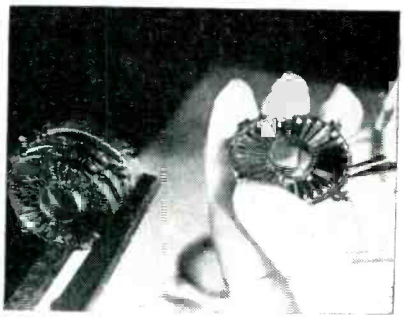

FIG. 10—A multiplier wheel being prepared for assembly in jig shown at left

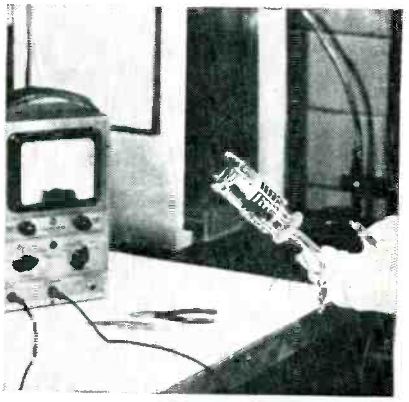

FIG. 11—Multiplier-gun assemblies are carefully examined for possible shorts

Amplifier used to provide controlled field current for dynamometer, employing twelve 807's in parallel

Dynamometer Control Simulates

Closed-servo electronic control system for laboratory automotive-engine dynamometer applies loads similar to those of auto accelerating on road. Effects of traffic hazards, wind, weather conditions and road bumps are thus eliminated when checking octane ratings of fuels or studying lubrication and wear during engine cyclic operations

By R. C. BOWERS

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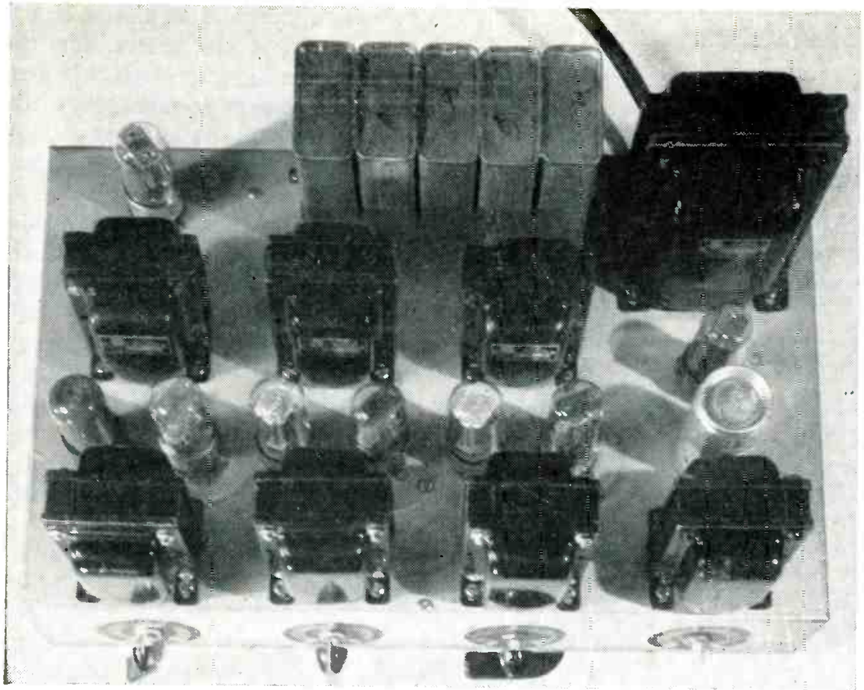
THE TENDENCY of a gasoline motor fuel to knock or detonate in a multicylinder automotive engine is affected by a number of operating variables, including engine speed, spark advance, cylinder-head temperature, fuel-air mixture ratio, distribution, mixture temperature and mixture density. In typical operation the engine is constantly changing with respect to one or more of these variables, with the result that detonation from a given fuel will vary greatly throughout the operating range. Fuels of varying hydrocarbon composition differ markedly in their tendency to knock and in the speed at which knock is most prominent.

It becomes exceedingly difficult, therefore, to define the performance of a fuel in an engine under operating conditions. In the past, motor-fuel octane ratings have been based on the motor method[1] and the research method[2], using laboratory engines operating at constant speed and fixed conditions. Recently, it has been realized that final automotive fuel ratings must be established on a multicylinder engine operating under road load conditions.

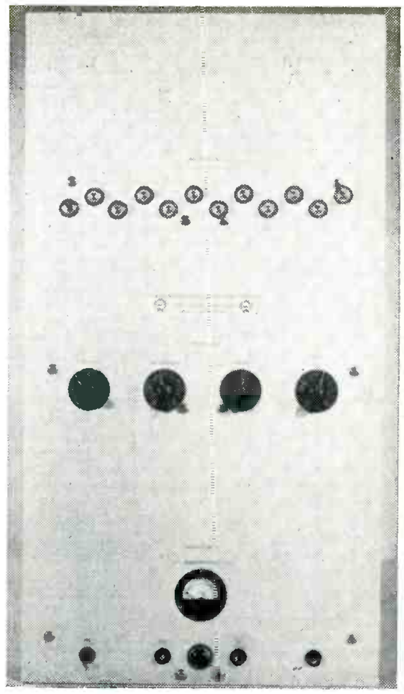
In view of this, it appeared desirable to develop a device for the laboratory automotive-engine dynamometer which could apply loads similar to the automotive engine on the road. It is believed that the accuracy and reproducibility of road-test ratings can be increased by the use of such a device in the laboratory, which eliminates the effects of traffic hazards, wind, variations in ambient air temperature, and road configuration. Although this control was developed primarily for fuel rating work, it may also be useful in fuel and lubricant deposit and wear studies, or other road-test problems where engine cyclic operation is a factor.

Test Technique

Dynamometer control devices have been built using a prearranged



Electronic control unit used between tachometer generator and dynamometer amplifier



Dynamometer acceleration control

Road-Testing of Engines

program employing a paper cam and photoelectric pickup[3], sequence relay system, or punched tapes in a pneumatic system. Essentially they are systems of controlled rheostats in the dynamometer field circuit.

The type of test used in fuel rating on the road involves high-gear acceleration at full throttle from 10 to 70 miles per hour. The acceleration curve of Fig. 1 was taken in a 1941 Chevrolet on a level highway. The torque curve is the load necessary to hold the engine at the speed shown, at full throttle.

Any laboratory device must, then, cause the engine to reproduce both these curves simultaneously, by representing to the dynamometer the inertia and resistance of any weight of car and any body type. The device could thus be used with any engine and any dynamometer to give the proper speed-versus-time (acceleration) curve, after setting the correct ratio of inertia and resistance loads. The device must, however, be capable of making successive runs rapidly and must start from any given speed.

The rise from *A* to *B* in the torque curve of Fig. 1 represents the increased load required at the instant the engine is given full throttle. This extremely high rate of application of load was the primary problem in the development of suitable equipment.

Major factors affecting acceleration are: (1) air resistance, which is a function of body design and varies as the square of the speed; (2) rolling resistance, which is a function of highway surface, tires and bearings and varies with speed and mass; (3) inertia, which is a function of mass and varies with acceleration. Summarizing, to a first approximation it can be said that the total resistance affects the ultimate speed to which an automobile can accelerate and the inertia affects the length of time to attain the ultimate speed; also, the resistance load on the engine varies with speed and the inertia load varies with acceleration.

Closed Servo System Used

The control system developed from these considerations employs a tachometer generator on the test engine crankshaft to provide a

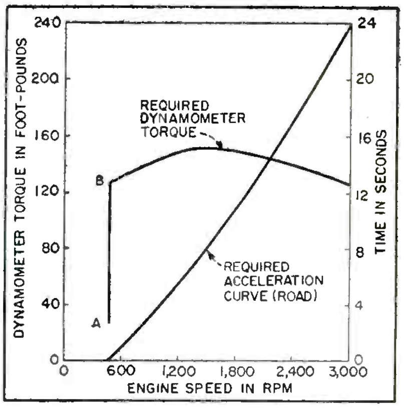


FIG. 1—Acceleration curve of 1941 Chevrolet going from 10 mph to 70 mph in high gear at full throttle on a level highway, and torque curve that electronic control system must produce to simulate this acceleration in laboratory

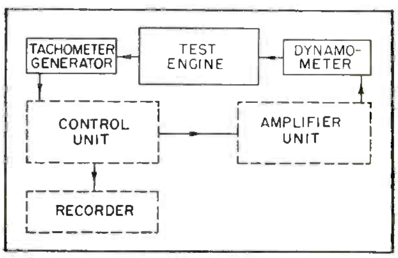


FIG. 2—Closed-servo electronic control system used with laboratory dynamometer to place controlled loads on auto engine

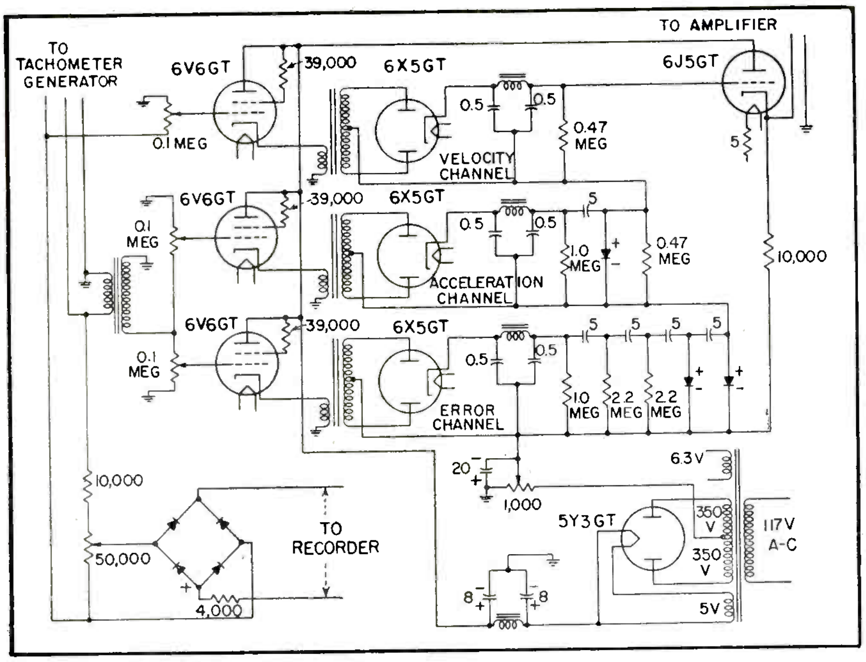


FIG. 3—Three-channel control unit. Input voltage is obtained from tachometer generator on engine, and output drives power amplifier that furnishes dynamometer field current

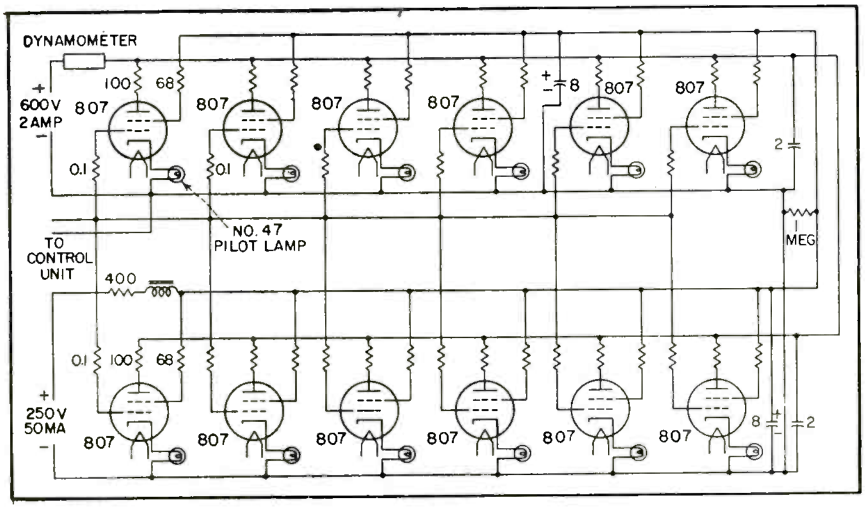


FIG. 4—Dynamometer amplifier, using 12 identical pentode tubes in parallel to provide an output current that follows the control signal despite high inductance of dynamometer field coils

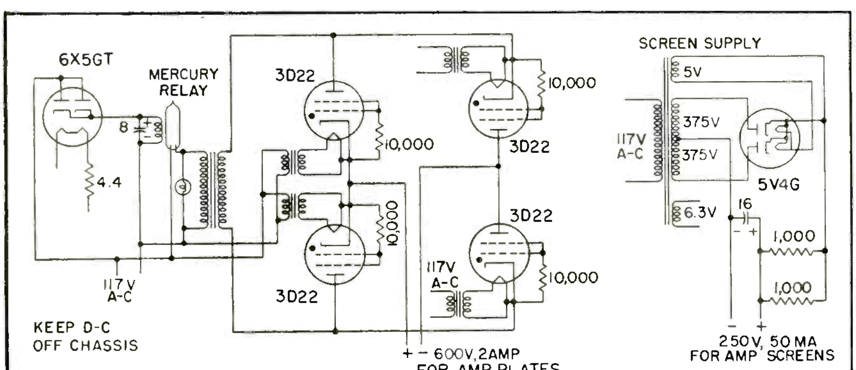


FIG. 5—Power supply circuits for amplifier and control unit. Filament heating time of 6X5GT rectifier provides time delay for application of plate voltage to gas rectifier tubes in full-wave bridge arrangement

velocity signal and an electronically obtained first derivative for the acceleration signal. With this general type of arrangement, shown in Fig. 2, it was possible to simultaneously reproduce the actual speed-vs-time and load-vs-speed curves in the laboratory. The device is essentially a closed servosystem in which a speed-sensitive generator on the test engine shaft feeds a signal to the control circuit which drives the amplifier to supply field current for the dynamometer which sets the speed of the test engine. The tachometer generator is a 3-phase, 4-pole a-c type which provides a voltage directly proportional to speed. The dynamometer is the eddy-current type in which the power is absorbed as heat from the iron structure by circulating water. Any other type of dynamometer which requires d-c field excitation, such as a resistance-loaded d-c generator, should also be applicable. In this case the d-c field excitation varies with the speed and acceleration of the test engine and is supplied by the dynamometer amplifier. The control circuit converts the a-c tachometer speed signal into a d-c control signal for the dynamometer amplifier.

Three-Channel Control Circuit

Since the load on a car at any instant is a summation of the velocity or resistance load and the acceleration or inertia load, the control similarly has a velocity and an acceleration channel. These two channels, plus a third error channel, are similar in design. Type 6V6GT tubes are used in a cathode-follower circuit as in Fig. 3 to provide a low-impedance output for type 6X5GT full-wave rectifier tubes. The rectifier is followed by a π-section filter to remove ripple. The filter section must be of extremely short time constant to prevent subjecting the signal to appreciable time delays. Small capacitors, low-resistance chokes and high-resistance loading satisfactorily limit the time delay.

The output of the velocity channel is a high-impedance direct voltage proportional to engine speed. Since acceleration is the first derivative of velocity, a voltage representing the acceleration can be obtained by differentiating the velocity voltage. The output of the derivative circuit of the acceleration channel, consisting of a capacitor and resistor in series, should then be a high-impedance direct voltage proportional to engine acceleration. The error channel provides a high-order derivative signal which actually precedes the acceleration signal, counteracting the slow response of the highly inductive dynamometer field at the start of the acceleration run, enabling the dynamometer torque to approach more closely the ideal response indicated by line *A-B* in Fig. 1.

A type 6J5GT tube operating at reduced filament voltage converts the summation of these high-impedance voltages to a low-impedance signal for the dynamometer amplifier. An additional circuit provides negative control bias to the dynamometer amplifier. The diodes load the derivative circuits to prevent their becoming negative and unloading the amplifier when the velocity slope reverses. An output is provided to operate an Esterline-Angus recording milliammeter from the tachometer generator. This instrument automatically plots the speed-vs-time diagram, helpful in adjusting the control.

Twelve 807's in Parallel

The design of the dynamometer amplifier, which converts the control signal to dynamometer field current, is complicated by the high value of inductance of the dynamometer field winding, approximately 90 henrys. To overcome the effect of this inductance the output (field) current must follow the control signal, whereas amplifier circuits generally produce an output voltage to follow the control signal. A pentode amplifier tube has the required output current characteristic. A high-power amplifier was therefore constructed using twelve type 807 tubes connected in parallel as in Fig. 4. A pilot light in series with each tube indicates failure or abnormal operation.

The power supply circuit, shown in Fig. 5, is a full-wave bridge using four type 3D22 grid-controlled rectifier tubes to deliver 600 volts at 2 amperes unfiltered. This tube was selected for its low-voltage, high-current characteristic and the control feature is not used. Filtering is unnecessary in a plate supply for pentodes operating with a well-filtered screen supply. The screen supply uses a 5V4G cathode-type rectifier to delay the application of screen voltage while rectifier and amplifier filaments are heating. A novel time-delay relay, utilizing the filament heating time of a type 6X5GT rectifier tube with a mercury relay, satisfactorily controls the plate voltage.

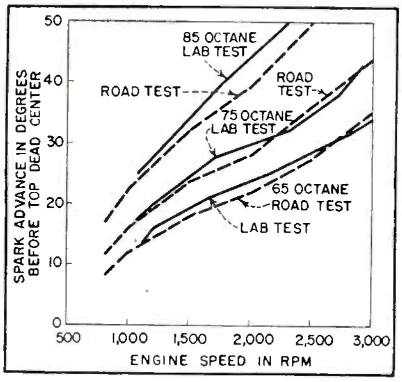


FIG. 6—Correlation of knock-rating curves obtained on road and with electronic control system in laboratory

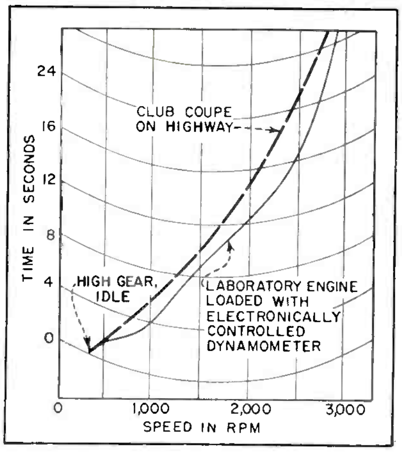


FIG. 7—Correlation of acceleration curves obtained for 1941 Chevrolet club coupe on road and with engine alone in laboratory

Operating Adjustments

In developing this device, a speed-vs-time (acceleration) curve was first obtained with an automobile on the highway operating at full throttle, the recording milliammeter being operated from a tachometer generator on the distributor shaft.

Adjustments are provided on the control unit to allow the use of any automotive engine and body style with any dynamometer. The order of these adjustments is as follows: (1) Adjust bias to proper low-speed load with velocity channel set at 50 percent, other channels at zero; (2) adjust velocity channel to limit ultimate speed of engine to proper value; (3) adjust acceleration channel to give proper time duration to acceleration curve; (4) adjust error channel to eliminate rapid acceleration at start of run. Some readjustment of all controls may be necessary. In general, the velocity loading affects the high-speed end and acceleration loading affects the low-speed end of the curve.

The device was developed to simulate knock testing using the Borderline[4] method in which the car is accelerated from 10 mph to 70 mph in high gear at full throttle and the speed at which knock die-out occurs is recorded. With this equipment it has been possible to evaluate fuels rapidly in the laboratory using standard road-test procedures. Figure 6 shows the correlation of laboratory and road-test data. Much of the deviation between curves is due to operator judgment in determining when knock dies out, hence the correlation shown can be considered excellent.

Figure 7 is an automatic plot of the acceleration curve. The laboratory curve, as shown, would represent some lighter body style than the club coupe used on the highway for comparison.

The device described has possible further applications. Since the engine with this electronic loading device will always have its correct road load, it is possible by simple variations of throttle position with time to provide any desired type of cyclic operation. Thus it is now possible to simulate stop-and-go city driving in the laboratory.

The author wishes to express appreciation for the cooperation of Shell Oil Company in supplying roadtest data, and in particular to F. B. Rolfson of this company for suggesting the power amplifier circuit.

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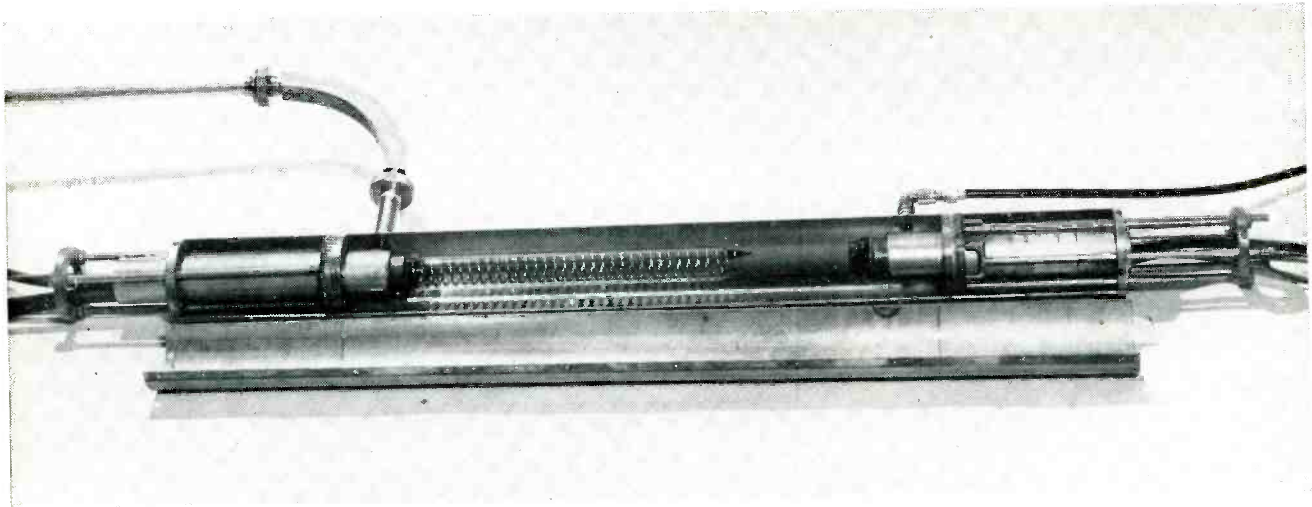
(2) ASTM Manual, "Engine Test Methods for Rating Fuels", p 21, 1948.
(3) Joseph Moller, *SAE Journal*, June 1941.
(4) "Coordinating Research Council Handbook," p 87, 1946 Edition.



Attenuator at right end of glass envelope suppresses oscillations in 1,000-watt power amplifier

1,000-WATT

By STANLEY E. WEBBER

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SEVERAL PAPERS have been published describing the t-w principle, analyzing performance on a small-signal basis and noise characteristics.

Because of the large bandwidth and high gain characteristics of the traveling-wave tube, it has been considered desirable to investigate its potentialities as a power amplifier in the high frequency bands.

Description

Preliminary considerations indicated that information about operation of traveling-wave tubes at a power output level of about a kilowatt and frequencies in the 450-megacycle region might be useful. As a point of departure a tube was designed for operation at a beam voltage of 4,000 to 5,000 volts and beam current of about one ampere. An efficiency of about 20 percent would be necessary for the desired power output. The computed gain was of the order of 10 db.

A one-inch spiral was formed from ⅛-inch diameter nickel tubing wound 2½ turns per inch 20 inches long. The electron beam diameter is between ⅝ and ¾ inch for a beam current of one ampere at beam voltages between 2,500 and 5,500 volts and a magnetic field of 1,000 gauss.

Details of tube construction and circuit arrangement are shown in Fig. 1. For operation at the kilowatt level it was thought necessary to provide for water cooling of the spiral. The arrangements for the water-cooled spiral are shown in Fig. 1A.

The r-f energy is coupled to the spiral from the usual coaxial line through a section of concentric line on the axis of the spiral. The spiral is simply attached directly to this center conductor at its edge. The r-f transition between a 50-ohm coaxial line and the spiral can be made with little reflection at the center frequency, with the bandwidth limited by the choke piston. The electron gun and necessary water connections for the spiral and water-cooled collector are inside of the concentric line sections.

A simplified tube and circuit arrangement can be provided when the spiral is cooled by radiation.

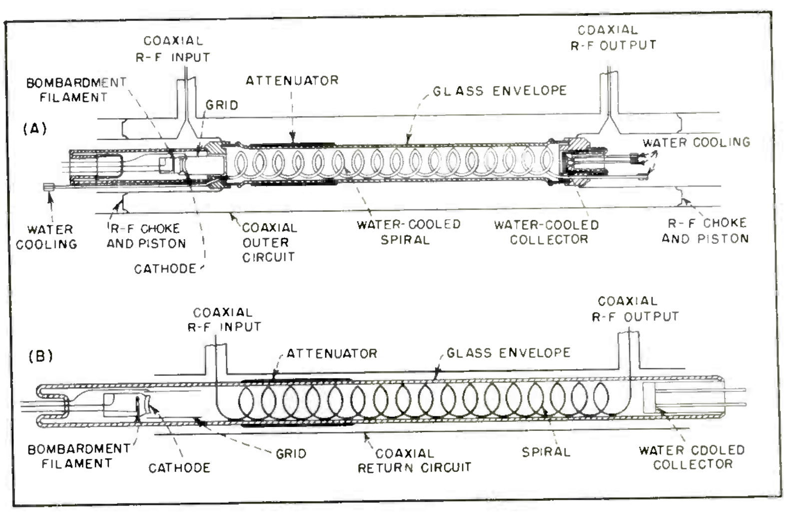
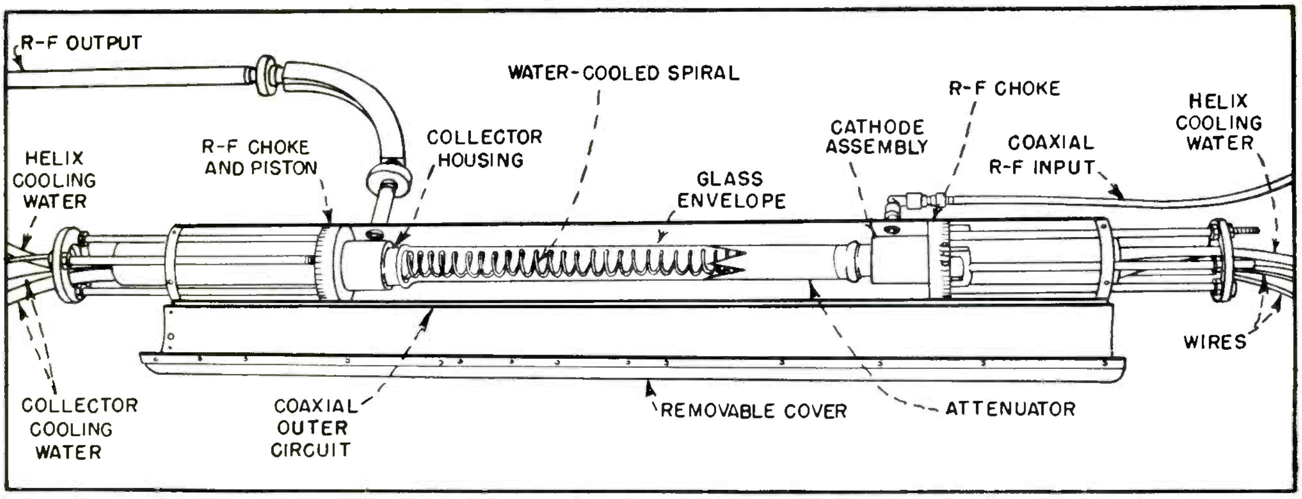


FIG. 1—Construction details of both types of traveling-wave tubes

This article is based on a paper presented by the author at the 1949 National Electronics Conference in Chicago. The conference paper will appear in the N.E.C. Proceedings.



In the 1,000-watt tube, both the spiral and collector are cooled by a continuous flow of water

Traveling-Wave Tube

Water-cooled 450-mc tube used as power amplifier produces power gain in the order of 25. Efficiency is 20 percent when tube is operated with 5,000 volts at one ampere. High performance is made possible by proper use of attenuation to suppress oscillations

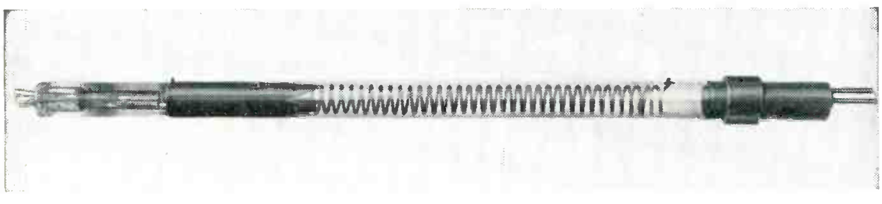
The tube and circuit shown in Fig. 1B have been operated at a power output level of 500 watts. The r-f power is coupled to the spiral by making a right-angle bend in the spiral and bringing the conductor out radially through the glass to become the center conductor of the external coaxial line. This provides a fairly satisfactory broad-band transition as shown by the standing-wave-ratio curve in Fig. 2A. Further alterations of the circuit geometry at the transition point have reduced the standing-wave ratio to a low value in the 450-megacycle region.

Attenuation

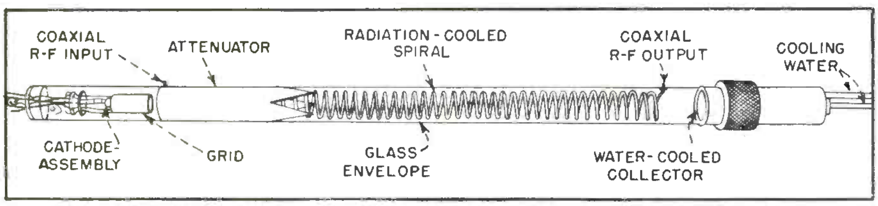
In order to suppress oscillations and stabilize the tube it is necessary to apply attenuation. This attenuates waves reflected at the output which would cause oscillations. Various means of achieving attenuation have been used. Among them are methods where the attenuators are applied uniformly along the length of the tube or concentrated in a short distance near the center of the tube. The material is usually a thin evaporated coating of metal or layer of Aquadag, applied on the inside of the glass in order to be close to the spiral.

Because of a geometry which permits a great radial penetration of the spiral fields it has been found possible to obtain sufficient attenuation by applying a conductive coating to the outside of the glass envelope. This has permitted extensive testing of the effect of the attenuation on the performance of the tube.

Figure 2B shows the variation of attenuation with d-c surface resistivity, a parameter which is proportional to thickness of material. It is observed that there is a point of maximum attenuation at about 1,500 ohms per square for Aquadag and 8 ohms per square for platinum. Also note that the peak attenuation



Radiation-cooled-spiral tube, capable of 500 watts output at 450 mc



Input and output connections are brought out radially from the spiral is less for platinum than for Aquadag.

The dependence of attenuation on frequency is shown in Fig. 2C. The attenuation is maximum in the 400-mc to 500-mc region. It has been found that most materials tested have about the same sort of frequency dependence, giving maximum attenuation in the 400-mc region. However, Aquadag has given the most attenuation per unit length.

Direct reflections from the attenuator are an important consideration in determining what sort of attenuation to use. A component of loss suddenly introduced on a uniform transmission system will introduce reflections. Also, in the case of the spiral the finite conductivity of the attenuating film tends to shift the currents and fields from the low-velocity spiral direction to the faster axial direction and thus distort the electromagnetic fields in the attenuating region. Figure 2D shows the standing-wave ratio, as measured by a probe coupled lightly to the spiral, caused by the abrupt transition between the unattenuating region and a region of uniform attenuation. Platinum with a swr around 2.5 is not satisfactory without tapering. Aquadag with a swr of about 1.2 is satisfactory for low-gain tubes. By tapering the Aquadag the standing-wave ratio has been reduced to less than 1.05.

The conducting sheet which is used for attenuation has an effect upon the velocity of the wave on the spiral. If the wave velocity in the attenuating region is materially different from that in the nonattenuating region, then the gain of the tube will be reduced, particularly if the attenuation is small.

The wave velocity in the presence of uniform attenuation has been measured. The schematic shown in Fig. 3A indicates the method used. The frequencies at which the phase of the wave through the tube was changed by 2π were determined by the null-point method. From this measurement and the geometry the velocity of the wave is computed.

The result of the measurement of velocity for Aquadag attenuation is presented in Fig. 3B. As the resistivity of the coating is decreased from a high value the wave velocity first decreases as it should simply from the introduction of some loss in the region. Then the velocity begins to increase rapidly to a value which should approach $v/c = 1$.

This increase is the result of a gradual shift from a wave which follows the spiral towards a direct coaxial mode. In the limit there would be a high velocity wave outside of the attenuator and a slow spiral wave inside. The point of minimum velocity corresponds roughly to the point of maximum attenuation. Thus at the operating point the wave velocity in the attenuating region is reduced by about 10 percent.

Operational Tests

Experimental work has shown that the most important single factor affecting performance at high power and efficiency has been the attenuator. Initially, tubes had been operated in the conventional manner using center attenuation. Figure 4A shows a typical curve of power output versus power input with saturation power occurring at about 100 watts output and efficiency of the order of eight percent. Wave velocity on the spiral with no space charge is $v/c = 0.11$, corresponding to a synchronous voltage of about 3,000 volts, while the operating voltage was between 3,700 and 4,100 volts. The variation of tube gain with beam current is illustrated in Fig. 4B. It will be noted that both low-level and high-level gains increase directly with current in the higher current regions.

In order to determine the effect on performance of the location of the attenuator, tubes were equipped with attenuators which could be moved axially while the tubes were in operation. The results of these experiments are shown in Fig. 4C. As the attenuator was moved toward the input end of the tube, with all other parameters held constant, the power output was observed to increase. The effect was more noticeable at high power input level where the tube was beginning to saturate than at low power input. The saturation power was approximately doubled when the attenuator

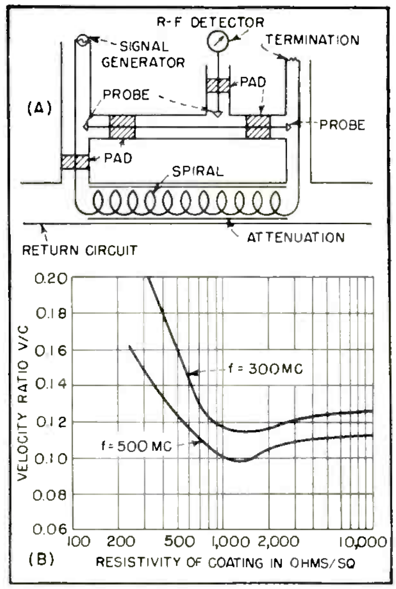


FIG. 3—Setup for determining velocity of waves on spiral is shown in (A). Curves in (B) show results obtained

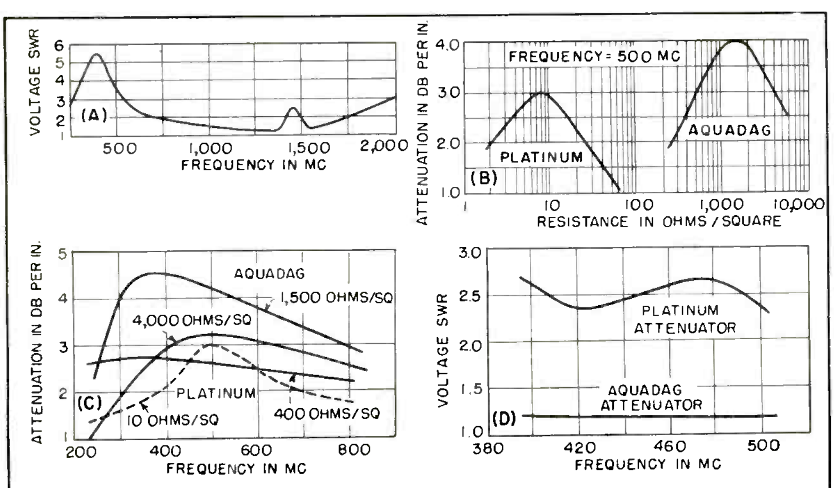


FIG. 2—The high-performance from the t-w tubes described resulted from careful study of attenuation and standing-wave characteristics shown above

was moved from the center of the tube to the input end. Tubes with a short uniform attenuator starting directly at the input end of the spiral have operated satisfactorily with high efficiency and gain.

The second variable of importance is the amount of the attenuation used to stabilize the tube. The effect of this was investigated both by varying the length of the attenuator and also the conductance. The results indicate that any reduction in the amount of the cold attenuation results in an increase in saturation power.

The results of several experiments on several different tubes is shown in Fig. 4D, where saturation power is shown as a function of cold attenuation. Below 25 decibels the tube will oscillate, but at power saturation all of the r-f energy will be found at the driving frequency. In order to determine limiting efficiencies, tubes have been operated with no external attenuation and the amount of power output is correspondingly higher as indicated by the point on the curve at about 400 watts. This represents an electronic efficiency of the order of 25 percent.

It will be noted that attenuation can be decreased by decreasing resistivity of the coating. It was found that decrease in attenuation obtained by increasing thickness resulted in decreased power output and gain. Measurements of wave velocity described above (and indicated in Fig. 3B) show that for this range of attenuation wave velocity is greater than that in the unattenuated region. The decrease in gain in tubes using attenuators with conductivities in this range of values is attributed to this fact that velocities are quite different.

Most of the previously described work has been done with the tube (illustrated in Fig. 1B) with a spiral cooled only by radiation. Current intercepted on the spiral has been of the order of one or two percent with a magnetic field of about 1,000 gauss. This tube has operated satisfactorily at these power levels. The tube with a water-cooled spiral (shown in Fig. 1A) has been used at higher power levels. The gain and efficiency of this structure are not materially different from that of the uncooled spiral at the same current levels.

Tubes with a water-cooled spiral equipped with an attenuator at the input end have been operated at beam current up to 1.2 amperes. Figure 4E presents power output at saturation versus beam current and shows that power increases slightly faster than the beam current. Since the beam voltage is increasing slightly simultaneously, the power output increases about in proportion to d-c power in the beam and the electronic efficiency is about constant. Maximum power was 1,200 watts, at which point r-f heating of the glass limited further increase in power.

Bandwidth

Investigation of the frequency characteristics of the traveling-wave tube indicates that the spiral geometry has an important effect on bandwidth. For the particular tube described herein the frequency of maximum gain is about 500 mc and bandwidth about 100 mc within plus or minus 1.5-db variation in output. It is emphasized that this is an electronic bandwidth, measuring the relative coupling between the spiral and the electron beam, and does not include any bandwidth limitations due to the input or output coupling systems. The frequency of maximum gain is not appreciably affected by attenuation or by external circuit but only by spiral geometry.

Conclusions

It has been demonstrated that the traveling-wave tube operating as a power amplifier at medium power levels can be made to have conversion efficiencies which compare favorably with that of other beam tubes.

Unlike any device which depends upon a resonant structure for interaction with the beam the gain of the traveling-wave tube can be increased without a corresponding decrease in useful bandwidth. The inherent bandwidth is more than adequate for most commercial applications where wide transmission band is required.

The work described in this paper was supported by the Bureau of Ships, U. S. Navy.

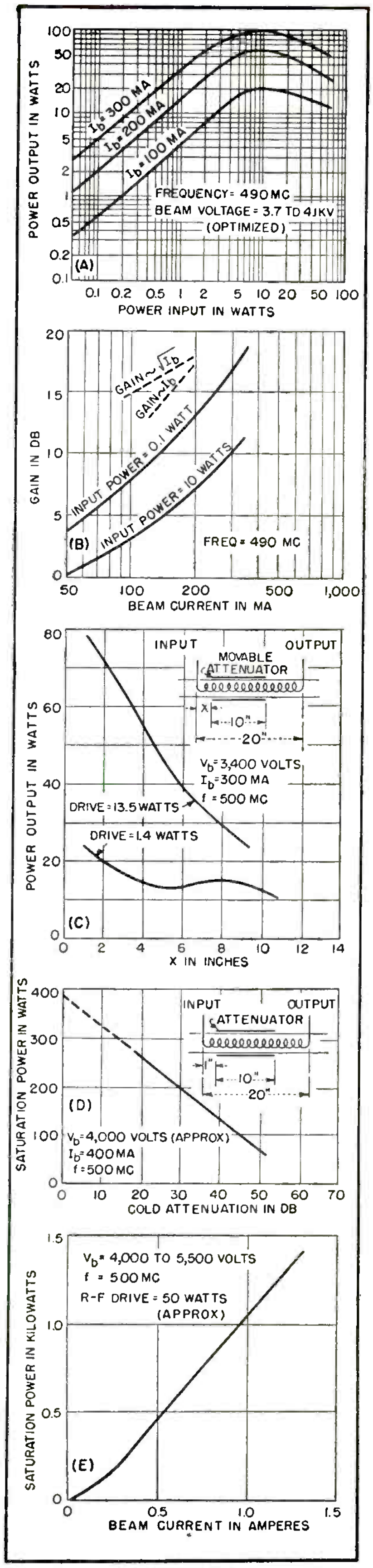


FIG. 4—Power output, gain and power saturation curves for the high-power water-cooled traveling-wave tubes under various conditions as derived by experimental methods

BIFILAR I-F COILS—

By S. R. SCHEINER

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Bifilar coils as interstage coupling devices in stagger-tuned amplifiers[1] provide a number of desirable features in addition to those of the conventional coupling system.

A bifilar coil may be defined as a transformer having as close to unity coupling as physically possible. The construction of a typical bifilar coil for use in the television i-f range from 21 to 26 mc is illustrated in Fig. 1. The coil shown is wound on a 0.292-inch O.D. Bakelite form using No. 30 wire with heavy formvar insulation.

The two windings are formed simultaneously, so that any turn on winding *A* is adjacent to two turns on winding *B*, thus insuring a high degree of coupling between coils. Measurements indicate a coefficient of coupling of approximately 90 percent. The insulation on the two windings is generally colored differently for convenience in wiring. The bifilar coil is tuned by a single iron core inside the form.

The use of bifilar coils in a typical television i-f system is illustrated in Fig. 2. This circuit represents a low-cost system employing only two i-f amplifier tubes and designed for a 3-db bandwidth of 2.2 mc and a 6-db bandwidth of approximately 2.65 mc. The three bifilar coils are labeled T_1, T_2 and T_3 in Fig. 2. The individual tuning frequencies and stage loading are based on the values determined by design formulas for an ideal stagger-tuned triple, and modified as required by practical considerations.

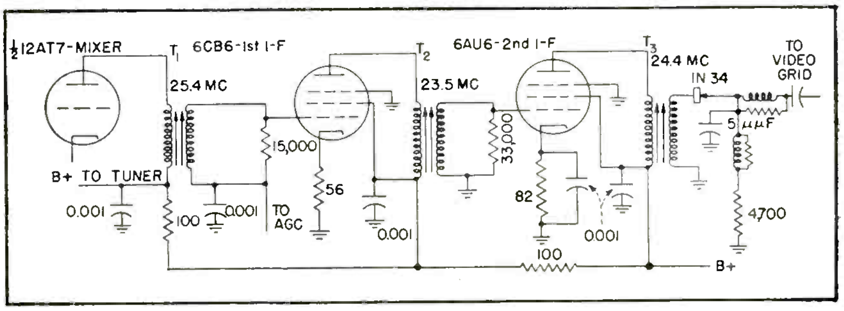

FIG. 2—Circuit of staggered two-stage i-f amplifier using bifilar coupling coils

A similar amplifier using single-tuned coils and coupling capacitors is shown in Fig. 3.

Economics

Comparison of Fig. 2 with Fig. 3 indicates that the use of a bifilar coil eliminates the necessity for a coupling capacitor in each stage. The added cost of winding the extra coil and providing the required insulation is approximately one cent. This is several cents less than the cost of an ordinary coupling capacitor, so that an appreciable cost saving is provided by the bifilar coil system.

An r-f choke is employed in Fig. 3 to feed B voltage to the last i-f tube plate, and the tuned-circuit coil is connected from video detector cathode to ground. Here, the resistance in series with the i-f plate must be low to avoid excessive drop in B voltage, and the resistance across the video detector load must be low to maintain diode detector efficiency. In this circuit, the use of a bifilar coil effects a further economy by eliminating the need for the r-f choke.

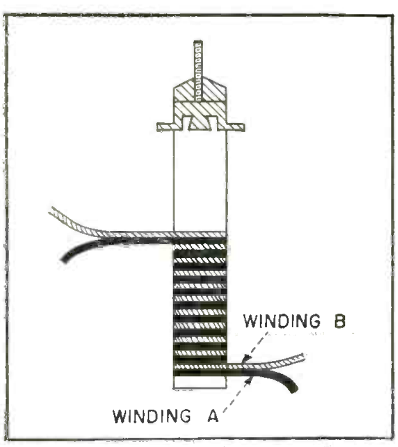

FIG. 1—Construction of bifilar coil

A second important advantage resulting from the use of bifilar coils is the improved noise immunity because of the low impedance in the i-f grid circuits. In the conventional amplifier illustrated in Fig. 3, where the d-c grid return is through the load resistor, an appreciable time constant in the grid may result. Noise pulses of sufficient amplitude to draw grid current will develop a charge on the coupling capacitor, and this charge will maintain bias on the tube until it can leak off through the grid resistor.

If bias is developed, the stage gain will be reduced after each noise pulse until the bias returns to normal. Severe noise may be sufficient to drive the tube to cutoff. The effect on the picture is that each noise pulse which modulates the carrier toward the black level is not itself very noticeable, but is followed by a white tail which is very objectionable.

In Fig. 3 the grid of the last i-f stage has a time constant of approximately 3.3 microseconds. The active time for one horizontal line is approximately 53.3 microseconds, so that severe noise would produce noticeable white streaking. When bifilar coils are employed, the grid time constant is virtually zero, so that the effect of noise on the picture is only to produce the black specks caused by noise modulation.

Improved noise immunity because of low grid time constant and economy in production due to the elimination of several components are achieved by use of bifilar coils between stages of stagger-tuned i-f amplifiers. Detailed analysis is given

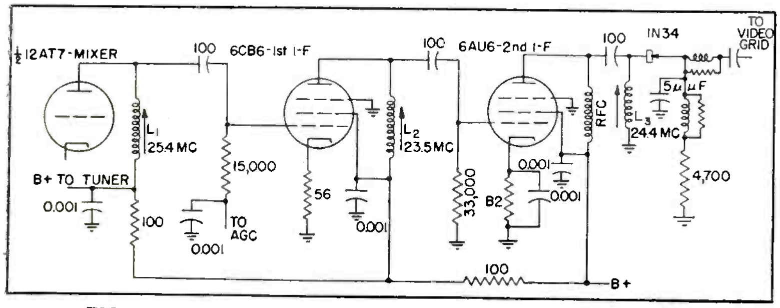

FIG. 3—Circuit of conventional single-tuned staggered stages

In the conventional single-coil system, the last i-f stages are the most susceptible to this effect because of the increased amplitude of noise pulses.

It becomes increasingly more difficult to use a resistor for the d-c grid return as the bandwidth of the amplifier is narrowed. This results from the fact that the individual stage loading, as prescribed by stagger-tuned design formulas, becomes less as the bandwidth is narrowed. Hence, the grid time constant becomes increasingly larger and the noise performance progressively poorer unless a bifilar coil or an additional choke is employed.

A higher i-f frequency would result in a longer grid time constant, since the increased tube transit time loading will necessitate less fixed loading to produce the desired stage bandwidth.

One alternative that might be suggested to reduce the grid time constant is to use a single-tuned coil in the grid circuit and feed B voltage through the loading resistor. This requires higher B voltage and greater power dissipation from the power supply components.

Comparison of Circuits

It is necessary to show that a tuned bifilar coil, as represented by Fig. 4A, is electrically equivalent to the single-tuned circuit of Fig. 4B, provided:—

$$L = \sqrt{L_1 L_2} \qquad (1)$$

$$C = \sqrt{\frac{L_1}{L_2}}\,C_1 + \sqrt{\frac{L_2}{L_1}}\,C_2 \qquad (2)$$

$$\frac{1}{R} = \frac{1}{\sqrt{\frac{L_2}{L_1}}\,R_1} + \frac{1}{\sqrt{\frac{L_1}{L_2}}\,R_2} \qquad (3)$$

The equivalence of these two circuits can be most easily demonstrated by several successive applications of Thevenin's Theorem. Figure 5A is the same as Fig. 4A redrawn with a constant current generator source of energy added.

If we consider the internal and load circuits to the left and right of terminals 1 and 2, then the equivalent circuit according to Thevenin's theorem will be as shown in Fig. 5B where

$$E_A = \frac{i_o}{j\omega C_1} \qquad (4)$$

$$Z_A = \frac{1}{j\omega C_1} \qquad (5)$$

If we apply Thevenin's theorem to Fig. 5B, the equivalent circuit illustrated in Fig. 5C is obtained, where

$$E_B = \frac{E_A R_1}{R_1 + Z_A} \qquad (6)$$

$$Z_B = \frac{1}{\frac{1}{R_1} + \frac{1}{Z_A}} \qquad (7)$$

One more application of Thevenin's theorem results in Fig. 5D, where

$$E_c = \frac{-j\omega M E_B}{Z_B + j\omega L_1} \qquad (8)$$

$$Z_c = \frac{\omega^2 M^2}{Z_B + j\omega L_1} \qquad (9)$$

$$e_2 = \frac{i_2}{\frac{1}{R_2} + j\omega C_2} \qquad (10)$$

$$i_2 = \frac{E_c}{Z_c + j\omega L_2 + \frac{1}{1/R_2 + j\omega C_2}} \qquad (11)$$

Substitution and simplification will result in Eq. 12 provided k, the coefficient of coupling, is set equal to unity so that $M = \sqrt{L_1 L_2}$.

$$e_2 = \frac{-i_o}{\sqrt{\frac{L_1}{L_2}}\frac{1}{R_1} + \sqrt{\frac{L_2}{L_1}}\frac{1}{R_2} + j\omega\left(\sqrt{\frac{L_1}{L_2}}\,C_1 + \sqrt{\frac{L_2}{L_1}}\,C_2\right) + \frac{1}{j\omega\sqrt{L_1 L_2}}} \qquad (12)$$

But Eq. 12 is recognizable as the equation for the response of a single-tuned circuit with the values set forth as in Eq. 1, 2 and 3.

In other words, a single-tuned circuit whose constants are so defined will be electrically equivalent to the bifilar coupling scheme. Hence, the bifilar coil will have the same selectivity curve as the equivalent single-tuned circuit and can be treated as such in the design of stagger-tuned amplifiers.

For the special case of a 1 to 1 transformer, $L_1 = L_2$, Eq. 12 becomes:

$$e_2 = \frac{-i_o}{\frac{1}{R_1} + \frac{1}{R_2} + j\omega\,(C_1 + C_2) + \frac{1}{j\omega L}} \qquad (13)$$

This is the equation for a single-tuned coil of inductance $L = L_1 = L_2$, having the same input and output loading and capacities as the bifilar coil. In other words, a 1 to 1 bifilar coil will produce the same selectivity curve and the same gain bandwidth factor as a single-tuned coil with the same capacitances and loadings.

If we consider once more the general case where L_1 is not equal to L_2, Eq. 12, then it can be shown that by selection of a proper ratio between L_1 and L_2, an improvement in gain-bandwidth factor over a single-tuned coil can be obtained provided the circuit input and output capacitances are unequal.

Consider the circuit in Fig. 6 where the coupling is 100 percent. Capacitance C_2 is greater than C_1 in the circuit. Let

$$A = \frac{N_1}{N_2} = \sqrt{\frac{L_1}{L_2}}$$

The stage gain from grid to grid is given by

$$\text{Gain} = \frac{g_m R_1}{A} \qquad (14)$$

and the bandwidth by

$$\Delta f = \frac{1}{2\pi R_1 C_{eq}} = \frac{1}{2\pi R_1 \left(C_1 + \frac{C_2}{A^2} \right)} \qquad (15)$$

then

$$\text{gain} \times \Delta f = \frac{g_m}{2\pi A \left(C_1 + \frac{C_2}{A^2} \right)} \qquad (16)$$

Equation 16 will be a maximum when

$A \left(C_1 + \frac{C_2}{A^2} \right)$ is a minimum which occurs

$$\text{when } \frac{d}{dA} \left[A \left(C_1 + \frac{C_2}{A^2} \right) \right] = 0 \qquad (17)$$

$$C_1 - \frac{C_2}{A^2} = 0 \qquad (18)$$

$$A = \sqrt{\frac{C_2}{C_1}} \qquad (19)$$

That is, maximum gain-bandwidth product will be obtained from such a coupling scheme when the turns ratio of the transformer is set equal to the square root of the capacitance ratio. Substituting this value in Eq. 16,

$$\text{Max gain} \times \text{BW} = \frac{g_m}{2\pi \, (2\sqrt{C_1 C_2})} \qquad (20)$$

Compare this with the gain-bandwidth product for a single coil given by

$$\text{Gain} \times \text{BW} = \frac{g_m}{2\pi \, (C_1 + C_2)} \qquad (21)$$

When $C_1 = C_2$, the equations are equivalent and no advantage results from the bifilar coil. But if C_1 and C_2 are not equal, a bifilar coil will possess an advantage since $2\sqrt{C_1 C_2}$ will be less than $C_1 + C_2$.

If $m = C_2/C_1$, the advantage of a properly designed bifilar transformer over a single coil becomes greater as this capacitance ratio is increased. In an unpublished paper, H. Goldberg has shown the following relationship to exist between m, the circuit capacitance ratio and the gain-bandwidth advantage over a single-tuned circuit. These results can easily be checked by Eq. 20 and 21.

m	Gain-Bandwidth Ratio
2.0	1.060
2.5	1.110
3.0	1.155
4.0	1.250
5.0	1.340
15.0	2.005

The above analysis indicates that of two tubes designed to have the same figure of merit, the one possessing the greater inequality between input and output capacitances is the better tube, since it is possible by proper design to secure a higher gain-bandwidth product.

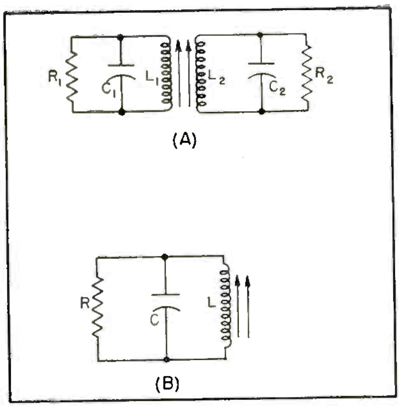

FIG. 4—Bifilar coil *A* is electrical equivalent of single-tuned coil *B*

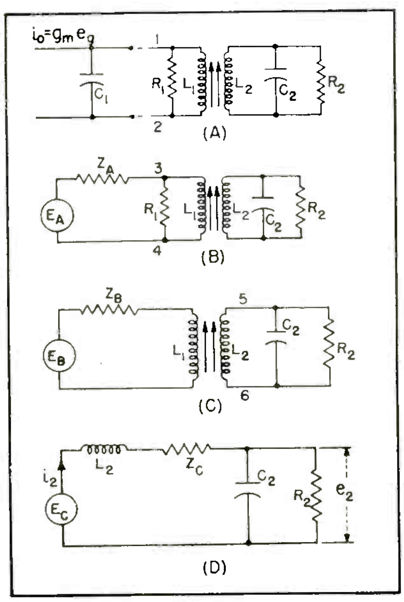

FIG. 5—Successive applications of Thevenin's theorem shows that single-tuned and bifilar-coupled circuits are equivalent

Turns Ratio

In a television i-f amplifier stage, the ratio between input and output capacitance depends primarily on the tube types employed. The capacitances contributed by tube sockets, leads, and coils can be minimized by careful design, but nothing further can be done. Tubes such as the 6CB6 and 6AG5 have a higher ratio of input to output capacitance than the 6AU6, but even their use would not provide a value of m greater than 2.

An increase in gain of only six percent could be obtained by increasing the turns ratio on the bifilar coil. To wind such a transformer is obviously more difficult and more expensive. Further, as the turns ratio is made larger, it becomes increasingly more difficult to maintain a high degree of coupling between coils. For these reasons, it has generally been found more feasible to use a 1 to 1 bifilar coil for interstage coupling in commercial television receivers.

In the output stage, however, a bifilar coil with a step-up turns ratio provides a very convenient method for transforming the video diode load until the operating Q of the last i-f circuit is correct. Here it is not possible to obtain the optimum value of gain-bandwidth product since the diode load resistor is determined by considerations of video response. If R_D represents the diode load resistor, the equivalent loading across the i-f tuned circuit is approximately

$$R_{eq} = \frac{R_D}{2\eta} \qquad (22)$$

where η is the efficiency of rectification[2].

In the circuit of Fig. 2, the diode load resistor, as determined by video design limitations, is 4,700 ohms. A practical value of diode efficiency is 50 percent. Then, by Eq. 22, the loading on the last tuned circuit is equivalent to 4,700 ohms. The bandwidth of this circuit, if a 1 to 1 transformer or a single coil is employed, will be given by

$$\Delta f = \frac{1}{2\pi R C_T} \qquad (23)$$

where C_T = total input plus output capacitance, R = total equivalent shunt loading and the gain is given by $g_m R$.

In a typical practical amplifier C_T is equal to approximately 10 $\mu\mu$f. Then Δf = 3.4 mc.

The particular i-f system shown represents a stagger-tuned triple of over-all 3-db bandwidth equal to 2.2 mc. Stagger-tuned design formulas indicate that the broadest individual circuit shall have a 3-db bandwidth of 2.2 mc. The problem is not to obtain maximum gain × bandwidth, but to devise some means of narrowing the bandwidth from 3.4 mc to 2.2 mc, and then to obtain as much gain as possible with that bandwidth.

In Eq. 23 R and C_T are the parameters over which we have some control. The most obvious method for narrowing the bandwidth is by adding fixed capacitance. But Eq. 23 and the gain equation show that the effect will be to narrow the bandwidth without increasing the gain.

However, it is possible to narrow the bandwith by some matching device, and increase the gain somewhat at the same time. If a bifilar coil is employed, Eq. 3 indicates that the diode loading resistance is multiplied by $\sqrt{L_1/L_2}$. The tube plate loading is simultaneously reduced by a factor $\sqrt{L_1/L_2}$ but the plate loading resistance is so large that this effect is unimportant.

If the capacitance on the plate side of T_3 in Fig. 2 equals 8 $\mu\mu$f and that on the diode side equals 2 $\mu\mu$f, then the equivalent capacitance for Fig. 4B according to Eq. 2 is given by $C = 8N + 2/N$ where $N = \sqrt{L_1/L_2}$ and by *Eq.* 3 $1/R = 1/(4{,}700N)$. Therefore

$$\Delta f = \frac{1}{2\pi \times 4{,}700\,N \times \left(8N + \frac{2}{N}\right) 10^{-12}}$$
$$= 2.2 \times 10^6$$
$$N = \sqrt{1.68} = 1.30$$

That is, if the primary and secondary inductances have a ratio of 1.68 to 1, the video diode load will be transformed to produce the desired bandwidth of 2.2 mc. Then the gain = $g_m R$ = 1.30 × 4,700 g_m.

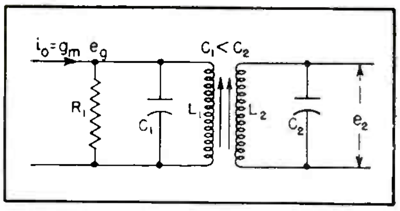

FIG. 6—Circuit with unequal capacitances and coupling of 100 percent

Hence, an increase in gain of 30 percent over that obtainable by adding shunt capacitance is realized through use of a bifilar coil.

The same impedance step-up, and consequent increase in gain, could be obtained by use of a suitable tapped coil or capacitance divider, but the bifilar coil is the simplest and most economical scheme.

Impedance Transformer

There are several other instances in the design of stagger-tuned i-f amplifiers where the use of a bifilar coil as an impedance transformer is desirable. For example, when the transit time loading of the tube itself becomes almost as large as the desired loading, the bifilar coil provides a simple means of decreasing this loading. One disadvantage of appreciable tube loading is poor noise immunity. Another disadvantage is that this loading varies between tubes, and therefore cannot be relied on to provide uniformity in production.

A bifilar coil enables the tube impedance to be stepped up and the circuit loaded with a close tolerance resistor, assuring uniformity of response. As mentioned previously, a narrow bandwidth and a high i-f frequency both result in the tube loading becoming appreciable. It is even possible in some amplifier design for the tube loading to exceed the desired circuit loading unless some step-up is employed.

Another instance where the circuit loading may exceed the required loading dictated by design considerations is the plate loading of a triode mixer. Here again, a bifilar coil of proper turns ratio may be employed to step up the mixer plate impedance, so that a fixed loading resistor can be used to insure circuit stability.

The bifilar type of construction lends itself most readily to a close wound assembly. Hence, the coil Q obtained is not as high as a space-wound single coil, but Q's of the value of 70 are obtained with no difficulty, and this is sufficient for most applications.

As the turns ratio between windings is increased, the difficulty of obtaining coupling approaching 100 percent is also multiplied. Also, the winding process itself becomes more difficult and expensive. All of the previous derivations were based upon the assumption that 100 percent coupling existed between the coils. If a high degree of coupling is not present, the bifilar coil is no longer equivalent to a single-tuned circuit, so that more than one resonant frequency may result. Coils having a step-up ratio as high as 1.30 to 1 have been tried with no difficulties.

A final limitation of the use of bifilar coils is the fact that they preclude the usual method of neutralization of grid to plate capacitance. Where the i-f is high, and the stage gain and grid to plate capacitance large, it may be necessary to provide neutralization of the grid-to-plate capacitance to avoid the dis-symmetry of the response curve resulting from feedback. In an i-f amplifier, this neutralization is usually provided by choice of a proper value of common plate screen bypass capacitor that enables balancing a capacitance bridge which prevents the feedback of output voltage (plate to screen) to the input terminals (grid to ground). Hence, the plate voltage is prevented from coupling back to the grid and the tube grid to plate capacitance is effectively neutralized.

When a bifilar coil is employed, the r-f voltage developed across the bifilar coil primary is effectively shorted across one leg of the bridge by the bifilar secondary and the balance is no longer maintained. In other words, the screen of the tube is effectively grounded by the secondary of the transformer, so that neutralization by this method is impractical.

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Automatic Control of High-Vacuum Systems

Accessory incorporating new circuits shows order of magnitude of vacuum by light panel and exact pressure by meter when used in conjunction with an ionization gage. Already in use as cyclotron beam-current indicator, the device has other remote-control potentialities

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THE IONIZATION GAGE accessory described here was developed as a fully automatic circuit for measurement and control of high-vacuum systems.

After the initial adjustments are made, no attention from the operator is required. The device is particularly suitable for use with large and complex vacuum systems such as those of cyclotrons and other nuclear machines, vacuum furnaces and continuously pumped vacuum tubes. In addition to providing automatic control of all the functions directly associated with the operation of the ionization gage itself, the new circuit provides for interlocking with other circuitry.

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Pressure indication can be provided at a multiplicity of remote points. The output circuit is powerful enough to drive an ink-writing recorder.

Pressure Indication

The pressure in the vacuum system is indicated on a large meter, calibrated directly in millimeters of mercury. This meter has an approximately logarithmic scale. It reads from 0 to 10, giving nearly constant percentage reading accuracy regardless of pointer position. The appropriate multiplier is indicated by the illumination of one of a group of panel lights, engraved with markings running from $\times 10^{-7}$ to $\times 10^{-3}$. The pressure is read by multiplying the meter reading by the multiplier indicated on the panel light. The front panel of the indicator unit shows the meter with its logarithmic scale and the panel lights with their multipliers.

This method of presentation relieves the operator of the necessity for manipulating a range-switch to obtain his readings. No confusing calculations are required to interpret the readings. The order of magnitude of the pressure is indicated by the multiplier lights. They can be observed from a distance and show immediately whether the vacuum is good or bad.

An automatic scale-changing mechanism acts to adjust the sensitivity of the indicator to keep the meter reading between 6 percent and 100 percent of full scale at all times. This mechanism simultaneously illuminates the panel light bearing the appropriate multiplier.

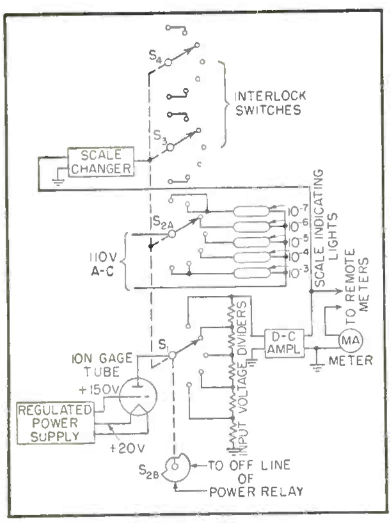


FIG. 1—Functional diagram of the automatic ionization gage circuit

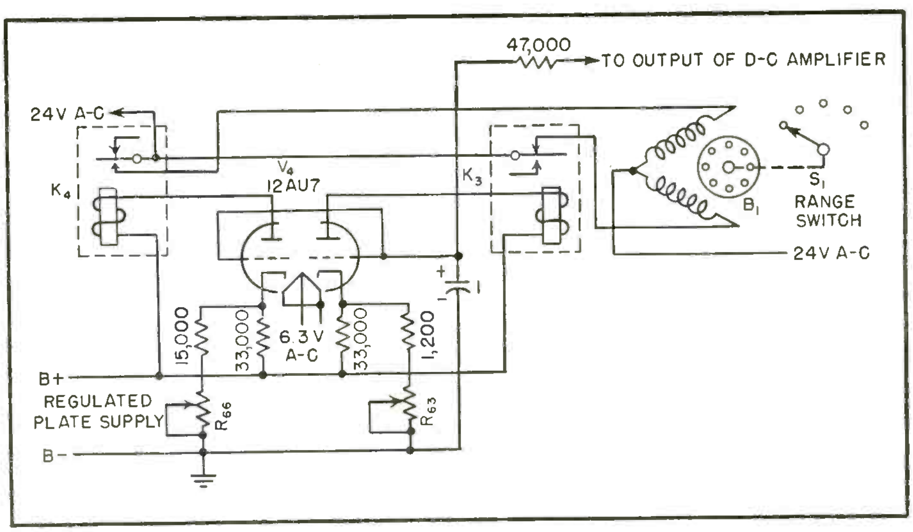
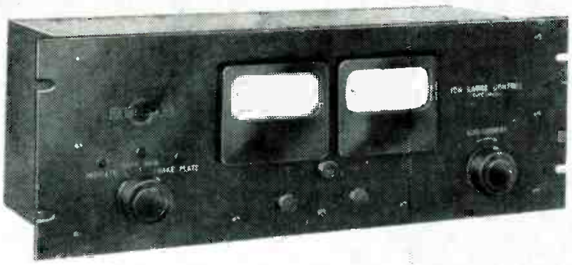


FIG. 2—Automatic scale-changer circuit prevents off-scale operation of the indicating meter without attention from operator



Ion-gage control unit

Ion-gage indicator unit

Additional contacts are provided on the range switch for external interlock purposes.

The amplifier that actuates the indicating meter has sufficient power output to drive a number of remote indicating meters (to a total of 500 ohms, 10 ma full scale). The range indicator lights may be multipled, so that complete pressure data are available at the remote points. The ion gage may be turned on and off, or switched from INDICATE to BAKE at a remote indicator if desired. Alternatively, one may use a portion of the output of the indicator amplifier to drive an ink-writing device to make a permanent record of prevailing vacuum conditions.

The automatic scale-changing mechanism is particularly well suited for interlock functions involving the control of other apparatus at predetermined pressure ranges. Two banks of contacts are provided on the range switch for this purpose, and are wired to terminal strips at the back of the indicator unit. These switches may be used directly or with supplementary relays either to permit or prevent operation of other apparatus. This arrangement can be set up to operate within any factor of ten (or combination of factors of ten) in pressure. As an example, a vacuum furnace could be so arranged that the heaters cannot be turned on until a pressure of 10^{-4} is attained, and will be turned off if the pressure rises to 10^{-2}.

An auxiliary contact is provided on the power relay. This can be used to prevent turning other equipment on when the ion gage is off.

Should the pressure go above 10^{-2}, the highest value indicated by the meter, the circuit will automatically turn itself off, thus preventing damage to the ion gage as well as to any equipment controlled by the gage circuit. The circuit will also turn itself off if the apparent pressure goes below 6×10^{-8}. This provision is incorporated since it is most unlikely that the pressure will ever get that low in any system in which this circuit will be used. A complete vacuum failure, or loss of emission in the ion gage, will cause the pressure apparently to go below this value. Since this is an abnormal situation, the circuit is arranged to turn off both itself and associated apparatus.

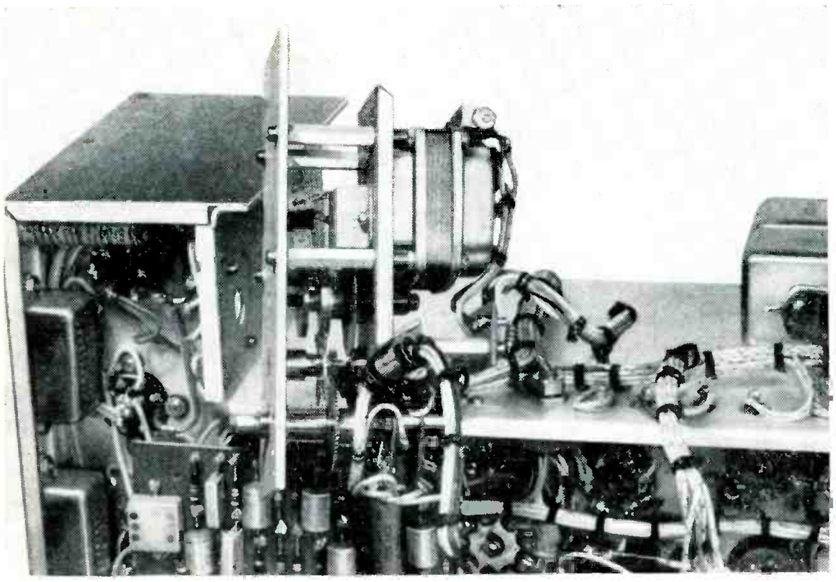
Operation

All the voltages and currents applied to the ion gage tube are electronically regulated. Thus, the only operating controls required are the ON and OFF pushbuttons that control the power unit. For convenience of assembly and installation, the indicator unit with its amplifier, indicator lights and scale changer motor is mounted on the panel. The control unit carrying power supplies, regulating circuits and power relays is mounted on a separate panel. Only the control unit is turned on and off; no power switch is provided on the amplifier unit, which has its own power supply. It is turned off only during prolonged periods out of use. The sensitivity of the amplifier unit is constant within 2 percent after a 30-minute warmup. It is independent of line voltage changes between 105 and 120 volts. No zero setting is required of this carrier-type amplifier; by the same token it is free from zero drift.

The control unit includes two meters on its front panel. They show respectively the filament current and the grid current in the ionization gage. The grid current is adjusted to a predetermined value to make the indicator readings correct. A knob is provided to adjust the grid current to a value appropriate to the gas being measured. The filament current meter is convenient for maintenance; excessive filament current indicates that the gage tube is inactive and should be replaced.

A switch on the control unit panel switches the instrument from indicate to bake conditions. The switching is accomplished by means of relays to permit control of this function from remote points as required. Indicator lights on the front panel inform the operator when the bake operation is in progress. During bake the grid current meter is removed from the circuit and power is removed from the scale-changer motor. The indicator amplifier is also removed from the circuit, so the indicator reads zero during the bake operation.

Figure 1 shows a block diagram of the instrument, as designed for use with a Western Electric D-79510 or D-79512 ionization gage tube. The reader is referred to Spangenberg[1] for a discussion of



Motor, gear train and Geneva gear used in the scale-changer, showing interconnection with electronic equipment

the theory of pressure measurement with the ionization gage. The filament, grid and anode voltages for the ionization gage are supplied from the control unit. The grid and anode (ion collector) voltages are regulated by means of voltage regulator tubes. The filament voltage is controlled by a well-known circuit[2] that adjusts the temperature of the filament to the value required to maintain the emission (grid) current constant at a predetermined value. The power unit thus maintains the sensitivity of the ion gage constant independent of changes in line voltage or filament emissivity.

The current to the ion gage anode is proportional to the pressure when the emission current and electrode voltages are held constant. However, the current corresponding to 10^{-7} mm Hg is only 0.01 microampere. A very sensitive d-c amplifier is required to produce such a pressure indication on a rugged meter. This amplifier with its power supply is contained in the indicator unit. It is a carrier-type using a vibrating reed to produce 60-cycle a-c proportional to the d-c input. This alternating current is amplified by a conventional four-stage amplifier, the output of which is rectified by a second vibrator operated synchronously with the first. The output circuit of this amplifier is capable of handling 10 ma into a 500-ohm load, and thus can operate any number of indicating or recording meters up to a total of 500 ohms. Each, of course, must have 10-ma full-scale sensitivity.

The automatic scale-changing is accomplished by a motor-driven rotary switch. The photograph shows the mechanism. A small split-phase reversible motor drives a Geneva motion through an appropriate gear train. The Geneva wheel is designed to advance the rotary switch one point for a full turn of the driving wheel. The switch itself is standard. One wafer, S_{2A}, is used to control the range indicator lights, while the two others, S_3 and S_4, are wired to terminals at the back of the units where they can be used as desired for interlock purposes. The voltage divider on the amplifier input is switched to the appropriate setting by S_1. Wafer S_{2B} is wired in series with the OFF pushbuttons. Its function is to remove power from the unit when the pressure rises above 10^{-2} or falls below 6×10^{-8}.

The schematic diagram, Fig. 2, shows the circuit that controls the scale-changing motor. The output voltage of the amplifier is applied to the two grids of a 12AU7 double triode. The scale-changing relays K_3 and K_4 are in the two plate circuits of this tube. The two operating points are independently adjusted by cathode resistors R_{63} and R_{66}. Normally K_3 is operated, K_4 is not operated and the motor B_1 is stationary. When the output meter reads full scale, K_4 operates and the motor runs in the direction to increase the attenuation of the input network. The motor continues to run in this direction until an on-scale reading is obtained.

When the indication on the output meter goes below 0.6 (this is 6 percent of full scale), K_3 releases and causes the motor to run in the opposite direction to increase sensitivity. The motor continues to run in this direction until the reading becomes larger than 0.6.

This simple circuit makes certain that the meter never goes off-scale and never goes below 6 percent of full scale. The meter scale is approximately logarithmic above 10 percent of full scale, giving approximately constant fractional reading accuracy at all parts of the scale.

Other Applications

The indicator unit described above is essentially a microammeter with one millivolt drop and a maximum full-scale sensitivity of 0.1 microampere. In the indicator unit this microammeter has been calibrated in millimeters of mercury for operator convenience. This same amplifier and scale-changing mechanism, calibrated in microamperes, will measure any direct current between 0.01 microampere and 1 milliampere without any setting of range switches by the operator.

The other features—indication at remote points and interlocking with other circuits, are retained when the instrument is used as a microammeter. These features have proved valuable in connection with cyclotron operation, where this instrument has been used as a beam-current indicator.

The writers wish gratefully to acknowledge the support that this project received from W. W. Salisbury, Director of Research, Collins Radio Company, without which it could not have been completed. Also, S. G. McNees contributed considerably to the design and was active in supervising the construction of the first models.

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Frequency Division with Phase-Shift Oscillators

Divisions as high as seven are easily obtained with standard component parts requiring only initial adjustment. Practical circuits described are customarily employed to obtain accurate power frequencies. They find additional use in the lower-frequency stages of frequency standards calibrated at r-f

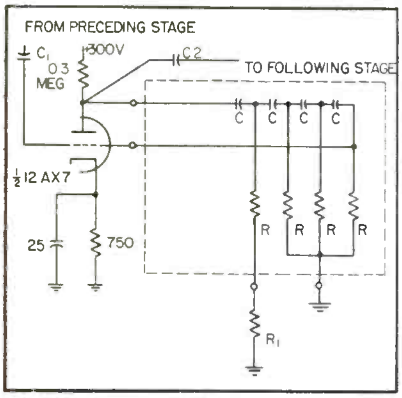

FIG. 1—Basic divider circuit illustrates importance of couplings

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Analysis Instrument Co.
East Paterson, N. J.

THE resistance - capacitance phase-shift oscillator has desirable charactertistics as a frequency divider. When suitably modified, it is possible to obtain relatively large division ratios that are unaffected by tube replacement, component drift due to aging or temperature. The single triode used per division gives it an advantage over conventional multivibrator types. In operating latitude it approaches that of the inductance-capacitance oscillator.[1] It is advantageous in that the transformers are replaced by resistance-capacitance networks as frequency-determining elements, with a consequent reduction in cost and weight.

Dividers operating from both crystal and tuning-fork oscillator standards have been constructed to give dependable 60-cycle output for motor drive applications. Divisions by five, six and seven were used in these designs. Scale-of-ten divisions in a single stage have also been used. They require more care in initial alignment because of the restricted locking range.

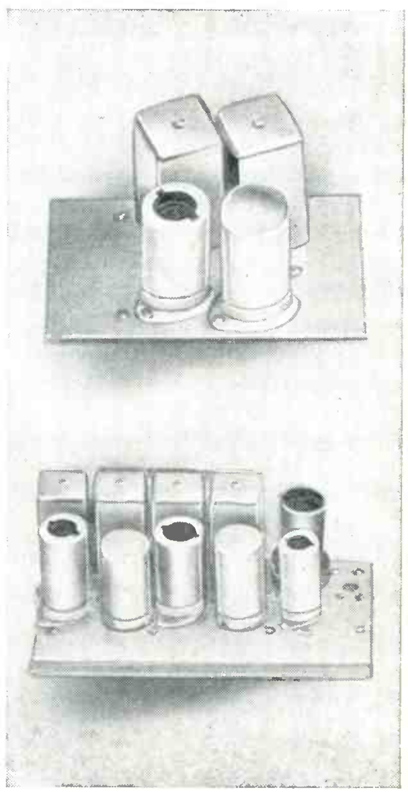
The resistance-capacitance phase-shift oscillator is particularly applicable in divider chains where the output frequency is below 10 cycles. In this frequency range, other dividing methods are undependable or require components of large size.

The basic phase-shift oscillator used for frequency division is shown in Fig. 1. The circuit is the standard four-section, series-capacitance shunt-resistance type and was favored over the three-section type because less gain is required for oscillation. It is desirable at higher frequencies where the tube output capacitance decreases the stage gain. Departures from the standard oscillator are found in the use of capacitors C_1 and C_2 and in the operating point of the tube.

Capacitor C_1 couples the control frequency, which is some multiple of the output frequency, into the frequency-determining network. This capacitor serves the additional function of dropping the control voltage to a suitable value for proper operation. The magnitude of C_1 is such that it only slightly affects the frequency of oscillation of either stage.

Output is taken from the plate of the tube through an appropriate coupling capacitor C_2, either to the grid of the following divider stage, or into the output load resistance. Each stage oscillates with an amplitude of about 60 volts at the design-center supply voltage of 300 volts. The operating point of the tube determined by the plate and cathode resistors is such that strong harmonics of the oscillating frequency are produced. The control-frequency voltage combines with the harmonic that is nearest in frequency, causing the frequency of the oscillator to change to an exact control frequency submultiple.

A 100-cycle oscillator can be used as a divider of frequencies of 500, 600 and 700 cycles without modification, because fifth, sixth and seventh harmonics of the fundamental frequency are generated. When locking of the oscillator occurs, the control frequency de-



Two of the frequency dividers described. The upper one is based on 1,800 cycles and the the lower upon 90.72 kc termines its frequency and the output wave shows a fundamental plus a pronounced harmonic at the control frequency. As the control frequency is varied the phase of this harmonic varies with respect to the fundamental wave. If the control frequency is changed sufficiently the divider will unlock. This effect is noticed in the ouput wave by the harmonic's continually changing phase with respect to the fundamental.

In Fig. 2 the locking range of a 100-cycle divider is shown as a function both of controlling frequency and magnitude of the capacitance C_1. In obtaining this data, the controlling frequency voltage was kept constant at 60 volts and applied to C_1 through a 100,000-ohm resistor to simulate the driving impedance of the preceding divider stage. The locking range is seen to be generally better for control frequencies that are odd multiples of the oscillator frequency than it is for those that are even multiples. When C_1 is small little of the control frequency energy is introduced into the oscillator and hence the locking range for a given division is restricted. When C_1 is made too large so much control frequency is introduced that the divider acts as an amplifier with the control frequency as output.

The locking range curves indicate that for the 100-cycle output divider a 250-$\mu\mu$f coupling capacitor from the previous stage will give the widest locking range for divisions by five and six, but a somewhat larger capacitor is required for divisions by seven for optimum operation. The locking range as a function of the phase-shift network resistance is shown in Fig. 3 for a 100-cycle oscillator. This curve was taken for

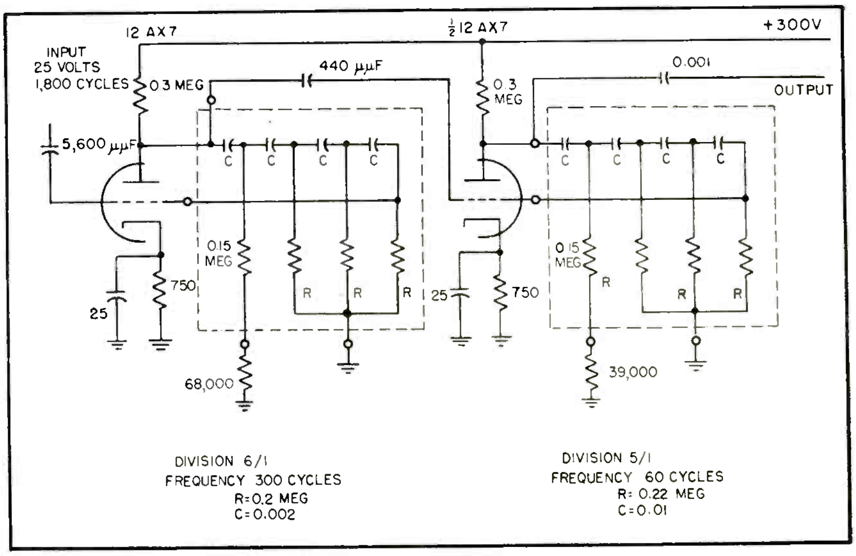


FIG. 4—Synchronous motor-control giving frequency division of 30

a division by six and is indicative of the results obtained for other divisions.

In designing a divider stage, the required oscillating frequency of the stage is determined, and the standard formula for the frequency of a four-section phase-shift oscillator is used,[2] making the R of the formula 200,000 ohms. In this way the required C is obtained. If the value of C determined in this way is not close to a standard value, a different R above 200,000 ohms can be chosen. Figure 3 shows that the operating range will only be slightly affected by this change of resistance.

It is usually required, when using standard-tolerance components in the phase-shift network that the frequency be adjusted by padding the first resistance in the network (shown as R_1 in the Fig. 1) to a suitable value. In the models constructed, the phase-shift resistors and capacitors of a stage are arranged in separate shield cans, indicated by the dotted lines. In practice, the first 150,000-ohm resistor is brought out to a terminal. The padding resistor R_1 completes the connection to ground.

Using the optimum values as determined by the foregoing, the operation of the divider is independent of supply voltage variations over a wide range. By setting the center of the locking range at the control frequency a supply-voltage variation of from 200 to 400 volts will not cause the divider to unlock. This stability results because the phase-shift oscillator's frequency is only slightly affected by supply voltage. The control voltage required to obtain locking is not critical.

The diagram of Fig. 4 shows a divider designed to give 60-cycle output controlled by an 1,800-cycle tuning-fork frequency standard. The first stage divides by six (300-

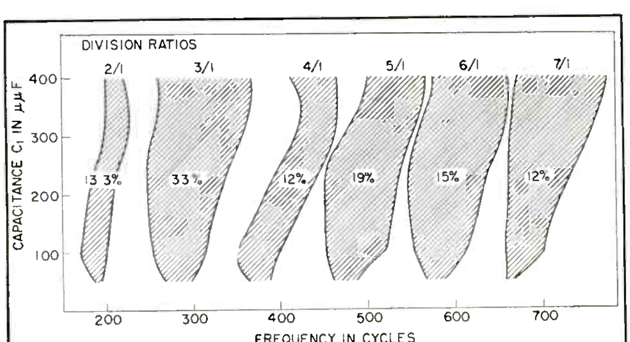


FIG. 2—Shaded areas indicate the locking range as a function of input coupling and frequency. Supply voltage is 300 v, frequency 100 cycles and resistance R is 200,000 ohms

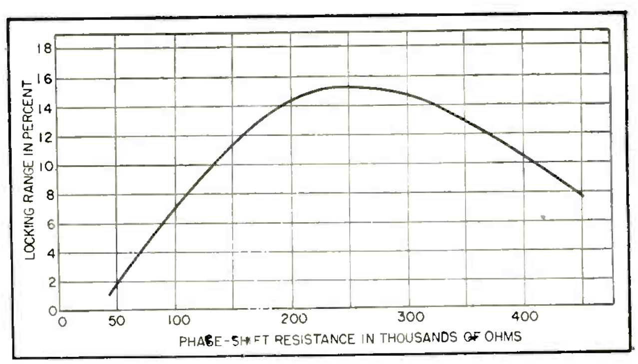


FIG. 3—Locking range in percent as a function of phase-shift resistance in thousands of ohms. The oscillator frequency used is 100 cycles and division ratio is six-to-one

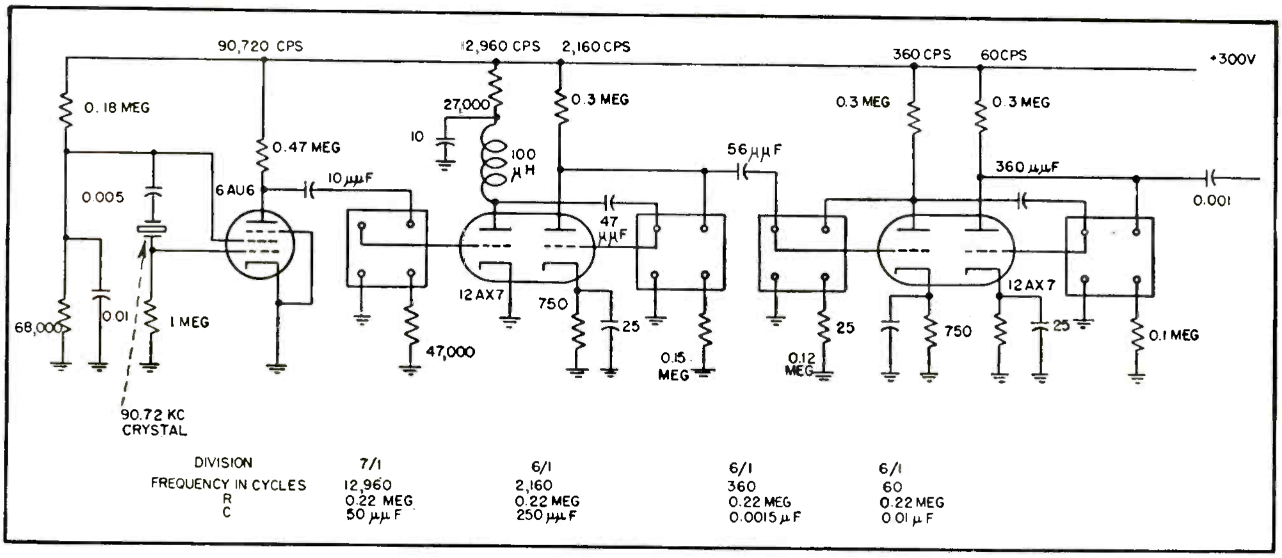


FIG. 5—Divider system using a 90.72-kc crystal gives highly accurate 60-cycle output

cycle oscillator) and the second stage by five (60-cycle oscillator). For a divider of this type, employing two divisions of a low order, standard-tolerance components of the values shown will produce satisfactory lock-in between the oscillators.

In order to insure stable operation despite variations in the oscillator frequencies with time, the frequency of each stage should be adjusted for the center of the control range. In practice, when the incoming 1,800-cycle frequency is applied to the vertical plates and the output from the plate of the first stage to the horizontal plates of an oscilloscope, a six-loop Lissajous figure is observed. By replacing R_1 with a resistance box its value can be adjusted so that the divider will unlock for a high value of resistance and also for a low value. A value is then chosen to give the midfrequency between these two drop-out points. By transferring the oscilloscope connections to the next stage, the procedure can be repeated to place the divider in final adjustment.

Range	Percent	Mid-frequency
1,645-1,895	14.1	1,770
1,671-1,947	15.2	1,809
1,669-1,931	14.6	1,800
1,668-1,932	14.6	1,800
1,656-1,932	15.3	1,794
1,694-1,945	13.7	1,819

This divider gave a control range of 15 percent when operated from a 25-volt control-frequency input. The tabulation shows the variation in locking range of the overall divider for six random-choice 12AX7 tubes.

The results indicate that for each tube there is ample latitude for frequency drift of the oscillators around the 1,800-cycle midfrequency.

A frequency standard with 60-cycle output controlled from a 90.72 kc crystal is shown in Fig. 5. Terminal connections, only, to the phase - shift circuit - blocks are shown. The R-C values, division ratios and oscillating frequencies of the dividers are indicated. There is one notable exception in this design. An inductive plate load is used in place of the usual resistive load in the first divider stage. The fundamental frequency of this oscillation is 12,960 cycles with a 90.72-kilocycle seventh harmonic.

The usual plate-load resistance of 300,000 ohms together with the plate-cathode capacitance of the tube reduces this harmonic to a level where satisfactory locking cannot be obtained. A 100-millihenry powdered-iron-core inductance provides the necessary high plate impedance together with sufficient peaking effect to insure the high-frequency response of the stage. The use of the inductive plate load requires that the operating point be readjusted. It was done by using a resistance-capacitance plate-decoupling filter and eliminating the cathode resistor. The alignment procedure for this divider is the same as for the previous one. In operation the overall locking range was 12 percent which is determined by the 7-to-1 stage. The voltage limits for satisfactory operation were 200 to 400 volts.

Experience with R-C and L-C oscillators of various types as frequency dividers indicates the following general requirements: a frequency-determining network of appreciable Q; a distortion element that produces harmonics; and the combining of the control frequency with the appropriate harmonic and the injection of the resultant into the oscillating circuit. The Q will determine the locking range; the lower the Q the broader will be that range. Using high-Q oscillating circuits and good distortion elements, stable divisions by as high as 300-to-1 are possible in a single stage.[3]

In the divider described in this article, the phase-shift network provides the low-Q frequency-determining element for a broad locking range. The distortion is produced in the tube itself. Control frequency and oscillator harmonic are combined at the grid of the stage. In this way the phase-shift oscillator meets the requirements in an economical way, using a minimum of tubes and components.

References

(1) E. Norrman, The Inductance-Capacitance Oscillator as a Frequency Divider, *Proc. IRE* 34, Oct. 1946.

(2) E. L. Ginzton and L. M. Hollingsworth, Phase-Shift Oscillators, *Proc. IRE*, 29, Feb. 1941.

(3) M. Silver and A. Shadowitz, A High Ratio Multivibrator Divider, Federal Telecommunication Laboratories, Inc., Technical Memorandum No. 261, Feb. 1947.

Efficiency of MISMATCHED LINES

Nomographs relate power transfer ratio and efficiency of extremely short transmission line to vswr and attenuation, permitting quick determination of how much power actually reaches the transmitting antenna or other load

By H. M. SCHLICKE
Port Washington, New York

ENERGY TRANSFER by short transmission lines is often considered to be very close to 100 percent, on the assumption that the transmission line approximates an ideal non-dissipative line and the voltage standing-wave ratio (vswr) approaches 1.

However, this idealization may lead to unanticipated marked differences, even for small deviations from the presumed conditions. If, for example, the load causes a vswr of 1.5 on a line that has an attenuation of only 0.5 db and if the input impedance of the line is matched to the output impedance of the generator, the efficiency is off 11.4 percent. If the generator output impedance were equalized to the

(continued on page 116)

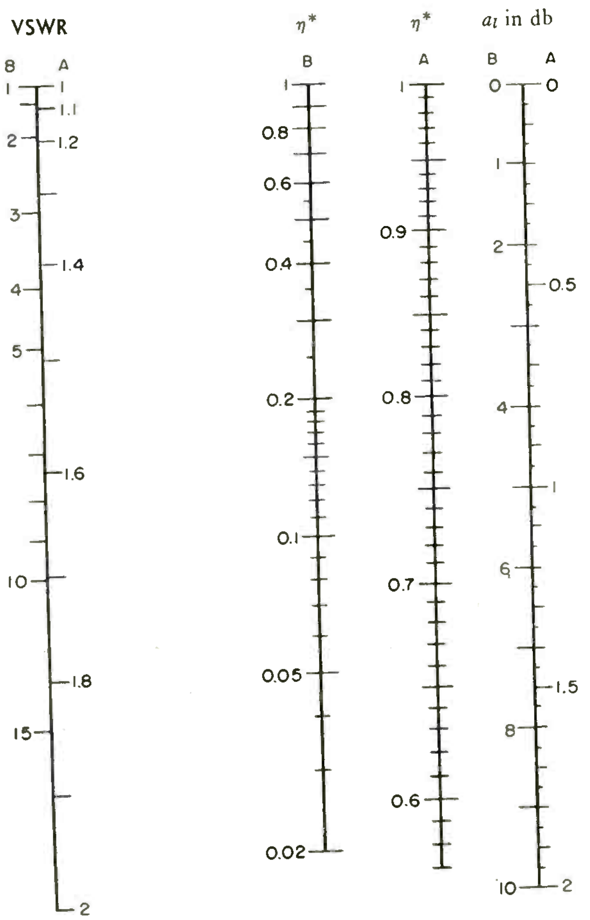


FIG. 1—Combination two-range nomograph for finding third value when any two are known. Use all three scales marked *A* together for lower ranges of attenuation *a* and vswr; use scales marked *B* together similarly for higher ranges

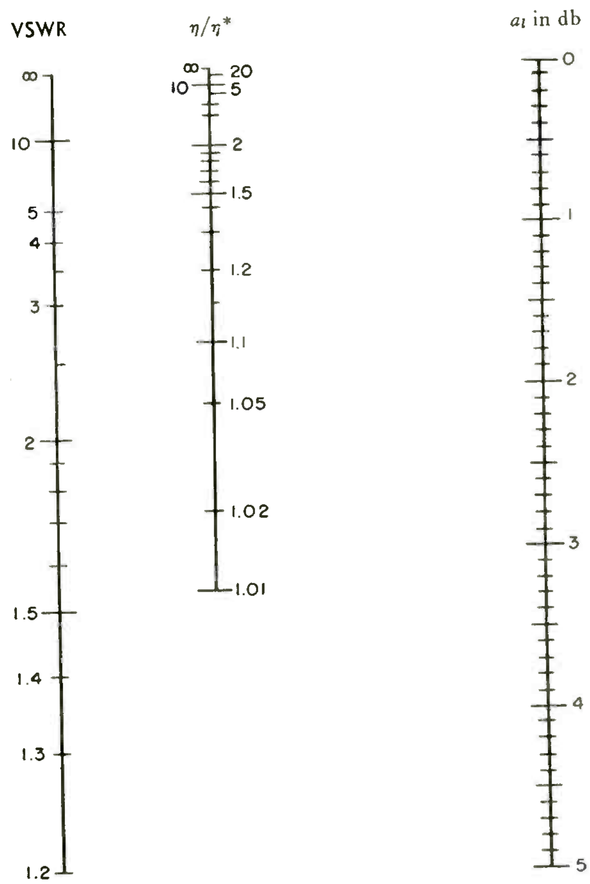
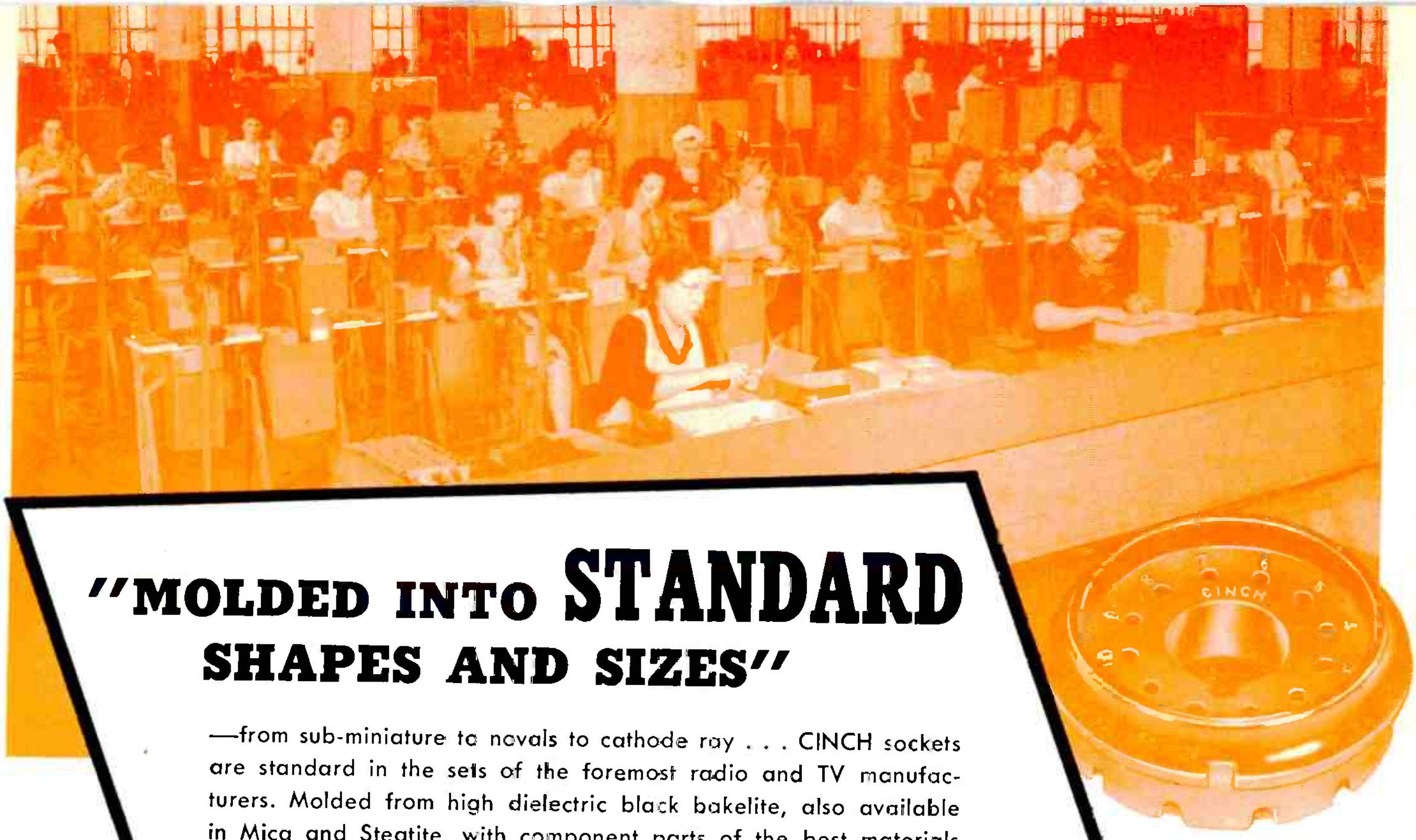


FIG. 2—Nomograph gives directly (center scale) the gain that can be obtained by matching the generator to the actual input impedance of the line, whereas nomograph of Fig. 1 is for matching generator to characteristic impedance of line



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Efficiency of Mismatched Lines (Continued from page 114)

characteristic impedance of the line, the efficiency of the line would drop to 85.9 percent. For measurement purposes, deviations of that magnitude are hardly negligible.

