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.

This 100 cubic foot modulation transformer is for 50 Kw. broadcast service. Frequency response flat from 30 to 20,000 cycles.

The high Q toroid coil shown is 12" in diameter. It operates in a 50 Kw. circuit at supersonic frequency.

This sub-miniature (1.18 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.

This sub-miniature (1.18 cubic inch) permalloy dust core toroid is available in a wide range of inductances, and for frequencies from 1,000 cycles to 50 Kc.
500-kW Beam Triode
RCA's new super-power 5001 uses 48 independent electron optical systems arranged cylindrically to get a half-mega-watt output with 16,000 volts on the plate and only 900 watts grid drive (see p 126)

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setting new standards for electrical instruments

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<th>Model</th>
<th>Frequency Range</th>
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<tr>
<td><strong>VHF!</strong></td>
<td>15 MC to 400 MC</td>
<td>Commercial equivalent of TS-587/U. Sensitivity as two-terminal voltmeter. (95 ohms balanced) 2 microvolts 15-125 MC, 3 microvolts 88-400 MC. Field intensity measurements using calibrated dipole. Frequency range includes FM and TV Bands.</td>
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<tr>
<td><strong>ULF!</strong></td>
<td>14 KC to 250 KC</td>
<td>Commercial equivalent of AN/VRM-6. A new achievement in sensitivity! Field intensity measurements, 1 microvolt-per-meter using rod; 10 microvolts-per-meter using shielded directive loop. As two-terminal voltmeter, 1 microvolt.</td>
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<tr>
<td><strong>HF!</strong></td>
<td>150 KC to 25 MC</td>
<td>Commercial equivalent of AN/PRM-1. Self-contained batteries. A.C. supply optional. Sensitivity as two-terminal voltmeter, 1 microvolt; Field intensity with ½ meter rod antenna, 2 microvolts-per-meter; rotatable loop supplied. Includes standard broadcast band, radio range, AM, and communications frequencies.</td>
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<tr>
<td><strong>UHF!</strong></td>
<td>375 MC to 1000 MC</td>
<td>Commercial equivalent of AN/URM-17. Sensitivity as two-terminal voltmeter, (50-ohm coaxial input) 10 microvolts. Field intensity measurements using calibrated dipole. Frequency range includes Citizens Band and UHF color TV Band.</td>
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Electronic Components Division

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ELECTRONICS — June, 1950
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June, 1950 — ELECTRONICS
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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.

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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.

SANGAMO ELECTRIC COMPANY
SPRINGFIELD, ILLINOIS

IN CANADA: SANGAMO COMPANY LIMITED, LEASIDE, ONTARIO

June, 1950 — ELECTRONICS
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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, adaptors 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.

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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."

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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.

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

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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
FULL SCALE RANGES WITH BUILT-IN 4" METERS
0 to 50 or -25 to +25 Microvolts; scale multipliers: 1, 2, 4, 10, 20, 40
ACCURACY
Of amplifier: ±0.4% of reading ±0.5 Microvolt; 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.
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.

USE AS
- DIRECT-READING MICROVOLT Meter
- MICRO-MICROAMPERE UNIT
- 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.

ELECTRONICS—June, 1950
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 P832 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.

FEATURES...

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

C A P A C I T O R S  •  V I B R A T O R S  •  T E S T  I N S T R U M E N T S

For Radio-Electronic and Industrial Applications

AEROVOX CORPORATION, NEW BEDFORD, MASS., U. S. A. • Sales Offices in All Principal Cities
Export: 41 E. 42nd St., New York 17, N. Y. • Cable: AEROCAP, N Y • In Canada: AEROVOX CANADA LTD., Hamilton, Ont.

22

June, 1950 — ELECTRONICS
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.
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

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

June, 1950 — ELECTRONICS
"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, 1500 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.
Why is "dag" Colloidal Graphite best for CRT Exterior Wall Coating?

**Q.**

**A.**

It's cheaper
...Has better adhesion
...Requires no baking
...Resists scratching

"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

ACHESON COLLOIDS CORPORATION
Port Huron, Michigan

June, 1950 — ELECTRONICS
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 "special" 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!
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.


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 Thyatron control
- Max. input voltage 550 V
- 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 Thyatrons and Phanatrons with ratings up to 100 amperes peak current. Can be operated by non-technical 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.
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 LI3 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
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.
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 arrangement with Western Electric Company.

THE ARNOLD ENGINEERING COMPANY
SUBSIDIARY OF ALLEGHENY LUDLUM STEEL CORPORATION
147 EAST ONTARIO STREET, CHICAGO 11, ILLINOIS
World's Largest Stock of
RHEOSTATS
RESISTORS
TAP SWITCHES

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!

OHMITE MFG. CO.
4818 Flournoy St.
Chicago 44, III.

RUSH SERVICE ON SPECIAL ORDERS, TOO

Be Right with OHMITE
RHEOSTATS RESISTORS TAP SWITCHES
UNFAILING DEPENDABILITY

with

OHMITE

RHEOSTATS

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.
Chicago 44, Ill.

Be Right with

OHMITE

RHEOSTATS • RESISTORS • TAP SWITCHES

Write on Company Letterhead for Catalog and Engineering Manual #40.
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 SXP 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.

---

**G E N E R A L S P E C I F I C A T I O N S**

<table>
<thead>
<tr>
<th>Cathode-ray Tube</th>
<th>Du Mont Type SXP-Accelerating potential</th>
<th>12,000 volts</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>7,000 volts</td>
<td></td>
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<table>
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<tr>
<th>Y-axis Amplifier</th>
<th>Frequency response</th>
<th>2 cps. to 700 kc.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensitivity</td>
<td>0.15 rms volt/in. at 7 kv.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.20 rms volt/in. at 12 kv.</td>
<td></td>
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<tr>
<td>Rise time</td>
<td>0.03 μs. from 10% to 90%</td>
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<table>
<thead>
<tr>
<th>X-axis Amplifier</th>
<th>Frequency response</th>
<th>2 cps. to 700 kc.</th>
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</thead>
<tbody>
<tr>
<td>Sensitivity</td>
<td>0.4 rms volt/in. at 7 kv.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.5 rms volt/in. at 12 kv.</td>
<td></td>
</tr>
<tr>
<td>Rise time</td>
<td>0.5 μs. from 10% to 90%</td>
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</tbody>
</table>

<table>
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<tr>
<th>Driven Sweep Range</th>
<th>0.1 sec. to 2 μs.</th>
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<table>
<thead>
<tr>
<th>Recurrent Sweep Range</th>
<th>10 cps. to 150 kc.</th>
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</table>

<table>
<thead>
<tr>
<th>Z-axis Amplifier</th>
<th>Polarity selection—3 volts peak to blank trace of normal intensity.</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Timing-Marker Intervals</th>
<th>100 μs., 10 μs., 1 μs.</th>
</tr>
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</table>

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<tr>
<th>Trigger Generator</th>
<th>Repetition rate</th>
<th>200 to 3600 p.p.s.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output amplitude</td>
<td>50 volts peak</td>
<td></td>
</tr>
<tr>
<td>Output polarity</td>
<td>positive or negative</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Physical Specifications</th>
<th>Indicator Unit</th>
<th>24½&quot; d.—15½&quot; h.—12½&quot; w.—62 lbs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Supply</td>
<td>19½&quot; d.—15½&quot; h.—12½&quot; w.—100 lbs.</td>
<td></td>
</tr>
</tbody>
</table>

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ANNOUNCING... 5 New UNITS

Making available a wider choice of ARMA Induction Motors

Designed specifically for high performance servo applications

**TYPICAL SPECIFICATIONS**

<table>
<thead>
<tr>
<th>TYPE</th>
<th>DWG. No.</th>
<th>FREQ.</th>
<th>FIELD VOLTAGES</th>
<th>(Min.) LOAD</th>
<th>OUTPUT</th>
<th>R.P.M.</th>
<th>MAX. WATTS</th>
<th>STALLED TORQUE</th>
<th>Rotor Inertia</th>
<th>WEIGHT No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>03A60</td>
<td>715758-1</td>
<td>60</td>
<td>2 24 24 24 1600</td>
<td>0.55 at 875</td>
<td>1.3</td>
<td>0.40</td>
<td>0.25</td>
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<tr>
<td>03B60</td>
<td>715758-2</td>
<td>60</td>
<td>2 24 24 24 3000</td>
<td>1.0 at 2000</td>
<td>1.0</td>
<td>0.040</td>
<td>0.25</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>1A60</td>
<td>213377-2</td>
<td>60</td>
<td>2 40 40 3100</td>
<td>1.5 at 1750</td>
<td>1.7</td>
<td>0.030</td>
<td>0.8</td>
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<tr>
<td>1B60</td>
<td>213251-1</td>
<td>60</td>
<td>2 115 115 3000</td>
<td>2.4 at 2000</td>
<td>3.0</td>
<td>0.25</td>
<td>1.4</td>
<td></td>
<td></td>
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<tr>
<td>1D60</td>
<td>213251-2</td>
<td>60</td>
<td>2 115 115 3000</td>
<td>6.5 at 2000</td>
<td>8.0</td>
<td>0.25</td>
<td>1.4</td>
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<td></td>
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<tr>
<td>1F60</td>
<td>64913</td>
<td>60</td>
<td>3 115 1500</td>
<td>1.0 at 750</td>
<td>3.0</td>
<td>0.051</td>
<td>0.56</td>
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<tr>
<td>1G60</td>
<td>65016 (715759)</td>
<td>60</td>
<td>2 115 115 40 1500</td>
<td>1.0 at 750</td>
<td>3.0</td>
<td>0.051</td>
<td>0.56</td>
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<tr>
<td>5A</td>
<td>213079-1</td>
<td>60</td>
<td>2 75 90 3000</td>
<td>6.3 at 1800</td>
<td>8.0</td>
<td>0.32</td>
<td>4.0</td>
<td></td>
<td></td>
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<tr>
<td>5C</td>
<td>213261-1</td>
<td>60</td>
<td>2 90 75 3000</td>
<td>7.5 at 2000</td>
<td>8.0</td>
<td>5.51</td>
<td>4.3</td>
<td></td>
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<td>6</td>
<td>213069-1</td>
<td>60</td>
<td>2 115 90 3000</td>
<td>18.0 at 2000</td>
<td>16.5</td>
<td>1.38</td>
<td>9.8</td>
<td></td>
<td></td>
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<tr>
<td>03A400</td>
<td>715640-1</td>
<td>400</td>
<td>2 24 24 10,000</td>
<td>1.8 at 6000</td>
<td>0.7</td>
<td>0.036</td>
<td>0.25</td>
<td></td>
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</tr>
</tbody>
</table>

**FEATURES**

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

**ARMA CORPORATION**

254 36th STREET, BROOKLYN 32, N.Y.

SUBSIDIARY OF AMERICAN BOSCH CORPORATION

Licensed for use under Arma patents Nos. 2,465,624 and 2,467,646. License information available.
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
Because Of 5 Outstanding Features

Pyrovac Plate
Long-Life Filament
Non-Emitting Grids
Input-Output Shielding
Low-Inductance Leads

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: Frazer & Hansen, 301 Clay St., San Francisco, California

The 4-125A is another Eimac contribution to electronic progress.
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 connections. 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 6-9, 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!

CONSISTENTLY DEPENDABLE

CORNELL-DUBILIER

CAPACITORS · VIBRATORS · ANTENNAS · CONVERTERS
Here's Why...

you now get Quick Delivery on these Top Quality 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.

AUTOMATIC ELECTRIC
CHICAGO

June, 1950 — ELECTRONICS
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

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.

Specify Westinghouse and be **SURE of all three**!

Westinghouse INSTRUMENTS

---

ELECTRONICS — June, 1950
Watch Master

Frequency Standards

GUARANTEED ACCURACY
1 part in 100,000
(0.001%)

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.

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

Name

Company

Address

City State

AMERICAN TIME PRODUCTS
580 Fifth Avenue INC. 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 throughout 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. GREE-NING WIRE COMPANY, LTD., Hamilton, Ontario, Canada

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

---

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HARRISON, NEW JERSEY

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Manufactured and sold in Canada by
The B. GREE-NING 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.
7. Chemical resistance.
8. High thermal conductivity.
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

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.

June, 1950 — ELECTRONICS
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
no matter how you record...

**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 & 3½"/sec. Three microphone input.

**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. 33½ and 38 rpm.

**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 portable disc recorder K-10**
Records and plays microgroove and standard records at 33½ 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

June, 1950 — ELECTRONICS
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 WAlDEns 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
REG. U.S. PAT. OFF.
TRUARC
RETAINING RINGS
WALDES KOHINOOR, INC., LONG ISLAND CITY 1, NEW YORK

Waldes Kohinoor, Inc., 47-16 Austel Place
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: ____________

ELECTRONICS — June, 1950
**EQUIPMENT:** Sorensen equipment (400 cycle line voltage regulators, Inverters, Regulated DC supplies, 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 supplies 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.

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**TYPICAL SORENSEN AIRBORNE UNITS**

<table>
<thead>
<tr>
<th>400 CYCLE REGULATOR</th>
<th>ELECTRONIC INVERTER</th>
<th>DC SUPPLY</th>
</tr>
</thead>
<tbody>
<tr>
<td>± 0.5% regulation; 400 cycles ± 10%; 3% distortion; 50 VA to 3 KVA capacities.</td>
<td>Inverters and Frequency changes under development. Specifications on request.</td>
<td>0-325 VDC; 0-500 VDC; 300-1000 DC regulated ± 0.5%; 125, 300, 500 ma.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>NOBATRON</th>
<th>400 CYCLE AUTO TRANSFORMER</th>
<th>SATURABLE CORE REACTOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>6-12-28-48-125 VDC from 5-350 amperes; regulated ± 0.25%; 60 or 400 cycles input.</td>
<td>0-130 VA; 400 Cycles 5 and 15 amperes.</td>
<td>For magnetic amplifier circuits. Request data book.</td>
</tr>
</tbody>
</table>

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

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**LITERATURE:**

- Catalog A 1049 (AC regulators)
- Catalog B 1049 (Nobatrons and DC supplies)
- Catalog C 1049 (wound components and fosterite)
- Saturable Core Reactor Technical Data sheets
- "Aircraft" issue of "Currently."

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**POWER Sorensen and company, inc.**

375 Fairfield Ave. • Stamford, Conn.

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

June, 1950 — ELECTRONICS
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 fostered. 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 5000-25—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

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

ELECTRONICS — June, 1950
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 310 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

**ALL INQUERIES WILL BE PROMPTLY HANDLED**

---

Exclusive Manufacturers of Communications Network Components

---

June, 1950 — ELECTRONICS
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.
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 ⅜ 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.
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.

EXTERNAL THERMOCOUPLES

RATINGS
100 MA TO 25 AMPS
25 TO 300 AMPS

THERMOCOUPLE (RF) METER

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-658.

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 \( \frac{1}{16} \) -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.
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
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

ELECTRONICS — June, 1950
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.

EDO CORPORATION • COLLEGE POINT, N.Y.
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 pre-tested 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.

<table>
<thead>
<tr>
<th>Type</th>
<th>Cathode voltage</th>
<th>Cathode current</th>
<th>Anode peak voltage</th>
<th>Anode peak current</th>
<th>Anode avg current</th>
</tr>
</thead>
<tbody>
<tr>
<td>GL-866-A</td>
<td>2.5 v</td>
<td>5 amp</td>
<td>10,000 v</td>
<td>1 amp</td>
<td>0.25 amp</td>
</tr>
<tr>
<td>GL-8008</td>
<td>5 v</td>
<td>7.5 amp</td>
<td>10,000 v</td>
<td>5 amp</td>
<td>1.5 amp</td>
</tr>
<tr>
<td>GL-673</td>
<td>5 v</td>
<td>10 amp</td>
<td>15,000 v</td>
<td>6 amp</td>
<td>1.25 amp</td>
</tr>
<tr>
<td>GL-869-B</td>
<td>5 v</td>
<td>19 amp</td>
<td>20,000 v</td>
<td>10 amp</td>
<td>1.5 amp</td>
</tr>
<tr>
<td>GL-857-B</td>
<td>5 v</td>
<td>30 amp</td>
<td>22,000 v</td>
<td>40 amp</td>
<td>2.5 amp</td>
</tr>
</tbody>
</table>

Electronics — June, 1950
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

ONLY $37.50 AT YOUR DISTRIBUTOR
THE ONLY CARRY-ABOUT

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

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.

BUNNELL SIGNAL ANALYZER
Dimensions: 9" x 6" x 8"
Weight: 18 lbs.
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. Manufactures 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:

<table>
<thead>
<tr>
<th>City</th>
<th>Shipments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Albany</td>
<td>27,032</td>
</tr>
<tr>
<td>Albuquerque</td>
<td>758</td>
</tr>
<tr>
<td>Atlanta</td>
<td>14,242</td>
</tr>
<tr>
<td>Baltimore</td>
<td>62,175</td>
</tr>
<tr>
<td>Birmingham</td>
<td>6,679</td>
</tr>
<tr>
<td>Boston</td>
<td>145,069</td>
</tr>
<tr>
<td>Buffalo</td>
<td>41,201</td>
</tr>
<tr>
<td>Charlotte, N. C.</td>
<td>7,041</td>
</tr>
<tr>
<td>Chicago</td>
<td>230,845</td>
</tr>
<tr>
<td>Cincinnati</td>
<td>77,800</td>
</tr>
<tr>
<td>Cleveland</td>
<td>75,437</td>
</tr>
<tr>
<td>Dallas</td>
<td>11,802</td>
</tr>
<tr>
<td>Davenport, Ia.</td>
<td>6,881</td>
</tr>
<tr>
<td>Detroit</td>
<td>109,307</td>
</tr>
<tr>
<td>Erie, Pa.</td>
<td>4,210</td>
</tr>
<tr>
<td>Greensboro, N. C.</td>
<td>1,862</td>
</tr>
<tr>
<td>Houston</td>
<td>8,862</td>
</tr>
<tr>
<td>Huntington, W. Va.</td>
<td>2,650</td>
</tr>
<tr>
<td>Indianapolis</td>
<td>12,180</td>
</tr>
<tr>
<td>Jerseyville</td>
<td>2,180</td>
</tr>
<tr>
<td>Kansas City, Mo.</td>
<td>25,076</td>
</tr>
<tr>
<td>Los Angeles</td>
<td>108,471</td>
</tr>
<tr>
<td>Louisville</td>
<td>9,250</td>
</tr>
<tr>
<td>Memphis</td>
<td>3,566</td>
</tr>
<tr>
<td>Miami</td>
<td>6,228</td>
</tr>
<tr>
<td>Milwaukee</td>
<td>34,336</td>
</tr>
<tr>
<td>Minneapolis</td>
<td>29,440</td>
</tr>
<tr>
<td>Nashville</td>
<td>34,442</td>
</tr>
<tr>
<td>Newark</td>
<td>152,080</td>
</tr>
<tr>
<td>New Haven</td>
<td>22,601</td>
</tr>
<tr>
<td>New Orleans</td>
<td>7,239</td>
</tr>
<tr>
<td>New York City</td>
<td>388,055</td>
</tr>
<tr>
<td>Oklahoma City</td>
<td>8,425</td>
</tr>
<tr>
<td>Onaha</td>
<td>10,381</td>
</tr>
<tr>
<td>Philadelphia</td>
<td>295,073</td>
</tr>
<tr>
<td>Phoenix</td>
<td>2,165</td>
</tr>
<tr>
<td>Pittsburgh</td>
<td>48,588</td>
</tr>
<tr>
<td>Portland, Ore.</td>
<td>1,911</td>
</tr>
<tr>
<td>Richmond</td>
<td>8,753</td>
</tr>
<tr>
<td>St. Louis</td>
<td>45,328</td>
</tr>
<tr>
<td>St. Petersburg</td>
<td>1,389</td>
</tr>
<tr>
<td>Salt Lake City</td>
<td>4,218</td>
</tr>
<tr>
<td>San Antonio</td>
<td>4,201</td>
</tr>
<tr>
<td>San Francisco</td>
<td>2,760</td>
</tr>
<tr>
<td>Seattle</td>
<td>9,068</td>
</tr>
<tr>
<td>Syracuse</td>
<td>15,887</td>
</tr>
<tr>
<td>Toledo</td>
<td>25,084</td>
</tr>
<tr>
<td>Tulsa</td>
<td>7,591</td>
</tr>
<tr>
<td>Washington, D. C.</td>
<td>37,351</td>
</tr>
<tr>
<td>Unknown</td>
<td>31,732</td>
</tr>
</tbody>
</table>

Certain printed-circuit techniques now coming into vogue are similar, believe it or not, to a process suggested in 1885 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
ECLIPSE-PIONEER
DIVISION OF
AVIATION CORP.

air pump and control unit

USES

AIR DAMPED BARRY MOUNTS
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 BARRY MOUNTS 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 BARRY MOUNTS. 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

BUSINESS BRIEFS (continued)

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:

<table>
<thead>
<tr>
<th>Product</th>
<th>Previous Unit Cost</th>
<th>Induction Unit Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermocouple wells, brazed</td>
<td>$0.08</td>
<td>$0.02</td>
</tr>
<tr>
<td>Spring, tempered</td>
<td>$0.24</td>
<td>$0.02</td>
</tr>
<tr>
<td>Well for recorder, silvered</td>
<td>$0.70</td>
<td>$0.00</td>
</tr>
<tr>
<td>Lever, brazed</td>
<td>$0.30</td>
<td>$0.01</td>
</tr>
<tr>
<td>Valve, brazed</td>
<td>$0.80</td>
<td>$0.01</td>
</tr>
<tr>
<td>Damper, brazed</td>
<td>$1.50</td>
<td>$0.17</td>
</tr>
<tr>
<td>Coupler, silvered</td>
<td>$0.01</td>
<td>$0.01</td>
</tr>
<tr>
<td>Flange, silvered</td>
<td>$0.36</td>
<td>$0.05</td>
</tr>
</tbody>
</table>

Wisconsin Gear Manufacturer

For example, the 1950

<table>
<thead>
<tr>
<th>Product</th>
<th>Previous Unit Cost</th>
<th>Induction Unit Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Furnace Heat</td>
<td>$0.30</td>
<td>$0.16</td>
</tr>
<tr>
<td>Sensor, brazed</td>
<td>$0.40</td>
<td>$0.16</td>
</tr>
<tr>
<td>Grind</td>
<td>$0.90</td>
<td>$0.30</td>
</tr>
<tr>
<td>Broach, brazed</td>
<td>$0.40</td>
<td>$0.16</td>
</tr>
<tr>
<td>Heat, press, grind</td>
<td>$0.19</td>
<td>$0.16</td>
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<tr>
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<td>$0.19</td>
<td>$0.16</td>
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Washington Hatchet-Head Manufacturer

<table>
<thead>
<tr>
<th>Product</th>
<th>Previous Unit Cost</th>
<th>Induction Unit Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plane, Brazing (per hour)</td>
<td>$1.00</td>
<td>$0.20</td>
</tr>
<tr>
<td>Fuel</td>
<td>$0.50</td>
<td>$0.20</td>
</tr>
<tr>
<td>Two men, machine</td>
<td>$1.20</td>
<td>$0.20</td>
</tr>
<tr>
<td>Labor, cleaning</td>
<td>$0.50</td>
<td>$0.12</td>
</tr>
<tr>
<td>Power, conveyor</td>
<td>$0.05</td>
<td>$0.04</td>
</tr>
<tr>
<td>Napthia, cleaning</td>
<td>$0.05</td>
<td>$0.04</td>
</tr>
<tr>
<td>Tube replacement</td>
<td>$0.01</td>
<td>$0.01</td>
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Electronic Equipment Manufacturer

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<td>$0.01</td>
</tr>
</tbody>
</table>

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

June, 1950 — ELECTRONICS
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 CONTROLLER TYPE—
HAVE IMPORTANT APPLICATIONS*

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 1200 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 crossovers 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 at a neutral, and it has positive de-lent 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.
Service Beyond Expectations!

