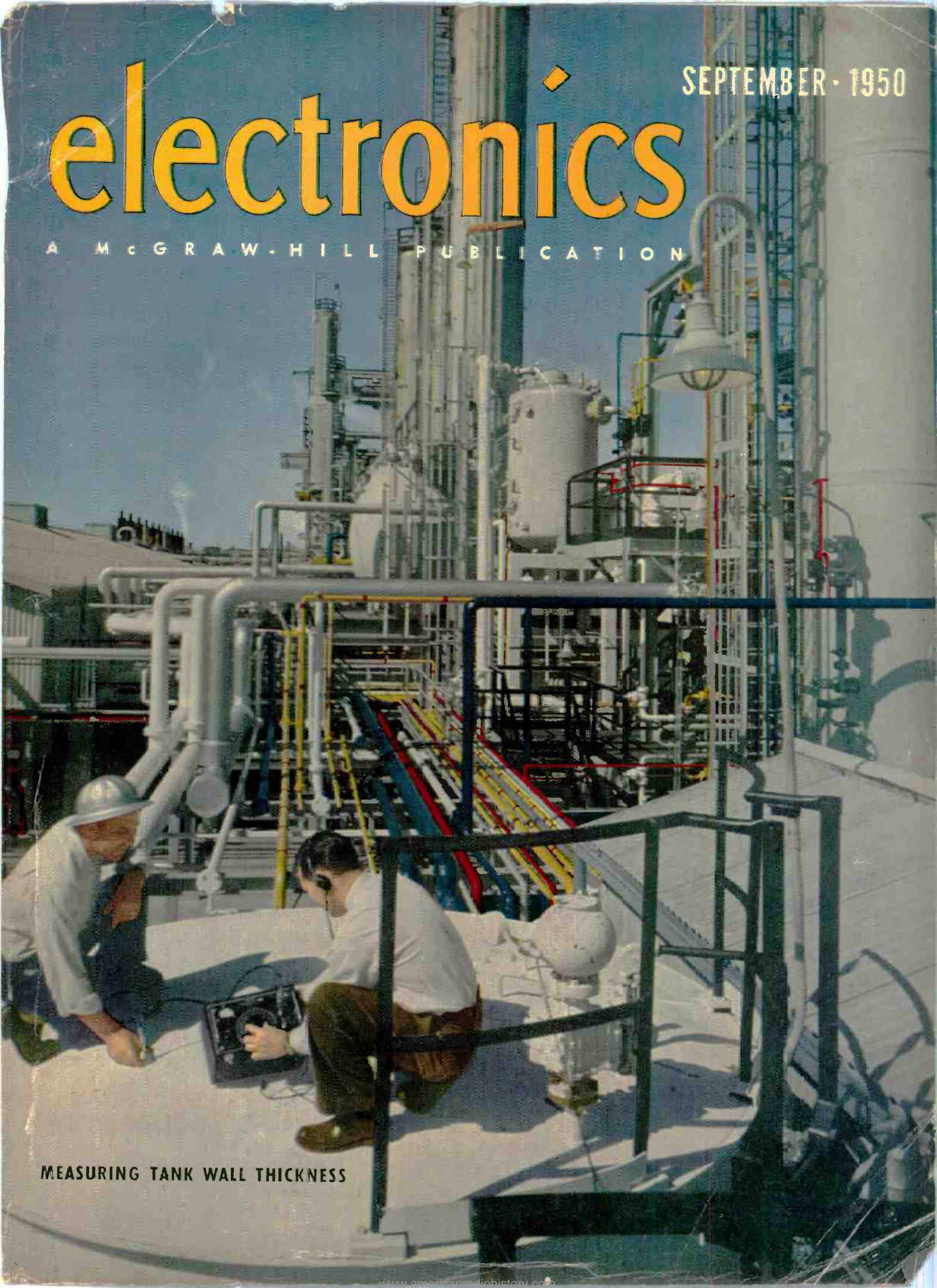

electronics

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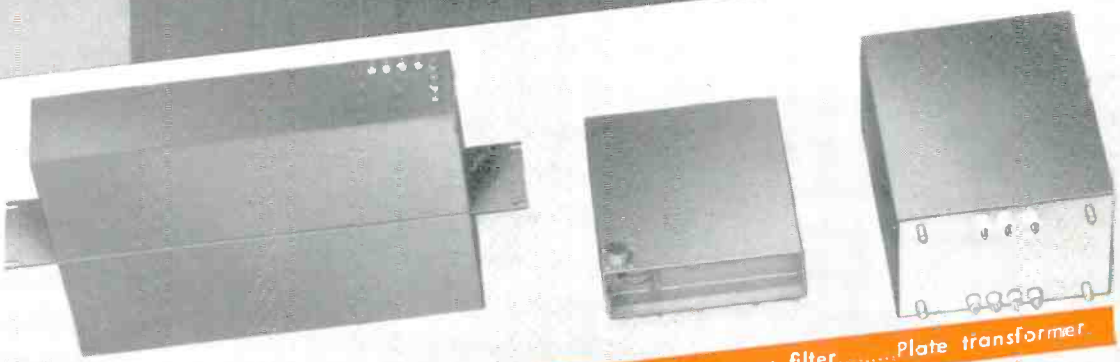
MEASURING TANK WALL THICKNESS

UTC for Military Components

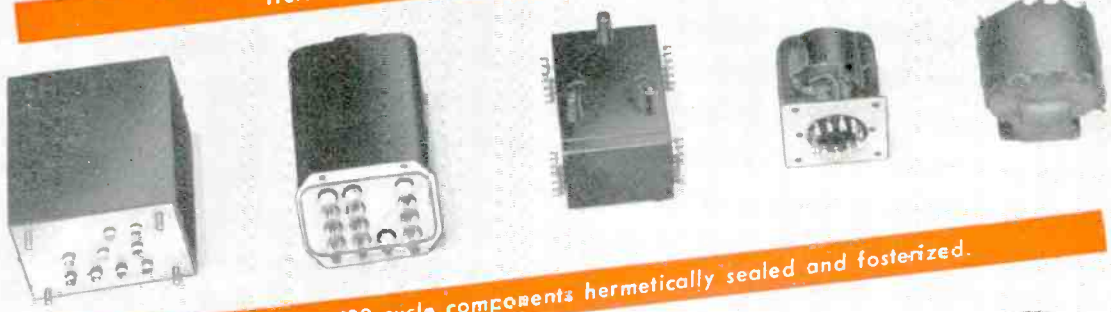
UTC was the largest supplier of transformer components in World War II. Present UTC production is on a similar basis. Illustrated below are a few of the thousand military types in UTC 1950 production.



Carrier frequency filter..... Aircraft low frequency filter..... Plate transformer

Typical hermetically sealed power transformers for 60 cycle service.

Hermetically sealed audio and pulse transformers.



60 cycle and 400 cycle components hermetically sealed and fosterized.

Miniaturized audio units, magnetic amplifiers, etc.

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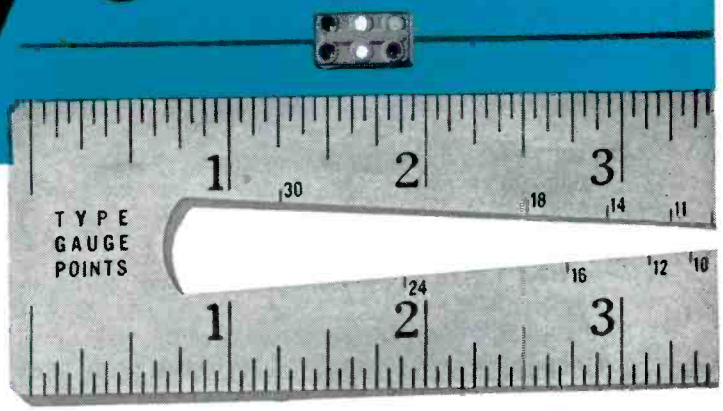
Tiny BUT TOUGH



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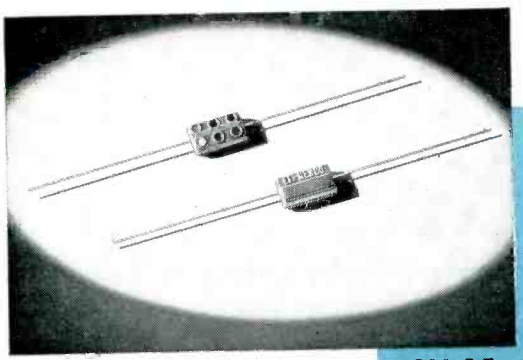
Built to Stand Up Under Severe Stress and Strain

Fixed mica El-Menco condensers are tiny but tough. They give sustained superior performance under adverse conditions. Pretested at *double* their working voltage, El-Menco capacitors prove their ruggedness *before* leaving the factory.

They are tested for dielectric strength, insulation resistance and capacity value.

When you want peak performance put them in your product. You can depend on El-Menco to stand up under critical operating conditions and extremes of temperature and climate.

Always Specify El-Menco — The Capacitor That's Tiny But Tough.



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Actual Size 9/32" x 1/2" x 3/16".
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2 mmf. —420 mmf. cap. at 500v DCw.
2 mmf. —525 mmf. cap. at 300v DCw.
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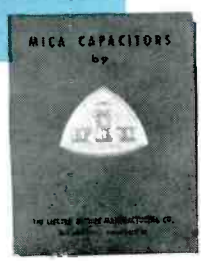

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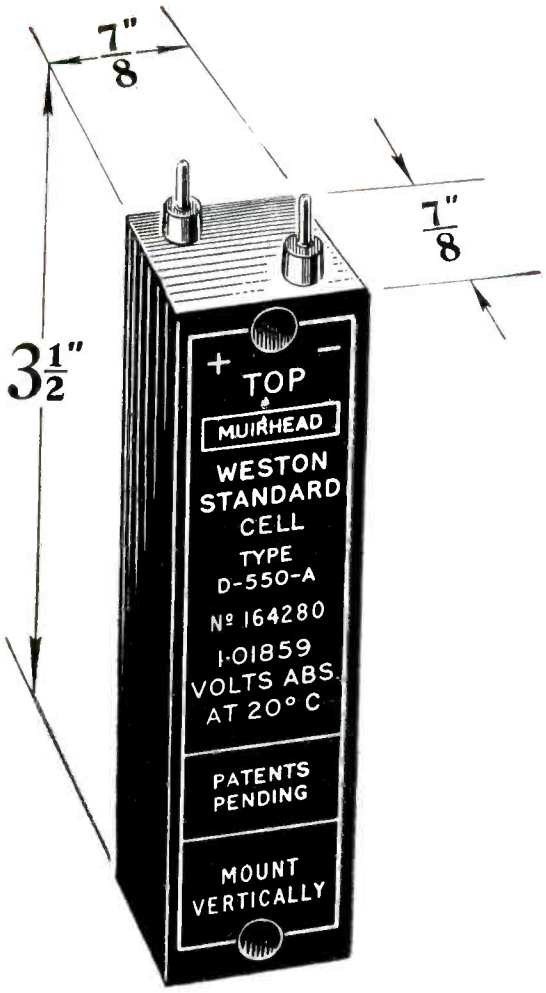

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THE MUIRHEAD MINIATURE WESTON STANDARD CELL

E.M.F.	1·01859 VOLTS ABS ±100μV AT 20° C
TEMPERATURE COEFFICIENT	40μV/°C APPROX.
DIMENSIONS	$3\frac{7}{8}$" x $\frac{7}{8}$" x $\frac{7}{8}$" OVERALL [9·8cm x 2·2cm x 2·2cm]
WEIGHT	$2\frac{1}{2}$ oz. [70 gm]
MOUNTING	MOLDED CASE—WITH PANEL AND CHASSIS FIXING HOLES

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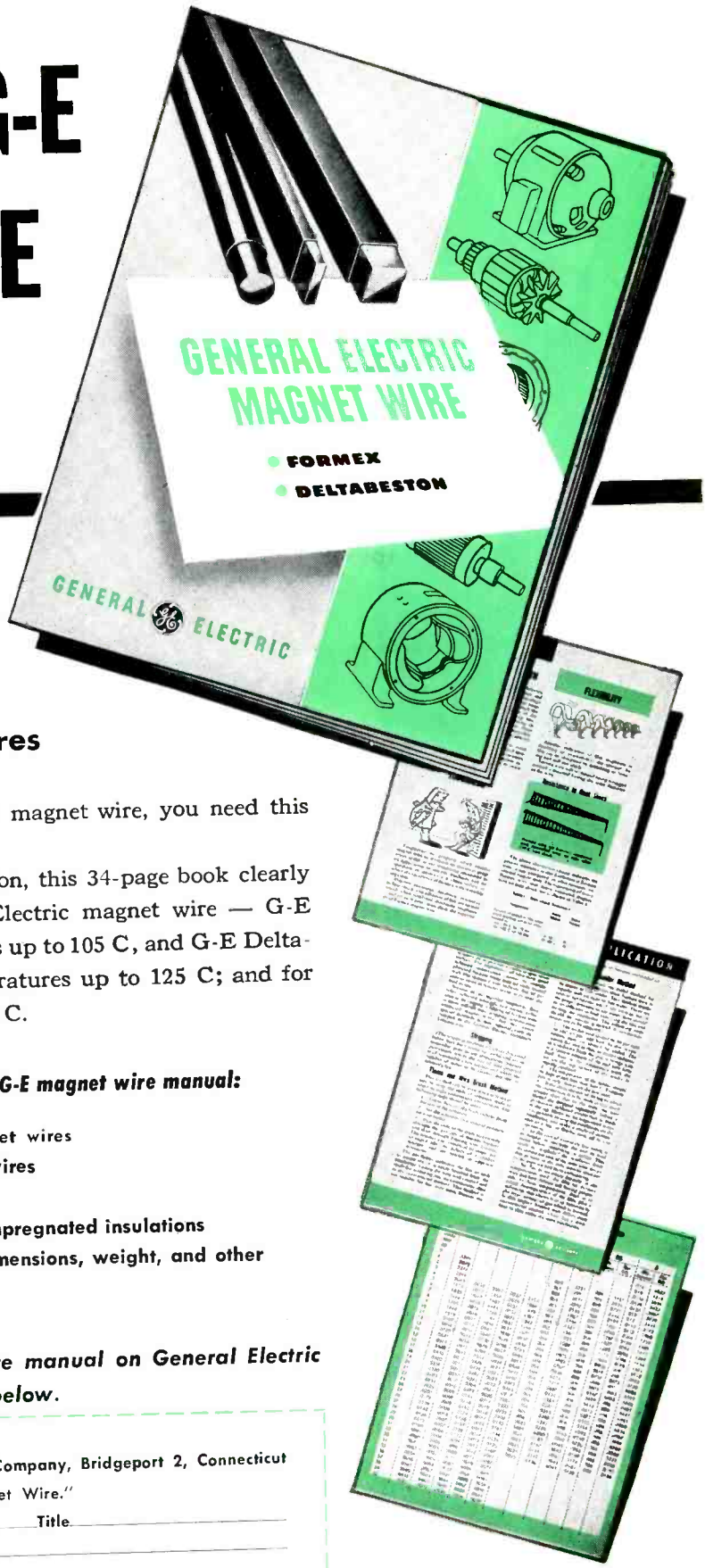

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DELTABESTON Magnet Wires

For jobs involving specifications and uses of magnet wire, you need this new General Electric magnet wire manual.

Packed with helpful, hard-to-get information, this 34-page book clearly and concisely covers all types of General Electric magnet wire — G-E Formex for Class A applications, temperatures up to 105 C, and G-E Deltabeston, both for Class B applications, temperatures up to 125 C; and for Class H applications, temperatures up to 180 C.

Here are just a few of the subjects covered by the G-E magnet wire manual:

- **Properties of Formex and Deltabeston magnet wires**
- **Tables of types and sizes of stock magnet wires**
- **Application procedures**
- **Information on special glass and silicone-impregnated insulations**
- **Tables covering electrical specifications, dimensions, weight, and other pertinent specification data**

To get your copy of this fact-filled reference manual on General Electric magnet wires, just clip and mail the coupon below.

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Please send me free copy of "General Electric Magnet Wire."

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No. 7 of a Series

Another Engineer's Problem Solved*

SUBJECT:

HIGH POWER, HIGH TEMPERATURE RF CAPACITORS

PROBLEM:

200 mmf. capacitor to carry 4½ amperes of current at 1Mc at an ambient temperature of 90°C. Small size was imperative.

SOLUTION:

This customer was unable to find a mica capacitor to meet the required specification. A wax-filled porcelain-cased mica capacitor having a 20°C rise weighs 8 lbs. and is $5\frac{3}{4}$" high and $5\frac{3}{4}$" x 5" base. This is too large. Moreover, mica capacitors must be derated to 70% of current rating even at 70°C; at 90°C, they cannot be used.

A Type TSG Glassmike was designed for the above application. Type T plastic film at 1Mc has a power factor of less than .0002. The Silicone fluid impregnant has similar low losses. The I^2R losses of the electrodes were kept to a minimum so that the overall power factor was slightly over .0002.

The finished Type TSG assembly weighed .35 lbs and was $1\frac{3}{8}$" in diameter and $3\frac{1}{2}$" long, with axial mounting studs on each end. With a current of 4.5 amperes at 1 Mc flowing, the temperature rise is 15°C. Total heating loss is equivalent to 3.3 watts. Volt-amperes handled are approximately 16,000 which indicates a Q of approximately 5,000.

• • •

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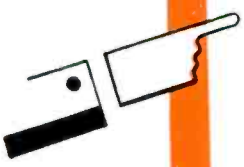


3760 HIGH MELTING POINT WAX
for Impregnating and Dip Coating

won't flow under extreme high heat
won't crack under extreme cold!

3767-A CORONA SUPPRESSING PLASTIC
for Dip Coating

won't sag or sweat under extreme heat
won't crack under extreme cold!

SPECIFICATIONS

MELTING POINT (DRIP)	260/265 F
COLD FLOW (M-R)	250/255 F
PENETRATIONS	
32/200/60	15-16
77/100/5	17-19
115/50/5	20-22
COLOR	Tan
APPLICATION TEMPERATURE	300/350 F
SPECIFIC GRAVITY	0.90
VISCOSITY (SAYBLT. UNIV.)	
@ 325 F	40-42 seconds
FLASH POINT	500 F
ELECTRICAL PROPERTIES	
POWER FACTOR	0.023 (10^6 cycles; 77 F)
DIELECTRIC CONSTANT	2.19 (10^6 cycles; 77 F)

COLD FLOW (M-R)	272/277 F
SOFTENING POINT (B&R)	190/195 F
DIPPING TEMPERATURE	325/375 F
MELTING POINT (DRIP)	275/285 F
COLOR	Tan
ADHESION	Good
PENETRATION 77/100/5	8-10
SPECIFIC GRAVITY	1.01
FLASH POINT	480 F
ELECTRICAL PROPERTIES (Representative Sample)	
Dielectric Strength	368 V/mil (77 F; 60 Cycles)
Dielectric Constant	2.51 (77 F; 10^6 Cycles)
Power Factor	0.0069 (77 F; 10^6 Cycles)

3760, Impregnating and Dip Coating **WAX COMPOUND,** was developed to meet the needs of applications which must resist flow at temperatures above the boiling point of water, and also which must resist cracking at temperatures below zero degrees F.

3760, with good electrical properties, resistance to bleeding at high temperatures, low application viscosity and high drip melting point, is recommended for moisture proofing coils, transformers, capacitors, etc.

TESTS—HIGH TEMPERATURE

Using paper tubular capacitor samples, the tubes were impregnated with, and the assembled units were flash dipped in 3760 (coating approximately 15 mils thick), the units were then subjected to oven tests at 220 F for 24 hours. **NO SAGGING OR BLEEDING OF THE COATING WAS EVIDENT.**

TESTS—LOW TEMPERATURE

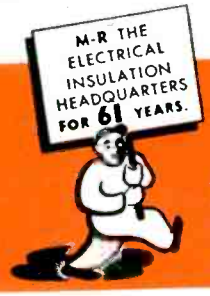
The same units were cold tested by being placed in a cold chamber at —40 F for a period of one hour. The units were then removed and permitted to return to room temperature. **INSPECTION SHOWED THAT THIS LOW TEMPERATURE TREATMENT CAUSED NO CRACKS IN THE COATING OF 3760** . . . and the surface obtained by dip coating with 3760 showed good resistance to blocking at temperatures normally encountered in shipping.

3767-A, CORONA SUPPRESSING PLASTIC, was developed to reduce or eliminate corona around certain points on television components, and similar electrical parts, which operate at high potentials. Application in the form of a corona suppressing "tire" on the periphery of "flyback" transformer coils and similar units is the primary function of 3767-A. The customary method for applying 3767-A is to dip or roll the units to be coated in a molten bath of the insulation.

Since low power factor and high dielectric strength are particularly desirable in this type of insulation, this material combines the best possible electrical properties consistent with the necessary physical properties. The surface obtained with this corona suppressing plastic is particularly smooth and free from ridges and bumps. This feature of itself reduces the evolution of corona. During the development of 3767-A particular attention was given to the physical stability of applied coatings at extremes of high and low temperatures.

FUNCTIONAL TESTS of this material applied in moderately heavy coatings on flyback transformer coils **SHOWED THAT 3767-A WILL WITHSTAND A CYCLE OF 24 HOURS AT —40 C FOLLOWED BY 24 HOURS AT 125 C WITHOUT THE APPEARANCE OF CRACKS AT THE LOW TEMPERATURE OR SAGGING AND SWEATING AT THE HIGH TEMPERATURE.**

Write for your laboratory test samples . . . free upon request.



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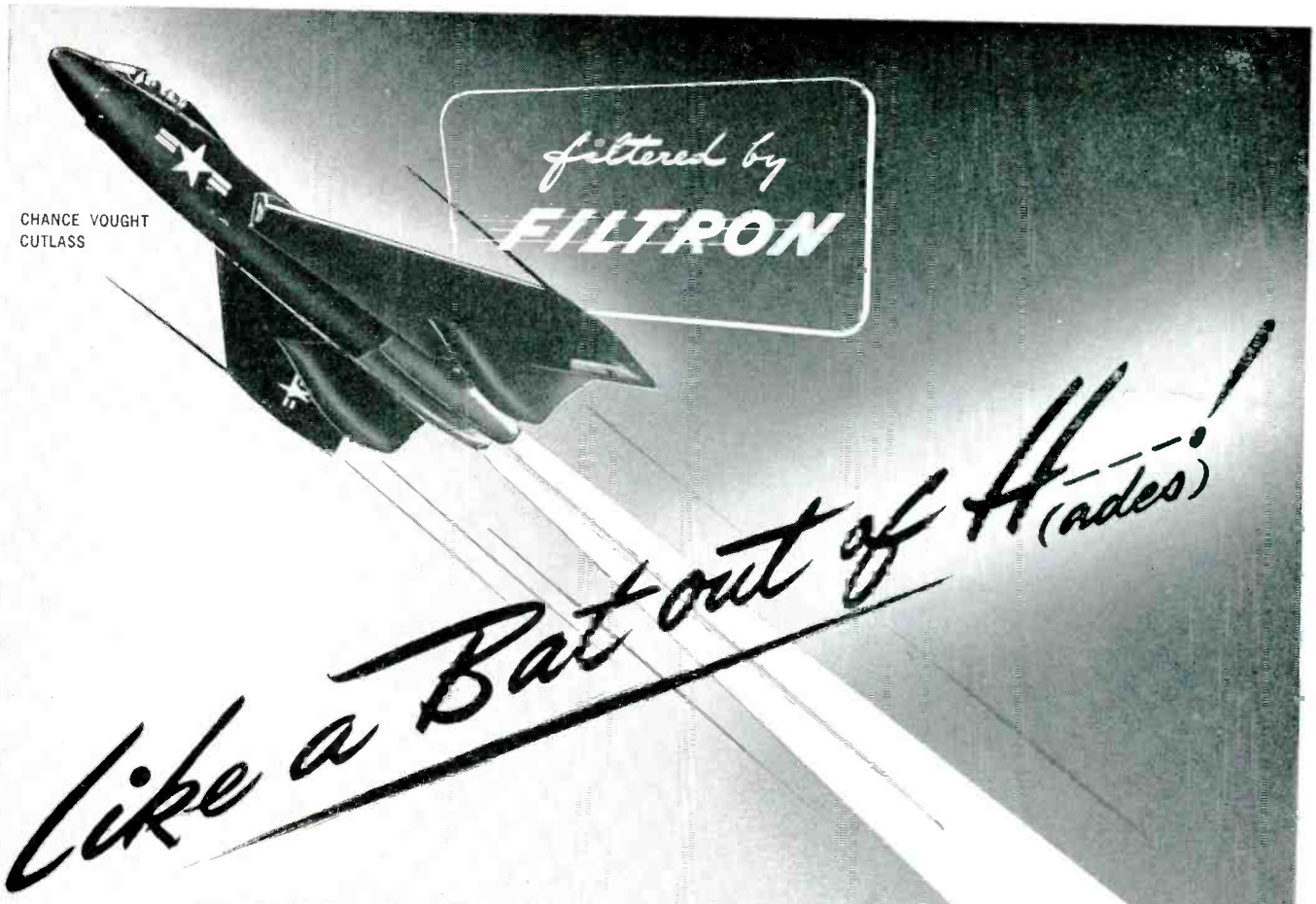

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FILTRON core structures are the result of many years of *research* to develop the *best materials* suited for your RF Interference Suppression Filter.

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FILTRON'S metal fabrication department permits us to give you a filter in the *size and shape you need to fit the space you have.*

FILTRON design assures you of the *smallest size* and the *least weight* for your filter.

FILTRON'S completely equipped shielded laboratory *is available to you* for the RF Interference Testing and filter design *for your equipment — to the required specification.*

RF INTERFERENCE FILTERS FOR:	
Electronic Controls	Signal Systems
Electric Motors	Business Machines
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An inquiry on your Company letterhead will receive prompt attention

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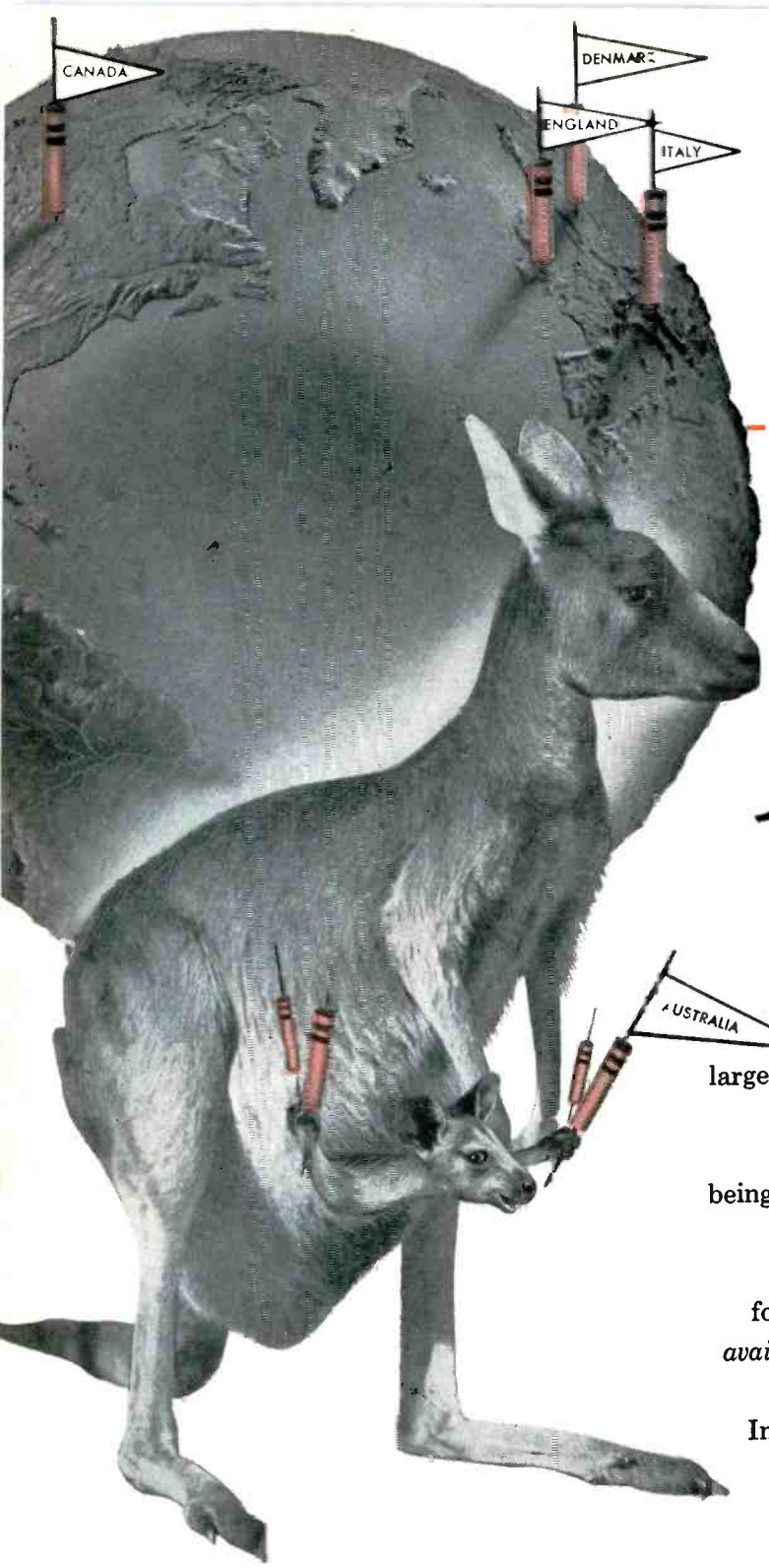
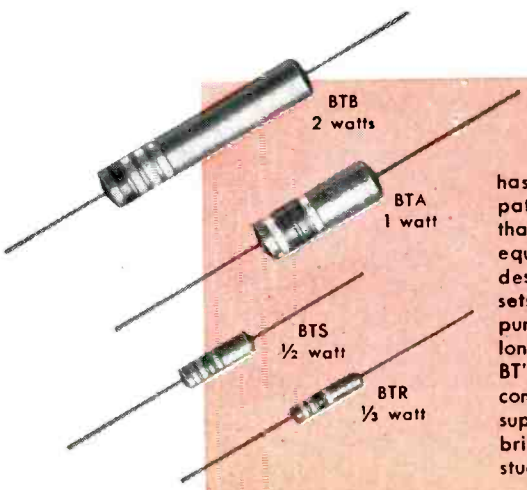


Logistics

for resistors too!

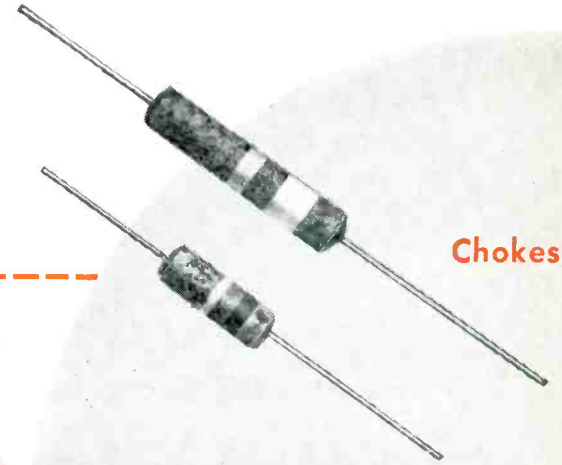
For *adequate* supplies of resistors in an ever-widening market, depend on IRC *logistics*. Already the largest manufacturer of resistors in the world, IRC has increased its output tremendously to meet your requirements. And in addition, IRC capacity is now being supplemented by licensees in Canada and Denmark—while English, Australian and Italian licensees provide resistors for other world markets formerly supplied from the United States. IRC *availability* extends even to your urgent, small-order requirements for standard resistors. Through our Industrial Service Plan, your IRC Distributor can supply these promptly from full stocks of the most popular types and sizes.



Stock-piling of advanced BT's

has been proved practical by IRC's study of resistor-use patterns. A recently completed three-year profile shows that 80% of the BT resistors used in TV and radio equipment include only 30 values. This holds true despite design changes and shifts in the industry's emphasis on sets. And these facts prove that you can now simplify purchasing, stocking and expediting practices by placing long-term orders covering your basic, recurring needs for BT's. Engineered to meet JAN-R-11 specifications for fixed composition resistors, IRC BT's have established their superiority in all important characteristics. Bulletin B-1 brings you full details of IRC BT's, and a copy of our study is yours for the asking.

is important



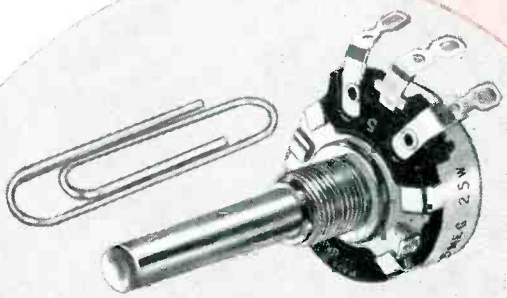
Chokes

The right Resistors . . .

for precision applications often require a *combination* of characteristics. IRC Deposited Carbon PRECISTORS combine accuracy and economy in:—Circuits in which the characteristics of carbon composition resistors are unsuitable and wire-wound resistors too expensive — Metering and voltage divider circuits requiring high stability and close tolerance of the resistance values — High-frequency applications. The two sizes of IRC PRECISTORS are manufactured to customers' specifications, rather than to standard RMA values (subject, of course, to minimum and maximum values for each type). For complete data on characteristics and values, mail coupon for Bulletin B-4.

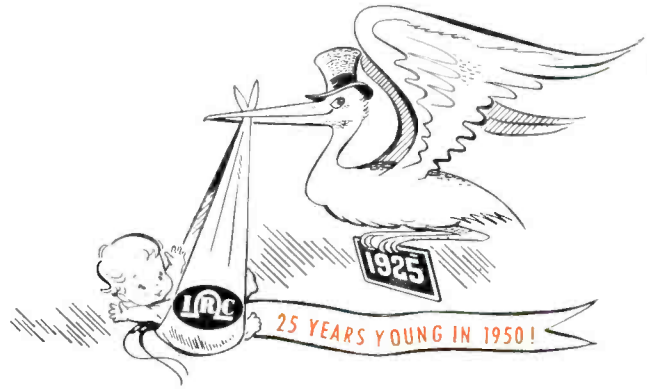
Modern mass production equipment . . .

plus exclusive manufacturing techniques, make IRC Insulated Chokes relatively inexpensive — and offer considerable savings over ordinary types. Available in two sizes, IRC chokes are insulated in molded phenolic housings for full protection against high humidity, abrasion, damage during assembly, and danger of shorting to chassis. "Q" improves with rise in frequency and is sufficiently high for broad-band tuning in FM and TV regions. Resistance is low enough to permit use as filament chokes for moderately high power tubes. Coupon brings you full information in Bulletin H-1.



Dependable source of small-size controls . . .

IRC meets your requirements with the new 15/16" Type Q. Mechanization of production and testing assures increased supplies of these miniature controls. And elimination of hand operations provides complete uniformity of construction and performance. New IRC Type Q Controls are rugged and compact. Resistance element is the best IRC has ever produced. Increased arc of rotation permits the same resistance ratios used in larger IRC Controls. IRC Type Q's are characterized by low noise level, negligible changes in resistance even after long exposure to humidity, unusual durability and efficiency, and adaptability to a wide variety of small-space applications. Bulletin A-1 gives full information.



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- ☐ PRECISTORS (B-4)
- ☐ IRC Study of Resistor Use
- ☐ New Q Controls (A-1)
- ☐ Insulated Chokes (H-1)
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Centralab's Printed Electronic Circuits May Solve a Problem for You

In a busy Washington office during the past war hung a sign which said — "We do the miraculous every day — the impossible takes just a little longer." Today, that sign could hang in the offices of Centralab. For example, someone wanted a *small* speech amplifier Centralab's answer — Ampec, a full 3 stage unit, two of which can fit inside of a regular pack of cigarettes! A radio manufacturer wanted a *small* audio-detection unit. Centralab's answer Audet, a unit one-third size of an ordinary soda-cracker! How were these things done? With Centralab's CRL Printed Electronic Circuits — a pioneered development of Centralab. Yes, and here are some of the benefits that many manufacturers of radio TV sets and other electronic gear have reaped from using PEC's. They've eliminated numerous individual parts their handling, inventory and assembly. They've gotten more consistent and better performance results. They've reduced finished product size and weight. They've eliminated wiring errors and cut down on the number of soldered connections. What's more, they've been able to stretch their resistor supplies . . . an important factor in meeting current volume demands for TV and radio production. Look over your own situation. Want to cut costs? Speed up assembly? Then on the next two pages you may see a Centralab Printed Electronic Circuit unit that will help you do just that! If you don't see what you want — contact us. Tell us your problems. Maybe we can do the miraculous or take a little longer and accomplish the impossible!

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42-59 — CERAMIC TUBULAR TRIMMERS — designed for TV and VHF application.
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AN IMPORTANT MESSAGE FROM *Federal* FOR USERS OF

RG TYPE CABLES

Federal Telephone and Radio Corporation has received approval to manufacture – and can supply – RG type cables with the

NEW LOW-TEMPERATURE NON-CONTAMINATING THERMOPLASTIC JACKET

(An original development by Federal)

This modification is in accordance with "Exceptions to Specification JAN-C-17A," dated March 21, 1949, and amendments thereto.

THESE ARE THE TYPES APPROVED TO DATE—

RG-5B/U RG-6A/U RG-8A/U RG-9B/U RG-10A/U RG-11A/U
RG-12A/U RG-13A/U RG-21A/U RG-22B/U RG-59A/U
RG-58C/U RG-62A/U RG-63B/U RG-65A/U RG-79B/U

Review your requirements now—to insure prompt delivery!

For further details on present and subsequent approvals, write or wire Dept. D-413, or telephone NUtley (N.J.) 2-3600

ANOTHER "Federal FIRST"

Federal Telephone and Radio Corporation

FEDERAL TELEPHONE & RADIO FTR — An IT&T Associate

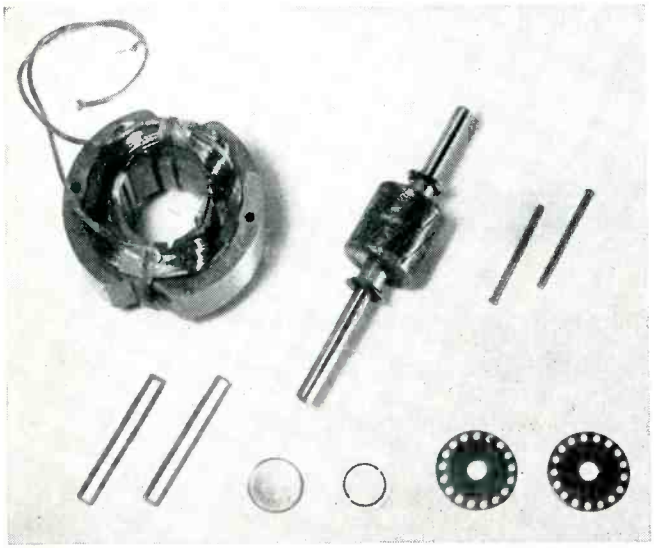
SELENIUM and INTELIN DIVISION, 100 Kingsland Road, Clifton, New Jersey
In Canada: Federal Electric Manufacturing Company, Ltd., Montreal, P. Q.
Export Distributors: International Standard Electric Corp., 67 Broad St., N.Y.

COPPER ALLOY BULLETIN

REPORTING NEWS AND TECHNICAL DEVELOPMENTS OF COPPER AND COPPER-BASE ALLOYS

Prepared Each Month by BRIDGEPORT BRASS COMPANY "Bridgeport", Headquarters for BRASS, BRONZE and COPPER

Copper Wire, Tube, Sheet Used in Electric Motor



Stator, rotor, copper pins, copper shading rings and shorting discs in induction motor—Courtesy Fasco Industries, Rochester, New York.

Copper wire, sheet and tube as well as free machining brass rod are an integral part of the illustrated 110-volt, 60-cycle induction motor.

Enameled copper wire is used for the windings of the stator which set up the magnetic fields. As a means of concentrating the magnetic flux in these fields, extruded and drawn rectangular copper tube is cut into narrow sections and two pieces are inserted opposite each other in the laminations as shading bands.

In the rotor, two blanked and pierced copper washers are used as shorting rings. Cold-headed copper pins are inserted through these discs and laminations and both ends are copper welded.

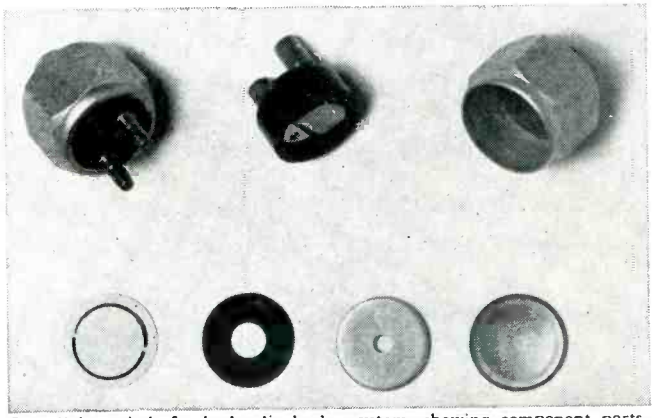
Two free machining brass bushings are used as spacing elements between the rotor ends and the bearings on the shaft.

Three main types of copper are commercially available:

Electrolytic tough pitch is used in greater quantities than the other two grades of copper for bus bars, conductivity wire, switches, terminals, contacts, etc. This metal contains a small quantity of copper oxide and its conductivity is set at 101%.

Deoxidized copper has a conductivity of 85% and is used for various tube applications. In the sheet form, it is suitable for operations where extra deep draws and flanging are required.

Oxygen-free copper does not contain cuprous oxide or phosphorus. It has an exceptionally high ductility and the highest electrical conductivity of the three types mentioned. Where a high degree of electrical efficiency is necessary, this metal is normally utilized.



Stop light switch for hydraulic brake system, showing component parts. Courtesy Fasco Industries Incorporated, Rochester, N. Y.

Phosphor Bronze Vital to Switch

Stop light switches for cars with hydraulic brake systems use phosphor bronze and free turning brass for both electrical and mechanical applications.

This unit is expected to operate for the life of the car without attention or maintenance.

When brake pressure is applied, oil is forced against a composition rubber diaphragm, applying pressure to a phosphor bronze diaphragm which in turn closes a phosphor bronze switch leaf, making electrical contact. When the brake is released, the bronze diaphragm acts as a cricket, snapping back to open the switch by combatting the residual pressure of the hydraulic system.

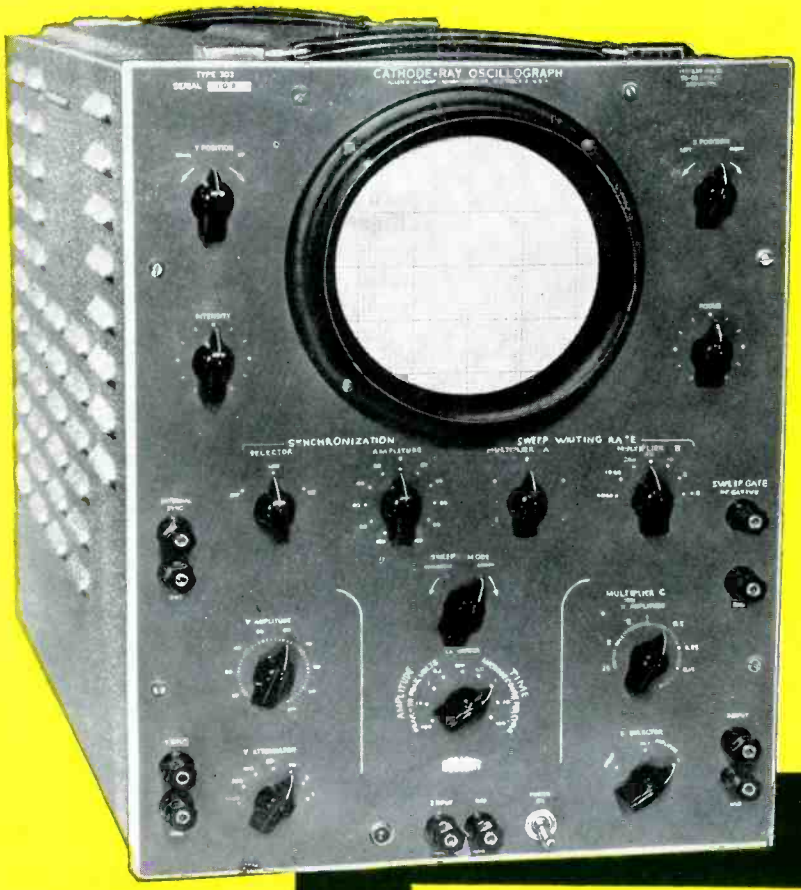
Due to the countless making and breaking of contact of the switch in the normal use of a car, spring temper phosphor bronze was selected because of its exceptional resistance to fatigue.

Free cutting brass rod is used for the terminal pins because of its machinability and ability to withstand corrosion from moisture and petroleum oils.

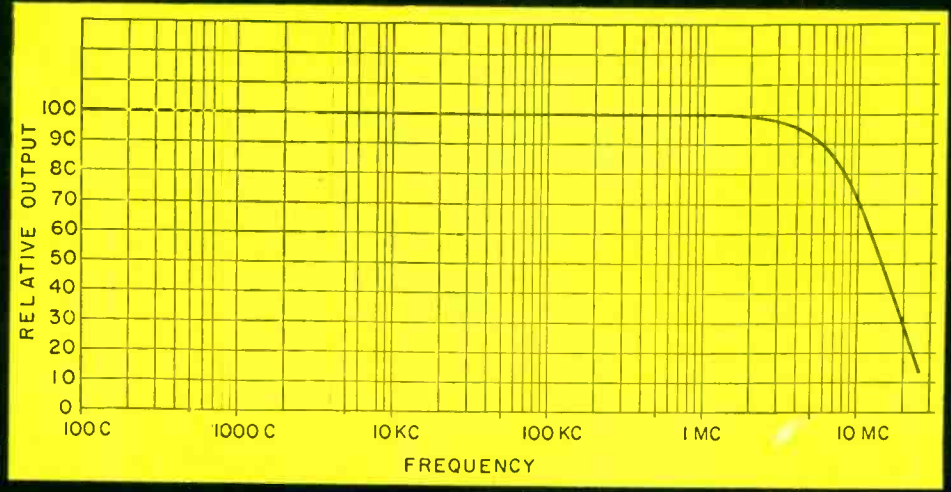
Such parts in both electrical and mechanical equipment play a far more important role than is indicated by their size and cost alone. With satisfactory performance of a complex assembly so dependent upon a small but vital spring part, it is essential that the material selected fully meets the requirements of the application. Bridgeport's Laboratory will be glad to work with manufacturers in the selection of alloys of the composition, temper and surface quality that will assure long, trouble-free service.

announcing

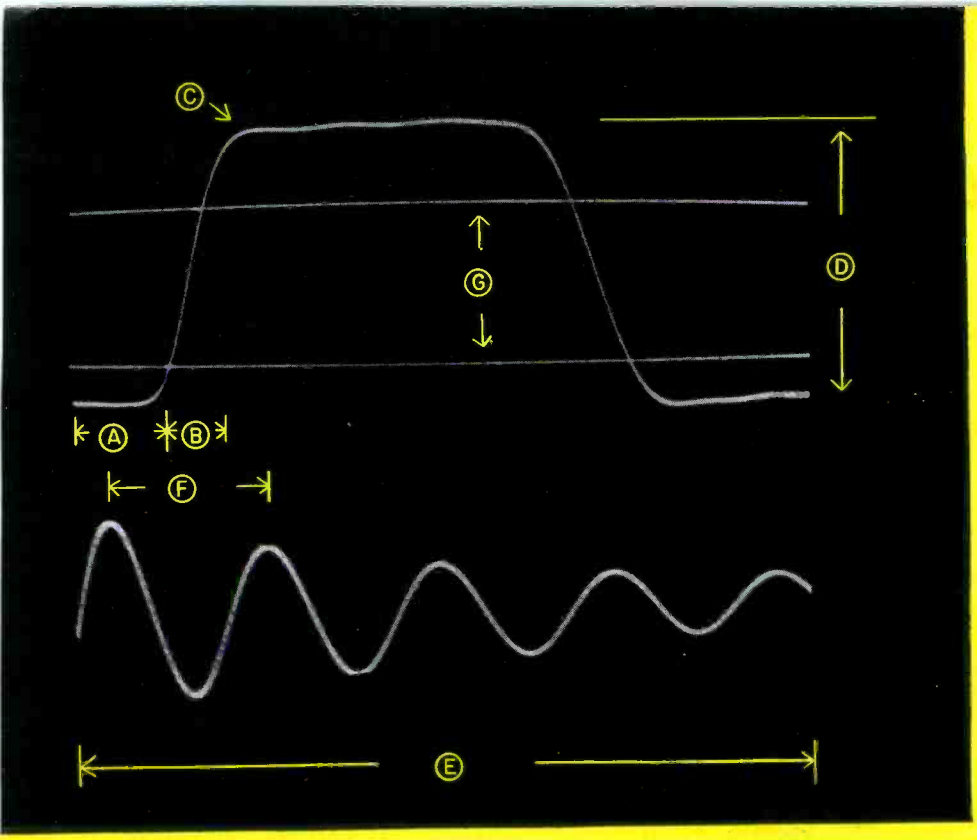
the new DuMont Type 303



a quantitative 10-megacycle CATHODE-RAY OSCILLOGRAPH



EXCELLENT FREQUENCY RESPONSE with a sensitivity of *0.1 volts, peak to peak, per inch* — down 3 db at 10 megacycles.



a SINGLE OSCILLOGRAM demonstrates...

A. Signal Delay
B. Transient Response
C. No High-Frequency Overshoot
D. Undistorted Deflection
E. Sweep Linearity and Speed
F. Time Calibration
G. Amplitude Calibration

Here, woven around the quantitative investigation of a 0.25 microsecond pulse, is a graphic account of the performance features which make the Type 303 an exceptionally fine, high-frequency cathode-ray oscillograph.

Time and voltage calibration, together with circuit refinements which make possible a more accurate qualitative presentation, add to the cathode-ray oscillograph a remarkable quantitative precision — invaluable to laboratory research.

A. SIGNAL DELAY built into the Y-axis amplifier insures complete display of the steep pulse rise. As illustrated by the portion "A", the 10% point of rise does not occur until sometime after the sweep starts. Y-axis frequency response, shown on reverse side, includes the performance of the signal-delay line.

B. EXCELLENT TRANSIENT RESPONSE — wholly essential to the proper study of high-speed phenomena — is depicted by the rise time which is reproduced without appreciable degradation. A rise time of 0.01 microsecond, or greater, will be reproduced as a rise time not exceeding 0.03 microsecond.

C. NO OVERSHOOT is observed even on extremely steep wavefronts. The low-frequency response limit is a 3% slope on a 30-cycle squarewave. As shown on the frequency-response curve, there is no positive slope above the mid-frequency range. Since the response tapers off so slowly, the Type 303 is usable at frequencies beyond 10 megacycles. The synchronizing circuits will lock in sine-wave signals as high as 20 megacycles.

D. UNDISTORTED DEFLECTION provided by the Y-axis amplifier is 2.5 inches for unidirectional pulses. An equivalent undistorted deflection of 5 inches is available for symmetrical signals and may be positioned over the useful area of the cathode-ray tube. Even at the highest attenuation ratios, the Y-axis input is not frequency sensitive, as shown by the illustrated pulse which has been attenuated 4000 times. The direct-coupled X-axis amplifier of the Type 303 will provide over 5" of undistorted deflection.

E. SWEEP SPEEDS available in the Type 303 make possible a presentation which is practical for qualitative and quantitative analysis of a pulse as short as 0.25 microsecond. Both driven and recurrent sweeps are continuously variable from 0.1 second to 5 microseconds. Through sweep expansion, sweep length is variable from a fraction of an inch to an effective 30 inches, any portion of which may be positioned on the screen. As shown above, even at the fastest sweep range, the sweep is extremely stable and linear. Notice the absence of jitter.

F. TIME CALIBRATION in the Type 303 is accomplished by substituting a damped sinewave for the signal. Double exposure by photographic recording of calibrating sinewave and signal provides a permanent quantitative analysis of the signal. In addition to the 10-megacycle signal shown above, calibrating frequencies of 10 KC, 100 KC, and 1 MC are also available. Accuracy of time calibration is within 3%.

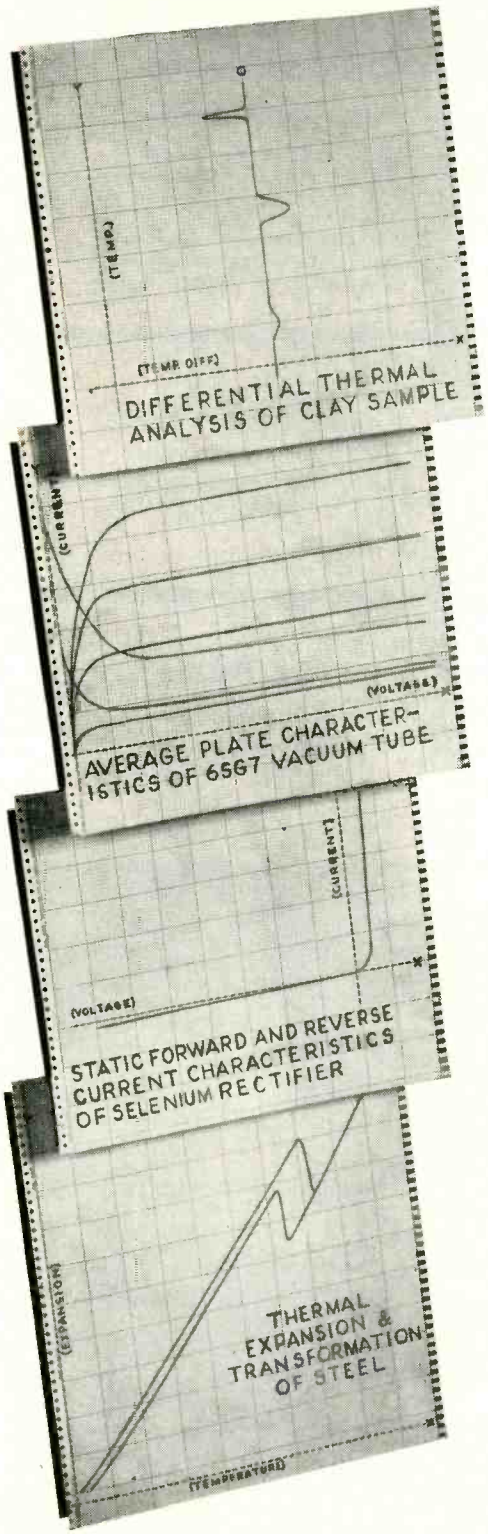
G. AMPLITUDE CALIBRATION completes the precise, quantitative analysis of the signal. A built-in, regulated, voltage-calibrator provides peak-to-peak signals of 0.1, 1.0, 10, and 100 volts. Similar to time calibration, the amplitude calibrating square wave is substituted for the signal. Amplitude calibration is accurate within 5%.

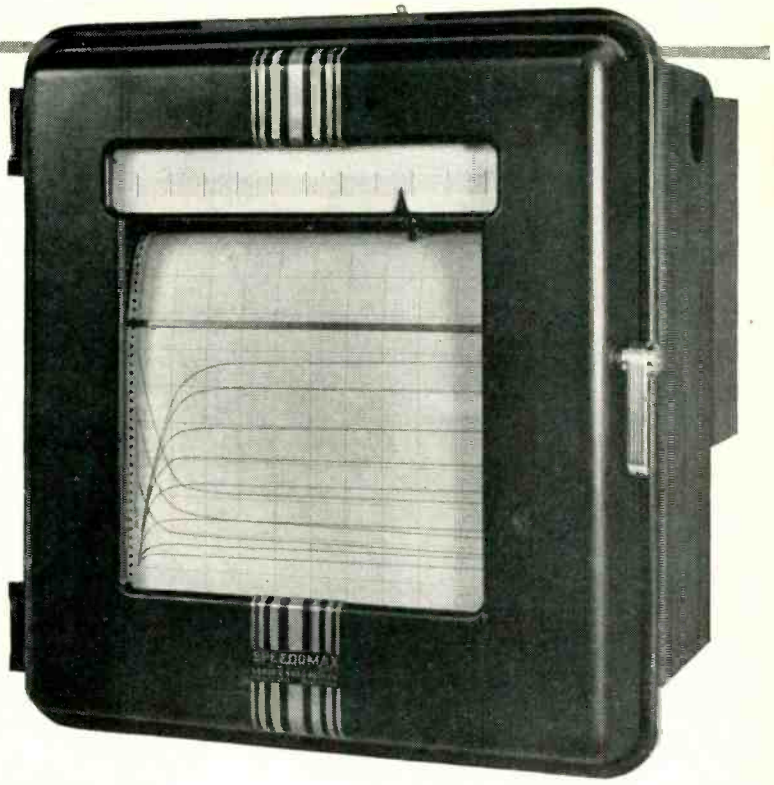
price $820.00 FOR COMPLETE DETAILS WRITE for bulletin TYPE 303

ALLEN B. DU MONT LABORATORIES, INC. Instrument Division 1000 Main Avenue, Clifton, N. J.

Now you can plot X vs. Y...automatically

TYPICAL CURVES





with the

New Speedomax 2-Function Recorder

Boon to engineering and research laboratories, this new Speedomax Recorder automatically plots a continuous, accurate curve showing the relationship between any two variables brought to the instrument in the form of d-c signals. Gone are those hours of tedious compilation and point-by-point plotting of data.

Just glance at these typical curves and note the instrument's remarkable versatility. Its big 10" chart provides remarkably complete detail. Potential applications are as broad as a researcher's imagination.

This new X-Y Recorder has two electronic circuits, one for each function. X corresponds to horizontal pen travel; Y to up-and-down movement of the chart. Input voltage can be as low as 2.5 mv for X; 10 mv for Y. Response time is amply fast—just 2 sec for full scale pen travel (X); 4 sec per 10" of chart (Y).

For details, send for Folder EM9-420(1). Write us at 4979 Stenton Ave., Philadelphia 44, Pa.

Jrl Ad EM9-420(2)

MEASURING INSTRUMENTS TELEMETERS AUTOMATIC CONTROLS HEAT-TREATING FURNACES

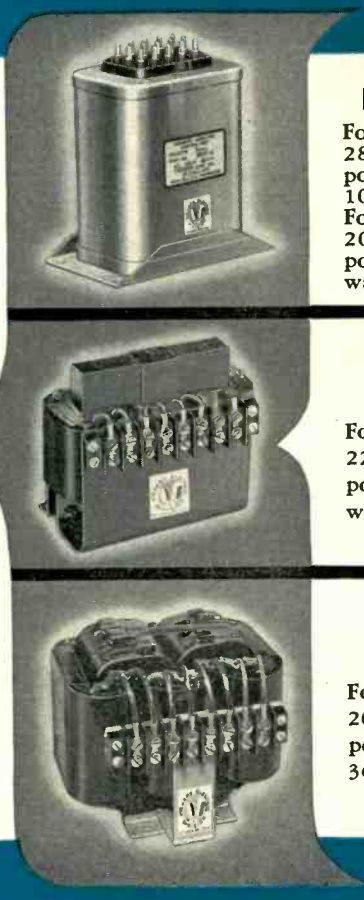
LEEDS & NORTHRUP CO.

3 TYPES OF VICKERS Standard MAGNETIC AMPLIFIERS

...designed to give you better control—at lower cost

Whatever your specific control operation needs in power . . . performance . . . and economy . . . you'll find a Vickers Standard Magnetic Amplifier that is tailored to give your control requirements these benefits:

- **NO MAINTENANCE**
- **HIGH PERFORMANCE**
- **RUGGED CONSTRUCTION**
  No Moving Parts
- **NO WARM-UP TIME**
- **A-C OR D-C CONTROL**
  A-C or D-C Output
- **RESPONDS TO SUM OR DIFFERENCE OF SEVERAL SIGNALS**
- **ALLOWS ELECTRICAL ISOLATION BETWEEN CIRCUITS**



HIGH PERFORMANCE

For 60 cps power sources — 28 styles — maximum output powers from milliwatts to 108 watts.
For 400 cps power sources — 20 styles — maximum output powers from 30 watts to 385 watts.

HIGH GAIN

For 60 cps power sources — 22 styles — maximum output powers from ½ watt to 1200 watts.

HIGH POWER

For 60 cps power sources — 20 styles — maximum output powers from 65 watts to 3660 watts.

TYPICAL APPLICATIONS

Servo Mechanisms • Line-to-line Voltage Regulators • Hydraulic Transmission Controls • A-C and D-C Generator Voltage Regulators • Speed and Frequency Regulators • Lamp and Furnace Controls
Temperature Regulators
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NOW AVAILABLE

BULLETIN 20-A, which lists condensed characteristics of the complete line of Vickers Standard Magnetic Amplifiers. Write for your copy today! Please make request on your letterhead.

VICKERS ELECTRIC DIVISION

VICKERS Inc.

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Mr. Isberg Proves A Point . . .

. . . regardless of how tough the service, Eimac 4E27A pentodes perform better—longer.

R. A. ISBERG, CHIEF ENGINEER, KRON-TV

TV AND FM SERVICES OF THE SAN FRANCISCO CHRONICLE

KRON-TV KRON-FM

CHANNEL 4 DIAL 96.5

TELEVISION AFFILIATE OF THE NATIONAL BROADCASTING CO.

June 13, 1950

Mr. O. H. Brown
Eitel-McCullough, Inc.
San Bruno, California

Dear Hank;

You will be interested to learn that the six Eimac 4E27A/5-125B tubes which were installed in the video modulator of our RCA TT-5A transmitter on March 11, 1950 are still functioning normally even though they have operated for nearly one thousand hours, and from all indications they will continue to give good service for many more hours.

The life history of 4E27/8001 tubes prior to the development of the improved version was uncertain; some tubes would fail within 100 hours of their installation and few would last more than 700 hours. This situation was especially aggravating in the picture modulator where six tubes are operated in parallel and the malfunctioning of any one tube could seriously degrade the picture or interrupt operation.

Following is a tabulation of the individual plate currents of the six tubes after approximately 1000 hours service in the picture modulator.

Tube No.	Plate Current
807	.178 Amperes
808	.171 "
809	.190 "
810	.173 "
811	.175 "
812	.185 "

We are happy that KRON-TV has been able to assist you in the "field test" of the new 4E27A and we feel that it will be welcomed by the television broadcasters because it will afford more reliable operation, reduce tube replacement costs, and promote greater satisfaction and confidence on the part of the operating personnel.

Kindest personal regards,

Sincerely,

Al Isberg

R. A. Isberg
Chief Engineer

RAI/md

901 MISSION STREET SAN FRANCISCO 19 GARFIELD 1-1500

The 4E27A is by no means limited to service in TV transmitters. Its rugged internal structures and pyrovac plate provide, in conventional amplifier or oscillator service, even far greater tube life than is indicated in the severe tests reported by Mr. Isberg.

This new Eimac pentode is rated at 125 watts of plate dissipation. Low grid-plate capacitances make it exceptionally stable and its high power-gain characteristics enable delivery of relatively large output with low driving power.

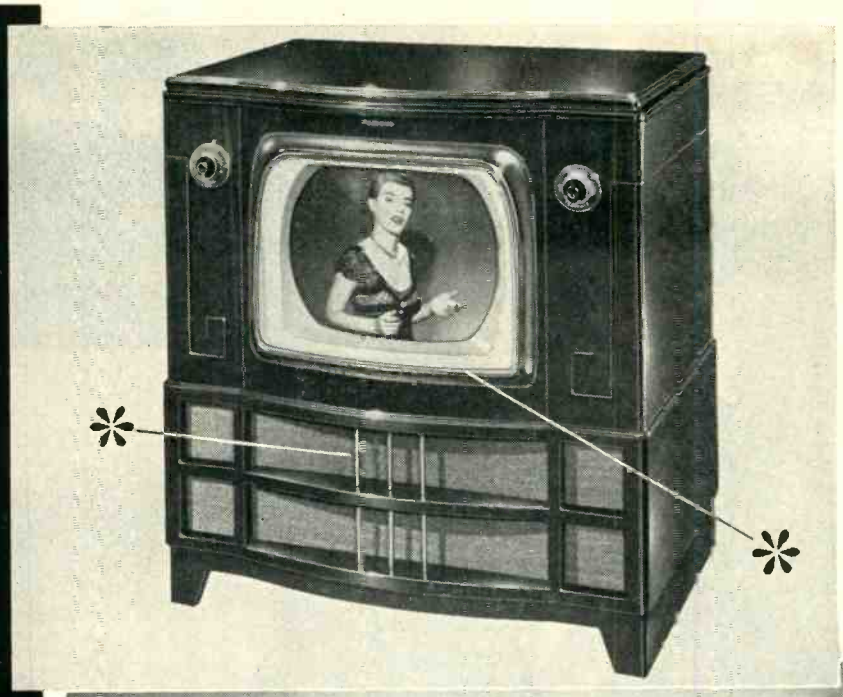
COMPLETE DATA ON THE EIMAC 4E27A BEAM POWER PENTODE IS AVAILABLE UPON REQUEST.

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

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

263

✻ REVERE COPPER AND BRASS *HELPS* keep TV Sales Hot FOR ~~CROSLEY~~ ...makes Cabinets Cool and Classy



The newest Crosley Television Cabinets are striking examples of how copper and brass can be used to give products sales appeal as well as serve a utilitarian purpose.

All models, two of which are shown above, are equipped with gleaming bezels which frame the television screens. They are made for the Crosley Corporation from Revere 90-10 Commercial Bronze. The table model shown is equipped with two control escutcheons drawn from this same metal by the Rex Engineering Company, Cincinnati, Ohio. The table model also has two strips of .0016" Revere Soft Copper of 5½" width on the under side of the top of the cabinet. This acts as an insulator by conducting any heat generated, away from the wooden cabinets. For, although copper is the best heat conductor of the commercial metals, when highly polished it dissipates rather than absorbs heat.

Note on the console model, shown above, how the three Revere Brass Tubes add a touch of luxury and richness to the cabinet.

Perhaps Revere Copper or Brass or one of its other metals or alloys can help in the development and improvement of your product. Why not call the nearest Revere Sales Office and see?

REVERE

COPPER AND BRASS INCORPORATED

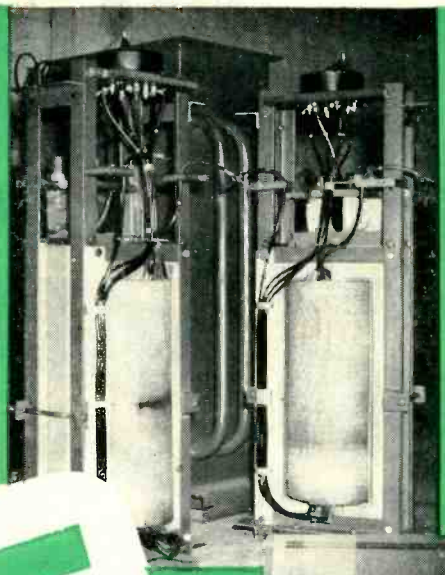
Founded by Paul Revere in 1801

230 Park Avenue, New York 17, New York

Mills: Baltimore, Md.; Chicago, Ill.; Detroit, Mich.; Los Angeles and Riverside, Calif.; New Bedford, Mass.; Rome, N. Y.

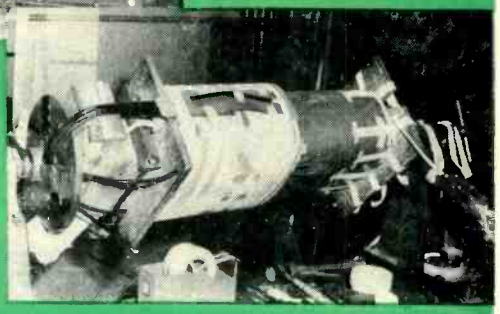
Sales Offices in Principal Cities, Distributors Everywhere

For Building or Rebuilding Transformers...



Core and coil assemblies of two 150 kva., single phase, 4330—125/250 volt transformers with 4—2½% taps, ready for mounting. Tierney has just built 30 of these submersible transformers for City Light, City of Seattle.

One of the coils being wound.



Tierney uses NATVAR 400

Natvar 400 Extruded Vinyl Tubing, approved for continuous operating temperature of 105°C., and with superior resistance to oil, is used to insulate and protect the leads.

The Tierney Electrical Manufacturing Company, Seattle, Washington, founded in 1933, repairs and manufactures distribution, power, and special transformers, and also repairs and rewinds any type or size of motor.

Like many other repair shops and smaller manufacturers, Tierney has discovered what the larger manufacturers already know—that it is profitable to standardize on Natvar products.

All Natvar flexible insulations are consistently uniform, no matter when or where purchased. They are immediately available either from your Wholesaler's stocks or direct from our own.

Natvar

Natvar Products

- Varnished cambric—straight cut and bias
- Varnished cable tape
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- Varnished tubings and sleevings
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THE NATIONAL VARNISHED PRODUCTS Corporation

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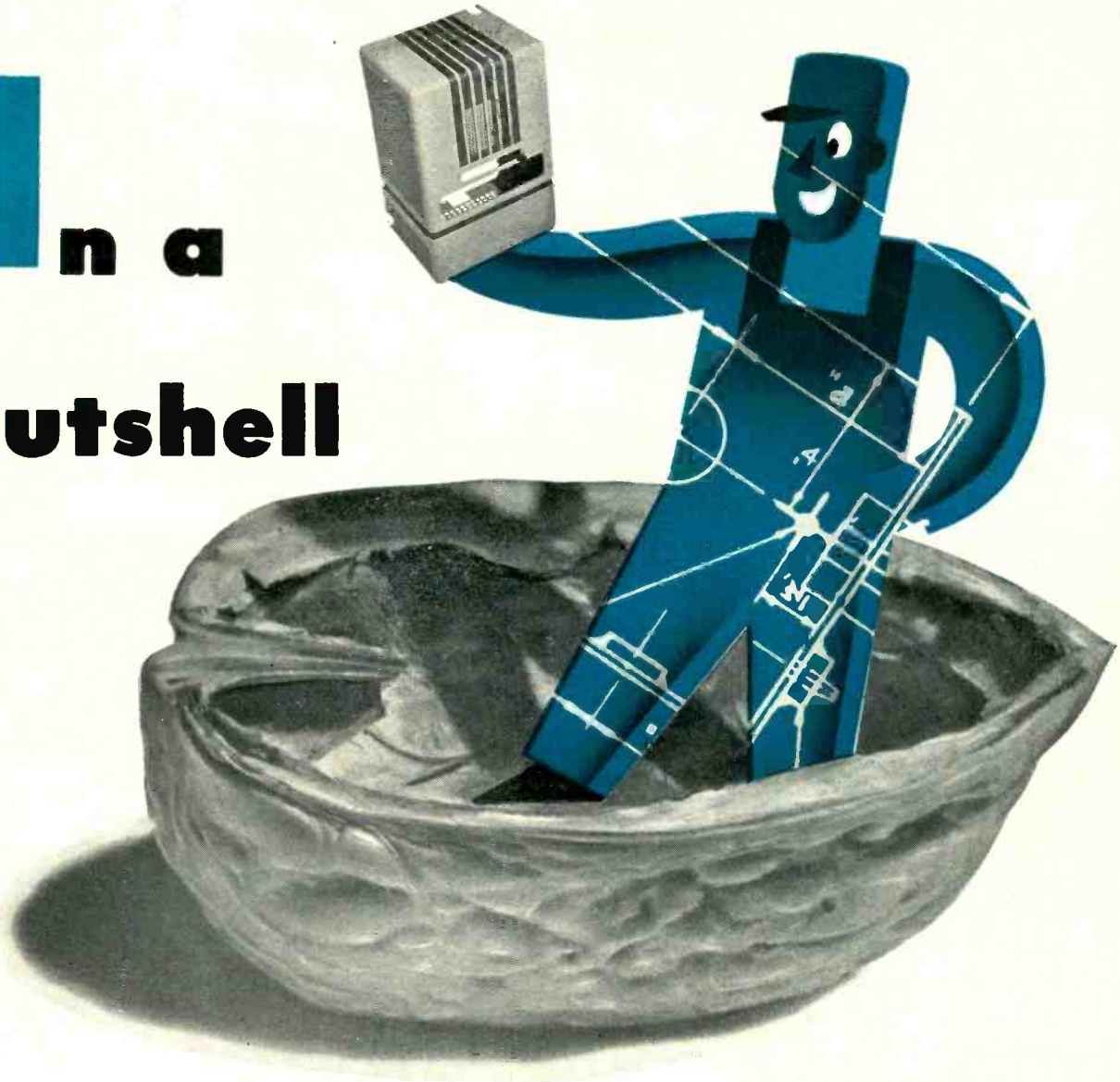
In a nutshell



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We are specialists in sheet metal fabrication with over 25 years' experience in our craft.