This situation deteriorates rapidly for increasing attenuation α_l of the transmission line and for higher vswr. Broadband loads fed over a certain length of transmission line may obtain power only in the order of magnitude of 10 to 50 percent. Electrically short transmitting antennas fed by relatively long transmission lines without matching transformers between antenna and cable may be supplied with far less than 1 percent of the power coupled in the line by the transmitter.

Except for very crude approximations, the efficiency of transmission lines should therefore be calculated and accounted for. The purpose of the accompanying nomographs is to simplify these calculations.

Definitions

The power transfer factor η^* holds if the generator output impedance equals the characteristic impedance of the line. With this premise, η^* is defined as the ratio of the power supplied to a mismatched load to the maximum power the power source can deliver to a matched load including transmission losses.

The actual efficiency η of the transmission line is the ratio of the load power to the power supplied to the input terminals of the line, and is independent of generator matching. The line input is identical to maximum generator power capacity, if generator output impedance and line input impedance are matched.

The factor η/η^* indicates the gain obtainable by matching the generator to the actual input impedance of the line, instead of matching to the characteristic impedance.

The vswr, unilaterally denoting the load, is measured at the load.

The attenuation α_l is the necessary and sufficient criterion for the transmission line.

It is assumed that the phase angle of the characteristic impedance of the line is negligible, since this condition holds for practically all transmission lines in use for power transfer.

The representation of the antenna in the cotanh diagram, or equivalently in a Smith chart, means that the antenna, or more generally the load, is substituted for by a hypothetical open-circuited transmission line possessing a certain attenuation α_a, so that vswr = cotanh α_a. In this and the following equations the attenuation is measured in nepers.

In terms of α_l and α_a, power transfer factor η^* and efficiency η as defined above are expressible as follows:

$$\eta^* = \frac{2 \sinh 2\alpha_a}{\epsilon^{2\alpha_l + 2\alpha_a}} \qquad (1)$$

$$\eta = \frac{\sinh 2\alpha_a}{\sinh (2\alpha_l + 2\alpha_a)} \qquad (2)$$

$$\frac{\eta}{\eta^*} = \frac{1}{1 - \epsilon^{-(4\alpha_a + 4\alpha_l)}} \qquad (3)$$

Use of Nomographs

Figure 1 serves to read any one of the three determinants η^*, α_l and vswr, when two of them are known. It should be noted that only the scales with the same letter (A or B) are commensurable.

Figure 2 permits the finding of the multifunctional relation between η and η^*.

Though η can be determined by multiplying η^* (Fig. 1) and η/η^* (Fig. 2), Fig. 3 will often be more convenient. The two-letter designations of the center scales indicate the coordinated outer scales.

Examples

A transmitter with a variable output transformer and a capacity of 100 watts is available. The vswr at the load is 5. What maximum attenuation α_l of the line is tolerable, if 60 watts are required in the load? Answer: η = 60 percent, hence from Fig. 3 α_{max} = 1.15 db.

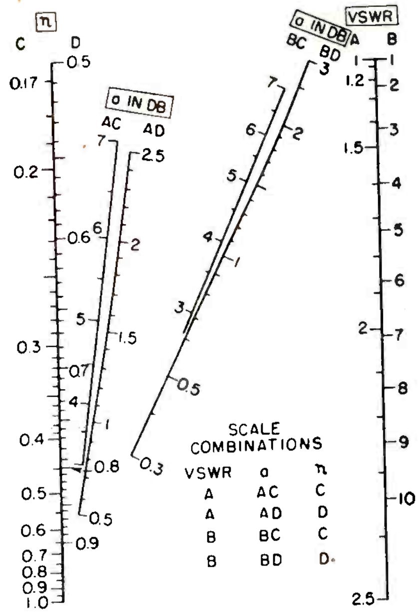
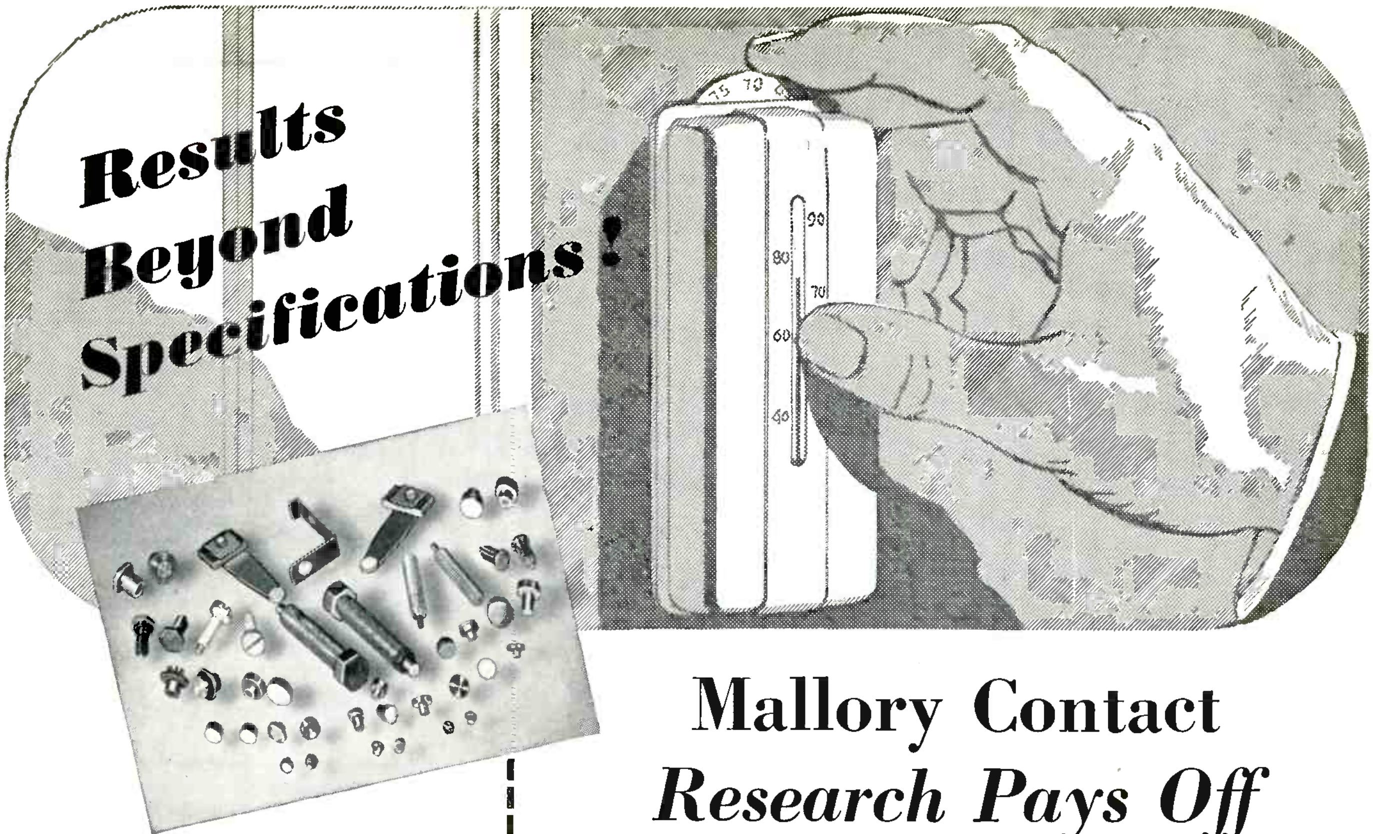


FIG. 3—Convenient four-range nomograph for determining efficiency of transmission line directly when attenuation and vswr are known. Use scales only in combinations indicated

A transmission line of 0.5 db attenuation feeds an antenna represented by vswr = 2. What is the antenna power relative to the maximum transmitter power, if (1) the transmitter output impedance equals the characteristic impedance of the transmission line, and if (2) line input and generator output are matched impedancewise? Answer: (1) from Fig. 1 η^* = 79.3 percent; (2) from Fig. 2, η/η^* = 1.1 and η = 87.4 percent. Note that η comes very close to η_{max} =89.2 percent, the latter being read from Fig. 1 or Fig. 3 for vswr = 1.

Under certain conditions the efficiency and power transfer factor seem to be considerably less than the values obtained from the nomographs. This is due to neglecting losses in the transmitter tuning and tank circuits; these losses must be calculated independently as they have no relation to the efficiency of the line itself.



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Edited by VIN ZELUFF

Electrolytic Capacitor Test Set

BY RICARDO MUNIZ

Division Manager
Television Receiver Manufacturing Division
Allan B. DuMont Laboratories, Inc.
East Paterson, N. J.

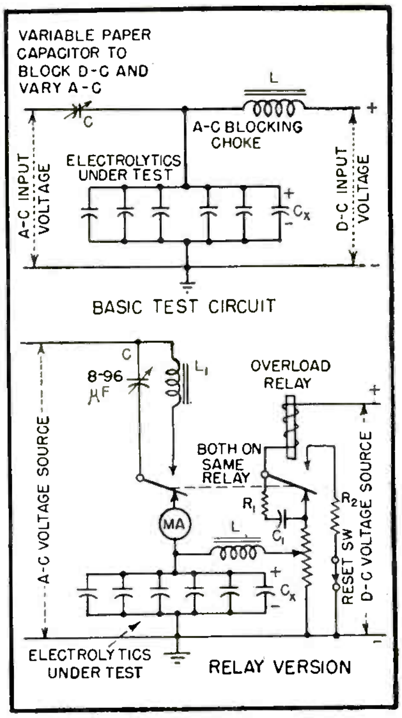


FIG. 2—Basic circuit used for life-testing electrolytics

LIFE TEST RUNS of electrolytic capacitors with specified values of d-c polarizing voltage and alternating ripple current can be made easily with the setup of Fig. 1, which permits testing up to six different batches independently. Each batch can have its own voltages, and failure of a unit in one batch does not affect the validity of tests for the other five groups.

Interaction between ripple current and polarizing voltage is prevented by using the basic circuit of Fig. 2. An overload relay disconnects the capacitor group safely when one fails during the usual 500-hour life test. The basic circuit was multiplied by six as in Fig. 1 to check up to six groups of six electrolytics at a time, enough to completely fill the heat oven used.

Ripple current is set at the desired value for a group by switching paper capacitors in or out. Unused capacitors in one group can be paralleled with those in another group calling for larger ripple current, by appropriately setting the master and group transfer switches. Polarizing voltages are changed with patch cords, which also permit applying only d-c polarizing voltages to other elements in the same electrolytic unit. Neon lights are connected across each fused circuit to indicate open fuses, and other pilot lights indicate the circuits that are in operation.

A reset switch, normally closed, permits releasing the overload relay to check if a short is temporary. A standard d-c power supply using five VR-105 regulator tubes in series provides the d-c polarizing voltages. The overload relay is adjusted to operate if direct current increases above the allowable leakage current value of the electrolytics under test. Extra contacts are provided on the relays to discharge both the ripple current-controlling capacitors and the electrolytics under test.

Whereas previously it took about

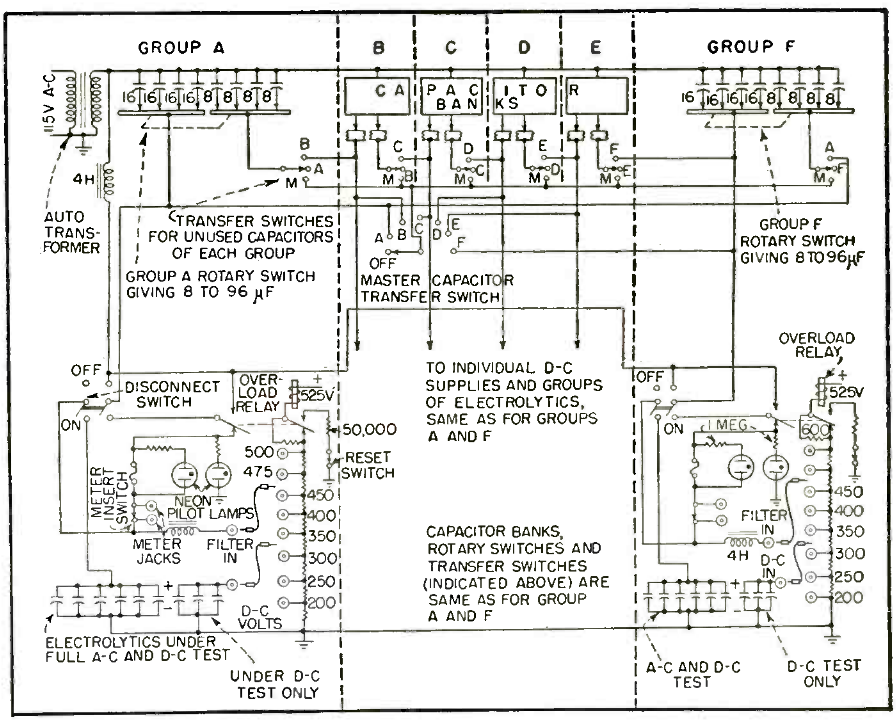
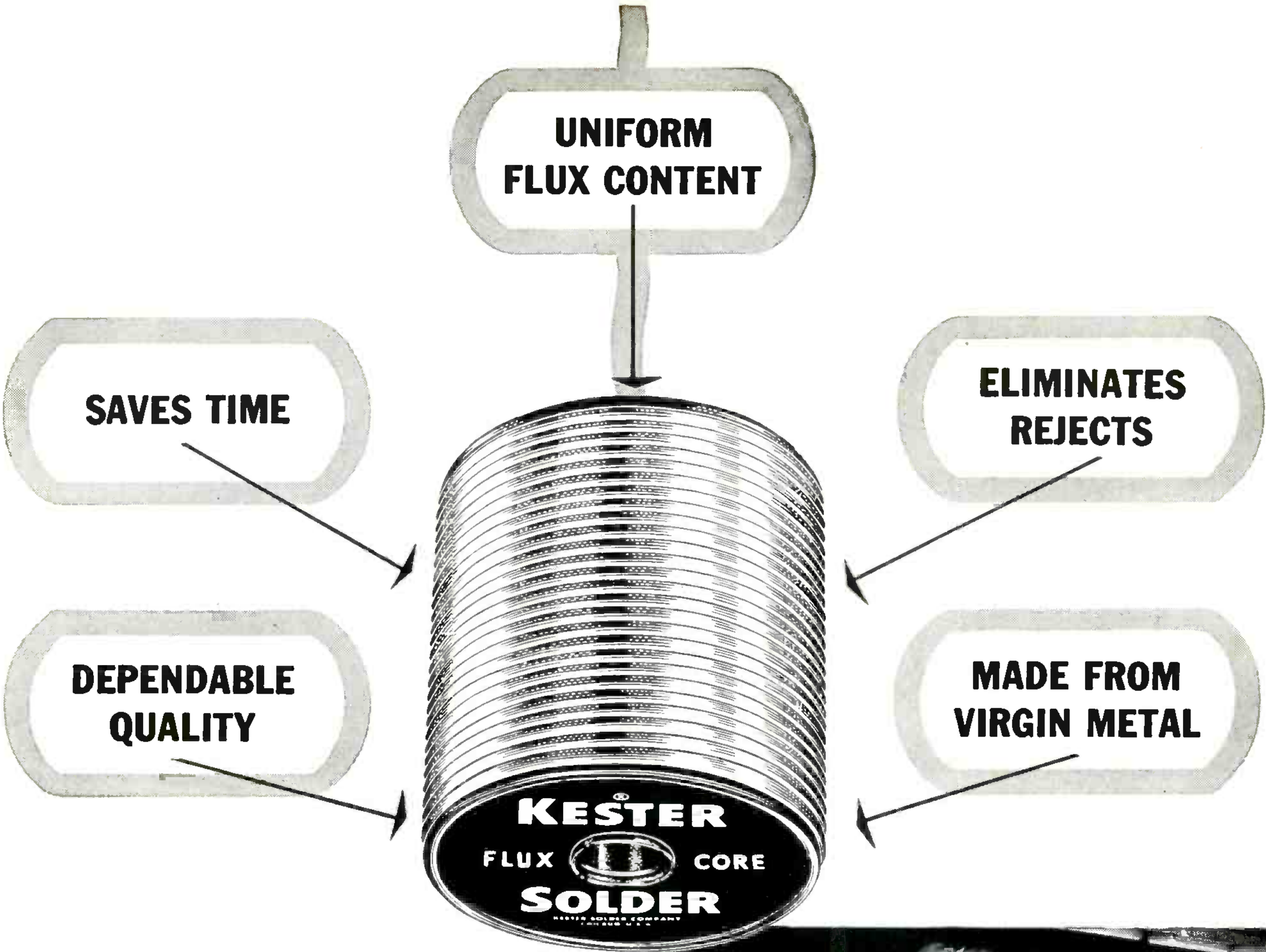


FIG. 1—Test set for making life test runs of up to six groups of electrolytic capacitors, each at different values of a-c ripple current and d-c polarizing voltage that are set up on a jack panel. Temperature oven is used for electrolytic capacitors under test. Paper capacitor banks at top provide various ripple currents needed



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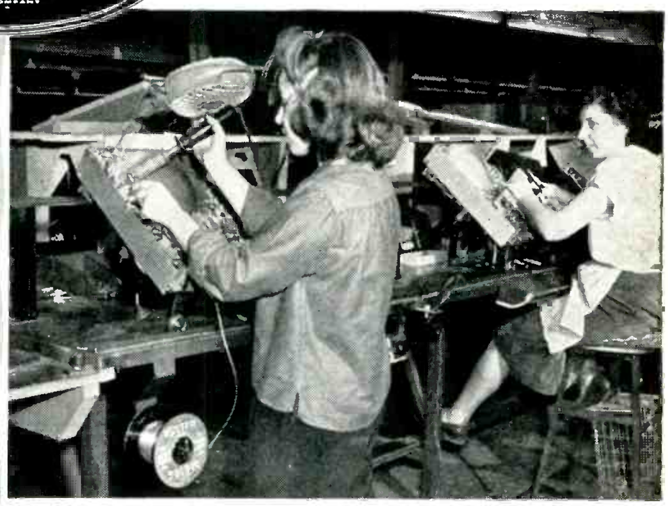

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10 hours to set up a test and the entire test was invalidated when even one unit failed, setup time for 36 units now takes only about an hour. Operation is automatic, releasing for other duties the engineer who formerly had to watch constantly to prevent overloads in the power supplies due to shorts. Only an occasional glance at the pilot lamps is now needed.

THE FRONT COVER

ELECTRON HEART of the new RCA 5831 is an array of 48 independent unit electron-optical systems arranged cylindrically in the tube. This construction, in effect, concentrates 48 triodes in relatively small space.

Each of the electron-optical systems consists of a filament in a slot in the beam-forming cylinder, grid rods and the copper anode. Electrons leaving the emitting surface of the filament are beamed between a pair of grid rods to the anode by the focusing action of the beam-forming cylinder.

Individual filament and grid elements of the unit triodes in the array are tungsten rods 8 inches long, supported at both ends by means of knife-edge V-notch arrangements. A pantagraphic mounting device has flexible spring-loaded fingers to which the filament rods are hooked. This makes each filament strand and grid rod mechanically independent, and allows vertical movement without disturbing the precise alignments and spacings essential to effective electron optics.

The accompanying photograph shows the anode-envelope assembly being lowered into position around the filament rods.

Receiver Circuits for Color Television

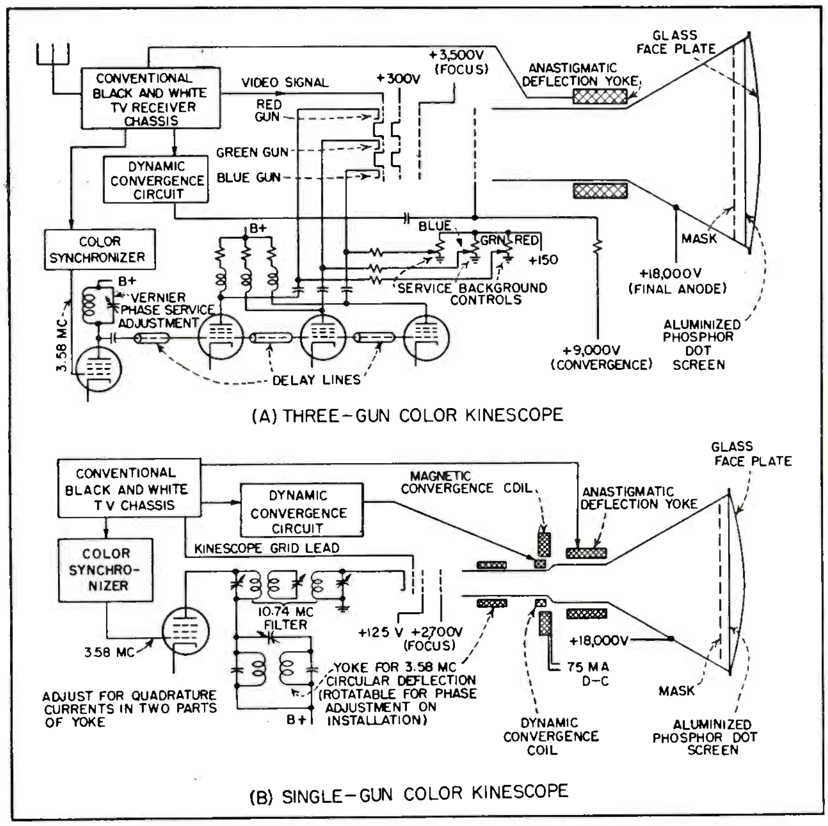
RECEIVERS demonstrated recently to the FCC in Washington by RCA engineers employed two types of picture tubes; one contained a single electron gun and the other is a three-gun affair.

Both types have the same kind of direct-view color screen. It comprises an orderly array of small, closely spaced, aluminized phosphor dots arranged in triangular groups, each group consisting of a green-emitting dot, a red-emitting dot and a blue-emitting dot. In the laboratory sample tubes used in the demonstrations there are 351,000 such dots, 117,000 of each color.

In the three-gun tri-color kinescope, an apertured mask is interposed between the three guns and the dot-phosphor screen in such a manner that the electrons from any one gun can strike only a single-color phosphor no matter which part of the raster is being scanned. The mask is a sheet of metal spaced from the phosphor screen and containing 117,000 holes, or one hole for each of the tri-color-dot groups. This hole is so registered with its associated dot group that the difference in the angle of approach of the three oncoming beams determines the color. Three color signals applied to the three guns produce independent pictures in the three primary colors and the pictures appear to the eye to be superimposed because of the close spacing of the small phosphor dots.

In so far as the color aspects are concerned, this three-gun tri-color kinescope may be utilized in a re-

(Continued on page 150)



Circuit arrangements for the two types of RCA color picture tubes

Early American Gunsmith . . .

Arming the soldiers of "young "America was a formidable task for the new, untried nation. Each musket, the weapon of the day, was laboriously made by hand . . . and repaired by hand.

It was Eli Whitney, Massachusetts-born Yale graduate, who showed the way to improvement. In 1798, he undertook to supply the U.S. Army with the unheard of quantity of "10,000 stand of arms" to be delivered within two years—a commission beyond the imagination of the most skilled mechanists of the day. To do this Whitney developed the concept of interchangeable gun parts wherein "the several parts were as readily adapted to each other as if each had been made for his respective fellow." History shows that Eli Whitney succeeded and from this humble, little-remembered beginning the new era of mass production was underway.

In the electronic, radio, and electrical fields alone, Sprague has done much to arm *modern* America. Of some 10,000 different component design variations produced each year, many are produced by the millions. But most important, like Whitney's interchangeable weapons, each component of a given type maintains its particular characteristics to an outstandingly high degree of uniformity.

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HPB 486

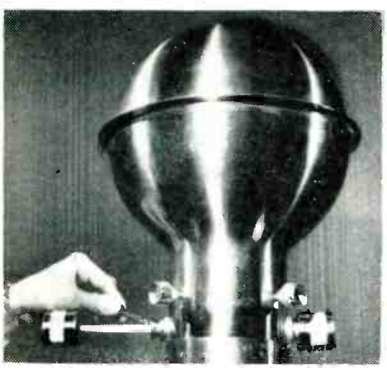
THE ELECTRON ART

Edited by JAMES D. FAHNESTOCK

Permanent-Magnet Electron Microscope

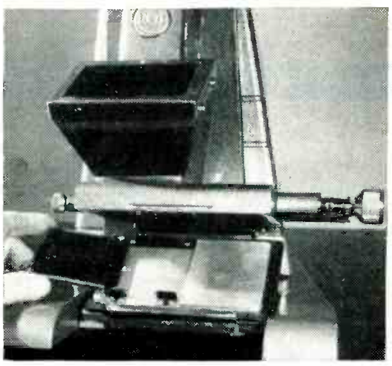
THE COST of the electron microscope has recently been radically reduced by the development of a permanent-magnet lens system. Heretofore, coils containing thousands of turns of wire, numerous cables and connectors, and a three-tube control circuit including several heavy and costly transformers were required for the electromagnetic electron microscope. Furthermore, the stability of the permanent-magnet lens is far superior to that of its predecessor.

The accompanying photographs illustrate several features of a packaged electron microscope using the permanent-magnet type lens system. It stands 30 inches high, weighs 50 pounds, and is capable of a resolving power of 100 Angstrom units with an accelerating potential or 50,000 volts. The image seen directly on the microscope viewing screen represents a magnification of 1,500, 3,000 or 6,000, depending on the lenses employed. When used in conjunction with photographic enlargement, magnifications up to 50,000 diameters can be obtained.



Specimens can be placed in the permanent-magnet electron microscope without disturbing the vacuum

The knobs extending radially just below the high-voltage gun chamber facilitate positioning of the specimen under observation. Provisions are made for exposing photographic negatives directly. Focusing is controlled by varying the accelerator potential, since object distance and magnetic field strength are fixed in this type. Specimens are introduced into the electron beam by a special lock arrangement which preserves the vacuum.



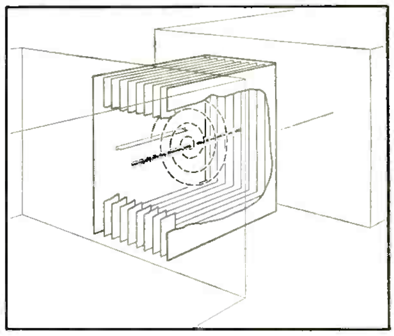
Provisions are made for photographing submicroscopic particles

The pumping system, which consists of two pumps in series, can evacuate the column in less than a half hour from a cold start.

The permanent magnet microscope was designed by Dr. J. Reisner, advance development engineer in the Scientific Instruments Engineering department of the Radio Corporation of America.

Omegatron—A Miniature Cyclotron

OPERATING on the same fundamental principle as the cyclotron, the recently developed omegatron has aided National Bureau of Standards scientists in making high-precision measurements of such electrical quantities as the numerical values of the faraday and the nuclear magneton. The omegatron, because of its high sensitivity, is expected to be helpful in many other branches of the field of measurements, such as gas and vapor analysis, and for the measurement of nuclear packing fractions (the excess of actual mass value over mass number for any isotope) which are of vital importance in atomic physics.



Cutaway drawing of the heart of the omegatron. Difference between applied r-f field and particle cyclotron frequency is inversely proportional to particle rotations before collision with central collector

The heart of the omegatron is little larger than a package of cigarettes. The present versions employ a rather bulky electromagnet, but a much smaller permanent magnet would serve as well and make the whole assembly desk-top size.

Operation

The functioning of the omegatron can be explained in terms of a simple physical law. If a charged particle is moving in a uniform magnetic field it will trace out a circular path. The particle's angular velocity ω_c about the center of the circular path is given by the so-called cyclotron equation $\omega_c = eB/M$, where e/M is the charge-to-mass ratio of the particle, and B is the magnetic flux density.

In the cyclotron this property

For Telemetering

NEW

SIGNAL GENERATOR
TYPE 202-D

Frequency Range 175—250 mc

The Type 202-D Signal Generator, developed to meet the specialized requirements of engineers working with telemetering receivers and other associated equipment, will be welcomed by many who have long needed a precise and reliable instrument for rapidly evaluating overall system performance.

SPECIFICATIONS:

RF RANGE: 175–250 megacycles in one range, accurate to ±0.5%. Main frequency dial also calibrated in 24 equal divisions for use with vernier frequency dial.

VERNIER FREQUENCY DIAL: This dial is divided into approximately 100 equal scale divisions and is coupled to the main frequency dial by a 24:1 gear train. The approximate frequency change per vernier division is 35 kc.

FREQUENCY MODULATION (DEVIATION): The FM deviation is continuously variable from zero to 240 kc. The modulation meter is calibrated in three FM ranges (1) 0–24 kc., (2) 0–80 kc., and (3) 0–240 kc. deviation.

AMPLITUDE MODULATION: Utilizing the internal audio oscillator amplitude modulation may be obtained over the range of 0–50% with meter calibration points of 30% and 50%. By means of an external audio oscillator the RF carrier may be amplitude modulated to substantially 100%. A front panel jack is provided which permits direct connection of an external modulating voltage source to the final stage for pulse and square wave modulation. Under these conditions the rise time of the modulated carrier is less than 0.25 microseconds and the decay time less than 0.8 microseconds.

MODULATION CONTROLS: Separate potentiometers are provided for continuous control of FM and AM levels.

MODULATING OSCILLATOR: The internal AF oscillator may be switched to provide either frequency or amplitude modulation. It may also be switched off. Eight fixed frequencies between 50 cycles and 15 kilocycles are available, any one of which may be selected by a rotary type switch.

RF OUTPUT VOLTAGE: The RF output voltage is continuously variable over a range from 0.1 microvolt to 0.2 volts at the terminals of the output cable. The impedance of the RF output jack, looking into the instrument, is 53 ohms resistive.

DISTORTION: FM: The overall FM distortion at 75 kc. is less than 2% and at 240 kc. less than 10%.
AM: The distortion present at the RF output for 30% amplitude modulation is less than 3% and for 50% AM less than 6.5. At 100% the distortion is 12% to 15% depending upon the modulating frequency.

SPURIOUS RF OUTPUT: All spurious RF output voltages are at least 25 db. below the desired fundamental. Total RMS spurious FM from the 60 cycles power source is down more than 50 db., with 75 kc. deviation as a reference level.

EXTERNAL MODULATION REQUIREMENTS:

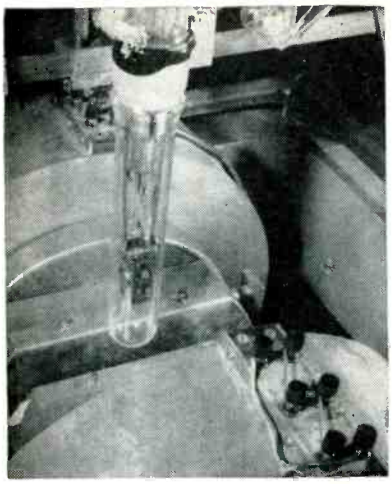
Frequency Modulation: The deviation sensitivity is 50 kc. per volt. For external FM the input impedance is 1500 ohms.
Amplitude Modulation: Approximately 45 volts are required for 50% modulation and 100 volts for 100% modulation. For external AM the input impedance is 7500 ohms.
Audio Voltage for External Use: There is available at the FM external oscillator binding posts about 5 volts a.c. maximum and at the AM external oscillator binding posts, 50 volts maximum.

DIMENSIONS AND WEIGHT: Outside cabinet dimensions: 17″ high, 13½″ wide, 11½″ deep. Weight: 35 pounds.

PRICE AND DELIVERY INFORMATION FURNISHED UPON REQUEST

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 INSTRUMENTS



Close-up view of omegatron. In operation glass tube is lowered between jaws of electromagnet

makes it possible to accelerate charged particles to extremely high velocities. In the omegatron, however, it is used to discriminate between particles of different masses; the heavier particles will have a lower angular velocity. Measurement of ω_c with the aid of accurate frequency standards and measurement of B by means of nuclear resonance methods provide an absolute determination of e/M in terms of the magnetic field strength and the cyclotron frequency alone.

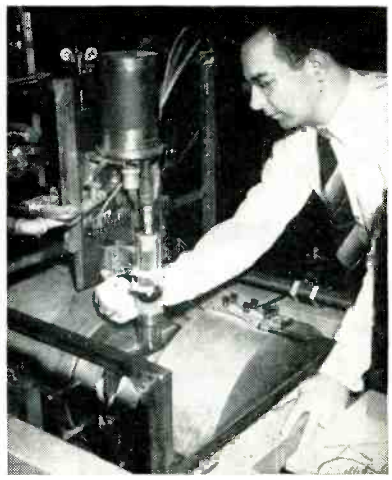
In addition to the constant and uniform magnetic field, the omegatron employs a radio-frequency electric field applied at right angles to the magnetic field. When the angular frequency of the electric field is ω, a charged particle will revolve in a plane perpendicular to the magnetic field at an angular velocity of $\frac{1}{2}(\omega + \omega_c)$. If the radio frequency differs from the cyclotron frequency, the radius of the ion path will periodically increase and decrease. The radius of the path traced out by the ion is then

$$R = \frac{K}{\omega - \omega_c} \sin \frac{\omega - \omega_c}{2} t$$

where K is a constant that depends in part on the strength of the r-f field and t is time. When the two frequencies are close together, the maximum radius of the path will be larger than when they are more widely separated, and when the frequencies are equal (in resonance) the radius of the path will increase steadily and the ion will spiral outward from the center. A collector placed at a fixed distance from the center of rotation of the ions will give maximum ion current at resonance.

Resonance in the omegatron is quite sharp and can be determined very precisely. The degree of sharpness of this resonance condition is described as the resolution and is defined as the width of the resonance peak at its base (expressed in cycles per second) divided by the center frequency of the peak. Resolution is proportional to the number of revolutions an ion makes before striking the collector. For greatest resolution, the ions must be held in the omegatron as long as possible. A trapping field produced by a positive potential applied to a set of guard rings retards axial loss of the ions. With the aid of this trapping field, ions are held for more than a millisecond so that they have time to complete thousands of revolutions before being collected.

Resolution increases as the r-f voltage is lowered, but the accompanying decrease in ion current at the collector places a limit on the attainable resolution. The omegatron has yielded resolutions as high as 1/14,000 at unit atomic mass, with strong indications of still higher resolutions to come. The extreme sensitiveness of the omegatron permits operation with very small samples. A wide range of operating pressures is possible; excellent resonance peaks have been obtained at pressures of the order of 10^{-7} millimeters of mercury.



Omegatron is shown as part of a mass analyzer

Bandspreading Resistance-Tuned Oscillators

By SEYMOUR BARKOFF
Senior Engineer
Emerson Radio and Phonograph Corp.
New York, N. Y.

ONE COMMON characteristic of most audio signal generators is the crowding of the calibration markings on the frequency dial toward the upper end of the audio frequency spectrum. Such crowding usually causes difficulty in interpolating frequency readings accurately between dial markings. Occasionally, the need arises for greater accuracy and precision in frequency readings.

It is the purpose of this article to describe a simple means of adding bandspread to a particular laboratory oscillator. Sufficient design information will be included to make the method applicable to other oscillators of the same general type, and for any desired frequency ranges.

Theory

The audio oscillator selected for the job was the Hewlett-Packard Model 200B, which consists of a two-tube audio oscillator and a two-tube feedback amplifier. Only the oscillator circuit is dealt with here, since the amplifier circuits are unaffected by the bandspread revision.

The basic circuit of the two-tube oscillator is shown in Fig. 1. The circuit resembles that of a multivibrator, except for the method of feeding grid and cathode of the 6J7 stage. Oscillations take place at a

(Continued on p 172)

2-WAY RADIO'S **Greatest VALUE!!** **TODAY and TOMORROW**

with exclusive ***SENSICON RECEIVER - NOW AVAILABLE*** *in the Dispatcher.*

PERMANENT VALUE of ADVANCED DESIGN

The Sensicon Circuit with the Permakay Wave Filter, Statomic Oscillator, Differential Squelch, Capacitance Discriminator, and Thermally Balanced Crystal Oven, all exclusive Motorola developments, has advanced the art to permit practicable adjacent channel operation. Further, it provides the only uncompromised design capable of accepting full modulation on the desired channel, and adaptable to "split-channel" frequency assignments. With *"Instantaneous Deviation Control"* of the transmitter carrier plus the broad nose, steep skirt characteristic of the Sensicon Receiver, you have an advanced design combination which will give superior performance *now and tomorrow!*

RELIABILITY

Put it in and forget about it! It breezes along with peak performance always. With fixed-tuned, sealed circuits, precision compensated elements, quality components and workmanship—the day of radio tinkering is over! Remember! the Sensicon System is *coasting* while ordinary systems using fewer tubes are taxed to the false-economy limit!

UNIVERSAL PACKAGING

Built for quick and easy installation—with full accessibility, *here is the solution* to any mounting problem in any type of vehicle. Choice of new all-in-one front model, or trunk mount unit—both are drawer-type with quick lift cover. Both units provide for complete metering and antenna alignment through the covered ports on front—yet the complete housing is closed against dust or other foreign particles.

ENDURING ECONOMY

A quality communications unit designed to deliver longer sustained service at the lowest operating cost. New single vibrator power supply provides for minimum tube and vibrator replacement.

FREEDOM FROM OBSOLESCENCE

The growth of land mobile services licensees from 5,000 in 1945 to over 17,000 (over 160,000 transmitters) today indicates that channel-splitting is imminent. With adjustable modulation control, I.D.C., and exclusive exchangeable Permakay filter you have every factor in hand for your future protection.

- at the best buy!

Motorola

4545 Augusta Blvd., Chicago 51 · in Canada: Rogers Majestic, Ltd., Toronto

MADE BY THE WORLD LEADERS IN 2-WAY MOBILE RADIO BACKED BY 20 YEARS RESEARCH, EXPERIENCE, AND SPECIALIZATION IN MOBILE RADIO

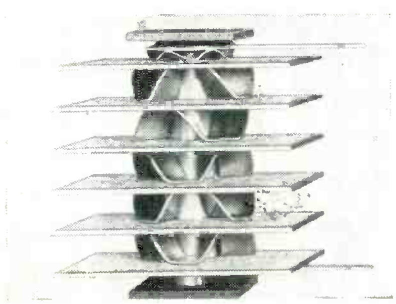
NEW PRODUCTS

Edited by WILLIAM P. O'BRIEN

Military Needs Influence Size, Weight and Composition of Components . . . Benefits to TV Service Engineers Seen in Variety of Test Apparatus . . . Thirty Items Available Trade Literature Are Reviewed

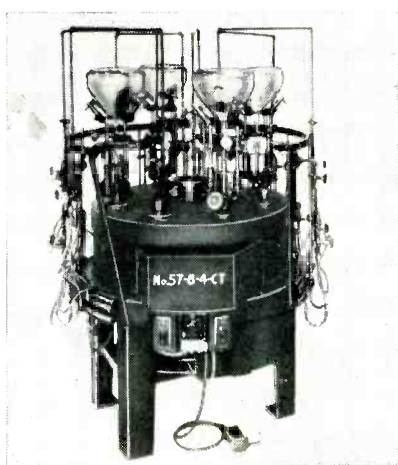
Electron Microscope

RADIO CORP. OF AMERICA, Camden, N. J., Type EMP table-model permanent-magnet electron microscope provides useful magnifications up to 50,000 diameters. Because it employs a 50-kv accelerating potential it is effective for studying thick specimens. Using permanent-magnet lenses it needs no stabilization circuits and controls. The unit features a resolving power to 100 angstrom units. Price is $5,750 and deliveries will begin in September.



Selenium Rectifiers

SARKES TARZIAN INC., 415 N. College Ave., Bloomington, Ind., has announced the Centre-Kooled selenium rectifiers designed for use in radio, television or electronic equipment. The center cooling feature provided by a special spacer between the cells insures lower overall operating temperatures by allowing air to reach the portions of the cells in which the current density is the greatest. Sixteen models are available in the standard line ranging from units rated at 65 ma at 130 volts to units capable of handling 450 ma at 130 volts.

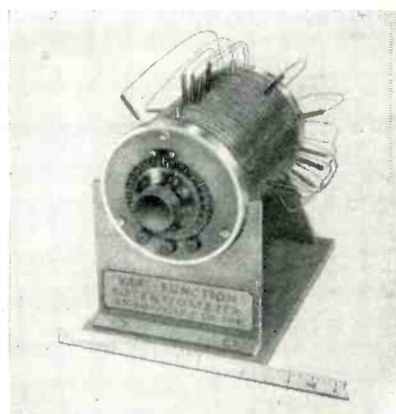


Sealing-In Machine

EISLER ENGINEERING CO., INC., 750 South 13th St., Newark 3, N. J. Model 57-8-4-CTL four-head sealing-in machine adaptable for sealing the electron gun to the bulb can handle up to 24-inch diameter video tubes in the range of 90 per hour. It is powered by two motors ($\frac{1}{2}$ h-p and $\frac{1}{4}$ h-p) for adjusting independently the index head and head drive respectively. The machine is automatically operated by a reset timer which stops the turret from rotation for a predetermined time which ranges from 0 to 60 seconds.

Electrostatic Generators

CHATHAM ELECTRONICS CORP., 475 Washington St., Newark 2, N. J., is producing two electrostatic generators of 6 kv and 20 kv, designed to replace cumbersome and short lived batteries as a high-voltage supply for Snooperscopes, Sniperscopes and similar infrared sighting equipment. The unit (illustrated above right, as compared with the older type shown on the left) weighs only 10 pounds, is powered by a spring motor and operates indefinitely. A variable speed governor provides constant speed which results in constant current output rather than constant voltage. Constant voltage output is maintained with a corona discharge regulation tube.

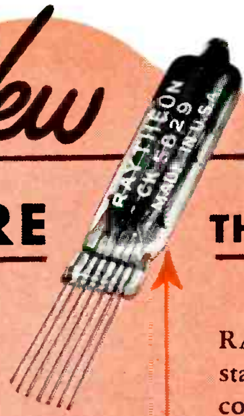


Adjustable Potentiometer

A. F. SMUCKLER & CO., INC., 202 Tillary St., Brooklyn 1, N. Y. The Vari-Function nonlinear potentiometer comprises a helical resistance and a plurality of taps that can be quickly adjusted to produce or reproduce any desired voltage indication or output as a function of angular displacement. It produces any form of voltage function with better than 0.5-percent accuracy. Some of its many typical applica-

ANOTHER *New* RAYTHEON

SUBMINIATURE



THE CK5829 TWIN DIODE

TO PROVIDE YOU WITH

1. High perveance (performance compares favorably with that of the larger 6AL5)
2. Low heater current (150 ma.); half as much as the 6AL5
3. Moderate cost

RAYTHEON *Subminiature Tubes* have long been standard throughout the world. More of them are in commercial use than all other makes combined. They assure *greater product salability* due to size reduction — *greater convenience* because they fit standard sockets or can be soldered or welded into the circuit, and because over half a million are available from stock; over 300 Raytheon Tube Distributors are at your service — *greater dependability*, backed by unsurpassed technical resources and a dozen years of production and application experience with long-life Subminiature Tubes.

→ NEW TYPES

This chart gives you at a glance the characteristics of representative Raytheon Subminiature Tubes

Type No.	Remarks	Maximum Diameter Inches	Maximum Length Inches	Filament Or Heater Volts	Filament Or Heater Ma.	Mutual Conductance umhos	Power Output MW	TYPICAL OPERATING CONDITIONS Plate Volts	Plate Ma.	Screen Volts	Screen Ma.	Grid Volts
HEATER CATHODE TYPES												
CK5702 CK605CX	Characteristics of 6AK5	0.400	1.5	6.3	200	5000		120	7.5	120	2.5	Rk = 200
CK5703, CK608CX	Triode, UHF Oscillator, ¾ watts at 500 Mc	0.400	1.5	6.3	200	5000		120	9.0			Rk = 220
CK5704/CK606BX	Diode, equivalent to one-half 6AL5	0.315	1.5	6.3	150			150ac	9.0			
CK5744/CK619CX	Triode, High mu.	0.400	1.5	6.3	200	4000		250	4.0			Rk = 500
CK5784	Characteristics of 6AS6	0.400	1.5	6.3	200	3200		120	5.2	120	3.5	−2.0
→ CK5829	Similar to 6AL5	0.285x0.385	1.5	6.3	150			117ac	5.0 per section			
FILAMENT TYPES												
1AD4	RF Pentode	0.285x0.385	1.5	1.25	100	2000		45.0	2.8	45.0	0.8	Rg = 2meg
2E31-32	RF Pentode for pocket radio	0.300x0.400	1.56	1.25	50	500		22.5	0.4	22.5	0.3	0
2E35-36	Output Pentode for pocket radio	0.285x0.385	1.5	1.25	30		6	45.0	0.45	45.0	0.11	−1.25
2E41-42	Diode Pentode for pocket radio	0.300x0.400	1.56	1.25	30	375		22.5	0.35	22.5	0.12	0
2G21-22	Triode Heptode for pocket radio	0.290x0.410	1.56	1.25	50	60 conv. cond.		22.5	0.20	22.5	0.30	
RK61	Gas Triode, Exp. Radio Control	0.550	1.81	1.4	50			45.0	1.5	Special Circuit		
CK510AX	Double Space Charge Tetrode Amplifier	0.285x0.410	1.25	0.625	50	150† both units		45.0	0.06			0
CK512AX	Low microphonic voltage amplifier	0.285x0.385	1.25	0.625	20	37†		22.5	0.125	22.5	0.04	−0.625
CK522AX	Output Pentode 20 ma. filament	0.285x0.385	1.5	1.25	20	450	1.2	22.5	0.30	22.5	0.08	0
CK524AX	Output Pentode	0.285x0.385	1.5	1.25	30	300	2.2	15.0	0.45	15.0	0.125	−1.75
CK525AX	Output Pentode	0.285x0.385	1.5	1.25	20	325	2.2	22.5	0.25	22.5	0.06	−1.2
CK526AX	Output Pentode	0.285x0.385	1.5	1.25	20	400	3.75	22.5	0.45	22.5	0.12	−1.5
CK527AX	Output Pentode 15 ma. filament	0.285x0.385	1.5	1.25	15	225	0.75	22.5	0.10	22.5	0.025	0
CK529AX	Shielded Output Pentode	0.285x0.385	1.5	1.25	20	350	1.6	15.0	0.32	15.0	0.075	−1.25
CK533AX	Output Pentode	0.285x0.385	1.5	1.25	15	400	1.8	22.5	0.36	22.5	0.09	0
→ CK534AX	Voltage Amplifier	0.285x0.385	1.25	0.625	15	30†		15.0	0.0047	15.0	0.0014	−0.625
CK535AX	Output Pentode	0.285x0.385	1.5	1.25	20	350	1.6	15.0	0.32	15.0	0.075	−1.25
CK551AXA	Diode Pentode	0.285x0.385	1.5	1.25	30	235		22.5	0.17	22.5	0.043	0
CK553AXA	RF Pentode	0.285x0.385	1.5	1.25	50	550		22.5	0.42	22.5	0.13	0
CK571AX	10 ma. filament Electrometer Tube, Ig = 2x10[-13] amps. max.	0.285x0.410	1.5	1.25	10	1.6†		10.5	0.20	Triode Conn.		−3.0
CK573AX	Triode, high frequency output	0.285x0.385	1.5	1.25	200	2000		90.0	11.0			−4.0
CK574AX	Shielded Pentode RF Amplifier	0.285x0.385	1.25	0.625	20	160		22.5	0.125	22.5	0.04	−0.625
CK5672	Output Pentode	0.285x0.385	1.5	1.25	50	650	65.0	67.5	3.25	67.5	1.1	−6.5
CK5676/CK556AX	Triode, UHF Oscillator	0.285x0.385	1.5	1.25	120	1600		135.0	4.0			−5.0
CK5677/CK568AX	Triode, UHF Oscillator	0.285x0.385	1.5	1.25	60	650		135.0	1.9			−6.0
CK5678/CK569AX	RF Pentode	0.285x0.385	1.5	1.25	50	1100		67.5	1.8	67.5	0.48	0
CK5697/CK570AX	Electrometer Triode Max. grid current 5x10[-13] amps.	0.285x0.410	1.25	0.625	20	1.5†		12	0.22			−3.0
CK5785	High voltage rectifier	0.285x0.410	1.5	1.25	15				0.1	Inverse peak 3500 volts		
→ CK5889	7.5 ma. filament electrometer pentode Ig = 3x10[-13] amps. max.	0.285x0.400	1.6	1.25	7.5	14		12	0.005	4.5	0.005	−2.0
VOLTAGE REGULATORS												
CK5783	Voltage reference tube — like 5651	0.400	1.5			Operating voltage 87. Operating current range 1.5 to 3.5 ma.						
CK5787	Voltage regulator	0.400	2.06			Operating voltage 100. Operating current range 5 to 25 ma.						

CK ® RK ®

†Voltage Gain Ratio.

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Excellence in Electronics

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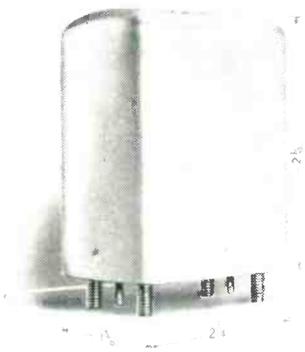
SPECIAL TUBE SECTION • Newton 58, Massachusetts

SUBMINIATURE TUBES • GERMANIUM DIODES and TRIODES • RADIATION COUNTER TUBES • RUGGED, LONG LIFE TUBES tions are in guided missiles, radar, electronic computers, and general-application laboratory instruments.



H-V Power Supply

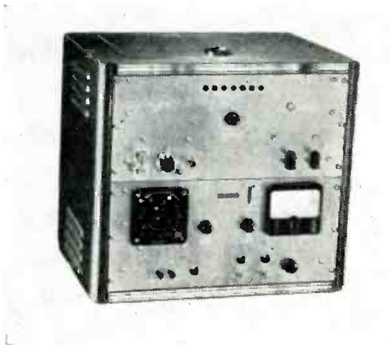
ELTRON INC., 407 North Jackson St., Jackson, Mich. Model 103D-6 hermetically-sealed, miniature, high-voltage power supply was designed for use in military Geiger-counter equipment. It operates from a 3-volt battery and delivers a regulated and filtered output of 900 volts d-c. The unit employs a novel four-pole vibrator used in a self-rectifying voltage-multiplier circuit. Power outputs ranging from a few milliwatts to about three watts can be furnished efficiently at output voltages as high as 2,500 volts.

Recording Counter

POTTER INSTRUMENT CO., INC., 136-56 Roosevelt Ave., Flushing, N. Y., announces the highspeed Teledeltos paper recorder for use with counters and counter-chronographs. The count or time interval normally registered on the electronic counter indicator lamps is transferred to Teledeltos paper at the completion of each measurement and the counter is automatically reset for the next measurement. The recorder illustrated is connected to a 1.6-mc counter-chronograph and was designed for measurements of machine-gun projectile velocity. It will measure and record time intervals with an accuracy of 0.625 μsec at repetition rates up to 25 per second.

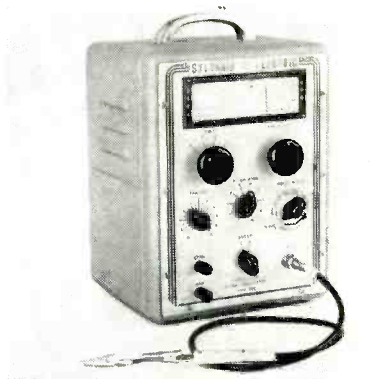
VTVM and Multirange Tester

PRECISION APPARATUS CO., INC., 92-27 Horace Harding Blvd., Elmhurst, N. Y. Series EV-20 portable vtvm and multirange test set is a complete vtvm-megohmmeter with true zero-center on all vtvm ranges, plus direct-reading h-f scales. It also provides full standard 100 ohms-per-volt functions. The unit affords 48 ranges to 1,200 volts, 2,000 megohms, 12 amperes, +63 db; and d-c vtvm ranges to 12,000 and 30,000 volts when used with the tv superhigh-voltage test probe.



All-Purpose Scaler

NUCLEAR INSTRUMENT & CHEMICAL CORP., 229 W. Erie St., Chicago, Ill. The Ultra-Scaler illustrated provides facilities for every type of counting by either automatic or manual methods within one instrument. It incorporates a built-in timer which may be set for a predetermined length of time and will then turn off the scaling unit automatically. The unit has two inputs, one for Geiger pulses and the other for very small proportional pulses requiring linear amplification. The Higinbotham-type scale of 128 has a resolution time of 2 μsec. Stabilized high voltage is available up to 2,500 v, and a built-in register indicates total number of counts.



Tele Signal Generator

SYLVANIA ELECTRIC PRODUCTS, INC., 500 Fifth Ave., New York 18, N. Y., has announced the type 500 sweep signal generator for servicing f-m and television receivers. Its f-m sweep range is from 0 to 600 kc, and television sweep from 0 to 15 mc. Fundamental output frequencies are provided that range from 2 to 230 mc, in four bands. Output is at least 100 mv on all bands controlled by a smooth attenuator.

Test Transformer

RADIO CORP. OF AMERICA, Harrison, N. J. The WP-25A television Isotap, a combination autotransformer

(Continued on p 192)

CHARACTERISTICS OF RCA MULTIPLIER PHOTOTUBES

Tube No.	Spectral Response	Maximum Response Wave Length Angstroms	Sensitivity uA/uW	Equivalent Noise Input—Lumens
5819	S-9	4800	4650	2×10^{-11}
931-A	S-4	4000	9300	1×10^{-11}
1P21	S-4	4000	74000	5×10^{-13}
1P22	S-8	4200	370	1×10^{-10}
1P28	S-5	3400	5665	1×10^{-11}
				*1.5×10^{-14}

**Equivalent ultra-violet noise input in watts at 2537 Angstroms*

The Fountainhead of Modern Tube Development is RCA

RCA Multiplier Phototubes...

for low-level detection and measurement

The extraordinarily high values of amplification obtainable from RCA Multiplier Phototubes make them particularly applicable to the detection and measurement of low levels of illumination. Coupled with suitable phosphors, these tubes may also be used for detecting and measuring nuclear particle radiation. The secondary-emission multiplier stages employed in these tubes make possible improved signal-to-noise ratio at very low illumination levels.

RCA-5819 with its head-on photocathode of large diameter may be used in scintillation counters for the detection and measurement of nuclear particle radiation, and in other applications involving low-level, large-area light sources.

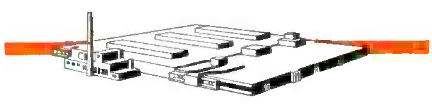
RCA-931-A is the preferred type for high-volume, low-cost applications.

RCA-1P21 now has a sixfold improvement in noise input. It is especially desirable for photo-electric spectrometers, astronomical telescopes, and scintillation counters using collimated light beams.

RCA-1P22 is especially useful in colorimetry and spectroscopy requiring the advantages of a panchromatic surface.

RCA-1P28 is intended for specialized industrial and scientific applications such as spectrophotometry, where the measurement of low levels of ultraviolet radiation is involved. Its envelope of special glass permits transmission of ultraviolet radiation down to a wavelength of 2000 Angstroms.

RCA Application Engineers are ready to assist you in the adaptation of these or any other RCA tube types to commercial electronic equipment. For further information write RCA, Commercial Engineering, Section F42R, Harrison, N. J.



The world's most modern tube plant...

RCA, LANCASTER, PA.

RADIO CORPORATION of AMERICA

ELECTRON TUBES — **HARRISON, N. J.**

NEWS OF THE INDUSTRY

Edited by WILLIAM P. O'BRIEN

Round-the-World Radio Signals in 55 Hops

VERY-LOW-FREQUENCY radio signals traveling completely around the world have now been detected by Jack N. Brown of the National Bureau of Standards. The signals, transmitted from the Naval Radio Station NSS at Annapolis, Maryland, on a frequency of 18 kc with a power of 350 kw, were received at the National Bureau of Standards radio propagation field station at Sterling, Virginia, about 50 miles away. Normal delay time for a round-the-world signal was more than a tenth of a second, and maximum signal intensity was observed at sunset.

The round-the-world signals were received, with the aid of a large loop antenna 150 feet high, on a tuned-radio-frequency receiver. A dual-beam oscilloscope was connected ahead of the detector stage in the receiver so that the actual unrectified r-f envelope was displayed on the 5-inch screen along with an 18-kc reference voltage. The delay time of the round-the-world signals was measured by making a moving film record of the oscilloscope screen.

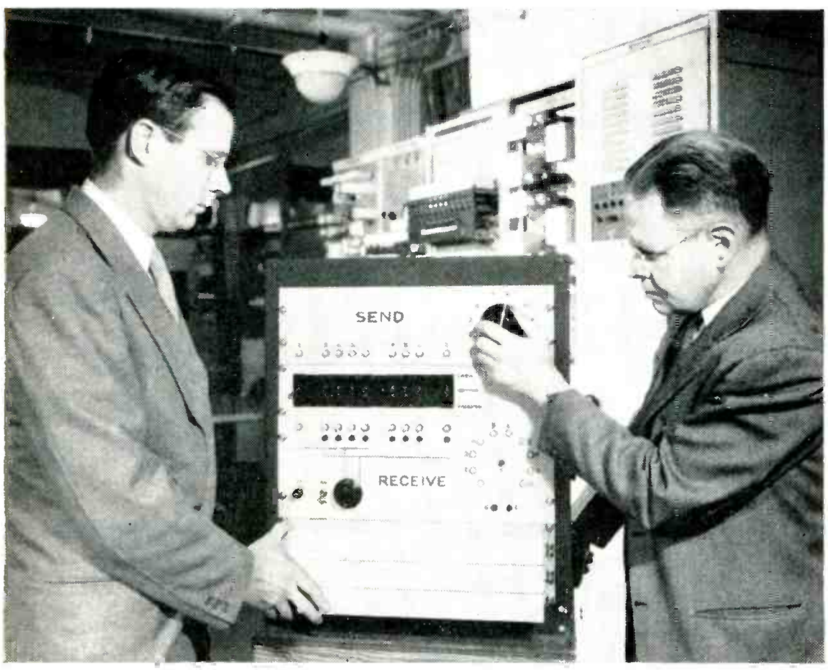
The test signal transmitted from NSS consisted of a series of dots, each dot followed by a quiet period equal in duration to five dots. The test tape was transmitted at normal sending speeds, so that the pulse length of each dot was about 40 milliseconds with a repetition rate of four pulses a second.

During the winter months when these tests were conducted, the delayed signal was visible throughout the entire day. Observations of field intensity over several 24-hour periods disclosed the striking sunset maximum. A sharp peak in signal strength at 4:30 p.m. corresponded to optical sunset at the place of transmission and reception. It is an observed fact that low-frequency signals are severely attenuated when their path crosses a sunset zone. Any round-the-world signal must cross a sunset zone except during that portion of the day when the sunset zone is at the transmitter-receiver location. This explains the relatively greater strength of the signals at sunset in the transmitter-receiver location.

Delay times were measured on two different occasions under widely differing ionosphere conditions. Measurements were made first during a severe ionosphere storm, and a second set of measurements were made on a normal day. The average delay time during the storm was 0.1365 ± 0.0005 second, but on a normal day the average was 0.1373 ± 0.0005 second. The shorter delay time during a storm may be explained by the slightly lower effective height of the reflecting layer of the ionosphere under the influence of corpuscular bombardment from the sun. In any case the average values indicate a shorter propagation path for l-f signals during an ionosphere storm.

The transmission of radio waves over long distances may be thought of either as the propagation of a guided wave between the concentric spherical surfaces formed by the earth and the ionosphere, or as successive multiple reflections from the earth and the ionosphere. Within the limits of a ray approximation, both pictures yield the same results. For the delay time on a normal day (0.1373 sec) the number of hops corresponding to an ionosphere height of 65 kilometers is 55 for one trip around the earth. The length of each hop is thus 728 kilometers and the angle of takeoff is 8 degrees.

ADVANCED COMPUTER TECHNIQUES



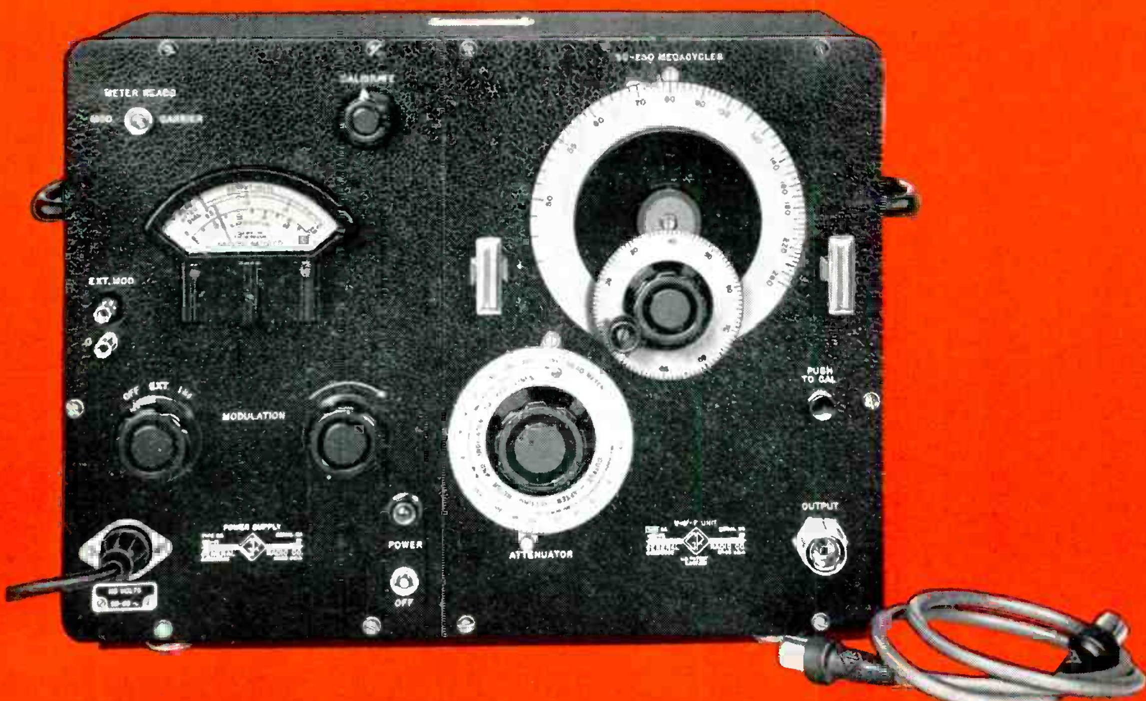
A means for endowing modern computers with a whole new faculty, the ability not only to detect their own mistakes but actually to correct them, has been developed at Bell Telephone Laboratories. The basic concepts underlying the new technique are the direct result of pure mathematical research carried out by Dr. R. W. Hamming (left), Bell Laboratories mathematician. Apparatus incorporating the mathematical discovery has been constructed under the direction of B. D. Holbrook (right), Bell Laboratories switching research engineer

Carrier-Current Measurements Meeting

A MEETING is scheduled to be held June 6, 1950 in the offices of the Federal Communications Commission for the purpose of establishing a joint industry-government committee to obtain field intensity measurements of line radiating devices and systems. Six working groups are now engaged in procuring field data.

All interested persons are invited

Announcing A New GR Standard Signal Generator



50 to 920 Mc

THE new General Radio Type 1021-A Standard-Signal Generator operates at frequencies between 50 and 920 Mc with the same convenience and reliability found in other G-R generators in the broadcast frequencies.

Its main use is the determination of radio receiver and circuit characteristics. With an inexpensive diode modulator, television picture modulation can be produced for overall testing of television receivers.

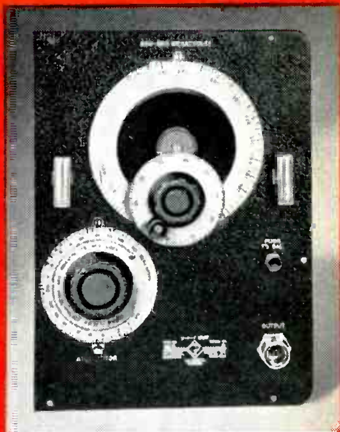
It is a convenient and well-shielded source of power for measurements with bridges, impedance comparators, and slotted lines. For these uses internal modulation is provided.

With the new G-R Type 874 line of Coaxial Elements, this generator provides a very complete and flexible system for measurements of voltage, power and standing-wave ratio from 50 to 920 Mc.

FEATURES

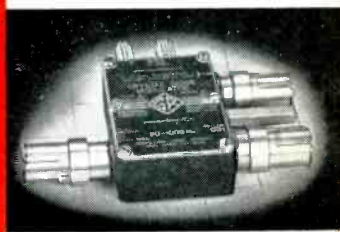
- **SIMPLICITY, RELIABILITY, CONVENIENCE** of a standard broadcast generator. **ACCURATE · COMPACT · LIGHTWEIGHT**
- **MODERATELY PRICED**
- **BUTTERFLY TUNING CIRCUIT** . . . no sliding contacts . . . no noise . . . perfectly smooth tuning . . . rugged design with good stability and very low drift
- **REGULATED POWER SUPPLY** assures good heterodyne beat note
- **OUTPUT FROM 0.5 MICROVOLT TO ONE VOLT** with overall accuracy better than ±20%
- **INTERNAL OUTPUT IMPEDANCE** 50 ohms
- **LEAKAGE AND RESIDUAL OUTPUT VOLTAGE** below sensitivity of most receivers
- **INTERNAL 1000-CYCLE AND EXTERNAL AMPLITUDE MODULATION** over audio range, adjustable from 0 to 50% . . . incidental fm under 100 parts per million over most of the ranges
- **T-V PICTURE MODULATION ON ALL CHANNELS** from 50 to 920 Mc with NO INCIDENTAL FM, when Type 1000-P6 Crystal-Diode Modulator and source of video signals are used. The power requirements for modulation are so low, video output from a standard T-V receiver can be used

TYPE 1021-AV V-H-F Standard-Signal Generator (50-250 Mc)...............	$595.00
TYPE 1021-AU U-H-F Standard-Signal Generator (250-920 Mc).............	615.00
TYPE 1000-P6 Crystal-Diode Modulator..	35.00



Type 1021-P2 Oscillator Unit (250-920 Mc) Two separate oscillators are available. They are mechanically and electrically interchangeable, and are sold as separate units to convert the range of one standard-signal generator to that of the other.

TYPE 1021-P2 U-H-F Oscillator Unit only (250-920 Mc)....	**$420.00**
TYPE 1021-P3 V-H-F Oscillator Unit only (50-250 Mc).....	**$400.00**



Type 1000-P6 Crystal Diode Modulator An inexpensive, wide-band modulator for amplitude modulation of carrier frequencies between 20 and 1000 Mc. Modulation-frequency range is 0 to 5 Mc. **$35.00**

GENERAL RADIO COMPANY Cambridge 39, Massachusetts

90 West St., New York 6 920 S. Michigan Ave., Chicago 5 1000 N. Seward St., Los Angeles 38

to attend. It is desirable that all participating persons come prepared to present and discuss such data as they may have available. The Commission suggests that all data and reports be furnished with copies for distribution to other persons present. All information received will be carefully considered and future plans projected.

Nonferromagnetic Synchrotron

SUCCESSFUL operation in its first phase of a new type of atom smasher, which is ultimately expected to produce X-rays of 300,000,000 volts, was announced recently by Dr. C. G. Suits, vice-president and director of research for General Electric Co. Schenectady, N. Y.

The new machine, known as a nonferromagnetic synchrotron, is being built under the joint sponsorship of the Office of Naval Research and the GE Research Laboratory. It has been operated thus far up to about a million volts and probably it will be in operation at much higher energies before the end of the year. It will be used to study the effects of high-energy radiation, particularly in nuclear research.

The new particle accelerator is of a design that eliminates the huge iron-core electromagnet commonly used in such devices. The requisite powerful magnetic fields are produced solely by specially designed coils of wire. These carry heavy currents, and are contained in a steel tank from which air has been exhausted.

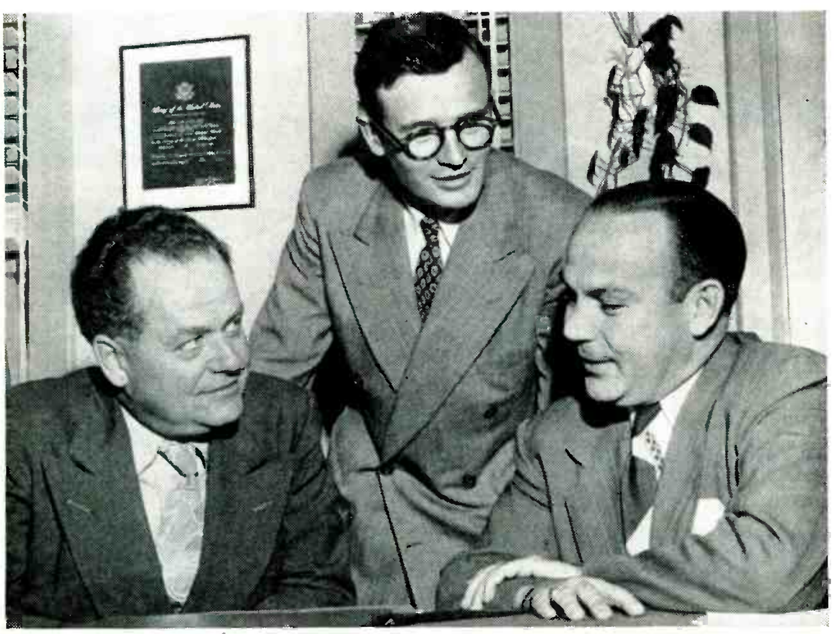
First erected in one of the old buildings of the GE Research Laboratory in downtown Schenectady, the new synchrotron is now being installed in its own building at the Laboratory's new quarters at the Knolls, in nearby Niskayuna.

The first operating synchrotron in the United States was completed in 1946 in the GE Research Laboratory. This 80,000,000-volt machine also was sponsored by the Office of Naval Research. In this synchrotron there is a doughnut-shaped vacuum tube, placed between the poles of an 8-ton electromagnet. Inside the tube is an electron gun. The electrons fired from it, guided by the magnetic field and accelerated by the increasing magnetic induction, reach energies of several million volts. Their speed is then practically that of light. Up to this point the operation is similar to that of another type of accelerator, the betatron.

In the nonferromagnetic synchrotron there is a cylindrical steel tank

(Continued on page 232)

PACIFIC ELECTRONIC EXHIBIT PLANNED



Discussing plans for the 6th annual Pacific Electronic Exhibit to be held in the Municipal Auditorium, Long Beach, Calif., Sept. 13, 14 and 15, 1950, are, left to right: L. W. Howard, general show committee chairman of WCEMA, which sponsors the exhibit; R. L. Sink, chairman of the Los Angeles Section of IRE and L. C. Sigmon, IRE liaison chairman for the exhibit

MEETINGS

JUNE 1–2: Fourth National Convention and Fifth Midwest Conference of the American Society for Quality Control, Milwaukee Auditorium, Milwaukee, Wisc.

JUNE 12–16: AIEE Summer and Pacific General Meeting, Huntington Hotel, Pasadena, Calif.

JUNE 19–20: 1950 annual convention of the American Society for Engineering Education, University of Washington, Seattle, Wash.

JUNE 26–30: Annual Meeting and 9th Exhibit of Testing Apparatus and Related Equipment, Hotel Chalfonte-Haddon Hall, Atlantic City, N. J.

JUNE 26–JULY 22: Summer Electronics Symposium, University of Michigan, Ann Arbor, Mich.

AUG. 27–31: NEDA National Convention and Exhibition, Cleveland Public Auditorium, Cleveland, Ohio.

AUG. 28–31: APCO National Conference, Hotel Hollenden, Cleveland, Ohio.

SEPT. 11–23: URSI Ninth General Assembly, Zurich, Switzerland.

SEPT. 13–15: 1950 IRE West Coast Convention and Sixth Annual Pacific Electronic Exhibit, Municipal Auditorium, Long Beach, Calif.

SEPT. 18–22: Fifth National Instrument Conference and Exhibit, Memorial Auditorium, Buffalo, N. Y.

SEPT. 25–27: National Electronics Conference. Edgewater Beach Hotel, Chicago, Ill.

OCT. 3–5: AIEE District No. 2 Meeting, Lord Baltimore Hotel, Baltimore, Md.

How SYLVANIA helps to beat News-Photo deadlines →

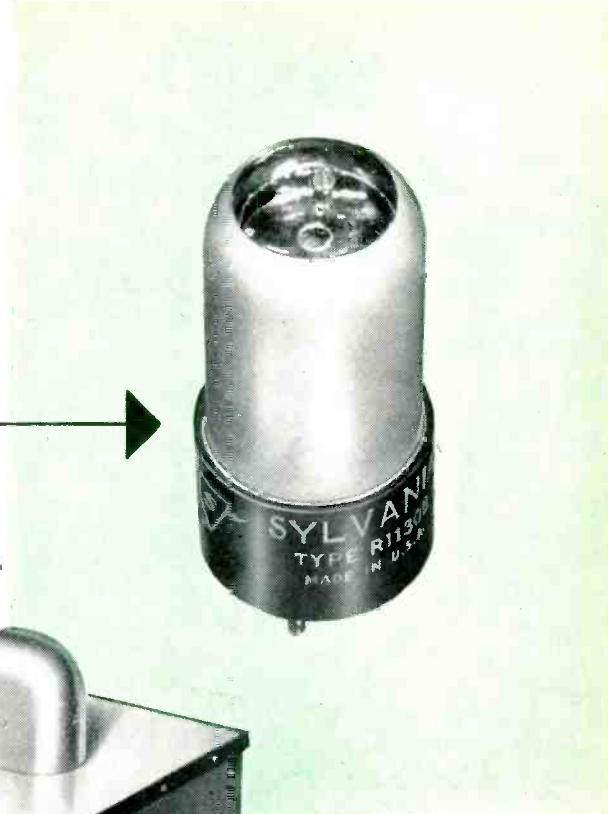


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Photo-electric Engraver ←

In just 6 minutes, this new Fairchild engraver will turn out a tough, plastic one-column halftone, all ready to go to press.

At the heart of this machine, a Sylvania Glow Modulator Tube "beats" at the rate of 240 cycles per second to produce a halftone screen on a plastic sheet by means of a red-hot pyramid-shaped stylus.

This Sylvania tube, capable of supplying modulated light output flat to 10,000 cycles, is used in conjunction with a photo cell to scan the picture to be reproduced. The resulting signal consists of a carrier, modulated by a current representing the contrast in picture detail. This signal is amplified, and applied to the hot stylus which engraves the plastic plate.

The many unusual uses of the Sylvania R1130B Glow Modulator Tube are made possible by its ability to produce a pin-point of light which varies linearly with current. For further information and latest catalog sheet covering Sylvania Glow Modulator Tubes, *mail the coupon today.*

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City.......... *Zone*.......... *State*..........

NEW BOOKS

Electron Tube Circuits

BY SAMUEL SEELY. *McGraw-Hill Book Co., New York*, 1950, 528 *pages*, $6.00.

A BOOK to cover the field of electron-tube circuits could easily fill a five-foot shelf all by itself. Professor Seely, therefore, has shown admirable restraint in producing a volume that is not only good looking from the standpoint of modern book design and format but which is of very reasonable size. He has done this by dividing the subject into certain broad divisions, by presenting a coordinated account of each division, by giving an analysis of characteristic examples of the use of tubes and circuits in these divisions, and by avoiding unnecessary details in describing any particular example or by giving too many examples.

The aim is to equip a student with the analytical power to study tube circuits. With such power the problems of design become simple.

About half of the book deals with circuits useful to radio engineers; the rest of the material covers radar, television, pulse communication and electronic control. Since it is not a radio book, there is nothing about radiation or about systems in it. There are 22 chapters and they cover amplifiers, oscillators, rectifiers, modulation and demodulation, relaxation circuits, sweep generators and electronic instruments.

The analytical techniques employed will be the chief interest for an engineer already trained; for the student the book will provide a high-level course; and if either understands the text sufficiently to work the problems correctly, he will be well on his way toward being a most competent electronics engineer.—K. H.

Theory and Design of Electron Beams

BY J. R. PIERCE, *Bell Telephone Laboratories, Inc. D. Van Nostrand Company, Inc., New York*, 1949, 197 *pages*, $3.50.

WELL-KNOWN J. R. Pierce has brought out a new book intended for those students and scientists interested in the behavior of electron beams. Written on the graduate level, it discusses that material on

(continued on page 135)

BACKTALK

This Department is Operated as an Open Forum Where Readers May Discuss Problems of the Electronics Industry or Comment Upon Articles Which ELECTRONICS Has Published

Video on Tape

DEAR SIRS:

YOUR EDITORIAL comment regarding Howard Chinn's ideas on recording television signals on magnetic tape started me to figuring out sizes and such.

I find that with the present state of the art the tape would have to be driven at 500 inches per second which is 41⅔ feet. In order to record a fifteen-minute program 37,500 feet of tape would be required, which could be wound on a spool having an outside diameter of 38 inches and a hub diameter of 10 inches. These figures preserve the same ratios as found in the popular seven-inch plastic spool. This spool would be required to revolve at approximately 950 revolutions per minute when nearly empty of tape. At this speed the rim would be making a speed of nearly two miles per minute.

At 500 inches per second the top frequency which could be reproduced would be about 500 kilocycles. The low end could be carried down to about 500 cycles without excessive equalization in the playback amplifier. For a 500-cycle low end the equalization required would be approximately 45 decibels. In order to carry the response down to 20 cycles the equalization required would be about 70 decibels.

Basing the design on a quarter-inch effective track width a piece of tape two inches wide would be required for a four-megacycle bandwidth. This all assumes that the problems of signal-to-noise ratio and differential phase shift could be overcome.

Not the least in importance is the cost of a fifteen-minute recording. Basing the computation on a 1,200-foot spool of 0.250-in.-wide tape costing $5.50, the 37,500 feet of two-inch material would come to $1,375.

I think it must be obvious that this approach is impractical, but I am sure the job will be done before too long.

JOHN S. BOYERS
Chief Engineer
Magnecord, Inc.
Chicago, Ill.

Let's Settle It

DEAR SIRS:

FOR A NUMBER of years you and I and numerous others have been busily engaged in this thing tacitly called electronics, earning our living thereby and creating a myriad of useful and maybe not-so-useful de-

(continued on page 242)

electron beams which lends itself most readily to mathematical analysis, although some attention is also given to experimental techniques. This book fills a definite need because most previous books on electron optics are intended for people whose primary interest is electron microscopes and image tubes and, therefore, include extensive treatments of such topics as aberrations.

Dr. Pierce's book is clearly intended for those concerned with the formation and focusing of electron beams for use in such devices as low-frequency amplifiers, oscillators, and, especially, microwave tubes.

The first part of the book deals with the basic concepts of the properties of electric and magnetic fields, the forces and equations of electron motion, and examples of simple electron motions. These concepts lead to some general relations such as Busch's and Liouville's theorems, trapping of electrons in symmetrical electric and magnetic fields, and index of refraction in electric fields. Special techniques (solution by inspection, rubber model, and tracing of paths) are treated.

The author develops the important paraxial-ray equation and its solution for electric and magnetic lenses. The properties of electric and magnetic lenses are fully discussed and both analytical and numerical solutions are presented for various important basic examples. Final chapters are devoted to the discussion of the Effect of Thermal Velocities, Space Charge in Electron Beams, and Electron Guns Utilizing Rectilinear Flow. The reader will also find information on such interesting topics as, for instance, "How Nearly Can The Limiting Current Density be Approached", effect of ions on limiting current density, and cathode-ray tube after-acceleration as affected by thermal velocities.

The book contains numerous illustrations and the reader is often given the benefit of the author's experience because comparisons between theory and practice are frequent. All chapters are followed by excellent problems which are so chosen as to bring out certain points and are typical of the prob-

TECHNICAL BOOKS

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by Milton Kaufman

This book is a most complete and comprehensive treatment of the subject and should prove especially valuable as a quick review of essential theory, as well as a refresher for advancement in the field. It lists all the QUESTIONS and ANSWERS for the FCC examinations. However, the outstanding feature of this volume is its thorough FOLLOW-THROUGH . . . a carefully simplified discussion of the answer to the technical question . . . so necessary for a complete and absolute understanding of the answer. Useful appendices, which include Small Vessel Direction Finders and Automatic Alarm, not ordinarily available in a book of this type, provide a valuable "extra."

608 pages, 193 explanatory diagrams **$6.00**

FM TRANSMISSION AND RECEPTION

by John F. Rider and Seymour D. Uslan

Up-to-date • Basic • Complete

For the student who is grooming himself for activity in the electronic field. This book covers the subject of frequency modulation thoroughly in a down-to-earth treatment of all types of FM systems employed in television, amateur radio, railroad, aviation, marine, police, point-to-point and mobile receivers. Basic theory, transmission, reception, circuit design and servicing are covered, with mathematics kept to an absolute minimum. Almost all presently used commercial FM transmitters are described in detail. Question section follows each chapter.

416 pages, profusely illustrated **$3.60**

INSIDE THE VACUUM TUBE

by John F. Rider

No other book explains so simply and clearly the theory of the vacuum tube and its operation. In plain language—with fascinating pictures and diagrams that really tell a story—you get a solid grounding in theory and a good working knowledge of basic tube types. It's concise, it's accurate.

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UNDERSTANDING VECTORS AND PHASE IN RADIO

by John F. Rider and Seymour D. Uslan

A Shorthand Method to Easier Understanding of Radio Theory

Written for the student and for any man learning, in radio and electronics, who has not had the advantage of previous extensive mathematical education. Step by step, the subject is developed, until finally its application to everyday radio problems is demonstrated.

160 pages, amply illustrated, cloth cover **$1.89**
paper cover .... **.99**

NEW . . . COMING SOON!

TV AND OTHER RECEIVING ANTENNAS (Theory and Practice)

by Arnold B. Bailey

This book is a rare combination of theory and practice that: 1.—Clearly explains and teaches. 2.—Can be used as a daily work reference.

An outstanding book, the like of which has never before been written. And since the author has resolved the mathematics of antenna problems into graphs, charts and tables—it can be put to good use by all. Reflecting world-wide knowledge of the antenna art, it clearly explains the theory behind the performance of every type of 30-1000 Mc receiving antenna on the commercial market, leaving the reader with a full understanding of why each behaves as it does. Practical in every sense of the word.

More than 500 pages, 6" x 9", cloth bound **$4.50**

ENCYCLOPEDIA ON CATHODE-RAY OSCILLOSCOPES AND THEIR USES

by RIDER et al

The greatest and most complete reference book ever written on the cathode-ray tube! It is a practical, down-to-earth encyclopedia about five times the size of the old standard text. Starting with basic theory of cathode-ray tube operation, it proceeds through application in scopes and TV receivers . . . with full and clear explanations for uses in every field and research activity which employs a cathode-ray oscillograph. All scopes produced and sold during the last 10 years, more than 70 different models are described completely—with schematic wiring diagrams. Almost 500,000 words and about 3,000 illustrations are incorporated in more than 900 pages. It is a book which will enjoy years and years of daily use. 22 chapters.

8½ x 11 inches **$9.00**

TELEVISION INSTALLATION TECHNIQUES

by Samuel L. Marshall

This book, written by Mr. Marshall, television instructor at the George Westinghouse Vocational High School, is a practical, easy-to-understand treatment of information pertaining to the antennas, transmission lines, receiver adjustments, and above all, the mechanical requirements, whether they be for short mast for chimney attachment or for the installation of a tower, including foundation. Both theoretical and practical aspects of every phase of this activity, from the topmost element of the antenna to the ground connection on the receiver terminal board, are fully discussed.

VACUUM-TUBE VOLTMETERS

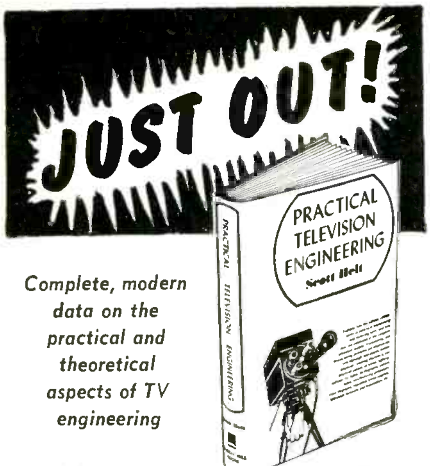
by John F. Rider

New • Revised • Enlarged

Now completely revised, enlarged, and thoroughly up-to-date, this volume explains theory and functions of the different types of vacuum-tube voltmeters. A special section is devoted to d-c and r-f probes and the concluding chapter discusses the latest commercial types of vacuum-tube voltmeters, complete with schematic diagrams.

JOHN F. RIDER PUBLISHER, INC.

480 CANAL ST., NEW YORK 13, N. Y.



Complete, modern data on the practical and theoretical aspects of TV engineering

PRACTICAL TELEVISION ENGINEERING

by Scott Helt

Research Division Allen B. Du Mont Laboratories —Instructor, Columbia University

700 pages, 6x9, 385 illus., $7.50

Here, just off the press, is the first book since the war which covers the entire field of Television from the viewpoint of a practical engineer actually employed in the field. Written by one of the industry's pioneers, it provides a sound knowledge of both theory and actual working practice, particularly as related to Television manufacturing and broadcasting.

Starting with the fundamentals of video transmission, PRACTICAL TELEVISION ENGINEERING progresses logically and understandably through every phase of its subject. Far from being a re-hash of old and often outmoded material, it brings you up-to-the-minute details of the latest developments, trends, problems, data and specific engineering know how.

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(Cash only outside U.S.A., same return privilege.)

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NEW BOOKS (continued)

lems encountered in the design and application of cathode-ray tubes, magnetrons, electron multipliers and similar devices. There are also frequent footnotes giving references for those wishing more information on specific subjects. The mks system of units is used.

It is to Dr. Pierce's credit that he has written a clear book on an especially difficult subject. The reader will do well, however, to have some background in electron ballistics. The book seems to suffer in organization to some extent, in that the content, although systematically arranged, is not continuous and is often a series of discussions of specific topics. Nevertheless, the book gives promise of becoming a bible in its field, both in the classroom and in the laboratory.—FRANK R. ARAMS, *Tube Dept., Radio Corp., of America, Lancaster, Penna.*

Television Antennas

BY DONALD A. NELSON. *Howard W. Sams & Co., Inc., Indianapolis, Indiana*, 1949, 166 *pages, paper-covered*, $1.25.

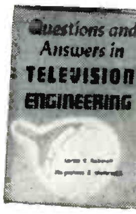
WAYS and means of converting a transmitted television signal to microvolts at the receiver input, to guide service technicians in selection and installation of suitable antennas and accessories for each location. The six chapters cover: Receiving Antenna Principles; Antenna Construction; Commercial Antennas; Antenna Installation; Common Installation Problems. Clearly written and liberally illustrated, it forms an excellent and inexpensive guide for the electronic engineer who chooses to install and adjust his own television antenna. —J.M.

Industrial Electronics

BY ANDREW W. KRAMER. *Pitman Publishing Company, New York*, 1949, 311 *pages*, $6.00.

This book is intended for readers who have "a good knowledge of general physics and engineering but who have had very little training or experience in electronics." To a very great extent, this purpose has been achieved, and a reader who has the time and initiative to sit

JUST PUBLISHED!
Question and Answers in TELEVISION ENGINEERING



1. This new manual gives you the most recent data on television transmitters, commercial receivers, and all phases of general theory in television engineering. Covers intercarrier sound, dual focus, germanium crystal detectors, and selenium power rectifiers. Answers the problems of the television serviceman, technician and others . . . gives FCC standards and regulations . . . discusses latest design factors in RF section of television transmitter, etc. Includes completely worked-out mathematical problems. By C. V. Rabinoff and M. E. Wolbrecht. 300 pages. $4.50

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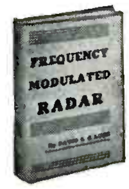

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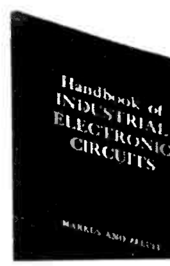

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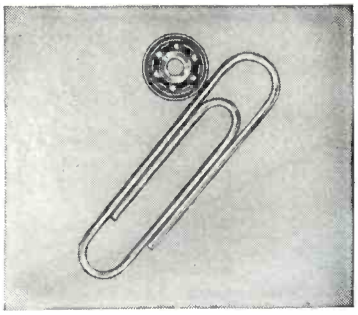

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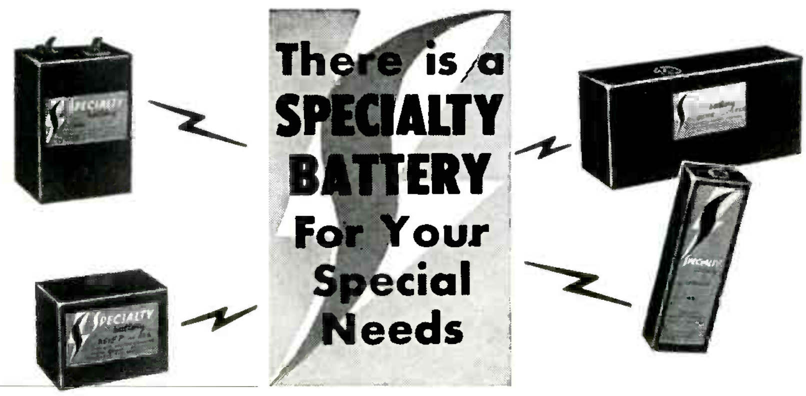

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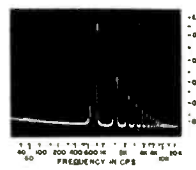

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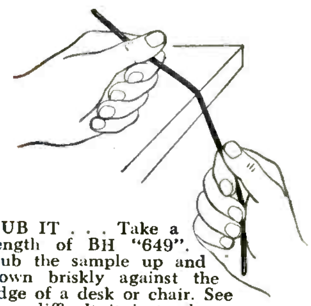

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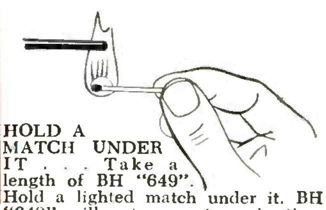

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BOONTON, NEW JERSEY, U. S. A.

down and assimilate the contents of this book can emerge enlightened in the field of electron tubes of all important types, and their application to industrial measurement, production and control problems.

As pointed out by the author in his preface, the basic material for much of this book appeared first in a series of articles on electron tubes published in *Power Plant Engineering* (of which the author is editor), from 1936 to 1939. As such, it is not recognizable, for many improvements and additions have been made.

The book begins logically with a general picture of the history and basic requirements of electronics in industry. Approximately the first 185 pages deal in generalities of tube characteristics and electron behavior, and the remaining sections cover specific applications.

One particularly obvious disadvantage to the application portion of the book is the absence of values for circuit components and of detailed calibration and installation information. However, wherever possible, the author has referred to the literature where additional information of such nature may be obtained.

It is questionable that this book would be of much value as a reference book. Its components are arranged in a logical teaching order, but for circuit references and engineering-level information, it falls slightly short of the mark. It should be, however, a welcome addition to the student's reading list while he is engaged in a course in electronics.—J.D.F.

The Characteristics of Electrical Discharges in Magnetic Fields

National Nuclear Energy Series, Division I, Volume 5, EDITED BY A. GUTHRIE AND R. K. WAKERLING. *McGraw-Hill Book Co., New York,* 1949, 376 *pages,* $3.50.