New Development In Mallory Midgetrol* Minimizes TV Drift!

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

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

*Trade Mark

P. R. MALLORY & CO., Inc., INDIANAPOLIS 6, INDIANA
> 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, plac-
ing particular emphasis on the
RTPB, JTAC, NTSC type of organ-
ization. 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 communica-
tions 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 mili-
tary 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 recom-
mand to the president, by October,
1950, a sound communications
policy, in the national and inter-
national spheres. Certainly the
board members are qualified, by
position and experience, to accom-
plish 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 regu-
lates government users (without
a comparable justifying procedure).
Surely also they must come to
grips with the problem of spec-
trum 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 broad-
cast engineers have urged that
several stations should occupy
jointly the best transmitting site
in a given locality. Major Arm-
strong hung six arms on his
Alpine f-m tower with this philos-
ophy 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 un-
derstandable. So, since 1930 or there-
abouts, NBC has been the sole
broadcasting occupant of the Em-
pire 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 asent of the NBC
engineers. But no. The credit
goes to management. Whose man-
agement? The owners of the Em-
pire 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, techni-
cally speaking, in the world. And
there's no patent on the idea. Bos-
ton, Philadelphia, Chicago, San
Francisco and los Angeles papers,
etc, please copy.

> TAPE APLENTY . . . Howard
Chinn's suggestion for recording
television transcriptions on mag-
netic tape (Crosstalk, February,
1950) has called forth a masterly
analysis of costs by John Bohers
of Magneord. Mr. Boys' 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! Im-
practical on the face of it but, says
Boyers, "I am sure the job will be
done before too long."
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.

**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 more 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.

Poly styrene 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.

**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 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 x 10⁻⁶ gm-cal per cm² 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 reinforcing-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

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

<table>
<thead>
<tr>
<th>Dissipation Factor</th>
<th>Dielectric Constant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency</td>
<td></td>
</tr>
<tr>
<td>100 cycles</td>
<td>0.00098</td>
</tr>
<tr>
<td>1 kc</td>
<td>0.00062</td>
</tr>
<tr>
<td>10 kc</td>
<td>0.00047</td>
</tr>
<tr>
<td>100 kc</td>
<td>0.00096</td>
</tr>
<tr>
<td>1 mc</td>
<td>0.00081</td>
</tr>
</tbody>
</table>

---

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

**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...
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 milliamp. 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 embedded in 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-μF 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 pre-loading. 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-methylacrylate 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

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific Gravity</td>
<td>1.24</td>
</tr>
<tr>
<td>Tensile Strength (psi)</td>
<td>9,000</td>
</tr>
<tr>
<td>Compressive Strength (psi)</td>
<td>19,000</td>
</tr>
<tr>
<td>Izod Impact, (ft-lb/in. of notch)</td>
<td>0.3</td>
</tr>
<tr>
<td>Rockwell Hardness (M scale)</td>
<td>110</td>
</tr>
<tr>
<td>Coefficient of Linear Expansion</td>
<td>50 x 10⁻⁴</td>
</tr>
<tr>
<td>(cm/cm/deg C)</td>
<td></td>
</tr>
<tr>
<td>ASTM Heat Distortion Under Load</td>
<td>110</td>
</tr>
<tr>
<td>(deg C)</td>
<td></td>
</tr>
<tr>
<td>Thermal Conductivity (BTU/ft²/hr)</td>
<td>1.5</td>
</tr>
<tr>
<td>Thermal Conductivity (BTU/ft²/hr)</td>
<td>1.5</td>
</tr>
<tr>
<td>Water Resistance (Gain 25 deg C,</td>
<td>0.2</td>
</tr>
<tr>
<td>in 24 hr, in %)</td>
<td></td>
</tr>
<tr>
<td>Dielectric Constant (at 60, 1,000</td>
<td>3.1</td>
</tr>
<tr>
<td>0 and 10⁶ cps)</td>
<td></td>
</tr>
<tr>
<td>Power Factor (60 cps)</td>
<td>0.008</td>
</tr>
<tr>
<td></td>
<td>0.005</td>
</tr>
<tr>
<td></td>
<td>0.017</td>
</tr>
<tr>
<td>Dielectric Strength (v/mil, 100-mil sample)</td>
<td>500</td>
</tr>
<tr>
<td>Resistivity (ohm-cm)</td>
<td>10¹²</td>
</tr>
<tr>
<td>Optical Properties</td>
<td>clear, water white when polymerized</td>
</tr>
<tr>
<td>Machineability</td>
<td>excellent</td>
</tr>
</tbody>
</table>
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. 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, 3½ 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

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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.

This basic oscillator is illustrated in Fig. 5A. Before the plate voltage is applied to the circuit, C is uncharged and the grid of V₃ is at ground potential. As soon as plate voltage is applied, the grid of V₃ is raised to some positive potential determined by the series of resistors. The plate resistor of V₃ 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 $E_a$. With the cathode of V₃ 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 $(1 - 1/e)$ of B⁺ in RC seconds. However, as the potential on the grid of V₃ increases as C charges, it will reach the shaded region below $E_a$ that represents the negative bias range for which $E_a$ will be conductive. As soon as $E_a$ begins to conduct, the plate current flowing through its plate resistor lowers the potential of the grid of V₃ 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 $E_a$, this potential will now drop to a very low value and the grid of V₃ will find itself highly positive with respect to its cathode. Capacitor C then discharges through the diode formed by the grid and cathode of V₃ 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 V₃. The exact frequency of oscillation of this circuit depends upon several factors including the value of the plate supply voltage, which is carefully regu-
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 afs signal thus developed is applied to the master oscillator to synchronize it with the power frequency.

The horizontal frequency generator is synchronized at 1/2 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 1/2 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 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 necessary 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 $L \frac{di}{dt}$ 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 only necessary to mix the two waveforms with appropriate amplitude adjustment to obtain the required shape.

**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.

**REFERENCES**


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

**All-Purpose**

By B. B. BAUER

Vice-President and Chief Engineer

Shure Brothers, Inc.

Chicago, Ill.

Among the problems confronting the designer of phonographs as a result of the introduction of 33⅓ 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 33⅓ 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. 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 33⅓ and 45-rpm records. Data issued by record manufacturers would indicate that the width of the grooves of 33⅓ 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...
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. 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. 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) 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.

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**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**
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, 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 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 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 33½ 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. 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
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 48 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
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. The advantages claimed by Mr. Reid for this needle are the same as those claimed for the large-radius needle described some years ago.

Because of the wide angle, the frictional 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 approximately 2 kHz. 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. 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 (1 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.

REFERENCES

(1) The dimensions of the so-called standard groove have not yet been standardized by the Radio Manufacturers Association. The dimensions given represent the current consensus regarding groove dimensions.


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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.

Resonance is obtained between the plate and grid of the 6F4 acorn triode while the plate-to-cathode and grid-to-cathode inter-electrode 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 inter-electrode 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-
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 are 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.

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**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 link 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 e-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 e-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

![Diagram of VHF Links at Manila](image-url)

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.

![Modem Circuit Diagram](image-url)

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

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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.

**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 demod-
ulator. 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 $T_{pp}$. Oscillator voltage is applied between the midpoint of the other winding and the paralleled midpoints of two windings of transformer $T_{pp}$.

The carrier-frequency (oscillator) voltage exceeds the voice-frequency voltage in $T_{pp}$ 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 $T_{pp}$ is positive with respect to $T_{pp}$, current flows through $VR$ and through both transformers, with the secondary of $T_{pp}$ in series with one primary of $T_{pp}$. When carrier voltage reverses, current flows through the secondary of $T_{pp}$ in series with the other primary of $T_{pp}$. Thus $VR$ acts as a switch to reverse the $T_{pp}$ windings at the carrier frequency. In doing this the oscillator current divides at the center tap and flows in opposite directions through the two halves of each winding of $T_{pp}$.

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 $T_{pp}$ 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 14pps. 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 $VT$, 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 $T$, to provide for oscillator level variation.

Diode $VT$, 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 $R_s$ 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 $VT_1$. Conduction through $VT_1$ 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 $R_1$ and $R_2$ for the plates and $R_1$ and $R_2$ for the cathodes. These are proportioned so $VT_1$ is normally nonconducting. Shorting $R_s$ to ground through the sending loop makes $VT_1$ continuously conducting. Grounding $R_s$ through various amounts of resistance in the sending loop makes $VT_1$ conductive for various intermediate portions of each cycle. The effect is to make the output vary in level. When $VT_1$ is conducting, signal from the oscillator passes

Traffic control tower at Manila International Airport, near control station
through transformer $T_1$, 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 off or 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 $VT_2$. This reduces the d-c plate current of $VT_2$, 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 twostage 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 imposes 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-circuit 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 $VT_3$ and $VT_4$ in Fig. 5. The outputs of the rectifiers drive d-c triode amplifiers $VT_5$ and $VT_6$, 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 tightly loaded indicator motor in step with the heavily loaded controlled motor.

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
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 needful for the control of other components in the functioning of the system. Thus the path of an airplane in a fire-control system, temperature...
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

\[
\varphi_1(\tau) = \lim_{T \to \infty} \frac{1}{2T} \int_{-T}^{T} f_1(t) f_1(t + \tau) \, dt \tag{1}
\]

In a general sense the correlation function shows the degree of dependence of one value in a time
series to another at a different time. As indicated by the equation, to obtain a point on the autocorrelation curve for a value of \( \tau = \tau_n \), \( f_1(t) \) which represents a message or a noise as the case may be is given a displacement \( \tau \), for all values of \( t \), obtaining \( f_1(t + \tau) \). Then the product \( f_1(t)f_1(t + \tau) \) 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 \( \phi_2(\tau) \). 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 \( \phi_2(\tau) = \phi_2(-\tau) \). A continuation of the process determines the whole curve which is even in the variable \( \tau \).

A sample autocorrelation curve in this elementary graphical determination is shown in Fig. 2. We observe that the value of \( \phi_2(\tau) \) 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 \( \phi_2(0) \) 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 \( \phi_2(\tau) \). 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

\[
\phi_{12}(\tau) = \lim_{T \to \infty} \frac{1}{2T} \int_{2T}^{2T+2T} f_1(t)f_2(t + \tau) \, dt \tag{2}
\]

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 \( \tau \). 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 \( f_3(t) \) reads

\[
\phi_{33}(\tau) = \frac{1}{T_1} \int_{0}^{T_1} f_3(t) f_3(t + \tau) \, dt \tag{3}
\]

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

\[
\phi_{12}(\tau) = \frac{1}{T_1} \int_{0}^{T_1} f_1(t)f_2(t + \tau) \, dt \tag{4}
\]

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

Let us put

\[
f_1(t) = A_1 \cos (\omega t + \theta_1)
\]

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

\[
\phi_{11}(\tau) = A_1^2 \cos \omega \tau \tag{6}
\]

For the general case of an arbitrary periodic function

\[
f_1(t) = a_0 + \sum_{n=1}^{\infty} a_n \cos (n \omega t + \theta_1) \tag{7}
\]

the autocorrelation function becomes

\[
\phi_{11}(\tau) = \frac{a_0^2}{4} + \frac{1}{2} \sum_{n=1}^{\infty} a_n^2 \cos 2 \pi \tau \tag{8}
\]

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

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![FIG. 6 — Duration-modulated pulses, characterized by equally-spaced leading edges](image)

![FIG. 7 — Autocorrelation function for duration-modulated pulses](image)
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 $\frac{1}{2}$.

**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 $\tau$ of the wave is given by the formula

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

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

$$\varphi_1(\tau) = E^2 e^{-2kr}$$  (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 applications, 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 $2\Delta$. For reason of simplicity in computation, let us assume that the pulse duration varies independently between the limits of zero and $\Delta$ 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 $\phi_n(\omega)$ represents the power density spectrum of a random process whose autocorrelation function is $\phi_n(\tau)$, then the following reciprocal relations must hold:

$$\varphi_n(\tau) = \int_{-\infty}^{\infty} \phi_n(\omega) \cos \omega \tau \, d\omega$$  (11)

$$\phi_n(\omega) = \frac{1}{2\pi} \int_{-\infty}^{\infty} \varphi_n(\tau) \cos \omega \tau \, d\tau$$  (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 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,

$$\phi_n(\omega) = \frac{1}{2\pi} \int_{-\infty}^{\infty} E^2 e^{-2kr} \cos \omega \tau \, d\tau$$

$$= \frac{E^2}{\pi} \frac{2k}{\delta^2 + \omega^2}$$  (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 \( a_1, a_\alpha, a_n, \ldots \) are obtained.

While this sampling is in progress one second set of values \( b_1, b_\alpha, b_n, \ldots \) are taken, each trailing a corresponding value of the first set by a time \( \tau \). The order of taking the samples is as indicated in the figure so that they appear in the order \( a_1, a_\alpha; a_2, a_\alpha; a_\beta, a_n; \ldots \) From these pairs of values a series of pulses is formed in such a manner that their heights are proportional to the values \( a_1, a_\alpha, a_n \ldots \) and their durations to the values \( b_1, b_\alpha, b_n \ldots \) 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 \( \tau \) is given by the approximate formula

\[
\varphi_\tau (\tau) \cong K \frac{1}{N} \sum_{n=1}^{N} a_n b_n |\tau|
\]

where \( K \) is a factor of proportionality. Repetition of this process for other values of \( \tau \) 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 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 \( \tau \) 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 \( f_s(t) \) and a periodic function \( f_p(t) \). By our assumption that the noise has no periodic component it is obviously true that \( f_s(t) \) and \( f_p(t) \) are incoherent. Let the mixture be written as

\[
f(t) = f_s(t) + f_p(t)
\]

According to Eq. 1, the autocorrelation function of \( f(t) \) is

\[
\varphi_\tau (\tau) = \lim_{T \to \infty} \frac{1}{2T} \int_{-T}^{T} \left[ f_s(t) + f_p(t) \right] \left[ f_s(t + \tau) + f_p(t + \tau) \right] dt
\]

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.

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which simplifies to
\[ \psi_n(t) = \phi_{nn}(t) + \phi_{nn}(t) \] (17)
The crosscorrelation terms having been dropped because of incoherence between \( f_s(t) \) and \( f_e(t) \). 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 relatively large values of the variable \( r \). Theoretically the noise autocorrelation curve approaches the square of the mean value of the noise as \( r \) becomes large; that is, \( \phi_r(x) = \phi_r(x) \) is a constant (or zero, if the mean is zero) for large \( r \). On the other hand, since the autocorrelation function of the sinusoid is another sinusoid, its behavior is the same irrespective of the magnitude of \( r \).

We see that if autocorrelation is performed on a random noise at reasonably large values of \( r \), 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 \( f_s(t) \) and the desired output which is, in the case of filtering, the message itself \( f_s(t) \) with possibly a delay \( \alpha \). Therefore the error expression is

\[ e = \lim_{T \to \infty} \frac{1}{2T} \int_{-T}^{T} \int_{-T}^{T} \left[ f_s(t) - f_e(t - \alpha) \right]^2 dt \] (18)

The output \( f_s(t) \) is expressible in terms of the system characteristic and the input to the system. The adoption of this measure of error, with the consequent 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 auto-correlation function for filtered noise, as recorded by correlator](image)

![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](image)
tion and filter theory are the auto-
correlation 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 func-
tions 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 trans-
ducer. 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 sys-
tem, for in general the crosscor-
relation between input and output
is given by the integral
\[ \varphi_{a}(t) = \int_{-\infty}^{\infty} h(t) \varphi_{a}(t - \tau) \, d\tau \]  
(19)
where \( h(t) \) is the system response
to a unit impulse and \( \varphi_{a}(\tau) \) is the
autocorrelation of the input signal.
If the input signal is a white noise
as assumed, Eq. 19 simply becomes
\[ \varphi_{a}(\tau) = h(\tau) \]  
(20)
This measurement technique has
considerable advantage over stand-
ard impulse amplitude measure-
ment methods when it is necessary
to work against large noise back-
grounds, or in cases where it is de-
sired to use small input signals.
The system function of the circuit
can be obtained by taking the Fourier transform of \( \varphi_{a}(\tau) \) 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 in-
dependent pulses, and the crosscor-
relation measures the relationship
between an input pulse and the
effect it has on a circuit an arbi-
trary time \( \tau \) later. The impulse re-
sponse is just the response at any
time \( \tau \) after \( \tau = 0 \) to an impulse
input. The crosscorrelation meas-
ures the average of a large number
of such input pulses to form a
value for \( \varphi_{a}(\tau) \).
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 auto-
correlation 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 cross-
talk 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 investi-
gated, but also upon signals in the
other circuits of the system. An
example of this is the cross-modu-
lation in a frequency-division multi-
plex 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 re-
results in intermodulation and dis-
tortion products which are a func-
tion 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. How-
ever, if each of the channels is fed
by an independent noise generator
so that the crosscorrelation func-
tion taken between any two noise
sources is zero, then the amount of
noise introduced into a given chan-
nel 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 servo-
mechanism systems and radar sys-
tems but are often not important as
applied to human communication
systems, because the properties
of the human transducers, ears and
eyes, which are left out of the com-
putation, 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. Since this tube had unheard-of sensitivity, compared to the earlier Iconoscope 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. 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
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 3769.

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.

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 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 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
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 lightly 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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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.

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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...
Road-Testing of Engines

program employing a paper cam and photoelectric pickup, 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
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.

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' 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 dies 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 load set, 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 road-test data, and in particular to F. B. Rolfsen of this company for suggesting the power amplifier circuit.

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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 \( \frac{1}{4} \)-inch diameter nickel tubing wound 2\( \frac{1}{2} \) turns per inch 20 inches long. The electron beam diameter is between 8 and 1/2 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.

![Attenuator at right end of glass envelope suppresses oscillations in 1,000-watt power amplifier](Image)

**FIG. 1**—Construction details of both types of traveling-wave tubes
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
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 attenuating 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 1.06.

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...
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.

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BIFILAR I-F COILS

Bifilar coils as interstage coupling devices in stagger-tuned amplifiers 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 form-var 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 T1, T2, and T3, 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.

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 i-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.