We have some of the most ingenious men in the industry—especially in our engineering department and among our technicians.

We have 70,000 square feet of ultra-modern plant, with every up-to-date aid in the way of tools, dies and machinery.

We have the most modern painting and finishing department, which is completely dust proof, and equipped with the newest water-washed spray booths and baking ovens.

We are geared to produce—at the right cost for its specifications—anything from a simple box or chassis to the largest transmitter housing—and in any quantity.

In short, we're at your service for sheet metal fabrication at its best. And we mean service!

KARP METAL PRODUCTS CO., INC.

215-63rd STREET, BROOKLYN 20, NEW YORK

Specialists in Sheet Metal for the Industry

Tuner Complaints reduced to 04%

with the use of Corning Metallized Glass Inductances!

A leading television manufacturer*, in a run of over 60,000 sets, has had only 25 complaints resulting from faulty tuners. There are good reasons for this. One of them is the fact that Corning Metallized Glass Inductances are included in the design.

The integral contact of fired-on metallizing with the special glass form makes Corning Inductances inherently stable. Drift is negligible, even under unusual temperature changes.

Tough and durable, Corning Inductances are not damaged by repeated handling. They are unaffected by vibration. The smooth glass wall assures noiseless tuning. They will give years of trouble-free service. When a receiver is shipped from the factory you know it will stay in alignment—complaints are minimized.

That's just part of the story. Corning Inductances make assembly rapid and easy. Installed by ordinary soldering or grommeting methods, they can be obtained with any length leads or just solder spotted. Tracking is assured by fine trimmer adjustments and consistently accurate inductance ratings. There is no time-consuming adjustment of coils as with inaccurate or less substantial inductances.

All of the above quality points regarding Corning metallized coils afford a precision inductance section of the tuner at an overall cost comparable to less stable coils plus compensating units.

Whatever your high frequency inductance requirements, Corning Metallized Glass Inductances can be designed to fit them exactly. Uniform, variable or double pitch windings are as easily manufactured as are fixed tuned, permeability tuned or permeability tuned inductance-trimmer combinations.

Let Corning engineers help you reduce tuner complaints and improve quality. Write for further information today.

Name on request.

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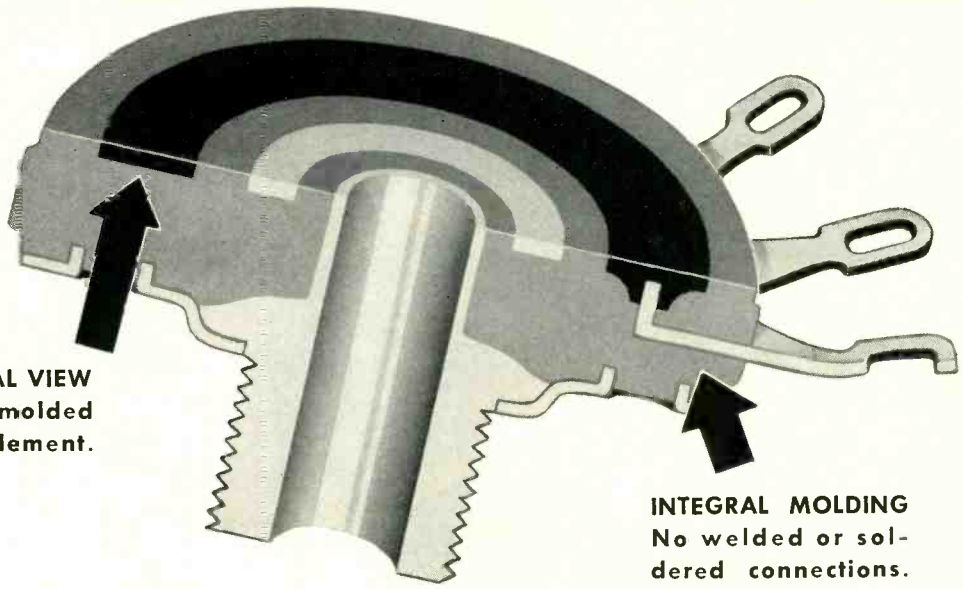
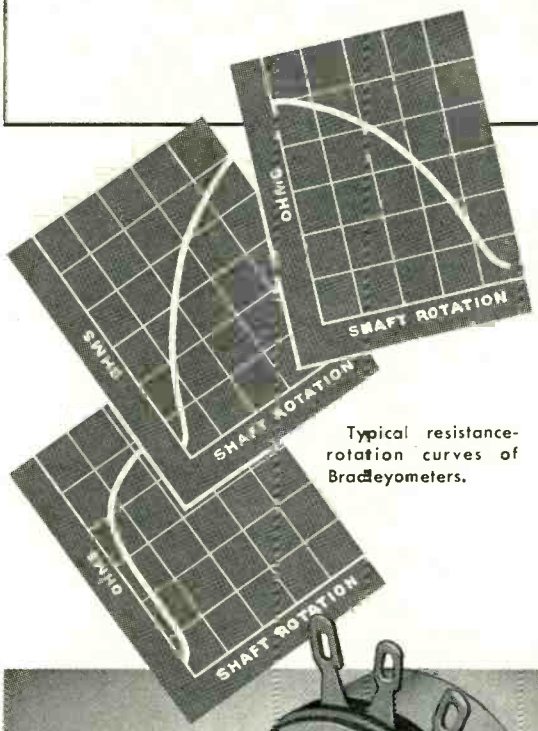


SECTIONAL VIEW
of solid molded
resistor element.

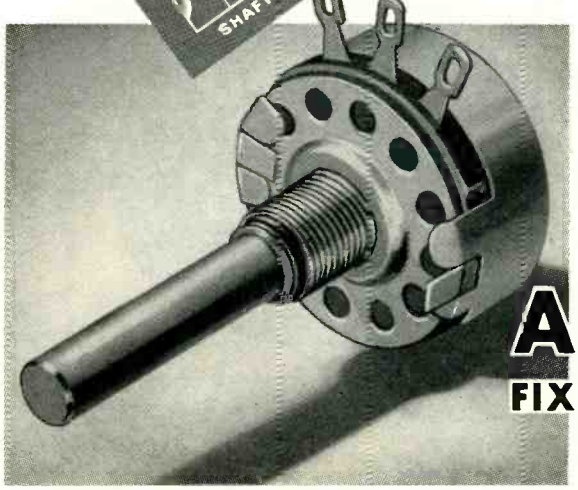
INTEGRAL MOLDING
No welded or sol-
dered connections.

Any Resistance-Rotation Curve

can be permanently molded into the Type J Bradleyometer



Typical resistance-rotation curves of Bradleyometers.



The Type J Bradleyometer can be built to produce any resistance-rotation curve because, during manufacture, the solid molded resistor can be varied in resistance throughout the circumference of the ring.

It is not a film or paint type resistor. The resistor unit is molded as one piece with terminals, face plate, and threaded bushing imbedded in the molded piece. After molding, the resistor material is no longer affected by heat, cold, moisture, or age. The contact brush actually improves with age.

Type J Bradleyometers can be supplied in single, dual, or triple unit construction for rheostat or potentiometer applications. A built-in line switch is an optional feature on single and dual models. Specifications sent upon application.

Allen-Bradley Co.
110 W. Greenfield Ave., Milwaukee 4, Wis.

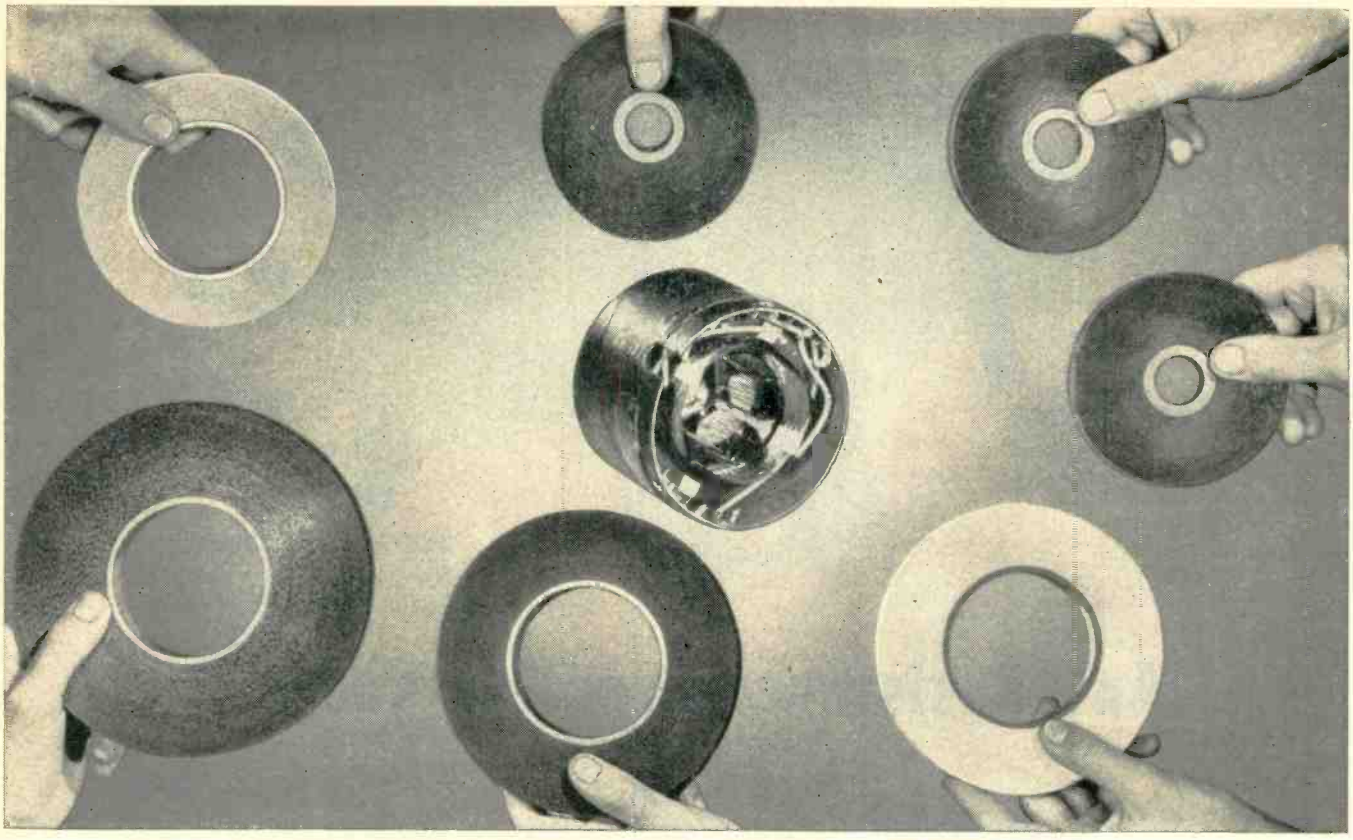
A-B

ALLEN-BRADLEY

FIXED & ADJUSTABLE RADIO RESISTORS

Sold exclusively to manufacturers of radio and electronic equipment

QUALITY



7 super-thin tapes in this compact TV coil!

Eight feet of tape holds and insulates 3 miles of crowded wiring

Crowded TV deflection coils get complete insulation with "SCOTCH" Electrical Tapes. At the Crosley Division of AVCO Manufacturing Corp., Cincinnati, Ohio, ninety-six inches of 7 different types of "SCOTCH" Electrical Tape protect *three miles* of wire inside the coil housing!

You get high dielectric and mechanical strength combined with thin caliper in "SCOTCH" Electrical Tapes. They're pressure-sensitive, clean to handle, take up little room. There are over 30 different tape formulations—many types of backings and electrical type adhesives, including vinyl plastic, acetate, cloth, treated paper, glass cloth and neoprene. In addition, there is new No. 880 Filament Tape—practically unbreakable, with strong fibers running lengthwise. It holds the channel retainer and nut in place—takes the place of a steel band—rapidly and easily applied. For full information mail coupon to Dept. ES-950.

MINNESOTA MINING & MFG. CO.
900 Fauquier Ave.
St. Paul 6, Minnesota

Please send full information on the complete line of "SCOTCH" Electrical Tapes.

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FIRM_____

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CITY_____ ZONE____ STATE_____

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SCOTCH BRAND
Electrical Tape

Made in U. S. A. by **MINNESOTA MINING & MFG. CO.**, St. Paul 6, Minn.

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NEW hp SIGNAL GENERATOR

FAST DIRECT READINGS

800 mc to 2100 mc

NO CHARTS OR INTERPOLATIONS

-hp- 614A UHF Signal Generator

Direct reading output, accuracy ±1 db...Constant internal impedance, SWR 3 db...Direct frequency control...External modulation 0.5 microseconds pulses to square waves...CW, FM, pulsed output.

This new –*hp*– signal generator will save you hours of time and work in making UHF measurements between 800 and 2100 mc. Its many different modulation and pulsing capabilities mean these man-hour economies can be applied to a wide variety of measurements—receiver sensitivity and alignment, signal-to-noise ratio, conversion gain, standing wave ratios, antenna gain and transmission line characteristics, to name but a few.

Carrier frequency in mc can be set and read directly on the large central tuning dial. R-f output from the klystron oscillator is also directly set and read in microvolts or db. No calibration charts or tedious interpolation are necessary. And thanks to the unique –*hp*– automatic tracking mechanism, no voltage adjustments are needed during operation.

R-f output ranges from 0.1 volt to 0.1 microvolt. Output may be continuous, pulsed, or frequency modulated at power supply frequency. The instrument may be modulated either externally or internally and may be synchronized with positive or negative pulses or sine waves.

Because of its wide range, high stability and versatile usefulness, this new –*hp*– signal generator is adaptable to almost any uhf measuring need. The instrument is available for early delivery. Contact your –*hp*– field representative or write direct to factory for complete details and technical specifications.

HEWLETT-PACKARD CO.
1874-D Page Mill Road, Palo Alto, California
Expert Agents: Frazar & Hansen, Ltd.
301 Clay Street • San Francisco, Calif., U.S.A.

SPECIFICATIONS

FREQUENCY RANGE:
800 to 2100 mc. Selection is made by means of a single directly-calibrated control covering entire range. No charts are necessary.

FREQUENCY CALIBRATION ACCURACY:
±1%.

OUTPUT RANGE:
1 milliwatt or .223 volts to 0.1 microvolt (0 dbm to –127 dbm). Directly calibrated in microvolts and db; continuously monitored.

ATTENUATOR ACCURACY:
Within ±1 db without correction charts. A correction chart is provided when greater accuracy is desired.

50 ohms. SWR 3 db (VSWR 1.4).

EXTERNAL MODULATION:
By external pulses, positive or negative, peak amplitude 40 to 70v., 0.5 microseconds to square wave.

FM MODULATION:
Oscillator frequency sweeps at power line frequency. Phasing and sweep range controls provided. Maximum deviation approximately ±5 mc.

INTERNAL MODULATION:
Pulse repetition rate variable from 40 to 4000 per second; pulse length variable from 1 to 10 microseconds. Pulse rise and decay approximately 0.1 microseconds.

TRIGGER PULSES OUT:
1. Simultaneous with r-f pulse.
2. In advance of r-f pulse, variable 3 to 300 microseconds.
(Both approximately 1 microsecond rise time, height 10 to 40 volts.)

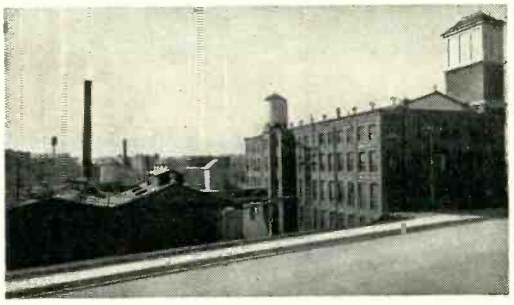
EXTERNAL SYNC PULSE REQUIRED:
Amplitude from 10 to 50 volts of either positive or negative polarity and 1 to 20 microseconds width. May also be synchronized with sine waves.

Data subject to change without notice.

hp laboratory instruments
FOR SPEED AND ACCURACY

NOW... AMERICAN SCREW CO.
Steps Up National Distribution

New plant at Willimantic, Conn.... one of the most modern operations in the screw industry.



Norristown, Pa., plant, now a full-scale American production unit manufacturing a complete line.

Chicago Warehouse in North Pier Terminal, 589 E. Illinois St., Chicago, Ill.

...as production steps up in NEW WILLIMANTIC PLANT

American's pipelines are being pumped full of ample supplies of all types of Phillips and slotted fasteners. Industrial supply distributors and hardware jobbers from coast to coast are set to serve you *now.*

For American's new high-production plant in Willimantic is now geared up to meet all demands promptly and efficiently. And this production is further augmented by the American plant at Norristown, Pa., while distribution is kept on a "delivery now" basis by large warehouse stocks in Norristown and Chicago.

So today, if you want *action* on orders for Phillips and slotted fasteners . . . just mark those orders "AMERICAN"!

4-WINGED DRIVER CAN'T SLIP OUT OF PHILLIPS TAPERED RECESS

Phillips

AMERICAN SCREW COMPANY
Plants at:
WILLIMANTIC, CONN. and NORRISTOWN, PA.
Warehouses at:
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502 STEPHENSON BLDG. DETROIT 2

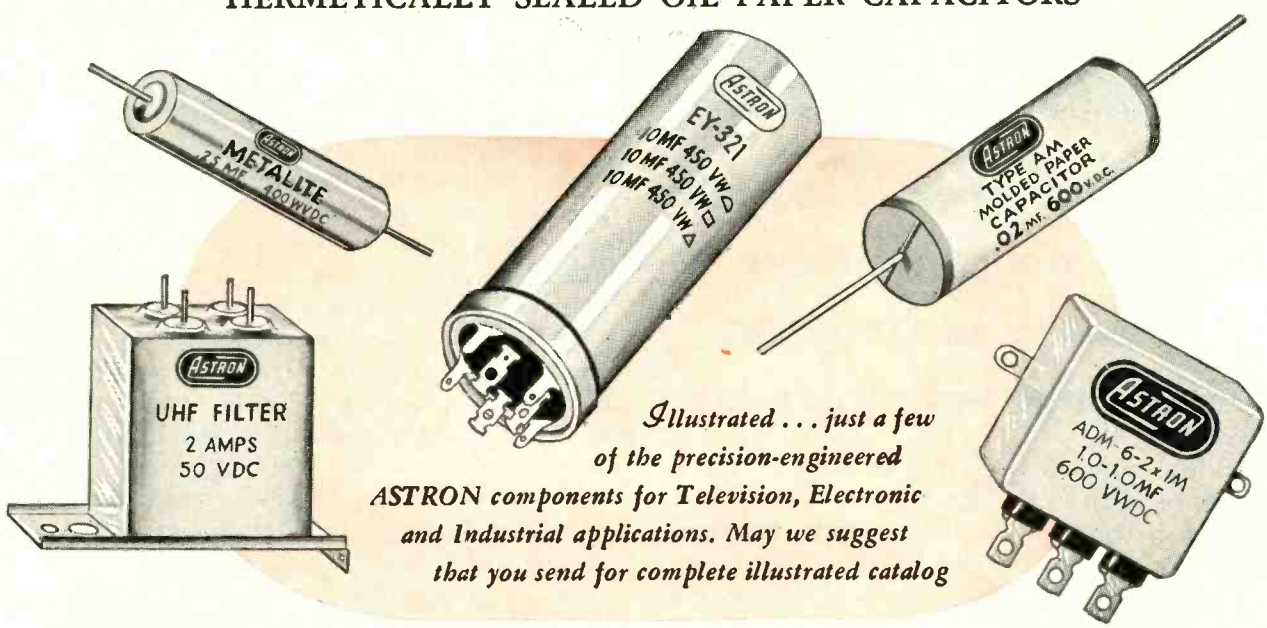
AMERICAN SCREWS

Slotted

Consecrated to Quality Output and Golden Rule Service

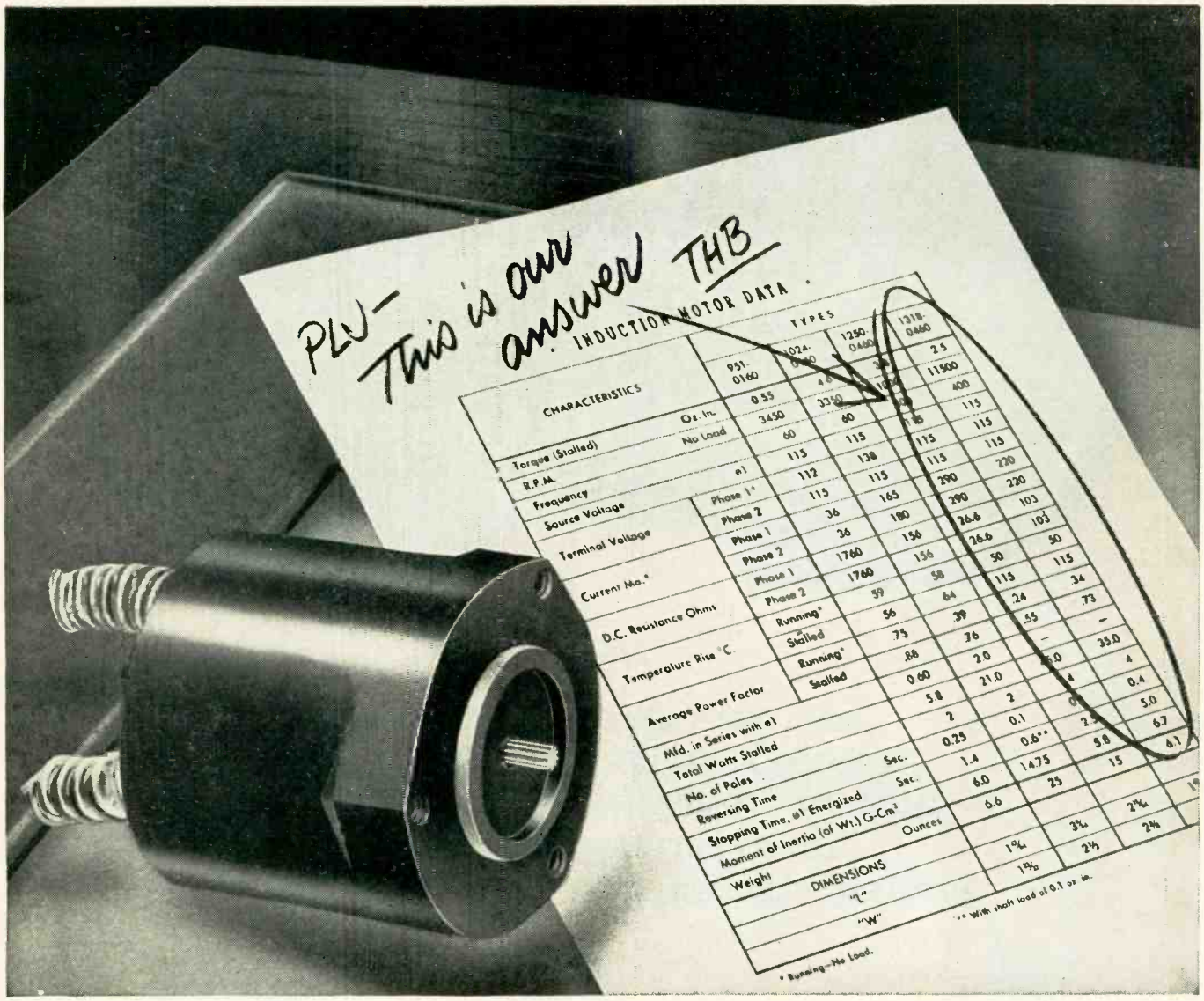
ASTRON

DRY ELECTROLYTIC CAPACITORS
MOLDED PAPER TUBULAR CAPACITORS
"METALITE" METALLIZED PAPER CAPACITORS
RADIO INTERFERENCE FILTERS
HERMETICALLY SEALED OIL PAPER CAPACITORS



Illustrated . . . just a few of the precision-engineered ASTRON components for Television, Electronic and Industrial applications. May we suggest that you send for complete illustrated catalog

ASTRON CORPORATION
255 Grant Avenue East Newark, New Jersey
HIGH QUALITY FIXED CAPACITORS AND FILTERS



Your answer, too, for extreme precision in remote indication and control systems

Instant responsiveness, complete smoothness of operation and a high torque/rotor inertia ratio make Kollsman Induction Motors ideally suited for use as servo or follow-up motors in control mechanisms. These miniature two-phase units have fast starting, stopping and reversing characteristics and deliver maximum torque at stall. Designed with distributed wound starors and squirrel-cage type rotors, they perform smoothly from zero to maximum r.p.m., with no "cogging" action in the low speed ranges. They may be energized by two-phase AC or by single-phase, using a phase-splitting condenser in series with one winding.

The Induction Motors constitute one series in a complete line of special purpose AC motors designed and manufactured by Kollsman, leader in the field of precision aircraft instrumentation and control. Among those available, you may find the exact answer to your control problem. If not, the skill and experience of Kollsman engineers may be relied upon to produce a unit that fulfills your particular specifications. For further information regarding these motors, address: Kollsman Instrument Division, Square D Company, 80-08 45th Avenue, Elmhurst, New York.

KOLLSMAN INSTRUMENT DIVISION

SQUARE D COMPANY

ELMHURST, NEW YORK GLENDALE, CALIFORNIA

TUNG-SOL

5881

BEAM POWER AMPLIFIER

for the ultimate in reliability where the 6L6 is called for . .

see other side for additional information

TUNG-SOL

a new beam power amplifier embodying all the important improvements in electron tube design . . .

Absolute reliability!

There, in two words, is the net result of all the engineering which TUNG-SOL has put into the 5881. This completely new tube is designed to operate in circuits for which the 6L6 is specified and is completely interchangeable wherever the 6L6 is now in use. Full utilization of the design and production techniques which have proved themselves over the past 15 years, has created this exceptionally reliable tube. The 5881 has tremendous overload capacity. It maintains high efficiency throughout its life and provides low cost operation through reduced maintenance.

The 5881 is manufactured under laboratory conditions accompanied by the most severe tests. It is rugged both mechanically and electrically. Here are six major features which assure its premium performance:

1. Glass button stem permits compact construction with high resistance to mechanical shock.

2. Rugged micanol low-loss base provides full lifetime electrical insulation and minimizes base leakage.

3. Cathode materials of exceptional stability give more uniform emission with greater life expectancy. Cathode is not poisoned by inactivity during standby periods.

4. Maximum control of grid emission achieved by gold plating and carbonizing.

5. Zirconium anode coating is most active under overload conditions providing ample gettering action to prevent accumulation of gases.

6. Life tests are made under severe overload conditions to assure adequate safety factor.

Where reliable service is essential in audio circuits, the TUNG-SOL 5881 is a "must." Order it from your regular TUNG-SOL supplier.

MECHANICAL DATA

Envelope	Glass RMA T-11
Base	Short shell micanol
Overall length	3-15/32"
Seated height	2-29/32"
Maximum diameter	1-7/16"

ELECTRICAL DATA

Maximum Ratings—(Design Center System in accordance with RMA Standard M8-210)

Plate dissipation	23 WATTS
Screen dissipation	3 WATTS
Plate voltage	360 VOLTS
Screen voltage	270 VOLTS
Heater-cathode potential	200 VOLTS
Heater voltage	6.3 VOLTS

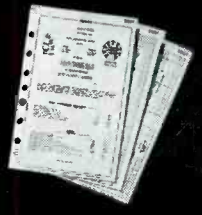
ELECTRICAL DATA

Typical Operating Conditions and Characteristics (Class A Amplifier)

Heater voltage	6.3	6.3	6.3	VOLTS
Heater current	0.9	0.9	0.9	AMP.
Plate voltage	250	300	350	VOLTS
Screen voltage	250	200	250	VOLTS
Grid voltage	−14	−12.5	−18	VOLTS
Peak A-F signal voltage	14	12.5	18	VOLTS
Transconductance	6100	5300	5200	μMHOS
Plate resistance	30000	35000	48000	OHMS
Zero signal plate current	75	48	53	MA.
Zero signal screen current	4.3	2.5	2.5	MA.
Maximum signal plate current	80	55	65	MA.
Maximum signal screen current	7.6	4.7	8.5	MA.
Load resistance	2500	4500	4200	OHMS
Power output	6.7	6.5	11.3	WATTS
Total harmonic distortion	10	11	13	%

TUNG-SOL
ELECTRON TUBES

The TUNG-SOL engineering which has produced the 5881 is constantly at work on a multitude of special electron tube developments for industry. Many exceptionally efficient general and special purpose tubes have resulted. Information about these and other types are available on request to TUNG-SOL Commercial Engineering Department.



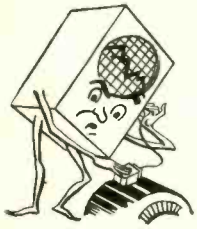
TUNG-SOL LAMP WORKS INC., NEWARK 4, NEW JERSEY

SALES OFFICES: ATLANTA • CHICAGO • DALLAS • DENVER • DETROIT • LOS ANGELES • NEWARK

Also Mfrs. of: RECEIVING TUBES, MINIATURE INCANDESCENT LAMPS, ALL-GLASS SEALED BEAM HEADLIGHT LAMPS and CURRENT INTERMITTORS

SEPTEMBER, 1950

How to get to the bottom of VIBRATION troubles...*fast!*

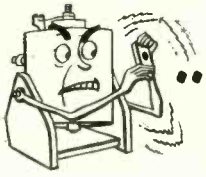


DETECT and measure vibration with this **MB PICKUP**

You'll find many tough vibration problems greatly simplified by the information an MB Pickup supplies. This sensitive instrument tells you how much vibration is being generated in your product. It enables you to check the efficiency of vibration isolation suspensions. It offers you a means for analyzing troubles from disturbing frequencies. As a quality control tool, it can also be used to check whether vibration is within acceptable limits.

This precision-built MB Pickup has virtually no lower limit to the amplitudes it can detect. Yet, it will withstand rough treatment and can be used for study of high energy vibrations as well. Attached to equipment under test, it transforms vibratory motions to electrical waves which you then feed to oscilloscope for visual inspection; or to vibration meter or analyzer for quantitative data.

Write for full details and specifications.



...SHAKE out the answer with this **MB EXCITER**

Here's the versatile shaker that is helping many leading companies turn out a better product — by shaking out "bugs" and exposing potential service problems.

It reproduces the vibratory effect of *years* of service within hours. Force and frequency are adjusted with a twist of the dial. Thus, not only can you easily "scan" products and parts for vibratory response, but also fatigue-test them, even to destruction. Used in conjunction with stroboscopic light, MB Exciters permit you to observe *visually* the vibratory motions. The shaker operates silently, and can help you locate and eliminate noise.

MB Exciters are being used for testing such objects as tubes, electrical components, assemblies, chassis, castings, forgings—even heavy mechanical equipment. Let us show *you* how to profit with one.

SEND FOR BULLETINS

No. 210-K5 gives you full details on the line of MB Exciters; No. 124-K5 on MB Vibration Pickups.

THE MB MANUFACTURING COMPANY, Inc.

1060 State St., New Haven 11, Conn.

PRODUCTS FOR *MEASUREMENT*...*REPRODUCTION*...AND *CONTROL* OF VIBRATION

MEMO TO WELDER MANUFACTURERS

FOR PLUS VALUES

Specify G-E Ignitrons

—More tube-design know-how! General Electric pioneered electronic controls for welding.

—More precise G-E manufacture, using highest-grade materials.

—More step-by-step tube inspections—more top-rating final tests before the product reaches your hands.

EXPERIENCE is the best guide to dependable tube design. Because electronic welding control is a G-E "first," General Electric experience excels. Twenty years ago—to name but one example of leadership—the first electronic welder used in the automotive industry was built by General Electric. Thousands of similar welders speed car and truck production today.

Backed by this big fund of practical welding knowledge, G-E control ignitrons should lead in quality. And they do!

A check of component materials, shows instance after instance of choice based solely on quality. Precision manufacture shapes these selected materials into sturdy, long-serving G-E ignitrons which—having passed a series of rigid inspections—then are subject to extensive tests under actual welder conditions at max ratings.

G-E ignitrons are *right* when you install them, and they stay right! Let expert G-E tube engineers work with you on their application. Wire or write *Electronics Department, General Electric Company, Schenectady 5, New York.*

GL-5551/FG-271

One of the most widely used G-E ignitrons—an established favorite in the welding industry. With max kva demand 600, the average anode current is 30.2 amp. Max average anode current of 56 amp checks with a kva demand of 200. . . . Other popular G-E ignitrons for resistance welding are the GL-5550/GL-415, GL-5552/FG-235-A, and GL-5553/FG-258-A. Ratings sent promptly on request.

GL-5822

Newest of the G-E ignitron line, and expressly designed for the rapidly growing 3-phase welding field. Peak voltage forward and inverse is 1,200 v, with peak and avg anode currents of 1,500 and 20 amp, or 420 and 70 amp . . . or 1,500 v, with currents of 1,200 and 16 amp, or 336 and 56 amp. Straight-line interpolation on log-log paper is allowed between similar current points. . . . Other G-E ignitrons for 3-phase welding are the GL-5554/FG-259-B and GL-5555/FG-238-B. Ratings gladly furnished.

GENERAL ELECTRIC

100-J20

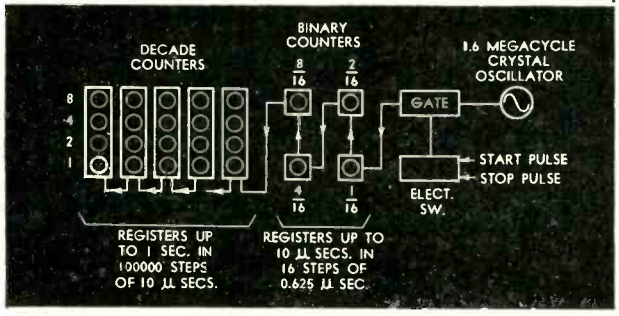
Divides a second into 1,600,000 parts—

1.6 MEGACYCLE COUNTER-CHRONOGRAPH

INSTRUMENT Potter COMPANY

APPLICATIONS:

PROJECTILE VELOCITY MEASUREMENTS
CAMERA SHUTTER TIMING
FREQUENCY MEASUREMENTS
PRECISION TACHOMETER
RELAY CONTACT TIMING
GEOPHYSICAL MEASUREMENTS
GAS TUBE MEASUREMENTS



FEATURES:

- **High Resolution and Accuracy—1/1,600,000 second.**
- **Direct Indication of intervals up to one second — recycling of counter can be observed or recorded for longer intervals.**
- **Retains Indication of measurement until reset.**
- **Easy to actuate — pulses from common or separate sources can be used.**
- **Dependable and stable — no adjustments required.**
- **Accepted standard in practically all government proving grounds.**

PRINCIPLE OF OPERATION:

A quartz crystal, continuously oscillating at 1.6 mc is used as a time base. During the time interval to be measured the cycles are gated into four binary counting stages having a capacity of 16 counts. The neon indicator lights of these stages are numbered 1/16, 2/16, 4/16, and 8/16 (sixteenths of 10 microseconds or 0.625 microsecond). Following the binary stages are five decade counting units having a capacity of 100,000 counts. Each count entering the decades from the binary stages represents 10 microseconds. Therefore, the time interval between 10 microseconds and 1 second is registered in the decades and the remainder is registered in the binary stages. For instance a time interval of .5374825 second would be indicated as follows: .53748 on the decade indicators plus 4/16 (of 10 microseconds) on the binary indicators.

HIGH SPEED ELECTRONIC COUNTERS, COMPUTERS AND PRECISION INTERVAL TIMERS FOR ALL APPLICATIONS—ADDRESS INQUIRIES TO DEPT. 6-V

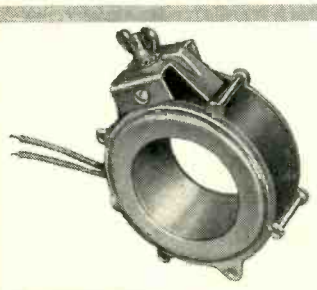
POTTER INSTRUMENT COMPANY
INCORPORATED
115 CUTTER MILL ROAD • GREAT NECK • NEW YORK

INSTRUMENT Potter COMPANY

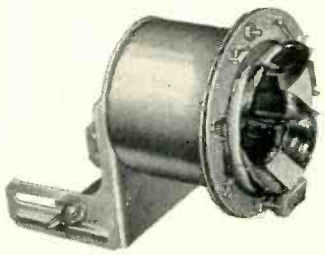
A NEW SERVICE TO TV MANUFACTURERS

A NEW MARKET FOR TV SERVICEMEN

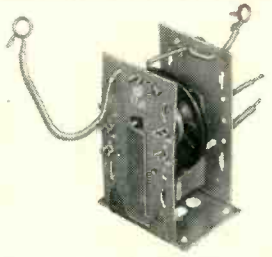
with General Electric TV Components



EM-PM FOCUS COIL—These units combine the effects of Alnico 6 permanent magnet and an electromagnet to provide uniform focus with a minimum of circuit power.



NEW DEFLECTION YOKE—Sweeps 70° with only 20 watts of power from a 260-volt supply. Ferrite core units available for high efficiency applications.



HORIZONTAL SWEEP TRANSFORMER—When used with high efficiency yokes, these ferrite core transformers provide 70° deflection at 13 kv.

You can put your confidence in—

GENERAL ELECTRIC • •

RECEIVER MANUFACTURERS

You can cut replacement parts servicing problems to a minimum... keep your sets in the field with the assurance of ready serviceability . . . reduce material and handling costs... by designing General Electric TV components into your product.

More than twenty TV receiver manufacturers are now using G-E components. Big makers like them because they're expertly fabricated, dependable, backed by a name you can depend on.

Smaller manufacturers turn to G.E. for components specially adapted to fit particular designs. Remember—when you use G-E parts, duplicates are stocked by G-E distributors and dealers everywhere —automatic assurance that your sets will be repaired in the field, not returned to the factory.

SERVICEMEN

Estimates peg the TV market at ten million sets in use by the end of 1950... *that's your opportunity!*

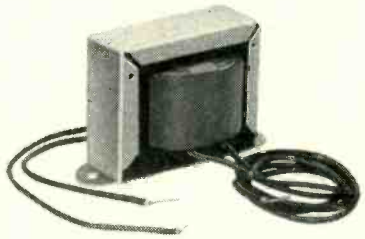
Millions of G-E parts are now in receivers everywhere... and more manufacturers are turning to General Electric every day... Be sure you get your share of the skyrocketing replacement business that supports these receiver sales... *that's your market!*

Now—*for the first time*—dealers and servicemen can stock the complete line of General Electric components shown here! They're available through parts jobbers and distributors in your area.

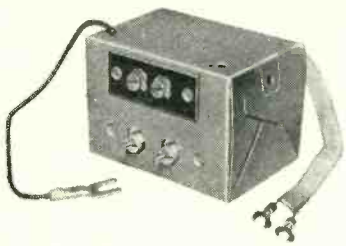
Put yourself in the replacement business for keeps—and for profit. Call your jobber or distributor for full details. Meanwhile, send for the complete G-E Parts Catalog, just off the press. Mail the coupon and the catalog will be rushed to you—free!

WIDTH & LINEARITY CONTROLS—
Provide convenient control of picture and linearity by screwdriver adjustment.

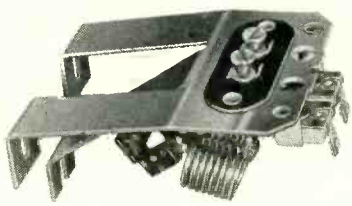
ION TRAP MAGNET—
Available in two sizes, 35 and 42 gauss.



VERTICAL SWEEP TRANSFORMER—For use in magnetic deflection circuits from 50°-70°. Designed to match vertical output tube to deflection yoke.

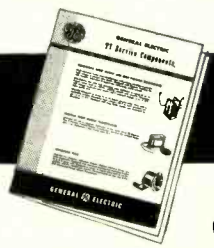


FM WAVE TRAP—Reduces or eliminates interference caused by FM broadcasting stations operating in 88 to 108 mc channels.



IF WAVE TRAP—Designed to reduce or eliminate interference on TV receivers caused by signals at IF frequencies of 41-47 mc.

ARE YOU READY? MAIL THIS COUPON TODAY!



General Electric Company, Section 490, Electronics Park, Syracuse, N. Y.

I want my share of the new TV replacement market. Send me complete catalog of TV components and facts on service sales.

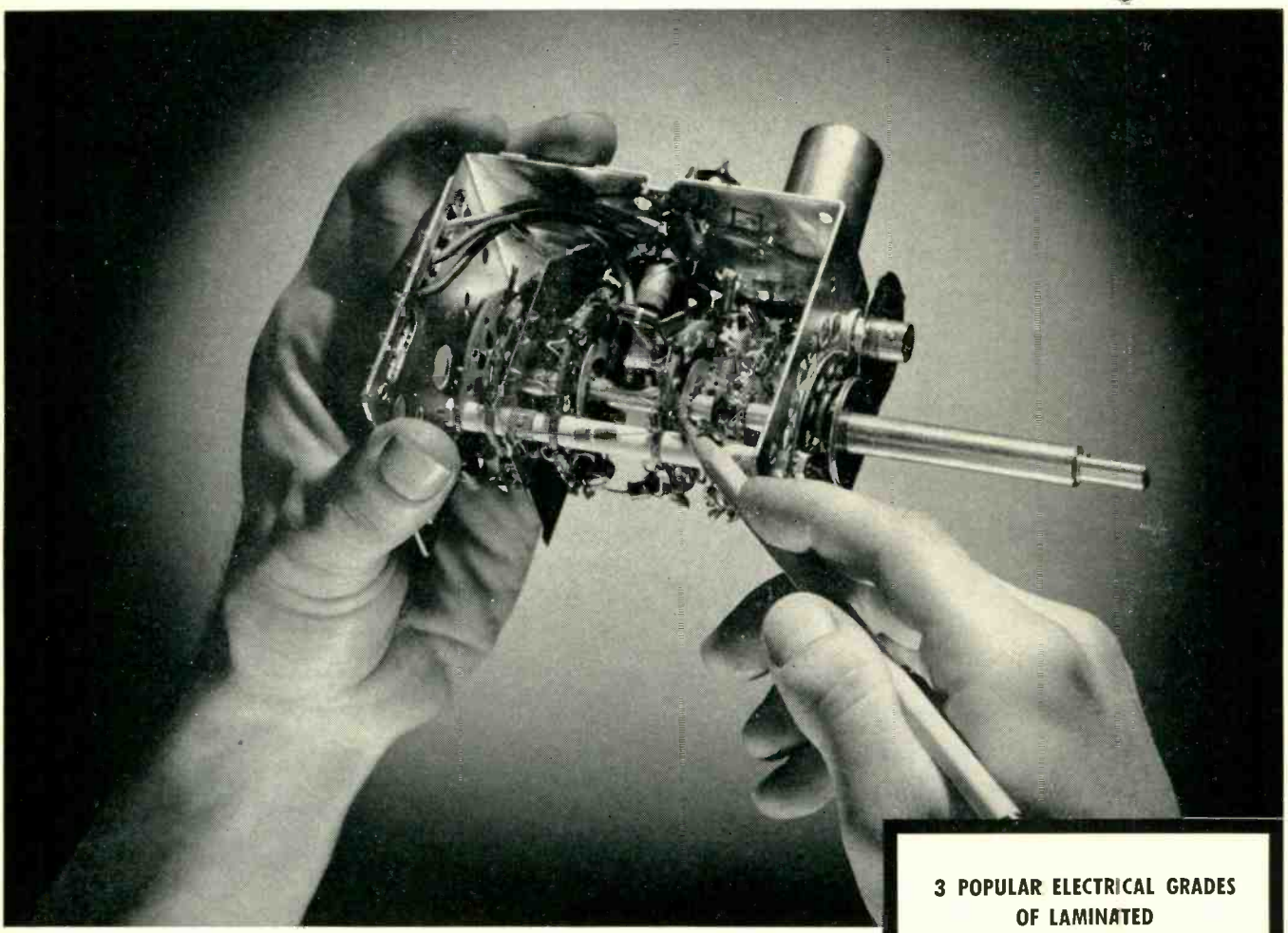
NAME_____

ADDRESS_____

CITY_____ STATE_____

INSUROK T-725

Retains Its Properties ...even AFTER SANDING



That's why it is used in this Tarzian Tuner . . . standard in TV sets of 17 leading manufacturers

Most laminated insulation that can be punched depends largely upon high-resin content surface for the maintenance of its electrical properties under conditions of varying humidity. When sanded to close tolerances, this surface is removed—seriously impairing the electrical behavior of the material.

INSUROK T-725, however, is uniformly top-quality insulation throughout the sheet. Sand it and it is still better than most unsanded materials.

This is one of the reasons why Oak Manufacturing Company selected INSUROK T-725 for the components it makes for Sarkes Tarzian, who supplies tuning heads to 17 leading TV manufacturers. Investigate INSUROK T-725 for your product. Full information upon request.

3 POPULAR ELECTRICAL GRADES OF LAMINATED

INSUROK

T-725 An outstanding paper-base laminate that can be hot-punched to intricate shapes. Has excellent electrical and physical properties, is stable under moisture and heat.

T-800 Has unmatched electrical properties, yet punches with ease. It has a sensational ability to retain these properties in high humidity.

T-812 A further development in the electrical sheet field with insulation resistance on the order of T-800 and mechanical properties comparable to T-725.

The RICHARDSON COMPANY

FOUNDED IN 1858

2797 Lake St., Melrose Park, Illinois (Chicago District)

SALES OFFICES: CLEVELAND • DETRIOT INDIANAPOLIS • LOCKLAND, OHIO • MILWAUKEE NEW BRUNSWICK, (N.J.) • NEW YORK • PHILADELPHIA ROCHESTER • ST. LOUIS

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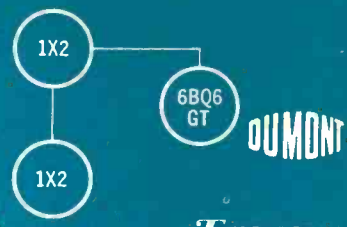
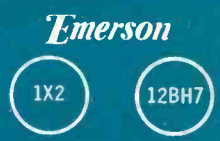
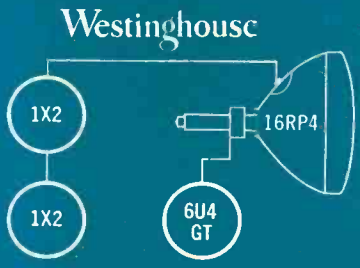
BUY WISE...

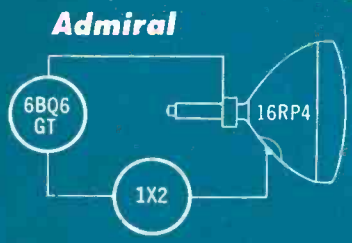
BUY THE ORIGINALS...

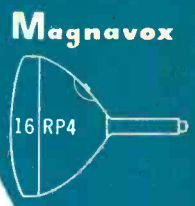
BUY HYTRON TV FIRSTS

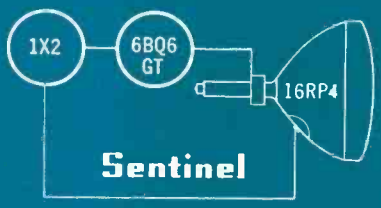


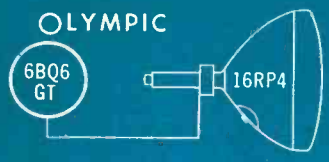


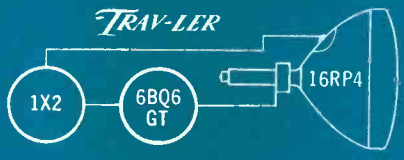


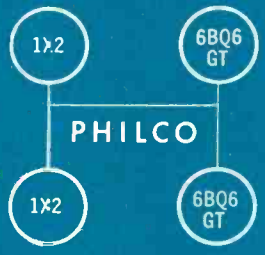


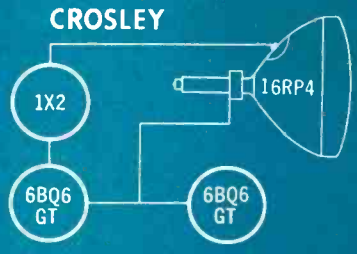


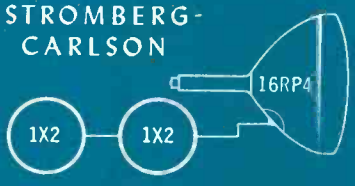


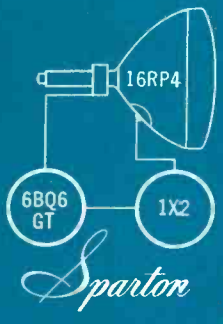


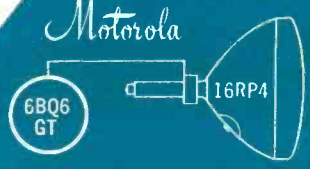








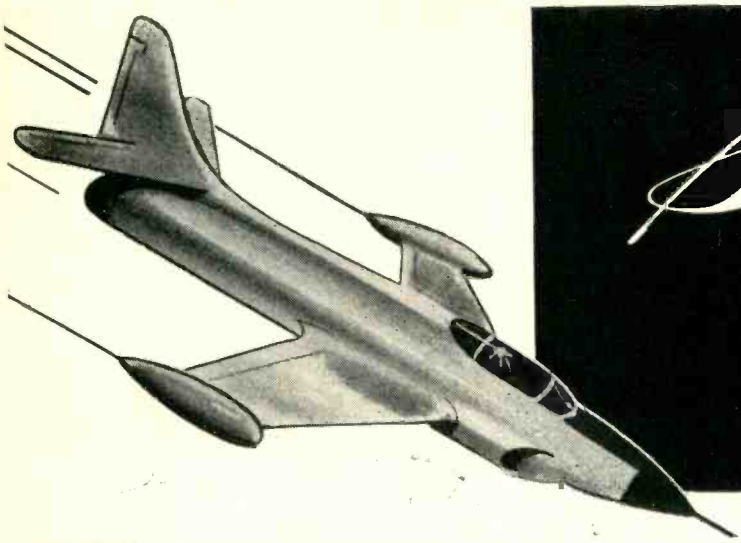




Ask for the original Hytron TV firsts: Hytron **1X2** compact, high-voltage TV rectifier. Hytron **6BQ6GT, 25BQ6GT** extra-performance deflection amplifiers. Hytron **6U4GT** high-perveance damping diode. Hytron **12BH7** twin-triode sweep amplifier with superior efficiency. Hytron **16RP4** original rectangular TV picture tube.

HYTRON RADIO TUBES

MAIN OFFICE: SALEM, MASSACHUSETTS



Sorensen

ELECTRONIC EQUIPMENT FOR *AVIATION*

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

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

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

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

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

TYPICAL SORENSEN AIRBORNE UNITS

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

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

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

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

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

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

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

POWER controlled converted

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

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

The Way Up!

1 SUB-MINIATURE "GUIDED MISSILES" FILTERS

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

2 TONE CHANNEL FILTERS *

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

3 HIGH Q TOROIDAL COILS

"Actually the first essential requirement in the design and manufacture of high quality audio filters, these toroids wound on molybdenum permalloy cores have provided the almost impossible solution for many network problems. As the leading independent manufacturer of toroids, our products are backed by years of experience and specialized knowledge."

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 interchannel attenuation in order to eliminate distortion in telemetering reception.

**Burnell & Company*

"Filters such as these are included in a wide variety of types which we are now producing for manufacturers and users of microwave communications and relay equipment. We would be pleased to discuss your application for filters in this field and bring you up to date on the latest developments in the application and design of filters which have resulted from our close association with the carrier communications industry."

BURNELL & CO.

Burnell & Company

YONKERS 2, NEW YORK

CABLE ADDRESS "BURNELL"

Exclusive Manufacturers of Communications Network Components

Serving Two Important

Brown products are incorporated in many of the tools for research produced by these companies.

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Expensive and far-reaching programs for scientific research and development are profiting by the precision and accuracy of thousands of modifications of the *ElectroniK* Potentiometer. And great numbers of special Brown Electronic Components are daily playing a vital role in the efficient and effective performance of a variety of servos.

These instruments and components are being utilized both as precision measuring devices and as integral elements of various analytical systems. Their versatility is recognized and valued not only in the laboratory but also by manufacturers of spectrometers, polarographs, densitometers, gas analyzers and other highly sensitive equipment for research . . . products of companies such as those listed at left.

Research is vital to man's progress . . . in many instances, Brown special instruments and components have become vital to research. Their unmatched precision and accuracy serve as important links in the search for knowledge.

Your development program may benefit from such specialized instrumentation. Your inquiry is invited.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, 4428 Wayne Ave., Philadelphia 44, Pa. Offices in more than 80 principal cities of the United States, Canada and throughout the world.

Visit Headquarters For Instrumentation For Research
Booths 55 and 56
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September 25, 26, 27

1

SPECIAL ELECTRICAL MEASURING INSTRUMENTS...

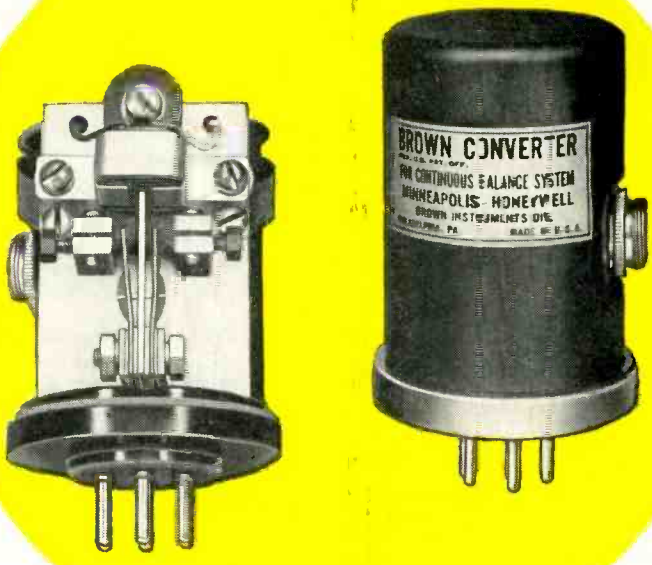
such as the Brown-Rubicon Precision Indicator. This instrument is ideal for use where it is desired to measure minute voltages with extremely high accuracy . . . for the checking, calibrating and standardizing of meters, potentiometers and thermocouples . . . or for obtaining large numbers of frequent, repetitive readings. It does not have to remain stationary and is not affected by vibration.

Needs Of Research

2

SPECIAL ELECTRONIC COMPONENTS...

such as the Brown 400-Cycle Converter. Housed in a dust and moisture-proof case, this unit is a precision, vibrator-type converter for use with any system requiring the conversion of low power direct voltage signals of the order of 100 microvolts to 400 cycle alternating voltages. It is unaffected by atmospheric pressure, is finding a host of applications in various electronic and electrical apparatus. 60-cycle unit also available.



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"Instruments Accelerate Research"

MINNEAPOLIS
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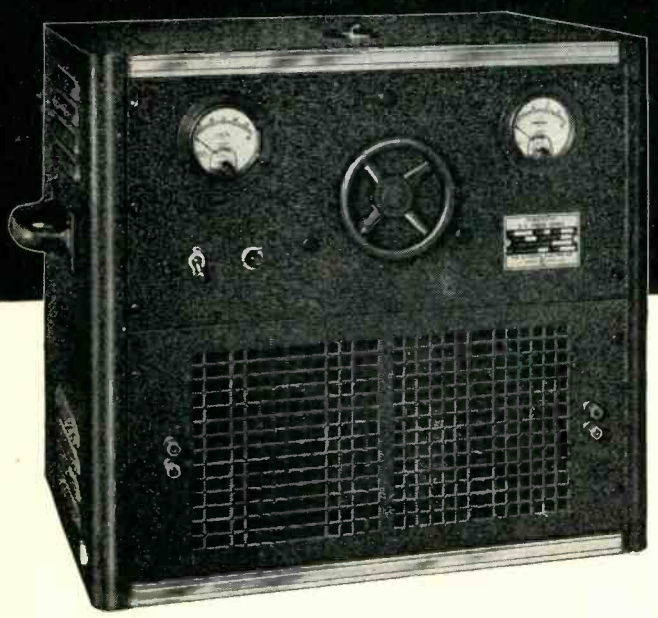
Varicell

THE IDEAL SOURCE OF LOW D-C VOLTAGE FROM A-C LINES



A-C INPUT: 95-135 volts, 60 cycles, single phase

D-C OUTPUT: 0-30 volts, 15 amperes

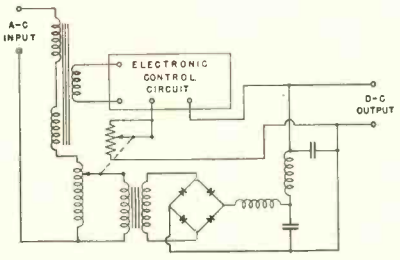
OUTPUT IS:

- **VARIABLE** - - The D-C output voltage of the VARICELL can be set to any value from 0 to 30 volts.
- **STABILIZED** - - The D-C output voltage is unaffected by any fluctuations in the incoming A-C line voltage.
- **REGULATED** - - The D-C output voltage is unaffected by any changes in the output load current.

For detailed information on VARICELL request Form 2504.

With the VARICELL, any D-C voltage in the range of 0 to 30 volts is *at your fingertips.* Rotation of the handwheel provides the D-C voltage you require — and the output is stabilized and regulated. The VARICELL compensates for line voltage fluctuations and load current changes. Stabilization and regulation is ± 0.25 volts for any output voltage setting in the range of 6 to 30 volts. R. M. S. ripple voltage never exceeds 0.1 volts for the 6-30 volt range.

The VARICELL is easy to operate. It plugs into any output receptacle of the proper voltage, frequency and phasing. The load is connected to either of two sets of SUPERIOR 5-WAY Binding Posts. A voltmeter and ammeter indicate output voltage and load current.

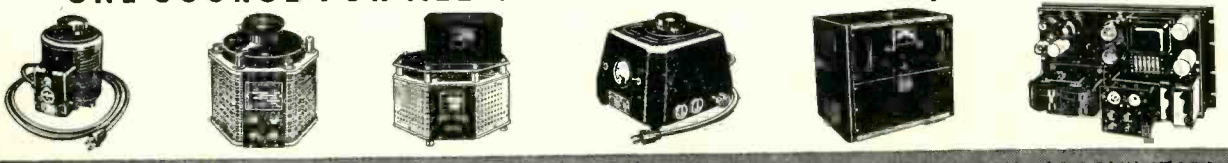


WRITE THE SUPERIOR ELECTRIC COMPANY, 409 MEADOW STREET, BRISTOL, CONNECTICUT

THE SUPERIOR ELECTRIC CO.

BRISTOL, CONNECTICUT

ONE SOURCE FOR ALL VOLTAGE CONTROL REQUIREMENTS



POWERSTAT VARIABLE TRANSFORMERS • VOLTBOX A-C POWER SUPPLIES • STABILINE VOLTAGE REGULATORS

Erie DISC AND PLATE Ceramicons®

for by-passing and coupling applications

High capacity in extremely compact size is the distinguishing feature of Erie Disc and Plate Ceramicons. Illustrations are exact size, and their shape as well as their compactness make them amazingly easy to install in small spaces. They simplify soldering and wiring operations and speed up the assembly line.

Erie Disc and Plate Ceramicons consist of a flat ceramic dielectric with silver plates fired onto the dielectric. Lead wires of 24 gauge tinned copper wire are firmly soldered to the silver electrodes and the unit is given a protective coating of phenolic.

Such simplicity of construction results in low series inductance and unusual efficiency in high frequency by-passing.

For complete information and samples to meet your particular needs, write us today.

STANDARD AVAILABLE CAPACITIES

ERIE STYLE	SIZE	CAPACITY	STAMPING
831	5/16" Max. Dia.	800 MMF	ER 800
801	3/8" Max. Dia.	.001 MFD	ER .001
		.0015 MFD	ER .0015
		.002 MFD	ER .002
811	19/32" Max. Dia.	.005 MFD	ER .005
821	3/4" Max. Dia.	.01 MFD	ER .01
812	19/32" Max. Dia.	Dual .001 MFD	ER 2 x .001
		Dual .0015 MFD	ER 2 x .0015
		Dual .002 MFD	ER 2 x .002
822	3/4" Max. Dia.	Dual .003 MFD	ER 2 x .003
		Dual .004 MFD	ER 2 x .004
883	9/16" x 3/4" Max.	Triple .0015 MFD	ER 3 x .0015

SPECIFICATIONS

Voltage: Units are rated at 500 VDC. Dielectric strength test: 1,500 VDC.

Power Factor: 2.5% max. at 1 K.C. at not more than 5 volts RMS.

Insulation Resistance: 7,500 meg. Ω min.

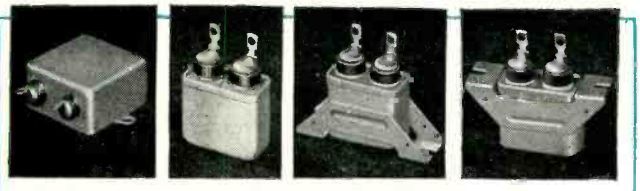
Capacity: Capacity measurements are made at room temperature (25° C) at 1 K.C. and at not more than 5 Volts RMS. Standard tolerance is +100%, —0%.

Temperature Characteristics:
Capacitance shall not decrease more than 50%, nor increase more than 25% from its value at room temperature (25° C), as the temperature is varied from +10° C to +75° C.

Electronics Division
ERIE RESISTOR CORP., ERIE, PA.
LONDON, ENGLAND . . . TORONTO, CANADA

Digest

TIMELY HIGHLIGHTS ON G-E COMPONENTS



PERMAFIL CAPACITORS

NO DERATING AT 125° C OPERATION

For operation at high ambient temperatures, these standard-line G-E Permafil capacitors are naturals. They're paper dielectric units and can be used at temperatures up to 125° C without derating. All are metal encased, compression-sealed, and have long-life silicone bushings. Ratings: up to 2 muf for operation at 400 volts d-c and below. Case styles: 53, 61, 63, and 65 (JAN-C-25 specifications). For more data, write Capacitor Sales Div., General Electric Co., Pittsfield, Mass.

HIGH-VOLTAGE SELENIUM RECTIFIERS

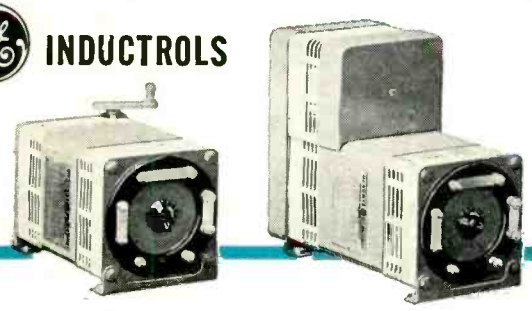
WITH LIFE EXPECTANCY OF 60,000 HOURS!

Now available from G.E. are 26-volt RMS selenium rectifier cells with a continuous-service life expectancy of over 60,000 hours. Their initial forward resistance is very low and samples show an average increase in resistance of less than 6% after 10,000 hours of operation. General Electric knows of no other high-voltage selenium cell on the market that can even approach their performance.

The high output voltage permits the design of smaller stacks while the low resistance means cooler operation and the space saving that goes with it.

Stacks made with the new G-E cells may be obtained with rated outputs from 18 to 126 volts d-c at .15 to 3.75 amps. Write now for Bulletin GEA-5280.

INDUCTROLS



STEPLESS VOLTAGE VARIATION

Inductrols are G-E dry-type induction voltage regulators for 120 and 240-volt operation. Hand-operated models provide smooth and extremely precise voltage adjustment for such uses as instrument calibration and rectifier control. Motor-operated models are used with automatic control to maintain voltage within narrow limits, irrespective of supply variations. Sizes range from 10¼ x 6⅛ x 7⅞ inches for the smallest hand-operated unit to 14 x 6 x 10⅞ for the largest motor-operated unit. One unit provides a voltage range of 10% raise and lower on 3 and 6-kva circuits, another gives 100% raise and lower for 2.4 and 3.6 kva circuits. Complete information in Bulletin GEA-4508.

General Electric Company, Section C 667-7
Apparatus Department, Schenectady 5, N. Y.

Please send me the following bulletins:

Indicate for reference only (V) for planning an immediate project (X)

- ☐ GEA—4254 Push-button units
- ☐ GEA—4508 Inductrols
- ☐ GEA—5280 Selenium rectifiers
- ☐ GEC—270 SB-1 switch
- ☐ GEC—368 Panel instruments
- ☐ GEC—369 Vu volume-level indicators

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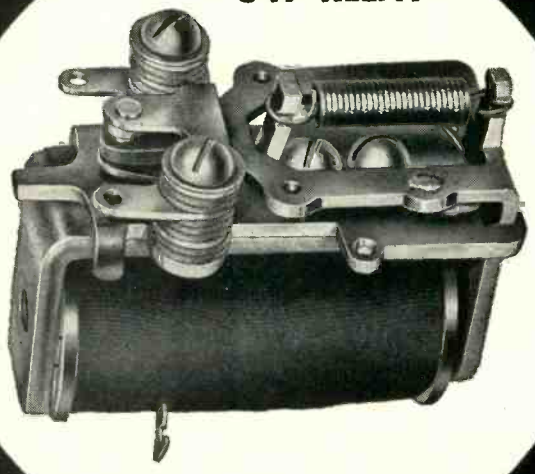
COMPANY_____

ADDRESS_____

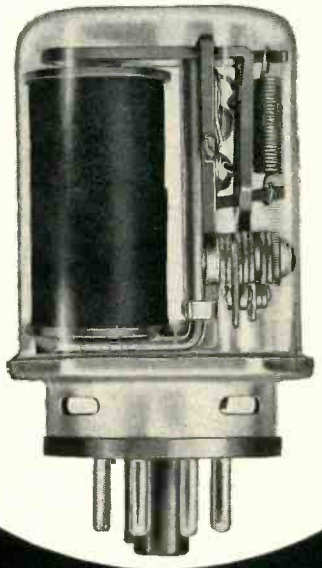
CITY_____ STATE_____

NEW SENSITIVE RELAY built for long service

SW RELAY



Hermetically Sealed



Supplied with OCTAL PLUG or SOLDER TERMINALS

Sensitivity Plus Dependability!

The new Allied SW relay offers an economical combination of both these important qualities. Here are the facts on this newest relay in the famous Allied line

Bulletin SW gives complete details. Send for your copy today.

Be sure to send for your copy of Allied's new Relay Guide. It shows 24 small, compact relays with a detailed table of characteristics and specifications.

SENSITIVITY:	S.P.D.T. .012 watts d.c. } Can be supplied D.P.D.T. .05 watts d.c. } in A.C.
COIL:	Acetate insulated, bobbin or layer wound, 12,500 ohms max.
CONTACTS:	Silver, one ampere non-inductive load at 24 volts d.c. or 115 volts a.c. Armature contact at frame potential.
MOUNTING:	One hole with locating lug. Also available with dust cover or hermetically sealed, plug-in or solder terminals.
DIMENSIONS:	Open Relay—1-19/32", 1-1/16", 1-7/16" Sealed Relay—3-3/16" long, including plug, 1-13/32" wide, 1-19/32" high.
WEIGHT:	2.5 oz.
WEIGHT HERMETICALLY SEALED:	4.5 oz.
SPECIAL APPLICATIONS:	Sensitivity down to .003 watts S.P.D.T., or .012 watts D.P.D.T. Palladium or other precious metal contacts for audio or low voltage circuits, tungsten or alloy contacts for higher current or voltage circuits. Maximum input 4.0 watts at 20°C for 85° rise.

ALLIED CONTROL COMPANY, INC.

2 EAST END AVENUE, NEW YORK 21, NEW YORK

SENSATIONAL...

* Records on discs

* Records on tape

* Plays back both tape and discs

* Plays any 78 R.P.M. Record

GENERAL INDUSTRIES MODEL 250

TAPE-DISC RECORDER

* *when connected with the proper amplifier.*

Sensational, indeed . . . at a cost which enables it to be incorporated in moderately-priced radio and TV combinations . . . the first *complete* home recording and play-back assembly for both tape and disc use.

The Model 250 Tape-Disc Recording Assembly is General Industries' newest development in the sound reproduction field. Already thoroughly tried and tested in actual use, it contains many new design innovations, including foolproof operating features that anyone can understand.

A very complete service manual is included with each unit. It also contains a suggested amplifier circuit as well as a complete amplifier parts list.

A new catalog sheet, describing all of the recording and play-back features of the GI Model 250, will be sent upon request. Write, wire or phone for your copy *today.*

The GENERAL INDUSTRIES Co.

DEPARTMENT B • ELYRIA, OHIO

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

Westinghouse

All of these sizes, shapes and types of mounting are made available to you in Westinghouse Panel Instruments—the most complete matched line in the industry. For all your panel instrument requirements refer to Westinghouse Catalog Section 43-300—or ask your nearest Westinghouse Representative.

Slash Instrument Inventory!

★ **The most complete line**

★ **Meets A.S.A. standards**

★ **Shipments in 10 days**

Cut overhead on instruments. Maintain production without costly stocks.

Westinghouse now offers the most complete matched line of panel and switchboard instruments in the industry . . . every one built to the rigid standards of "The American Standards Association". Shipment can be made to meet practically every electrical requirement within ten days of receipt of order at the factory.

Westinghouse Instrument Specialists are ready to help you plan. These men have nationwide experience in solving instrument application problems of all kinds. For application help on instrument problems, phone, write or wire your nearest Westinghouse Representative, or Westinghouse Electric Corporation, 95 Orange Street, Newark, N. J.

J-40390-A

Specify Westinghouse *- get more for your instrument dollar!*

Westinghouse

INSTRUMENTS

Watch Master

Frequency Standards

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

Type 212

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

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.....

product of

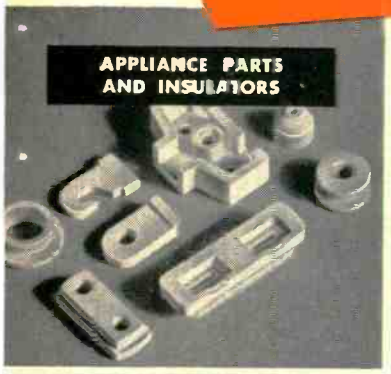
AMERICAN TIME PRODUCTS INC.

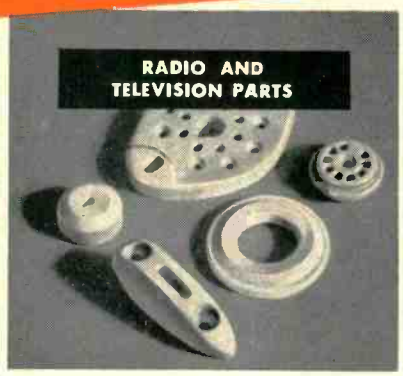
580 Fifth Avenue New York 19, N. Y.