THIS BOOK presents mainly the experimental results and supporting theory on the characteristics of the arc discharge produced by an electron beam, the arc being subjected to a strong magnetic field and confined in a rather specialized volume;

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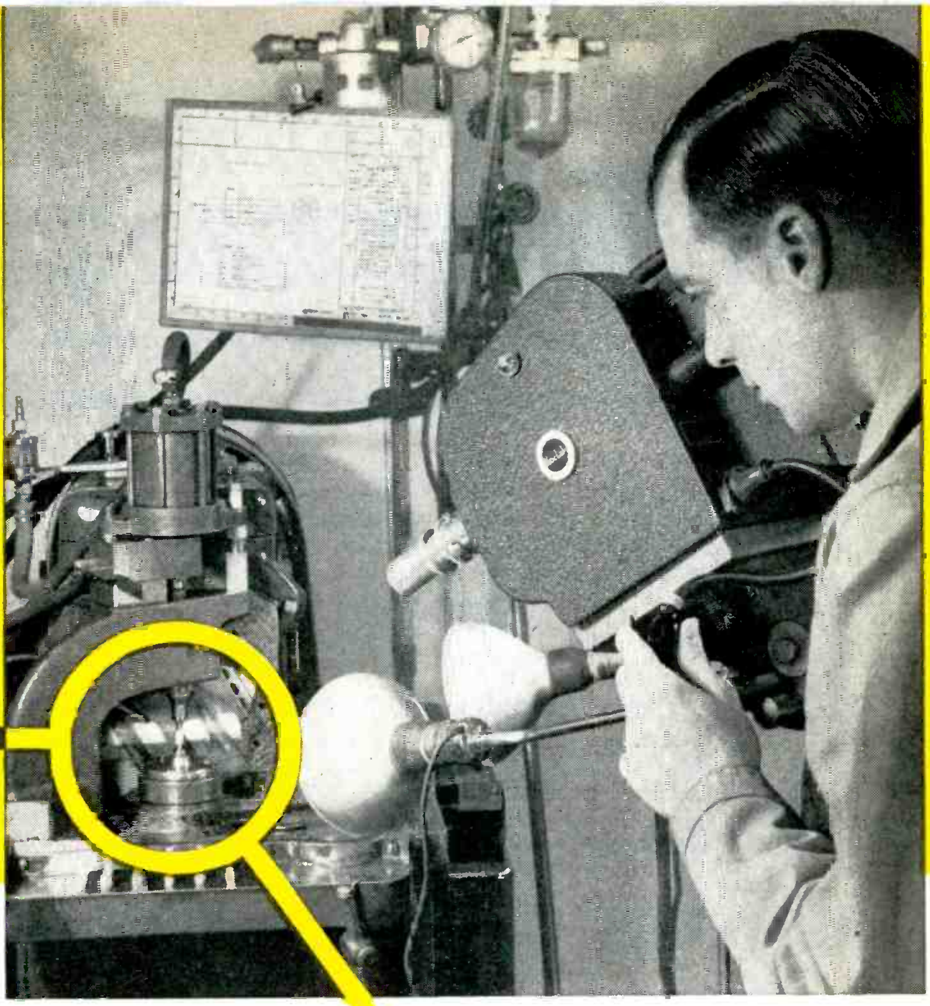

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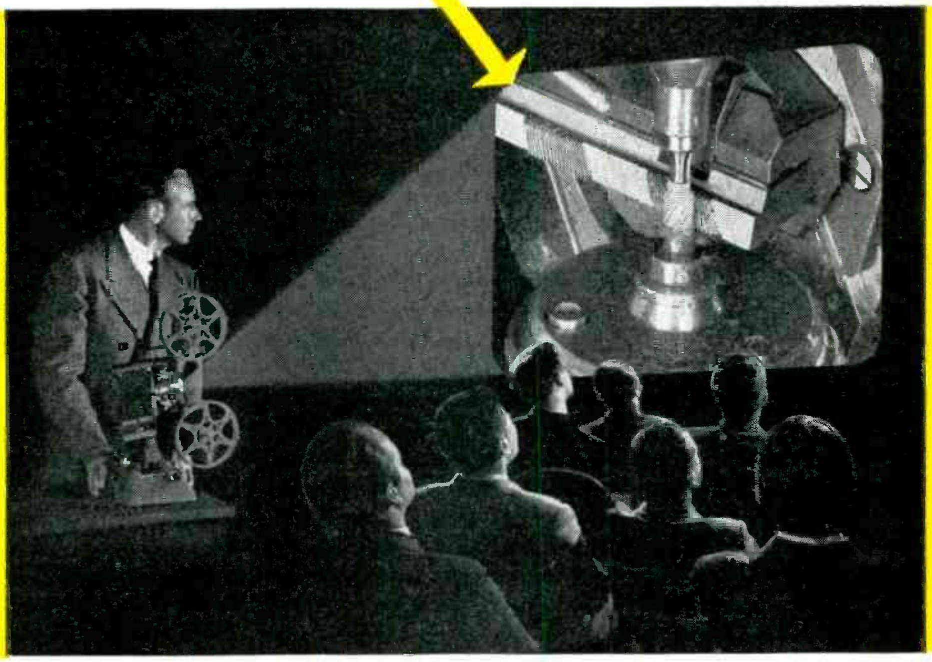

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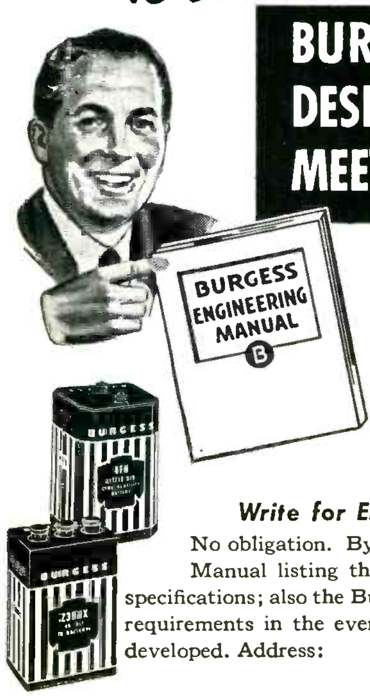

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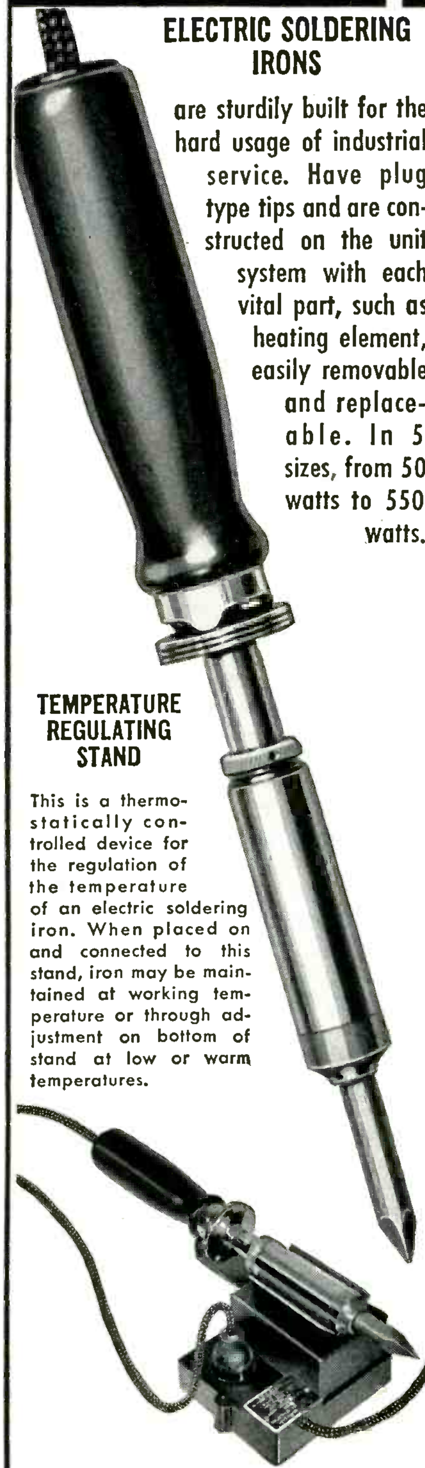

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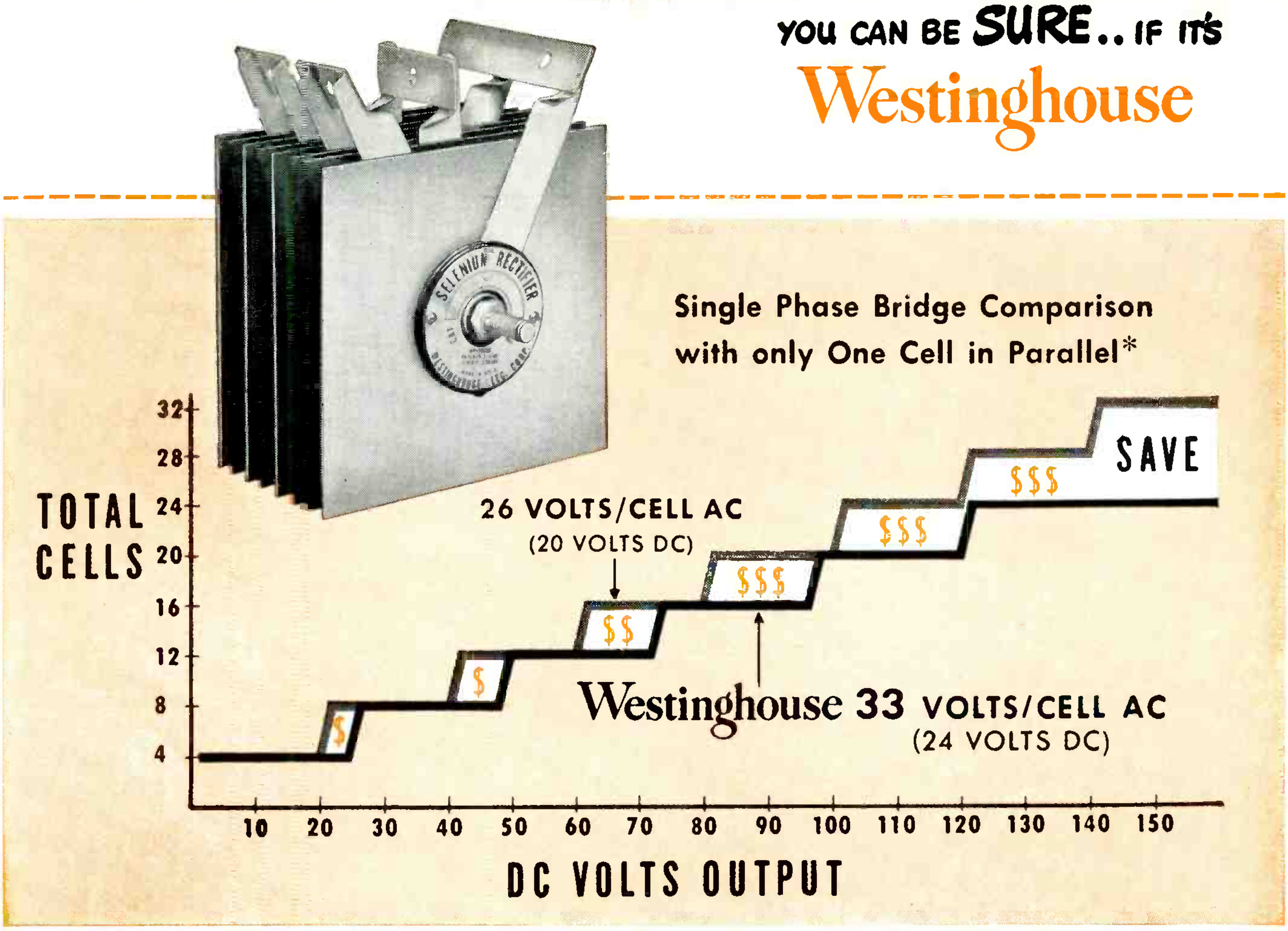

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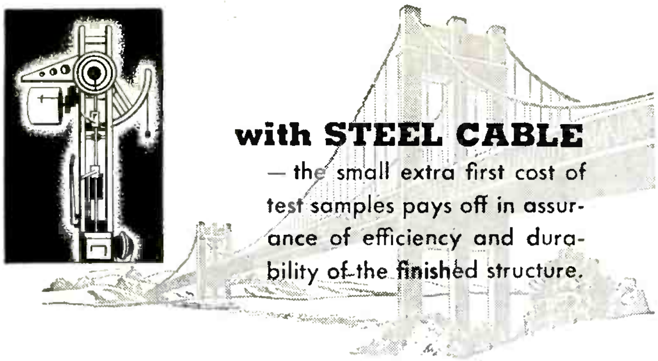

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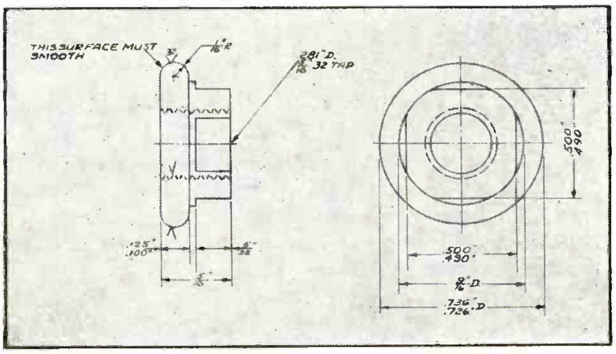

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the principal parameters studied and displayed are type of gas, gas pressure, ion currents, arc currents and voltages and their space distributions, and the magnetic field intensity.

The contents are derived principally from technical reports issued by the Radiation Laboratory of the University of California during the progress of their work. Although these reports were not written with this volume in mind, skillful editing has created a creditable degree of unity and clarity. Three of the chapters were written specifically for this volume, the first aiding considerably the general orientation of the reader to this rather specialized subject.

Workers concerned with the problems of ion production by these means will find a great amount of valuable detailed information, even though the scope of the information is considerably less than the title suggests. This book suggests a number of problems for further investigation, and is therefore of interest to research workers looking for new problems. One of these problems of fundamental interest, to which reference is made throughout the book, is that of high-frequency oscillation of the plasma. The immediate aims of war-time development apparently excluded a study of this phenomenon at that time.

The several introductions to the book merit particular attention because they explain the aims of the National Nuclear Energy Series and the constraints applicable to the publication of such a great volume of material. These explanations allay to a great extent any criticism which might arise from judging this book by all of the conventional standards of technical publications.—WALTER E. TOLLES, *Airborne Instruments Laboratory, Mineola, New York.*

Radar Systems and Components

BY BELL TELEPHONE LABORATORIES STAFF MEMBERS. *D. Van Nostrand Co., New York,* 1949, 1,042 *pages,* $7.50.

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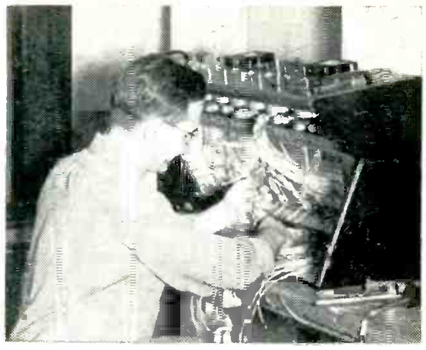

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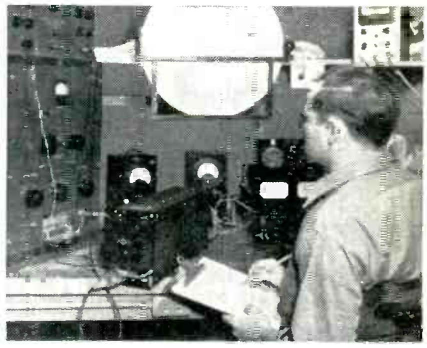

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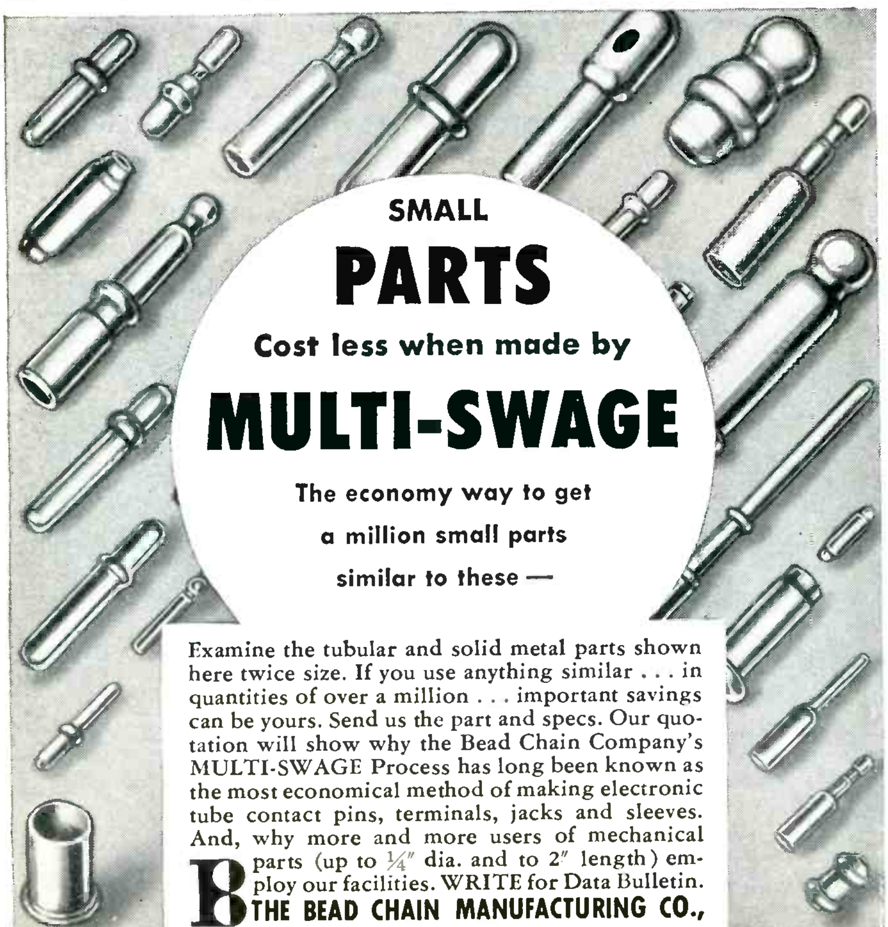

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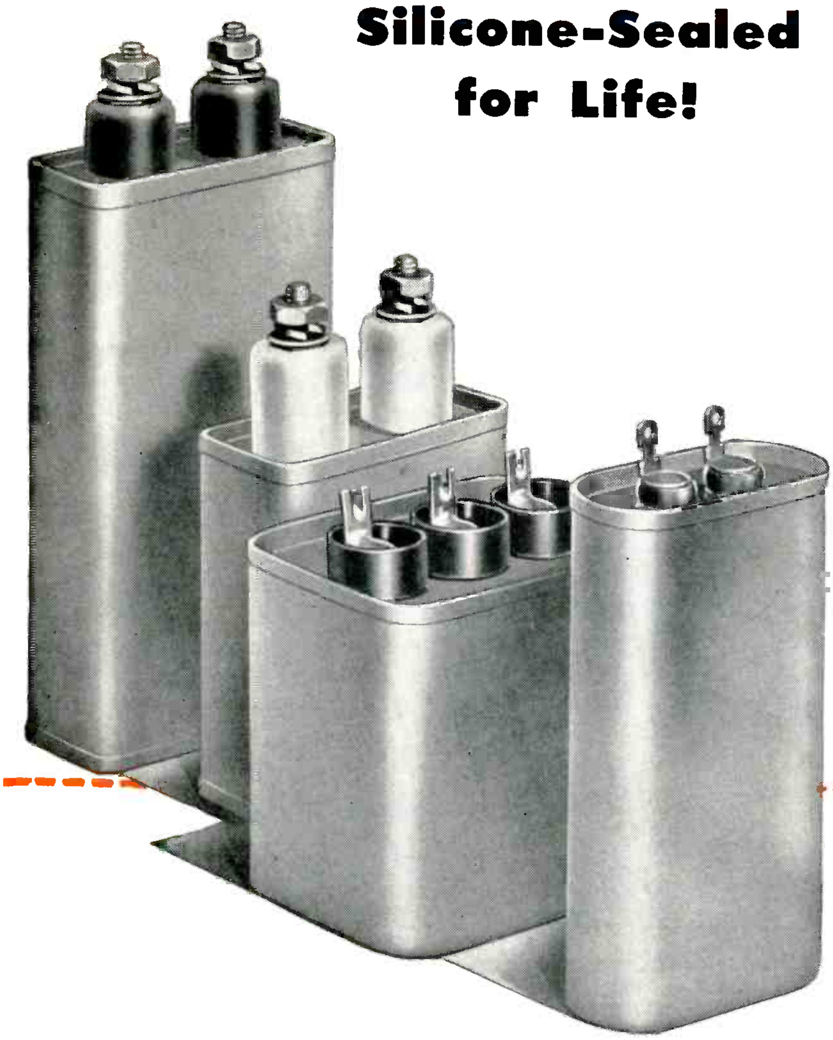

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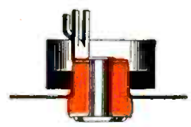

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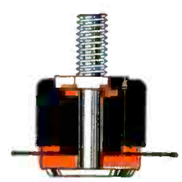

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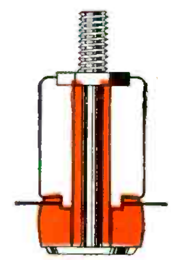

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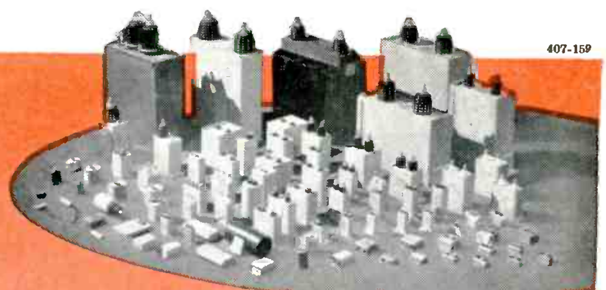

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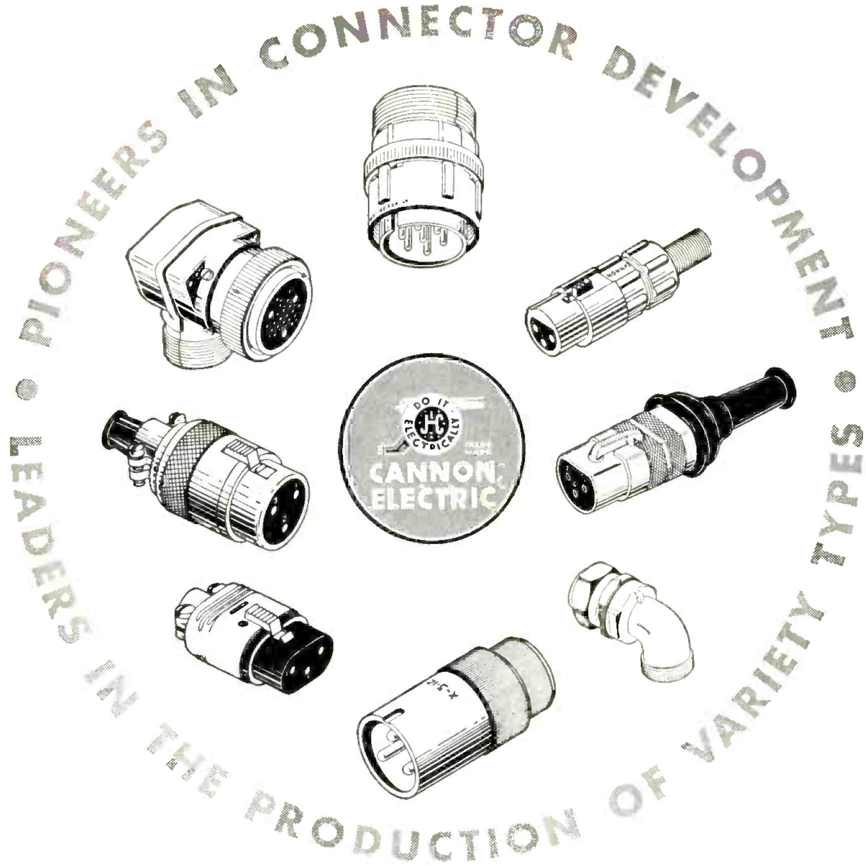

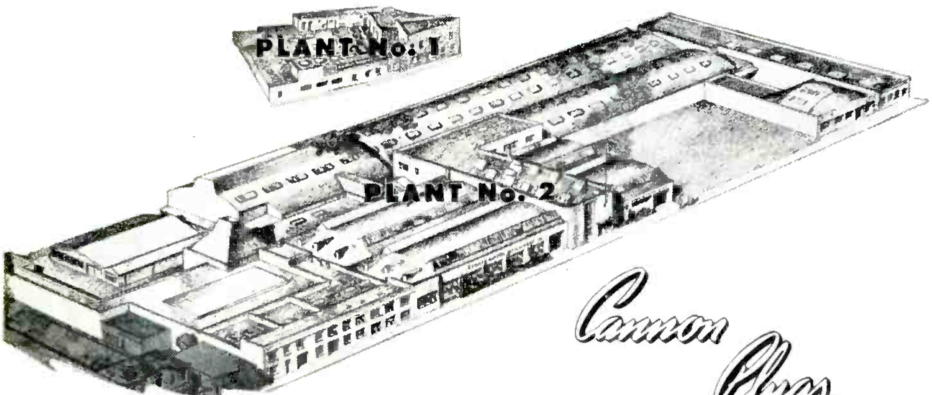

Cannon Plugs

Bigness in itself is no virtue . . . good products just as surely issue from small concerns as well as large—as during the years from 1915 to 1940 before Cannon Electric emerged as a "large company." Constantly adding to its products, today Cannon Electric ranks at the top of its particular industrial field, producing electric connectors, signal equipment, light specialities, automobile parts, etc. Still, the policy of its management is the same as during the "early days"—quality of product and conscientious service to its numerous direct customers and to thousands more who buy through radio parts jobbers and electrical wholesalers. These principles guide the company toward maintenance of good relations.

Main offices and factory, Cannon Electric Development Company, Division of Cannon Manufacturing Corporation, 3209 Humboldt Street, Los Angeles 31, California. Canadian offices and factory, Cannon Electric Co. Ltd., Toronto. Export: Frazar & Hansen, San Francisco, Los Angeles and New York.

SINCE 1915
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logical order. A comprehensive 22-page cross-index adds greatly to the reference value by speeding location of desired data. Though the individual articles were originally directed toward radar development, they today have broad application also in the field of microwave transmission and reception.

The opening 55-page paper, Early Fire-Control Radars For Naval Vessels, covers the first 500–700-mc radar, the CXAS radar and the Mark 1, 2, 3 and 4 radars. The next five papers deal with components, covering magnetrons, pulse modulator tubes, coil pulsers, spark gap switches and TR boxes. Two papers on circuitry follow, covering radar receivers and reflex oscillators. One paper deals with silicon crystal rectifiers, one with tubes for radar i-f amplifiers and one with radar antennas. Next comes a paper on microwave radar testing, followed by three final papers on various aspects of cavities.

All in all, the volume is a real contribution to the reference literature on radar and at the same time a good buy. Even for those who have a file of BSTJ the book is well worth getting, for the time saved in finding a desired topic.—J.M.

• • •

Books Received for Review

TELEVISION SIMPLIFIED. By Milton S. Kiver. D. Van Nostrand Co. Inc., New York, 1950, third edition, $6.50. Chief additions in this edition are a chapter on intercarrier sound systems and new material on color television.

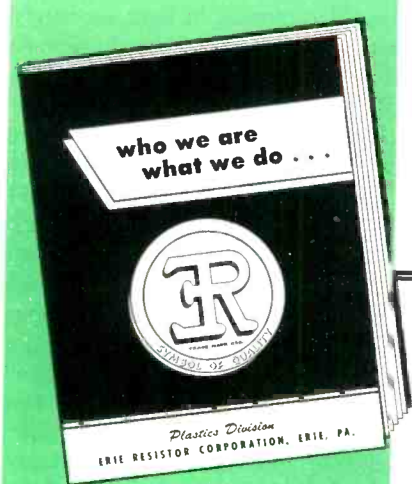
RADIO OPERATOR'S LICENSE Q & A MANUAL. By Milton Kaufman. John F. Rider Publisher, Inc., New York, 1949, 608 pages, $6.00. Covers FCC questions on f-m, radio communication, television, frequency-shift keying, marine radar and loran.

ELECTRICAL MACHINERY. By Fred A. Annett. McGraw-Hill Book Co., New York, 1949, Third Edition, 458 pages, $3.75. Four entire chapters of new material on electron tubes and circuits: Electrons and Electron Tubes; Electronic Rectifiers; D-C Motor Speed Control; Flame-Failure Protection and Smoke-Density Indicators.

THE PROTECTION OF TRANSMISSION SYSTEMS AGAINST LIGHTNING. By Walter W. Lewis. McGraw-Hill Book Co., New York, 1949, 418 pages, $8.00. Though dealing specifically with power lines, many of the basic chapters are applicable to lightning problems of radio and television transmitting and receiving antennas.

PRACTICAL TELEVISION SERVICING & TROUBLE SHOOTING MANUAL. Coyne Electrical & Radio-Television School, Chicago, 1949, 400 pages, $4.25. Final chapter deals with color television and ultra-high frequencies. For servicemen, students and engineers who like to fix their own tv sets.

Custom Molded PLASTICS for the RADIO AND TV INDUSTRY *by Erie Resistor*



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One of a series of advertisements showing Erie Resistor Custom Molded Plastics used in various industries.

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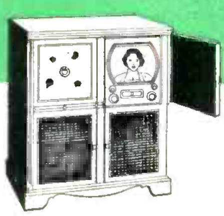

Plastics Division

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TUBES AT WORK

(continued from page 120)

ceiver in much the same manner as three single-color picture tubes except that no optical superposing or registration means need be provided and deflection power need be provided for only one deflection yoke.

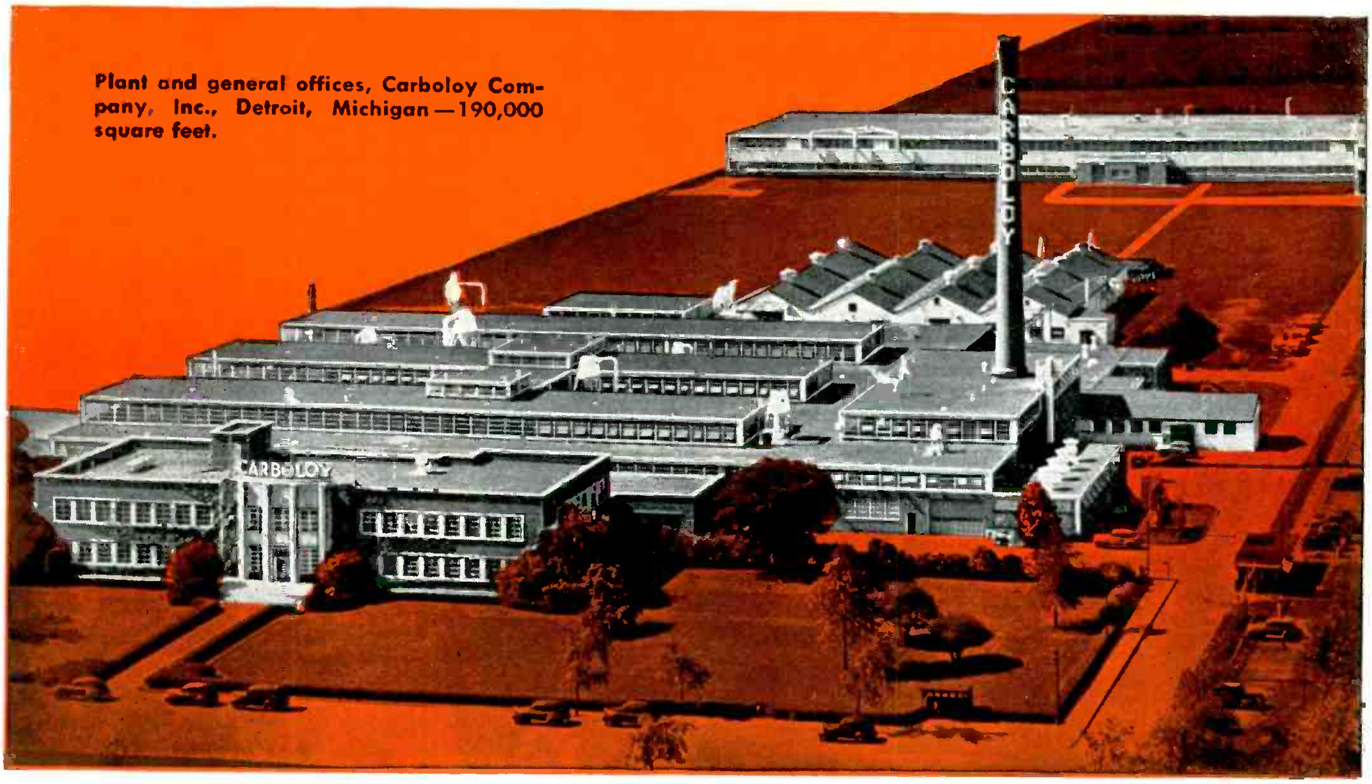
One experimental receiver demonstrated employed the three-gun tube and high-level sampling of the video signal. This receiver contains 46 tubes and consists essentially of a 27-tube black-and-white television receiver to which have been added 19 tubes for color synchronization, sampling and additional power supplies.

Single-Gun Tube

Operation of the single-gun kinescope is analogous to the operation of the three-gun tube in that the beam from the single gun is magnetically rotated so that, in effect, it occupies, in time sequence, the three positions of the three guns in the three-gun kinescope. When the beam is in a position corresponding to the green gun of the three-gun kinescope it excites only the green phosphor dots and is at this particular time modulated only by the green component of the video signal. A short time later the beam has been rotated to a position corresponding to the red gun of the three-gun kinescope and is modulated by the red component of the video signal to excite red phosphor dots. A third position similarly produces the blue picture. Sampling is automatically provided by rotating the beam synchronously at sampling frequency.

The experimental receiver employing the single-gun tube utilizes 37 tubes and consists essentially of a 27-tube black-and-white television receiver to which have been added 10 tubes for color synchronization, beam rotation and additional power supplies.

A block diagram of the principles of the circuit arrangement employed in the receiver utilizing the three-gun tri-color kinescope is shown. Video signal from a conventional black-and-white television receiver is applied simultaneously to the three internally-connected control grids of the three-gun kinescope. Another signal, derived



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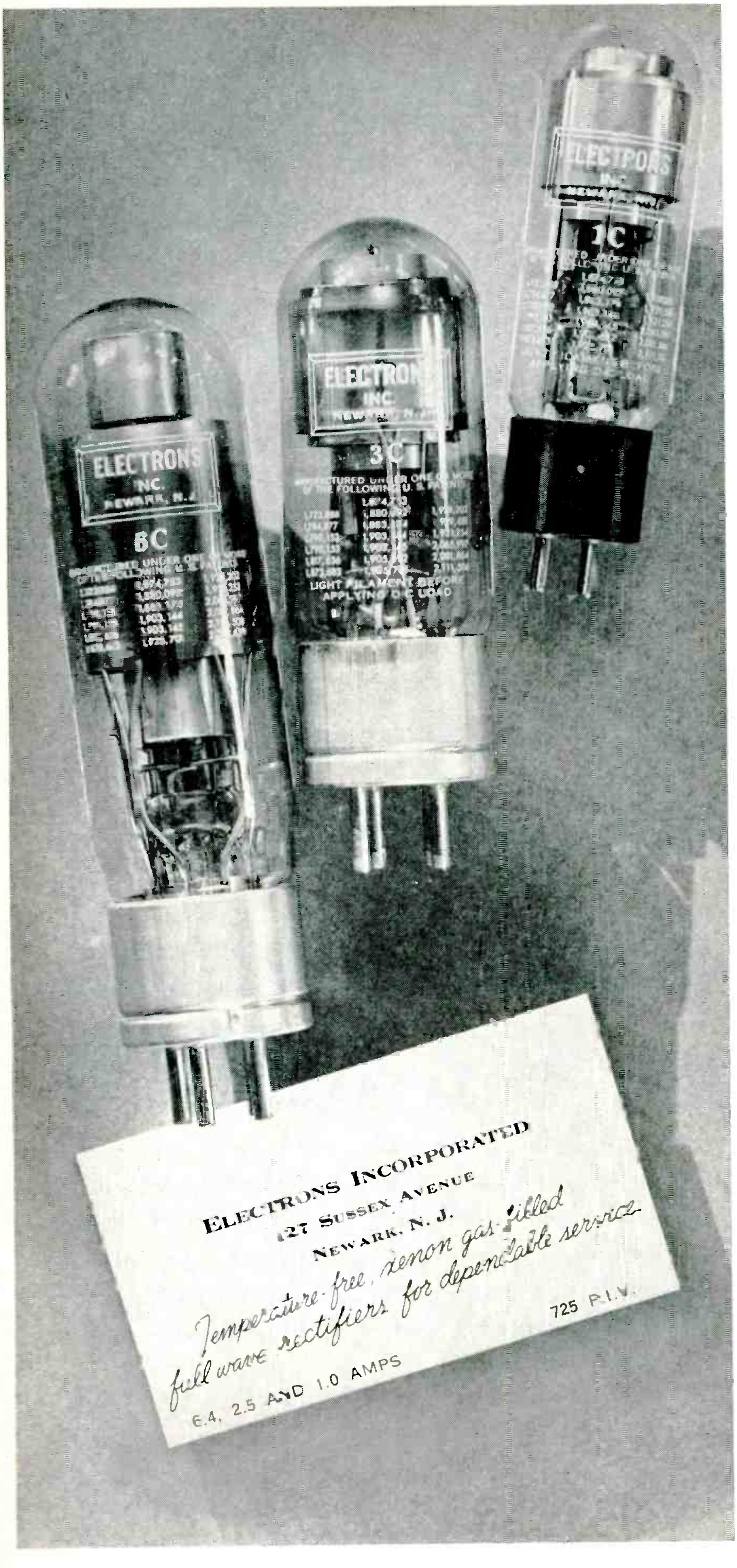

from the video amplifier, is used to actuate an automatic color phasing and sampling synchronization circuit which produces a local 3.58-mc sampling wave. The latter is applied through an amplifier tube and appropriate delay lines to three gating tubes which supply three sampling pulses, differing in phase by 120 degrees at 3.58-mc, to the three cathodes of the kinescope. Thus, each gun is turned on in time sequence corresponding to the original sampling process at the transmitter and the beam current from each gun excites only one of the three phosphor colors.

The tuning adjustment in the plate circuit of the 3.58-mc sampling-signal amplifier permits fine adjustment of the overall color phasing. However, proper color phasing is essentially determined by permanently installed delay lines which are cut to proper length.

The front-panel operating controls are the same for color as for black-and-white operation. Individual service adjustment controls are provided in the cathode circuits of the three guns to permit initial equalization of the control characteristics of the three guns.

The deflection circuitry is conventional but minor changes in deflection-tube types have been made to supply additional deflection power occasioned by the increased kinescope second-anode potential of 18 kv. The deflection yoke is of the anastigmatic type and has an internal diameter of two inches to accommodate the converging beams.

Convergence

Registration in the three-gun tube is accomplished by the proper registration of the masking apertures with their corresponding groups of phosphor dots. Means are also provided to converge the three beams to the same point on the phosphor screen during scanning. This is done for the undeflected beams by a convergence electrode, operated at 9,000 volts, and, when necessary, by small correcting magnets set up initially as a permanent service adjustment when the tube is installed. Because of the essentially flat face of the phosphor screen, simple geometrical considerations show that slightly

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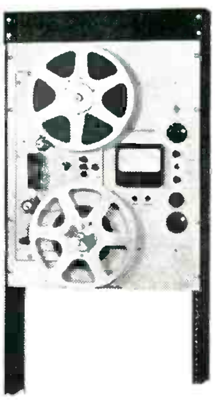

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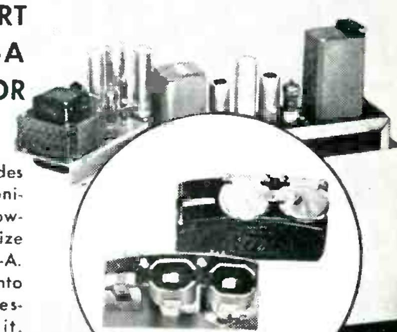

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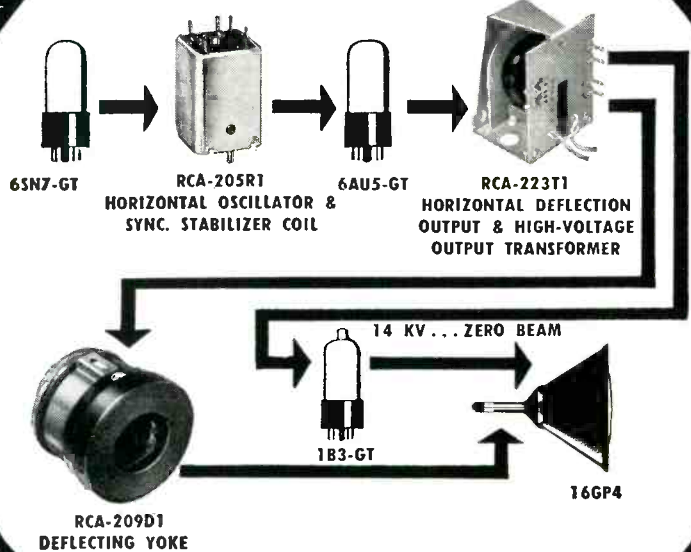

Now . . . a lower cost, high-efficiency wide-angle horizontal deflection system

Utilizing newly-designed Ferrite Core in both the High-Voltage Transformer and the Deflecting Yoke, the RCA single-tube-rectifier, Wide-Angle Deflection System provides a new high in efficiency. Developed especially for use with the 16GP4, or similar tubes having deflection angles up to 70 degrees, the new system features low cost, low weight, low power consumption, low B+ supply and 14-kv output at zero beam current. In addition, this system will supply boost voltage for the vertical deflection amplifier.

All RCA television components are "originals," designed with characteristics which are correct both electrically and mechanically for the tubes and circuits. They are "performance proved" and competitively priced.

RCA Application Engineers are ready to work with you in the adaptation of RCA television components to your specific designs. For further information, write RCA, Commercial Engineering, Section F43S, Harrison, N. J. or the nearest sales office.

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RADIO CORPORATION of AMERICA
ELECTRONIC COMPONENTS HARRISON, N. J.

less convergence is desirable as the beam is deflected from center. This dynamic convergence is accomplished by deriving a voltage from vertical and horizontal deflection circuits of the receiver and applying it to the convergence electrode through a capacitor.

An r-f type anode voltage supply provides a potential of 18 kv for the kinescope final anode, 9 kv for the electrostatic converging electrode and approximately 3.5 kv for the parallel-connected first anodes which produce initial electronbeam focus.

Single-Gun Receiver

A block diagram of the principles of the circuit arrangement employed in the receiver utilizing the single-gun picture tube is also shown. Video signal from the output of the video amplifier of a conventional black-and-white television receiver is applied to the control grid of the single-gun kinescope in the conventional manner. As in the previous receiver, another signal from the video amplifier actuates an automatic color phasing and sampling synchronization circuit which produces a local 3.58-mc signal which is locked in step with the transmitter sampler.

Circular deflection of the beam, which produces sampling automatically, is provided by a small deflection yoke having two sets of coil which are fed with quadrature currents at sampling frequency to produce a rotating field. Service adjustment of color phasing is provided by mechanical positioning of this yoke. The amplitude of the circular deflection is adjusted to produce the proper convergence angle as required by the mask and phosphor-dot screen.

The duration of the sampling period is controlled by a signal having a frequency three times the sampling frequency which is injected into the kinescope cathode circuit. The amplitude and phase of this 10.74-mc signal are determined by the alignment of a filter circuit which utilizes the third harmonic of the circular-deflection driver tube.

As in the receiver for the three-gun tube, the front panel controls of the single-gun set are the same

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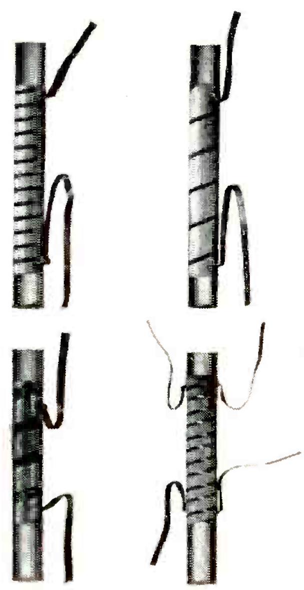

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as those used in a conventional black-and-white receiver. Because a single gun is used in this kinescope, color balance may be achieved by proper deposition of the phosphor dots. The deflection circuitry and deflection yoke are the same as those employed in the three-gun receiver.

The electron gun which is employed is the same as that used in the projection type 5TP4. Potentials of 18 kv for the final anode and 2.7 kv for the electrostatic focus electrode are derived from the kickback voltage on the horizontal-deflection output transformer just as in conventional black-and-white receivers.

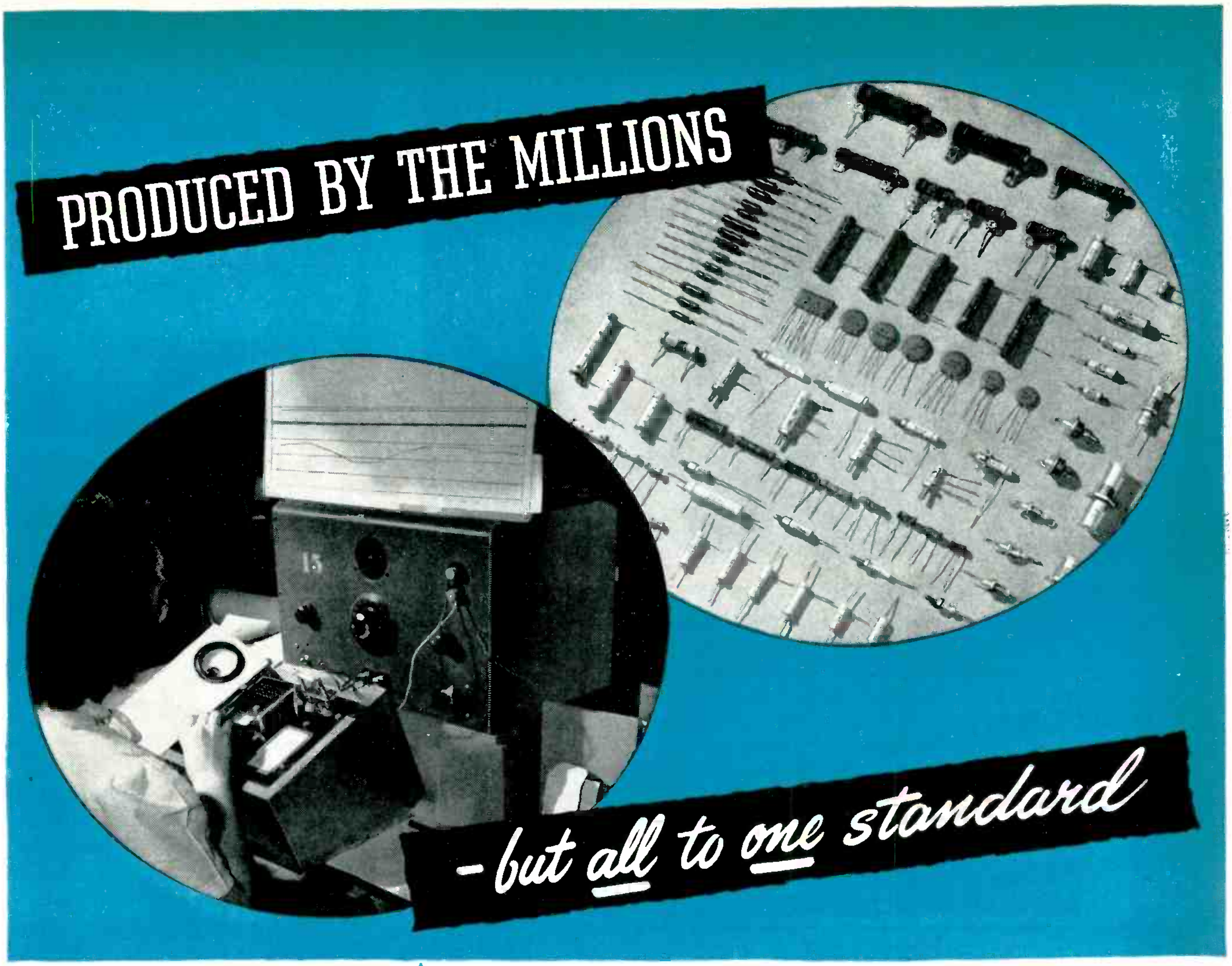
Convergence of the circularly deflected beam is produced by a magnetic lens in the single-gun kinescope instead of the electrostatic method employed in the three-gun version. A coil similar to the focus coil normally employed in conventional black-and-white receivers is used for this purpose. The dynamic convergence variation is likewise applied magnetically in this tube and is introduced by means of a smaller auxiliary coil located near the main convergence coil. As in the previous receiver, the dynamic convergence waveforms are derived from the deflection circuits.

Both tube types are fabricated in 16-inch metal cones and produce pictures approximately 9 by 12 inches.

Circuits of Phonevision System

PHONEVISION is a method of applying secrecy to a television transmission so that the modified signal from a conventional transmitter can be received as a clear, intelligible picture only on a receiver supplied with a correcting signal over a secondary control link.

One method of incorporating secrecy or privacy in a video signal is to modify the original signal by producing a deliberate change in the relation of video and horizontal or vertical synchronizing signals. In this case, a key signal is sent to the television receiver via a second



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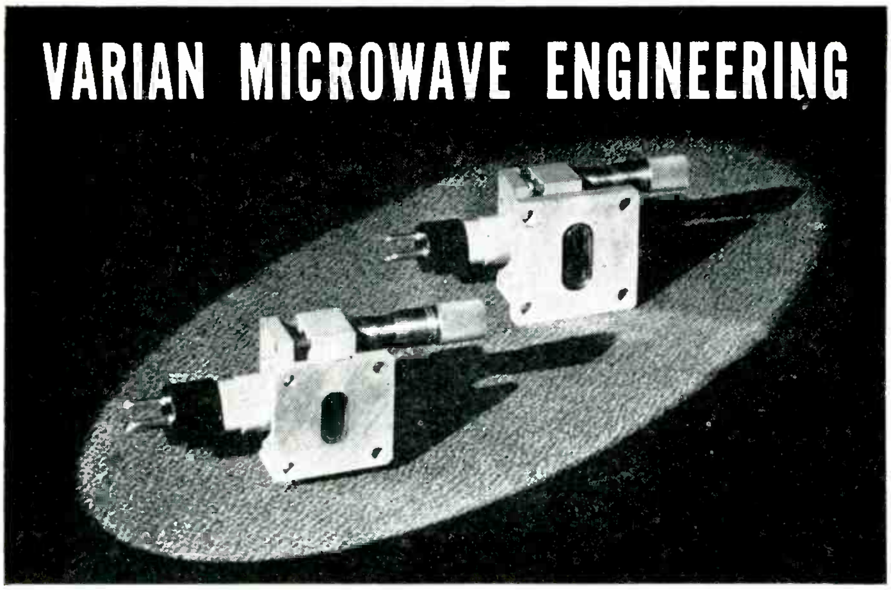

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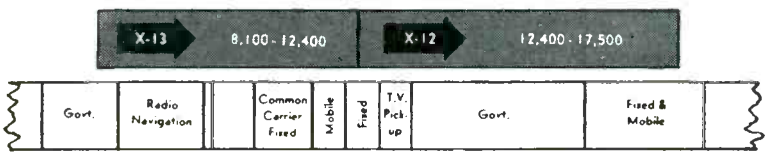

Electrical Characteristics

	X-13	X-12
Beam Voltage	500 volts, max	600 volts, max
Beam Current	60 ma, max	60 ma, max
Heater Voltage	6.3 volts	6.3 volts
Heater Current	1.1 amp	1.1 amp
Reflector Voltage	0 to —1000 volts	0 to —1000 volts
Tuning Range	8,100-12,400 mc min	12,400-17,500 mc min
Power Output	100 milliwatts, min with transformer	10 to 100 milliwatts

Mechanical Specifications

Cathode	Oxide coated, unipotential	Oxide coated, unipotential
Clearance dimensions	3½ x 2½ x 2½ in.	3½ x 2½ x 2½ in.
Weight	6 ounces	5 ounces
Output Flange	Mates with standard flange for 1 x ½ x 0.050 in. waveguide	Mates with standard flange for 0.702 x 0.391 x 0.040 in. waveguide
Cooling	Forced air cooling required for beam power inputs exceeding 10 watts	Forced air cooling required for beam power inputs exceeding 10 watts
Mounting position	Any	Any

Typical Operation

Frequency	10,000 mc	16,000 mc
Beam Voltage	400 volts	600 volts
Beam Current	48 ma	50 ma
Reflector Voltage	575 volts	280 volts
Power Output	230 milliwatts	25 milliwatts
Load VSWR	Less than 1.1	
Modulation Bandwidth	30 mc	50 mc
Temperature coefficient	Less than 0.25 mc per degree C	

Not illustrated, X-21 klystron. Five-watt two-cavity oscillator. Weight approximately 4½ ounces. Specifications upon request.

VARIAN ***associates***

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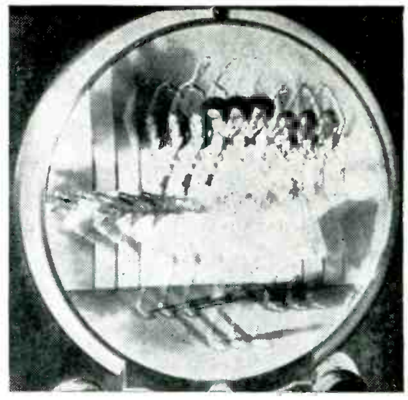

Television picture without Phonevision coder

path to inform the set when this change is to occur so that a correction may be made for it.

In the Phonevision system developed by Zenith engineers, the video information is shifted at times with respect to the horizontal synchronizing pulses. The shift introduced amounts to a small percent of the horizontal period. The picture is therefore transmitted in either of two modes in one of which the video information appears normally phased with respect to the horizontal synchronizing pulses, while in the other a phase shift is introduced between the video and horizontal synchronizing pulse.

Change from mode to mode is made at a random sub-field rate. For example, for three or four fields the picture may be transmitted with a phase shift between video and synchronizing signals followed by two fields with normal phase relation. The changing between modes is entirely random and is determined by a noise source so as to give the system secrecy. The resulting scrambled picture with this type of transmission is one in which the image is moving back and forth

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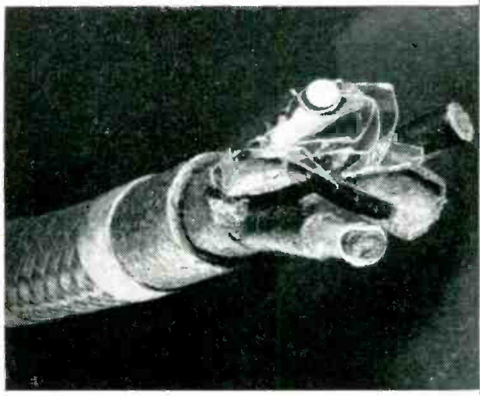

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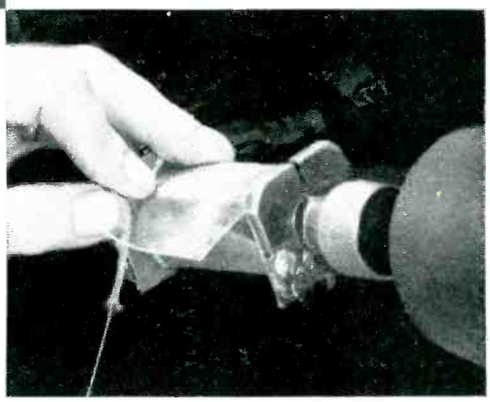

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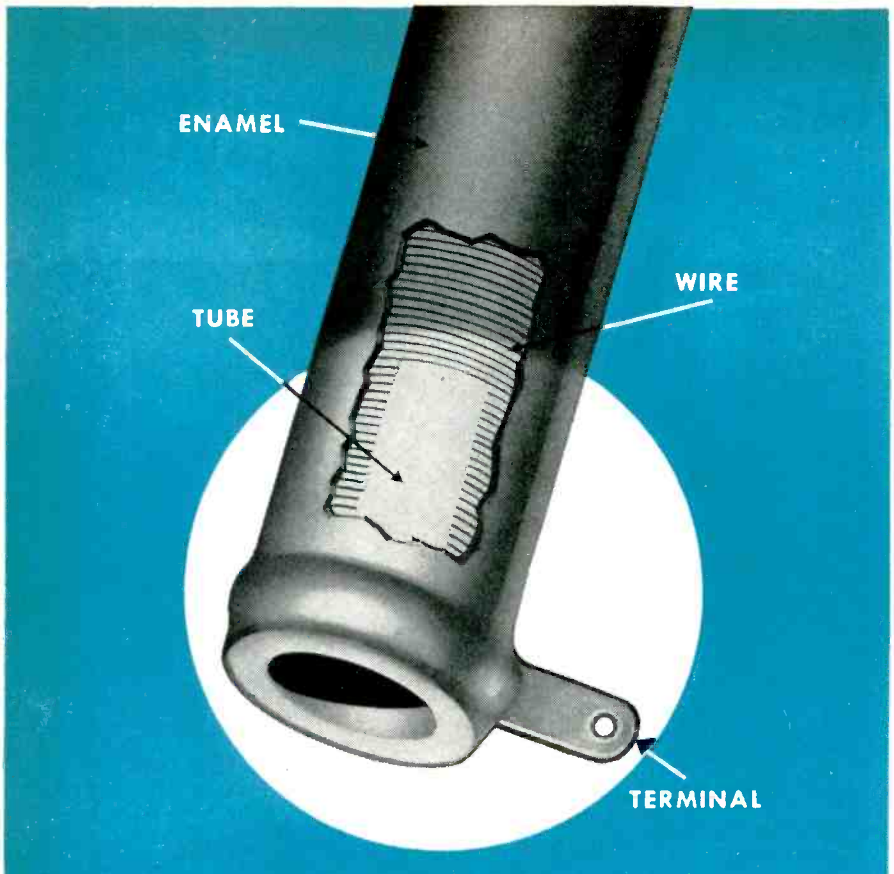

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horizontally at a slow irregular rate, producing an annoying blurred effect.

The change between modes is accomplished during the vertical blank period, thereby giving all circuits adequate time to stabilize. Accompanying one of the two modes of transmission is a key signal which consists merely of a tone of any frequency substantially higher than the field frequency. This key signal is sent via a secondary link to the Phonevision receiver.

At the Phonevision receiver the key information is used to cause circuits to compensate for the phase shift introduced between video and horizontal synchronizing pulses. Therefore, when the video is being sent out, shifted with respect to the horizontal synchronizing pulses, the start of the horizontal sweep in the receiver is correspondingly changed. Absence of the key signal indicates normal phase between the video and the horizontal synchronizing pulses.

Transmitter

As shown in the block diagram, Fig. 1, a typical transmitter consists of a normal crystal oscillator stage, followed by r-f amplifiers, multipliers and modulator. The studio consists of some type of pickup tube, an iconoscope or equivalent. The heart of the studio gear is the synchronizing signal generator in which the sync pulses, both horizontal and vertical, and blanking pulses, are generated. Vertical sync pulses are supplied to the vertical sweep circuits directly with no change in this portion of the circuit. However, the horizontal sync pulses, instead of being fed directly into horizontal sweep-forming cir-

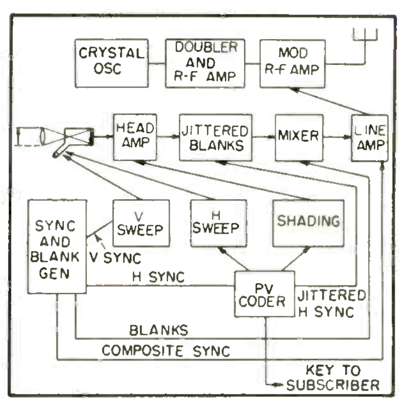

FIG. 1—Block diagram of typical Phonevision transmitter

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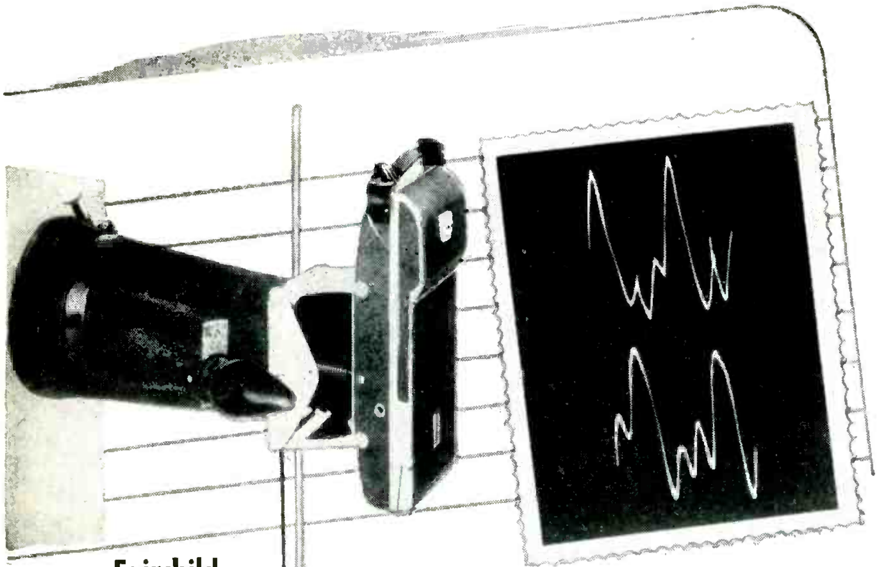

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Lens — Special 75 mm. f/2.8 Wollensak Oscillo-anastigmat.

Shutter — Wollensak Alphax; speeds 1/25 sec. to 1/100 sec., "time," and "bulb."

Focus — Fixed (approx. 8 in.).

Picture Size — 3¼ x 4¼ in. (2 images per print; 16 exposures per roll of film).

Image Size — One-half reduction of scope image.

Writing Speed—to 1 in/μsec at 3000V accelerating potential; higher speeds at higher voltages.

Dimensions — Camera, 10½ x 5¼ x 6¼ in.; hood, 11 in. length, 7½ in. dia.; adapter, 2 in. width, 6⅝ in. max. dia.

Weight — Complete, 7¾ lb.

Fairchild
CAMERA AND INSTRUMENT CORPORATION

cuits, pass through a new unit which forms jittered sync pulses, the Phonevision coder.

The output of the iconoscope is fed into a head amplifier in which mixing of video signals, plus the shading signal, is accomplished. The output of the head amplifier is fed into the jittered blank unit after which the signal passes to the mixer where steady blanks are added. At this point, control is also maintained over contrast and background setting. Synchronizing and blank generators also supply the composite sync signal to the video amplifier where the video signal from the iconoscope, plus the blanks, are mixed with the composite sync waveform. The entire composite video signal is then fed to the modulator. Also generated by the Phonevision coder is the key signal which is applied to the secondary control link and distributed to Phonevision subscribers.

Coder

Figure 2 is a block diagram of a typical coder unit comprising four primary sections as indicated by the dotted lines. In the first section is the random key generator, the heart of the Phonevision system as far as secrecy is concerned. Input to this portion of the unit consists of a normal vertical drive which is fed through an isolation stage and phase control to a blocking oscillator circuit. Combined with

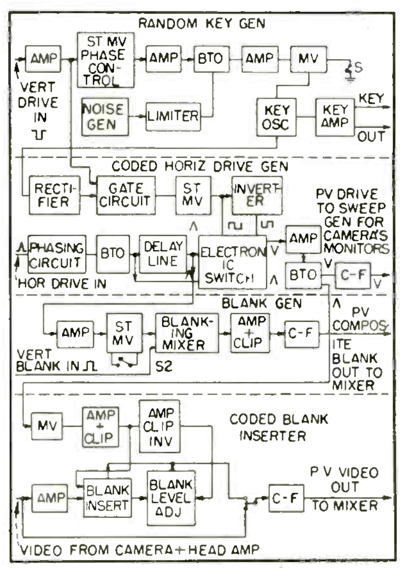

FIG. 2—Setup of stages in the four main sections of the coder unit for the transmitter

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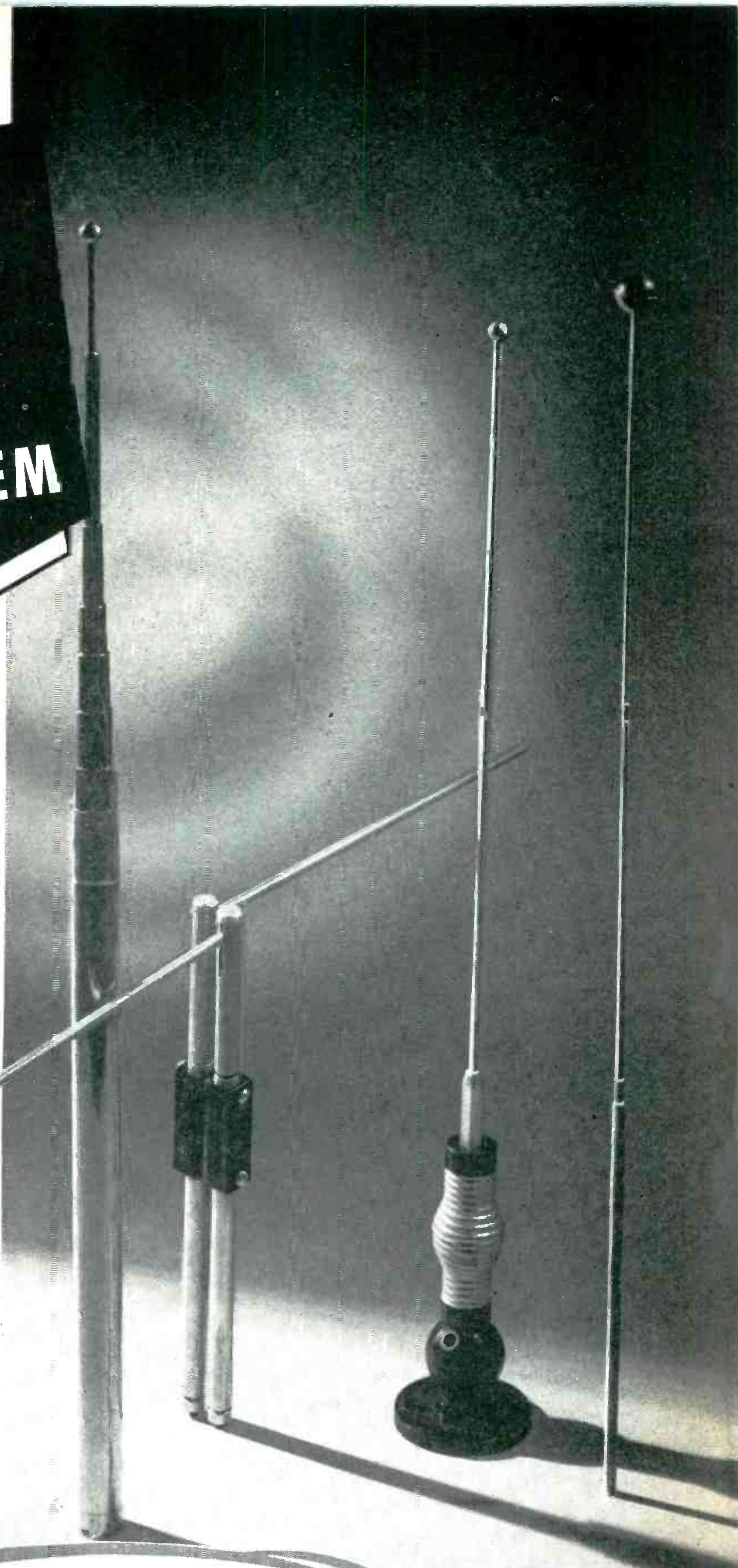

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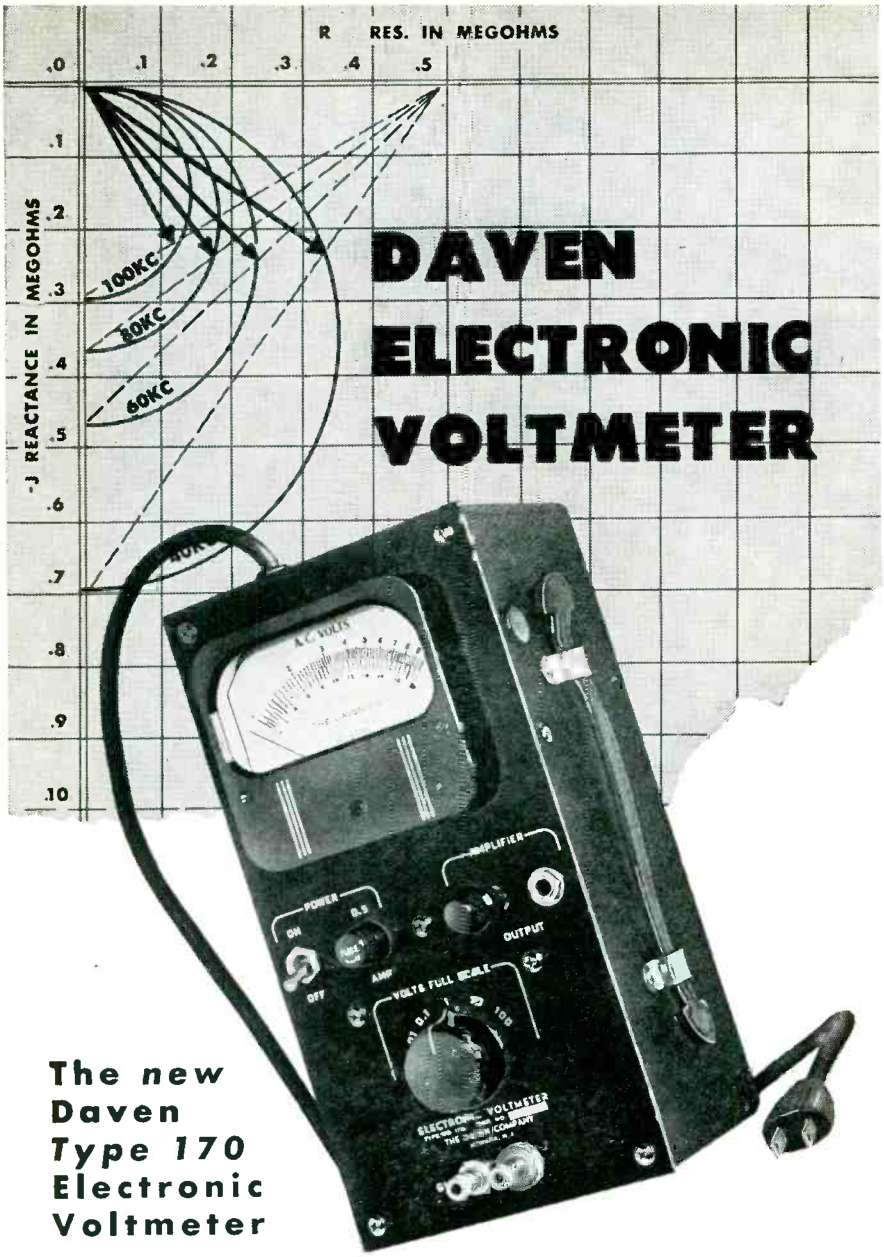

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the vertical pulse is the output of a noise generator. Combination of these two signals results in a pulse from the blocking oscillator occurring at random but only at the time of the vertical synchronizing signal.

By adjusting the noise signal by means of the limiter, the blocking oscillator can be made to operate between 60 and 20 times per second. Alternate signals from the blocking oscillator produce square-wave control signals by means of a multivibrator. The square wave in turn keys an oscillator operating at the key signal carrier frequency. The output from this oscillator is shaped in an amplifying stage to have a rise time of approximately two-thirds of a field period and is then distributed through the secondary control link.

Camera Drive

The output of the key oscillator is also fed to the second section of the coder which generates the coded horizontal drive used by the cameras, monitors and shading generators. The oscillator signal is combined with the vertical pulse in a gating circuit which in turn determines the points of transition of a single-trip multivibrator.

The vertical pulses out of the gate circuit are positive when the key signal is applied and negative in absence of the key. Application of the positive and negative pulses to one of the control grids of the single-trip multivibrator causes a change in mode of operation at the time of the first vertical pulse present with the key and the first vertical pulse after the key has been turned off.

A normal horizontal drive pulse is fed into the coded horizontal drive generator through a phasing circuit which produces a pulse shifted in phase with respect to the normal horizontal synchronizing pulse. A blocking oscillator triggered by the shifted pulse drives a long line having a delay equal to the time change desired in the video.

An electronic switch chooses either the pulse from the input or from the output of the delay line as directed by the single-trip multivibrator and in this way produces the coded horizontal drive.

The horizontal shift in the video

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(Meets low temperature requirement of -40°C when tested according to JAN-C-76)		
SLOW COMPRESSION TEST Actual force in pounds to ground	81.3	59.8
FLAME TESTS Horizontal Test	Self-extinguishing no falling particles	Self-extinguishing no falling particles
Vertical Test (As described in Underwriters' Standard for Thermoplastic Wires)	Specimens meet requirements satisfactorily	Specimens meet requirements satisfactorily
VOLTAGE BREAKDOWN TEST As received – 2000 V/min. Ave. breakdown KV	No failure 23.9 KV (1/64" wall)	No failure 24.7 KV
After 60 days at 113°C-2000 V/min. Average breakdown KV	No failure 21.5 KV (1/64" wall)	No failure 24.0 KV
INSULATION RESISTANCE TEST 12 hrs. in water at 15.6°C Megohms/1000'	988 megohms	1270 megohms

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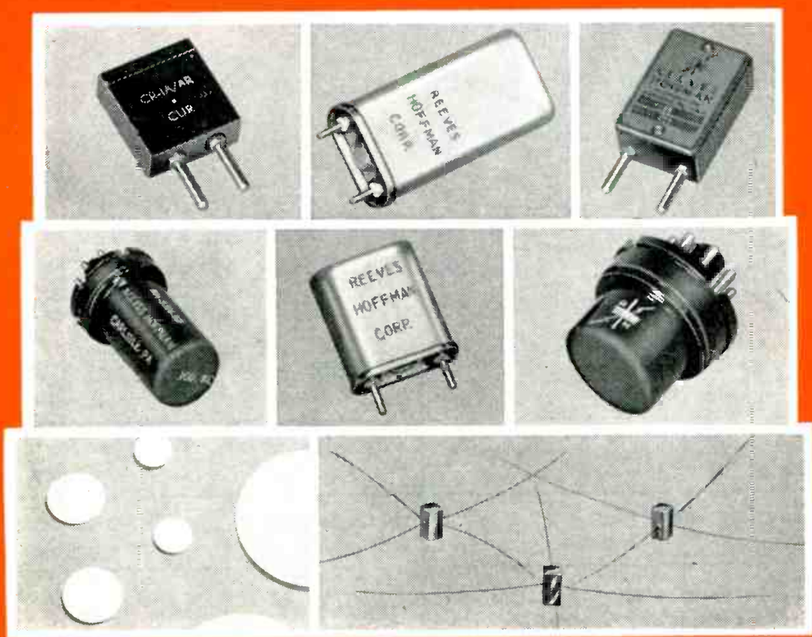

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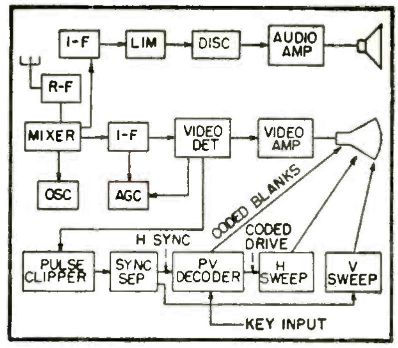

FIG. 3—A decoder is added to a normal receiver

is obtained by using time normally required for the horizontal blank pulse. This calls for a revised horizontal blanking signal of less width. The new blanks are generated in the third unit of the coder by feeding horizontal pulses from the output of the delay line through an isolation amplifier to a single-trip multivibrator.

Normal vertical blanking signals and the output of the single-trip multivibrator which forms the horizontal blank are mixed in the blanking mixer and then amplified and clipped and made ready for distribution through a cathode follower.

An additional requirement, that of coded blank insertion, is taken care of in the fourth section of the adapter. The output of the coded horizontal drive generator triggers a single-trip multivibrator by means of which coded blanks are obtained. Both polarities of the blank wave form are combined in two tubes having a common load impedance. Video from the camera chain is applied to the blank inserter and mixed with the coded blank.

The second section of the blank inserter adjusts the blank level, maintaining this level approximately at the average video point. After insertion of the coded blank the signal is distributed to the usual mixers through a cathode follower.

Receiver

A Phonevision receiver circuit, shown in Fig. 3, consists of the normal stages plus a decoder. The video detector is followed by the sync pulse separating circuit. The vertical pulse is separated in normal fashion and actuates the vertical sweep of the picture tube. The separated horizontal sync pulse is

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Minimum useful screen diagonal	15½"
Base	Duodecal 5 pin
Bulb contact	Recessed small cavity cap
Anode voltage	12,000 volts DC
Grid No. 2 voltage	300 volts DC
Focusing coil current	115 approx. ma. DC
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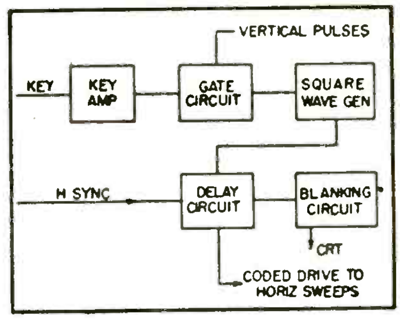

FIG. 4—Stages of the decoder unit at the receiver

fed into a decoder unit. This unit, actuated by the key signal coming over the secondary link to the receiver, applies a correction to the horizontal sync pulse which triggers the horizontal sweep circuit.

A block diagram of a typical decoder unit is shown in Fig. 4. Since the level of the key signal from the control link is approximately 50 millivolts, the decoder is preceded by a stage of gain. A gating circuit combines the key information with the vertical pulse obtained from the television receiver to trigger a square-wave generator. The gating circuit and square-wave generator have the unique property of being able to detect the first vertical pulse in presence of key and the first vertical pulse in absence of key. Thus the square-wave generator will change modes of operation as dictated by the key information and will at the same time be synchronized with the transmitted vertical sync signals. The resulting square wave controls the phase of pulses obtained from the normal horizontal sync circuits of the receiver and thereby controls the drive to the horizontal sweep of the picture tube. Proper amount of phase shift controlled by the key corrects for the phase shift originally inserted in the transmitter by the coder.

A blanking circuit is also provided which is controlled by the coded horizontal pulses and restores the blanking interval to normal width.

Distribution of Key Signal

The method of distribution of the key or decoding signal in the Phonevision system is to superimpose it upon the regular telephone line of a customer. Since the key signal required needs only about 120 cycles

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of spectrum space, it can be added immediately above the normal voice band. The attenuation at this frequency in the usual telephone subscriber plant is well within the limits required to permit sensing the decoding signal at the customer's home. Frequency separation networks of simple type have been produced to do this with low insertion loss. This is one possible means of extending the decoding signal to the user.

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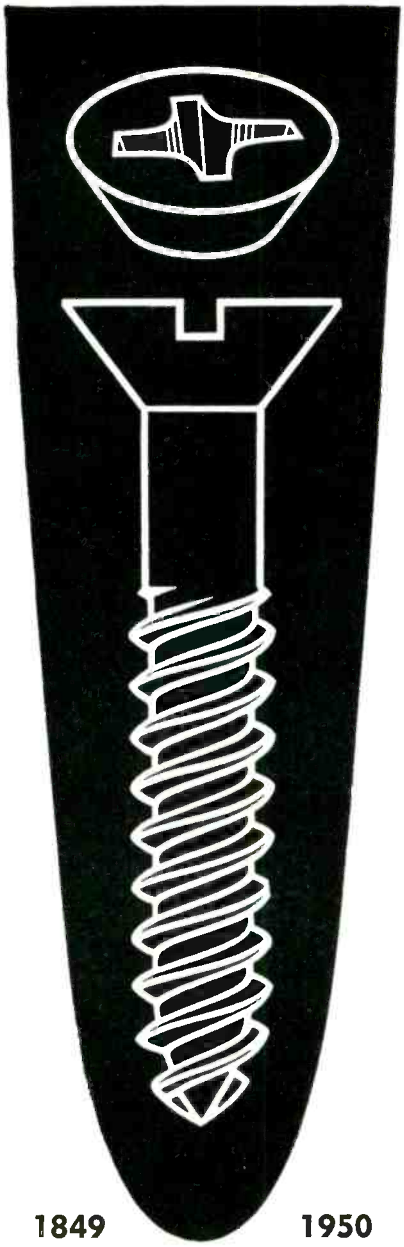

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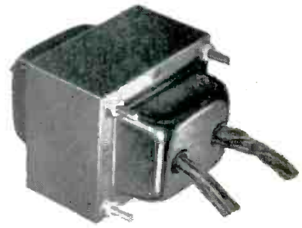

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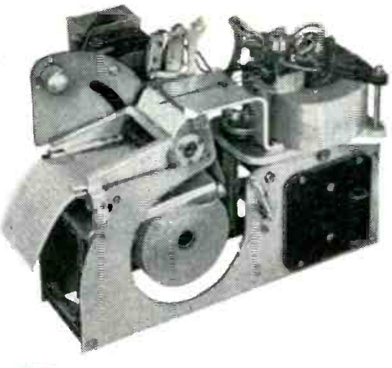

Records are produced by a heated writing stylus in contact with heat sensitive paper. The paper is pulled over a sharp edge in the paper drive mechanism (standard speed 25 mm/sec., slower available) and the stylus wipes along this edge as it swings, thus producing records in *true rectangular coordinates.* The writing arm is driven by a D'Arsonval moving coil Galvanometer with an extremely high torque movement (200,000 dyne cms per cm deflection).

This recorder assembly may be obtained in bare chassis form, as illustrated (51-600) with or without built-in timer; or, with the addition of a stylus heating transformer, temperature controls, and control panel (127); or, with the entire assembly, controls and control panel enclosed in a mahogany carrying case (127C). Complete catalog available, see below.

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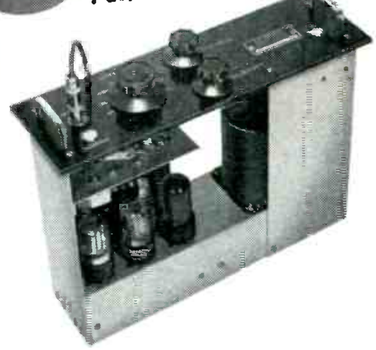

A general purpose, A.C. operated driver amplifier for use with model 127 Recorder, comprising three direct coupled push-pull stages. Maximum sensitivity 50 mv. per cm., minimum sensitivity 50 volts per cm., with four intermediate ranges. Balanced input terminals available with impedances of 5 megohms to ground. Complete information in catalog shown below.

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THE ELECTRON ART

(continued from p 124)

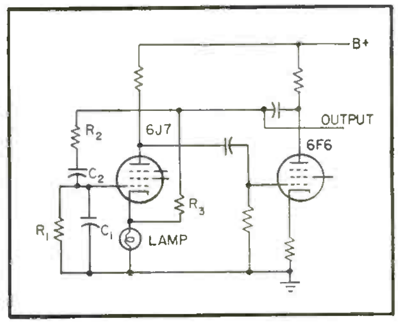

FIG. 1—Basic circuit of a well-known resistance-tuned oscillator to which bandspreading will be added

frequency at which the 6J7 grid voltage is in phase with the 6F6 plate voltage. The Wien bridge network, $R_1C_1R_2C_2$, determines the frequency at which these two voltages are in phase. The frequency is made smoothly variable through the use of a standard type of ganged variable air capacitor for C_1 and C_2. Each of these consists of two sections of a four-gang capacitor, with a maximum capacitance of 525 $\mu\mu$f per section.

Trimmers are used across C_1 and C_2 for the purpose of calibration and maintenance of a constant amplitude of oscillation.

In modifying the oscillator, the most desirable method is to remove the original bandswitch, together with the tuning resistors assembled on it, and substitute another switch having the desired number of positions and circuits. The original resistors, or preferably new ones, are then assembled onto the switch together with the extra components for the bandspread ranges. Additional tuning scales may then be placed on the frequency dial, or a new dial substituted.

Bandspread Computations

In the original tuning circuit of the oscillator, all of the tuning component values are specified in the manufacturer's instruction book except the ΔC of the tuning capacitor, and the minimum capacitance, C_{min}, across C_1 and C_2 each when the tuning capacitor is set to the high-frequency end of the dial. The values of ΔC and C_{min} are obtainable by simple calculation: $C_{min} = 86$ $\mu\mu$f and $\Delta C = 1{,}019$ $\mu\mu$f. Values of components for any desired bandspread range may now be readily calculated.

Example: Calculate a tuning cir-

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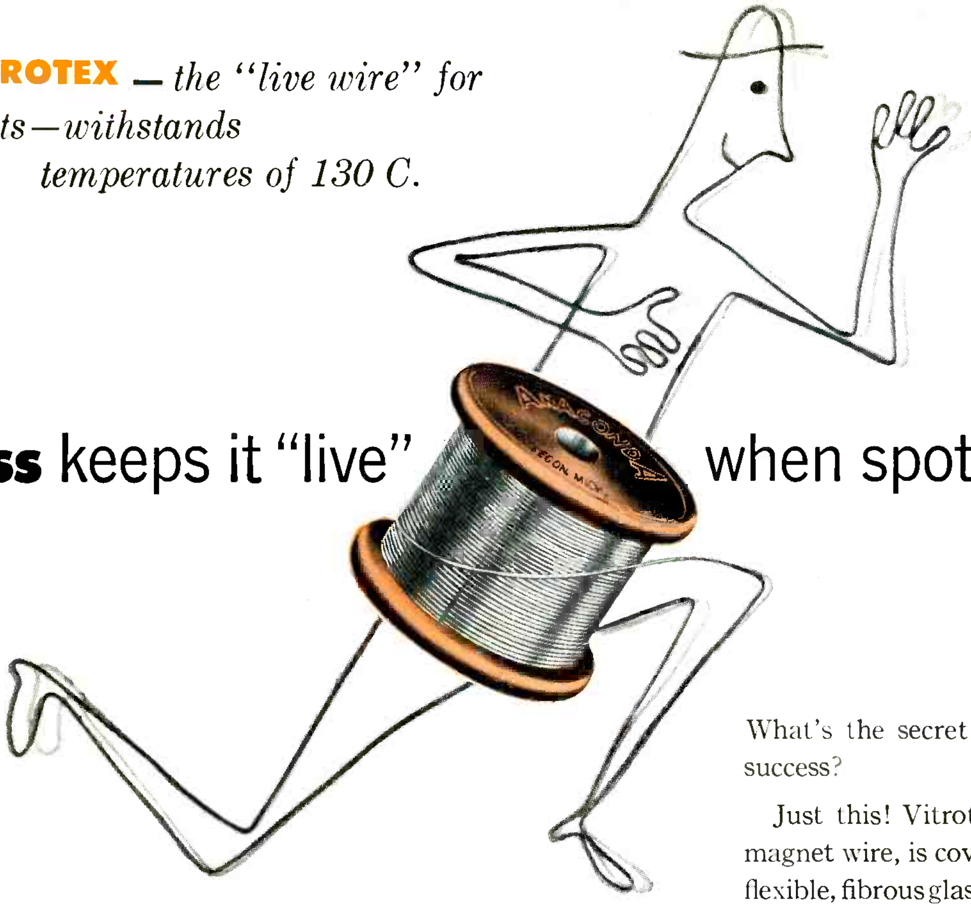

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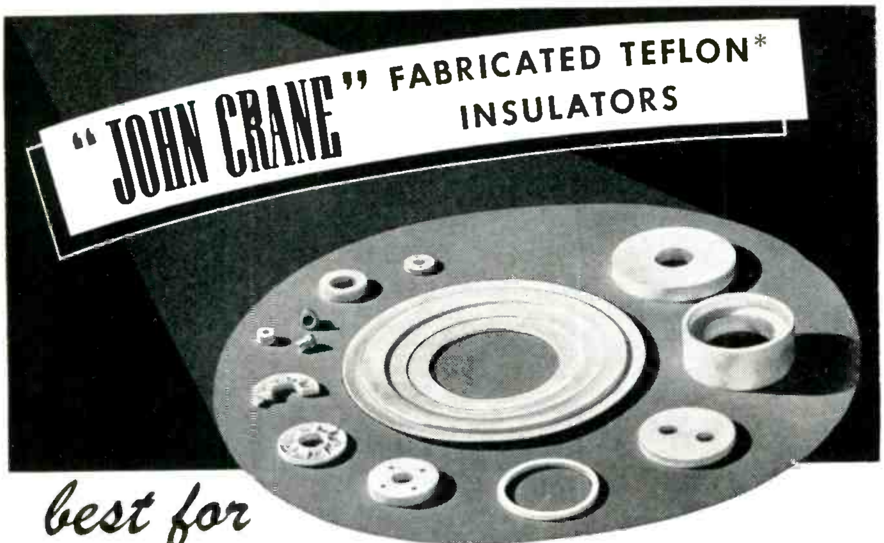

best for

ULTRA HIGH FREQUENCY NEEDS!

You can't beat the properties of Teflon when you're looking for hf and uhf insulators . . . and you'll never find more perfectly fabricated Teflon parts than those made by "John Crane".

Teflon insulators combine low dielectric constant, low loss factor, high heat resistance, toughness and resiliency.

As pioneers in the fabrication of Teflon products, we can fill your requirements. Scores of "John Crane" insulating spacers, connectors, beads, etc. are in use throughout the world on installations such as coaxial cables and radar units.

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* John Crane products fabricated from DuPont Teflon are sold under the registered trade name "Chemlon".

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time saving... cost saving!

dependable instruments

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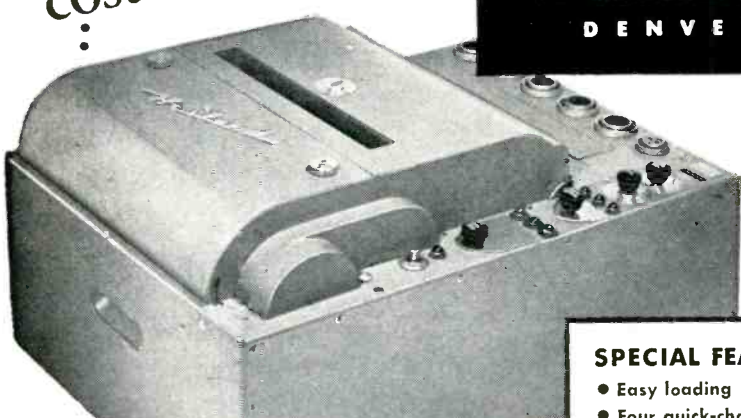

Type A-708 24-channel

SPECIAL FEATURES
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Developed for simplicity and ease of operation, the HEILAND Automatic Oscillograph Recorder saves time... reduces costs. Flexibility of operation permits the recording of strain, vibration, pressure, acceleration and temperatures.

Write for complete detailed information

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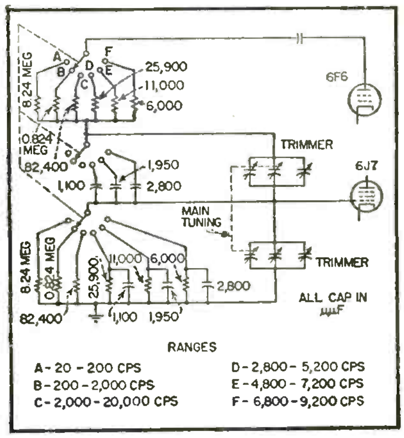


FIG. 2—Complete bandspread circuit covering 3 to 5, 5 to 7 and 7 to 9-kc ranges in addition to original bands

cuit to produce a range of 3,000 to 5,000 cycles for a complete rotation of the tuning capacitor.

$$\frac{f_{max}}{f_{min}} = \frac{C_{min}{}^1 + \Delta C}{C_{min}{}^1}$$

$$C_{min}{}^1 = 1{,}529\ \mu\mu f$$

The tuning circuit already contains a C_{min} of 86 $\mu\mu$f. Therefore, a fixed capacitor of 1,529 − 86 = 1,443 $\mu\mu$f must be added across each two sections of the tuning capacitor.

The tuning resistors are selected to give a frequency of 5,000 cycles with the tuning capacitance at minimum, which is 1,529 $\mu\mu$f.

$$R = \frac{1}{2\pi fC} = 20{,}900 \text{ ohms}$$

The complete bandspread circuit including the switching is given in Fig. 2. The values indicated obtain three ranges of 3,000 to 5,000, 5,000 to 7,000, and 7,000 to 9,000 cycles, with approximately 10 percent overlapping of ranges. All of the fixed resistors and capacitors are mounted directly on the switch, as shown in Fig. 3.

Selection of Components

Resistors and capacitors for bandspread circuits must be selec-

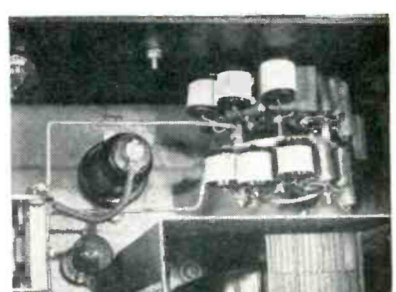
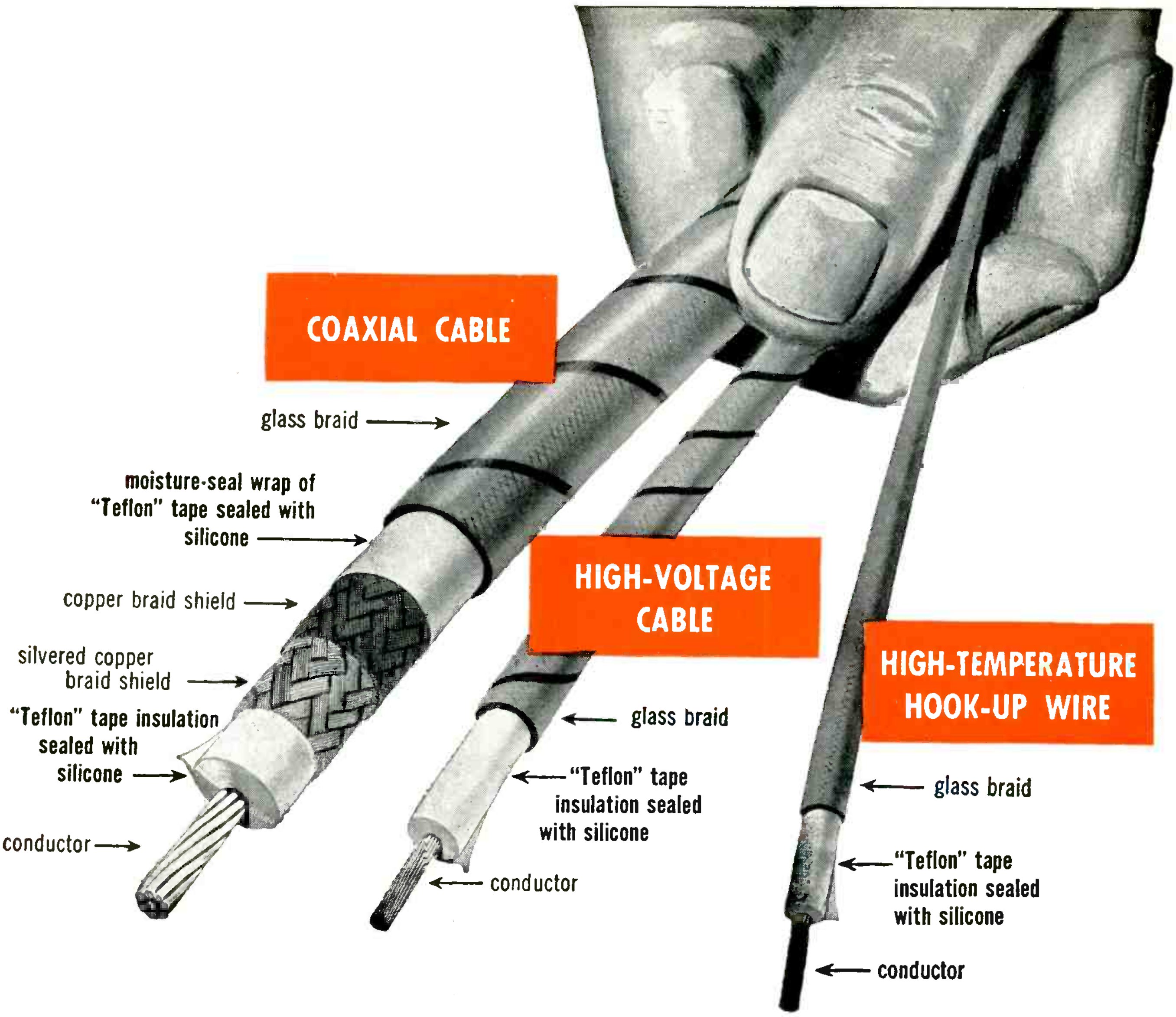


FIG. 3—All frequency-determining components are mounted on bandswitch



"TEFLON"* TAPE INSULATION SERVES FROM –80° TO 500°F.

No other available material has the combination of low electrical losses and heat-resistance of Du Pont "Teflon" tetrafluroethylene resin.

"Teflon" tape is seeing wider and wider use in such applications as insulation for wire and cable, ground insulation for motors and generators, conductor and layer insulation in transformers and coils. Its power factor is less than 0.0005 and its dielectric constant only 2.0 over the entire spectrum measured to date, 60 cycles to 30,000 megacycles. Its dielectric strength is excellent and is unaffected by temperature changes up to at least 400°F. The tape gives service up to 500°F. "Teflon" tape has excellent mechanical strength and pliability . . . at temperatures as low as –80°F. In wrapped construction it fits even more tightly as the temperature is raised. It has zero water-absorption, and is unaffected by outdoor weathering.

"Teflon" is supplied by Du Pont in the standard shapes of rods, tubes, sheets, beading, and tape, and in molding powder, both shredded and granular. WRITE NOW for more data on the properties and electrical uses of "Teflon"!

E. I. du Pont de Nemours & Co. (Inc.), Plastics Department, Main Sales Offices: 350 Fifth Avenue, New York 1, New York; 7 South Dearborn Street, Chicago 3, Illinois; 840 East 60th Street, Los Angeles 1, California.

*TRADEMARK REG. U. S. PAT. OFF.

(Wire and cables shown above made with "Teflon" Tape by Boston Insulated Wire & Cable Co., Boston, Mass.)

Tune in to Du Pont "CAVALCADE OF AMERICA," *Tuesday nights—NBC coast to coast.*

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Plastics
BETTER THINGS FOR BETTER LIVING
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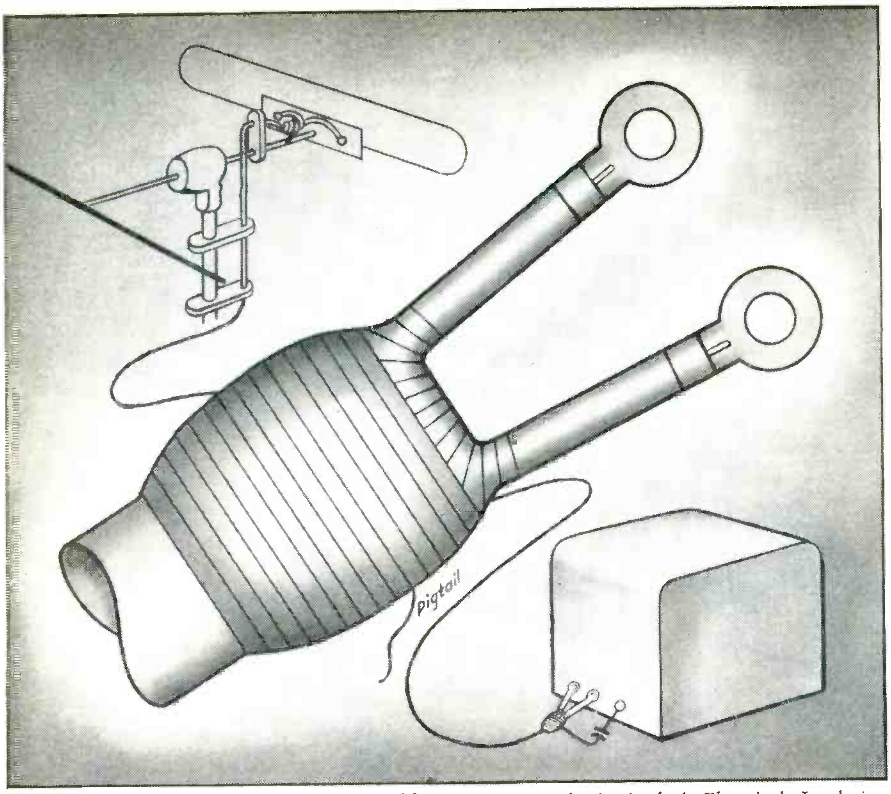

FEDERAL TELEPHONE AND RADIO CORPORATION'S shielded balanced 300-OHM Lead-in, lap-wrapped with "SCOTCH" No. 33 Plastic backed Electrical Insulating Tape to prevent moisture from condensing under cable jacket.

Protect TV lead-ins with this new plastic tape

Happier customers, more customers, fewer trouble-calls when you protect TV lead-ins with "SCOTCH" No. 33 Electrical Tape. This plastic-backed tape helps protect against snow and ghosts, improves the signal-to-noise ratio.

Try "SCOTCH" No. 33 Electrical Tape on your next installation. Find how this amazing tape can simplify your television and radio work. A letter to us will bring complete information — with no obligation. Write Dept. ES-650.