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 to the single-tuned circuit of Fig. 4B, provided:

$$L = \sqrt{L_0 L_2}$$  \hspace{1cm} (1)

$$C = \sqrt{C_0 C_2}$$  \hspace{1cm} (2)

$$\frac{1}{R} = \frac{1}{L_2 R_1} + \frac{1}{L_1 R_2}$$  \hspace{1cm} (3)

The equivalence of these two circuits can be most easily demonstrated by several successive applications of Thévenin’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 Thévenin’s theorem will be as shown in Fig. 5B where

$$k = \frac{-i_2}{-i_1}$$  \hspace{1cm} (4)

$$Z_A = \frac{1}{\omega C_1}$$  \hspace{1cm} (5)

One more application of Thévenin’s theorem results in Fig. 5D, where

$$E_A = -\frac{j \omega M E_B}{Z_B + j \omega L_2}$$  \hspace{1cm} (6)

$$Z_A = \frac{Z_B + j \omega L_2}{Z_B + j \omega L_2}$$  \hspace{1cm} (7)

$$k = \frac{-i_2}{\frac{1}{R_1} + \frac{1}{R_2} + j \omega (C_1 + C_2) + \frac{1}{j \omega L}}$$  \hspace{1cm} (8)

The equivalence of these two circuits can be most easily demonstrated by several successive applications of Thévenin’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 Thévenin’s theorem will be as shown in Fig. 5B where

$$E_A = -\frac{j \omega M E_B}{Z_B + j \omega L_2}$$  \hspace{1cm} (9)

$$Z_A = \frac{Z_B + j \omega L_2}{Z_B + j \omega L_2}$$  \hspace{1cm} (10)

$$k = \frac{-i_2}{\frac{1}{R_1} + \frac{1}{R_2} + j \omega (C_1 + C_2) + \frac{1}{j \omega L}}$$  \hspace{1cm} (11)

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:

$$k = \frac{-i_2}{\frac{1}{R_1} + \frac{1}{R_2} + j \omega (C_1 + C_2) + \frac{1}{j \omega L}}$$  \hspace{1cm} (12)

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 $C_1$ is greater than $C_2$ 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

$$\text{Gain} = \frac{g_m R_t}{A}$$  \hspace{1cm} \text{(14)}$$

and the bandwidth by

$$\Delta f = \frac{1}{2R\cdot C_m} = \frac{1}{2\pi R \left( \frac{C_1 + C_2}{A^2} \right)}$$  \hspace{1cm} \text{(15)}$$

then

$$\text{gain} \times \Delta f = \frac{g_m}{2\pi R \left( \frac{C_1 + C_2}{A^2} \right)}$$  \hspace{1cm} \text{(16)}$$

Equation 16 will be a maximum when

$$A \left( \frac{C_1 + C_2}{A^2} \right) \text{ is a minimum which occurs when }$$

$$\frac{d}{dA} \left[ A \left( \frac{C_1 + C_2}{A^2} \right) \right] = 0$$  \hspace{1cm} \text{(17)}$$

$$C_1 - \frac{C_2}{A} = 0$$  \hspace{1cm} \text{(18)}$$

$$A = \sqrt{\frac{C_2}{C_1}}$$  \hspace{1cm} \text{(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,

$$\text{Max gain} \times \text{BW} = \frac{g_m}{2\pi \left( 2\sqrt{C_1C_2} \right)}$$  \hspace{1cm} \text{(20)}$$

Compare this with the gain-bandwidth product for a single coil given by

$$\text{Gain} \times \text{BW} = \frac{g_m}{2\pi \left( C_1 + C_2 \right)}$$  \hspace{1cm} \text{(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 $2\sqrt{C_1C_2}$ will be less than $C_1 + C_2$.

If $m = C_1/C_2$, 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.

$$\text{Gain-Bandwidth}$$

<table>
<thead>
<tr>
<th>$m$</th>
<th>Ratio</th>
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<tbody>
<tr>
<td>2.0</td>
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<tr>
<td>2.5</td>
<td>1.110</td>
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<td>1.340</td>
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<tr>
<td>15.0</td>
<td>2.005</td>
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</table>

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.

**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 $R_o$ represents the diode load resistor, the equivalent loading across the i-f tuned circuit is approximately

$$R_{eq} = \frac{R_o}{2\gamma}$$  \hspace{1cm} \text{(22)}$$

where $\gamma$ is the efficiency of rectification.

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

$$\Delta f = \frac{1}{2\pi RC_f}$$

where $C_f = \text{total input plus output capacitance, } R = \text{total equivalent shunt loading and the gain is by } g_{mR}$.

In a typical practical amplifier $C_f$ is equal to approximately 10 $\mu\text{f}$. Then $\Delta f = 3.4 \text{ mc}$.

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 x 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 $C_f$ 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 bandwidth 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 $\sqrt{L'/L}$. The tube plate loading is simultaneously reduced by a factor $\sqrt{L'/L}$ but the plate loading resistance is so large that this effect is unimportant.

If the capacitance on the plate side of $T_1$ in Fig. 2 equals 8 $\mu\text{f}$ and that on the diode side equals 2 $\mu\text{f}$, then the equivalent capacitance for Fig. 4B according to Eq. 2 is given by $C = 8N + 2/N$ where $N = \sqrt{L'/L}$ and by Eq. 3 $1/R = 1/(4700N)$. Therefore

$$\Delta f = \frac{1}{2\pi \times 4700N \times \sqrt{8N + 2/N}} \times 10^{-12}$$

$$= 2.2 \times 10^6$$

$N = \sqrt{1.58} = 1.30$

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 $= g_{mR} = 1.30 \times 4700 g_{m}$.

**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.

**References**

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.

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 \(10^{-1}\) to \(10^{2}\). 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.

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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 multiplied, 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 $10^{-3}$.

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 $10^{-3}$, 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 $6 \times 10^{-4}$. 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's for a discussion of
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 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, S₁, is used to control the range indicator lights, while the two others, S₂ and S₃, 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 S₁. Wafer S₃ is wired in series with the OFF pushbuttons. Its function is to remove power from the unit when the pressure rises above 10⁻¹ or falls below 6 x 10⁻⁹.

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 K₁ and K₂ are in the two plate circuits of this tube. The two operating points are independently adjusted by cathode resistors R₁ and R₂. Normally K₁ is operated, K₂ is not operated and the motor B is stationary. When the output meter reads full scale, K₂ 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), K₂ 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.

References

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.

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 C1 and C3 in the operating point of the tube.

Capacitor C1 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 C1 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 C2, 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-

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**FIG. 1—Basic divider circuit illustrates importance of couplings**

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The resistance - capacitance phase-shift oscillator has desirable characteristics 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. 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 C1 and C3 in the operating point of the tube.

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Output is taken from the plate of the tube through an appropriate coupling capacitor C2, 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-
terminates 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 output 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 \( C \). In obtaining this data, the controlling frequency was kept constant at 60 volts and applied to \( C \), 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 \( C \) is small little of the controlling frequency energy is introduced into the oscillator and hence the locking range for a given division is restricted. When \( C \) 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-µuf 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 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, 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 \( R \), 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 \( R \), 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-
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 \( R \), 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.

**Mid-Range**

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<th>Range</th>
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</table>

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-kilohertz 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.

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**

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

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 $a$, 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 $\eta^*$ holds if the generator output impedance equals the characteristic impedance of the line. With this premise, $\eta^*$ 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 $\eta$ 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 output power capacity, if generator output impedance and line input impedance are matched.

The factor $\eta^*/\eta^*$ 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 $a$, 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 $a$, so that vswr = cotanh $a$. In this and the following equations the attenuation is measured in nepers.

In terms of $a$ and $a^*$, power transfer factor $\eta^*$ and efficiency $\eta$ as defined above are expressible as follows:

\[
\eta^* = \frac{2 \sinh 2a}{e^{2a} + e^{-2a}} 
\]

\[
\eta = \sinh 2a \sinh (2a + 2a^*) 
\]

\[
\eta^* \eta = \frac{1}{1 - e^{-4(a^2 + a^*)}} 
\]

**Use of Nomographs**

Figure 1 serves to read any one of the three determinants $\eta^*$, $a^*$, 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 $\eta$ and $\eta^*$.

Though $\eta$ can be determined by multiplying $\eta^*$ (Fig. 1) and $\eta/\eta^*$ (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 $a$, of the line is tolerable, if 60 watts are required in the load? Answer: $\eta = 60$ percent, hence from Fig. 3 $a_{\max} = 1.15$ db.

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 $\eta^* = 79.3$ percent; (2) from Fig. 2, $\eta^*/\eta^* = 1.1$ and $\eta = 87.4$ percent. Note that $\eta$ comes very close to $\eta_{\max} = 89.2$ 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.
MALLORY PLATINUM CONTACTS

Platinum, the noble metal, is ideal for electrical contacts where low resistance must be maintained for long periods of time. However, pure platinum lacks hardness. Mallory platinum alloys overcome this by the use of such hardening agents as iridium, ruthenium or palladium. Mallory is fully qualified to recommend the best contact material for your design. Write today.

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

ELECTRONICS - June, 1950

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**TUBES AT WORK**
Including INDUSTRIAL CONTROL

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.

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 leak-

**FIG. 2**—Basic circuit used for life-testing electrolytics.

Aging 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 d-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.
Using Kester Flux-Core Solders, Plastic-Rosin and "Resin-Five" Core Solders, will keep your solderers satisfied. Kester flows better—handles easier—faster to use. Kester Solders are made only from newly mined grade A tin and virgin lead.

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CHICAGO 39, ILL. • NEWARK, N. J. • BRANTFORD, CANADA
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**

**E**L**E**CTRON 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 pantographic 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-

(Circuit arrangements for the two types of RCA color picture tubes)

(Continued on page 150)
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.

**SPRAGUE**

**PIONEERS IN**

**ELECTRIC AND ELECTRONIC DEVELOPMENT**

**SPRAGUE ELECTRIC COMPANY**

North Adams, Massachusetts

Subminiature paper capacitors, hermetically sealed in metal cases, are a Sprague product developed especially to meet the rigors of military service. A direct result of new techniques, materials, and processes evolved after painstaking research, they provide optimum performance under the most stringent electrical, temperature, and humidity conditions. Operating temperatures cover a range of -55°C to 125°C.
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 of 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.

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.

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.

Specimens can be placed in the permanent-magnet electron microscope without disturbing the vacuum.

Provisions are made for photographing submicroscopic particles.

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.

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 \( \omega \), about the center of the circular path is given by the so-called cyclotron equation \( \omega = eB/m \), where \( e/m \) is the charge-to-mass ratio of the particle, and \( B \) is the magnetic flux density.

In the cyclotron this property

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 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 10%, 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

DESIGNERS AND MANUFACTURERS OF THE Q METER · QX CHECKER · FREQUENCY MODULATED SIGNAL GENERATOR · BEAT FREQUENCY GENERATOR AND OTHER DIRECT READING INSTRUMENTS
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 $\omega$, 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 $\omega$, a charged particle will revolve in a plane perpendicular to the magnetic field at an angular velocity of $\frac{1}{2}(\omega + \omega_i)$. 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

$$R = \frac{K}{\omega - \omega_i} \sin \frac{\omega - \omega_i}{2} t$$

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 sensitivity 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 10⁻⁸ millimeters of mercury.

**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)
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.

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MADE BY THE WORLD LEADERS IN 2-WAY MOBILE RADIO BACKED BY 20 YEARS RESEARCH, EXPERIENCE, AND SPECIALIZATION IN MOBILE RADIO

ELECTRONICS — June, 1950
NEW PRODUCTS
Edited by WILLIAM P. O'BIEN

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

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.

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.

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 (4 h-p and 1 1/2 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.

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-
1. High permeance (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

<table>
<thead>
<tr>
<th>Type No.</th>
<th>Remarks</th>
<th>Maximum Diameter Inches</th>
<th>Maximum Length Inches</th>
<th>Heating Capacity Watts</th>
<th>Maximum Current Ma.</th>
<th>Typical Operating Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>CK5205</td>
<td>CK5206CKR</td>
<td>Characteristics of 6AS5</td>
<td>0.400</td>
<td>1.5</td>
<td>6.0</td>
<td>200</td>
</tr>
<tr>
<td>CK5203</td>
<td>CK5204CKR</td>
<td>Tube, UHF Oscillator; 25 W watts at 500 V.</td>
<td>0.400</td>
<td>1.5</td>
<td>6.0</td>
<td>200</td>
</tr>
<tr>
<td>CK5200</td>
<td>CK5200AR</td>
<td>Diode, equivalent to one-half 6AS5</td>
<td>0.315</td>
<td>1.5</td>
<td>6.0</td>
<td>150</td>
</tr>
<tr>
<td>CK5198</td>
<td>CK5198R</td>
<td>Tube, High ma.</td>
<td>0.400</td>
<td>1.5</td>
<td>6.0</td>
<td>200</td>
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<tr>
<td>CK5196</td>
<td>Characteristics of 6AS6</td>
<td>0.400</td>
<td>1.5</td>
<td>6.0</td>
<td>200</td>
<td>3500</td>
</tr>
<tr>
<td><strong>CK5829</strong></td>
<td>Similar to 6AS6</td>
<td>0.284 x 0.385</td>
<td>1.5</td>
<td>6.3</td>
<td>150</td>
<td>1170</td>
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### FILAMENT TYPES

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<thead>
<tr>
<th>Tube</th>
<th>80,000-Volt</th>
<th>120,000-Volt</th>
<th>200,000-Volt</th>
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<tbody>
<tr>
<td>C64</td>
<td>0.284 x 0.385</td>
<td>1.5</td>
<td>1.25</td>
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### TYPICAL OPERATING CONDITIONS

<table>
<thead>
<tr>
<th>Tube</th>
<th>Filament Voltage</th>
<th>Grid Voltage</th>
<th>Plate Voltage</th>
<th>Screen Voltage</th>
<th>Heatsink Fuse</th>
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<tbody>
<tr>
<td>C64</td>
<td>3.0</td>
<td>2.5</td>
<td>22.5</td>
<td>22.5</td>
<td>0.25</td>
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### VOLTAGE REGULATORS

<table>
<thead>
<tr>
<th>Type No.</th>
<th>Voltage Reference Tube — 6AO3</th>
<th>Operating Voltage</th>
<th>Operating Current Range</th>
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<tbody>
<tr>
<td>CK5783</td>
<td>0.400</td>
<td>5.0</td>
<td>150</td>
</tr>
<tr>
<td>CK5757</td>
<td>0.400</td>
<td>2.0</td>
<td>150</td>
</tr>
</tbody>
</table>

### RAYTHEON MANUFACTURING COMPANY

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., 467 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.

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-megohmometer 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.

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-chrono-graphs. 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-chrono-graph and was designed for measurements of machine-gun projectile velocity. It will measure and record time intervals with an accuracy of 0.005 µsec at repetition rates up to 25 per second.

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.

All-Purpose Sealer
NUCLEAR INSTRUMENT & CHEMICAL CORP., 229 W. Erie St., Chicago, Ill. The Ultra-Sealer 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.

Test Transformer
RADIO CORP. OF AMERICA, Harrison, N. J. The WP-25A television iso-tap, a combination autotransformer (Continued on p 192)
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.
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
New Standard Signal Generator

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.

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

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>1021-AV</td>
<td>V-H-F Standard-Signal Generator (50-250 Mc)</td>
<td>$595.00</td>
</tr>
<tr>
<td>1021-AU</td>
<td>U-H-F Standard-Signal Generator (250-520 Mc)</td>
<td>$615.00</td>
</tr>
<tr>
<td>1000-P6</td>
<td>Crystal-Diode Modulator</td>
<td>$35.00</td>
</tr>
</tbody>
</table>

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.

GENERAL RADIO COMPANY
90 West St., New York 6 920 S. Michigan Ave., Chicago 5 1000 N. Seward St., Los Angeles 38

Cambridge 39, Massachusetts
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 others. 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 donut-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)
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.

Sylvania Electric Products Inc.
Electronics Division, Dept. E-106
1740 Broadway, New York 19, N. Y.

Please send me latest information about Sylvania Glow Modulator Tubes.

Name: ________________________________
Company: ________________________________
Street: __________________________________
City ____________________ Zone ______ State ______

How SYLVANIA helps to beat News-Photo deadlines

SYLVANIA GLOW MODULATOR TUBES enable this machine to produce complete photo-engravings . . . in just 6 minutes.

SYLVANIA ELECTRIC

ELECTRONICS — June, 1950
NEW BOOKS

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Electron Tube Circuits

A BOOK to cover the field of electron-tube circuits could easily fill a five-foot shelf all by itself. Professor Seeley, 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

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 (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 41 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 band-width. 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 $1,575.

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 tactfully called electronics, earning our living thereby and creating a myriad of useful and maybe not-so-useful de-

June, 1950 — ELECTRONICS
NEW BOOKS (continued)

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-
PRACTICAL TELEVISION ENGINEERING

by Scott Holt
Research Division Allen B. Du Mont Laboratories
—Instructor, Columbia University

Here, just off the press, is the first book since the war which covers the entire field of Tele
vision 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 understand
ably through every phase of its subject. From being a rehash of old and oftused material, it brings you up-to-the-minute details of the latest developments, trends, problems, data and specific engineering know how.

COMPLETE—MODERN—AUTHENTIC

Complete coverage of the following subjects makes PRACTICAL TELEVISION ENGINEERING complete:

Fundamentals of Picture Transmission
Cathode-Ray Tubes
Cathode-Ray Oscillographs
Electron Tubes and Image Pickup
Synchronizing Generators, Timing, Shaping and Preflection Circuits
The Video Amplifier and Cathode Follower
Voltage-regulated Power Supplies
Television Receivers
Television Camera Chains
Television Transmitters
Television Broadcasting Techniques
Glossary of Terms

Television Antennas


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


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
Look for the orange package... the universally popular solder for use in electrical applications where bonding must be secure and free from corrosion.

The flux is in the solder... all you need is heat! Federated Rosin Core Solder is available in 1, 5, and 20-pound sizes.

Federated makes every commercial solder...

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It's a Fact...

Ground miniature bearings are obtainable and at NO EXTRA COST

The major development of the decade in anti-friction bearings made possible by
* Production skill and "know-how."
* The last word in machine tools and equipment.
* Precision grinding spindles of 100,000 rpm and more.

RESULT:
The smooth performance and accurate geometry of GROUND Bearings is now available in sizes as small as 1 mm (.040") bore x ¼" O.D. with the millionths inch refinement of ABEC-7.

"The smaller the bearing the better it runs."

New Hampshire Micro Ball Bearings, Inc.
5 Main Street • Peterborough, New Hampshire

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with the
AP-1 PANORAMIC SONIC ANALYZER

Provides the very utmost in speed, simplicity and directness of complex waveform analysis. In only one second the AP-1 automatically separates and measures the frequency and amplitude of wave components between 40 and 20,000 cps. Optimum frequency resolution is maintained throughout the entire frequency range. Measures amplitude of components down to 0.1%.

- Direct Reading
- Logarithmic Frequency Scale
- Linear and Two Decade Log Voltage Scales
- Input voltage range 10,000,000:1

AP-1 is THE answer for practical investigations of waveforms which vary in a random manner or while operating or design constants are changed. If your problem is measurement of harmonics, high frequency vibration, noise, inter-modulation, acoustics or other sonic phenomena, investigate the overall advantages offered by AP-1.

* Write NOW for complete specifications, price and delivery.

Send For This Free Catalog

Custom Built Dry Batteries Built to Exacting Industrial and Electronic Requirements

If you need a battery that's completely new, one you've never heard of, or that's no longer available through normal channels, call on Specialty Battery Company. Specialty supplies hard-to-get batteries for every purpose, designs and manufactures dry batteries to your specifications.

SPECIALTY BATTERY COMPANY
A SUBSIDIARY OF THE RAY-O-VAC COMPANY
MADISON 3, WISCONSIN

138 June, 1950 — ELECTRONICS
BH "649"

One of the largest manufacturers of electrical equipment required an insulation that was definitely non-corrosive and non-fogging, in addition to being toughened against abrasion.

They found what they wanted in BH "649":

1. Rated dielectric strength retained even after roughest handling
2. No corrosion of silver, brass, aluminum, copper or nickel-plated parts
3. No evidence of fogging on glass under test conditions

If you require a tough insulation with superior dielectric properties, you will be interested in tests made on BH "649" by leading manufacturers of television and radio, transformers, meters, electronic instruments, aviation instruments. They have found that BH "649" is unaffected by severe bending in assembly or product use. They have learned that BH "649" stays supple after baking 12 hours at 300°F. BH "649" is made in Grades A-1, B-1, C-1 and C-2—in all sizes from No. 24 to ½" inclusive. Write for production samples.

BENTLEY, HARRIS MANUFACTURING CO., CONSHOHOCKEN, PA.
The outstanding characteristic of the Model 305 Electronic Voltmeter is its ability to provide absolute indication of transient or pulse voltages of short duration. Reliable indication of pulses a few microseconds wide repeated only 10 times per second is readily obtained with this instrument. The Voltmeter is pre-calibrated, compact, easy to operate and observe. Positive and negative peaks are registered over the range of .001 volt to 1000 volts, peak to peak. Decade ranges and a logarithmic scale output meter are characteristic features, along with a separately available high gain, wide-band amplifier.

Send for Bulletin No. 12

Ballantine's PEAK to PEAK Electronic VOLTOMETER

Designed for PULSE AMPLITUDE MEASUREMENTS

NEW BOOKS (continued)

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


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.
The shortest distance between guessing and knowing

Fast-moving machines are hard to study under actual working conditions. But with high speed movies you can slow down fast action to a pace the eye can follow.

With the Kodak High Speed Camera you can take pictures of your problem (up to 3200 a second on regular 16mm movie film). Then you can see the operation clearly—enlarged on the projection screen—slowed down 200 times! You can see the reasons for excessive wear, faulty operation, noise, vibration, or early failure. What you see can point the way to better design, better methods, better performance.

High speed photography is not difficult, and its cost is small compared with the savings it makes possible. For more information, write for the booklet "Magnifying Time" or for loan of the 16mm demonstration film made with the Kodak High Speed Camera.

EASTMAN KODAK COMPANY, Industrial Photographic Division, Rochester 4, N. Y.

High-Speed Movies

... another important function of photography
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This is a thermostatically controlled device for the regulation of the temperature of an electric soldering iron. When placed on and connected to this stand, iron may be maintained at working temperature or through adjustment on bottom of stand at low or warm temperatures.

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June, 1950 — ELECTRONICS
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NEW BOOKS
(continued)
the principal parameters studied and displayed are type of gas, gas pressure, ion currents, are 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, 1,043 pages, $7.50.

Compilation of fifteen papers originally published in the Bell System Technical Journal, arranged in
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Welding aluminum by the inert arc method. Modern processes that save time and at the same time assure better construction. By these means savings are made and passed on in the form of high quality products.

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This exclusive G-E feature—with the use of highest grade materials, with strictest quality control and individual testing—make General Electric capacitors finer and more dependable than ever before. Apparatus Dept., General Electric Company, Schenectady 5, N.Y.
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


THE PROTECTION OF TRANSMISSION SYSTEMS AGAINST LIGHTNING. By Walter W. Lewis. McGraw-Hill Book Co., New York, 1949, 418 pages, $4.90. 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, $1.25. Final chapter deals with color television and ultra-high frequencies. For servicemen, students and engineers who like to fix their own tv sets.