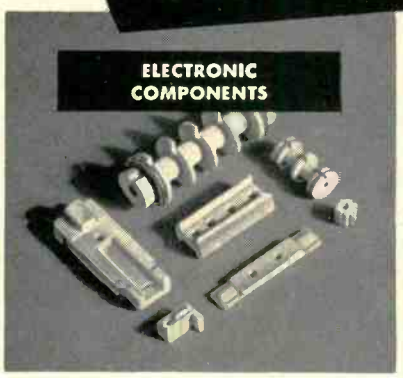
Operating under patents of the Western Electric Company

A Problem?

THE ANSWER MAY BE ALSIMAG®







Your use may be similar to, or completely different from, those listed here . . . yet AlSiMag may solve your problem.

This versatile material is solving production, design and technical problems for many industries. For your business, AlSiMag may offer lower costs, improved manufacturing processes, increased production, or possibilities of a new product.

CAN YOU USE ALSIMAG? AlSiMag is the trade marked name of a large family of technical ceramic compositions. They are now being used in production machines, electronic equipment, chemical processing equipment, gas and electric appliances and in many other consumer products. AlSiMag ceramics are custom made as to physical characteristics, size and shape. Special combinations of raw materials, fluxes, pressures, processes and firing temperatures produce ceramics with characteristics to meet individual requirements. These compositions are fabricated by us into finished parts, ready for your production line.

Given your requirements, our Research Division can frequently develop a special composition to suit your need. Carefully cross-indexed research records usually permit a prompt and accurate reply to inquiries, even if they involve most unusual requirements. If you have a problem that can be solved by a special component of unusual physical characteristics, outline that problem to us. We can indicate the possibilities of its solution by the use of AlSiMag Technical Ceramics. Your inquiry involves no cost or obligation.

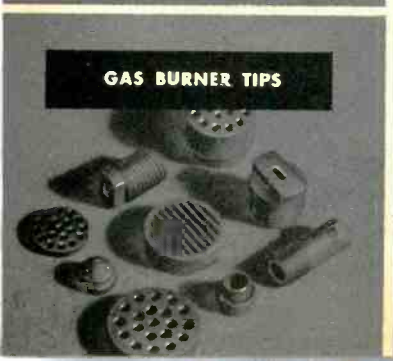
SENT FREE ON REQUEST
The AlSiMag Property Chart 501

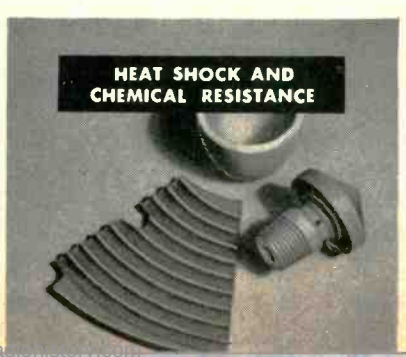
AMERICAN LAVA CORPORATION

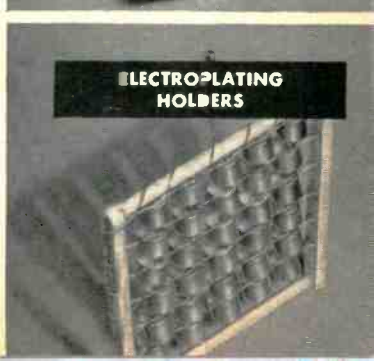
CHATTANOOGA 5, TENNESSEE

49th YEAR OF CERAMIC LEADERSHIP

OFFICES: METROPOLITAN AREA: 671 Broad Street, Newark, N. J., Mitchell 2-8159 • CHICAGO, 9 South Clinton Street, Central 6-1721 PHILADELPHIA, 1649 North Broad Street, Stevenson 4-2823 LOS ANGELES, 232 South Hill Street, Mutual 9076 NEW ENGLAND, 38-B Brattle Street, Cambridge, Massachusetts, Kirkland 7-4498 • ST. LOUIS, 1123 Washington Avenue, Garfield 4959





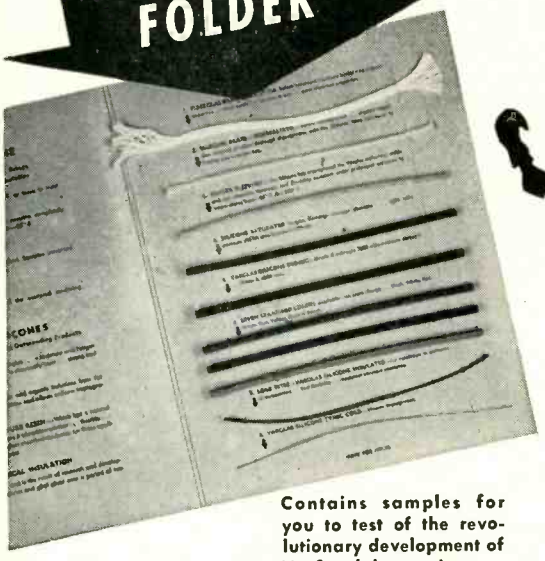


85° BELOW ZERO

would freeze an eskimo

. . . WON'T FREEZE VARGLAS SILICONE

SEND FOR THIS FREE SAMPLE FOLDER



Contains samples for you to test of the revolutionary development of Varflex laboratories . . .

500° ABOVE

would roast the devil

. . . WON'T ROAST VARGLAS SILICONE

Electrical Insulating Tubing and Sleeving lead wire and tying cord

Efficient at 500° F. or more in some applications—yet completely flexible at —85° F. Resistant to moisture and lubricating oil—flame resistant and self-extinguishing—this pioneer silicone tubing and sleeving developed by Varflex is available in various NEMA colors where required.

Varglas Silicone is a combination of *Varglas*—continuous filament Fiberglas; moisture and fungus proof; will not burn; strong and flexible at high and low temperatures; chemically inert . . . and *Silicone High Temperature Resin*—which has a natural affinity for Fiberglas; renders it abrasion-resistant, flexible and non-fraying. Normalizing process removes binder and organic inclusions from the Fiberglas; improves electrical qualities and allows uniform impregnation.

Investigate the NEW, low cost VARFLO Sleeving and Tubing if you do not have to allow for an unusually high operating temperature. Samples and prices on request. It's flexible. It takes rough handling without loss of dielectric. It won't fray out. Made with a Fiberglas braid, it won't support combustion—YET COSTS NO MORE THAN **COTTON.**

Clip and mail this coupon TODAY!

VARFLEX CORPORATION
308 N. Jay St. Rome, N. Y.

Please send me folder containing free samples of Varglas SILICONE products.

Name_____

Company_____

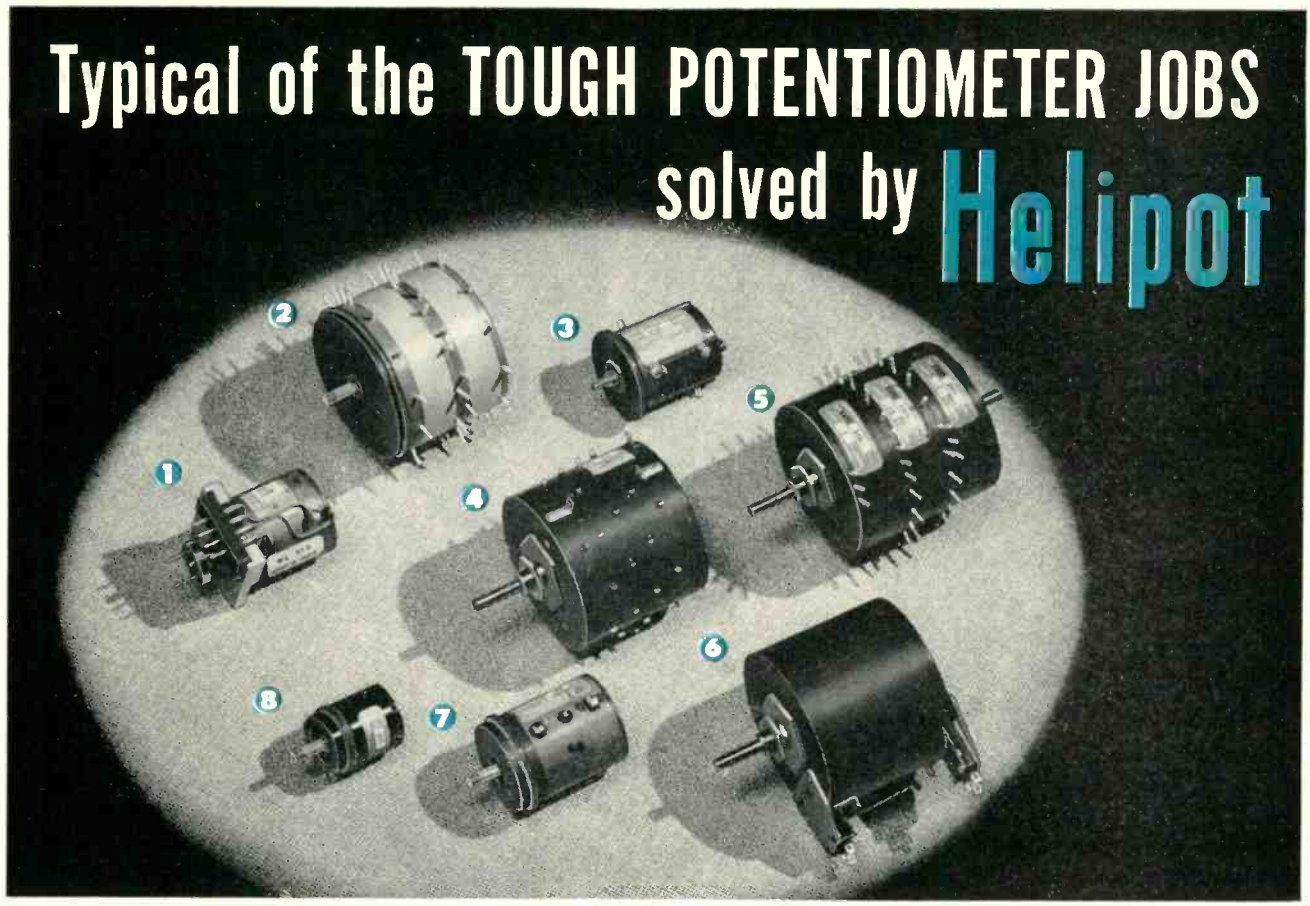
Address_____

City_____ Zone____ State_____

Varflex CORPORATION

Makers of Electrical Insulating Tubing and Sleeving

Typical of the TOUGH POTENTIOMETER JOBS solved by Helipot



Precise Accuracy + Maximum Versatility + Space-saving Compactness

The potentiometers illustrated above are typical examples of the tough problems HELIPOT engineers are solving every day for modern electronic applications. If you have a problem calling for utmost precision in the design, construction and operation of potentiometer units—coupled with minimum space requirements and maximum adaptability to installation and operating limitations—bring your problems to HELIPOT. Here you will find advanced "know-how," coupled with manufacturing facilities unequaled in the industry!

The HELIPOTS above—now in production for various military and industrial applications—include the following unique features . . .

1 This 10-turn HELIPOT combines highest electrical accuracies with extremes in mechanical precision. It features zero electrical and mechanical blacklash...a precision-supported shaft running on ball bearings at each end of the housing for low torque and long life . . . materials selected for greatest possible stability under aging and temperature extremes . . . special mounting and coupling for "plug-in" convenience . . . mechanical and electrical rotation held to a tolerance of ½° . . . resistance and linearity accuracies, ±1% and ±0.025%, or better, respectively.

2 *This four-gang assembly of Model F single-turn potentiometers has a special machined aluminum front end for servo-type panel mounting, with shaft supported by precision ball bearings and having a splined and threaded front extension. Each of the four resistance elements contains 10 equi-spaced tap connections with terminals, and all parts are machined for greatest possible stability and accuracy.*

3 This standard Model A, 10-turn HELIPOT has been modified to incorporate ball bearings on the shaft and a special flange (or ring-type) mounting surface in place of the customary threaded bushing. This HELIPOT also contains additional taps and terminals at the ¼- and 9¾-turn positions.

4 *This standard Model B, 15-turn* HELIPOT *has a total of 40 special tap connections which are located in accordance with a schedule of positions required by the user to permit external resistance padding which changes the normally-linear resistance vs. rotation curve to one having predetermined non-linear characteristics. All taps are permanently spot-welded and short out only one or two turns on the resistance element—a unique* HELIPOT *feature!*

5 This six-gang assembly of standard Model F single-turn potentiometers has the customary threaded bushing mountings, and has shaft extensions at each end. The two center potentiometers each have 19 equi-spaced, spot-welded tap connections brought out to terminals. *Each tap shorts only two turns of .009" diameter wire on the resistance element.*

6 *This Model B, 15-turn* HELIPOT *has been modified to incorporate, at the extreme ends of mechanical and electrical rotation, switches which control circuits entirely separate from the* HELIPOT *coil or its slider contact.*

7 This 10-turn HELIPOT has many design features similar to those described for unit No. 1, plus the following additional features . . . a servo-type front end mounting . . . splined and threaded shaft extension . . . and a center tap on the coil. All components are machined to the highest accuracy, with concentricities and alignments held in some places to a few *ten-thousandths* of an inch to conform to the precision of the mechanical systems in which this HELIPOT is used. *Linearity accuracies frequently run as high as ±0.010%!*

8 *This single-turn Model G Potentiometer has been modified to incorporate a ball bearing shaft and a servo-type front end mounting. Special attention is given to contact designs and pressures to insure that starting torque does not exceed 0.2 inch-ounces under all conditions of temperature.*

The above precision potentiometers are only typical of the hundreds of specialized designs which have been developed and produced by HELIPOT to meet rigid customer specifications. For the utmost in accuracy, dependability and adaptability, bring your potentiometer problems to HELIPOT!

Representatives in all major areas of the United States. Export agents: Frathom Co., 55 W. 42nd St., New York 18.

THE Helipot CORPORATION, SOUTH PASADENA 2, CALIFORNIA

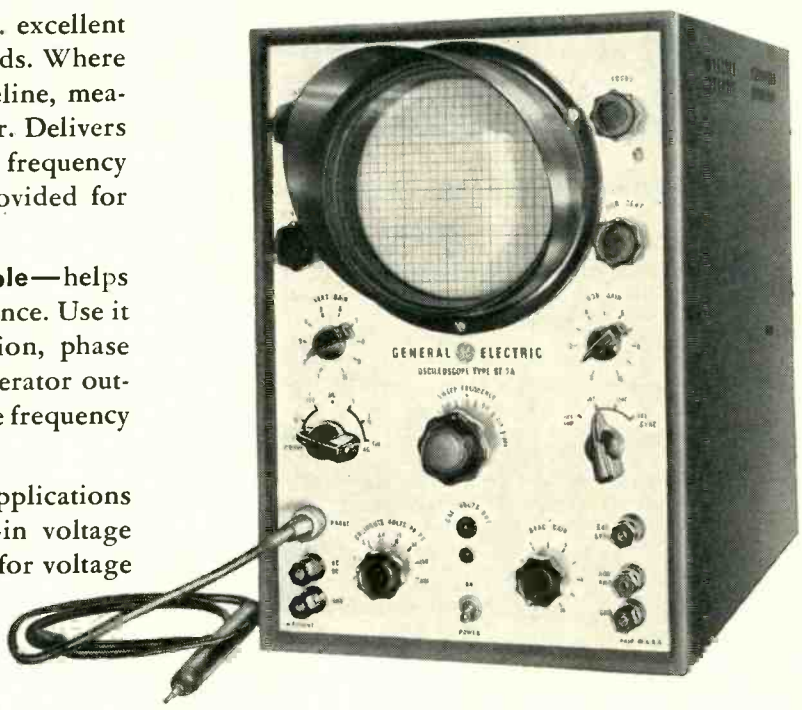
FOR TV RECEIVER TESTING ★ FOR BROADCAST

Get both VHF and GE Electronic

Fast and Reliable TV Receiver Testing—makes this scope particularly useful in head-end position work. Unsurpassed for stability and fine trace . . . excellent definition . . . no bounce when shifting bands. Where the sweep generator does not have a baseline, measurements can be taken on the DC amplifier. Delivers maximum sensitivity without sacrifice of frequency response. Low capacity input probe is provided for trouble shooting.

In Broadcast Stations, It Pin-points Trouble—helps you stay on the air with maximum performance. Use it to check hum, noise, distortion, modulation, phase relationships; measure gain and sweep generator output; isolate defective components; determine frequency response of audio circuits.

In Laboratories, It's Versatile—Fits many applications where waveform study is essential. Built-in voltage calibrator permits calibration of the scope for voltage measurements. Gives you wide frequency response without recourse to peaked amplifier coupling circuits. Straight resistance coupling is used, and the scope can be employed on frequencies up to 3 mc. Excellent transient response within the frequency range of the instrument.



TV SCOPE ST-2A

SPECIFICATIONS

Frequency Response

Vertical Amplifier
Probe and AC—+0,—20% from 20 cycles to 500 kc (Square Wave response 60 to 40,000 cycles.)
+0,—50% from 20 cycles to 1 megacycle with gradual reduction in response beyond 1 mc.
DC—+0,—20% from 0 to 500 kc at full gain setting.

Sweep Range

10 cycles to 100 kc in six overlapping ranges.

Sensitivity

Vertical
1. AC Input—.015 volts RMS per inch
2. DC Input—2.0 volts DC per inch
3. Probe—.20 volts RMS per inch

Horizontal—.4 RMS volts per inch

Calibrating Voltages

Seven AC voltages of power line frequency—.3, 1.5, 3, 15, 30, 150 and 300 volts with ±15% accuracy.

STATIONS ★ FOR DEVELOPMENT LABORATORIES

UHF coverage TEST EQUIPMENT

VARIABLE PERMEABILITY SWEEP GENERATOR—ST-4A

Completely Electronic. No Moving Parts. Using an exceptionally wide linear sweep, this instrument is ideal for television receiver maintenance, TV production and development laboratories, wide band amplifier study, and transmission line impedance measurements. The front panel is slotted, permitting the equipment to be removed and mounted in a standard 19-inch relay rack. A new Balanced Output Adaptor (Type ST-8A), also available, provides balanced 300 ohm output from the sweep generator.

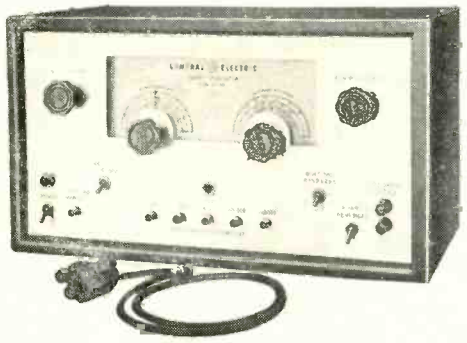
SPECIFICATIONS

Frequency Range: Continuously variable from 4 to 110 mc and 170 to 220 mc. Can be used through 900 mc on harmonic operation.

Sweep Width: Linear from 500 kc to greater than 15 mc.

Output Voltage: Greater than 0.1 volts from 4 to 110 mc.
Greater than 0.5 volts from 170 to 220 mc.

Output: Single-ended or balanced 300 ohm output.



MARKER GENERATOR TYPE ST-5A

Functions as a crystal referenced calibrator from 10 mc to 300 mc. When used with the G-E sweep generator, it provides a multiple of markers spaced 1.5 or 4.5 mc apart . . . or can be used to supply a marker or markers at any frequency from 10 mc to 900 mc.

SPECIFICATIONS

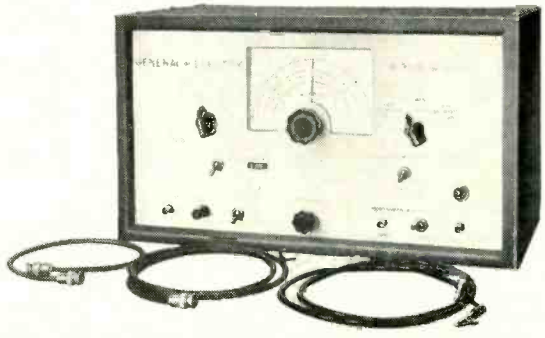
Picture Carrier Oscillator: 15 position rotary selector switch selects 12 crystal-controlled frequencies plus 3 tuneable ranges covering intermediate frequencies.

Channel Crystal Accuracy: .02%

IF Ranges: 3 Bands—20 to 27 mc; 27 to 37 mc; 37 to 50 mc
Accuracy: dial hand calibrated, crystal calibrator ±.05%.

Crystal Modulator: Provides audio and intermediate frequency locations simultaneously with picture carrier.

Crystal Accuracy: 4.5 mcs .05%. 1.5 mcs .15%.



ILLUSTRATED BULLETINS

Complete information will be furnished on any of the General Electric test instruments listed here. Check those you are interested in . . . then fill in and mail the coupon today.

- ☐ TV Scope ST-2A
- ☐ Sweep Generator ST-4A
- ☐ Marker Generator ST-5A
- ☐ Balanced Output Adaptor ST-8A
- ☐ Regulated Power Supply YPD-2
- ☐ Industrial Tube Analyzer YTW-3
- ☐ Distortion and Noise Analyzer YDA-1
- ☐ Square Wave Generator
- ☐ Industrial Scope YNA-4

General Electric Company, Section 480
Electronics Park, Syracuse, New York

Please send me further information on products checked at left.

NAME.....

COMPANY.....

ADDRESS.....

CITY.....STATE.....

GENERAL ELECTRIC

BUSINESS BRIEFS

By W. W. MacDONALD

As Military Requirements for electronic gear step up, principal fear of the industry is that civilian production may be shut down too fast, before specifications and materials are available for military production. Hope is that a graduated transition can take place. Otherwise some plants may face shut downs of several months on certain lines, with possible loss of labor force to other industries not yet affected.

First Quarter sale of radio and television components to set manufacturers increased 60 percent over the same period in 1949, and the sale of parts to jobbers increased 17 percent, according to A. D. Plamondon, Jr., chairman of the RMA Parts Division.

Industry Shipment of television sets in the first quarter of 1950 totalled 1,556,000, broken down as follows by RMA:

Alabama	2,091
Arizona	1,217
California	90,831
Connecticut	24,129
Delaware	5,047
District of Columbia	26,257
Florida	5,247
Georgia	11,061
Illinois	116,061
Indiana	11,922
Iowa	3,068
Kansas	890
Kentucky	10,453
Louisiana	8,279
Maryland	55,919
Massachusetts	89,665
Michigan	60,918
Minnesota	18,044
Missouri	40,632
Nebraska	3,562
New Jersey	99,871
New Mexico	496
New York	266,976
North Carolina	2,969
Ohio	110,720
Oklahoma	4,409
Pennsylvania	145,763
Rhode Island	13,756
South Carolina	176
Tennessee	7,050
Texas	22,686
Utah	2,463
Virginia	12,069
Washington	3,844
West Virginia	1,161
Wisconsin	18,900
Unlisted	257,398

Proposed New Publication called *Television Service Guide Book* is intended for free distribution to purchasers of television sets by dealers and maintenance firms. Obviously designed to reduce the number of false-alarm calls and to improve dealer-consumer relations, it contains significant chapters entitled "What to Expect From Your Service Contractor", "Partial and Freak Service Contracts" and "C.O.D. Service Calls."

Philadelphia contractors are reported to have placed pre-publication orders for 20,000 copies of the booklet, which will have 20 to 24 pages and will fit in a No. 10 business envelope.

Total TV Investment of the public, manufacturers and broadcasters will exceed the $2½-billion now invested in the entire motion-picture industry by the end of 1951, thinks H. C. Bonfig of Zenith.

Howard Sams says his next three Photofact service folders will cover 55 television models and 16 radios, and that this ratio reflects current production schedules.

The Latest nation to announce plans for tv is Colombia, South America. Negotiations are said to be going on between the Director of Cultural Extension and unnamed British firms for a station in Bogota. The installation is planned for the end of this year.

Time required to assemble a television set at Westinghouse is 6½ hours, of which 1½ hours is devoted to inspections and tests. There are 19 of the last-mentioned operations.

What equipment does an electronic research lab need? Here's the list of laboratory items currently available at the Western Union's Electronics Research Division at Watermill, N. Y.:

Amplifier, Valentine
Analyzer, Harmonic Wave, Hewlett-Packard
Analyzer, Weston (8)
Attenuator, General Radio (2)
Attenuator, Hewlett-Packard
Balance, Analytical, Cenco
Balance, Triple Beam, Cenco
Bridge, Capacitance, General Radio
Bridge, Decade, General Radio
Bridge, Hickok
Bridge, Impedance, General Radio (2)
Bridge, Wheatstone
Cameras, (5)
Capacitor, Decade, Cornell-Dubilier Company (14)

The A-B-C's of SYLVANIA SILICON DIODES

FREE to ELECTRONICS ENGINEERS

Applications

Band Coverage

Characteristics

● Here's a fund of up-to-the-minute information about Sylvania Silicon Diodes that belongs in the file of every electronics engineer.

This new 16-page booklet describes crystal rectifiers covering the frequency range from 1000 to 25,000 mc per second. It explains the various types of Silicon Diodes with their ratings and common applications.

The booklet discusses mixer crystals, including the new matched pairs, microwave video detectors and Silicon Diode use in UHF and SHF instrument applications. For your free copy of this new booklet, simply clip the coupon and mail today.

SYLVANIA ELECTRIC

ELECTRONIC DEVICES; RADIO TUBES; TELEVISION PICTURE TUBES; ELECTRONIC TEST EQUIPMENT; FLUORESCENT LAMPS, FIXTURES, SIGN TUBING, WIRING DEVICES; LIGHT BULBS; PHOTOLAMPS; TELEVISION SETS

Sylvania Electric Products Inc.
Dept. E-1009, Emporium, Penna.

Please send me your new FREE booklet "Microwave Crystal Rectifiers." Also send me information on Sylvania Magnetrons.

Name_____

Company_____

Street_____

City_____ Zone____ State_____

BUSINESS BRIEFS (continued)

Capacitor, Decade, General Radio (5)
Chronograph, High-Speed
Densitometer, Projection Comparator, Dietert Company
Electro-Copyist, Hunter
Furnace, Electric High-Temperature, Cenco
Furnace, Electric Multiple-Unit Type, Hevi Duty Elect. Co.
Furnace, Hydrogen, High-Temperature, Callite Tungsten Corp.
Galvanometers, Weston and General Radio (28)
Inductances, Standard, General Radio (6)
Inductometer, Brooks L & N
Machine, Basing, Kahle Engineering Company
Machine, Developing, Dietert Company
Machine, Exhaust, Kahle Engineering Company
Machine, Flare-Kahle Engineering Company
Machine, Sealing, Kahle Engineering Company (2)
Machine, Stem, Kahle Enginering Company
Megger, Biddle
Meter, Audio-Frequency, General Radio (2)
Meter, Capacitance, General Radio
Meter, DB (3)
Meter, Frequency, General Radio
Meter, Frequency, Micrometer, Lampkin Labs (2)
Meter, Graphic, Single and Twin Recorder, Esterline-Angus (2)
Meter, Heterodyne Frequency, General Radio
Meter, Output, General Radio (2)
Meters, Various ammeters, voltmeters, milliammeters, microammeters, Weston and Simpson (230)
Microscope, Bausch & Lomb (2)
Microscope, Binocular, Bausch & Lomb
Oscillator, Audio, Clough Brengle
Oscillator, Audio, Hewlett Packard (3)
Oscillator, Beat-Frequency, General Radio
Oscillator, High-Frequency, Lepel-Lab (3)
Oscillator, Interpolation, General Radio
Oscillator, Low Frequency, General Radio
Oscillator, RF & UHF, General Radio (2)
Oscillograph, Cathode-ray, Du Mont (3)
Oscillograph, Cathode-ray, RCA (5)
Oven, Annealing, Kahle Company
Oven, Constant Temperature, Cenco
Oven, Vacuum
Polariscope, R. Fuess
Polisher, Metallographic, Eimer & Amend
Pumps, Diffusion, Cenco
Pump, Diffusion, Distillation Products Company (2)
Pumps, Vacuum (10)
Recorder, Portable Table Model, Presto Recording
Signal Generators, General Radio, Hewlett Packard (5)
Standard, Frequency, General Radio Company
Standard, Frequency, Gibbs Company
Still, Electric Stokes Automatic Company
Strobolux, General Radio
Strobotac, General Radio
Testor, Rockwell Hardness, Wilson Instrument Company
Transmitters, RCA (3)
Transmitter and Receiver, Portable FM, Radio Engineering Labs (2)
Transmitter and Receiver, RCA, (4)
Unit, Glass Working, Eisler Engineering Company
Receivers, Radio, Hallicrafters (13)
Receiver, Television, RCA

We Wonder if makers of a-c operated soldering guns know that you can demagnetize a watch by shoving it through the loop? No charge for the sales idea.

Here's The Picture on the total number of broadcast stations in the United States, as of June 1950:

	AM	FM	Comm. Ed.	TV	Total
Alabama	71	14	1	2	88
Arizona	25	0	2	1	28
Arkansas	34	7	0	0	41
California	143	58	7	11	219
Colorado	35	3	0	0	38
Connecticut	27	11	0	1	39
Delaware	5	3	0	1	9

District of Columbia	7	8	0	4	19
Florida	75	21	1	3	100
Georgia	76	22	1	3	102
Idaho	22	3	0	0	25
Illinois	74	46	5	5	130
Indiana	45	20	6	2	73
Iowa	52	20	2	2	76
Kansas	39	6	1	0	46
Kentucky	43	12	3	2	60
Louisiana	42	16	2	1	61
Maine	16	2	0	0	18
Maryland	22	18	0	3	43
Massachusetts	51	28	2	2	83
Michigan	63	25	4	6	98
Minnesota	49	10	2	2	63
Mississippi	43	5	1	0	49
Missouri	51	15	2	2	70
Montana	25	0	0	0	25
Nebraska	22	3	0	2	27
Nevada	10	1	0	0	11
New Hampshire	12	4	0	0	16
New Jersey	20	13	2	1	36
New Mexico	25	0	1	1	27
New York	95	56	6	13	170
North Carolina	93	42	2	2	139
North Dakota	14	0	0	0	14
Ohio	69	45	6	12	132
Oklahoma	46	10	3	2	61
Oregon	43	8	2	0	53
Pennsylvania	111	63	4	7	185
Rhode Island	11	5	1	1	18
South Carolina	42	11	0	0	53
South Dakota	14	1	0	0	15
Tennessee	57	13	1	2	73
Texas	183	29	4	6	222
Utah	18	3	1	2	24
Vermont	9	0	0	0	9
Virginia	57	20	0	2	79
Washington	53	7	1	1	62
West Virginia	38	15	0	1	54
Wisconsin	55	18	6	1	80
Wyoming	13	0	0	0	13
Alaska	10	0	0	0	10
Hawaii	12	0	0	0	12
Puerto Rico	25	0	0	0	25
Virgin Islands	3	0	0	0	3
	2,295	740	82	109	3,226

Reading Our Own Ads again, we note that:

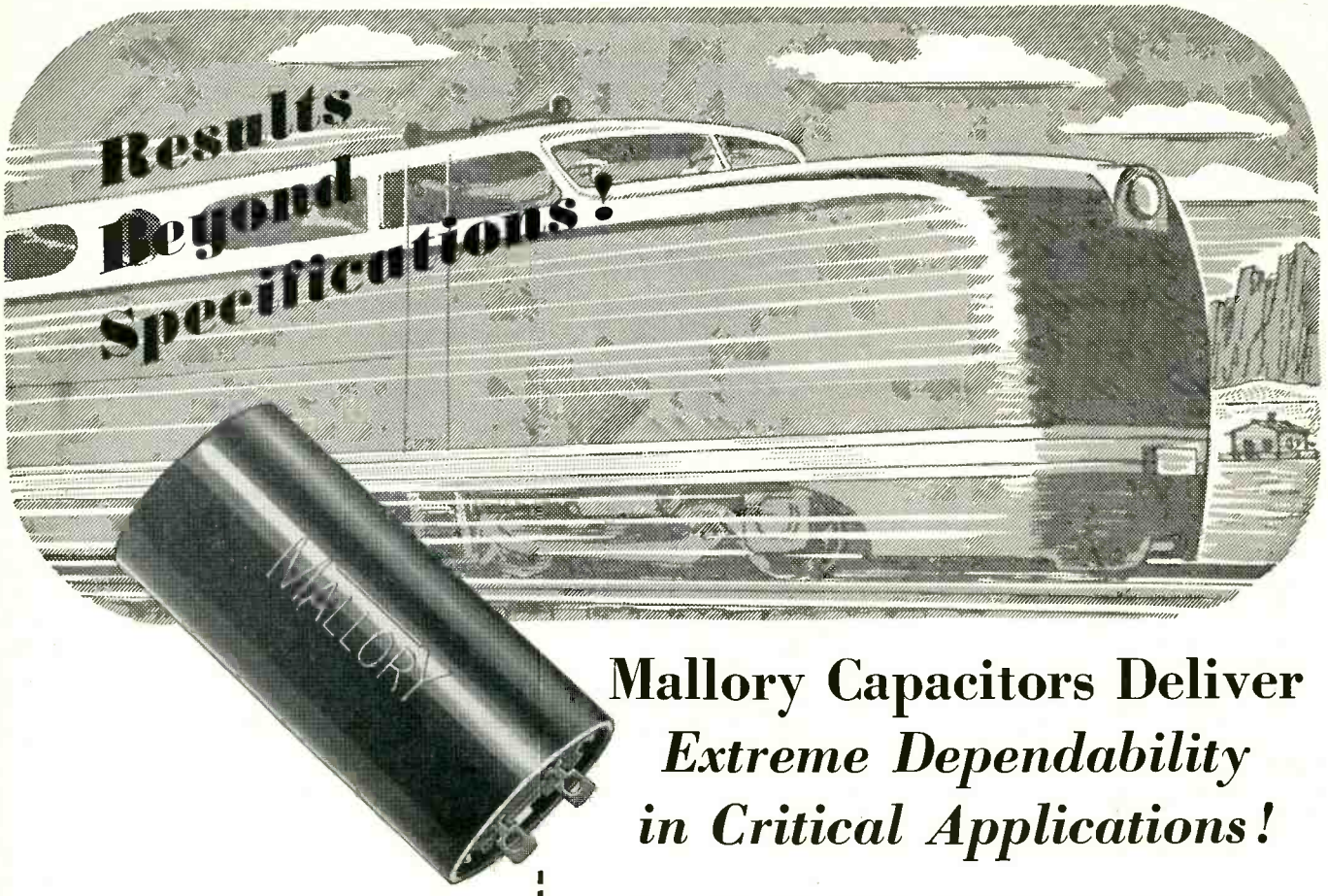
The print-a-minute Polaroid-Land camera has been adapted to the job of photographing oscilloscope traces.

At least two companies offer to make almost any size or shape dry battery in quantities large or small.

The word "manufacts", defined in our super-duper dictionary as meaning "made by hand", has been corrupted to mean "manufacturing facts."

We note, also, that our consistent editorial use of the word "capacitor" to distinguish electronic components from those used in the steam business goes unnoticed by many copywriters, who still use "condenser", and sometimes use both "capacitor" and "condenser" in the same ad.

In Your Wanderings through surplus-equipment stores if you see a piece of equipment inscribed with the letters BBG better buy glasses. According to the latest AN-system definitions such a device would be an underwater mobile item designed for installation on a carrier pigeon for the purpose of directing a gun or searchlight.



Mallory Capacitors Deliver *Extreme Dependability in Critical Applications!*

MALLORY NP CAPACITORS

Mallory NP Capacitors are non-polarized and designed for heavy-duty applications where extreme dependability is essential. Priced competitively at ordinary capacitor levels, they are ideal for controls and other unusual circuits. Write for your copy of the Mallory NP Capacitor data folder.

Long trouble-free service has become so synonymous with Mallory Capacitors that customers have come to assign critical responsibilities to them without hesitation.

For example . . . a complex rpm control for diesel-electric locomotives. The failure of a single component would stall the train, blocking rail traffic for hours. For absolute safety and dependability, the manufacturer specified Mallory NP Capacitors in this control.

The Mallory-originated NP Capacitor is widely used in such important applications. This complete confidence is the result of years of *demonstration* of Mallory superiority. Yet Mallory Capacitors cost you no more.

That's results beyond specifications!

And whether your problem is electronic or metallurgical, what Mallory has done for others can be done for you!

P. R. MALLORY & CO. Inc.

MALLORY

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

SERVING INDUSTRY WITH

Capacitors	Contacts
Controls	Resistors
Rectifiers	Vibrators
Special Switches	Power Supplies

Resistance Welding Materials

CROSS TALK

▶ **MOBILIZATION** . . . Military events are moving at such a pace that it is impossible to predict, as we write, what the electronics industry will be faced with two weeks later when this issue reaches the subscribers. But the trend is unmistakable. There are going to be cutbacks of civilian production and a sharp stepup of military production, whatever the outcome of our Asiatic involvement. This should come as no surprise, and should be met with no reluctance whatever. The place of electronics in military operations today is near the top. So our responsibility to assume a major portion of the load is not only unavoidable, it is an opportunity to participate in what may well be the biggest and most constructive project of our generation.

While participating wholeheartedly in whatever program is laid out for us, we can hope that the transition from civilian to military production will be carried out as skillfully as possible. Cutbacks should be geared closely to the actual ability of plants to absorb military work. Otherwise unemployment is inevitable, temporary to be sure, but an interruption of production nonetheless. Fortunately men of the caliber of Fred Lack have been planning for this eventuality for many months, as civilian advisers to the Munitions Board. If their advice is taken, we have little to fear.

▶ **FCC/IRAC** . . . The Condon Committee (see p 66, this issue) has brought to the attention of Senator Edwin C. Johnson, for whom they labored, the fact that the FCC and IRAC do not operate under a common policy, and has cast doubt that any allocation of the vhf and uhf bands can be in the best interest of the country unless such a common policy is adhered to. We hope this view prevails, among the members of the Communications Policy Board and elsewhere among the President's advisers. Now, of all times, we must be sure that these important frequencies are *used*, actually and fully, not squatted upon.

▶ **CHICAGO** . . . The Chicago section of the IRE is currently observing its 25th anniversary with a four-months program culminating in the National Electronics Conference. Of the striking trends in the electronics business since 1925, not the least is the steadily increasing concentration of electronic manufacturing in the Chicago area. Four of the ten biggest producers of television sets, for example, are located in Chicago, three in the New York area, two in or near Philadelphia. It's refreshing to note that the IRE, thought of as a stodgy outfit in some quarters, has had the get-up-and-go to tell the people of Chicago that their town is the center of the wonder industry. Other sections could profit by the example.

▶ **LAMPREYS** . . . Speaking of Chicago, the Cook Research Laboratories there have just been awarded a contract by the Department of the Interior to develop electronic instruments to exterminate sea lampreys. These eel-like fish attach themselves to other fish, sucking their blood, and have all but destroyed the lake-trout fishing industry in the Great Lakes. According to Fish and Wildlife Service scientists, the lamprey displays selective reactions to visual and audible stimuli which may be used to drive them into electrocution devices, while not affecting fish of other species. The contract calls for development of "radar-type instruments, submarine sound generators and other electronic devices". One idea is to tune the sonic generators to the heart beat of the lampreys; this appears to have a fatal effect if the intensity is high enough. The eel-killers hope to catch 'em going upstream and downstream. Quick, Cook, the (underwater) Flit!

The Case for VHF TELEVISION

"ANNEX C"

Hidden away in the Annexes of the report of the Senate Advisory Committee on Color Television, where it has attracted little public attention, is a cogent statement of the vhf-vs-uhf argument over new television channels. Annex C is an inquiry directed by the Committee to Senator Edwin C. Johnson, prior to the formation of President Truman's Communications Policy Board. Since this brief and forthright statement of the problem is a matter of deep concern to every television engineer, it is reprinted in full herewith—The Editors

EARLY in the deliberations of the Senate Advisory Committee on Color Television (the "Condon Committee"), the question of the proposed expansion of the television service on uhf channels was brought up, as stated in the final report:

"At its meeting of November 21, 1949, the Committee discussed the question of the basic terms of reference of the report, particularly regarding the availability of additional channels not then contemplated by the FCC proposals. As a result of this discusion, an inquiry was prepared and forwarded to Senator Johnson as of February 2, 1950. A copy of this inquiry is appended as Annex C.

"Shortly thereafter, the formation of the President's Communications Policy Board was announced. In view of the contemplated activity of this Board, Senator Johnson advised the Committee to proceed within the terms of reference proposed by the FCC, namely to consider channels in the vhf band from 54-88 and 174-216 mc, and channels in the uhf band from 475 to 890 mc."

Annex C

The full text of Annex C, referred to above, follows:

The plans for expansion of the television service, whether for additional black-and-white stations or for a color service, must be evaluated in terms of the radio spectrum now reserved for television and other services. Television broadcast stations are currently allocated in 12 channels in the vhf spectrum in the following bands: 54-72 mc, 76-88 mc, 174-216 mc.

In expanding the television service it would appear to this Committee that it would be highly advantageous to allocate additional vhf channels between 72 and 300 mc. But the space in the vhf spectrum is currently occupied by, or nominally allocated to, other services. These are:

72-76 mc—Government aeronautical navigation and nongovernment fixed
88-108 mc—F-M broadcasting
108-144 mc—Aeronautical navigation and communication
144-148 mc—Amateur
148-152 mc—Aeronautical communication
152-156 mc—Police
156-162 mc—Nongovernment fixed and mobile
162-174 mc—Government fixed and mobile
216-220 mc—Government fixed and mobile
220-225 mc—Amateur
225-400 mc—Government aeronautical communication and navigation.

In view of this extensive occupancy of the vhf spectrum by non-television services, the FCC allocated a portion of the uhf spectrum, from 475 to 890 mc, for experimental television service, looking toward the development of improved television systems including high definition black-and-white and color systems. The FCC has recently issued a proposal to allocate a large segment of the uhf band to commercial black-and-white television broadcasting. The proposal, to be debated shortly in hearings before the Commission, is to allocate approximately 42 channels, each 6 mc wide, extending from 475 mc to 727 mc (or from 500 to 752 mc, if the band 475-500 mc is allocated to common-carrier fixed-mobile communications).

The proposal to allocate uhf channels is open to a number of serious objections which stem from differences in the performance of transmitters and receivers and in the propagation of radio waves. The available power of transmitters and the sensitivity of receivers are lower, in any given state of the art, in the uhf band than in the vhf band. The performance of the uhf system is impaired further than the vhf system by natural impediments to transmission over the earth's surface. These technical factors have important implications, which may be summed up in the statement that uhf television stations cannot cover as large an area (by a factor of the order of 3

Condon Committee, in its report on the status of color tv, recommends new vhf channels, states arguments against uhf, and calls for review at highest administrative level of allocations policies of FCC and IRAC

times) as can vhf stations of the same effective radiated power.

The effect on the extent of the service to the public is manifest. In the first place, areas which might be covered by vhf stations cannot be covered by the same number of uhf stations. A second effect of a uhf allocation which is against the public interest, is the tendency to foster monopoly. In areas of dense population, such as the eastern seaboard, a vhf station can reach an audience much larger than can an equivalent uhf station. Accordingly there is serious doubt that a uhf station could, under these circumstances, compete with the vhf stations in the same area. The limited number of stations on the existing 12 vhf channels would then operate at a substantial competitive advantage.

These disadvantages of a uhf allocation may have to be faced, provided that no additional vhf channels can be found. But to the extent that space in the vhf spectrum could be transferred to the television service from other services, the technical, social, and economic shortcomings of uhf television service could be obviated. All the future needs of television may not be satisfied by additions to the vhf allocation. But with even a small addition (e.g. 6 channels) it is possible that an adequate public service can be achieved, both as to coverage and for fostering competition, without the necessity of the extensive uhf allocation proposed by the FCC.

This committee is concerned primarily with the technical factors underlying a color television service, and is not in a position to recommend specific changes in the vhf allocation. Moreover, the committee wishes to emphasize that the transfer of spectrum facilities from one service to another involves judgments which transcend technical factors. Such judgments must be based on sound technical knowledge, but they involve also the far more difficult determination of the needs of the various services, their established positions and investments, and the quantity and quality of the service they render to the public and the national security. No technical group can properly undertake judgments of the latter type. They must be made on a high administrative level, by a group of judicial merit, having knowledge of, and properly responsive to, the needs of *all* the radio services.

It is the considered opinion of this committee that the distribution of the vhf and uhf regions of the spectrum to various services has not been carried out in the past on the basis just suggested. This failure has stemmed from the fact that no government agency has been given the authority or responsibility to make a judicial review of the use of the entire portion of the spectrum involved. Two groups, operating with different procedures and policies, have been responsible for the main features of the allocation. These are the FCC, which allocates frequencies to nongovernment services and the IRAC (Interdepartmental Radio Advisory Committee) which allocates frequencies to government, including military services, and, in addition, allocates frequencies for assignment by the FCC to nongovernment services. These groups have not operated, during peacetime, under a common policy and the IRAC has not reviewed, in the manner employed by the FCC for nongovernment requirements, the needs of all government and nongovernment services. Unless and until such a review is carried out, at an administrative level sufficiently high to command the respect and cooperation of the industries and government departments affected, serious doubt will remain that the allocations, as they now stand, are for the maximum benefit of the public and the national security.

While this situation exists, this committee is faced with a difficult choice in its deliberations. It may assume on the one hand, that a review of the allocations to both government and nongovernment services should be made, and will in fact be made by an appropriate government agency existing or to be set up, before the proposed expansion of television facilities takes place, and that such a review would probably result in the allocation of additional vhf channels. Alternatively it may assume that the creation of an administrative body to review the allocations, its deliberations and the preparation of its findings, would take so much time that the expansion of television service should not be delayed so long. In the latter event, the committee has no alternative but to proceed within the terms of reference now proposed by the FCC, even though these terms may be faulty.

Since the members of the committee believe this to be a matter of great importance, not only to the future of the television service, but of other radio services as well, they respectfully bring the matter to the attention of the Senate Interstate Commerce Committee and request guidance in the matter.

LONG-LIFE TUBES for INDUSTRY

Commercial airlines have worked closely with manufacturers to produce types that fit the service. Experience over the past three years indicates that the extra cost is more than absorbed in reduced maintenance and fewer flight cancellations. Program points the way to improved tubes for other applications

By ELWOOD K. MORSE

Project Engineer
Aeronautical Radio, Inc.
Washington, D. C.

ELECTRON TUBES have been used for many industrial purposes for years. Yet other industrial applications for which they have long seemed ideal remain in the experimental stage. Why?

Certainly the lag between experimental application and commercial acceptance is not because tubes cannot be developed to do the work. They can be given a very wide variety of characteristics. So it must be that tubes are still considered unreliable. Yet radio stations operate 24 hours a day and the vast telephone service of this country is using more and more tubes each year.

Perhaps the answer lies in the fact that many tube manufacturers have been reluctant to invest in the development of tubes to meet the needs of industry while the lucrative large volume and less exacting business of supplying tubes for radio and television receivers exists. Perhaps industry itself does not really know what it needs.

Aviation Shows the Way

One branch of industry did know what it needed in electron tubes. That branch was commercial aviation. It presented its requirements to tube manufacturers. Other users of mobile communications equipment with like requirements and manufacturers of equipment were contacted and the whole problem was jointly discussed. The outcome was the selection of a minimum number of tube types deemed necessary to perform the required functions, and which tube manufacturers agreed could be improved.

The selections were from the miniature group of tubes. Improvement was to include design changes for improved performance and reliability as well as physical ruggedization. A list of ten types to be initially improved was made and this list is shown in the accompanying table.

As part of the improvement program and to provide manufacturers with information regarding the performance of the types produced, Aeronautical Radio Inc., representing the airlines, agreed to return to the manufacturers all tubes which became defective from any cause, accompanied with complete data stating nature of failure, hours of service, type of equipment in which the tube was used and function for which it was used. The manufacturer agreed to analyze returned tubes and, on the basis of the reports and their analysis, modify design and construction to remedy any faults shown in service.

Program Brings Results

As a result of three years of operation of this improved tube program, nine of the ten types initially chosen are now in production and use and the tenth (5727) is under consideration. Sufficient information is on hand to evaluate the progress of the first tube to be improved. The 6AK5 is used in larger quantities by the airlines than any other miniature type. Data from one airline showed failure of one equipment every 50 hours, on the average, due to failure of this tube type. After almost three years of production, improvement and operation of the substituted 5654 it is evident that considerable progress has been made toward obtaining a reliable tube. Compilation of data received from the airlines as well as from the manufacturer indicates that the 5654 is 100 percent better

PLEASURE Before BUSINESS?

WHEN a tube fails in a home radio or television receiver the user is merely inconvenienced. When one fails in industry, machine down-time may completely disrupt production.

YET small-tube design and production techniques are still aimed primarily at entertainment applications, because of the volume which may be obtained in this field

LONG-LIFE 6.3-VOLT AIRCRAFT MINIATURES

		Heater
5654 (6AK5) pentode	R-F and wide-band I-F	175 ma
5670 (2C51) twin triode	R-F and A-F	350 ma
5726 (6AL5) double diode	Detector	300 ma
5725 (6AS6) pentode	R-F and wide-band I-F (similar to 6AK5 with suppressor pin available for use in circuit designed to minimize receiver desensitization from noise pulses)	175 ma
5749 (6BA6) pentode	Medium-frequency and low-frequency R-F and narrow-band I-F	300 ma
5686 pentode	A-F, R-F oscillator and R-F amplifier	350 ma
5751 (12AX7) high-mu twin-triode	A-F and noise suppression	350 ma
5727 (2D21)	Thyratron	600 ma
5750 (6BE6) pentagrid converter	L-F and M-F converter-timing circuits	300 ma
5814 (12AU7) medium-mu twin-triode	A-F amplifier	350 ma

than the 6AK5. This improvement is based on a comparison of life.

Since engineering time is required to produce an improved tube, it was at first suggested by manufacturers that selection of existing tubes be tried to reduce failures in the field until an improved type could be produced. The airlines purchased 2,000 type 6AK5's. After tests, which included filament on-off cycling, vibration, shock and glass strain, less than 60 remained. These were assumed to be reliable tubes, tubes which would give long service without failure. Service records later showed them to be no better than those picked at random from stock. This proved the ARINC contention that you can't test quality into tubes—it must be built in.

Ideally, industrial tubes should operate a predetermined number of hours before failure, thus permitting a before-failure replacement schedule to be established. The actual number of hours a tube will last is not nearly so important as knowing how long it can be depended upon. Of course, reasonably long life is desirable to hold down replacement costs; 10,000 or 20,000 or 50,000 hours are desirable goals. Such tubes would cost more initially but savings in service cost and, for the air carriers, elimination of flight delays would pay for any reasonable increase many times over. Increased demand for such tubes would also lower their cost in time.

Present Practices

There is a practical limit to the improvement of industrial electron tubes but most of the types of tubes now produced for radio and television receivers fall far short of this limit because the competitive market does not permit wholesale adoption of more exacting and costly manufacturing practices.

Differences in the design of the 5654 as contrasted with the 6AK5 include ruggedization developed under the Navy W program and an improved filament that withstands the many off-on cycles encountered in aircraft service. The tolerances to which critical dimensions are held are smaller than in regular tube production and a 100 percent check of all parts is made before assembly. As part of the manufacturing process all tubes are given a 50-hour burn-in run under rated conditions. This process tends to stabilize emission and eliminate early failures.

Production-line workers making long-life tubes are compensated on a daily wage scale and are not dependent upon the quantity of production for their earnings. They are encouraged to discard any part or assembly which does not measure up to the highest quality of workmanship. A small group of tubes of each week's production, selected to include each day's production, is given a 500-hour life test. The production represented by these tubes is held from shipment until the test is satisfactorily completed.

The improvement resulting from electrical and mechanical changes in design and the employment of rigid quality control is reflected in the 5 to 1 ratio of rejects during the final tests in the production of the regular tubes and the improved tube.

Tubes of the Future

The aircraft industry has shown the way toward tube improvement. Other branches of industry can look forward to increased reliability in electronic equipment and the utilization of more electronic devices, with their many advantages, if more tubes are designed and manufactured to meet the conditions under which they must operate.

Of course, both the user and the manufacturer of electron tubes must understand the problem and make an honest effort to solve it. If this is done, time need not be lost by the stoppage of an assembly line because a tube failed in the electronic control of a welder or other equipment.

Electron tubes and electronic devices will then achieve the same order of reliability as other man-made equipment upon which our lives depend every day.

Frequency-Interlace

Red, blue and green picture signals are transmitted simultaneously, with good fidelity, over the standard 6-mc channel. System is completely compatible and requires addition of only six tubes to convert conventional monochrome circuits for tricolor tube

ANY SYSTEM for the transmission and reception of images in natural color by television in the same frequency bandwidth as is employed in a monochrome system must in some way attempt to transmit up to three times as much information as is contained in the monochrome channel. This premise is based upon the assumptions that at least three primary colors are employed in the color composition and that substantially the same overall picture definition or detail is to be portrayed at the receiver.

Multiplex Systems

Since there are in effect three messages to be transmitted, some method of multiplexing must be devised. There are in general two means available for multiplexing, namely time-division multiplex and frequency-division multiplex.

In a time-division multiplex system only one message is dealt with at any given instant. The rapidity with which messages (or colors) are switched in rotation may vary over very wide limits. The longest interval of time devoted to one color may be as long as one complete field of scanning. An intermediate interval corresponding to the length of time required to transmit one scanning line may be the next logical switching interval. Finally, a very rapid switching may be used wherein only a small portion of a line (such as a dot) forms the switching interval.

Any one of these three choices may form the basis of a system of color television. Each of these systems has its own attendant problems. In general, however, it may be stated that all time-division multiplex systems require a total elapsed time varying from two to three times that required to transmit a monochrome picture of equal definition. A longer elapsed time, however, means that the flicker problem may become a serious limiting factor.

Viewed from the economic standpoint, time-division multiplex is not too attractive. The receiver must be equipped with suitable gating apparatus to switch the incoming information into the correct reproducing channels. Means must also be provided for identifying which of the three colors is being transmitted at any given instant so that at the same instant the correct color is reproduced. These two functions add to the complexity of the receiver and tend to make the receiver less attractive as an article of merchandise because of increased price, less reliability, and greater difficulty of adjustment.

An examination of the possibilities of frequency-division multiplex therefore seems to be in order. If the bandwidth available for the television signals were arbitrarily divided into three equal segments, one for each message (or color), the rate of transmission of the entire information would have to be slowed down to one third that used in monochrome. This could be done, of course, but the flicker problem would enter and would be a serious limiting factor to commercial acceptance. A way should therefore be sought to transmit the three messages simultaneously in the same frequency spectrum. This method forms the basis of the system to be described and which has

DARK HORSE

A few weeks ago the simultaneous system of color television was considered as dead as the dodo, because it could not fit into the 6-mc channel on a compatible basis. Or so people thought. Within weeks of the end of the FCC color hearing, a wholly new approach to simultaneous transmission was conceived by Bob Dome. Presented herewith, in essentially complete form, is the text of the report on the new system forwarded to the FCC on July 24th.

The Editors

Color Television

By R. B. DOME

Receiver Division, General Electric Company
Electronics Park, Syracuse, New York

been given the name "Frequency Interlace Color Television System."

Frequency Interlace

As the name frequency interlace implies, the frequencies employed by the three messages are sandwiched so as to be noninterfering. This can be done in scanned information systems such as in television because the video frequencies associated with a television signal are bunched around harmonics of the line frequency and a large part of the available spectrum is unused. It has been estimated that about 46 percent of the space between harmonics is not occupied.[1]

Suppose the video-frequency bandwidth available is 4 megacycles. Furthermore, let it be assumed that scanning frequencies compatible with monochrome television are to be used, namely, a vertical or field frequency of 60 per second, and a line rate of 15,750 per second. This results in the standard 525-line system employing two-fold interlace. Suppose that the three primary colors to be used in the system are green, red and blue.

At the camera the composite television picture being televised is split by electro-optical means into three separate groups of signals associated with the three primary colors. Each channel may contain frequencies extending up to 4 mc. The signals associated with the color green may be regarded as the basic signals and may be used to modulate the picture carrier in the same manner as in a monochrome transmitter. Since the line frequency is 15,750 cps, it will be found that the sideband energy is chiefly bunched at frequencies spaced from the carrier by 15,750 cps, 31,500 cps, 47,250 cps, and so on out to 4 mc. It is planned to use the spaces between these harmonics to transmit the information associated with the two remaining colors.

Green and Red Interlace

The video frequencies associated with a second color, for example red, may be utilized as modulating frequencies for a video-frequency subcarrier. This subcarrier frequency is carefully selected to lie exactly midway between two harmonics of the line frequency, or in other words, at an odd multiple of half the line frequency. Half of 15,750 cps, is 7,875 cps; so that a frequency of 3,583,125 cps, which is the 455th multiple of 7,875 cps, may be selected. This subcarrier is modulated with video signals of the red channel, and the modulated wave is superimposed on the green channel signals. It is evident, then, that the red video signals will lie halfway between green-signal line-frequency harmonics in unused parts of the spectrum.

The entire red spectrum does not have to be used. A number of investigators have found that acceptable color reproduction may be obtained by identifying only the lower video frequencies with their respective colors. The higher video frequencies may be transmitted either by green alone or by the principle of mixed highs. Good reproduction will be obtained if red is transmitted as red out to only 1 mc. Furthermore, use may be made of vestigial side-band transmission of the red signal, so that the lower sideband is the dominant one. The spectrum of the combined green and red signals may therefore be as shown in Fig. 1A. This signal may be received by a conventional monochrome receiver insofar as the r-f,

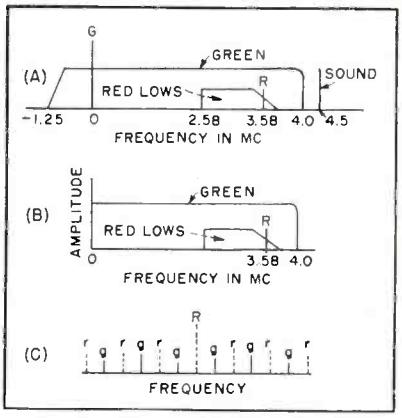


FIG. 1—Spectrum diagrams of green and red video frequencies

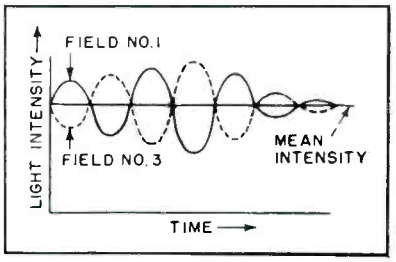


FIG. 2—Red modulation of green signal cancels on alternate odd fields

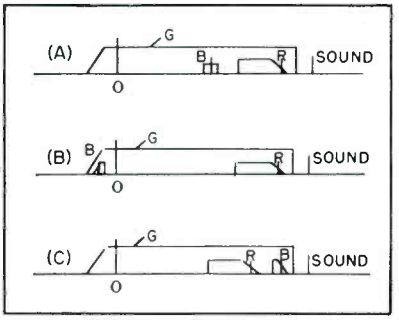


FIG. 3—Alternative locations for blue subcarrier

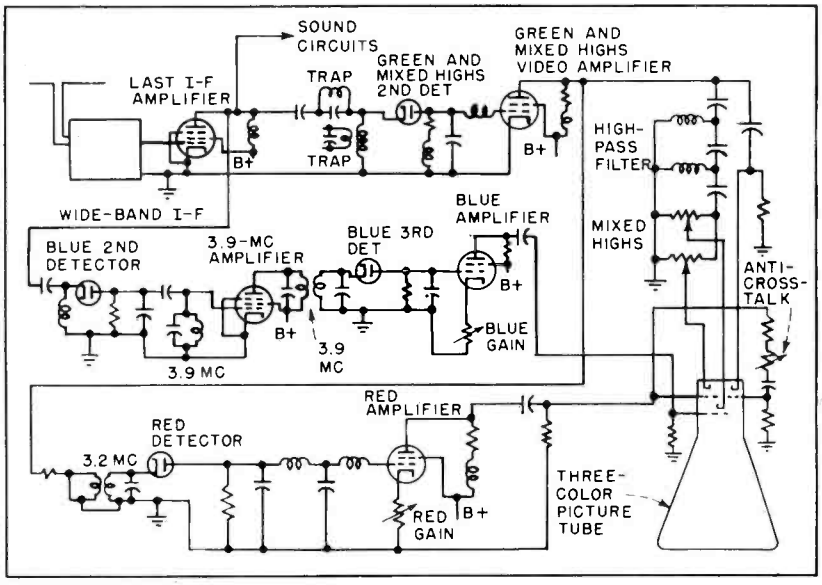


FIG. 4—Schematic of color receiver for frequency-interlace color television

i-f, and second detector are concerned. The video-frequency spectrum out of the second detector would then be as shown in Fig. 1B.

A more detailed view of the frequency spectrum in the vicinity of the red subcarrier is shown in Fig. 1C.

Separating Green and Red

The way in which the signals associated with the two colors are interleaved is now clearly revealed. It is necessary now to provide some means at the receiver for separating the signals for portrayal on the picture tube of the correct color. One way of accomplishing this would be to employ an elaborate wave filter having multiple pass bands for the desired frequencies and multiple elimination bands to exclude the undesired frequencies. Such a filter would probably be too expensive for home receivers because of the large number of sections indicated.

Fortunately a cheap natural filter is available in the form of the human eye. The satisfactory operation of the system depends to a considerable extent on the physiological phenomenon known as the persistence of vision. Any one line of the green television picture will be modulated in intensity at the rate of the red subcarrier. But two fields later in time, in 1/30 of a second, the modulation effect will be 180 degrees out of phase with the modulation of the first field. Thus a lighter dot on field 1 will appear as a darker dot on field 3 and vice versa. In the eye the mean illumination tends to average out to a medium background.

This principle is illustrated in Fig. 2 in which are depicted light intensities along a single green line in field 1 and in field 3. The sine wave is the red subcarrier and is shown here to be amplitude modulated by low-frequency red picture signals. If the eye were a perfect long-time integrator the visual sensation would be represented by the line marked mean intensity which corresponds in this case to the desired green signal.

The repetition rates involved here are not fast enough to give perfect integration, but the practical result is believed to be sufficiently close to the ideal to be commercially acceptable.

The superposition of fields yields twice the number of dots per line as one field alone gives so that a very fine dot structure results. Its fineness is comparable to horizontal scanning line structure and disappears at substantially the same distance away from the picture tube that normal line structure disappears. Thus although both the red and green signals appear on the green gun, the red is effectively filtered out by the eye and only the green remains.

The information contained in the red camera signal above 1 mc and up to 4 mc may be superimposed on the green signal to yield a mixed-high signal above 1 mc.

Addition of Blue Signals

The video frequencies associated with the third color, blue, may be transmitted as modulation on a second subcarrier. As in the case of the red signals, only the lower blue frequencies need be transmitted, so that a comparatively narrow channel is required. A blue video band up to 0.2 mc may be sufficient. Figure 3 shows several possible locations for the blue subcarrier. It is not known at this writing which one of these various methods is likely to provide the best all around performance. Consider for example the third alternative in which the red subcarrier is shown moved down to about 3.2 mc, or to 3.189375 mc, the 405th multiple of 7,875 cps. The blue carrier may be located just under 4 mc at 3.898125 mc, the 495th multiple of 7,875 cps. (The 3.189375-mc signal may be derived from the 3.898125-mc signal by dividing the latter by 11 and then multiplying the quotient by 9.)

Again, as was the case with red and green, the blue signal appearing on the green gun is effectively filtered out by the eye, as are the green signals appearing on the red and blue guns. The blue and red signals, since they do not overlap in frequency, do not exhibit this effect.

Video Components

As stated before, the high video frequencies may be represented by the green channel alone. In order to avoid a greenish tinge to high frequencies, the green highs may be taken off the green video channel by the shunt connection of a suitable high-pass filter and added to the blue and red guns (as well as direct connection to the green gun) of the reproducing means to produce black-and-white fine detail. Alternatively, blue and red highs may be added to the green channel at the transmitter and taken off from the green video channel in the receiver to feed the blue and red guns as well as the green gun. The cutoff frequency of the high-pass filter would be selected at approximately the cutoff frequency of the

red channel low-pass filter, or in the example given, at about 1 mc.

Simplified Receiver

A schematic of the color section of a simple receiver for the reception of a television transmission, such as indicated in Fig. 3C, is shown in Fig. 4. The i-f is kept wide band at the plate of the last i-f amplifier so that the blue channel will not be adversely attenuated before it is detected in the blue second detector. Following this detector is an amplifier and tuned circuits centered around the blue subcarrier to remove effects of the sound carrier and the red subcarrier. The blue third detector yields the blue low-frequency video signals which are amplified and fed to the blue gun grid.

Appropriate sound traps (and if desired blue subcarrier traps) are employed before the green and mixed-highs second detector. The output of this detector is amplified and fed to the green gun. Two shunt circuits leading from the plate of the green-channel amplifier feed respectively the red detector through a 3.2-mc band-pass circuit and the mixed-high filter for addition of mixed highs into the red and blue guns. The 3.2-mc filter feeds a red-signal detector and the output of the detector feeds a red amplifier connected to the red gun.

The receiver as shown here employs 6 sets of tube elements over and above those a receiver would employ if designed to receive black-and-white pictures. By using available combination type tubes, the actual number of envelopes may be reduced to three. The polarity of the detectors may be reversed from those shown to produce the right phase of light intensity, that is, a positive picture. Alternatively, the picture tube gun connections may be reversed to achieve the same result.

A mathematical analysis of the action of the green second detector shows that some of the red low-video-frequency modulation will appear as a low frequency spurious signal in the green detector output because the system is single sideband. The presence of this signal in the green channel may cause an undesirable crosstalk effect making itself evident in a change in hue but not in geometrical design. This color-shift crosstalk effect may be reduced to a small amount by feeding some low-frequency red signals into the green gun in phase reversal to the crosstalk. Again depending upon the modulation polarity of the red signals, the anticrosstalk connection may be made either to the cathode or to the grid of the green gun as required. It is shown here connected to the grid of the green gun.

Receiver Refinements

The simple receiver shown in Fig. 4, while it contains sufficient circuit elements to receive color pictures, has for simplification two features omitted which may be desirable in a commercial product. These are d-c restorers and agc's. The green agc and the green restorer are the same as for black-and-white receivers and need not be discussed in detail. The red and blue d-c restorers are likewise conventional.

Automatic gain control for the red and blue channels will probably be needed in a practical receiver to take care of receiver i-f response variations due to tuning and effects of agc on the i-f response shape.

Many methods of transmitting reference signals for use by the agc systems will suggest themselves, but one of the simplest is that adopted by communication services which employ suppressed-carrier channels. This method is to transmit a pilot signal of fixed amplitude which may be continuous except for blanking intervals, but which lies outside the normal communication channel frequencywise.

Thus in the red channel, a continuous unmodulated wave at a frequency of 1.1 mc from the red carrier might be used as a pilot frequency. Another pilot frequency 220 kc from the blue channel carrier could be used for blue agc. In a practical receiver however, it is quite likely that the red and blue signals would maintain their relative magnitudes fairly well but that the green might change with respect to them depending upon the position of the green carrier along the slope of the i-f response characteristic. Therefore a single agc for the red and blue channels may prove to be adequate, and in which case a pilot frequency may be radi-

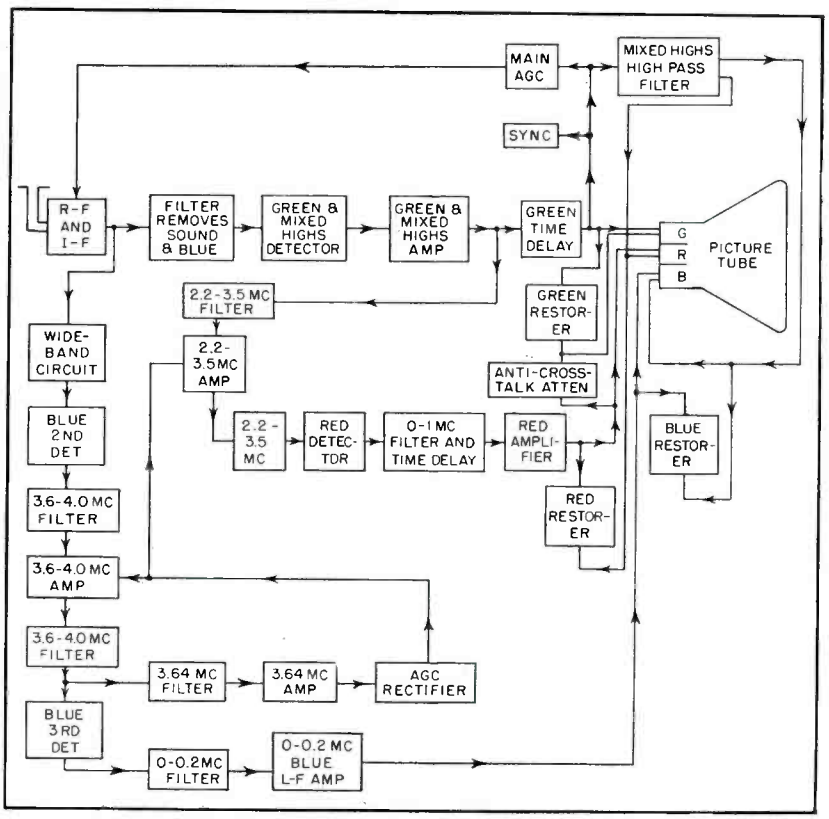


FIG. 5—Block diagram of receiver with necessary d-c restorers and agc circuits

ated in the vicinity of 3.65 mc in the guard band between the blue and red channels shown in Fig. 3C.

The exact frequency for the pilot may be 3.646125 mc, the 463rd harmonic of 7,875 cps. This frequency may be generated by subtracting the eighth harmonic of 31,500 cps from 3.898125 mc. This pilot would then lie 252 kc below the blue carrier or 456.75 kc above the red carrier in a position so that the pilot carrier can be eliminated from the blue and red low-frequency signals by the use of suitable traps, and so that its effect on the green picture will be cancelled by the eye.

The pilot agc signal may be amplified and rectified to obtain an agc–d-c control voltage which may be applied to the 3.9-mc blue-signal amplifier as control-grid bias. The d-c may also be applied to an amplifier which may be inserted in the system shown in Fig. 4 just prior to the red detector. A d-c delay voltage may be employed on the agc rectifier to make the output become quite uniform regardless of variations in input over a suitably wide range in magnitudes. Since the receiver as a whole has its gain controlled by the green channel, it is not likely that very extreme ranges in input variations to the red and blue channels would occur.

The d-c delay voltage may be made adjustable if desired so that the service man at the time the receiver is installed may adjust this control (as well as the individual red and blue gain controls) for best color balance.

Time-delay networks may be required in the green and red channels to give a resultant overall uniform time-delay equal to the time-delay of the blue low-frequency channel because the blue channel is the narrowest and therefore will probably have the greatest inherent time-delay.

A block diagram of the color portion of a receiver incorporating some of the finer points mentioned in the above discussion is shown in Fig. 5. This receiver employs the following tube functions above what is required for a black-and-white television receiver: (1) 2.2 to 3.5-mc red i-f amplifier, (2) red diode detector, (3) 0 to 1-mc red video amplifier, (4) red restorer diode, (5) blue second detector diode, (6) 3.6 to 4.0-mc blue i-f amplifier, (7) blue third detector diode, (8) 0 to 0.2-mc blue video amplifier, (9) blue restorer diode, (10) 3.64-mc agc carrier amplifier, and (11) agc rectifier diode.