Quick facts about "SCOTCH" No. 33 Electrical Tape

- **THIN CALIPER**—only .007 in. thick; makes a neat, tight wrap.
- **HIGH DIELECTRIC STRENGTH**—over 7,000 volts.
- **TOUGH**—Abrasion resistant, unaffected by water, acids, alkalies, alcohols, exposure to sunlight, rain, snow, ice.
- **STRETCHY**—Easy to apply, conforms snugly to uneven surfaces.

TIP—for perfect high-heat insulation try "SCOTCH" Electrical Tape No. 27 with Glass Cloth backing, thermosetting adhesive.

Made in U. S. A. by MINNESOTA MINING & MFG. CO., St. Paul 6, Minn.

also makers of other "Scotch" Brand Pressure-Sensitive Tapes, "Scotch" Sound Recording Tape, "Underseal" Rubberized Coating, "Scotchlite" Reflective Sheeting, "Safety-Walk" Non-Slip Surfacing, "3M" Abrasives, "3M" Adhesives.

General Export: DUREX ABRASIVES CORP., *New Rochelle, N. Y.*
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ted with care. Particular attention should be paid to their temperature coefficients, for frequency drift due to warmup shows up much more readily on a bandspread than on a compressed scale. For example, a drift of 1 percent at 5,000 cycles will nullify the accuracy of a dial which may have initially been calibrated to an accuracy of 20 cycles.

It has been found most desirable to use wirewound resistors and silver mica capacitors as the tuning elements for the bandspread circuits. The resistors should be wound non-inductively, and of a wire with the lowest possible temperature coefficient. The writer has used resistors made with 331 Alloy, also known by the trade names of Karma and Evenohm. This wire has about the same temperature coefficient as manganin (0.00002 per C) but holds it over a wider temperature range than manganin. The silver mica capacitors should likewise have a zero temperature coefficient.

It has been found that at the upper end of the third bandspread range—9,000 cycles—that the drift over a two-hour period from a cold start is less than 20 cycles, or about 0.2 percent. This should prove satisfactory for most applications.

R-F Field Mass Spectrometer

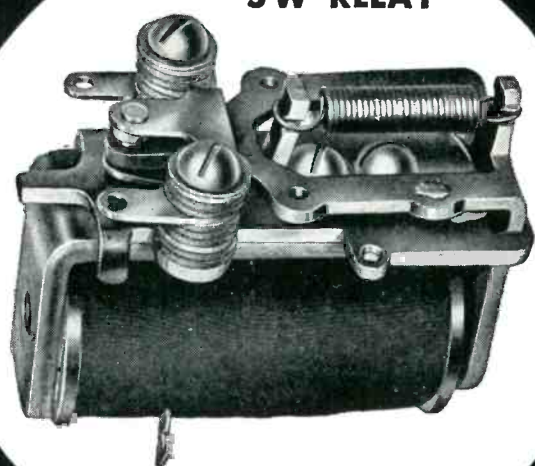
A THREE-STAGE nonmagnetic mass spectrometer, employing the principle of velocity selection, has been developed at the National Bureau of Standards. In the new spectrometer an r-f field replaces the usual magnetic field. Combining unusually simple operation with small size, light weight, and high sensitivity, the instrument has promising applications in several fields of science and industry.

The nonmagnetic mass spectrometer uses neither bending nor focusing. Ions produced in the ionization chamber travel in parallel paths through the tube, a glass cylinder 8 inches long and 2 inches in diameter. Three sets of three tungsten-wire grids are spaced along the tube to form the three stages. An r-f potential is applied

NEW

SENSITIVE RELAY
built for long service

SW RELAY



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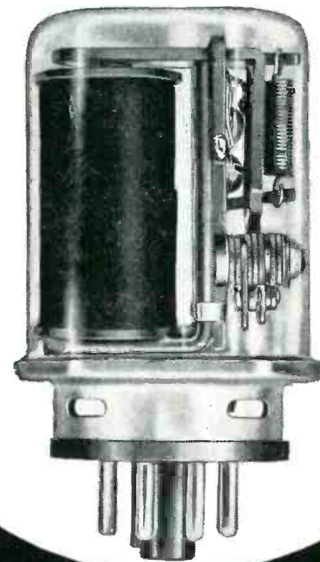


Supplied with OCTAL PLUG or SOLDER TERMINALS

Sensitivity Plus Dependability!

The new Allied SW relay offers an economical combination of both these important qualities. Here are the facts on this newest relay in the famous Allied line →

Bulletin SW gives complete details. Send for your copy today.

Be sure to send for your copy of Allied's new Relay Guide. It shows 24 small, compact relays with a detailed table of characteristics and specifications.

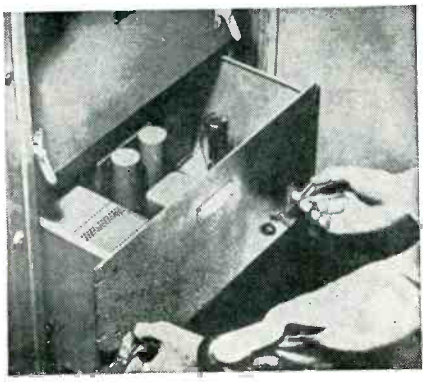
SENSITIVITY:	S.P.D.T. .012 watts d.c. / D.P.D.T. .05 watts d.c. } Can be supplied in A.C.
COIL:	Acetate insulated, bobbin or layer wound, 12,500 ohms max.
CONTACTS:	Silver, one ampere non-inductive load at 24 volts d.c. or 115 volts a.c. Armature contact at frame potential.
MOUNTING:	One hole with locating lug. Also available with dust cover or hermetically sealed, plug-in or solder terminals.
DIMENSIONS:	Open Relay—1-19/32", 1-1/16", 1-7/16" Sealed Relay—3-3/16" long, including plug, 1-13/32" wide, 1-19/32" high.
WEIGHT:	2.5 oz.
WEIGHT HERMETICALLY SEALED:	4.5 oz.
SPECIAL APPLICATIONS:	Sensitivity down to .003 watts S.P.D.T., or .012 watts D.P.D.T. Palladium or other precious metal contacts for audio or low voltage circuits, tungsten or alloy contacts for higher current or voltage circuits. Maximum input 4.0 watts at 20°C for 85° rise.

ALLIED CONTROL COMPANY, INC.

2 EAST END AVENUE, NEW YORK 21, NEW YORK

MODERN ELECTRONIC DESIGN MEANS PLUG-IN UNIT CONSTRUCTION

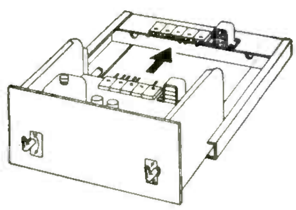
With basic elements as units—that plug-in, slide-in, lock-in, break away *easily*—so that electronic equipment is *instantly accessible*—ready for rapid checks, servicing, and unit replacement.



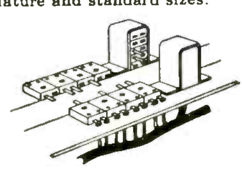
More and more engineers are finding that *plug-in unit construction* is the type of design that makes many of the new complex electronic projects feasible to operate and maintain. It's also recognized that *plug-in, unit principles* make present electronic equipment much more practical for wider general use.

Up to now there has been no one place where components *specifically designed* for *plug-in, unit construction* were available. To get this type of construction—it has been necessary for engineers to design and have parts custom made or improvise with standard components in make shift arrangements.

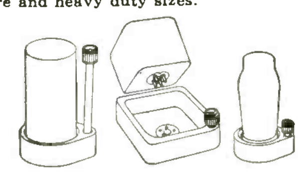
Here at Alden's we are designing and manufacturing components for *plug-in unit construction*. We are setting up to work with manufacturers on as many of these problems as possible. Very frankly, much of our work is still in the pilot run stage—but, in every instance—proven in use. If you don't see the answer to your problems here—let us work it out with you.



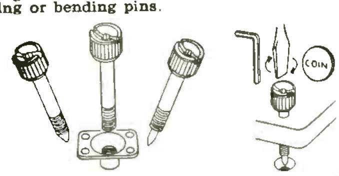
Back connected chassis—become instantly accessible. Half twist of handles brings chassis into place or ejects—no matter how heavy. Built for racks or as separate units—miniature and standard sizes.



Rugged color coded back connectors—make and break circuits—provide rapid circuit checks. Wide mating tolerances compensate for any chassis misalignment. Miniature and heavy duty sizes.

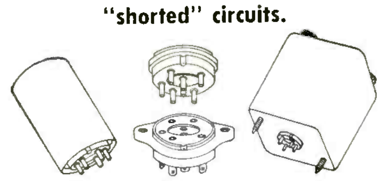


Top operated clamps for tubes and plug-in units. Take minimum of space. Can be operated in cramped locations. Free floating—orients unit to socket without straining or bending pins.



Alden Cap Captive Convenience Screws—Hold miniature chassis, heavy plug-in cans or detachable mechanical units securely. Assemble easily in production by power tools—yet any tool or coin services in field.

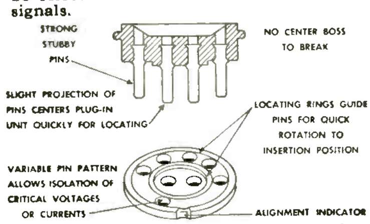
At last—a base specifically designed for plug-in units. No more broken bosses, bent pins, "shorted" circuits.



More and more engineers have been unitizing the basic elements of their circuits into compact, easily replaceable plug-in units. Since the conventional octal and tube socket bases have been the only component readily available, they have been constantly plagued by the broken bosses, bent pins, and "shorted" circuits caused by these bases.

This suggested an entirely new approach was necessary, so we went to work with some of these engineers. Out of this work the *Alden-Noninterchangeable plug-in base* was developed.

Pins have been made strong and stubby—for long, rugged use. The boss is eliminated entirely. Slight lead of center pins and locating rings with marker in the socket allow quick lining up of plug-in units. Further, this base is supplied with 2 to 11 contacts—in variable pin patterns—so that even where the same number of contacts are used, the pin layout may be varied so only the correct unit will mount in its proper socket. Pin patterns can even be selected to isolate critical voltages or signals.



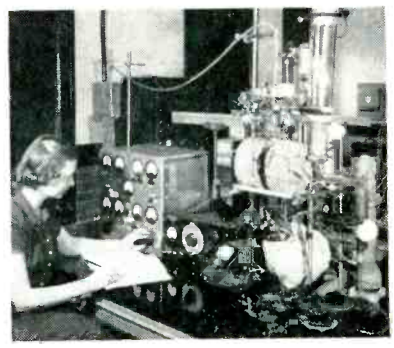
Write today for literature and samples. Let Alden work with you on your components for *plug-in, unit construction*.

Write for new booklet on "Components for Plug-in Unit Construction"

ALDEN PRODUCTS CO. 117 NORTH MAIN ST. BROCKTON 64, MASS.

to the middle grid in each stage. An additional grid, with a negative potential applied, follows that final stage and in the absence of r-f potential turns back any electrons that may have arisen anywhere along the tube. Following the final grid is a collector plate whose potential is sufficiently positive to repel all but the desired positive ions.

The distances between grids and between stages are selected very accurately so that for any particular ion mass there will be a single definite frequency of the r-f potential which can speed up ions of that



The three-stage nonmagnetic mass spectrometer in experimental operation at the National Bureau of Standards

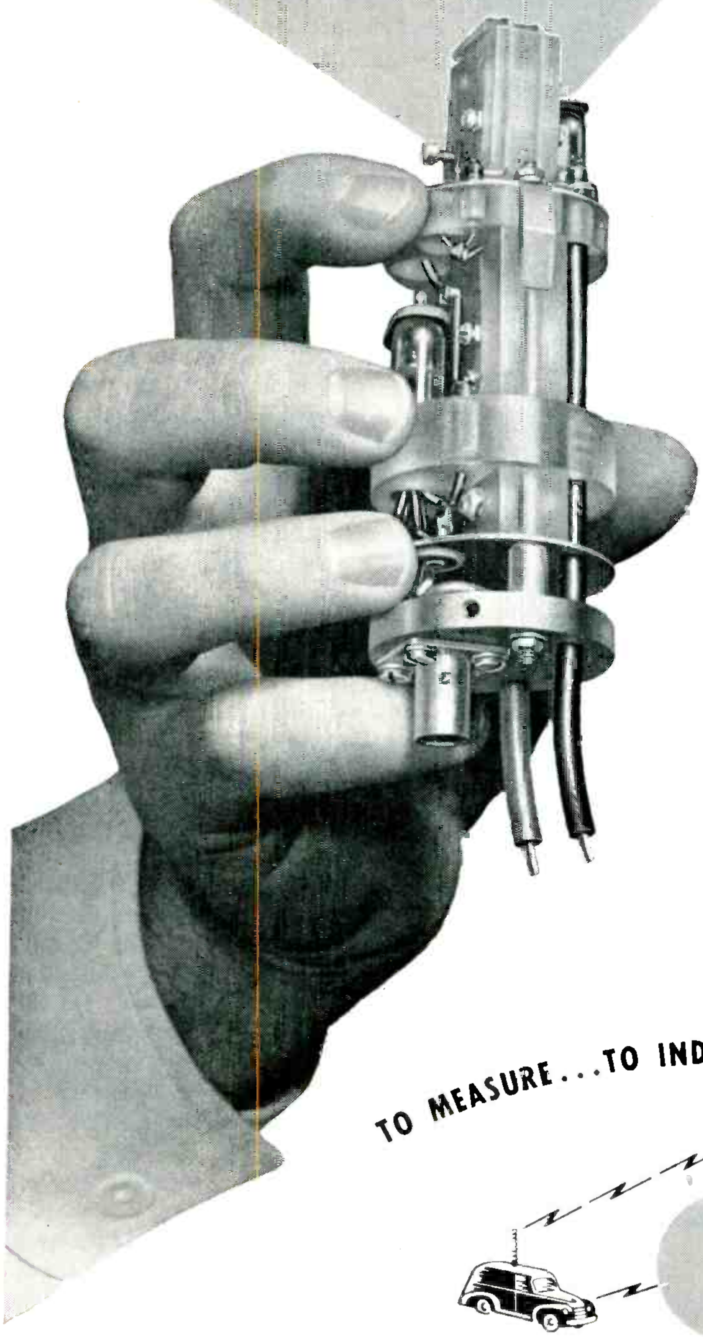
mass as they pass through each stage. The increased speed of these ions enables them to overcome the opposing potential on the collector while all other kinds of positive ions are turned back. Successive distances between stages must be chosen so that the r-f potential will complete an exactly integral number of cycles during the time it takes for an ion of the desired mass to travel between stages, picking up maximum energy in each stage.

The spectrometer can make use of all the ions that can be made to emerge through a grid several centimeters in diameter, and a new kind of positive ion source has been developed to take advantage of this. A spiral filament delivers an ionizing electron current of 100 milliamperes through a double grid attached at one end of a hollow metal cylinder 3 centimeters deep. At a pressure of 4×10^{-5} millimeters of mercury the source delivers a positive ion current of 100 microamperes.

Applications

By an appropriate change in ion source and reversal of potentials,

UP TO 15 WATTS POWER OUTPUT WITH THIS BENDIX-PACIFIC **RELIABLE** TELEMETERING COMBINATION



These two new units are indicative of the engineering leadership Bendix-Pacific has established in the field of electronics.

The new 421250 Transmitter supplements a complete line of telemetering components in the Bendix-Pacific FM/FM subminiature telemetering systems and has a nominal power output of 2 watts. The total weight, including the case, is only .845 pounds and it measures 2″ diameter by 5⅛″ long.

The 421250 Transmitter can be tuned over the frequency range of 215 mc to 230 mc and is adaptable for use with current fed or voltage fed antenna systems. It has a line of sight range of up to 40 miles and may be used to drive the 421230 Power Amplifier.

The Bendix-Pacific 421230 Telemetering R. F. Amplifier has a nominal power output of 15 watts which provides adequate power for line of sight ranges of 40 to 100 miles. The tuning range matches that of the 421250 Transmitter. The total weight, including the case, is only 1.75 pounds.

The two transmitting units described above exemplify the building block method of telemetering system assemblies. Through the use of standard Bendix-Pacific components, the purchaser can readily assemble an instrumentation system exactly suited to his specific needs – thus effecting the utmost economy in volume, weight and cost.

RADAR BEACON

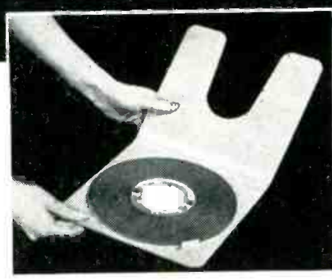
Bendix-Pacific has developed for restricted use an exceptionally small, compact radar beacon for use in the common radar bands to facilitate vehicle tracking.

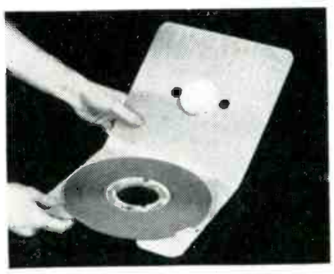
Complete engineering facilities are available at Bendix-Pacific to assist you with special applications of these systems.

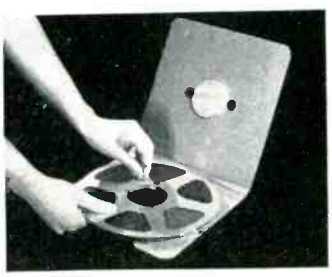
TO MEASURE...TO INDICATE...TO WARN...AT A DISTANCE

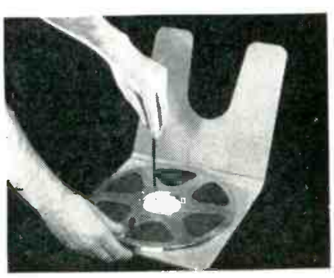
EASTERN ENGINEERING OFFICE: 475 FIFTH AVE., NEW YORK 17, N. Y.

NOW you can get audiotape* in 2500-foot rolls!









...with 5 important advantages to all professional users

Plastic base, red oxide Audiotape is now available in professional-size, 2500-foot rolls — on standard NAB aluminum hubs or on complete 10½-inch aluminum reels. This latest addition to the complete Audiotape line offers you these 5 outstanding advantages:

1. *Exceptionally Low Cost*
2. *4% More Tape* than the usual 2400-foot roll
3. *Absolutely No Splices* in the entire roll
4. *Uniform Volume*—guaranteed not to exceed ±¼ db for the full reel, and ±½ db from reel to reel
5. *A Unique Package* (Pat. Pending), specially designed for easier and safer handling and storage

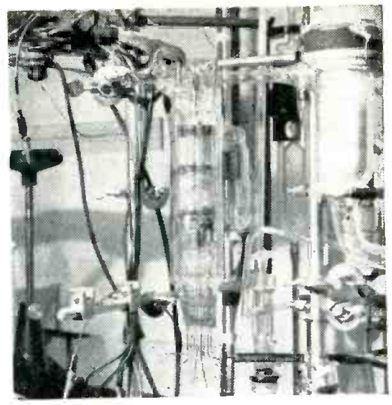
The folding inner container, shown above and at right, permits the tape to be placed onto the turntable of a machine without danger of its slipping from the hub or becoming unwound. It also permits tape to be transferred from turntable to package with equal ease and safety. What's more, the container is so designed that reel flanges can be attached to the hub quickly and easily, without danger of spilling the tape or dropping the sleeve screws. The package protects the tape in storage, too—prevents flattening of the bottom of the roll or damaging of the edges. This same type of package is also used for 5000-foot rolls of Audiotape.

Ask your dealer to show you the new professional size Audiotape. Or write to us for a free 200-foot sample reel of the tape and a descriptive sheet on the new container.

*Trade Mark

AUDIO DEVICES, INC.

444 Madison Ave., New York 22, N.Y.



Close-up of a completed three-stage nonmagnetic mass spectrometer tube

the spectrometer works well for the study of negative ions, an important feature of the new instrument. Since negative ions are in general much less abundant, when they exist at all, the unusual sensitivity of the r-f field spectrometer is a great advantage in the study of negative ions.

In the development of vacuum tubes, as for example power transmitting tubes, such a spectrometer can be very helpful in analyzing gases and vapors that are evolved from the heated electrodes.

Surface reactions form another group of processes for which the new spectrometer can be used, separately analyzing the positively or negatively charged components. In gaseous discharges, the instrument can be used for direct analysis of the ions without magnetically disturbing the discharge.

One of the urgent needs of the U. S. Bureau of Mines is an instrument which can be used in the field for the analysis of small percentages of hydrogen in the manufacture of helium. The new spectrometer has already demonstrated adequate sensitivity and resolution for this task, and it can be readily adapted to automatic operation. Similarly, the new instrument could be used for continuous observation of the air in an enclosed space, giving warning of the presence of dangerous components such as hydrogen or chlorine. In addition, an active project is now under way at the National Bureau of Standards to adapt this instrument for use as an extremely sensitive carbon monoxide detector.

The lightness and compactness of the nonmagnetic spectrometer offers

versatile

Multi-channel -- telegraph Al or telephone A3.

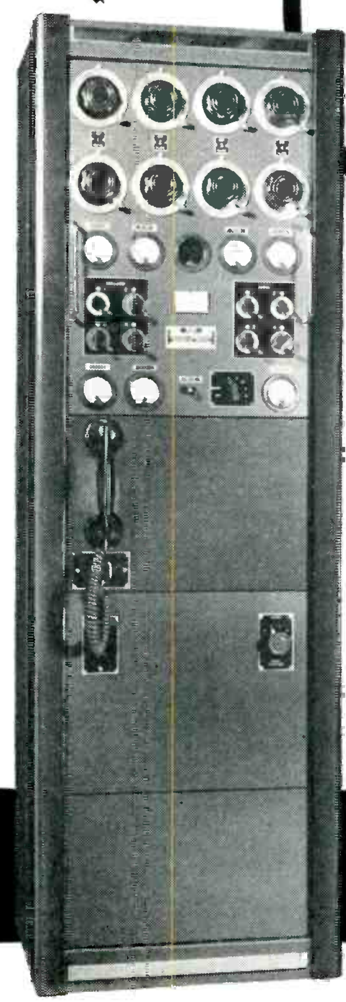
FROM GROUND TO AIR OR POINT TO POINT

STABLE

High stability (.003%) under normal operating conditions.

RUGGED

Components conservatively rated. Completely tropicalized.



Model 446 transmitter operates on 4 crystal-controlled frequencies (plus 2 closely spaced frequencies) in the band 2.5-13.5 Mcs (1.6-2.5 Mcs available). Operates on one frequency at a time; channeling time 2 seconds. Carrier power 350 watts, A1 or A3 AM. Stability .003% using CR-7 (or HC-6U) crystals. Operates in ambient 0° to + 45° C using mercury rectifiers; -35° to + 45° C using gas filled rectifiers. Power supply, 200-250 volts, 50/60 cycles, single phase. Conservatively rated, sturdily constructed. Complete technical data on request.

Here's the ideal general-purpose high-frequency transmitter! Model 446... 4-channel, 6-frequency, medium power, high stability. Suitable for point-to-point or ground-to-air communication. Can be remotely located from operating position. Co-axial fitting to accept frequency shift signals.

Consultants, designers and manufacturers of standard or special electronic, meteorological and communications equipment.

AER -O- COM

Reg. U. S. Pat. Off.

AERONAUTICAL COMMUNICATIONS EQUIPMENT, INC.

3090 Douglas Road, Miami 33, Florida

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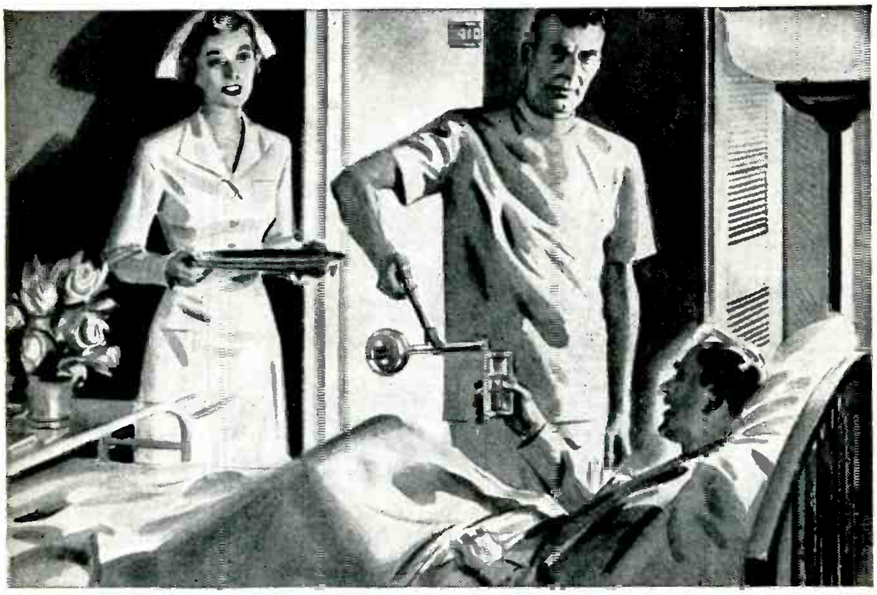
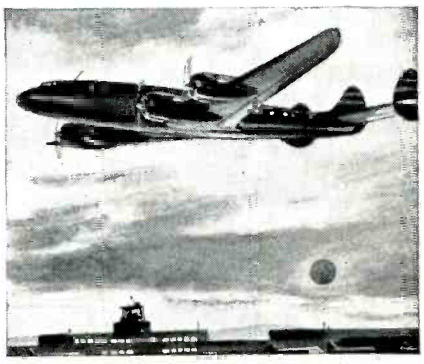
Atom pile by-products "fly" to help medical research



Radioisotopes were needed by a Boston hospital for patient treatment. Lead-shielded box of radioactive iodine (weight, 35 lbs.) picked up by Air Express in Knoxville, Tenn., at 11 A.M., delivered 7:15 P.M. Charge, $8.60. Hospitals, like all business, use Air Express regularly to get supplies from anywhere in hours.

It's easier and more convenient to use the *world's fastest* shipping service. When shipments are ready, just phone for pick-up. Special door-to-door service included in the low rates.



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Only Air Express gives you all these advantages

World's fastest shipping service.
Special door-to-door service at no extra cost.
One-carrier responsibility all the way.
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a way to settle the question of the chemical composition of the upper atmosphere. This is a problem which is directly related to work in radio propagation and stratospheric flight. Arrangements have been made with the Applied Physics Laboratory of the John Hopkins University to send one of the new spectrometers aloft in a rocket. Before it is mounted in the rocket, the spectrometer tube will be evacuated and sealed; when the rocket has reached maximum altitude, an arm of the tube will be broken open to the rarefield air. The relative densities of atmospheric components will then be telemetered back to the ground for recording.

The nonmagnetic mass spectrometer is now being adapted to the rapid scanning of mass spectra. Present methods permit sweeping twice a second through the mass range from 10 to 50, displaying the measured mass components directly on the screen of an oscilloscope. The scanning is accomplished by sweeping the ion accelerating voltage from 50 to 250 volts while modulating the r-f potential with a 1,000-cycle signal.

Thermal Detector Response To Triangular Pulses

By NORMAN ALPERT
Servo Corporation of America
New Hyde Park, New York

THE RESPONSE of thermal detectors to triangular radiation pulses whose duration is 0.1 to 100 times the time constant of the thermal detector is best illustrated graphically. The following presents such information along with a representation of the effect of a 5-stage R-C coupled amplifier on the output from the thermal detector.

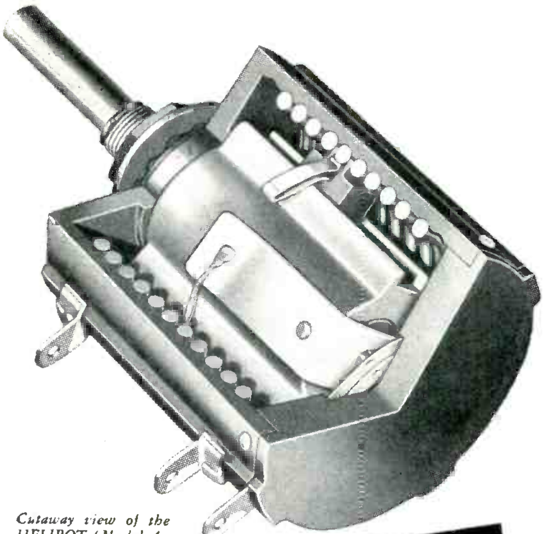
In general, the response to a unit step input of certain thermal detectors can be characterized by a single time constant as follows:

$$E_{out} = 1 - \epsilon^{-\frac{t}{T}}$$

where T is the thermal detector time constant. Hence the thermal detector can be represented by the equivalent circuit shown in Fig. 1A.

The response to a symmetrical

For new simplicity, wide range, and high accuracy in the control of modern electronic circuits...



Cutaway view of the HELIPOT (Model A—10 Turn—1¾" Diameter)

THE BECKMAN Helipot

(Trademark of the HELical POTentiometer)

Provides *many times* greater resistance control in *same* panel space as conventional potentiometers!

IF YOU are designing or manufacturing *any type* of precision electronic equipment be sure to investigate the greater convenience, utility, range and compactness that can be incorporated into your equipment by using the revolutionary HELIPOT for rheostat-potentiometer control applications... and by using the new DUODIAL turns-indicating knob described at right.

Briefly, here is the HELIPOT principle... whereas a conventional potentiometer consists of a *single* coil of resistance winding, the HELIPOT has a resistance element *many times* longer coiled *helically* into a case which requires no more panel space than the conventional unit. A simple, foolproof guide controls the slider contact so that it follows the helical path of the resistance winding from end to end as a single knob is rotated. Result... *with no increase in panel space requirements,* the HELIPOT gives you as much as 12 times* the control surface. You get far greater accuracy, finer settings, increased range—with maximum compactness and operating simplicity!

COMPLETE RANGE OF TYPES AND SIZES

The HELIPOT is available in a complete range of types and sizes to meet a wide variety of control applications...

MODEL A: *5 watts, 10 turns, 46" slide wire length, 1¾" case dia., resistances 10 to 50,000 ohms, 3600° rotation.*

MODEL B: *10 watts, 15 turns, 140" slide wire length, 3¼" case dia., resistances 50 to 200,000 ohms, 5400° rotation.*

MODEL C: *3 watts, 3 turns, 13½" slide wire length, 1¾" case dia., resistances 5 to 15,000 ohms, 1080° rotation.*

MODEL D: *15 watts, 25 turns, 234" slide wire length, 3¼ case dia., resistances 100 to 300,000 ohms, 9000° rotation.*

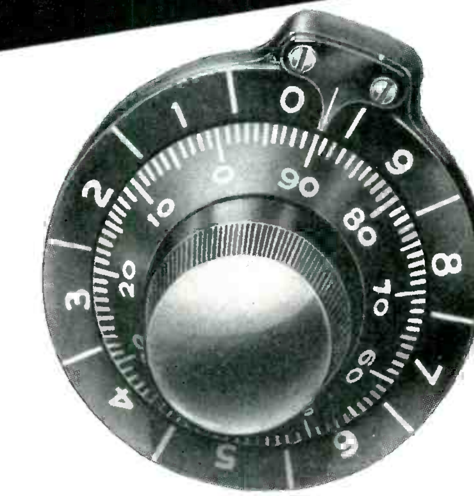
MODEL E: *20 watts, 40 turns, 373" slide wire length, 3¼" case dia., resistances 150 to 500,000 ohms, 14,400° rotation.*

Also, the HELIPOT is available in various special designs... with double shaft extensions, in multiple assemblies, integral dual units, etc.

Let us study *your* potentiometer problems and suggest how the HELIPOT can be used—possibly is already being used by others in your industry—to increase the accuracy, convenience and simplicity of modern electronic equipment. No obligation, of course. Write today outlining your problem.

**Data for Model A, 1¾" dia. Helipot. Other models give even greater control range in 3" case diameters.*

THE BECKMAN Duodial



The inner, or Primary dial of the DUODIAL shows exact angular position of shaft during each revolution. The outer, or Secondary dial shows number of complete revolutions made by the Primary dial.

A multi-turn rotational-indicating knob dial for use with the HELIPOT and other multiple turn devices.

THE DUODIAL is a unique advancement in knob dial design. It consists essentially of a primary knob dial geared to a concentric turns-indicating secondary dial—and the entire unit is so compact it requires only a 2" diameter panel space!

The DUODIAL is so designed that—as the primary dial rotates through each complete revolution—the secondary dial moves one division on its scale. Thus, the secondary dial counts the number of complete revolutions made by the primary dial. When used with the HELIPOT, the DUODIAL registers *both* the angular position of the slider contact on any given helix as well as the particular helix on which the slider is positioned.

Besides its use on the HELIPOT, the DUODIAL is readily adaptable to other helically wound devices as well as to many conventional gear-driven controls where extra dial length is desired without wasting panel space. It is compact, simple and rugged. It contains only two moving parts, both made entirely of metal. It cannot be damaged through jamming of the driven unit, or by forcing beyond any mechanical stop. It is not subject to error from backlash of internal gears.

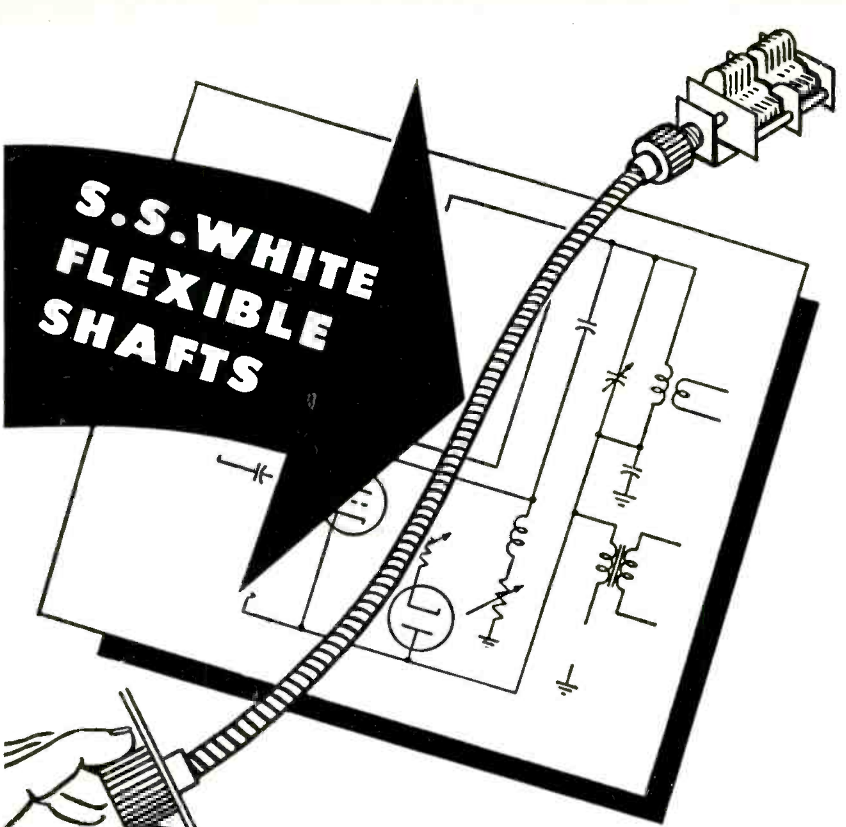
TWO SIZES—MANY RATIOS

The DUODIAL is now available in two types—the Model "R" (illustrated above) which is 2" in diameter, and the new Model "W" which is 4¾" in diameter and is ideal for main control applications. Standard turns-ratios include 10:1, 15:1, 25:1 and 40:1 (ratio between primary and secondary dials). Other ratios can be provided on special order. The 10:1 ratio DUODIAL can be readily employed with devices operating *fewer* than 10 revolutions and is recommended for the 3-turn HELIPOT. In all types, the primary dial and shaft operate with a 1:1 ratio, and all types mount directly on a ¼" round shaft.

Send for this HELIPOT AND DUODIAL CATALOG!

Contains complete data, construction details, etc., on the many sizes and types of HELIPOTS... and on the many unique features of the DUODIAL. Send for your free copy today!

THE Helipot CORPORATION, SOUTH PASADENA 2, CALIFORNIA



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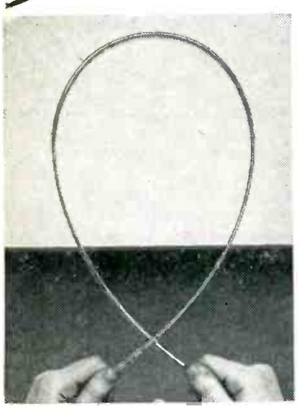

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In radio, television and electronic equipment design, S.S.White remote control flexible shafts are valuable assets because they make it possible to place both the variable units and their controls in the most desirable locations.

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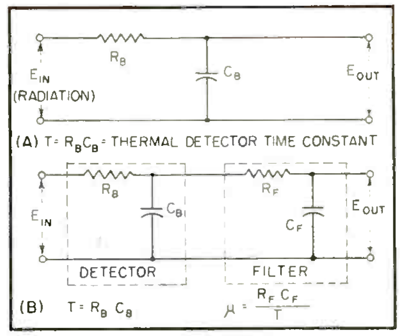


FIG. 1—Equivalent circuits for thermal detector *A* and for detector with low-pass filter *B*

triangular input pulse δT seconds wide can be obtained by Laplace Transform methods.

Figure 2A shows normalized curves of e_{out} vs time with δ as a parameter. It can be seen that for $\delta \geqq 100$, the output follows the input very closely, while for $\delta \lesseqgtr 0.1$ there is practically no output at all. Furthermore, the time lag for the peak instantaneous output to occur is greater the smaller the pulse width, δ.

Amplifier Response

The response of a thermal detector and five-stage R-C amplifier (where the amplifier time constant is 10 times the thermal detector time constant, or $\alpha = 10$) is shown by the normalized curves of e_{out} vs time with δ as parameter (Fig. 2B). It can be seen from a comparison of Fig. 2A and 2B that for $\delta = 2$, the amplifier faithfully reproduces the pulse output from the thermal detector except for a slight negative undershoot, while for $\delta = 20$, the

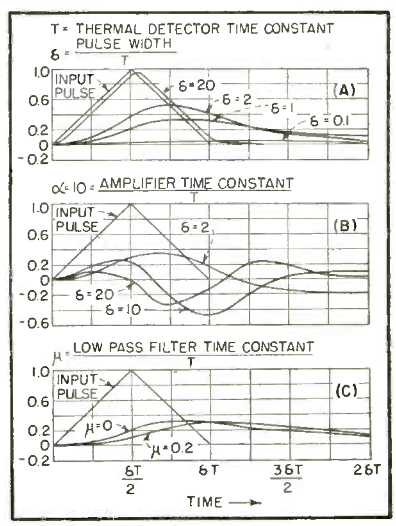
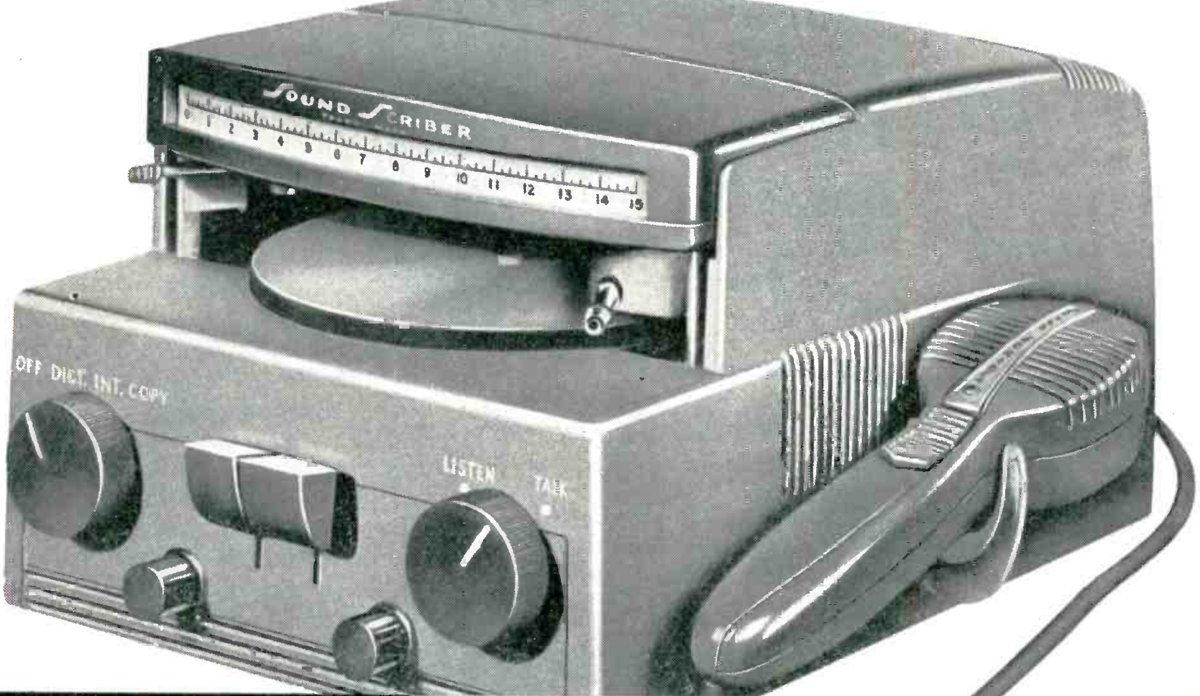
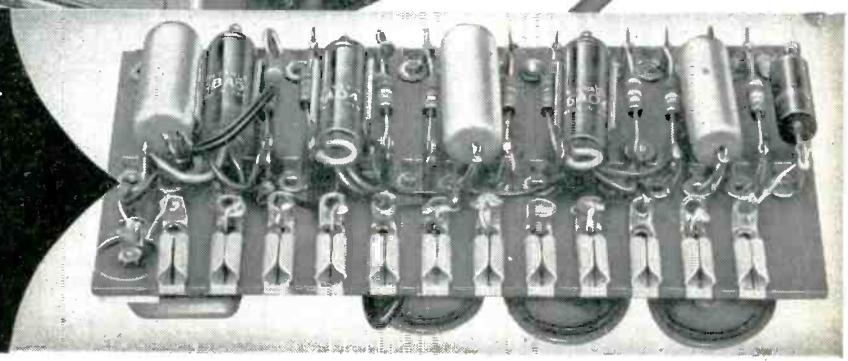


FIG. 2—Curves show response of thermal detector and five-stage amplifier to symmetrical triangular input pulses

GREAT LITTLE TUBES FOR A GREAT LITTLE INSTRUMENT



Here is the heart of the SoundScriber "Tycoon". Note how Sylvania's three subminiature tubes (1-6BA5 and 2-6AD4's) are mounted directly on the plastic card—allowing all-round compactness of design.



Sylvania's subminiature tubes are one of the secrets that enable SoundScriber to make the world's lightest, most compact dictation instrument. Only 15 lbs., the "Tycoon" covers as little desk space as an ordinary letter. Such concentration of electronic efficiency is typical of the advantages offered by Sylvania's subminiature tubes.

The "Tycoon" also owes much of its reputation for reliability to the Sylvania subminiatures that serve it . . . for they are lightweight little wonder-workers that stand up to heavyweight treatment.

In electronics, wherever compactness demands minimum size . . . wherever dependability is wedded to economy . . . you'll find Sylvania subminiatures at work, cutting space, cutting costs, cutting servicing requirements and replacement. Write Sylvania Electric Products Inc., Dept. R-2106, Emporium, Pa.

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undershoot attains considerable proportions. When $\delta = 10$, the magnitude of the peak negative undershoot is almost twice as great as the first positive peak, while for $\delta = 20$, the undershoot is three times greater. In addition, the positive overshoot which occurs in the latter case is more than twice the first positive peak.

Inspection of Fig. 2B reveals that δ must be between 1 and 20 for reasonable pulse outputs which could be detected above noise.

The value for α was chosen as 10 from considerations of a typical thermal detector time constant of about 10 milliseconds and could easily be attained with a 0.05 μf capacitor and a 2 megohm resistor. The use of larger capacitors and resistors to increase the amplifier time constant and thus improve the response to pulses of longer duration is not recommended because of leakage resistance, grid current and because of their large physical size.

Summary of Figures

Figure 3 is a resume of Fig. 2A and 2B to an actual time scale. The pulses are shown in their relative time domains rather than on a normalized basis in order to provide a better insight into the relative effects on the input pulse of the thermal detector and five-stage R-C amplifier.

It should be noted from the curves that for relatively small

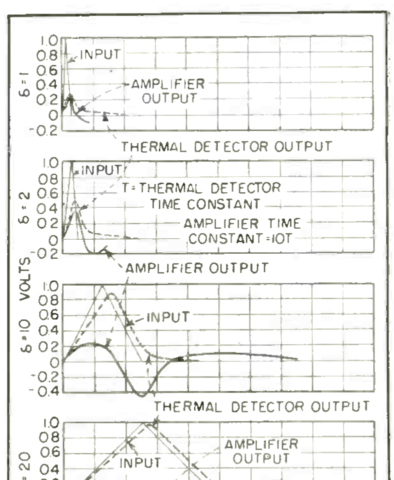
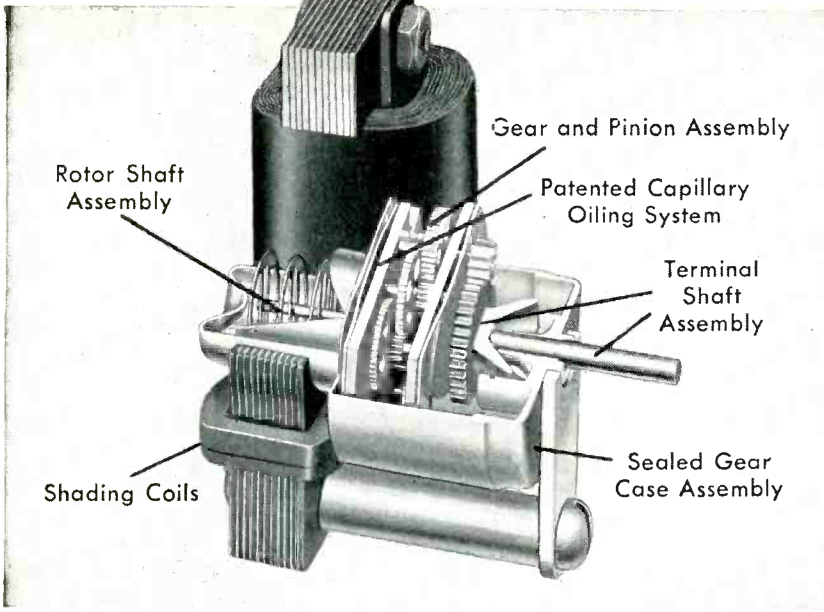
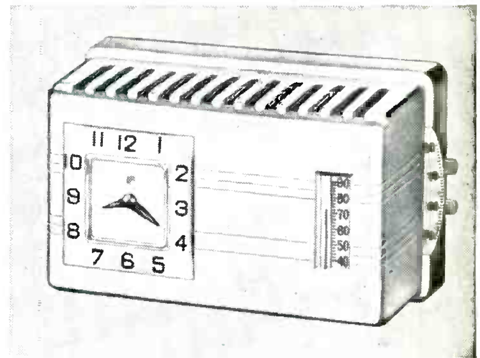


FIG. 3—Curves of pulses in relative time domain for detector and amplifier



Telechron Type B Synchronous Motor. For switches, recording-controlling mechanisms and other medium duty controlling purposes. Other models available with lower or higher torques for light or heavy duty applications.



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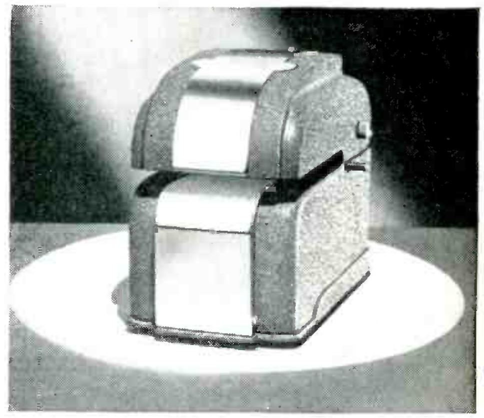
Unique Oiling System Prolongs Timing Accuracy

Capillary action in the spaces between each bearing and capillary plate of Telechron Timing Motors draws a specially formulated oil from the reservoir at the bottom of the sealed gear case. This keeps bearings and pivot surfaces constantly covered with a thin coating of oil. Oil creepage along the shafts, pinions and gears maintains complete, continuous lubrication. Brass terminal gear baffles meter the right amount of oil to the terminal shaft bearing . . . cutting down bearing wear and making the sealed-in oil supply last for years.

This oiling system is just one of many reasons why *all Telechron Timing Motors are instantly, constantly synchronous* . . . and why designers concerned with split-second timing or precise control of lightweight moving parts invariably specify Telechron motors.

If accurate timing enters into your product design, talk things over with a Telechron Application Engineer. Backed up by the experience that makes all electric timing possible (virtually all frequency-controlling master clocks in power stations are made by Telechron), he can probably show you how to save time and money by fitting a standard Telechron motor into your product. In the meanwhile, get complete data by mailing the coupon below. Telechron Inc. A General Electric Affiliate.



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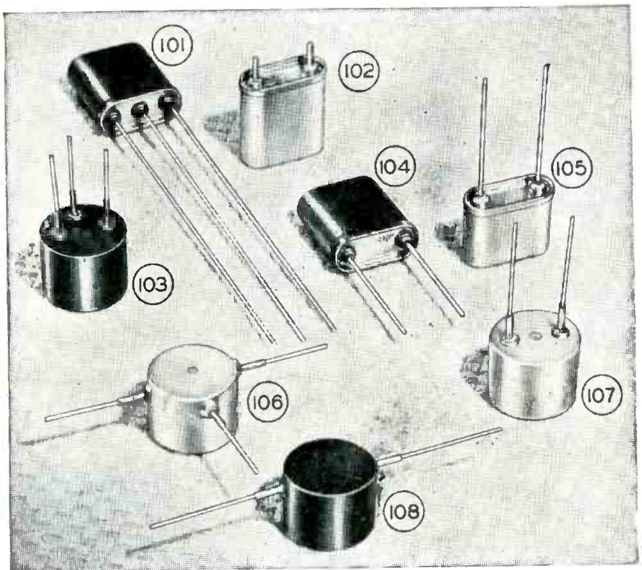

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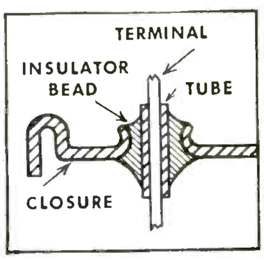

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pulse widths, it is mainly the thermal detector which has the major effect on the output, while for relatively large pulse widths the thermal detector drops out of the picture and the amplifier assumes the prominent role.

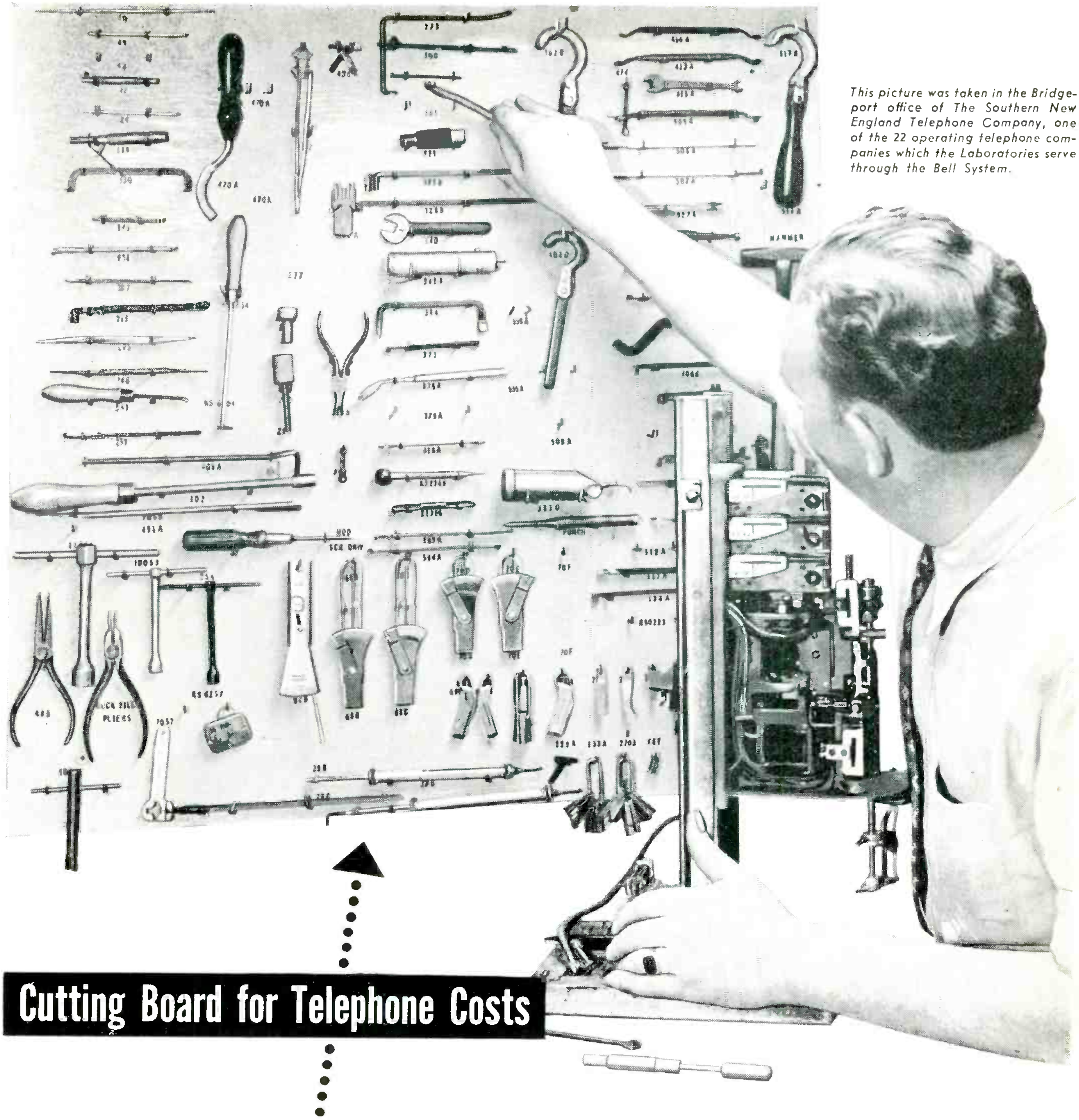
Ideally, the pulse width should be at least ten times the thermal detector time constant, and the amplifier time constant should be at least ten times larger than the pulse width. Under these conditions, the amplifier time constant would probably be so large that a d-c amplifier with its inherent problems would be required. It is for this reason that an amplifier time constant of ten times the thermal detector time constant (about 0.1 second for a 10-millisecond thermal detector) has been selected.

Cutoff Filter

To obtain a higher signal-to-noise ratio it is desirable to make the high-frequency cutoff as low as possible without seriously affecting the pulse amplitude or phase. Since the problem of calculating the response of a five-stage R-C amplifier which contains from one to four low-pass filters is extremely complex and since furthermore the high-frequency cutoff point can be made sufficiently high if necessary, to leave the signal pulse unaffected, this calculation was not performed. Instead, the effect of one low-pass filter on the thermal detector response alone is given to illustrate the effect of different high-frequency cutoff points and to enable a reasonable choice of low frequency filter to be made.

Figure 2C shows normalized curves of e_{out} vs time with μ as parameter, and is a plot of the response of the circuit in Fig. 1B. The pulse width was a constant ($\delta = 1$) at the lowest value giving reasonable output, in order to impose the severest restrictions on the low pass filter cutoff frequency. From the curves it is apparent that the larger μ is, the greater is the time lag. In fact, if μ is of the same order of magnitude as T (the thermal detector time constant), the phase lag would be prohibitive.

For all practical purposes, the pulse will be hardly affected in amplitude, shape or phase provided



This picture was taken in the Bridgeport office of The Southern New England Telephone Company, one of the 22 operating telephone companies which the Laboratories serve through the Bell System.

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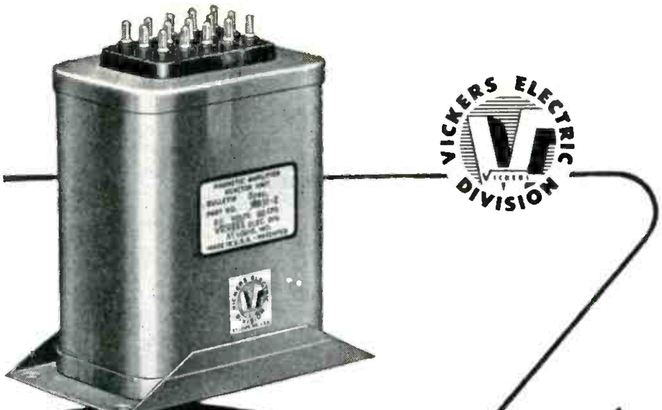

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μ is about 0.1. It should be borne in mind, however, that for several low-pass filters in cascade, the time lag will be correspondingly increased.

Conclusions

If a triangular radiation pulse is applied to a thermal detector and an associated five-stage R-C coupled amplifier, each stage having a time constant ten times greater than the thermal detector, usable outputs will be obtained provided the pulse width is 1 to 20 times the thermal detector time constant.

In addition, if a low-pass filter is included in the amplifier to increase the signal-to-noise ratio, its time constant should be a maximum of about one-tenth that of the thermal detector, otherwise additional phase lag will be introduced into the system.

SURVEY OF NEW TECHNIQUES

NONFERROUS strip materials like aluminum, brass, copper and stainless steel can be heat treated by induction heating because of a new development explained by Robert M. Baker of Westinghouse. The strip is passed between two opposing laminated pole structures. The field coils are so polarized that at any instant opposing poles have opposite sign and force flux through the strip. The technique, which is called transverse flux induction heating, was described in a paper before a recent meeting of the North Eastern District of the American Institute of Electrical Engineers.

TWO F-M SIGNALS can be simultaneously transmitted on the same frequency and separately received by a new technique called the bisignal system by its inventor, Raymond M. Wilmotte, consulting engineer of Washington, D. C. Instead of differentiating between signals by a frequency separation, as in the present f-m setup, Wilmotte provides two signals of different intensities and separates the signals, without crosstalk, in special receiving equipment.

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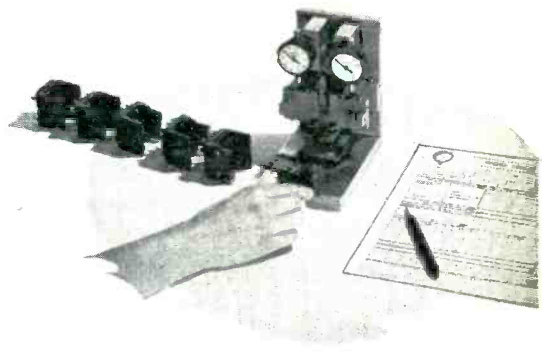

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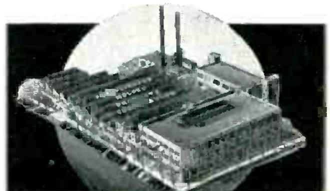

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APPROVED BY UNDERWRITERS LABORATORIES AT 90° CENTIGRADE — 600 VOLTS

Proven BEST, and specified regularly, by leading manufacturers of television, F-M, quality radio and all exacting electronic equipment. For maximum output and minimum rejects. Available in all sizes, solid and stranded. Over 200 color combinations.

PRODUCTION ENGINEERS: Specify "NOFLAME-COR" for absolute uniformity of diameter, permitting clean stripping of insulation without damage to the copper conductor . . .

NO NICKING OF CONDUCTORS

NO CONSTANT RESETTING OF BLADES

AVOID LOSSES FROM

"BLOBBING"

Not being an extruded plastic, eliminates the costly "blobbing" of insulations under soldering heat

- Flame Resistant
- High Insulation Resistance
- Heat Resistant
- Facilitates Positive Soldering
- High Dielectric
- Easy Stripping
- Also unaffected by the heat of impregnation — therefore, ideal for coil and transformer leads

COMPLETE DATA AND SAMPLES ON REQUEST

"made by engineers for engineers"

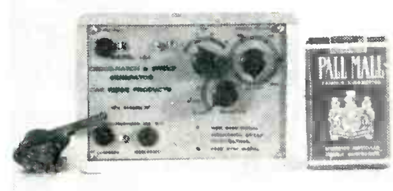
CORNISH WIRE COMPANY, Inc.

605 North Michigan Avenue, Chicago 11 — 15 Park Row, New York 7, N. Y. — 1237 Public Ledger Bldg., Philadelphia 6

MANUFACTURERS OF QUALITY WIRES AND CABLES FOR THE ELECTRICAL AND ELECTRONIC INDUSTRIES

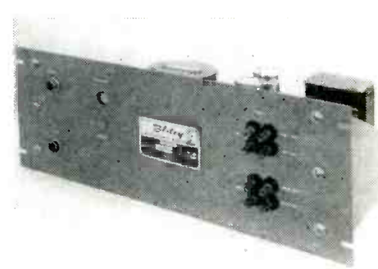
(continued from p 128)

and isolation transformer, is designed to speed up tv receiver service, minimize shock hazards, cut down service returns and prevent damage to shop test equipment. The primary winding has a line-voltage matching switch which is adjustable in 5-volt steps over the 105 to 130-v range. The instrument has two output circuits, a 275 volt-ampere isolation secondary and an autotransformer connection providing 500 volt-amperes.



Tele Test Set

OAK RIDGE PRODUCTS, 239 E. 127 St., New York 35, N. Y. Model 104 cross-hatch and sweep generator provides a new approach to the problem of servicing sync and sweep failures in a tv receiver. The unit consists of an r-f oscillator section which is calibrated on channels 2 to 5 and a modulator section with a specially designed switching network to provide a variety of frequencies. By turning the selector switch to different positions the serviceman can adjust sync and sweep of the receiver without a test pattern or program on the air.



Frequency Standard

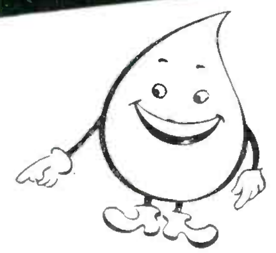
BLILEY ELECTRIC CO., Erie, Pa., has announced a frequency standard employing a 100-kc crystal and featuring 24-hour frequency stability of two parts in 10 million when subjected to line voltage fluctuation of as much as 10 percent. Terminals

READ WHAT USERS SAY ABOUT

G.E.'s New All-Purpose* Insulating Varnish G-E 9574

J. L. Hughes, owner of the J. L. Hughes Electric Company, Columbus, Ohio, says:

"We have found from test and practical experience that General Electric general-purpose varnish 9574 is tops for our work."



J. Lindborg, owner of AAA Electric Motor Service, Atlanta, Ga., says:

"Our experience has been that this varnish is as good as G.E. claims. It gives a good coat on every type of wire, bakes easily and dries to a tough coating that stands up perfectly in service."

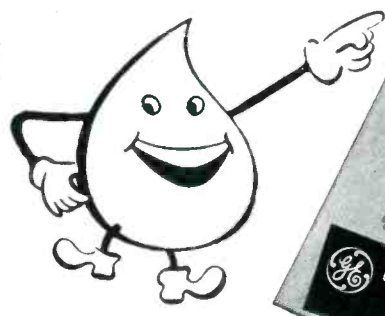
Guy W. Probst, owner of Lockhaven Electric Repair Co., Lockhaven, Pa., says:

"I find that I only use about half as much 1201 Glyptal as a cover coat on 9574 as I had to use over the varnish I had been using, and I get higher gloss and better bonding."

These statements indicate the success of the new G-E 9574. If you are looking for an insulating varnish which bakes at low temperatures, penetrates deep coils easily, and requires no special thinner, investigate G-E 9574.

***G-E 9574** *gives excellent results on all types of coils except extra-high-speed armatures. It is one of G.E.'s complete line of electrical insulating materials, including wedges, adhesives, cements, compounds, cords and twines, sleeving, wire enamels, mica, papers and fibers, permafils, tapes, tubing, varnished cloths, and varnishes.*

Here's A Bulletin You Should Have! If you haven't yet tried G-E 9574 get in touch with your local G-E Distributor, or write for our new bulletin to Section K3, Chemical Department, General Electric Company, Pittsfield, Massachusetts.



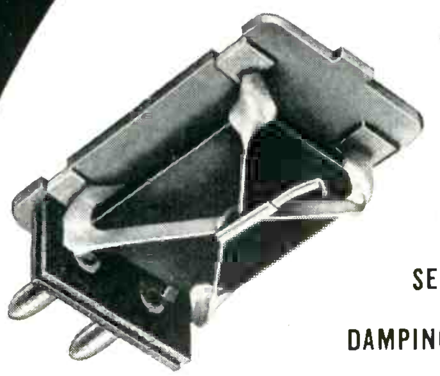
You, too, can put your confidence in

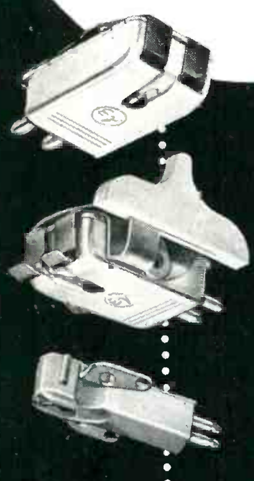
GENERAL ELECTRIC

TORQUE DRIVE

only TORQUE E-V DRIVE gives you *everything* you want exactly as you want it!

- LOW-MASS DRIVING SYSTEM
- HIGH VOLTAGE COMPLIANCE PRODUCT
- MORE THAN ADEQUATE LATERAL COMPLIANCE
- FREQUENCY RESPONSE MATCHED TO YOUR OWN CURVE
- EXTRA MOISTURE PROTECTION AT NO EXTRA COST
- NO TEMPERATURE SENSITIVE PADS OR DAMPING MATERIALS
- NO BEARINGS OR BUSHINGS TO CAUSE FRICTION
- ZERO OUTPUT FOR VERTICAL MOTIONS
- HIGH VERTICAL COMPLIANCE





A Basic Specification in Original Equipment by Leading Manufacturers

Users of E-V TORQUE DRIVE* cartridges have long enjoyed these major advantages. Advanced design and performance characteristics have made them readily adaptable to all speeds and all requirements. This has made it easy to provide the right solution for each phono cartridge problem. Laboratory control assures consistent uniformity in quantity production. Available in single-stylus and dual-stylus types . . . for 33⅓, 45 and 78 rpm single-speed or multi-speed record players. Let E-V engineers help you now. Our full facilities are at your service.

PHONO PICKUPS
MICROPHONES
SPEAKERS

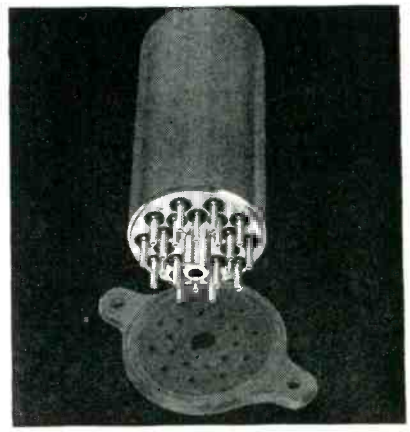
Electro-Voice INC.

401 CARROLL STREET • BUCHANAN, MICHIGAN

Export: 13 East 40th Street, New York 16, N. Y., U. S. A., Cables: Arlab

*E-V Pat. Pend. Licensed under Brush Patents

are provided for sine wave or harmonic output at both high and low impedance. Power supply is self-contained and the equipment is designed for rack or cabinet mounting. Complete technical literature is available.



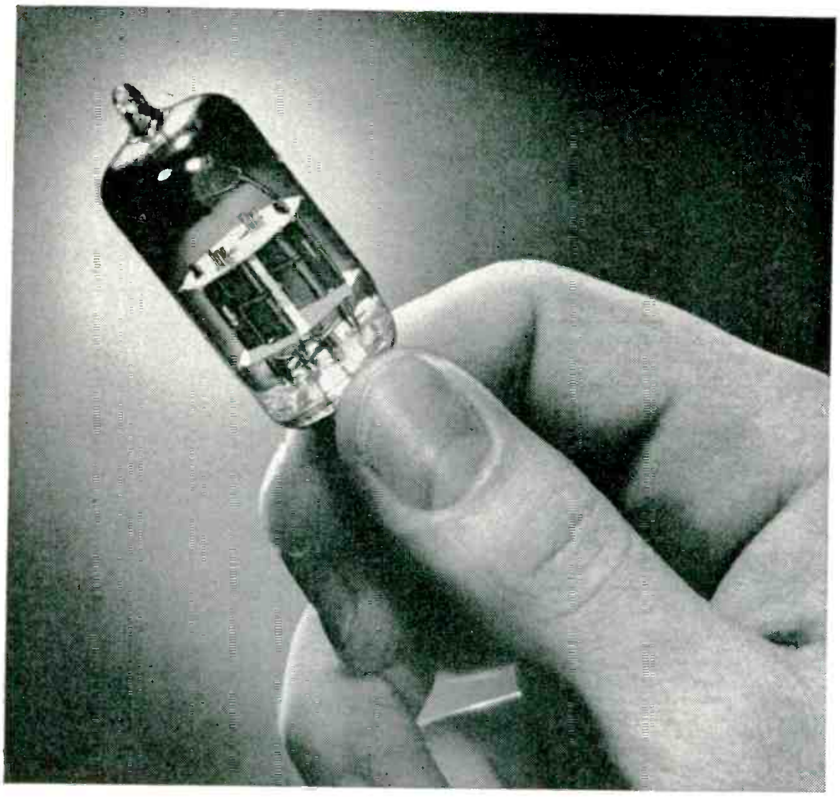
Plug-In Hermetic Terminal

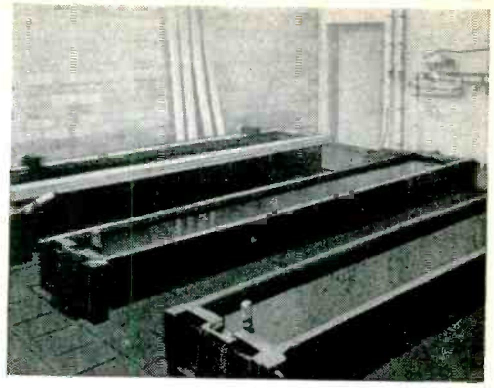
THE FUSITE CORP., Carthage at Hannaford, Cincinnati, Ohio, has introduced an octal-type-key plug-in terminal which incorporates tubular steel electrodes interfused with inorganic glass and plugs into a socket without external wiring. It offers 20 electrodes in a single metal disc and is especially suited for the hermetic sealing of relays. Standard sockets for the new terminal are available.

Remotely Controlled VHF Receiver

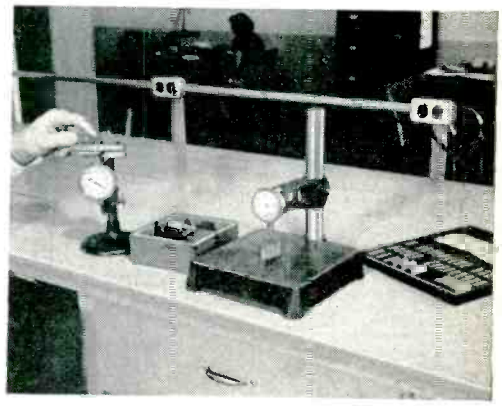
LEAR INC., AIRCRAFT RADIO DIV., 110 Ionia Ave., N. W., Grand Rapids 2, Mich. Model LR-5BR remotely controlled vhf receiver with small cockpit tuning control is available for aircraft owners requiring flexible mounting arrangements. The receiver weighs 3 lb 11 oz and measures 3½ in. × 6 7/16 in.,

Inside Information on the Inside of a Tube

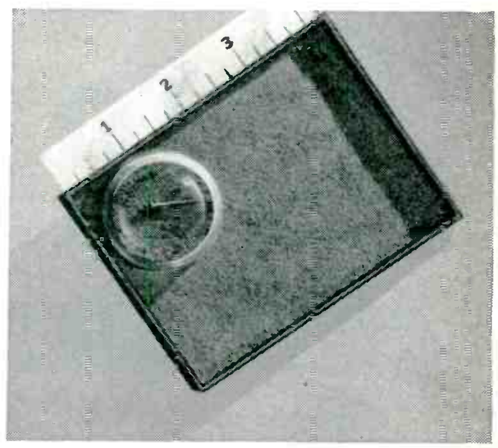




Acid House Equipment where material is cleaned and rinsed before bright annealing.



Inspection and Gaging . . . equipment for checking dimensions of Seamless and Lockseam Cathodes.



52,600 Seamless Nickel Cathodes... standing on end compared with a ruler, and an ordinary pin under a lens.

● The public-at-large does not know, as you do, that within nearly every electronic or television tube are other tubes. Or that these other tubes—of metal—can be as troublesome as they are tiny.

To see that they behave properly, the Electronics Division of Superior maintains excellent tubing research facilities, exercises tight control over production and product, helps you think your way out of problems in design and specification.

Superior was one of the early birds in electronics tubing—is always one of the first to come to your aid when you have tubing trouble . . . and is definitely a leader in tubing technology.

If you are one of the few electronic tube manufacturers who are not now enjoying all the help Superior can give you, get in touch with us today. Superior Tube Company, 2500 Germantown Avenue, Norristown, Pennsylvania.

Which Is The Better For Your Product . . .

SEAMLESS . . . ? The finest tubes that can be made. In all O.D.'s from 1⅝" and lower. Excellent for forming, bending, machining, etc., carbon, alloy, stainless, non-ferrous and glass sealing alloys.

Or LOCKSEAM* . . . ? Cathodes produced directly from nickel alloy strip stock by our patented machines. Available in a wide range of nickel alloys. Round, rectangular, or oval, cut to specified lengths, beaded or plain.

Superior

THE BIG NAME IN SMALL TUBING

All analyses .010" to ⅝" O.D.
Certain analyses (.035" max. wall) Up to 1⅝" O.D.

*MFG. UNDER U. S. PATS. SUPERIOR TUBE COMPANY

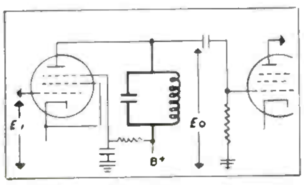
Electronic Products for export through Driver-Harris Company, Harrison, New Jersey • Harrison 6-4800

TOROIDAL COMPONENTS

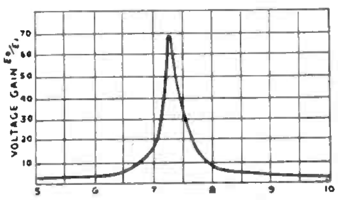
PRECISION TUNED CIRCUITS FOR YOUR SELECTIVE AMPLIFIER

ACTUAL SIZE

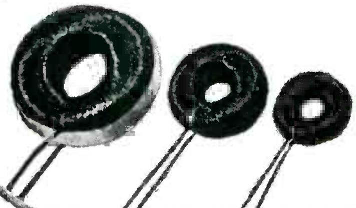
High Q precision tuned resonant circuits, accurately adjusted to your specified frequency. Toroid coil and capacitor are permanently protected by tough thermosetting plastic. Pigtail leads and light weight allow direct or terminal board mounting.



TYPICAL APPLICATION



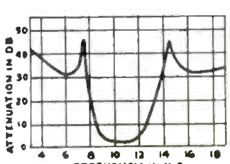
CUSTOM MADE TOROID COILS



Toroid coils, transformers and discriminators in a large range of inductances, frequencies and power levels. Permalloy dust cores. Uncased, mounted in hermetically sealed cans or coated with thermosetting plastic. Close tolerances with taps at any point. Multiple windings. Up to 2 Henries on wedding ring size. Larger sizes to 50 Henries.

MINIATURE TOROID FILTERS

1½" x 1¼" x 2" HIGH



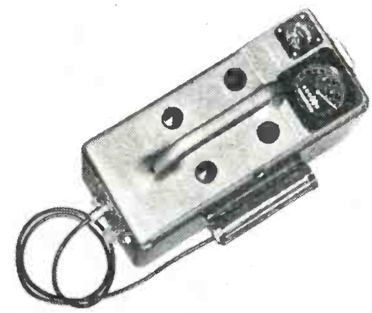
Specialized design and complete production facilities for your filter requirements. Where space is critical, miniature filters with wedding ring toroids and special capacitors. Supplied in standard units, or designed to your specification. A miniature band pass filter and curve are shown.

RAPID PRODUCTION DELIVERY. Engineering requirements given special attention. Wire, phone or write complete specifications.

COMMUNICATION ACCESSORIES *Company*

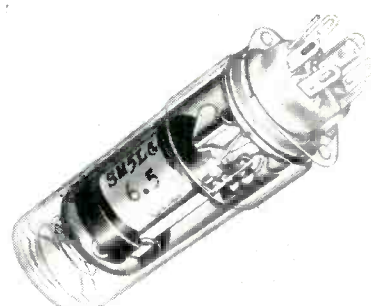
HICKMAN MILLS, MISSOURI

× 10 27/32 in.; the tuning control weighs 6 oz and measures 1 7/8 in. × 3 29/32 in. × 3 1/32 in.



Portable Scaler

BERKELEY SCIENTIFIC CO., Richmond, Calif. Model 80 portable, battery-operated scaler is specifically designed to meet the need for accurate determinations of radioactive levels in locations where conventional power supplies are not available or where line transients make conventional scalers unreliable. The instrument consists of a G-M tube and probe, a scale-of-eight electronic counter, a mechanical register and an adjustable, high-voltage battery supply. It has a maximum continuous counting rate of 14,400 counts per minute and will resolve individual pulses at 90 microseconds.

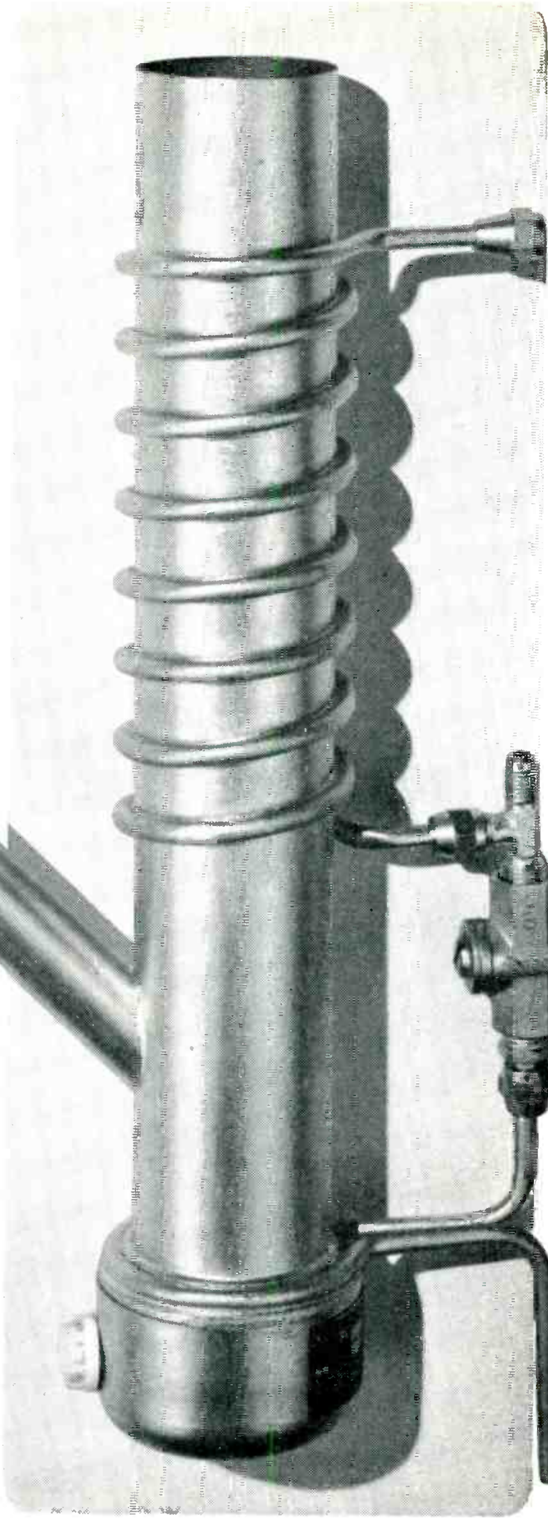


Subminiature Relays

POTTER & BRUMFIELD MFG. CO., INC., Princeton, Ind. Series SM subminiature relays are constructed so as to permit use with miniature socket and shield with inner spring. They can be made for use in guided missiles, aircraft applications and many general uses. The relays are offered with coil power ratings up to 1.75 watts and with d-c windings

Here's why this Diffusion Pump Sets the Pace

in Cathode Ray Plants



HIGHER SPEEDS mean better tubes. Note these speeds—consider what they can mean in profits for you.

30 liters/ sec. at 10^{-3} mm.
70 liters/ sec. at 10^{-4} mm.
75 liters/ sec. at 10^{-5} mm.
48 liters/ sec. at 10^{-6} mm.

HIGHER FOREPRESSURE TOLERANCE reduces mechanical pump maintenance. Down-time of mechanical pumps is far less in a year . . . productive operating periods longer. Mechanical pumps need not be at high efficiency.

High Vacuum Pressures	Maximum Forepressure
10^{-3} mm.	0.300 mm.
10^{-4} mm.	0.275 mm.
10^{-5} mm.	0.260 mm.
10^{-6} mm.	0.225 mm.

QUICKER COOLING eliminates troublesome valves. *With only 2 minutes cooling* you can open this pump to atmospheric pressure. No need to tie up valuable equipment during long cooling periods . . . no need to pay for expensive valves and their maintenance.

IMMEDIATE SHIPMENT! For your convenience, adequate stocks of standard National Research Corporation pumps are kept on hand at all times. We can make immediate shipment as required.

SPECIAL MODELS are no problem. We gladly fabricate many specials to suit the requirements of different plant designs . . . in a variety of flanges, foreline lengths, etc.

Added together these advantages have quickly made this National Research diffusion pump first choice of the cathode ray industry. If high vacuum is a problem in your plant or laboratory, you will find it will pay to investigate. Write today.

New, Low Cost DIFFUSION PUMP FLUID NARCOIL 20 Write for Details!

INDUSTRIAL RESEARCH · PROCESS DEVELOPMENT
HIGH VACUUM ENGINEERING AND EQUIPMENT

METALLURGY · DEHYDRATION · DISTILLATION
COATING · APPLIED PHYSICS

National Research Corporation

Seventy Memorial Drive, Cambridge, Massachusetts

In the United Kingdom: BRITISH-AMERICAN RESEARCH, LTD., London S. W. 7, England—Glasgow S. W. 2, Scotland

Designed for

Application

The No. 90651

GRID DIP METER

The No. 90651 MILLEN GRIP DIP METER is compact and completely self contained. The AC power supply is of the "transformer" type. The drum dial has seven calibrated uniform length scales from 1.5 MC to 300 MC plus an arbitrary scale for use with the 4 additional inductors available to extend the range to 220 kc. Internal terminal strip permits battery operation for antenna measurement.

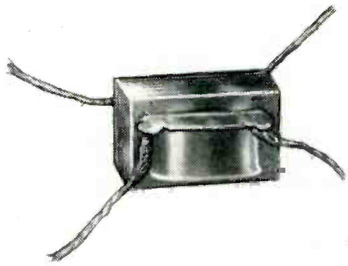
JAMES MILLEN MFG. CO., INC.

MAIN OFFICE AND FACTORY

MALDEN

MASSACHUSETTS

from 0.155 to 8,000 ohms. With minimum adjustment they pull in on 3 ma at 75 mw. Ask for bulletin 102.



Tiny Auto Transformer

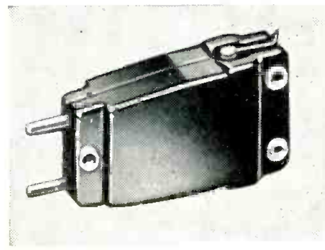
UNITED TRANSFORMER Co., 150 Varick St., New York 13, N. Y. Type SSO standard audio transformer measures 0.4 × 0.75 × 0.56 in., and weighs 0.28 oz. Especially suitable for hearing aid, aircraft and all other applications where size and weight are the prime consideration, the transformer is ideal for the military's miniaturization program. Designs are available for all types of low-level applications requiring wide frequency range. All are vacuum impregnated for dependable operation under high humidity conditions.

Pulse Rise Time Indicator

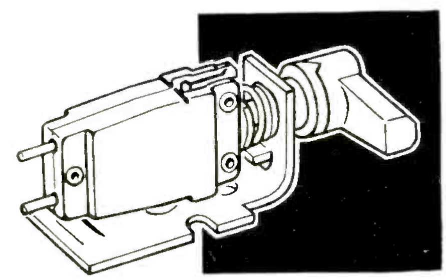
ELECTRONIC SYSTEMS Co., 555 E. Tremont Ave., New York 57, N. Y. Model 632-B pulse rise time indicator is an instrument for the accurate plotting of the rise time of rapidly rising positive voltage pulses. It employs a specially designed delay line of variable length and a vtvm. Controls include an on-off switch, zero set and sensitivity selector, speed and direction

Webster Electric

Model "A" Cartridge



with Twist Mechanism



A complete unit with top performance and absolute minimum of service and installation problems.

The twist mechanism is factory assembled with Model A7 cartridge in place, ready for installation in tone arms without adjustment or modification. This completely assembled unit gives positive tracking at all playing speeds. High vertical and lateral compliance eliminate "skating". The simple, foolproof twist mechanism gives positive indexing, eliminating the possibility of twisting and damaging the leads in the tone arm.

There are no delicate parts to break or get out of order. The Model A7 with twist mechanism reverses through a 180 degree arc for playing either 33⅓ — 45 or 78 R.P.M. records.

Send for a sample assembly today... try it . . . then note first hand the advanced improvement.

WEBSTER ELECTRIC

Webster Electric Company, Racine, Wis. • Established 1909

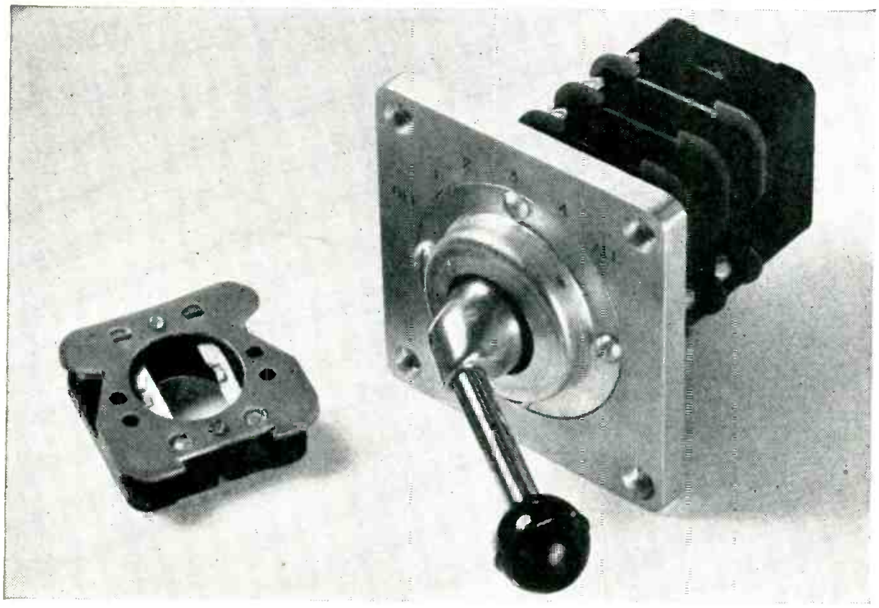
"Where Quality is a Responsibility and Fair Dealing an Obligation"

COPPER ALLOY BULLETIN

PRODUCT IMPROVEMENT EDITION

REPORTING NEWS AND TECHNICAL DEVELOPMENTS OF COPPER AND COPPER-BASE ALLOYS

Prepared Each Month by Bridgeport Brass Co. "Bridgeport" *Headquarters for BRASS, BRONZE and COPPER*



Push-Pull-Selector switch and section showing copper contact bars.
Courtesy The Arrow-Hart & Hegeman Electric Co., Hartford, Conn.

Copper, Brass Used for Parts in Push-Pull Selector Switch

Each copper-base alloy has individual characteristics such as electrical conductivity, strength and workability. The design engineer first selects his material from the standpoint of the job to be done by each part. Then, when given a choice, he selects the alloy which may be worked or machined more readily.

A good example of this type of product designing is seen in the rotating cam sections of the Push-Pull-Selector switch control manufactured by the Arrow-Hart & Hegeman Electric Company, Hartford, Conn. A small, compact unit, this switch provides a single point of control for multi-operation machines.

Electrical Conductivity Solved

Copper, due to its high conductivity and low resistivity, was used in various tempers for all the main pole, current carrying sections such as the movable and stationary contact members. High electrical capacity was thereby allowed in minimum spaces.

The external shunt employed for tieing the poles together, however, is of high brass (65% copper, 35% zinc), due to its lower cost and the fact that it is an external part where heat dissipation was not a problem. The central driving tube and several assembly eyelet bushings are also this alloy because of its greater machinability and strength.

Brass for Low-current Parts

In the low current circuit section, the brass plates to which the contact buttons are attached is also of yellow brass. This material has greater electrical resistance than copper and the silver contact buttons are attached more readily by resistance welding.

Silver butt type contacts are also resistance welded to the copper plates in the high-current sections.

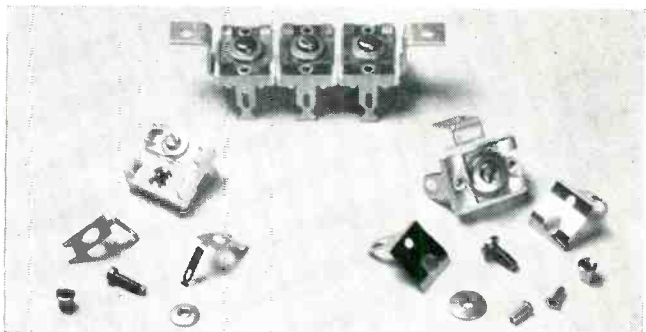
Four Copper-Base Alloys Used in Small Condensers

Many types of copper-base alloys are used for making padder and trimmer condensers for electronic equipment.

In the illustrated condensers, the threaded bushings which take the adjusting screw are screw machine parts of medium-leaded brass rod (63% copper, 1.8% lead and remainder zinc). This alloy has a lower lead content than the free-machining rod. Machinability is reduced slightly, but it is more ductile, permitting staking of the bushing into the shell.

The thin plates in both types of condenser, blanked from strip, are of yellow brass rolled to a spring temper. However, the top compression plates are of spring temper phosphor bronze. This alloy has excellent fatigue resistance, needed in these units due to continual adjustment.

For the eyelets which are swedged over to hold the plates in place, cartridge brass (70% copper, 30% zinc) is utilized for its high ductility and good drawing characteristics. All the parts are tinned to facilitate soldering.



Padder condenser is shown on left and trimmer condenser and parts on right. Ganging, as shown at top right, may include any number of individual condensers. Courtesy Electro Motive Manufacturing Co., Willimantic, Conn.

The dielectric spacers are of pure mica and the shell, or base, is also of a dielectric material.

Capacity is increased when the dielectric space is decreased. Since adjustment is exceptionally fine, the brass bushing provides a smooth-operating bearing surface with the steel adjusting screw.

BRASS · BRONZE · COPPER · DURONZE — STRIP · ROD · WIRE · TUBING

MILLS IN
BRIDGEPORT, CONNECTICUT
INDIANAPOLIS, INDIANA

In Canada:
Noranda Copper and Brass Limited, Montreal

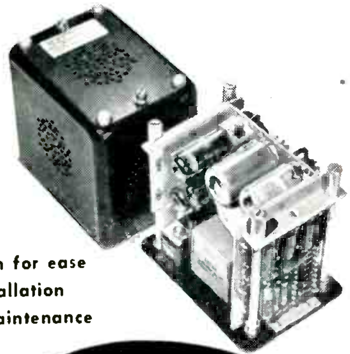
BRIDGEPORT BRASS COMPANY
BRIDGEPORT 2, CONNECTICUT

Established 1865

"Bridgeport" *District Offices and Warehouses in Principal Cities*

PACKAGED
Functional Electronics

SERVO
amplifiers
A MECHA PRODUCT



Plug-in for ease of installation and maintenance

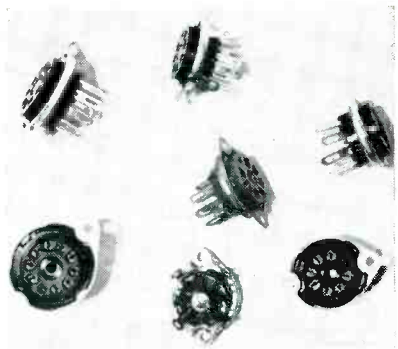
Servomechanisms, Inc. offers a group of functionally packaged Servo Amplifiers and companion Power Supplies designed to fulfill every need in the control and instrument field, providing the system designer with a facility of proven dependability and maximum performance.

60 cycle—400 cycle; open or hermetically sealed construction

DESIGNERS AND PRODUCERS OF PRECISION ELECTRONIC DEVICES

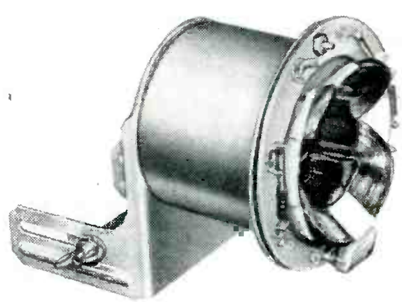
SERVOMECHANISMS inc.
Old Country & Glen Cove Roads
MINEOLA, N. Y.
Garden City 7-0754-5-6

controls for varying the length of line, and an indicator denoting delay of line. Rise time is 0.005 μsec to 0.1 μsec in 20 steps. It is also available in other ranges.



Radio Receiving Tube Sockets

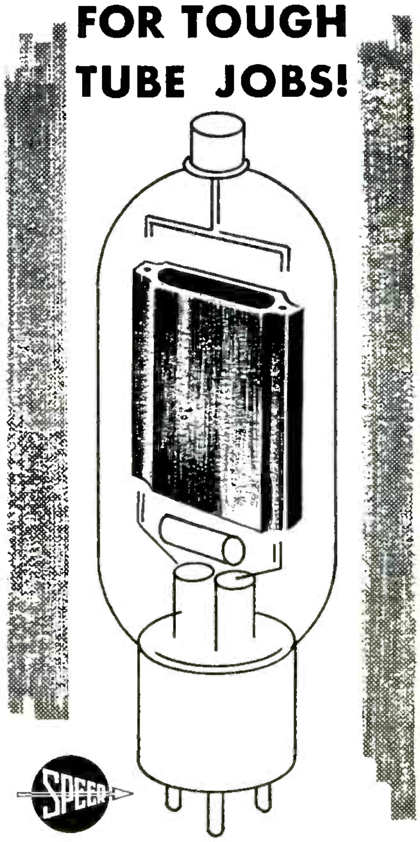
SYLVANIA ELECTRIC PRODUCTS, INC., Warren, Pa. The radio receiving tube sockets illustrated are designed for use with a wide range of miniature and GT-type tube circuit applications. Socket types include T5½, T6½ and octal with 7, 8 and 9 cadmium-plated brass contacts; general-purpose low-loss shielded or unshielded phenolic bases; with or without center shield, and with or without ground lugs on cadmium-plated or hot-tin-finish saddle, for top or bottom chassis mounting.



Sweep Yoke

GENERAL ELECTRIC CO., Syracuse, N. Y., has announced a new sweep yoke designed to sweep up to 70-deg picture tubes with high efficiency. When the yoke is used in conjunction with associated sweep components the horizontal sweep system requires only 20 watts of horizontal input from a 250-volt supply. Horizontal inductance is 18 millihenrys, and vertical inductance, 30 milli-

TOUGH
GRAPHITE ANODES
FOR TOUGH TUBE JOBS!



Speer's graphite anodes were especially developed to meet the severest demands of modern equipment for superior tubes that would withstand extreme shock and distortion under impact. Rugged, long-lasting and dependable, graphite anode tubes offer such Speer plus values as:

... *Higher Ratings*—200-300% higher power rating over most metallic anodes.

... *Greater Tube Stability*—Because graphite won't warp, maintains its characteristics, warping of other tube elements is eliminated.

... *Longer Life*—Thanks to their lower operating temperatures, graphite anode tubes successfully withstand severest usage.

The demonstrated superiority of graphite anode tubes has made them "must" equipment for short wave and FM transmitters, diathermy, oscilators, modulators, rectifiers and similar equipment. For maximum efficiency under *all* conditions, *look for the tube with the graphite anode.*

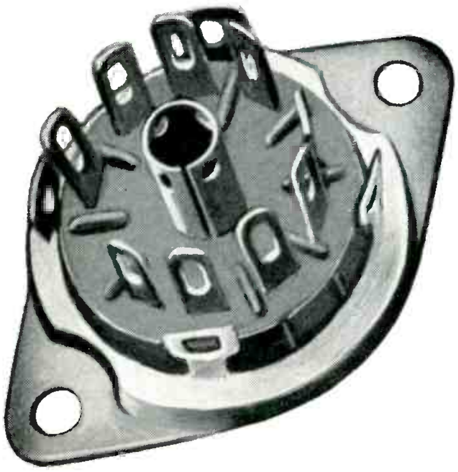
6477

Speer CARBON COMPANY ST. MARYS, PENNA

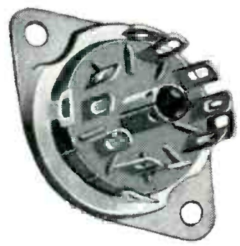
For Extremely Low Insulation Loss Factor

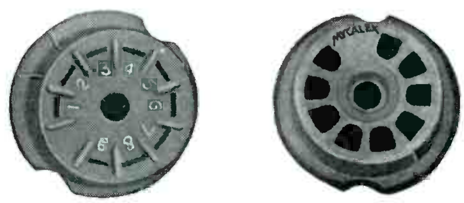
MYCALEX

9-Pin and 7-Pin Miniature Tube Sockets and Subminiature Sockets



Enlargement of the new 9 (NOVAL) pin miniature tube socket.