June, 1950 — ELECTRONICS
Radio and television manufacturers depend on Erie Resistor for scores of parts in custom molded plastics... from such basic units as one piece windows and frames to cabinets, dials, gauges, and control knobs. They have learned that Erie combines the beauty of quality molding with the economy of production know-how.
TUBES AT WORK
(continued from page 120)

driver 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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It is anticipated that the streamlining and conversion of necessary facilities will be completed at an early date.

LOOK to CARBOLOY for the finest in special metals
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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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.

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Easy and convenient to use, Corning inductances can stand repeated handling during production assembly. They are readily installed by conventional soldering methods or grommet mounting techniques. The tin electroplated surface facilitates soldering and minimizes oxidation. Low initial cost, accuracy, ease of installation and durability contribute to production economy.

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Electrical Products Division

CORNING, N. Y.

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CORNING GLASS WORKS
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ELECTRONICS — June, 1950
That's what this versatile interval timer by Haydon® says when its buzzer sounds off. This audible signal—at cycle completion—sounds continuously until manually turned off. The unit is driven by a dependable Haydon synchronous motor; is built to give constant, efficient, dependable Haydon service. That's quick break.

FEATURES? LOTS OF THEM!
1. Many intervals available with a wide range of motor speeds and minor variations in design.
2. Optional buzzer for audible signal at completion of cycle; sounds continuously until manually turned off.
3. Load contact ratings: 10A, 250 VAC; 1/2 HP, 250 VAC.
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5. Snap action device for quick break.
6. Operates at peak efficiency in any mounting position.

ALL HAYDON TIMERS GIVE YOU
these features of the dependable Haydon motor:
Total enclosure — Very small size — Slow (450 rpm) rotor for long life, quiet operation—Controlled lubrication with separate systems for rotor and gear train — Mounting and operation in any position.

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For complete design and engineering specifications, write for catalog: Timing Motors No. 322 — Timers No. 323 — Clock Movements No. 324. Yours without obligation.

Tubes at Work (continued)

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 kick-back 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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TWO NEW WAVEGUIDE-OUTPUT REFLEX KLYSTRONS

Varian engineered to tune over the frequency range from 8,100 to 17,500 megacycles. These tubes are designed for transmitter service, for use as local oscillators and bench oscillators as a power source for measurements. The tubes are small, light and sturdily built. Flanges with mica windows bolt directly to the waveguide with a lapped surface to avoid reflections and leakage. Special grid techniques increase efficiency, reduce microphonics. A single screw tuner covers the entire broad tuning range.

<table>
<thead>
<tr>
<th>Mechanical Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cathode: Oxide coated, unipotential</td>
</tr>
<tr>
<td>Clearance dimensions: 3/16 x 1/2 x 1/2 in.</td>
</tr>
<tr>
<td>Weight: 6 ounces</td>
</tr>
<tr>
<td>Output Flange: Mates with standard flange for 1 x 1 x 0.06 in. waveguide</td>
</tr>
<tr>
<td>Cooling: Forced air cooling required for beam power inputs exceeding 10 watts</td>
</tr>
<tr>
<td>Mounting position: Any</td>
</tr>
<tr>
<td>Typical Operation</td>
</tr>
<tr>
<td>Frequency: 10,000 mc</td>
</tr>
<tr>
<td>Beam Voltage: 400 volts</td>
</tr>
<tr>
<td>Beam Current: 48 ma</td>
</tr>
<tr>
<td>Reflector Voltage: 575 volts</td>
</tr>
<tr>
<td>Power Output: 250 milliwatts</td>
</tr>
<tr>
<td>Load VSWR: Less than 1.1</td>
</tr>
<tr>
<td>Modulation: Bandwidth: 30 mc</td>
</tr>
<tr>
<td>Temperature coefficient: Less than 0.25 mc per degree C</td>
</tr>
</tbody>
</table>

Not illustrated, X-21 klystron. Five-watt two-cavity oscillator. Weight approximately 4 1/2 ounces. Specifications upon request.

TUBES AT WORK

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.

Same picture with coder
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FREE 8-page "COUNT BOOK" shows standard and some special types of V-R Counters for mechanical, electrical and manual operation. Write for your copy today.
Don't draw it—Photograph it!

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Fairchild now offers an inexpensive oscilloscope camera that gives you accurate photographic records of waveshapes in almost as little time as it takes to sketch them from memory. Only one minute after the shutter is snapped, a print is ready to mount in your notebook. This permits you to evaluate oscilloscope "stills" immediately and then proceed with laboratory work.

The 3½ x 4¼ print is small enough to mount easily in a notebook or on a data sheet, large enough for accurate evaluation. Each print records two traces to facilitate comparison runs and cut film costs in half. Operation is simple—no focusing, no darkroom processing. You just snap the shutter and remove the print from the back of the camera.

The complete Fairchild-Polaroid Oscilloscope Camera consists of a scope adapter to fit any five-inch oscilloscope, a light-tight hood with viewing port, and a Polaroid-Land Camera body with special lens and two-position shift device.


3½ x 4¼ Print is ready to mount on data sheet a minute after the shutter is snapped

Specifications

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 — 3½ 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./usec 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, 8½ in. max. dia.
Weight — Complete, 7½ lb.

TUBES AT WORK (continued)

The output of the head amplifier 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

June, 1950 — ELECTRONICS
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Division of the Gabriel Company
1523 E. 45TH STREET • CLEVELAND, OHIO
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 camera, 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...
THERMOPLASTIC INSULATED WIRE IN ALL SIZES

TESTS ON NO. 20 SOLID CONDUCTOR INSULATED WITH WHITE SURCO A-10

<table>
<thead>
<tr>
<th></th>
<th>1/32&quot; Wall (no jacket)</th>
<th>1/64&quot; Wall (nylon jacket)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FLEXIBILITY TEST</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. 60 days at 113°C</td>
<td>No evidence of cracking</td>
<td>No evidence of cracking</td>
</tr>
<tr>
<td>2. 7 days at 136°C</td>
<td>No evidence of cracking</td>
<td>No evidence of cracking</td>
</tr>
<tr>
<td>(Meets low temperature requirement of -40°C when tested according to JAN-C-75)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SLOW COMPRESSION TEST</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Actual force in pounds to ground</td>
<td>81.3</td>
<td>59.8</td>
</tr>
<tr>
<td>FLAME TESTS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Horizontal Test</td>
<td>Self-extinguishing</td>
<td>Self-extinguishing</td>
</tr>
<tr>
<td></td>
<td>no falling particles</td>
<td>no falling particles</td>
</tr>
<tr>
<td>Vertical Test (As described in Underwriters' Standard for Thermoplastic Wires)</td>
<td>Specimens meet requirements satisfactorily</td>
<td>Specimens meet requirements satisfactorily</td>
</tr>
<tr>
<td>VOLTAGE BREAKDOWN TEST</td>
<td></td>
<td></td>
</tr>
<tr>
<td>As received - 2000 V/min.</td>
<td>No failure</td>
<td>No failure</td>
</tr>
<tr>
<td>Ave. breakdown KV</td>
<td>23.9 KV (1/64&quot; wall)</td>
<td>24.7 KV</td>
</tr>
<tr>
<td>After 60 days at 113°C-2000 V/min. Average breakdown KV</td>
<td>No failure</td>
<td>No failure</td>
</tr>
<tr>
<td></td>
<td>21.5 KV (1/64&quot; wall)</td>
<td>24.0 KV</td>
</tr>
<tr>
<td>INSULATION RESISTANCE TEST</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12 hrs. in water at 15.6°C</td>
<td>988 megohms</td>
<td>1270 megohms</td>
</tr>
<tr>
<td>Megohms/1000'</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Data appears as on the approval and test report from Underwriters' Laboratories, Inc.

u/L Approved for Continuous Operation at 105°C

Surprenant

MFG. CO.

199 Washington St., Boston 8, Mass.

ELECTRONICS — June, 1950
"Custom Built" QUALITY CRYSTALS
by
REEVES-HOFFMAN

Precision Performance makes the difference... .

The ability of a crystal to maintain its close tolerance and operating efficiency under difficult operating conditions is the real test of quality. Illustrated above are a few of the many types of CUSTOM BUILT Reeves-Hoffman crystals which have passed the quality test.

Whatever your particular requirements may be, the facilities and personnel at Reeves-Hoffman are available to develop and to mass produce the CUSTOM BUILT crystals you need. Feel free to contact us at any time... send along the details of your circuit.

REEVES HOFFMAN CORPORATION
Cherry and North Streets • Carlisle, Penna.

Representatives: NEW YORK • BALTIMORE • BUFFALO • CHICAGO • KANSAS CITY

June, 1950 — ELECTRONICS
Picture tube sizes for television have been paced by Du Mont for the past decade. And again it is Du Mont with the rectangular tube in the size the public wants — a rectangular with screen area (150 sq. in.) comparable with the round sixteen-inch tube. There is no need to sacrifice picture size to incorporate the advantages of the rectangular tube. This latest Teletron* features the exclusive Du Mont-designed Bent Gun for the sharpest focus and longest life free from ion spot blemishes. For that extra sales appeal, incorporate this newest Du Mont design in your receiver. Write for complete specifications.

GENERAL SPECIFICATIONS...

Overall length ........................................ 18 1/4”
Greatest dimension of bulb ......................... 16 1/4”
Minimum useful screen diagonal ................... 15 1/2”
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
Grid No. 1 circuit resistance ...................... 1.5 max. megohms

FIRST WITH THE FINEST IN TV TUBES

ALLEN B. DU MONT LABORATORIES, INC. • TUBE DIVISION • CLIFTON, N. J.

ELECTRONICS — June, 1950
In the field of electronics and the electrical goods industry, MOSINEE stands for paper-base processing materials with scientifically controlled chemical and physical properties, high quality standards and dependable uniformity... with good dielectric strength, high tensile or tear strength; proper softness or stiffness; creped with controlled stretch or flexibility; specified pH for maximum-minimum acidity or alkalinity; accurate caliper, density, liquid repellency or absorbency... or other technical characteristics vital to your quality standards and production requirements.

MOSINEE PAPER MILLS COMPANY • MOSINEE, WIS.

"Essential Paper Manufacturers"
Simple, dependable on-off switching is a must with many products... and generally, the shortest distance between the problem and the solution is a Honeywell Mercury Switch.

Honeywell Mercury Switches are tiny and compact... are adaptable to unusual mountings. They operate at low angles... have no moving parts... are sealed against dust, gas and corrosion. Fouled contact points cannot occur.

The complete line is at your command... offering greater latitude in product design, with improved performance and trouble-free operation. Write for a copy of new Catalog 1343 for down-to-earth information... or call in your local Honeywell engineer for a detailed discussion of a particular application.
specify fastenings
from
fastening specialists

BLAKE & JOHNSON
Fastenings

THE BLAKE & JOHNSON COMPANY, WATERTVILLE 48, CONN.

<table>
<thead>
<tr>
<th>Name</th>
<th>Title</th>
<th>Company</th>
<th>Address</th>
</tr>
</thead>
</table>

Please send me your new catalog containing full data on the complete line of Blake & Johnson fastenings.

TUBES AT WORK

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.

Time Scale for Watches

A German inventor claims he has developed a new electric-acoustic apparatus enabling watchmakers to set the speed of watches within three minutes, a job which normally takes 24 hours. A control watch and the customer's watch are fastened to microphones which feed their strokes into the headphones of the watchmaker who hears if there is any defect.

As soon as the strokes of the watches coincide, the pointer on the meter scale starts to move. It stops when the strokes coincide again and the watchmaker then can read how many minutes the customer's watch is slow or fast. The instrument was invented and is being made by Alfred Driesellmann of Hamburg-Rahlstedt, Schwerinerstrasse. It costs about $600. A girl mechanic is operating the machine shown in the photograph.
NO. 1110 INCREMENTAL INDUCTANCE BRIDGE

FOR ACCURATE TESTING OF COMMUNICATION AND TELEVISION COMPONENTS UNDER LOAD CONDITIONS.

Designed for measuring the inductance of Iron Core components for frequencies up to 100 cycles. Inductors can be measured with superimposed direct current. Ideal instrument for manufacturers and users of iron core components for communications and television.

Accuracy 1%
Inductance Range 1 millihenry to 10,000 Hx
Maximum current 1 Amp DC.

Recommended accessories:
- AC Supply #1180
- DC Supply #1170
- Null Detector £.140 or
- Vacuum Tube Voltmeter & Null Detector #1210

SEND FOR LATEST CATALOG!
FREED TRANSFORMER CO., INC.
DEPT. JE 1718-36 WEIRFIELD ST., (RIDGEWOOD) BROOKLYN 27, NEW YORK
DIRECT WRITING RECORDERS

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 dynes/cm 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.

INSTRUMENT AMPLIFIERS

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/cm, minimum sensitivity 50 volts per cm, four intermediate ranges. Balanced input terminals available with impedances of 5 megohms to ground. Complete information in catalog shown below.

AMPLIFIER-RECORDERS

Model shown at right is a single channel unit comprising above Amplifier 126 and Recorder 127, contained in one mahogany carrying case, and designed for use in the industrial field as a direct writing vacuum tube recording voltmeter capable of reproducing any electrical phenomena from the order of a few millivolts to more than 200 volts. More complete data in catalog shown below.

At lower right is a typical "Poly-Viso" multiple channel direct writing Recorder and Amplifier in a metal case. Numerous combinations of this recording equipment and associated amplifiers and accessories are available. The Multi-channel Recorder (Model 165) provides for the simultaneous registration of up to four input phenomena, using the same principles and method as for the Recorder Assembly above. In addition, the "Poly-Viso" Recorder provides a selection of eight paper speeds: 50, 25, 10, 5, 2.5, 1, 0.5, 0.25 mm/sec, and for the use of 4, 2, or 1 channel recording Permapaper.

The Amplifier equipment is housed in a rack which has space for four individual driver amplifiers (electrically identical to model 126, above) and one 4-channel preamplifier.

For complete catalog giving tables of constants, sizes and weights, illustrations, general description, and prices, address:

SANBORN COMPANY
Industrial Division
CAMBRIDGE 39, MASS.

THE ELECTRON ART
(continued from p 124)

FIG. 1—Basic circuit of a well-known resistance-tuned oscillator to which bandwidth spreading will be added

frequency at which the 6J7 grid voltage is in phase with the 6F6 plate voltage. The Wien bridge network, R.C.R.C., 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 C1 and C2. Each of these consists of two sections of a four-gang capacitor, with a maximum capacitance of 926 µF per section.

Trimmers are used across C1 and C2 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 3C of the tuning capacitor, and the minimum capacitance, Cmin, across C1 and C2, each when the tuning capacitor is set to the high-frequency end of the dial. The values of ΔC and Cmin are obtainable by simple calculation; Cmin = 86 µF and ΔC = 1,019 µF. Values of components for any desired bandspread range may now be readily calculated.

Example: Calculate a tuning cir-
VITROTEX — the "live wire" for hot spots—withstanding temperatures of 130 C.

Glass keeps it "live" when spots get Hot.

What’s the secret of its heat-resistant success?

Just this! Vitrotex®, unlike ordinary magnet wire, is covered with alkali-free, flexible, fibrous glass insulation—bonded with a special, high-temperature varnish. This protects windings against hot spots as high as 130 C... provides high flexibility, excellent heat conductivty and an amazing space factor... plus high dielectric strength.

The smooth surface of Vitrotex successfully resists abrasion, moisture, acids, oils and corrosive vapors... and its tightly wound coils provide safer operation in confined areas under high heat.

Contact your nearest Anaconda Sales Office or Distributor for information on Vitrotex and the entire line of Anaconda Magnet Wire. Anaconda Wire & Cable Company, 25 Broadway, New York 4, New York, or 20 N. Wacker Drive, Chicago 6, Illinois.

"JOHN CRANE" FABRICATED TEFLOV* INSULATORS

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.

If you need Teflon insulators, let "John Crane" solve your problem. Write for full information

* John Crane products fabricated from DuPont Teflon are sold under the registered trade name "Chemlon"

CRANE PACKING COMPANY
1802 CUYLER AVENUE • CHICAGO 13, ILLINOIS

 Offices in all Principal Cities in United States and Canada

time saving...
cost saving!

dependable instruments

Heiland
DENVER

AUTOMATIC
OSCILOGRAPH
Recorder

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

HEILAND RESEARCH CORPORATION
137 East Fifth Avenue
Denver, Colorado

SPECIAL FEATURES

• Easy loading
• Four quick-change paper speeds
• Simultaneous viewing, recording, scanning
• Trace identification
• Zero mirror
• Adjustable automatic record length
• Synchronizing reference trace
• Lamp burn-out indicators
• Size: 9½" (H) x 13⅞" (L) x 19⅝" (D)
• Weight: 59 lbs.

THE ELECTRON ART

FIG. 2—Complete bandspread circuit covering 3 to 5, 5 to 7 and 7 to 9-kc ranges in addition to original bands

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 \(-80^\circ\) TO 500°F.

No other available material has the combination of low electrical losses and heat resistance of Du Pont "TEFLON" tetrafluoroethylene 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 \(-80^\circ\)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.

ELECTRONICS — June, 1950

(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.

BETTER THINGS FOR BETTER LIVING... THROUGH CHEMISTRY
Protect TV lead-ins with this new plastic tape

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, alkalis, 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.

THE ELECTRON ART

(continued)

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...
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" long, including plug, 1-13/32" wide, 1-19/32" high.

Sealed Relay—3-3/16" long, including plug.

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°C rise.
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 principle makes 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.

At last—a base specifically designed for plug-in units.
No more broken bosses, bent pins, "shorted" circuits.

Brock connected chassis—become instantly accessible. Half twist of handles brings chassis into place on the heavy duty, built for long or as separate units—miniature and standard sizes.

Rugged color coded back connectors—make and break circuits—provide rapid circuit switching. Their size is compensating for any chassis misalignment. Miniature and heavy duty sizes.

Top operated stumps for tubes and plug-in units. Take minimum of space. Can be operated in cramped locations. Free floating—orientate unit to socket without straining or bending pins.

Alden Cap Captive Convenience Screws—Hold miniature chassis, heavy plug-in units or detachable mechanical units securely. Assemble easily in production by power tools—yet any tool or coin services in field.

Write for new booklet on "Components for Plug-in Unit Construction"

ALDEN PRODUCTS CO. 117 NORTH MAIN ST. BROCKTON 64, MASS.

THE ELECTRON ART (continued)

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 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 exact 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 x 10^-6 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,
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 5½" 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.
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 101⁄2-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 ±1⁄4 db for the full reel, and ±1⁄2 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

THE ELECTRON ART (continued)

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
Multi-channel -- telegraph A1 or telephone A3.

VERSATILE

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.

RUGGED

Components conservatively rated. Completely tropicalized.

STABLE

High stability (.003%) under normal operating conditions.

Consultants, designers and manufacturers of standard or special electronic, meteorological and communications equipment.

ELECTRONICS — June, 1950
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, 3.5 lb.) picked up by Air Express in Knoxville, Tenn., at 11 A.M., delivered 7:15 P.M. Charge, $86.60. 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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**The Electron Art** (continued)

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

Seavo 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:

\[ E_{\text{out}} = 1 - e^{-\frac{t}{T}} \]

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...

THE BECKMAN Helipot

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 thermocouple-potentiometer control applications and by using the new DUODIAL cut-in-dial-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 coded helically into a case which requires no more panel space than the conventional unit. A simple, foolproof guide controls the slider contacts 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 minimum 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, 1/4" slide wire length, 11/4" case dia., resistances 10 to 50,000 ohms, 3600° rotation.
- **MODEL B**: 10 watts, 16 turns, 7/8" slide wire length, 1 1/8" case dia., resistances 30 to 200,000 ohms, 3600° rotation.
- **MODEL C**: 2 watts, 3 turns, 15/32" slide wire length, 11/2" case dia., resistances 3 to 15,000 ohms, 1080° rotation.
- **MODEL D**: 12 watts, 25 turns, 3/4" slide wire length, 3/4" case dia., resistances 100 to 300,000 ohms, 900° rotation.
- **MODEL E**: 20 watts, 40 turns, 1 1/4" slide wire length, 1 1/2" 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 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 problems.

*Data for Model A, 1 1/4" dia. Helipot. Other models give even greater control range in 3" case diameters.*

THE BECKMAN Helipot CORPORATION, SOUTH PASADENA 2, CALIFORNIA

ELECTRONICS — June, 1950 183
for smooth, sensitive, trouble-free CONTROL

S.S. White remote control flexible shafts are velvety smooth, jump-free and sensitive in operation—because they're engineered and built expressly for the job of remote control. The loop test at left tells the story. Furthermore, these shafts perform for years without attention. They're practically immune from trouble.

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.

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 \( \tau = 10 \)) is shown by the normalized curves of \( e_{\text{out}} \) vs time with \( \tau \) 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. 1**—Equivalent circuits for thermal detector A and for detector with low-pass filter B, triangular input pulse \( \delta T \) seconds wide can be obtained by Laplace Transform methods.

Figure 2A shows normalized curves of \( e_{\text{out}} \) vs time with \( \delta \) as a parameter. It can be seen that for \( \delta > 100 \), the output follows the input very closely, while for \( \delta \leq 0.1 \) 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, \( \delta \).

**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 \( \tau = 10 \)) is shown by the normalized curves of \( e_{\text{out}} \) vs time with \( \delta \) 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
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 heavy-weight 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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Completely electronic in operation; no moving parts. Offers instantaneous action, to maintain output voltage to within ±0.1 volts of nominal for any line voltage variations; to within ±0.15 volts for any load current change or load power factor change from 0 lagging to 0 leading. Waveform distortion never exceeds 3%.

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**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 undershoot attains considerable proportions. When \( \beta = 10 \), the magnitude of the peak negative undershoot is almost twice as great as the first positive peak, while for \( \beta = 20 \), 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 \( \beta \) must be between 1 and 20 for reasonable pulse outputs which could be detected above noise.