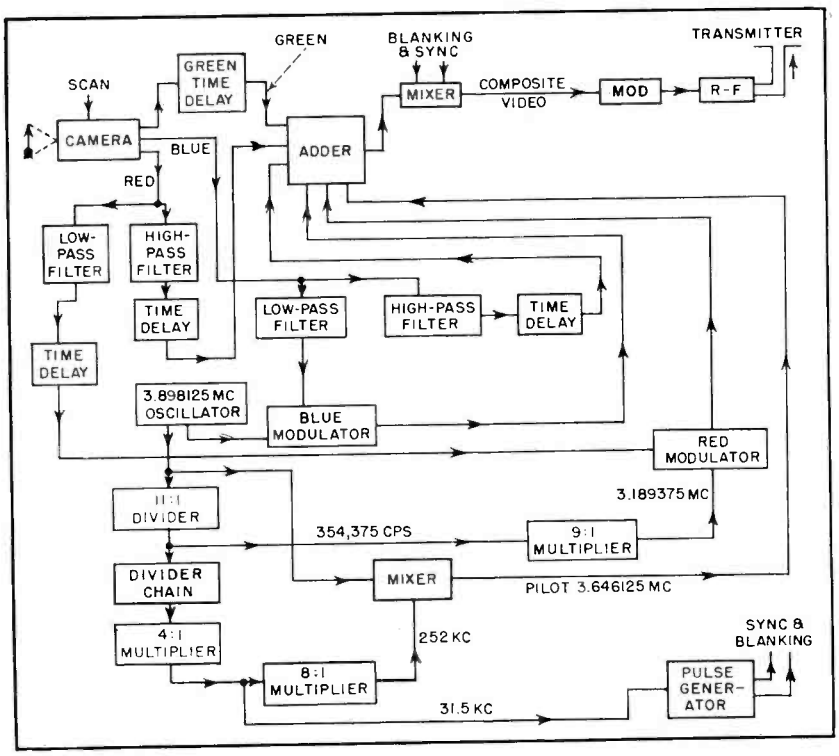


FIG. 6—Block diagram of color-television transmitter

These 11 tube functions can be obtained by employing fewer than 11 separate tubes when use is made of suitable double-purpose tubes. The following combination is a suggestion: (1) 2.2 to 3.5-mc red i-f amplifier and red diode detector, 6SF7, (2) 3.6 to 4.0-mc blue i-f amplifier and blue third detector diode, 6SF7, (3) red restorer diode and blue restorer diode, 6AL5, (4) 3.64-mc amplifier and 3.64-mc detector diode, 6SF7, (5) blue video amplifier and red video amplifier, 6SN7GT, and (6) blue second detector, ½ 6AL5.

Thus approximately 5½ or 6 tubes are needed in addition to the tubes employed in a black-and-white receiver.

Picture-Tube Types

The picture tubes which may be employed as an electro-optical transducer in the receiver may be any of the forms described in the literature including (1) Three separate tubes, one for green, one for red, one for blue, (2) A three-gun single tube as demonstrated by RCA, (3) A single-gun single tube as demonstrated by RCA.

The first two forms of the transducer require no additional apparatus, but the third form would require a circular sweep generator and an auto-sampler, the total number of added tubes possibly being as high as six. For this reason, and for reasons of avoiding the problems attendant to optical registration, the three-gun single tube would appear to be the preferred form for the transducer.

Transmitter

The transmitter for the frequency-interlace color system would be a standard transmitter with some modifications. A block diagram is shown in Fig. 6.

An adder having 6 input terminals is shown in this diagram into which may be fed: (1) green video signals, (2) red lows on a subcarrier, (3) red highs direct, (4) blue lows on a second subcarrier, (5) blue highs direct, and (6) agc pilot signal. The adder output frequency spectrum would then look like that shown in Fig. 7.

Time-delay networks may also be required in the transmitter and if so would probably go into the green

and red channels since once again the blue channel will be retarded the longest inherently because of the relatively narrow bandwidth devoted to blue low-frequency components. Time-delay networks may also be required in the red high and blue high circuits as indicated in Fig. 6.

Relaying and Propagation

The video signal is capable of being transmitted over cable and radio relay networks without loss of fidelity providing the characteristics of the network are such as to provide good transmission up to 4 megacycles. If the cable or radio link has a band pass of only 2.8 mc, the picture is still usable as a black-and-white picture but not as a color picture because the blue and red information would be missing or incomplete.

Anomalous transmission vagaries at uhf are rare and hence it is not anticipated that any difficulties will be encountered which would temporarily blot out a portion of the radiated band thereby removing a blue or a red carrier and their sidebands. Instead, it is to be expected that a continuous flow of all of the information would be received.

Compatibility

The color system is compatible in that present black-and-white receivers regardless of video bandwidth may be used to receive color transmissions in black-and-white. The green picture would constitute the signal employed in reception. Crosstalk would cause no trouble because it is geometrically in the same position on the screen as the green signal itself. If the polarity of modulation is chosen carefully, the black-and-white tube may actually be aided by the crosstalk to give lights and shadows even when the green component is weak.

When the color receiver is tuned to a black-and-white transmission, all of the guns may be fed from the main signal. The operator of the receiver may do this manually in low-priced receivers. Switching would be indicated because the red and blue channels would be dead and the picture would be green. On the other hand, if the receiver were switched for standard black-and-white reception, and a color signal were tuned in, the operator would have no positive signal that the transmission was in color and would have to try the color switch to see if it were in color. On a more expensive receiver, the switching could be accomplished automatically. For example if the pilot signal at 3.64 mc is employed its presence in color transmissions could be used to operate a relay to do the color switching. An absence of signal at 3.64 mc would fail to close the relay so that the receiver would automatically be set up for black-and-white reproduction.

Tests

As yet the system has not been completely set up and color pictures as such transmitted and received. This is due to the relatively short time available. Preliminary laboratory tests have been made however to verify some of the basic principles.

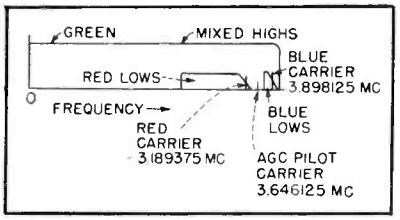


FIG. 7—Spectrum of transmitter output

For example, a continuous-wave oscillation frequency representative of a red carrier has been superimposed on a black-and-white picture and it has been determined that the best frequencies for it are any of those lying between line-frequency harmonics. When the injected frequency coincides with a line-frequency harmonic, vertical black and white bars are visually evident. When the frequency of the injected wave is shifted to lie midway between harmonics of the line frequency two effects are noticed: A dot pattern replaces the vertical line pattern, and the intensity of the variations in light are reduced. These points substantiate the theory.

Secondly, low-frequency amplitude modulation has been applied to the injected carrier and low-frequency crosstalk observed; but the low frequencies at the output of a detector, tuned to the injected frequency, when inserted into the video channel in the proper corrective phase substantially removed all traces of low-frequency crosstalk. This experiment therefore verified the anticrosstalk possibilities referred to in the description.

When the injected carrier frequency is above 3 mc the fine dot pattern has about the same quality as normal line structure and disappears from view at about the same viewing distance from the picture tube. No observable twinkle, flicker, or crawling could be obtained in any of the tests, indicating freedom from these particular types of disturbances.

Advantages and Disadvantages

The proposed frequency-interlace color television system appears to offer the following advantages over other known systems: (1) All precision equipment is localized at the transmitter, so that the receiver can be relatively low in cost, reliable in operation, easy to adjust and maintain, and simple in construction. It is estimated that only 6 more tubes are required than in a monochrome receiver. (2) The receiver should be free from color shifts due to noise interference. (3) The system is inherently compatible with present monochrome standards. (4) The receiver should exhibit a complete absence of twinkle, crawl, or flicker and of field-sequential color fringing.

The anticipated disadvantages of the proposed system are: (1) The requirement of either (a) more accurate receiver alignment and tuning, or (b) an effective automatic gain control on each color. (2) Possible color fringing due to differential time-delay in propagation between color carrier frequencies. (This is not expected, but tests ultimately should be made to check it.) (3) Full 4-mc bandwidth is required in relaying. (4) Possible second-order color fringing due to incomplete physiological filtering in rapidly moving objects.

Reference

(1) Pierre Mertz and Frank Gray, A Theory of Scanning and Its Relation to the Characteristics of the Transmitted Signal in Telephotography and Television, *BSTJ*, **13**, p 464, July 1934.

INTEGRATION

Device developed for repetition rates between 60 and 800 cycles, covering wide range of pulse durations, shows minimum improvement of 5 db in noise for 5-microsecond pulses at 200 cycles. Pulses from radar receiver are gated at twice repetition rate and converted to zero frequency. A d-c integrator drives conventional or special indicators

THE SIGNAL returned from a target to the receiver of a radar system consists of a train of pulses having a definite repetition frequency. In addition to these pulses, extraneous noise is introduced during transmission of the signals and in the receiver itself. If an attempt is made to observe a target at a great distance, the noise may well be sufficient to prevent observation of the returned signals. It is possible to minimize the effect of noise and to increase the useful range of the radar through the use of an integrating device located in the receiver.[1, 2, 3]

One type of integrating device consists of a filter having a narrow pass band centered about the repetition frequency of the signal pulses. Such a filter eliminates energy from those components of the noise having frequencies located outside the pass band of the filter. The filter accepts energy from the fundamental component of the pulses. If the filter has a very narrow pass band, an appreciable time, called the integration time, is required for it to attain its final response following the application of a train of signal pulses. In other words, energy from successive pulses is integrated to give a large response. On the other hand, the noise energy being of a random character tends to build up at a slower rate than the signal. The process is one in which the ability to improve the separation of signal from noise is obtained at the expense of a longer time of observation. The process is relatively inefficient, since the only energy utilized is from that component of the signal having the fundamental repetition frequency.

The duration of a signal pulse is but a fraction of the period between successive pulses, so that a signal is present only a small portion of the time. Noise is present at all times. Considerable noise energy can be eliminated from the system if the receiver is turned on by a suitable gating circuit only at the time when a signal is expected. During the remainder of the time the receiver is turned off. In order to allow a search for a signal at any location on the time scale, corresponding to targets at various distances, the position of such a gate must be continuously adjustable in time.

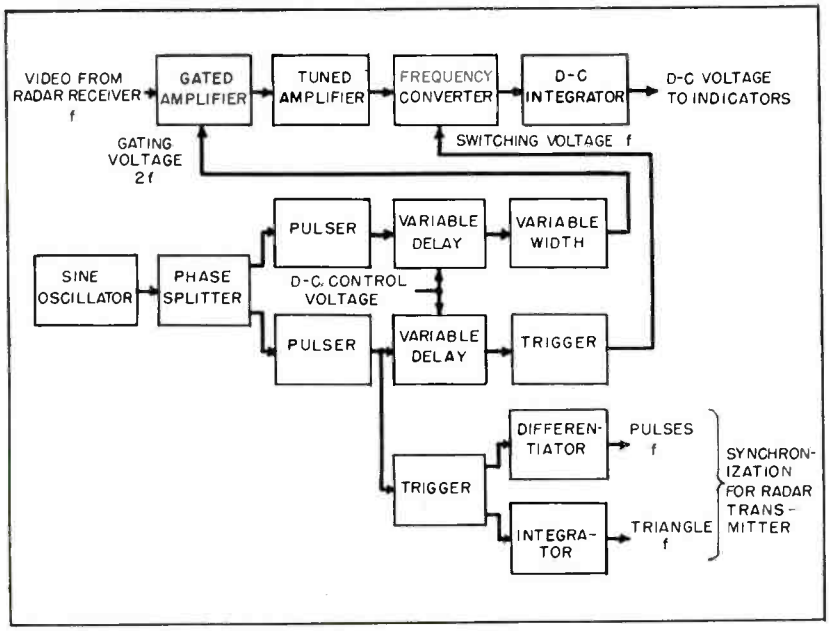


FIG. 1—Complete noise reduction system. Upper components produce a narrow-band filtering action by integration. Elements below generate timing voltages

Gating Disturbances

Disturbances are always introduced in circuits by such a gating action. If the gate operates at the repetition frequency of the signal pulses, the disturbances produced by the gate will be integrated by the narrow-band filter, and a spurious response will be indicated. In order to prevent such a spurious response, the gate must operate at an integral multiple of the repetition frequency, preferably at twice this frequency.[4] In this way, the gate will allow the receiver to be on at the time the signal is expected, but will introduce no component of

NOISE REDUCER for RADAR

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its own at the repetition frequency.

An integrating device has been designed and constructed employing this principle of a narrow-band filter. The specifications for the design were such that the integrator could be used with many existing radar systems. In particular, the repetition frequency of the signal pulses was to be continuously adjustable between 60 and 800 cycles per second. The bandwidth of the integrating filter and the duration of the gate were to be continuously adjustable within relatively wide limits. The position of the gate in time was to be adjustable over a complete period of the signal pulses.

It is obviously desirable to keep the number of controls on the device to a minimum, and to allow a change of the repetition frequency with the least number of readjustments. In order to achieve this end, the circuits of the integrator are designed to operate with pulse-type timing signals that require no tuning of the various portions of the circuit. A block diagram of the complete system is shown in Fig. 1. The components in the upper part of the figure are those that produce the narrow-band filter forming the actual integrator. The components in the lower part of the figure generate the necessary timing voltages. The complexity of the device is brought about mainly by the necessity for operation over a wide range of repetition frequencies.

Block Diagram

The components in the actual integrator will be considered first. A video signal, consisting of signal

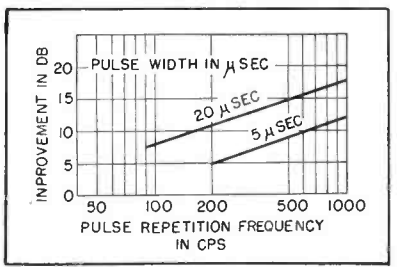

FIG. 2—Improvement in performance of a radar system using the integrator in laboratory tests

pulses with accompanying noise, is supplied from the radar receiver to a gated amplifier. The signal pulses have a repetition frequency f. These pulses are those which were sent out originally by the radar transmitter and which have been reflected from some target. The radar transmitter is synchronized with the integrating device by suitable voltages supplied from the integrator. The gated amplifier is turned on and off by a gating voltage obtained from the timing signal generator. The gating voltage is a train of pulses of repetition frequency $2f$, twice that of the signal pulses. The duration of the gating pulses and their position in time are both adjustable. The gated amplifier contains a balancing circuit[5] to minimize disturbances from the gating action.

An adjustable band-pass amplifier tuned to the repetition frequency f follows the gated amplifier. Its tuning is achieved by means of a resistance-capacitance circuit with feedback.[6] The effective Q of the amplifier is about 10, so that it provides only a small amount of selectivity. The main purpose of the tuned amplifier is to smooth large fluctuations in the signal, and to provide at its output terminals a voltage that is approximately sinusoidal at the repetition frequency.

The filter that provides most of the integrating action must have a very narrow pass band, only a fraction of a cycle per second wide. If the integrating time is to be controlled, the bandwidth of this filter must be adjustable. It is difficult to build such a filter with both its midfrequency and its bandwidth continuously adjustable. For this reason, the integrating device was designed with a frequency converter that shifts the energy of the signal from the repetition frequency down to zero frequency. Integration is then accomplished by means of a simple resistance-capacitance circuit used as a d-c integrator. The frequency converter is a ring modulator[7] using four crystal diodes. A square-wave switching voltage of the repetition frequency f is supplied to the diodes, along with the sinusoidal signal from the tuned amplifier. The phase relations of the square wave and the sinusoidal signal must be correct in order to give maximum d-c voltage of a given polarity at the output terminals of the converter.

Integration is accomplished in a resistance-capacitance circuit. The capacitor is made adjustable so that the integration time (the reciprocal of the bandwidth) can be varied. The d-c voltage controls a current amplifier that may supply a recording milliammeter, used to provide a

permanent record. The d-c voltage is used in a circuit that produces a pattern for observation on an oscilloscope. If there is no integrating action, the oscilloscope pattern is that of the incoming signal from the radar receiver. If integration occurs, synthetic pulses of large amplitude appear on the oscilloscope.

In the lower part of Fig. 1 are shown the components that generate the timing voltages for the integrator and the radar transmitter. Since the gating voltage must be accurately of frequency $2f$, twice the repetition frequency, with no component at f, it was decided to use as the basis for all the timing an adjustable oscillator providing a sinusoidal voltage of frequency $2f$. The voltage from this oscillator is supplied to a phase splitter that produces two voltages of opposite phase relations. The first of these voltages is converted into a train of pulses in the upper channel of the timing signal generator. This train of pulses is passed through a delay circuit[8] in which the time delay relative to the period of the pulses can be controlled by a d-c voltage. At the same time, an adjustable differentiating circuit allows the width of the pulses to be controlled. The voltage resulting from this sequence of operations is a train of pulses of frequency $2f$, adjustable in width and in position on the time scale. This voltage is the gating voltage used to control the gated amplifier.

The sinusoidal voltage from the second part of the phase splitter is converted into a train of pulses in the lower channel of the timing signal generator. This second train of pulses is interleaved in time with the train in the upper channel of the generator. The second train is delayed by a time-delay circuit exactly like that in the first channel. The d-c control voltage for the two delay circuits is the same and is obtained from a single potentiometer, so that delays in the two channels are identical. Pulses from the second delay circuit are used to control a trigger circuit that trips from one stable state to the other for each incoming pulse. The output voltage of the trigger circuit is a square wave of the repetition frequency f. This square wave is related to the gating voltage in such a way that the gating pulse is centered within the flat portion of the square wave. This relation is maintained as the delay circuits are adjusted and the gate is moved in time. The square wave is, therefore, of the proper phase to serve as the switching voltage for the frequency converter.

The train of pulses in the lower channel of the timing signal generator is supplied with no delay to a second trigger circuit. The square wave from this trigger circuit is differentiated to give pulses, and integrated to give an approximate sinusoid. These voltages of repetition frequency f can be used to synchronize the radar transmitter.

Operations

The procedure for operating the integrating system is as follows. The sine oscillator is set to twice the desired repetition frequency and the tuned amplifier is set to the repetition frequency. The pulse repetition frequency of the radar transmitter is synchronized by the proper voltages from the integrator. The duration of the gating interval is adjusted to be about the same as that of the signal pulses. The integration time of the d-c integrating circuit is set to the desired value. In order to locate a signal through the use of the integrator, it is necessary merely to search for the reflected signal pulses by adjusting the time delay of the gating voltage. The presence of a signal is indicated by a rise in the d-c voltage produced by the integrating circuit, as observed with any of the indicating devices. Since the integration time is usually in the order of several seconds, it is necessary that the search be carried out slowly and carefully.

The improvement in performance of the radar system produced by the integrator in laboratory tests is shown in Fig. 2. The tests were made with a sensitive receiver providing the signal for the input of the integrator. The sensitivity of the receiver was such that considerable noise was present; the receiver bandwidth was fixed. Pulse-type r-f signals were supplied to the receiver through an attenuator. An oscilloscope connected to the output of the receiver was used to provide a type-A presentation. The amplitude of the r-f pulses at the input of the receiver was reduced until the pulses were just visible in the midst of noise as seen on the oscilloscope. A strong indication of the presence of the signal is given by the integrator under this condition. The amplitude of the r-f pulses can be reduced further before it is just barely possible to recognize the presence of a signal from indications of the integrating system. The additional attenuation allowed the r-f pulses is plotted as improvement in decibels in the figure. All data of this figure were obtained with equal widths for the gate and the signal pulses. A fixed integration time of five seconds was used in all cases. It is seen that significant improvements are produced by the integrator, but at the expense of a longer time of observation.

If an integrating system were to be used with only one radar operating at a single repetition frequency, the system could be simplified considerably. For single-frequency operation probably sinusoidal timing signals would be more convenient than the pulse-type signals used here.

The integrating system described in this paper was designed and constructed under contract W-19-122ac-10 between Yale University and the Air Materiel Command. We wish to acknowledge the assistance in this work of Dr. E. W. Samson of the Air Force Cambridge Research Laboratories and of the members of his staff. Much of the mechanical work on the device was done by C. B. Wakeman of our laboratory.

References

(1) J. H. Van Vleck and D. Middleton, Reception of Pulsed Signals in Noise, *Jour. App. Phys.*, 17, p 940, 1946.
(2) S. Goldman, Noise Reduction and Range in Radar and Communications, *Proc. IRE*, 36, p 584, 1948.
(3) F. R. Dickey, A. G. Emslie, and H. Stockman, Extraction of Weak Signals from Noise by Integration, Cambridge Field Station Report No. E5038, Sept. 1948.
(4) Reference 1, p 949.
(5) W. H. Stevens, Variable Slope with Constant Current, *Wireless Engineer*, 21, p 10, 1944.
(6) O. G. Villard, Tunable A-F Amplifier. ELECTRONICS, p 77, July 1949.
(7) F. E. Terman, "Radio Engineers' Handbook," McGraw-Hill Book Co., New York, 1943, p 552.
(8) J. C. May, Variable Pulse Length Generator, ELECTRONICS, p 109, Jan. 1950.

Television Receiver Transient Analysis

Response of entire television receiver to 100-kc square waves provides convenient method of production quality control. Results, normally plotted on graph paper, can be shown as composite video on picture tube

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THE ability of a television receiver to reproduce fine detail and sharp transitions without excessive ringing or smear may be judged by the response of the receiver to a 100-kc square wave. In order that the transient response of the entire receiver from antenna terminals to the picture-tube grid may be determined, this equipment provides means of modulating a standard television picture carrier with the square wave. In addition, a marker generator places time dots upon the oscilloscope presentation so that rise time, transient ringing, and smear can be accurately measured.

Equipment

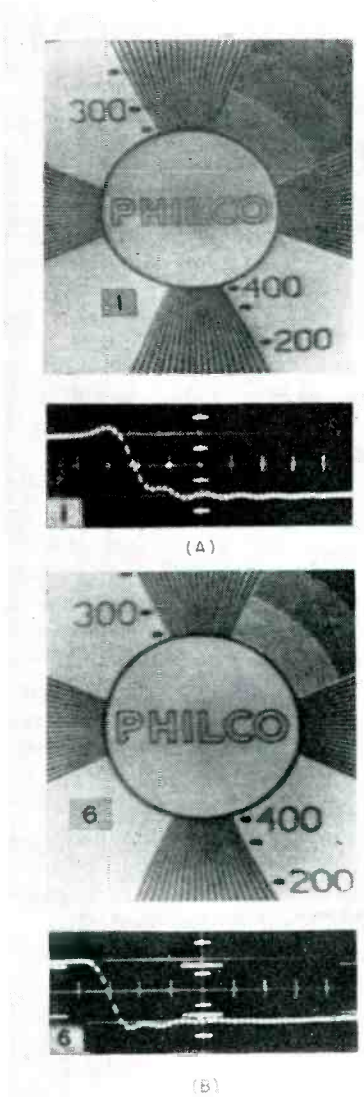
The transient analyzer comprises four units used in conjunction with three pieces of commercial test gear. The analyzer itself is made up of a regulated 150-volt power supply, a square-wave clipper, a modulator and a marker generator. The complete test setup employs in addition a Ferris model 18C r-f signal generator, a Measurements Corp. model 71 square-wave generator and a Tektronix model 511 cathode ray oscilloscope. For accurate measurement of the transient response of the receiver, the inherent distortion in the measuring equipment must be minimized.

In operation, a 100-kc square wave (5-μsec pulse) produced by the generator operating at maximum output is applied to the input of a three-stage clipper shown in Fig. 1. The rise time of the signal produced by the square-wave generator is 0.2 μsec. The clipper unit reduces this rise time to 0.05 μsec. Signals of either polarity are available at the output, and the amplitude may be varied from zero to two volts peak-to-peak.

The output of the clipper unit is connected to one of two balanced modulators. One of these is for an intermediate frequency of 26.6 mc. The other is for television channel 2 (55.25 mc).

The r-f generator is connected to the modulator input as shown in the circuit diagram of Fig. 2. The bandwidth of the input circuit is $\pm$ 10 mc, while the bandwidth of the output circuit is $\pm$ 15 mc. Modulation is applied to the cathodes of the two 6BH6 tubes. For overall transient tests the depth of modulation should be about 30 percent, so that any peculiarities of vestigial side-band transmission near 100-percent modulation are avoided.[1,2] A signal input of 0.6 volt peak-to-peak applied to the cathode circuit produces 30-percent modulation.

With the r-f generator attenuator



Response of one receiver (A) is poor, as predicted by transient response curve plotted below picture of test pattern, whereas another receiver's response (B) is much better in accordance with its characteristic curve

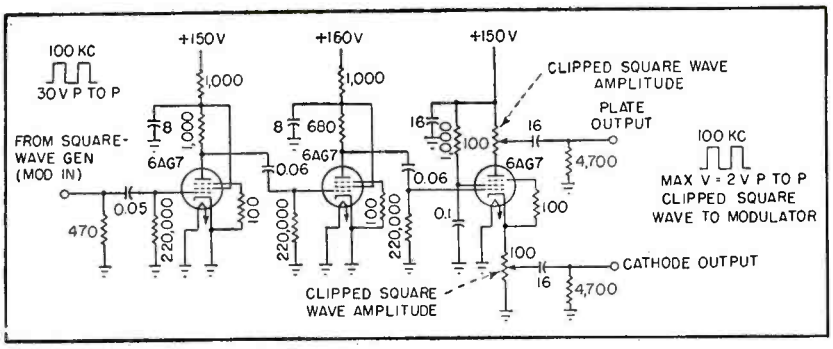


FIG. 1—Diagram of the square-wave clipper that reduces rise time of test pulses

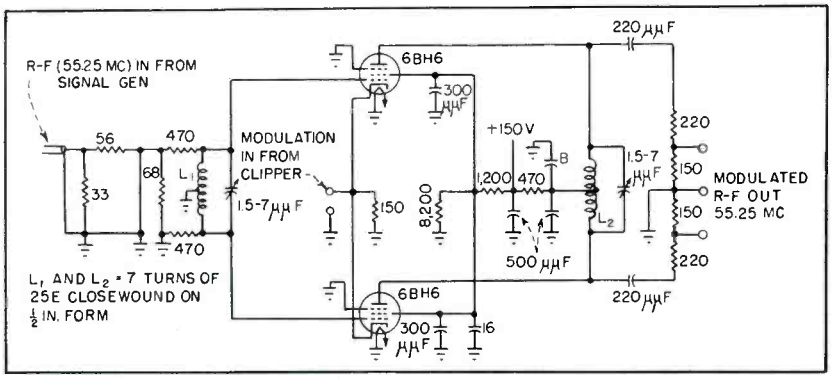


FIG. 2—Modulator for television channel 2 is driven by r-f signal generator and modulated by output of square-wave clipper, Fig. 1

set to 100,000 μv, the open circuit voltage across the 300-ohm balanced output of the modulator is approximately 20,000 μv. Since the percentage modulation of the analyzer remains constant as the r-f input voltage is changed, the output level of the modulator may be changed by means of the r-f attenuator on the generator. If desired, the r-f generator may be left at 100,000 μv and resistance pads having known attenuation inserted in the 300-ohm balanced line connecting the output of the modulator to the antenna terminals of the television receiver under test. The modulator unit can be used as a double-sideband r-f picture generator by impressing a composite video signal on the modulation input terminal. The video signal must have negative sync.

The two-stage vertical amplifier in the test oscilloscope has a rise time of 0.05 μsec, a frequency response within 3 db from 5 cycles to 8 mc, and a minimum amount of overshoot. The probe supplied with the oscilloscope has an input resistance of 10 megohms shunted by 12 $\mu\mu$f. The input capacitance of a picture cathode-ray tube such as the 12LP4 is about 6.0 $\mu\mu$f.

At first thought, it would seem possible merely to replace the c-r tube with the probe when measuring overall transient response. However, most television receivers use series peaking between the final video amplifier tube and the c-r tube grid, and circuits of this type are critical to end capacitance. To eliminate this source of measurement error, c-r tube bases are supplied that have a built-in R-C compensated attenuator, consisting of a 7-megohm resistor shunted by a 15-$\mu\mu$f capacitor. To make measurements, the tube socket is unplugged from the tube base and the socket is plugged into the adapter. The scope probe is then connected to the adapter output connection. This method of measurement insures that the capacitance terminating the lead to the picture-tube grid is the same when either the picture tube or the adapter is used.

A marker generator shown in Fig. 3 is incorporated to place time dots on the oscilloscope presentation so that rise time and transient ringing can be measured accurately. The 20-mc oscillator voltage, producing dots spaced 0.05 μsec apart, is connected to the cathode input of the test oscilloscope. To insure that the dots will remain stationary a quenched oscillator is used. The positive gate, a pulse lasting for the duration of the triggered sweep, is connected to the input of the marker oscillator from the test oscilloscope. The 20-mc oscillator employs a 12AU7 tube held in a non-oscillating state by means of the diode damping across the plate coil. The positive gate pulse raises the cathode potential of the diode damper and the circuit goes into oscillation for the duration of the pulse.

When measuring over-all transient response from antenna terminals to cathode-ray tube grid, for receiver comparison, the following standards have been used:

(1) modulation depth of 30 percent

(2) transition from black to white

(3) 2 μsec sweep

(4) synchronous time dots spaced 0.05 μsec apart

The photograph (A) shows the transient response and test pattern of a receiver in a misaligned condition. The rise time is approximately 0.2 μsec with a definite smear axis lasting for approximately 0.6 μsec. The distance between dots is 0.05 μsec and corresponds to approximately one-hundredth of an inch displacement on a ten-inch picture tube.

The illustration (B) shows the transient response and test pattern of a receiver that is in better alignment. The rise time is approximately 0.17 μsec and the angle of the smear axis is much less than for the first receiver. The transient analyzer was used as a double-sideband television signal generator and was modulated with composite video from a monoscope signal source to obtain the picture illustrated in these photographs.

Recording Transients

A permanent record of the transient response of a given receiver can be obtained either by photographing the oscilloscope presentation or by transferring the response indicated on the scope to graph paper.

A Paillard Bolex Model H-16

camera using Super XX 16-mm reversible film is used to photograph the trace. A hood between the camera lens and the screen eliminates ambient light. The distance between the camera lens and tube face is 42 cm, and pictures have been taken at f:1.5 with an exposure time of 1/30 sec. The oscilloscope used has a green filter and piece of transparent plastic mounted in front of the tube face. The top edge of the plastic is coated with red lacquer and illuminated by a small lamp. Lines scribed in the face of the plastic sheet appear red and are used as calibration marks. To indentify the photograph a small square area is sanded so as to transmit red light, and a semitransparent piece of paper with the identifying number marked in ink is pasted over this area. The illustrations show a receiver identifying number at the lower left-hand corner. The oscilloscope presentation is held to 2 cm to prevent overload on any receivers having an excessive amount of overshoot.

A faster method of recording the information is to transfer the scope presentation to graph paper. It is most conveniently done by scribing nine short horizontal lines on the left side of the plastic between the 2-cm calibration lines. The time dotted transient response curve can then be moved bodily through these calibration lines by adjustment of the oscilloscope controls. The vertical position of each dot as it is moved past the calibration lines is then recorded on graph paper. The X axis of the graph used contains forty equal divisions spaced 3/16 inch apart, each equal to a time interval of 0.05 μsec. The Y axis contains ten equal divisions also spaced 3/16 inch apart. After some experience is gained using this method it is possible to plot the transient response in a few minutes.

Single-Pulse Testing

For more detailed studies of transient response it is advantageous to modulate the analyzer with a composite video signal containing mixed sync, mixed blanking and a single 5-μsec pulse located in the center of each scanning line. The block diagram of the equipment used to produce this signal is shown in Fig. 4.

Horizontal driving pulses from a standard sync generator are applied to two cathode-coupled multivibrators indicated as MV 1 and MV 2. The first multivibrator produces a rectangular pulse with a duration of 30 μsec while the second multivibrator produces a pulse having a duration of 35 μsec. These pulses are differentiated and inverted and the trailing edge of MV 2 is used to trigger MV 3, which produces the 5-μsec test pulse. The trailing edge of MV 1 is used as a trigger for the oscilloscope. The pulse output of MV 3 is applied to a two-stage clipper to achieve a rise time of 0.05 μsec with a minimum amount of overshoot. This test signal is applied to a specially designed line mixing amplifier to produce a composite video signal including sync and blanking. This signal can be used to modulate the transient analyzer or may be applied directly to the input of a video amplifier for measurement of its transient response.

Since the scope trigger impulse leads the test pulse by 5 μsec the same dotted type of presentation is obtained.

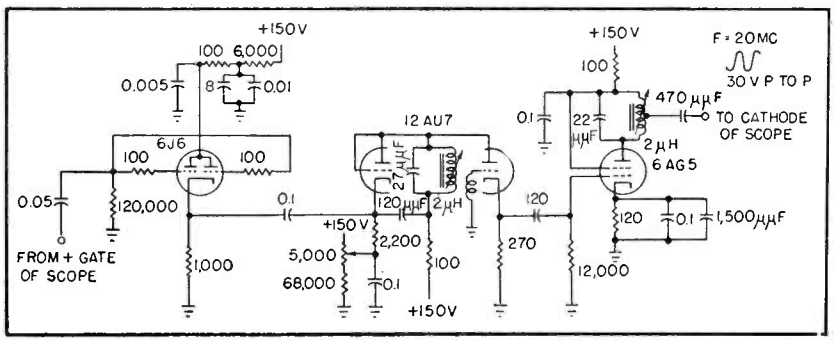


FIG. 3—Marker generator puts time dots on trace accurately to measure rise time and transient ringing effects

The equipment described is a double-sideband generator. All transmitters operating in this country employ vestigial-sideband transmission in which all modulation frequencies three-quarters of a megacycle below picture carrier are rapidly attenuated. Our measurements have shown that receivers having a good transient response from the double-sideband generator produce a good quality picture from a standard television transmitter.

Equal Performance

The original television standards were formulated on the premise that a receiver having the standard RMA selectivity curve, in which picture carrier is located at the 50-percent response point should work

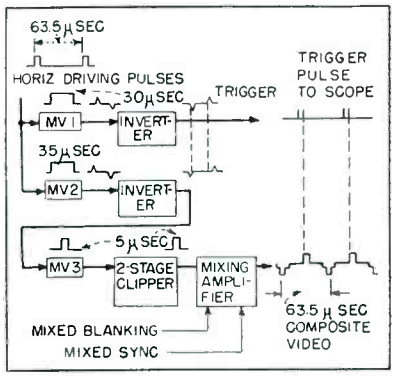


FIG. 4—Method of single-pulse testing using composite video signal

equally well whether receiving a double-sideband signal or a vestigial-sideband signal. As reported by others, the presence of the sideband filter in the transmitter gives rise to a slight leading signal and some smear.

Other writers have advocated the use of phase correction in television transmitters to correct both the distortion introduced by the sideband cutting and the high-frequency cutoff of standard television receivers. The use of such circuits would require industry agreement, a standard station monitor, and the establishment of definite transient standards for television broadcast stations. It would certainly represent an avenue of improvement for television.

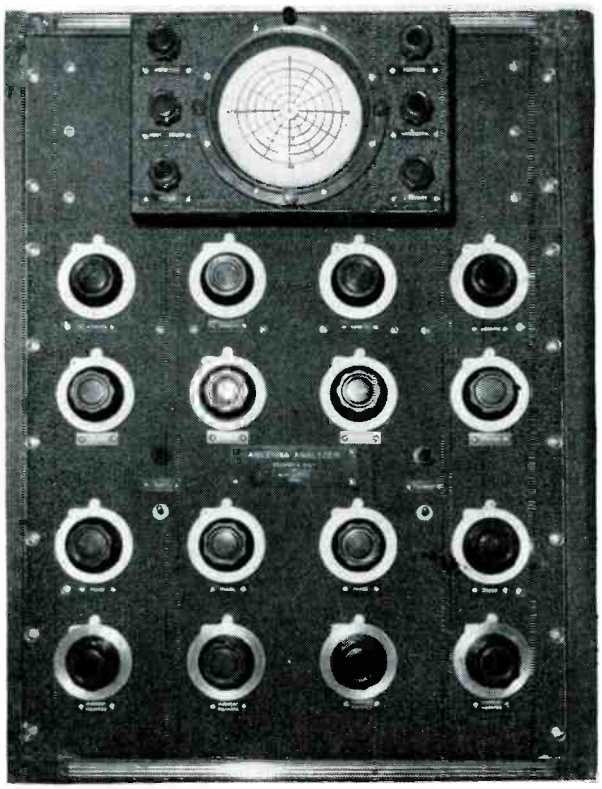
References

(1) R. D. Kell and G. L. Fredendall, Selective Sideband Transmission in Television, *RCA Review*, p 425, April 1940.

(2) R. D. Kell and G. L. Fredendall, Standardization of the Transient Response of Television Transmitters, *RCA Review*, p 17, March 1949.

An Antenna Analyzer

Radiation patterns of standard broadcast antenna arrays are produced on the screen of a cathode-ray tube by an improved electronic computer employing only 38 tubes. Polar or rectangular presentation of the array pattern can be displayed



Panel of instrument contains three units, a five-inch cathode-ray indicator, electronic computer chassis and power supply

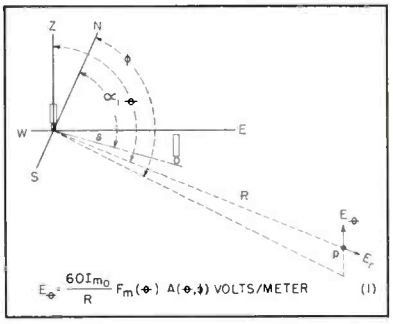


FIG. 1—Simple array consisting of two parallel elements and equation for distant field

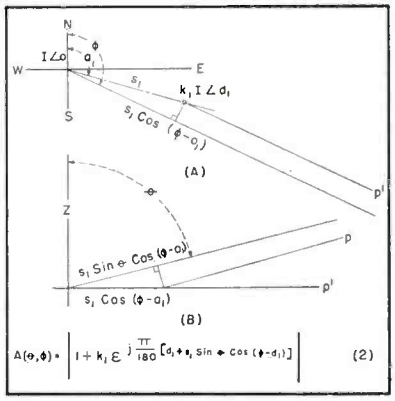


FIG. 2—Horizontal projection of the two-element array is shown at A and the ZO p′ plane protection at B

THE RADIATION EQUATION for the multielement parallel antenna array does not lend itself readily to analysis in broadcast antenna radiation pattern problems. The task of synthesis of an array to produce a certain desired radiation pattern is much more difficult. A trial and error process must be followed and the task is both tedious and time consuming.

To reduce the problem to practical proportions, numerous mechanical computers[1] and electromechanical computers[2] have been constructed. The mechanical computers have been limited by mechanical complexity to three antenna elements, but no apparent limit exists for the curve-drawing electromechanical devices. Any one of these machines is capable of giving the relative distant field pattern for a given array fed in a proper prescribed manner.

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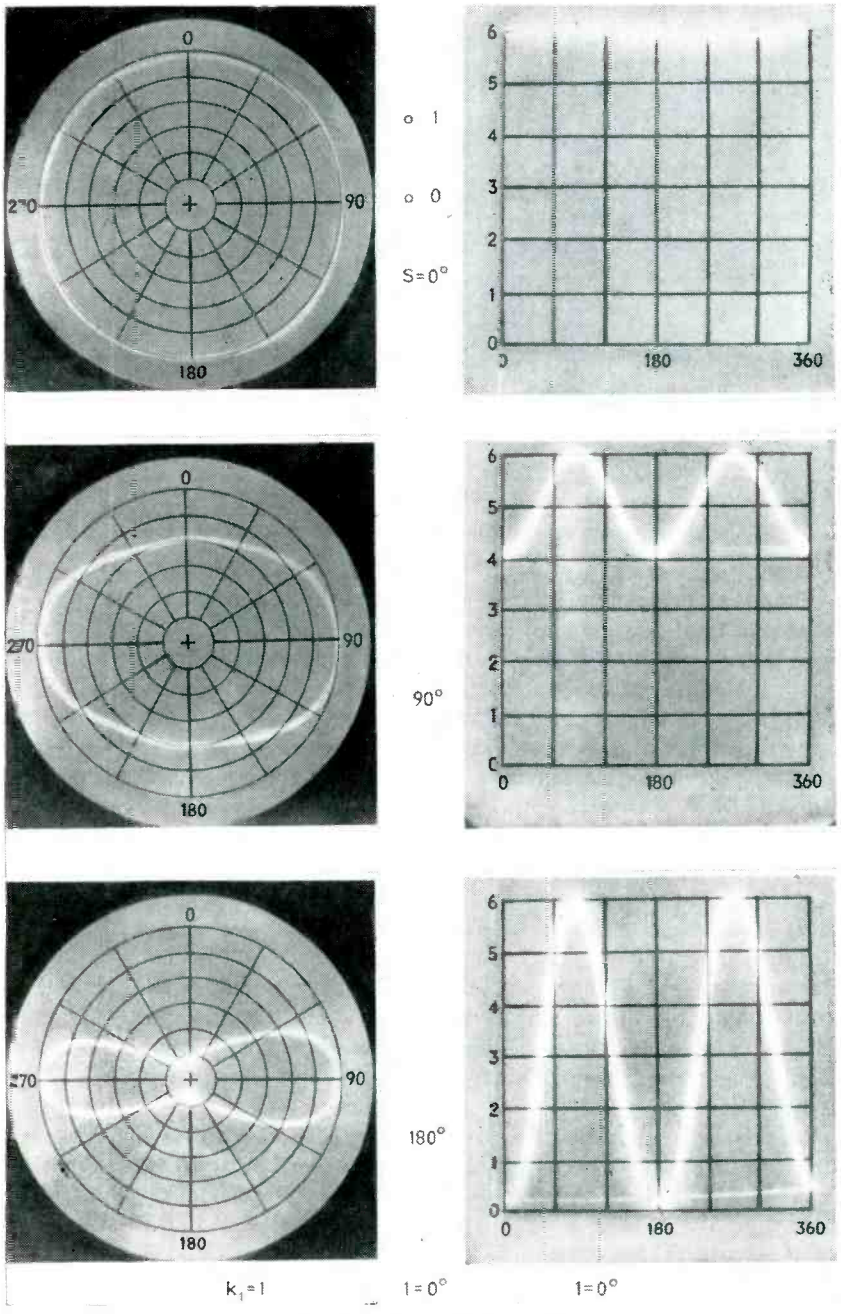
One of the most recent contributions in the field of antenna array computer design was made by Brown and Morrison[3]. They built an entirely electronic device capable of giving a continuous picture of the antenna array radiation pattern on the screen of a cathode-ray tube. With the aid of such a computer, the problem of antenna array synthesis was reduced to dial adjustment until the desired radiation pattern was observed on the screen of the cathode-ray tube. The



Horizontal radiation patterns for a two-element array

approximate solution obtained from the computer then could be improved to the desired degree of accuracy by a much shorter trial and error process.

A similar electronic calculator that was designed for classroom antenna array demonstration, as well as for array analysis and synthesis, will be described.

Control of element parameters is effected by potentiometer adjustment of direct current and 60-cps voltages, and by the use of selsyn control transformers as 60-cps voltage phase shifters. Each dial is calibrated in terms of the parameter it controls. Provisions are included for polar or rectangular presentation of the array radiation pattern.

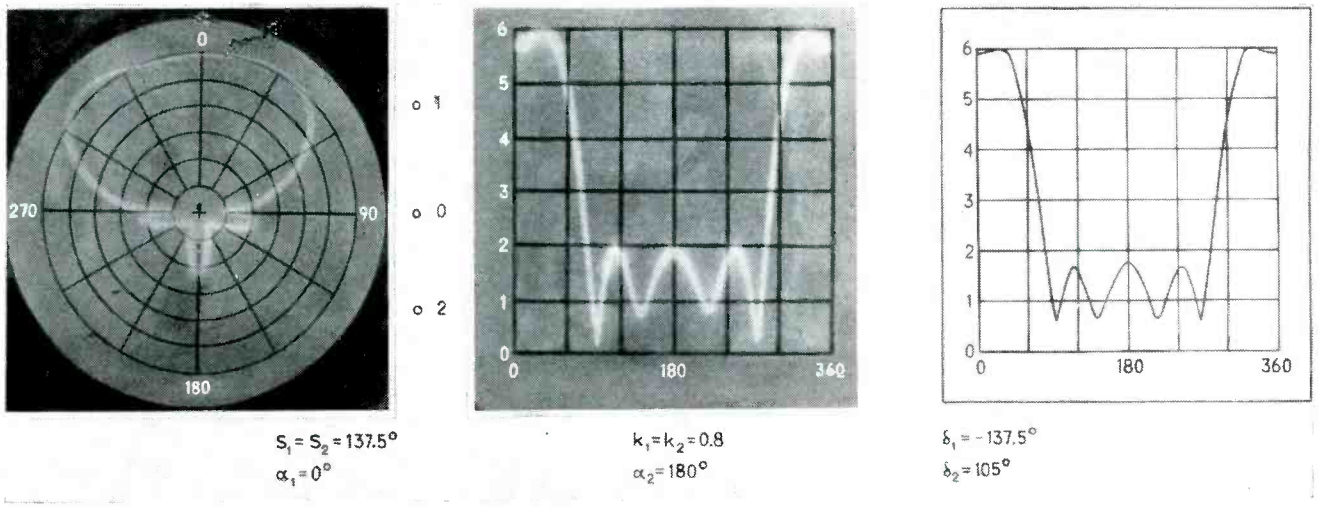
As was pointed out by Brown and Morrison, the electronic reproduction of the radiation pattern of an antenna array depends upon the fact that the array factor can be represented exactly by the magnitude of the sum of a sine wave voltage, representing the field contribution of the reference element, and a series of phase-modulated sine-wave voltages, representing the field contributions of the other elements. Consider an array of parallel elements erected vertically on a perfectly conducting plane earth as shown in Fig. 1. The vertical component of the electric field at point p, located at distance R (R very large compared with the wavelength λ) from the reference element is given in Eq. 1, where $F_m(\theta)$ is the element factor, $A\ (\phi,\theta)$ is the array factor, R is the distance in meters to the point of measurement, θ is the angle from the top of the element to the point of measurement, ϕ is the bearing angle from true north of the point of measurement, and I_{mo} is the effective value of current in the reference element at the point of maximum current along the element. The horizontal plane and ZOp' plane projections of the antenna array are shown in Fig. 2. If the distance to the point of measurement is much greater than the spacing between elements, rays from the elements to the point of measurement may be considered parallel and the array factor for a two-element array is as shown in Fig. 2.

The array factor for a five-element array is shown in Fig. 3, where k_n is the ratio of current in element n to current in the reference element, δ_n is the phase difference between current in element n and current in the reference element in electrical degrees, α_n is the azimuth of element n in degrees, and S_n is the spacing between element n and the reference element in electrical degrees.

If the elements are not of equal length, k_n becomes the ratio of the product of the current maximum and the element factor of element n to the product of the current maximum and the element factor of the reference element.

To duplicate the array factor electrically, let the component of the electric field produced by the reference element be represented by the expression of Eq. 6 in Fig. 4. Let the component of the relative electric field produced by element n be represented by Eq. 7.

If five elements are the maximum number to be considered, the



Horizontal radiation pattern for the WBAA night antenna array. The calculated pattern is shown at right

sum of the simulating voltages becomes Eq. 8 and expansion of one expression allows the sum of the simulating voltages to be written as shown in Eq. 10. Grouping of terms and substituting as shown, the sum of the simulating voltages becomes Eq. 14.

If $B_n = y_n$, Eq. 14 has an amplitude identical to $A_a(\theta,\phi)$, Eq. 5, and is phase modulated in a very complex manner. If the simulating voltages are combined in a mixing circuit with a bandwidth sufficient to accommodate all significant sideband components, and the resulting sum is applied to a linear detector, the array factor will be simulated by the output of the detector.

Thus to produce a complex voltage whose envelope magnitude simulates the array factor of the multielement parallel antenna array erected vertically on a perfectly conducting plane earth, for arrays with not more than five elements, we require a sine-wave voltage of constant amplitude and frequency, and up to four phase-modulated voltages of arbitrary magnitude and arbitrary average phase, maximum phase deviation, and phase of phase deviation.

Let us again consider the expression for the phase deviation of the voltage intended to represent the distant field contribution of element n.

$$B_n = \delta_n + S_n \cos(\phi - \alpha_n) \quad (4a)$$

Element current phase angle δ_n must have a range of ± 180 degrees. If spacing S_n between element n and the reference element has a maximum value of 900 degrees, the total phase swing B_n may be as large as $\pm$ 1,080 degrees. Several wide-range phase modulators employing conventional electron tubes have been developed. Systems of phase modulation by Kell[4] and by Day[5] give good linearity over a range of $\pm$ 120 degrees. The system due to Day was found to give a somewhat more linear phase-modulation characteristic and a higher output voltage; therefore that system was used in the electronic computer. Two tripler-amplifiers in cascade increase the $\pm$ 120-degree variation capability to $\pm$ 1,080 degrees.

Reference is made to the circuit diagram of the computer unit, Fig. 5. A type 6SJ7 pentode is employed in a modified Pierce crystal oscillator circuit. The quartz plate has a nominal frequency of 100 kc. The circuit is arranged to allow plate current flow during only a very small fraction of the oscillation cycle. A 39,000-ohm resistor isolates the plate from the oscillating circuit. The resulting plate-voltage wave is a pulse about -50 volts high and one-half microsecond wide. The output voltage of the oscillator is applied to a type 6SN7 tube in a differentiator cathode-follower circuit in which the pulse phase is reversed, the pulse width is reduced to a very small fraction of a microsecond, the pulse amplitude is reduced slightly, and the impedance level is reduced to about 450 ohms.

The output voltage of the cathode follower is applied to a pulse bus which feeds the reference-element cascade-tripler amplifier and the four element-phase modulators. Two type 6SJ7 pentodes are employed in the two-stage cascade-tripler amplifiers. The reference-element tripler amplifier introduces a 900-kc voltage of constant amplitude in series with the common resonant circuit employed for voltage mixing.

Phase Control

The element-phase modulators use the positive pulse from the pulse bus to key one-half of a 6SN7 in a hard-tube sawtooth oscillator circuit. The time constant of the sawtooth circuit is 2.5 times the wave period; therefore, the resulting sawtooth voltage has a peak value of 0.32 E_{bb} or 70 volts.

A second 6SN7 is employed in a variable clipper-differentiator circuit; the clipper grid is directly coupled to the plate of the sawtooth-generator tube. The cathode bias of the clipper is adjusted to allow grid conduction when the sawtooth voltage rises to 35 volts. Shortly before grid conduction begins, clipper plate conduction produces a sudden drop in clipper plate voltage.

The clipper plate voltage drives a differentiator - phase - reverser which gives a sharp 40-volt positive pulse, the position of which is determined by the clipping level. Fairly linear pulse position variation with clipper cathode-voltage variation was obtained over a range of $\pm$ 130 degrees. The average clipping level, which is deter-

mined by the d-c cathode potential of the clipper, is made adjustable over a ±20-degree range, and the dial of the 5,000-ohm wire-wound potentiometer used to control the cathode d-c potential is calibrated linearly in terms of average channel output phase, which corresponds to antenna element current phase, over a range of ±180 degrees. The two 5,000-ohm rheostats in series with the calibrated potentiometer are used to adjust the 180 and −180-degree phase positions. The control dial is labeled PHASE.

Spacing

Modulation at a frequency of 60 cps simulates variation in ϕ and was achieved by means of a low-gain modulating amplifier, directly coupled to the cathode of the clipper. The second half of the first 6SN7 in the modulator section was used for this purpose. Excitation of the modulating amplifier was furnished by the secondary of a selsyn control transformer whose delta connected primary was excited by a three-phase 60-cps power source in the power-supply unit. The level of the 60-cps modulation was controlled by a 10,000-ohm wire-wound potentiometer in the grid circuit of the modulating amplifier. At the maximum setting of this potentiometer, the position of the modulator output pulse is sinusoidally varied over a range of ±100 degrees. This corresponds to a crest phase modulation of 900 degrees in the output of the element cascade-tripler amplifier, and therefore the dial controlling the potentiometer is linearly calibrated from 0 to 900 degrees. Crest phase modulation represents the spacing between the element and the reference element; hence the dial is marked SPACING. A series 5,000-ohm rheostat allows initial calibration of the spacing control.

The phase position of 60-cps modulating voltage is controlled by the shaft position of the selsyn control transformer. Deviation between rotor mechanical angle and secondary-voltage phase angle for 6.3 volt, balanced three-phase 60-cps excitation of the primary was found to be very small, and therefore permitted direct phase-shift calibration of the selsyn transform-

$$A(\theta,\phi) = \left| \begin{array}{l} 1 + k_1 \varepsilon^{j\frac{\pi}{180}[d_1 + s_1 \sin\theta \cos(\phi - \alpha_1)]} \\ + k_2 \varepsilon^{j\frac{\pi}{180}[d_2 + s_2 \sin\theta \cos(\phi - \alpha_2)]} \\ + k_3 \varepsilon^{j\frac{\pi}{180}[d_3 + s_3 \sin\theta \cos(\phi - \alpha_3)]} \\ + k_4 \varepsilon^{j\frac{\pi}{180}[d_4 + s_4 \sin\theta \cos(\phi - \alpha_4)]} \end{array} \right| \quad (3)$$

$$y_n = d_n + s_n \sin\theta \cos(\phi - \alpha_n) \quad (4)$$

$$A(\theta,\phi) = \sqrt{\left[\begin{array}{l} 1 + k_1 \cos y_1 \\ + k_2 \cos y_2 \\ + k_3 \cos y_3 \\ + k_4 \cos y_4 \end{array}\right]^2 + \left[\begin{array}{l} k_1 \sin y_1 \\ + k_2 \sin y_2 \\ + k_3 \sin y_3 \\ + k_4 \sin y_4 \end{array}\right]^2} \quad (5)$$

FIG. 3—Array factor for a five-element system

$$e_0 = \sin\omega t \quad (6)$$

$$e_n = k_n \sin(\omega t + B_n) \quad (7)$$

$$e = \sin\omega t + k_1 \sin(\omega t + B_1) + k_2 \sin(\omega t + B_2) + k_3 \sin(\omega t + B_3) + k_4 \sin(\omega t + B_4) \quad (8)$$

$$\sin(\omega t + B_n) = \sin\omega t \cos B_n + \cos\omega t \sin B_n \quad (9)$$

$$e = \sin\omega t + k_1 \sin\omega t \cos B_1 + k_1 \cos\omega t \sin B_1 + k_2 \sin\omega t \cos B_2 + k_2 \cos\omega t \sin B_2 + k_3 \sin\omega t \cos B_3 + k_3 \cos\omega t \sin B_3 + k_4 \sin\omega t \cos B_4 + k_4 \cos\omega t \sin B_4 \quad (10)$$

$$e = \sin\omega t (1 + k_1 \cos B_1 + k_2 \cos B_2 + k_3 \cos B_3 + k_4 \cos B_4) + \cos\omega t (k_1 \sin B_1 + k_2 \sin B_2 + k_3 \sin B_3 + k_4 \sin B_4) \quad (11)$$

$$e = g \sin\omega t + h \cos\omega t \quad (12)$$

$$e = \sqrt{g^2 + h^2} \sin(\omega t + \arctan \frac{h}{g}) \quad (13)$$

$$e = \sqrt{\left[\begin{array}{l} 1 + k_1 \cos B_1 \\ + k_2 \cos B_2 \\ + k_3 \cos B_3 \\ + k_4 \cos B_4 \end{array}\right]^2 + \left[\begin{array}{l} k_1 \sin B_1 \\ + k_2 \sin B_2 \\ + k_3 \sin B_3 \\ + k_4 \sin B_4 \end{array}\right]^2} \quad (14)$$

$$\sin(\omega t + \arctan \frac{k_1 \sin B_1 + k_2 \sin B_2 + k_3 \sin B_3 + k_4 \sin B_4}{1 + k_1 \cos B_1 + k_2 \cos B_2 + k_3 \cos B_3 + k_4 \cos B_4})$$

LET $B_n = y_n$ (15)

THEN $|e|_{MAX} = A(\theta,\phi)$ (16)

FIG. 4—Equations for simulating voltages for duplicating the array factor electrically

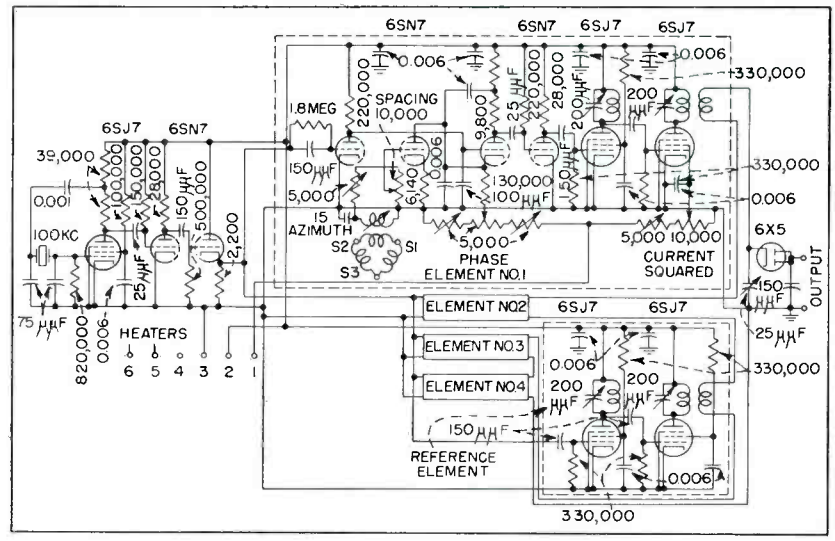


FIG. 5—Circuit of the computer unit for the antenna analyzer

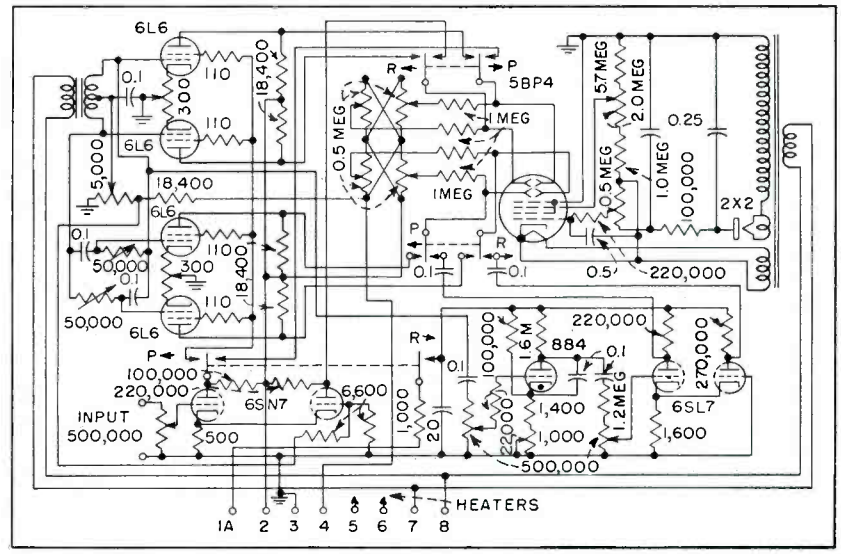
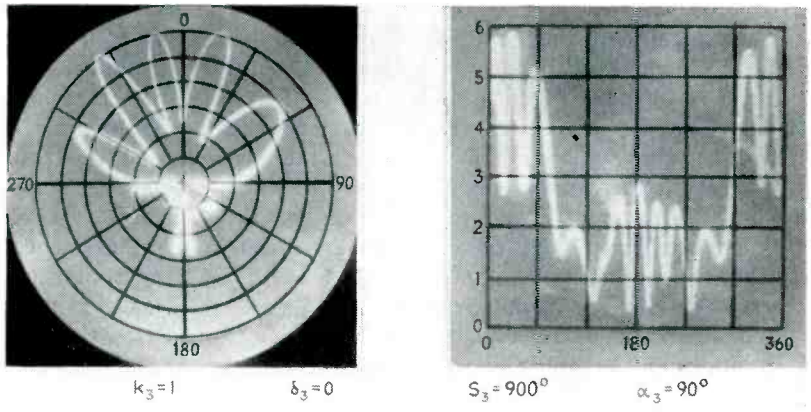
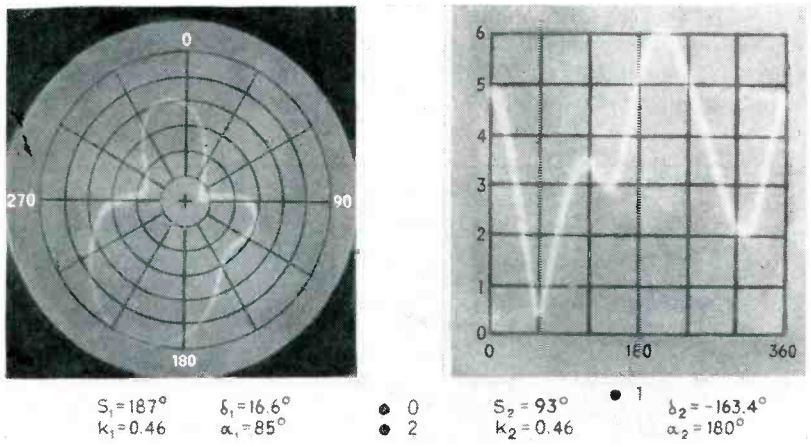


FIG. 6—Circuit of indicator unit mounted on top of front panel



Horizontal radiation pattern of the WBAA night antenna array with an interference element added having the parameters given



Horizontal radiation pattern of an unsymmetrical three-element array

ers. The control dials of the selsyn transformers were marked azimuth, as variation in the phase of the 60-cps modulating voltage corresponds to changes in the azimuth of the element α_n.

The output pulse voltage produced by the element phase-modulator drives the control grid of a 6SJ7 pentode operating as a class-C tripler amplifier. The sine-wave voltage produced across the tripler-amplifier plate parallel-resonant circuit has a center frequency of 300 kc and a phase-modulation crest three times as large as present at the output of the modulator.

The second tripler amplifier is capacitance coupled to the plate of the first and also uses a 6SJ7. The second tripler amplifier performs the function of output voltage control for the element channel. A linear 10,000-ohm wire-wound potentiometer is employed to control the screen grid d-c potential and hence the output voltage. A series 5,000-ohm rheostat is provided for initial adjustment.

The output voltage of the tripler was found to vary almost exactly with the square root of the screen-grid voltage; a linear dial calibration was used for the voltage-amplitude control, and as the output-voltage magnitude simulates the antenna-element current magnitude (for equal-length elements), the dial was labeled CURRENT SQUARED.

The secondaries of the second tripler-amplifier plate transformers are connected in series and the combination is tuned to resonate at 900 kc. Although five tripler amplifiers are coupled to a common 900-kc mixing circuit, almost no cross-channel modulation exists; the angle of plate-current flow for the type 6SJ7 pentodes is very small and therefore their effective plate resistance is very high.

The indicator unit occupies the top chassis of the antenna analyzer. This unit, Fig. 6, includes a 5BP4 cathode-ray tube and high-voltage power supply, a linear sweep generator, a computer signal amplifier, and a polar converter.

If the rectangular presentation of the antenna-array radiation pattern is desired, the polar-rectangular switch is placed in the rectangular position. A 6SN7 in a direct-coupled amplifier circuit increases the computer output voltage. A potentiometer in the grid circuit permits control of the output signal voltage.

The computer signal amplifier is directly coupled to the vertical plates of the cathode-ray tube. Direct coupling is necessary to preserve the d-c component of the complex voltage wave that may be produced by the computer. The 60-cps linear sweep voltage applied to the horizontal plates of the cathode-

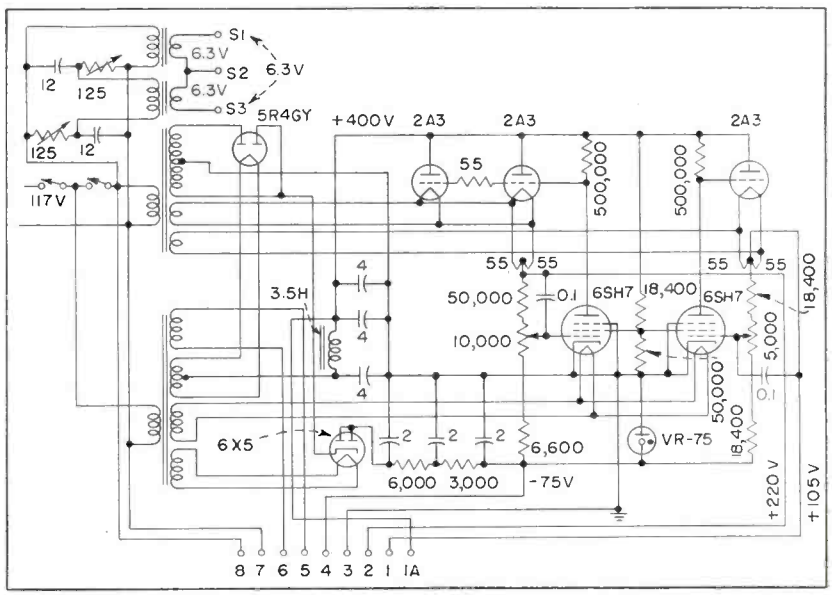


FIG. 7—Power supply circuit includes three-phase 6.3-volt source at top left

ray tube is furnished by a type 884 gas-triode sawtooth generator followed by a 6SL7 amplifier.

Means are provided for the initial synchronization of the sawtooth generator and for the initial adjustment of sweep-voltage amplitude. Double potentiometers provide centering control for the cathode-ray tube. The cathode-ray tube is equipped with a rectangular coordinate scale, drawn on a blue plastic filter, to assist in pattern evaluation. If polar presentation of the antenna-array radiation pattern is desired, the rectangular-polar switch is turned to the polar position. The plate voltage of the linear oscillator and its amplifier is interrupted and screen voltage is applied to a double-balanced modulator circuit employing four 6L6-G tubes. The plates of the cathode-ray tube are directly coupled to the double-balanced modulator. The push-pull connected control grids of the balanced modulators are fed in quadrature from a 6.3-volt transformer secondary by means of a 90-degree phase-shifting network. The control grids are biased to produce plate-current cutoff for a screen voltage of about 20 volts. Screen voltage for the modulator tubes is provided by the computer signal amplifier.

If all antenna current-squared controls are set at zero, and the gain control of the indicator unit is set at about one-third full rotation, a circle will be produced on the screen of the cathode-ray tube. If other elements are introduced, the resulting figure will be more complex if the spacing controls are not set at zero.

The cathode-ray tube is equipped with a polar coordinate scale to assist in pattern evaluation. Sufficient gain has been provided in the unit to permit enlargement of minor lobes in complex array patterns. The polar presentation is not linear enough for computing work, but it is satisfactory for classroom demonstration and for first approximations in array design.

Power Supply

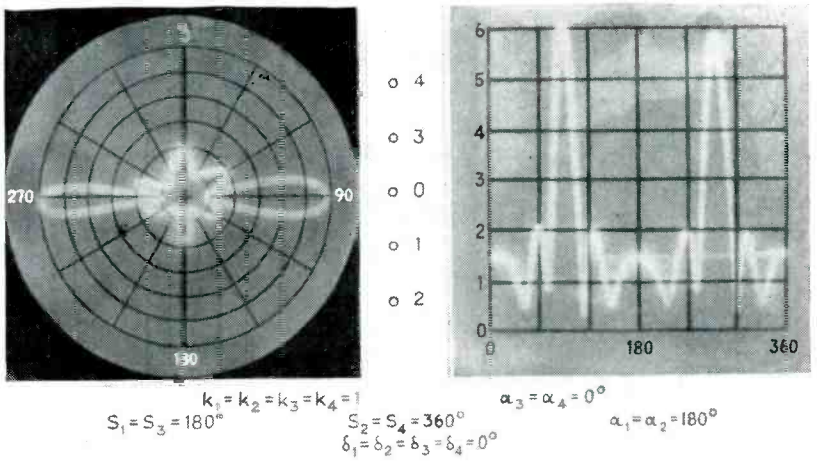
The power unit of Fig. 7 furnishes 6.3-volt 60-cps filament voltage, 6.3-volt 60-cps 3-phase for the four selsyn transformers, 220 volts d-c plate voltage, 105 volts control voltage, and −75 volts bias voltage for the computer and indicator units. The rectifier, voltage-regulator section is conventional.

Three-phase voltage for the selsyn transformers is obtained from two 6.3-volt transformers connected in open delta. One of the transformers is fed directly from the 117-volt line and the second is fed through a 60-degree constant-voltage phase shifter connected to the line. Switches provide separate control of filament and plate voltage.

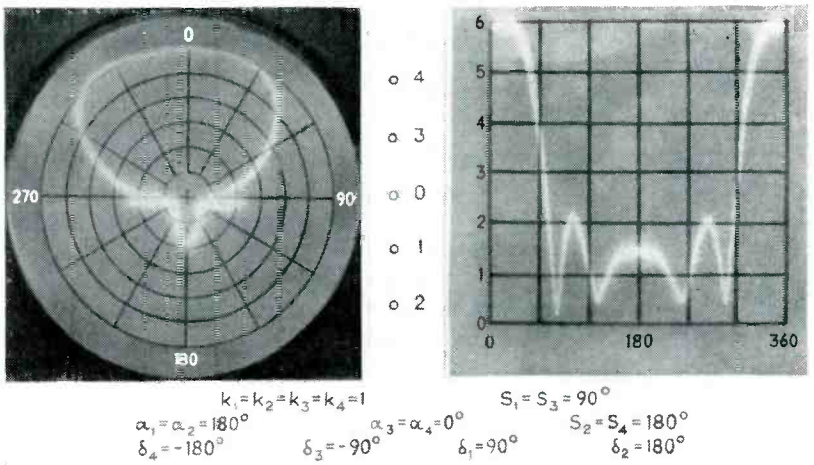
Oscillograms of horizontal radiation patterns are given for two-element, three-element, four-element and five-element arrays.

If the oscillograms of the WBAA night antenna array radiation pattern are compared with the computed pattern, it may be seen that the error is relatively small. It is believed that the device will continue to be of value as a classroom teaching aid in antenna array study, and that the equipment is accurate enough to be employed for first approximation work by the broadcast-array design engineer.

The writer gratefully acknowledges the encouragement and guidance of Robert P. Siskind of the School of Electrical Engineering at Purdue University, under whose supervision this project was carried forward.



Horizontal radiation pattern of a broadside array of five elements



Horizontal radiation pattern of an end-fire array of five elements

References

(1) Alston F. Everest and Wilson S. Prichett, Horizontal-Polar Tracer for Directional Broadcast Antennas, *Proc. IRE*, 30, p 227, May 1942.
William G. Hutton and R. Morris Pierce, A Mechanical Calculator for Directional Antenna Patterns, *Proc. IRE*, p 233, May 1942.
(2) Carl E. Smith and Edward L. Grove, An Electromechanical Calculator for Directional Antenna Patterns, *Trans. AIEE*, (*Elec. Eng.*, Feb. 1943) 62, p 78, Feb. 1943.
(3) George H. Brown and Wendell C. Morrison, The RCA Antennalyzer, *Proc. IRE*, 34, p 992, Dec. 1946.
(4) Ray D. Kell, RCA Laboratories, U. S. Patent no. 2,061,734.
(5) J. R. Day, Serrasoid F-M Modulator, ELECTRONICS, p 72, Oct. 1948.

WIDE-RANGE

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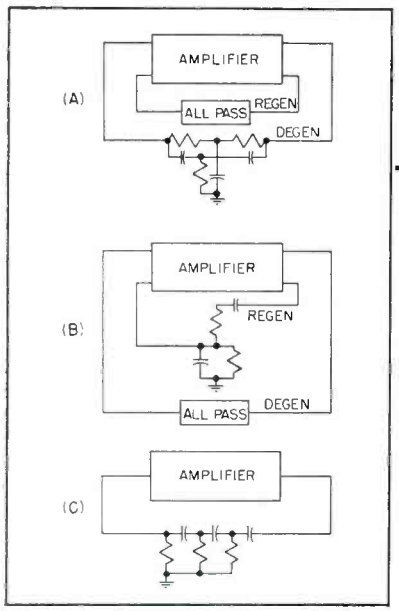


FIG. 1—Block diagrams illustrating types of R-C oscillators

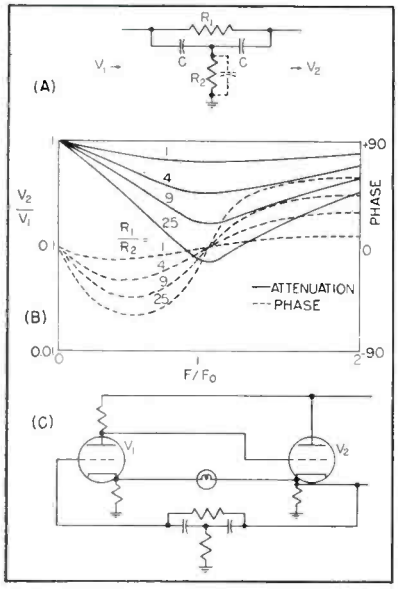


FIG. 2—Bridged-T network (A), its characteristics (B), and simplified schematic of the new oscillator

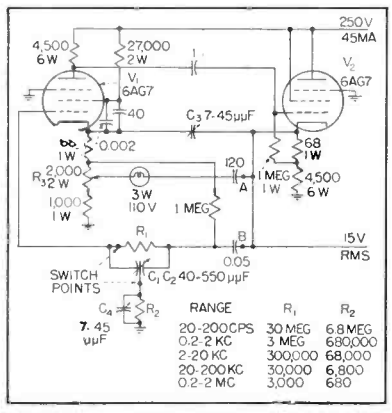


FIG. 3—Complete circuit of the wide-range oscillator showing component values and characteristics for all ranges

RESISTANCE-CAPACITANCE oscillators have seen wide use in the laboratory and elsewhere because of several important features, among which are compactness, excellent frequency stability, and a wide tuning range. Unfortunately their application has been restricted to audio and ultrasonic measurements with a top frequency of approximately 200 kilocycles. It is the purpose of this paper to describe a new but simple circuit that functions over the range from 20 cycles to 2 megacycles with good waveform and constant output.