Above: Complete 9 pin miniature socket.
Below: Precision moldings in MYCALEX actual size two views.

We recently made news by the addition of a 9 pin (NOVAL) miniature tube socket to the MYCALEX line. It has all the electrical characteristics of the widely used MYCALEX 410 and 410 X 7 pin tube sockets and fully meets RMA standards.

The NOVAL is injection molded and produced in two qualities to satisfy different requirements.

MYCALEX 410 for applications requiring close dimensional tolerances. Insulation loss factor of .015 (at 1 MC) yet compares favorably in price with mica filled phenolics.

MYCALEX 410X for applications where general purpose bakelite was acceptable but with an insulation loss factor of only .083 (at 1 MC). Prices compare with lowest quality insulation materials.

Write us today and let us quote you prices on your particular requirements. We will send you samples and complete data sheets by return mail. Our engineers are at your disposal and would be glad to consult with you on your design problems.

Mycalex Tube Socket Corporation

"Under Exclusive License of Mycalex Corporation of America"

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

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

MYCALEX CORP. OF AMERICA

"Owners of 'MYCALEX' Patents"

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

PRECISION RECORDING WITH THE Variplotter

The Model 205 Variplotter, highlighting accuracy, speed, and versatility, brings to industry and laboratory a new tool with a wide field of application. This instrument will present on a 30-inch square plotting surface a precise graphic representation of one variable as a function of another variable, requiring only that the variables be expressed by d-c voltages.

ACCURACY The static accuracy is .05 percent of full scale at 70°F. The dynamic accuracy averages .05 percent of full scale plus the static accuracy at a writing speed of 8½ inches per second.

SENSITIVITY The standard sensitivity of the Variplotter is fifty millivolts per inch with other ranges of sensitivity available.

RESPONSE The maximum pen and arm accelerations are 350 and 150 inches per second squared, respectively. Slewing speeds of both pen and arm are 10 inches per second.

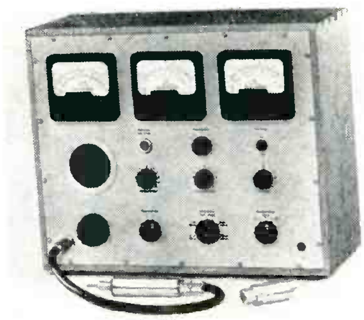
The Variplotter may be adapted for special use by the addition of accessories selected from our standard line—such as multiple variable conversion kits, low-drift d-c amplifiers, analog computer components; or components designed for your specific need.

YOUR INQUIRIES ARE CORDIALLY INVITED.

ELECTRONIC ASSOCIATES, INC.

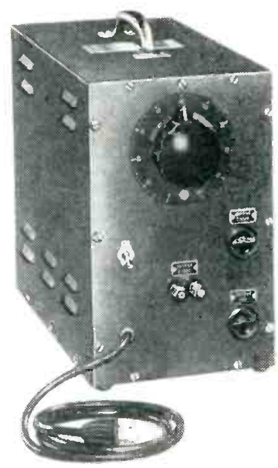
LONG BRANCH NEW JERSEY

henrys. It is available with either a laminated, or for higher efficiency, a Ferrite core.



Heterodyne Voltmeter

BRUAL & KJAER, Naerum, Denmark. Type 2002 beat-frequency voltmeter is a selective tube voltmeter for the measurement of a-c voltages in the h-f range. It is specially designed for use in laboratories for measurements on radio receivers, radar i-f circuits, control of signal generators and coax carrier-frequency systems. Frequency range is from 20 kc to 27 mc. Voltage range is from 10 μv to 10 v. Accuracy is better than ± 0.5 db. A specification sheet is available.



Regulated Voltage Supply

SOLA ELECTRIC Co., 4633 W. 16th St., Chicago 50, Ill. Type CVL Solavolt is a precision source of regulated voltage with minimum harmonic distortion, designed for use with equipment requiring an adjustable source of constant a-c voltage (from 0 to 130 volts) of undistorted wave shape. Regulation is ±1.0 percent for line input changes from 95 to 125 v with less than 3-

This may be the solution to your D. C. AMPLIFICATION problems

MICROSEN
D. C. AMPLIFIER

Simple in operation, the Microsen D. C. Amplifier is designed to meet the need for stable and accurate amplification. It is compact to provide easy portability and convenient general use, is moderate in cost. The amplifier has many applications in both laboratory and field work. Three different ranges are furnished in a single model. The Microsen Balance, an electro mechanical feedback amplifier, combines the advantages of high torque to current input ratio with rugged, shock-resistant construction. Available models include Voltage, Current and Potentiometer Type Amplifiers, Direct Current Converters, Direct Current Transformers, and Engineered Designs to meet special requirements.

TYPICAL APPLICATIONS OF THE MICROSEN D. C. AMPLIFIER

Field of Measurement	Input Element	Output Instrument	Application	Design Advantages
Thermometry	Thermocouple	Recorder	Combustion Research Gas Turbine Development Thermocouple Inspection Meteorology Distillation Processes	High Speed Response Accuracy Sensitivity Stability
Photometry	Photo Cell	Recorder	Polarimetry Physiology of Blood Fluid Flow & Turbulence Density	Stability Sensitivity Responsive Accuracy
Gas Analysis	Catalytic Filament Thermocouple	Recorder	Detecting Explosive Mixture Efficiency of Filters Mixture Control	Sensitivity Stability Accuracy High Speed Response
Electrical Bridges	Resistors Resistance Elements	Recorder	Resistor Inspection Moisture Detection Conductivity Measurements	Sensitivity Stability Accuracy Fast Response
	Pirani Gauge		Vacuum Gauging	Stability
	Strain Gauge		Transient Stresses	Accuracy
Electronics	Inductance Ionization Thermionic	Recorder	Wave Guide Studies Vacuum Gauging Tube Development	Sensitivity Stability Low Resistance Input
Electrolysis	Electrolytic Cells Current Shunt	Recorder	Production Control Electrolytic Plating Electrolytic Process	Isolated Input Stability Accuracy

In each of the above applications, the Recorder could be replaced with a suitable milliammeter indicator, or the output can be used to actuate automatic control relays or signal devices. Inquiries for modification within the useful scope of the Microsen D. C. Amplifier are invited. If possible, such inquiries should contain complete application specifications.

MANNING MAXWELL & MOORE INC. TRADE MARK

MICROSEN
ELECTRICAL INSTRUMENTS

MICROSEN BALANCE

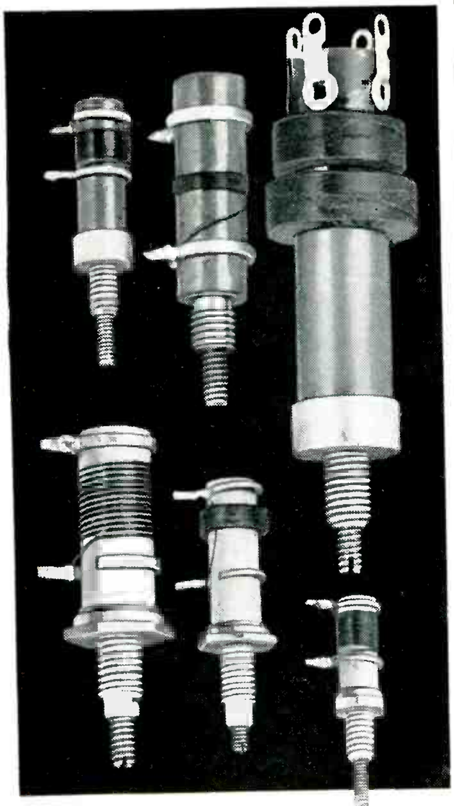
A PRODUCT OF
MANNING, MAXWELL & MOORE, INC.
STRATFORD, CONNECTICUT

Makers of 'Microsen' Electrical and 'American' Industrial Instruments, 'Hancock' Valves, 'Ashcroft' Gauges, 'Consolidated' Safety and Relief Valves. Builders of 'Show-Box' Cranes, 'Budgit' and 'Load Lifter' Hoists and other lifting specialties.

Manning, Maxwell & Moore, Inc.
250 East Main Street
Stratford, Conn.

We are interested in your Microsen D. C. Amplifier. Please send the bulletin describing the instrument to the following address:

Name ____________________
Position ____________________
Company ____________________
Street Address ____________________
City ____________________ State ____________



Which Of These Coil Forms Best Fits YOUR Needs?

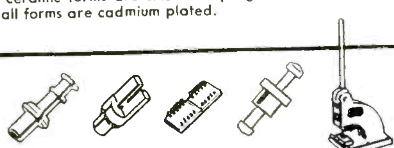
Coil Forms Only, Or Coils Wound To Your Specifications . . . Cambridge Thermionic will furnish slug tuned coil forms alone or wound with either single layer or pie type windings to fit your needs, in high, medium or low frequencies . . . and in small or large production quantities.

See table below for physical specifications of coil forms.

SEND COMPLETE SPECIFICATIONS FOR SPECIALLY WOUND COILS

Coil Form	Material	Mounting Stud Thread Size	Form O.D.	Mounted O.A. Height
LST	L-5 Ceramic	8-32	3/16″	19/32″
LS6	L-5 Ceramic	10-32*	1/4″	27/32″
LS5	L-5 Ceramic	1/4-28*	3/8″	1 1/16″
LSM	Paper Phenolic	8-32	1/4″	27/32″
LS3	Paper Phenolic	1/4-28	3/8″	1 1/8″
LS4†	Paper Phenolic	1/4-28	1/2″	2″

*These types only provided with spring locks for slugs.
†Fixed lugs. All others have adjustable ring terminals.
All ceramic forms are silicone impregnated. Mounting studs of all forms are cadmium plated.



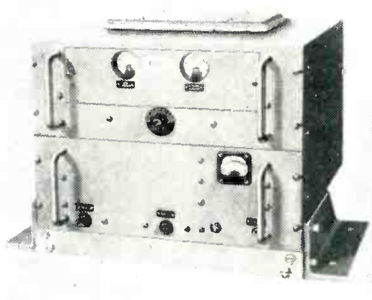
custom or standard the guaranteed components

CAMBRIDGE THERMIONIC CORP.
437 Concord Ave., Cambridge 38, Mass.
West Coast Stock Maintained By: E. V. Roberts, 5014 Venice Blvd., Los Angeles, California

percent harmonic distortion. Voltage regulation is automatic and maximum response time, 1.5 cycles. Write for technical bulletin CVL-140.

Nuclear Circular Slide Rule

NUCLEAR INSTRUMENT & CHEMICAL CORP., 229 W. Erie St., Chicago 10, Ill., has announced the Nuclearule, a new type of slide rule, which makes it possible to obtain quickly count rate, statistical error, coincidence loss, activity of sample versus half life, radiation flux after passage through absorbers, and other data. These values are obtained by simple settings of the rule.



VHF Transmitter

PLESSEY INTERNATIONAL LTD., Ilford, Essex, England. Designed originally to meet airport local control requirements, the type PT.10 twelve-watt vhf transmitter has a wide field of application wherever a compact fixed-station transmitter with an r-f power output of this order is required. The complete equipment consists of a modulator and an r-f unit, available either desk or rack mounted. Covering the 118 to 132-mc band the crystal-controlled operational frequency can be varied by insertion of the appropriate crystal. Bandpass circuits in the r-f unit minimize the neces-

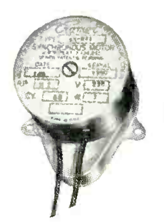
BUILDERS OF COMMUNICATIONS EQUIPMENT, MEASURING INSTRUMENTS FOR COMMERCIAL AND INDUSTRIAL USE, AND OTHER ELECTRONIC DEVICES—PRODUCTS WHERE PRECISION PERFORMANCE LARGELY DEPENDS UPON *TIME AS A FACTOR OF CONTROL* — KNOW THEY

can rely on

Cramer DESIGN QUALITY ACCURACY

RUNNING TIME METERS
Synchronous motor driven. Register automatically and cumulatively total operating or idle time on circuits, machines, systems.

TIME DELAY RELAYS
Provide adjustable or fixed time delay between operation of a control circuit and subsequent opening or closing of a load circuit.



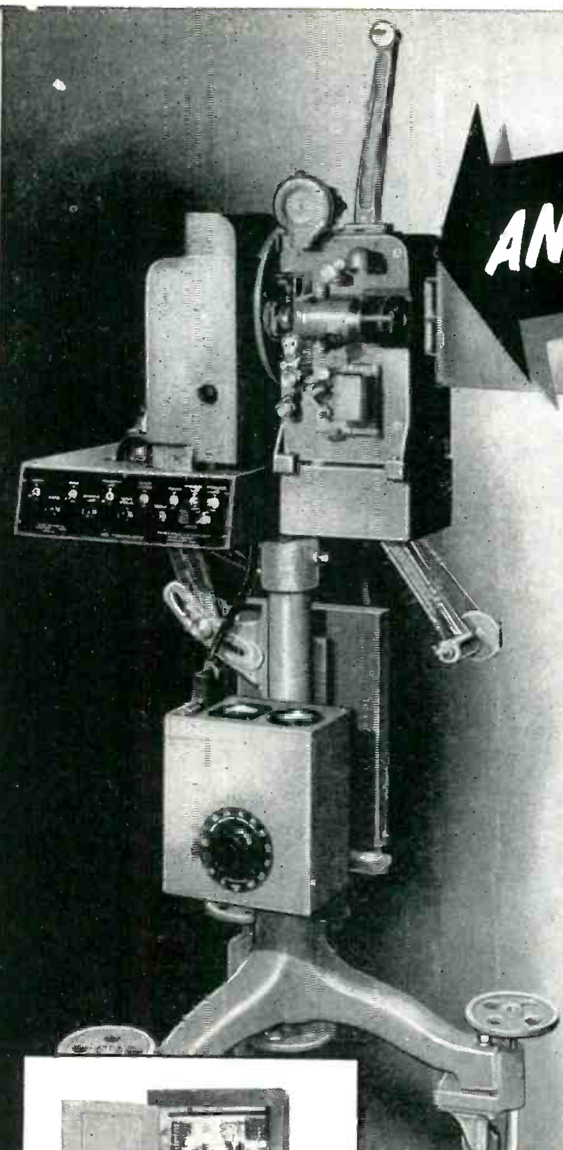
SYNCHRONOUS MOTORS
Permanent magnet type for applications requiring a constant speed at a given frequency. Small size. 30″ ounce torque. Twenty-eight speeds from 60 rpm to 1/24 rph.

For a wide range of standard timers and controls.. or special adaptations for specific applications..consult **R. W. CRAMER CO.,** Box No. 3, Centerbrook, Conn.

Cramer
SPECIALISTS IN *TIME* AS A FACTOR OF *CONTROL*
INTERVAL · DELAY · CYCLE · IMPULSE · PERCENTAGE

ANOTHER DUMONT FIRST!

The New Du Mont-Holmes *SUPERSPEED* Projector



▶ Sets new standards of performance, utility and economy for TV station operation. Provides a means of film pickup that approaches the contrast and clarity characteristic of studio productions.

▶ DIRECT FILM PROJECTOR

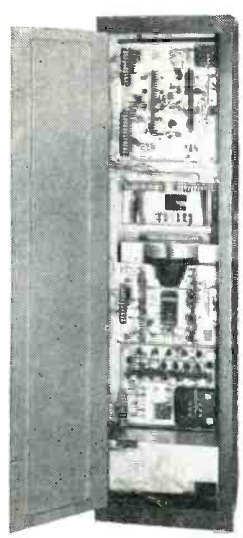
Used with a Du Mont Special Image-Orthicon film pickup to give *studio clarity* to movies and teletranscriptions.

▶ BACKGROUND PROJECTOR

Brings dramatic moving sets and backgrounds into any studio. Eliminates costly and cumbersome sets and backdrops.

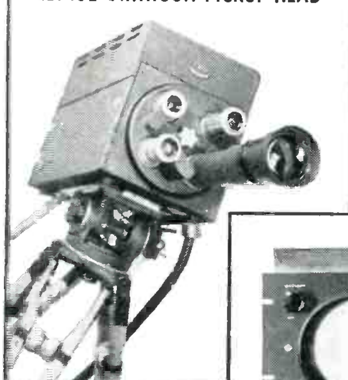
For information on the Superspeed Projector or other Du Mont Telecasting Equipment write, phone, or visit.

© ALLEN B. DU MONT LABORATORIES, INC.



FLYING SPOT SCANNER

IMAGE ORTHICON PICKUP HEAD



RF WAVEFORM MONITOR

ACORN TRANSMITTER

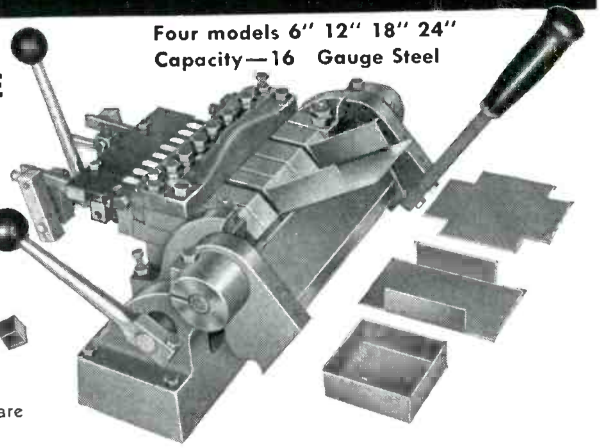
DUMONT *First with the Finest in Television*

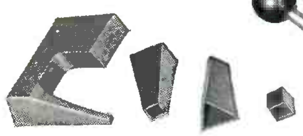
New! di-acro BOX FINGER BRAKE

Four models 6" 12" 18" 24"
Capacity—16 Gauge Steel

3 TOOLS IN ONE

1. BOX and PAN BRAKE
2. STANDARD BRAKE
3. BAR FOLDER





OPEN END FINGER
for forming triangular, square and rectangular tubes.

Versatility from the word GO!! One box or 10,000—can be economically produced with the new Di-Acro Box Finger Brake. The complete box finger bar also serves perfectly for all standard brake operations. An Acute Angle Bar—quickly mounted—converts the brake to a bar folder for locks, seams, hems and sharp angles. The unique Di-Acro Open End Finger forms square or triangular tubes and other similar parts difficult to make. Real machine tool construction, with hardened and precision ground box fingers, assures permanent accuracy in producing duplicated parts. The Box Finger Bar can be easily mounted on all standard Di-Acro Brakes.

Send for
40 PAGE CATALOG
describing DI-ACRO Shears, Punches, Benders, Brakes, Notchers and Rod Parters,—also Power Shears and Benders.

Di-Acro is pronounced "DIE-ACK-RO"

DI-ACRO PRECISION MACHINES DIE-LESS DUPLICATING

O'NEIL-IRWIN MFG. CO.
321 EIGHTH AVENUE, LAKE CITY, MINN.

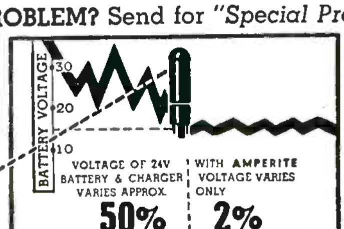
AMPERITE

THERMOSTATIC METAL TYPE
Delay Relays

PROVIDE DELAYS RANGING FROM 1 TO 120-SECONDS

FEATURES: — Compensated for ambient temperature changes from —40° to 110° F . . . Hermetically sealed; not affected by altitude, moisture or other climate changes . . . Explosion-proof . . . Octal radio base . . . Compact, light, rugged, inexpensive . . . Circuits available: SPST Normally Open; SPST Normally Closed.
PROBLEM? Send for *"Special Problem Sheet"*

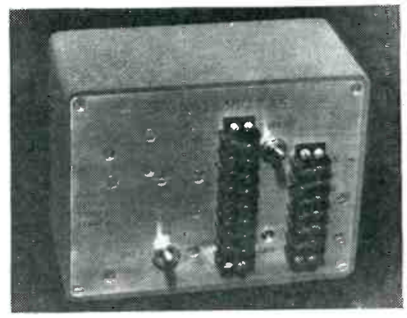
Regulators



Amperite REGULATORS are the simplest, lightest, cheapest, and most compact method of obtaining current or voltage regulation . . . For currents of .060 to 6 Amps. . . . Hermetically sealed; not affected by altitude, ambient temperature, humidity.
Write for 4-page Illustrated Bulletin.

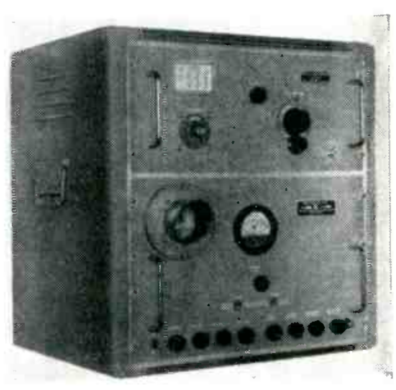
AMPERITE CO., Inc., 561 Broadway, New York 12, N. Y.
In Canada: Atlas Radio Corp., Ltd., 560 King St., W. Toronto

sary tuning controls and a preset circuit in the modulator unit automatically prevents over-modulation.



Balance Amplifier

SCHAEVITZ ENGINEERING, Camden 11, N. J. Type 60AD-1 balance amplifier for use with linear variable differential transformers has been announced. The instrument enables the lvdt to regulate the power of a motor. It senses the phase condition and magnitude of the lvdt output, amplifies the information and supplies power to operate the motor in the correct direction. The amplifier can operate two phase induction motors rated up to 25 watts, at full power in either direction of rotation in accordance with signals corresponding to a lvdt core motion of as little as 0.0001 inch. It is powered directly from the 117-v, 60-cycle, a-c line.



Spectrum Analyzers

POLYTECHNIC RESEARCH AND DEVELOPMENT CO., INC., 202 Tillary St., Brooklyn 1, N. Y. A series of microwave spectrum analyzers permits accurate determination of r-f pulse characteristics. Each unit consists of a type 850 power supply, i-f and video unit, together with a demountable r-f unit appropriate

The RCA "TV Duo"...

Designed for the Professional Television Technician

The new WR-59B Television Sweep Generator ***for all TV channels and having continuous IF and video coverage from 0.3 to 50 Mc.***

The new WR-39B Television Calibrator ***is a Linearity Pattern Generator.***

Matched in design . . . unmatched anywhere for their advanced engineering features . . . these new companion units furnish *all basic signals* essential for the rapid, precision servicing and production testing of television receivers. Flexibility, versatility, and accuracy are outstanding characteristics of each unit individually and in combination.

The RCA WR-59B Television Sweep Generator covers all broadcast television channels on preset selector-switch positions, and in addition features a continuous tuning range from 0.3 to 50 Mc, to accommodate current and future intermediate frequencies. The rf signal is frequency-modulated at the fundamental frequency by a precision-type vibrating capacitor of advanced design. The signal is free from spurious responses and other frequency components often found in harmonic generators and beat-frequency oscillators.

An additional feature of the WR-59B is the inclusion of a blanking circuit which produces a zero-reference line on the cathode-ray tube. This base line aids in determining the amplitude of the signal. The base line is also very useful in aligning FM discriminator circuits, or in checking the exact slope of the frequency-response curve of any circuit.

The RCA-39B Television Calibrator features crystal calibrated markers for all TV frequencies and is useful in making linearity adjustments. Included in this one instrument is a crystal-calibrated variable-frequency oscillator, two crystal-controlled oscillator stages with three crystals supplied, a wide-band modulator stage for internally modulating the output at audio and radio frequencies, and an audio amplifier with speaker. The instrument provides a crystal-controlled 4.5-Mc output for alignment of TV sets employing intercarrier sound . . . crystal-controlled markers 4.5 megacycles removed from the main marker, for television rf and if alignment . . . and crystal-controlled markers 250 kilocycles removed from the main marker, for sound discriminator alignment.

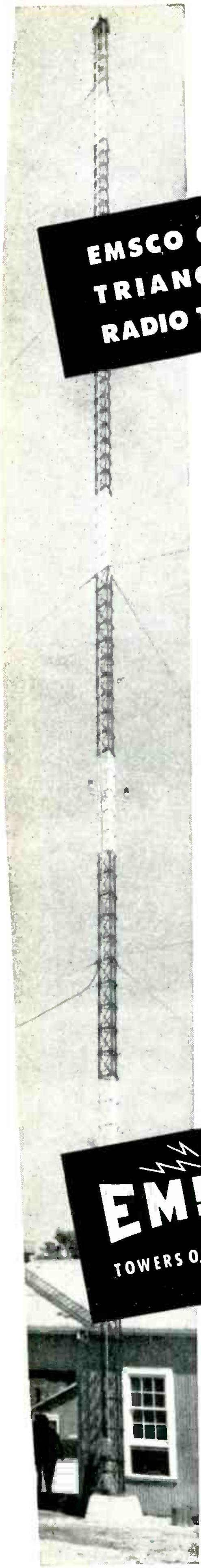
Additional features are—provision for injection of external marker . . . internal audio and rf modulation of variable-frequency oscillator . . . and crystal-calibrated heterodyne frequency meter.

For a complete and modern television alignment setup, your best buy is the WR-39B Television Calibrator combined with the WR-59B Television Sweep Generator and the new, revolutionary WO-57A Oscilloscope matching unit. This "TV Trio" is also available in the WS-17A 3-unit rack.

For complete details on the WR-39B and WR-59B, see your RCA Test Equipment Distributor, or write RCA, Commercial Engineering, Section F42Y, Harrison, N. J.

Available from your RCA Test Equipment Distributor

RADIO CORPORATION of AMERICA
TEST EQUIPMENT — **HARRISON, N. J.**



EMSCO GUYED TRIANGULAR RADIO TOWERS

FOR AM, FM, UHF, VHF, MICROWAVE, TELEVISION AND RADAR

Emsco guyed triangular radio towers are engineered for high wind load capacity, low maintenance costs and perfect transmission pattern . . . for *all* types of communication . . . in *all* industries. Standard towers available with 20½″, 3′, 5′ or 14′ faces, heights to 1000 feet and to withstand 20, 30 or 40 pound wind loads.

FREE BULLETIN

New Emsco Bulletin F-173 gives complete information on Emsco guyed triangular radio towers and Emsco free-standing square and triangular towers. Write for your free copy today!

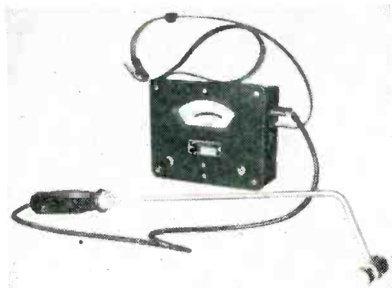
EMSCO

TOWERS OF STRENGTH

EMSCO DERRICK & EQUIPMENT COMPANY
Houston, Texas
LOS ANGELES, CALIFORNIA
Garland, Texas

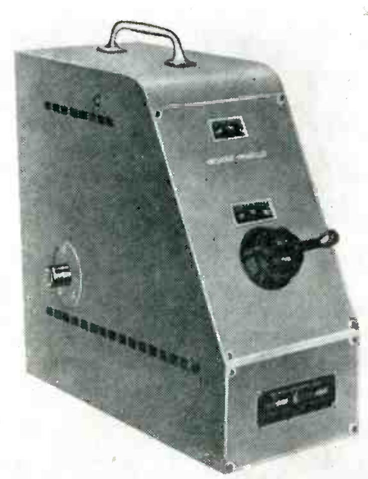
Shown here is an Emsco 20½-inch face, 160-foot Type IRT Emsco radio tower with 30-pound wind load rating.

for the particular frequency range of interest. Available units now covered the S-band and X-band regions of the microwave spectrum, with a special combination instrument, type 855, containing r-f units for both ranges.



Tin-Content Indicator

Wheelco Instruments Co., Chicago 7, Ill., has released a new portable direct-reading indicator for the determination of the ratio of lead and tin content in solder. It consists essentially of a high-resistance pyrometer and a convenient plug-in type sensing unit. Up to 7-percent tin content of lead alloys may be tested in a matter of seconds, thus eliminating time-consuming laboratory tests.



UHF Frequency Meter

Polytechnic Research & Development Co., Inc., 202 Tillary St., Brooklyn 1, N. Y. Type 584 tunable frequency meter permits accurate measurement of r-f signals throughout the new uhf television band. Dials are calibrated to read directly in mc. A coaxial-type cavity resonator is employed in which

how would you have this copper stud made?

Transformer stud shown actual size

This transformer stud was made in *one* piece by cold heading at a much lower cost than would be possible by any other method. Cold working of the metal also produces a stronger part.

Perhaps the cold heading process, in the hands of Scovill's engineers, toolmakers and operators, can help *you* get better parts at lower cost. Send your sample or blueprint for further information.

"Guide to the Profitable Use of Cold Heading" —Bulletin No. 2 describes the advantages and limitations of this process for the designer. It's free for the asking.

A PRODUCT OF SCOVILL

Recessed Head Screws • Sems
Tapping Screws • Standard
Machine Screws • Special Cold
Headed Parts

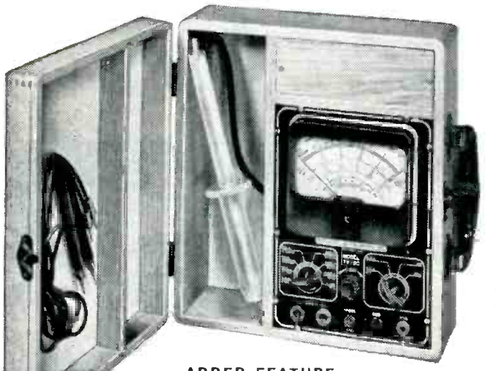
SCOVILL FASTENERS AND SPECIAL PARTS

Industrial Fastener Sales, Waterville Division
Scovill Manufacturing Co., Waterville 14, Conn.

New York • Detroit • Wheaton, Ill.
Los Angeles • Cleveland • San Francisco

Superior's New Model TV-20 A COMBINATION **20,000** OHMS PER VOLT **MULTI-METER**

and TELEVISION KILOVOLTMETER



9 D. C. VOLTAGE RANGES: (At 20,000 ohms per Volt) 0-2.5/10/50/100/250/500/1,000/5,000/50,000 Volts

8 A. C. VOLTAGE RANGES: (At 1,000 ohms per Volt) 0-2.5/10/50/100/250/500/1,000/5,000 Volts

5 D. C. CURRENT RANGES: 0-50 Microamperes 0-5/50/500 Milliamperes 0-5 Amperes

4 RESISTANCE RANGES: 0-2,000/20,000 ohms 0-2/20 Megohms

7 D. B. RANGES: (All D. B. ranges based on ODb = 1 Mv. into a 600 ohm line)

— 4 to + 10 db
+ 8 to + 22 db
+ 22 to + 36 db
+ 28 to + 42 db
+ 36 to + 50 db
+ 42 to + 56 db
+ 48 to + 62 db

7 OUTPUT VOLTAGE RANGES: 0 to 2.5/10/50/100/250/500/1,000 Volts

ADDED FEATURE

Includes an Ultra High Frequency Voltmeter Probe with a frequency range up to 1,000 MEGACYCLES. When plugged into the Model TV-20, the V. H. Probe converts the unit into a Negative Peak-Reading H. F. Voltmeter.

The Model TV-20 operates on self-contained batteries. Comes housed in beautiful hand-rubbed oak cabinet complete with portable cover, Built-In High Voltage Probe, H. F. Probe, Test Leads and all operating instructions.

$39.95 NET

SUPERIOR'S NEW MODEL TV-10

TUBE TESTER

SPECIFICATIONS:

Tests all tubes including 4, 5, 6, 7, Octal, Lock-in, Peanut Bantam, Hearing-aid, Thyratron, Miniatures, Sub-Miniatures, Novals, etc. Will also test Pilot Lights.

Tests by the well-established emission method for tube quality, directly read on the scale of the meter.

Tests for "shorts" and "leakages" up to 5 Megohms.

Uses the new self-cleaning Lever Action Switches for individual element testing. Because all elements are numbered according to pin-number in the RMA base numbering system, the user can instantly identify which element is under test. Tubes having tapped filaments and tubes with filaments terminating in more than one pin are truly tested with the Model TV-10 as any of the pins may be placed in the neutral position when necessary.

The Model TV-10 does not use any combination type sockets. Instead individual sockets are used for each type of tube. Thus it is impossible to damage a tube by inserting it in the wrong socket.

Free-moving built-in roll chart provides complete data for all tubes.

Newly designed Line Voltage Control compensates for variation of any line voltage between 105 Volts and 130 Volts.

The Model TV-10 operates on 105-130 Volt 60 cycles A.C. Comes housed in a beautiful hand-rubbed oak cabinet complete with portable cover.

$39.50 NET

The New Model 200 **AM and FM**

SIGNAL GENERATOR

★ **R.F. FREQUENCY RANGES:** 100 Kilocycles to 150 Megacycles.

★ **MODULATING FREQUENCY:** 400 Cycles. May be used for modulating the R.F. signal. Also available separately.

★ **ATTENUATION:** The constant impedance attenuator is isolated from the oscillating circuit by the buffer tube. Output impedance of this model is only 100 ohms. This low impedance reduces losses in the output cable.

★ **OSCILLATORY CIRCUIT:** Hartley oscillator with cathode follower buffer tube. Frequency stability is assured by modulating the buffer tube.

★ **TUBES USED:** 12AU7—One section is used as oscillator and the second is modulated cathode follower. T-2 is used as modulator. 6C4 is used as rectifier.

★ **ACCURACY:** Use of high-Q permeability tuned coils adjusted against 1/10 of 1% standards assures an accuracy of 1% on all ranges from 100 Kilocycles to 10 Megacycles and an accuracy of 2% on the higher frequencies.

The Model 200 operates on 110 Volts A.C. Comes complete with output cable and operating instructions.

$18.85 NET

Superior's New Model TV-30 **TELEVISION SIGNAL GENERATOR**

Enables alignment of television I. F. and FRONT ENDS without the use of an oscilloscope.

SPECIFICATIONS

Frequency Range: 4 Bands—No switching

18— 32 Mc.
35— 65 Mc.
54— 98 Mc.
150—250 Mc.

Audio Modulating Frequency: 400 cycles (Sine Wave)

Attenuator: 4 position, ladder type with constant impedance control for fine adjustment.

Tubes Used:
6C4 as Cathode follower and modulated buffer.
6C4 as R.F. Oscillator.
6SN7 as Audio Oscillator and power rectifier.

Model TV-30 comes complete with shielded co-axial lead and all operating instructions.

$29.95 NET

SUPERIOR'S NEW MODEL 670

SUPER METER

A Combination VOLT-OHM-MILLIAMMETER plus CAPACITY REACTANCE, INDUCTANCE and DECIBEL MEASUREMENTS.

D.C. VOLTS: 0 to 7.5/15/75/150/750/1500/7500 Volts. **A.C. VOLTS:** 0 to 15/30/150/300/1500/3000 Volts. **OUTPUT VOLTS:** 0 to 15/30/150/300/1500/3000 Volts.

D.C. CURRENT: 0 to 1.5/15/150 ma. 0 to 1.5 Amps. **RESISTANCE:** 0 to 500/100,000 ohms. 0 to 10 Megohms. **CAPACITY:** .001 to .2 Mfd., .1 to 4 Mfd. (Quality test for electrolytics.) **REACTANCE:** 700 to 27,000 Ohms; 13,000 Ohms to 3 Megohms.

INDUCTANCE: 1.75 to 70 Henries, 35 to 8,000 Henries.

DECIBELS: -10 to +18, +10 to +38 +30 to +58.

The model 670 comes housed in a rugged, crackle-finished steel cabinet complete with test leads and operating instructions. Size 5½" x 7½" x 3".

$28.40 NET

SUPERIOR'S NEW MODEL 770 *An Accurate Pocket Size*

VOLT-OHM MILLIAMMETER

(Sensitivity: 1000 ohms per volt)

Features:

Compact, measures 3⅛" x 5⅞" x 2¼". Uses latest design 2% accurate 1 Mil D'Arsonval type meter. Same zero adjustment holds for both resistance ranges. It is not necessary to readjust when switching from one resistance range to another. This is an important time-saving feature never before included in a V.O.M. in this price range. Housed in round-cornered, molded case. Beautiful black etched panel. Depressed letters filled with permanent white, insures long life even with constant use.

Specifications: 6 A.C. VOLTAGE RANGES. 0-15/30/150/300/1500/3000 volts.

6 D.C. VOLTAGE RANGES: 0-7½/15/75/150/750/1500 volts.

4 D.C. CURRENT RANGES: 0-1½/15/150 Ma. 0-1½ Amps.

2 RESISTANCE RANGES: 0-500 ohms. 0-1 Megohm.

The Model 770 comes complete with self-contained batteries, test leads and all operating instructions.

$13.90 NET

GENERAL ELECTRONIC DISTRIBUTING CO. Dept. EL-6, 98 Park Place, New York 7, N. Y.

Another First!

. . . in radiation instrumentation

VICTOREEN introduces . . .
a new 100r hi-intensity pocket ionization chamber.

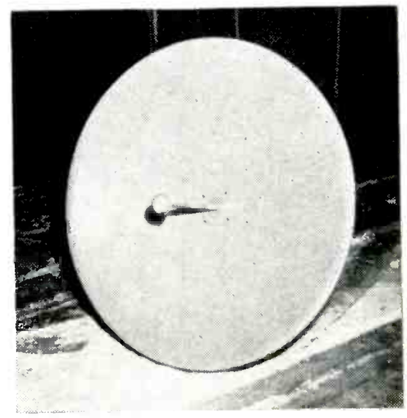
The new Victoreen Model 506 pocket ionization chamber is designed to meet the need for a compact dependable chamber for measurement of radiation in the 100 r range.

Many new features make the 506 unique for measuring hi-intensities. This pocket chamber fulfills basic requirements as it incorporates accurate measurement even with short exposure time—affords a wide energy response from 40 KV and up—offers high dosage with overdosage not affecting its performance and, equally important, the chamber is tamper-proof and cannot be discharged except by using the Model 392 Minometer Charger.

The 506 hi-intensity chamber is shorter than the conventional pocket size and fits an aluminum shell $\frac{1}{2}''$ in diameter and $3\frac{3}{4}''$ overall. It is further identified by color coding the clip end.

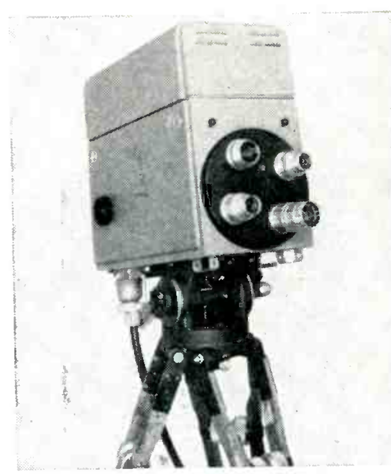
THE VICTOREEN INSTRUMENT CO.
5806 HOUGH AVE., CLEVELAND 3, OHIO

the center conductor is adjusted by rotation of the frequency dial so as to vary the resonant frequency continuously from 470 to 950 mc.



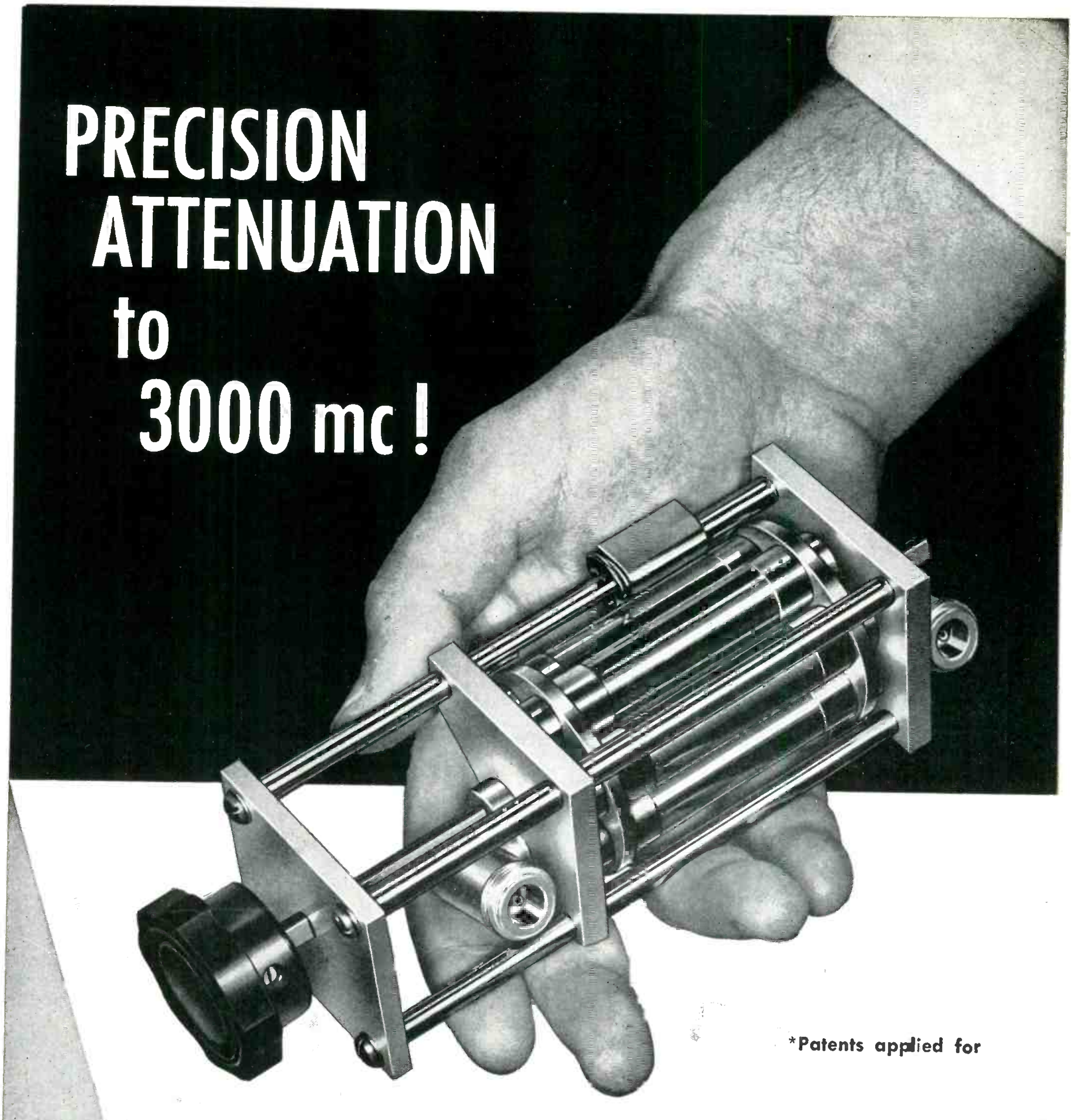
Parabolic Antennas

THE WORKSHOP ASSOCIATES, INC., Crescent Road, Needham Heights, Mass. Five new parabolic antennas cover the 5,929 to 7,125-mc frequency band. Each is available in two, four, six and eight-ft diameters, and mounts can be had for all types of installations. The antennas have gains up to 44.9 db and can be supplied with complete deicing equipment and junction boxes. Write for the descriptive booklet.



Field TV Camera Chain

POLARAD ELECTRONICS CORP., 100 Metropolitan Ave., Brooklyn 11, N. Y. Model CV-2 lightweight versatile field television camera chain incorporates the latest design image orthicon pickup tube, type 5820, which enables it to be used



*Patents applied for

- VSWR less than 1.2 at all frequencies to 3000 mc.
- **Turret Attenuator*** featuring **"Pull — Turn — Push"** action with 0, 10, 20, 30, 40, 50 DB steps.
- Accuracy ± .5 DB, no correction charts necessary.
- 50 ohm coaxial circuit. Type N connectors.

Inquiries are invited concerning single pads and turrets having other characteristics

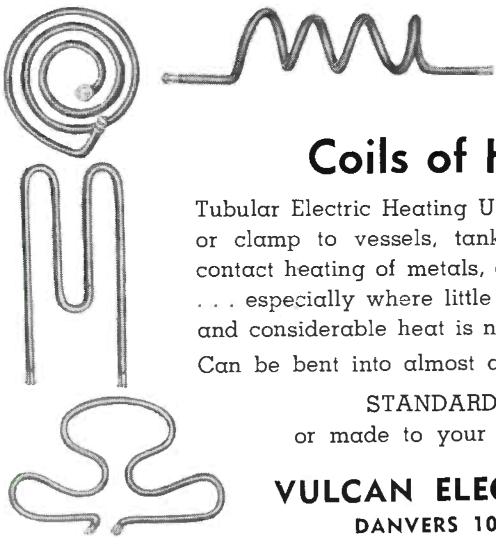
STODDART AIRCRAFT RADIO CO.

6644 SANTA MONICA BLVD., HOLLYWOOD 38, CALIFORNIA

Hillside 9294

VULCAN

ELECTRIC HEATING UNITS



Coils of Heat

Tubular Electric Heating Units that fit around or clamp to vessels, tanks, pipes, etc., for contact heating of metals, oils, air and water. . . . especially where little space is available and considerable heat is needed.

Can be bent into almost any shape.

STANDARD SIZES
or made to your requirements.

VULCAN ELECTRIC CO.
DANVERS 10, MASS.

Makers of Vulcan Electric Soldering Tools, Electric Solder Pots, Electric Glue Pots, Electric Branding Irons and Electric Heating Units, including the new Vulcan 900 series, for changing over any hot water heater to electric operation.

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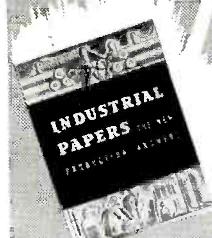

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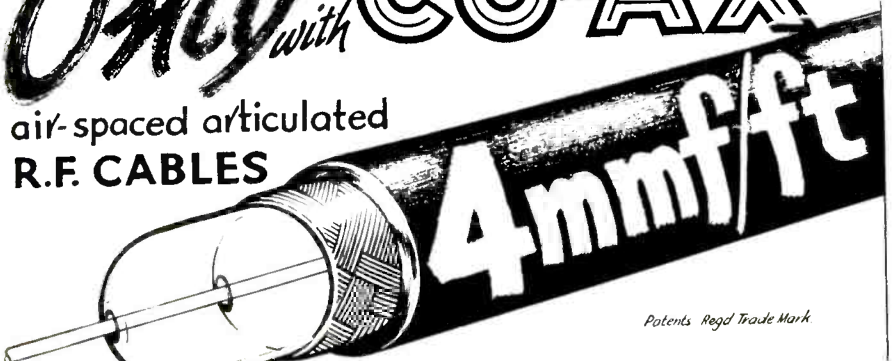
CENTRAL PAPER COMPANY
INCORPORATED
2442 LAKESHORE DRIVE, MUSKEGON, MICH.

Only with CO-AX

air-spaced articulated R.F. CABLES



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THE LOWEST EVER CAPACITANCE OR ATTENUATION

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IMMEDIATE DELIVERIES FOR U.S.A.

Billed in Dollars Settlement by your check. Transaction as simple as any local buy

LOW ATTEN TYPES	IMPED OHMS	ATTEN db100ft at 100 Mc/s.	LOADING Kw at 100 Mc/s.	O.D."	
A 1	74	1.7	0.11	0.36	HIGH POWER FLEXIBLE
A 2	74	1.3	0.24	0.44	
A 34	73	0.6	1.5	0.88	
LOW CAPAC TYPES	**CAPAC mmf/ft.**	**IMPED OHMS**	**ATTEN db/100ft 100Mc/s.**	**O.D."**	
C 1	7.3	150	2.5	0.36	
PC 1	10.2	132	3.1	0.36	PHOTOCELL CABLE
C 11	6.3	173	3.2	0.36	
C 2	6.3	171	2.15	0.44	
C 22	5.5	184	2.8	0.44	
C 3	5.4	197	1.9	0.64	V.L.C. ★
C 33	4.8	220	2.4	0.64	
C 44	4.1	252	2.1	1.03	

★ *Very Low Capacitance cable.*

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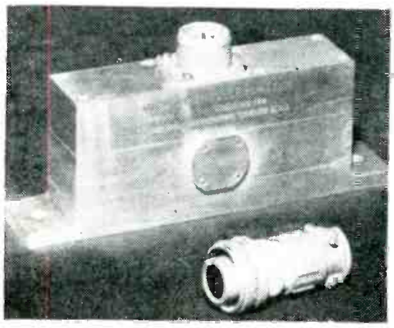
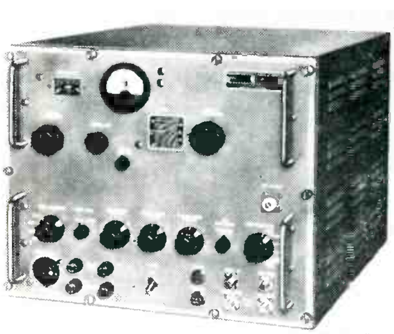
CONTRACTORS TO H.M. GOVERNMENT
138A CROMWELL ROAD·LONDON S.W.7. ENGLAND
CABLES: TRANSRAD. LONDON.

readily under conditions of poor illumination as well as in bright sunlight. The electronic viewfinder unit plugs in and clamps to the camera unit.



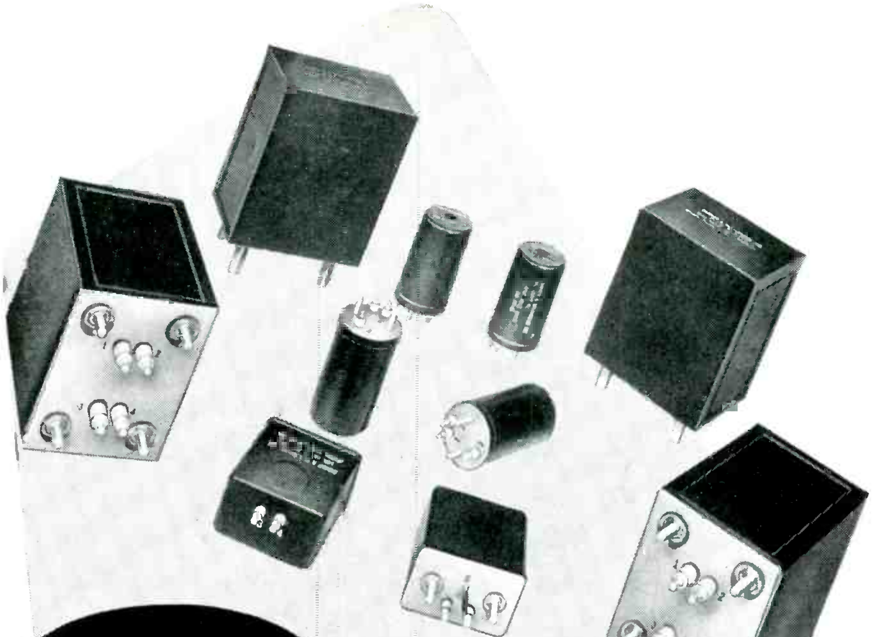
Angular Accelerometer

SCHAEVITZ ENGINEERING, Crescent Blvd. at Drexel Ave., Camden 11, N. J. Type W accelerometer, an application of the linear variable differential transformer, measures the angular acceleration of any body to which it is fastened. The sensitive element consists of a torsionally-suspended beam, spring loaded at each end, with the lvdt core mounted on the beam. This torsionally-suspended mass is displaced angularly with respect to the instrument case when the latter is subjected to angular accelerations. The instrument is available in one of three natural frequencies, 6, 12, or 18 cps for the ranges of ±5, ±10 and ±30 radians per sec per sec respectively.



Microwave Signal Generators

POLYTECHNIC RESEARCH AND DEVELOPMENT Co., INC., 202 Tillary St., Brooklyn 1, N. Y. Types 902 and 903 broadband signal generators cover in two units the frequency range from 3,650 to 10,900



B&W Filter Manufacts*

- HIGH-PASS FILTERS
- LOW-PASS FILTERS
- BAND-PASS FILTERS
- BAND SUPPRESSION OR REJECTION FILTERS

For RF or audio filtering and line RF suppression . . . for harmonic attenuation and teletype communications . . . for single side band and telemetering equipment—these and many more are the uses to which B & W Filters are being applied daily. Time-tested and performance-proved, each of the filters listed above offers you a combination of accuracy and ruggedness that can't be beat in commercial equipment, military equipment . . . ANY EQUIPMENT.

That's why if your equipment requires filters—real filters built for day-in day-out dependability—B & W is the perfect answer. For details, write today to Barker & Williamson, Dept. EL-60.

*Manufacts = Manufacturing facts

BARKER & WILLIAMSON, INC.
237 Fairfield Avenue Upper Darby, Penna.

STANDARD...

Stands for Quality

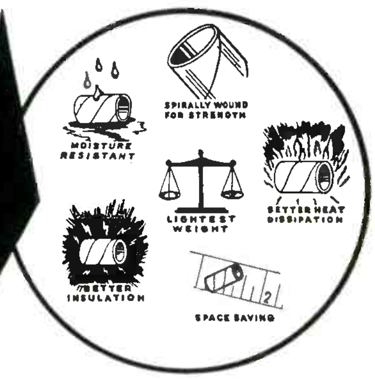
Low Frequency Crystal Units

A special process has been developed to overcome fragility and give sturdiness to this STANDARD unit. Range—200 to 1200 kc. CT and DT cut. Hermetically sealed and filled with dry nitrogen. Good stability over wide temperature range. Meets government specifications. Write or wire for additional information.

We are in a position to make prompt delivery.

Standard Piezo Company
CARLISLE, PA.

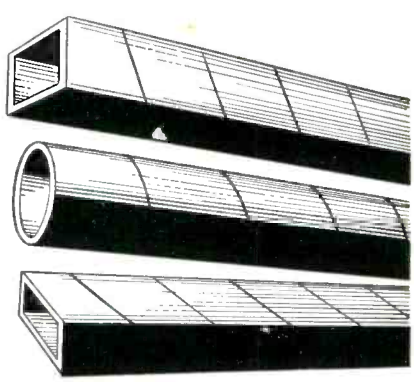
How PRECISION PAPER TUBES protect your coil windings . . .



How far do these characteristics of your COIL BASES affect coil quality?

Every engineer knows the answer. Precision coil bases have long proved their reliability in these factors — with light weight and space saving. Made to your specifications of finest dielectric Kraft, Fish Paper, Cellulose Acetate or combinations. Any length, any ID or OD, round, oval, square, rectangular. Ask for new Mandrel list, over 1000 sizes.

Send for sample and LOW PRICES.



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- **D**ependable
- **Q**uality

DELUXE TERMINALS

FWG. Polystyrene terminal strip for high frequency use. Binding posts take banana plugs at top, grip wires thru hole at bottom. Net 60¢

FWH. Molded mica bakelite insulators with serrated bosses grip thinnest panel firmly. Binding posts, same as FWG. Net 66¢

FWJ. Same insulators as FWH but with jacks. When used with FWF plug no metal is exposed. Net 54¢

FWF. Banana plugs in molded mica bakelite. Fits FWG, FWH, FWJ. Leads may be connected thru top or side. Excellent for 300-ohm twin lead. Net 70¢

National deluxe insulators and fittings are available for a wide range of uses.

Address export inquiries to Dept. E-650

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NATIONAL COMPANY, Inc.
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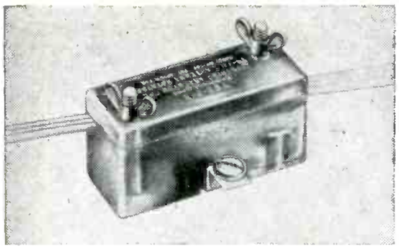
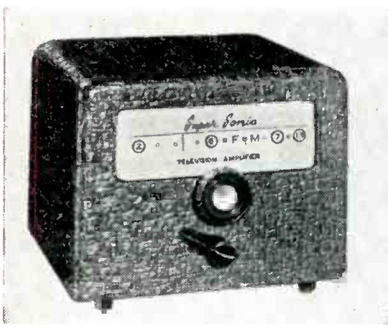
mc. Each employs a tunable coaxial cavity oscillator incorporating a Raytheon type 5721 klystron. Resonant frequency of the oscillator is controlled by a front panel dial reading directly in frequency. Provision is made for c-w, f-m and pulse operation as well as for external modulation.



Lightning Arrester

THE LAPOINTE-PLASCOMOLD CORP., Unionville, Conn. Model RW 204 lightning arrester is designed for use with the four-wire control cable employed with antenna rotators. It is meant to serve dual purposes in that it may also be used for standard 300-ohm ribbon transmission line. Pin-point contacts in its polystyrene case eliminate the need for wire stripping and installation is accomplished by simply tightening down the cover with two wing nuts.



TV/F-M Amplifier

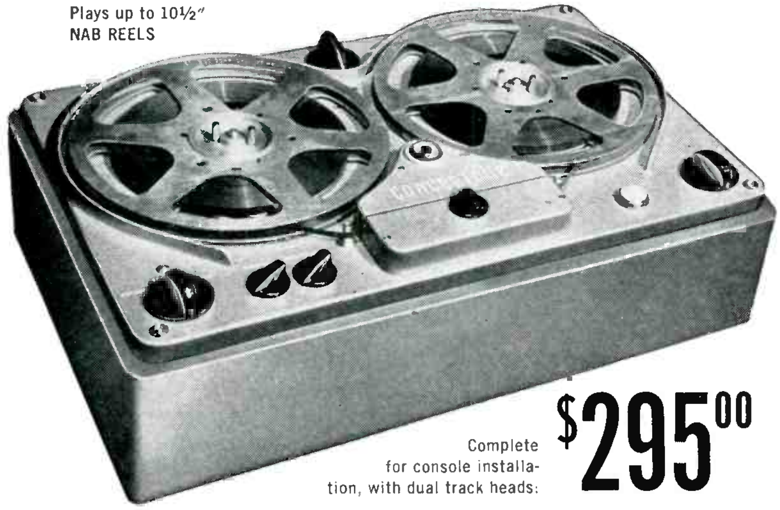
SONIC INDUSTRIES, INC., 221 W. 17th St., New York, N. Y. Model IT4 amplifier is designed to provide high-gain preselection for any tv or f-m receiver, with adequate bandwidth to pass all desired modulating elements and yet with adequate selectivity to reject unwanted off-carrier signals and noise. Balanced input and output circuits provide for minimum noise pickup. Versatility in application has been

AN IMMEDIATE SENSATION!

CONCERTONE

PROFESSIONAL TAPE RECORDER

Plays up to 10½" NAB REELS



Complete for console installation, with dual track heads: $295.00

■ Never before in the history of tape recording has there been an instrument to equal the CONCERTONE. Its performance and specifications are beyond the $1000 class, yet its price is little more than that of mass-produced "novelty" recorders. Unbelievable? Yes . . . until you see and hear it. Write us today for a descriptive booklet. After you have read it, we know that like ourselves you will not rest until there is a CONCERTONE in your home or office. The supply is limited. Better not delay.

Outstanding Features of the CONCERTONE

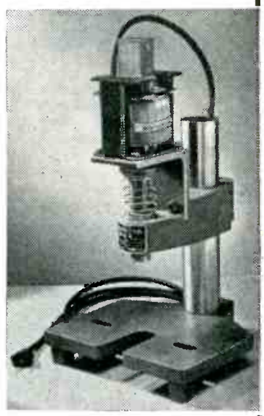
• Broadcast studio quality; complies with latest NAB standards. • Plays 5", 7" *as well as* 10½" NAB reels. (With 10½" reels: 33 min. at 15"/sec., 66 min. at 7½"/sec.) • Separate heads for erase, record and playback. All heads prealigned and quickly interchangeable for single or dual track. • Instantaneous choice of 7.5" or 15" tape speeds; automatic equalization for speed selected. • High speed forward and reverse—2500 feet in 60 seconds. • Three dynamically balanced motors. • Flutter: less than 0.1% at 15" and 0.2% at 7.5". • Frequency range 30-15,000 cycles: (2 db from 40-12,500 cycles at 15"/sec.; 2 db from 40-7500 cycles at 7.5" per second.) • Signal-to-noise ratio: better than 50 db. • Total harmonic distortion: less than 2% at normal maximum signal level. • Recording level indicator. • Simultaneous monitoring from the tape while recording. • All controls interlocked to protect tape. • Available, at additional cost, with base shown, console, or carrying case. *Size:* 14" x 22" x 7¼" high

Exclusive Eastern Distributor

FISHER RADIO CORPORATION · 37 E. 47th ST., NEW YORK

READY TO STAKE CUT SWAGE CRIMP RIVET MARK

ELECTROPUNCH



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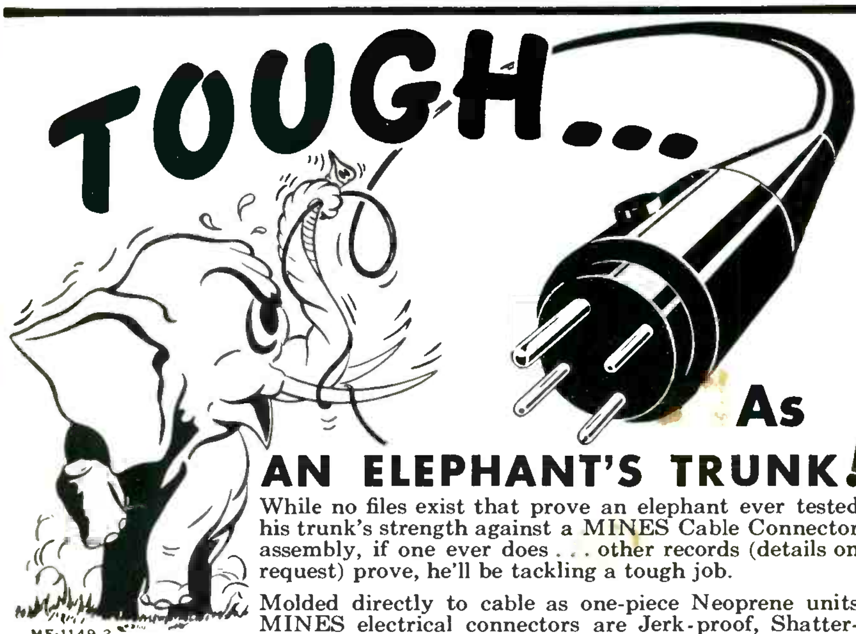
ELECTRIC IMPACT HAMMER

A Production Tool with 1000 Uses

- Low priced
- Plug-in Units
- Controllable impacts up to a ton
- Higher power units engineered

BLACK & WEBSTER, INC.
306 PLEASANT STREET, NEEDHAM 92, MASS.

TOUGH... As AN ELEPHANT'S TRUNK!



While no files exist that prove an elephant ever tested his trunk's strength against a MINES Cable Connector assembly, if one ever does . . . other records (details on request) prove, he'll be tackling a tough job.

Molded directly to cable as one-piece Neoprene units MINES electrical connectors are Jerk-proof, Shatter-proof and Wear-resistant—Special construction and resilient rubber mounting of pins and spring loaded sockets insure a long life of low contact resistance — and the famous MINES Water-Seal automatically protects connections from dirt, oil or water.

A wide variety of sizes, shapes and pin combinations are available to meet the portable power requirements of TV, FM, AM or PA Circuits. No. 4A093 Male plug illus.

Consult a Joy Engineer

MINES EQUIPMENT (MINES) Division
JOY MANUFACTURING COMPANY
HENRY W. OLIVER BLDG., PITTSBURGH 22, PENNA.

NATURAL TREBLE
kettle drum SPEAKERS by BOZAK
TRUE TYMPANY BASS

For *On-stage Realism* of tone, the Bozak "Kettle Drum" loudspeaker is unmatched in price, unsurpassed in listening pleasure. Critical listeners—those interested in complete musical enjoyment, in recording, broadcast monitoring or speech training—agree that the "Kettle Drum" adds new dimensions to high fidelity sound reproduction.

Years of electronic and acoustical research have combined to develop these unprecedented features:

- Bozak "Kettle Drum" 32" spun steel baffle for true pitch bass
- Bozak 12" free-moving cone woofer for outstanding, low resonance bass response
- Bozak damped-cone dual tweeter for distinctly natural treble and broad, smooth response

Response: 40—13,000 cycles with useful response to 16,000; Input: 12 watts, peaks to 18 watts; Impedance: 8 ohms; Coverage: 120° at 10 kc; Woofer magnet: 22 oz. Alnico V

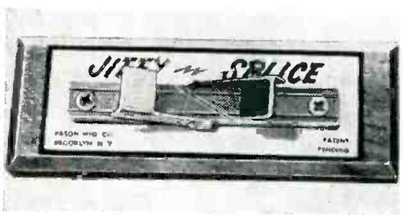
For all applications demanding highest quality sound reproduction at moderate power levels, hear the Bozak "Kettle Drum", model B-201 (patents pending) at your dealer's, or write

Speakers by
R. T. BOZAK CO.
90 Montrose Ave. • Buffalo 14, N. Y.

provided for by both 72-ohm and 300-ohm input and output matching impedances.

Tiny Pressure Pickup

BENDIX AVIATION CORP., Pacific Division, 11600 Sherman Way, North Hollywood, Calif. The new subminiature pressure pickup with a range from 0 to 400 psi is designed for use in the AN/DKT-3 or other f-m/f-m telemetering systems. Natural frequency is 500 to 2,000 cps with the response time dependent upon the length and diameter of the connecting tubing. Acceleration error is negligible. Weight is 0.32 lb.

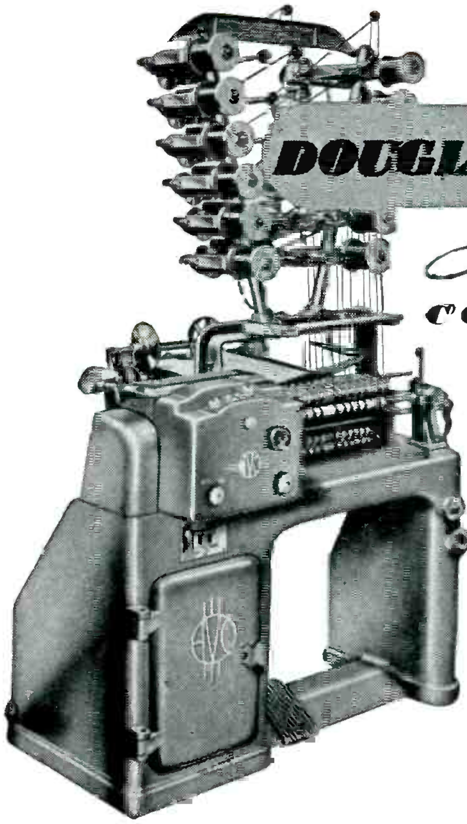


Recording-Tape Splicer

RASON MFG. CO., 61 Myrtle Ave., Brooklyn, N. Y. The Jiffy Splice is a precision tool for splicing of recording tape with minimum waste. Operation consists in placing the two ends under the clamps overlapping about ½ in. and cutting in the diagonal groove with razor blade or knife. Then one places Scotch tape over the cut and trims by cutting in horizontal grooves.

Literature

Universal Impedance Bridge. Brown Electro-Measurement Corp., 4635 S. E. Hawthorne Blvd., Portland 15, Oregon, announces a four-page bulletin on the model 250-B universal impedance bridge for



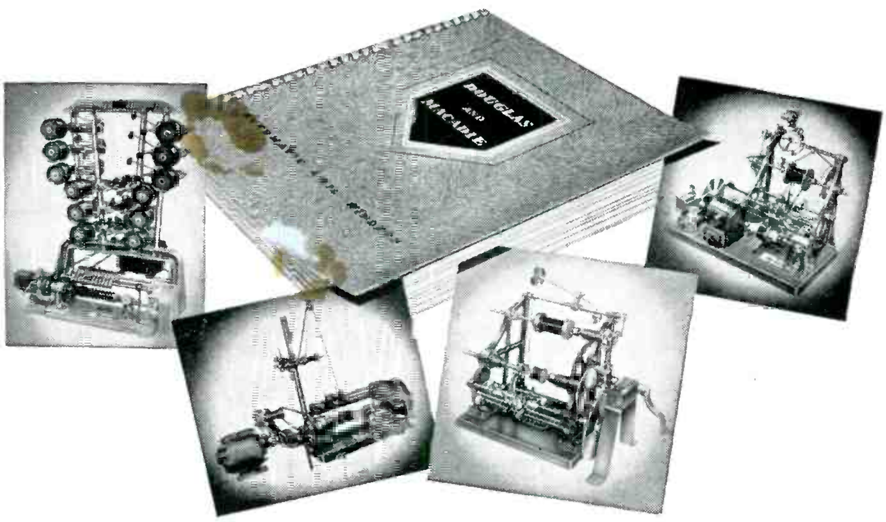
DOUGLAS AND MACADIE

Automatic

COIL WINDERS

THE large illustration depicts the improved "Douglas" Fully Automatic Multi-Winder, specially developed for the high-speed production of large quantities of coils with or without paper interleaving. It will produce round, square or rectangular coils up to 6 inches each in length and up to 4½ inches diameter. As many as twelve smaller coils can be wound simultaneously within the total available winding length of 12 inches at headstock speeds of between 600 and 2,000 revolutions per minute.

Numerous other Coil Winding and Taping Machines are illustrated in our complete Catalogue, a copy of which will be sent to interested executives on application.



THE AUTOMATIC COIL WINDER & ELECTRICAL EQUIPMENT CO., LTD.

WINDER HOUSE • DOUGLAS STREET • LONDON • S.W.1 • ENGLAND

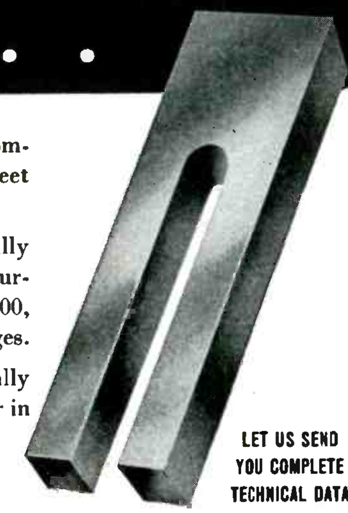
Cables: "Autowinda, Sowest, London." *Code: A.B.C. 5th. Edn.*

Tuning Forks for precision frequency control . . . .

Philamon Laboratories manufactures a complete line of tuning fork resonators to meet your frequency control requirements.

Temperature-compensated and hermetically sealed, the resonators are available in accuracies from 1 part in 3,000 to 1 part in 100,000, for operation over wide temperature ranges.

The resonators may be obtained individually—as a part of compact sub-assemblies—or in completely engineered equipment.



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PHILAMON LABORATORIES
5717 Third Avenue, Brooklyn 20, N. Y.

EMC MODEL 11A

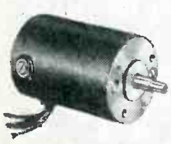
Cut costs

THE RIGHT MOTOR AT THE RIGHT PRICE
EMC AND CYCLOHM FRACTIONAL H. P. MOTORS

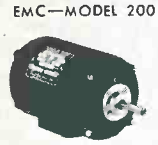
Looking for a way to reduce the costs of your product? You can CUT COSTS without cutting quality by using EMC Model 11A fractional h.p. motors. Best testimonial we can offer is the amazing sales record showing sales of more than 8,000,000 model 11A m... to leading manufacturers of vending machine... ...il movie projectors, adding machines, small appli... ...nd a host more.

Model 11A is a low cost, quality motor that fits the requirements for hundreds of applications. It can be equipped with EMC gear units—12 models to choose from, hundreds of ratios available.

For information about EMC model 11A or any of the famous EMC universal, shunt wound or shaded pole motors and Cyclohm induction motors, write for handy reference literature and specification sheets. For the right motor at the right price, check with Howard.



EMC—MODEL 200



CYCLOHM—MODEL 2900

EMC—MODEL 800B

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DIVISIONS:
EMC ELECTRIC MOTOR CORP.
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measuring resistance, capacitance and inductance. Illustrations, applications, chief features and specifications of the unit described are included. Range of the instrument treated is as follows: resistance—1 milliohm to 11 megohms; capacitance—1 $\mu\mu$f to 1,100 μf; inductance—1 μh to 1,100 henrys.

Resistor Bulletin. Hardwick-Hindle Inc., Newark 5, N. J. Bulletin 350 describes the construction (ceramic core, uniformly-wound resistance wire and corrosion-resistant terminals) and coating (blue-gray vitreous enamel) of a line of resistors. Illustrations, technical data and information on ordering are given.

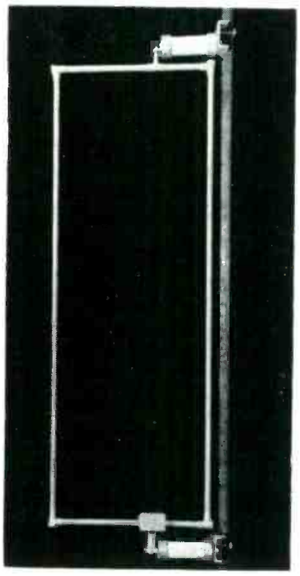
Rectangular TV Bulbs. American Structural Products Co., Box 1035, Toledo 1, Ohio, offers a booklet of scale details to enable television tube and set manufacturers to take full advantage of the all-glass television bulbs. The 12-page book contains scale drawings showing all dimensions of the rectangular bulbs in 14, 16 and 19-in. sizes, and round bulbs in 12½, 16 and 19-in. sizes. It illustrates the advantages of rectangular bulbs over round bulbs by comparisons of area, shape and completeness of picture.

VHF Signal Generator. Hewlett-Packard Co., 395 Page Mill Rd., Palo Alto, Calif. Volume 1, No. 7 of the Journal is an article on the model 608A vhf signal generator which covers the range from 10 to 500 mc. The four-page folder includes a complete description with photographs, diagrams and a table of specifications.

Radioactivity Instruments. Tracerlab Inc., 130 High St., Boston 10, Mass. Catalog B is a 92-page booklet covering a variety of radioactivity measuring and handling instruments. Units illustrated and described include: scalers, scaler accessories, preamplifier and tube accessories, counting-rate and survey meters, G-M tubes, general

3 New JOHNSON Sampling Loops

Now available, three newly designed models of JOHNSON Phase Sampling Loops covering all broadcasting sampling requirements and at sharply reduced prices.



For installations requiring high sensitivity and extreme stability, the 173-10 adjustable shielded loop (illustrated) is recommended. For less exacting applications and where economy is a major consideration, the new 173-11-1 and 173-11-2 unshielded loops are ideal.

The 173-10 shielded loop responds only to the magnetic field and provides high accuracy phase sampling, unaffected by weather conditions. The loop consists of two enamelled copper conductors securely supported and insulated from the ⅞" copper electrostatic shield tubing. Dimensions are: height 6 feet, width 2 feet. Heavy duty insulators support the loop which may be rotated and locked in position. Entry for the sampling line is provided in the bottom pivot shaft.

The unshielded loops offer an economical means of sampling tower currents where the use of the more sensitive electrostatically shielded loop is not warranted. The 173-11-2 is an insulated, adjustable single turn loop. The 173-11-1 loop is grounded to the tower and the tower member serves as the fourth side of the loop. Sensitivity is adjusted by varying the distance between the tower leg and the outer side of the loop. Construction is of heavily plated steel tubing and all necessary hardware for mounting and bonding is furnished. Broadcast net prices of JOHNSON Sampling Loops are:

173-10	$65.00
173-11-1	30.00
173-11-2	40.00

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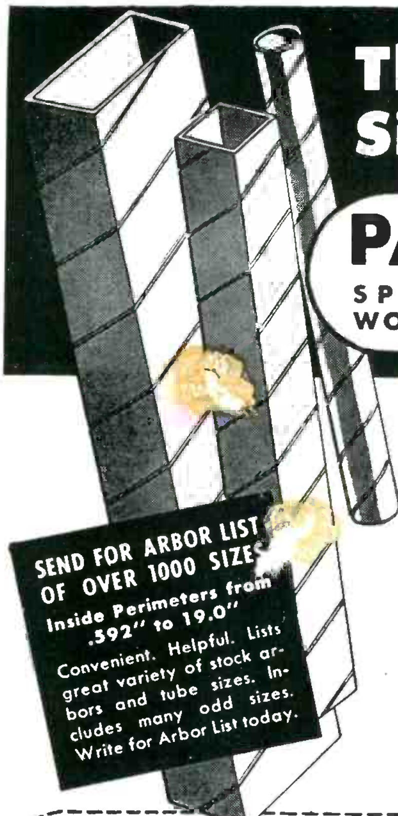

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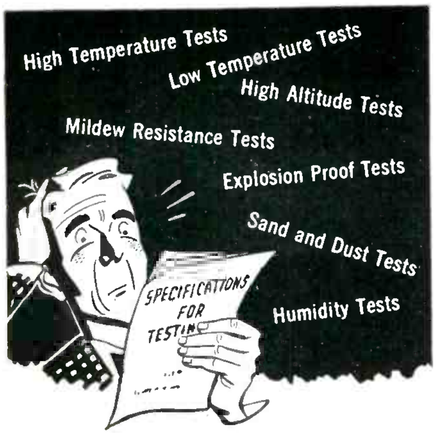

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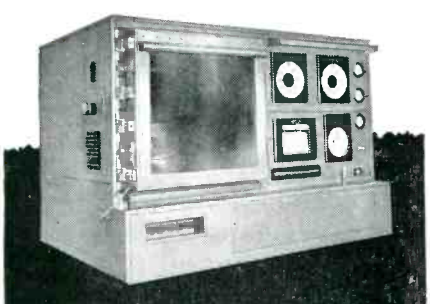

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equipment, lead shields, industrial instruments and dosage meters. Other topics treated are tagged chemicals, laboratory services, and procedure of service and repair.

Microwave Test Equipment. Polytechnic Research & Development Co., Inc., 202 Tillary St., Brooklyn 1, N. Y., has issued 19 loose-leaf catalog pages giving technical data and illustrations for its latest line of microwave test equipment. An attached instruction bulletin will enable holders of catalogs to bring them up to date. Also available are a table of contents and a price list.

Low-Loss Switches. Communication Products Co., Inc., Keyport, N. J. The looseleaf perforated bulletin 107 describes models 86 low-power, 88 medium-power and 90 high-voltage high-power switches. Supports for all the switches are low-loss impregnated steatite, and all current and voltage ratings indicated are for 60 cycles. Electrical data and dimensional drawings for each model are given.

Precision Potentiometer. Southwestern Industrial Electronic Co., 2831 Post Oak Road, Houston 19, Texas. Model P-2 precision electronic potentiometer for use on high-impedance electrochemical cells or electronic tubes and circuits is the subject of a recent four-page brochure. Included are essential features, block diagram, applications, specifications and prices.

Capacitor Bulletins. Glenco Corp., Durham Ave., Metuchen, N. J. A 14-page booklet enclosed in a looseleaf folder contains bulletins giving the dielectric constant vs temperature on capacitor bodies K-23, K-17, K-24, K-28, K-31, K-38 and K-45. Also included are dielectric constant and power factor vs temperature figures on capacitor bodies K-85, K-300, K-1500 and K-3300. For the latter two capacitor bodies are found information

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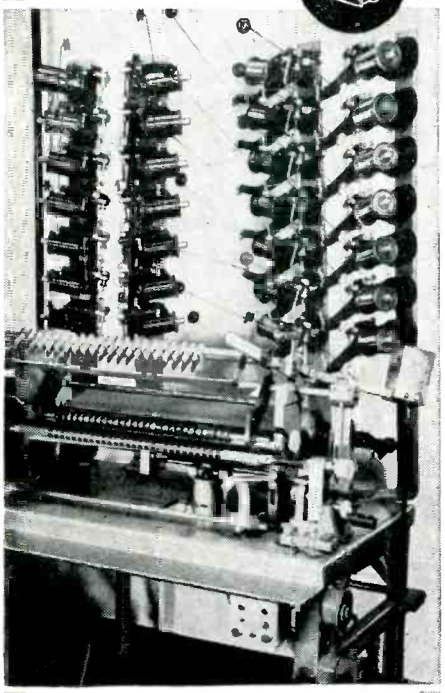

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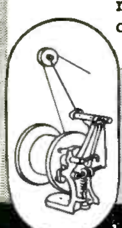

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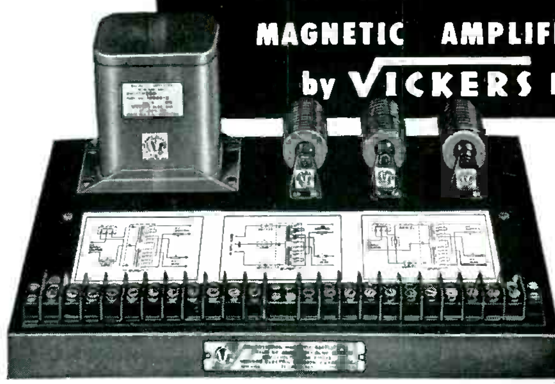

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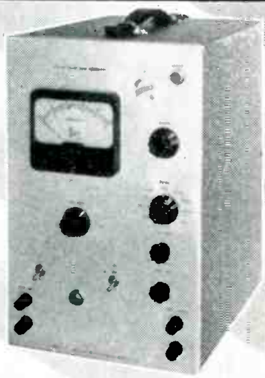
Square wave testing techniques come into wider use as the need for good transient response in wide band amplifiers becomes increasingly important. In order to test the high frequency response it is necessary to have a signal which has a rise and fall at least equal to and preferably faster than the risetime of the amplifier being tested. In addition to a sharp rise and fall, the test signal should be free of over-shoot and other spurious responses. For examination of the low frequency response a square wave signal having flat horizontal portions is needed.



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on dielectric constant vs measuring voltage, dielectric constant vs applied d-c bias voltage and stabilization of room temperature capacity after heating above 120 C.

Marine Communications. Kaar Engineering Co., 2815 Middlefield Road, Palo Alto, Calif. An eight-page folder covers the model D-24 marine radio direction finder, the 100-watt series 96 medium-frequency radiotelephone, the series 19(20 w) and 46(50 w) marine, mobile and land station radiotelephone equipment, the series 25 radio receiving equipment and the ES-29, a 100-fathom echo depth sounder. Description, illustrations and specifications are given.

Beryllium-Copper Wrought Products. The Beryllium Corp., Reading, Pa. Bulletin 12, which describes alloy, condition and temper and includes tables of mill sizes and properties, will aid in specifying beryllium-copper strip. Data covered includes strip in thicknesses ranging from 0.002 to 0.187 in., inclusive. Similar data for beryllium-copper in rod, bar and wire forms will be found in bulletin 13.

Wired Television. Diamond Power Specialty Corp., Lancaster, Ohio, has available a 16-page bulletin on the Utiliscope wired television system. Descriptive and illustrated pages show the many applications of the system which enables seeing where looking is impossible. The system treated consists of a camera, power unit and monitor or viewing unit. The whole installation under discussion weighs only 121 pounds.

Induction Resolvers. Reeves Instrument Corp., 215 E. 91st St., New York 28, N. Y. Bulletin RICO-3 shows the theory and application of induction resolvers used to perform trigonometric operations in analog computing devices and control systems. Description, tabulated performance data, circuits and dimensional

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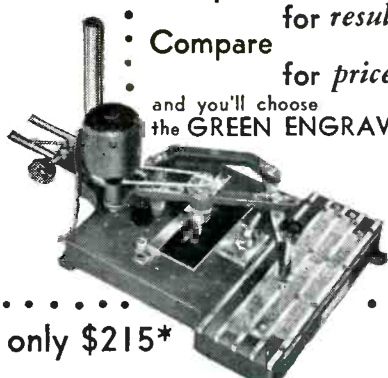

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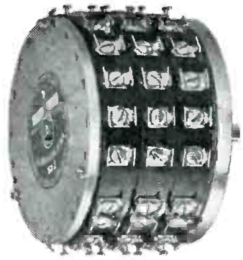

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Here's a custom-built instrument that's typical of Fairchild's job-engineered solutions of difficult potentiometer problems. It's a 3-gang potentiometer with 17 taps per unit, giving 16 sections of equal resistance — 8 each side of center. By using resistors of various sizes between taps, almost an infinite number of non-linear functions can be approximated. For control purposes, each unit can be used as a continuously varying switch to fire tubes such as Thyratrons in sequence.

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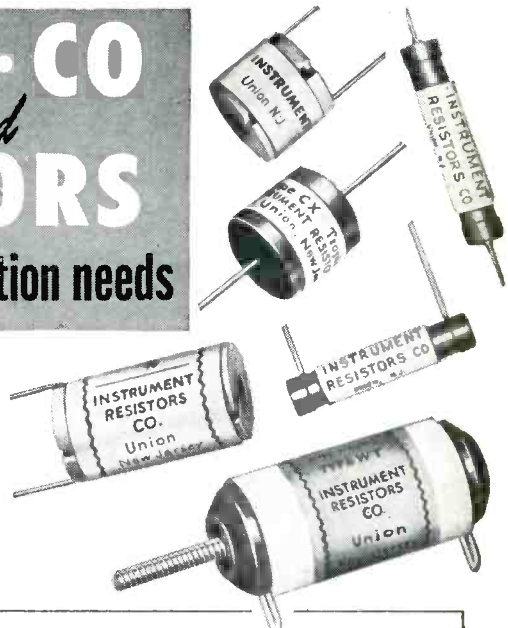

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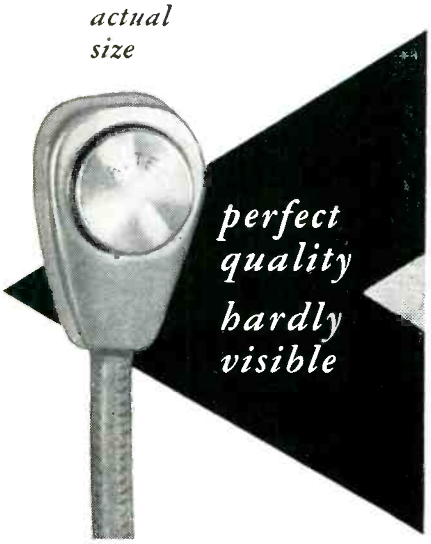

The new Altec 28A Lapel Microphone permanently incorporates the Altec 21B. Its small size makes it practically invisible when clipped to the clothing of the user. Here is a development that offers public speakers and professional people a microphone that is invisible, gives them complete freedom of movement and provides them with quality that was never before available. The 28A is held to the clothing by a jewelry clip and is equipped with 6 ft. of cable.

The 154A Matching Unit is used with the 28A and contains the necessary impedance matching tube. The size of a pack of cigarettes, it is easily carried in the pocket. Equipped with 25 ft. of cable.

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drawings are included. Range of operating frequencies for the units described is from less than 60 to greater than 1,000 cps.

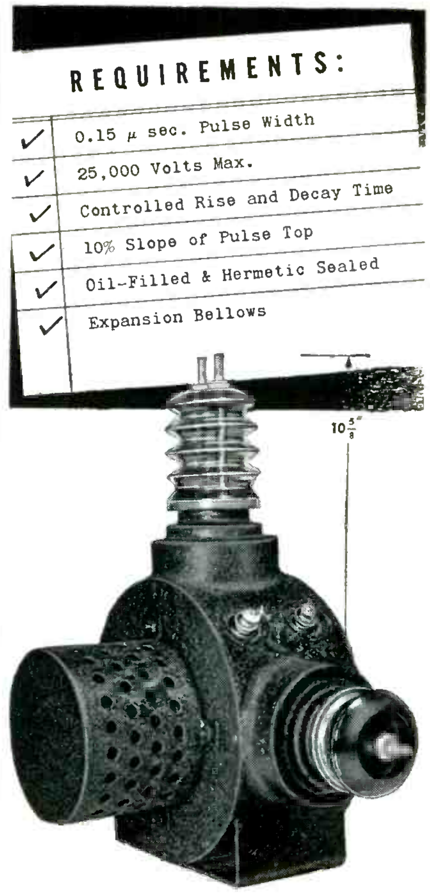
D-C Breaker Amplifier. Liston-Folb, Stamford, Conn., has issued a four-page bulletin on the model 10 breaker-type d-c amplifier, an electronic unit designed to replace high-sensitivity galvanometers. Included are a block diagram of the amplifying system and performance and characteristics charts. A price list is also available.

Heterodyne Eliminator. J. L. A. McLaughlin, P. O. Box 529, LaJolla, Calif. A recent bulletin treats the MCL-4 Signal Splitter, an asymmetrical off-frequency inverter-type heterodyne eliminator. The unit described was intended for radio press services, airway ground-station control, or wherever off-frequency interference is likely to mar the reception of the vital radio intelligence.

Vacuum Rectifier. Radio Corp. of America, Harrison, N. J., has published a technical data bulletin on the 6AX5-GT full-wave vacuum rectifier of the heater-cathode type intended for use in a-c operated receivers and automobile receivers. Rating and characteristics charts, dimensional outline and socket connections are given.

Crystal Impedance Meter. Lavoie Laboratories, Inc., Morganville, N. J. A single sheet is devoted to the model 50 crystal impedance meter for use in laboratories employing piezoelectric frequency-control crystals. Specifications of the unit described include a frequency range of 75 to 1,100 kc, an impedance range of 0 to 29,900 ohms and an accuracy of 5.0 percent.

Technical Ceramics. American Lava Corp., Chattanooga 5, Tenn. Chart No. 501 gives the mechanical and electrical properties of AlSi-



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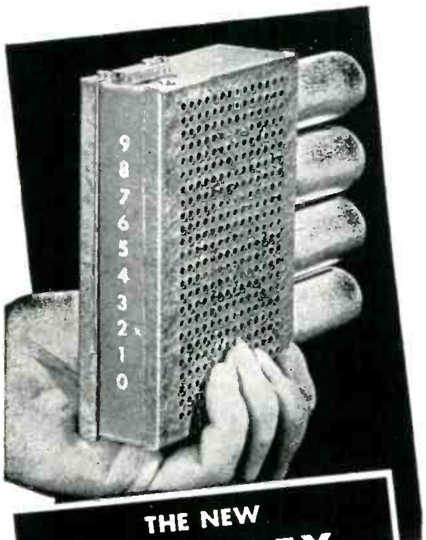

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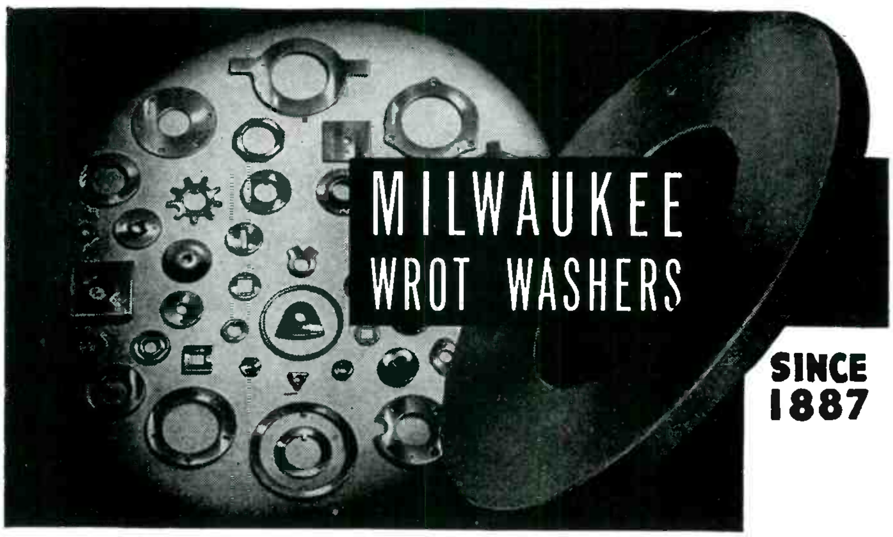

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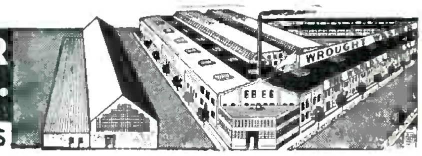

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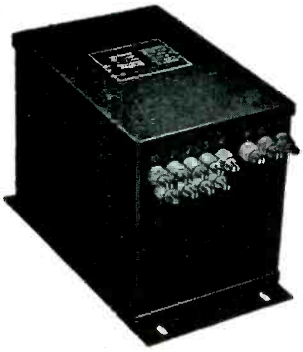


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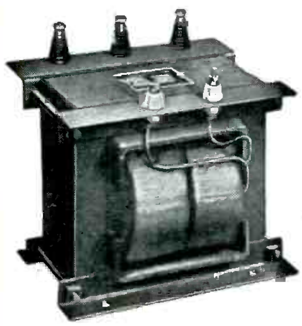

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Mag custom-made technical ceramics. It covers 17 of the more frequently used compositions and features a selection chart which simplifies choice of the most useful type for the individual requirement. Included are graphs showing linear thermal expansion, dielectric strength variation with thickness and dielectric strength variation with temperature.

Wire-Wound Resistors. Shallcross Mfg. Co., Collingdale, Pa. Bulletin No. 122 gives full details of the type 265A flat, metal-encased mica-insulated, wire-wound power resistors which are specifically designed for business machines and other exacting equipment where the call is for real dependability in minimum size. The resistors described are rated for 7½ watts in still air and 15 watts when mounted on a metal chassis (at 175 C continuous operating temperature.)

Boom Bracket Kit. Atlas Sound Corp., 1449 39th St., Brooklyn 18, N. Y., has published a one-page catalog release on the US-1 boom bracket kit for microphone support. It illustrates how the setscrew assembly makes it possible to cut down any tubular section so that the support bracket can be custom built to meet a specific requirement.

Nuclear Measurements. Nuclear Instrument and Chemical Corp., 223 W. Erie St., Chicago 10, Ill. Catalog K is a 40-page booklet covering 32 nuclear scaling, counting, monitoring and detector instruments. Also included are an illustrated description of 36 accessories and special instruments, service information, suggestions for ordering and a price list.

Spectrum Analyzer. Polarad Electronics Corp., 100 Metropolitan Ave., Brooklyn 11, N. Y. A single-page bulletin covers the LSA all-band direct-reading spectrum

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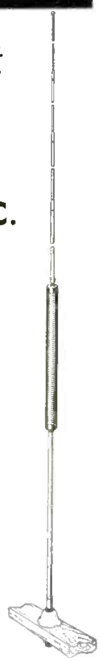

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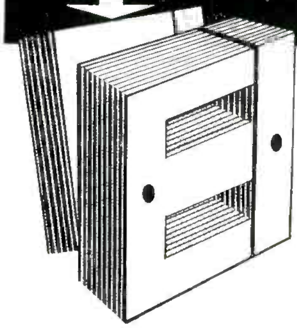

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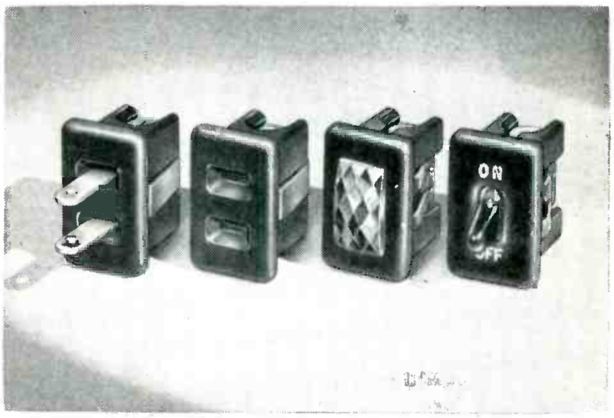

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analyzer, a laboratory instrument used to provide a visual indication of the frequency distribution of energy in an r-f signal in the range of 10 to 16,520 mc. Outstanding features and an illustration of the equipment are given.

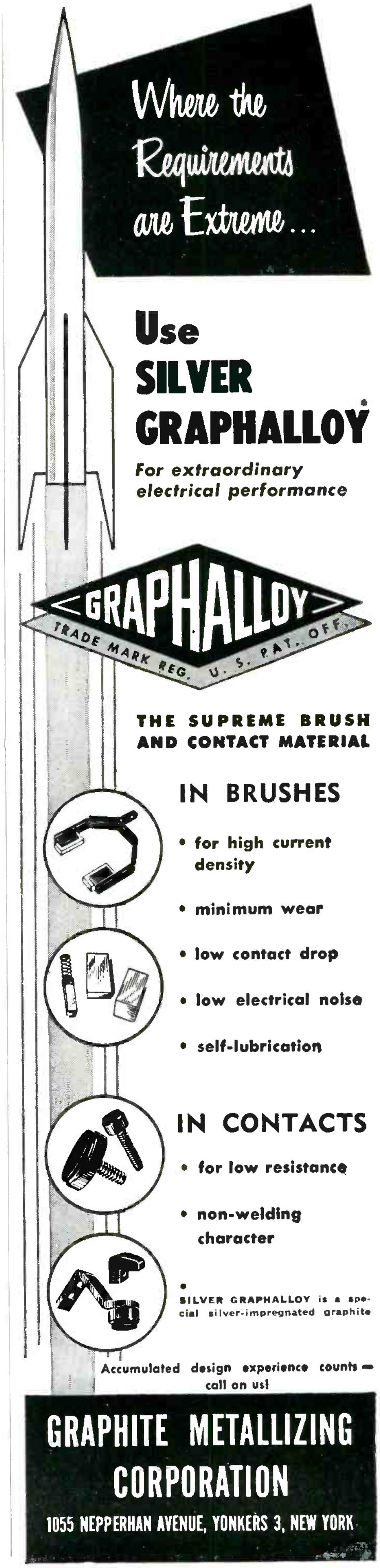
Synchronous Timing Motor. The Bristol Motor Co., Old Saybrook, Conn. The Circle B a-c self-starting synchronous timing motor is illustrated and described in a recent four-page folder. Design, construction, lubrication, compactness, dependability and specifications are covered.