The value for \( \alpha \) 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 \( \mu \)F 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.
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.
STEVENS HERMETICALLY SEALED THERMOSTATS

![Illustration of thermostats]

- fast response
- close control
- operation from -60° to 600°F
- dust, moisture and explosion-proof

Specially engineered for precision control of radio and electronic devices, instruments, cameras and other equipment subjected to dust, moisture or corrosive atmospheres, Stevens hermetically sealed thermostats are enclosed in corrosion-resistant metal cans.

Carefully precalibrated in pots simulating your actual service conditions, Stevens hermetically sealed thermostats have a tight, permanent seal that prevents deterioration or sulphiding of contacts. They can also be sealed in helium or other inert gas atmosphere. Terminals are sweat-soldered into inert alloy tubes interfused with inorganic glass insulator bead.

Stevens hermetically sealed thermostats—featuring an electrically independent bi-metal element that eliminates artificial cycling or life-shortening "jitters"—are available in disc types for controlling high-wattage circuits, or in strip types for controlling low-wattage circuits or for use in conjunction with disc thermostats.

To insure the satisfactory performance of your product, specify Stevens hermetically sealed thermostats—they perform better...last longer.

*Stevens also makes a complete line of semi-sealed and standard bi-metal disc and strip thermostats. Write for data.

THE ELECTRON ART

(continued)

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 design of a 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 $\theta_{\text{out}}$ vs time with $\mu$ as parameter, and it is a plot of the response of the circuit in Fig. 1B. The pulse width was a constant ($T = 1$) 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 $\mu$ is, the greater is the time lag. In fact, if $\mu$ 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...
Few of these tools have sharp edges. But they are powerful cost cutters. Whenever a telephone craftsman reaches for one, he finds the right tool ready to his hand. There's no time wasted trying to do a complicated job with makeshift equipment.

Most telephone tools are highly specialized. 90% of dial system tools were designed by Bell Laboratories. Each saves time in maintenance, installation or construction.

There are tools with lights and mirrors to work deep within relay bays; tools to brush, burnish and polish; tools that vacuum clean — even a tool to weld on new contact points without dismantling a relay. There are gauges to time dial speeds, others to check spring tension. Some look like a dentist's instruments. Some you have never seen.

Keeping the telephone tool kit abreast of improvements is a continuing job for Bell Telephone Laboratories. It's another example of how the Laboratories help keep the value of your telephone service high, the cost low.
\( \mu \) 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.
"Statistical Quality Control" goes Mrs. Pod more-than-one better!

The original Mrs. Pod, unconcerned about specifications, delivers nature-molded pieces which, to the eye, need only look alike in appearance and size!

"Statistical Quality Control" goes much further. As a special production-improvement factor ... and with the custom molder's press as its pod, each delivered part must fully comply with each and every required specification! Not only must parts look alike—they must be alike! ... Size—shape—molding uniformity—precision placement of inserts— together with a multiplicity of inside and outside measurements ... all, in all ways, must pass rigid tests before passing to the customer.

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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-ke 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., Lockhawn, 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 cloth, 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

ELECTRONICS — June, 1950
only \textit{TORQUE EY DRIVE} gives you everything you want exactly as you want it!

- LOW-MASS DRIVING SYSTEM
- HIGH VOLTAGE COMPLIANCE PRODUCT
- MORE THAN ADEQUATE LATERAL COMPLIANCE
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Users of E-V TORQUE DRIVE\textsuperscript{*} 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.

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NEW PRODUCTS (continued)

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.

\textbf{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.

\textbf{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.,

June, 1950 — ELECTRONICS
Inside Information
on the Inside of a Tube

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.

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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.

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Inspection and Gaging... equipment for checking dimensions of Seamless and Lockseam Cathodes.

Electronic Products for export through Driver-Harris Company, Harrison, New Jersey * Harrison 6-4800

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All analyses .010" to .14" O.D.
Certain analyses (.035" max. wall) Up to .14" O.D.

Electronics — June, 1950
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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.

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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.

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COMMUNICATION ACCESSORIES

Company

HICKMAN MILLS, MISSOURI

NEW PRODUCTS

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

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- 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. Downtime of mechanical pumps is far less in a year... productive operating periods longer. Mechanical pumps need not be at high efficiency.

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<td>$10^{-3}$ mm.</td>
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<td>$10^{-6}$ mm.</td>
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**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.

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NEW PRODUCTS (continued)

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 $0.4 \times 0.75 \times 0.56$ 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.

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ELECTRONIC SYSTEMS Co., 555 E. Tremont Ave., New York 57, N. Y. Model 682-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.

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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 33 1/3 or 45 or 78 R.P.M. records.

Send for a sample assembly today...try it...then note first hand the advanced improvement.

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MAIN OFFICE AND FACTORY
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"Where Quality is a Responsibility and Fair Dealing an Obligation"

June, 1950 — ELECTRONICS
Copper Alloy Bulletin

Product Improvement Edition

Reporting News and Technical Developments of Copper and Copper-base Alloys

Prepared Each Month by Bridgeport Brass Co. Headquarters for Brass, Bronze and Copper

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 tying 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 but-

tons 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 swaged 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.

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.
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.

New Products (continued)

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 T5i, T6i 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-...
For Extremely Low Insulation Loss Factor

9-Pin and 7-Pin Miniature Tube Sockets
and Subminiature Sockets

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.
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 8 1/2 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. Slowing 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

---

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 Sold- volt 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

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

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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.

We are interested in your Microsen D. C. Amplifier. Please send the bulletin describing the instrument to the following address:

Manning, Maxwell & Moore. Inc.
250 East Main Street
Stratford, Conn.

Name ____________________________
Position __________________________
Company __________________________
Street Address _____________________
City ____________________________ State ________

Manners, Maxwell & Moore, Inc.
250 East Main Street
Stratford, Conn.

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.

Electronics — June, 1950

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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 SPECIALY WOUND COILS

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<tr>
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<td>8-32</td>
<td>1/4&quot;</td>
<td>1/4&quot;</td>
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<tr>
<td>LS 6</td>
<td>Ceramic</td>
<td>10-32</td>
<td>1/4&quot;</td>
<td>1/4&quot;</td>
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<tr>
<td>LS 5</td>
<td>Ceramic</td>
<td>14-28</td>
<td>1/4&quot;</td>
<td>1/4&quot;</td>
</tr>
<tr>
<td>LS 8</td>
<td>Phenolic</td>
<td>8-32</td>
<td>1/4&quot;</td>
<td>1/4&quot;</td>
</tr>
<tr>
<td>LS 9</td>
<td>Phenolic</td>
<td>14-28</td>
<td>1/4&quot;</td>
<td>2&quot;</td>
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</tbody>
</table>

*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.

NEW PRODUCTS (continued)

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 whatever 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-
**ANOTHER DUMONT FIRST!**

The New
Dumont-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.

---

**DUMONT** First with the Finest in Television
New! **diacro** BOX FINGER BRAKE

**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 Folders,—also Power Shears and Benders.**

**AMPERITE**

**THERMOSTATIC METAL TYPE**

**Delay Relays**

**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"**

**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-59B Television Calibrator combined with the WR-59B Television Sweep Generator and the new, revolutionary WS-57A Oscilloscope matching unit. This "TV Trio" is also available in the WS-17A 3-unit rack.

For complete details on the WR-59B 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.

ELECTRONICS — June, 1950

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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...
SUPERIOR'S NEW MODEL TV-30 

TELEVISION SIGNAL GENERATOR

- **R.F. FREQUENCY RANGES**: 25, 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 modulating circuit by the buffer tube. Output impedance of the test model is 200 ohms. This low impedance provides an output suitable for the buffer tube.
- **OSCILLATORY CIRCUIT**: Maintains phase between cathode follower output and buffer tube. Quality is assured by modulating the buffer tube.
- **ACCURACY**: The permeability of the coil under test is a constant 1% on all ranges. Kilocycles to 10 Megacycles and an accuracy of 2% on the higher frequencies.

**TUBES USED**: 12AT7-One section is used as oscillator and the second is modulated cathode follower. 6J7 is used as modulator. 6C4 is used as rectifier.

The Model 290 operates on 110 Volt A.C. Comes complete with test cable and operating instructions.

**$39.95 NET**

SUPERIOR'S NEW MODEL 670

VOLT-OHM MILLIAMMETER

A Combination VOLT-Ohm-Milliampere plus Capacity Reactance and Decibel Measurements.

**D.C. VOLTS**: 0 to 7,5,15,30,75,150,250,500,1000 Volts. A.C. VOLTS: 0 to 75, 30, 150, 250, 500, 1000 Volts. D.C. CURRENT: 0 to 20 Microamps, 500, 1000, 5000 Ohms, 2 to 10 Megohms. A.C. CURRENT: 0 to 2000 Ohms, 10,000 Ohms to 5 Megohms.

**INDUCTANCE**: 0.25 to 70 Megahms, 35 to 9000 Hertz. **DECIBELS**: 0 to +18, +10 to +30, +20 to +50.

The model 670 comes housed in a rugged, cradle-mounted cabinet complete with leads and operating instructions. Size 11x4 1/2 x 3 1/2.

**$28.40 NET**

SUPERIOR'S NEW MODEL 770 

VOLT-OhM MILLIAMMETER

(Sensitivity: 1000 ohms per volt)

**FEATURES**: Compact, measures 3 1/2 x 5 1/2 x 2 1/2. Uses latest design, automatic 1.015 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. On the highest resistance range. Housed in round-cornered molded case. Silvered black etched panel. Depressed letters filled with white luster. Measures large size instrument even with constant use.

**SPECIFICATIONS**: 6 A.C. VOLTAGE RANGES: 0-15, 0-30, 0-75, 0-150, 0-250, 0-500 Volts. 6 D.C. VOLTAGE RANGES: 0-0.15, 0-0.30, 0-0.60, 0-1.20, 0-2.40, 0-4.80 Volts. 4 D.C. CURRENT RANGES: 0-10, 0-20, 0-50, 0-100 Ma. 6.1% Accuracy. 0.05 Ohms, 0.1 Megohms.

**$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 \(\frac{3}{4}\)" overall. It is further identified by color coding the clip end.

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 de-icing 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...
Inquiries are invited concerning single pads and turrets having other characteristics.

- 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.

*Patents applied for

STODDART AIRCRAFT RADIO CO.
6644 SANTA MONICA BLVD., HOLLYWOOD 38, CALIFORNIA
Hillside 9294
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.

Coils of Heat

We are especially organized to handle direct enquiries from overseas and can give IMMEDIATE DELIVERIES FOR U.S.A.

Billed in Dollars. Settlement by your check Transaction as simple as any local by TRANSRADIO LTD

CONTRACTORS TO H.M. GOVERNMENT
138A CROMWELL ROAD- LONDON SW7 ENGLAND

Patents: Angel Trade Mark

THE LOWEST EVER CAPACITANCE OR ATTENUATION

LOW ATTEN 4mm/ft IMPED ANS ATTEM TIME IN 100 MHZ OD'

A1 74.7 0.01 0.36
A2 76.3 0.26 0.44
A3 73.6 1.5 0.88

HIGH POWER FLEXIBLE

PHOTOCELL CABLE

V.L.C.***

Very Low Capacitance cable

TRANSLUZENT®
REG. U,S. PAT. OFF.

CENTRAL PAPER COMPANY
INCORPORATED
2442 LAKESHORE DRIVE, MUSKEGON, MICH.

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We are specialists in Electrical Papers - Let our laboratories analyze your requirements.

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CONTRACTORS TO H.M. GOVERNMENT
138A CROMWELL ROAD- LONDON SW7 ENGLAND

VULCAN ELECTRIC SOLDERING TOOLS, ELECTRIC SOLDER POTS, ELECTRIC GLUE POTS, ELECTRIC HEATING UNITS, INCLUDING THE NEW VULCAN 900 SERIES, FOR CHANGING OVER ANY HOT WATER HEATER TO ELECTRIC OPERATION.

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.

We are especially organized to handle direct enquiries from overseas and can give IMMEDIATE DELIVERIES FOR U.S.A.

Billed in Dollars. Settlement by your check Transaction as simple as any local by TRANSRADIO LTD

CONTRACTORS TO H.M. GOVERNMENT
138A CROMWELL ROAD- LONDON SW7 ENGLAND

Patents: Angel Trade Mark

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LOW ATTEN 4mm/ft IMPED ANS ATTEM TIME IN 100 MHZ OD'

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A2 76.3 0.26 0.44
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2442 LAKESHORE DRIVE, MUSKEGON, MICH.
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...
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.

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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.

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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 FWJ 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

National Company, Inc.
Malden, Massachusetts

June, 1950 — ELECTRONICS
me. 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-PLEASCOMOLD 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

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**PROFESSIONAL TAPE RECORDER**

Plays up to 10½" NAB Reels

$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 ratios: 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. Sold at 14" x 22" x 7½" high.

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CUT SWAGE CRIMP RIVET
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A LIGHTNING-FAST ELECTRIC IMPACT HAMMER
A Production Tool with 1000 Uses
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306 PLEASANT STREET, NEEDHAM 92, MASS.

NATURAL TREBLE
kettle drum SPEAKERS by BOZAK
TRUE TYPANY 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:
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- 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 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.

June, 1950 — ELECTRONICS
NEW PRODUCTS (continued)

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 1/2 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


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 4 1/2 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.

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.
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.

Resistor Bulletin. Hardwick-Hinde 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 12A, 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 prime 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 3/4" 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 173-11-1 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:

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<td>173-11-2</td>
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For literature and technical data write:

E. F. JOHNSON CO. WASECA, MINN.

Glass Bushings

NOW AVAILABLE TO MANUFACTURERS OF ELECTRONIC EQUIPMENT

General Electric is now offering to other manufacturers the cast glass bushings it has used so successfully on many types of electrical equipment.

These bushings are cast of stable, low-expansion glass. They are attached directly to the apparatus without gaskets—by soldering, welding or brazing, thus forming a strong, permanent, vacuum-tight seal that eliminates moisture problems and often permits more compact, light-weight design.

Available to meet dry, 60-cycle flashover values of from 10 to 50 kv, and in current ratings of 25 and 50 amperes (in large sizes to 800 amperes), for single or multi-conductor. If you will send us a sketch and ratings of bushings you are now using, we will furnish you with samples of our standard glass bushings. See them and evaluate their advantages. Or write for our Bulletin GEA-5093, Apparatus Department, General Electric Company, Schenectady, N. Y.

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PARAMOUNT SPIRAL WOUND PAPER TUBES

All Sizes In Square and Rectangular Tubes

Leading manufacturers rely on the quality and exactness of PARAMOUNT paper tubes for coil forms and other uses. Here you have the advantage of long, specialized experience in producing the exact shapes and sizes for a great many applications. Hi-Dielectric, Hi-Strength. Kraft, Fish Paper, Red Rope, or any combination. Wound on automatic machines. Tolerances plus or minus .002". Made to your specifications or engineered for YOU.

SEND FOR ARBOR LIST OF OVER 1000 SIZES

Insulated Perimeters from .392" to 19.0"

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**LET BOWSER MEET YOUR TEST SPECS**

Bowser Chambers for testing equipment under simulated environmental conditions meet all Government test specifications. Standard Bowser Units, for example, will perform the tests for High and Low Temperature, Humidity, High Altitude, Mildew Resistance, Sand and Dust, and Explosion Proof tests as required in USAF Spec. No. 41065-B. Special Bowser Units are available to meet other specs such as those set up by A.S.T.M., A.P.I., A.S.A. etc.

Send your testing problems to us. Mail the coupon below NOW!

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**NEW PRODUCTS (continued)**

- Microwave Test Equipment. Polytectnic 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. Glencol 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...
NEW EDUCATIONAL MAGNETIC AMPLIFIER
by VICKERS Inc.

for School and Industrial Laboratories

- A unit designed by Vickers Electric Division to help students and industrial personnel obtain a wider knowledge of the characteristics and applications of high-performance self-saturating magnetic amplifiers.
- All three basic single-phase self-saturating circuits may be studied, and the educational unit can actually be used in operating controls circuits. Gives d-c or a-c output, uses d-c or a-c control power.
- Magnetic Amplifier Laboratory Manuals and Magnetic Amplifier Design Bulletins included with each educational unit.

Write for information and price.

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NEW HIGHS IN
RESOLUTION

The Hathaway SC-16A Six Element Recording Cathode-Ray Oscillograph, designed for recording fast transients and continuous phenomena, brings you new highs in resolution because of its unusually high frequency response and high chart speed. Note these unusual features:

FREQUENCY RESPONSE 0 to 200,000 cycles per second  •  RECORDS up to 1000 ft. long at speeds up to 600 inches per second  •  RECORDS up to 10 ft. long at speeds up to 6000 inches per second  •  WRITING SPEED above 100,000 inches per second  •  SIX ELEMENTS with interchangeable lens stages for 1, 2, 3, or 6 traces on full width of chart  •  INTERCHANGEABLE RECORD MAGAZINES for continuous recording or short records of fast transients  •  PRECISION TIMING tuning fork controlled QUICK-CHANGE TRANSMISSION for 16 record speeds  •  AUTOMATIC INTENSITY CONTROL  •  CONTINUOUS SWEEP OSCILLATOR

Investigate the Hathaway SC-16A Recording Cathode-Ray Oscillograph
Write for Bulletin 261A-G

WIND more COILS faster

WITH YOUR PRESENT COIL-WINDING MACHINE!

- use PAMARCO Wire DeReeling Tensions for PERFECT COILS

Installation of these inexpensive PAMARCO tensions lowers winding costs because each machine will accommodate more coils at higher winding speeds. In addition to increased production, PAMARCO tensions raise production quality. Free-running action practically eliminates wire breakage and shorted turns. Simple thumb screw setting quickly adjusts for any wire gauge. No tools or special skill are needed for operation. For complete data call or write.

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ROSELLE, NEW JERSEY

RAW TEXT END
NEW PRODUCTS (continued)

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. Kanr 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 Utiloscope 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
**JOB-ENGINEERED**

**FAIRCHILD PRECISION POTENTIOMETERS**

Fairchild Type 748
3-Gang Precision Potentiometer

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 nonlinear functions can be approximated. For control purposes, each unit can be used as a continuously varying switch to fire tubes such as Thytrons in sequence.

To help you in analyzing your special applications, Fairchild offers you the services of its Potentiometer Sample Laboratory engineers. Write, giving complete details on your requirements, to Dept. O, 88-06 Van Wyck Boulevard, Jamaica, N. Y.

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**IN - RES - CO**

**WIRE WOUND RESISTORS**

meet all instrumentation needs

- **TOLERANCE TO ± 0.1%**
- **.01 OHM TO 1.0 MEGOHM**
- **HIGH OR LOW WATTAGE**
- **HERMETIC SEALED TYPES**
- **ALL TYPES OF MOUNTING**

INRESCO Resistors are offered in high-speed winding techniques that introduce a new measure of economy in precision wire wound resistors.

They are available for IMMEDIATE DELIVERY, in diversified types that meet practically every circuit requirement of load, ohmic value, size, shape, and operating condition.

When planning a new circuit design, investigate the advantage of INRESCO resistors for economy, dependability and permanently fixed characteristics. For complete details, call or write today for your copy of the INRESCO catalog.

Manufacturers and designs of wire wound resistors—exclusively. Estimates on custom built resistors furnished.

**INSTRUMENT RESISTORS COMPANY**

1036 COMMERCIAL AVENUE, UNION, NEW JERSEY
NEW PRODUCTS (continued)

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.

SOURCE: FOR HIGHLY SPECIALIZED APPLICATIONS

THE TRANSFORMER SOURCE IS SPERRY

Vacuum - impregnated, HIPERSIL core, open or cased transformers to meet exacting electrical requirements in any given case size. Special design skills, premium materials, painstaking manufacture of custom units. If you have a transformer problem, consult us immediately.

WRITE FOR SPECIFICATION FORMS TO FACILITATE NEGOTIATION SERVICE.

SPERRY PRODUCTS, INC. DANBURY, CONN.
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June, 1950 — ELECTRONICS
"Just tell them they CAN'T AFFORD TO USE ANYTHING ELSE . . ."

That's Joe Gibbons speaking. We were talking about how to make people realize what a terrific thing this new JELLIFF ALLOY 1000 RESISTANCE WIRE really is, and that's the way he summed it up. And even when you make allowances for a salesman's natural enthusiasm, he's pretty near right. Just look at some of the important data:

- Resistivity 1000 ohms/cm
- Tensile strength 165,000 psi
- TC of Resistance 20 ppm
- Coefficient of Expansion 13.9 ppm
- Corrosion Resistance equal to the best nickel-chromiums
- Winds fast and solders easily
- Lots more ohms in lots less space.

See what we mean? For the whole story, write for Bulletin 17.
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 set-screw 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
**New Low-Cost Marine Antenna FOR 2 AND 3 MC.**

Premax Series "B" Center Loaded Marine Radiators, will increase effective power 5 times over that radiated by straight whips. 2' base section. 18" coil and 72" whip -- 9½" overall. Will resonate at center of 2-3 Mc band. Comes with heavy ceramic insulator Mountings, complete. Write for special bulletin and amazingly low prices!

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**DIVISION CHISHOLM-RYDER CO., INC.**
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**Transformer Designers!**

**Save Materials and Space Reduce Weight Gain Flexibility, Efficiency**

*Use the NEW 11/2 Oriented Silicon Laminations*

You can reduce the stack—use less copper—because of higher permeability with fewer core loss in 11/2 oriented silicon laminations. Obtain greater transformer efficiency with the normal number of E & I's... or equal efficiency with fewer laminations. You gain production flexibility because you can use Thomas & Skinner's new oriented materials for either your standard E & I designs or for special applications.

Write today for bulletin giving curves and full data.