In developing the new oscillator, the limitations of previous types were considered. The first[1], Fig. 1A, consists of an amplifier with two feedback paths; regeneration occurs at all frequencies, while the degenerative loop contains a parallel-T null network. Thus oscillation takes place at the null frequency. The principal disadvantages are that three circuit elements must be varied to change frequency, and that a two-stage amplifier is required to provide proper phasing. Phase shifts become important at the extremes of the frequency range, affecting frequency calibration.

A second oscillator,[2] Fig. 1B, is somewhat similar to the first. However, degeneration is provided at all frequencies, while regeneration occurs through a half-Wien bridge, which exhibits a broad maximum in its response. Oscillation tends to occur at the frequency of the maximum, but the Q of the Wien circuit—about 0.3— is so low that phase shifts in the amplifier will affect the frequency calibration.

The phase-shift oscillator,[3,4,5] one form of which is shown in Fig. 1C, contains a 180-degree network in a single feedback loop. Although it is the simplest of the oscillators described, functioning with a single tube, a minimum of three circuit elements must be varied to change frequency. Furthermore, it is found that an additional tube is required to provide suitable amplitude regulation, and that high-frequency operation is limited by the low impedance of the phase-shift network at the high frequencies.

Circuit Development

In an attempt to improve the oscillator of Fig. 1A, the bridged-T network[6] of Fig. 2A was investigated. This simple network, which has been used for the measurement of high resistances at radio frequencies, has but four circuit elements, as compared with six for the parallel-T. Although a true null is not produced, a fairly-sharp minimum, accompanied by zero phase shift, occurs at $\omega_0 = 1/[C(R_1R_2)^{\frac{1}{2}}]$. It is seen from Fig. 2B, that the selectivity is improved by increasing the ratio R_1/R_2. It can be shown that, for large values of R_1/R_2, the equivalent Q of the network approaches $\frac{1}{2}(R_1/R_2)^{\frac{1}{2}}$. Thus phase characteristics superior to those of the network of Fig. 1B are easily obtained, with consequent reduction in the effects of amplifier phase shift when employed in an oscillator.

A very useful feature of the bridged-T is that a trimmer capacitor (shown dotted) placed across the vertical arm will permit minor adjustment of ω_0 where the capacitances C are small. Therefore, if capacitive tuning is used

R-C OSCILLATOR

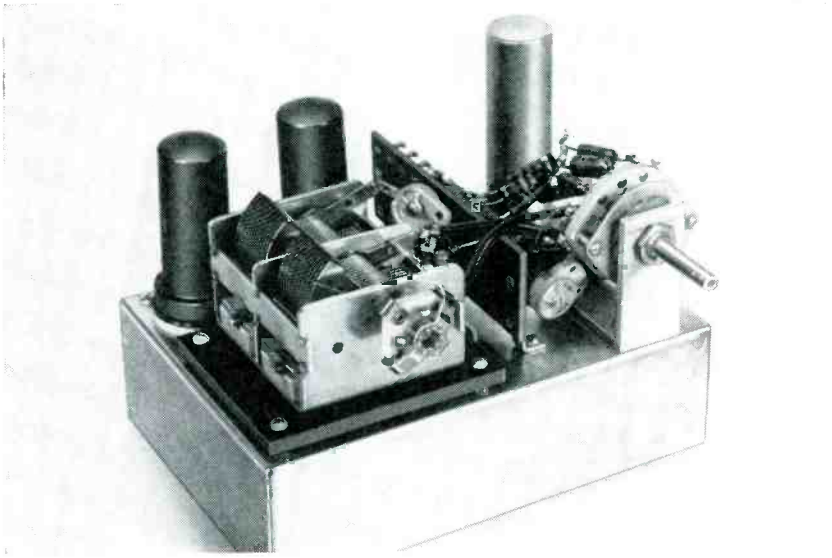
A simple resistance-capacitance oscillator with good waveform and constant output uses two tubes to produce 15 volts rms output. It covers the frequency range from 20 cycles to 2 megacycles in five decade ranges

it is possible to adjust the upper end of a frequency range nearly independently of the lower end. This is helpful when the circuit is employed in an oscillator where a single dial calibration must suffice for two or more decade ranges.

Figure 2C is a simplified schematic diagram of the new oscillator, which consists of an amplifier, V_1, driving a cathode-follower, V_2. Regeneration is provided at all frequencies by cathode-to-cathode feedback through a lamp as a series resistor, while the degenerative loop contains the bridged-T network. Oscillation tends to take place at ω_0, the frequency of minimum degeneration, while amplitude stabilization is provided by the positive-resistance-current characteristic of the lamp. The combination of amplifier plus cathode follower is ideal for this application because it provides wide-band operation with small phase shift and low output impedance.

Figure 3 is the schematic diagram of the compact oscillator illustrated. The frequency range, 20 cycles to 2 megacycles, is covered with a small dual variable capacitor, C_1C_2, of the type used in broadcast receivers. A frequency ratio of 10 to 1 is covered in each range, while ranges are changed by switching resistors R_1 and R_2. The output is 15 volts rms from the cathode of V_2, remaining constant within one decibel at all frequencies. Although the distortion was not measured, it is believed to be very low, since oscillation will stabilize at an amplitude approximately one-third of that at which clipping occurs.

Certain circuit details are of considerable importance in obtaining



Chassis of the new oscillator with frequency-determining capacitor at left and decade range switch at right. Power supply occupies separate chassis

proper operation of the oscillator. In making the initial adjustments the points marked A and B were opened to permit the voltage gain from the grid of V_1 to the cathode of V_2 to be checked. Positive feedback peaking[7] is provided by C_3, which was adjusted for constant gain through two megacycles. In this manner, good phase response is obtained. The points A and B were then closed, and R_3, which controls positive feedback, was set for constant output with low distortion on all ranges. The low-frequency end of each range was set by trimming R_1, assuming that R_2 had the indicated value. It was found that the two low-frequency ranges covered the dial properly; however, it was necessary to employ C_4 to align the upper end of each of the high-frequency ranges. Additional switching was not involved because it was possible to leave a separate trimmer capacitor C_1 connected across each of the resistors R_2.

It should be noted that it is essential that the oscillator be well shielded to prevent synchronization with the line frequency and submultiples thereof. The unit described is built into a cabinet that also contains a power supply and output amplifier.

References

(1) Britton Chance, "Waveforms", McGraw-Hill Book Co., New York, p120.
(2) F. E. Terman, R. R. Buss, W. R. Hewlett, and F. C. Cahill, Some Applications of Negative Feedback with Particular Reference to Laboratory Equipment, *Proc. IRE*, 27, Oct. 1939.
(3) E. L. Ginzton and L. M. Hollingsworth, Phase-Shift Oscillators, *Proc. IRE*, 29, Feb. 1941.
(4) R. W. Johnson, Extending the Frequency Range of the Phase-Shift Oscillator, *Proc. IRE*, 33, Sept. 1945.
(5) P. G. Sulzer, The Tapered Phase-Shift Oscillator, *Proc. IRE*, 36, Oct. 1948.
(6) P. M. Honnell, Bridged-T Measurement of High Resistances at Radio Frequencies, *Proc. IRE*, 28, Feb. 1940.
(7) P. G. Sulzer, Circuit Techniques for Miniaturization, ELECTRONICS, Aug. 1949.

UHF Industrial

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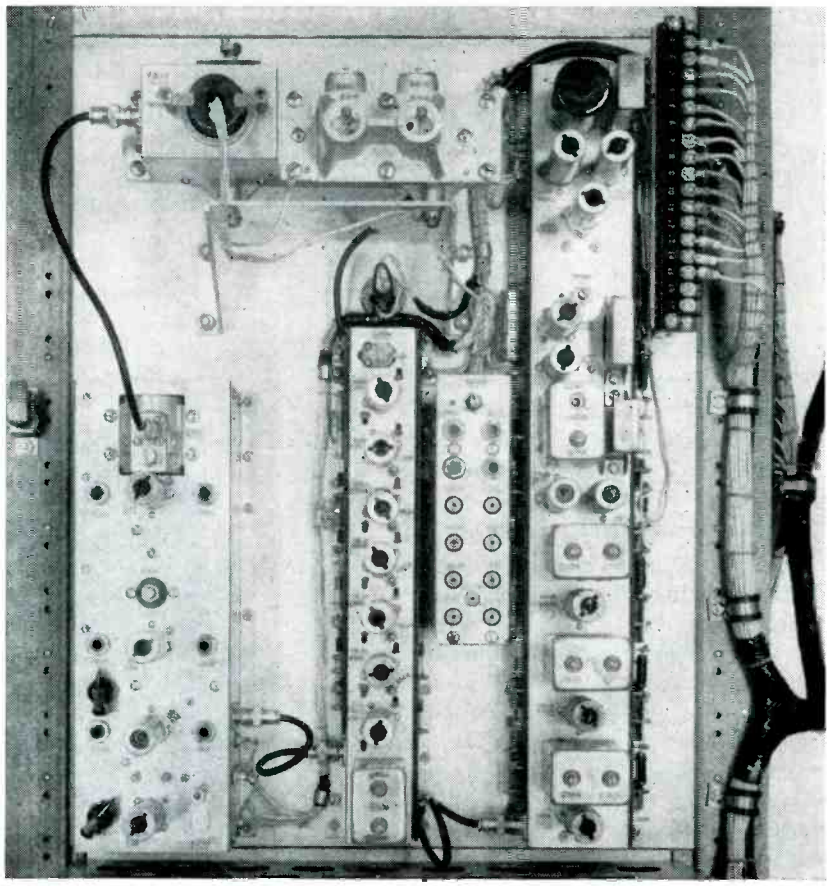

Double-superheterodyne receiver of Westinghouse type FB industrial microwave equipment. At top of panel is double-tuned cavity-type preselector

EXPANSION of the facilities of industrial organizations such as power companies, railroads and pipe lines has created an increasing demand for point-to-point communication facilities for voice communications, supervisory control, telemetering, load control, protective relaying and allied functions. These functions can be carried out by using carrier equipment on power transmission lines, by telephone equipment on wire lines, or by the use of h-f and vhf radio. However, the crowding of the lower-frequency spectrum and the susceptibility of wire lines to outage in sleet storms and other bad weather make it desirable to perform many of these functions by using uhf radio equipment.

Many industrial firms view their electronic equipment as just another tool, such as a circuit breaker or lathe, with which to do a job. They do not expect to hire highly trained electronic personnel as operators and maintenance personnel. This user philosophy demands utmost dependability, maximum ease of adjustment, excellent accessibility for maintenance and low maintenance cost.

An analysis of possible customer applications indicated that most customer needs could be met with seven voice channels and that a large number could be met with as low as four voice channels. Based on this investigation, it was decided to develop microwave equipment operating in the 940–960 mc band, having a signal bandwidth of 30 kc, and to develop audio multiplexing equipment which could transmit seven voice channels in the 30-kc band. In applying the voice channels, several tones can be used in each channel to permit several functions to be carried out simultaneously.

A block diagram of the uhf transmitter and receiver is given in Fig. 1. The 6-mc phase-modulated crystal oscillator is followed by four tripler stages and a doubler output stage to get to the desired output frequency. The receiver is a double superheterodyne type with crystal-controlled oscillator and a tunable-cavity preselector at the input.

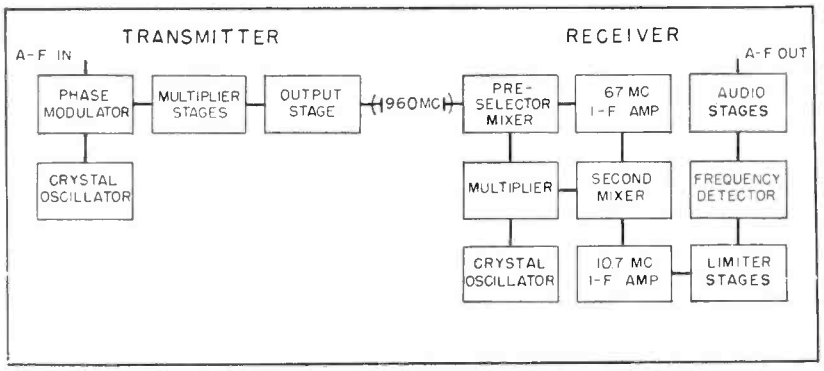

FIG. 1—Complete uhf system providing 30-kc band for audio multiplexing

UHF Transmitter

A phase modulator was chosen for the transmitter because of circuit simplicity and because it permitted direct crystal oscillator control of frequency. A reactance tube may be used for phase modulation,

Communications System

Crystal-controlled microwave transmitter and companion double-superheterodyne receiver operating in 940-960 mc band provide seven voice channels for communication, telemetering and remote control, with maximum bad-weather reliability for public utility systems

but it has a disadvantage. The output circuit of such a reactance tube will ordinarily have inductive and capacitive components of admittance which are individually large compared to the conductive component. To minimize harmonic distortion, however, the variable reactive admittance introduced by modulation must at maximum modulation be small compared with the conductive component and therefore very small compared with the individual reactive component of the circuit admittance. Thus a very accurate tuning adjustment of the tank circuit is required to maintain the entire output circuit, including the reactance tube, normally conductive.

Variable Conductance

The phase modulator used is a variable-conductance type in which the reactive components of the output circuit admittance do not directly enter into the phase deviation. This results in a phase modulator which is not highly critical in adjustment for very low percentages of harmonic distortion. This phase modulator is inherently regenerative since its function is to provide a variable negative conductance, but circuit constants were selected which eliminated the possibility of oscillation.

The variable-conductance phase modulator is represented in the simplified diagrams of Fig. 2. Modulator tube V_1 varies the conductance of the load offered to the crystal oscillator tube by tank circuit C_1–T_1. The equivalent circuit in Fig. 2B shows that the modulator presents an admittance to terminals 1 and 2 that contains a negative conductance vector whose magnitude is proportioned to the transconductance G_m of V_1. This admittance vector is then combined vectorally with the admittance of the load circuit to produce a susceptance vector whose angle is a function of the G_m of the modulating tube. If the operating point of the phase modulator tube is selected so that G_m is a linear function of modulation, then the phase of the current in the load circuit is a linear function of modulation.

Figure 2C is equivalent to Fig. 2B with E' representing the modulating voltage. The following equations can be set up:

$$I_1 = \frac{E}{R + j(\omega L' - 1/\omega C')} \qquad (1)$$

$$I_P = G_m E' + \frac{E}{R_P} \qquad (2)$$

$$E' = \frac{E(R + j\omega L')}{R + j(\omega L' - 1/\omega C')} \qquad (3)$$

If we combine these equations and, by proper design, make $1/\omega C'$ very much greater than $R + j\omega L'$, we obtain

$$Y = \frac{I_1 + I_P}{E} = \frac{1}{R_P} - G_m \omega^2 L' C' + j(\omega C' + G_m R \omega C') \qquad (4)$$

Since $G_m R$ is very much less than 1 and $\omega C'$ is very much greater than $G_m R \omega C'$, there remains

$$Y = \frac{1}{R_P} - G_m \omega^2 L' C' + j\omega C' \qquad (5)$$

We can now replace Fig. 2A with Fig. 2D, with G_a representing the equivalent parallel conductance of T_1 including secondary loading. Here $-j/\omega L$ is the inductive susceptance of the transformer, $j\omega C$ is the capacitive susceptance of all capacitances involved, $1/R_P$ is the positive conductance of the modulator tubes, and $-G_m \omega^2 L' C'$ is the negative conductance of the modulator circuit.

The vector diagram of Fig. 2E shows the addition of all of these admittances, giving a resultant sus-

Table I—System Characteristics

Tuning range—*940–960 mc*
Transmitter output—*5 watts*
Transmitter spurious output— *–60 db*
Frequency stability—*better than 0.005%*
Receiver sensitivity—*10 microvolts input for 20 db noise quieting*
Rejection of modulated signal 1 mc from center frequency of receiver—*80 db*
Receiver spurious response— *–70 db*
System noise and distortion—*less than 1%*
System intermodulation—*less than 1%*
Maximum channel attenuation permissible —*125 db*

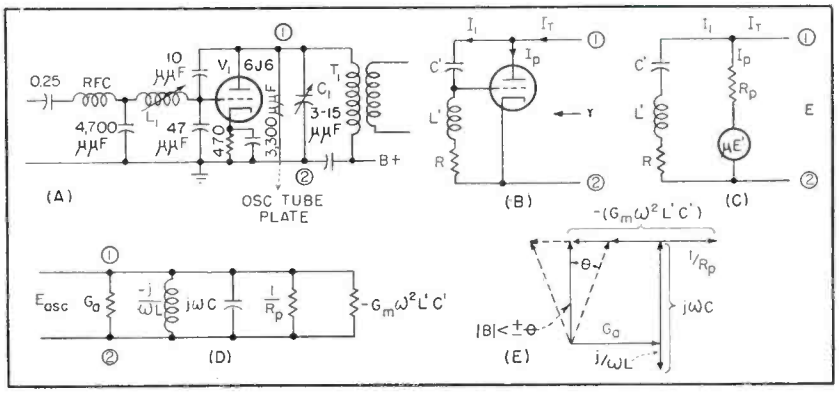

FIG. 2—Phase modulator, with equivalent circuits and admittance vector diagram

ceptance B which varies by the angle θ as G_m is varied by modulation. If θ is kept small enough so it is approximately equal to tan θ, then the phase of the oscillator current varies linearly with modulation.

The low-power multiplier (tripler) stages of the transmitter consist of push-pull triode tubes. Push-pull operation was chosen to eliminate even-order harmonics. A small amount of regenerative feedback (well below that required for oscillation) in each stage improves efficiency. Tuning components are selected so that the multiplier stages cannot be tuned to the wrong harmonic.

Mechanical and electrical features of the driver and output stages both using Lighthouse-type planar-element triodes, are shown in Fig. 3. The input (cathode) circuit of the driver stage extends outside the plumbing assembly and is adjustable in inductance by positioning of the crossbar which connects between the cathode posts of V_1 and V_2. The heater and cathode d-c leads are contained inside the plumbing assembly and leave it at the r-f ground potential. The 480-mc output circuit of V_1 is a cavity tuned by C_2. An adjustable regenerative feedback control C_1 is provided to improve efficiency.

The 480-mc output of V_1 couples to the cathode input circuit of doubler amplifier V_2 through an orifice connecting the two cavities. This cathode input circuit is fixed tuned and is designed to be resonant below normal operating frequency. The V_2 output circuit is tuned by C_4 and also has a regenerative feedback control C_3 to improve efficiency. Output (940–960 mc) from this cavity is taken from loop L_1, which is normally connected to the transmitting antenna through coaxial cable. An additional loop, L_2, is provided for monitoring.

UHF Receiver

At the input of the receiver is a double-tuned cavity-type preselector. This unit, together with the last tube in the local oscillator multiplier chain and the detector crystal, is shown in Fig. 4. The inductances and capacitances indicated symbolically here actually consist of posts and diaphragms extending into and across the walls of a rectangular cavity. Thus, L_2 and C_2 represent one tuned circuit which is coupled by diaphragm M_2 to another tuned circuit represented by L_3 and C_3. These two tuned coupled circuits provide the selectivity desirable for discrimination against strong off-frequency signals from radar sets and other high-powered equipment which might shock-excite the cavity and damage the detector crystal.

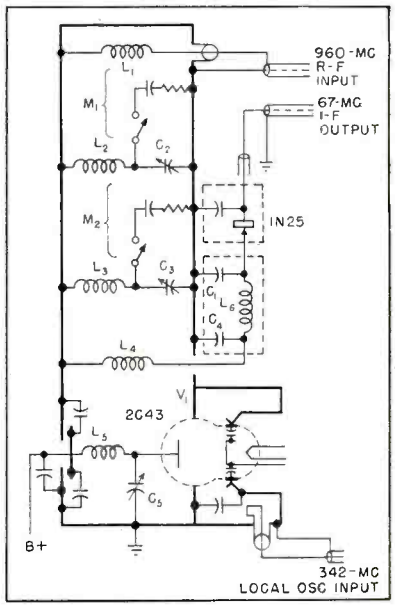

FIG. 4—Receiver preselector, crystal mixer and last tube of local oscillator multiplier chain

Radio-frequency input to the cavity is obtained by means of a post represented by L_1, which is coupled to the two tuned circuits by another post represented by M_1. The plate

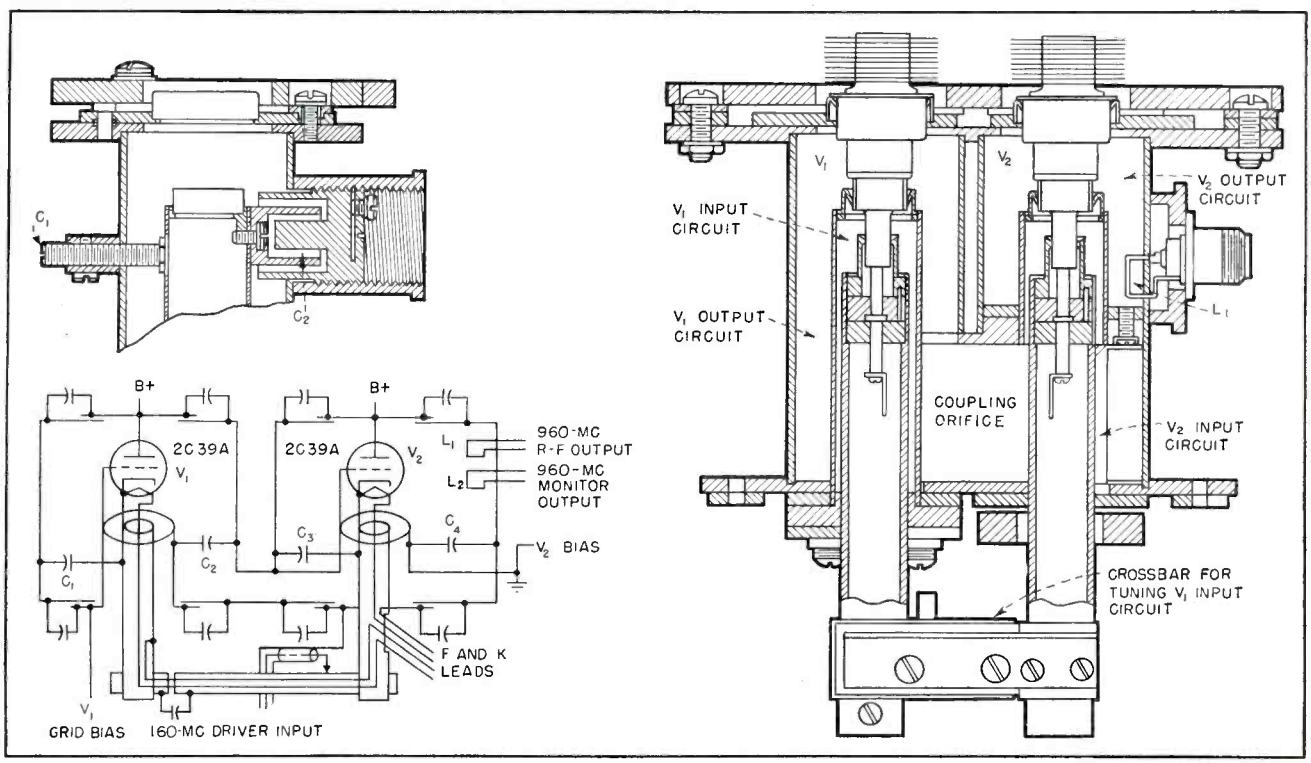

FIG. 3—Mechanical and electrical details of plumbing used with Lighthouse tubes for driver and output stages of transmitter

tank circuit of local oscillator multiplier tube V_1 comprises a post and tuning screw represented by L_5 and C_5. The incoming r-f signal from the double-tuned preselector circuit and the output from the local oscillator are coupled to the detector circuit by another post represented by L_4. To give further protection to the crystal detector against the possibility of excitation of the cavity by higher-frequency signals which might cause the cavity to resonate under some other mode, a low-pass filter consisting of L_6, C_1 and C_4 is inserted between the cavity output post and the crystal detector.

To facilitate tuning the preselector, a loading resistor can be placed in each tuned circuit of the cavity to load it so that the other section can be tuned independently. The cathode cavity of V_1, which acts as a tripler stage, is excited at about 340 mc from the local oscillator multiplier chain. The output of the crystal detector is at 67 mc.

Generally speaking, the larger the power output from a uhf tube, the shorter its life. This makes it desirable to limit transmitter power output to a minimum and obtain maximum range by increased receiver sensitivity. At lower frequencies, atmospheric noise usually limits sensitivity of receivers and we are forced to operate at very high transmitted power levels to get great range. In the uhf band, however, there is little atmospheric or man-made noise and the limiting noise usually is that generated in the receiver itself. With this in mind, the low-noise-figure amplifier of Fig. 5 was used as the first i-f amplifier of the receiver The amplifier input circuit consists of a triode-connected 6AK5 which drives a grounded-grid 6J6 stage. This combination has the gain and stability of a pentode and the low input impedance of a triode, giving a very low noise figure.

The amplifier tank circuits are tuned by adjustable brass slugs. The coils are shunted by capacitors to minimize variations in tuning with variations in tube characteristics. These circuits are damped by 6,800-ohm resistors in the grid circuits of succeeding stages to obtain desired band-pass characteristics.

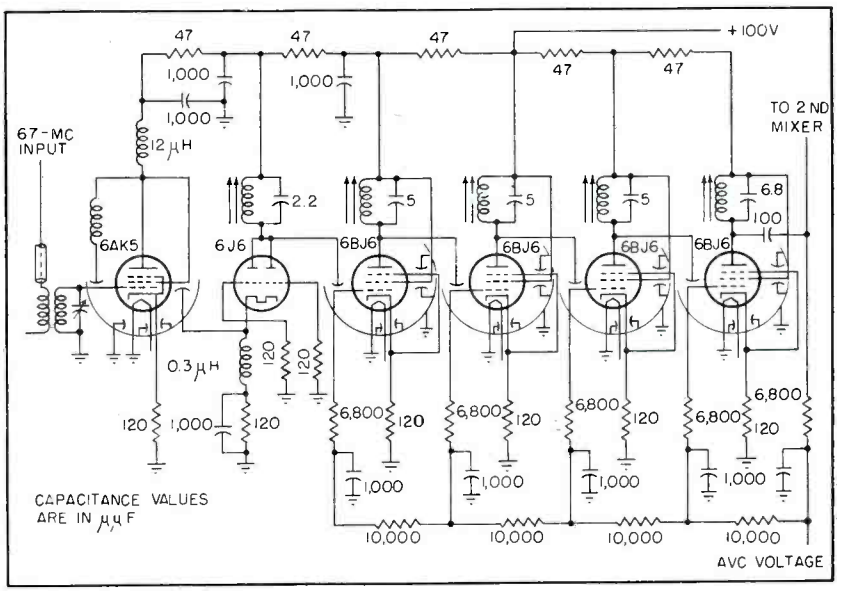

FIG. 5—Details of 67-mc i-f amplifier, which feeds into second mixer stage to produce 10.7-mc second i-f value for further amplification

The overall gain at 67 mc from the crystal to the second mixer grid is about 90 db. Remote-cutoff tubes are used and avc voltage is applied to prevent nonlinear operation of the receiver, giving adjacent-channel performance comparable with the overall selectivity.

The second mixer is a type 6J6 dual-triode, with the output signal from the 67-mc i-f stages fed to one grid and a local oscillator signal fed to the other grid. A common cathode inductance mixes the two signals to give a 10.7-mc output which is fed to the second i-f amplifier.

The 10.7-mc i-f amplifier assembly is largely conventional in design, using three 6AU6 amplifier stages operated with fixed bias. The gain per stage is about 25 db. The i-f transformers for these stages are slightly under-coupled and loaded to give the desired pass band.

The avc voltage for the 67-mc i-f amplifier is obtained from a dynamic limiter circuit, which is effectively a voltage doubler operating across the output of the last 10.7-mc i-f transformer. The avc voltage is delayed by the connection of a 1-megohm resistor to +150 volts. The avc bus is prevented from going positive by half of a 6AL5 dual-diode connected to it.

Additional limiting at 10.7 mc is obtained in a grid bias limiter using a 6AU6 tube. This limiter is operated with a short time constant in its input grid circuit to enable it to handle high-frequency amplitude modulation produced by adjacent-channel signals.

The frequency discriminator is of the ratio-detector type. The transformer is tuned by a variable air dielectric capacitor in the primary and a powdered iron slug in the secondary. The fixed secondary capacitor is of the zero-temperature-coefficient type to minimize effects of changing temperature. A bifilar winding is used for the secondary to maintain good balance.

The audio-frequency amplifier consists of three stages— a pentode voltage amplifier, a pentode phase inverter, and push-pull pentode output tubes with cathode circuits provided with a means of balancing anode currents for minimum harmonic distortion. The amplifier is designed to give outputs up to +16 dbm with low distortion at frequencies up to 30,000 cycles.

After extensive laboratory tests, preproduction models of this equipment were installed on the property of the Pennsylvania Electric Corp. near Johnstown, Pennsylvania, and put in operation in February 1949. These sets have been operating on a 24-hour-a-day basis to supply voice communications, telemetering, supervisory control and protective relaying. The performance of the equipment in this field installation has proved its suitability for industrial communications applications.

Automatic Beam Blanker

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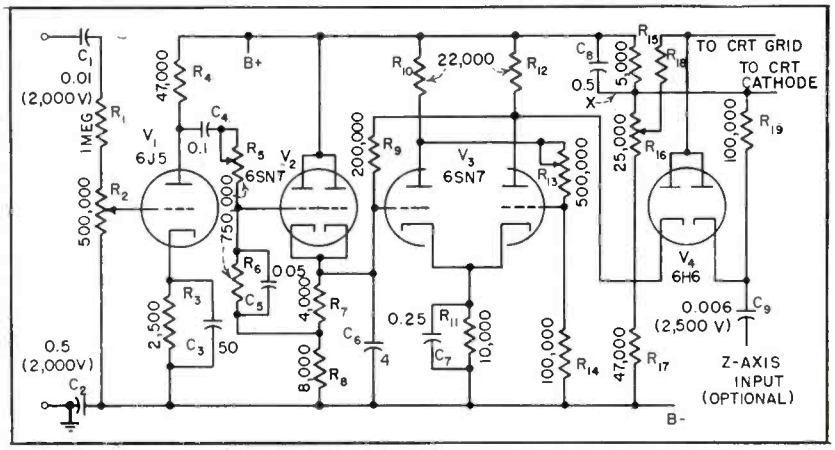


FIG. 1—Because of direct connection to high-voltage crt elements, isolating capacitors are required. Circuit B— is not connected to chassis

MODERN commercial oscilloscopes in the medium price range are usually provided with a single sweep feature which makes possible the initiation of the sweep by an external triggering impulse. They are equipped with suitable arrangement for blanking the return trace but, where high writing speeds are required with consequent high beam intensity for photographic recording, the sensitized paper or film is exposed to an extremely strong background illumination caused by scattered electrons impinging on the screen when the beam is not actually producing a trace. The resultant fogging of the photographic material makes it difficult to obtain a clean-cut record.

This effect can be minimized by blanking the electron beam and releasing it only for the precise time interval required for the desired trace. A method for producing this result by the use of a flip-flop circuit has been described in the literature[1]. This system depended on external triggering impulses to release the beam and to blank it subsequently. In the interest of greater convenience of operation, a method has been devised whereby the sweep itself can be used to release the beam and to blank it when the trace is completed.

Circuit Diagram

The complete circuit is shown in Fig. 1. It consists essentially of an isolating amplifier V_1 coupled to a cathode follower V_2 through a circuit composed of C_4, C_5, R_5 and R_6 which, in conjunction with C_6, controls the length of the release interval. In the cathode circuit of V_2 capacitor C_6 delays the release of the beam until the nonlinear portion of the beginning of the trace has passed. Tube V_2 is a double triode with the elements paralleled to yield a cathode follower which will develop a high amplitude pulse in the low impedance circuit which it drives.

The cathode of V_2 is direct coupled to one grid of the flip-flop tube V_3. The values of R_7 and R_8 are selected so that V_2 receives proper grid bias, and at the same time the cathode of V_2 is at the correct potential for the input grid of V_3 when the left side of V_3 is in the nonconducting condition. Tube V_4 couples the flip-flop tube to the grid of the c-r tube and at the same time allows for the introduction of a Z-axis signal when desired.

The operation of the instrument is straightforward. When R_{13} is adjusted properly and no sawtooth wave is coming through from the oscilloscope sweep circuit, the right side of V_3 is conducting, which causes the potential at the plate of this section to assume a relatively low value. This potential appears at a terminal which is connected to the grid of the c-r tube, making this grid about 100 volts negative with respect to its cathode. As a result the beam is blanked.

The negative segment of the oscilloscope sweep sawtooth is used to release the beam; the positive segment blanks the beam after an adjustable delay. Figure 2 shows the approximate release and blanking times. Potentiometer R_2 controls the input from the oscilloscope sweep circuit and should be adjusted to give V_1 sufficient drive but not enough to cause it to draw power from the positive portion of the sawtooth. The timing circuit made up of C_4,C_5,R_6 and potentiometer R_5 controls the duration of the beam release interval by varying both the amplitude and the buildup time of the positive pulse on the grid of V_2. The positive pulse developed in the cathode circuit of V_2

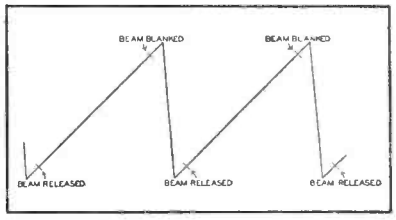


FIG. 2—Cathode-ray tube beam is unblanked only for center portion of the sweep

For Oscilloscopes

Eliminates background fogging caused by scattered electrons impinging on sensitized paper before and after trace in high-speed high-intensity single-trace oscillography. Unit may be attached to standard oscilloscope. Also provides for Z-axis modulation

serves to charge C_6. When the voltage across C_6 reaches sufficient magnitude, the left side of V_3 suddenly conducts, and the right side becomes nonconducting. When this occurs the potential at this plate rises to approximately the same value as that of point X, whereupon the beam is released since the negative bias on the c-r tube grid falls to the value determined by the position of the intensity control R_{16}. This series of events is reversed when the positive portion of the sweep comes through. After the desired delay, the right side of V_3 becomes conducting and the beam is blanked.

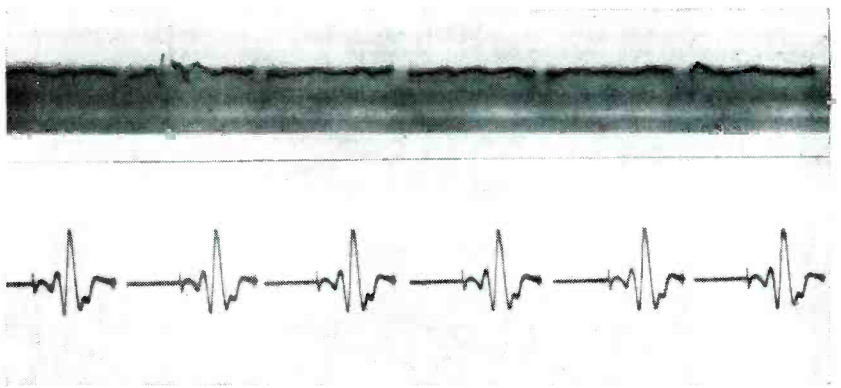


FIG. 3—Oscillograms show effect of adding beam blanker. Top shows result of scattered electrons. Bottom illustrates improvement made by addition of blanker

Choice of Capacitors

Since most commercial oscilloscopes are arranged so that the second anode and the deflection plates are essentially at ground potential, it follows that the grid and cathode must necessarily operate at a large negative potential with respect to ground. For this reason considerable care must be used in insulating the beam-blanking device from ground and from the power line. Capacitors C_1 and C_2 in Fig. 1 should have ample voltage rating; in the present instrument they are 2,000-volt oil-filled units. The B + supply could use a special power transformer with primary-secondary insulation adequate for 2,500 volts. In this instrument a 1-to-1 isolating transformer was used in conjunction with an ordinary small power transformer. The beam-blanking device was assembled in a metal cabinet. The top of the metal chassis was cut away leaving only a narrow rim to support a sheet of Bakelite on which were mounted the various components. The two controls which project through the front panel were carefully insulated from the chassis and the front panel. As a final precaution the metal chassis and cabinet were grounded.

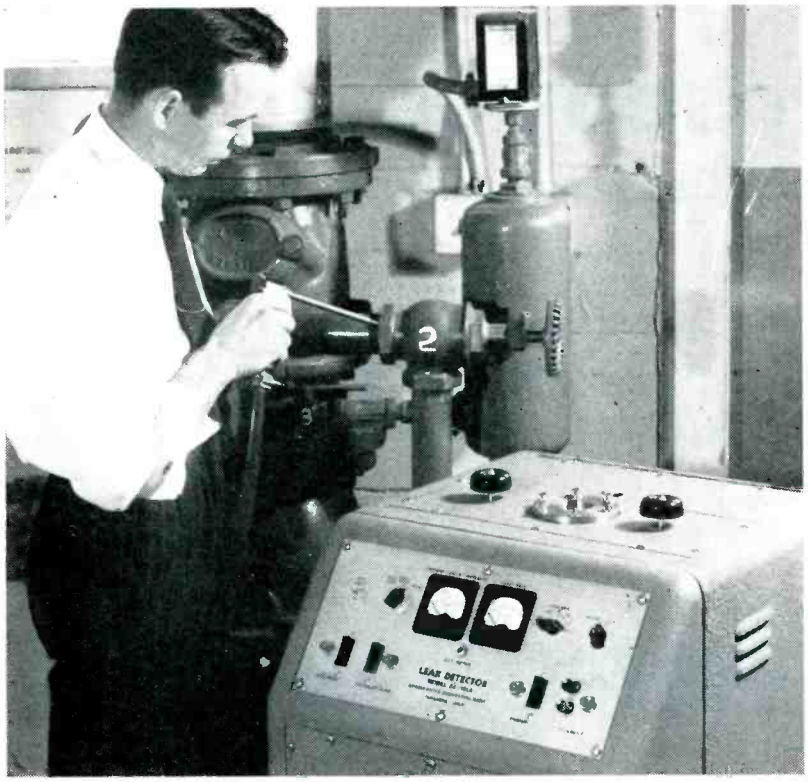
A word of caution is in order with regard to the possibility of capacitors being incorporated in the grid-cathode circuit of the oscilloscope on which the beam blanking device is to be used. The presence of any considerable amount of capacitance at this point will affect the shape of the square wave from the flip-flop circuit so that the intensity of the trace will vary markedly during the time the beam is released. The ideal situation is obtained with a pure resistance network supplying the c-r tube grid bias, and on which the bias from the beam blanking device is superimposed.

The present version of the instrument was provided with standard Amphenol fittings so that it could be attached to any one of several oscilloscopes as the need arose. Removal of the beam-blanking device from an oscilloscope simply leaves it operating in the conventional manner. The delay circuits can be modified to suit individual requirements. The work for which this instrument was constructed required trace durations ranging from 0.001 to 0.020 second with a repetition rate of three traces per second.

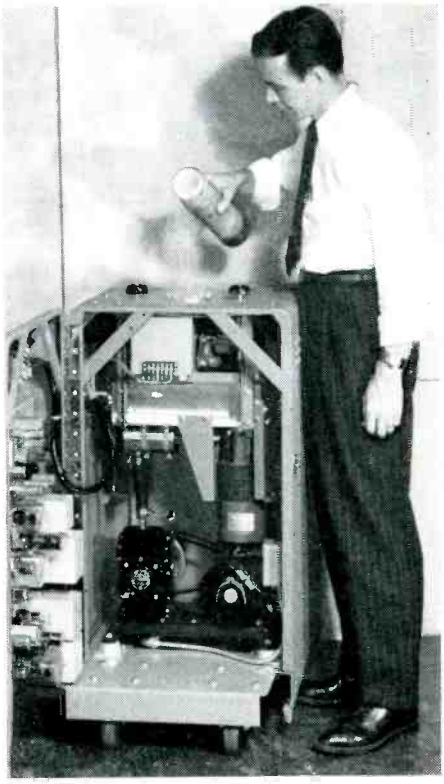
Figure 3 shows samples of records made with and without the blanking device.

Reference

(1) Walther Richter, Beam Blanking Circuit for Oscilloscopes, ELECTRONICS p 128, Sept. 1944.



Checking valve threads of industrial vacuum system for leaks, using helium-emitting probe and helium leak detector made by Consolidated Engineering Corp.



Interior of helium leak detector. Cold trap is being filled with refrigerant

LEAK DETECTORS
for Industrial Vacuum Systems

Analysis of eight methods of locating and measuring leaks, and repair techniques. Major emphasis is on the helium leak detector, which rapidly indicates by meter and audio tone the presence of helium ions inside a leaky system when helium gas is applied outside

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THE LOCATING and repairing of leaks in vacuum systems is probably the most troublesome aspect of high-vacuum technique.

The ideal leak-detecting method should be capable of measuring total leakage and isolating individual leaks, should be rapid in response, should not seal the leak more than momentarily, should be highly sensitive, should be capable of application to any vacuum system without loss of vacuum if necessary, and should make use of equipment that is relatively simple and inexpensive to procure, maintain and operate. It is also highly desirable that the instrument used be selective, so that it gives nearly a zero reading for air and residual gases and responds only to a probe material.

A large number of leak detection methods have been reported in the literature or have come into use in various laboratories without being made generally available. Some of the most useful of these methods are summarized in Table I. Several are limited in sensitivity primarily by the type of indicating device used. Most of the methods are not particularly suitable for obtaining an accurate determination of the size of a leak. However, in many cases this is not too important, the problem being to locate and repair the leaks as rapidly as possible.

Each of the eight methods listed in Table I has its place in vacuum technique, but the helium leak detector is the most generally useful for locating vacuum leaks rapidly.

Table I—Methods of Locating Leaks in Industrial Vacuum Systems

Method	Technique	Characteristics
Spark coil over outside of system	Pass high-potential electrode of spark coil over outside of insulated, transparent portion of system. Find leak by: (a) Spark passing through leak; (b) change in color of discharge when material such as ether, alcohol or CO_2 passes through leak	Cannot be used on all-metal systems. Useful pressure range limited by need for glow discharge (few mm Hg to around 5×10^{-2} mm Hg)
Discharge tube	Tube is attached to system, usually between mechanical and diffusion pumps (adequate pressure). Find leaks as in method (b) above	Same pressure limitation as above. Greatest sensitivity for probe material with high rate of diffusion (CO_2 is satisfactory)
Rate-of-rise measurement	Isolate portion of system in which leak is suspected and measure rate-of-rise of pressure. Can be used to determine presence of leaks in pumping system	Slow in application. Great sensitivity if sufficient time allowed. Must use suitable pressure-indicating device
Over-vacuum or evacuated hood	Pressure is reduced on portions of outside surface of system. Leak is indicated by drop in pressure of system. Must use appropriately shaped hoods to seal to outside surface (pumped down by roughing pump)	Must use suitable pressure-indicating device. Application limited by problem of devising hoods to fit irregular or curved surfaces
High-pressure inside system, appropriate indicator outside	Increase pressure inside system (determined by mechanical construction). Large leaks are found with gas hissing or wavering of flame over leak, or with liquid-wetting of surface around leak. For small leaks, use gas and: (a) Soap surface bubbles; (b) immerse portion of system in water bubbles; (c) halide gas inside, torch over outside, and note change in color of flame. Also, with one chemical vapor inside, another outside, observe reaction at leak	Immersion in water very good for testing parts before assembly. With gas, greatest sensitivity is for gas with high rate of diffusion (He, H_2). Soap solution likely to clog small leaks temporarily
Partial vacuum inside system, soap solution applied inside	System is partially evacuated. Observer (with oxygen mask) goes inside and applies soap solution to suspected portions. Leak is indicated by soap bubble	Limited to large vacuum systems. Need for great care to avoid danger to observer
Sealing substance on outside, change of pressure inside	Apply sealant (permanent or temporary) over outside surface and observe change in pressure inside. Permanent sealants are glyptal, lacquers, shellac in alcohol, etc. Temporary sealants are water, acetone, ether, etc. For ether, vapor replaces air. Effect on pressure depends on indicating device	For temporary sealants. Best results with material having high diffusion rate. Permanent sealants not dependable
Change in pressure or nature of gas inside system, probe gas outside	Similar to previous method. Use permanent gas instead of vapor. Observe change in pressure inside. Helium leak detector is example	Sensitivity depends on gas used — should have high rate of diffusion. Also depends on nature of pressure — indicating device

For this reason, emphasis in this article will be on the helium leak detector and its predecessor, the vacuum analyzer.

Vacuum Analyzer

In certain processes a knowledge of the residual gases in a vacuum system may be of great value to an understanding of the process in question. The apparatus giving this information should be semi-quantitative in action and should be suitable for continuous operation. Such an apparatus was developed at the Radiation Laboratory, University of California, in connection with the electromagnetic separation of uranium isotopes. This instrument provided much useful information regarding the nature of gases and vapors inside the vacuum system, but it was not particularly suited to routine leak hunting. Modifications resulted in the helium leak detector, which was designed specifically for routine leak hunting.

Since the vacuum analyzer is the forerunner of the helium leak detector and the basic principle involved is the same, it will be worthwhile discussing the former instrument briefly. The vacuum analyzer is a small-radius spectrometer using a cold-cathode ion source for the production of positive ions, and cathode-ray scanning for a detector.

Figure 1 illustrates the general nature of the instrument. The analyzer was designed to be mounted on a port in a large vacuum tank, which was in a uniform magnetic field. Two collector slots are provided so that an extended mass spectrum (mass 1 to 50 approximately) can be obtained without an excessively large range

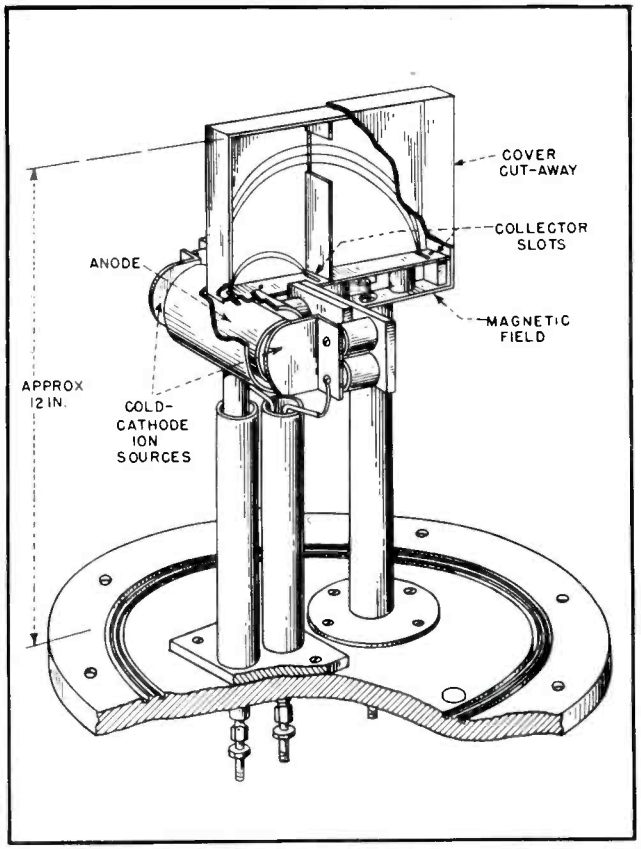

FIG. 1—Vacuum analyzer, designed primarily for analysis of gases in vacuum systems, but used also for leak-hunting with helium or methane probe gases

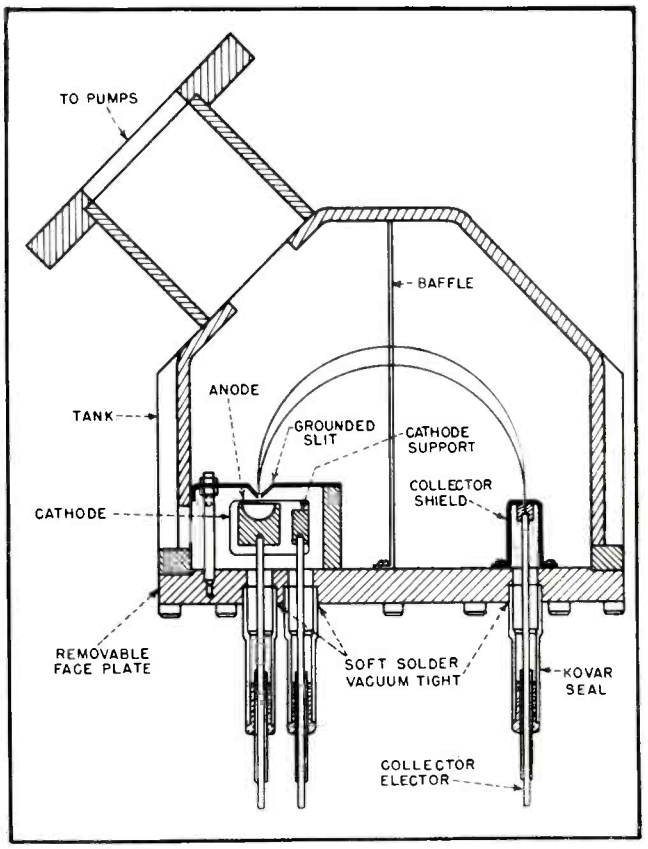

FIG. 2—Cross-section of helium leak detector tank, in which cathode, collector and baffle hole are spaced for maximum response to helium ions of probe gas

of ion accelerating voltage.

The vacuum analyzer is operated as a 180-degree mass spectrometer with a sweep voltage superimposed on the ion accelerating voltage so as to sweep the various mass peaks across the collector slots, for observation with an oscilloscope.

Helium Leak Detector

The design of this instrument is directed toward obtaining a portable self-contained unit for the detection of helium atoms introduced into a vacuum system in the process of leak hunting. To satisfy this requirement, a portable magnet and pumping system must be provided.

Only one collector slot is used, since only helium ions are detected. These ions are collected at about 180 degrees, as shown in Fig. 2. The output current is approximately 5×10^{-11} amperes for 1 part of helium in 75,000 parts of air. These values and the description to follow are based on the helium leak detector developed and used at the Radiation Laboratory, University of California. Commercially available instruments differ in detail but the fundamental principles of operation are the same.

The tank of the helium leak detector is supported by the vacuum line, as indicated in Fig. 2. The ion source and collector, as well as a baffle at the 90-degree position, are attached to the tank faceplate which is constructed of nonmagnetic material (brass). The inside of the chamber is covered with a silicone lacquer baked so as to minimize the cleaning problem and reduce the absorption of moisture. The sidewalls of the chamber are constructed of magnetic iron $\frac{1}{8}$ inch thick, which constitute the magnetic-pole faces. The inside spacing of the walls is $1\frac{3}{8}$ inches.

To obtain maximum sensitivity, a suppressor grid is put in front of the collecting slit as shown in Fig. 3 and tied electrically to the anode. Grounded shields must be used on both sides of this grid. The grid serves to block out low-energy ions due to gas scattering and increases the signal-to-background ratio by a factor of about 5.

The magnet consists of two four-inch-long Alnico slugs, each 4 inches in diameter on one end and 5 inches in diameter on the other, which are mounted on an iron return path having a cross-section of about 16 square inches. The slugs are wound with 100 feet of No. 12 wire, or about 125 turns, which can be used to give up to 2,700 gauss over a 1-inch gap 5 inches in diameter. The overall weight of the magnet is about 200 lb.

The positive-ion source consists of two cathodes separated by about $\frac{5}{8}$ inch in the direction of the magnetic field (length of discharge), with a hollow cylinder between these cathodes serving as an anode. The principle of this ion source is simply that of the Philips ionization gage. The cathodes are tantalum or tungsten to minimize wear. The ions enter the grounded spectrometer box through a $\frac{1}{2}$-inch long slot in the anode (along the magnetic field) with an energy given by the potential of the discharge plasma (essentially anode potential) with respect to ground, plus or minus their random energies. The accelerating slit is about $\frac{3}{16}$ inch long and $\frac{1}{32}$ inch wide. The ion

source must give a sufficient supply of ions at pressures at least down to 10^{-5} mm Hg, and the ion beam must be sufficiently homogeneous in energy so the desired resolution is obtained.

The arrangement used for the main units of the vacuum system is shown in Fig. 4

Circuits

Amplifiers and power supplies for the helium leak detector are arranged as in Fig. 3, for use with the pumping system of Fig. 4. The high-voltage supply for the ionization gage should give voltages up to about 2,000 volts; a half-wave supply with RC filtering is adequate. The accelerating supply voltage is determined by the field and radius chosen; current requirements are quite low, but voltage regulation should be good to within a few percent. The preamplifier, shown in Fig. 5, is in a spring-suspended box near the leak detector tank, thus damping out vibrations and keeping the input capacitance low. The signal is fed to a 9001 pentode, followed by a 9002 tube used as a cathode follower. Feedback is used to give an improved signal-to-noise ratio.

The main amplifier consists of three stages of conventional resistance-coupled amplification (not shown), feeding the vertical deflecting plates of a cathode-ray tube. In addition, a double-diode rectifier tube is used to block one-half of the signal cycle so that both the forward and return sweeps will not appear simultaneously on the c-r tube. The horizontal sweep of the c-r tube is a sine wave in phase with the sweep inside the leak detector tank, which is also a sine wave. When an external scope is used, it is synchronized to 60 cycles, and the helium peak appears as a single peak but not necessarily in the middle of the trace.

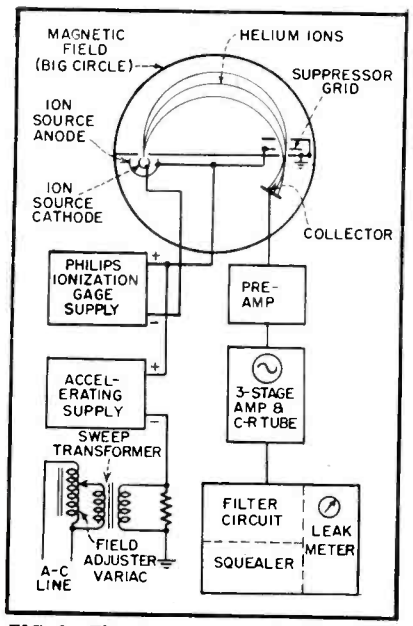

FIG. 3—Electrical system of helium leak detector

The squealer and meter circuits used as indicators are shown in Fig. 6. The output signal from the a-c amplifier is fed to triode V_1 which serves as a signal limiter to protect the meter that follows. The output of V_1 goes into a filter circuit that removes all frequencies but the signal frequency. The net effect of this circuit is that random frequencies average to zero on the two sides of the meter, but a 60-cycle signal in phase with the 60-cycle voltage on the grids of V_5 averages positive on one side of the meter and negative on the other and hence gives a net d-c deflection. The effects of signals of various frequencies are shown in Fig. 7.

The signal from one of the plates of V_5 in Fig. 6 is put into one half of V_2, and the output voltage then goes to a relaxation oscillator made up of C_1 and a neon lamp. The oscillator tone signal, about 1,000 cps, goes through one stage of amplification for phones and two stages for a speaker.

Leak Detector Sensitivity

Using reasonable care in operation, the helium leak detector should be capable of detecting 1 part of helium in 200,000 parts of air. The sensitivity is limited by base noise level, which is due to noise inherent in any a-c amplifier, pickup of stray frequencies near the signal frequency, ion background from elements other than helium, and a helium background of at least 1 part in 670,000 (normal atmospheric concentration) and often greater due to contamination and leaks.

An arbitrary criterion for the limiting sensitivity has been the mixture ratio of helium in air that gives a deflection twice the noise level. To determine the sensitivity

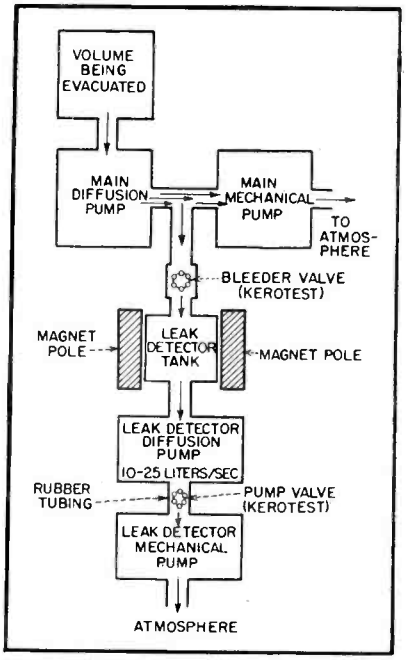

FIG. 4—Pumping system used with helium leak detector

a known mixture of helium in air must be used. One way of doing this is to prepare a known mixture in a fixed volume (static method) simply by evacuating the volume being used and then filling with known pressures of helium and air.

To measure the pressures a McLeod gage should be used since other gages must be calibrated for their response to helium. Making mixtures in long hose connections should be avoided due to the danger of getting a nonuniform mixture. In introducing the mixture into the leak detector, the connections between the mixture region and the detector must be evacuated by an auxiliary pump. All connections, as well as the leak detector itself, must be free of leaks.

In some cases the so-called dynamic method of obtaining the sensitivity is used. Here a very small leak is made, say by collapsing a small copper tubing. This leak is calibrated by connecting to a manometer and measuring the rate at which the bubble moves. It is best to perform this calibration with helium. The leak can be installed on the same vacuum system to which the leak detector is connected.

Response Time

The response time may be considered to be the time from application of helium to the suspected point of leak to the appearance of an ap-

preciable response at the indicating meter. Delay may occur in the regions outside the vacuum wall, inside the vacuum system and in the indicating circuits.

Any large volume between the point of application of the helium and the leak itself may result in very long time delays. For example, in the case of water lines hours may be involved. However, if helium flows in one end of the line and out the other until the line is filled, then the response is immediate. The line can then be cleaned out by blowing air through it. With a pump-out a good procedure is to apply helium under pressure, release the pressure and repeat the cycle. The helium can then be removed by a roughing pump. By noting the speed of response and cleanup it is often possible to say immediately that the leak is or is not at a certain place, thus greatly

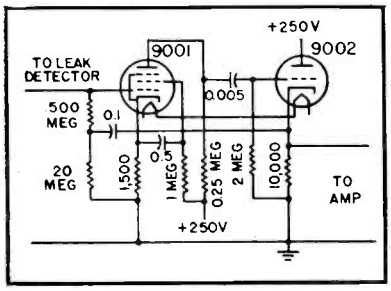

FIG. 5—Preamplifier with high input impedance, fed directly from collector electrode of leak detector

speeding up the leak hunting.

The exact methods to be used in applying helium depend on the circumstances and the alertness and ingenuity of the operator. For rapid movement of helium from leak to detector, it is necessary to have small volumes, low pressure, fast pump lines, and fast pumps. A compromise must be made between small volume and fast pump line.

Leak Hunting

The helium leak detector tank must operate at a pressure of about 1 μ Hg. By connecting the leak detector between the mechanical and diffusion pumps of the system being studied, enough gas can be bled off to raise the leak detector to its operating pressure. The pressure is adjusted to its proper value with the bleeder valve (Fig. 4). Although the gas going through the main mechanical pump is many

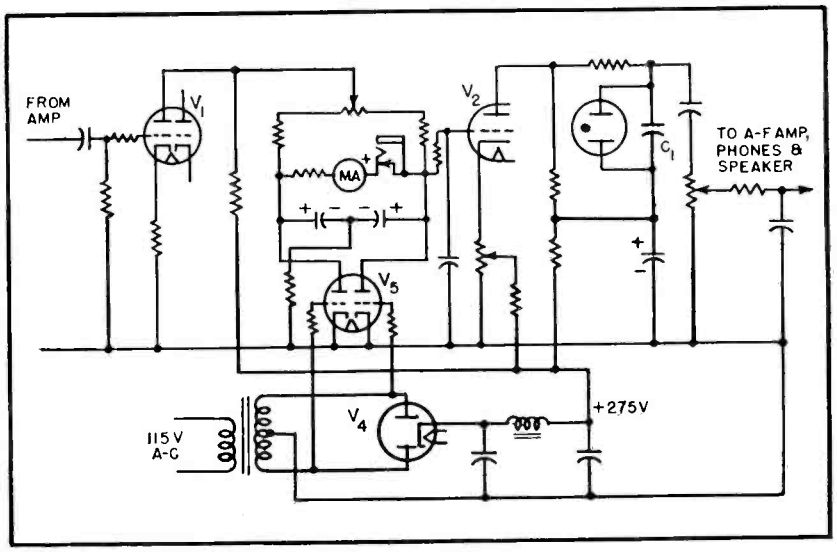

FIG. 6—Arrangement used for meter and leak-indicating squealer. Input is from output of three-stage amplifier fed by preamplifier of Fig. 5

thousand times greater in amount than that going through the leak detector, the compositions are the same. The instrument actually continuously samples the gas in the main vacuum system for helium. The instrument could be set for gases other than helium. Helium is used because it is light and hence diffuses rapidly into a leak, is relatively cheap and readily available, and cannot explode or catch fire.

The overall leak of any unit is most conveniently found by using a hood and flooding the interior of the hood with helium. The reading of the leak detector will depend on a number of factors, including size of leak and amount of helium in hood. Specific rules as to procedure must be set up for each installation where hood testing takes place and these should be followed exactly by the operator.

For specific leaks, a probe should be used. This should be designed with a long flexible line from the helium supply, with means for control of the flow and with a long narrow tip for differentiation between near-by parts. The hunt should usually be started by using a moderate flow of gas that is easily felt on the hand. It can then be played over broad areas without too close attention to detail. When some indication is noted, the helium stream can be turned down to a fine one and the indication followed to the leak itself.

Helium being lighter than air, it is necessary to start at the top and work down. Various means of isolating portions of the system, including the use of hoods, can be used. Because of the rapid diffusion of helium, it is necessary to use a small stream of gas and move the probe slowly in the vicinity of a leak to get a maximum indication. The method of applying helium will depend to some extent on the mechanical design of the vacuum system being studied.

For convenience in observing the response of the instrument, the observer can use a portable meter in series with the fixed one or a headphone or portable speaker connected to the squealer circuit. A headphone is particularly convenient since it is effective in a noisy environment and it frees the eyes and hands of the operator for leak hunting. The speaker or headphone should be provided with volume and threshold adjustments. The threshold adjustment allows the operator to set the base tone to something not too objectionable to his ears.

General Procedure

Suppose that a large all-metal industrial vacuum system is roughed down after having been let down to atmospheric pressure or after some major accident. If the pressure is much over 100 μ Hg, the diffusion pump cannot be turned on. The first step is to try to find the general region of the system in which the leak is located. This is best done by isolating certain parts of the system from the fore pumps by

means of valves and taking rates-of-rise measurements. The main part of the vacuum system, including the diffusion pump, should first be isolated from the fore pump. If there is no indication of a leak in the main vacuum system, the oil in the mechanical pump should be inspected, since it may be low or contaminated.

Once it is fairly clear that there is a leak in some portion of the main vacuum system, check such obvious sources of leaks as gasket seals, which should be tightened. If this gives negative results, a Pirani gage and a gas such as methane, propane or helium could be used. Also, the system can be tested under pressure, using air or helium and soap, helium and a leak detector, or any of the other methods already discussed. Once the pressure indicated by the McLeod or Pirani gage reads below about 100 μ Hg, the diffusion pumps can be turned on.

If, after the diffusion pumps have been on for an adequate length of time, the pressure is too high to be read on a pressure-measuring device such as an ionization gage or for the operation of a helium leak detector directly connected to the system, it will be necessary to resort to one of the other types of leak-hunting procedures in Table I. If the difficulty lies in the diffusion pumps, this can usually be proved by isolating the vacuum system from the diffusion pumps and taking a rate-of-rise measurement. After the pressure has dropped to a point where such gages as the ionization gage can be used but is still too high for operating the process in question, probably the most rapid method is the use of helium for probing the outside surface of the system in conjunction with a leak detector. If such an instrument is not available, one of the other methods such as the application of a gas outside with an ionization gage or other suitable gage reading the response inside can be used.

A knowledge of pumping speed and the geometrical form and arrangement of the vacuum system can be used to get some idea of leak size by calibration against a known leak. Experience with a given system is useful in estimating leak size.

Probably the best method for determining accurately the size of leak is the rate-of-rise measurement. This involves pumping down the system, closing it off, and noting the rise in pressure in the known evacuated volume over a period of time.

Repairing Leaks

The most frequent sources of leaks in a vacuum system are the gasket seals, flare fittings, solder seals and welded joints. If a leak is located in a rubber gasket, the gasket should be tightened but not too much. When this procedure fails to stop the leak, the system should be shut down and the gasket examined. If the gasket is in bad shape, it should be replaced. However, it is often sufficient simply to clean it and the surfaces that it meets. Vacuum greases can be used if the pumping speed of the system is adequate. It is inadvisable to try to stop leaks in gaskets with some sealing material such as glyptal, as such a repair is usually only temporary and ruins the gasket.

Flare fittings are constructed of a soft metal, usually copper, which gives enough when two surfaces are compressed against each other to provide a vacuum seal. If a leak is found in a fitting, the nut by which the compression is obtained can be tightened moderately. Tightening too much is likely to twist the tubing passing into the fitting. If tightening fails to stop the leak, it will be necessary to break the joint open. Annealing the copper flare will almost always give a tight seal. If this is not practical, a thin coating of glyptal can be applied to the surfaces that make contact.

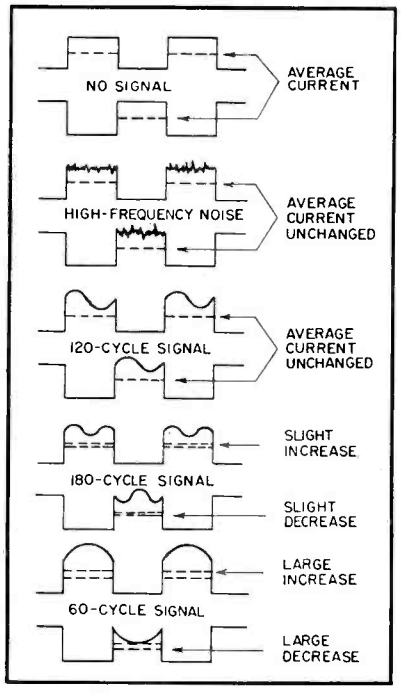

FIG. 7—Effect of various frequencies on plate currents of double-triode in meter circuit, showing how desired 60-cycle signal gives increased current but other frequencies do not

In solder seals and welds, if the leaks are small enough so that the vacuum system is very near operating pressure, clear glyptal can be used. On leaks too large for that, but small enough so that the pressure goes down to diffusion-pump operation, red glyptal can be used sparingly. It is advisable to make every effort to locate the leak accurately before applying glyptal indiscriminately. Leaks that are too large to be stopped by the above methods should be repaired by remaking the solder seal or weld that is at fault or by replacing a portion of the vacuum system that includes the leaks.

In the case of glass components of a vacuum system, leaks usually occur in glass-to-metal seals, glass-to-glass joints, cracks in the glass, and stopcocks. In the case of glass-to-metal seals, the repairing procedure depends on the nature of the seal. For wax seals it is sometimes necessary to rework the seal or replace it. In other cases the application of some sealing compound such as glyptal is adequate.

Leaks in glass-to-glass joints or through cracks and pinholes in a glass section of the system, if small enough, can be repaired by the use of materials such as glyptal, which can be applied at room temperature. Often a wax can be used (such as picein) by heating the glass and pouring the wax over the leak. If the leak is too large, it will be necessary to rework the glass or replace the part of the system where the leak is located.

Much of the material in this paper is based on Chapter V of "Vacuum Equipment and Techniques", by A. Guthrie and R. K. Wakerling, a volume in the National Nuclear Energy Series, published in 1949 by McGraw-Hill Book Co.

Phase-To-Amplitude Modulation

System saving cost, size and weight, applied experimentally to a 150-watt 530-mc television transmitter, shows promise for use with high-power tubes such as the resnatron. Dual phase-modulator tube simplifies equipment

PHASE-TO-AMPLITUDE or outphasing modulation offers an effective means for amplitude modulating very large amounts of power using small receiving-type tubes as modulators. For example, KFBK in Sacramento, California, employs six 6J5 receiver triodes to modulate a standard 50-kilowatt a-m broadcast transmitter with resulting economy of space, initial cost and operating expense.

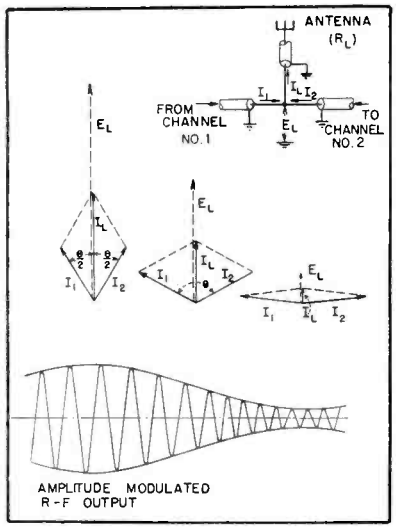

FIG. 1—Vector relations of a phase-to-amplitude modulated system at antenna input

This system was invented nearly twenty years ago by Henri Chireix,[1] who successfully applied the principle to several large European broadcast stations. Recent tests in this country on an experimental 150-watt 530-mc television transmitter indicate the feasibility of 50-kilowatt uhf television transmitters utilizing presently known techniques, including such tubes as the resnatron.

System Operation

A phase-to-amplitude a-m transmitter is in reality two identical phase-modulated transmitters driven from the same crystal oscillator, and fed into a common antenna. For the peaks of the amplitude modulation cycle the two channels are arranged to be in phase and a maximum amount of r-f power is delivered to the antenna. During the modulation troughs the two channels are swung out of phase so that the outputs effectively cancel.

Figure 1 shows the vector relations encountered at the antenna at three successive instants during a sinusoidal modulation cycle. If equal output currents I_1 and I_2 are caused to vary in phase so that phase shift in one channel is always accompanied by an equal but oppositely directed phase shift in the other channel, it can be seen that the vector sum of these two currents will vary in amplitude but not in phase, as a function of the relative phase angle θ. This resultant current is the one which is fed to the antenna.

The use of this principle permits building amplitude-modulated transmitters in which all amplification is done at relatively high efficiency in saturated class-C amplifiers, and which require no modulation transformers or other high-level modulation equipment. For a large standard broadcast transmitter the elimination of the massive modulation transformer and reactor alone results in a very large saving in physical size and initial cost of equipment.

Suitability for Television

The elimination of the modulation transformer permits a phase-to-amplitude modulated transmitter to be fully modulated down to zero frequency, if necessary, and to an upper frequency limit determined only by the r-f bandwidth of the power amplifiers. This feature makes the system appear quite attractive for obtaining high-power television signals. The video modulation can be inserted at low level, on the order of a few watts, yet the succeeding r-f amplifiers do not have the critical biasing requirements of the linear amplifiers which are usually associated with low-level modulation systems.