Electronics Dictionary. Allied Radio Corp., 833 W. Jackson Blvd., Chicago 7, Ill., has published a 64-page dictionary of over 2,500 terms used in television, radio and industrial electronics. Over 125 illustrations and diagrams of components, equipment and electronic circuits are included, as well as an appendix section containing useful radio data. Price is 25 cents to cover handling and mailing costs.

Circuit Control. G. H. Leland Inc., 123 Webster St., Dayton 2, Ohio, has released a four-page bulletin giving a few of the many applications of circuit selectors and stepping relays. The units described feature remote control, rotary-solenoid operation, positive detent action, and self-stepping or external impulsing.

Germanium Crystal Diodes. Kemtron Electron Products Inc., 23 Brown St., Salem, Mass. A recent four-page folder gives performance characteristics, dimensional diagram and chief features of a line of germanium crystal diodes. Specifications for eleven types are included.

Electronic Plotting Board. Electronic Associates, Inc., Long Branch, N. J., has issued a descriptive pamphlet on its model 205 Vari-



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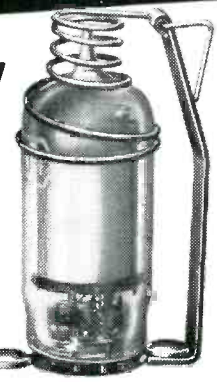

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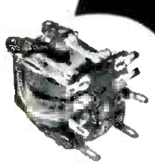

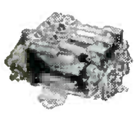

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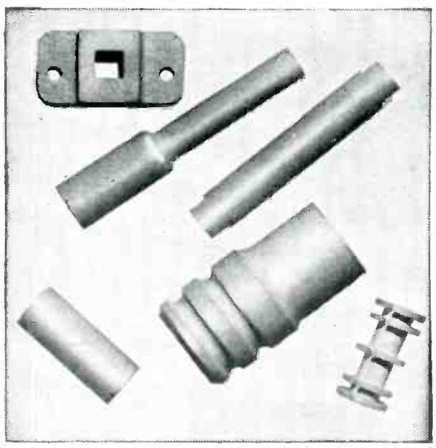

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plotter which is primarily designed to plot one variable as a function of another variable. Some applications of the instrument described include aeronautics, acoustics, radio, atomic research, materials and industry. Accessories are listed.

Servo Actuators. Lear, Inc., 110 Ionia Ave., N. W., Grand Rapids 2, Mich. Bulletin B-102 gives an eight-page illustrated description of the model 118 series fast-response servo actuators with the Learflux Magnadrive torque amplifier. The units described were originally made for aircraft applications and component parts are ruggedly constructed. Suggested applications and two pages of performance curves are given in the new bulletin.

Educational Magnetic Amplifier. Vickers Electric Division, Vickers Inc., 1815 Locust St., St. Louis 3, Mo. Holders of registered copies of the company's magnetic amplifier design handbook (April ELECTRONICS, p 243) will receive supplementary information on magnetic amplifiers as it becomes available. Latest issue of such data consists of three bulletins on the educational magnetic amplifier for schools and industry. One of the publications now available is a laboratory manual of specifications, instruction notes and experiments.

Electronic Instrumentation. Berkeley Scientific Co., Richmond, Calif. A six-page folder gives a cross-section of a diverse line of instruments now in production or under development. Included are illustrated descriptions of the model 700 decimal counting unit, model 410 industrial counter, model 80 portable, battery-operated scaler, model 554 meter, model 902 double-pulse generator, models 500 and 510 time-interval meters, model 1600 counting-rate computer, the Colman soil moisture unit, models 1000-B and 2000 decimal scalers, model 3500 multichannel scaler and model 3000 hand and foot monitor.

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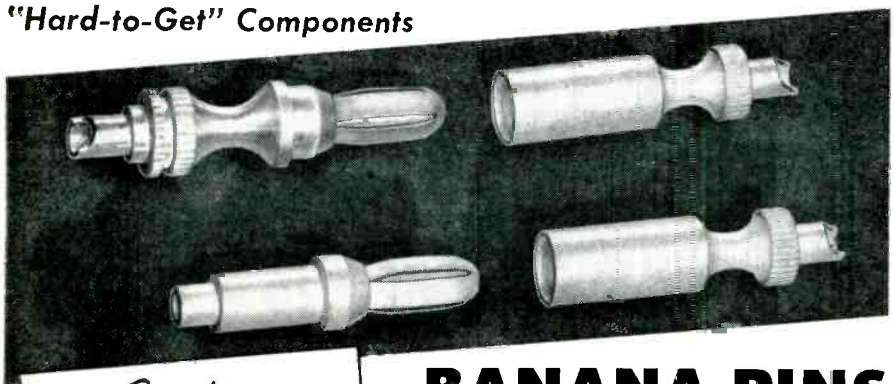

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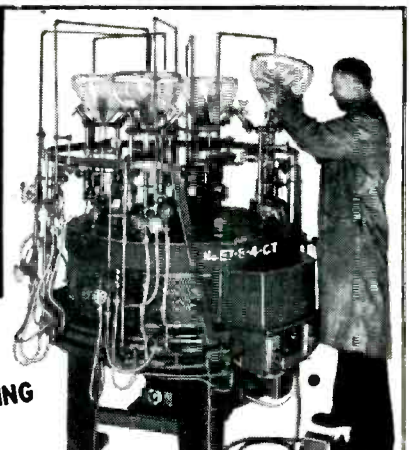

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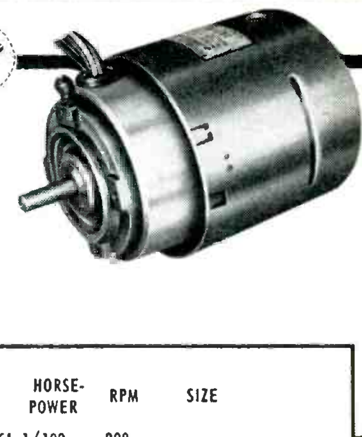

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LH731NCJ	1/50	1800	3⅞" Dia. x 4-9/16"
LH73QCJ	1/100	1800	3⅞" Dia. x 4-1/16"
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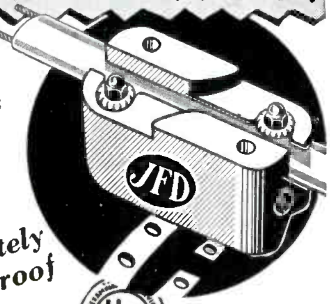

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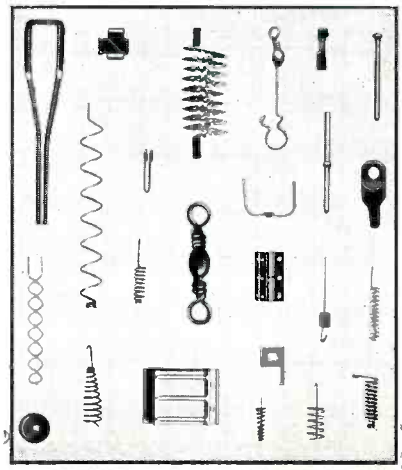

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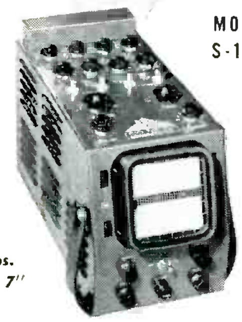

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NEWS OF THE INDUSTRY

(continued from page 132)

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AIEE Summer and Pacific General Meeting

THE 1950 Summer General Meeting of the AIEE has been combined with the Pacific General Meeting usually held in August, to form the 1950 Summer and Pacific General Meeting at the Huntington Hotel, Pasadena, Calif., from June 12 to 16. The tentative technical program, insofar as it is of particular interest to electronic engineers, is as follows:

Monday, June 12

2:00 P.M.—Electronics

An Oscillograph Amplifier Using A Transductor as the Input Stage, by G. W. Downs and R. Morrison of William Miller Corp.

A Simple Stabilized D-C Amplifier for Use with Electric Analog Computers, by V. Briggs of U. S. Naval Ordnance Test Station.

Magnetic Modulators, by G. Wennerberg of Lear, Inc.

Recent Trends in the Field of Miniature Electronic Components, by M. J. Ainsworth of Bendix Aviation Corp.

Electronics Goes to the Farm, by D. Packard of Hewlett-Packard Co.

Tuesday, June 13

9:30 A.M.—Computers—Features of the INA and MADDIDA computers will be covered by several papers.

2:00 P.M.—Applications of Computers to Aircraft Engineering Problems (five papers).

Wednesday, June 14

9:30 A.M.—Electronic Communication Systems for Mine Shafts, by C. M. Marquardt of Combined Metals Reduction Co.

9:30 A.M.—Particle Acceleration and Detection Cloud Chamber Studies of Cosmic Rays, by C. D. Anderson of Calif. Inst. of Technology.

Operation of the 350 Mev Berkeley Synchrotron, by M. Martin of U. of Calif.

A 500-KV Radio-Frequency Power Supply as a Bevatron Injector, by J. R. Woodyard of U. of Calif.

The Klystron as a High-Power Source for the Electron Linear Accelerator, by

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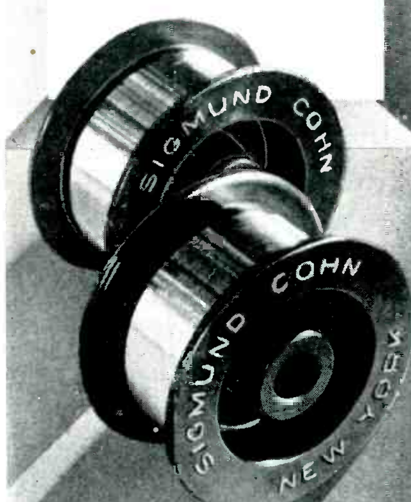

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Stainless Steel

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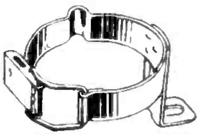

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Actual Size

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10 to 10,000,000 MEGOHMS

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It gives details of both the Standard and High Value resistors, including construction, characteristics, dimensions, etc. Copy with Price List mailed on request.

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Experience has proved that expensive radio programming must have the best recording equipment . . . it saves in many ways in the long-run. Ampex Recorders are unequalled for this critical service—they are reliable—easiest to operate—maintenance is nil. Ampex has the lowest flutter and wow of any recorder built.

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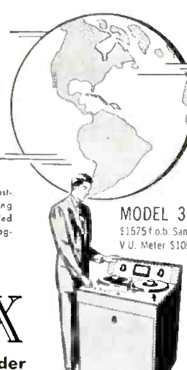

MODEL 300-C
$1575 f.o.b. San Carlos
V.U. Meter $105 Extra

AMPEX
Magnetic Tape Recorder

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AMPEX ELECTRIC CORP., San Carlos, California
Without obligation please send 16-page illustrated booklet containing technical specifications of Ampex Magnetic Tape Recorders.

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Our need is for:
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- ☐ Recording-Broadcasting
- ☐ Telemetering
- ☐ Industrial Recording
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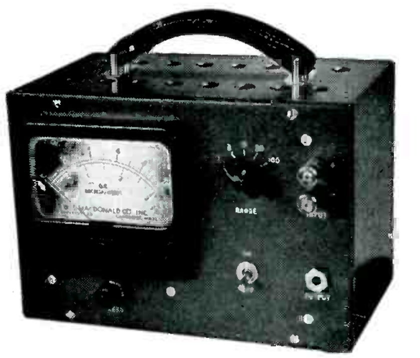
AX-13b.

MACDONALD ELECTRONIC MICROAMMETER



THIS instrument is designed to replace high-sensitivity galvanometers in many applications. Due to its ruggedness, freedom from burnout, and relative insensitivity to shock, it is an ideal instrument for use in balancing resistance bridges, measuring crystal rectifier output, photo-cell, strain-gage, thermocouple, and lead-sulphide cell currents, etc. The instrument may also be used as a DC pre-amplifier for recorders. When used in this manner, current amplification of 1,000 is available.

SPECIFICATIONS:

Sensitivity •
1 microampere full scale
50 microvolts full scale

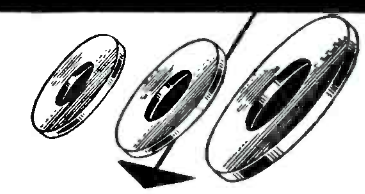
Ranges •
1, 3, 10, 30, 100 microamperes

Permissible overload – ¼ ampere
Accuracy – ±3% full scale
Time constant – about 6 seconds
Power supply – 110 – 125 V, 60 C. P. S.
Dimensions – 7" x 8" x 9½".

PRICE — $250.00 F.O.B. CAMBRIDGE, MASS.

W. S. MACDONALD CO., INC. 33 UNIVERSITY ROAD CAMBRIDGE 38, MASSACHUSETTS

For *Precision* Washers... For *Precision* Stampings...



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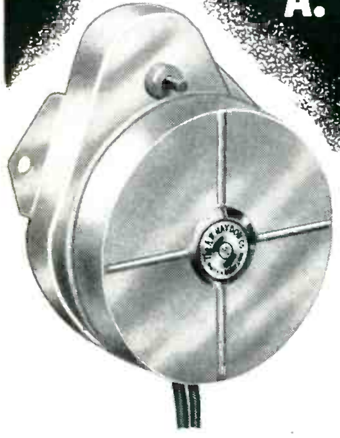
A-10300 SERIES



Now available is a complete new line of *standardized* A.C. Synchronous Hysteresis Timing Motors by A. W. Haydon. These new motors are of superior design and performance . . . have a high starting and running torque . . . and are extremely quiet in operation. You can effect appreciable savings in motor costs by using these new Haydon Standardized Timing Motors on *your* product.

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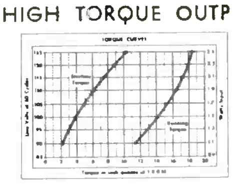

Complete Timers incorporating these motors can be supplied specially designed for volume requirements.

Special Features:

- Long Life
- Wide Range of Voltage, Speed and Current Ratings
- Welded Construction
- Shaded Pole Starting
- Capillary Lubrication

Write today for Catalog Sheet Giving Full Information On Standardized A.C. Timing Motors

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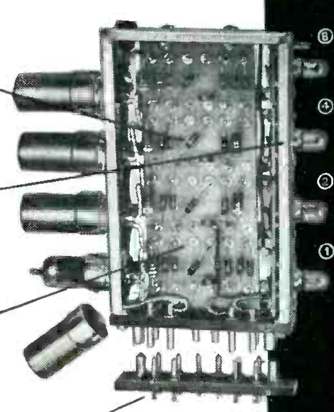
Design and Manufacture of Electrical Timing Devices

Simple • Reliable • Economical
Potter decimal counter



Highest quality pretested components, conservative ratings

Four large, easy reading, bulls-eye glow lamps — replaceable socket type

All components turret-lug mounted and accessible . . . all wiring color coded

Special silver plated, self-aligning contact and rigid connectors for positive mechanical mounting

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STABLE OPERATION — WIDE VOLTAGE RANGE.

HIGH COUNTING RATES — UP TO 130,000 PER SECOND ABSOLUTE ACCURACY GUARANTEED.

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INCORPORATED
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S. Sonkin of Stanford U.

Proton Linear Accelerators, by W. K. H. Panofsky of U. of Calif.

2:00 P.M.—Electronics

Use of Reflection Doppler Techniques for Test Range Instrumentation, by D. Kean of U. S. Naval Ordnance Test Station.

Application of Electronics to Test Range Instrumentation, by F. Ashbrook of U. S. NOTS.

A Precision Timing System for Test Range Instrumentation, by T. Parkin of U. S. NOTS.

Sound Ranging at the Morris Dam Torpedo Ranges, by R. N. Skeeters of U. S. NOTS.

Electrical Requirements for Firing Rockets by Induction, by J. P. McClellan of U. S. NOTS.

Determination of the Composition of Surface Layers by Ion Scattering, by S. Rubin of Stanford Research Institute.

Thursday, June 15

9:30 A.M.—Instruments and Measurements—Front-of-Wave Impulse Measurement Techniques, by M. M. Newman and P. Bellaschi of U. of Minn.

9:30 A.M.—Microwave Applications

Field Testing a Microwave Channel for Voice Communication, Relaying, Telemetering and Supervisory Control, by D. R. Pattison of Pennsylvania Electric Co. and M. E. Reagan, S. C. Leyland and F. B. Gunter of Westinghouse Electric Corp.

Microwave Applications to Bonneville Power Administration System, by R. F. Stevens and T. W. Stringfield of Bonneville Power Administration.

Microwave Systems for 960 and 2,000 Megacycles, by R. V. Rector of GE and W. E. Sutter of International GE Co.

940 to 960-Megacycle Communication Equipment for Industrial Applications, by F. B. Gunter of Westinghouse Electric Corp.

Problems to be Solved in the Application of Microwave Equipment, by R. C. Cheek of Westinghouse Electric Corp.

2:00 P.M.—Instruments and Measurements

The Status and Applications of Microwave Spectroscopy, by W. D. Hershberger of the U. of Calif.

2:00 P.M.—Conference on Carrier Current

A Low Noise and Distortion Audio Multiplexing Equipment with High-Stability Carrier Supply, by F. S. Beale of Westinghouse Electric Corp.

Friday, June 16

9:30 A.M.—Symposium on the Bevatron

Pulsed Power Particle Accelerators, by G. Farley of U. of Calif.

Multi-Purpose Generators and Controls for High-Energy Particle Accelerators, by G. L. Godwin and L. A. Kilgore of Westinghouse Electric Corp.

Ignitron Converters for High-Energy Particle Accelerators, by J. L. Boyer and C. R. Marcum of Westinghouse Electric Corp.

Design and Preliminary Operation of the Bevatron with Emphasis on the Magnetic Circuit, by D. Sewell of U. of Calif.

Frequency Control for the Bevatron R-F Voltage, by J. Reidel of U. of Calif.

9:30 A.M.—Substations

Automatic Control of Ignitron Rectifier Stations, by E. J. Cham and W. A. Derr of Westinghouse Electric Corp.

Multi-Station Supervisory Control, Telemetering and Communication on Single-Frequency Carrier Channel, by W. A. Derr and J. V. Kresser of Westinghouse Electric Corp. and T. C. Wren of Sierra Pacific Power Co.

System-Wide Fast Response Telemetering, by G. W. Dupree of Southwestern Public Service Co.

Use of Ultrahigh-Frequency Equipment for Supervisory Control and Telemetering, by L. E. Ludekens of Southern California Edison Co., Ltd.

2:00 P.M.—Magnetic Amplifiers and Transformers

The Design of Broadband Transformers for Linear Electronic Circuits, by H. W. Lord of GE Research Laboratory.

General Characteristics of Magnetic Amplifiers, by L. A. Finzi and D. C. Beaumariage of Carnegie Inst. of Technology.

Response Time of Magnetic Amplifiers, by E. L. Harder and W. F. Horton of Westinghouse Electric Corp.

The Extension of Amplistat Performance by Alternating-Current Components, by R. E. Morgan, H. M. Ogle and V. J. Wattenberger of GE Co.

Theory of the No-Load Characteristics

FLEXLOC

ONE-PIECE SELF-LOCKING NUTS

The FLEXLOC is one-piece, all-metal . . . has ample tensile and long life. It is a Stop and Lock-Nut that can be reused many times. Its "chuck-like", resilient locking segments lock the FLEXLOC securely in any position on a threaded member. It positively "won't shake loose", yet can be removed easily with a wrench.

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It is evil to gloat upon man's errors. But only a monkey blinds his eyes to the evils man suffers. We must open our eyes to the facts of cancer in order to defend ourselves against this dreaded scourge. For humanity's sake — and our own preservation — we must support the crusade against this mortal enemy of man.

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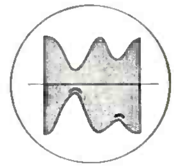
INTERMODULATION UNIT *For . . . .*

DISTORTION TESTING and ANALYSIS at LOW COST

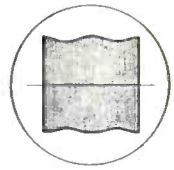
WITH MODEL 162, using charts like these you can measure and analyze the performance of an amplifier or a complete system at a glance. Significant distortion is shown much more clearly by the intermodulation method than by trying to see directly the distortion of a single frequency wave on an oscilloscope screen.

Use your own audio oscillator and oscilloscope with MODEL 162 to indentify these faults: wrong bias, wrong load impedance, tube unbalance, regeneration, insufficient drive capacity. For the first time phonograph pick-up distortion can be tested at low cost with an intermodulation record.

Curves and pictures in instruection book tell how to read intermodulation percentage directly, how to determine harmonic distortion, how to adjust an amplifier for best performance quickly by using the screen images as a guide.



INCORRECT ADJUSTMENT



CORRECT ADJUSTMENT

Experience shows that an amplifier adjusted for low IM will also have low harmonic distortion, but the reverse is not true. Low harmonic distortion does not assure low IM.

This unit tests over a wide frequency range and at 1:1 or 4:1 voltage ratio of the two frequencies. It permits separate testing of low and high frequency overload.

It uses basic relation between total notch depth and percent of intermodulation. *Using special screen supplied with unit, you can read percent of IM directly on the oscilloscope range.*

TEST FREQUENCIES

Low: Any frequency from 10 to 250 cps. from external oscillator or 60 cps. from power line via internal transformer.

High: Any frequency above 2000 cps. from external oscillator.

Price $88.50

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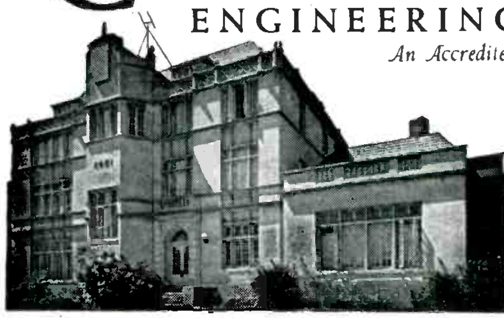
Audio INSTRUMENT COMPANY
1947 BROADWAY NEW YORK 23, N.Y.

Pioneer in Radio Engineering Instruction Since 1927

CAPITOL RADIO ENGINEERING INSTITUTE

An Accredited Technical Institute



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For AC CURRENT ANYWHERE . . . .
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Specially Designed for operating A. C. Radios, Television Sets, Amplifiers, Address Systems, and Radio Test Equipment from D. C. Voltages in Vehicles, Ships, Trains, Planes and in D. C. Districts.
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"A" Battery Eliminator, DC-AC Inverters
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See your jobber or write factory
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SAINT PAUL 1, MINNESOTA—U. S. A

of Highly Saturable Reactors with Hysteresis, by A. Banos, Jr., of U. of Calif.
2:00 P.M. Electronic Power Converters
High-Voltage Rectifier Equipment and Control for Tube Testing, by S. R. Durand of Allis-Chalmers Mfg. Co.
High-Voltage Ignitron Rectifiers, by M. J. Mulhern of GE Co.
Ignitron Pulse Equipment for Particle Accelerators, by C. C. Herskind and J. E. Hudson of GE Co.
A Brief Pictorial Story on the Early Development of the Mercury Arc Rectifier, by W. C. White of GE Co.
Survey of Operation of Mercury Arc Rectifiers, by Committee on Electronic Power Converters.
Protection of Electronic Power Converters, by Committee on Electronic Power Converters.

BUSINESS NEWS

UNITED GEOPHYSICS CO. will form a permanent home in $250,000 quarters at Pasadena, Calif., for the manufacture of electronic instruments used in the earthshock method of exploring subterranean formations.

HERMAN H. SMITH, INC., manufacturer of radio hardware, electronic components and television accessories, has moved to new and larger quarters at 436 18th St., Brooklyn, New York.

SONOTONE CORP., manufacturers of hearing aids and other electronic devices, have been licensed by Allen B. Du Mont Laboratories, Inc., to manufacture and sell the Du Mont bent-gun mount to all television tube manufacturers.

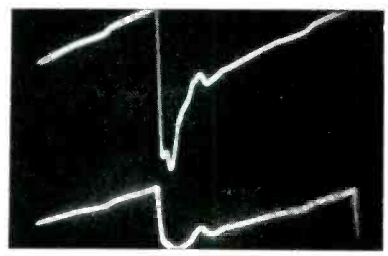
CENTRALAB DIVISION OF GLOBE-UNION INC., Milwaukee, Wisc., has acquired a new 46,000-sq ft plant in Denville, N. J., for the exclusive production of a full line of ceramic capacitors.

ADVANCE ELECTRIC & RELAY CO., manufacturers of relays for general circuit control, electronic, aircraft and marine applications, is now occupying its new 20,000-sq-ft plant at 2435 No. Naomi St., Burbank, Calif.

JOHN VOLKERT METAL STAMPINGS, INC., Queens Village, N. Y., recently passed the 1,500,000 mark in the production of sets of metal parts for electron guns used in television tubes. This figure represents over one-third of the total number presently produced for tv receivers.

RAYTHRONIC LABORATORIES, INC., Cincinnati, Ohio, has been formed

COSSOR for QUALITY
TWIN BEAM OSCILLOSCOPES
compare. . .
INPUT VS. OUTPUT
VOLTAGE VS. CURRENT
CAUSE VS. EFFECT
with
twin beams in exact time synchronism
plus
accurate voltage and time measurement controls at your fingertips.
IS YOUR WORK TV?



TV horizontal output tube waveform
upper trace—grid volts
lower trace—cathode current
STUDY THIS PHOTO—note exact phase comparison given by unique Cossor twin beam tube. . .no need for electronic switching with attendant troubles.
Photographed on Cossor Model 1035 with Model 1428 Camera.
Cossor simplifies scope photography.
Model 1035 Scope for wide band amplifiers and fast traces.
Model 1049 Scope for DC amplifiers and slow traces.
both with the
COSSOR TWIN BEAM TUBE
Write today for details and demonstration.
ALL MODELS AND COMPLETE SPARES IN STOCK NEW YORK AND HALIFAX
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BEAM INSTRUMENTS CORP.
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New York 18, N. Y.

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Nos. 28, 29, 58, 68

Deep Throat, Toggle Action

FOOT PRESSES

The deep throats (7", 10", 18", and 24") and powerful punching action of these foot presses permit the handling of a wide variety of work. All sizes, with 5 ton capacity, punch a 2" hole through 16 gauge mild steel.

Length of stroke — 1"
Height of throat — 6-3/4"

WHITNEY METAL TOOL CO.
150 FORBES ST., ROCKFORD, ILL.

IMPROVED ULTRA-SENSITIVE DC AMPLIFIER

1. This new and improved DC amplifier of the General Motors breaker type offers many advantages in the measurement of DC and low frequency AC voltages in the microvolt and fractional microvolt regions. It is useful for the amplification of low level thermocouple voltages, infra red detectors, photovoltaic cells and the like. It can be used to replace suspension galvanometer systems.
2. This new amplifier (Model 10) features very high immunity to the effects of AC pickup in the input circuit. The discrimination ratio against 60 cycle pickup is over 1000. It has an improved life breaker. Convenient and accurate coarse and fine gain controls, zero position controls and calibration signals are provided.
3. This instrument has a zero stability of better than .005 microvolts per day after warm up. The noise level approaches the limit imposed by the Johnson noise of the external circuit. This amplifier is available for operation with input circuits from 0 to 1 megohms. The DC output of the amplifier is sufficient to operate standard recorders, milliammeters and DC relays. For 110 volts, 60 cycle operation.

Price $580.00

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Division of Atlas Coil Winders, Inc.

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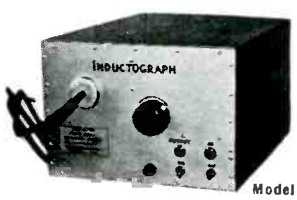
STAMFORD — CONNECTICUT

1 to 40 KV



Model 99

VARIABLE HIGH VOLTAGE RF POWER SUPPLY

Engineered with care and precision for the specific needs of Industrial users and Research Engineers in the fields of electrostatic painting, nuclear and research physics, insulation testing, precipitators, projection television, etc.

- Positive or Negative output, as specified
- AC stand-by switch —green
- High Voltage switch —red
- Variable voltage control knob
- All aluminum construction
- Focusing voltage control (Optional)
- Size—17 x 13 x 9"
- Tubes 1—5U4, 1—6L6, 1—1625, 3—1B3's

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Little-thought-of facts about capacitors

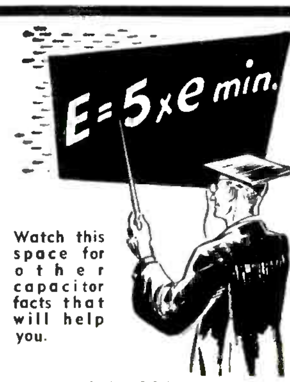
The short time breakdown voltage of a well-made D.C. capacitor is not less than 5 to 6 times the actual working voltage at 20°—

E = 5 × e min
E = Breakdown voltage
e = Rated d.c. working voltage

INDUSTRIAL CAPACITORS are unvaryingly held to this formula.

Designed for maximum safety factor and the smallest possible volume, INDUSTRIAL CAPACITORS are the most widely used capacitor in industrial applications.

WRITE TODAY FOR DETAILED CATALOG



Watch this space for other capacitor facts that will help you.

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We are interested in highly technical lines, such as electronics and machinery. Our firm has connections throughout the world. Correspondence invited from principals only.

Write to Box 6577, Electronics
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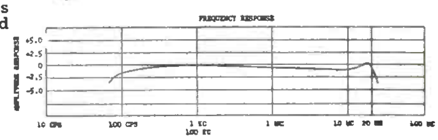
20 MC VIDEO AMPLIFIER
Model V

- Flat frequency response from 100 cps to 20 mc ± 1.5 db.
- Uniform time delay of .02 microseconds.
- Gain of 50 db.
- Frequency compensated high impedance attenuator calibrated in 10 db steps from 0-50.
- Fine attenuator covers a 10 db range.
- Phase Linear with frequency over entire band.

This unit is designed for use as an oscilloscope deflection amplifier for the measurement and viewing of pulses of extremely short duration and rise time, and contains the Video Amplifier Unit, Power Unit and a low Capacity Probe.



Specifications

Input Impedance: Probe—12 mmf + 470,000 ohms; Jack—30mmf + 470,000 ohms; Output Impedance 18mmf + 470,000 ohms each side push pull; Max. Input Volts 500 peak to peak with probe; Max. Output Volts 120 volts peak to peak (push pull); Power: 115 volts 50/60 cps AC Line; Size 19¼"x22"x14¾".

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100 Metropolitan Ave. Brooklyn 11, N. Y.

TELEVISION ENGINEERS and CONSULTANTS to the Nation's Leading Television Stations

BRAND-NEW!

- ★ Only two holes in chassis
- ★ Readily-wired lugs
- ★ 19/32" dia. 1½, 2, 2½ and 3" h.
- ★ 10, 15, 20 and 25 w.
- ★ Max. res. 6,000, 9,000, 12,000 and 15,000 ohms

STANDEE--ABOVE-CHASSIS-MOUNTED POWER RESISTOR . . .

★ Just what the underwriter ordered! Mounts ABOVE chassis. Takes heat out in the open. ⅝" hole clears terminals below. Mounting bracket takes self-tapping screw.

Wire winding on fibre-glass core, bent in hairpin with mica separator between legs, placed in ceramic tube filled and sealed with cold-setting inorganic cement.

★ **Write on business letter-head for literature, sample and quotations.**

CLAROSTAT Controls and Resistors

CLAROSTAT MFG. CO., INC. • DOVER, NEW HAMPSHIRE • In Canada: CANADIAN MARCONI CO., LTD. Montreal, P. Q., and branches

to deal in electronic materials and devices and to do research in radio and radar equipment. The firm will bid on government contracts for aeronautical research work.

CENTRALAB DIVISION OF GLOBE-UNION INC., Milwaukee, Wisc., recently acquired two buildings formerly occupied by the Eclipse Molded Products Co., Milwaukee, and will devote the space exclusively to the manufacture of electronic component parts.

CORNING GLASS WORKS, Corning, N. Y., has begun construction of a 300,000 sq-ft-floor-area plant in Albion, Mich., to provide additional manufacturing capacity for television glass requirements.

AIR KING PRODUCTS CO., INC., Brooklyn, N. Y., has acquired 40,000 additional square feet of space in the Kenyon Bldg., Brooklyn, N. Y., to expand production capacity for television receivers.

THE WORKSHOP ASSOCIATES, INC., Newton Highlands, Mass., has moved to a new building on Crescent Road, Needham Heights, Mass., to accommodate increased

Workshop Associates new building

research and development activities and to provide expanded production facilities for a new television antenna.

PERSONNEL

ROBERT A. STAREK, formerly commercial engineer for the radio tube division of Sylvania Electric Products, Emporium, Pa., was recently appointed field engineer of the division.

RICHARD G. LORRAINE, at one time engaged in the design and development of the network analyzer and later assigned to work on problems of utilizing atomic energy as a source of power in the production of

ELECTRONICALLY REGULATED

LABORATORY POWER SUPPLIES

• STABLE • DEPENDABLE • MODERATELY PRICED •

MODEL 28 STANDARD RACK MOUNTING

PANEL SIZE 5¼" x 19"
WEIGHT 16 LBS.

- **INPUT:** 105 to 125 VAC, 50-60 cy
- **OUTPUT #1:** 200 to 325 Volts DC at 100 ma regulated
- **OUTPUT #2:** 6.3 Volts AC CT at 3A unregulated
- **RIPPLE OUTPUT:** Less than 10 millivolts rms

For complete information write for Bulletin E8

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specialists in custom-built, ultra-precision

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KAHLE CUSTOM-BUILDS machines to make the exact tubes you require—from big 20-inchers to tiny sub-miniature—from laboratory types to those for high-speed production. Kahle puts each unit through exhaustive trial runs in our plant to assure trouble-free operation in yours.

We specialize in cost-cutting production-boosting, labor-saving equipment for complete manufacture of cathode ray tubes, standard, miniature and sub-miniature radio tubes, sub-miniature tubes, fluorescent lamps, photocells, x-ray tubes, glass products.

#1545 Neck Splicing Machine →
For all types and sizes of cathode ray tubes.

Used in salvage operations—bulb making. Essentially a vertical lathe, with two special chucks. Overall height 5'; overall diameter 3'6".

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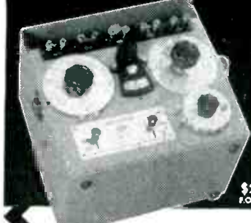

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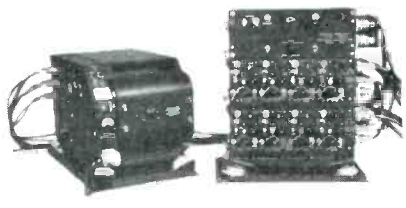

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electricity, was recently named head of a new project in the Knolls Atomic Power Laboratory, operated for the AEC as part of the GE Research Laboratory, Schenectady, N. Y.

NORMAN B. KRIM has been promoted from assistant vice-president and manager of the receiving tube division to vice-president in charge of the same division at Raytheon Mfg. Co., Waltham, Mass.

N. B. Krim

R. L. Harding

ROBERT L. HARDING, secretary of the National Telemetering Forum, has been promoted from project engineer to staff engineer of the products division of Bendix Aircraft Corp., South Bend, Ind.

THEODORE W. JARMIE, one of the original founders of Electronic Associates, Long Branch, N. J., has joined the Electronic Engineering Co. as resident project engineer at the Naval Air Missile Test Center, Point Mugu, Calif.

JOHN F. HARRIS, engaged in transformer engineering with the American Transformer Co. for the past 16 years, recently became chief transformer engineer at Langevin Mfg. Corp., New York, N. Y.

LAWRENCE HYLAND, vice-president in charge of engineering research at Bendix Aviation Corp., was recently awarded the Navy's distinguished public service award for his service to science and to the welfare of the U. S. through his contribution to the early development of radar.

G. PRYOR MOLLOY, formerly associated with RCA, has been named head of the field engineering department, Industrial & Electronics Division of American Structural Products Co., Columbus, Ohio.

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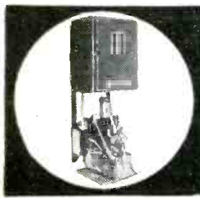

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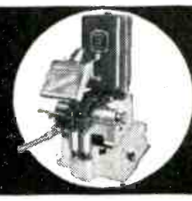

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vices as well. Yet there is today no good, concise, definition which meets all the usages commonly associated with the term.

While it is true that we have progressed thus far without a complete definition and that no insuperable obstacle to future progress may be interposed by its lack, it would still be a most valuable adjunct to activities dealing with the allocation of research tasks, research funds, scientific personnel and the like in almost any large-scale enterprise including in its scope the art or science of electronics. Its value in that connection is, of course, of secondary importance when compared with the feeling of satisfaction which would accrue to each and every one of us if he were able to point to a definition and say: "That's what I do!"

Consequently, a group of us has studied the available attempts at formulating such a definition and we present, humbly and without setting it up as a finished piece of work, the following version:

> Electronics The science and technology dealing with the emission, behavior and effects of electrons in gas-filled or vacuum tubes or with photoelectric, photoconductive, semiconductor or similar devices, and/or the control or production of electric or electromagnetic energy therefrom, (but excluding chemistry and power engineering).

We hope that this definition may be published in your columns with a request to the readers to comment, constructively, on its content. We should like to stress that it is not necessarily a complete nor all-inclusive definition but affirm that at the same time considerable thought has gone to the detailed wording therein so as to try to encompass most of the varied phases of electronics without including extraneous material. We believe that if the suggestions submitted by your readers are collated and combined to form a concise definition and published in ELECTRONICS it would go a long way towards filling this need and may then be considered an authoritative definition.

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(Continued on page 246)

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(Continued from page 244)

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Veteran. Over ten years' actual working experience (electronics, dielectrics, gas discharges, infrared, magnetic, servo-control, etc.). Testing, development, and research (experimental and analytical). Experienced in planning and completing projects and in directing personnel, also in discussing procurement of contracts with government agencies. Has acted as consultant for government agencies and industry.

Has been head of Physical Dept. of small research organization for past five years. Wishes to join an organization which can offer a future commensurate with his abilities. Competent and reliable. Solid scholastic background.

PW-6417, Electronics
330 W. 42nd St., New York 18, N. Y.

ELECTROMAGNETIC F FLOWMETER
Engineer Available

Thorough background for this device, including Original Experimental and Theoretical Work.

PW-6591, Electronics
520 N. Michigan Ave., Chicago 11, Ill.

Announcing Formation of New

SALES ENGINEERING AGENCY

for Industrial Electronic Components and Instruments covering Upper New York State.

Competent, experienced representation with established contacts.

Openings available for a very limited number of lines.

RA-6271, Electronics
330 W. 42nd St., New York 18, N. Y.

Manufacturer offers for sale complete inventory including finished equipment, dies, test equipment, engineering drawings and lab samples to manufacture television distribution system for apartment buildings. Operates by means of channel amplifiers utilizing 4-6AK5's per channel which feed coax cable with attenuating take-off at each set. Reason for sale—other products using full capacity.

BO-6385, Electronics
520 North Michigan Ave., Chicago 11, Ill.

PATENT AVAILABLE
Unusual Electrical Printing Technique

For column printing—potential speed is several thousand lines per minute. For communications—extremely simple teleprinting circuit and mechanism. *Basic protection involved; Inventor ownership—outright sale preferred.*

BO-6559, Electronics
330 W. 42nd St., New York 18, N. Y.

$20,000 IS LOOKING

for investment in growing business, manufacturing or assembling electronic equipment, especially industrial controls and devices; TV and UHF parts; Navigational and detectional aids; etc.

Write in Detail

BO-6551, Electronics
330 W. 42nd St., New York 18, N. Y.

CONTRACT
ENGINEERING—MANUFACTURING

electronic and electro-mechanical devices
- developed to meet your specifications
- manufactured per sample or drawings

TELETRONICS LABORATORY, Inc.
Westbury, L. I., N. Y.—Westbury 7-1028

"AN" "K" CONNECTORS

What Types Do You Need

LARGE QUANTITIES IN STOCK

WILGREEN
74 Cortland St. N. Y. 7, N. Y.
BA-7-4862

WESTINGHOUSE MOLYBDENUM STRIP SURPLUS CLOSE-OUT!

Coils of 1" x .005"; Quantity: 30 KG. Priced @ $28 Per KG FOB Your Plant. Also offer small lots of other similar items.

J. M. HIRSCH COMPANY
622 Washington Street
San Francisco 11, Calif.

VACUUM EQUIP'T.

- DIFFUSION PUMPS
- FORE PUMPS
- VACUUM GAUGES, etc.

Some Brand New—WRITE FOR LIST

ZENITH OPTICAL LAB.
123 W. 64 St., New York 23, N. Y.

#104 Universal Coil Winders
FOR SALE

Two 1946, Unused - Complete with Motors and Accessories

MILLER ELECTRIC CO.
32 River St. Pawtucket, R. I.

WHOLESALE ONLY

ELECTRONIC COMPONENTS
AIRCRAFT EQUIPMENT
HYDRAULICS

RADIO & ELECTRONIC SURPLUS
13933-9 Brush St. Detroit 3, Mich.
Phone Townsend 9-3403

FOR SALE! MAKE OFFER!

Just 300 complete BC-221 Frequency Meters, with tubes, crystal, calibration book. Splendid condition. Mail or wire your offer TODAY, to:

FS-6473, Electronics
330 W. 42nd St., New York 18, N. Y.

GIGANTIC SURPLUS EQUIPMENT MAIL SALE

Amazing Values: Gas engines, farm A-C power plants, farm compressors, weed spray booms, weed spray pumps, water systems, telephones, winches, AC and DC welders, tools, small engine clutch, burglar-fire alarms, etc. We pay freight. Rush card for sales catalog.

Burden Sales Co., 842 "O" St., Lincoln, Nebr.

A service to save you TIME and MONEY by locating your "HARD TO FIND" items and selling your "NON MOVABLE" surplus.

ATTENTION: We are instructed by our customers to PAY HIGHEST prices for all kind of CONDENSORS, RESISTORS. VOLUME CONTROLS, etc.

Don't hesitate to wire or write IMMEDIATELY.

ELECTRONIC SURPLUS BROKERS
3232 Broadway, N. Y. C. 27

COMMUNICATIONS EQUIPMENT COMPANY

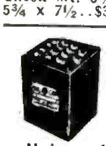
Birtcher Tube Clamps

926C
926-16
926-B1
926-B2
926-B8
926-C15
926-C-13
926B
926-C-19
926B-16
926A-14
926A
926C1
926A11
926-B31
926C-23
929-1
926B-10
926B-18
926-K2

Each 15¢
10 $1.40
100 $12.00

ARC/5 Switching Relay w/Ant current Ind. w/19.5 Millivolt Movement, current Xfrmr & Thermocouple 2.79

Yagi Switch encl in Jnct. Box 24 VDC for BC 929 Scope w/Toggle Sw. 6 Plugs, Shock Mt. 5¾ x 5¾ x 7½..$3.00



Universal Output Transformer

Amertran Silcor, PRI: 20,000/16,000/5000/4000 ohms. Sect. 500/15/7.5/5/3.75/1.25 ohms. 30 db. contin. Flat to 17,000 CY, w/ Diag. & Inst. for 6 watt amplifier $4.75

VIBRATORS

TR 1210, 12 vdc, 5 pin $1.00
OAK V-6675, 24-32 vdc, 7 pin $1.00
Mal. Type G534C, 12 vdc, 5 pin $1.00
Mal. Type G629-C, 12 vdc, 4 pin $1.00
Mfrs. quantities in all types available.

INTERPHONE AMPLIFIER
RL-7

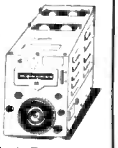
Convert to high fidelity phone Amp. or speech Amp. Complete with tubes and dynamotor, for 24 V. DC operation. Used but in good condition. SPECIAL PRICE $2.29

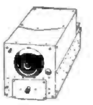
Heineman Ckt. Bkrs. for AC-DC Operation Amperes .010, 3, 7, 50, 80, 100, 150. Ea. $1.10
Klixon 25A, 5A 75¢

ARC/5 Xmtrs VFO Drivers
40 Watts Output

2.1—3 Mc	$6.95
3—4 Mc	8.95
7—9.1	6.95

Used Good Cond.





Superhet Recvrs
W/Dyn Used Good
Can be converted to 110v 60 cy.

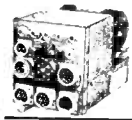
190-550 Kc	7.95
1.5-3 Mc	9.95
3-6 Mc	4.95
6-9 Mc	5.95

ARC-5 PARTS

80 Mtr. Xmitr. Conv. Kit	$1.50
Fuses, 10A, 3AG..	.04
Condenser Kit, 4-3X-.05 1-15 Mfd.	.59¢
Cond., .05-01-05..	.19
Cond., 3X1.05 ...	.19
Mod. Xfmr. 807 to Parlel 807	1.00
Xmttr. Rack	1.79
Shock Mts. Rec..	.29
Control Cable	1.19
Modulator, w/Dyn. & Tubes. New ...	7.95
Parasitic Suppressors	.10
Dial Plates, Rec. & Trans. 190-550 Kc	.10
Plates for Control Box, 190-550, 6-9.1..	.10
Kit of 2— 5 Mfd. Cond. 1—Choke 5634, 1—Trans. 692327-1, 1—Choke 5546 .	.98
Control Box Switch	.15
Neon Ind. Bulb..	.15
15 Mmf. Trimmer.	.15
Relay, 24V Dpdt..	.49
12SK7 Tube	.59
12SR7 Tube	.59
12A6 Tube	.29
12SF7 Tube	.59

PLUGS FOR ARC-5

9821, 8 Png, Fem.	.55
6418, 8 Png, Male.	.30
6577, 8 Png, Fem.	.55
5577, 6 Png, Male..	.30
PL154A, 12Png, Fem.	.55
PL154, 12 Png, Ma.	.45
W/15U, 16 Png, Fem.	.55
PL148A, 3Png, Fem.	.35
7027, 18 Png, Male	.30
PL147, 2 Png, Fem.	.50
6967, 5 Png, Fem.	.50
Small—3 Png Chassis, Female	.10
Large—3 Png Chassis, Female	.15
Chassis, 6 Png. Ma.	.15
7025, 12 Png, Male	.30
FB03442—5 Mfd.	.19
.85 Mfd., 600V....	.23
5413—3X .22 Mfd	.49
10247—.35 Mfd. .	.19

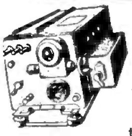


2 KVA: 90 130v input 50-60 cycles, output 115v 2 kva type RH Amertran ..$7.95

BC-603 FM Receiver Push-button 23-28 MC. Can easily be converted to 10 mtr. coverage (25-32 MC). Used. Good. Price $12.50

NAVY ARB RECEIVER

195 Kc thru 9 Mc. Includes broadcast band. Can be converted easily to a good ham receiver. 28 V. DC input. Covers 4 bands. This is a deluxe type super-het receiver. Note: The frequency coverage includes the standard broadcast band. Has 4-gang tuning condenser; can be converted to 110 V. AC receiver. Complete with tubes: 12SF7, 12SA7, 3—12SF7 and 12A6. Dial is built on front of chassis. Electric driven or Manual band change switch. Weight 28 lbs. Size 6" x 7" x 15". Complete with tubes and dynamotor. (Fair as is Cond.) $19.95



RU 19/GF11 or SCR 183 Recvr & Xmtrs Designed for Mobile and Aircraft 2000 to 9050 Kc for Xmting. 187-13950 for Recvg, Using T.U. 12-15 watt. Rec Less T.U..... 3.95
Xmtr Less T.U......... 3.95

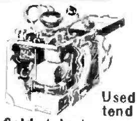
SCR 183 Rec Tuning Units
D Range 850-1330 KC
E Range 1330-2040 KC
F Range 2.04-3 MC
G Range 3-4.5 MC
H Range 4-6 MC
K Range 9.05-13.5 MC
Oval Range 400-600 KC
6-9 MC
1.79 ea.

SCR 183 XMTR TUNING UNITS

1-1.2 MC
1.2-1.5 MC
3.2-4 MC
5-6.2 MC } 1.49
4-5 MC w/4495 KC XTAL 2.79

WHOLESALE ONLY
Phone or Write for Quantity & Price
Digby 9-4124
ATT. MR. C. ROSEN

1,000,000	Bathtubs
4,000,000	Micas
300,000	Sil. Micas
100,000	Oil Cond.
4,000,000	Resistors
400,000	Electrolytics
400,000	H. V. Micas
5,000	K. V. Cond.
150,000	Prec. Resis.
500,000	Tube Clamps
1,000,000	An. Connectors
50,000	Dynamotors
20,000	Power Xfrmrs
20,000	Chokes
100,000	Antennas
50,000	Audio Xfrmrs
100,000	400 Cy Xfrmrs
100,000	Shock Mts.
25,000	Magnetrons
5,000	Magnets
50,000	Pulse Xfrmrs
50,000	Control Boxes
500,000	Tubes
300,000	Relays
500,000	Pots
35,000	Vibrators
200,000	UG Connectors
2,000	Scopes
1,500	Asst. Phones
20,000	Headsets
5,000	Mikes
100,000	Elements
Tons of	Nuts & Bolts Screws, Etc.
1,000	Gibson Girls
500	BC 375 Complete
500,000	Insulators
150,000	Binding Posts
200,000	Wafer Switches
300,000	Ceramicons
500,000	Ferrule Resis.
50,000	PL 54
25,000	JK 26



EE89A Telephone Repeater

Used to extend range of field telephones. Simplex Teleg. and 20 cycle ringing possible over lines equipped with unit. Supplied w/305 tube. Phone supplied. (Featherweight) $9.75

EE65E Telephone Test Set

To locate any kind of trouble on Tel lines; can be used as telephone. Includes ringing circuit etc. A valuable unit...$18.98

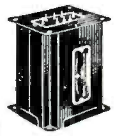
T.V. Transformer, 7" or 9" scope, 3000v/5MA, 720 vct/200MA, 6.4/8.7A, 6.4/6A, 5/3A, 1.25/3A, 115 V 60 cy input. Price $3.95

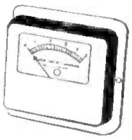
TIME DELAY RELAY VACUUM 45 Sec. 117v 60 cy Metal Tube, 4 Prong. Edison. Price $1.95

GE Relay Herm. Sealed CR2791 5 prong 5 Amp. Cont. SPDT $1.25

Special Xfmrs. 115v 60 cy.

36v/3.5A for Rect., etc........	2.75
24v/1.5A for ARC/S, etc........	1.95
2300v/4Ma, 2.5/2A	5.79
1080 Vct/55Ma, 2x6.3/1 2A......	4.49
720Vct/220Ma. 6.4/8.7A, 6.4/.6, 5v/3A, 1.25/.3A................	3.25





0-5 MA & 0-5 V Scale w/10V Movement 2" Metal Case Readrite Meter 98¢ ea. 10 for 9.00

FREQ METER CABINET For BC221 Wood. New $2.95

Special Chokes

10 HY 250 MA.	3.25
20 HY 300 MA.	6.49
6 HY 150 MA..	.99
25 HY 75 MA..	1.25
8.5 HY 125 MA.	1.29
11.5 HY 90 MA.	1.39
5 HY 150 MA...	1.45
Dual 7 & 11 HY. 9 MA	1.39
10 HY 450 MA.	11.95
5 HY 200 MA..	1.29
10 HY 500 MA	12.95

Many others. Write.

OIL CONDENSERS

Mfd.	Volt	Price
15	220AC	$2.20
.5.5	400	.50
1	600	.45
6	600	.98
7	600	1.05
.5	750AC	1.69
7	800	1.20
5	1K	.69
1.5	1K	.75
2	1K	.99
4	1K	.98
10	1K	1.95
15	1K	2.20
.25	1.5K	1.05
1	1.5K	.89
1.5	1.5K	.95
2	1.5K	1.05
6	1.5K	2.25
1	2K	.98
.1	2.5K	1.20
.15	4K	2.95
.1.1	4.8K	2.95
.4	5K	2.95
.1	6K	2.79
.15.15	6K	3.95
1.5	6K	9.75
.1.1	7K	3.39
.1	7.5K	2.95
1	7.5K	12.95
.15.15	8K	4.95
.1	10K	14.95
.0016	15K	7.95
1	15K	30.95
.015	16K	6.95
.25	20K	16.95
.5	25K	36.95
1	25K	83.95
4	50	.29
1	100	.15
2.5	100	.23

TU for BC 223
TU18A 3-4.5 Mc 2.50
TU25 3.5-5.2 Mc 2.50

BC-620 Mobile FM TRANSCEIVER — P.O. SCR-610. Includes 10 meter band. Excellent condition with tubes $15.95
PE-120 Power Supply and Tubes — Less vibrator and Cond. $5.50
Combination BC-620 and PE-120. Both for $20.95

FAMOUS MAKES BRAND NEW

200VDC		
2x.1	2ST	.15
2x.1	3TT	.15
2x1	4ST	.16
2	2ST	.20
.5	2TT	.15
.5	2ST	.15
400VDC		
2x.25	3ST	.21
2x.1	3ST	.21
2x.1	2TT	.20
3x.1	3ST	.25
.1	2TT	.19
.5	1TT	.19
1	2ST	.23
2	2ST	.26
600VDC		
.1	2BT	.20
.1	2ST	.21
2x.1	3ST	.27
2x.1	3BT	.25
2x.1	2ST	.26
3x.1	ST	.25
2x.25	3ST	.23
.25	2TT	.20
1	2ST	.30
2x1	3ST	.35
2	2ST	.40
2	2BT	.39
1000VDC		
1	2ST	.45

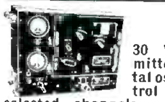
MANY OTHERS

BC-733D SUPERHET RECEIVER

w/10 Tubes, 6 Selector-Relays operates on Xtal Controlled Freq. 108.3-110.3 MC. Can easily be converted to 2 Mtr. ham bands 7.95 ea.

SCR 522 VHF XMTR-RCVR

10 Tube Xtal Controlled Revr, 7 Tube Xmtr. Makes ideal 2 Mtr. 2 way mobile rig for Cabs. etc. 100-156 MC w/Tubes 33.95



BC 223 XMITR

30 Watt Transmitter with crystal oscillator control on four preselected channels — also master oscillator. Frequency coverage 2000 KC, to 5250 KC, by use of three plug in coils. Five tube operation, 801 oscillator, 801 power amplifier, two 46 modulators, and one 46 speech amplifier. Price with TU-17 Tuning Unit, 2000 to 3000 KC 32.95

GIBSON GIRL

The Emergency Radio Transmitter. Sends S O S signals automatically on 500KC. 150-mile range. No batteries required. Has hand-driven generator, tubes, wire. New. It's only.....$3.49

ARC 3 MINIATURE RELAYS

Can SPDT 5 Prong. GECR2791C104 1.95

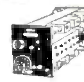
SPDT,	28 vdc	300	RBM55342	35¢
6PST	22-28 vdc	300	RBM5528	35¢
SPST	22-28 vdc	300	RBM55251	35¢
DPDT, DPST	22-28 vdc	300	RBM55531	35¢
SPDT,	22-28 vdc	300	RBM55526	35¢

Ceramicons

Mmf	
1	25
3	27
3.1	35
4	30
5	47
6	50
7	57
8.5	58
11	60
15	62
20	67
24	70
79	220
115	240
125	250
150	350
180	1000
200	
100	750

Feed Button Thru

40	100	50
180	200	
175	500	470
185	100	950



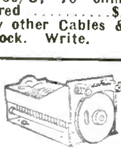
ARR2 Homing Rec.
334-358 MC w/Dia. To convert to 2 Mtrs. w/Dyn... 5.75

R5/ARN 7 Compass Rec.
ADF Rec. 100 to 1750 KC. in 4 Bands 5-Gang Tuning Capacitor w/15 Tubes, 4-6K7, 1-6L7, 1-6J5, 2-6B8, 2-6F6, 1-6N7, 1-6SC7, 2-2051, 1-524. Excellent $35.00 Good ... 30.00

Control Remote For Above $4.49

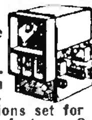
COAX CABLE

RG 8/U, 52 ohm..........
RG 9/U, 52 ohms..$.25/Ft.
RG 57/U, Twin Cond. 95 ohms ....$.55/Ft.
RG 23/U, twin coax. 125 ohm imp. armored.$.50/Ft.
RG 28/U, 50 ohm imp. pulse cable Corona min. starting voltage 17 KV $.50/Ft.
RG 35/U, 70 ohm imp. armored ....$.50/Ft.
Many other Cables & Wire in stock. Write.



7324—Variable Cond	.95
7321—Variable Cond	1.95
5032—Variable Cond	1.25
6558—Variable Cond	1.95
5546—Rec. Choke Assy., RF	.49
5634—Rec. Choke Assy., AF	.49
6385—Relay Spst. ..	.69
MC211A—Right Angle Drive	39¢

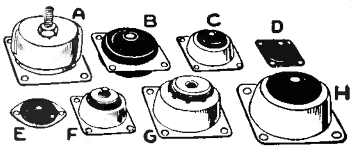
BC-605 Interphone Amplifier



Easily converted to an ideal Inter-Communications set for office-home-or factory. Original. New w/conversion Diagram $4.75

MOUNTINGS

FT 234A For 274N Trans
FT 232A For 274N Trans
FT 229A For 274N, BC442
FT 225A For 274N, BC456
MT 62 For ARC/5, ARR2
MT 78/ARC5 Control Unit
MT 85/ARC5 Junction Box
FT 141 6⅜x1⅜
MT 80 ARC5 Junction Box
FT 282A P/o SCR 518A
FT 308A P/o PE119A
MT 167/U SAR
FT 340 P/o SCR 540
FT 265A P/o BC-701
MT 171A/U SAR
MT 7/ARR2 R4/ARR2
MT 5/ARR2 6¾x10¾
Write for Many Others



SHOCK MOUNTS

D	Lord	#1	1 1/4x1 1/4x3/8H	10¢
D	Lord	#6	1 1/4x1 1/4x3/8H	10¢
D	Lord	#5	1 1/4x1 1/4x3/8H	10¢
B	Lord	#15	1 3/4x1 3/4x5/8H	15¢
B	Lord	#12	1 3/4x1 3/4x9/16H	15¢
B	Lord	#35	2 1/4x2 1/4x1"H	18¢
C	U. S.	#5150-C	2 3/8x2 3/8x1 1/8H	55¢
C	Lord	#4	1 23/32x1 23/32x1"H	35¢
C	Lord	#1	1 11/16x1 11/16x3/4"H	14¢
C	Lord	#10	2 3/8x2 3/8x1 1/16H	25¢
C	Lord	#8	2 3/8x2 3/8x1 1/16H	20¢
H	Lord	#35	3x3x1 1/2H	45¢
H	Lord	#20	3x3x1 5x8H	39¢
H	Lord	#25	3x3x1 5/8H	45¢
H	Henrite	#55	3x3x1 5x8H	49¢
H	Lord	#15	3x3x1 1/2H	35¢
H	Lord	#45	3x3x1 1/2H	49¢
A	Barry	#C2070	3x3x1 1/2H	55¢
A	Barry	#C2060	3x3x1 1/2H	55¢
A	Barry	#C2090H	3"x3"x1 1/2H	55¢

Shaft 6 1/8"Lx3/8" Dia. Thread both sides with nuts, washer, and two woven leads..........ea. 35¢

WRITE FOR TYPES NEEDED

MICA CAPACITORS
SOLAR XMB—TAPPED HOLES

Mfd.	Price
2500 V Test	
.00001	$.35
.000025	.35
.00003	.35
.00005	.35
.000075	.35
.0001	.35
.00015	.35
.00025	.35
.0003	.35
.0004	.35
.0005	.40
.00075	.40
.00085	.40
.001	.50
.0015	.50
.0016	.50
.0017	.55
.002	.65
.0023	.65
.003	.75
.004	.95
.005	.95
.006	.98
.0063	.98
.0069	.98
.007	.98
.0075	.98
.0076	.98
.008	1.05
.01	1.25
.015	1.25
.02	1.30
.025	1.30

Mfd.	Price
.027	1.35
.03	1.45
5000 V Test	
.0015	1.75
.002	2.00
Solar XQ Solder Lugs 2500 V Test	
.01	1.25
.015	1.30
.02	1.50
.04	1.75
.001	.60
.0015	.60
.002	.75
.0022	.75
.0023	.75
.0024	.75
.0025	.75
.0027	.80
.003	.80
.004	.85
.005	.90
.0056	.95
.006	.95
.0063	.95
.0075	1.00
.0076	1.00
.008	1.05
.0085	1.20
.0005	.60
.00085	.70
.00015	.60

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1000000 IN STOCK

COMPLETE LINE OF RECTIFIERS

SEND YOUR SPECS

Line FILTER, GE 100 Amp Filter w/2x5Mfd 50V oil cond. Operates on 110V AC DC $1.98

KW LINE FILTER clean up BCI & TVI. With 4-.002 Mfd. Cond. Easy to Mount.... $3.95

RUBBER COVERED CABLE

4⅛ ft long w/red, blk. & white leads for Mike or Hdset .... 12¢
10 for........ $1.00

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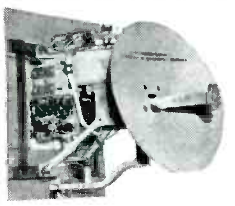
COMMUNICATIONS EQUIPMENT CO.

131 Liberty St., New York, N. Y. Dept. E-6 MR. CHAS. ROSEN **Phone: Digby 9-4124**

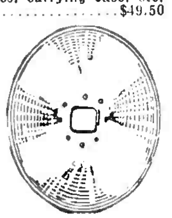
COMMUNICATIONS EQUIPMENT COMPANY

MICROWAVE ANT — RF EQUIPMENT

MICROWAVE ANTENNAS



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-122 Dipole Assy....$22.50
LP-21-A ADF Loop W-Selsyn and Housins, New $8.00
DAK Bellino Tossi DF Loops....$125.00
Adcock DF Arrays. Complete....$65.00
SA Radar 200 Mc Bed Springs. Complete with Pedastee, Less Drive....$600.00
APS-15 Antennas. New....$99.50
AN MPG-1 Antenna. Rotary feed type high speed scanner antenna assembly, including horn parabolic reflector. Less internal mechanisms. 10 deg. sector scan. Approx. 12'L x 4'W x 3'H. Unused. (Gov't Cost—$4500.00)....$250.00
AN/TPS3. 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: 4' x 3' rectangle, now....$35.00
TDY "JAM" RADAR ROTATING ANTENNA, 10 cm. 30 deg. beam, 115 v.a.c. drive. New....$100.00
DBM ANTENNA. Dual, back-to-back parabolas with dipoles. Freq. coverage 1,000-4,500 mc. No drive mechanism....$65.00
AS125/APR Cone type receiving antenna. 1030 to 3208 megacycles. New....$4.50
140-600 MC. CONE type antenna, complete with 25 sectional steel mast, guys, cables, carrying case, etc. New....$49.50
ASD 3 cm, antenna, used, ex. cond....$49.50
YAGI ANTENNA AS-46A, APG-4, 5 elements....$14.50
Dish for Parabola 30"..$4.85
AS17/APS 10 CM Antenna. APS-2 30 Inch Dish with ⅞ Coax Dipole and fittings. New and Compl. with 24 V DC Drive motor, selsyn. 360 Deg. Rotation and Vertical Tilt....$94.50
RC-224 Antenna, 10 CM, 30" Dish P/O. SCR-717 Radar, New and Complete...$94.50



R. F. EQUIPMENT

LHTR. LIGHTHOUSE ASSEMBLY. Part of RT-39/APG 5 & APG 15. Receiver and Trans Cavities w/ assoc. Tr. Cavity and Type N CPLG. To Revr. Uses 2040, 2C43, 1B27. Tunable APX 2400-2700 MCS. Silver plated....$49.50
APS-2 10CM RF HEAD COMPLETE WITH HARD TUBE (715B) Pulser. 714 Magnetron 417 A Mixer all ⅞" rigid coax. incl. revr. front end....$210.00
Beacon lighthouse cavity 10 cm with miniature 28 volt DC FM motor. Mfg. Bernard Rice....$47.50 ea.
T-128-/APN-19 10 cm. radar Beacon transmitter package. Used, less tubes....$59.50 ea.
Pre-Amplifier cavities type "M" 7410590GL, to use 446A lighthouse tube. Completely tunable. Heavy silver plated construction....$37.50 ea.
RT/32APS 6A RF HEAD. Compl. with 725A Magnetron magnet pulse xfmr. TRA-ATR 723 A/B local osc. and beacon mount, pre amplifier. Used but Good cond....$97.50
AN/APS-15A "X" Band compl. RF head and mod. incl. 725-A mag and magnet, two 723A/B klystrons (local osc. & beacon) 1824. TR, revr and ampl. duplexer, HV supply blower, pulse xfmr. Peak Pwr. Out: 45 KW apx. input: 115, 400 cy, Modulator pulse duration .5-2 microsec., apx. 13KV. PK. Pulse, with all tubes incl. 715B, 829B, BKR 73, two 72's. Complete pkg....$350.00
S BAND AN/APS2. Complete RF head and modulator, including magnetron and magnet. 417A mixer. TR receiver duplexer, blower, etc., and complete pulser. With tubes, used, fair condition....$75.00
ASB-500 Megacycles Radar Receiver with two GI 446 lighthouse cavities, new less tubes....$37.50
10 CM Rec Assy. Less Local OSC. Tube. Consists of mixer stabilizer cavity 30 MC preamp AFC. Inc. Amp. plugs & cables p/o APS2....$37.50
#SCR-520 RF Head Compl. with Hard Tube Pulser c/o 2 Aluminum Drums MTD. In Tandem. Compl. w/Tubes....$350.00
Mark 4 Radar Console (FD) Compl. "L" Band RF Pkg. c/o Magnetron CSC, Pulser, Revr. H.V. Power Supply. Complete....$850.00 115 V. 60 cy. operation.

PULSE EQUIPMENT

MIT MOD. 3 HARD TUBE PULSER: Output Pulse Power 144 KW (12 KV at 12 Amp). Duty Ratio: 001 max. pulse duration: 5, 1.0, 2.0 microsec. Input voltage: 115v. 400 to 2400 cps. Uses 1-715B, 4-829-B, 3-72's, 1-'73. New w/Tubes....$110.00
APQ-13 PULSE MODULATION. Pulse Width .5 to 1.1 Micro Sec. Rep. rate 624 to 1348 Pps. Pk pwr. out 35 KW Energy 0.018 Joules....$49.00
TPS-3 PULSE MODULATOR. Pk power 50 amp. 24 KW (1200 KW pk); pulse rate 200 PPS 1.5 microsec. pulse line impedance 50 ohms. Circuit series charging version of DC Resonance type. Uses two 705-A's as rectifiers. 115 v. 400 cycle input. New with all tubes....$49.50
APS-10 MODULATOR DECK. Complete, less tubes....$75.00
APS-10 Low voltage power supply less tubes....$18.50
BC 1203B Loran pulse modulator....$125.00
BC 758A Pulse modulator....$395.00
725A magnetron pulse transformers....$18.50 ea.

MAGNETRONS

Ask for Qty. Price

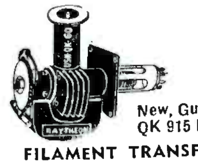
Tube	Frq. Range	Pk. Pwr. Output	Price
2J27	2865-2992 mc.	275 KW.	$8.50
2J31	2820-2860 mc.	265 KW.	$25.00
2J21 A	9345-9405 mc.	50 KW.	$25.00
2J22	3267-3333 mc.	265 KW.	$25.00
2J26	2992-3019 mc.	275 KW.	$25.00
2J27	2965-2992 mc.	275KW.	$8.50
2J32	2780-2820 mc.	285 KW.	$25.00
2J37			$45.00
2J38 Pkg.	3249-3263 mc.	5 KW.	$35.00
2J39 Pkg.	3267-3333 mc.	87 KW.	$35.00
2J40	9305-9325 mc.	10 KW.	$65.00
2J49	9000-9160 mc.	58 KW.	$85.00
2J34			$55.00
2J61	3000-3100 mc.	35 KW.	$65.00
2J62	2914-3010 mc.	35 KW.	$65.00
3J31	24,000 mc.	50 KW.	$55.00
5J30			$39.50
714AY			$25.00
718DY	2720-2890 mc.	250 KW.	$25.00
720BY	2800 mc.	1000 KW.	$50.00
720CY	2860 mc.	1000 KW.	$50.00
725-A	9345-9405 mc.	50 KW.	$25.00
730-A	9345-9405 mc.	50 KW.	$25.00
728	AY, BY, CY, DY, EY, FY, GY		$50.00
700	A, B, C, D		$50.00
706	AY, BY, DY, EY, FY, GY		$50.00
Klystrons. 723A/B $12.50; 707B W/Cavity			$20.00
417A $25.00		2K41	$95.00

MAGNETRON MAGNETS

Gauss	Pole Diam.	Spacing	Price
4650	¾ in.	⅝ in.	$12.50
5200	21/32 in.	¾ in.	$17.50
1300	1⅝ in.	1 5/16 in.	$12.50
1860	1⅝ in.	1½ in.	$14.50

Electromagnets for magnetrons....$24.50 ea.
GE Magnets type M7765115, GI Distance Between pole faces variable. 2 5/16" (1900 Gauss) to 1½" (2200 Gauss) Pole Dia. 1⅝" Now Part of SCR 584..$34.50

"CW" MAGNETRONS

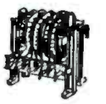


QK 62	3150-3375 mc	
QK 59	2675-2900 mc	
QK 61	2875-3200 mc	
QK 60	2800-3025 mc	

New, Guaranteed Each $65.00
QK 915 Raytheon....$150.00

FILAMENT TRANSFORMER

for above 115V/60 cy Pri; four 6.3V/4A Sec. 50000VT....$27.50
Magnetron Kit of four QK's 2675-3375 inc. w/transformer....$250.00



PRECISION CAPACITORS

D-163707: 0.4 mfd @ 1500-vdc. —50 to plus 85 deg. C....$4.50
D-163035: 0.1 mfd @ 600 vdc. 0 to plus 65 deg. C.$2.00
D-170803: 0.152 mfd. 300 v. 400 cy. —50 to plus 85 deg. C....$2.00
D-164960: 2.04 mfd @ 200 vdc. 0 to plus 55 deg. C $2.50
D-163344: 2.16 mfd @ 200 vdc. 0 to plus 55 deg. C $3.00
D-161555: .5 mfd @ 400 vdc. —50 to plus 85 deg. C....$3.00
D-161270: 1 mfd @ 200 vdc. temp comp —40 to plus 65 deg. C....$12.50

30 US ARMY SIGNAL CORPS RADIO MASTS

Complete set for erection of a full flat top antenna. Of rugged plymold construction telescoping into 3 ten-foot sections for easy stowage and transportation. A perfect set-up for getting out. Supplied complete: 2 complete masts, hardware, shipping crate. Shipping wt. approx. 300 lbs. Sig Corps #2A289-233-A. New....$39.50 per set

YD-2 MARKER BEACON EQUIP. Compl. installation in Trailer w/Gas Generator—WRITE.

PULSE TRANSFORMERS

G.E.K.-2745....$39.50
G.E.K.-2744-A. 11.5 KV High Voltage. 3.2 KV Low Voltage @ 200 KW oper. (270 KW max.) 1 microsec. or ¼ microsec. @ 600 PPS....$39.50
W.E. #D166173 Hi-Volt input transformer. W.E. Impedance ratio 50 ohms to 900 ohms. Free range: 10 kc to 2 mc. 2 sections parallel connected. potted in oil....$36.00
W.E. KS 9800 Input transformer. Winding ratio between terminals 3-5 and 1-2 is 1.1:1. and between terminals 6-7 and 1-2 is 2:1. Frequency range: 380-520 c.p.s. Permalloy core....$6.00
G.E. #K2731 Repetition Rate: 635 PPS. Pri. Imp: 50 Ohms Sec. Imp: 450 Ohms. Pulse Width: 1 Microsec. Pri. Input: 9.5 KV PK. Sec. Output: 28 KV PK. Peak Output: 800 KW. Riflar 2.75 Amp....$64.50
W.E. #D169271 Hi Volt input pulse Transformer $27.50
G.E. K2450A. Will receive 13 KV. 4 micro-second pulse on pri., secondary delivers 14KV. Peak power out 100KW G.E....$34.50
G.E. #K2748A. Pulse Input. line to magnetron..$36.00
#9262 Utah Pulse or Blocking Oscillator XFMR Freq. limits 790-810 cy-3 windings turns ratio 1:1:1 Dimensions 1 13/16 x 1⅛" 19/32....$1.50
Pulse 131-AWP L-421435....$6.00
Pulse 134-BW-2F L-440805....$2.25
RAY—WX-4298F....$39.50
G.E.—K6324730....$50.00
G.E.—K921945....$50.00

PULSE NETWORKS

15A—1-400-50: 15 KV. "A" CKT. 1 microsec., 400 PPS. 50 ohms imp....$42.50
G.E. #6E3-5-2000-50P2T. 6KV, "E" circuit. 3 sections, .5 microsecond, 2000 PPS, 50 ohms impedance....$6.50
G.E. #3E (3-84-81C: 8-2-24-405) 50P4T; 3KV, "E" CKT Dual Unit: Unit 1, 3 Sections, .84 Microsec. 810 PPS. 50 ohms imp.: Unit 2. 8 Sections. 2.24 microsec. 405 PPS, 50 ohms inp....$6.50
7.5E3 1-200-67P 7.5 KV. "E" Circuit. 1 microsec. 200 PPS, 67 ohms impedance. 3 sections....$7.50
7.5E4-16-60.67P. 7.5 KV. "E" Circuit. 4 sections. 16 microsec. 60 PPS, 67 ohms impedance....$15.00
7.5E3-3-200-6PT. 7.5 KV, "E" Circuit. 3 microsec. 200 PPS, 67 ohms imp., 3 sections....$12.50

DELAY LINES

D-163169 Delay Line Small quantity available..$50.00
D-168184: .5 microsec. up to 2000 PPS, 1800 ohm term....$4.00
D-170499:.25/.50/.75 microsec. 8 KV. 50 ohms imp....$16.50
D-165997: 1¼ microsec....$7.50

SONAR

QCU Magneto striction head RCA type CR 278225—New....$95.00
Stainless Steel streamlining housings for above..$18.50
QBG Driver Amplifier. New....$200.00
QCU Magneto striction head, coil plate assembly, new....$14.50
QCQ-2/QCS Magneto striction head coil plate assembly....$14.50
QCQ2 Sonar complete set—Write for details.
QC-RCA magneto striction head assy. consists of coil. plate, nickle diaphragm plate, milled steel body unassembled....$65.00
Supersonic Oscillator RCA 17-27 Kc. Rec. Driver. Csc. 116 v 60 cy. AC. Designed for use w/200 watt driver. New less tubes....$39.50
WEA-1 Console. Consists of Rec. Ind. Osc. Remote training control 200 watt driver amp. 17-27 kc range....$450.00
QCQ 2 Console Sub. Sig. Co....$450.00
QBF Sonar mfg. WE complete console consists of 10-40 kc rec. driver osc. ind. & control unit, and driver amplifier. 22-28 kc. Write
QJA Sonar QBF w/QJA adaptor kits w/cathode ray tube indication. Write
QCQ-2 Sonar Compl. Less Hoist—Write

I.F.F.

1 KW Pulsed Output Pkg. Tunable 154-186 mc. adj. modulating pulses 4-10 micro sec. comp. 115v 60cy ac pwr. supply.
Video output receiver. New w/tubes....$350.00
Wavemeter for above....$75.00
Dipole Array for above....$85.00
BC 800 XMTR. RCVR. Unit New....$55.00
BC 929 Indicator New....$35.00

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RADAR SETS

SCR 663-T3 Sperry searchlight training, aircraft, tracking, 10 CM 360° horizontal sweep 90° vert. sweep. Used $450.00
APS15 Consists of transmit., mod. rec. ind. ant., 400 cy pwr unit, less control boxes & cable, new .. $400.00
Mark 8 Model 2 Gyro stable element designed for use in stabilizing large caliber naval gun $2,500.00

APS-2	Airborne	10 CM, Major Units	New
APS-4	Airborne	3 CM, Compl.	Used
APS-15	Airborne	3 CM, Major Units	New
SD-4	Submarine	200MC, Compl.	New
SE	Shipboard	10 CM, Compl.	New
SF-1	Shipboard	10 CM, Compl.	New
SJ-1	Submarine	10 CM, Compl.	Used
SL-1	Shipboard	10 CM, Compl.	Used
SN	Portable	10 CM, Compl.	Used
SO	Portable	10 CM, Compl.	Used
SO-1	Shipboard	10 CM, Compl.	Used
SO-8	Shipboard	10 CM, Compl.	Used
Mark 4	Gunlaying	800MC, Less Ant.	Used
Mark 10	Gunlaying	10 CM, Compl.	New
		Less Rack	New
		Less Rack	Used
CPN-3	Beacon	10 CM, Major Units	Used
CPN-6	Beacon	3 CM, Complete	New
CPN-8	Beacon	10 CM, Complete	New
		Less Ant.	New
SCR-533	IFF/AIR Search Tracer	500MC,	New
Airborne Radar Altimeter		500MC, Complete	New
		WRITE FOR INFO.	

200 MC COAXIAL PLUMBING

Right Angle Bend $35.00
T Section $55.00
T Section with Adapter to 7/8" in rigid coax $65.00

X BAND

Cross gd. Directional coupler 20db Mounted on 90° bend $14.50
90° H Plane 4" Radius Cover to Cover $8.00
Directional coupler, UG-40/U take off, 20 DB ... $17.50
Directional coupler, APS-6, Type "N" take off, 20 DB, calibrated 17.50
Broad Band Directional coupler, type "N" take off, choke to cover, 23 DB, calibrated 18.50
Directional coupler, APS-31, type "N" take off, 28 DB 17.50
Bi-directional coupler, type "N" take off 22.50
Flexible Section 18" long 12.00
Straight Sections 2½ ft. long choke to cover, silver plated 6.50
Pressure Test Section with 15 lb. gauge and pressurizing nipple 10.00
Bulk Head Feed Through, choke to cover 12.00
Mitered Elbow, choke to cover or choke to choke .. 12.00
Right Angle Bend 2½" Radius, choke to cover ... 12.00
90° Twist, 6" long 7.50
45° Twist, 6" long 7.50
90° Twist, 5" long with pressurizing nipple 7.50
15° Bend 10", Choke to cover 4.50
5 ft. Sections UG-39 to UG-40, silver plated 9.50
180° Bend, 26" Choke to cover 2½" radius 5.00
SWR Measuring Section 4" long, 2 type "N" probes mounted full wave apart 1¼ x 5/8" guide 8.50
WE attenuator 0 to 20 DB, less cards, bell size guide 12.50
90° Bend E Plane 18" 4.00
Rotary Joint, choke to choke 10.00
Rotary Joint, choke to choke with deck mounting 10.00
TR-ATR Duplexer Section for 1B24 and 724B ... 12.50
Wavemeter-Thermistor MTG Section 6.00
2K25/723 AB Receiver, Local Oscillator Klystron Mount, complete with Crystal Mount, Iris Coupling and Choke Coupling to TR 22.50
TR-ATR Duplexer Section for above 8.50
723AB Mixer—Beacon Dual Oscillator Mount with Crystal Holder. Used 12.00
723AB Mixer—Beacon Dual Oscillator Mount with Matching Slugs and tunable termination, new .. 24.50
Bi-Directional Coupler, type "N" termination, 26 DB, calibrated, 1¼ x 5/8" guide 24.50
12" Flexible Section 1¼ x 5/8" guide 10.00
Crystal Mount in Waveguide 17.50
SO-3 Echo Box, Transmission type cavity with bellows 28.50
180° Bend with pressurizing nipple 5.00
"S" Curve 18" long 5.00
"S" Curve 6" long 3.25
APS-31 Mixer Section for mounting two 2K25s, Beacon Reference Cavity, 1B24 TR Tube 42.50
Transition 1 x ½ to 1¼ x 5/8", 14" long 8.00
Receiver Front End, complete, C/O Dual 723AB Klystron mount, TR-ATR Duplexer Section, 2 stage 30 MC. Preamplifier, new, with ALL tubes ... 59.50
Random Lengths of Waveguide 6 to 18" long .... 1.00 per ft.

MICROWAVE COMPONENTS

THERMISTORS

D-167332 (tube) .... $.95
D-170396 (bead) .... $.95
D-167613 (button) .. $.95
D-167018 (tube) .... $.95
D-164699 .... $2.50

VARISTORS

D-170225 .... $1.25
D-167176 .... $.95
D-168087 .... $.95
D-171812 .... $.95
D-171528 .... $.95
D-168687 .... $.95
D-165593 .... $3.00
D-168392 .... $1.25
D-99946 .... $2.00
D-161871A $2.85
D-171121 .... $.95
D-162356 .... $2.25
D-162708 .... $3.00
D-98836 .... $2.25

WRITE FOR C.E.C. MICRO-WAVE CATALOG NOW AVAILABLE

S BAND

90° Twist, circular cover to circular cover $25.00
Magnetron to Waveguide Coupler with 721A Duplexer Cavity, gold-plated $45.00
Waveguide Switch—Transposes one input to any of three outputs. Standard 1½" x 3" square flanges. Complete with 115V drive motor. Raytheon CET24AAS, new $150.00
721A TR Box complete with tube and tuning plungers $12.50
McNally Klystron Cavities for 707B or 2K28. Three types available $4.00
Right Angle Bend 5½ ft. over-all with 8" slotted section $21.00
Pick-up Dipole in Lucite Ball with Sperry Fitting $4.50
F-29/SPR-2 Filters, Type "N", input and output $12.50
726 Klystron Mount, Tunable output, to type "N", complete, with socket and mounting bracket $12.50
WAVEGUIDE TO 7/8" RIGID COAX "DOORKNOB" ADAPTER, CHOKE FLANGE, SILVER PLATED BROAD BAND $32.50
WAVEGUIDE DIRECTIONAL COUPLER, 27 db, Navy type CABV-47AAN, with 4 in. slotted section .. $32.50
SQ. FLANGE to rd choke adapter, 18 in. long OA 1½ in. x 3 in. guide, type "N" output and sampling probe $27.50
Crystal Mixer with tunable output TR pick up loop, Type "N" connections. Type 62ABH $14.50
Slotted line probe. Probe depth adjustable, Sperry connector, type CPR-14AAO $9.50
Coaxial slotted section, 5/8" rigid coax with carriage and probe $25.00
Right Angle Bend 6" radius E or H plain $27.50
Right Angle Bend 3" radius E or H plain—Circular flanges $17.50
AN/APR5A 10 cm antenna equipment consisting of two 10 CM waveguide sections, each polarized, 45 degrees .... $75.00 per set
PICKUP LOOP, Type "N" Output $2.75
TR BOX Pick-up Loop $1.25
POWER SPLITTER: 726 Klystron Input dual "N" output $5.00
"S" BAND Mixer Assembly, with crystal mount, pick-up loop, tunable output $3.00
721-A TR CAVITY WITH TUBE. Complete with tuning plungers $12.50
10 CM OSC. PICKUP LOOP, with male Homedell output $2.00
10 CM FEEDBACK DIPOLE ANTENNA, in lucite ball, for use with parabola 7/8" Rigid Coax Input $8.00
PHASE SHIFTER, 10 CM WAVEGUIDE, WE TYPE FS-683816, E PLANE TO H PLANE, MATCHING SLUGS, MARK 4 .... $95.00
721A TR cavities. Heavy silver plated .... $2.00 ea.
Coax Xtal Mount for Type "N" tunable $15.00
10 CM Mixer $3.00

7/8 Rigid Coax

Directional coupler, Type "N" take off $22.50
Magnetron Coupling with TR Loop, gold-plated .. $7.50
Flexible Section Male to Female $4.50
Right angle bend 15" over-all $3.50
Sperry Rotating Bend, pressurized $22.50
5 Ft. Lengths Stub Supported, gold-plated, per length 7.50
Short Right Angle Bends (for above) $2.50
Rigid Coax to Type "N" Adapters $18.50
Test Block CU-60/AP $8.00
CG-54/U—4 foot flexible section ¼" IC pressurized $15.00
7/8 RIGID COAX, Bead Supported ¼" I. C. $1.20
SHORT RIGHT ANGLE BEND ¼" I.C. $2.50
Rotating joint, with deck mounting ¼" I. C. ... $15.00
7/8 Rigid Coax Coupler $17.50

COUPLINGS—UG—CONNECTORS

UG/15U	$ .75	UG 116 Cover & Coupling Ring	$1.95
UG206U	.90	UG 117 Choke	2.50
UG87U	1.25	UG 51 Cover	1.00
UG27U	1.69	UG 52 Choke	1.35
UG21U	.89	UG 210 Cover	1.85
UG167U	2.25	UG 212 Choke	2.40
UG29U	.90	UG 40U Special for Duplexer	.70
UG254U	1.69	7/8 Coax Female Ring Thd or unthd	.50
UG86U	1.40	7/8 Coax Male Fitting thd or unthd	.95
UG342U	3.25	X Band Circ. Choke Flange	.50
UG85U	1.45	X Band Flat Contact Flange 1/8 Thk	.25
UG58U	.60	Contact Ring ¼" Thk 1 3/8 dia. hole	.25
UG9U	.89	UG 53/U, Cover	$4.00
UG102U	.45	UG 54/U, Choke	4.75
UG103U	.45	UG 55/U, Cover	4.00
UG255U	1.65	UG 56/U, Choke	4.75
UG 40/U Speci. for Mixer Assy.	$ .75	UG 65/U, Contact	6.50
UG 40A	1.10	UG 149/U, Cover	3.00
UG 343 Cover	2.35	UG 148/U, Choke	4.00
UG 344 Choke	3.00	UG 150/U, Contact	3.00
UG 425 Contact	2.00	UG 39/U, Cover	.60
		UG 40/U, Choke	.80

Various other types available. Write us your needs.

RADAR TEST EQUIPMENT

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APS-34 Rotating Joint $49.50
Right Angle Bend E or H Plane: specify combination of couplings desired $12.00
45° Bend E or H Plane, Choke to cover $12.00
Directional coupler CU-103/APS 32 .... $49.50
Mitered Elbow, cover to cover $4.00
TR-ATR Section, choke to cover $4.00
Flexible Section 1" choke to choke $5.00
"S" Curve choke to cover $4.50
Adaptor, round to square cover $5.00
Feedback to Parabola Horn with Pressurized window $27.50
Low Power Load, less cards $18.50
K Band Mixer Block $45.00
Waveguide ½ x ¼" .... $1.00 per ft.
Circular Flanges .... $ .50
Flange Coupling Nuts .... $ .50
Slotted line, Demornay-Budd #397, new $450.00
90° Twist $10.00
"K" Band Directional Coupler CU 104/APS-34 20 DB .... $49.50 ea.

TEST EQUIPMENT

CG-176/AP Directional coupler X Band, 20 DB nominal, type "N" take off, choke to choke, silver-plated $17.50
X Band 1 3/8" x 5/8" absorption type wavemeter, micrometer head, 0000 to 8500 mc. Demornay-Budd #358 .... $185.00
C Band "T" gold-plated at $97.00
C Band Flap attenuator Demornay-Budd type #339, gold-plated $100.00
X Band 1 3/8" x 5/8" Klystron mount with tunable termination gold-plated $75.00
X Band 1 3/8" x 5/8" low power load, gold-plated .. $45.00
X Band 1 1/8 x ½ waveguide to type "N" adapter, gold-plated $22.50
X Band 1 1/8 x ½ "T" Section, gold-plated $55.00
Dehydrator Unit CPD 10137 Automatic cycling. Compressor to 50 lbs. Compl. for Radar XSMN. Line. New $425.00
H. V. Pwr. Supply 15,000 V 30 MA. DC Bridge Rect. Pwr. Sply. Oper. FM. 115 V 60 cy $115.00
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APS-2 10CM RF HEAD COMPLETE WITH HARD TUBE (715B) Pulser, 714 Magnetron 417A Mixer all 7/8" rigid coax, incl. rcvr. front end $210.00

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Test set designed to provide a means of rapid checking of crystal diodes 1N21, 1N21A, 1N21B, 1N23, 1N23A, 1N23B. Operates on 1-½ volt dry cell battery. 3 x 6 x 7, New $35.00

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9000-9500 MCS Transmission type $92.50
SL wavemeter, Type CW60ABM $125.00
10CM ECHO BOX CABV 14ABA-1 of OBU-3, 2890 MC to 3170 MCS direct reading micrometer head. Ring prediction scale plus 9% to minus 9%. Type "N" input. Resonance indicator meter. New and Comp. w/access. Box and 10CM Directional Coupler $350.00
10 cm horn assembly consisting of two 5" dishes with dipoles feeding single type "N" output. Includes UG28/U type "N" "T" junction and type "N" pickup probe. Mfg. cable. New $15.50
10 cm. cavity type wavemeter 6" deep 6½" in diameter. Coax. output. Silver plated .... $64.50 ea.
10 cm. echo box. Part of SF1 Radar W/115 volt DC tuning motor Sub Sig 1118AO $47.50
THERMISTER BRIDGE: Power meter 1-203-A. 10 cm. mfg. W.E. Complete with meter, interpolation chart, portable carrying case $72.50
W.E. I 138. Signal generator, 2700 to 2900 Mc. range. Lighthouse tube oscillator with attenuator & output meter. 115 input reg. Pwr. supply. With circuit diagram $150.00

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TS 235 UP Dummy Load $87.50

10 cm Wavemeter. WE type B 435490 Transmission type. Type N Fittings. Veeder Root Micrometer dial. Gold Plated W/Calib. Chart P/o Freq. Meter X66404A. New $99.50

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5071930, Delco, 115 V., 60 Cycle, 7000 r.p.m. **Price $4.50 each net.**

36938-2, Haydon Timing Motor, 110 V., 60 cycle, 2.2 w.; 4/5 r.p.m. **Price $3.00 ea. net.**

Type 1600 Haydon Timing Motor—110 V., 60 cycle, 3.2 w., 4 r.p.m., with brake. **Price $4.00 each net.**

Type 1600 Haydon Timing Motor—110 V., 60 cycle, 2.2 w., 1/240 r.p.m. **Price $3.00 each net.**

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Eastern Air Devices Type J33 Synchronous Motor 115 V., 400 cycle, 3 phase, 8,000 r.p.m. **Price $8.50 each net**

Telechron Synchronous Motor, Type B3, 115 V., 60 cycle, 2 r.p.m., 4 w. **Price $5.00 each net.**

Barber-Colman Control Motor, Type AYLC 5091, reversible 24 volts D.C. .7 amps 1 R.P.M., Torque 500 in. lbs. Contains 2 adjustable limit switches with contacts for position indication. Ideal for use as a remote positioner or a beam or television antenna rotator, will operate on A.C. 60 cycle. **Price $6.50 each net.**

SERVO MOTORS

CK 1, Pioneer, 2 phase, 400 cycle. **Price $10.00 each net.**

CK 2 Pioneer, 2 phase, 400 cycle. **Price $4.25 each net.**

10047-2-A Pioneer 2 phase, 400 cycle, with 40:1 reduction gear. **Price $7.25 each net.**

FPE-49-6 Diehl, Low-Inertia, 115 V., 60 cycle, 2 phase, .3 amps., 10 watt, output. **Price $34.50 each net.**

FPE-25-16 Diehl Low-Intertia 20 V., 60 cycle, 2 phase, 1600 r.p.m., .85 amps. **Price $10.00 each net.**

CK 2, Pioneer, 2 phase, 400 cycle, with 40:1 reduction gear. **Price $6.50 each net.**

MINNEAPOLIS-HONEYWELL TYPE B Part No. G303AY, 115 V., 400 cycle, 2 phase, built-in gear reduction, 50 lbs. in torque. **Price $8.50 each net.**

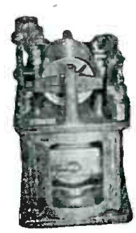
Kollsman Type 776-01 400 cycle 2 phase drag-cup type, fix phase voltage 29, variable phase 35V. maximum, frequency 400 cycle. **Price $10.50 each net.**

REMOTE INDICATING MAGNESYN COMPASS SET

Pioneer Type AN5730-2 Indicator and AN5730-3 Transmitter 26 V., 400 cycle.
Price $40.00 per set new sealed boxes.

Kollsman Remote Indicating Compass Set Transmitter part No. 679-01, indicator part No. 680k-03, 26 V., 400 cycle. **Price $12.50 each net.**

GYROS



Schwein Free & Rate Gyro type 45600. Consists of two 28 V. D.C. constant speed gyros. Size 8" x 4.25" x 4.25".
Price $10.00 ea. net.

Schwein Free & Rate Gyro, type 46800. Same as above except later design.
Price $15.00 ea. net.

Sperry A5 Directional Gyro, Part No. 656029, 115 volts, 400 cycle, 3 phase. **Price $17.50 each net.**

Sperry A5 Vertical Gyro, Part No. 644841, 115 V., 400 cycle, 3 phase. **Price $20.00 each net.**

Sperry A5 Amplifier Rack Part No. 644890. Contains Weston Frequency Meter. 350 to 450 cycle and 400 cycle, 0 to 130 voltmeter. **Price $10.00 each net.**

Sperry A5 Control Unit Part No. 644836. **Price $7.50 each net.**

Sperry A5 Azimuth Follow-Up Amplifier Part No. 656030. With tube. **Price $5.50 each net.**

Pioneer Type 12800-1-D Gyro Servo Unit. 115 V., 400 cycle, 3 phase. **Price $10.00 each net.**

Norden Type M7 Vertical Gyro. 26 V., D.C. **Price $19.00 each net.**

Allen Calculator, Type C1 Bank and Turn Indicator, Part No. 21500, 28 V. D.C. Contains 28 V. D.C. constant speed gyro. **Price $10.00 each net.**

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C. A. A. approved instrument repair dept. No. 3564.

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5069625, Delco Constant Speed, 27 V., 120 r.p.m. Built-in reduction gears and governor. **Price $3.90 each net.**

A-7155, Delco Constant Speed Shunt Motor, 27 V., 2.4 amps., 3600 r.p.m., 1/30 h.p. Built-in governor. **Price $6.25 each net.**

C-28P-1A, John Oster Series Motor, 27 V., 0.7 amps., 7000 r.p.m., 1/100 h.p. **Price $3.75 each net.**

Jaeger Watch Co. Type 44-K-2 Contactor Motor, Operates on 3 to 4.5 volts D.C. Makes one contact per second **Price $2.00 each net.**

General Electric Type 5BA10AJ52C, 27 V. D. C., 0.65 amps., 14 oz. n. torque, 145 r.p.m. Shunt Wound, 4 lead reversible. **Price $5.00 each net.**

General Electric Type 5BA10AJ37C, 27 V. D. C., 5 amps., 8 oz., in. torque, 250 r.p.m. Shunt Wound, 4 leads reversible. **Price $6.50 each net.**

D.C. ALNICO FIELD MOTORS

5069466, Delco, 27 V., 10,000 r.p.m.
Price $4.50 each net.

5069370, Delco, 27 V., 10,000 r.p.m. **Price $6.00 each net.**

S. S. FD6-16, Diehl, 27 V., 10,000 r.p.m. **Price $4.50 each net.**

S. S. FD6-18, Diehl, 27 V., 10,000 r.p.m. **Price $4.50 each net.**

S. S. FD6-21, Diehl, 27 V., 10,000 r.p.m. **Price $4.50 each net.**

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8TJ9-PDN Transmitter, 24 V. **Price $3.75 each net.**

8TJ9-PAB Transmitter 24V. **Price $3.75 each net.**

8DJ11-PCY Indicator, 24 V. Dial marked—10° to +65°. **Price $4.50 each net.**

8DJ11-PCY Indicator, 24 V. Dial Marked 0 to 360°. **Price $7.50 each net.**

RELAYS

Type B4 28 volts D.C., 200 amps. continuous duty. Electric Auto-Lite Co. Part no. WSN4001. **Price $2.50 each net.**

Type B5B, 28 volts D.C., 50 amps., continuous duty Hart Mfg. Co. Part no. 692R6 **Price $1.85 each net.**

Type B8, 28 volts D. C., 250 amps., intermittent duty Cutler-Hammer. Part no. 6041H139A **Price $2.50 each net.**

AMPLIFIER

Pioneer Gyro Flux Gate Amplifier, Type 12076-1-A.
Price $17.50 ea. net, with tubes.