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**Working with Inert Gases?**

**Linde HELIUM • NEON ARGON • KRYPTON • XENON**

Now available in commercial-size cylinders in addition to glass bulbs. Write for information on sizes, prices, rigid purity tolerances, special rare gas mixtures...

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**New Improved H SNAP-INS**

AGAIN lead the way to cost-saving and better performance in your products

"Diamond H" Snap-Ins... toggle switches, convenience outlets, pilot lights and inter-connecting load plugs... have always been tops for performance and for cost-saving on users' assembly lines. Just snap them into their holes, spring clips hold them tight. Wire them up before or after.

**NOW...NEW IMPROVEMENTS MAKE THEM BETTER THAN EVER!**

- All... have wider face areas with wider flanges. Greater over-lap eliminates need for cramping tolerances in porcelain or other finishing around 2¾" x 1¾" installation holes.
- Switches... operate on principle new and exclusive in this application. In "on" position, contacts are held together under pressure of spring action to assure positive, unfailing action. Ratings: 15 and 20 A — 125 V.; 10 A — 250 V., A.C. also H.P. ratings.
- Pilots... with larger, faceted lenses, give greatest light output of any comparable pilots on the market. Rated 115 V. or 230 V., A.C.
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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.


Electronic Plotting Board. Electronic Associates, Inc., Long Branch, N. J., has issued a descriptive pamphlet on its model 205 Vari-
A quality Tube Guard that is Bargain Priced

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(Proceedings of previous conferences available upon request)
NEW PRODUCTS
(continued)

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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**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**

**Tuesday, June 13**
9:30 A.M. — Computers—Features of the INA and MADDIDA computers will be covered by several papers.
9:30 P.M. — Applications of Computers to Aircraft Engineering Problems (five papers).

**Wednesday, June 14**

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NEWS OF THE INDUSTRY (continued)

S. Sonkin of Stanford U. 
Protol 0 Linear Accelerators, by W. K. H. Panofsky at L. of Cali.
2:30 P.M. - Electronics Use of Reflection Doppler Techniques for Test Range Instrumentation, by M. Ivan of U. S. Naval Ordnance Test Station.
Application of Electronics to Test Range Instrumentation, by F. Ashbrook of U. S. N.T.S.
A Precision Timing System for Test Range Instrumentation, by T. Parkin of U. S. N.T.S.
Sound Ranging at the Morris Dam Torpedo Ranges, by R. N. Blackers of U. S. N.T.S.
Electrical Requirements for Firing Rockets by Induction, by J. P. McClellan of U. S. N.T.S.
Determination of the Composition of Surface Layers by Ion Scattering, by S. Rubin of Stanford Research Institute.

Thursday, June 15
Microwave Applications to Bonneville Power Administration System, by R. F. Atkins and T. W. Stringfield of Bonneville Power Administration.
Microwave Systems for 360 and 2,000 Megacycles, by R. V. Rector of GE and W. E. Butler of International GE Co.
Problems to be Solved in the Application of Microwave Equipment, by R. C. Cheek of Westinghouse Electric Corp.
3:00 P.M. - Instruments and Measurements
The Status and Applications of Microwave Spectroscopy, by W. D. Herbst of the U. of Calif.
3:00 P.M. - Conference on Carrier-Carrier High Frequency and Defective Audio Multiplexing Equipment with High-Stability Carrier Supply, by F. E. Fairs of Westinghouse Electric Corp.

Friday, June 16
9:30 A.M. - Symposium on the Pevatron Pulsed Particle Accelerators, by G. Purcell of U. of Calif.
9:30 A.M. - Substations
Automatic Control of Ignitor Emitter Stations, by F. J. Cham and W. A. Derr of Westinghouse Electric Corp.
System-Wide First Response Telemetering, by W. G. Thome of Southern California Public Service Co.
Use of Ultrasonic-Frequency Equipment for Supervisory Control and Telemetering, by L. F. Ludens of Southern California Edison Co. Ltd.
2:00 P.M. - Magnetic Amplifiers and Transformers
The Design of Broadband Transistor for Linear Electronic Circuits, by H. W. Lord of GE Research Laboratory.
Theory of the No-Loud Characteristics.
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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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 identify 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 instruction 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.

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.

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NEWS OF THE INDUSTRY (continued)

of Highly Saturable Reactors with Hysteresis, by A. Sanes, 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 Ignition Equipment for Particle Accelerators, by C. C. Herskind and J. E.
Hudson 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 quar-
ters at Pasadena, Calif., for the manufacture of electronic instruments
used in the earthquake
method of exploring subterranean formations.

HERMAN H. SMITH, INC., manufacturer of radio hardware, electronic components and television accessor-
ies, 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 oc-
cupying its new 20,000-sq-ft plant at
2435 No. Naomi St., Burbank,
Calif.

JOHN VOLTERT 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 pre-
sently produced for tv receivers.

RAYTHRONIC LABORATORIES, INC.,
Cincinnati, Ohio, has been formed
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 80 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 200 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 5 to 1 megahertz. 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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20 MC VIDEO AMPLIFIER
Model V

- Flat frequency response from 100 cps to 20 mc 1.5 db.
- Uniform time delay .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 md 470,000 ohms; Jack-30 mf 470,000 ohms; Outer Impedance 18 md 470,000 ohms each side push pull; Max. Input Volts 500 peak to peak with probe; Max. Output Volts 120 volts peak to peak, quick pull; Power: 15 volts 1500 cps AC Line; Side loss 0.2% at 1 hz.

NEWS OF THE INDUSTRY (continued)

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 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

- INPUT: 105 to 125 VAC, 50-60 cy
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Effective length, 59.6 feet; 38,000 turns; 11,000 scale divisions; accuracy ± (0.05% + 1 scale division)
FOR WIDE RANGE MEASUREMENT OF RESISTANCE, CAPACITANCE AND INDUCTANCE WITH 0.1% PRECISION

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For further information on Consolidated Systems and Oscillographs, send for Bulletin 1500-X13.

Consolidated System D, 8-channel amplifier system using self-generating or carrier-excited pickups, and a Consolidated Multi-channel recording oscillograph.
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OF COURSE NOT! Literally, their normal body temperature is 98.6—same as laborers, engineers or any other group of people. And, figuratively, they're no more, or no less, cold-blooded—as a group.

We all know unreasonable generalizations can be dangerously false. Common sense and on-the-job experience show us the value of dealing specifically with ideas, problems—and people.

Let's not make the big—and costly—mistake, then, of generalizing on religious or racial groups. Adopt and carry out these common sense principles:

1. Accept—or reject—people on their individual worth.

2. Don't listen to or spread rumors against a race or a religion.

3. Speak up, wherever we are, against prejudice. Work for understanding.

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ELECTRONICS — June, 1950
242 June, 1950

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   C. UHF, VHF and Microwave antenna design
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(4) Originality and inventive ability of major importance.

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(2) Electronic experience, commercial, hobby or military

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Information confidential. Address

DANIEL E. NOBLE
4545 Augusta Blvd. Chicago 51, Illinois

Electronics — June, 1950
PHYSICIST. Veteran. Over ten years' actual working experience (electronics, dielectrics, gas discharges, infra-red, naphthenic solvent-control, etc.) in teaching, experimental and research activities. Expertise in planning and completing projects and in directing personnel, also in discussing procurement of equipment 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 conducive to his abilities. Competent and reliable. Solid scholastic background. PW-6417, Electronics.

PHYSICIST, VETERAN. Over ten years' actual working experience (electronics, dielectrics, gas discharges, infra-red, naphthenic solvent-control, etc.) in teaching, experimental and research activities. Expertise in planning and completing projects and in directing personnel, also in discussing procurement of equipment 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 conducive to his abilities. Competent and reliable. Solid scholastic background. PW-6417, Electronics.

M.D.-BIOPHYSICIST, 39. Fully qualified internist plus a good background, including research experience, in electronics as applied to medicine and biology, biologic effects micro-waves and bioengineering. Can contribute biologic and clinical know-how to a team developing medical on biological electronic instrumentation. Qualified in industrial toxicology and chemistry, directs position in electronic industrial establishment where background with useful in research program and in industrial medicine. PW-6195, Electronics.


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| Mount 3 | Steel 2000 lb. New | $125.00 |
| Mount 4 | Steel 2000 lb. New | $125.00 |

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| Accessory 3 | Headset complete, $25.00. | $25.00 |

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5069370, Delco, 27 V., 10,000 r.p.m. Price $6.00 each net.

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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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37 EAST BAYVIEW AVE., GREAT NECK, N. Y.

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June, 1950 — ELECTRONICS
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INVERTERS
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21117, Pioneer. Input 12 V.D.C. Output 26 V., 400 cycle, 6 V.A. Price $22.50 each net.

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RECTIFIER POWER SUPPLY
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" with depth 17¼". Price $200.00 each net. New.

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AY131D, new with calibration curve. Price $35.00 each net.
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Weston Voltmeter. Model 833, 0 to 130 volts, 400 cycle, Price $4.00 each net.
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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.
Weston Ammeter. Type F1, Dwg. No. 116465, 0 to 150 amps. D. C. With ext. shunt $9.00 each net.
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J36A, Eastern Air Devices, 02 V. per r.p.m. Price $9.00 each net.
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5G Generator 115 volts, 60 cycle. Price $30.00 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.
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SEARCHLIGHT SECTION

ELECTRONICS — June, 1950 251
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All New Perfect Standard Brands

In Large Quantities Only

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5,000 Tubes 9001 at .45
5,000 Tubes 9002 at .29
5,000 Tubes 903 at .45
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100 Magnetrons 4J38 $5.50
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NEW YORK'S RADIO TUBE EXCHANGE

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Microwave K Band 24000 MC.
TSK-1SE Spectrum Analyser
K Band Flap Attenuator

X Band
TSX-4SE Spectrum Analyser
TS 12 Unit 1 USWR Measuring Amplifier
Amplifier, 2 channel
TS 12 Unit 2 Plumbing for above TS13

X band Pulsed Signal Generator
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Electromotive
TS 33 X Band Power and Frequency
Meter
TS 35 X Band Pulsed Signal Generator
TS 26 X Band Power Meter
TS 45 X Band Signal Generator
TS 146 X Band Signal Generator
TS 262 Navy Version of TS 146
X Band Magic T Plumbing
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TVN-8SE MIT Klystron pulse and power
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TS185 S Band Signal Generator
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Meter

RF 4 Electrically Tuned S Band Echo
Box
5C 1277/60ABQ S Band Pulsed Signal
Generator
PE 102 High Power S Band Signal Gen-
erator

L Band
Harlaxine 1030 Signal Generator
145 to 235 Megacycles
TS 53, 300 to 1000 MC Frequency Meter
Measurements Corp. type 84 Standard
Signal Generator
TS 47, 40 to 100 MC Signal Generator

Broadcast Wave Bands
162C Rider Chornalist
Short Wave Adaptor for 162C
Ferris 22A, Signal Generator

Oscilloscopes
BC 1287/A used in LZ sets
TS 34 Oscilloscopes WE
Supreme 564
Conor: two-beam scope

Audio Frequencies
RCA Audio Chornalist
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Other test Equipment and Meters
TS 15/A Magnet Flux Meter
General Radio V T Voltmeter 728A
Calibrator WE 1-147
Hozeline Pulse & Sweep Generator
UHF Radio Noise & Field Strength Meter
Measurements Corp type 58
General Radio 1000 cycles type 213
Limit Bridges
Boonton Standard Inductances
Western Meters types 450, 429, 741
Model 40 Pyrometer
Rawson, meters 0.10 Micrometer
0.5 Millivolt

Motor Generator type MG 215
Made by Ozon & Sons
Input 110 Volt 120 Cycles, 1500 Watt
Output 115 Volt 480 Cycles and 20 Volt
DC.
Will operate any airborne Radar from
110 Volt 60 Cycle Line

Radar Sets & Parts
APS 3
APS 4
SCR 284
R/111/APRMA Receivers

June, 1950 — Electronics
## Reliance Specials

### Capacitors

<table>
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<th>Type</th>
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<td>MFD 100V</td>
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<td>MFD 500V</td>
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### Oil Filled

| MFD 1000V | $3.75        |
| MFD 1500V | $5.00        |
| MFD 2000V | $6.25        |
| MFD 2500V | $7.50        |
| MFD 3000V | $8.75        |

### WW Precision Resistors, 1% or Better

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<td>50 W</td>
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### 2J Specials

- 115 V, 60 Cyl. USED $3.50
- 370 MFD @ 630 $1.00
- 1000 MFD @ 630 $2.50

### Differential

<table>
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### Price Schedule

- MFD 0.22 $0.01
- MFD 0.22 $0.02

### Transformer

- 220 V, 60 CYL. $10.00
- 220 V, 60 CYL. $15.00

### Coaxial Cable

- RG 8/U $55.00 per 1000 ft.

###在未来，我们计划增加以下功能：

- 更大的字体和更清晰的视觉效果
- 用于视觉障碍者的概述
- 为不同类型的读者提供的选项，如学生、专业人士等

值得一提的是，我们正在使用最先进的技术来确保这些变化的实施，以适应更广泛的用户群体。
OUTSTANDING VALUES NOW AVAILABLE

- AMPLIFIERS
- COILS
- AN CONNECTORS
- CABLES
- CAPACITORS
- FUSES
- CIRCUIT-BREAKERS
- COAX-CONNECTORS
- INVERTERS
- JACKS
- KLYSTRONS
- KNOWS
- FILTERS
- HANDSETS
- METERS
- MOTORS
- POTENTIOMETERS
- POWER PLANTS
- POWER SUPPLIES
- PROJECTOR LAMPS
- RECORDERS
- RESISTORS
- SELSYNS
- SCOPE ACCES.
- SHOCK MOUNTS
- SOCKETS
- SWITCHES
- TELEPHONE EQUIP.
- TEST EQUIPMENT
- TRANSFORMERS
- TRANSMITTERS
- TUBES
- WIREGUDE
- WAVEGUIDES
- WAVEMETERS

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.

Send for our monthly packed flyer. Your requirements for immediate quotation will receive a prompt reply.

REMEMBER—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.

OCEANSIDE BROADCASTS! 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!

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PHONE DIGBY 9-0347
WHITE FOR QUANTITY PRICES
Prices Subject to Change Without Notice
All Merchandise Guaranteed
F.O.B. N.Y.C.

June, 1950 — ELECTRONICS
PEAK ELECTRONICS CO.
188 Washington St., New York 7, N. Y.

OIL CONDENSERS

Cru 12
mfd
440 vac
-6.95
10 mfd 2000 vac
-6.95
4 mfd 600 vac
-6.95
3 mfd 600 vac
-5.95
1 mfd 400 vac
-4.95
1 mfd 200 vac
-4.95
.1 mfd 200 vac
-0.95
.05 mfd 200 vac
-0.95
.025 mfd 200 vac
-0.49
.01 mfd 200 vac
-0.49
.005 mfd 200 vac
-0.49
.0025 mfd 200 vac
-0.49
.001 mfd 200 vac
-0.49

HIGH VOLTAGE VACUUM CONDENSER

12 MFD 32 KV EIMAC VC-12-32...4.95

FILAMENT TRANSFORMERS

110 V 60 CY Pri.
Casad...$2.75
110 15 Volt...3.15
110 Volt CT...$3.45
20 Volt CT...$4.75
20 Volt CT...$1.45
20 Volt CT...$2.54
20 Volt CT...$2.47

HEAVY DUTY RHEOSTAT

15 Ohms, 675 Watts Max. with Knob and Hardware...$3.95
10 Ohm...$2.50

SILENT RELAY


PLUG IN CAPACITOR

8 x 8 Mfd 600 volts DC. Oil filled. Plugs into standard 4 prong socket. 5% x 3.5 x 1/4 x 5...$1.15

GENERAL ELECTRIC Type PBC Instantaneous Overcurrent Relay. Adjustable. No. 4 PDT, Electrical and Manual Reset. 4 PDT. Reset 110 volts 60 cycles...$7.50

BAKELITE CASED MICA

Mossman Switches

4 Pole Single Throw...$1.10
3 PDT, plus 6 PST...$.75

Heavy Duty Top-Switch

Glimite Model 412


Mallory Vacuum Transformers 6 Volt Input. Output 100 Volts at 100 M.A. $2.55 ea.
**Searchlight Section**

**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.

<table>
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**Searchlight Section**

**Just Out — Catalog H500**

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. 5, Chicago 10, Ill.

June, 1950 — Electronics
BROWN TELEPLOTTER RECEIVER
Model 791X1R
115 volt 60 cycles
Contains a pen driven by two balancing motors which writes on a roll of translucent chart. Pen arm position is in terms of two coordinates supplied to plotting motors thru two amplifiers. Originally intended for recording plotted or written data from electronic or analog instruments. Written at one half scale on 18 in. chart. Discriminator circuit designed to operate unit as function of two varying R.F. frequencies varying about mean of approx. 420 Kc. Further data on request. (Shipping weight 435 lbs.)
Price $375.00

MICROWAVE ANTENNA
Price $80.05 ea.

INVERTER SPECIALS 400 Cycles
Pioneer Type 12101-B, 25 volts D-C, input 24 volts 160 cycles 1 phase output 8.0 V.A. (Current- no load) Prices on Request.

AC-SERVO MOTORS

PIONEER CK-17

FORD SERVO MOTOR
115 volt 60 cycle two phase low inertia motor. 16 watts output. Stock ZSA-239. Price $12.50 each.

MINNEAPOLIS-HONEYWELL

SAWTOOTH POTENTIOMETER
W.E. KS-1513B

SPECIALS

400 Cycle Generators

MOTOR SPECIALS


G.E. 5PS66HC14 - Split field reversible motor. 60 v. d-c at 1.4 am. 550 rpm. 2" diam. x 3" lg. Ideal for servo applications. Stock ZSA-217. Price $8.15 each.

OSTER PM MOTOR
Alnor Field
27.5 v. d-c. Can also be used as rate generator. Price $2.75 each.

Gyro and Housing Mirror Assembly For L K-11A sighting head. Gyro stabilized mirror assembly Stock ZSA-231. Price $80.75 each.

AC-SERVO MOTORS


PIONEER CK-17

FORD SERVO MOTOR
115 volt 60 cycle two phase low inertia motor. 16 watts output. Stock ZSA-239. Price $12.50 each.

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OSTER PM MOTOR
Alnor Field
27.5 v. d-c. Can also be used as rate generator. Price $2.75 each.

Gyro and Housing Mirror Assembly For L K-11A sighting head. Gyro stabilized mirror assembly Stock ZSA-231. Price $80.75 each.
THERMOSTATIC TIME DELAY RELAY

Apparatus (Type 115 No.—II) House voltage 115V. Normally open SPDT contacts, 15 second opening time after reaching 110V to 120V. A.C. (for 60V, A.C. 2A) max. voltage on contacts 650V, max. current 10 Amps. and heater—1000. Size 3 9/32 x 1 1/4" overall. Made for U. S. Navy...

High Voltage Capacitors—Oil Filled

25 MFD, 20KV...

All brand new. Made by prominent manufacturers.

TUBE SPECIALS

$5.50

Brand New

LINER SAWTOOTH POTENTIOMETER

No. KS 15138

Has continuous resistance ranging to which AC with D.C. is fed to two fixed taps 10° apart. Two rotating heads 10° apart

Turn fine linear sawtooth wave voltage at current. Size approx. 3 1/2" x 3" deep x 2 1/2" high. E convenient alum frame with AC connection.

U. S. NAVY SOUND POWERED BATTLE PHONES

Western Electric type H-103S. Type C, Continuous head set andalam set. Brand new including 20 ft. of covered cable...

$17.50

Automatic Echo Co. No. QEC-15151.

Similar set, but including Throat microphone in addition to head set. Brand new with 20 ft. rubber covered cable...

SYNCHRO GENERATORS

Brand new—Geot. sealed and tampered.. Pulsed for accurates.

Synchro Transmitters—115V, 200, 400, 500, etc. 2.5KVA answer for all special purposes.

90°/90 volts, 400 cycles. Brand new in sealed containers. Ford Co. type SIRIG. Brand new...

$12.50

Differential Synchros

115° x 605°...

MICROWAVE RECEIVERS

APR-1, APR-2, APR-5A.

Tuning Units for APR-1 to APR-1 in 15-1895 mc. Ty. 15-2895 (1200 and AN-10000 mc.) These units may be used with any 30 mc. 1f amplifier or as converters into power lines tuned to 30 mc.

MODEL AN/APA-10

PANORAMIC ADAPTER

Provides 4 Types of Presentation:

(1) Panoramis (2) Aural

(3) Oscillographic (4) Oscilloscope

Designed for use with monitoring equipment, AN/AAR-5, AN/AAR-4, AN/SLX-7 or any of 455 kHz. Eveson, etc. Brand new with 31 tubes including 3" scope tube. Converted for operation on 115V, 60 cycle, complete includes 80 page T. M. $195.00

LINE VOLTAGE STABILIZERS

RAYTHEON—Type CHP, 

$14.00


SCOPE PL & FIL.

WECO.

$10.00

400/2400 volt, 45°. New $195.00, 300/3000 volt, 45°. New $295.00...

PLATE & FIL.

$29.50

400/2400 volt, 3050/6000 volt, 45°. New $195.00, 300/3000 volt, 3050/6000 volt, 45°. New $295.00...

$195.00

Motor Generators

DYNAMOMETERS, INVERTERS, ETC.

2.5 KVA MG SET. Dilex Elec. Co. 100V, 500V. 115V. 200V, 400V. 500V. Complete with Magnetic Controller, 2 Field Rotor and Full Set of Shale Parts, including Armature for Generator and Motor

$185.00

2 KVA MG SET. Onwee and Merriot. 125V DC to 115V AC. 50 cycles. Idem at 200V, 50 cycle. New. Export crated. $165.00

1 1/2 KVA MG SET. Allis-Chalmers.