During the past year an experimental uhf television transmitter utilizing this system has been built for the Pacific Video Pioneers in

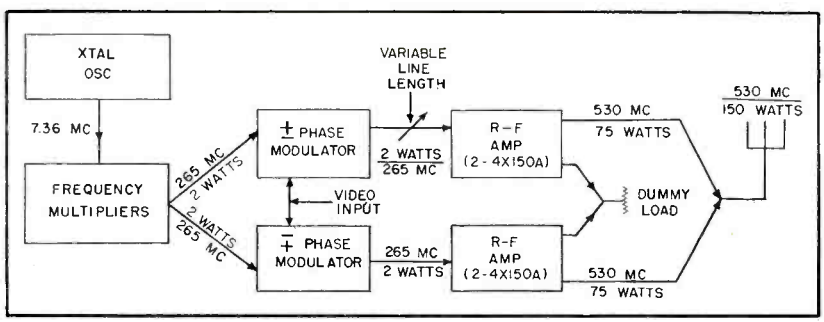

FIG. 2—Block diagram of experimental 150-watt uhf television transmitter

For UHF-TV Transmitters

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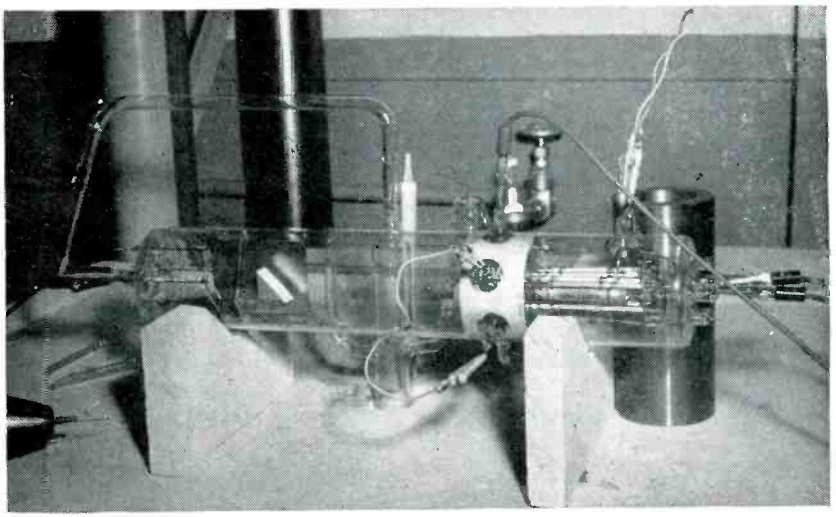


Special uhf modulator tube produces ± 45-degree phase shift in two 265-mc channels. The beam source in experimental model shown is a twin-gun structure rather than a rectangular beam gun as described in the text

Long Beach, California. This transmitter is now on the air in Long Beach on a carrier frequency of 530 mc. The peak power output of the unit is 150 watts. Although at present it is being used at this power level, just as in the case of f-m transmitters, all of the modulation equipment necessary for operation at any power level is present, and it is hoped soon to use the present unit merely as an exciter for succeeding r-f power amplifier stages.

The choice of tubes which can be used to go on to higher power is made easier by the fact that there is no amplitude linearity requirement placed on these amplifiers. High-power traveling-wave tubes, klystrons, resnatrons, and other similar devices which are difficult to modulate by any other method, should be ideally suited for use in a phase-to-amplitude modulated television transmitter.

Figure 2 is a block diagram of the present 150-watt uhf transmitter. The crystal oscillator output is multiplied up to a power level of about four watts at 265 mc. There it divides to go through the two halves of a twin-channel phase modulator, each side of which is capable of linear modulation up to ±22.5 degrees. The two-watt output of each phase modulator is then doubled in frequency and amplified to 75 watts power level in two 4X150A coaxial cavity stages. These two 75-watt 530-mc signals, which are constant in amplitude but varying in phase, are then fed into the common antenna. There they combine to produce a resultant 150-watt output wave which is constant in phase but modulated in amplitude. The function of the dummy load shown on this diagram will be discussed later.

A phase-to-amplitude transmitter can be functionally divided into three major sections: a twin-channel phase modulator, a radio-frequency power amplifier section, and an output combining network. The operation of the transmitter is easier to visualize by starting at the output end and working back to the crystal.

Output Combining Network

As one might suspect, the full story on the power-combining process is not quite as simple as the basic vector addition discussed earlier. There is a troublesome reactive component introduced by the relative phase of the drive voltages and the common load current.

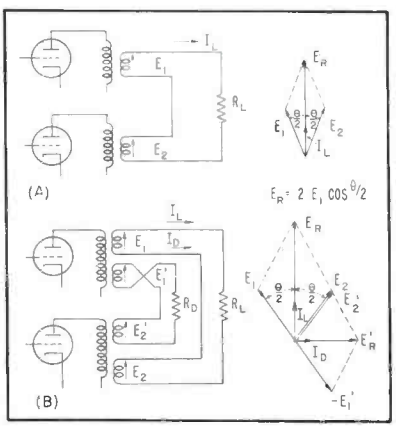


FIG. 3—Basic arrangement (A) and output circuit (B) with compensation

Consider a phase-to-amplitude transmitter in which the final stages of the two phase-modulated channels are connected in series in order to feed the common load resistance by means of the link coupling arrangement shown in Fig. 3A. The two channel voltages E_1 and E_2 add vectorially to produce a resultant voltage E_R which is effective in driving current through the load R_L. It can be seen that

$$E_R = 2E_1 \cos \theta/2 \qquad (1)$$

where θ is the relative phase angle between the two channel voltages.

Since R_L is resistive, the common load current I_L circulating in the series circuit will be in phase with E_R. Channel No. 1 is then putting out a voltage of E_1 but has a current of I_L flowing through its link coil. Since E_1 leads I_L in phase, this channel sees an inductive load. Channel No. 2 on the other hand, puts out a voltage of E_2 but has a load current of I_L and thus sees a capacitive load impedance. These reactive components effectively de-

tune the final tank circuits and if left uncompensated would reduce the plate-circuit efficiency of the final amplifiers in approximate proportion to the power factor of the load. This power-factor angle varies over the modulation cycle so that no static correction can be made which will be effective at all times.

It is possible judiciously to detune the final tank circuits, one to the inductive side and the other to the capacitive side in order to compensate completely for the reactive power somewhere near the middle of the modulation cycle. This is the procedure normally followed in low-frequency transmitters. With such an adjustment the power factor, and consequently the efficiency, will be found to remain high over the peak half of the modulation cycle.

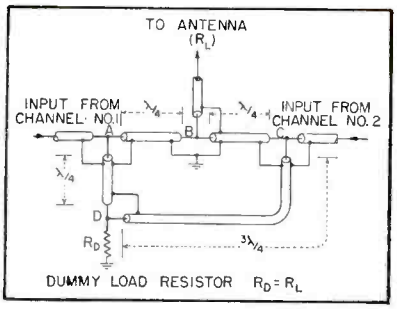


FIG. 4—Constant impedance output coupling network

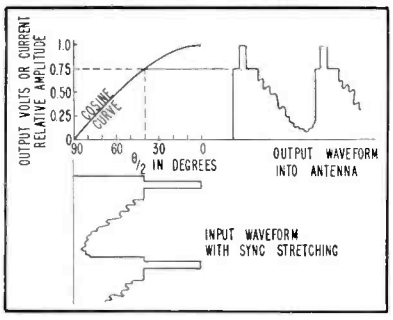


FIG. 5—Modulation characteristic illustrates linearity of system

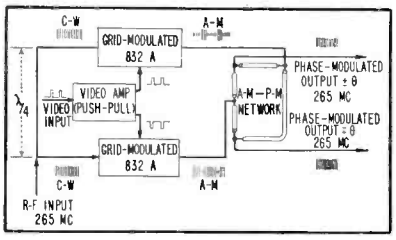


FIG. 6—Twin-channel 265-mc phase modulator offers further simplification

The load power factor will then become very poor near the modulation troughs, but there the total power being handled is low and the actual power loss is small. Because of interaction of the two final circuit adjustments the actual detuning procedure is in practice rather critical and has not yet been attempted at uhf.

There is one further complication. The foregoing discussion has assumed that the output of each final amplifier remains constant in amplitude while varying in phase. Since the power drawn out of these constant voltage output stages varies over the modulation cycle it can be seen that with such an output connection the phase-to-amplitude system is in reality a load impedance modulation system. It is very much the same as if one had a frictionless and inertialess link-coupling device between the transmitter and its load. Amplitude modulation could then be accomplished by swinging the link back and forth, a process which would require no modulator power.

When confronted with such a widely varying load impedance the output voltage regulation of a normal class-C amplifier is quite poor. This is especially true near the no-load condition where the peak r-f plate voltage can rise to several times the applied d-c voltage. The result is a curvature of the modulation characteristic and danger from high-voltage breakdown unless steps are taken to regulate the final tank voltages.

Dummy Load

At the cost of somewhat reduced overall efficiency there is a simple way of completely overcoming both the reactive detuning problem and the voltage regulation problem. In Fig. 3B another output winding has been added to each final tank coil. These two new windings are connected in series and feed power to a dummy load resistor in such a manner that when E_1 and E_2 are series aiding, E_1' and E_2' are in series opposition. The vector diagram shows the resultant voltage across the dummy load to be a sinusoidal function of $\theta/2$.

$$E_R' = 2E_1 \sin \theta/2 \qquad (2)$$

From Eq. 1 the power into the useful load at any time is

$$P = \frac{4E_1^2\cos^2\theta/2}{R_L} \qquad (3)$$

Similarly, the power into the dummy load is

$$P' = \frac{4E_1^2\sin^2\theta/2}{R_D} \qquad (4)$$

If $R_L = R_D = R$, then the total power drawn from both final amplifiers is the sum of 3 and 4;

$$P_{total} = \frac{4E_1^2}{R}\ (\sin^2\theta/2 + \cos^2\theta/2)$$

$$= \frac{4E_1^2}{R} \qquad (5)$$

Equation 5 states that the total power drawn from the final amplifiers with the circuit arrangement shown in Fig. 3B is constant. The power is smoothly shifted back and forth between the antenna and the dummy load in accordance with the relative phase between channels which is determined earlier in the transmitter. Further analysis shows that the inductive component introduced by one load is exactly compensated by the capacitive component of the other load so that each looks into a load impedance which is resistive and constant during all parts of the modulation cycle.

The series voltage addition which has been discussed thus far is rather difficult to handle physically with coaxial lines, so that in the actual transmitter, instead of adding two constant-voltage generators in series, use is made of the quarter-wave transmission line property that such a line when fed with a constant-voltage generator at one end looks like a constant-current generator at the other end. These constant-current generators can then be combined parallel.

Figure 4 shows the actual configuration used in the present uhf transmitter. The constant voltage outputs from the two final stages are fed into terminals *A* and *C*. The top two $\lambda/4$ lines transform these into constant-current generators which are combined in shunt to feed current to the antenna. The other half of the network takes the place of the second windings shown in Fig. 3B. Two more $\lambda/4$ lines provide the constant-current generators and an extra $\lambda/2$ added to one of the lines gives the necessary 180-

degree phase reversal.

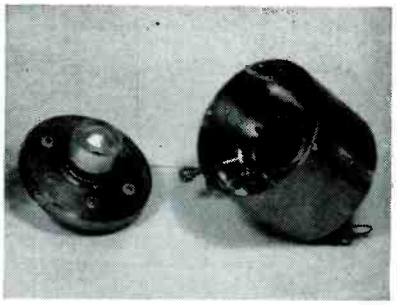
The network shown in Fig. 4 then has the useful property of converting phase modulation to amplitude modulation. Its input impedances are resistive and constant regardless of the relative phase angle between the two input voltages. The input resistances equal the load resistances when the Z_0 of all the lines in the network is $\sqrt{2}R_L$.

Figure 5 shows the modulation linearity to be expected from the phase-to-amplitude system. It has already been pointed out that this curve of volts to the useful load versus the relative channel phase angle is cosinusoidal. For speech or sine-wave modulation all operation must be restricted to the linear portion of this curve. Television video waveforms offer less of a problem, for although the transfer characteristic is quite curved near the top part, it departs from a straight line by less than 4 percent over the first 75 percent of its total amplitude. Thus, for television the full swing of a phase-to-amplitude transmitter, from completely out-of-phase to completely in-phase operation, can be utilized. The picture information which occupies the lower 75 percent of the composite video waveform falls on the more linear portion of the transfer characteristic and a simple sync-stretching operation at the video input to the modulator insures the required sync pulse height at the transmitter output.

It should be noted that when using the constant-impedance output network none of the high-power stages works any harder at the sync peaks than at any other part of the cycle so that sync compression from the usual causes is not present.

Power Considerations

For television waveforms the power diverted into the dummy load is less than half the total power because of the one-sided nature of the television signal. This loss is not so serious as might first be imagined because of two reasons: first, at the present stage of the uhf transmitter art the primary emphasis is not so much on what final stage efficiency can be



Experimental 530-mc cavity amplifier capable of 75 to 100 watts with 15 to 20 watts drive

obtained as it is on how much modulated power can be produced with available tubes. The power loss may be regarded as the price paid for using high-power tubes which are difficult or impossible to modulate by other means; second, the power loss is little more than one would expect to expend in high-level video equipment even if the modulation could be accomplished by other means.

If we make the simplifying assumption that the average plate efficiency of a uhf tube is roughly the same when operating near the peak power level, whether it be operated with grid modulation, as a class-B linear amplifier or as a saturated class-C amplifier, we can draw the following conclusions about the loss suffered by throwing away a portion of the power in a dummy resistor in order to obtain a simplified outphasing system. When a television transmitter is radiating sync pulses and a completely black picture, its average power output is very nearly 60 percent of the peak synchronizing pulse power. Thus, a tube which could produce 100 watts continuously without exceeding its ratings would be capable of producing $100/0.60 = 166$ watts peak power when running with a black-level picture, still staying within its power dissipation ratings.

When the same tube is used in a phase - to - amplitude transmitter utilizing the constant-impedance output network, it is required to deliver continuously to the network an amount of power equal to the peak synchronizing pulse power. This would mean peak power per tube of 100 watts for the tube of this example when used in outphasing service as compared with 166 watts for the same tube in a grid-modulated transmitter.

This represents a 2.2-db penalty in the peak r-f power available caused by use of the dummy load resistor and represents the worst possible case. It is a pessimistic figure since the average plate efficiency of the saturated class-C stage will usually be somewhat higher than that of the other two systems at black level instead of equal to it as was assumed. Also, the foregoing comparison was based on the useful power obtained from a single tube. An outphasing system has two final stages whose power outputs add at the antenna, while no additional video power is required as would be the case if a grid-modulated transmitter were operated with multiple tubes in the final amplifier.

It should be pointed out, moreover, that the phase-to-amplitude system when operated without this dummy resistor is a high-efficiency system with overall efficiencies surpassing even that of plate modulation when losses in the modulator are taken into account. After becoming more familiar with the actual operating characteristics of the completed 150-watt transmitter, it may be possible to dispense with the dummy load resistor and the network arms leading to it, and to operate the final amplifier stages at higher efficiency by purposely detuning them, one to a higher frequency and the other to a lower one, just as is done in low-frequency transmitters. One very preliminary and partially successful attempt at this has already been made. Whether the more complicated tuning procedure can be held to a practical operating routine is something that only continued tests can determine.

Radio-Frequency Amplifiers

The second major division of a phase-to-amplitude system is the r-f power amplifier section. The amplifiers used in this television transmitter are of the conventional coaxial cavity type. Each channel utilizes one 4X150A tube as a straight-through amplifier on 265 mc followed by another 4X150A operating as a frequency doubler to 530 mc. Since both of the p-m sidebands must be amplified special attention was paid to the circuit load-

ing and to the interstage coupling networks to maintain the required 9-mc bandwidth.

The final and driver stages of this particular transmitter are located on a separate frame from the rest of the equipment and can be remotely mounted on top of the tower close to the antenna in order to minimize the 530-mc transmission line loss. At the present transmitter location the antenna is on top of a sturdy oil derrick which makes such an installation possible.

The third major component, the phase modulator unit, is really the heart of this type of transmitter.

Phase Modulator

Constructing a stable linear phase modulator which will work reliably at carrier frequencies of several hundred megacycles is quite a problem in itself. The prime requirements are simplicity and ease of adjustment, since the operating frequency makes it impractical to use a monitoring oscilloscope during tune-up. Several types of phase modulators have been built for this transmitter and tried with varying degrees of success.

The one in use at present makes use of a network similar to the one used at the output of the transmitter to convert p-m into a-m. Since this network is a linear, bilateral device it can be used equally well for converting a-m to p-m. It is only necessary to feed two nonadjacent terminals of the network with amplitude-modulated signals having the proper r-f and video phase relationships. From the other two terminals one can then obtain two signals of substantially constant amplitude, but phase modulated in opposite directions by equal amounts. This is exactly the result desired, and it comes about when the two amplitude-modulated input voltages are 90 degrees out of r-f phase and 180 degrees out of video phase with each other. The total linear modulation range of this arrangement is about 50 degrees, so that in order to obtain a 530 mc phase-shift versus video-voltage curve linear over the necessary ± 45-degree range, it is necessary to operate the phase modulator at half the final frequency, or at 265 mc.

Figure 6 is a block diagram of this 265-mc twin-channel phase modulator.

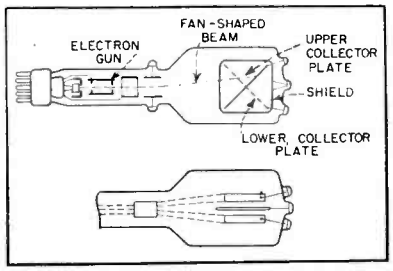


FIG. 7—Cross sections of experimental phase-modulator tube

Special Modulator Tube

To obtain in practice the precise phase relationships required at the input to the network of the phase modulator just described, a rather involved tuning procedure must be used. In order to obtain a still simpler modulator, a special twin-channel phase modulator tube has been developed which does the entire job in one tube and requires virtually no alignment. Fig. 7 is a cross-sectional diagram of such a tube.

A fan-shaped electron beam of rectangular cross section falls on two diagonal collector plates which are separated by a ground plane. The beam is intensity modulated at the carrier frequency and is electrostatically deflected laterally by the video modulation. Sideways deflection of the beam causes the point of electron impingement on one collector plate to move forward, thus shortening the transit time. At the same time the point of electron impingement on the other plate moves backward, increasing the transit time to that plate. Two separate output circuits tuned to the carrier frequency are then connected to these two collector plates, and the two output signals are thus phase modulated in opposite directions by the video input. The modulation characteristic can be linear or curved, depending upon the configuration of the collector plates.

Several of these special phase-modulator tubes have been built and successfully demonstrated. However, the maximum r-f power output that has thus far been obtained from any of them has been in the milliwatt region, and they have not been used in the transmitter because of all the extra amplification involved. If such a tube can be built to deliver on the order of one to ten watts into each channel, the problem of a really simple phase modulator for phase-to-amplitude television transmitters should be completely solved.

Overall Transmitter Operation

The developmental 150-watt transmitter has been as stable in operation as any other type of uhf television transmitter and has given consistent service. The measured overall video response is flat within 1 db to 4.8 mc, the modulation linearity is good, and the horizontal resolution of the radiated picture is better than 400 lines.

The phase modulator is at present the weakest link in the chain, and requires about twenty minutes of warm-up time to completely settle down to drift-free operation. After this period, however, the transmitter will operate over a normal eight-hour day with only occasional monitoring.

The real value in the phase-to-amplitude modulation system lies in its ability to go to very high power levels. The added complexity of the system can hardly be justified at levels where modulation power can be easily obtained by conventional means. For broadcast transmitters the savings in physical size, overall efficiency, and initial cost do not ordinarily become evident below five or ten kilowatts. The 150-watt uhf phase-to-amplitude television transmitter on the other hand is about the same physical size and only slightly more complex than a conventional grid-modulated transmitter of the same power level. It would then appear that the system would have distinct advantages for use in uhf television transmitters above 500 to 1,000 watts.

The work described in this paper has been carried on at the Stanford Research Institute, Stanford, California, as a portion of a uhf television program sponsored by John H. Poole, owner of experimental station KM2XAZ in Long Beach, California.

References

(1) Henri Chireix, High Power Outphasing Modulation, *Proc. IRE*, 23, p 1,370, Nov. 1935.

(2) O. G. Villard, Jr. and W. E. Evans: Final Report to Air Material Command, Watson Laboratories, Red Bank, New Jersey, on Project W-28-099-ac-121, Aug. 1947.

Electronic Control of ANESTHESIA

Brain potentials, which increase as anesthesia decreases, are integrated and amplified to fire thyratron that actuates one-stroke electric pump for feeding more anesthetic to patient to maintain desired degree of anesthesia during an operation

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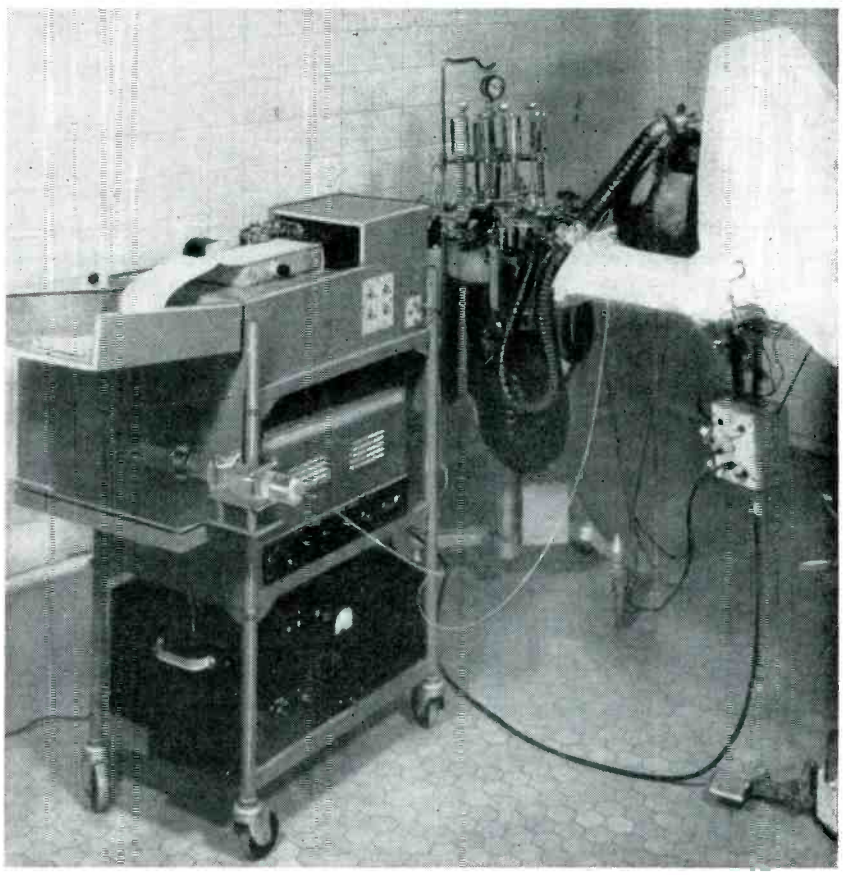
THE TECHNIQUE of production of anesthesia at first sight may appear to be far removed from electronic problems and interests. Actually, this is not so. Those engineers who are versed in the theory of servomechanisms will have a good background for the understanding of some of the fundamental problems of anesthesia and the attempts that have been made recently to solve them by electronic means.

The anesthetist, in the course of giving an anesthetic agent, receives a continuous flow of information from his sense organs (eyes, ears and hands) which he integrates and, in the light of previous experience, utilizes to form a judgment of the patient's depth of anesthesia. He compares this estimate with a known standard depth of anesthesia which the surgeon requires for the particular stage of the operation, and then he takes appropriate action to increase or to decrease the anesthetic concentration.

The servoengineer will immediately recognize this operation as a rather complex form of servomechanism with a human linkage. This is an important concept, for it leads directly to an understanding of some of the defects which such a system might develop. These are actually of two kinds: (1) a failure to integrate satisfactorily the information received from the patient, with a consequent erroneous estimate of anesthetic depth, and (2) a slowness or lag in the system which results in information being acted upon too late. The overall result of the second defect is that anesthesia alternates rapidly between being too deep and too light.

While the first defect usually is seen only in the work of an inexperienced anesthetist, the hunting defect appears to be present to some extent in most manually controlled anesthetic administrations.

An extensive series of experiments on animals[1] has shown that the electrical activity of the brain undergoes a characteristic series of changes in relation to depth of anesthesia. Most anesthetic drugs appear to act in the following manner. In low concentrations, such as would be necessary to induce a state of light anesthesia, these drugs appear to stimulate the cortical nerve cells and result in a considerable increase in electrical output over that of the resting state. With a further



Clinical model of servoanesthetizer, being used for administration of nitrous oxide-ether anesthesia to patient on operating table

increase in the concentration of the anesthetic drug, this stimulating effect changes to one of depression of the electrical output which continues until, in deep anesthesia, the brain may become electrically inactive. This will be understood by reference to Fig. 1, which shows the effects of two commonly employed anesthetic drugs, ether and pentothal, on the brain potentials (electroencephalogram) of the monkey. The patterns are similar to those seen in the human being.

Thus, the electrical output of the brain provides us with a simple index of depth of anesthesia which can replace the estimate resulting from the integration of rather complex clinical signs. Since this electrical activity can be recorded by relatively simple means (electrodes attached to the surface of the scalp) and can be quantitated by integration, that part of the human linkage in the servomechanism which is concerned with estimating depth of anesthesia can now be replaced by an electronic circuit.

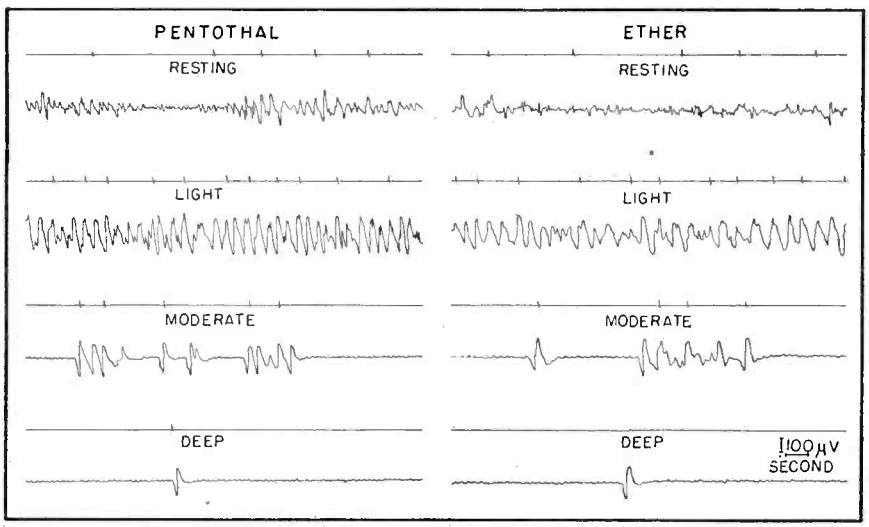


FIG. 1—Influence of pentothal sodium and ether anesthesia on electroencephalogram and integrated brain potential output of monkey brain. Pips of integrated tracing each produce one stroke of anesthetic pump

The next problem, that of replacing the error-computing and anesthetic-administrating side of the servomechanism, is relatively simple. If an electromechanical system is designed that will deliver the anesthetic agent to the patient at a rate proportional to the energy output of the cortex, a servoloop will be completed that will automatically maintain a given level of anesthesia. The system is illustrated diagrammatically in Fig. 2.

Details of Apparatus

The complete apparatus for the automatic production and maintenance of anesthesia is called the servoanesthetizer. It comprises essentially five separate units: (1) electrodes and leads, (2) amplifier, (3) integrator, (4) electromechanical transducer, and (5) anesthetic reservoir and piston feed (with vaporizer for ether).

The electrodes which pick up the potential variations from the scalp consist of either small silver disks held in contact with the scalp by conductive jelly or fine needles which pierce the scalp a small distance. Two active leads and a ground are employed, the former being placed in the frontal and occipital (back) parts of the head, while the ground usually is located intermediately.

The amplifier has five R-C coupled stages and is push-pull throughout. By the use of cathode degeneration on the first two stages, a high (50,000 to 1) in-phase rejection ratio can be obtained which assists in eliminating interference. Since the brain-wave frequencies which are of interest for the control of anesthesia fall between about 1 and 6 cycles per second, it is advantageous to eliminate most of the frequencies outside this range. The amplifier used is linear between 1 and 10 cps, with cutoff at 0.5 and 30 cps. The first two stages are battery-operated. The voltage amplification employed is about 10^5.

The output from the power stage is fed to an inkwriter which traces the brain potential onto paper traveling at a rate of 1.5 cm per second. The inkwriter is used for monitoring and, if necessary, for the permanent recording of the brain wave and heart tracings throughout anesthesia.

A second amplifier-inkwriter is used to register the electrocardiogram and is not directly concerned in the automatic production and maintenance of anesthesia.

The input to the integrator circuit (Fig. 3) is taken asymmetrically from the third stage of the push-pull amplifier. The signal passes through potentiometer R_1, which is the main regulator of depth of anesthesia, to the grid of integrator tube V_3. By adjustment of screen potential with R_2, this tube is biased to cutoff in the absence of an input signal. With the arrival of brain potentials, anode current flows in V_3 and C_2 charges until, at a critical voltage, it is rapidly discharged by the flip-flop circuit using V_{4A} and V_{4B}. The repetition frequency of the discharge is proportional to the integrated potential output of the brain, which, it will be remembered, is the electronic measure of depth of anesthesia. This relationship is illustrated well in Fig. 1, where the integrator pulses appear above the corresponding brain-wave tracing.

It remains to discharge to the patient appropriate amounts of anesthetic agent at each integrator pulse. This is done by use of the pulse to energize via thyratron V_5 a modified electromechanical stepping relay, the threaded shaft of which advances a metal block which is in contact with the piston of a syringe containing ether or barbiturate in solution. The syringe is connected, through a fine plastic tubing, to a vaporizer or a vein, according to the kind of anesthetic agent in use.

Operation

When this system is in operation, the anesthetic agent is fed to the

animal or to the human patient at a rate which varies directly with the integrated potential output of the cortex. A point of equilibrium is reached at which the rate of infusion of the anesthetic drug balances the rate of removal or destruction by the tissues, as indicated in Fig. 2. The actual depth of anesthesia at which this equilibrium is attained is dependent on the proportionality settings between potential output of the cortex and dosage. This can be adjusted by gain control potentiometer R_1 (Fig. 3), which is calibrated in terms of depth of anesthesia.

The system is put into operation by injecting, initially, a small amount of anesthetic agent. On reaching the brain, the anesthetic stimulates the cortical neurones and increases their electrical output; this in turn will increase the rate of administration of the drug. In this phase the system will be seen to be selfaugmenting (positive feedback). As soon as the drug reaches the concentration at which suppression of cortical electrical activity commences, the system changes to a selflimiting (negative feedback) cycle. It is in this phase that the system settles into equilibrium and will maintain a depth of anesthesia which depends on the adjustment of R_1.

Homeostatic Properties

Because of its feedback cycle, the apparatus has some of the properties of a homeostatic system, and it tends to compensate for factors which disturb the equilibrium. For instance, if the anesthetic mixture is diluted or a leak develops in the intravenous tube, the machine automatically increases its rate of administration in an attempt to compensate for these changes. Complete compensation is not attained, since this is a droop variety of servomechanism (similar to the governor of a steam engine) in which a change in conditions results in a relatively slight shift of the system to a new equilibrium point. However, the fact that animals have been kept automatically anesthetized for periods up to two or three days without circuit readjustment suggests that compensation is adequate to deal with the disturbances encountered in normal anesthesia.

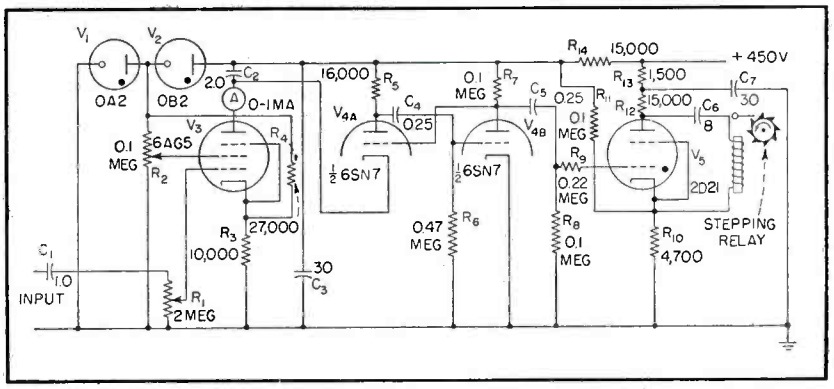


FIG. 3—Integrator and electromechanical transducer that act together to apply more anesthetic when brain potential of patient rises

Applications

The servoanesthetizer is finding a number of different applications in both research and practical anesthesia. Its ability to hold a steady and known level of anesthesia is important in research work on brain function in the animal, since a variable which in the past has been difficult to control is eliminated. Research in human anesthesia, and more particularly investigations into the interaction of various anesthetic agents, also will be facilitated. The greatest interest, however, naturally attaches to the application of the servoanesthetizer to maintain clinical anesthesia. The control of the administration of ether by this method is at present under trial, but early results indicate that smooth anesthesia free from hunting can be maintained.

Although automatic anesthesia will relieve the anesthetist of much tedious work, it should be emphasized that he will always be required to initiate and probably to supervise the administration. Safety devices are now under development which will ensure that when an emergency arises, such as operative shock or failure of respiration, a warning signal is given and administration of the anesthetic agent is automatically discontinued. A further development is the provision of an adjustment for depth of anesthesia (R_1) which can be operated directly by the surgeon. This should ensure that the patient is always at a suitable level of anesthesia for any particular stage of the operation. A fuller discussion of the problems will be found in the original papers.[1, 2, 3, 4]

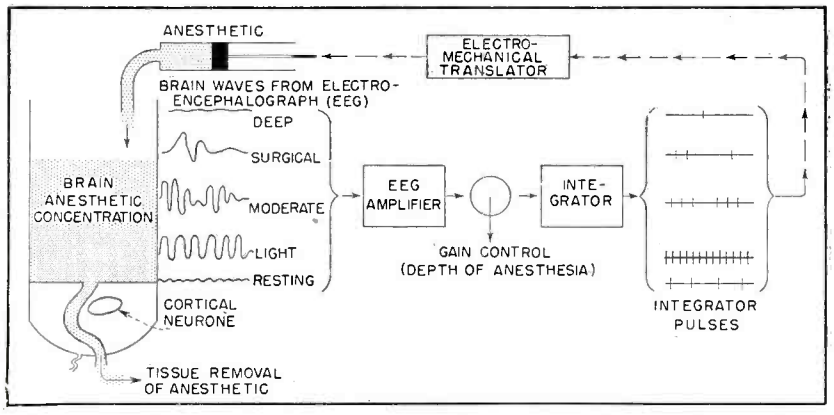


FIG. 2—Type of servoloop employed to maintain desired level of anesthesia without hunting

References

(1) R. G. Bickford, Automatic Electroencephalographic Control of General Anesthesia, *Electroencephalography & Clin. Neurophysiol.*, 2, p 93, Feb. 1950.

(2) R. G. Bickford, Neurophysiological Applications of Automatic Anesthetic Regulator Controlled by Brain Potentials, *Am. J. Physiol.*, 159, p 562, Dec. 1, 1949.

(3) R. F. Courtin, R. G. Bickford and Albert Faulconer, Jr., The Classification and Significance of Electroencephalographic Patterns Produced by Nitrous Oxide-ether Anesthesia During Surgical Operations, *Proc. Staff Meet., Mayo Clinic*, 25, p 197, Apr. 12, 1950.

(4) D. Soltero, Albert Faulconer, Jr. and R. G. Bickford, Clinical Applications of Servoanesthesia, Unpublished.

PHOTOMETER for Electron Microscope

Correct photographic exposure is determined by a simple attachment. A multiplier phototube views the fluorescent focusing screen and beam intensity is indicated by a microammeter. Special circuits protect the meter movement during exposure to strong light

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ALL electron microscopes incorporate a fluorescent screen located close to the photographic plate for the purpose of visualizing and focusing the electron image. To make an exposure, the screen is displaced and the electron beam is allowed to fall directly upon the photographic emulsion.

The usual method of determining the proper exposure has been to try to make an intelligent guess of the intensity by judging the brightness of the fluorescent image. In practice this procedure is not reliable and results in a considerable variation in the exposure of the plates. It was decided to try some type of photosensitive device to measure the light from the screen of the type EMU electron microscope in order to obtain more consistent results.

The light from the fluorescent screen at the intensity normally used for an exposure is weak and ordinary photocells are inadequate, unless a fairly sensitive galvanometer is used. The brightness of the screen will vary over a wide range during the exploration of a specimen, particularly in microscopes employing the biased gun. Because the pickup device might be exposed accidentally to strong artificial light or even daylight, it is possible for the output current from a phototube to rise to a value dangerous to a sensitive meter.

It was found that the type 931A multiplier phototube would give a satisfactory output when mounted externally in a position to receive light from the fluorescent screen. To avoid the use of a delicate meter, a self-limiting balanced vacuum-tube voltmeter output stage was added to the electron multiplier. The input circuit of this final stage includes a resistor R_1 in series with the anode of the phototube. A voltage is developed across this resistor when the phototube is illuminated, and the vacuum-tube voltmeter is used to measure this voltage. The circuit components are mounted in a small chassis, which was designed to fit into a space available inside the microscope cabinet.

This paper is based on work performed under contract with the United States Atomic Energy Commission at The University of Rochester, Atomic Energy Project, Rochester, N. Y.

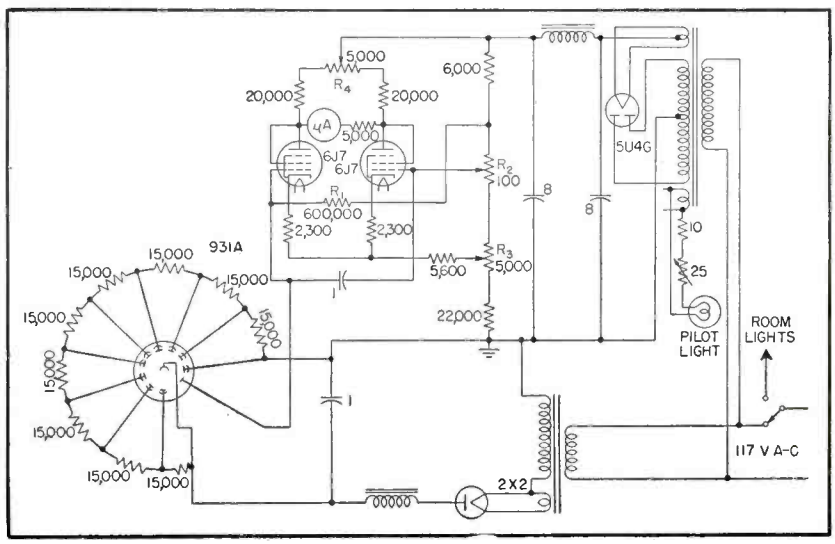
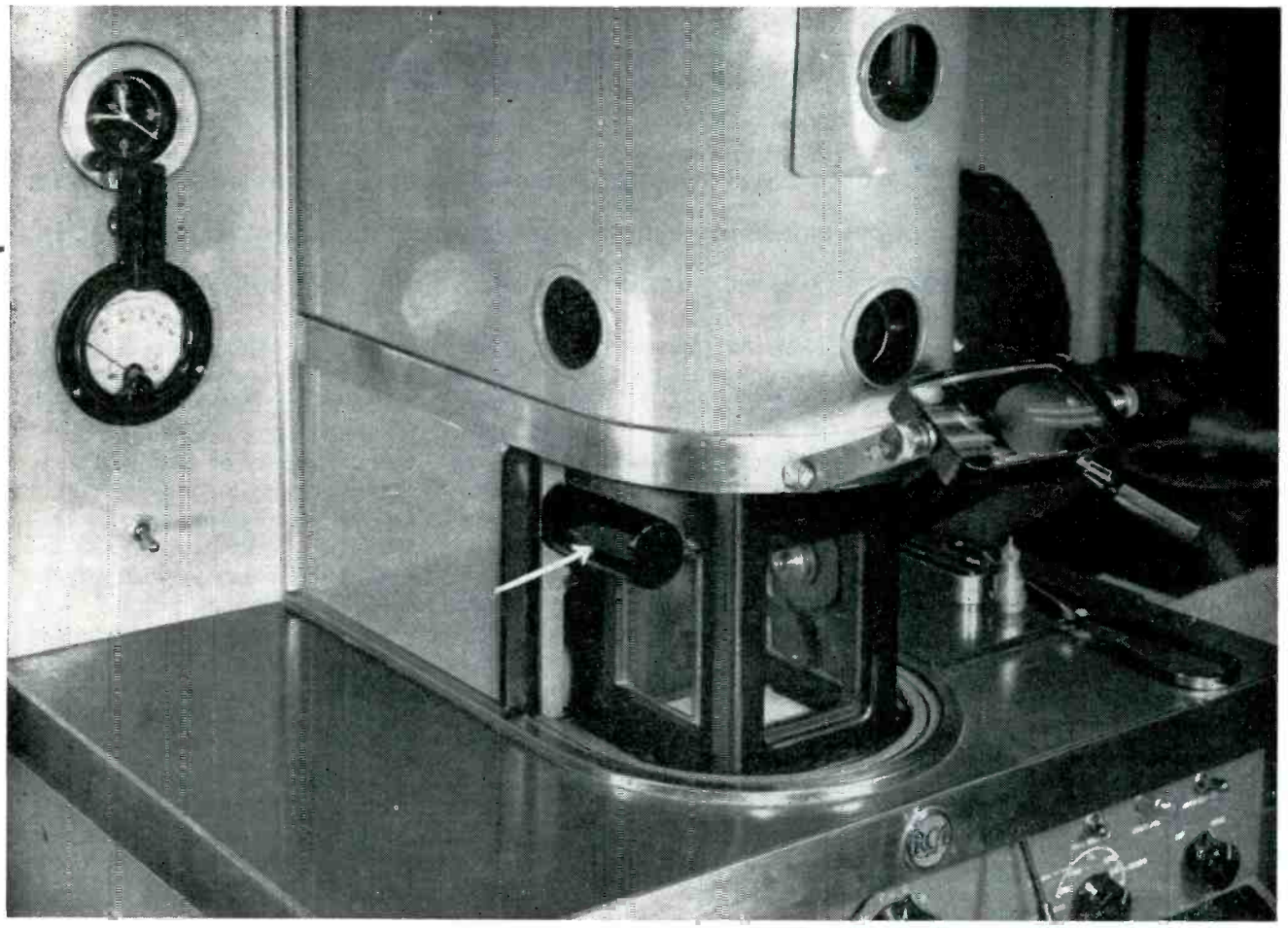


FIG. 1—Circuit of the photometer used with the electron microscope

Design Details

The 931A phototube requires a supply of some 1,250 volts. The power source is made in two sections: the first is a 1,000-volt pack to supply the dynode voltages, while the second is used to furnish the 250 volts between the final dynode and the anode. This last voltage source is also used to operate the vacuum-tube voltmeter, which consists of two 6J7 tubes operating with about 45 volts on the plates and about 2.5 volts negative grid bias. The grids are connected to the two ends of the resistor R_1 which is in series with the plate of the 931A phototube. When current flows through this resistor, a voltage drop occurs and one of the 6J7 tubes draws less current, producing



The photometer components are mounted inside the microscope housing. Arrow points to the brass cylinder enclosing the multiplier phototube. Both the meter and the clock mounted at left are illuminated via plastic rods

an unbalance in the plate circuit. A 0–200 microampere meter between the plates measures this unbalance. When the signal approximates 3 volts, the 6J7 reaches cutoff, and beyond this point there is no increase in the meter deflection.

With no light on the phototube, and a rough balance obtained with R_1, the meter is set to zero with R_2. Then with 3 volts or more applied to resistor R_1, the meter is set to full-scale deflection by means of the control R_3. This completes the circuit adjustments.

The meter is mounted on the panel of the microscope just below the clock, and a pilot light is arranged with plastic conductors so that both the meter and the clock, which has a sweep second hand, are illuminated. This is a convenient arrangement because timing of the exposure is done by this clock. The control panel lights of the microscope are turned off during an exposure since a small amount of light from this source may reach the phototube. The room light switch on the panel of the microscope is wired so that only when the room lights are off is the photometer energized, making its operation more or less automatic.

The phototube is mounted externally on the microscope column at the top edge of the left-hand viewing window as shown in the photograph. It is protected by a brass tubing in which is milled a narrow slit oriented in such a way that it picks up light only from that portion of the fluorescent screen upon which the useful image falls. This arrangement insures accuracy at any magnification.

Using the Instrument

When the image of an opaque specimen covers a large part of the field, some judgment must be exercised in determining the proper exposure from the deflection of the meter but a few trials will calibrate the unit for almost any condition. For most of our work the light intensity is adjusted to a predetermined reading of the meter by means of the condenser lens control and a constant exposure time is used. If illumination from unwanted sources is excluded the phototube may be mounted in any convenient position and the light from the screen brought to it by means of a plastic rod.

The use of this attachment to the electron microscope has resulted in extremely uniform exposures. The elimination of guesswork in the exposure does away with the loss of otherwise useful plates and greatly simplifies the making of prints or enlargements from the negatives. The location of the phototube near the top of the window does not interfere with visual observation of the fluorescent screen from this side. Experience with the device for some two years has proved its practicability.

Microwave Diffraction Charts

The radius of the first Fresnel zone at various distances from the nearest terminal end of a microwave relay course can be determined from one nomogram. The adjusted distance required in Fresnel zone calculations is shown in the second alignment chart

By EARL D. HILBURN
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The Evening Star Broadcasting Co.
Washington, D. C.

MICROWAVE SIGNALS over line-of-sight courses are frequently observed to depart considerably from the free-space predictions.

Variations from free-space calculations are due to combinations of refraction and diffraction effects, as well as occasional absorption conditions due to rain, snow or fog. Of these factors, all but diffraction vary with weather conditions and combine to form the diurnal and seasonal variations noted in point-to-point relay services.

Although considerable information is available in the literature to enable the engineer to predict with fair accuracy the signal strength under given conditions of temperature and percentage of water vapor in the atmosphere, the usual practice is to allow certain empirical margins of safety or fading factors based on long-term observations of relay signals at various frequencies. Diffraction effects, unlike those associated with refraction, do not change with time and weather conditions but are determined by the choice of operating sites and the intervening terrain. As the course line clearance is readily determined, and frequently is a factor under the engineer's control, diffraction factors are of practical interest in most microwave relay installations.

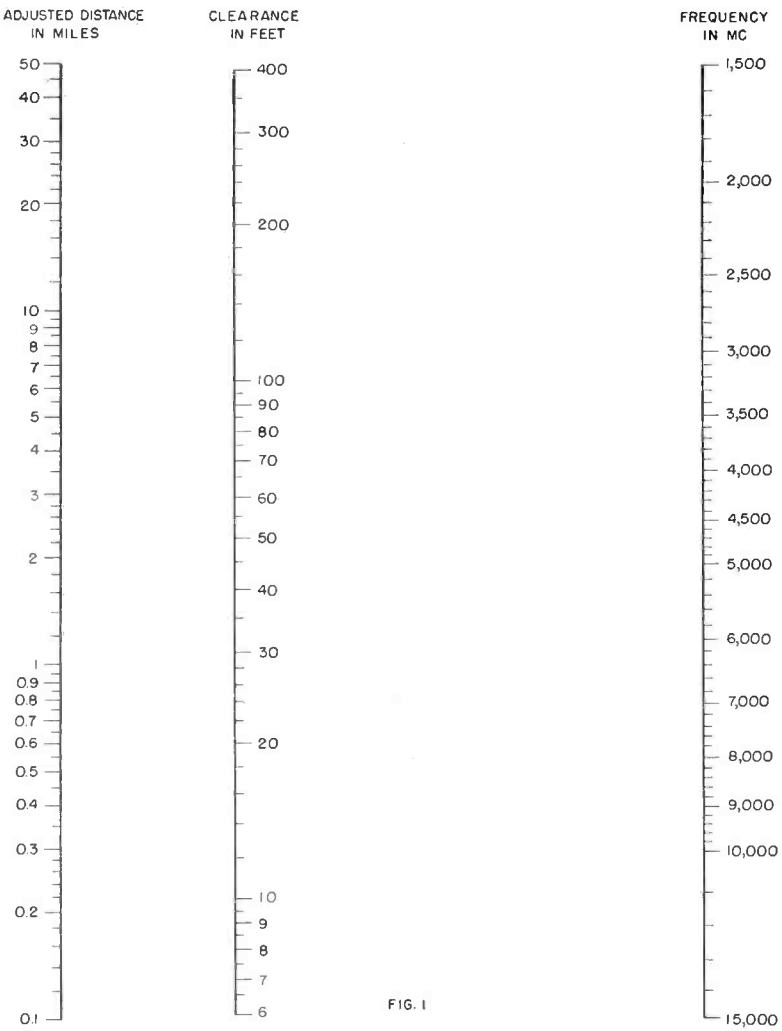


FIG. 1

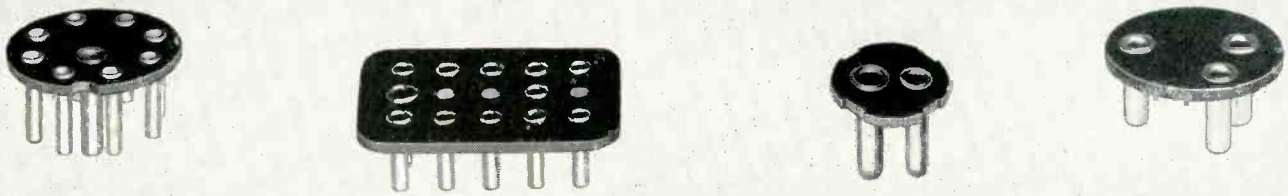
Fresnel Zone

From diffraction theory,[1] when a wave strikes an intervening object a spherical wavefront radiates from the edge of the obstruction. The field intensity at any point beyond the obstruction is thus dependent upon the vector sum of the direct and scattered wavefronts reaching the receiver. A Fresnel zone may be defined as a circular zone about the direct path at such a radius that the distance from a point on this circle to the receiving point has a path length that is some multiple of a half wavelength longer than the direct path. Hence, according to Fresnel's zone theory, all the even-numbered zones will send wavefronts to the receiver in opposite phase to all those from odd-numbered zones.

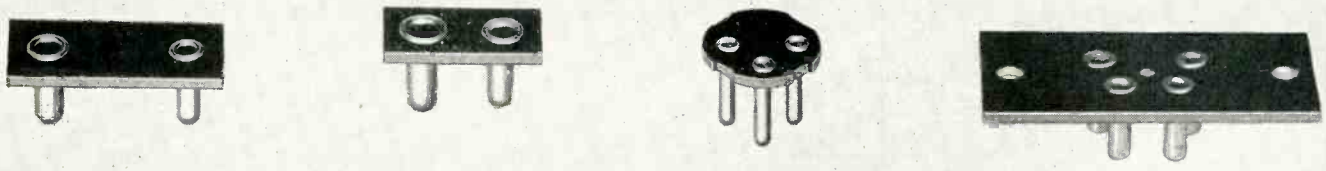
The effective field intensity at the receiver will rise and fall above and below the free-space value as the scattered waves alternately reinforce and cancel

(continued on p 114)

CINCH CONNECTOR PLUGS



AND BATTERY SOCKET PLUGS



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Microwave Diffraction Charts (Continued)

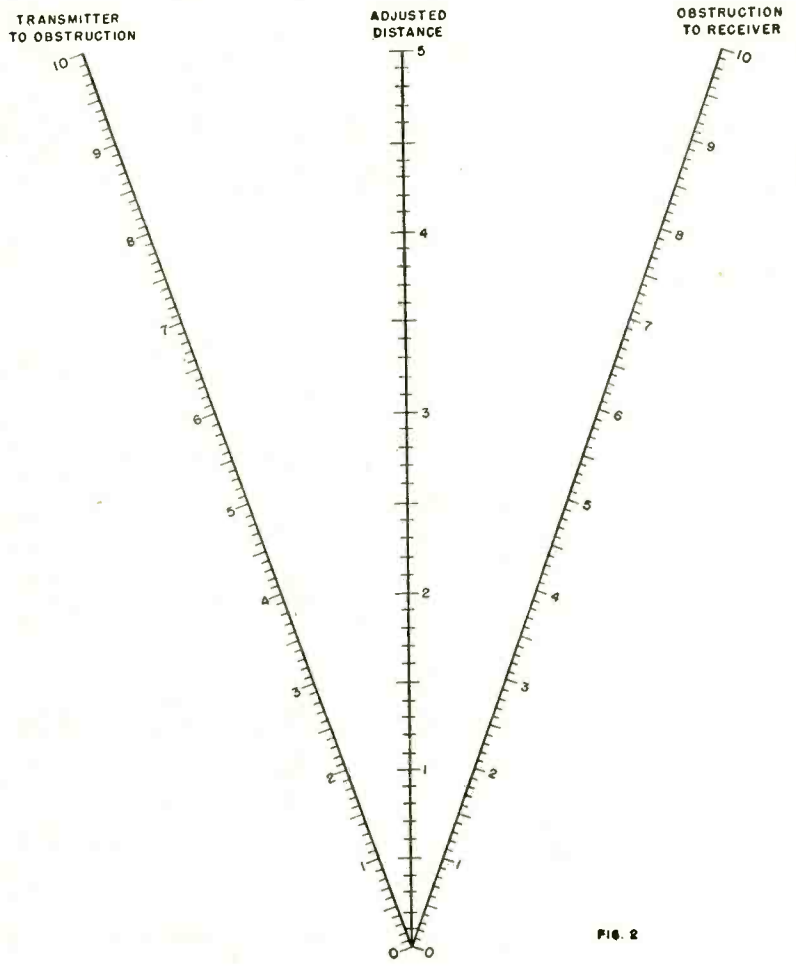


FIG. 2

the direct wave. The energy reaching the receiver from a given zone is proportional to the area of that zone and inversely proportional to the distance from the receiver. As the width of the rings making up the zones decreases rapidly as the radius of the circles increases, the first few zones are the only ones of any practical importance in diffraction studies of radio waves.

It has been stated[2] that a good optical path for microwave transmission is one with full first-Fresnel-zone clearance. With such an optimum path the signal strength at the receiver (excluding meteorological effects) is somewhat better than free space values due to the fact that the phase shift along a line from the transmitting antenna to the top of the obstruction and from there to the second antenna is about one-half wavelength greater than the phase shift of the direct path and some signal reinforcement is obtained.

Figure 1 indicates directly the radius of the first Fresnel zone as a function of distance and operating frequency. The construction shown assumes a plane wave (that the spherical wave has expanded to the point where the front is flat over the diameter of the diffraction zones).

The results given by this chart hold true only if the obstruction is very close to one end of the course. For accurate results at any point along the path, the setting on the distance scale should be adjusted in terms of the results given by Fig. 2. This enables the retardation on both parts of the circuit to be taken into account. Figure 2 is a simple reciprocal nomogram and, as the scales are linear, they may be multiplied by different decimal factors as required.

For example, to find the clearance required for a good microwave path, assume an operating frequency of 7,000 mc, a total course length of 11.5 miles and a principal obstruction 3 miles from the transmitter.

A line connecting 3 and 8.5 on the outside scales of Fig. 2 gives an adjusted distance of 2.2 miles. Connecting this point with 7,000 mc on Fig. 1 shows a required clearance of 40 feet at the point in question.

In addition to determining easily the requirements for a good optical path, these alignment charts permit making quantitative studies of signal intensity conditions under various diffraction conditions including grazing or even badly obstructed courses where the receiver may be in a shadow area.

The principal course obstruction should be plotted showing the projected area normal to the direct course between stations. The Fresnel zones should be drawn in as circles about the dot representing the course path, the radii being obtained from the charts. (While the nomograms show only the first zone radius, values for higher-order zones may be obtained by multiplying the indicated value by the square root of the number of the zone being considered.)

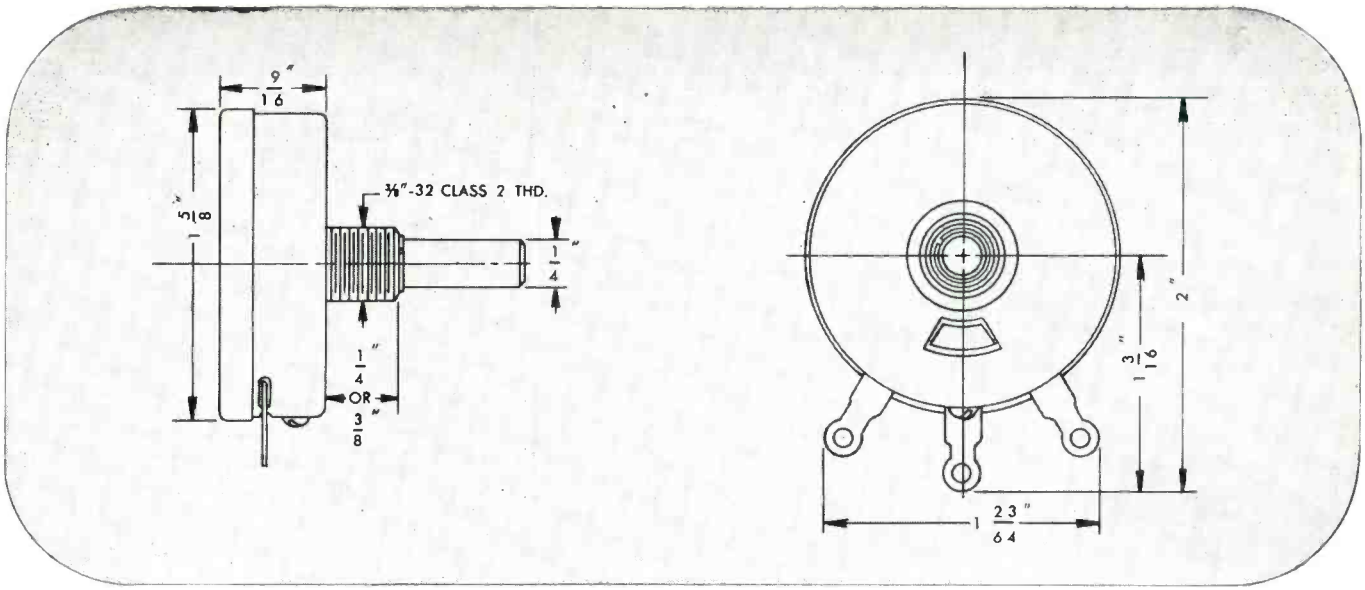
Having drawn the zone areas, with respect to the masking obstruction, the net field intensity may be obtained by integrating the area of the exposed zones. This can be accomplished graphically by means of the Cornu spiral.[3] In this manner, the departure from free-space values may be accurately estimated for any course.

References

(1) Charles F. Meyers, "The Diffraction of Light, X-Rays and Material Particles", J. W. Edwards Co., 1949.

(2) Kenneth Bullington, Radio Propagation at Frequencies Above 30 mc, *Proc. IRE*, 35, p 1,122, Oct. 1947.

(3) C. R. Burrows and S. S. Atwood, "Radio Wave Propagation," Academic Press Inc., 1949.



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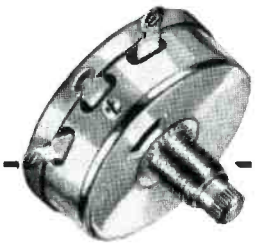

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TUBES AT WORK

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Edited by VIN ZELUFF

Motor-Controlled Charger

By T. A. BENHAM
Asst. Prof. of Physics, Haverford College
Haverford, Pa.

FULLY-AUTOMATIC charging at a constant two amperes is provided for a bank of 50 two-volt storage cells by a circuit employing a W. L. 672 thyratron as rectifier and charger with a motor-driven rheostat for phasing control.

Figure 1 shows the means for deriving motor control. The charging current flows through R_1 developing a voltage proportional to the current. The wave shape varies from a quarter wave to something less than a half wave.

The average value of voltage is kept to 4 volts by the motor. The voltage is changed to steady d-c by L_1C_1. The output of this filter is applied to the grids of two type 2050 thyratrons. The grid voltage for each tube is controlled by a potentiometer. The relays in the plate circuits of the 2050's operate the phasing motor.

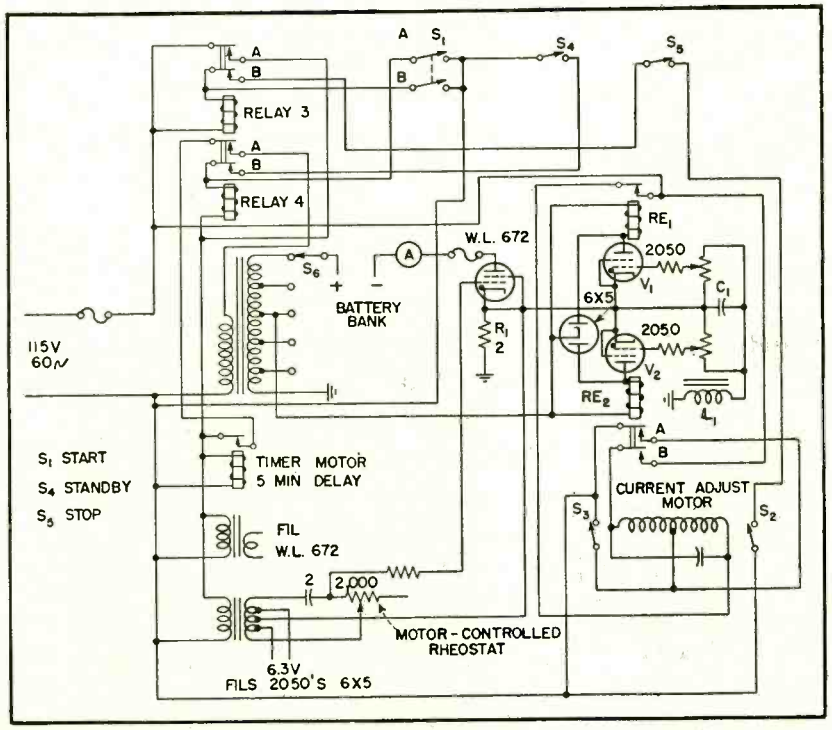

FIG. 1—Battery charger uses motor-driven rheostat to control current

When the charging current is too small, both relays are closed, the motor is energized and turns the phasing control rheostat to increase current. The grid voltage of V_2 is adjusted to extinguish the tube when the charging current is between 1.9 and 2 amp. When only RE_1 is energized, the motor is disconnected from the line voltage. As the charging current increases due to changes in battery voltage, V_1 extinguishes opening RE_1. This closes the motor circuit and the phasing control is turned to decrease current.

The wattage rating of R_1 must be high. When current flows for 90 degrees the power in R_1 is 39.5 watts.

When S_1 is pressed, RE_3 and RE_4 close. Relay RE_3 applies line voltage through one set of contacts and holds through the other. Relay RE_4 applies 115 volts to the primary of the plate transformer through the timer switch and holds. The five-minute timer, which starts when relay RE_3 closes, delays application of plate voltage to the W.L. 672 until the cathode attains operating temperature. When the timer switch closes, full plate voltage is applied to the thyratrons and RE_1 and RE_2 close with the motor in minimum charging current position.

The motor turns, increasing current to between 1.9 and 2 amperes. The system maintains 2 amp within 1/10 amp. To improve the sensitivity of the thyratron relay, a diode is connected across it. The diode reduces the cemf of the relay coil as thyratron plate current is decreasing. For increasing plate current, the diode is nonconducting.

As the battery voltage rises and the drop across the internal resistance decreases, the W. L. 672 conducts longer over the half cycle to maintain 2-ampere average current and the phasing rheostat decreases toward zero. Limit switch S_2 is placed so that the motor will close it when the batteries are fully charged. This switch, in series with the holding contacts of RE_3, releases the relay and removes the

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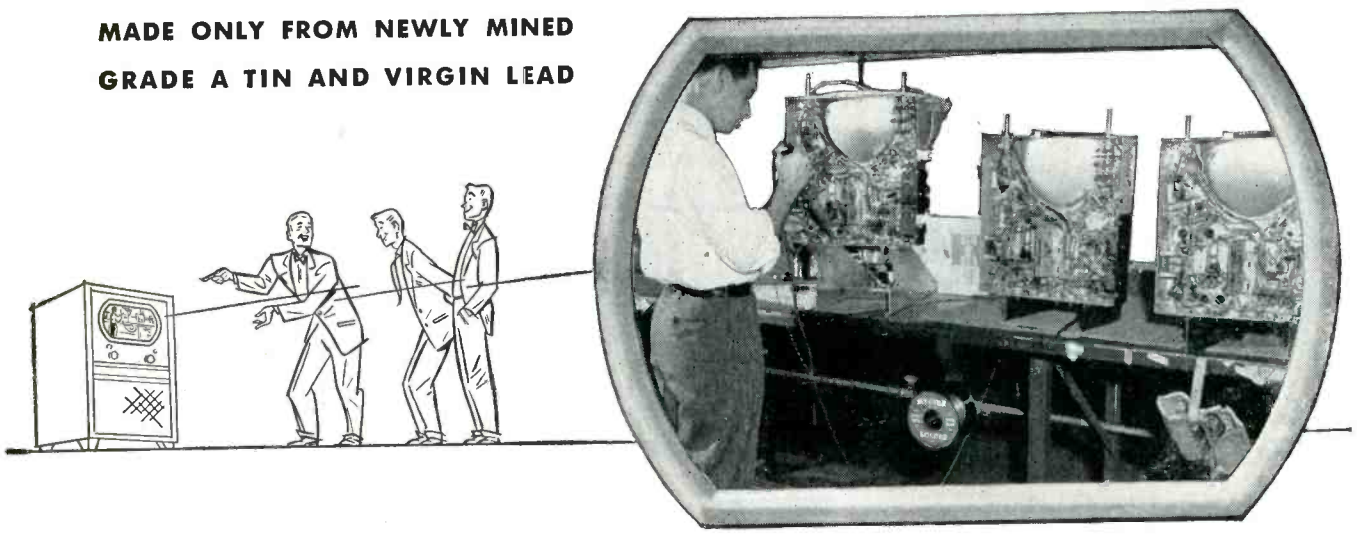

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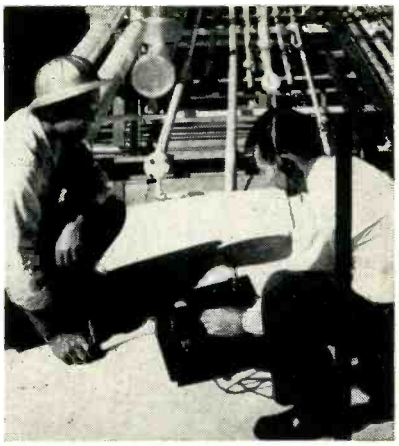
line voltage, opening all relays. With RE_1 and RE_2 open, the motor reverses and runs to the end of its travel closing limit switch S_3. Relay RE_3 has an extra set of contacts to short out S_3 and the motor runs when the charger is again turned on.

Standby button S_4 provides for stopping the charging without having to wait for the five-minute timer before resuming operation. This button breaks the holding contact for RE_4. Switch S_1 has a second make contact to reclose RE_4 to continue charging. Switch S_5 is provided to shut off the charger before the end of the cycle. This switch breaks the holding contact of RE_3, acting in the same manner as S_2.

To charge any desired combination of the five groups of batteries, the secondary of the plate transformer is tapped and tap-switch S_6 provided. The primary is also tapped. The transformer must be able to deliver 15 amperes with good regulation and transient response to accommodate high peak currents.

THE FRONT COVER



METAL loss due to corrosion or erosion in tanks, pipes, pressure vessels and other process equipment is determined by the Audigage. It replaces older methods of inspection, such as drilling a hole, calipering the wall thickness and rewelding.

The instrument, manufactured by Branson Instruments of Stamford, Conn., uses an X-cut quartz crystal to generate ultrasonic waves from 0.65 to 2.0 mc. The oscillator that drives the crystal is frequency-modulated over a small increment at an audio-frequency rate. When a thickness resonance is located within the modulated-frequency range, an audible indication is provided in headphones. Full details of the technique appeared in ELECTRONICS for January, 1948, page 88.

Semiautomatic Darkroom Timer

BY MARLOWE W. IVERSON
Pako Corporation
Minneapolis, Minn.

THE TIMER to be described and its associated enlarging machine were designed for use by photographic processing concerns. The majority of these desired one enlarging machine that could handle negative sizes from half 35 mm to 116 and magnifications from 1.3 to 5.0, so that the one machine could handle all of the oversize printing. A push-button timer embodies automatic correction for exposure time variation with negative magnification.

The circuit of the timer is shown in Fig. 1. A time key is depressed corresponding to the relative time of exposure desired by the operator. The selected time key sets the value of bias resistance in the cathode circuit of the 2050 thyratron. The initiating bar is then depressed, initiating relay K_1, which in turn actuates the clutch solenoid.

The clutch and its associated mechanism then lowers the neghood and platen, energizes relay K_2, and closes the print switch, which turns on the power circuit to the 1,000-watt printing lamp. Relay K_2 then removes the short across the charging capacitor, C_4, and connects the open end of the coil of relay K_3 to the plate of the 2050.

Upon the removal of the short across the charging capacitor, C_4, it is charged through the charging resistance R_4. This resistance is a potentiometer, mechanically coupled to the paper carriage so that its resistance varies with the negative magnification in such a manner as to produce a time response which is a linear function of the magnification.

When the voltage across C_4 rises to the point where its algebraic addition with the voltage across the

(Continued on p 144)

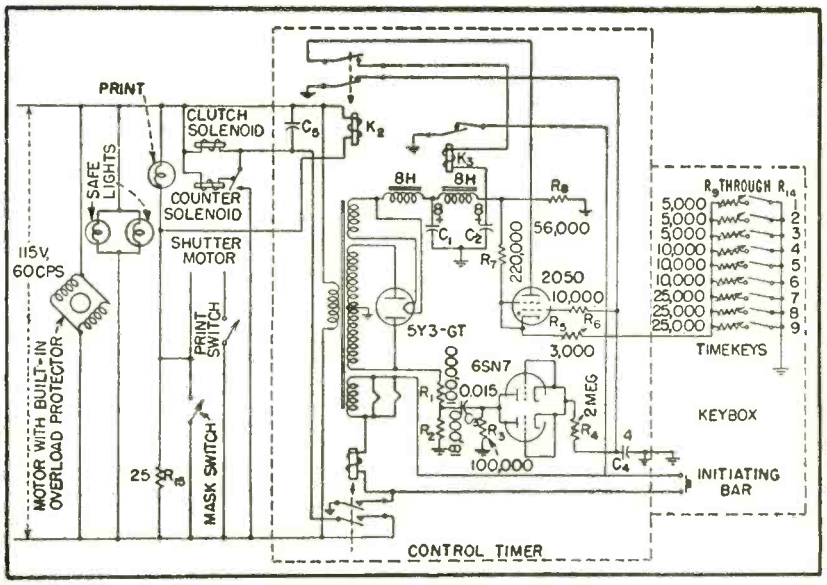


FIG. 1—Complete circuit of the automatic timer

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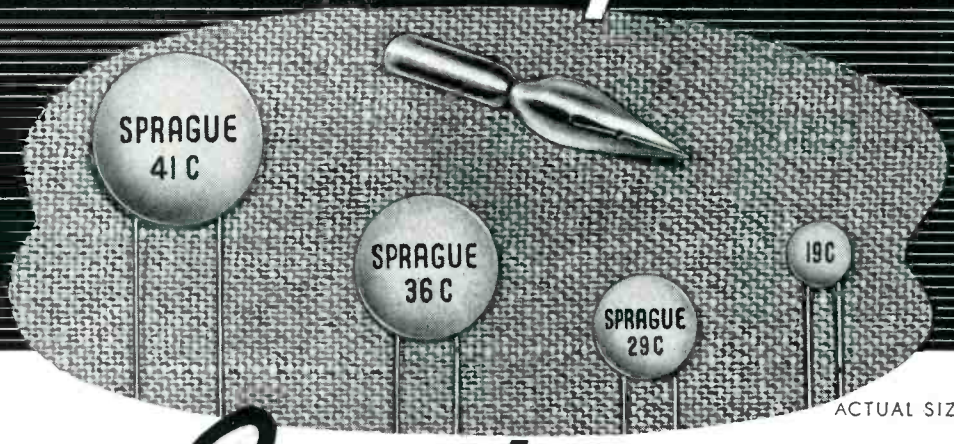

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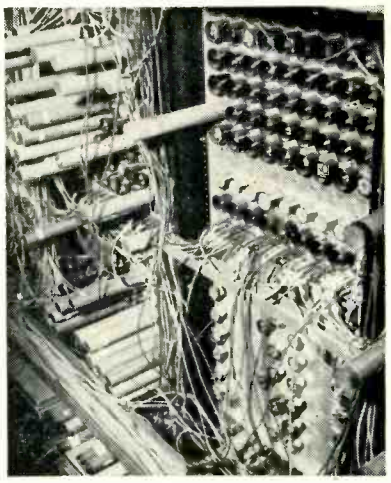
Edited by JAMES D. FAHNESTOCK



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SEAC—General-Purpose, Superspeed Computer

SEAC, the National Bureau of Standards Eastern Automatic Computer, is the first automatically-sequenced superspeed computer to be put into useful operation and is the fastest computer in operation.