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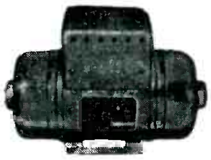

153F, Holtzer Cabot, Input, 24 V.D.C. Output 115 V., 400 cycle, 3 phase, 750 V.A. and 26 V., 400 cycle, 1 phase, 250 V.A. Voltage and frequency regulated also built in radio filter. **Price $115.00 each net.**

149H, Holtzer Cabot. Input 28 V. at 44 amps. Output 26 V. at 250 V.A., 400 cycle and 115 V. at 500 V.A., 400 cycle. **Price $40.00 each net.**

149F, Holtzer Cabot. Input 28 V. at 36 amps. Output 26 V. at 250 V.A., 400 cycle and 115 V. at 500 V.A., 400 cycle. **Price $40.00 each net.**

12117, Pioneer. Input 12 V.D.C. Output 26 V., 400 cycle, 6 V.A. **Price $22.50 each net.**

12117-2 Pioneer. Input 24 V.D.C. Output 26 V. 400 cycle, 6 V.A. **Price $20.00 each net.**

12116-2-A Pioneer. Input 24 volts D.C., 5 amps. Output 115 volts 400 cycle single phase 45 watts. **Price $100.00 each net.**

5D21NJ3A General Electric. Input 24 V.D.C. Output 115 V., 400 cycle at 485 V.A. **Price $12.00 each net.**

PE218, Ballentine. Input 28 V.D.C. at 90 amps. Output 115 V., 400 cycle at 1.5 K.V.A. **Price $50.00 each net.**

METERS

Weston Frequency Meter. Model 637, 350 to 450 cycles, 115 volts. **Price $10.00 each net.**

Weston Voltmeter. Model 833, 0 to 130 volts, 400 cycle. **Price $4.00 each net.**

Weston Voltmeter. Model 606, Type 204 P, 0 to 30 volts D. C. **Price $4.25 each net.**

Weston Ammeter. Model 506, Type S-61209, 20-0-100 amps. D. C. **Price $7.50 each net with ext. shunt.**

Weston Ammeter. Type F1, Dwg. No. 116465, 0 to 150 amps. D. C. **Price $6.00 each net. With ext. shunt $9.00 each net.**

Westinghouse Ammeter. Type 1090-D120, 120-0-120 amp. D. C. **Price $4.50 each net.**

Weston Model 545. Type 82PE Indicator. Calibrated 0 to 3000 RPM. 2¾" size. Has built-in rectifier, 270° meter movement. **Price $15.00 each net.**

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General Electric, input 230 V. 60 cycle 3 phase. Output 130 amps. at 28 V. D.C. Continuous duty, fan cooled, has adjustable input taps. G.E. model No. 6RC146F3. Size: Height 46", width 28", depth 17½". **Price $200.00 each net.** New

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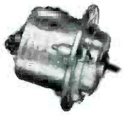
AY1, 26 V., 400 cycle. **Price $5.50 each net.**

AY14D, 26 V., 400 cycle, new with calibration curve. **Price $15.00 each net.**

AY20, 26 V., 400 cycle. **Price $7.50 each net.**



AY5 26V., 400 cycle. Has hollow shaft. **Price $7.50 ea. net**

PRECISION AUTOSYNS

AY101D, new with calibration curve.

PRICE—WRITE OR CALL FOR SPECIAL QUANTITY PRICES

AY131D, new with calibration curve. **Price $35.00 each net.**

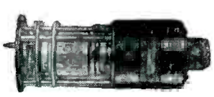
AY130D, new. **Price $35.00 each net.**

PIONEER AUTOSYN POSITION INDICATORS

Type 5907-17. Dial graduated 0 to 360°, 26 V., 400 cycle. **Price $15.50 each net.**

Type 6007-39, Dual, Dial graduated 0 to 360°, 26 V., 400 cycle. **Price $30.00 each net.**

PIONEER TORQUE UNIT



Type 12602-1-A. Price $40.00 each net.

Type 12606-1-A. Price $40.00 each net.

Type 12627-1-A. Price $80.00 each net.

MAGNETIC AMPLIFIER ASSEMBLY

Pioneer Magnetic Amplifier Assembly Saturable Reactor type output transformer. Designed to supply one phase of 400 cycle servo motor. **Price $8.50 each net.**

PIONEER TORQUE UNIT AMPLIFIER

Type 12073-1-A, 5 tube amplifier, Magnesyn input, 115 V., 400 cycle. **Price $17.50 each net with tubes**

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RATE GENERATORS

PM2, Electric Indicator Co., .0175 V. per r.p.m. **Price $8.25 each net.**

F16, Electric Indicator Co., two-phase, 22 V. per phase at 1800 r.p.m. **Price $12.00 each net.**

J36A, Eastern Air Devices, .02 V. per r.p.m. **Price $9.00 each net.**

B-68, Electric Indicator Co., Rotation Indicator, 110 V., 60 cycle, 1 phase. **Price $14.00 each net.**

Weston Tachometer Generator (aircraft type) model 752-J4 single phase. A.C. output **Price $17.50 each net.**

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(Resolvers)

FPE 43-1, Diehl, 115 V., 400 cycle. **Price $20.00 each net.**

SYNCHROS

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7G Generator, 115 V., 60 cycle. **Price $30.00 each net.**

2J1F3 Selsyn Generator 115 volts, 400 cycle. **Price $5.50 each net.**

2J1M1 Control Transformer 105/63 V., 60 cycle. **Price $20.00 each net.**

2J1G1 Control Transformer, 57.5/57.5 V., 400 cycle. **Price $1.90 each net.**

2J1H1 Selsyn Differential Generator, 57.5/57.5 V., 400 cycle. **Price $3.25 each net.**

W. E. KS-5950-L2, Size 5 Generator, 115 V., 400 cycle. **Price $4.50 each net.**

5G Generator 115 volts, 60 cycle. **Price $50.00 each net.**

5G Special, Generator 115/90 V., 400 cycle. **Price $15.50 each net.**

5SF Repeater, 115/90 V., 400 cycle. **Price $19.00 each net.**

2J1F1 Selsyn Generator, 115 V., 400 cycle. **Price $3.50 each net.**

5SDG Differential Generator 90/90 V., 400 cycle. **Price $12.00 each net.**

1CT Control Transformer. 90/55 volts, 60 cycle. **Price $40.00 each net.**

POSITION TRANSMITTER

Pioneer Type 4550-2-A Position Transmitter, 26 volts 400 cycle, gear ratio 2:1. **Price $15.00 each net.**

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C1B	3.95	4C27	5.95	250R	5.95	722A	.95	991	.40
1B22	2.95	4C30	1.25	HK253	6.95	723A	6.95	CK1005	.35
1B23	8.95	4C35	22.50	274B	1.75	723A/B	10.95	CK1006	.95
1B24	4.95	4J25	95.00	287A	3.95	724A	2.95	1280	.99
1B26	2.95	4J26	95.00	CE303	3.95	724B	3.95	1611	1.50
1B35	19.95	4J31	95.00	304TH	3.95	725A	12.95	1613	.75
1B38	32.50	4J35	195.00	307A	4.25	726A	9.95	1616	1.10
1B42	7.95	4J38	95.00	310A	7.50	726B	36.00	1619	.50
1B56	45.00	4J40	195.00	316A	.69	726C	45.00	1622	1.50
1B60	45.00	4J52	250.00	350A	3.00	728AY	45.00	1624	.99
1N21	.85	5BP1	2.75	350B	1.80	730A	6.95	1625	.45
1N21A	.95	5BP4	3.95	368AS	2.40	801A	.69	1626	.45
1N21B	1.50	5C22	45.00	371B	.89	802	4.50	1629	.45
1N23	.85	5C30	9.95	388A	1.80	803	4.50	1631	.89
1N23A	.95	5CP1	1.95	393A	4.95	804	10.95	1641	1.00
1S21	3.75	5D21	19.95	394A	4.95	805	4.95	1851	1.10
2AP1	3.50	C5B	1.95	417A	12.95	807	1.35	1852	.99
2C23	.75	5FP7	1.95	434A	3.50	808	2.75	1853	.90
2C33	1.95	5JP1	29.50	450TL	37.50	809	2.75	2050	.99
2C40	5.75	5JP2	10.95	446A	.90	810	7.50	2051	.55
2C43	12.50	5JP4	25.00	446B	1.80	811	2.11	8012A	3.95
2C44	1.25	6AC	3.95	WL468	5.95	813	7.95	8013A	2.75
2C51	7.50	6AC7	.90	WL469	2.75	814	2.95	8014A	25.00
2D21	1.25	6AC7W	1.75	WL525	2.75	815	1.50	8016	1.25
2J22	9.95	6AK5	1.16	527	7.95	827R	90.00	852	9.95
2J26	8.75	6C21	19.95	WL530	12.95	829B	8.45	860	3.75
2J27	9.75	6F4	5.95	WL531	7.95	832	4.50	861	19.95
2J31	12.75	6J4	4.95	WL532	2.95	832A	4.95	866A	1.15
2J32	17.50	6-8	.95	533	39.95	834	7.59	869B	29.95
2J36	105.00	6SU7GTY	1.25	WL535	7.75	836	1.10	872A	2.75
2J38	7.95	7BP7	4.95	WL538	1.25	837	1.95	874	1.95
2J40	25.00	7DP4	12.50	GL570	1.25	838	3.75	876	.75
2J42	150.00	10Y	.59	575A	12.50	845	4.50	878	2.25
2J48	49.50	15E	1.50	579B	5.95	849	19.95	8019	1.75
2J49	69.00	15R	1.00	700A to B	19.50	851	19.95	8020	2.95
2J50	24.50	RX21	2.50	701A	3.95	884	1.45	8021	1.75
2J55	95.00	CV35	15.00	703A	2.40	885	1.25	8022	1.00
2J61	45.00	RK72	.95	705A	.75	931A	3.95	8025	3.75
2J62	45.00	RK73	.95	707A	6.95	954	.45	9001	.55
2K25	19.95	OK77	249.00	707B	9.95	955	.45	9002	.35
2K28	24.95	OK59	59.00	710A	1.25	956	.45	9003	.55
2K29	24.95	OK61	49.50	714AY	4.95	957	.25	9004	.45
2K45	on Request	RK39	2.25	715A	6.95	958A	.55	9005	1.50
2X2A	.69	RK49	2.40	715B	9.95	959	.75	9006	.25
2V3G	.99	VR53	.29	715C	24.95				
3A4	.75	VR95	.45	717A	.95				
3A5	.95	100TH	10.95	720AY	45.00				
3AP1	4.95	VR105	.79	720BY	45.00				
3BP1	3.95	F123A	8.95	720CY	45.00				
3B24	1.95	VR150	.63	720DY	45.00				
3C23	3.95	VT98	39.95	721A	2.40				
3C24	.95	X99	.75						
3C31	3.95	203A	3.95						
3C45	13.95	211	.75						
3DP1A	3.25	217C	6.95						
3E29	8.95	233A	2.95						
3J31	50.00	242C	7.50						
4A1	.95	249C	3.75						
4B30	1.75	250TH	19.25						

350A is a long life WE807
350B is a long ilfe WE6L6G
WE 701A can be used for a Super 813

$10 Minimum Order

THIS MONTH'S SPECIALS AT PRICES NEVER BEFORE

IN STOCK SUBJECT TO PRIOR SALES

ALL NEW PERFECT
STANDARD BRANDS

IN LARGE QUANTITIES ONLY

3,000 Magnetrons, Type 725 A at $6.75
1,000 Magnetrons, Type 730 A at 5.00
2,000 Magnetrons, Type 714 AY at 3.75
1,000 TR Tubes, Type 1B22 at .99
1,000 TR Tubes, Type 1B26 at 1.99
50,000 Acorn Tubes, Type 954 at .19
50,000 Acorn Tubes, Type 957 at .10
50,000 Acorn Tubes, Type 1625 at .19
1,000 Klystrons, Type 723 A/B at 7.95
1,000 Rectifiers, Type 1616 at 1.00
1,000 Tubes, Type 814 at 1.95
5,000 Tubes 9001 at .45¢
5,000 Tubes 9002 at .29¢
5,000 Tubes 9003 at .45¢
5,000 Tubes 9004 at .35¢
5,000 Tubes 9006 at .20¢
100 Magnetrons 4J38 $55.00
1,000 5D21 $10.00

LIBERTY ELECTRONICS, INC.

PHONE WORTH 4-8262 135 LIBERTY ST., NEW YORK 6, N.Y.

NEW YORK'S RADIO TUBE EXCHANGE

TEST EQUIPMENT

Microwave K Band 24000 MC.

TSKI-SE Spectrum Analyzer
K Brand Flap Attenuator

X Band

TSX-4SE Spectrum Analyzer
TS 12 Unit 1 USWR Measuring Amplifier, 2 channel
TS 12 Unit 2 Plumbing for above TS13

X band Pulsed Signal Generator

TS16AA VSWR Measuring Amplifier. Navy type TS 12 Unit 1
TAA-11BL VSWR Measuring Amplifier, Browning
TS 33 X Band Power and Frequency Meter
TS 35 X Band Pulsed Signal Generator
TS 36 X Band Power Meter
TS 45 X Band Signal Generator
TS 146 X Band Signal Generator
TS 263 Navy Version of TS 146
X Band Magic T Plumbing
X Band Tunable Crystal Mounts
TVN-8SE MIT Klystron pulse and power Supply

S Band

TS155 S Band Signal Generator
TS3A/AP S Band Power and Frequency Meter
RF 4 Electrically Tuned S Band Echo Box
BC 1277/60ABQ S Band Pulsed Signal Generator
PE 102 High Power S Band Signal Generator

L Band

Hazeltine 1030 Signal Generator 145 to 235 Megacycles
TS 69, 300 to 1000 MC Frequency Meter
Measurements Corp. type 84 Standard Signal Generator
TS 47, 40 to 400 MC Signal Generator

Broadcast Wave Bands

162C Rider Chanalyst
Short Wave Adapteur for 162C
Ferris 22A, Signal Generator

Oscilloscopes

BC 1287A used in LZ sets
TS 34 Oscilloscopes WE
Supreme 564
Cossor two-beam scope

Audio Frequencies

RCA Audio Chanalyst
Hewlett Packard

Other test Equipment and Meters

TS 15/A Magnet Flux Meter
General Radio V T Voltmeter 728A
Calibrator WE 1-147
Hazeltine Pulse & Sweep Generator
UHF Radio Noise & Field Strength Meter Measurements Corp type 58
General Radio 1000 cycles type 213
Limit Bridges
Boonton Standard Inductances
Weston Meters types 430, 429, 741
Model 40 Pyrometer
Rawson, meters 0-10 Microampere 0-2 Millivolt

Motor Generator type MG 215

Made by Onan & Sons
Input 110 Volt/60 Cycles, 1500 Watt
Output 115 Volt 480 Cycles and 28 Volt DC.
Will operate any Airborne Radar from 110 Volt 60 Cycle Line

RADAR Sets & Parts

APS 3
APS 4
SCR 284
R-111/APR5A Receivers

LIBERTY ELECTRONICS, INC.

PHONE WORTH 4-8262 135 LIBERTY ST., NEW YORK 6, N.Y.

Reliance Specials

CAPACITORS

POSTAGE STAMP MICAS

MMF	MMF	MMF	600	MFD
8.2	60	240	620	.00136
10	62	250	650	.0015
15	68	300	680	.002
20	70	350	700	.0026
22	75	370	750	.0027
24	82	390	800	.003
25	90	400	820	.0033
30	100	430	900	.005
39	110	470	910	.007
40	150	500	MFD	.0068
47	160	510	.001	.0075
51	180	560	.0012	.0082
56	200	580	.0013	.01

Price Schedule
8.2 MMF to .001 MFD.. 5¢
.0012 MFD to .002 MFD...7¢
.0026 MFD to .0082 MFD..12¢
.01 MFD....................18¢

SILVER MICA

MMF	MMF	MMF	MMF	MFD
10	85	260	488	.0023
24	100	270	500	.0024
30	110	300	510	.0027
39	115	325	525	.003
40	120	330	560	.0033
45	125	360	680	.0039
50	150	370	700	.004
51	180	390	750	.0047
60	200	400	820	.005
62	208	430	MFD	.0051
66	225	450	.001	.006
68	240	466	.0013	.0082
75	250	470	.0022	.01

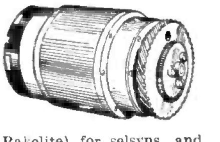
Price Schedule
10 MMF to .001 MFD..10¢
.0012 MFD to .0027 MFD..20¢
.003 MFD to .0082 MFD..50¢
.01 MFD.................65¢

OIL FILLED

MFD	V.D.C.	Price
.375@ .75@	16,000 and 8,000 (dual)	$6.95
.4	10,000	8.95
1	7,500	1.55
.1-.1	7,000	1.55
.02-.02	7,000	1.50
1	6,000	8.50
2	4,000	4.50
.25	3,000	1.95
2x.1	2,000	.95
1	2,000	.95
4	1,000	.90
3	1,000	.80
2	1,000	.65
10	600	1.00
4	600	.69
2	600	.39

SELSYNS

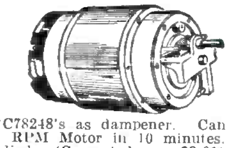
115 V., 60 Cyc.
#C78248
3⅜" dia. x 5⅜" long
$7.95 pair



Mounting Brackets — (Bakelite) for selsyns, and differentials shown above ....25c pair

DIFFERENTIAL

115 V., 60 Cyc.
#C78249
3⅜" dia. x 5⅜" long
$2.25 ea.



Used between two #C78248's as dampener. Can be converted to 3600 RPM Motor in 10 minutes. Conversion sheet supplied. (Converted......$3.00)

WW PRECISION RESISTORS, 1% OR BETTER

¼ WATT—25c

6.68Ω	12.32Ω	16.37Ω	123.8Ω	414.3Ω
10.48	13.02	62.54	147.5	705
10.84	13.52	79.81	220.4	2193
11.25	13.89	105.8	301.8	10,000
11.74	14.98		366.6	59,148

½ WATT—25c

.250Ω	11.1Ω	210Ω	3,427Ω	8,500Ω
.334	13.15	235	4,000	14,825
.502	46	260	4,451	15,000
.557	52	270	5,000	15,750
.627	55.1	298.3	5,900	17,000
.76	75	400	6,500	30,000
1.01	97.8	723.1	7,000	100,000
1.53	125	2,500	7,500	
2.04	180	2,850	8,000	

1 WATT—30c

1.01Ω	5.21Ω	1,250Ω	9,000Ω	65,000Ω
2.58	10.9	3,300	18,000	70,000
3.39	270	7,000	55,000	

1 WATT—40c

120,000	128,000Ω	320,000	522,000Ω
125,000	130,000	470,000	600,000
	160,000		700,000

1 Megohm—1 Watt 1%—65c; 5%—40c
100 pieces—10% off; 1,000 pieces—20% off.

HAYDON TIMING MOTORS

1 R.P.M., 115V., 60 Cycle...........$1.79

POSTAGE STAMP MICA ASSORTMENT

100 asst. regular and silver micas.................$3.29
10 Conductor shielded cable, 5 ft. long & complete 400 series Jones plug ....98¢

#18 SHIELDED WIRE—STRANDED

Single Conductor—100 ft........$1.95 1,000 ft.....$12.50
Two Conductor —100 ft........$2.95 1,000 ft.....$19.50

PULSE TRANSFORMERS

X 124 T2, UTAH, marked 9262, small gray case. Ratio 1:1:1, hypersil core $1.50
D161310. 50 Kc to 4 Mc. 1¾" dia. x 1⅞" high. 120 to 2350 ohms $1.50
352-7178—Spec. 10, 111 Chicago Trans. equivalent to 9262 (above) $1.00
D166638 W.E. Permalloy core, Semi-toridal windings $1.25
KS9800. Ratio, 1:1:1, 2:1, Freq. range 380 to 520 C.P.S. $3.50
D106173, W.E. Freq. resp. 10KC to 2 MC..........$9.80
800 KVA G.E. K2731., 28000 Volt pk. output: Bifilar: one microsecond pulse width..................$28.50

CARBON MIKE

T-17—Slightly used, guaranteed, 5 ft. cord & PL 68..69c

JONES BARRIER STRIPS

Type	Price	Type	Price	Type	Price
2-140Y	$.05	4-141W	$.22	9-141Y	$.47
2-140¾W	.10	4-141¾W	.22	10-141¾W	.52
3-140¾W	.13	4-141Y	.22	12-141	.44
4-140	.13	5-141	.20	14-140Y	.56
8-140W	.33	5-141Y	.27	17-141Y	.87
10-140¾W	.40	5-141¾W	.27	3-142	.15
13-140	.37	7-141	.27	5-142	.24
2-141	.60	7-141¾W	.37	6-142	.28
3-141¾W	.17	7-141Y	.37	10-142¾W	.64
3-141W	.17	8-141¾W	.42	2-150	.28
3-141Y	.17	9-141¾W	.47	4-150	.52

Gear Assortment $6.50
Experimenters dream, 100 pieces, many stainless steel.

CHROMALUX STRIP HEATER—115 V.A.C.

60 Cycle, 750 Watt, curved.........................95c

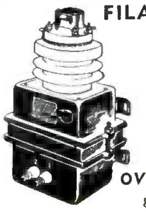
2J1G1 SELSYNS (Brand New)

400 Cyc. Use on 24V. or 110 VAC.......$2.25 each

FILAMENT TRANSFORMER

Pri., 115 V., 60 Cyc.—Sec., 5V., 110 A. 6000 volt insulation ....$9.95 each

FILAMENT TRANSFORMER



Amertran Type WS
For High Voltage Rectifiers. PRI. 115V., 50/60 Cycle.
SEC. 5V., C/T @ 10 Amp.
35 KV R.M.S. Test 12 KV D.C. Operating. Uses 872A Tube or other tubes.
NEW OVERSEAS PACKED $10.95
872-A Tube.....$1.98

PRECISION CONTROLS

6 WATT

20,000	Muter	314A	*1.70
20,000Ω	GR	314A	2.50
6,000	De jur	260	1.70
6,000	Muter	314A	1.70
5,000	Muter	314A	2.50
5,000	GR	214A	1.40
2,000	De jur	260	1.70

25 WATT

100K	GR	433A	$4.95

4 WATT

500Ω	Centralab	48-501	$.90
50	De jur	292	.75
50	GR	301	1.10
25	GR	301	1.10
20	De jur	292	.75
12	GR	301	1.10

12 WATT

10,000	Muter	471A	$2.00
10,000Ω	De jur	271T	2.00
5,000	De jur	271T	2.00

7 Terminal Bakelite tie point.................35 for $1.00

VERNIER DIAL (From BC-221)

2 ⅝" Dia. 0-100 in 360°. Black with silver marks. Has thumblock 85c

POWER RHEOSTATS

STANDARD BRANDS

25 WATT

Resist.	Shaft	
10Ω	7/16"	49¢
25	⅛"	59
145	½" with switch	49
250	7/16"	59
370	½"	59

25 WATT

5,000	S.D.*	69

50 WATT

8Ω	S.D.*	79¢
20	7/16"	79
90	½"	79¢

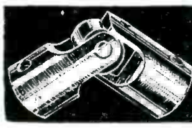
123Ω	½"	79¢
1,250	½"	89
2,000	½"	89
3,500	⅛"	89

150 WATT

8Ω	½"	$1.99

*S.D. Screw Driver Slot

UNIVERSAL JOINT



3/16" hole x 3/8" O.D.
1 1/8" long
Steel or Aluminum
50¢

4AG FUSES 4AG

AMP	Per 100	AMP	Per 100
1/10	$4.00	3.2	$2.00
1/4	3.50	5	2.00
1/2	3.50	10	2.50
1	2.00	15	2.50
2	2.00	20	2.50
3	2.00	25	2.50
		30	2.50

MICRO AMMETER 0-500

2" round Basic move. 500 micro amps. Used—Guaranteed ....$3.21 ea.

Write for Monthly Bulletin

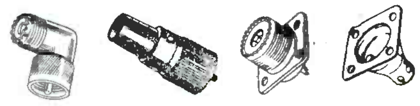
COAXIAL CABLE

RG 8/U 52 OHM

$55.00 per 1,000 feet

	Ohm	Price per 1,000 ft.		Ohm	Price per 1,000 ft.
RG 5/U	53.5	$70.00	RG 27/U	48	$290.00
RG 7/U	97.5	60.00	RG 29/U	53.5	50.00
RG 8/U	52	55.00	RG 34/U	71	175.00
RG 9/U	51	135.00	RG 39/U	72.5	180.00
RG 10/U	52	125.00	RG 41/U	67.5	575.00
RG 11/U	75	100.00	RG 51/U	58	65.00
RG 12/U	75	190.00	RG 51/AU	58	75.00
RG 13/U	74	125.00	RG 55/AU	53.5	60.00
RG 18/U	52	450.00	RG 57/U	95	100.00
RG 20/U	52	450.00	RG 58/U	53.5	50.00
RG 22/U	95	110.00	RG 59/U	73	40.00
RG 24/U	125	240.00	RG 62/U	93	50.00
RG 25/U	48	575.00	RG 74/U	52	250.00
			RG 77/U	48	100.00

COAXIAL CABLE CONNECTORS



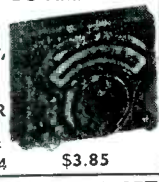
Angle-Adapter	Plug	Socket	Hood
15c	28c	28c	9¢
M-359	PL-259A	SO-239	83-1H
83-1AP	83-1SPN	83-1R	

Adapter for PL-259 A for use on small coax. 12c each ....$10.00 per 100

83-1SP	$.28	83-22SP	.48	UG 59/U	.60
83-1J	.80	UG 13/U	.60	UG 61/U	.60
83-1T	1.12	UG 21/U	.60	UG 85/U	.62
83-1F	1.12	UG 22/U	.60	UG 86/U	1.22
83-22AP	.85	UG 24/U	.60	UG 87/U	.68
83-22F	.88	UG 25/U	.60	UG 167/U	2.00
83-22R	.48	UG 27/U	.60	UG 281/U	.60

0-15A DC AMMETER

BASIC MOVE
12 Ma.
5" x 4"
METAL CASE
MIRROR SCALE



$3.85
Lots of 10—$34

CHOKE

400 MA
12 Hy.
90 OHM
6,000 V. D. C. TEST

$3.85
10 for $34.00

ALLEN SET SCREWS

4-40 x ⅛ 8-32 x ⅛ 8-32 x 5/16
4-40 x 3/16 8-32 x 3/16 8-32 x 3/8
ALL SIZES.............................$1.50 per 100

GLYPTAL CEMENT 1 qt...............................75c

Wrapped—BALL BEARINGS—New

Mfg	ID	OD	Width	Price
Fafnir 33K5	3/16"	1/2"	5/32"	.25
N.D. 38	5/16	7/8"	9/32"	.45
Fafnir K8A	1/2"	1 1/8"	5/16"	.60
N.D. 5202C13M	1/2"	1 3/8"	1/8"	1.00
Fafnir 7308W	1 37/64"	3 9/16"	5/16"	2.00
SKF 466430	6"	8"	1"	5.00
SKF170645	3 11/32"	4 1/8"	7/16"	1.50
Fafnir 545	2 1/16"	2 5/8"	15/32"	1.00

NEEDLE BEARINGS

B108 1/2" wide	5/8"	13/16"	30¢
GB34X 1/4" wide	3/16"	11/32"	25¢

SOUND POWERED HANDSET

Brand New! TS-10
Includes 6 ft. cord & spring clips
$8.92 ea. — $17.60 pr.

WALL HANGER — Navy type, for Sound Powered Phones (Shown above) ....$1.00 each

3AG FUSES 3AG

⅛ Amp	$4.00 per 100	2 Amp	$2.50 per 100
¼	4.00	3	2.50
¾	4.00	5	2.50
1	2.50	10	3.00
1½	2.50	15	3.00

Fuse Holder—Littlefuse for 4AG fuse..................18c

SELENIUM RECTIFIERS HALF WAVE

117 V.A.C. IN, 110 V.D.C. OUT @ 75 Ma.........$ .49
117 V.A.C. IN, 110 V.D.C. OUT @ 100 Ma......... .72
117 V.A.C. IN, 110 V.D.C. OUT @ 400 Ma......... 1.51

TIME DELAY RELAY

Raytheon CPX 24166 KS 10193-60 Sec. • 115 V., 60 Cycle • Adj. 50-70 Seconds • 2½ second recycling time—spring return • Micro-switch contact, 10A. • Holds ON as long as power is applied • Fully cased
ONLY $6.50

DELAY NETWORK—ALL 1400Ω

T 113—Approx. 1.2 micro sec. delay...............85c
T 114—Approx. 2.2 micro sec. delay...............85c
T 115 Similar to T 114 with tap brought out........85c

Minimum Orders $3........All orders f.o.b. PHILA, PA.

RELIANCE MERCHANDIZING CO.

Arch St. Cor. Croskey Phila. 3, Pa. Telephone RIttenhouse 6-4927

OUTSTANDING VALUES NOW AVAILABLE

- AMPLIFIERS
- AN CONNECTORS
- CABLE
- CAPACITORS
- CHOKES
- CIRCUIT-BREAKERS
- COAX-CONNECTORS
- COILS
- CORDS
- CRYSTALS
- DELAY LINES
- FILTERS
- FUSES
- HANDSETS
- INVERTERS
- JACKS
- KLYSTRONS
- KNOBS
- MAGNETRONS
- MAGNETS
- MICROPHONES
- METERS
- MOTORS
- POTENTIOMETERS
- POWER PLANTS
- POWER SUPPLIES
- PROJECTION LAMPS
- RECORDERS
- RESISTORS
- SELSYNS
- SCOPE ACCES.
- SHOCK MOUNTS
- SOCKETS
- SWITCHES
- TELEPHONE EQUIP.
- TEST EQUIPMENT
- TRANSFORMERS
- TRANSMITTERS
- TUBES
- WAVEGUIDE
- WAVEMETERS
- WIRE

RADIO HAM SHACK broadcasts its sincere thanks to all its old friends and a hearty welcome to new ones.

TO OUR OLD FRIENDS. It is not news that **RADIO HAM SHACK** is the house of value. They know that our mass purchasing policy of vast quantities of surplus equipment and the maintenance of one of the largest stocks of radio tubes and electronic components in the United States enables us to offer them low, low prices that are difficult to beat anywhere in the world.

TO THE NEW FRIENDS we should like to meet, we extend our services and facilities to bring them the best of equipment at the lowest prices. Deal with us in confidence, secure in the knowledge that our tubes, components and equipment are of standard manufacture, rigidly inspected and securely packed to insure that only first **QUALITY, BRAND NEW MERCHANDISE** reaches you.

Send for our monthly value packed flyer. Your requirements for immediate quotation will receive a prompt reply.

REMINDER—RADIO HAM SHACK is a **BIG BUYER** of tubes, components and equipment. Submit your surplus stock inventory to us for fast action. No lot too large—none too small.

WIRE! WRITE! today for latest prices. **SPECIAL DISCOUNTS** for large quantity purchases.

OVERSEAS BROADCAST!! WE SHIP ALL OVER THE WORLD!! SPECIAL HANDLING BY OUR EXPORT DIVISION INSURES SWIFT, CHEAP DELIVERIES TO ALL DESTINATIONS. CORRESPONDENCE IN ALL LANGUAGES. CABLE ADDRESS: HAMSHACK—NEW YORK.

TUBES!! BRAND NEW! STANDARD BRANDS! NO SECONDS! COMPARE! TUBES!!

OA3/VR75	$1.05
OB3/VR90	.65
OC3/VR105	.69
OD3/VR150	.48
1B21/ GL471A	2.87
1B22	2.87
1B23	8.75
1B24	4.59
1B26	2.79
1B27	7.95
1B29	.79
1B32	1.89
1B36	3.95
1B38	36.50
1D21	3.75
1N21	.49
1N21A	.89
1N21B	1.39
1N22	.98
1N23	.79
1N23A	.79
1N23B	1.89
1N27	1.29
1N34	.82
1P23	2.49
1P24	.59
1P36	2.85
1S21	3.95
2AP1	3.89
2C21/RK33	.24
2C22/7193	.15
2C26A	.15
2C34/RK34	.22
2C39	17.95
2C40	4.95
2C43	7.95
2C44	.98
2C46	6.95
2C51	5.95
2D21	.89
2D29	1.39
2E22	1.19
2E26	3.39
2E30	2.39
2J21A	7.95
2J22	7.95
2J26	6.95
2J27	12.75
2J30	49.50
2J31	8.49
2J32	12.95
2J33	18.75
2J34	18.95
2J36	97.50
2J37	12.95
2J38	11.95
2J39	19.95
2J40	24.50
2J46	49.50
2J48	12.75
2J49	39.50
2J50	22.50
2J54B	22.50
2J55	69.50
2J61	34.50
2J62	34.50
2K25	22.50
2K28	24.95
2K29	24.50
3AP1	4.59
3B22	1.98
3B24	1.49
3B25	4.87
3B26	1.49
3B27	1.95
3B28	7.95
3BP1	2.39

3C22	$39.50
3C23	2.19
3C24/24G	.35
3C30/809	1.89
3C31/C1B	2.98
3C45	12.95
3CP1	1.39
3DP1	1.79
3DP1-S2A	2.79
3D21A	.98
3EP1	2.59
3E29	8.95
3FP7	.97
3GP1	5.95
3HP7	3.95
4-65A	14.21
4-125A	26.05
4-250A	36.25
4AP10	1.98
4B22	9.98
4B24	1.98
4B25	7.95
4B26	4.49
4B28	2.47
4B32	9.95
4C35	19.38
4D22	9.95
4D32	9.95
4E27/ 257B	12.45
5AP1	2.95
5AP4	2.95
5BP1	2.29
5BP4	2.39
5CP1	1.29
5CP7	2.95
5D21	24.45
5FP7	1.19
5GP1	2.98
5JP1	39.50
5JP2	8.95
5JP4	39.50
5J23	12.95
5J29	12.95
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5LP1	12.95
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5NP1	4.98
6C21	19.69
6F4	5.59
6J4	4.49
7BP7	9.95
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9LP1	19.95
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10BP4	19.69
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12DP7	14.95
12GP7	12.75
12HP7	13.95
12LP4	24.95
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16AP4	49.50
19T8	.89
23D4	.29
28D7	.29
30SP	.19
35TG	5.95
45SP	.19
53A	5.95
75TL	5.95
100R	.97
100TH	9.95
100TS	2.25
211	.25
217C	9.95

227A/5C27	$2.69
249C	1.49
250R	5.95
250TH....	18.95
250TL	18.95
274B	2.69
293A	2.98
294A	2.95
300B	9.95
304TH	3.49
304TL	1.29
305A	24.95
307A	3.69
316A	.29
327A/5C37	2.75
331A	12.95
350A	1.98
350B	1.39
368A/S	4.98
371B	.49
388A	.47
393A	3.69
394A	3.69
417A	9.95
446A	1.25
446B	1.79
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450TL	44.50
527	5.95
559	.98
575A	11.95
631P1	3.75
700A	19.95
700B	19.95
700C	19.95
700D	19.95
701A	3.95
702A	2.69
703A	1.89
704A	1.49
705A	.69
706B	18.95
706CY	18.75
706FY	47.50
706GY	47.50
707B	14.95
708A	3.59
713A	.79
714AY	3.59
715A	5.49
715B	6.59
715C	19.95
717A	.49
721A	1.98
723A/B	12.95
724A/B	2.95
725A	6.45
726A	6.75
726B	29.50
726C	49.50
730A	9.95
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800	1.49
801A	.19
802	4.19
803	2.95
804	7.95
805	3.65
807	1.09
808	.99
809/3C30	1.89
810	7.95
811	1.98
812	2.45
812H	6.86
813	6.85
814	1.98
815	1.59

816	.99
826	.39
828	10.95
829	7.45
830B	3.19
832A	4.89
833A	33.95
836A	1.97
837	1.19
838	1.98
841	.29
843	.29
845	4.25
851	12.95
860	14.95
861	9.95
864	.29
865	.79
866A	1.05
866JR	1.05
869B	26.50
872A	1.12
874	.39
876	.29
878	1.98
884	1.19
885	1.19
902	3.39
905	2.49
908	4.95
918	1.49
919	1.95
923	.79
927	1.25
930	.98
931A	2.98
954	.16
955	.25
956	.25
957	.22
958	.22
959	.35
991/NE16	.24
1613	.49
1614	1.35
1616	.49
1619	.17
1624	.67
1625	.19
1626	.25
1629	.19
1630	.49
1631	.98
1632	.69
1633	.79
1634	.98
1635	1.09
1636	1.98
1638	.65
1644	.98
1654	2.45
1665	1.10
1851	.69
1960	.89
2050	1.19
2051	.39
8005	4.75
8011	.25
8012	1.39
8013	1.39
8014	22.50
8020	.89
8025	3.69
9001	.32
9002	.25
9003	.33
9004	.24
9005	1.35

9006	.15
C1JA	9.95
C5B	6.95
C6A	7.95
C6J	3.65
C100D	.98
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CK503AX	1.95
CK505AX	2.25
CK506AX	1.95
CK507AX	1.95
CK512AX	2.25
CK571AX	8.45
CK1005	.09
CK1006	.85
CK1007	.89
E1148	.29
EF50	.39
F123A	7.95
F127A	15.95
F128A	69.50
F606	37.50
F660	49.50
F862A	397.50
FG17	2.69
FG27A	6.95
FG32	4.95
FG33	7.95
FG57	12.95
FG81A	3.29
FG105A	8.95
FG172	13.95
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GL434A	2.69
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GL562	89.50
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RK73	.59
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RX120	8.95
V70D	7.35
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VR53	.19
VR78	.29
VT127A	2.19
VT158	14.95
VU111	.49
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WL532	1.89
WL616	37.50
WL619	18.95
WL677	34.50
WL681/ 686	22.50
WL710A	.25
OA2	1.29
OA4G	.89

0B2	$1.67
0Z4	.57
01A	.39
1A3	.44
1A4	1.09
1A4P	.97
1A5GT	.49
1A6	.79
1A7GT	.67
1AB5	.59
1B3/8016	1.15
1B4	1.19
1B5/25S	.89
1C5GT	.59
1C6	.89
1C7G	.89
1D5GP	.97
1D7G	.89
1D8GT	.95
1F4	.75
1F5G	.75
1G4GT	.69
1G6GT	.65
1E7G	1.15
1H4G	.55
1H5GT	.54
1H6GT	.87
1J6G	.75
1L4	.48
1LA4	.79
1LA6	.89
1LB4	.89
1LC5	.69
1LC6	.79
1LD5	.79
1LE3	.69
1L5	.79
1LH4	.79
1LN5	.67
1N5GT	.59
1P5GT	.67
1Q5GT	.67
1R4	.59
1R5	.69
1S4	.59
1S5	.49
1T4	.53
1T5GT	.69
1U4	.59
1V	.57
2A3	.87
2A4G	1.07
2A5	.69
2A6	.79
2A7	.79
2V3G	.69
2X2	.37
2X2A	.65
3A4	.34
3A5	.79
3A8	1.59
3B7/1291	.29
3D6/1299	.29
3LF4	.79
3Q4	.47
3Q5GT	.67
3S4	.57
3V4	.67
5R4GY	1.09
5T4	.87
5U4G	.49
5V4G	.87
5W4	.67
5X4G	.57
5Y3GT	.39
5Y4G	.49
5Z3	.52

5Z4	.77
6A3	.92
6A4LA	1.09
6A6	.79
6A7	.69
6A8	.75
6AB7	.79
6AC7	.74
6AD7G	1.09
6AF6G	.79
6AG5	.69
6AG7	.98
6AH6	1.29
6AJ5	.79
6AK5	.85
6AK6	.79
6AL5	.59
6AQ5	.49
6AQ6	.59
6AR5	.52
6AT6	.44
6AU6	.59
6AV6	.47
6B4G	.89
6B6G	.79
6B7	.87
6B8G	.69
6BA6	.55
6BE6	.52
6BF6	.57
6BG6G	1.47
6BH6	.59
6BJ6	.57
6C4	.19
6C5	.47
6C6	.57
6C8G	.69
6D6	.44
6D8G	.79
6E5	.69
6F5	.47
6F6	.57
6F6GT	.57
6F7	.69
6F8G	.87
6G6G	.69
6H6	.39
6H6GT	.37
6J5	.47
6J5GT	.39
6J6	.77
6J7	.67
6J7GT	.65
6K5GT	.79
6K6GT	.44
6K7	.49
6K8	.79
6L5GT	.79
6L6	1.05
6L6G	.99
6L6GA	.85
6L7	.79
6L7G	.87
6N7	.75
6Q7	.64
6R7	.79
6S7G	.79
6S8GT	.77
6SA7	.44
6SC7	.59
6SD7GT	.44
6SF5	.49
6SF7	.59
6SG7	.59
6SH7	.37
6SJ7	.47
6SK7GT	.44
6SL7GT	.59

6SN6GT	.97
6SN7GT	.54
6SQ7	.45
6SR7GT	.52
6SS7	.49
6ST7	.72
6SU7GTY	1.25
6SV7	.79
6T7G	.89
6U5G	.65
6U6GT	.63
6U7G	.49
6V6	.89
6V6GT	.57
6W4	.63
6W7G	.77
6X4	.57
6X5GT	.47
6Y6G	.67
6C7G	.98
6ZY5G	.59
7A4/XXL	.49
7A6	.59
7A7	.53
7AG7	.72
7B4	.53
7B5	.67
7B6	.56
7B7	.59
7C4	.34
7C5	.48
7C7	.59
7E5	.67
7E6	.54
7E7	.62
7F7	.59
7H7	.59
7K7	.89
7L7	.69
7N7	.67
7Q7	.59
7R7	.69
7V7	.87
7W7	.79
7X7	.79
7Y4	.47
7Z4	.57
12A	.57
12A6	.17
12A7	.89
12A8GT	.49
12AH7GT	.80
12AT6	.44
12AT7	.79
12AU6	.57
12AU7	.67
12AV6	.54
12BA6	.55
12BE6	.49
12C8	.34
12F5GT	.58
12H6	.27
12J5GT	.34
12J7GT	.67
12K7GT	.52
12K8	.59
12Q7	.49
12SA7	.57
12SC7	.54
12SF5	.59
12SF7	.54
12SG7	.52
12SH7	.35
12SJ7	.47
12SK7	.57
12SL7	.59
12SN7	.52
12SQ7	.49

12SR7	.49
12Z3	.69
14A4	.79
14A7	.52
14B6	.67
14F7	.69
14F8	.79
14H7	.59
14J7	.87
14N7	.85
14Q7	.53
14R7	.67
19	.69
24A	.49
25L6GT	.53
25Z5	.44
25Z6GT	.43
26	.49
27	.42
28D7	35
30	.37
31	.59
32	.85
32L7GT	.89
33	.69
34	.37
35/51	.57
35A5	.63
35B5	.55
35C5	.59
35L6	.52
35W4	.39
35Y4	.49
35Z3	.57
35Z4	.44
35Z5	.39
36	.67
37	.35
38	.37
39/44	.27
41	.49
42	.49
43	.49
45	.52
45Z3	.57
45Z5	.55
46	.62
47	.69
49	.85
50	1.39
50A5	.69
50B5	.53
50L6GT	.52
50Y6	.57
53	.87
56	.45
57	.45
58	.49
59	.89
70L7	.99
71A	.59
75	.53
76	.44
77	.43
78	.44
80	.37
81	1.25
82	.84
83	.75
83V	.89
84/6Z4	.56
85	.69
89Y	.35
117L7/M7	1.19
117N7	1.19
117P7	1.19
117Z3	.49
117Z6	.65

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189 GREENWICH STREET . NEW YORK, N. Y.

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GUARANTEED
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WESTINGHOUSE OVERCURRENT RELAY

Push Button Reset. Glass Enclosed.
.5-2 Amps Type SC-1 .... 5.95
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2mfd 250 volts ac oil cond .... 6 for .99
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.35 at 16 KV plus .75 at 8 KV Oil Cond 3.95
.1 MFD 7500 VDC Oil Cond .... .89
.05 MFD 7500 VDC Oil Cond .... .75
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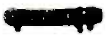
50 megohm 35 watt Resistor with mount....$1.49 each; 10 for $9.90
10 Meg 10 Watts... .49; 2 Meg 5 Watt .... .35

30 WATT WIRE WOUND RESISTORS

Ohms: 100-2000-2500-3k-4k-4500-5k-5300
18k .... .15 ea. 8 for .99



ADJUSTABLE RESISTORS

20 Watt: 1, 5, 50 Ohms .... .25
50 Watt: 80, 100, 500 Ohms .... .35
75 Watt: 40, 80, 100, 150, 200 Ohms .... .39
100 Watt: 20, 50, 75, 120, 180 Ohms .... .49
150 Watt: 50, 100 Ohms .... .59

WIRE WOUND RESISTORS

5 Watt type AA, 20-25-50-200-470-2500-4000 ohms .... $.09 ea.
10 watt type AB. 25-40-84-400-470-1325-1000-2000-4000 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.

MIDGET VARIABLE CONDENSERS

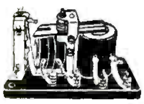
Steatite Insulation

15 MMF (HF 15) .... .39
Dual 15 MMF (HF 15 D) .... .69
250 MMF (MC 250 S) .... .69
325 MMF .... .79

CERAMICONS

MMF: 1.5, 2, 3, 8, 10, 20, 22, 120, 500 .... .05 ea.

General Electric Overload Relay. Electrical Reset 110 Volts 60 Cycle



Breaks at 640 Milliamps but easily adjustable for other currents. Terrific values at only $2.95

10 for 25.00

MINIATURE HEADPHONES

250 ohms imp. Can be used for sound power Telephones, etc.
Type HS 30 .... .69 ea.
HS 30 With Transformer .... .99
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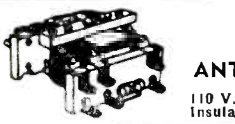
GENERAL PURPOSE TRANSFORMERS

Ideal for Bias, Filament, Isolation, Stepdown, etc. 2 isolated 110V Pri. Sec. 110V at 900 ma plus 6.3 @ 2 amps. Fully cased .... New $1.49 ea.



ADVANCE D.P.D.T ANTENNA RELAY

110 V. 60 cycle coil Steatite Insulation. Only $1.95 each.

W. W. POWER RHEOSTATS

25 Ohms 25 Watt .... .39
250 Ohms 50 Watt .... .59
300 Ohms 50 Watt .... .59
Dual 200 Ohms 50 Watt .... .79
100 ohm 100 watt .... .99
200 ohm 100 watt .... .99

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BRAND NEW

Govt Surplus

2" Gruen 0-500 Microamps (Volt Scale) 3.25
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3" Triplett 0-75 Amps AC 2.95
3" GE 0-15 Volts AC 3.95
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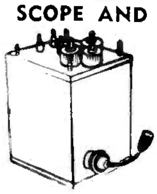
Pri 110V 60CY—Hermetically Sealed
1050V @ 20MA, 20V 4.5A, 2.5V 5A 4.75

SCOPE AND FIL. TRANSFORMERS



Pri. 115 volts, 60 cycles. Sec. 4400 volts RMS 4.5 MA., 5 volts CT 3 amps. Fil. Ins. 15 KV RMS test. Hermetically sealed. Has insulated plate cap for rectifier. Made by Raytheon, 4½ x 5 x 5½ .... Only $4.95
5 for $22.50

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Type G4 Ceramic Case 5¾" High, 5" Diameter Tolerance 5% or Better.

CAP MFD	Amps 1 Mc	Amps 300 Kc	KV DC	Price Each
.08	60	42	4	$27.50
.1	70	50	4	29.50
.65	60	42	5	24.50
.037	45	35	6	26.50
.02	40	30	9	29.50
.02	55	38	10	29.50
.0117	40	27	14	24.50
.0075	39	27	15	24.50
.009	40	25	15	29.50
.00978	40	25	15	29.50
.01	43	28	15	29.50
.0025	23	15	20	29.50
.00315	26	18	20	29.50
.004	30	20	22	33.50
.0033	25	16	25	35.50
.00082	14	8	30	27.50
TYPE G3 4" HIGH, 5" DIAMETER				
.0013	15	9	15	14.50
TYPE G2 3" HIGH 3½" DIAMETER				
.00057	8	4	10	6.95
Type G1 ½" High 2/16 DIAMETER				
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SILVER MICA CAPACITORS

MMF: 10, 47, 50, 60, 340, 750, 780, 1000 .... .09 ea.

Precision 15 Meg. 1% Accuracy Resistor, Non-inductive, 1 watt, hermetically sealed in glass .25 ea. 10 for $1.90

Thermal Time Delay Relay. 15 to 3 seconds, plugs into 4 prong Tube Socket Glass Enclosed 250 V. .75

PRECISION 1% W.W. RESISTORS

Ohms: 2K, 2500, 5K, 8500, 95K, 750K .... .25 ea.

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2 mfd 600 vdc— .39
4 mfd 600 vdc— .59
6 mfd 600 vdc— .79
3/3 mfd 600 vdc— .79
10 mfd 600 vdc— .89
4 mfd 1000 vdc— .95
5 mfd 1000 vdc—1.39
10 mfd 1000 vdc—1.99
2 mfd 1500 vdc—1.25
4 mfd 1500 vdc—2.25
6 mfd 1500 vdc—2.95
1 mfd 2000 vdc—1.45
2 mfd 2000 vdc—2.25
10 mfd 2000 vdc—6.95
2 mfd 4000 vdc—4.95
1 mfd 5000 vdc—4.50
.1/.1 mfd 7000 vdc—2.25
2 mfd 6000 vdc—9.95
1 mfd 7500 vdc—9.25
.01/.01 mfd 12kv dc—5.75
.005/.01 mfd 12 kv dc—5.50
65 mfd 12,500 vdc—12.95
2 mfd 18 kv dc—49.55
1 mfd 15 kv dc—15.95

HIGH VOLTAGE VACUUM CONDENSER

12 MMF 32 KV EIMAC VC 12-32 .... 4.95

FILAMENT TRANSFORMERS

110 V 60 CY Pri. Cased.
5 Volt 15 Amp $2.75
2.5 Volt 10 Amp 3.49
2.5 Volt CT 21 Amps 4.75
5 Volt 4A, 6.3V, 3A 2.45
2.5V CT 20A, 2.5V CT 20A 6.95

CHOKE BARGAINS

6 Henry 50 ma 300 ohms .... 3 for $0.99
8 Henry 150 ma 140 ohms .... .99
1.5 Henry 250 ma 72 ohms .... .59
6 Hy. 400 MA 97 Ohms $3.95

HEAVY DUTY RHEOSTAT

25 Ohms, 675 Watts Max. with Knob and Hardware $3.95
10 for $29.50

FILAMENT TRANSFORMER

6.3 volts at 12 amps. Primary 110 volts 60 cy. Size 3¼"H x 2⅞"W x 3"D. WT 3½ lbs. As Illustrated. While they last .... $1.69 ea.

SENSITIVE RELAY

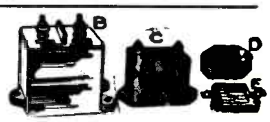
Breaks at 3 MA. Beautifully Constructed and delicately pivoted. Approx. 2000 ohms resistance. Housed in dustproof aluminum can. Plugs into 5 prong socket. Only .... .99 ea.

PLUG IN CAPACITOR

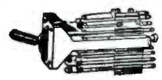
8 x 8 Mfd 600 volts DC. Oil filled. Plugs into standard 4 prong socket. 3¾ h x 3⅛ w x 1⅞ d $1.39

GENERAL ELECTRIC Type PBC Instantaneous Overcurrent Relay. Adjustable from 100 to 200 MA. Electrical and Manual Reset, 4 PDT, Reset 110 Volts 60 Cycles $7.95

BAKELITE CASED MICA

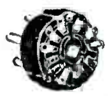


MMF	VDC	Price	MMF	VDC	Price
D .001	600	$ .18	C .001	3 KV	.90
E .01	600	.26	C .002	3 KV	.95
D .02	600	.26	D .005	3 KV	.70
E .027	600	.26	C .005	3 KV	1.24
C .01	1 KV	.45	C .006	3 KV	1.50
C .056	1 KV	.50	D .002	3 KV	.70
C .07	1 KV	.55	C .0001	5 KV	.70
D .02	1200	.35	C .0005	5 KV	.85
C .024	1500	.65	C .0015	5 KV	1.60
C .033	1500	.75	C .003	5 KV	1.90
C .015	2 KV	.80	C .005	5 KV	2.50
C .02	2 KV	.90	C .002	6 KV	2.90
D .002	2500	.45	B .007	5 KV	2.75
E .005	2500	.55	B .0005	8 KV	2.90
C .025	2500	1.25	B .002	12 KV	6.50



MOSSMAN SWITCHES

4 Pole Single Throw....$1.10
3 PDT. plus 6 PST..... 1.75



Heavy Duty Tap-Switch Ohmite Model 412

Single Pole 6 Positions, Non-Shorting 50 amp. contacts. Vitreous Enamel case. List $16.00 .... Only $2.95

Mallory Vibropack Transformers 6 Volt Input. Output 300 Volts at 100 MA. .... $2.95 ea.

Tremendous stocks on hand. Please send requests for quotas. Special quantity discounts. Price f.o.b. N. Y. 20% with order unless rated, balance C. O. D. Minimum order $5.00.

PEAK ELECTRONICS CO.
188 Washington St., New York 7, N. Y.

Phone CO 7—6486 / 6443
DEPARTMENT EA

Latest WELLS Tube Price List

Many Types Are Now Scarce At These Low Prices. Check your requirements at once for your own protection. All tubes are standard brand, new in original cartons, and guaranteed by Wells. Order directly from this ad or through your local Parts Jobber.

TYPE.	PRICE EA.
0A4G	.95
01A	.45
EL-C1A	3.95
1A3	.60
1A5GT	.65
C1B/3C31	4.85
1B4P	1.75
1B21A/GL471A	2.55
1B22	3.40
1B23	7.50
1B32/532A	1.85
1B42	5.25
1B48	9.90
EL1C	4.85
1C5GT	.65
1C6	.75
1C7G	.85
1D8GT	.95
1E7GT	1.95
1F4	.90
1G6	.65
1H4G	.80
1H6G	.80
1L4	.50
1LC6	.75
1LN5	.85
1N5GT	.75
1P24	2.50
1Q5GT	.85
1R4	.55
1S5	.70
1T4	.75
2A3	1.05
2A7	.75
2AP1	4.75
2B7	.75
2B22/GL559	3.25
2C22/7193	.35
2C26	.30
2C26A	.40
2C34	.10
2C44	1.25
2J21	10.45
2J21A	11.45
2J22	9.85
2J26	8.45
2J27	12.95
2J31	9.95
2J32	12.85
2J33	18.95
2J34	17.50
2J37	13.85
2J38	6.95
2J48	12.95
2J61	24.50
2J62	14.95
2X2	.55
2Y3G	1.20
3A4	.35
3A4/47	.45
3B7	.45
3B22	2.35
3B24	1.75
3BP1	3.75
EL-3C	3.95
3C21	5.00
3C24/24G	.50
3C31-C1B	4.85
3CP1-S1	1.95
3DP1	3.75
3D6/1299	.45
3FP7	1.85
3FP7A	4.95
3GP1	4.50
3H17	1.00
3HP7	2.95
3Q5	.90
3Q5GT	.90
3S4	.75
GA4	2.00
REL5	14.95
VT5/215A	1.20
5AP1	3.95
EL-C5B	4.25
5BP1	2.75
5BP4	3.95
5CP1	3.75
5D21	24.75
5FP7	2.75
5GP1	2.75
5HP4	4.75
5J23	14.25

TYPE.	PRICE EA.
5J29	13.45
5V4G	1.07
5W4	.76
5Z3	.80
5Z3G	.75
6-4	.35
6-7	.35
EL-C6A	2.00
6A3	.80
6A6	.65
6AB7	.95
6AC7	.90
6AE6G	.85
6AG5	1.20
6AH6	1.10
6AK5	1.20
6AK6	.80
6AL5	.95
6AU6	.95
6AV6	.81
6B4G	.95
6B7	.75
6B8	.95
6B8G	.95
6BA6	.95
6BE6	.65
6C4	.40
6C8G	1.05
6C21	19.25
6D6	.50
6F5	.85
6F6	.60
6F6G	.60
6F8G	.95
6G6G	.80
6H6	.45
6J6	.90
6J7GT	.70
6J8G	.95
6K6GT	.55
6K7	.80
6K7G	.80
6L6G	1.35
6L7	.75
6N7	.75
6N7/GT	.75
6Q7	.55
6R7G	.75
6SA7	.65
6SC7	.75
6SC7GT	.70
6SF7	.80
6SF5	.65
6SG7	.65
6SH7	.40
6SH7GT	.40
6SJ7	.60
6SJ7GT	.60
6SK7	.60
6SK7GT	.60
6SL7GT	.60
6SN7GT	.85
6SQ7	.60
6SQ7GT	.60
6SR7	.60
6SR7GT	.60
6SS7	.60
6U7G	.85
6V6GT	.75
6W5G	.80
6X5GT	.73
6Y6G	.65
7-7-11	.35
7A4/XXL	.60
7A5	.80
7A6	.75
7A7	.60
7B4	.60
7B6	.60
7B8	.60
7BP7	4.95
7C4/1203A	.35
7C5	.65
7C7	.65
7E5/1201	.60
7E6	.60
7F7	.70
7H7	.70
7L7	.70
7N7	.70
7T7	.90

TYPE.	PRICE EA.
7Y4	.90
9-3	.45
10	.55
10 ACORN	.65
10 (VT-25A)	.55
10E/146	1.00
10T1	.60
10Y (VT-25)	.45
12A6	.25
12A6GT	.25
12A7	.80
12AH7GT	1.12
12AU7	.96
12AX7	1.20
12BD6	1.20
12C8	.50
12F5GT	.65
12H6	.40
12J5GT	.40
12J7GT	.70
12K8	.65
12Q7GT	.75
12SA7	.73
12SC7	.75
12SF7	.60
12SG7	.65
12SH7	.40
12SJ7	.73
12SK7	.60
12SK7GT	.60
12SL7GT	.60
12SN7GT	1.10
12SQ7GT	.60
12SR7	.60
12X825-2AMP. TUNG.	1.95
12Z3	.90
13-4	.35
14A7	.90
14B6	.75
14F7	.90
14H7	.90
14Q7	.90
14R7	.90
15E	1.50
15R	1.20
16X879-2AMP. TUNG.	1.95
FG17/967	3.25
19	1.20
20-4 BALLAST.	.45
21-2 BALLAST.	.45
REL21	2.75
23D4	.45
RK24	1.75
24A	.75
RK25/802	2.85
VT-25-A/10	.55
25Z5	.73
25Z6GT	.55
25Z6G	.55
26	.65
27	.50
28D7	.40
30/VT-67	.75
30 (NOT VT-67)	.75
33	.75
34	.35
GL34	1.50
RK34/2C34	.45
35/51	.60
35L6GT	.73
35W4	.73
35Z5GT	.62
36	.40
37	.40
38	.40
39/44	.35
41	.55
42	.50
43	.50
45 SPEC.	.50
46	.75
EF50	.45
UH50	1.00
50B5	1.00
50L6GT	.95
56	.65
57	.45
58	.50
RK60/1641	.65
VT62 (BRITISH)	1.10
65	1.25

TYPE.	PRICE EA.
66B4	.90
VT67/30	.90
70L7	1.05
71A	.75
CEQ72	1.50
CRP72	.95
CYN72	1.75
RKR72	.90
RKR73	1.25
75	.89
76	.55
77	.55
78	.50
VR78	.65
80	.45
FG-81-A	3.95
83V	.90
89	.73
89Y	.40
VR90	.65
VT90 (BRITISH)	2.55
VR92	.65
FG95/DG1295	9.95
VT98/REL5	14.95
100R	2.75
100TH	11.50
101/837	1.65
102F	3.55
FG105	9.75
VR105	.85
VU-111-S	.55
114B	1.20
121A	2.65
122A	2.65
VT127 (BRITISH)	.35
VT127A	2.95
VR150	.50
VT158 (HK)	14.95
FG172	19.75
205B	1.45
211 (VT-4-C)	.60
215A (VT5)	1.20
CEP220	2.00
221A	1.75
227A	4.75
231D	1.20
RX233A	1.95
250R	9.00
257A	3.00
268A	2.95
282B	4.25
287A/722A	9.50
304TL	1.75
304TH	5.75
307A	4.25
316A	.55
327A	2.50
350B	2.65
354C	14.95
356B	4.95
368AS/703A	3.95
371A/VT62	.95
371B	.85
388A	3.95
393A	4.65
395A	4.95
MX408U-BALLAST.	.30
417A	14.50
434A	3.40
446A	1.55
446B	1.55
450TH	17.95
GL451	1.90
GL471A	2.55
SS501	3.00
527	9.95
WL530	5.00
WL531	12.95
WL532	1.85
532A/1B32	3.55
GL559	3.75
KU610	7.45
HY615	1.05
WL632A	8.75
700	7.95
700B	7.95
700C	7.95
700D	7.95
701A	3.00
702A	2.95
703A/368AS	3.95
704A	1.75

TYPE.	PRICE EA.
705A	1.55
706AY	17.50
707A	14.00
707B	15.00
708A	3.75
709A	4.75
710A	2.45
713A	1.50
714AY	3.75
715B	9.75
717A	.85
718BY	15.00
718EY	15.00
721A	3.75
721B	3.95
722A/287A	9.50
723AB	14.95
724A	4.25
725A	9.95
726A	12.50
726B	13.50
730A	9.95
801	.50
801A	.70
803	5.25
804	8.95
805	5.95
807	1.25
808	1.65
809	2.50
812	2.95
813	7.85
814	3.75
815	2.85
826	.75
830B	3.95
832A	7.95
834	5.75
835/38111A	1.10
836	1.35
837	1.65
838	3.25
841	.50
842	2.75
843	.50
851	39.00
852	6.25
861	29.45
864	.45
865	2.55
866-JUNIOR.	.85
866A	1.30
869	19.75
869B	27.25
872A	2.45
874	1.95
876	.50
878	1.95
879/2X2	.55
902	3.50
923 (PHOTO)	1.35
930	1.00
931A	3.95
954	.35

TYPE.	PRICE EA.
955	.55
956	.55
957	.45
958	.55
958A	.55
959	.55
967/FG17	3.25
991/NE-16	.24
1005	.35
1007	4.50
1148	.35
1201	.45
1203	.55
1203A	.65
1294	.55
DG1295	9.95
1299/3D6	.45
1613-SELECT. 6F6	.55
1616	1.25
1619	.35
1624	1.25
1625	.35
1626	.35
1629	.35
1630	3.95
1638	.90
1641/RK60	.65
1642	.50
1852/6AC7	.90
1853/6AB7	.95
1960	1.35
1961/532A	1.85
2050	.78
2051	.75
UX6653	1.20
7193	.35
8011/VT90. BRITISH	2.55
8012	3.25
8013	1.25
8013A	1.50
8019	1.75
8020	3.25
8025	6.75
9001	.65
9002	.45
9003	.60
9004	.40
9006	.40
38111A/835	1.10

XTAL DIODES

1N21	.65
1N21A	.95
1N21B	1.20
1N22	.80
1N23	.80
1N23A	.85
1N27	.85
1N29	.85
1N51 (GE)	.75
1N48 (GE)	.75
1N52 (GE)	1.00

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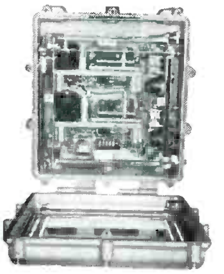
Manufacturers, Distributors and Amateurs: Write for the brand new Wells Electronic Catalog H500. It's full of Tremendous values in highest quality components.

WELLS SALES, INC. 320 N. LA SALLE ST. DEPT. SL, CHICAGO 10, ILL.

IMMEDIATE DELIVERY • LOW PRICES • FULLY GUARANTEED

BROWN TELEPLOTTER RECEIVER



Model 791X1R

115 volt 60 cycles

Contains a pen driven by two balancing motors which writes on rear of a translucent chart. Pen arm position is in terms of two co-ordinates supplied balancing motors thru two amplifiers. Originally intended for recording plotted or written data from central plotting board. Writes at one half scale on 18 in. chart. Discriminator input circuit designed to operate unit as function of two varying R.F. frequencies varying about mean of approx. 430 KC. Further data on request. (Shipping weight 435 lbs.)

Price $375.00

LP-21-LM Compass Loops

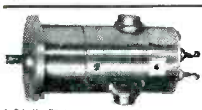
Motor driven loop enclosed in graphited zeppelin housing includes Autosyn transmitter. Stock #SA99.

$14.50 each

G.E. Servo Amplifier—2CV1C1 Aircraft amplidyne control amplifier, 115 volt 400 cycles. Two channel. Uses 2 6SN7GT and 4 6V6GT tubes. Supplied less tubes. Stock #SA-168. **Price $9.50 each.**

D.C. MOTORS

Universal Electric W.E. KS-5603-1-02,-28 v. d-c 0.6 amps. 1/100 hp. 4 lead shunt. Stock #SA-233. **Price $3.75 each.**



12 V.D.C. Motor John Oster B-9-2

1.4 amps. 5600 rpm. 1¾" Diam. x 3¾" Lg. Spline shaft. C.W. rotation. Stock #SA-46. **Price $1.95 each**

DELCO CONSTANT SPEED MOTOR A-7155

1/30 hp. 27.5 v d-c 3600 rpm. Cont. duty. 2½" diam. x 5½" lg. ⅞" shaft extension, 5/32" diam. 4 hole base mounting. Stock #SA-94. **Price $4.75.**

Delco 506925 Constant Speed DC Motor, 27 v. d-c 120 rpm. Governor controlled. Stock #SA-249. **Price $3.95 each.**

General Electric 2 RPM Motor. Type 5BA10FJ228. 27 v. d-c @ 0.6 amps 10 lb/in torque at 2 rpm. Shunt wound. D-C noise filter. Stock #SA-274. **Price $6.75 each.**

Synchron 10 RPM D.C. Timing Motor—24 V. Hanson Mfg. Co. Stock #SA-110. **Price $3.75 each.**

General Electric Type 5BA10AJ52C 145 rpm. 27.5 volt D-C motor. 0.65 amps. 14 in./oz. torque. Shunt wound four lead reversible. Stock #SA-218. **Price $4.75 each.**

D-C ALNICO FIELD MOTORS

Delco 5069456. 27.5 volts. 10,000 rpm. 1" x 1" x 2" lg. Stock #SA-236. **Price $6.75 each.**

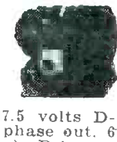
Other models also available

MICROWAVE ANTENNA

AS-217-APG 15B, 12 Cm dipole and 13 inch Parabola housed in weatherproof Radome 16" dia. 24 v. DC spinner motor for conic scan. Stock #SA-95. Shipping wt. 70 lbs.

Price $6.95 ea.

INVERTER SPECIALS 400 Cycles



Pioneer Type 12128-1-B. 27.5 volts D-C input. 26 volts 400 cycle 1 phase out. 6.0 V.A. (Current manufacture) Prices on Request.

General Electric 5D21NJ3A — Input 28 volts DC at 35 amps. Output 110 volts 400 cycles. 485 V.A. at 0.90 P.F. Weight 15 lbs. Stock #SA-41. **Price $12.50 each**

General Electric 5AS131NJ3 — Input 26 volts DC at 100 amps. Output 115 volts 400 cycles. 1500 V.A. 0.8 PF. Stock #SA-286. **Price $19.50 each**

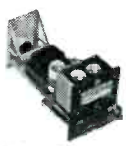
SYNCHROS

Navy Types

1G, 1F, 1CT, 5G, 5F, 5CT, 5DG, 5HCT, 5SF, 5HSF, 5SDG, 6DG, 6G, 6DG, 7G, etc.

Prices on Request

SERVO AMPLIFIER



Minneapolis Honeywell 115 v. 400 cycle unit. For use with SA-268. Model G403ATCA3. Designed for use with A-C error signal from bridge circuit. Stock #SA-269A. **Price $8.50.**

MOTOR SPECIALS

G.E. 5BA25AJ31A and 32A. Dual field reversible gear head shunt wound. 24 v. @ 2.9 amps. 9 rpm. 10 min. time rating. Aircraft type. Magnetic brake. Stock #SA-298. **Special Price $19.50 each.**

G.E. 5PS56HC18 — Split field series reversible motor. 60 v. d-c at 1.4 amperes. 5500 rpm. 3" diam. x 5" lg. Ideal for servo applications. Stock #SA-273. **Price $8.75 each.**

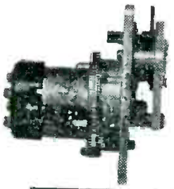
OSTER PM MOTOR

Alinco Field

27.5 v. d-c Can also be used as rate generator. #SA-281. **$3.75 each**

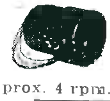
Gyro and Housing Mirror Assembly. For K-14A sighting head. Gyro stabilized mirror assembly. Stock #SA-294. **Price $9.75 each.**

AC-SERVO MOTORS



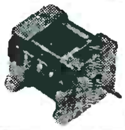
Pioneer Type CK-2. 26 v. 400 cycles fixed phase, var. phase 49 v. max. 40:1 gear reduction. Stock #SA-97A. **Price $6.50 each.** Also available less gear train. **Price $4.25 each.** Stock #SA-97.

PIONEER CK-17



400 cycle 2 phase. 26 v. fixed phase. 45 v. max. variable phase. Built in gear reduction. Output shaft speed approx. 4 rpm. Stock #SA-287. **Price $12.50.**

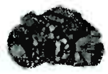
FORD SERVO MOTOR



115 volt 60 cycle two phase low inertia motor. 15 watts output. BuOrd. 207927. Stock #SA-291. **Price $19.50 each.**

MINNEAPOLIS-HONEYWELL

Type G303AY2CA4 Servo Motor

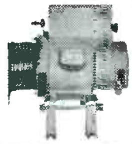


115 v. 400 cycles. Built in gear reduction. 50 in/lb. torque. Stock #SA-268. **Price $6.75 each.**

SAWTOOTH POTENTIOMETER

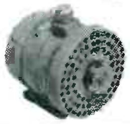
W.E. KS-15138

Type RL-B-R. 100 ohm element. Non linear ring gives linear output with CRT deflection coil load. Cont. rotation. 2 brushes 180 degrees opposed. 2 taps 180 degrees opposed. Stock #SA-288. **Price $5.50 each.**



400 Cycle Generators

Homelite 18A120D28-1 400 cycle out at 1 phase 115 v. 39 amps. Also a d-c output of 28 v. and 17.9 amps. **Special at $175.00 each.**



G. E. 5ASB31JJ3. 400 cycles out at 115 volts 7.2 amps. Ideal for lab. 6" lg. x 6" diam. 8000 rpm. Stock #SA-292. **Price $79.50 ea.**

PRECISION AUTOSYN

Pioneer Type AY-150 Control Autosyn. Precision type. 26 v. 400 cycle. Stock #SA-297. **Special low price $14.50 each.**

A-5 Autopilot Indicator

Autosyn Type Pilot Indicator for A-5 Autopilot. 26 v. 400 cycles. Stock #SA-299. **Price $12.50 each.**

ANTENNA TILT INDICATOR

D-C Selsyn type tilt indicator. G.E. 8DJ29AAK. 24 volt. Stock #SA-296. **Price $2.75 each.**

Prices F.O.B. Paterson
Phone ARmory 4-3366
Teletype PAT. 199
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Servo-Tek products co.
4 Godwin Ave. Paterson, N. J.

SPECIALISTS IN FRACTIONAL HORSE POWER MOTOR SPEED CONTROL

LAVOIE FREQ. METER MICRO-WAVE

375 to 725 MCS

Model TS-127/U is a compact, self-contained, precision (± 1 MC) frequency meter which provides quick, accurate readings. Requires a standard 1.5V "A" and 45V "B" battery. Has 0-15 minute time switch. Contains sturdily constructed Hi-"Q" resonator with average "Q" of 3000 working directly into detector tube. Uses 957, LS6 and 3S4 Tubes. Complete, new with inst. book, probe and spare kit of tubes. Less batteries.
Write for descriptive circular.............. **$49.50**

THERMOSTATIC TIME DELAY RELAY

Amperite type 115 No.—45 Heater voltage 115V. Normally open SPST contacts. 45 sec. delay. Contact rating 115V-3A., A.C. (or 440V., A.C. 2A) max. voltage on contacts—1000 max. voltage bet. contacts and heater—1500. Size 3 9/32 x 1¼" overall. Made for U. S. Navy.............. **$1.10**

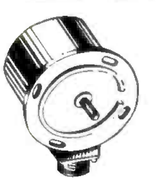
High Voltage Capacitors Oil Filled

.25 MFD., 20KV.... **$15.75**
.5 MFD., 25 KV.... **$23.50**
1 MFD., 15KV...... **$16.50**
1 MFD., 7.5KV..... **$4.95**

All brand new. Made by prominent manufacturers.

TUBE SPECIALS

1B24	$3.75	700A	$19.50
2J26	$7.50	7060CY	$18.50
2J27	$12.50	721A	$3.90
2J49	$19.50	725A	$8.50
2J62	$35.00	7BP7	$4.25
3BP1	$2.00	814	$3.60
3B22	$2.00	826	$ .40
3B24	$1.45	861	$10.00
3CP1	$2.60	8020	$1.25
3C45	$10.00	8025	$3.00
3D21A	$1.00	9LP7	$3.85
4C35	$17.50	WE394A	$3.65
5FP7	$1.25	WL531	$6.75
		C6J	$2.00



LINEAR SAWTOOTH POTENTIOMETER

No. KS 15138

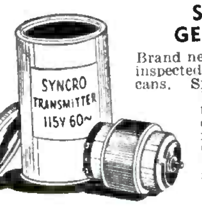
Has continuous resistance winding to which 24 volts D.C. is fed to two fixed taps 180° apart. Two rotating brushes 180° apart take off linear sawtooth wave voltage at output. Size approximately 3¾" dia. x 3" deep x 4¾" long. Enclosed in die cast alum. frame with AN connector socket.

$5.50
Brand New

U. S. NAVY SOUND POWERED BATTLE PHONES

Western Electric No. D173312. Type O. Combination headset and chest microphone as illustrated. Brand new including 20 ft. of rubber covered cable **$17.50**

Automatic Elec. Co. No. GLS43AO. Similar to above but including Throat microphone in addition to chest microphone. Brand new with 20 ft. rubber covered cable **$13.50**



SYNCHRO GENERATORS

Brand new—Gov't. sealed and inspected—Packed in overseas cans. Synchro Transmitters 115 V., 60 cy. operation. Precision accuracy made for gun fire control. Cost Gov't $90.00 each. Wgt. 5 lbs. Dimensions: 4½"L x 3¼". Brand New Per Pair **$14.75**

Differential Synchros

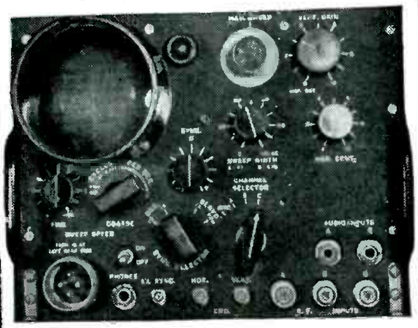
90/90 volts, 400 cycles. Brand new in sealed containers. **Ford Inst. Co.** type 5SDG. Brand new... **$12.50**

MICROWAVE RECEIVERS

APR-1, APR-4, APR-5A.

Tuning Units for APR-1 or APR-4. TN-16 (38-95 mc). TN-17 (74-320 mc) TN-18 (300-1000 mc.) These front ends may be used with any 30 mc. IF amplifier or as converters into receivers tuned to 30 mc.)

MODEL AN/APA-10 PANORAMIC ADAPTER



Provides 4 Types of Presentation:
(1) Panoramis (2) Aural
(3) Oscillographic (4) Oscillosocopic

Designed for use with receiving equipment AN/ARR-7, AN/ARR-5, AN/APR-4, SCR-587 or any receiver with I.F. of 455kc. 5.2mc. or 30mc. With 21 tubes including 3" scope tube. Converted for operation on 115 V. 60 cycle source
Includes 80 page T. M.................... $195.00

MOTOR GENERATORS DYNAMOTORS, INVERTERS, ETC.

2.5 KVA MG SET. Diehl Elec. Co. 120V DC to 120V AC, 60 cy. 1 Ph. Complete with Magnetic Controller, 2 Field Rheos and Full Set of Spare Parts including Spare Armatures for Generator and Motor.
Full specs. on request. New.............. **$185.00**

2 KVA MG SET. O'Keefe and Merritt. 115V DC to 120V AC. 50 cy. Idles as 3 Ph. syncs motor on 208V, 50 cy. New. Export crated. **$165.00**

1.25 KVA MG SET. Allis-Chalmers. 115V DC to 120V AC, 60 cy, 1 Ph. Fully enclosed. Splashproof. Ball Bearings. Centrifugal Starter. New **$97.50**

Same machine but for 230V DC operation.... **$110.00**

Spare Parts for either machine.............. **$15.00**

MG SET FOR NAVY TBS TRANSMITTER. Type CG-21302. 440V AC, 60 cy, 3 Ph, 1500VA to 875V DC and 300V DC. New **$45.00**

DYNAMOTOR. Navy Type CAJO-211444. 105/130V DC to 13V DC at 40A or 26V DC at 20A. Radio filtered. Complete with Line Switch. New **$69.50**

DYNAMOTOR. Eicor. 32V DC to 110V AC, 60 cy, 1 Ph, 2.04 Amps. New.............. **$24.50**

DYNAMOTOR. Eicor. 32V DC to 110V AC, 60 cy, 1 Ph. 0.43 Amps. New **$17.50**

MISCELLANEOUS SMALL MOTORS INVERTERS, AMPLIDYNES

AMPLIDYNE—G. E. Model 5AM31NJ9A. 530 Watts. 7300 R.P.M. Input: 27V. DC, Output: 60V. DC. Weight—34¼ lbs. New.............. **$10.50**

AMPLIDYNE—G. E. Model 5AM21JJ7. 4600 R.P.M. Motor Compound wound. 150 Watts. Input: 27V. DC Output: 60V. DC Sig. Corp. U. S. Army MG-27-B. New **$16.50**

INVERTER—Leland Elec. Co. Model PE206A. Input: 28V. DC, 38 Amps. Output: 80V., 800 cy, 485 VA. New **$12.50**

INVERTER—G. E. Model 5D-21NJ3A. Input: 24V. DC, Output: 115V. 400 cy. 485 VA. New.... **$12.50**

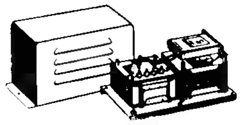
INVERTER—Bendix Pioneer Type 12121-A. 24V DC to 115V AC. 400 cy, 3 Ph. 250 VA. New **$89.50**

D.C. MOTOR—G. E. Model 5BA 50LJ2A 0.5 HP. Armature: 27V. at 8.3 Amps. Field: 60V. at 2.3 Amps. R.P.M. 400. New.............. **$12.50**

DYNAMOTOR—Type PE94C. For use with SCR522 Transmitter-Receiver. Brand new in export cases **$9.50**

LINE VOLTAGE STABILIZERS

RAYTHEON—Navy Type, CRP-301407 Input: 92-138V. 57/63 CPS., 1 PH Output: 115V. 0.82 KVA., 1% Reg., 0.96 PF. Weight 385 lbs. Overall size—36" high x 20" wide x 12¼" deep. Enclosed in Navy Grey Ventilated Cabinet for Wall Mounting.
Brand New $69.50



RAYTHEON Adj. input taps 95-130V., 60 cy. 1 Ph Output: 115V., 60 Watts. ½ of 1% Reg. Wt. 20 lbs. 6⅛" H x 8¼" L x 4⅝" W. Overload protected. Sturdily constructed. Tropicalized.
Special..... **$12.50**

400 CYCLE TRANSFORMERS

AUTO. 400 cy. G.E. Cat. No. 80G184 KVA .945S—.520P. Volts 460/345/230/115. New **$3.45**

FILAMENT. 400/2600 cy. Input: 0/75/80/85/105/115/125V. Output: 5V3A/5V3A/5V3A/5V3A/5V6A/5V6A/6.3V6A/6.3V5A. New **$1.95**

THYRATRON POWER. 400/1600 cy. Raytheon UX-8876. 400/1600 cy. Pri: 115V, Sec: 50-0-50V at 0.5A. 6.3V at 1.2A. Test r.m.s. 1780. New.......... **$2.75**

PLATE. WECO KS9560. 400/800 cy. Pri: 115V. Sec: 1350-0-1350 at .057A (2700V Total). Elecstat shlded. Wt. 2.3 lbs. New.............. **$2.95**

SCOPE PL. & FIL. WECO 9556. 400/2400 cy. Pri: 115. HV. Wdg. 1125V at .008A. Fil. Wdgs. 6.4V4A/2.5V1.75A/6.4V.6A. Elecstat shlded. Wt. 1.4 lbs. New **$2.75**

FILAMENT. 400/2400 cps. WECO KS9553. Pri: 115V, Sec: 8.2V1.25A/6.35V1.5A. Elecstat shlded. Wt. 0.5 lbs. New.............. **$1.65**

PLATE & FIL. 400/2600 cy. Pri: 0/80/115V. Sec#1=1200VDC at 1.5MA, Sec#2=400VDC at 130MA. Fil Secs: 6.4V4.3A/6.35VO.8A (ins.1500V)/5V2A/5V2A **$3.95**

RETARD. 400cy. WECO KS9598. 4 Henry 100MA **$1.00**

400 CY. SERVO TRANSFORMERS

G.E. #68G665X Pri: 57.5V. Sec:#1=28.75V. Sec: #2=28.75V **$1.50**

G.E. #68G666X Pri: 57.5V. Sec: 115V C.T..... **$1.50**

G.E. #68G667 Pri: 220V C.T. Sec: 220V C.T... **$1.50**

G.E. #68G668X Pri: 115V. Sec: 275V/275V/275V/275V/230V/230V/6.3V CT/ 6.3V CT.......... **$3.50**

60 CYCLE TRANS

1.5 KVA STEPDOWN. G.E. Cat. No. 76G173. Pri: 115/230V Sec: 23/11.5V. Either high voltage connection may be used with either low voltage connection **$23.95**

50KVA STEPDOWN. Standard Trans Corp. Oil trans type MD. Pri: 450V111A, Sec: 117V427A. Navy type. Ambient temp. 50 Deg. C **$125.00**

FILAMENT. Raytheon Hypersil Core. Pri: 115V. Sec: 6.3V22A/6.3V2.4A/6.3V2.25A/6.3VO.6A Ins. for 1700V **$3.95**

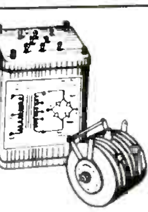
FILAMENT. Kenyon. For 866 tubes. Pri: 115V Sec: 2.5VCT at 10A. Insulation 10,000V.......... **$2.95**

SPECIAL TRANS

PULSE. Utah No. 9350.............. **$1.25**

PULSE. WECO KS-9563. Supplies voltage peaks of 3500V from 807 tube. Tested at 2000 Pulses/sec and 5000V peak. Wdg. 1-2=18 ohms. Wdg. 1-3=72 ohms. L of Wdg. 1-3= .073-.082H at 100 cps.......... **$5.50**

BLOCKING OSC. Westinghouse #132AWP.... **$4.95**

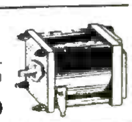


12 and 24 Volt POWER KIT

Consists of Power Trans. and full wave bridge selenium rectifier. Input: 115/230 A.C. Output: 12/24V D.C. at 1.1 amps. Fine for operating relays, small motors, dynamotors, or for low voltage D.C. source in laboratories, etc.

Brand New **$7.95**

SWEEP GENERATOR CAPACITOR



High speed ball bearings. Split stator silver plated coaxial type 5/10 mmfd. Brand new.
$1.00

PARABOLOIDS

Spun Magnesium dishes 17½" dia., 4" deep. Mounting brackets for elevation and azimuth control on rear. 1½" x 1⅝" opening in center for dipole. Brand new per pair.............. **$8.75**

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LECTRONIC RESEARCH TUBE SPECIALS

STANDARD BRANDS ONLY

RECEIVING TUBES

Tube	Price
OZ4G	.59
1A3	.45
1AB5	.73
1B3GT	1.18
1L4	.66
1R4	.29
1R5	.69
1S4	.86
1S5	.64
1T4	.64
2X2/879	.49
2X2A	.79
3A4	.61
3A5	.96
3A8GT	1.76
3B7/1291	.29
3D6/1299	.29
3Q5GT	.79
3S4	.61
5R4GY	1.30
5T4	.89
5U4G	.59
5V4G	.84
5Z3	.65
6AB7/1853	.99
6AC7/1852	.79
6AC7W	1.45
6AG5	.89
6AG7	1.19
6AJ5	.89
6AK5	1.20
WE-6AK5	1.50
6AK6	.82
6AL5	.69
6AQ5	.72
6AQ6	.65
6AS7G	4.22
6AT6	.54
6AU6	.72
6AV6	.55
6BA6	.65
6BA7	.86
6BE6	.65
6BG6G	1.72
6BH6	.72
6BJ6	.72
6C4	.21
6F6	.69
6H6	.49
6J5	.49
6J6	.89
6J7	.72
6K6GT	.52
6K7	.54
6K8	.83
6L6	1.22
6L6G	1.11
6L6GA	.87
6SB7Y	.79
6SC7	.66
6SF7	.72
6SG7	.69
6SH7	.44
6SJ7	.59
6SL7GT	.69
6SN7GT	.79
6SN7W	1.45
6V6	1.07
6V6GT	.59
6W4GT	.65
6X4	.59
6X5GT	.59
7F7	.79
7N7	.79
10Y	.19
12A6	.24
12AH7GT	.87
12AT6	.59
12AT7	.99
12AU6	.72
12AU7	.86
12AX7	.86
12BA6	.64
12BA7	.86
12BE6	.64
12C8	.59
12SG7	.69
12SH7	.49
12SJ7	.49
12SK7	.59
12SL7GT	.69
12SN7GT	.79
12SR7	.69
28D7	.61

Cathode Ray

Tube	Price
2AP1	3.65
2AP5	5.95
3AP1	4.63
3AP4/-906P4	5.94
3BP1	2.59
3CP1	1.87
3DP1A	5.75
3EP1	2.92
3HP7	4.91
4AP10	5.35
5AP1	3.75
5AP4	4.75
5BP1	2.40
5CP1	2.87
5CP7	3.76
5FP7	1.05
5HP4	3.35
5JP2	9.55
5LP1	13.95
5MP1	10.65
7BP1	12.87
7BP7	4.95
7BP14	14.95
9GP7	9.85
9LP7	3.88
10BP4	21.95
10FP4	28.88
12DP7	12.85
12GP7	12.85
902P1	3.95
905	4.47
913	4.90

Photo Cells

Tube	Price
1P24	.29
918	.88
919	1.79
923	.97
927	1.67
931A	3.22
1645	1.67

Thyratrons and Ignitrons

Tube	Price
OA4G	.95
EL-C1A	3.35
2A4G	1.15
2D21	1.09
3C23	3.20
3C31/EL-C1B....	3.35
4C35	21.00
EL-C5B	8.95
C6J	4.44
FG-17	2.89
FG-33	11.95
FG-67/-1904	8.85
FG-81A	4.95
91	5.85
FG-95	20.60
FG-105	9.95
FG-172	14.50
WE-355A	14.15
393A	5.77
394A	3.77
GL-415/-5550	22.00
KU-610	6.35
KU-628	16.90
KU-634	17.20
WL-652/-5551	38.00
WL-672	13.25
WL-677	24.00
WL-681/-5550	22.00
722A	3.75
873/973	6.95
884	1.35
885	1.20
1665	.97
1904	8.85
2050	.83
2051	.49

Transmitting & Special Purpose Tubes

Tube	Price
OA2	1.32
OB2	1.75
1B22	3.87
1B23	8.95
1B24	4.90
1B26	4.50
1B27	4.50
1B29	2.90
1B32	3.15
1B36	4.50
1B42	9.80
1H20	.58
2B22	1.41
2C22	.22
2C26	.27
2C34	.28
2C44	.79
2E22	1.25
2J21A	8.95
2J22	8.95
2J26	7.80
2J27	13.70
2J31	9.60
2J32	14.45
2J33	19.90
2J34	19.90
2J37	13.70
2J38	12.70
2J41	132.50
2J48	14.95
2J61	36.20
2K23	23.95
2K25	19.95
2K28	19.95
2X2A	.79
3B22/EL-1C	1.12
3B23	4.75
3B24	1.25
3B27	1.29
3C24	.44
3E29	6.20
3J31	39.25
4-125A	26.95
4-250A	36.75
SN-4/631-P1	3.77
4A1	.58
4B22/EL-5B	5.20
4B24/EL-3C	2.44
4B25/EL-6CF	8.70
4C28	21.65
4E27	12.75
5D21	26.50
5123	14.20
5J29	14.20
6C21	19.88
6J4	5.20
7-7-11	.89
10T1	.58
10Y	.19
15E	1.25
15R	.75
REL-21	3.25
24G	.44
RK-25	2.11
FG-32	4.25
RK-34	.28
REL-36	.78
RK-47	4.92
EF50	.45
VT-52	.36
53A	3.82
RK-59	2.44
RK-60/1641	.59
RK-72	.92
RK-73	.92
VR-75/-OA3	1.10
75T	3.80
VR-78	.34
VR-90/OB3	.81
VT-98-(BR)	29.90
C100E	2.30
100R	2.90
100TH	10.25
WE-101D	1.65
WE-101F	3.62
VR-105/-0C3	.72
WE-113A	1.32
WE-124A	3.80
VT-127A	2.40
VR-150/-0D3	.65
FG-190	12.15
203A	6.40
203B	4.33
204A	27.90
CE-206	3.15
211	.62
WE-215A	.24
221A	1.95
227A	2.40
WE-231D	1.25
RX-233A	2.95
WE-244A	4.20
WE-245A	1.35
WE-249C	1.88
WE-254A	4.90
WE-257A	2.77
WE-259A	4.22
WE-271A	6.75
WE-283A	1.27
WE-300B	7.50
304TH	3.86
304TL	1.25
307A	3.90
WE310A	7.50
WE-313C	3.15
316A	.66
WE-329A	2.90
WE-336A	3.10
WE-339A	3.22
350A	2.80
350B	1.95
354C	19.50
WE-356B	4.45
361A	4.75
371B	.82
388A	2.95
417A	10.65
434A	3.65
446A	.79
446B	1.95
450TH	19.70
451	1.75
471A	2.75
SS-501	11.50
503AX	1.47
506AX	1.47
507AX	1.47
527	9.75
530	17.20
531	17.80
532A	3.15
559	1.41
561	1.45
579B	5.85
HY615	.29
631-P1	3.77
WL-670A	8.70
700B	16.90
700C	16.90
700D	16.90
701A	3.67
702A	2.95
702B	3.87
703A	3.90
704A	2.75
705A	1.17
706AY	45.00
706BY	45.00
706CY	17.95
706FY	45.00
706GY	45.00
707A	5.22
707B	6.95
708A	4.85
709A	4.87
710A	2.25
713A	1.45
714AY	6.95
715A	6.75
715B	9.95
717A	.97
721A	3.93
723A	6.95
723A/B	16.50
724A	3.22
724B	3.22
725A	8.95
726A	14.50
730A	10.95
731A	2.45
WL-787	9.80
800	1.88
801A	.48
802	4.25
803	4.87
804	8.95
805	4.75
807	1.25
808	2.19
809	2.40
810	7.95
811	2.11
813	7.25
814	3.79
815	1.72
816	.97
826	.57
828	13.48
829	4.91
829B	6.20
830B	3.35
832	4.50
832A	4.91
836	.89
837	1.38
838	2.93
841	.49
843	.59
851	27.50
852	6.40
860	4.50
861	17.70
864	.19
865	.88
866A	1.15
869B	27.00
872A	1.88
874	1.65
876	.39
878	1.85
954	.39
955	.39
956	.49
957	.49
958A	.49
959	.49
991	.29
1005	.24
1201/7E5	.29
1203/7C4	.19
1294/1R4	.29
1299/3D6	.29
1602	.68
1613	.61
1616	.87
1619	.19
1624	.69
1625	.19
1626	.29
1629	.29

SEND FOR OUR COMPLETE TUBE LISTING

CAPACITORS

MOLDED OIL-IMPREGNATED PAPER

.02 MFD	200 VDC	.04½ Ea.	$3.00 per 100
.05	200	.04½	3.00
.1	200	.04½	3.00
.25	200	.06	4.00
.1	400	.09	6.00
.005	600	.04½	3.00
.01	600	.07	4.75
.05	600	.08	5.50

FILTER CHOKES

ALL HIGH VOLTAGE INSULATION

13 H	250 MA	GEN. ELEC.	$3.22
10 H	400 MA	ACME	3.77
15 H	500 MA	AMERTRAN	9.20
14/7 H	130/570 MA	AMERTRAN	9.85
22/8 H	50/860 MA	AMERTRAN	18.75
.02 H	5 AMP	RCA	3.95

TEST EQUIPMENT

- ● Alfred W. Barber Labs. Mod. VM-25 VTVM $86.00
- ● General Radio Model P-500A Standard Signal Generator (Same as G. R. 805A except covers 9KC to 32 MC) $450.00
- ● Galvin Model CES-I Standard Crystal Test Set $45.00
- TS-10A/APN Delay Line Test Set....$25.00
- TS-19/APQ-5 Calibrator $75.00
- AT-48/UP "X" Band Horn....$3.95
- REL W-1158 Frequency Meter 160-220 MC....$32.95
- CWI-60AAG Range Calibrator for ASB, ASE, ASV and ASVC Radars....$39.95
- CRV-14AAS Phantom Antenna for Transmitters up to 400 MC $11.75
- ● Raytheon VR-5 Constant Voltage Transformer Input 95/130 V 60 cy—Output 115 V 500 W...$38.50
- Sola Constant Voltage Transformer Input 95/125 V 60 cy.—Output 15.8 V 285 VA....$24.70
- Federal Constant Voltage Transformer Input 95/135 V 50/60 cy—Output 115 V 210 W....$34.00
- ● C-D Quietone Filter Type IF-16 110/220 V AC/DC 20 Amps $9.00

All Items New Except Where Noted. ● (Exc. Used Condition)

PULSE TRANSFORMERS

UTAH 9262	$1.50
UTAH 9278	$1.50
G. E. 68G-627	$3.75
AN/APN-9 (901756-501)	$1.25
AN/APN-9 (901756-502)	$1.25
AN/APN-4 Block. Osc	.88

RADIATION COUNTER TUBES

1B98 GAMMA COUNTER $9.87
AMPEREX 75NB (Beta & Gamma)....$9.90
Full Line of Amperex Radiation Counters in Stock

115 V 60 CY AC RELAYS

Struthers-Dunn Type 8HXX—SPST Normally Open 30 Amp Contacts $1.88
CRAMER Type C5M—Synchronous motor type 5 min. time delay—SPST normally open 10 Amp contacts $2.87

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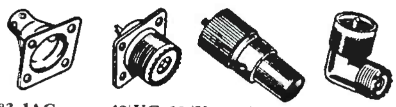
COAXIAL CONNECTORS



83-1AC	.42	UG-12/U	.63	UG-86/U	1.22
83-1AP	.15	UG-21/U	.67	UG-87/U	.68
83-1F	1.12	UG-22/U	.86	UG-171/U	1.33
83-1H	.10	UG-23/U	.63	UG-175/U	.15
83-1J	.80	UG-24/U	.67	UG-176/U	.15
83-1R	.28	UG-27/U	.68	UG-180A/U	3.82
83-1SP	.28	UG-29/U	.83	UG-191/AP	.57
83-1SPN	.28	UG-30/U	.94	MX-195/U	.41
83-1T	1.12	UG-34/U	12.80	UG-197/U	1.33
83-22AP	.85	UG-36/U	12.80	UG-206/U	.58
83-22F	.88	UG-37/U	12.80	UG-255/U	.82
83-22R	.48	UG-58/U	.57	UG-264/U	1.74
83-22SP	.60	UG-85/U	.62	MX-367/U	.15

Full Line of JAN Approved Coaxial Connectors in Stock. Send us your inquiries.

TYPE "J" POTENTIOMETERS

38c each

Resis.	Shaft	Resis.	Shaft	Resis.	Shaft
100	SS	10K	½"	50K	5/8"
200	SS	10K	SS	50K	SS
500	½"	15K	½"	100K	5/8
650	½"	15K	SS	100K	SS
1000	SS	20K	SS	150K	½
5000	3/8"	25K	1½"	200K	SS
6500	SS	25K	SS	250K	SS
10K	3/8"	30K	1 1/8"	1 MEG	SS

Triple 100K - 3/8" Shaft - 1.47
All shaft lengths beyond bushing - SS (screw slot)

UNIVERSAL OUTPUT TRANSFORMER

RCA 15 WATT HIGH FIDELITY
PRI—1000/2000/4000/8000/16000 Ohms
SEC—2/6/15 Ohms
$1.69 Each — $1.52 Ea. Lots of 10

IGNITRONS

GL-415/5550	$22.00
WL-681/5550	$22.00
WL-652/5551	$38.00

ROTARY CONVERTER

Janette Type CA-18 F with Filter Assy. Input—115 VDC. Output—110 V 60 cy 1.17A with spare brushes and brush-holders $28.80

PIONEER SERVO SYSTEM UNITS

- ● Type 12073-1A Torque Amplifier. Input 115 V 400 cy. Complete with Tubes....$14.95
- ● Magnetic Amplifier Assy. Saturable Reactor Type to supply one phase of 400 cycle Servo Motor....$5.95

OIL-FILLED CAPACITORS

50 MFD	220 VAC	$2.95
60 MFD	330 VAC	$4.89
32 MFD	2500 VDC	$10.80
7 MFD	660 VAC	$2.95
3.5-.5 MFD	1000 VDC	.95
.1 MFD	7000 VDC	$1.79
.045 MFD	16 KVDC	$4.70

SPECIAL
2 MFD 12, 500 VDC
INERTEEN TYPE FP
$23.95

SELENIUM RECTIFIERS

HALF-WAVE 130 VDC OUTPUT

75 MA - .58 150 MA - .91 250 MA - 1.21
100 MA - .72 400 MA - 1.51

SOUND POWERED TELEPHONES

- ● U. S. INSTRUMENT Type A-260
- ● WESTERN ELECTRIC Type D-173013
- ● AUTOMATIC ELECTRIC Type GL-832BAO

U. S. NAVY TYPE M HEAD AND CHEST SETS

These are high quality heavy-duty units not to be confused with cheaper units now available. Designed to withstand exacting shock, vibration, salt water corrosion, temperature and pressure tests. ANY TYPE $14.88 ea., $28.00 per pair

SURPLUS EQUIPMENT TROUBLE SHOOTING MANUALS

(Includes Schematics)

BC-348 J, N, Q SCR-522
BC-779 BC-610 $1.00 Each

KOLLSMAN INSTRUMENT

LOW INERTIA SERVO MOTORS

Freq. Cycles	100	Res.—Phase 1	306Ω
Volts—Phase 1	85	Res.—Phase 2	776Ω
Volts—Phase 2	68	No. of Poles	4
Current—Phase 1—110MA		Speed—RPM	2650
Current—Phase 2— 40MA		Weight—Oz.	6.5

Input Watts—No Load 2650 RPM CW	5.8
Input Watts—Stalled	5.0
Torque Stalled—(Oz. In.)	.80
Temp. Rise (°C)—2650 RPM—No Load	54
Temp. Rise (°C)—Stalled	54
Reversing Time—(Seconds)	0.1
Moment of Inertia (G. CM.^{2})	6.7

Will Operate Satisfactorily at 60 Cycles
Original Price $34.50—Our Price—$8.22 ea.
$7.50 EACH—Lots of 10

SPECIAL! 1N34 GERMANIUM DIODES 69¢

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Telephones - MARKET 7-6590 and 6591

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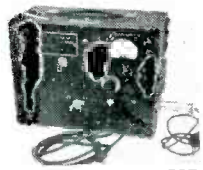
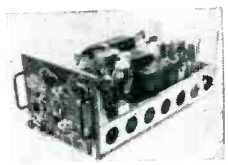
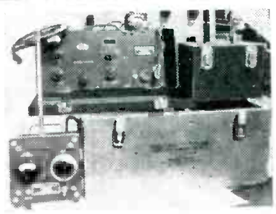
IN MANY ITEMS WE HAVE THE WORLD'S LARGEST SUPPLY!