115V DC to 120V AC. 50 cycle. Thru. 200V, 60 cycle. Fully enclosed. Splashproof. Ball Bearings. Centrifugal:

$127.50

Same machine but for 230V DC operation...

$119.00

$15.00

MESS FOR NAVY TBS TRANSMITTER

Type 150 A, 400 A, 500 A, 600 A, 750 A, 1500 A, 2000 A, and 3000 A.

New...

$45.00

$45.00

DYNAMOMETER. New Type CAPO 111444. 500V DC. 1000V DC at 115V. Radio filtered. Complete with Line 300. New...

$69.50

DYNAMOMETER. Eveson 25V DC to 75V AC. 50 cycle. New...

$29.50

DYNAMOMETER. Eveson 25V DC to 105V AC. 60 cycle. 1/8 453 Amps. New...

$17.50

MICROSCOPES SMALL MOTORS

INVERTERS, AMPLIFIED

AMPLIFIED—D. E. Model SAMIPEHA. 600 Volts 10000. Input: 25V. IAL, Output: 4000 Volts 1000A. DC Weight: 23 lbs. New...

$16.00


$10.00


$12.50

INVERTER—G. E. Model 30-2. NEW. Input: 25V DC. Output: 1100V. 40 A. New...

$12.00

INVERTER—G. E. Model 30-2. NEW. Input: 25V DC. Output: 1100V. 40 A. New...

$12.00

D. C. MOTOR—G. E. Model 500A. 300 A. 690. 3 HP. 35 RPM. Armature: 25V at 8.5 Amps. Field: 600. 45 A. New...

$12.50

DYNAMOMETER—Type E06FIC. For use with SCME222 Transmitter—Receiver. Brand new...

$9.50

$49.50

$69.50
MEASUREMENTS CORP. TEST EQUIPMENT
1020 Portable battery operated test
transmitter and receiver: Used for
motor and drive mechanism, precision
250, 25-42, 115V. $125.00

FERRIS TEST EQUIP. 100 Elo-1051 VHF
50$ 1069, 10$ in stock. $65.00
50. 75, 150 MC, 180-250 MC, 300-500
55$0.00

BC-520 Portable battery operated freq.
50$ 150, 10$ in stock. $65.00

TC-500 Test set for SCR
50$ 150, 10$ in stock. $65.00

TUBE TESTERS 465 (TS-200U) De-
50$ 150, 10$ in stock. $65.00

VARIOUS VOLTS

Handie-Talkies

HB-49 Test set for SCR-522, ABC-3,
50$ 150, 10$ in stock. $65.00

BC-II-F also available.

BE-721 and Mount FT-295. same size as
50$ 150, 10$ in stock. $65.00

BC-100 A portable type for automatic
50$ 150, 10$ in stock. $65.00

orders promptly filled. Prices for
50$ 150, 10$ in stock. $65.00

DEVICES

1073 WAVE METER Pwr. supply section.
50$ 150, 10$ in stock. $65.00

1050 VACUUM TUBE TROUBLESHOOTER.
50$ 150, 10$ in stock. $65.00

1090-TROUBLESHOOTER.
50$ 150, 10$ in stock. $65.00

Write for new catalog. Foreign inquiries invited.

THE LARGEST FIRM OF ITS TYPE IN THE WORLD

RADIO & ELECTRONICS SUPPLY

2033 West Venice Blvd.
Los Angeles 6, Calif.
Dept. E-3

June, 1950 — ELECTRONICS
TOP VALUES at BEST PRICES!

TUBES

Dramatically Reduced from 10 to 50%—Nationally Advertised Brands

BEAM INDICATORS

9085 $1.55 9097 $4.95 9460 $6.70

WRITE FOR QUANTITY PRICES

BEAM INDICATOR

Information and Prices on Request

Miscellaneous SPECIALS

BC-605 Interphone Amplifier

Easily converted to an ideal intercommunication set for office—home—office. Original—New $4.95.

New April 1950 Radio News for complete conversion data.

New

$12.95

BC-604 Transmitter FM 20-28 MC

11 and 15 meters can be operated on 10 meters (18 channel) push button crystal tubes and meter but less dynamic.

New

$35.40

COMMAND (SCR 274 N) EQUIPMENT

New

$12.95

DYNAMOTORS

DM-29—For BC-606 with Mount and Filter

New

$6.95

Used

$3.50

DY-12—For ART-11 Less Filter and Base

New

$6.95

Used

$2.50

DI-36

New

$4.50

Used

$2.50

BD-77

New

$5.50

Used

$2.50

PB-206

New

$6.50

Used

$3.50

PB-101

New

$7.50

Used

$3.50

PB-73

New

$5.50

Used

$3.50

DT-32

New

$5.50

Used

$3.50

TEN TUBE SUPERHERETIC RECEIVER

with crystal controlled local oscillator. Has provisions for six crystal channels between 108 to 115 MCPS complete with tubes and crystals but less dynamometer.

New

$7.95

Used

$5.00

Less Tubes and dynamometer but new 3.05

HERMETICALLY SEALED CHOKES

101. 190 M.A. $5.95

3.7. 115 M.A. $5.95

50 H. 100 M.A. $9.50

10 H. 25 M.A. $9.50

145 h-4 winding layer wound. 5 h at $5 A 110 ohms

$80.40

CONDENSERS

Send for Price List—Illustrated BULLETIN No. 103

$1.95

$3.25

1.05

$1.00

$1.19

All shipments FOB Chicago. 2% Deposit required on all orders. MC3, CO本貨款寄付時、$5.00. Illinois residents please add regular sales tax to your remittance.

ARROW SALES, Inc.

1712-14 S. Michigan Ave., Chicago 16, Ill.

PHONE Harrison 7-9734

ELECTRONICS—June, 1950
WANTED RESISTORS and POTENTIOMETERS
single J—dual JJ—triple JJJ
made by ALLEN BRADLEY CO.
any wattage
any ohmage
any tolerance
WE PAY HIGHEST PRICES

Resistors Other Makes Are Acceptable Too:

LEGRI S CO., INC.
130 West 102 St., New York, N. Y.
Phone: AC adeny 2-0018

WANTED
INSULATORS; POLE LINE HARDWARE;
GYR STRAND WIRE; COPPERWELD WIRE;
WESTERN ELECTRIC TOOLS; SPLICING
SLEEVES.
VICTOR-BERNARD INDUSTRIES
NE Cor. 22nd & Lehigh Aves., Phila. 32, Pa.

WANTED TO BUY
PRIVATE LABORATORY Wishes To Pur-
chase For Its Own Use High Grade Test
Equipment and Basic Radio Components.
Replies Held In Confidence.
W-6905, Electronics
320 West 42nd St., New York 18, N. Y.

WANTED
RESISTORS
and POTENTIOMETERS
single J—dual JJ—triple JJJ
made by ALLEN BRADLEY CO.
any wattage
any ohmage
any tolerance
WE PAY HIGHEST PRICES

Resistors Other Makes Are Acceptable Too:

LEGRI S CO., INC.
130 West 102 St., New York, N. Y.
Phone: AC adeny 2-0018

Highest Prices Paid
for manufacturers' over-runs and closeouts of electronic parts.

RAND RADIO CORPORATION
84 Courtlandt Street
New York 7, New York
Telephone: Co 7-7368

WANTED
RADIO TRANSMITTERS
1 to 3 KW
2 to 16 Mc
Also, modulators and rectifiers for same.
Reply:
W-6618, Electronics
320 W. 42nd St., New York 18, N. Y.

WANTED
Teletypewriters complete, components or parts. Any quantity and condition.
W-6664, Electronics
320 West 42nd Street, New York 18, N. Y.

WANTED
WESTERN ELECTRIC VACUUM TUBES
Ballast Lamps.
W-6641, Electronics
320 W. 42nd St., New York 18, N. Y.

WANTED
TEST EQUIPMENT
state asking price, age and condition in first letter.
W-1150, Electronics
330 W. 42nd St., New York 18, N. Y.

WILL BUY ALL
BC-348'S WITH DYNAMOTORS
Letters "T," "N" & "O" .... $50.00 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 manufac-
turers' surplus tubes and equipment.
Highest prices paid. State quantity, condition and best price in first letter.
W-2369, Electronics
330 W. 42nd St., New York 18, N. Y.
1100-A
FOUR TRANSMITTERS IN ONE
Can be present on 4 bands. Has R.F. or external 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 in 8L6 into 3467's in parallel. 125 watts on phone and 125 watts on cw. Modulator has 4685 in push-pull parallel. Rf is telephone dial on need to select. 4 transmitters, selecting phone. Cw, tuning between or plate current, or turning everything out. Also has remote control. $225.00 unit for remote operation. Used, but in excellent condition. With remote.

SCR 528 FM RECEIVER & XMT/R. Complete with 20 kits for operation in the 20-27.5 mcs. Powered by 12 or 24 VDC, with crystals, dynamos, hams, mix, headset, must base and section. Used but excellent.

APS-4 RADAR: Complete. Excellent Condition.

APS-4 COMPONENTS: Indicators, control boxes, junction boxes, 900-1C inverters, amplifier boxes, cords and plugs.

VARICIA TRANSTAT AMERTRAN
Input 0-115 V., 50-60 cycle; output 115 V 100 amps. 115 V Rca. Excellent 750.00

COLUMBIA ELECTRONICS Ltd.
524 S. San Pedro St., Los Angeles 13, Cal. cable address: COLECT.

ATTENTION! TV Schools Studios Experimenter TELEVISION CAMERA

ELECTRO IMPULSE LABORATORY
P. O. Box 250 Eaton town 3-0768 Red Bank, N. J.

X BAND SPECTRUM ANALYZER $500.00 Mc, calibrated attenuator, calibrated frequency meter, tuned meters, 41 steps, 2 video slots, overall gain 125 db, regulated power supply.

S BAND SPECTRUM ANALYZER 2700-3000 Mc, simulations, and power. The above Spectrum Analyzer also available with 8 and X band tuning.

K BAND TEST LOAD $200.00

X BAND POWER, Frequency and SWR Measuring Equipment complete with R.F. source V.S.W.R. equipment.

COMPLETE CUT-OFF WAVE GUIDE ATTENUATOR, with calibrated dial, tube X input connector, output connector to "Y" 1/2 waveguide. $35.00

1PAR-1 RADAR SEARCH RECEIVER, 30 mc F.E., B. Band 2 A

TUNING UNITS FOR APR-1 or APR-4 RECEIVERS can be used with any 20 mc amplifier $40.00

TX 54, range 1000-2000 mc, tuned mixer cavity $120.00

TX 5L, range 2000-6000 mc, tuned mixer cavity $200.00

50 MC I. F. STRIP AND 119 VOLT 60 cps POWER SUPPLY, complete with 10 mc, complete new set of APR-1 Receiver. $65.00

TS-15A/AP-11 SIGNAL GENERATOR, 2000-6000 mc, 110 V., 60-000 cps $50.00

TS-15A/UP S BAND SIGNAL GENERATOR, complete, calibrated output, 110 V., 69, NEW $50.00

TS-56/AP SLOTTED LINE, 12 feet length 1/2" tuned waveguide $100.00

TS-15/AP X BAND SIGNAL GENERATOR, complete, calibrated output, 110 V., 69, NEW $750.00

TS-13/AP X BAND SIGNAL GENERATOR, complete, calibrated output, 110 V., 69, NEW $50.00

X BAND VSWR TEST SET TS-2AP, complete with linear attenuator, driven VSWR meter, dials, 300-2000 Mc, calibrated with 3-2000 Mc, complete, new $125.00

S BAND SIGNAL GENERATOR CAVITY WITH CUT-OFF ATTENUATOR, 2100-2100 Mc, 1/2" tube with matching chasis $300.00

HIGH PASS FILTER F-29/SPR-2, cut off at 1000 m and lower, used for receivers above 1800 Mc $10.00

UPJ-1, S BAND BEACON RECEIVER, trans. $75.00

S BAND TEST LOAD TPS-355/11, 70 ohms $8.00

X BAND TEST LOAD 50 WATTS, 2000 Mc $35.00

250 WATT X BAND TEST LOAD, VSWR less than 1.5 between 1-1000 Mc $150.00

LAF-1 SIGNAL GENERATOR, 100-600 Mc, crop modulation, calibrated output, and 60-800 Mc, $100.00

GENERAL RADIO PRECISION WAVE METER TYPE RAD-10, 18 to 50 Mc, 0.25% accuracy, V.T.V.M. resistance-induction, calibrated with meter, & meter case, NEW $125.00

GENERAL RADIO SIGNAL GENERATOR 605-B, good working order $300.00

GENERAL RADIO VACUUM TUBE BRIDGE Model 565 $275.00

FEDERAL RADIO 605-C, 3 to 50 mc, $85.00

HEWLETT-PACKARD AUDIO SIGNAL GENERATOR 205A $225.00

S BAND CRYSTAL MIXER (illustrated), Variable, specified as "a" crystal mixer, 100 Mc, $20.00

S BAND MIXER, tunable by means of slider, type X monostar for the I.F. and local oscillator input, U.F. connector for the I.F. output. $105.00

FIXED ATTENUATOR 20 db + 0 to 2 db, 50-0000 Mc, 30 W. $65.00

WAVEGUIDE BELOW CUT-OFF ATTENUATOR, similar to above except frequency input is 3000 Mc $30.00

WAVEGUIDE BELOW CUT-OFF ATTENUATOR same as above except frequency input is 2000-2500 Mc $300.00

PULSE TRANSFORMER, 112 AWP $50.00

PULSE TRANSFORMER, 112 AWP, $65.00

TS-10/AP CALIBRATED DELAY FOR APR-1 $125.00

TS-203/AP CALIBRATED DELAY $150.00

50-100 Mc, 2C4s complete $105.00

TUN-JEV THERMISTOR BRIDGE $65.00

S BAND THERMISTOR BRIDGE CU-60 ABU. Part of 1st Radar. Used, but in good working order, complete with antenna, etc $175.00

FERRIS MODEL 22A SIGNAL GENERATOR, 50 to 25 Mc, trans. 0.25% accuracy, regulated output, good working condition, $175.00

FERRIS MODEL 100 SIGNAL GENERATOR, 50 to 15 Mc, calibrated output, good working condition, $105.00

STANDARD SIGNAL GENERATOR MEASUREMENTS (O.D.) 100 to 200 Mc, 0.000001 volts, good working order $40.00

50-60 Mc, wide band $5.00

50-60 Mc, wide band $10.00

50-60 Mc, wide band $25.00

SP-3 SHIPBOARD RADAR, New and complete with test equipment $1050.00

S SIGNAL RADAR, used but in good working order, complete with antennas, complete $650.00

SN SIGNAL, used, good working order, complete $550.00

HYPERSI CORE COHRE, 1 Home, Westinghouse 122011 or 122202. $3.00

PULSE FORMING NETWORK, 90 kc. 30 microsecond, 50 ohms, 100 p.s. $140.00

SEARCHLIGHT SECTION
BRAND NEW U.S. GOVT. SURPLUS GUARANTEED

SEARCHLIGHT 23

10 100 6 5 80 75 150 50 50 25 3 12

POWER RHEOSTATS

Checks with 0-100 Ohm (or more) scale is required.

Mfd VDCW Each

100 100 100 100

100 100 100 100

3 5 7 9

8 10 12 15

14 16 20 25

28 35 40 50

60 80 100 150

200 300 400 500

125 125 125 125

500 750 1000 2500

1500 2000 2500 5000

AT

50 25 225 100 500 2500 3500 7500

14

11 1 2

1.0-.1

0.2-.2

1.36

0.28

.0015

.001

.0013

.00025

.00005

.00003

.0001

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.00001

RHEOSTATS

50

100

200

400

800

1600

3200

6400

12,800

25,600

51,200

102,400

204,800

409,600

819,200

16,384

32,768

65,536

131,072

262,144

524,288

1,048,576

2,097,152

4,194,304

8,388,608

16,777,216

33,554,432


Select SURPLUS ELECTRONIC Equipment

AIRCRAFT RADIO TRANSCEIVERS

Type BC-373 F

100 watt output. Frequency range 200-500 and 1500-13kc., complete, new, with all tuning units, dyanmator, tubes, plugs, etc. Brand new original packing. Not removed from aircraft. Original cost $2180.

$975.00 ea.

Navy Model TDF Radio Transmitters

Frequency range 300 to 18,000 kc., 125 watt output on C, W., 25 watts on phone, for operation from 1500-13kc. D.C. power supply, complete with tubes and ready for operation. Our information indicates that these units cost the F. S. Navy $8000 ea. We offer them to you at a mere fraction of the original price.

$675.00 ea.

Rayovac Corporation

Telegraph Transmitter Model ET-5023 D1

Power output 300 watts master-oscillator or crystal controlled in operation. Frequency range 2,500 to 24,000 kc, in nine overlapping bands. New, in original export packing. Complete with tubes and typewriter cable. Does not include motor-generator power supply.

$375.00 ea.

Generating Plants Type PE-197, 5 KW

Gasoline-engine driven. 120 volts, 60 cycles AC, manufactured by Robert with Mercury 4-cylinder engine, water cooled, including battery, set of tools, automatic starting.

$675.00 ea.

Navy Model TCS Transmitters- Receivers

Covering L to 12 mc. 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.

Attention Foreign Buyers We have RC52F TRANSMITTERS

Completely rebuilt and guaranteed, priced at $1250.00. This fine unit is suitable for international CW and phone transmitters, traffic control and general commercial use.

WESTON LABORATORIES

WESTON 93, MASS.

RCA ELECTRICAL CONSUMERS ARMY FOR SALE

Two type WF98A and WF98A Complete with all accessories.

Springfield Machinery Exchange

20 Belle St.

Springfield, Mass.

Select SURPLUS ELECTRONIC Equipment

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WESTON LABORATORIES

WESTON 93, MASS.

RCA ELECTRICAL CONSUMERS ARMY FOR SALE

Two type WF98A and WF98A Complete with all accessories.

Springfield Machinery Exchange

20 Belle St.

Springfield, Mass.
IF YOU OPERATE ANY WESTERN ELECTRIC TRANSMITTER

We have SPARE METERS from the discontinued Western Electric Transmitter program. If you own or operate any of these units and need spare meters, now is your chance to stock up on them, at only a small fraction of replacement costs. These are scarce items and you won't have another opportunity like it! ACT NOW! LIMITED QUANTITIES! STOCK UP!

All units are 7½" Round. Surface mounting Switchboard Meters, with Black scales.

GENERAL ELECTRIC METERS DC & RF model DR-2, AC model AR-2

<table>
<thead>
<tr>
<th>RANGE</th>
<th>SCALE</th>
<th>CAPTION</th>
<th>NOTES</th>
<th>W.E.</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Amp D.C.</td>
<td>0-6</td>
<td>&quot;Amperes DC Total Plate&quot;</td>
<td>Self contained</td>
<td>15765</td>
<td>17.50</td>
</tr>
<tr>
<td>1 Amp D.C.</td>
<td>0-6</td>
<td>&quot;Amperes DC K.W. Plate&quot;</td>
<td>Self contained</td>
<td>15765</td>
<td>17.50</td>
</tr>
<tr>
<td>2 Amp D.C.</td>
<td>0-6</td>
<td>&quot;Volts RF Transmission Line&quot;</td>
<td>Self contained</td>
<td>15765</td>
<td>17.50</td>
</tr>
<tr>
<td>3 Amp D.C.</td>
<td>0-6</td>
<td>&quot;Amperes RF Antenna&quot;</td>
<td>With internal vacuum coupling</td>
<td>8305</td>
<td>17.50</td>
</tr>
<tr>
<td>4 Amp D.C.</td>
<td>0-6</td>
<td>&quot;Amperes RF Transmission Line&quot;</td>
<td>Less Thermocouple</td>
<td>8305</td>
<td>17.50</td>
</tr>
<tr>
<td>5 Amp D.C.</td>
<td>0-6</td>
<td>&quot;Amperes RF Antenna&quot;</td>
<td>With external thermocouple</td>
<td>8312</td>
<td>27.50</td>
</tr>
<tr>
<td>6 Amp D.C.</td>
<td>0-6</td>
<td>&quot;Amperes RF Antenna&quot;</td>
<td>With external coupling</td>
<td>8312</td>
<td>27.50</td>
</tr>
<tr>
<td>7 Amp D.C.</td>
<td>0-6</td>
<td>&quot;Kilowatts RF Output&quot;</td>
<td>1 MA, with tubular multiplier</td>
<td>13606</td>
<td>25.00</td>
</tr>
<tr>
<td>8 Amp D.C.</td>
<td>0-6</td>
<td>&quot;Kilowatts RF Output&quot;</td>
<td>1 MA, with tubular multiplier</td>
<td>13638</td>
<td>50.00</td>
</tr>
<tr>
<td>9 Amp D.C.</td>
<td>0-6</td>
<td>&quot;Kilowatts RF Output&quot;</td>
<td>1 TA, with tubular multiplier</td>
<td>13675</td>
<td>75.00</td>
</tr>
<tr>
<td>10 Amp D.C.</td>
<td>0-6</td>
<td>&quot;Kilowatts RF Output&quot;</td>
<td></td>
<td>13744</td>
<td>17.50</td>
</tr>
<tr>
<td>15 Amp D.C.</td>
<td>0-10</td>
<td>Self contained</td>
<td></td>
<td>13756</td>
<td>50.00</td>
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<tr>
<td>20 Amp D.C.</td>
<td>0-15</td>
<td>Self contained</td>
<td></td>
<td>13763</td>
<td>75.00</td>
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<tr>
<td>25 Amp D.C.</td>
<td>0-20</td>
<td>Self contained</td>
<td></td>
<td>13763</td>
<td>75.00</td>
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<tr>
<td>30 Amp D.C.</td>
<td>0-25</td>
<td>Self contained</td>
<td>With internal vacuum coupling</td>
<td>8305</td>
<td>17.50</td>
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<td>35 Amp D.C.</td>
<td>0-30</td>
<td>Self contained</td>
<td>Less Thermocouple</td>
<td>8305</td>
<td>17.50</td>
</tr>
<tr>
<td>40 Amp D.C.</td>
<td>0-35</td>
<td>Self contained</td>
<td>With external thermocouple</td>
<td>8312</td>
<td>27.50</td>
</tr>
<tr>
<td>45 Amp D.C.</td>
<td>0-40</td>
<td>Self contained</td>
<td>With external coupling</td>
<td>8312</td>
<td>27.50</td>
</tr>
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</table>