SEAC's high speed permits the use of many simple steps that can be combined into a complex sequence for the solution of difficult problems. This makes possible the solution of mathematical, computational and statistical problems which would otherwise be impossible to solve in any reasonable period or prohibitive in cost if attempted by conventional methods.

SEAC performs seven basic operations: addition, subtraction, multiplication, division, comparison, logical transfer and input-output control. The comparison and logical transfer operations give the computer a degree of initiative and judgment. SEAC can modify its instruction, detect its own errors, determine when it has computed results to predetermined accuracy and refrain from printing incorrect answers.

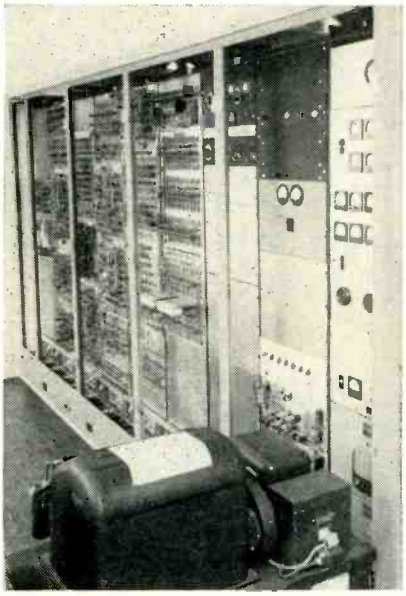
The computer can add or subtract sets of eleven-digit numbers at the rate of 1,100 times per second. It multiplies and divides such numbers at the rate of 330 times per second. Instructions and numbers are sent in code at the rate of 1,000,000 pulses per second.

In any computer, the capacity and speed of its memory determine the limits of difficulty for the problems it can solve. The memory has a storage capacity of 512 words, achieved by use of 64 acoustic delay lines. A word is a sequence of 45 binary digits. The average time required for SEAC to refer to a word is 168 μsec.

Conversion from the decimal system to the binary system is done automatically by the machine. The presence of a pulse is used to represent 1, while the absence of a pulse indicates 0.

Physical Description

The computer has four main sections: an input-output unit, a memory unit, a control unit, and an arithmetic unit. The input-output section receives instructions and prints the answers. The memory unit stores instructions and numbers, and the control unit directs the flow of information within the machine. The arithmetic unit performs the actual computations as directed by the control unit. When the arithmetic unit has arrived at a solution to a problem, the control unit orders the memory unit to send the answer to the output where it is printed out. The present input-output unit employs a manual keyboard and teleprinter for direct input.



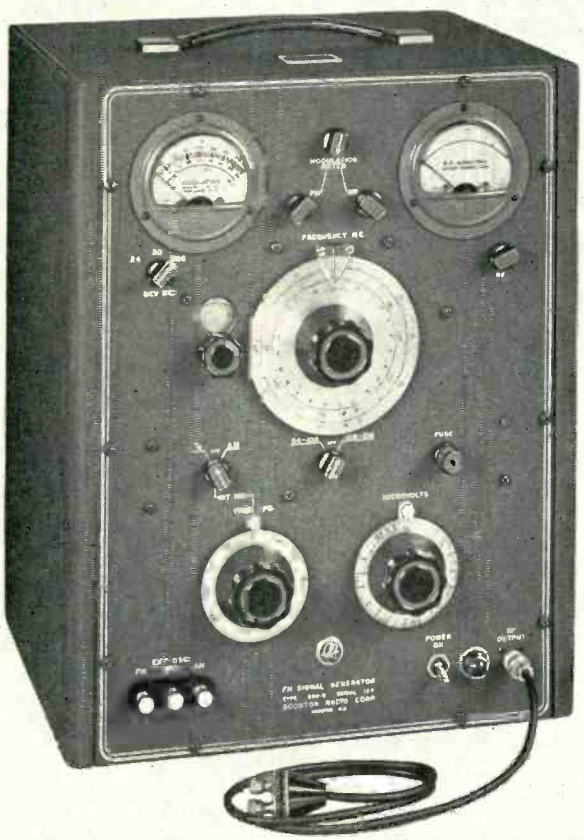
SEAC's teleprinter keyboard and printer are used for direct input and output of numbers and instructions. Punched tape permits indirect operation

Indirect operation is accomplished by use of punched tape. However, SEAC's design provides for later replacement of the teleprinter system by a faster magnetic wire system.

SEAC is housed in two consoles. One contains the acoustic memory, and the other contains the rest of the computer (including an additional memory, for future use, which consists of cathode-ray tubes). The memory cabinet is 60 inches wide, 31 inches deep and 84 inches high. The computer proper is shown in the photograph of the operator's position.

The principal components of the memory are the acoustic delay lines and associated electronic equipment. Each delay line has a capacity of 8 words. A word is stored as a series of sound waves travelling in a column of mercury. The waves are generated by a quartz crystal at one end of the tube and received by a

Laboratory Instruments for TELEVISION



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- **R. F. INCREMENT DIAL: ± 250 kc. in 10 kc. increments.**
- **R. F. OUTPUT: 0.1 microvolt to 0.1 volt, ± 1 db. Also approximately 2 volts maximum (uncalibrated).**
- **OUTPUT IMPEDANCE: Approximately 60 ohms at 0.1 volt jack, 470 ohms at 2 volt pin jack.**

BOONTON RADIO Corporation
BOONTON · N.J. · U.S.A.

DESIGNERS AND MANUFACTURERS OF THE Q METER · QX CHECKER FREQUENCY MODULATED SIGNAL GENERATOR · BEAT FREQUENCY GENERATOR AND OTHER DIRECT READING INSTRUMENTS

similar crystal at the other. A special amplifier then transforms the sound energy into a pulse sequence, which is returned to the first crystal at its original strength. Thus a word is recirculated until called for by the control unit.

The memory unit contains 380 tubes used largely for reshaping and amplifying the pulses in the delay lines and for energizing the switches in the system. There are 3,500 germanium-diode switches.

The principal elements in the remainder of the computer are 9,300 germanium diodes and 495 tubes. In SEAC, the number of tubes is relatively small, a total of 875, in contrast to the 18,000 tubes in ENIAC. This reduces the number of tube failures.

The tubes in SEAC are used only for amplification of the signals and as sources of energy, not as part of the computing components proper. The use of 12,800 germanium diodes in the equipment has reduced the number of tubes used in contrast to previous computers. Standardized tube-and-transformer combinations simplify maintenance. The transformer method provides high-frequency coupling with a minimum of crosstalk between circuits.

Optimum Dimensions for Parasitic Arrays

By Larry S. Cole and William L. Jones
Utah State Agricultural College
Logan, Utah

At the present time theoretical results for calculating the performance of parasitic arrays having three or more elements are not available. This led to setting up an experimental unit* which could be used either as a two-element or a three-element array to determine the effects of spacing and tuning on forward gain and input impedance. Figure 1 shows the arrangement of equipment used.

Verification of experimental techniques was accomplished by measuring gain and impedance versus spacing for two-element arrays. The results compare favorably with theoretical results obtained by Brown[1].

For the three-element array each parasitic element was tuned, in turn, for maximum gain at each spacing combination. Results are shown in Fig. 2. In all cases the driven element was fixed at its self-resonant length and maintained at constant power input.

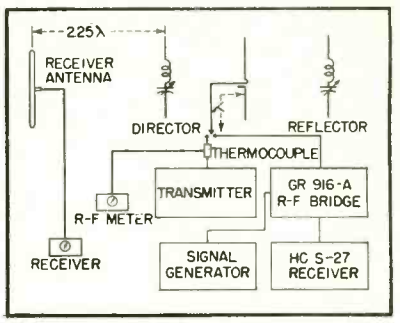


FIG. 1—Block diagram of equipment used in optimizing dimensions for maximum gain of parasitic arrays

Data on array input resistance R_a and array input reactance X_a are included in Fig. 2A and 2B respectively. These data are useful in obtaining the relative input impedance only, since the impedance of any other array would depend chiefly upon its height above ground.

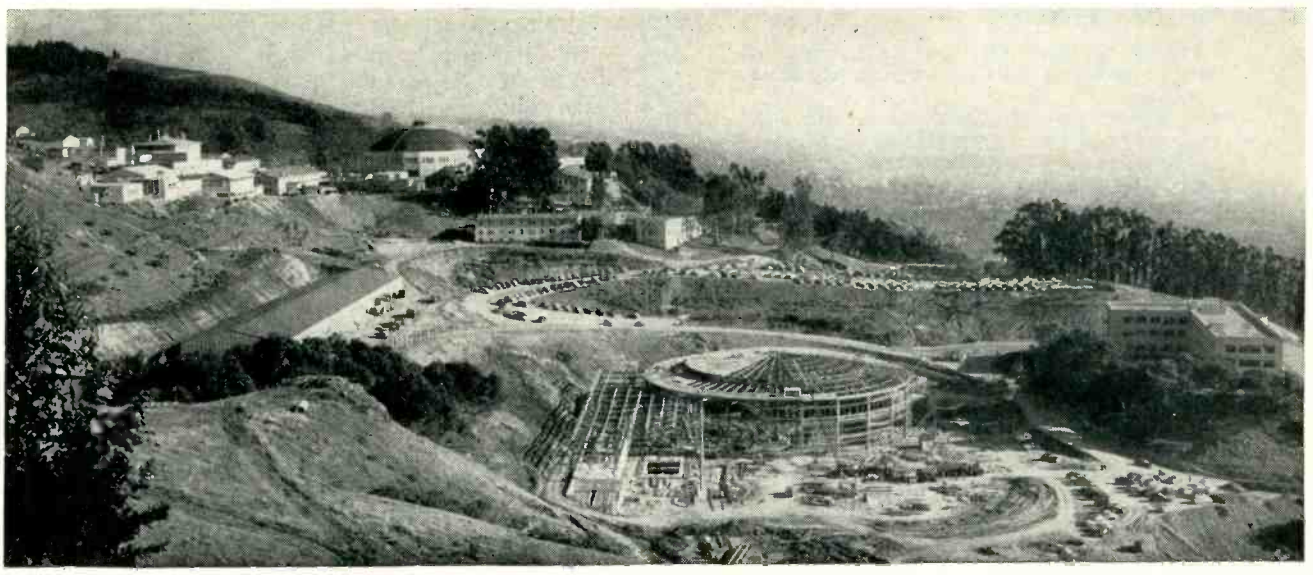
Corrected Curves

The curves of Fig. 2C are slightly in error because of attenuation in the coaxial line to the array. Therefore the maximum points of the curves of Fig 2C were corrected for known errors and presented in Fig. 2D. Thus Fig. 2D summarizes the

(Continued on p 184)

*This work was done in part under Project No. 11, Engineering Experiment Station, Utah State Agricultural College, Logan, Utah.

BEVATRON BUILDING TAKES FORM AT UNIVERSITY OF CALIFORNIA



Expected to be completed early in 1953, the University of California Bevatron Building is shown here under construction. Steel fabrication is being handled by Consolidated Western Steel Corp., a U. S. Steel subsidiary. Visible at left is U. C. Cyclotron Building. When completed, bevatron is expected to accelerate protons to 6 billion electron volts

Photographed with the Du Mont Type 314A Oscillograph Recording Camera

PHOTOGRAPHY measures the "DEAD-TIME" of a G-M TUBE

How long does it take a Geiger-Mueller tube to recover full sensitivity after a pulse? That's its time-resolution, and you may need to know it with considerable accuracy.

If you've formed the habit of teaming the camera with the oscillograph, you know how to handle this measurement—or many others that may be closer to your interests. For records you can examine over and over again of action occurring in very short time—circuit behavior, or any kind of phenomena translatable into electronic signals—there's nothing to match photography.

Recording cameras are available at reasonable cost. The Kodak Linagraph Pan Film they use is stocked by your Kodak Industrial Dealer. (Also Kodak Linagraph Ortho Film for depressed sensitivity to red light.) Eastman Kodak Company, Industrial Photographic Division, Rochester 4, N. Y.

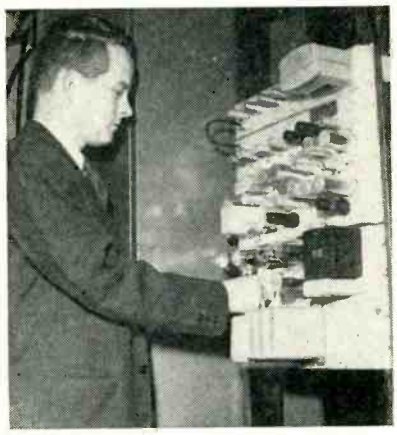
PHOTORECORDING

...an important function of photography

Kodak
TRADE-MARK

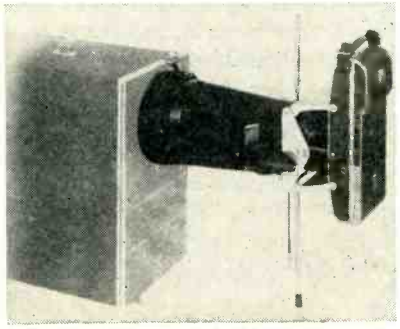
NEW PRODUCTS

Edited by WILLIAM P. O'BRIEN



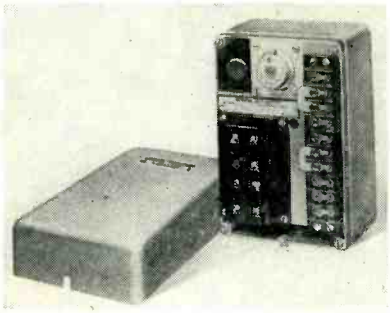
TV Visual Demodulator

GENERAL ELECTRIC CO., Syracuse, N. Y. Type TV-21 television visual demodulator allows the transmitter operator to measure accurately the transmitted signal. The new unit feeds both picture and waveform monitors simultaneously and is easily installed in a standard equipment rack. It is crystal controlled, eliminating the need for tuning, and is practically impervious to stray r-f fields. Besides its primary use as a transmitter monitor it can be used as a double sideband detector or a transient demodulator.



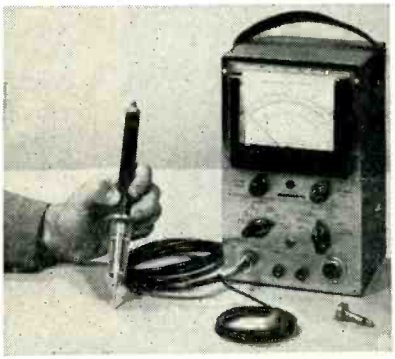
Oscillograph Camera

FAIRCHILD CAMERA AND INSTRUMENT CORP., Jamaica, N. Y. The F-284 Polaroid oscilloscope camera was designed for photographing the screen of any standard 5-in. c-r scope and producing a print for engineering study within one minute without the need for darkroom processing. Writing speeds up to 1 in. per μsec have been recorded with an accelerating potential of 3,000 volts. Print size is $3\frac{1}{4} \times 4\frac{1}{4}$ in. with the two recorded images reduced by a ratio of only 2 to 1 from the original trace.



Electronic Timer

GENERAL ELECTRIC CO., Schenectady 5, N. Y., has announced a new compact electronic timer which provides automatic control of operation, limit and sequence timing for industrial processes. It is available in three time ranges: 0.06 to 1.2 sec, 0.6 to 12 sec, and 6 to 120 sec. Controlled load requirements are: inrush—15 amperes, carry—10 amperes, and break—5 amperes.



H-V TV Test Probe

INSULINE CORP. OF AMERICA, 3602 35th Ave., Long Island City 1, N. Y. The 100X Kilovolter is a new heavy-duty probe that multiplies the existing ranges of any standard 10- or 11-megohm vtvm by a factor of one hundred. Measuring $8\frac{1}{2}$ in. long and fitted with a clear Lucite nose piece and red barrier insulator, the probe is designed especially for testing h-v circuits in tv receivers. It is furnished with a 5-ft coax cord and a separate grounding lead. The cord terminates in a standard single-contact microphone connection. An adapter plug is also available for using the connector with v-t meters having phone jacks instead of microphone fittings.

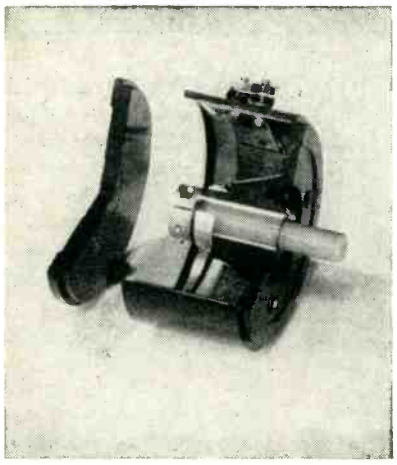
Specialized Tube Tester

MULTI-PRODUCTS CO., 559 E. Ten Mile Rd., Hazel Park, Michigan. The portable tube tester illustrated is designed for servicing controls employing a limited number and specific type of tubes as specified by the manufacturers of various types of electronic control equipment. The unit, which checks tube condition and internal shorts, measures only 4 in. × 6 in. × 8 in. and weighs only 6 pounds. It is fuse protected, operating on 115 volts 60 cycles.

C-R Oscilloscope

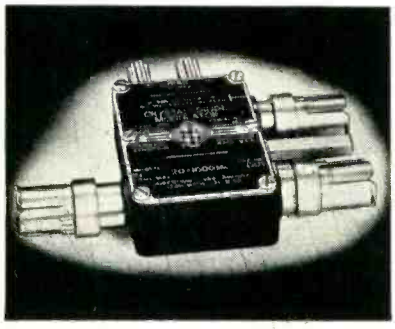
SYLVANIA ELECTRIC PRODUCTS INC., 1740 Broadway, New York 19, N. Y. Type 400 high-gain, wide-band c-r oscilloscope, designed particularly for tv circuit, laboratory and industrial applications, provides a vertical sensitivity of 10 mv per in. and a vertical response which is useful up to 4 mc. It also features an internal 60-cycle sine wave sweep

which eliminates one set of leads during tv alignment operations. The oscilloscope provides linear sweeps ranging from 10 cycles to 50 kc; and 5 megohm, 26-μμf input impedance for negligible circuit loading which is suitable for any crystal, direct or special probe or with supplied lead.



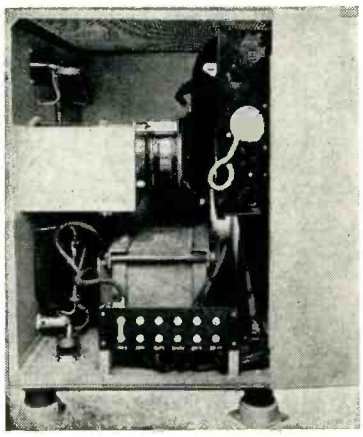
Precision Potentiometers

TECHNOLOGY INSTRUMENT CORP., 1058 Main St., Waltham 54, Mass. Types RV3-8 (8 watts) and RV3-12 (12 watts) are improved precision potentiometers. Their new features include: (1) bronze bushings for the rotor shaft; (2) tapped mounting inserts; (3) rotor take-off slip ring constructed of silver-overlaid brass and mounted concentric to the shaft; (4) molded parts of low-loss mica-filled Bakelite to withstand high humidity and electrolysis.



Diode Modulator

GENERAL RADIO CO., 275 Massachusetts Ave., Cambridge 39, Mass. Type 1000-P6 crystal diode modulator converts an oscillator, standard-signal generator or other r-f source into a test-signal generator for tv receiver testing. Range of modulating frequencies is 0 to 5 mc and carrier-frequency range is 20 to 1,000 mc, covering the proposed new uhf tv bands, as well as at currently used frequencies. Impedance is 50 ohms for r-f circuits, and coaxial 50-ohm attenuators and other accessories are available.

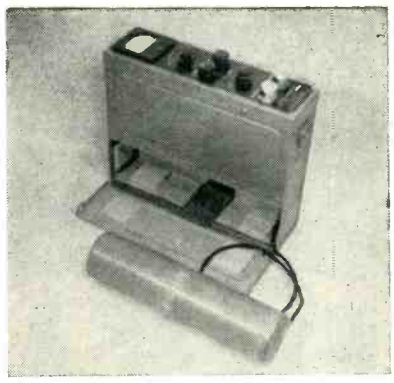


TV Power Control Unit

RADIO CORP. OF AMERICA, Camden, N. J. Illustrated above is the power control unit for mobile tv pickup equipment. It provides power consumption readings and permits regulation of both input and output voltages from a central point in the mobile unit, and can operate from any two-wire system providing input voltages between 100 and 120 volts, or 200 and 220 volts, 60 cycles at 5 kva. The unit is shock-mounted and designed for mounting in the television truck.

Industrial Power Amplifier

RADIO CORP OF AMERICA, Camden, N. J. Type MI-12188 two-stage bridging power amplifier features inverse feedback control and a voltage-regulated power supply. Frequency response is from 30 to 15,000 cycles with low distortion. The unit will supply 70 watts to any one of several load impedances when bridged across a line of 3.3 volts rms maximum. It operates from a 105 to 125-volt, 50 to 60-cycle power supply. Normal power consumption is 240 watts.



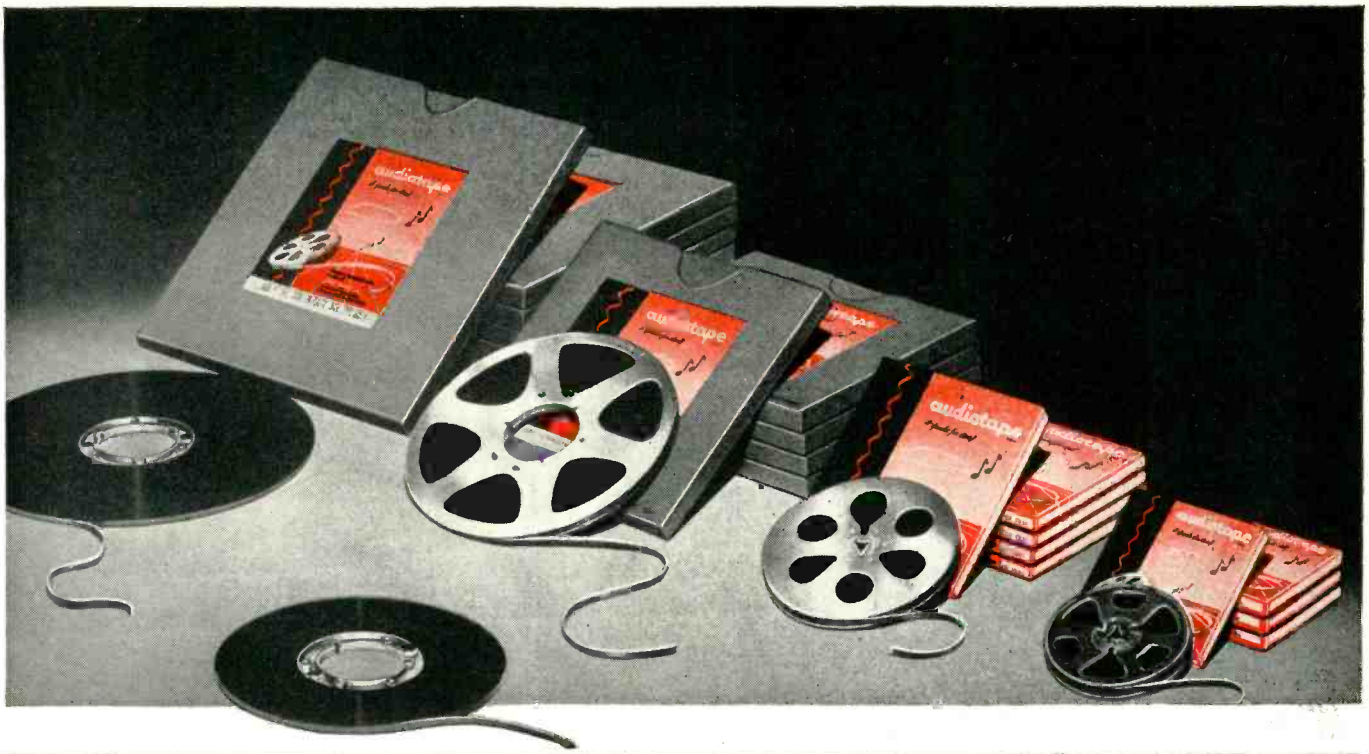
Gamma-Ray Detector

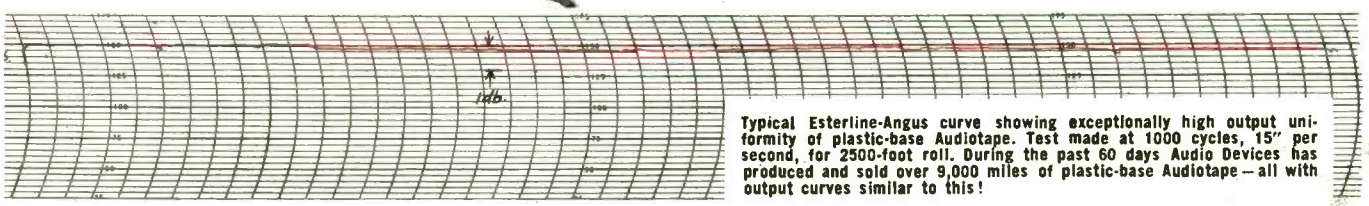
HALROSS INSTRUMENTS CORP., LTD., 171 Garry St., Winnipeg, Canada. Model 939 Scintillometer employs the scintillation principle and provides a detection sensitivity over 100 times that obtained by conventional portable Geiger counters. It employs only high-vacuum tubes in conservatively designed circuits and will operate continuously between −20 and +110 F, with a relative humidity of 95 percent. A probe in the lower section of the case can be removed for lab research purposes.

VTVM

GENERAL RADIO CO., 275 Massachusetts Ave., Cambridge 39, Mass. Type 1803-A vacuum-tube voltmeter meets most a-c voltage measurement requirements of the electronics laboratory. Voltage range is from 0.1 to 150 v, covered

(Continued on page 212)





Typical Esterline-Angus curve showing exceptionally high output uniformity of plastic-base Audiotape. Test made at 1000 cycles, 15" per second, for 2500-foot roll. During the past 60 days Audio Devices has produced and sold over 9,000 miles of plastic-base Audiotape—all with output curves similar to this!

UNIFORMITY PLUS

that's what you get in every reel of

audiotape*

Unequalled uniformity of output volume is one of the outstanding advantages of Audiotape. This is especially important in professional work where shows are edited and assembled on tape. For even slight variations in output can become very objectionable when splicing brings high and low volume sections together.

Every 2500-foot reel of plastic-base Audiotape is *guaranteed* to have a volume deviation, at 1000 cps, of not more than ± ¼ db within the entire length — and not more than ± ½ db from reel to reel. And these are *outside limits*, not averages. What's more, every 2500-foot reel is guaranteed to be entirely *free from splices!*

This extremely high uniformity is made possible by Audio's specially designed coating machines, which permit control of coating thickness to within *five millionths* of an inch. During the past 60 days, these machines have turned out more than *9,000 miles* of plastic-base tape—with a volume deviation of not more than ± ½ db!

Remember—when you use Audiotape, you can be *sure* of the results every time. For every foot of Audiotape is monitored for output, distortion and uniformity—your assurance of the finest, professional quality recording tape obtainable.

*Trade Mark

- **STRAIGHT-LINE SLITTING** that makes tape track and wind absolutely flat.
- **FREEDOM FROM CURL** that permits tape to maintain perfect contact with heads.
- **SMOOTH UNWINDING,** with no tendency to stick layer-to-layer.
- **NO FRICTION SQUEAL.** Smooth surface rides quietly over pressure blocks and tensioning devices.
- **LOW COST.** 2500-foot roll on NAB hub has list price of $10—subject to Audio's usual discounts to professional users.
- **IMPROVED PACKAGING.** 2500 and 5000 foot rolls of Audiotape, on hub or complete reel, are boxed in special containers for easier and safer handling and storage. Folding inner section permits loading onto turntable without danger of spilling tape—also permits easy attachment of reel flanges on hub.

TEST IT—COMPARE IT

We will be glad to send you a free 200-foot sample reel of either plastic-base or paper-base Audiotape. It will speak for itself.

AUDIO DEVICES, INC.

444 MADISON AVE., NEW YORK 22, N. Y.

Export Dept.: ROCKE INTERNATIONAL, 13 East 40th St., New York 16, N. Y.

NEWS OF THE INDUSTRY

Edited by WILLIAM P. O'BRIEN

FCC Authorizes Complete Transcontinental Link

COMPLETION of the American Telephone and Telegraph Company's proposed transcontinental microwave relay system was authorized in grants made recently by the Federal Communications Commission.

Chief among these are construction permits for 55 microwave relay stations to bridge the present gap between Omaha and San Francisco. This final link is scheduled to be completed by Jan. 1, 1952. It will provide four microwave channels, two of which will be used for television circuits, one in each direction. The other two channels will carry telephone traffic.

Construction of the New York-Chicago portion of the cross-country microwave route is virtually completed and is expected to be available for intercity tv network service in the near future. The Chicago-Omaha section, under construction, is planned to be ready for operation by April of 1951. As in the case of the coaxial cable, microwave relay can be used to augment tv network broadcast operation. The two facilities can be interconnected.

The estimated construction costs involved in the microwave relay grants total $20,400,000, of which amount $17,900,000 is for the Omaha-San Francisco link and $2,500,000 for additional equipment in the Chicago-Omaha section. This will bring the indicated cost of the completed transcontinental microwave system to $37,590,000.

NEC Technical Program

THIS YEAR'S National Electronics Conference will be held at the Edgewater Beach Hotel, Chicago, Ill., on September 25, 26 and 27. The advance technical program is as follows:

Mon. Sept. 25

10:00 A.M.

MICROWAVES AND ANTENNAS

Corrugated End-Fire Antennas, by D. K. Reynolds and W. S. Lucke of Stanford Research Institute.

New Techniques in Microwave Spectroscopy, by W. E. Good of Westinghouse Research Laboratories.

Properties of Longitudinal Slots in Circular Waveguides, by G. E. Feiker and S. C. Clark, Jr., of General Electric Co.

MAGNETIC AMPLIFIERS

Magnetic Amplifier Voltage Regulator, by J. L. Wolff of Westinghouse Electric Corp.

Noise Figure of the Magnetic Amplifier, by N. R. Castellini of Signal Corps Engineering Laboratories.

Magnetic Amplifiers with Orthonol Tape Cores, by W. A. Geyger of Naval Ordnance Laboratory.

DIELECTRIC HEATING

Dielectric Load Tuning in R-F Heating, by R. H. Hagopian of Westinghouse Electric Corp.

Measuring Dielectric Properties During H-F Heating, by E. Mittelman of Chicago, Ill.

2:00 P.M.

TIME-POSITION MEASUREMENT

The Electronic Umpire, by R. F. Shea of General Electric Co.

Thyratrons as Close-Differential Relays, by J. J. Baruch of MIT.

Electromechanical Pulse Delay Unit, by J. F. Gordon of Bendix Radio Co.

CIRCUITS

Miniaturizing Pentode Amplifiers by Positive Feedback, by W. B. Anspacher of Naval Ordnance Laboratory.

Using Conductance Curves in Electronic Circuit Design, by K. A. Pullen of Aberdeen Proving Ground, Md.

Analysis of Twin-T Filters, by L. G. Gitzendanner of General Electric Corp.

Cascading Cathode-Followers to Provide High Impedance Transformation Ratios, by S. E. Smith and W. J. Kessler of U. of Florida.

TUBE TECHNOLOGY

Electrolytic Tank Studies in Designing High-Vacuum Tubes, by J. E. Jacobs of General Electric X-Ray Corp.

A Beam-Type Tank That Multiplies, by A. Somerville of Northwestern U.

Low-Noise Miniature Pentode for Audio Amplifier Service, by R. A. Wissolick and D. P. Heacock of RCA Victor.

Glass Selection and Production Techniques for X-Ray and Other Tubes, by J. B. Gosling of General Electric Co., and M. J. Zunick of General Electric X-Ray Corp.

Tues. Sept. 26

10:00 A.M.

TELEVISION

Television in Industrial Applications, by J. A. Good of Diamond Power Specialty Corp.

Stereo Television in Remote Control, by H. R. Johnson, C. A. Hermanson and H. L. Hull of Argonne National Laboratory.

The Genlock—A new Tool for Better Programming in TV, by J. H. Roe of RCA Victor.

INSPECTION AND CONTROL

Reliable Electronic Equipment—A Progress Report, by G. B. Devey of the Office of Naval Research.

Detection of Tramp Metal, by C. W. Clapp of General Electric Co.

Production Testing Techniques for Metallized Paper Condensers in a Telephone Network, by A. L. Bennett of Western Electric Co. and G. M. L. Sommerman of Northwestern U.

Selecting Critical Components for Matched Channel Radio Receiving Systems, by H. D. Webb of U. of Illinois.

EXPLORATION AND NAVIGATION

Recent Lorac Developments, by J. E. Hawkins of Seismograph Service Corp.

Flight Path Control, by D. L. Markusen of Minneapolis Honeywell Regulator Co.

Radio Interference Blanking Ahead of Receivers, by M. M. Newman, J. R. Stahmann and E. Svendson of Lightning and Transients Research Institute.

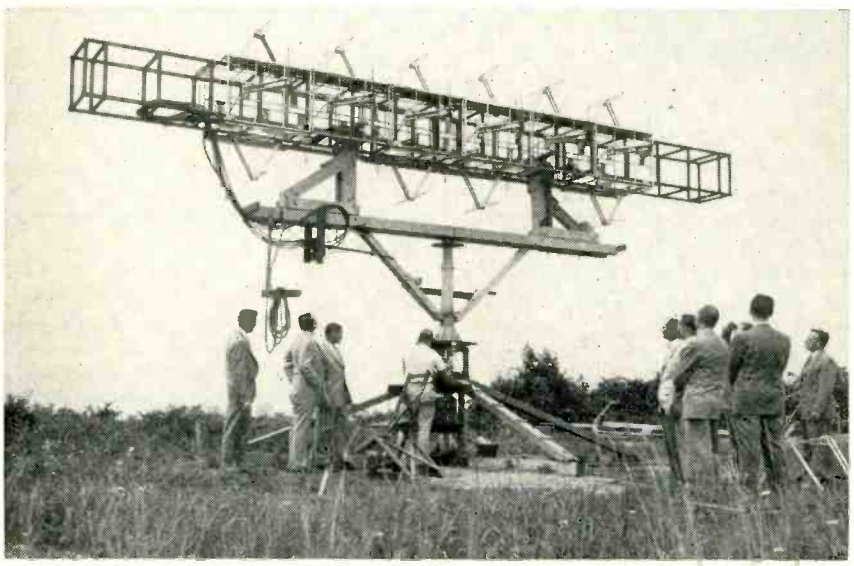
2:00 P.M.

RESEARCH INSTRUMENTATION

The Electron Optical System of a Permanent Magnet Electron Microscope, by J. H. Reisner of RCA Victor.

Electronic Scanning Techniques for Low

RCA BEGINS TESTS ON NEW EMPIRE STATE ANTENNA

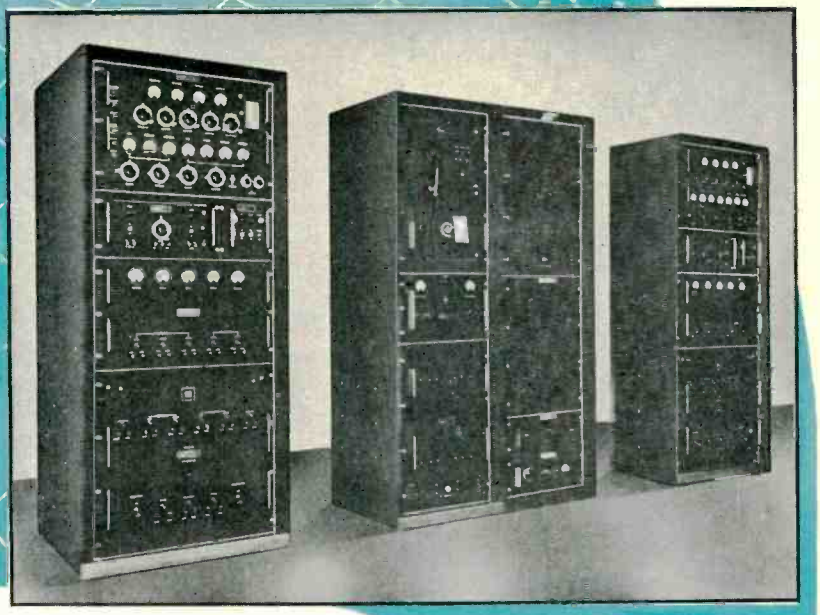


New television antenna, one of five designed for multiple video and f-m antenna system on the Empire State Building, is shown on revolving turret during recent tests by RCA engineers at a site near Camden, N. J. L. J. Wolf, of RCA, extreme left; Frank J. Kear, consulting engineer of Kear and Kennedy, and C. W. Lyon, Jr., executive vice-president of Empire State, Inc., look on while R. S. Grimm, RCA engineer, monitors the test equipment. Group of interested onlookers at right includes: H. E. Gihring and David Bain, both of RCA, and Thomas Howard, chief engineer of tv station WPIX, New York

Lavoie VHF

omni-directional

RADIO RANGE SYSTEM



The Very High Frequency Omnidirectional Radio Range System, more simply known as VHF Omni Range (or VOR), has been standardized by international agreement as the most desirable method of short range aircraft navigation. A multiplicity of courses, theoretically infinite, is provided instead of the usual four courses obtained from the conventional Aural A-N system. The advantages of this are immediately apparent. Tangential courses are practical, as well as the conventional 'head-on' approach. By means of 'fixes' on two Omni stations, absolute position may quickly be determined, and by presetting the aircraft receiver, a pilot may maintain any angle of approach.

This Omnidirectional Radio Range System was DEVELOPED-DESIGNED-PRODUCED by LAVOIE LABORATORIES, Inc. We have both the experience and the facilities for the precise mass production of ELECTRONIC SYSTEMS at low unit cost.

If you will address us on your letterhead we shall be glad to send you a detailed description of the LAVOIE Omnidirectional Radio Range System.

UHF

Lavoie Laboratories, Inc.

RADIO ENGINEERS AND MANUFACTURERS

MORGANVILLE, N. J.

Specialists in the Development and Manufacture of UHF Equipment

Level Circuits, by B. R. Shepard of General Electric Co.

The Point-Contact Photoconductance Cell, by G. D. O'Neill of Sylvania Electric Products Co.

A Multipurpose D-C Amplifier with Reduced Zero Offset, by W. McAdam, R. E. Tarpley, and A. J. Williams, Jr. of Leeds and Northrup.

COMPUTERS

The Study of Oscillator Circuits by Analog Computer Methods, by H. Chang, R. C. Lathrop and V. C. Rideout of U. of Wisconsin.

Rosette Principal Strain Computer, by C. M. Hathaway and R. C. Eddy of Hathaway Instrument Co.

A Versatile Small Scale Analog Computer, by J. T. Carleton of Westinghouse Electric Corp.

An Electrical Analog for Indeterminant Mechanical Structures, by J. P. Corbett and J. F. Calvert of Northwestern U.

ELECTROACOUSTICS

Function of A-C Bias in Magnetic Recording, by R. E. Zenner of Armour Research Foundation.

Recent Design Developments on Electronic Organ Tone Generators, by S. L. Krauss and C. Tennes of C. G. Conn, Ltd.

Design of Loudspeaker Enclosures, by L. L. Beranek of MIT.

Wed. Sept. 27

10:00 A.M.

OSCILLOGRAPHY

Progress Report on Millimicrosecond Oscillography, by Y. P. Yu, H. E. Kallman and P. S. Christaldi of Allen B. DuMont Labs, Inc.

A Six Channel Cathode-Ray Recording Oscillograph, by W. D. Tilton, Jr. of Hathaway Instrument Co.

A Portable Projection Oscilloscope, by V. Wouk of Beta Electric Corp.

A Cathode-Ray Oscillograph for Impulse Testing, by W. G. Fockler of Allen B. DuMont Labs, Inc.

CONTROL INSTRUMENTATION

Non-linear Techniques for Improving Servo Performance, by D. McDonald of Cook Research Laboratories.

Electronic Control for Heating Systems, by J. M. Wilson of Minneapolis-Honeywell Regulator Co.

Automatic Control of Inaccessible Terminal Voltages, by R. Cosgriff and E. H. Gamble of Curtiss Wright Corp.

NUCLEONICS

Electronic Aspects of Radiation Instruments, by E. E. Goodale and R. M. Lichtenstein of General Electric Co.

Corona Voltage Regulator Tubes for Nucleonics, by D. L. Collins of Victoreen Instrument Co.

Electronics in Particle Accelerators, by T. M. Dickinson and T. W. Dietze of General Electric Co.

2:00 P.M.

INDUSTRIAL CONTROL

Industrial Electronic Control Design Practices, by E. H. Vedder of Westinghouse Electric Corp.

Electronics in Electric Power Central Stations, by A. J. Ward of Sargent and Lundy.

An Indirect Method of Process Control by R. G. Durnal of Westinghouse Electric Corp.

SIGNAL GENERATORS AND ANALYZERS

A 20 Mc to 1,000 Mc Sweep Oscillator, by J. E. Ebert and H. A. Finke of Polytechnic Research and Development Co.

A Miniature Crystal Controlled S-Band Signal Generator, by W. F. Marshall of Bendix Radio.

A High Resolution Spectrum Analyzer, by T. Miller and D. S. Sims of Westinghouse Research Laboratories.

NUCLEONICS

Radioactive Snow Gage with Telemetering Systems, by J. A. Doremus of Motorola Inc.

Design Characteristics of Air Proportional Counters, by A. C. Scheckler of General Electric Co.

An Investigation of a Scintillation Counter Using Anthracene Crystals, by B. Ross of Radiation Counter Labs., Inc.

Hermetically Sealed High Pressure Ion Chambers, by J. G. Haines of General Electric Co.

MEETINGS

MAY 15-SEPT. 27: Silver Anniversary of the Chicago Section of IRE (Sponsored by the IRE and NEC), Chicago, Ill.

AUG. 27-31: NEDA National Convention and Exhibition, Cleveland Public Auditorium, Cleveland, Ohio.

AUG. 28-31: APCO National Conference, Hotel Hollenden. Cleveland, Ohio.

SEPT. 11-23: URSI Ninth General Assembly, Zurich, Switzerland.

SEPT. 13-15: 1950 IRE West Coast Convention and Sixth Annual Pacific Electronic Exhibit, Municipal Auditorium, Long Beach, Calif.

SEPT. 18-22: Fifth National Instrument Conference and Exhibit, Memorial Auditorium, Buffalo, N. Y.

SEPT. 25-27: National Electronics Conference, Edgewater Beach Hotel, Chicago, Ill.

SEPT. 30-OCT. 8: Third Annual National Television & Electrical Living Show, Chicago Coliseum, Chicago, Ill.

OCT. 3-5: AIEE District No. 2 Meeting, Lord Baltimore Hotel, Baltimore, Md.

OCT. 23-25: Third Annual Joint IRE-AIEE Conference on Nucleonics, Park Sheraton Hotel, New York City.

OCT. 26-28: Second Audio Fair, sponsored by the Audio Engineering Society, Hotel New Yorker, New York City.

Television Begins in Mexico

MEXICO'S first television station began its trial telecasting recently, and three other stations were hurrying to get under way. Licenses for operation have been issued to all four—three in Mexico City and one in Tiajuana on the U. S. border.

The latter station, proposing to use channel six which would conflict with a nearby U. S. station in San Diego, has resulted in the U. S. and Mexico beginning exploratory talks toward a U. S.-Mexican television channel agreement.

At the same time, RCA-Victor has sent down the first mobile television unit ever to cross into Latin-America. This unit will be used in connection with the opening of XHTV, the television station of the Mexico City newspaper Novedades.

The first station to begin telecasting, XHTV, has its studios and transmitters located in the National Lottery Building, the highest in the Mexican capital. From the new tower on what is equivalent to the 23rd floor of the building, the beams can cover every home in the Mexico City area.

A second station, to be opened by the owner of Mexico's largest broadcasting and theater chain, Emilio Azcarraga, is under construction and will start three-hour nightly telecasts in September.

All of the equipment for these two stations has come from the U. S., but a third station has been practically built in Mexico by an electronic engineer from imported parts and it was the first to get going with test shows (started last year). This man, Ing. J. Cameren, hopes to start not only a telecasting but a television manufacturing plant in Mexico.

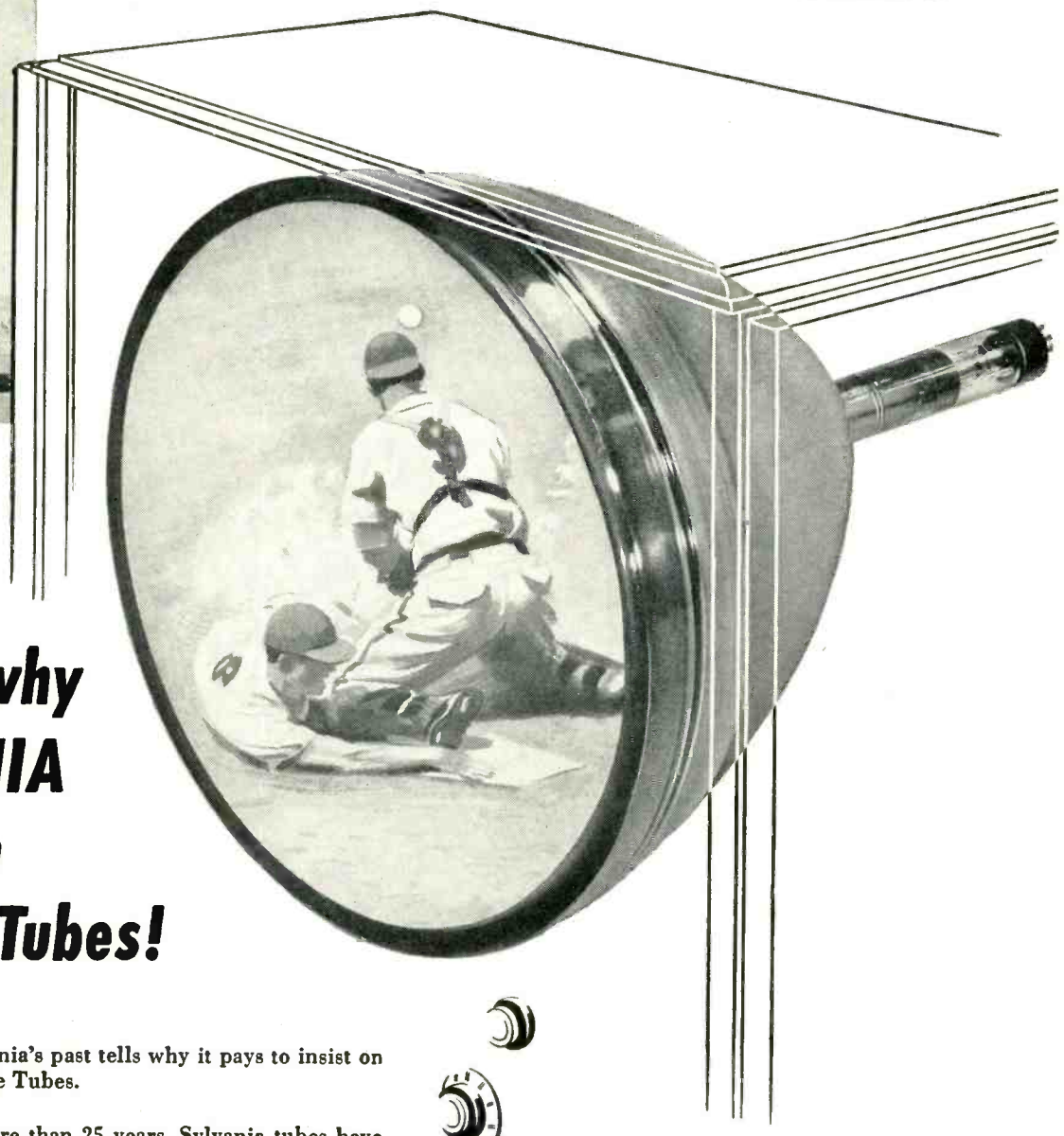
Industry Mobilization Committee

AN ELECTRONICS industry mobilization committee to plan, coordinate and advise government agencies in war conversion and production was named in Chicago recently by James M. Blacklidge, chairman of the Association of Electronic Parts and Equipment Manufacturers. The committee will work with manufacturers, distributors and government agencies to expedite production of war material and to consider problems of allocation and procurement.

James P. Quam, of Quam Nichols Co., Chicago, was named chairman of the mobilization committee, which includes William J. Halligan, Hallicrafters Co.; Jerome J. Kahn, Standard Transformer Corp.; John H. Cashman, Radio Craftsmen, Inc.; S. N. Shure, Shure

(Continued on page 250)

It takes Experience to make a Leader



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A look at Sylvania's past tells why it pays to insist on Sylvania Picture Tubes.

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Lighting. Over half a century of experience lies behind Sylvania's lighting leadership. This includes years of research in filamentary wire, coiling and coating processes . . . further important reasons for the clarity and long life of Sylvania TV Picture Tubes.

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NEW BOOKS

An Introduction to Luminescence of Solids

By HUMBOLDT W. LEVERENZ, *RCA Laboratories, Princeton. John Wiley & Sons, New York*, 1950, 569 *pages*, $12.00.

THIS book is an amazingly complete compilation of information on inorganic phosphors in their chemical, crystallographic and physical aspects, and also an excellent review of the modern physics of atoms and radiation.

The treatment is predominantly theoretical, but no practical aspect is neglected. There are actually six pages of cook-book recipes for making the more commonly useful phosphors, but especially the accompanying sage advice on the making of phosphors should be very carefully considered by beginners.

The author struggles valiantly to bring the theory of luminescence into a coherent whole. His obtention and interpretation (p 102) is thorough, but the subject seems to be like the biological field in that every explanation of the phenomena requires two more postulates to justify the first explanation so that the field continually expands instead of closing in.

The behavior of electrons in solids here described is so complicated and uncertain that to a radio engineer, accustomed to having electrons follow relatively simple rules in circuits, the picture of their behavior in nonmetallic solids given here may seem hopelessly confusing.

The luminescence of natural organic materials and synthetic dyes is fortunately largely ignored, which allows the book to remain in one volume and restricts the treatment to the prime purpose of the use of phosphors in cathode-ray tubes in general and television tubes in particular.

In spite of the large number of complex and elaborate symbols used, it is practically impossible to find a misprint. However, some of the figures are not completely self-explanatory.

The book is thoroughly indexed for authors, subjects and chemical formulas of phosphors as well as 750 references to modern articles pertinent to the subject material.

In the "Vorwort" to the 1930 edition of Leverenz on luminescence (privately published), the author states "This work is later to be revised, enlarged and then maintained as complete as the writer's

(Continued on p 133)

RELEASED THIS MONTH

Electrical Communication, Third Edition; *Arthur L. Albert; Wiley; $6.50.*

Electromagnetic Fields: Theory and Application—Vol. I: Mapping of Fields; *Ernst Weber; Wiley; $10.00.*

Heaviside's Electric Circuit Theory; *H. J. Josephs; Wiley; $1.25.*

High-Frequency Induction Heating, Second Edition; *Frank W. Curtis; McGraw-Hill; $6.00.*

Photoelectric Cells in Industry; *R. C. Walker; Pitman; $8.50.*

BACKTALK

This Department is Operated as an Open Forum Where Readers May Discuss Problems of the Electronics Industry or Comment Upon Articles that ELECTRONICS has Published

Television Servicing

DEAR SIRS:

SINCE ONE of the functions of Delta Electronics is the servicing of television receivers, your article "Why Television Receivers Fail in Service" was particularly appealing to us.

Your charts (Table I and II) are in agreement with our statistics, and within the limits therein. Due to the fact that there is only one station in our area, however, we have a deficit of tuner calls and antenna troubles, but this is counteracted by unnecessary service calls that would be eliminated by trying another station.

As an independent, we are definitely against manufacturers and distributors getting up their own service agencies, as they are in direct competition with their own customers. We have nothing against retailers doing their own repairing, however.

We would be willing to go on record as approving of a system of standards among manufacturers as to policies, such as one year guarantee on all parts including the picture tube, or 90 days on all parts and one year on all tubes, provided such is done at no cost to the retailer, service organization, or customer. This should be incorporated in the original price of the television set.

We are also severely against the present trend (here) of salesmanship in which the customer is told the built-in antenna will work anywhere. This places the serviceman at a decided disadvantage when he is confronted with severe ghosts, snow, or other obvious reception difficulties.

A national manufacturer advertises that his built-in aerial will work in 8 out of 10 places of good signal. The customer takes this to mean the set will work in his home, period: and the salesman is the first person to agree. A few well scheduled advertisements by the manufacturer could easily change this unfortunate situation.

Perhaps we are lucky, but your average of 5 to 6 calls per year per set is high. Our yearly average is around four. This may not seem strange except for the fact that we are one of the organizations using low priced labor for service calls, pulling all sets to the shop for other than tube replacements. We count-

(Continued on p 260)

NEW BOOKS (continued)

time will permit," which promise has been here most successfully fulfilled.—D. T. WILBUR, *Allen B. DuMont Laboratories, Inc.*

Wave Filters

BY L. C. JACKSON. *John Wiley & Sons, Inc., New York,* 1950, 107 *pages,* $1.25.

THE AUTHOR has "aimed at providing an account of the properties of electric wave filters adequate for the needs of the student of physics and radio". He has attempted to "strike a desirable mean" between the extended treatises on wave filters and the single chapters of general radio texts devoted to such filters. The book actually gives only a brief review of the elements of wave filters. Although Jackson attempted to provide "an adequate account of the subject, neither too brief nor too full of technical detail," it is this reviewer's opinion that the account is too brief to accomplish its object. The section in Terman's Radio Engineers Handbook on "Network Theory, Filters and Equalizers" is as complete as this monograph.—MATTHEW LEBENBAUM, *Airborne Instruments Laboratory.*

Matrix Analysis of Electric Networks

BY P. LE CORBEILLER. *Harvard Monographs in Applied Science No.* 1. *The Harvard University Press and John Wiley and Sons, Inc., New York,* 112 *pages,* $3.00.

THIS little book is an attempt to present the essential portions of Gabriel Kron's method of network analysis in the simplest manner possible. As originally presented by Kron in "Tensor Analysis of Networks" (Wiley), stationary networks were considered as a special case of the broader and more difficult field of rotating machinery. Prof. Le Corbeiller contends this has prevented wide acceptance of Kron's techniques in the simpler application.

The central idea of Kron's original work is to consider a complex interconnected network as a

NEW BOOKS (continued)

tensor transformation of a primitive network in which all the branches are short-circuited on themselves. The problem of setting up the mesh or node equations is then reduced to one of setting down two tensors, one representing the circuit values and one representing the interconnections. The transformation is then merely a matter of routine manipulation. Although the minimum amount of computation necessary to arrive at a numerical solution is not reduced by the tensor analysis, it is organized in such a way that the procedure is largely routine and the chance for error, especially an error in the sign of a mutual impedance term, is greatly minimized.

In the book under review, the presentation has been greatly simplified by avoiding any mention of tensors or tensor concepts. As implied by the title, the material is presented purely in terms of matrix algebra. Actually, in the case under discussion, it makes little difference whether we call the quantities tensors or matrices. The distinction becomes significant only in applications, such as the study of rotating machinery, in which the network is varying. In avoiding discussion of the more difficult concepts commonly associated with tensor analysis nothing is lost, but simplification is achieved.

The author has indeed succeeded in presenting his material in simple form. The book is quite suitable for undergraduate students who have had no more than a standard course in a-c networks or for practicing engineers who have had no previous experience with matrices. The first chapter presents the fundamentals of matrix algebra in such a simple and clear fashion as to make it an excellent medium for the student's first introduction to the subject. The other three chapters take up respectively the mesh method, the node pair method, and the mixed method of network analysis all from the matrix point of view. Although the discussion is entirely in terms of steady-state analysis, the extension to include transient problems will follow immediately once the student has mastered the operational methods of transient analysis.

Although the book does succeed

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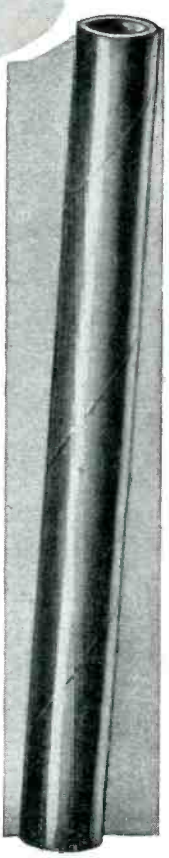

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in presenting the material in clear and simple terms, it is to be regretted that the author has not included more examples and problems of a type that demonstrate the power of the method. Primarily because of the lack of such problems, the book is likely to leave the reader unenthusiastic about the utility of the matrix method. Although the author says that he considers Kron's work to be the most significant advance since the introduction of impedance, he is not too successful in conveying this impression to the reader. If the book is used as an under-graduate text, it should definitely be supplemented with problems of analysis of complicated networks. Of course, for the practicing engineer who can supply problems from his own experience, this is not a serious problem.

In spite of the above criticism, the book does fill a very definite need. It is highly recommended to anyone wishing an introduction to the subject.—WARREN D. WHITE, *Airborne Instruments Laboratory, Mineola, New York.*

• • •

THUMBNAIL REVIEWS

TELEVISION AND F-M RECEIVER SERVICING. By Milton S. Kiver. D. Van Nostrand Co. Inc., New York, 1950. Second Edition, 248 pages, paper-covered, $3.25. Practical treatment, with theory only where needed to indicate solution of servicing problem. Revised material covers new tv circuits used in past two years, including one entire chapter on intercarrier sound. For students, servicemen and others who already know radio servicing.

KENT'S MECHANICAL ENGINEER'S HANDBOOK. Twelfth Edition. Two volumes: Design and Production, edited by Colin Carmichael; Power, edited by J. Kenneth Salisbury. John Wiley & Sons, Inc., New York, 1950, $8.50 each. Production volume contains one section on control mechanisms, including automatic regulators, servomechanisms and industrial electronic controls. Power volume contains section on atomic power, and pertinent data on electronic equipment used for instrumentation and control in power plants.

HOW TO BUY A TELEVISION SET. By Alvin C. Gary. Television Sales & Directory Service, Box 314, Brooklyn, N. Y., 1950, 56 pages, $1.00. Nontechnical discussion of picture tube sizes, indoor and outdoor antennas, lightning arresters, selection of receiver, care, service, and legal aspects.

ELECTROMAGNETIC THEORY. By Oliver Heaviside. Dover Publications Inc., New York, 1950, 386 pages, $7.50. Unabridged reprint edition containing all three volumes of this scientific classic, with critical and historical introduction by Ernst Weber. Though originally published between 1891 and 1912, the contents are still regarded as one of the most readable

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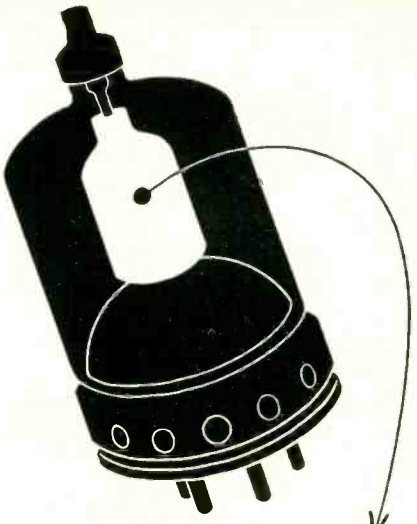

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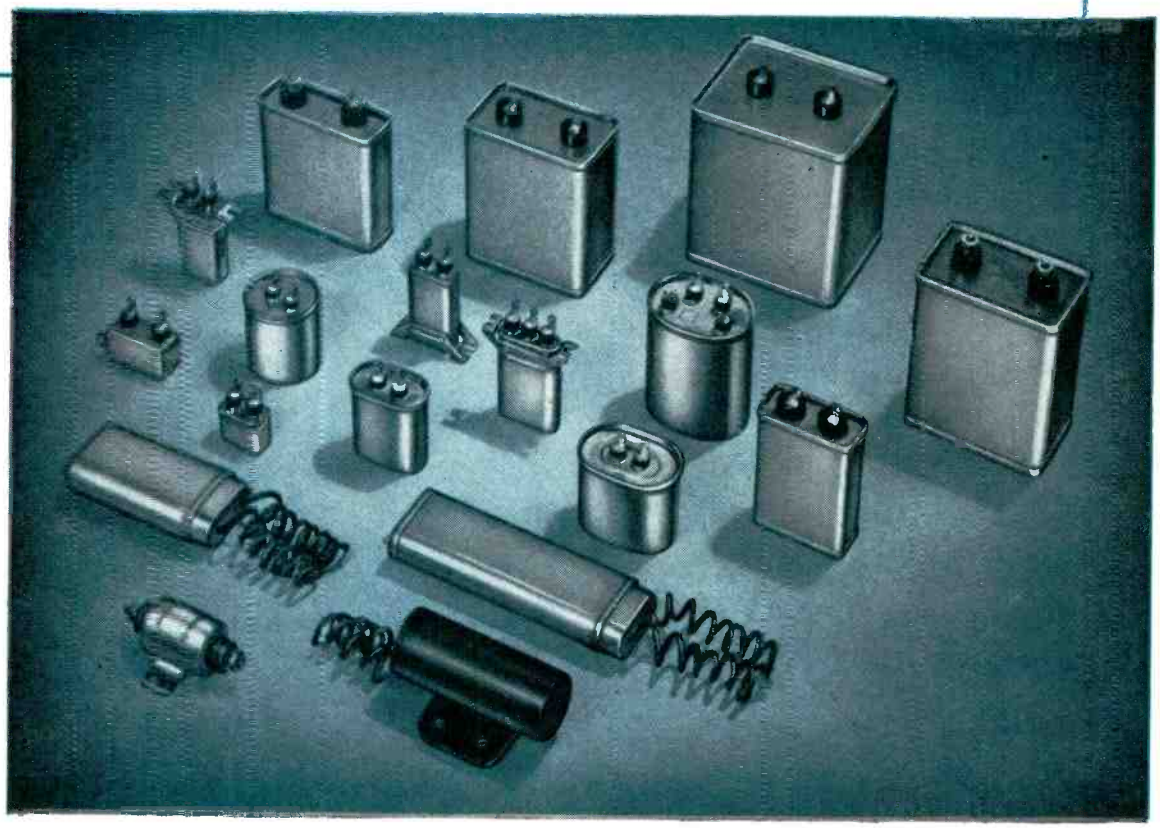

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INFRARED RADIATION THERAPY SOURCES AND THEIR ANALYSIS WITH SCANNER. By Leopold Rovner. Charles C. Thomas, Publisher, Springfield, Illinois, 1950, 34 pages, $1.50. Description of infrared scanner using bolometer with rotating shutter, a-c amplifier and recorder, and reproductions of coverage patterns obtained with various infrared sources.

GERMAN-ENGLISH TECHNICAL DICTIONARY. Edited by Kirt F. Leidecker. S. F. Vanni, Publisher, 30 W. 12th St., New York, 1950, Vol. I—A-K now available, and Vol. II—L-Z out in fall 1950; both volumes $35.00. Based on data compiled by the U. S. Air Force for use in translating scientific terms in documents captured by the Allies after the fall of Germany. Its terminology has been adopted in official U. S. and British documents. Over 100,000 German terms are listed alphabetically, followed by English equivalents or definitions.

HYDROGEN IN CHEMICAL ATOMS. By W. M. Venable. Markowitz, Haas & Kopelman, Pittsburg 32, Pa., 1950, 156 pages, $4.00. Analysis of spectral levels from Li I to O VII, with 48 pages of tables showing how wave numbers of classification levels evaluated by usual methods are derived from wave numbers of true series levels by deductions of wave number differences contributed by hydrogen.

FUNDAMENTALS of A-C CIRCUIT INTERRUPTION. By Erwin Salzer. Allis-Chalmers Mfg. Co., Milwaukee, Wisc., 56 pages paper-bound, 40 cents. Physics of circuit interruption, action of transients, design of circuit breakers, and bibliography.

PUBLIC-ADDRESS GUIDE. By Guy S. Cornish. Radcraft Publications, New York, 1950, 80 pages paper-covered, 75 cents. Planning equipment details, installation, servicing, and system construction.

PRIMARY BATTERIES. By George Wood Vinal. John Wiley & Sons, New York, 1950, 336 pages, $5.00. Elementary theory of cells, materials and production, operating characteristics, effect of temperature, standard cells, depolarized cells, copper and copper oxide cells, silver oxide and chloride cells, lead cells, mercuric oxide and vanadium cells, and fused-electrolyte cells.

MODERN PLASTICS ENCYCLOPEDIA AND ENGINEER'S HANDBOOK. Breskin Publications, New York, 1950 edition, 1,200 pages, $3.00. All phases of plastics design and production, all types of plastics materials and new developments of past twelve months.

RADIO NOISE METER. ASA standard C63.2. American Standards Association, 70 E. 45, New York, 16 pages, 65 cents. Proposed specifications for an instrument covering the range of 0.015 to 25 mc, intended for general use in factories and in the field for measuring radio noise field intensities near electrical equipment and power lines as well as for determining broadcast field intensities.

HIGH-FREQUENCY INDUCTION HEATING. By Frank W. Curtis. McGraw-Hill Book Co., New York, 1950, second edition, 389 pages, $6.00. Revised to include more comprehensive analysis of work coil design, localized hardening, joining of metal assemblies, methods of quenching, fixture designs and types of solders, brazing alloys and fluxes best suited for production-line applications of induction heating.

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(continued from p 118)

selected time key resistance is equal to the 2050 grid firing potential, the thyratron starts conducting. The 2050 plate circuit relay K_3 is then actuated, which breaks the holding circuit of relay K_1. Relay K_1 then de-energizes the clutch solenoid. The clutch and its associated mechanism then opens the print switch, de-energizes relay K_2, and raises the platen and neghood.

In changing to its nonoperating position, K_2 opens the 2050 plate circuit, and grounds out the charging capacitor. Thus the printing cycle is completed, and the machine is ready for the next exposure.

Timing

The diode in the charging circuit makes possible stable accurate timing. Reference is made to the charging circuit voltage curves of Fig. 2. The voltage across C_4 plotted as a function of time is not a continuous transient, but consists of a series of transients, each initiated at the beginning of a positive half-cycle input to the 6SN7.

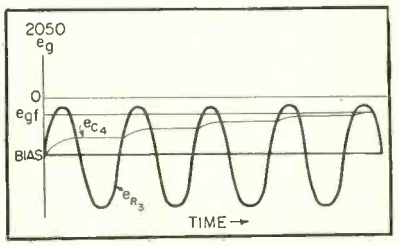

FIG. 2—Charging circuit during positive alternation

During the negative half-cycle input, the voltage across C_4 is for all practical purposes a constant, since there is but little inverse current flow through the diode-connected 6SN7.

The fact that the slope of the broken transient, after the first few cycles, will be greater at every point than the slope of a normal d-c transient, with the exception of the negative half cycles of e_{R3}, accounts for the reliability and accuracy of the timer. Accuracy of plus or minus one percent of the total exposure time is possible.

The d-c power supply of the timer minimizes the opportunity for power line transients to upset the stability of the timer since the filter for the power supply acts as a block-

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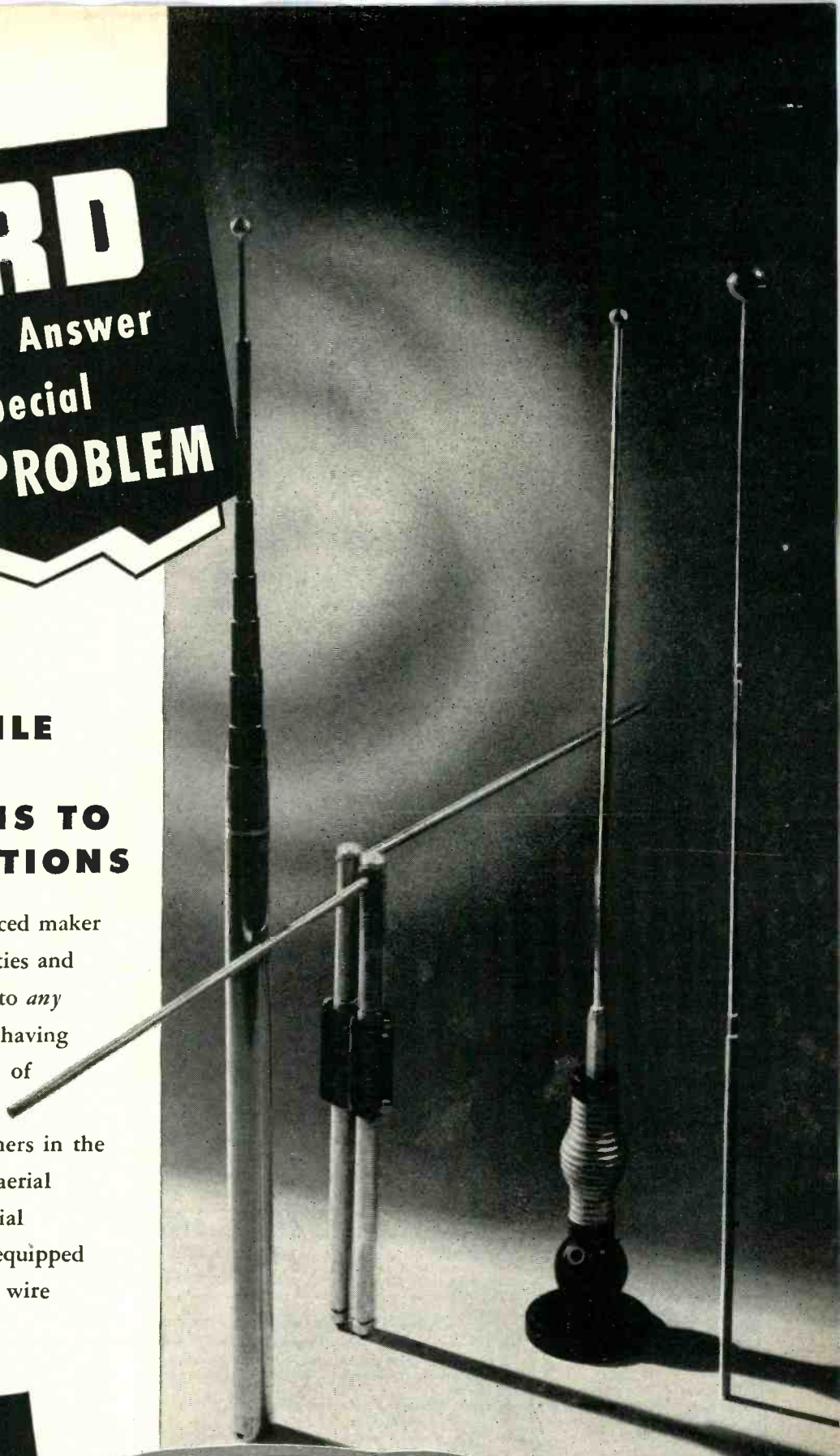

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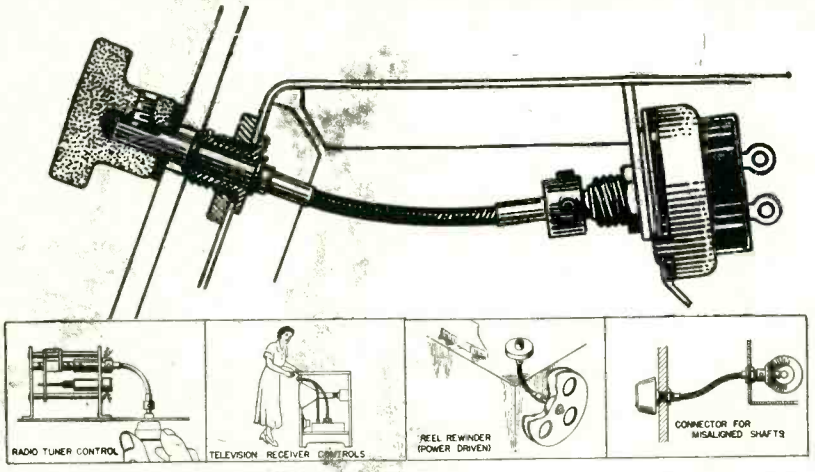

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- STANDARD END FITTINGS
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THE FLUTED CORE

—stellate in section—contains a fluxing medium of unrivaled efficiency close to periphery of the solder at six points. It permits instantaneous "wetting" and fluxing at correct temperature, and obviates dry and high resistance joints.