MEASUREMENTS CORP. TEST EQUIPMENT 78B: 15-25 and 190-230 meg., output 1-100,000 microvolts, modulation 400 or 8 200 cps. $49.50
78C: 15-75 MC and 90-125 MC, continuously variable from 1-1000,000, output impedance 34 ohms. $100.00
78E: 50-75 MC, output 1-100,000 microvolts. $60.00



T-28/APT-1 90-212 MC Jammer. 2-832, 2-5R4GY, 3-6AC7, 1-6U6, 1-6x5, 1-931A, 2-6C4. New ..... $50.00 Used $25.00

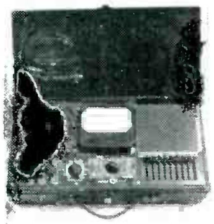


IE-19 Test set for SCR-522, ARC-3, ARC-1, ARC-5. Consists of I-130 signal generator 100-156 m.g., I-95 Field Strength Meters, I-139 test meter, battery case, wood trunk. $195.00

HANDIE-TALKIES BC-611: No wires to attach. Easy to operate. Push button controlled. No skill necessary. Already tuned to set frequency. Crystal controlled. Transmitter and receiver in same case. Only 5½ lbs. with batteries (batteries can be supplied). Small: 15¼"x3⅝"x5⅝". Aluminum case. With tubes, crystals. Freq. 3-6 MC.
BC-611-F also available.
BC-721 and Mount FT-295. same size as BC-611, except airborne & revised improved chassis and bottom cover with connections for external control.
IE-17 complete Handie Talkie test equip. available.
CRC-7 VHF Navy Handie Talkie. 100-156 MC. **Prices on request.**

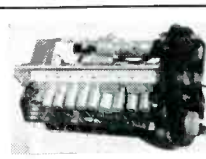
I-100 A portable test set for automatic radio compasses. Has following features: Test automatic loop control circuit. Test loop motor and drive mechanism, calibration of compass deviation correction. Test and measurement of accuracy selsyn xmitter & rcvr. Operation as a multiple range AC or DC vacuum tube voltmeter. Price on request.

BC-1000 Portable battery operated freq. mod. transmitter and receiver. Used for voice transmission and receiver over a distance of about 3 miles. Freq. 40-48 MC, xtal controlled.

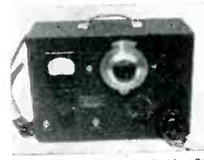


TUBE TESTERS 105 (TS-298/U): Dynamic Mutual Conductance designed to test std. receiving tubes and small transmitting tubes, which have filaments from 1.5V to 117V and 95 to 130V 115V AC 60 cy. input. PO/AN/GPM-1 .... $55.00
Tube Tester Triplett 1183-SC (TS-393-U): For testing every type of receiving tubes also volt ohm milliameter. AC & DC volts 0 to 10/50/250/500/1000, ohm per volt 10,000 DC, 2,000 AC; DC MA 0-1/10/50/250; resistance 0-500/15000 ohm; 0-1.5/15 meg. PO 1-56-J. $39.95

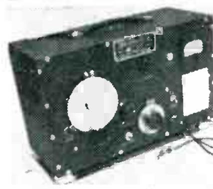
LAVOIE 105 SM A compact, self contained, battery powered precision freq. meter providing quick and accurate readings of frequencies with a minimum of operating controls. Accuracy is .1 of 1% and maintained because of rugged construction, precision parts and fits. The tuning of the resonator is done by varying the capacity in a totally enclosed high "Q" tuned circuit. The dial system is divided into 5000 equal divisions. Ratio is 50 divisions on dial to one turn 360°. This unit provides continuous frequency coverage between 375 to 725 MC. Having a 0-200 microameter for indication also including headphone jack for audible monitoring, 2 stages of amplification, grid leak detector, modulation switch, tuning mechanism and calibration chart. **Brand new with book & probe.** $59.95



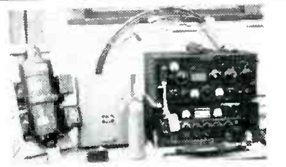
RT-34/APG-5 A 2700 megacycle xmitter & receiver using 2C40 rcvr. loc osc. 5621B 1st det., 2C43 transmitter, 3E29 modulator, 6-6AK5, 30 MC IF strip. 6AL5 detector, 6AK5, limiter, 6AK5 cathode follower, power supply uses 2-2x2, 1-5Y3 & 1-VR105/30. Comes in hermetically sealed drum 9⅞ dia. x 16½" long. With AS/68 ant. $59.50



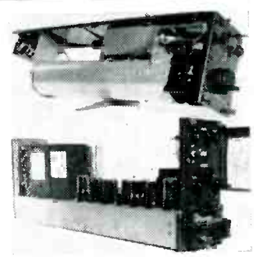
FERRIS TEST EQUIP. 18B (I-136): VHF Signal generator, 20-150 MC, mod 400 cps, 115V, 60 cy input. $80.00
18F (TS-122/U): 25-42 MC, 40-75 MC, 150-195 MC and 180-230 MC output impedance 30 ohm, output 700MV max. freq. 400 to 1000 cp at 30%. $175.00
BC-1236: 15-40 MC, 95-115 MC & 195-230 MC 110V AC input. $125.00



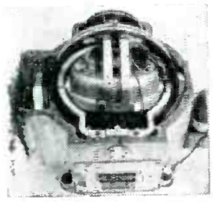
ESPEY TEST EQUIP. I-122: RF Signal 15-25 MC and 90-125 MC modulated at 400-625 cps, 110V 60 cy input. $60.00
I-126: 15-25 MC and 95-225 MC modulated by ant osc at freq of 400-8200 cps, 110V 60 cy input. $100.00



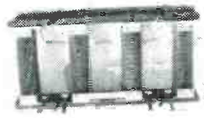
TBS TRANSMITTER-RECEIVER Transmitter CRV-52093; covers 60-80 MC, xtal, controlled, voice or tone modulation. Carrier power 50 watts. Receiver CRV-46068 will deliver 2 watts audio output to 600 ohm speaker with 10 microvolt output. Receiver operates from 115V 60 cy. Transmitter power is obtained from motor generator (CCG 21302) which is controlled by automatic starter (CRV 21301) 440V AC input. Transformer CHT-30445 440V AC 110V AC 60 cy. is used for receiver. Also included is copper transmission line, gas filled type 120 ft. long complete with fittings, couplings, gas flask and pressure gauge. Receiver uses following tubes, 1-956, 1-6F8-G, 1-6S5, 2-6C6, 3-6D6, 1-6F7, 4-808, 1-6A6, 2-6D6, 2-2As, 1-84. Transmitter tubes: 2-807, 4-808, 1-6A6, 2-6D6, 2-2A3, 1-84. All TBS equip. is brand new and was formerly used in small surface vessels for reliable communication within range of approx. 15 miles. .. $250.00



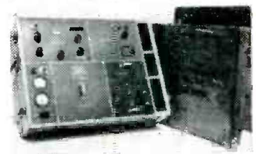
1073 WAVEMETER Pwr. supply section: 110V 60 cy. 330V DC 85 MA 2 section filter. Also 15 tubes: 10-6NS7's, 1-5Y3, 16H6, 1-6SJ7, 1-6V6, 1-6SA7. Can be purchased separate at $9.95
Wavemeter section: has high quality resonant cavity tuning from 150-210 MC oscillator, heterodyne amplifier, electric tuning eye, precision millen gear drive and collapsible antenna. Built-in oscillator checks against cavity for proper frequency setting: Uses 9002, 6SF5 and 6E5 tubes. Used $14.00 Pwr. supply and wavemeter in one $22.50



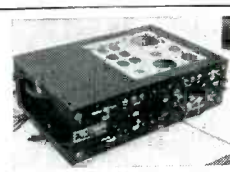
C-1 GYRO Part of C-1 auto pilot and can be used to conduct many experiments. 24V DC input or can be operated for short periods on 110V AC. Will run 5 minutes after actuating. $6.95



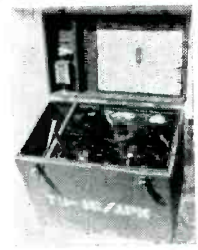
RECTIFIERS 300V DC at 100 MA type 4D-0243 D-162805 Internat onal Telephone Development Co. 4 in a stack. **Brand new.** $10.00



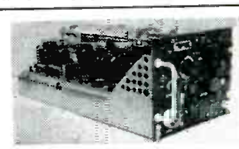
I-96 Used for tuning & aligning SCR-522, BC-624 and BC-625. In wood case, 6 compartments shielded. Battery or 110V AC 60 cy input. RF signal generator 100-156 MC PO IE-Test Equip.



JB-70 Junction box contains start and stop switch components of phone and speaker control circuit, 2 key jack, 50 A circuit breaker and all necessary wiring to provide for inter-connection of receiver BC-312 and 342, transmitter BC 610, speech amp. BC-614 and speaker LS-3, spare storage battery and lighting plant PE-95. PO/SCR-299. .... $19.00



TS-16 A portable self contained unit to make comprehensive check of performance of altimeter equip. **Price on request.**



BC-939 Couples output of transmitter to 15 ft. or lg. wire ant. from 2-18 MC. Has loading coil continuously variable, coupling coil indicator meter fixed vacuum capacitor. PO BC-610, transmitter and SCR-399 & 499 .... $35.00

Orders promptly filled. Prices fob L. A. and subject to change. To save COD charge, send full price and only shipping charge will be COD. Or send 25% deposit. Minimum order $5.00. Export orders $25.00. Shipments via Railway Express unless otherwise specified. Inquiries and requests for quotations given immediate attention.

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BC-605 Interphone Amplifier

Easily converted to an ideal intercommunication set for office — home — or factory.

Original—New $4.95

Like New 3.95

(With Schematic)

See April 1950 Radio News for complete conversion data.

All necessary parts and instructions to convert the above to AC operation with one remote station $8.25 additional.

TUBES

Drastically Reduced from 10 to 50%— Nationally Advertised Brands

Type	Net Price	Type	Net Price	Type	Net Price
1A4P	$0.24	6SF5GT	.34	39/44	.24
1A6	.19	6S7G	.39	49	.39
1B5/25S	.24	6S8GT	.59	50	.39
1B22	1.49	6SG7	.59	56	.24
1B26	2.29	6SF7	.39	57	.24
1B29	.39	6SJ7	.69	76	.24
1B32-532A	2.29	6T7G	.39	77	.24
1C6	.19	6U7G	.29	211/Vt4L	.29
1C7G	.19	6Z7G	.39	316A	.34
1D5GP	.24	6ZY5G	.29	371B	.34
1D7G	.19	7C4/1203A	.24	700A	7.95
1F4	.24	7E5/1201	.39	703A	1.49
1F5G	.24	10YVT25A	.19	705A	.79
1H4G	.24	12A6	.34	714AY	5.95
1J6G	.24	12A6GT	.34	724B	4.95
1J6GT	.24	12A7	.34	801A	.39
1P5GT	.24	12A8GT	.19	813	5.95
1V	.24	12F5GT	.29	829	6.95
2A6	.39	12H6	.29	832	4.95
2A7	.24	12J5GT	.24	837	1.49
2C26A	.19	12J7GT	.24	841	.29
2V3G	.49	12K8GT	.24	864	.29
2X2/879	.25	12Q7GT	.24	872A	.98
3FP7	.98	12SF5	.24	954	.19
4AP10	.98	12SF5GT	.24	955	.34
5BP4	2.95	12SF7	.24	957	.34
5CP1	2.95	12SH7	.24	1625	.19
5D21	9.95	12SR7	.24	1626	.24
5FP7	.95	12SR7GT	.29	1629	.24
5J23	5.95	12SN7GT	.89	1630	.29
5T4	.49	12Z3	.29	1636	2.95
5W4	.49	15R	.19	1638	.69
5Z4	.49	19	.59	1642	.29
6AB7	.59	2J22	.24	2050	.89
6AJ5	.89	28D7	.34	2051	.49
6B8	.59	30SPEC		7193	.19
6C4	.29	(Vt67)	.59	9002	.34
6D8G	.59	30	.24	9003	.39
6F5GT	.39	304TL	1.29	9006	.29
6F6G	.59	32L7GT	.39	GL4A21	.29
6H6	.29	33	.24	Amperite	
6J7GT	.39	34	.24	10T1	.29
6K6G	.59	35/51	.24	Jan CRP72	.98
6L5G	.39	36	.24	REL36	.69
6L7G	.39	37	.24	VR150	.39
6R7	.34	38	.24	VR105	.69

WRITE FOR QUANTITY PRICES

BEAM INDICATORS

I 82—5" .... New $4.95

Transmitter Selsyn for above 2.45

both for 7.00

I 81—3" .... New 3.45

Transmitter Selsyn for above 2.45

both for 5.25

I 81 .... Used 2.45

T85/APTS UHF TRANSMITTER

operating over a frequency range of 300 to 1400 MCPC with a nominal output of from 10 to 30 watts. Unit is equipped with 110 V 60 CPS filament transformer; blower; lecher wire test frequency set, and 8 tubes—1-931A; 2-6AC7; 2-6AG7; 1—6L6G; 2-829B; 1-3C22 (GL522) (oscillator).

New in original box with Operating Instruction Manual $69.50

BC 620

Receiver-Transmitter—2 crystal channels—20 to 27.8 MC FM—13 tubes. Metered. Plate and Filament .... New $14.95

Used 9.95

PE 97 Power Supply for above 6-12 volt vibrator type.

Used—complete $6.95

Used less tubes, vib. & cond. 2.95

FT 250 Mount for both BC 620 and PE 97 New $1.50

BC 223

Brand new Transmitter with all three tuning units, two tuning unit cases, spare tube carrying case, shock mount and brace; but less tubes at new low price of $19.95

Set of 5 tubes 3.95

Tuning units are available separately at Ea. $2.50

Cases at .... Ea. .95

PE-125—12-volt Vibrator Pack...New $12.95

Used 8.95

Spare parts kit for PE 125 containing 2 tubes; 2 vibrators and 13 fuses in metal container with handle and clasp (BX 41)..New $2.95

RECEIVER—Easily Converted for Use in Citizens Band Crystal Controlled Local Oscillator. Broad Band pass—20.7 MC IF's. Complete with 7-6AJ5, 1—12SR7, 2—12SN7, 1—28D7, Relays, crystals. Schematic furnished .... New $7.95

Miscellaneous SPECIALS

	Used	New
ID 6/APN 4 Scope. Excellent	$29.50	—
R 7APS 2 Receiver-Indicator	—	$79.50
R 78/APS-15 Receiver-Indicator	34.50	—
BC 1287 A Scope	75.00	—
ASB 7 Indicator Scope	12.95	—
SCR 522 Transceiver 100 to 150 MC	34.95	75.00
BC 1206 Receiver, 200 to 400 KC	3.95	5.95
MN 26 C	17.50	24.95
RA 10 DA Receiver	17.50	24.95
T26/APT2 Transmitter	8.95	—
RT7/APN1 Transceiver	4.95	9.95
APN 1 Complete	—	24.50
BD 71 6 Pos. Switchboard	9.95	12.95
EE 8 Field Phones	7.95	—
BC 347 Interphone Amplifier	—	2.95
I-70 Tuning Meter	—	.89
AM 61 Indicating Amplifier	—	9.50
SCR 625 Mine Detector	—	39.50
PE 237 Power Supply	—	12.95
BC 461 Veeder Root Counter	—	.59
BC 442 Less Condenser	1.49	1.95
A 27 Phantom Antenna	—	.98
APS 13 UHF Antenna Pair	—	.98
Manual for BC 312&342J	—	1.00
Manual for SCR 269 G	—	2.50
FL 8 Filter	2.95	—
I-97 Bias Meter	4.95	3.95
RM 29 Remote Telephone Control	7.95	9.95
BC 602 Control Box	—	.98
One Tube Interphone Amplifier		—

Small compact aluminum case fully enclosed 2¼"x 3¾"x5¾". Less Tubes .... .79

BC 717 Transmitter, New but less Tubes 24.50

96Q1 Complete Autotune assembly with motor and frame as used in **ARC-1** Transmitter ... New 35.00

BC 709 Battery operated lightweight interphone amplifier. Complete with tube and shock mount, but less battery .... New 3.95

SCR 183 Complete .... New 49.50

Motor—Universal Electric, 24 VDC, will also operate on 24 VAC Diameter 1⅝"; Length 2 1/16". Shaft ¼" x ¾" .... New 1.49

BC-746 Bantam one watt foundation (See QST Jan. 1948). Contains 2 crystals, coil, tuning condensers, etc. Numbers 1-7-10-11-12-13-76. Each ... 0.95

BC-1291 Control box contains motor rheostat control rated 10 ohms at 3.88 amps. Brand new with cord and plug-in ventilated, mounted case 1.95

MC-385A Headset Adapter .... New .49

Information and Prices on Request

BC 639 Receiver wih **RA 42** Rectifier
RTA 1B Transceiver
TA 2J24 Transmitter and **MP 10G** Power Jack
SCR 269 Compass Installation
R 5/ARN 7 Compass Installation
MN 26 Compass Installation
I. L. S. Installation (**R 89-BC733**)
SCR 584 Components
R-132/TPS 10 Radar Receiver
MD-22-URA/T1 Radar Modulator
AN APR1 Receiver and Tuning Units
ASB7 Complete Radar Installation
TS-251 Test Set
BC221 Freq. Meter

MONTHLY SPECIAL!

MN 26 Y Compass Receiver

2 tube superhet covering frequencies of 150 to 325 KC; 325 to 695 KC; 3400 to 7000 KC in three bands. Complete with dynamotor and tubes. Like New $14.95

Model 15—Ground radar training unit complete. 115 V. 60 C.P.S. operated. Consists of 515 MC transmitter; power supply; and pulse generator. Trains operator to detect land, air or sea targets and can be adapted to various receiver-indicator sets operating at 515 MC. New, with instruction manual...$225.00

HEADSETS—MIKES

HS-23 Hi Imp. Headsets .... New $2.95

HS-33 Lo Imp. Headsets .... New 2.95

HS-30 Hi Imp. Headsets .... New 1.50

Used .79

T-17D Carbon Mike .... New 2.75

T-24 Hi Imp. Carbon Mike .... New 1.19

T-30 Throat Mike .... New .98

T-45 (or Navy) Lip Mike .... New .98

CD-307 Extension Cord for Headsets New .59

Send for free 8-page, illustrated BULLETIN #103 listing many exceptional values

BC-604 Transmitter FM 20-28 MC

11 and 15 meters. Can be operated on 10 meters—10 channel push button crystal. With all tubes and meter but less dynamotor. Excellent Condition $12.95

Crystals—Set of 80 .... 14.95

BC-603—Companion receiver to above with tubes but less dynamotor. Used $17.50

COMMAND (SCR 274 N) EQUIPMENT

	Used	New
BC-453	$12.95	—
BC-454	4.95	$6.95
BC-455	7.95	—
BC-456	1.95	2.95
BC-457	5.95	—
BC-458	5.95	—
BC-696 (or T19)	14.95	24.95
BC-450—3 Receiver Remote Control	.89	1.95
BC-442	—	2.95
3 Receiver Rack	1.95	—
2 Transmitter Rack	1.50	—

Complete Command set as removed from aircraft — 3 receivers — 2 transmitters — Relay unit—control boxes—mounting racks—plugs—modulator and dynamotors—crated .... Set $34.50

DYNAMOTORS

DM-28—For BC-348 with Mount and Filter .... New $6.95

Used 3.95

DY-12—For ART-13 less filter and base .... New 6.95

DM-36 .... Used .95

New 1.95

BD-77 .... New 5.95

PE-206 .... New 6.95

Used 2.95

PE-101 .... New 2.75

PE-73 .... New 3.95

DM-53 .... New 3.95

Used .95 (3 for $2.00)

DM-32 .... New 1.95

Used .95 (3 for $2.00)

TEN TUBE SUPERHET RECEIVER

with crystal controlled local oscillator. Has provisions for six crystal channels between 108 to 112 MCPS complete with tubes and crystals but less dynamotor

New $7.95

Like New 5.95

Less Tubes and dynamotor but new 3.95

HERMETICALLY SEALED CHOKES

10H. 100 M.A.....59¢ **3.7 H.** 145 M.A....59¢

59 H. 100 M.A.....95¢ **10 H.** 20 M.A.....39¢

.5x.5x1x1 H—4 winding layer wound.

.5 H at 3.56 A 140 ohms

1 H at 1.56 A 320 ohms **New $0.49**

CONDENSERS

	Each
2 mfd. 4000 VDC. OIL FILLED	$2.95 (4 for 10.00)
1 mfd. 6000 VDC. OIL FILLED	1.98
.25 mfd. 15000 VDC. OIL FILLED	4.95
.00025 mfd. 25000 VDC. OIL FILLED	2.95
.4 mfd. 1500 VDC. OIL FILLED	.29 (10 for 2.49)
2 mfd. 600 VDC. OIL FILLED	.39 (3 for 1.00)
1 mfd. 600 VDC. OIL FILLED	.24 (5 for 1.00)
.1x.1x.1—1200 VDC. OIL FILLED	.59 (2 for 1.00)
50 mmfd—5KV—5 Amp. Vacuum Cond.	1.19

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single J—dual JJ—triple JJJ

made by

ALLEN BRADLEY CO.

any wattage

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RAND RADIO CORPORATION
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RADIO TRANSMITTERS

1 to 3 KW
2 to 16 Mc

Also, modulators and rectifiers for same.

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W-6618, Electronics
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Teletypewriters complete, components or parts. Any quantity and condition.

W-6654, Electronics
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WANTED

WESTERN ELECTRIC VACUUM TUBES

Types 101F, 102F, 272A, 274A or B, 310A or B, 311A, 313C, 323A, 328A, 329A, 348A, 349A, 352A, 373A, 374A, 393A, 394A, 121A Ballast Lamps.

W-6641, Electronics
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WANTED

TEST EQUIPMENT

state asking price, age and condition in first letter.

W-1150, Electronics
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WILL BUY ALL

BC-348'S WITH DYNAMOTORS

Letters "J", "N" & "Q" .... $60.00 ea.
All others except "C" .... $50.00 ea.
Ship via Express C.O.D. subject to Inspection to:

H. FINNEGAN
49 Washington Ave. Little Ferry, N. J.

WANTED TO BUY

Large and small quantities of new or used electronic government or manufacturers' surplus tubes and equipment. Highest prices paid. State quantity, condition and best price in first letter.

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WANTED

INSULATORS; POLE LINE HARDWARE; GUY STRAND WIRE; COPPERWELD WIRE; WESTERN ELECTRIC TOOLS; SPLICING SLEEVES.

VICTOR-BERNARD INDUSTRIES
NE Cor. 22nd & Lehigh Aves., Phila. 32, Pa.

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PRIVATE LABORATORY Wishes To Purchase For Its Own Use High Grade Test Equipment and Basic Radio Components. Replies Held In Confidence.

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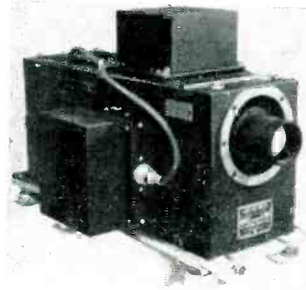
TELEVISION CAMERA

Just arrived! Fills a raft of vital TV uses. 350-lines resolution. Easily converted to present R.M.A. standards. Circuits available with cameras. Complete like new.



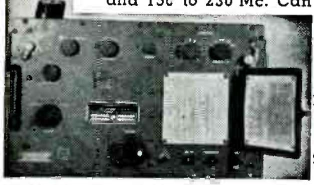
1100-A
FOUR TRANSMITTERS IN ONE

Can be present on 4 bands. Has BFO or extal on each from 1.5 to 10 mcs. Oscillators are all between 1.5 and 5 mcs. 6L6 osc. VR-150 regulator, buffer or doubler is a 6L6 into 3-807's in parallel. 125 watts on phone and 125 watts on cw, modulator has 4-6L6's in push-pull parallel. Rig has telephone dial on front for selecting any one of 4 transmitters, selecting phone, CW, turning heaters on, plate current, or turning everything off. Also has remote control unit for remote operation. Used, but in excellent condition **$225.00 With Remote**

SCR-528 FM RECEIVER & XMTR: Complete with 80 xtals for operation in the 20-27.9 mcs. Powered by 12 or 24 VDC, with crystals, dynamotors, rack, mike, headset, mast base and section. Used but excel. cond.

APS-6 RADAR: Complete. Excellent Condition.

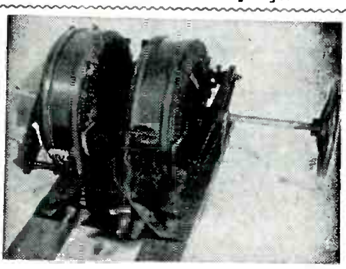
1-222-A RF SIGNAL GENERATOR



2 bands cover from 8 to 15 Mc., and 150 to 230 Mc. Can use up to the 3-harmonic; 110 V. 60 cycles built in power supply. New, **$125.00**

APS-4 RADAR: Complete. Excellent condition.

APS-4 COMPONENTS: Indicators, control boxes, junction boxes, 800-1C inverters, amplifier boxes, cords and plugs.



VARIAC TRANSTAT AMERTRAN

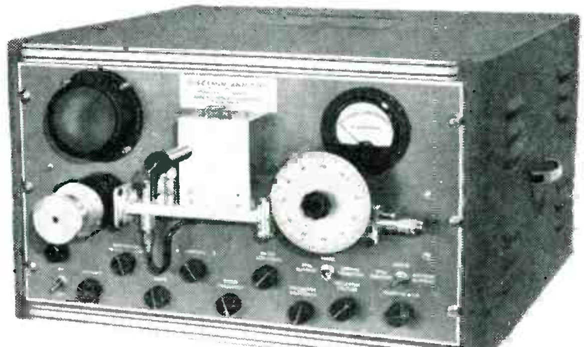
Input 0-115 V., 50-60 cycle; output 115 V 100 amps. 11.5 Kva. Excellent condition **$75.00**

COLUMBIA ELECTRONICS Ltd.

524 S. San Pedro St., Los Angeles 13, Cal.
Cable Address: COLELECT

25% deposit with order. Balance C.O.D.
All items subject to prior sale.

TEST EQUIPMENT



X BAND SPECTRUM ANALYZER 8500-9600 Mc., calibrated linear below cut-off attenuator, calibrated frequency meter, tuned mixer, 4 i.f. stages, 3 video stages overall gain 125 db., regulated power supply.

S BAND SPECTRUM ANALYZER 2700-3900 Mc., similar to above.

The above Spectrum Analyzer also available with S and X band tuning units.

K BAND TEST LOAD $20.00

X BAND POWER, Frequency and SWR Measuring Equipment complete with R.F. source, A.S.D. equipment.

X BAND BELOW CUT-OFF WAVE GUIDE ATTENUATOR, with calibrated dial, type N input connector, output connects to ½" x 1" wave guide $55.00

APR-1 or APR-4 RADAR SEARCH RECEIVER, 30 mc I.F., 2 mc wide.

TUNING UNITS FOR APR-1 or APR-4 RECEIVERS (can be used with any 30 mc amplifier):

TN-19, range 1000-2000 mc, tuned mixer cavity $150.00

TN-54, range 2000-4000 mc, tuned mixer cavity $150.00

30 MC I. F. STRIP AND 110 VOLT 60 cps POWER SUPPLY, bandwidth 10 mc, complete, new (part of APR-5 Receiver) $65.00

TS-45A/APM-3 SIGNAL GENERATOR, 9200-9600 mc, 110 V, 60-800 cps

TS-155A/UP S BAND SIGNAL GENERATOR, pulsed, calibrated output, 110 V, 60 cy., NEW

TS-56/AP SLOTTED LINE, slot length 16", tuned probe and meter $100.00

TS-35/AP X BAND SIGNAL GENERATOR, pulsed, calibrated power meter, frequency meter, 8700-9500 mc

TS-13/AP X BAND SIGNAL GENERATOR, pulsed, calibrated output, 110 V, 60 cycles

X BAND VSWR TEST SET TS-12/AP, complete with linear amplifier, direct reading VSWR meter, slotted waveguide with gear driven traveling probe, matched termination and various adapters, with carrying case, NEW. UNITS I AND II are available separately or together as a test set.

S BAND SIGNAL GENERATOR CAVITY WITH CUT-OFF ATTENUATOR, 2300-2950 mc, 2C40 tube, with modulator chassis $30.00

HIGH PASS FILTER F-29/SPR-2, cuts off at 1000 mc and below; used for receivers above 1000 mc $12.00

UPN-1 S BAND BEACON RECEIVER-TRANSMITTER $75.00

S BAND TEST LOAD TPS-55P/BT, 50 ohms $8.00

X BAND TEST LOAD, 50 WATTS $35.00

250 WATT X BAND TEST LOAD, VSWR less than 1.15 between 7 and 10 KMC $150.00

LAF-1 SIGNAL GENERATOR, 100-600 mc, CW & pulse modulation, calibrated output, good condition, 110 v, 60 cps operation

GENERAL RADIO PRECISION WAVEMETER TYPE 724A, range 16 kc to 50 mc, 0.25% accuracy, V.T.V.M. resonance indicator, complete with accessories & carrying case, NEW ... $175.00

GENERAL RADIO SIGNAL GENERATOR 605-B good working order $300.00

GENERAL RADIO VACUUM TUBE BRIDGE, Model 561D $275.00

FEDERAL RADIO 605-CS, 9 kc to 50 mc SIGNAL GENERATOR (JAN version of G. R. 605) $350.00

HEWLETT-PACKARD AUDIO SIGNAL GENERATOR 205A $230.00

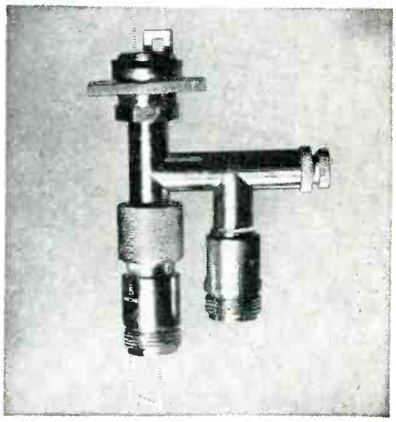
TBN-3EV THERMISTOR BRIDGE

S BAND THERMISTOR BRIDGE CU-60 ABU, Part of LZ Radar $60.00

FERRIS MODEL 22A SIGNAL GENERATOR, 85 kc to 25 mc. Output .2 microvolts to 1 volt, modulation variable, good working order $175.00

FERRIS MODEL 10B SIGNAL GENERATOR, 85 kc to 25 mc, calibrated output, good working order $100.00

STANDARD SIGNAL GENERATOR MEASUREMENTS 65B, 100 kc to 30 mc, 1-2,000,000 microvolts, good working order $400.00



S BAND CRYSTAL MIXER (illustrated), Variable Oscillator Injection $12.50

S BAND MIXER, tunable by means of slider, type N connector for the R.F. and local oscillator input, U.H.F., connector for the I.F. output, variable oscillator injection $30.00

FIXED ATTENUATOR PADS, 20 db + 0 — 2 db, DC-1200 mc, 50 ohms, VSWP 1.3 or less, 2 watts average power $30.00

WAVEGUIDE BELOW CUT-OFF ATTENUATOR, type N connectors, rack and pinion drive, attenuation variable 120 decibels, calibrated 20-120 db, frequency range 300-2000 mc $32.00

WAVEGUIDE BELOW CUT-OFF ATTENUATOR, similar to above except upper frequency limit is 3300 mc $32.00

WAVEGUIDE BELOW CUT-OFF ATTENUATOR, same as above except input is matched in range of 2200-3300 mc. VSWR less than 1.2 ... $34.00

PULSE INPUT TRANSFORMER, permalloy core, 50 to 4000 kc impedance ratio 120 to 2350 ohms $3.00

PULSE TRANSFORMER, 132-AWF $6.00

PULSE TRANSFORMER, GE 68G, 828G-1 $5.00

TS-10/AP CALIBRATED DELAY FOR APN-1. $25.00

TS-203/AP CALIBRATED SELSYN $10.00

UG-27/U TYPE N RIGHT ANGLE ADAPTERS 10 for $5.00; 1000 for $250.00

SD-3 SHIPBOARD RADAR, New and complete with test equipment $1050.00

SQ RADAR, used but in good working order, complete with antenna, control unit $650.00

SN RADAR, used, good working order, complete $550.00

HYPERSIL CORE CHOKE, 1 Henry, Westinghouse L-422031 or L-422032 .... $3.00

PULSE FORMING NETWORK, 20 kv, .92 microsecond, 50 ohms, 800 p.p.s. $40.00

ELECTRO IMPULSE LABORATORY

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BRAND NEW U. S. GOV'T. SURPLUS GUARANTEED

POWER RHEOSTATS

Ohms	watt	ea.	Ohms	watt	ea.
2	225		150	150	
3	100	G	200	25	G
3	225	E	200	150	E
4	225	T	225	50	T
5	50		250	25	
5	100	O	350	25	O
5	150	U	350	100	U
6	25	R	378	150	R
6	50		400	25	
7	25	F	500	25	F
8	50	L	500	75	L
10	25	Y	585	150	Y
10	100	E	750	25	E
12	25	R	750	150	R
15	25		1000	25	
16	50	#	1200	225	#
22	50	5	1250	50	5
25	25	0	1250	150	0
32	300	3	1500	50	3
50	25		2000	25	
50	50	F	2000	50	F
50	750	O	2500	100	O
60	25	R	3000	25	R
75	150		3000	100	
80	50	P	3500	50	P
80	500	R	5000	25	R
100	25	I	5000	50	I
100	50	C	7500	50	C
100	225	E	7500	100	E
125	25	S	10000	50	S
125	500		10000	100	
150	50		20000	150	

Specify whether shaft required is for knob or screwdriver type. (Discount to Quantity Users.)

SELECTOR SWITCHES

Pole	Pos.	Deck	Type	Each
1	6	1	bak-shtg	.31
1	12	1	cer-n shtg	.55
1	21	3	bak-n/shtg	.69
1	24	2	bak-n/shtg	.79
2	2	1	cer-shtg	.39
2	6	2	bak-n shtg	.49
2	8	2	bak-shtg	.54
2	11	2	bak-shtg	.60
4	4	2	cer-n/shtg	.54
4	11	4	bak-shtg	1.20
5	3	2	cer-n/shtg	.56
6	11	6	bak-n/shtg	1.98
10	5	5	cer-shtg	1.49
12	2	3	bak-shtg	.75
16	2	4	bak-n/shtg	.98

"AN" CONNECTORS

LARGE VARIETY AVAILABLE AT GREAT SAVINGS

Send your specs and let us quote

BIRTCHER TUBE CLAMPS

#926-A, #926-A1, #926-B, #926-B1, #926-B2, #926-B7, #926-B22, #926-C, #926-C1, #926-C5, #926-C10, #926-C24

14¢ ea. $12.00 per 100

OIL CONDENSERS

Mfd	VDCW	Each
.1	3000	.75
.1	6000	1.89
.1	20,000	18.95
.25	3000	1.10
.5	1500	.89
1	600	.35
1	2000	1.95
2	400	.35
2	600	.39
2	1000	.79
4	600	.69
6	400	.75
6	600	.79
10	600	.98
14	600	1.75
15	600	1.98
15	1000	3.25
2 x .1	7000	3.95
2 x .5	9000	14.95

IMPORTANT

to Purchasing Agents

BARGAINGRAM also FREE Pilot Lamp Extractor

WRITE TODAY!

BATHTUBS

mfd	vdcw	each
.033	400	.17
.05	200	.17
.05	400	.19
.05	600	.21
.1	400	.20
.1	600	.22
.1	1000	.32
.15	600	.22
.25	200	.19
.25	600	.23
.35	400	.22
.5	400	.23
.5	600	.25
.5	1000	.35
1	200	.29
1	600	.35
2	400	.44
2	600	.59
4	50	.25
8	500	.59
25	50	.28
25	75	.30
40	25	.27
50	25	.28
200	12	.35
300	6	.39
.05-.05	600	.29
.05-.05	1500	.45
.1-.05	200	.25
.1-.1	400	.26
.1-.1	600	.28
.16-.16	600	.28
.2-.2	600	.29
.25-.25	600	.30
.5-.5	600	.35
1.0-.1	300	.29
200-200	9	.49
3 x .05	600	.40
3x.1	400	.42
3x.1	600	.45
3x.25	600	.50
3x1.0	100	.40

Specify Top, Side or Bottom Lugs.

TYPE "J" POTENTIOMETERS

Specify whether regular or screw-driver shaft is required.

TYPE "J" 50c

ohms	ohms	ohms
60	2000	20K
100	2100	25K
150	2200	30K
200	4000	50K
300	4700	75K
400	5000	80K
500	10K	100K
600	11K	200K
1000	12K	250K
1400	15K	300K
1500	16K	1meg

When ordering locking type bushings, locking nuts are available in the following types:

Hex shaft lock @ .05
Acorn " " @ .10
Knurled " " @ .10

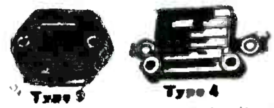
TYPE "JJ"

$1.25 ohms	$1.50 ohms
100-100	100K-100K
200-200	130K-130K
500-500	150K-150K
600-600	200K-200K
1500-1500	250K-250K
2000-2000	350K-5000
2200-24K	350K-25K
20K-2000	500K-500K
25K-10K	800K-75K
35K-5000	1meg-1meg
50K-50K	2meg-2meg
	4meg-2meg
	5meg-5meg

TYPE "JJJ" $2.25

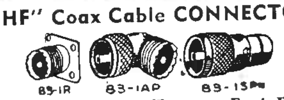
ohms
20K-200K-20K
45K-27K-2500
700K-700K-700K
750K-750K-750K
800K-800K-800K
1meg-1meg-1meg

TRANSMITTING MICAS



mfd	vdcw	type	ea.	mfd	vdcw	type	ea.
.00001	600	4	.18	.00162	600	4	.18
.00003	600	4	.18	.002	600	4	.20
.00005	600	4	.18	.002	1200	4	.48
.00005	2500	9	.31	.0022	2500	9	.78
.0001	600	4	.18	.0025	600	4	.23
.0001	2500	9	.31	.003	600	4	.25
.000152	600	4	.18	.0039	600	4	.25
.0002	600	4	.18	.005	600	4	.25
.00025	600	4	.18	.005	1200	9	.60
.0005	600	4	.18	.005	2500	9	1.18
.00051	2500	4	.43	.0062	600	4	.30
.0007	600	4	.18	.01	600	4	.40
.0008	600	4	.18	.01	600	9	.49
.0009	600	4	.18	.01	1200	9	.98
.001	600	4	.18	.0142	600	4	.45
.001	1200	4	.31	.02	600	4	.55
.001	1200	9	.31	.02	1250	9	1.36
.0013	600	4	.18	.027	600	4	.66
.0015	600	4	.18	.043	600	4	.99

"UHF" Coax Cable CONNECTORS



Cat. No.	Army No.	Type	Each	Per/C
83-1AP	M-359	Plug	.35	.28
83-1D	PL-271	Adap	1.25	1.00
83-1F	PL-274	Feed	1.10	.90
83-1R	SO-239	Rec.	.35	.28
83-1SPN	PL-259A	Plug	.35	.28
83-22R	SO-264	Rec.	.50	.40
83-22SP	UG-102/U	Plug	.68	.60

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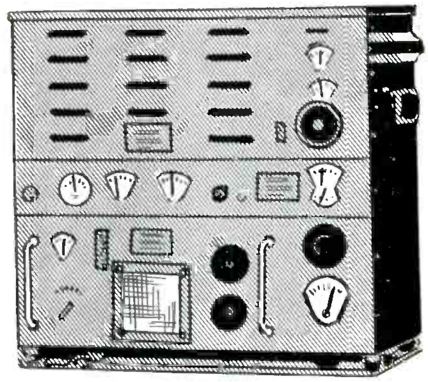

AIRCRAFT RADIO TRANSMITTERS

Type BC-375-E

100 watt output. Frequency range 200-500 and 1500-12kc., complete, new, with all tuning units, dynamotor, tubes, plugs, etc. Brand new in original packing. Not removed from aircraft. Original cost $1800.

$97.50 ea.

Navy Model TDE Radio Transmitters

Frequency range 300 to 18,000 kc., 125 watt output on C. W., 25 watts on phone, for operation on 230 volts D.C. power supply, complete with tubes and ready for operation.

Our information indicates that these units cost the U. S. Navy $8,000 ea. We offer them to you at a mere fraction of the original price.

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These sets are sold individually packed in strong, steel-strapped, wooden cases, and they are ready to set up and operate.

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Power output 200 watts master-oscillator or crystal controlled in operation. Frequency range 2,000 to 24,000 kc., in nine overlapping bands. New, in original export packing. Complete with tubes and typewriter table.

Does not include motor generator power supply.

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Gasoline-engine driven. 120 volts, 60 cycles AC, manufactured by Hobart with Hercules 4-cylinder engine, water cooled, including cable, set of tools, automatic starting.

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Covering 1.5 to 12 mcs. Output 25 watts. Complete with remote control, power supply, antenna tuning unit, cables, key and microphone. Available for 110-220 volts AC and 12 or 24 volt operation. Ask for special leaflet and prices.

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FRENCH-VAN BREEMS, Inc.
405 Lexington Avenue, New York 17, N. Y.

NOTICE! IF YOU OPERATE ANY WESTERN ELECTRIC TRANSMITTER

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All units are 7½" Round, Surface mounting Switchboard Meters, with Black scales.

GENERAL ELECTRIC METERS DC & RF model DR-2, AC model AR-2

RANGE	SCALE	CAPTION	NOTES	W.E. KS#	Price
1 Amp D.C.	0–1	"Amperes D.C. Total Plate"	Self contained	8304	$17.50
1 Amp D.C.	0–1	"Amperes DC 1 KW Plate"	Self contained	13768	17.50
2 Amp D.C.	0–2	"Amperes DC 3 KW Plate"	Self contained	13675	17.50
3 Amp D.C.	0–3	"Amperes DC 10 KW Plate"	Self contained	13676	17.50
300 MA RF	0–300	"Volts RF Transmission Line"	With internal vacuum couple	13605	27.50
5 Amp R.F.	0–5	"Amperes RF Transmission Line"	Less Thermocouple	8305	17.50
5 Amp R.F.	0–5	"Amperes RF Antennae"	With external thermocouple	8306	27.50
5 Amp R.F.	0–8	"Amperes RF Antennae"	With 5 ampere couple	8312	27.50
6 Amp R.F.	0–6	"Amperes RF Antennae"	With external couple	8313	27.50
6 Amp R.F.	0–6	"Amperes RF Transmission Line"	With external thermocouple	8305	27.50
4 KV D.C.	0–4	"Kilovolts DC Amplifier Plate"	1 MA, with tubular multiplier	13606	22.50
4 KV D.C.	0–4	"Kilovolts DC 1 KW Plate"	1 MA, with tubular multiplier	13769	22.50
10 KV D.C.	0–10	"Kilovolts DC 10 KW Plate"	1 MA, with tubular multiplier	13638	30.00
12.5 KV D.C.	0–12.5	"Kilovolts DC Power Amp Plate"	1 MA, with tubular multiplier	13677	32.50
6 MA D.C.	0–4	"Kilowatts RF Output"		13744	17.50
10 MA D.C.	0–12	"Kilowatts RF Output"		13745	17.50
300 V A.C.	0–300	"Volts A. C. Power Supply"	Self contained	8302	20.00

WESTON METERS DC & RF model 252, AC model 260

RANGE	SCALE	CAPTION	NOTES	W.E. KS#	Price
1 Amp D.C.	0–1	"Amperes DC 1 KW Plate"	Self contained	13768	17.50
2 Amp D.C.	0–2	"Amperes DC 3 KW Plate"	Self contained	13675	17.50
3 Amp D.C.	0–3	"Amperes DC 10 KW Plate"	Self contained	13676	17.50
300 MA R.F.	0–300	"Volts RF Transmission Line"	With internal vacuum couple	13605	27.50
4 KV D.C.	0–4	"Kilovolts DC Amplifier Plate"	1 MA movement, tubular Multiplier	13606	22.50
4 KV D.C.	0–4	"Kilovolts DC 1 KW Plate"	1 MA movement, tubular multiplier	13769	22.50
5 KV D.C.	0–5	"Kilovolts DC 3 KW Plate"	1 MA movement, tubular multiplier	13770	25.00
12.5 KV D.C.	0–12.5	"Kilovolts DC Power Amp Plate"	1 MA movement, tubular multiplier	13677	32.50
6 MA D.C.	0–4	"Kilowatts R.F. Output"		13744	17.50
10 MA D.C.	0–12	"Kilowatts R.F. Output"		13745	17.50
300 V A.C.	0–300	"Volts A.C. Power Supply"	Self contained	8302	20.00

WESTINGHOUSE METERS DC & RF model SX, AC model SY

RANGE	SCALE	CAPTION	NOTES	W.E. KS#	Price
1 Amp D.C.	0–1	"Amperes DC Total Plate"	Self contained	8304	17.50
300 MA R.F.	0–300	"Volts RF Transmission Line"	With internal vacuum couple	13605	27.50
500 MA R.F.	0–1000	"Volts RF Power Amp. Trans. Line"	With internal vacuum couple	ESA #680437	27.50
6 Amp D.C.	0–6	"Amperes RF Transmission Line"	With external couple	8307	27.50
4 KV D.C.	0–4	"Kilovolts DC Amplifier Plate"	1 MA, with tubular multiplier	13606	22.50
5 KV D.C.	0–5	"Kilovolts DC Amplifier Plate"	1 MA, with tubular multiplier	8303	25.00
10 KV D.C.	0–10	"Kilovolts DC Power Amp Plate"	1 MA, with tubular multiplier	ESA #680434	30.00
300 V A.C.	0–300	"Volts A.C. Power Supply"	Self contained	8302	20.00

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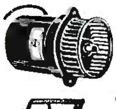
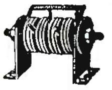
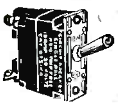
PRECISION LEVEL — interior ground tube level with 4 adjusting screws. Overall length 1⅝". diam. 15/32". One end with shoulder ⅛" diam. **$.85**



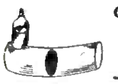
DELCO BLOWER — sirocco type D.C. Flange diameter 3½" blade 3-3/16" RPM @ 12 volts 3400 RPM @ 6 volts 1600 .... **$3.95**



SELENIUM RECTIFIERS — G.E. model 6RS 5FB3 maximum A.C. volts 56 D.C. amps. 0.150..... **$1.35**



CIRCUIT BREAKER — 10 amp 30 volt D.C. C-H. Cat. #8751K4... **$1.10**



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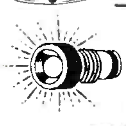
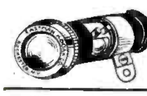


Miniature lamp T1¼, 3 volt .19 amp. Airplane Indicator, Amb. Ctd.
10 for .... .85
100 for **$7.50**



Lamp Assembly C203 Genl. 1 Made by Eastman Kodak with Iris Diaphragm 12 volt lamp ......each **$1.95**

WATTHOUR METER SINGLE PHASE— G.E. type 1-16 two wire 5 amp. 115 volt 60 cycle **$5.75**

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3 GANG— 25 MMFD to 450 MMFD each section. Size: 6" x 3¼" x 3". Price........ $1.95

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MP-132—1" heavy coil spring, 2" insulator. Overall length: 11½", Weight: 2¾ lbs. Price........ $3.95
MP-22 Spring action direction of bracket. 4" x 6" mounting. Price $2.95

MAST SECTIONS FOR ABOVE BASES:

Tubular steel, copper coated, painted, 3 foot sections, screw-in type. MS-53 can be used to make any length, with MS-52-51-50-49 for taper. Price, per section .... 50¢

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BAG BG-56 for carrying 5 mast sections.....50¢ ea.

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0-150 Volt AC 3" Round........ $3.95
0-150 Volt 400 Cycle 2½" Round........ 2.95
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	220 V. 100 MA.	D-104	9.95
12 V. DC	330 V. 150 MA.	BD-87	5.95
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PERMANENT MAGNET FIELD DYNAMOTORS:

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PRICE—$2.95 F.O.B.

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D-H. Enameled. .004 and .005; 43+ and 25+ ohms per ft. On original spools. New and clean. Approximately ½ Lb. ....59¢

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Type W.E. 396A with speaking spout, single headphone and double plug. New original packing. While They Last!..........................$4.95

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WL-531 50 K.V. Vacuum. Rectifier (HW). New $1.10
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705-A 35 K.V. H.W. Vacuum Rectifier. New..95¢
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1632 12.6 V. Filament, 25L6..................69¢
1633 25 V. Filament, 6SN7....................69¢
1634 12.6 V. Filament, 6SC7..................69¢
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Minimum to Mamixum. Cap. in 90° rotation. (.03 spacing with shaft lock nut)
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(H) BFC-35-6. Min.: 7.5 mmf. Max.: 75 Mmf. $1.39

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807 PLATE TUNING ASSEMBLY

Consists of a Cardwell 150 mmf. Condenser, Ceramic Beaded Plate Lead, R.F.C. and .002 mfd. 2500 V. Blocking Condenser. (.07 spacing) With shaft lock and mounting hardare. New $1.95

5 GANG, INSULATED ROTORS

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MAIN TUNING GANG—SX-28A

7 section. Ceramic insulation. Exact replacement. ⅜" shaft. New $2.95

PRECISION GANG AND DIAL ASSEMBLY

As used in BC-223 Transmitter. 3 section, 175: 200 and 250 mmf. High ratio loaded gear drum dial drive. No slip or back lash. Ideal for test or measuring equipment. New $2.75

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G.E. Type NE-48. ¼" W. Bayonet Base. 10 for $1.45

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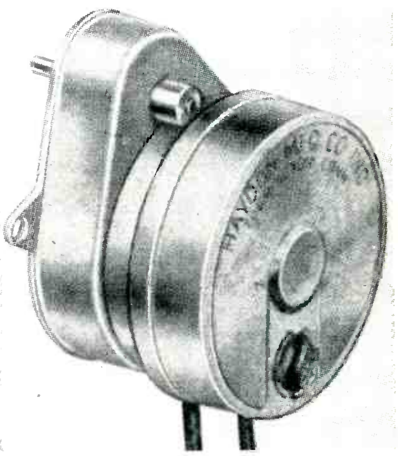

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Weston Elapsed Times Hour Meters Model 691 Type 2 9999-9 115v 60¢ $10.45
H.V. Micas Sangamo Type G3B .011 mfd. 25000 v. $12.95
H.V. Micas Sprague 500 mmfd 10000v. $5.95
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Germanium Diodes 1N34 $0.69
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UG 9/U	$ 0.75 each
UG 36/U	10.00 each
UG 234/U	10.00 each
UG 250/U	10.00 each
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Turner Microphones Type 9DH1 NEW $8.75
Tubes in original boxes Nationally Advertised Brands

26	40¢	721	$2.95
56	52¢	575A	$11.95
27	40¢	CRP-72	$1.25
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24A	46¢	3 B 24	$1.45
12Q7	46¢	4B31	$10.45
75	50¢	1B51	$9.75
6J4	$4.50	FG 104	$12.75
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Contains BC-713A and BC-714A. For ARN7 or SCR-269. With cables. Like new. A wonderful buy at this low price. $595.00

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Indicator for APN-2. Can also be used as overmodulation indicator. Wonderful deal for cheap test scope. Contains 8 tubes: 1-3BP1, 2-6SN7, 2-6H6, 1-6G6, 1-2X2 and 6X5. Excellent condition. $14.95

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Complete with motor and frame as used in ARC-1 transmitter. Good used condition. $22.50

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2.5 Volt ct. 10 Amp. Heavy Duty. $3.95

WESTON MODEL 426 AC VOLTMETER

0-130 volts AC. 3". Bakelite case. Boxed, brand new. $3.95

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Ten tube superhet with crystal controlled local oscillator. Provision for six crystal channels between 108-112 Mc. Complete with tubes and crystals, less dynamotor. Used. $4.95

R89/ARN-5 RECEIVER

Glide path receiver. Broad band pass. Crystal controlled local oscillator. 20.7 Mc IFs. Complete with 7-6AJ5, 1-12SR7, 2-12SN7, 1-28D7, relays, crystals. Good used condition. $4.95

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150 Watts Phone or CW. 2-211 tubes in final. Complete with all tubes and one tuning unit. Used. $14.95

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Portable SOS sea-rescue unit. Approved. $50.00

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Los Angeles 5, Calif.
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Eicore D-401 Cont. Duty Dynamotor 12 V at 9.9 Amp. 440 V at 200 Ma.	$ 10.50
P E-125 AX Vibrated Power Supply 12V at 14 Amp. or 24V at 7½ Amp. 500 V at 160 Ma output	8.90
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Dynamotor. New 27V at 2.7A 300 V at 120 Ma.	4.50
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FOR COOL—CLEAN AIR WINTER & SUMMER

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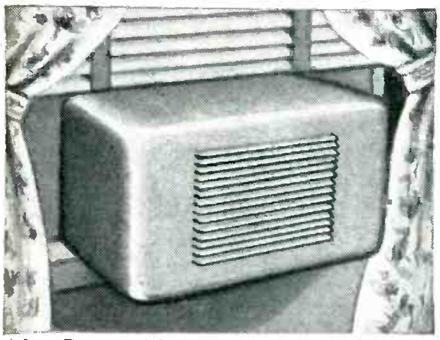

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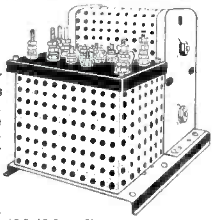
24 to 28 VDC Filtered

Designed for continuous duty ground operation and bench testing of aircraft equipment, these kits provide a reliable means of obtaining a source of low ripple 24 VDC, from a 115 VAC 60 cycle line. Full wave bridge Selenium Rectifiers insure instantaneous and efficient operation. Adjustment of the DC output voltage is accomplished by transformer primary taps. Ripple is limited to within 2% of the average DC output by choke-input filters.

Kit	Amperes DC	Net Price
242	2.0	$16.39
245	5.0	22.39
2410	10.0	47.44
2420	20.0	79.44

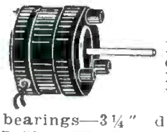
Write for descriptive Bulletin No. 201

DC POWER SUPPLY



Limited quantity — Gov't Surplus Ready to operate. Full wave bridge copper-oxide rectifier heavy duty multi-tapped transformer.
Input: 85/95/105/115/VAC50/60 cps
Output: 2.5/24/28/32/36 VDC at 5 amperes, unfiltered
For wall or bench mounting. Overall dimen. 9" x 8¼" x 8½" high. Shpg. wt. 30 lbs. Tested and guaranteed $36.00
Filter Kit, 2% ripple 6.65

DIEHL MOTOR



Fan duty, brushless induction type (no TVI. 115 VAC 60 cycles 46 watts 1800 RPM. Shaft ¼" x 1". Noiseless ball-bearings—3¼" diam. x 2½". Brand new $4.50

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6 and 12 VDC at 10 Amperes

This unit will deliver unfiltered direct current for operation of motors, dynamotors, solenoids, relays and similar equipment. Employs full wave Selenium Rectifier and heavy-duty primary tapped transformer. The two output voltages can be used simultaneously and may be adjusted between 6.7-7.5 VDC and 13-15 VDC, under full load. For 115 VAC 60 cycle input. With schematic diagram and instructions. Shpg. wt., 12 lbs. **$15.95**

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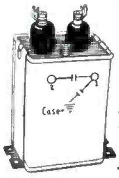

8 or 16 KV Condenser. Oil filled—voltage doubler type. .15 MFD—8000 VDC each section. Can be used in series for .075 MFD 16 KV. Brand New .... $3.25 ea.
Lots of 6 in orig. box .... **$3.00 ea.**

Minimum order $3.00. No COD's accepted. Orders shipped via Rwy. Exp. charges—collect, unless accompanied by additional 10% for parcel post and handling—15% west of Rockies.

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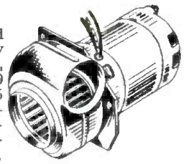

#KS5881 — Brand New — Heavy Duty Sirocco type blower, capacitor start, 1/40 H.P. 3400 RPM 115 VAC 60 cycles. Displaces 84 C.F.M. Extremely quiet operation. Opening 2¾", overall size 7½" long, 6" diam. Moisture and fungus resistant. With capacitor. Shpg. Wt. 15 lbs. Quantity limited $13.95

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Standard Brands

12 Mmfd.	20 Kv	$4.95
50 Mmfd.	32 Kv	5.95

Overall length: 6½", Diam. 2-3/16". Terminal Diam: ¾". Shpg. Wt. 2 lbs.

EDISON THERMO TIME DELAY RELAY

Heater voltage 115 V. Norm. open SPST contacts, 15-30 sec. delay. Contact rating 115 V. 3A., 440 V. 2A. Size 3¾" x 1⅛" diam. Standard 4 prong tube base .... **98c ea.**

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Attractive, rugged and reasonably priced. Moving vane solenoid type with accuracy within 5%. Square case.
0-6 Amperes D-C
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Any range **$2.49 ea.**

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FOR ALL APPLICATIONS

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Westinghouse R5, 1 meg., w.w., noninductive ½% tol. $.90 each, 10 for $7.50 or 10 multipliers plus a Weston or Westinghouse 3", 1 ma. meter....................$10.00

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Copper Sulphide, F.W.B., 3.5 v. a-c in, 1.8 v. d-c @ 1 amp out. (Fine for 1.5 v. d-c filaments). New, boxed. $.60 each, 10 for $5.00, 100 for $40.00.

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Discount 20% on orders over $50.00

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388A	2.75	725A	8.50
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701A	3.50	846	47.50
702A	2.75	872A	1.75
703A	2.75	C5B	7.75
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708A	2.75	VT98 (Br.)	12.50
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SPECIAL: Rectigon, Westinghouse Battery Charger Tube, 6 amp. 65 v., Cat. #289414/JAN4B28. New, orig. box. $1.50 each, 4 for $5.00.

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- components

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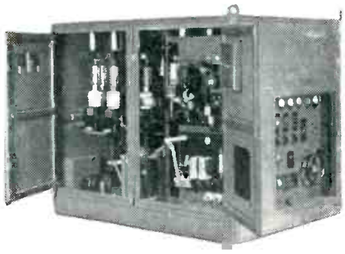
115 v., 60 cy. 1 phase input, output 0-15,000 v. d-c @ 500 ma. Write for detailed information



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VACUUM CAPACITOR: 50 mmfd. 32,000 v. d-c. New, original carton. $4.50 each, 4 for $15.00.

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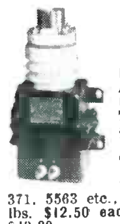

HIGH VOLTAGE FILAMENT TRANSFORMERS: Amertran Type W.S. .050 KVA, 50/60 c., 1 phase; 35 KV test, 12 KV d-c operating; sec. 5 v c-t @ 10 amps. Has socket that takes 872A, 250T, 371, 5563 etc., rectifiers. Net Wt. 16 lbs. $12.50 each, 2 for $22.50, 4 for $40.00.

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RA-10 DA Aircraft Communications Receiver, Bendix Mfg., complete with Control Box, plugs, mount, tuning shaft (24 v) ....Set $69.50
BC-375 E Aircraft Transmitter, G. E. mfg. Complete with 7 Tuning Units, Ant. T. U. Dynamotor, plugs ....Set $75.00
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Flexible Housing for wiring, with female couplings, fits AN connector 10 ft. length $1.50 20 ft. length ....ea. $2.77
Regulator Control Unit, G. E. model 3GBD1A22 ea. $12.50

Terms: Prices Net FOB Chicago, 25% Deposit, balance COD. Send us your requirements.

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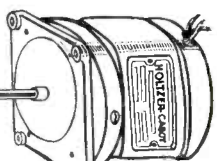
NEW HOLTZER-CABOT TOTALLY ENCLOSED MOTORS



50 R.P.M. Reversible Single Phase Capacitor-Run type. 115 Volts AC 60 cycle 0.3 Amp. Torque 100 oz. inches. 4¾" shaft ⅜" dia. 400 at $16.50 ea. SAMPLE $17.50

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Mazda G.E. 323 3V..19.A Mazda G.E. 328 6V..2A
Either type, doz. **$1.50**

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A 10 amp. timing device. Pointer moves back to zero after time elapses. Ideal for shutting off radios and TV sets when you go to bed. Limited supply at this special PRICE **$3.90**

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Nat. known Mfgrs. 50 watt 2 windings, 115 V. to 115 V. 60 cy. Ideal to prevent shocks from small radios and medical and electronic devices. Shipping Weight 5 lbs.
Other sizes and 220-110 in stock.

Kilowatt Demand Meter Totalizer containing heavy duty TELECHRON B-7, 1 RPM motor and hundreds of watch size gears, clutches, springs, etc. Shipping weight 2 lbs. 5 for $10.00 **$2.50**

RADAR MAGNETS ....$5.00 to $17.50
Write for Sizes and Weights.
RCA 930 PHOTO TUBE......................$1.25
CRYSTAL DIODE IN 23...................... .55
INSTANT REVERSIBLE 50 RPM
SMALL 12V. DC-40 OHM RELAY......5 for $1.00
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ALLIANCE OR RUSSELL 110V AC MOTOR $1.85; 3 for $5.00

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Experimenters and Inventors Supplies
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FREQ. STANDARD, to 40 MC, James Knight type FS-544, excellent condition $75.00
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FREQ. METER, aircraft type. 350-450 cycles — direct reading — 3" flush Mtg. 90-140V, accuracy 1/3 of 1%. Electrodynamometer type—low drain—.8VA—Hickok Mod. 59 (list $90.00). New..........$19.00
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72 OHM LINE, for 1 KV per ft....... .04
CRYSTALS, 120 in box, 5675 KC to 8650 KC in 25 KC steps. FT-243 B.C. 1335..$49.00
RU/GF COIL SETS, receiver & Xmitter, used, good condition................ .50

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Single phase full wave bridge type

0-18V. A.C. in. 0-14V. D.C. out.		0-36V. A.C. input 0-28V. D.C. output	
5 Amps	$3.95	5 Amps	$7.75
10 Amps	$7.75	10 Amps	$14.00

Full wave center tap, 30 Amp......$14.50
Write for our low prices on all other types; discounts on quantities.
CHOKE, 7 Amp.; .03 Henry..........$3.50
ARC-5 RECEIVER, 3-6 MC less dial & drive, like new..........................$3.95
RED PLASTIC TUBING for #20 wire. 1500 Ft spool..........................$1.95

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230/450V. .750 KVA also good for 110V/220V use, new.......................$7.95
5.7V—600 AMP 110/220V Pri. new...$29.00
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Tubular Condensers	Electrolytic Condensers
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Cables and other miscellaneous parts.

"Write for quantity prices on the above Equipment"

AMERICAN SALES COMPANY

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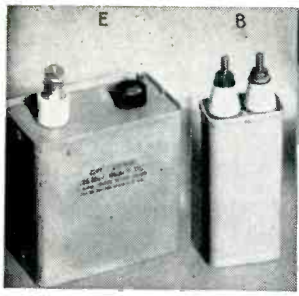
TELEVISION TUBE MACHINERY

8-HEAD MACHINE, for button stems.
TUBE STEM MACHINES Mfd. by Kahle Eng. Co. 4-5-6-7-8 positions with Geneva movements.
HYDROGEN FURNACES Complete with automatic controls, 20" x 7" x 4". Brick-lined, with two Bristol automatic controllers, Brown pyrometers.
EXHAUST MACHINE 32 head, capacity 60 tubes per hour, 60 W. type B174 Sealiex chassis.
VACUUM FIRING EQUIPMENT Mfg. by GE.
SEALING & STEM MACHINE 16 head, mfd. by GE.
EXHAUST MACHINE 16 head, mfd. by GE, can be converted to standard tube production.

Many other items of good, used glass-working equipment. Please write for details:

HAYDU BROTHERS

Plainfield, New Jersey



Sylvania Type #216 Sig. Generator

For general purpose use on freq. mod., amp. mod. and TV rcvrs. Seven bands 80 KC to 60 MC. Guaranteed brand new and latest type. Send for descriptive literature.

Price $139.50

OIL CONDENSER—New

Symbol	Cap.	Voltage	Type	Price
B	.005–.005–.01	10KV	#26F344	$2.50
I	.007	1,000V	Rev. bkt.	.08
Special	.02	20KV		6.50
E	.03	16KV	#26F380	3.00
B	.05–.05	2,000VAC	#25F648	.95
B	.1	1,500V		.22
O	.1	2,000V		.28
F	.1	2,500V	#2516CB	.40
G	.1	3,500V		.55
B	.1	5,000V		.75
B	.1	7,000V	#25F744	1.00
G	.1	7,000V	Can 1 Term.	.90
B	.1	7,500V	#23F447	1.20
B	.1	10KV	#23F644	4.25
B	.1	15KV	#25F572	5.25
B	.2	10KV	#25F133	4.50
B	.25	3,000V		1.00
E	.25	6,000V	#23F659	1.25
B	.25	20KV		16.95
B	.4	10KV	#14F267	4.75
D	.5	400V	#416MCT	.12
D	.5	500V	#9CE6A3	.14
B	.5	1,500V	Can	.25
B	.5	2,000V		.75
B	.5	3,000V		1.10
B	.5	25KV		19.85
F	.5–.1	2,000V		.89
B	.5–.5	600V		.20
B	.75	1,000V		.17
F	1	400V		.16
D	1	500V	#23F266	.18
F	1	500V	#23F225	.18
F	1	600V	CP6881EF105	.24
B	1	600V		.20
B	1	1,000V	TJU10010G	.25
B	1	2,500V	#23F121	1.15
B	1	10KV	#14F267	12.95
B	1	15KV		15.75
B	1.25–1.25	7,500V	#23F360	5.75
D	2	600V		.25
G	2	600V	TLA Type	.16
G	2	1,000V	TLA Type	.40
B	2	1,000V		.49
B	2	2,500V	Bkts	2.15
B	2	4,000V	#23F47G2	3.65
B	3	600V	Can	.25
B	3	4,000V		4.50
B	3–3	600V		.65
B	4	500V	#25F796	.44
B	4	600V	#23F317	.48
B	5	600V		.52
B	6	2,000V		2.90
B	7	800V		.69
F	8–8	600V		.90
B	10	600V		.85
B	10	1,000V		1.95
B	10	1,500V		2.30
B	15	1,000V	TJU10150	2.15

TYPE "J" POTS
$.35

Symbols: LS=Locking Type Shaft. S=Screwdriver. R=Round Shaft

Ohms	Shaft	Ohms	Shaft
50	1/4S	25,000	1/8LS
200	1/8S	50,000	1/4S
500	1/8S	50,000	1/8S
500	1/2R	50,000	1 1/4R
1,000	1/8LS	50,000	1/8LS
2,000	3/8LS	100,000	1/8LS
3,000	1/8LS	100,000	1.0R
3,000	1/2R	100,000	1/4S
5,000	1/8LS	150,000	2 1/8R
5,000	1/4R	200,000	1/8LS
10,000	1/8LS	200,000	1/2S
10,000	3/8R	250,000	1/8LS
15,000	1/8S	250,000	1/8S
16,000	1 1/8LS	300,000 (2 Terms)	1/8S
20,000	1/8LS	1 Meg	1/8LS
20,000	1 1/4R	1 Meg	1/8S

TYPE "JJ"
$.70

Ohms	Shaft	Ohms	Shaft
1500	1/4R	100K	1/2LS
1K–5K	3/8R	100K	33/8LS

Available in other sizes

NEW MICA CONDS.

6, 15, 25, 30, 39, 75, 100, 140, 150, 185, 200, 230, 240, 250, 300, 350, 400, 500, 750, 1000, 1250, 1300, 1500, 3000, 3800, 4700, 5000, 6000 and 10,000 mmfd @ 500V. $3.50 per "C". **Special, 100 assorted $2.95.**

NEW S. MICA CONDS.

10, 20, 30, 50, 100, 120, 140, 150, 200, 240, 250, 300, 345, 400, 500, 670, 1000, 1800, 2000 and 2500 mmfd @ 500V. $7.00 per "C". **Special, 100 assorted $5.95.**

BATHTUB KIT 10 for $.99

For Bathtub Conds. see Mar. issue.

SPECIAL
5—5 mfd—400 vdc Oil Cond.

3 terms. bot. mntg flanged type. Dimensions 3¾ x 3½ x 2. Tested at 1800 V. Meets commercial specs. for 600 Volt operation up to 40 degrees C. Being used as power factor correction capacitors. Numerous applications. 24 per carton. See symbol "F".

Price........ **$.39** each

Price F.O.B., 25% with order. Balance C.O.D. Minimum order $2.00.

MONMOUTH RADIO LABORATORIES

BOX 159 OAKHURST, N. J.

ALLIED TYPE BO RELAYS

55 VAC DPDT. Operates on 12 VDC or 110VAC intermit. duty (5 min). 2 units in series for 110 VAC for 4PDT oper. #R211 $1.10 ea
BO 6D29 6 VDC DPDT 14.2 ohms. #R212 $1.10 ea.
BOX-103 24 VDC DPDT 230 ohms. #R04....$.89 ea.
BO-13D35 24 VDC SPST NO Dble Br 230 ohms. #R06 $.79 ea.

Over 100,000 Relays In Our VAST STOCK

GUARANTEED—IMMEDIATE DELIVERY

Write us your needs for our quote

Write for Our Quote

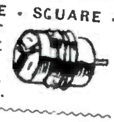
SOLENOIDS

G. E. CR9533K100A2 240 ohm 24 VDC DPST N.C. & SPST n.o. 2 switchettes. Extra Long throw. #R132 ...$8.45
HART M569A CAT # 694R19 75 ohm 24 VDC 200 amp. cont. SPST n.o. #R127A $1.75

H-F TIE POST

LOW-LOSS BAKELITE INSULATION
$7.50/C $67.00/M

SINE - COSINE WAVE POTENTIOMETER W.E. CO# D169100 for very low freq. sweep circuits $9.95 ea.



• SQUARE •

LARGE STOCKS OF

AN Connectors, APC's, Binding Posts, Cable, Capacitors, Ceramicons, Ceramics, Chokes, Circuit Breakers, Coils, Controls, Crystals, Filters, Fuses, Hardware, Knobs, Relays, Resistors, Shock-Mounts, Sockets, Spaghetti, Switches, Transformers, Tubes

S.S. WHITE DENTAL LAB RESISTORS 1K, 4K, 60K, 100K, 500K. All 1 Watt $7.50/C

Write Us Your Needs for Immediate Quote

Min. Order $2.50

Universal general corp.

324 Canal St. New York 13, N. Y. WAlker 5-9642

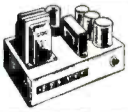
Prices Net FOB Our Plant

SOUNDTRONICS SPECIALS

JUNE SPECIAL

1B-110 TWISTED PAIR TEL. FIELD WIRE Stranded 4 Steel, 3 Copper, Weatherproof
½ MI. Reel ....$ 5.00
1 MI. Reel 10.00

TRANSFORMER POWER SUPPLY



115 V. 60 Cy., 300 V. @ 55 MA., 6.3 V. @ 2 Amps. Has 5Y3, 2-8 Hy. Chokes, 3-30 MFD Filters, Pilot, Term. Strip. Meas. 5"x5"x8". Completely wired $6.85

6 V. 12 Amp. TRANSFORMER 115 V. @ 60 Cy. Inp., Open Frame 2½"x3"x3½"..........$1.65

TG 10 KEYERS w/TUBES..............$24.95

ANTENNA INSULATOR

Heavy Glazed Porcelain 12"x1"x1¼" 18c

SELENIUM RECTIFIERS

Single Phase Full Wave Bridge

Input 0—18 volts	Output 0—14 volts
2.4 Amps.	$3.07
6.4 Amps.	$4.09
13 Amps.	$7.67
17.5 Amps.	$8.69

WHEATON TRONEX TERMINALS

#1301 for Circuits up to 5000 Volts 10c ea.
#1302 for Circuits up to 6500 Volts 12c ea.

U.T.C. CHOKES P.A. STYLE

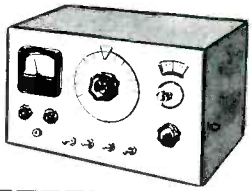
10 HY. @ 66 MA. 400 ohm DC. R..........$ .97
10 HY. @ 110 MA. 80 ohm DC. R..........1.40
10 HY. @ 150 MA. 130 ohm DC. R..........2.25
5 HY. @ 150 MA. 120 ohm DC. R..........1.85

OUTSTANDING VALUE

New Army MINE DETECTOR AN/PRS-1 Will detect metallic and non-metallic objects, buried cables, etc. Uses 3- 45 V. & 1- 6 V. Batteries. Complete w/spare rods, tubes, etc. Less Batteries. In Original Overseas Packing $16.95

FOLLOWING EQUIP. USED BUT LIKE NEW

U.H.F. SGNAL GENERATOR



Similar to RCA type 710A 370 to 560 Meg. Output 1 Microvolt to .09 V., 400 Cy. Int. Mod. Dial Cal. Directly in Meg. Cavity Tuner, Cal. Piston Atten. Ideal for Citizens Band $145.00

BC 716A—680—710 M.C. Rec. & Reg. Pwr. Sup. Part of SCR 296 RADAR 16 Tubes $138.00

TRANSTATS—3.9 KVA 1 Phase 50/60 cy. fixed winding 115/230 V. output 0-260 V. Max. amps. 15 ....$42.00

5.85 KVA 1 phase 50/60 cy. fixed winding 115/230 V., Output 0-260 V., Max. amps. 22.5......$52.00

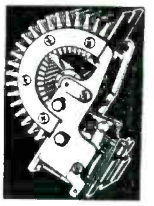
DUAL LINE LEVEL RECORDER +6 to —16DB. 115 V. 60 Cy. Made by Brown Instrument..$155.00

LARGE QUANTITY OF SEMI-PRECISION FACTORY TEST EQUIP. Pulse Gen., Pulse amp., Multi-Vib., Sig. Gen., Wavemeters., Delay lines, etc. Write requirements.

SOUNDTRONICS LABS.

632 Arch St., Phila. 6, Pa. MA 7-2115

CLARE STEPPING SWITCHES



Type SD-14, 20 steps, 6 levels. Coil 12V, DC. Lists at $40.26; our low price $13.00. Brand new in original boxes—not war surplus. Quantities of four or more, $12.25 each. Satisfaction guaranteed or money refunded.

NEOMATIC, INC.

879 Wellesley Ave., Los Angeles 49, Cal.
ARizona 3-4897

"TAB" THAT'S A BUY — TUBES Tested—Guaranteed

Tube	Price
OA2	1.20
OA3/VR75	.98
OA4G	.94
OB2	1.54
OB3/VR90	.74
OC3/VR105	.75
OD3/VR150	.47
OZ4	.56
C1A	4.80
O1A	.45
1A3	.42
1A4	1.00
1A5GT	.48
1A6	.78
1A7GT	.63
1B3/8016	.81
1B4	.98
1B5/25S	.84
1B7GT	.98
1B21/471A	2.85
1B22	4.50
1B23	9.00
1B24	4.65
1B26	4.50
1B27	8.49
1B29	3.39
1B32/532A	2.75
1B37	45.00
1B38	36.00
1B41	49.95
1B42	7.50
1B53	49.95
1B54	49.95
1B56	49.95
1C5	.86
1C6	.87
1C7G	.89
1D5GP	.95
1D7G	.84
1D8GT	.94
1E5	1.08
1E7G	1.00
1F4G	.75
1F7GT	1.55
1G4GT	.69
1G5G	.98
1G6GT	.63
1H4G	.87
1H5G	.54
1H6G	.99
1J5G	.98
1J6	.72
1L4	.45
1LA4GT	.99
1LA6	1.19
1LB4	.99
1LC5	.64
1LC6	.75
1LD5	1.19
1LE3GT	.85
1LH4	.64
1LN5	.62
1N5GT	.59
1N6G	.98
1P5GT	.54
1P24	.85
1P25	59.50
1P25A	98.00
1Q5GT	.96
1Q26	75.00
1R4/1294	.65
1R5	.59
1S4	.96
1S5	.48
1T4	.51
1T5GT	1.05
1U4	.49
1U5	.69
1V	.49
1X2	.78
1Z2	3.98
2A3	.84
2A4G	1.04
2A5	.65
2A6	.75
2A7	.75
2B7	.78
2B22/GL559	.73
2C21/1642	.81
2C22/7193	.15
2C26	.25
2C34/RK34	.27
2C39	21.00
2C40	5.50
2C43/464A	9.39
2C44	1.69
2C50	3.69
2C51	6.98
2C52	3.06
2D21	1.10
2E5	.89
2E22	1.15
2E24	4.50
2E25/HY65	4.00
2E26	3.45
2E30	2.35
2G5	.98
2J21	11.45
2J21A	11.45
2J22	9.75
2J26	8.15
2J27	14.50
2J31	9.95
2J32	14.85
2J33	18.95
2J34	17.50
2J37	13.85
2J38	12.70
2J39	29.00
2J48	24.50
2J49	22.50
2J50	39.00
2J56	81.00
2J61	39.00
2J62	39.00
2K25	22.25
2K28	24.89
2K29	24.95
2V3G	.49
2W3GT	.98
2X2	.36
3A4	.32
3A5	.75
3A8GT	1.89
3B4	3.49
3B5	.98
3B7/1291	.29
3B22	2.64
3B24	1.75
3B25	4.85
3B28	5.89
3C23	3.98
3C31 C1B	3.75
3C45	12.85
3D6/1299	.29
3D21A	1.20
3E29/829B	7.98
3LF4	1.25
3Q4	.45
3Q5GT	.65
3S4	.54
3V4	.67
4C33	81.00
4C35	19.30
4E27/257	12.39
4J31	95.00
4J32	95.00
4J42/700	29.85
4J47	98.00
4T4/2	9.95
5C22	47.00
5C30/C5B	8.49
5D21	24.50
5J23	13.45
5J29	17.39
5J32	99.00
5R4GY	1.29
5T4	.86
5U4G	.47
5V4G	.88
5W4	.66
5X4G	.71
5Y3GT	.38
5Y4	.45
5Z3	.51
5Z4	.74
C6A	7.85
6A3	.98
6A4	1.29
6A6	.88
6A7	.68
6A8GT	.78
6AB4	.69
6AB5/6N5	.88
6AB7/1853	.77
6AC7	.87
6AC7W	1.30
6AD5	.98
6AD6G	.81
6AD7	1.17
6AE5	.89
6AF5	.81
6AF6G	.77
6AG5	.59
6AG7	.97
6AH6	.89
6AJ5	.73
6AK5	.98
6AK6	.81
6AL5	.55
6AL7	1.00
6AN5	1.19
6AQ5	.47
6AQ6	.54
6AQ7GT	.98
6AR5	.50
6AS5	.59
6AS6	2.89
6AS7G	4.29
6AT6	.40
6AU5GT	1.19
6AU6	.53
6AV5GT	1.49
6AV6	.43
6AX5GT	.69
6AW6	.89
6B4G	.84
6B5	1.49
6B6	.75
6B7	.89
6B8G	.65
6BA4	1.08
6BA6	.49
6BA7	.79
6BC5	1.19
6BD6	.69
6BE6	.49
6BF6	.52
6BG6G	1.39
6BH6	.52
6BJ6	.55
6BQ6GT	.89
6C4	.29
6C5	.45
6C6	.52
6C6G	.55
6C7	1.26
6C8G	.65
6C21	23.95
6CB6	.69
6CD6G	3.49
6D4	2.75
6D6	.47
6D7	.98
6D8	.75
6E5	.69
6E7	1.20
6F5	.47
6F6	.55
6F6GT	.52
6F7	.80
6F8	.84
6G6	.99
6H6	.45
C6J	3.90
6J4	4.65
6J5GT	.37
6J6	.70
6J7	.65
6J7GT	.59
6J8GT	.95
6K5GT	.79
6K6GT	.42
6K7	.48
6K8	.75
6L5	.84
6L6	.98
6L6G	.82
6L6GA	.82
6L7	.77
6N4	1.08
6N6G	1.49
6N7GT	.90
6P5G	.81
6Q7	.57
6R7	.77
6R8	.79
6S4	.79
6S7	.85
6S8GT	.75
6SA7GT	.43
6SB7Y	.81
6SC7	.57
6SD7GT	.45
6SF5	.48
6SF7	.58
6SG7	.57
6SH7	.35
6SJ7GT	.45
6SK7GT	.40
6SL7GT	.58
6SN7GT	.59
6SN7WGT	.89
6SQ7GT	.43
6SR7	.56
6SS7	.57
6ST7	.75
6SU7GTY	.85
6SV7	.75
6T7G	.84
6T8	.89
6U4GT	1.35
6U5/6G5	.63
6U6GT	.89
6U7G	.48
6V6GT	.52
6V6GTY	.90
6V6M	.98
6V7G	1.18
6W4GT	.59
6W7G	.87
6X4	.52
6X5GT	.42
6Y5	1.85
6Y6G	.65
6Y7G	.98
6Z5/12Z5	1.18
6Z7G	1.08
6ZY5G	.67
7A4/XXL	.57
7A5	.65
7A6	.65
7A7	.56
7A8	.69
7AF7	.70
7AG7	.69
7AH7	.87
7B4	.55
7B5	.70
7B6	.58
7B7	.57
7B8	.70
7C4/1203A	.36
7C5	.44
7C6	.69
7C7	.57
7C23	69.00
7E5/1201	.65
7E6	.57
7E7	.59
7F7	.58
7F8	1.03
7G7/1232	.98
7H7	.64
7J7	.98
7K7	1.05
7L7	.67
7N7	.65
7Q7	.57
7R7	.63
7S7	.89
7T7	1.03
7V7	.85
7W7	.85
7X7/XXFM	.85
7Y4	.44
7Z4	.55
10Y	.60
12A6	.17
12A7	.96
12A8GT	.48
12AH7GT	.99
12AL5	.72
12AT6	.43
12AT7	.70
12AU6	.52
12AU7	.62
12AV6	.50
12AV7	1.89
12AW6	.55
12AX7	.81
12BA6	.56
12BA7	.75
12BD6	.59
12BE6	.45
12BF6	.54
12BH7	1.11
12C8	.32
12E5	.95
12F5	.57
12H6	.23
12J5GT	.32
12J7GT	.57
12K7GT	.59
12K8	.59
12L8GT	1.55
12Q7GT	.59
12S8GT	.75
12SA7GT	.55
12SC7	.54
12SF5GT	.50
12SF7GT	.52
12SG7	.52
12SH7	.34
12SJ7GT	.45
12SK7GT	.51
12SK7M	.52
12SL7GT	.54
12SN7GT	.47
12SQ7GT	.45
12SR7	.48
12X3	.90
12Z3	.72
14A4	1.09
14A7/12B7	.67
14AF7	.86
14B6	.65
14B8	.77
14C5	.87
14C7	.86
14E6	.71
14E7	.87
14F7	.89
14F8	.75
14H7	.63
14J7	.80
14N7	.86
14Q7	.55
14R7	.65
14S7	1.05
14W7	1.05
14X7	.98
14Y4	1.05
15E	1.44
15R	.75
FG17	3.98
RK18	.98
19	.95
19BG6G	1.98
19J6	1.89
19T8	.89
20	1.17
RK20A	6.98
PJ21	4.98
REL21	4.85
RX21	3.20
PJ22/CE1C	1.49
HY24	1.39
24A	.40
24G/3C24	.45
25A6	1.04
25A7	2.98
25AC5GT	1.08
25B5	1.39
25B6	1.49
25BQ6GT	.89
25C6	1.18
25L6GT	.49
25N6	1.69
25W4GT	.70
25Y5	1.08
25Z5	.40
25Z6GT	.47
26	.42
27	.69
FG27A	9.50
28D7	.35
30	.39
HY31Z	4.89
32	.89
FG32	4.98
32L7GT	.85
33	.63
FG33	8.49
34	.33
35/51	.59
35A5	.65
35B5	.54
35C5	.49
35L6GT	.53
35W4	.38
35Y4	.49
35Z3	.61
35Z4GT	.49
35Z5GT	.49
REL36/6J4	.54
36	.61
37	.36
38	.34
39/44	.25
CRC40	.54
41	.49
42	.47
43	.49
45S/VT52	.27
45Z3	.54
45Z5	.51
46	.65
47	1.08
48	1.98
49	.81
50	1.49
EF50	.40
50A5	.73
50B5	.54
50C5	.59
50C6	1.18
50L6GT	.52
50X6	.98
50Y6	.63
50Y7GT	1.08
53	.84
56	.79
57	.47
58	.53
59	.84
RK61	1.98
RK65	24.95
HY69	4.95
70A7	1.49
70L7GT	1.10
71	.65
71A	.55
72	.95
CRP72	1.37
73	1.67
NR74	.29
75	.53
HY75A	4.59
76	.38
77	.45
78	.45
79	.84
80	.35
81	1.29
FG81A	4.45
82	.84
82V	.95
83	.99
83V	.89
84/6Z4	.56
85	.57
89	.32
VR92	.25
FG104	14.98
FG105	10.75
VU111	.49
HY114B	.81
HY115/145	.80
117L7	1.23
117N7GT	1.36
117P7GT	1.20
117Z3	.49
117Z4GT	1.15
117Z6GT	.77
117Z7GT	1.49
F127A	16.95
CV148	4.98
155	.98
FG166	49.00
FG172	19.50
FG190	12.98
205B/VT2	1.69
211/VT4C	.42
RX215	9.95
WE215A	.25
227A	2.90
231	1.20
250TH	24.98
250TL	24.98
282B	8.49
304TH	3.70
304TL	1.98
307A/RK75	3.60
310A	6.98
316A	.49
327A	2.70
350	1.23
350B	1.88
355A	14.15
368AS	3.75
371B	.84
380A	.79
388A	.89
393A	3.65
394A	3.65
395A	4.95
417A	19.95
GL434	2.90
446A/2C40	1.17
446B	1.80
450TH	19.75
450TL	49.95
GL451	1.90
460/HF200	9.98
WL468	6.75
CK506AX	1.29
RH507	9.98
527	12.95
530	12.95
531	1.80
WL531	1.95
CK533AX	1.49
GL534/1S21	3.98
544	4.98
GL546	1.69
550P1	19.95
CK551AXA	1.69
575A/975	12.65
601B	.19
HY615	.24
WL619	19.75
KU627	7.49
631P1/SN4	3.98
WL632A	8.98
701A	2.90
702A/702B	2.75
703A	3.75
704A	1.08
705A/8021	1.05
707	7.98
710A/8011	.65
713A	1.49
715B	6.95
717A	.61
721A	2.65
722A/287A	9.95
723A	6.95
723A/B	7.90
724A/B	3.90
725A	6.90
726A	4.98
726C	29.98
730A	10.90
801A	.45
802	4.15
803	3.45
804	6.90
805	3.59
807	1.89
808	1.25
809	2.70
810	11.96
811	2.45
812	2.98
813	13.20
814	2.61
815	2.40
816	1.05
826	.39
SD828	2.98
829B	7.29
832A	10.64
836	1.49
837	2.35
838	3.20
842	2.75
843	.39
845	3.95
851	13.95
860	9.95
861	10.79
864	.45
865	1.90
866A	1.04
866Jr	1.00
868/PJ23	1.90
869	30.00
872A	1.49
GE872A	2.98
874	.55
876	.36
878	1.95
884/6Q5G	1.59
885	.87
920	2.70
922	1.19
923	.85
927/CE25	1.26
929	1.33
930	.80
931A	3.95
954	.18
955	.24
956	.24
957	.20
958	.35
SD968	2.95
991	.23
1000UHF	59.95
FM1000	.95
CK1005	.18
CK1006	.64
CK1089	3.98
CK1090	2.69
R1100	5.00
R1130B	12.00
HY1231Z	5.39
HY1269	5.39
1273	1.15
1280	1.15
1609	5.98
1613/6F6X	.45
1614	1.42
1616	.75
1619	.16
1620	4.95
1622	1.75
1624	1.25
1625	.33
1626	.35
1629	.23
1632	.89
1633	.97
1635	1.49
1641 RK60	.48
2050	.93
2051	.36
P4340	36.00
5514	4.85
5516	5.85
5517	1.39
5656	18.90
5686	4.23
CK5702	5.59
CK5744	4.98
CK5784	5.59
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UX6653	.69
8012A	1.35
8013A	2.50
8020	.97
9001	.34
9002	.23
9003	.30
9004	.34
9006	.17

C'RAY TUBES

Tube	Price
2AP1	6.49
2AP5	7.98
3AP1	4.63
3BP1	2.55
3BP1A	7.98
3CP1-S1	2.49
3DP1	3.75
3EP1	2.65
3FP7A	.98
3GP1	8.95
3HP7	4.80
3HP14	9.98
4AP10	4.70
5AP1	3.75
5BP1	1.98
5BP4	4.50
5CP1	1.75
5CP7	3.70
5FP5	6.49
5FP7	1.26
5FP14	18.95
5GP1	6.95
5HP1	4.95
5HP4	6.75
5JP2	11.75
5LP1	18.00
5MP1	4.75
7BP7	4.65
7CP1	12.95
7HP7	5.95
7JP4	16.49
9GP7	12.33
9LP7	18.00
10BP4	20.95
10FP4	24.50
10HP4	27.50
12DP7	12.49
12GP1	49.98
12GP7	18.00
12JP4	27.00
12KP4	34.00
12LP4	27.45
12QP4	32.00
12RP4	36.00
15DP4	56.00
16AP4	55.00
16DP4	49.98
16FP4	57.50
16RP4	49.98
16TP4	49.98
19AP4	96.00
19CP4	85.00
902	3.15
905	2.90
910/3AP1	4.63
912	89.98
914	45.00

Tungar Bulbs

16X897	2.49
29X672	2.95
189048GE	3.49
199698	2.95
289881	2.50
859483	3.98

Ballast

1P1	.49
PM3	.98
4A1	1.29
6-11	.49
PM5	.98
PM6	.98
PM7	.98
PM8	.98
9-3	.49
10-4B	.49
13-4	.49
20-4	.49
K49A	.36
K55B	.36
M55B	.36
L62A	.49
K80B	.36
WL121A	2.61
C376	2.98
ZB583	3.98

Mazda Pilots

44, Box 10	.50
49, Box 10	.60
55, Box 10	.50
64, Each	.07
S6/T4/3W	.18
100W/20V	.25
291, Box 10	.36
311/28V	.15
313/28V	.15
323/3V	.10
Sylvania S6/6W/120V	.15
Wstghs C7/7W/120V	.09
Med. Scr. Base 15W/125V	.08
25W/125V	.08

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NE16/991	.23
NE32	.35
NE45/¼W	.27
NE51/NE20	.07

Bull's Eye Lite Dialco Type, Chromed, Less Bulb 59¢; 2 for 98¢

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1N21A	1.00
1N21B	1.98
1N22	1.39
1N23	1.75
1N23A	1.50
1N23B	2.49
1N25	2.69
1N26	2.98
1N27	1.75
1N29	1.75
1N32	18.00
1N34	.67
1N35	1.95
1N48	.70
1N51	.70
1N52	.95
1N63	.98

Thermistors

D167019	2.95
D168391	.90
D168392	2.00
D170396 HF	.90
1C Bulb Time Delay	.90
Varistor USN CW20259/38C	2.95

Xtal Standards

100Kc	7.98
200Kc	3.98
1000Kc	2.95
4700Kc	.98

Oven Xtals 5010/5025/5055 Kc, Ea. 14.98

Tubes Gtd Exc Open Fil & B'kage Via R' Exp only
Min Tube Order.. $5.00

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AH&H SW'S—UL Appvd, 6A/125V. Hi-Nickel Finish. Fr Equip. CLEAN. SPDT, 5 for $1.00; DPDT, 4 for $1.00
Sound-Pwr Phones: Used, Tested, Gtd. Complete Pair 9.98

NEW COMPONENTS!

HiV Horiz & Defl Output Xformer Sim RCA 211T5 For 16" & 19" Tubes $1.98
UTAH9318 HBO Xfmer H'Sd.......89¢
UTC 88662 VBOXXfmr H'Sd.......89¢
TV HiV Cndsr 500mmf/10KV.......49¢
TV HiV Cndsr 500 mmf/20KV......81¢
IonTrap Magnet RCA 203D1.......39¢
RCA HiV Defl Xfmr 211T1 ....4.98
V'OutptXfmrSimRCA204T2 ....1.98
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36 Exp Super Pan.
35 mm. Cartridges Special....5 for $1.
36 Exp Microfile 35 mm Loads Special 5 for $1.

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TS69/AP. 341 to #1000 Mc Freq Mtr NEW.....$59.95
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2500 Mc TR Assy......$29.95

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Mfd	Each	Mfd	Each	Mfd	Each
1000 wvdc		3000 wvdc		225vac/630dc	
.1	.39	2	3.98	3.3	.49
.45	.63	4	5.95	230vac/660dc	
1	.45	5000 wvdc			.90
2	.89	.2	2.25	330vac/10000dc	
5	1.98	2	9.98	1.25	.55
1500 wvdc		4	16.00	1.5	.60
.025	.59	7000 wvdc		1.75	.65
.05	.39	.002	.98	2	.65
.1	.59	.0075	1.29	2.5	.75
2x.1	.79	1	2.69	2.8	.80
.5	.98	7500 wvdc		3	.85
.75	1.03	.03	1.98	4	.87
1	1.09	.05	2.29	5	1.00
4	2.39	.1	2.89	12	3.69
5	2.49	12500 vwdc		15	3.98
6	2.69	.65	14.89	25	4.98
2000 wvdc		15000 wvdc		40	7.98
.1	.89	.0016	4.98	405vac/1200dc	
2x0.1	1.08	25000 wvdc		1000 cycles	
1	1.27	.00025	4.95	.15	.98
2	1.98	1	95.00	600vac/1800dc	
3	3.49	AC Rated		10	4.49
4	3.98	Mfd	Each	16	5.98
2500 wvdc		220vac/600dc		660vac/2000dc	
.25	.74			5	3.75
3000 wvdc		2	.39	6	3.95
.1	1.90	4	.55	10	5.49
.5	2.49	5	.90	16	6.98

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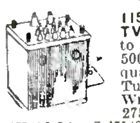

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115 Volt 60 Cyc Input TV Pwr Supply for 7" to 20" Tubes. HiVolts 5000 to 20000V (w/ quadrupler ckt). ALL Tubes, Plates & Fil Wndgs Dlvrg: 300VDC/275 Ma Full-Wave, 6.4V/10.3A, 5.4V/8A, 2.5V/3A, Hypersil Core Oil Impreg USN..........$6.98
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900v/35Ma. 2x2.5v/2A Csd, HiVins..2.98
700vct/120Ma, 115v/100Ma, 2x6.3v/1A, 5v/2A Csd HiV ins.........2.98
420vct/120Ma, 6.3v/1.9A w/inpts 6-12-24-115vdcy&115/230vdc $1.98; 10/$16.98
3000v/10Ma...$4.50; 2x330vct/Ma ...98¢
24V/6A Csd 3.89; 24V/2A Csd 1.59
2x5v/12A HiV ins 12.5KV..........8.98
12.6vct/1.25A Csd HiV ins.........1.39
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6.3vct/4A (gud6.5A) Csd HiVins...1.69

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Amazing Infra-Red Tube that Sees In Dark! 2" Dia. Willemite Screen. ...$4.98
SPECIAL ....2 for $9.49

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100 CFM 12vacdc..5.95
Xfmr 12or28v/115vac
Xfmr12or28v/115vac 1.98
250 CFM 28vacdc...........9.95
250 CFM & 28/115vacXfmr.........11.95
100 CFM 115vacdc..........7.98
180 CFM 115vacdc..........10.98

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Heinemann Magn Bkrs AMPS: 0.22, 3, 9, 15, 30..Ea. 1.29; 10/11.49; 100/$110
KlixonThermalPushButton Bkrs 5, 15 Amps.......Ea. 69¢; 10/4.98; 100/$39
Sq'D & CH AN ToggleSw Bkrs 5, 10, 25 Amps....Ea. 79¢; 10/5.98; 100/$49

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13.5Hy/1A, AZohm/17KV.........$54.
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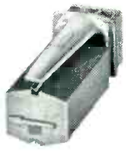

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for COMMUNICATIONS and INDUSTRIAL Applications

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Maximum Ratings — Class "C" Telegraphy	
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Plate Dissipation (Kw.)	5
Typical Power Output (Kw.)	8.5
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