WESTON METERS DC & RF model 252, AC model 260

<table>
<thead>
<tr>
<th>RANGE</th>
<th>SCALE</th>
<th>CAPTION</th>
<th>NOTES</th>
<th>W.E.</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Amp D.C.</td>
<td>0-6</td>
<td>&quot;Amperes DC Total Plate&quot;</td>
<td>Self contained</td>
<td>15768</td>
<td>17.50</td>
</tr>
<tr>
<td>1 Amp D.C.</td>
<td>0-6</td>
<td>&quot;Amperes DC K.W. Plate&quot;</td>
<td>Self contained</td>
<td>15768</td>
<td>17.50</td>
</tr>
<tr>
<td>2 Amp D.C.</td>
<td>0-6</td>
<td>&quot;Volts RF Transmission Line&quot;</td>
<td>Self contained</td>
<td>15768</td>
<td>17.50</td>
</tr>
<tr>
<td>3 Amp D.C.</td>
<td>0-6</td>
<td>&quot;Amperes RF Antenna&quot;</td>
<td>With internal vacuum coupling</td>
<td>8305</td>
<td>17.50</td>
</tr>
<tr>
<td>4 Amp D.C.</td>
<td>0-6</td>
<td>&quot;Amperes RF Transmission Line&quot;</td>
<td>Less Thermocouple</td>
<td>8305</td>
<td>17.50</td>
</tr>
<tr>
<td>5 Amp D.C.</td>
<td>0-6</td>
<td>&quot;Amperes RF Antenna&quot;</td>
<td>With external thermocouple</td>
<td>8312</td>
<td>27.50</td>
</tr>
<tr>
<td>6 Amp D.C.</td>
<td>0-6</td>
<td>&quot;Amperes RF Antenna&quot;</td>
<td>With external coupling</td>
<td>8312</td>
<td>27.50</td>
</tr>
<tr>
<td>7 Amp D.C.</td>
<td>0-6</td>
<td>&quot;Kilowatts RF Output&quot;</td>
<td>1 MA, with tubular multiplier</td>
<td>13606</td>
<td>25.00</td>
</tr>
<tr>
<td>8 Amp D.C.</td>
<td>0-6</td>
<td>&quot;Kilowatts RF Output&quot;</td>
<td>1 MA, with tubular multiplier</td>
<td>13638</td>
<td>50.00</td>
</tr>
<tr>
<td>9 Amp D.C.</td>
<td>0-6</td>
<td>&quot;Kilowatts RF Output&quot;</td>
<td>1 TA, with tubular multiplier</td>
<td>13675</td>
<td>75.00</td>
</tr>
<tr>
<td>10 Amp D.C.</td>
<td>0-6</td>
<td>&quot;Kilowatts RF Output&quot;</td>
<td></td>
<td>13744</td>
<td>17.50</td>
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</tbody>
</table>

WESTINGHOUSE METERS DC & RF model SX, AC model SY

<table>
<thead>
<tr>
<th>RANGE</th>
<th>SCALE</th>
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<th>NOTES</th>
<th>W.E.</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 Amp D.C.</td>
<td>0-6</td>
<td>&quot;Amperes DC Total Plate&quot;</td>
<td>Self contained</td>
<td>15768</td>
<td>17.50</td>
</tr>
<tr>
<td>3 Amp D.C.</td>
<td>0-6</td>
<td>&quot;Amperes DC Total Plate&quot;</td>
<td>Self contained</td>
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<td>17.50</td>
</tr>
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<td>4 Amp D.C.</td>
<td>0-6</td>
<td>&quot;Volts RF Transmission Line&quot;</td>
<td>Self contained</td>
<td>15768</td>
<td>17.50</td>
</tr>
<tr>
<td>5 Amp D.C.</td>
<td>0-6</td>
<td>&quot;Amperes RF Antenna&quot;</td>
<td>With internal vacuum coupling</td>
<td>8305</td>
<td>17.50</td>
</tr>
<tr>
<td>6 Amp D.C.</td>
<td>0-6</td>
<td>&quot;Amperes RF Transmission Line&quot;</td>
<td>Less Thermocouple</td>
<td>8305</td>
<td>17.50</td>
</tr>
<tr>
<td>7 Amp D.C.</td>
<td>0-6</td>
<td>&quot;Amperes RF Antenna&quot;</td>
<td>With external thermocouple</td>
<td>8312</td>
<td>27.50</td>
</tr>
<tr>
<td>8 Amp D.C.</td>
<td>0-6</td>
<td>&quot;Amperes RF Antenna&quot;</td>
<td>With external coupling</td>
<td>8312</td>
<td>27.50</td>
</tr>
<tr>
<td>9 Amp D.C.</td>
<td>0-6</td>
<td>&quot;Kilowatts RF Output&quot;</td>
<td>1 MA, with tubular multiplier</td>
<td>13606</td>
<td>25.00</td>
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<tr>
<td>10 Amp D.C.</td>
<td>0-6</td>
<td>&quot;Kilowatts RF Output&quot;</td>
<td>1 MA, with tubular multiplier</td>
<td>13638</td>
<td>50.00</td>
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<tr>
<td>15 Amp D.C.</td>
<td>0-10</td>
<td>Self contained</td>
<td></td>
<td>13756</td>
<td>75.00</td>
</tr>
</tbody>
</table>

MARITIME SWITCHBOARD

338 Canal St., N. Y. 13, N. Y.
Worth 4-8217

Orders accepted from rated concerns, public institutions and agencies on order, otherwise you must send 25% deposit, balance C.O.D. or check with order. All prices FOB our warehouse, N.Y.C.

FAIR RADIO SALES

132 SOUTH MAIN ST.
LIMA, OHIO

SPECIAL METER BUY !!!!


THE OVERTOON COMPANY
OVERTOWN 61, MASS.

AVAILABLE

Western Electric 400 D Crystals $3.50 each—3 for $12.00

HARTY & YOUNG
42-44 Cornhill, Boston 10, Mass.
Louisiana State 2-2664
NICHROME WIRE
D. H., enamelled, .001 and .005. 24-9 and 25-1 ohms
per ft. On worktable. New and used.

G49E.

GLASS FLEXOHM RESISTORS

ANTENNA STRAIN INSULATORS
50 type #100. Glazed porcelain. 1 3/8" long. 1 0.5" spaced. between five feet. All new.

40C. 9 each. 4 for $1.00

SIGNAL GENERATORS (AM)
Model 20. Medium frequency. 1700 megacycles between 100 K. and 28 M. 201 type available at 229.00 c. A popular generator with many set manufacturers. Used, $17.95. When Thru Last! $17.95 (Express Only)

TELEPHONE OPERATORS CHEST SET
Trade W/105, 36 volt. Simple plain, single hand

palm and double print. New original packaging. When Thru Last! $4.95

ANTENNA LOADING UNIT

TUBES (Special)
VYL-581 50 K. Vacuum Rectifier (2T). $16.95
VYL-582 50 K. Vacuum Rectifier (2T). $16.95
VYL-317 100 K. Vacuum Rectifier (2T). $14.95
3010 50 K. Vacuum Rectifier. New. $19.95
3520 V. H. W. Vacuum Rectifier. New. $19.95
1016 15 V. Filament. 2566. $16.95
1016 15 V. Filament. 2566. $16.95
1353 12 5 V. Filament. 608C. $19.95
1353 12 5 V. Filament. 608C. $19.95
3711 15 V. Filament. SIl. $19.95

SPECIAL
5 V. 7.0. Ideal for Audio Oscillators, Interception. Bridge, etc. New. $2.95

VARIABLE CONDENSERS
Made for leading manufacturers. Quantities limited, 20% discount. Now your Local Jobber's catalog for dimensions.

UNITED SURPLUS MATERIALS
312 SOUTH HALSTED ST.
CHICAGO 6, ILLINOIS

BUTTERFLY TYPES
Minimum to Maximum. Open in 50° rotation. .03
.

inch cap. inch shaft lock nut.

HFC-30-2. Min. 2.5 mm. Max. .27 mm. $70

BFC-36-6. Min. 7.5 mm. Max. .52 Min. $1.99

SPLIT STATOR TYPES
HFC-50-40. Per sec. Min. .5 5 mm. Max. .55

inch. $1.40

HFC-75A-TA. Per sec. Min. .11.5 mm. Max.

15 mm. (Opposed Rotors) $1.95

SINGLE UNITS
ZM-100 AR. Screwdriver shaft with lock nut. 

1/8" hub cap for gaging. Min. : .1 mm. Max.: .100 mm. .95 (a)

(ZD) Double bored. Screwdriver shaft, with lock nut. 1/8" X 9/32" X 5/8". 40-83 spacers. Min. 12.5 mm. Max.: .140 mm. New. $1.10

807 PLATE PLATING ASSEMBLY
Contains a Delco 100 B. Crystals. Crystals, Bonded Plate Lead. R.F. and 1500.600 grams. Biconcave type. When thru lock and mounting hardware. New .95

5 GANG, INSULATED ROTORS
15 in 100 mm. per sec. Crystals shaft, 5000 ohm

rotors. Individual rotor contacts. 9/16" shaft. 

laminated, flat, round, and片子. $1.50 each. $7.50 X 9 3/4" X 7 1/2. Ideal for Audio Oscillators, Interception. Bridge, etc. New. $2.95

MAIN TUNING GANG—SX-28A
Cabinet. Complete set. Revert to older type, new replacement.

5/8" shaft. $2.95

PRECISION GANGED AND DIAL ASSEMBLY
As used in Hitco 75A-1. Section 175-170. 200 and 125 mm. High ratio bored lens focal

distance. No bearings, 25-50 m., for test use. New $2.75

NEON BULBS
G.E. Type NE-18. 10% Wattage Rate. 

10 for $1.45


Orders Below 50c.$1.95

ALVARADIO BARGAINS !
1—100 TEST SET
Contains BC-71A and BC-74A. For ARENT or


buy at this low price. $595.00

BC-929 INDICATOR SCOPE
Indicator scope to be used as an

over-modulation indicator. Wonderful deal for

cheap. $15.00 (Express Only)

9601 AUTOTUNE ASSEMBLY
Complete with motor and frame as used in

Hitco 75A-1. Section 175-170. New. $49.95

TRANSFORMER BARGAIN
2.5 Volt cv. 36. Heavy Duty. $3.95

DEJUW DC MILLIAMMETER
1-1000 MA. 2" round. Black. $2.95

BC-733 RECEIVER
Ten tube superheterodyne with crystal controlled

local oscillator. Provision for six crystal channels

between 100-112 Mc. Complete with tubes and

crystals, less dynamotor. Used. $4.95

89/R-5M-5 RECEIVER
Glade phone superheterodyne. Good parts. Crystal
controlled local oscillator. 25 mc. $1.00. Complete

with tubes and crystals, less dynamotor. Cost.$4.95

BC-375 TRANSFORMER
150 Watts output. 30 VAC. 221 tubes in total. Complete

with all tubes and one transformer. New. $14.75

ANC/RT PORTABLE RESCUE UNIT
Portable 806-voice outfit. $1.50 (Express Only)

ORDER DIRECTIONS FROM THIS AD
Check work preferred. P. O. box only. Send on C.O.D. order.

ALVARADIO SUPPLY CO., Inc.
Dept. L-4, 341 S. Vermont
Los Angeles 5, Calif.
Dunkirk 8-2217
SAVE $180!

BANISH FOREVER HOT NIGHTS!

VARIABLE ELECTRIC (PATENTED FILTER)
FOR COOL—CLEAN AIR WINTER & SUMMER

BRAND NEW!

No Dirt—No Draft—No Noise Continuous Variable Control
Plus a Radio—No Installation Required.

DELIVERS 695 (C. F. M.) CUBIC FEET PER MINUTE IN FREE AIR.

POWER SUPPLY KITS
24 to 28 V.D.C. 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 V.D.C. from a 115 V.A.C. 60 cycle line. Full wave bridge Selenium Rectifiers insure instantaneous and efficient operation. Adjustment of the D.C. output voltage is accomplished by transformer primary taps. Ripple is limited to within 2% of the average D.C. output by choke filter inputs.

No. Kit Amp. DC Net Price
242 2 6 $16.95
243 2.5 22.30
244 3 27.44
245 3.5 32.44

Write for descriptive Bulletin No. 201

DC POWER SUPPLY

Limited quantity Gov't Surplus Reconditioned.

Full wave bridge copper-oxide rectifier heavy duty multi-tapped transformer.

Input: 85-135/115/220-250/32 V.D.C. 59.95

For schematic diagram and wiring please write.

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A 24 and 28 V.D.C. at 10 Amps. This unit will deliver unfiltered direct current for operation of motors, dynamos, relays and similar equipment. Employed full wave Selenium Rectifier and heavy duty primary tapped transformer. The two output voltages can be used simultaneously and may be adjusted between 24.5 and 25.5 V.D.C. Full 10 Amp. 60 cycle input with schematic diagram and in-struction sheet. Shipped wt. 1 lb. $15.95.

HI-VOLTAGE!

1 or 16 KV Condenser. Oil filled—voltage doubler type 16 M.P.—5000 V.D.C. Each section can be used in series for 675 M.P. 16 KV. Brand new. $3.95 ea. Lots of 6 $18.30 ea. $3.00 ea.

Minimum order $3.00. No COD's accepted. Orders shipped via R. O. Y. Exp. charges—collected, unless accompanied by additional 10% for parcel post and handling—15% west of Rockies.

ELECTRONICS—June, 1950

MANUEL KLEIN

NEW YORK 7, N. Y.

RECTOR 2-4460

HEADQUARTERS FOR RESISTORS

1/2 1 2 Watts

LIFE ELECTRONIC SALES

91 Gold St. N. Y. 7, 9-4154
NEW RA-38 RECTIFIERS... 
115-v., 60 c. 1-phase input, output 0-15,000 + d-c @ 503 ma. Write for detailed information.

ALL BRAND NEW 
ELECTRONIC SURPLUS 
from Army-Navy stockpiles


MN-26 E Portable Loop "F" Ring type. ca. $15.00.

MN-43 C Portable Loop "F" Ring type. ca. $15.00.

RT-7/AMP-1 Radar Altimeters, Receivers - ca. $50.00.


R-23 ARC-3 Command Receiver with Diamond Mfg. Box.

BC-846 Boil Control Box, Veedoor-Dee, Mfg. ca. $8.50.

PE-191 A Power Condenser A. New. $8.25.

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MC-136 Right-Angle Domes. ca. $9.50

1/7-A Mags. Mfg. ca. $8.50.

D-4/ARN-7 Control Box for A.D.F. ca. $25.00

DM-22 A Operator for SCR-214. ca. $1.50.

DM-33 Operator for I. L. Ki. ca. $2.50.

21402B Diamond, 12 volt, battery type. ca. $2.50.

BC-906 Antenna Tuning Units for SCR-522 ca. $20.50.

N-88 Heavy-Duty Hughes. Heavy Duty 400. ca. $1.50.

Flexible Housing for wiring, with female connections, for an connector 16 ft. length. ca. $1.00.

Regulator Control Unit, G. F. model. New. ca. $0.25.

Tubes Prices Net FOB Chicago. 3% Discount. balance COD. Need in your requirements.

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CHICAGO 16, ILLINOIS

CLOSING OUT

Tubular Condensers
Electrolytic Condensers
Oil Filled Condensers, Wire Condensers
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Heart Light Assemblies, Type F & Peddy Condensers
Permeability Tapes
Tube Sockets
Argon Bulbs
Switches
Relays
Sparapeti Tablets
Radar Condensers
Gang Switches
Coil & Cell Fuses
Cribs
Transformers

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1811 West 47th Street
Chicago 9, Illinois
Yards 7-0656

TELEVISION TUBE MACHINERY

6 HEAD MACHINE, for button stems.

TUBE STEM MACHINES Mfg. by Lodge & Co. 4-5-6-7-8 positions with Geneva movement.

HYDROGEN FURNACES Complete with automatic controls, 29" x 7" x 4". Brick-lined, with two Bristol Ultrasonic Welders, Brown pyrometers.

EXHAUST MACHINE 52 head, capacity 60 tubes per hour, 65 W. type B174 Sealey chassis.

VACUUM FILLING EQUIPMENT Mfg. by GE. SEALING & STEM MACHINE 16 head, mfd. by GE.

ELECTRONICS Mfg. 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

June, 1950 — ELECTRONICS

268
Sylvania Type #216 Sig. Generator

For general purpose use on freq., mod., audio and TV sets, seven bands 80 kC to 60 MC. Guaranteed brand new and latest type. Need for descriptive literature.

Price $139.50

**OIL CONDENSER—New**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Cap. Voltage</th>
<th>Type</th>
<th>Price</th>
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<tr>
<td>B</td>
<td>0.5 to 10</td>
<td>µf</td>
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<td>µf</td>
<td>1.50</td>
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**NEW MICA CONDS.**

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<td>0.5</td>
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**TYPE "J" POTS**

$3.50

<table>
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**NEW MICA CONDS.**

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<tr>
<td>0.5</td>
<td>$7.95</td>
</tr>
</tbody>
</table>

**BATTRUSH KIT 10 for $9.99**

For Heath Cond. See Mater. issue.

**SPECIAL**

3—5 mfd—400 V Oil Cond. $3.90 each

**MONMOUTH RADIO LABORATORIES**

OAKHURST, N. J.

**SOUNDTRONICS SPECIALS**

**JUNE SPECIAL**

R-110 TWISTED PAIR TEL. FIELD WIRE Stranded 4 Strand 3000'... $46.50 1/2 MI. Reel... $23.25

**TRANSFORMER POWER SUPPLY**

115 V, 60 CY, $60 V @ 55 MA. 6 V, 15 CY, $15 V @ 2 Amperes. Incl. Tax. 15 V. Choice. 3-3/8 110V 250V Filler. Term. Reg. B. 10 KV. Complete Wires...$68.65

**TO 15 KV SEPARATE $12.85**

**ANTENNA INSULATOR**

Heavy Glazed Porcelain 12'x12'........... $6.65

**SELENIUM RECTIFIERS**

Input 0-18 volts Output 0-14 volts

-4.4...$3.97
-4.5...$4.09
-5.1...$7.07
-7.5...$6.95

**WHEATON TRONUX TERMINALS**

#509 for Circuits up to 5000 Volts $0.50 ea.

#509 for Circuits up to 6000 Volts $0.60 ea.

**U.T.C. CHOKES P.A. STYLE**

10 HY. 68 MA. 400 ohm DC. $1.97
10 HY. 110 MA. 400 ohm DC. $1.48
10 HY. 130 MA. 250 DC ohm $1.85

**OUTSTANDING VALUE**

New Army MINE DETECTOR AN/PCS-1: Fully Automatic, time-saving. Uses 3-45 V. A & C V. Battery. chassis, tubes, etc. Less Batteries. In Original Overseas Fitting. Complete. $155.00

Following equip. Used but like new.

**H.F. SIGNAL GENERATOR**

Similar to RCA 1204 $260.00

**OUTSTANDING VALUE**

BC-75A $390.00-719 31 C. Bc. Reg. Reg. War Sup. Part of RCA 290 RADAR 16 Paces...$138.00

**TRANSISTOR—3.5 KV 1 Phase 50/60 cy. Fixed winding 115/220 V. 18-100. $49.00
**TRANSISTOR—5.5 KV 1 Phase 50/60 cy. Fixed winding 115/220 V. 18-100. $49.00

**DUAL LINE LEVEL RECORDER—4 to 10000 115 V 40 CY. Made in Brown Instrument. $120.00

**LARGE QUANTITY OF RHEOSTAT學校**

U.S. TYPE 100 WATT 500 OHMS $2.50 each

**CLARE STEPPING SWITCHES**

Type SS-14, 20 steps, 6 levels. Coil 12V, DC. Lists at $12.65; our low price $13.00. Brand new 1942-45 surplus stock. Quality of four or more $12.25 each. Satisfaction guaranteed or money refunded.

**NEOMATIC, INC.**

879 Wellesley Ave., Los Angeles 49, Cal. ARizons 3-4897
<table>
<thead>
<tr>
<th>Meters</th>
<th>$</th>
<th>MDC 3/4&quot;</th>
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**SEARCHLIGHT SECTION**

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<td>1LD5</td>
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**TUBES**

**THAT'S** **TAB** **BUY**

**TUBES**

Tested—Guaranteed

**MICROWAVE**

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**THAT'S** **TAB** **BUY**

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<td>35.95</td>
<td>10.00</td>
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</table>

**THAT'S** **TAB** **BUY**

**DEPT. 66** **SIX CHURCH ST. NEW YORK 6, N.Y. U.S.A.**

**CORNER CHURCH & LIBERTY STS.**

**SUNDAY** **SERVICES**

**6:00** | **9:30** | **11:30** | **6:30** |

**THAT'S** **TAB** **BUY**

**TAB** HONEY ROYAL GUARANTEED

$3.00 ORDER F.O.B. N.Y.C.

ADD SHIPPING CHARGES AND 25% DEPOSIT. PHONE NO. 3-7307

**6/30/50**

**ELECTRONICS**

**TAB** HONEY ROYAL GUARANTEED

$3.00 ORDER F.O.B. N.Y.C.

ADD SHIPPING CHARGES AND 25% DEPOSIT. PHONE NO. 3-7307

**6/30/50**
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