SUPERSPEED WHITE FLASH Activated Rosin Cored Solder comes in different diameters and alloys—YOU CAN SELECT THE SOLDER TO GIVE MAXIMUM EFFICIENCY AT THE CORRECT TEMPERATURE—FOR YOUR JOB—or—we make it to fit your requirements.

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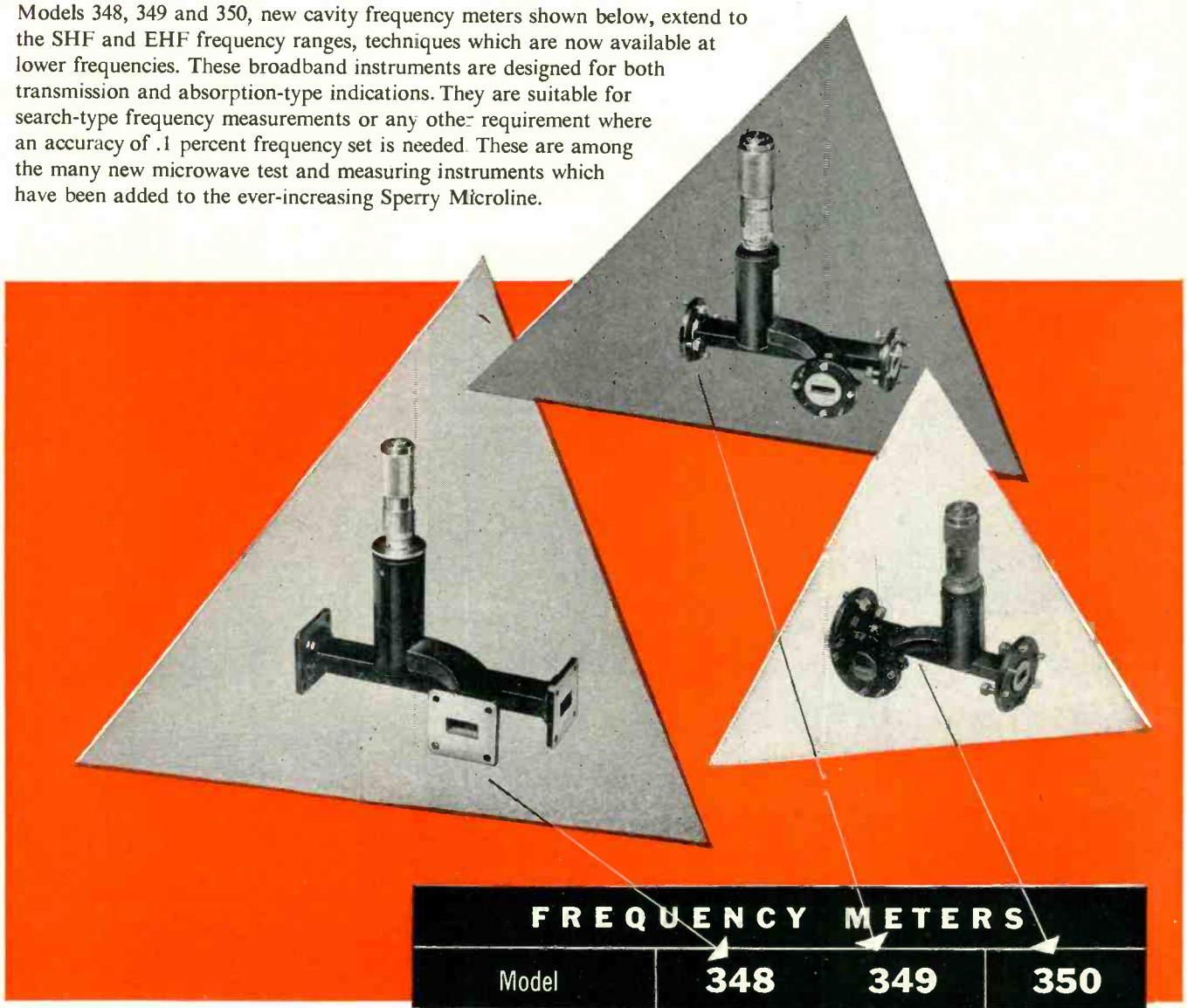
New Instruments for Microwave Testing

COMPLEMENT SPERRY'S *Microline**

Models 348, 349 and 350, new cavity frequency meters shown below, extend to the SHF and EHF frequency ranges, techniques which are now available at lower frequencies. These broadband instruments are designed for both transmission and absorption-type indications. They are suitable for search-type frequency measurements or any other requirement where an accuracy of .1 percent frequency set is needed. These are among the many new microwave test and measuring instruments which have been added to the ever-increasing Sperry Microline.



FREQUENCY METERS			
Model	348	349	350
Description	CAVITY	CAVITY	CAVITY
Frequency Range mc	13,000-18,000	19,000-26,000	26,500-39,000
Absolute Accuracy	1/1000	1/1000	1/1000
Approximate Loaded Q	1000	450	1000
Fittings R-F	UG-419/U	UG-425/U	UG-381/U
Fittings Video	UG-419/U	UHF	UG-381/U

Other new instruments in the frequency ranges of the above mentioned meters are:

Instrument	Model	Frequency Range mc
Impedance Meter	320	18,000-26,500
Impedance Meter	346	26,500-40,000
Impedance Transformer	347	26,500-40,000
Directional Coupler	405	26,500-39,000
Directional Coupler	413	18,000-26,500
Directional Coupler	415	18,000-26,500
Directional Coupler	388	12,400-17,000
Directional Coupler	429	32,000-39,000
Short	371	26,500-40,000
Short	372	12,400-18,000
Termination	401	12,400-18,000
Termination	402	26,500-40,000
Detector and Mixer	357	12,400-18,000
Detector and Mixer	358	18,000-26,500
Detector and Mixer	359	26,500-40,000
Detector and Mixer	382	26,500-40,000
Magic Tee	390	18,000-26,500
Magic Tee	391	26,500-40,000

Catalog information on these and other Microline instruments is available on request.

*Trade Mark

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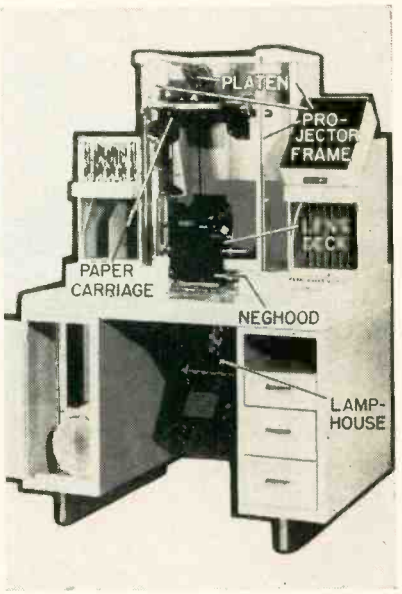
ing network. The d-c supply also improves the accuracy of the timer in that the grid firing potential of the 2050 thyratron becomes a constant upon the application of a d-c voltage to its plate.

In experimentation, it was found that great care must be exercised in the adjustment of the capacitor grounding contacts of relay K_2. These contacts must have a good wiping action in order to maintain their cleanliness. If they become dirty, the charging capacitor will not fully discharge between exposures, thus affecting the stability of the timer. The use of pushbuttons to control the timing operation was selected to facilitate high-speed



Complete photographic enlarger with electronic control permits operator to estimate exposure time from negative density and automatically adjusts timing for print size

production of prints. The capacity of the machine is 600 prints per hour.

The automatic magnification control of the timer makes it unnecessary for the operator to mentally calculate exposure time in terms of both negative density and magnification, but only in terms of the former. The timer is usually adjusted to give exposures of 0.2 to 5.1 seconds at a magnification of 1.3, and exposures of 1.5 to 37 seconds at a magnification of 5. The transient network of the timer might be used to advantage in

are businessmen

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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.*

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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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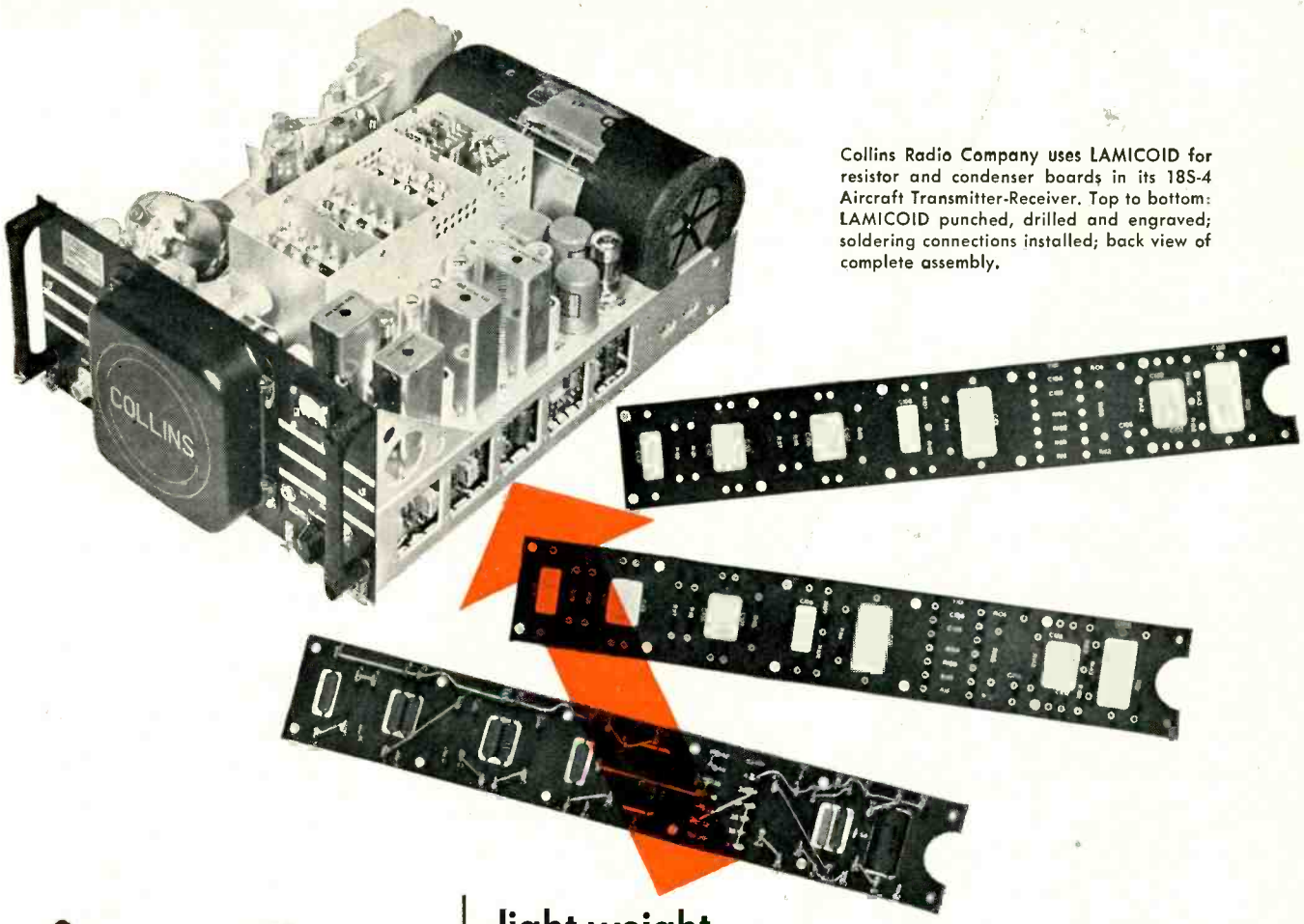

Collins Radio Company uses LAMICOID for resistor and condenser boards in its 18S-4 Aircraft Transmitter-Receiver. Top to bottom: LAMICOID punched, drilled and engraved; soldering connections installed; back view of complete assembly.

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LAMICOID thermosetting plastic offers properties that make it ideal for resistor and condenser boards used in Collins Radio Company Aircraft Transmitters and Receivers —where compactness and light weight are essential.

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counting and frequency measurement circuits as well as in other timing operations.

A-C Voltmeter for Built-In Instrumentation

By LAWRENCE FLEMING
Falls Church, Virginia

FULL-SCALE sensitivity of 10 millivolts is provided by the electronic voltmeter whose circuit is shown in Fig. 1 and 2.

Designed for built-in instrumentation, the voltmeter is stable, linear and maintains an accuracy of three percent. Covering a range to 50 kc with a full scale sensitivity of 10 mv, it is suitable for a-f measurements made in connection with amplifiers, filters and equalizers.

Figure 1 shows the basic circuit designed by Howard L. Daniels, of Engineering and Research Associates, Minneapolis, Minn. It differs from most a-c voltmeters in the proportioning of the circuit constants. The first stage, V_1 is a voltage amplifier designed to give maximum voltage gain in the required bandwidth. The second stage, V_2, is a current amplifier. Its load resistance is determined by the following considerations: it must be higher than the resistance of the rectifier and meter combination; it must be high enough to limit the overload current through the indicating instrument and low enough to permit a reasonable value of transconductance to be developed in the current amplifier.

A full-wave bridge rectifier may

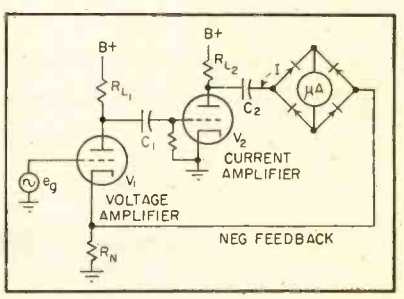

FIG. 1—Basic voltmeter circuit employs full-wave bridge

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In a wide range of sizes and container shapes to meet every known interference filtering application. A few typical types are listed below. Thousands of other types on request. Our engineers will be glad to consult with you on your specific noise problems. Engineering bulletin on request. CORNELL-DUBILIER ELECTRIC CORPORATION, Dept. K-90 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.

Capacitive inductive filters — single and multiple section pi circuits in hermetically sealed containers for aircraft, marine, and heavy-duty application requiring filters with high insertion loss over temperature range from −55 to +85°C.

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Electrical appliance filters — for fluorescent lamps, food mixers, vacuum cleaners, business machines, and a wide variety of other electrical equipment available in many styles with both flexible lead and solder lug electrical connections.

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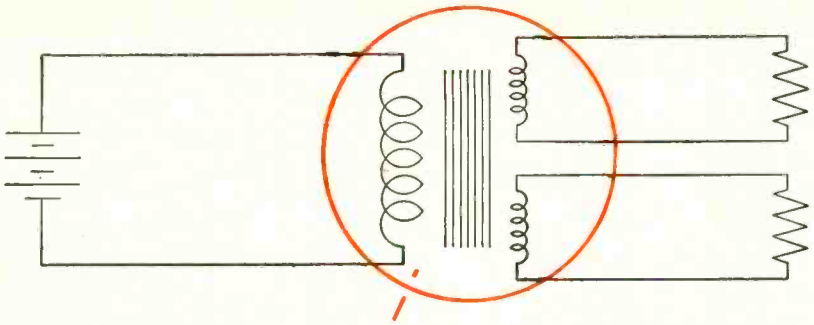

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Whenever DC power is required at other than the supply voltage, Bendix* Specialized Dynamotors function as DC transformers. They can be wound for any input or output voltage between 5 and 1200 volts, and they can deliver power up to 500 watts. Multiple outputs can be supplied to correspond with several secondaries on transformers, and their output voltages can be regulated within close limits regardless of input voltage or load variations. Bendix Specialized Dynamotors are tailored to the exact requirements of each application by the design of the windings used in standardized frames. This reduces the cost, size and weight to an absolute minimum, consistent with the operational requirements. Compliance with Government specifications is assured by the choice and treatment of materials and the basic design. *A complete description of your requirements will enable our engineers to make concrete recommendations . . . All orders are filled promptly and at moderate cost.*

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be employed in conjunction with a microammeter as shown; or a half-bridge may be used as in Fig. 2. The latter arrangement halves the sensitivity. Germanium diodes are used. The low-frequency limit of the instrument is determined by the ratio of C_2 to the plate resistance of V_2.

Since the actual load impedance of V_2 is low, this stage is inherently a wide-band device, and the high-frequency response of the circuit is that of the first stage. Because of this disparity in high-frequency response of the two stages, there is a wide margin of safety against high-frequency oscillation when feedback is applied. The low-frequency response is on a par with that of a conventional two-stage amplifier.

Average-Reading

The deflection of the indicating d-c meter is proportional to the full-wave average value of the a-c voltage applied to the input, since the signal can produce no change in the average charge on C_2.

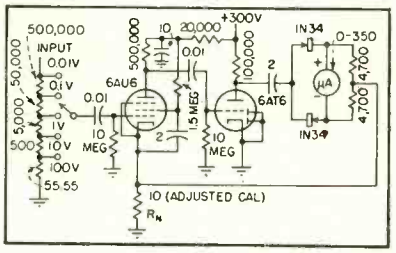

FIG. 2—Practical millivoltmeter circuit maintains 3-percent accuracy from 10 cps to 50 kc

In Fig. 1, the full-scale range of the circuit is measured by the ratio of meter current to input voltage:

$$\frac{I}{e_i} = \frac{A_1 g_{m2}}{1 + R_n A_1 g_{m2}}$$

where I = current in meter circuit, e_i = input voltage to grid of V_1 A_1 = voltage gain of V_1, g_{m2} = transconductance of tube V_2, and R_n = feedback resistance common to input and output circuits. For the case of no feedback, this expression reduces to the product of the gain of the first stage and the transconductance of the second.

Practical Circuit

A practical embodiment of the Daniels principle is shown in Fig. 2;

VOLTAGE REGULATED POWER SUPPLIES

For Industrial and Research Use

MODEL 510

Model 510 features TWO COMPLETELY INDEPENDENT REGULATED POWER SUPPLIES.

OUTPUT DC FOR EACH SUPPLY: 200-500 volts, 200 Ma.
REGULATION: ½% for both line and load variations.
RIPPLE: 5 millivolts.
OUTPUT IMPEDANCE: 2 ohms.
OUTPUT AC FOR EACH SUPPLY: 6.3 volts, 6 Amp., CT.

The supplies may be connected for series, parallel, or bucking operation.

MODEL 245

OUTPUT DC: 200-500 volts, 200 Ma.
REGULATION: ½% for both line and load variations.
RIPPLE VOLTAGE: 5 millivolts.
OUTPUT IMPEDANCE: 2 ohms.
OUTPUT AC: 6.3 volts, 6 Amp., CT, unregulated.

MODEL 103, MULTIPLE POWER SUPPLY

TWO B SUPPLIES: 0-300 volts, 75 Ma. each, 150 Ma. when paralleled. Ripple 10 millivolts. Unregulated.
ONE C SUPPLY: Minus 50 volts to plus 50 volts, 5 Ma. Ripple 5 millivolts. Unregulated.
ONE FILAMENT SUPPLY: 6.3 volts AC, 5 Amp.

MODEL 515

B SUPPLY: 0-500 volts, 200 Ma.
REGULATION: ½% for both line and load variations.
RIPPLE: 5 millivolts.
OUTPUT IMPEDANCE: 2 ohms.
C SUPPLY: 0-150 volts, 5 Ma.
REGULATION: 10 millivolts for line 105-125 volts. ½% for load at 150 volts.
RIPPLE: 5 millivolts.
FILAMENT SUPPLY: 6.3 volts AC, 10 Amp., CT.

This unit is available with a 300 Ma. B Supply; with or without C Supply.

MODEL 315

B SUPPLY: 0-300 volts, 150 Ma.
REGULATION: ½% for both line and load variations.
RIPPLE: 5 millivolts.
OUTPUT IMPEDANCE: 2 ohms.
C SUPPLY: 0-150 volts, 5 Ma.
REGULATION: 10 millivolts for line 105-125 volts. ½% for load at 150 volts.
RIPPLE: 5 millivolts.
FILAMENT SUPPLY: 6.3 volts AC, 5 Amp., CT.

MODEL 600

Model 600 features TWO INDEPENDENT REGULATED POWER SUPPLIES.

OUTPUT DC FOR EACH SUPPLY: 0-500 volts, 200 Ma.
REGULATION: ½% for both line and load variations.
RIPPLE: 5 millivolts.
OUTPUT IMPEDANCE: 2 ohms.
OUTPUT AC FOR EACH SUPPLY: 6.3 volts, 10 Amp., CT, unregulated.

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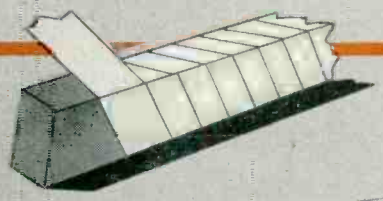
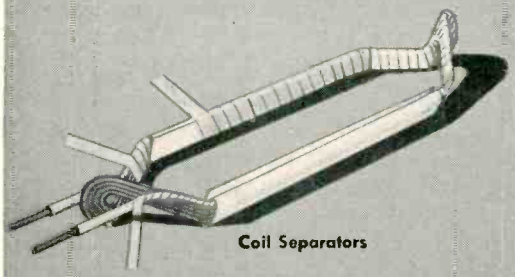
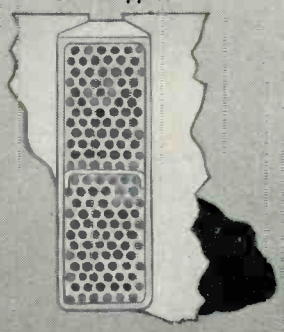


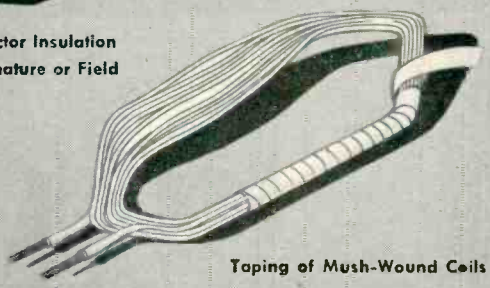
Conductor Insulation for Armature or Field



Coil Separators

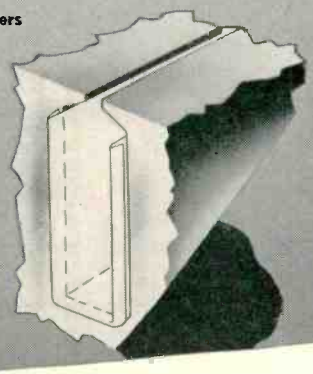
Coil Wrappers



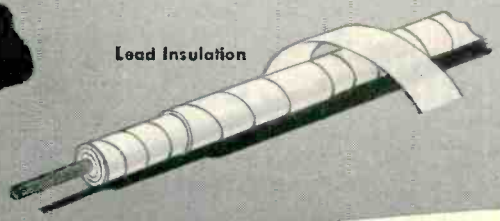


Taping of Mush-Wound Coils

Slot Liners



Lead Insulation



Look at these properties!

MECHANICAL. "Teflon" tetrafluoroethylene resin is extremely tough—withstands considerable abuse in assembly and in use. Doesn't deteriorate with time. In applying, it's easy to handle, smooth, conforms well to corners and odd shapes—is adaptable to automatic operations.

ELECTRICAL. Its electrical properties are excellent over wide ranges of temperatures and frequencies. Its power factor is less than 0.05% over the entire spectrum measured to date. Short-time dielectric strengths are high. "Teflon" has good arc-resistance, and doesn't carbonize under an arc discharge. It has zero water-absorption.

THERMAL. "Teflon" is capable of continuous service at 250°C. (482°F.) without deterioration, exceeding the requirements of even Class H materials. In laboratory tests, molded bars kept at 250°C. for one month show only a 1% loss in tensile strength. "Teflon" also maintains good properties down to as low as −196°C. (−320°F.). Thus, an insulation of "Teflon" on a motor would not crack when motor is started in arctic temperatures.

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the full-scale sensitivity is 10 millivolts. The frequency range is 10 cps to 50 kc, within 3 percent. Five higher decade ranges are provided. The high-frequency limitation imposed by the first amplifier plate circuit coincides with the limitation imposed by the lack of capacitance compensation in the input step attenuator. Further extension of the high end implies extra complication. In this respect, the performance is narrower than in commercial meters.

The circuit employs 14-db feedback. At 26-db feedback, low-frequency oscillation appears, providing a 12-db margin of safety.

The device is extremely insensitive to tube and line voltage changes, and is not critical as to component placement or lead dress. Filtering and decoupling in the power supply is essential.

Circuits of lower sensitivity may be made using a triode for the first stage, and they are inherently more stable.

R-F Heats Combustion Furnace

CARBON and sulphur analysis of iron and steel by direct combustion is now being done by r-f induction heating.

The electronic combustion furnace comprises a class-C oscillator with suitable controls mounted in a metal enclosure. The frequency of operation is approximately 10 mc at a power output of 500 watts.

Loading and unloading of the sample to be analyzed is accomplished by means of a bolt-action mechanism centrally located on the panel, which provides an atmosphere seal in the same operation. The sample container is a small crucible or cupelet manufactured from a special high-refractory mixture to withstand the high temperatures generated. The cupelet is supported on a ceramic hearth mounted on an aluminum pedestal.

The combustion tube is a 10-inch section of high-silica tubing. The tube is fitted with a replaceable ceramic plug to diffuse the flow of oxygen immediately above the cupelet and to trap any particles thrown off during firing. A vitreous-

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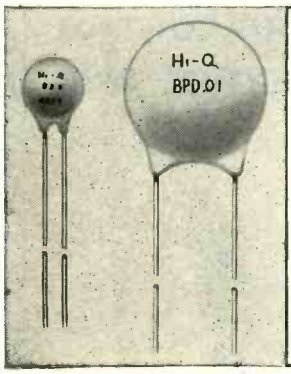
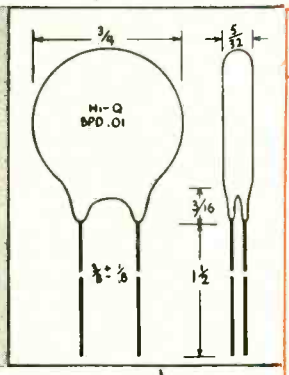




Type	A Diameter	B Lead Width	C Thickness
B.P.D. .00047	5/16" max.	3/16" ± 1/16"	5/32" max.
B.P.D. .0008	5/16" max.	3/16" ± 1/16"	5/32" max.
B.P.D. .001	3/8" max.	1/4" ± 1/16"	5/32" max.
B.P.D. .0015	3/8" max.	1/4" ± 1/16"	5/32" max.
B.P.D. .002	7/16" max.	1/4" + 1/8" − 0	5/32" max.
B.P.D. .004	19/32" max.	1/4" + 1/8" − 0	5/32" max.
B.P.D. .005	19/32" max.	1/4" + 1/8" − 0	5/32" max.
B.P.D. .01	3/4" max.	3/8" ± 1/8"	5/32" max.
B.P.D. 2x.001	19/32" max.	3/8" ± 1/8"	5/32" max.
B.P.D. 2x.0015	19/32" max.	3/8" ± 1/8"	5/32" max.
B.P.D. 2x.002	19/32" max.	3/8" ± 1/8"	5/32" max.
B.P.D. 2x.003	3/4" max.	3/8" ± 1/8"	5/32" max.
B.P.D. 2x.004	3/4" max.	3/8" ± 1/8"	5/32" max.
B.P.D. 3x.0015	3/4" max.	3/8" ± 1/8"	5/32" max.
B.P.D. 3x.002	3/4" max.	3/8" ± 1/8"	5/32" max.

Insulation: Durez and Wox impregnated.
Leads: 22 gauge pure tinned dead soft copper.
Capacity: Guaranteed minimum as stamped.
All capacitance measurements made at 25°C at 1 KC at a test voltage not over 5 volts RMS.

Insulation Resistance: 7500 megohms min.
Power Factor: Max. 2.5% at 1 KC at not over 5 volts RMS.
Test Voltage: 1500 volts D.C.

HI-Q
COMPONENTS
Capacitors
Trimmers • Choke Coils
Wire Wound Resistors
BETTER 4 WAYS
✓ UNIFORMITY ✓ DEPENDABILITY
✓ PRECISION ✓ MINIATURIZATION

JOBBERS — ADDRESS: 740 Belleville Ave., New Bedford, Mass.

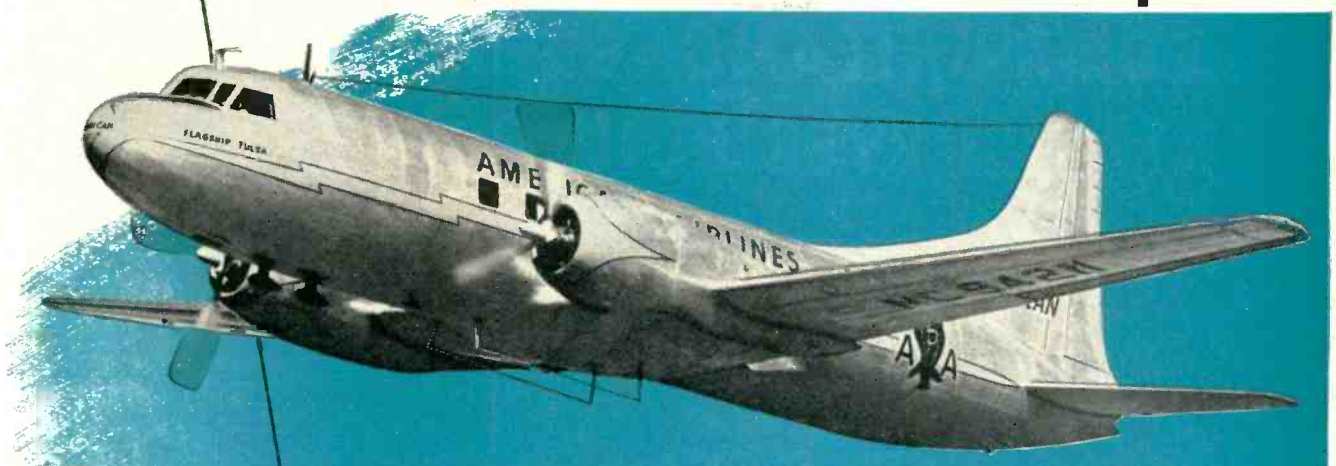
HI-Q

Electrical Reactance Corp.
OLEAN, N. Y.

SALES OFFICES: New York, Philadelphia
Detroit, Chicago, Los Angeles

PLANTS: Olean, N. Y., Franklinville, N. Y.
Jessup, Pa., Myrtle Beach, S. C.

For Vital Control Circuits in Curtiss Electric Propellers



American Airlines' Convair Flagship equipped with CURTISS ELECTRIC propellers

IT'S BENDIX-SCINTILLA ELECTRICAL CONNECTORS

. . THE FINEST MONEY CAN BUY

CHECK THESE ADVANTAGES

- Moisture-proof
- Radio Quiet
- Single-piece Inserts
- Vibration-proof
- Lightweight
- High Insulation Resistance
- Easy Assembly and Disassembly
- Fewer Parts than any other Connector
- No additional solder required

FACTORY BRANCH OFFICES:
117 E. Providencia Avenue, Burbank, California
23235 Woodward Avenue, Ferndale, Michigan
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Unfailing dependability is the standard set by Curtiss propellers and American Air Lines in their selection of equipment.

Bendix-Scintilla is therefore the logical choice for the electrical connectors in the Curtiss Electric propellers on American Flagships.

In fact, wherever circuits must be arranged to connect and disconnect with ease and certainty Bendix-Scintilla is the choice.

Remember whenever there is no compromise with quality—it pays to specify Bendix-Scintilla electrical connectors—the *finest* money can buy.

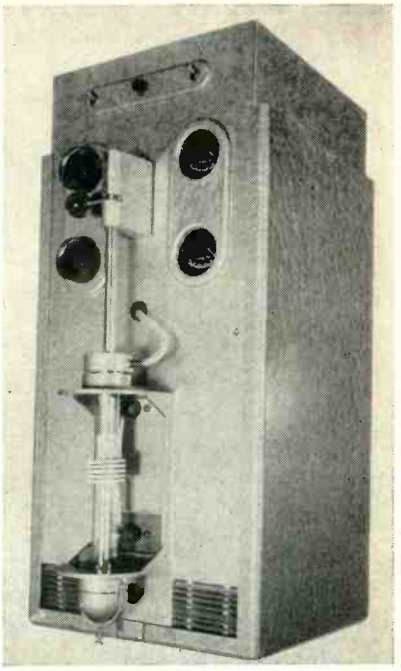
Write our Sales Department for detailed information.

BENDIX SCINTILLA

SCINTILLA MAGNETO DIVISION OF

SIDNEY, NEW YORK

Export Sales: Bendix International Division, 72 Fifth Avenue, New York 11, New York



Work coil surrounds atmosphere-sealed tubing containing sample of iron being analyzed

enameled work coil surrounds the combustion tube, and is supplied with r-f energy by the oscillator.

Integral piping for oxygen and combustion products is included, and flow is controlled by needle valves located in both lines. Oxygen is introduced through the top rear hose connector, flows through the top control valve and enters the combustion tube through the top breech opening. The products of combustion are led out through the bottom breech, through the bottom control valve and are conducted to the external train through the bottom rear hose connector.

When used for carbon determinations the oxygen flows from the top, over the heated sample, and the products of combustion are taken from the bottom of the combustion tube.

Flow of oxygen is indicated by the lowering of the level in the burette. The liquid level will come to a halt when about ¼ of the liquid is expelled. This indicates that combustion and fusion are taking place. After the combustion is completed, (about 1 min) the flow of liquid resumes. When the level reaches the calibrated portion of the stem, the oxygen valve is closed, the plate current is turned off, and the loading mechanism lowered.

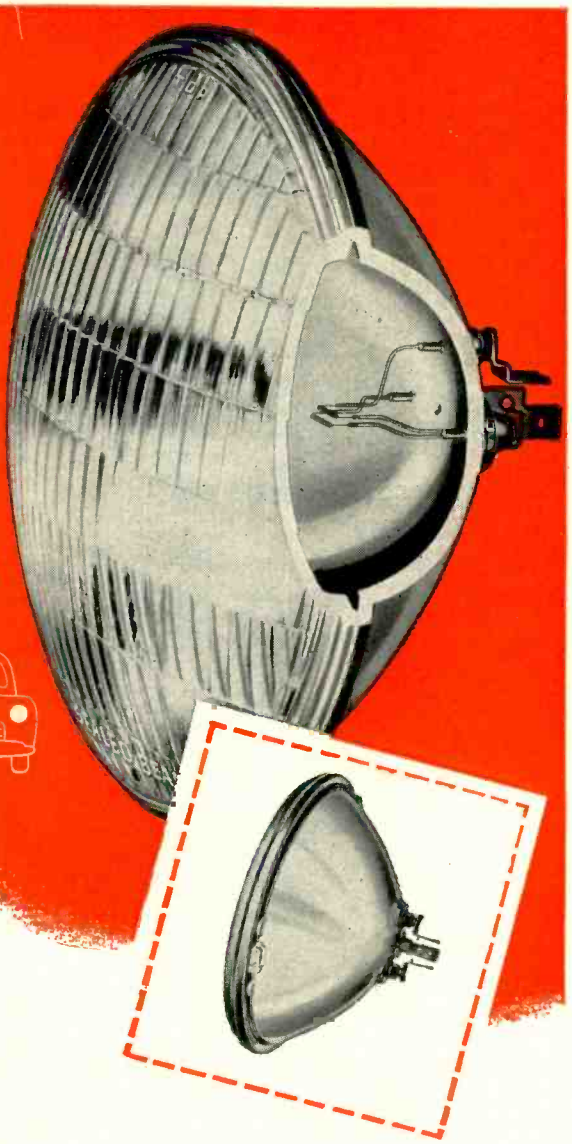
For sulphur determinations the

Driver-Harris

perfects

new alloy for

WESTINGHOUSE lamps



HERE WAS THE PROBLEM:

How to obtain a strong, rigid assembly for conductors supporting the filaments of sealed beam automobile headlights and, at the same time, make a perfect seal between the conductors and the glass housing of the lamp, so that gas sealed within the lamp might not escape.

AND HERE'S THE SOLUTION:

The back wall of the lamp, cast from Pyrex-like glass, has three holes through which the conductors can be passed. The area around these holes is heated until the glass is near-molten. Over each hole, on the rear side of the lamp, is then placed a "thimble"—made of *specially produced* D-H alloy. These thimbles are pressed into the molten glass, which, upon cooling, holds them firmly in position. The conductors are then passed through the holes in the glass wall, and their free ends soldered to the base of each thimble respectively. Lugs soldered to the thimbles, outside, provide terminals for mounting the lamp in a socket. In this manner, a strong, stable, gas-tight assembly is obtained.

Westinghouse discussed its needs with Driver-Harris. Could the necessary type of thimble stock be obtained, and supplied in strip form, .009" thick, with negligible tolerances?

The answer is found on all Westinghouse sealed beam headlights today. Driver-Harris not only produces an alloy with precisely the properties needed, but advanced D-H rolling techniques meet the exacting dimensional requirements specified.

SPECIAL ALLOYS FOR SPECIAL PURPOSES is an important phase of our business. If you have been unable to find the alloy you need, tell us about it. Our 50 years of development and manufacturing experience are at your service.

The part played by the metal thimbles in solving the problem is vitally important:

1. It is imperative that the thimbles be composed of a metal alloy *with a coefficient of expansion closely approximating that of glass at all temperatures up to the melting point of glass* Any appreciable difference in the rates of expansion would result in the glass being fractured.

2. The thimble stock must be initially and entirely gas-free—to avoid the possibility of bubbles or strains being formed in the glass at the seal.

3. The stock must be held to extremely close tolerances when manufactured—to meet the requirements of meticulous, high-speed presses and dies specially developed to produce the thimbles.

Makers of world-famous Nichrome and over 80 alloys for the electrical, electronic and heat-treating fields*

Driver-Harris Company

HARRISON, NEW JERSEY

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

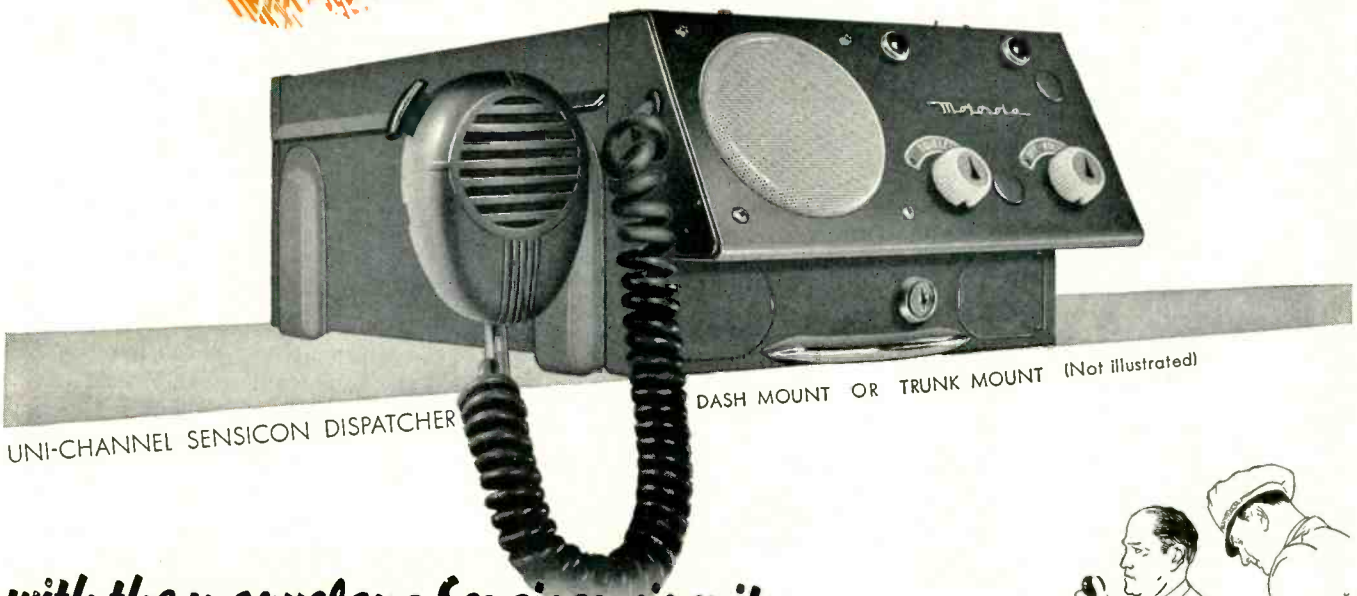
Manufactured and sold in Canada by
The B. GREENING WIRE COMPANY, LTD., Hamilton, Ontario, Canada

FIFTIETH ANNIVERSARY — SPECIAL PURPOSE ALLOYS SINCE 1900 — D-H — TRADE MARK REG. U. S. PAT. OFF.

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

Motorola—Precision-Engineered for
ADJACENT CHANNEL OPERATION

New "Uni-Channel" Top performer in low-cost 2 way radio



UNI-CHANNEL SENSICON DISPATCHER

DASH MOUNT OR TRUNK MOUNT (Not illustrated)

with the marvelous Sensicon circuit...

...for *permanent selectivity*—and 8 other Motorola improvements—Count on Uni-Channel through any routine or emergency to handle *whole* messages in heavy adjacent channel traffic (±35 Kc. at 100 db. down, and ±15 Kc. at 6 db. down)—your practical proof of superior *Motorola* equipment!

A marvel of mechanical convenience in one compact and accessible package. Just 4 screws install it in any vehicle. Or, as an emergency station, simply connect antenna and power. Investigate Uni-Channel before buying.

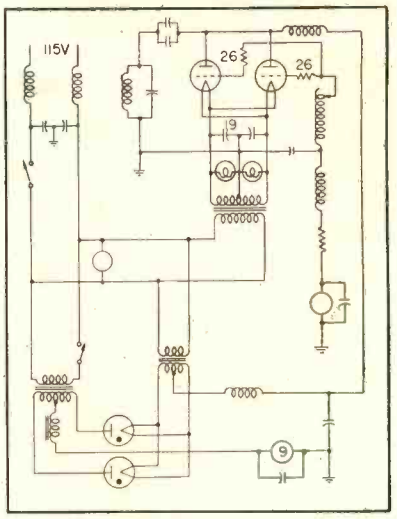
FM 2-WAY RADIO

BY THE WORLD LEADERS

BACKED BY 20 YEARS RESEARCH, EXPERIENCE, AND SPECIALIZATION IN MOBILE RADIO

Motorola

COMMUNICATIONS DIVISION 4545 AUGUSTA BLVD., CHICAGO, in Canada: Rogers Majestic, Ltd., Toronto



Circuit of high-frequency heating unit designed for carbon and sulphur determination

flow of oxygen is reversed, that is, the direction of oxygen flow should be from the bottom of combustion tube towards the top. Glass wool in the dome traps iron oxide.

The oscillator is of the tuned-plate type using a pair of 250-watt triodes in parallel. The oscillator components, with the exception of the tank coil, are mounted in the top section of the unit. The tank circuit comprising a 250-μμf vacuum capacitor and a 5-turn tank coil is coupled to the plate circuit through two ceramic capacitors mounted on the top coil terminal.

The tank coil also functions as the applicator and is located on the front panel inside the screened enclosure. This screen is designed to allow ventilation of the coil as well as physical protection to the operator. The equipment is manufactured by Lindberg Engineering Co. of Chicago.

Plug-In Amplifier Card

By W. H. LYON
Service Manager
Soundscriber Corporation
New Haven, Connecticut

INCREASING USE of electronic circuits in equipment which had previously been considered as almost wholly mechanical, has posed a maintenance problem for many manufacturers. One company, a manufacturer of disc-type office equipment, has solved its service problem by designing its electronic circuits for easy replacement by a

Another DU MONT First...

Picture tube sizes for television have been paced by Du Mont for the past decade. And again it's 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 5/8"
Greatest dimension of bulb	16 5/8"
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

DU MONT Teletrons*

*Trade-mark

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

RAYTHEON

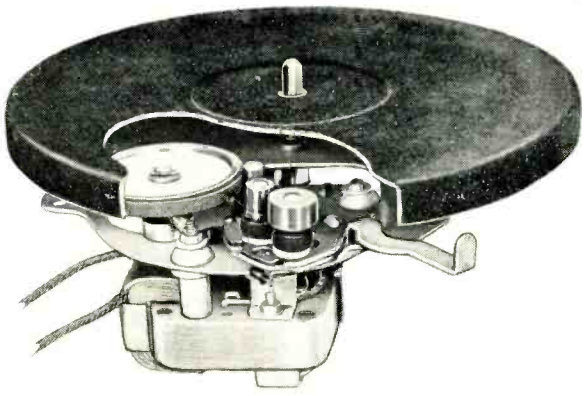
"CAT'S-PAW"
ELECTRIC PHONODRIVES

LOW COST QUIET

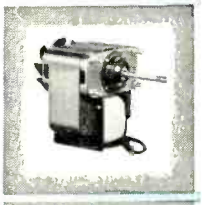
An outstanding example of Raytheon creative electronic engineering in action. The new, improved Raytheon Electric Phonodrive features a "Cat's-Paw" tangent-contact drive resulting in unusually smooth, positive operation. Raytheon had one purpose in mind in developing this new line of phonodrives —to provide a reliable mechanism with the least possible background noise.

The high degree of perfection achieved in the Raytheon "Cat's-Paw" phonodrive is the mechanism that builders of de luxe phonograph equipment have been seeking. Yet, due to Raytheon mass production, manufacturing skill and the finest equipment, these Raytheon precision phonodrives are available at a remarkably low cost, to meet the demands of a competitive market.

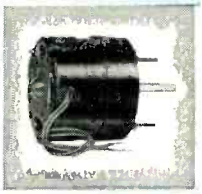
Put them to the test. You'll discover why more and more manufacturers are standardizing on Raytheon — for trouble-free, low cost phonodrives.



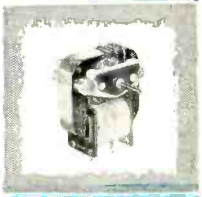
Model DTP De Luxe 3-Speed Turret Type 78-45-33 1/3 rpm 115 Volts 60 Cycles a-c Rim drive, 2-pole precision dynamically balanced motor incorporating Raytheon De Luxe Features; positive turret drive mechanism; shift lever control throws drive wheel into instant positive contact with motor shaft for desired speed; turntable shaft which revolves with turntable, grooved for "C" clip to secure table. For trouble-free operation all models are equipped with oil impregnated bearings. Also available in 78 rpm 115 V. 60 Cy. a-c De Luxe (DSP) and Economy (ESP) models. Send for Bulletin 5000.



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



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



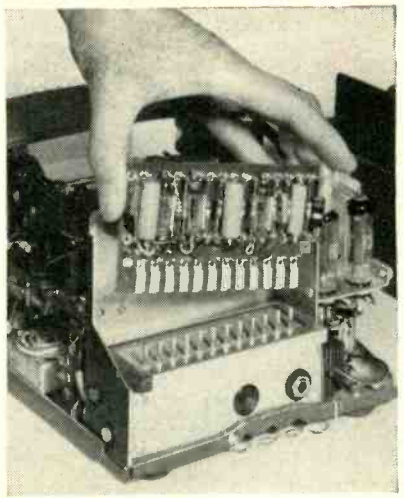
RAYTHEON TYPE 230 SHADED 2-POLE, 1/200 to 1/150 hp at 3200 rpm.

"You can rely on Raytheon to run it"

RUSSELL ELECTRIC COMPANY

MOTOR DIVISION OF **RAYTHEON** MANUFACTURING CO.

4501 So. Western Boulevard Dept. 1-24 Chicago 9, Illinois



All stages except the power amplifier are mounted on the pocket-size plug-in card

mechanic or other nonelectronic serviceman.

The Soundscriber Tycoon model incorporates a three-stage amplifier of the plug-in card type. Included on the card is a miniature 25-ohm input transformer working into a 6BA5 pentode and two 6AD4 tubes. The output of the card amplifier directly drives an external push-pull power stage. The overall recording gain of the amplifier is 90 db.

All electrolytic filter capacitors are included on the card. The only parts of the complete amplifier that are not on the card are the 50C5 power tubes, the output transformer, the volume controls and the dry rectifier.

Service Exchange

Cards are replaced on an exchange basis. The customer pays a small fixed exchange price, and there is no interruption in the service from busy equipment for trouble-shooting.

The play-back amplifier card is similar to the recorder card, except it uses two 1S6 filament-type tubes for instant warm up.

The size and shape of the amplifier card permits a compact fit into a small compartment at the rear of the machine with the output tubes and rectifier. Natural ventilation of this compartment isolates the heat from the recording mechanism.

To promote long life for the power tubes, the plate current is substantially reduced during stand-

REDUCE PICTURE TUBE WEIGHT ONE-THIRD

WITH U·S·S 17-TV Stainless Steel

WHEN you remove excess weight from your television picture tubes, you take an important step toward cutting the cost of handling, packing, shipping and installing sets.

By using U·S·S Stainless Steel for the conical portion of the picture tube, manufacturers have found they can eliminate more than one-third of the weight of the tube. A special grade of U·S·S Stainless Steel—U·S·S 17-TV—has been developed for this application. Its thermal characteristics make possible fusing of the faceplate and neck to the metal cone with an airtight seal.

U·S·S 17-TV, like all other Stainless Steels, combines exceptional strength with its light weight. As a result, the picture tube can withstand extreme pressures . . . breakage hazards are reduced . . . there is less danger of implosion during manufacturing, installation and service.

In developing U·S·S 17-TV for the television industry, United States Steel engineers have assembled important facts on metal picture tube construction. Whether you manufacture or use cathode ray tubes, these facts are at your disposal.

AMERICAN STEEL & WIRE COMPANY, CLEVELAND · CARNEGIE-ILLINOIS STEEL CORPORATION, PITTSBURGH
COLUMBIA STEEL COMPANY, SAN FRANCISCO · NATIONAL TUBE COMPANY, PITTSBURGH · TENNESSEE COAL, IRON & RAILROAD COMPANY, BIRMINGHAM
UNITED STATES STEEL SUPPLY COMPANY, WAREHOUSE DISTRIBUTORS, COAST-TO-COAST · UNITED STATES STEEL EXPORT COMPANY, NEW YORK

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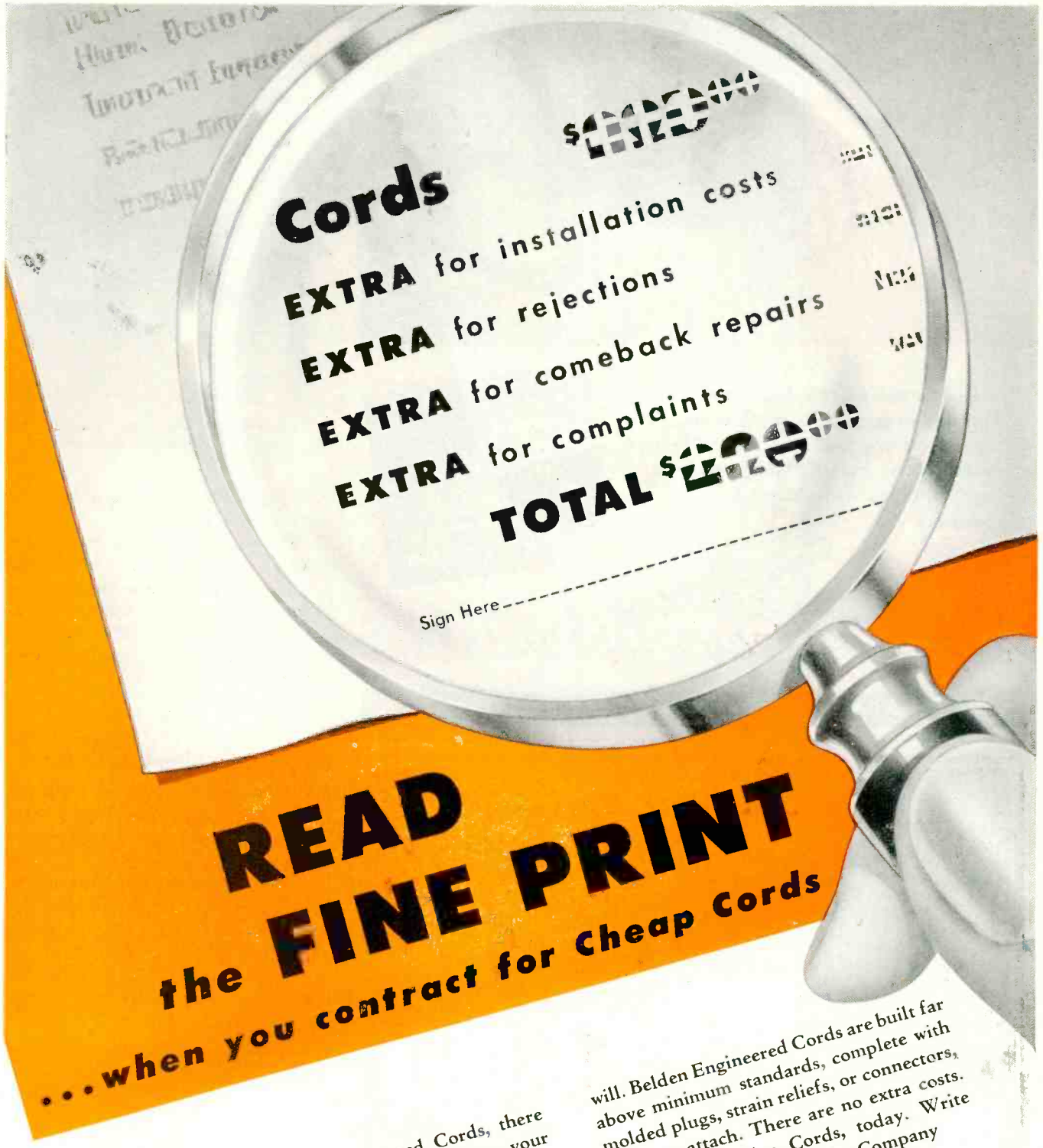
U·S·S STAINLESS STEEL

SHEETS · STRIP · PLATES · BARS · BILLETS · PIPE · TUBES · WIRE · SPECIAL SECTIONS

0-1558

UNITED STATES STEEL



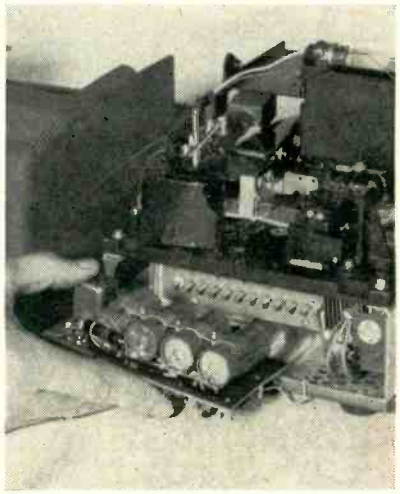
READ the FINE PRINT

...when you contract for Cheap Cords

With Belden Engineered Cords, there are no hidden costs. Engineered to your product, Belden Cords make for easy installation—eliminate costly extra assembly operations. Engineered for the service they encounter, Belden Cords give your product the chance to operate without cord failure and to maintain your customers' good will. Belden Engineered Cords are built far above minimum standards, complete with molded plugs, strain reliefs, or connectors, ready to attach. There are no extra costs. Investigate Belden Cords, today. Write

Belden Manufacturing Company
4625 W. Van Buren Street
Chicago 44, Illinois

CORDITIS-FREE CORDS BY . . . **Belden** WIREMAKER FOR INDUSTRY



Filament-type tubes are used in the play-back unit for the stenographer

by periods by removing the voltage from the screen grids.

Following the same replacement pattern, the recording and playback head assemblies are furnished as completely adjusted units ready for quick installation. One screw secures the units on accurately aligned dowels.

Boiler Combustion Control

CONTINUOUS CONTROL of small boilers and reliable operation at moderate cost are the advantages of the automatic combustion control system shown in the illustrations. Developed by James Hodgkinson of Manchester, England, the system employs a BTH photo-relay.

As shown in Fig. 1, a Bourdon tube indicator, calibrated to respond

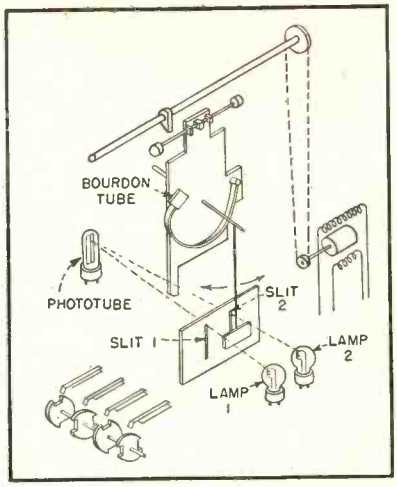


FIG. 1—Single phototube responds to vane excursions

USERS SAY G.E.'S 9574 ALL-PURPOSE* INSULATING VARNISH "is tops!"

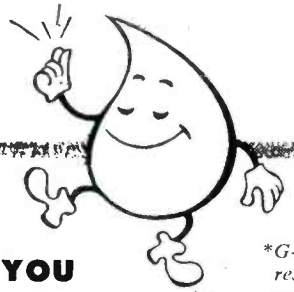
J. L. Hughes

How do users like General Electric's new all-purpose insulating varnish G-E 9574?

Here's a statement from J. L. Hughes, owner of the J. L. Hughes Electric Company, Columbus, Ohio.

> *"We have found from test and practical experience that General Electric general-purpose varnish 9574 is tops for our work."*

Mr. Hughes knows what he is talking about. He has been in the business of motor repair and rewinding in Columbus for thirty-three years.



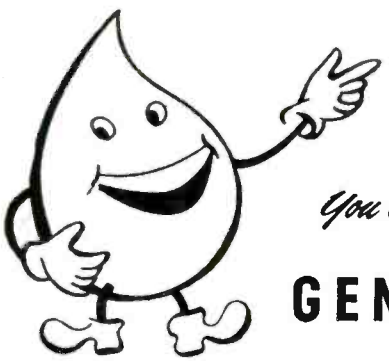
YES, G-E 9574 OFFERS YOU

One varnish you can depend on for ALL* jobs.

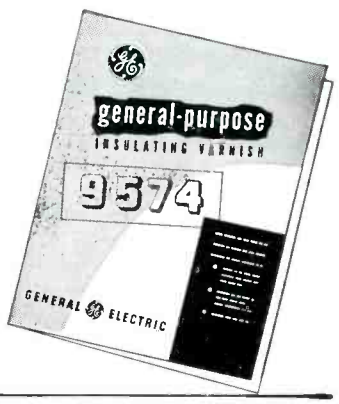
A Combination of electrical, chemical and mechanical properties formerly found only in special-purpose varnishes.

Easier Handling: Low baking temperature; deep penetration; simple thinning with petroleum spirits.

**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 adhesives, wedges, cements, compounds, cords and twines, sleeving, wire enamels, mica, papers and fibers, permafils, tapes, tubing, varnished cloths, and varnishes.*



SEND FOR BULLETIN! 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 K1, Chemical Department, General Electric Company, Pittsfield, Massachusetts.



You can put your confidence in

GENERAL ELECTRIC

CD50-K1

to boiler pressures of 100 to 105 psi gage, is fitted with a pointer and vane system. Any excursion of the vane due to rising or falling boiler pressure will cause light to reach the phototube from either lamp 1 or 2.

The signal is amplified and used to energize the control relays of the electric motor. Action of dampers, fan speed, or stoker feed may then be controlled.

The camshaft rotates at one rpm and alternate contacts make simultaneously. One pair of contacts controls the lamps, while the other determines which direction relay (clockwise or counter-clockwise)

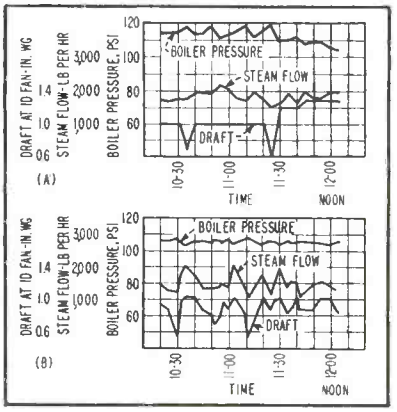


FIG. 2—Electronic control provides continuous regulation

shall be energized by the amplifier output voltage. Hence, only one phototube is required in this application.

Antihunt Control

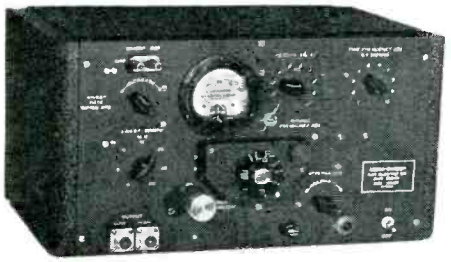
A mechanical system provides antihunt control. Once the motor is started, the Bourdon gage is tilted to return the vane to normal position. Figure 2A shows the wide variations in boiler pressure experienced in manual operation while Fig. 2B was compiled over a similar period with electronic combustion control in use.

Video Yardstick

A TRANSPARENT RULER for measuring the duration and determining the frequency of video signals dis-

BE READY . . .
INSTRUMENTS for USE in the UHF and COLOR TV BANDS

THE CALIBRATED MEGA-SWEEP



CONTINUOUSLY TUNABLE BROAD BAND SWEEPING OSCILLATOR

For Displaying the Pass Band of all TV Amplifiers

- Single knob tuning of sweep frequency from 100 kc. to 900 mc. Approximate center frequency of sweep indicated by panel dial.
- Sweep bandwidths variable up to 30 mc. wide.
- Completely electronic sawtooth sweep—No phasing or synchronizing.
- Micrometer head absorption wavemeter for calibrating tuning system.
- Continuously variable output attenuator and "high", "low" output connectors provide output from approximately 200 microvolts to 100 millivolts.
- Internal impedance of output connector approximately 50 ohms.

Price: $425.00

THE MEGA-MODE SR.

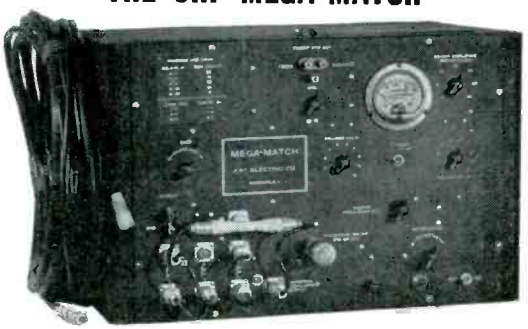
RANDOM NOISE SOURCE for the UHF and MICROWAVE RANGES

Measures the Noise Figure of TV Receivers in the UHF and Color Ranges.

- Employs a coaxial NOise dioDE to provide random noise over a frequency range of 100 to 900 mc.
- Noise figure of test circuits (db above ideal) between 0 and 20 db can be measured.
- Low VSWR at 50 ohm unbalanced output. Smith chart provided with each instrument indicating actual amount of mismatch.
- Noise figure indicated on panel meter linear in db.
- Operates with diode temperature limited. Has regulated filament supply.

Price: $895.00

THE UHF MEGA-MATCH



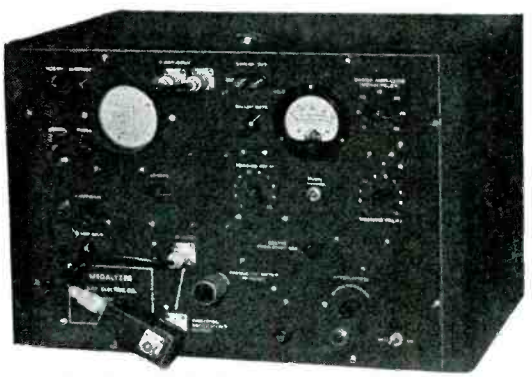
DISPLAYS REFLECTION COEFFICIENT OF TERMINATIONS SIMULTANEOUSLY OVER WIDE FREQUENCY SWEEP

- Displays reflection coefficient on standard oscilloscope over 30 mc sweep anywhere between 10 and 1000 mc.
- Useful for rapidly designing broad band antennas, transformers, TV front ends, matching distribution systems and measuring transmission line terminating impedances.
- Resolves reflection coefficients down to 0.01 to 500 mc. and 0.1 to 1000 mc.
- With auxiliary signal generator and Mega-Chart (Smith Chart) can be used to determine phase of reflection coefficient and components of terminating impedances.

Price: $895.00

(VHF Model (10 to 250 mc.) available at $695.00)

THE MEGALYZER



SENSITIVE VISUAL VOLTMETER and SPECTRUM ANALYZER

- Displays VHF and UHF energy over sweep widths up to 30 Mc.
- Frequency Range 30 to 1000 mc.
- Frequency Resolution: Discriminates between Frequencies Separated by 100 kc.
- Input Signal Level 100 to 10,000 microvolts (Useful above 0.000 microvolts with external pads.)
- Output vs. Input Linear for Inputs above 100 microvolts.
- Determines Frequencies and Levels of RF Energy over Wide Frequency Range.

Price: $895.00

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played on a picture tube, the RCA Microstick measures microseconds and is useful in determining bandwidth of receivers, calibration of test-pattern wedges, frequency of beat interference and ringing, and many other measurements.

Ruler Divisions

It is based on the fact that the electron beam in the kinescope is deflected from the left-hand to the right-hand edge of the picture in approximately 53.3 microseconds during one horizontal scanning line.

To design a ruler for measuring millionths of a second in terms of horizontal distances across the picture, such a ruler would have a length equal to the width of the picture, and would be divided into approximately 53 equal divisions, each division representing one millionth of a second. With such a ruler, it is a simple matter to measure the duration, or elapsed time, from start to finish, of any signal that is present in the picture. Knowing the duration of the signal, or the number of cycles of signal that occur in a given time, it is easy to compute the frequency of the signal.

Application

One cycle of signal consists of a positive half-cycle and a negative half-cycle which, when applied to the kinescope grid, produce a bright spot and a dark spot on the scanning line. One bright spot and one dark spot, therefore, represent one cycle. Normally, the eye does not distinguish the individual spots in each scanning line, but, if the signal is repeated in each line in such a way that the spots become vertically aligned, the spots will appear as vertical lines. One dark and one light vertical line is equivalent to one cycle of signal on each scanning line. The frequency of the signal can be determined by counting the number of cycles in any desired number of microseconds, using the RCA Microstick to measure the number of microseconds.

$$\text{Frequency in megacycles} = \frac{\text{Number of cycles}}{\text{Number of microseconds}}$$

If a fairly large number of cycles is to be counted, it is sufficiently

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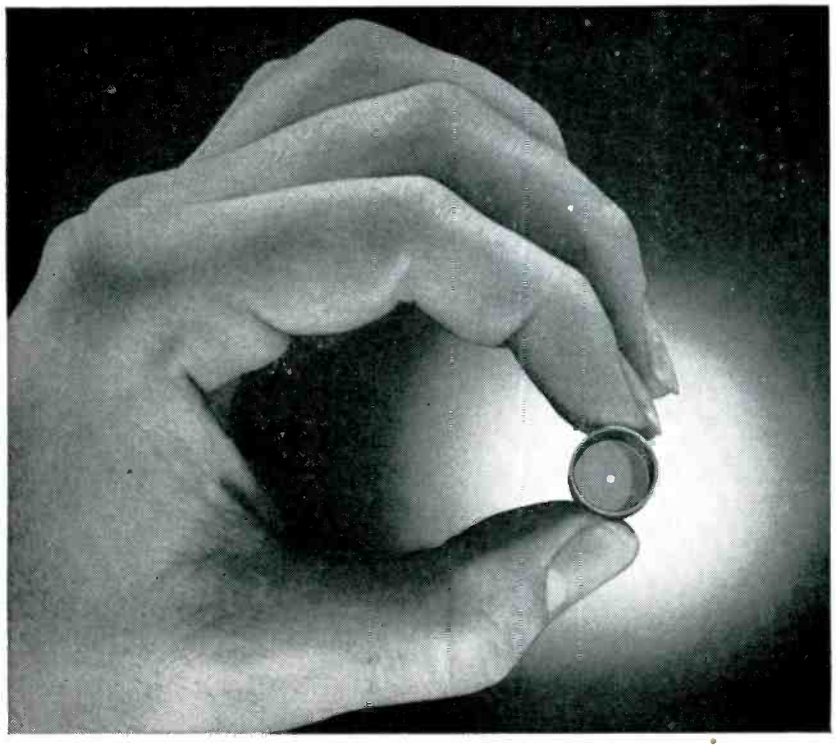
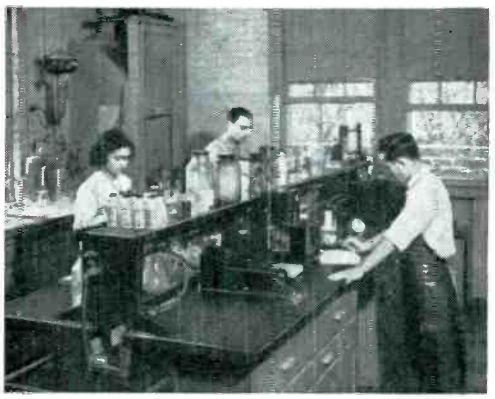


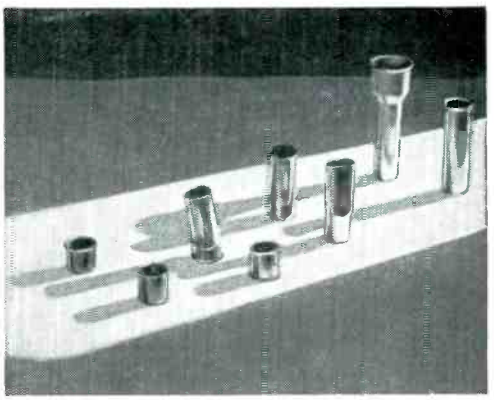
● You may not recognize the object pictured above. It is the first grid cylinder for a cathode ray tube gun structure, photographed from an unusual angle. The hole is only .040" in diameter —and the grid itself is deep drawn in one piece to save unnecessary welding and assembly operations by TV tube manufacturers.

This is tubing technology in operation. It is an example of Superior's superiority in electronic research, production know-how and facilities, and metallurgy. It is one product of hundreds pioneered for the electronic industry by Superior.

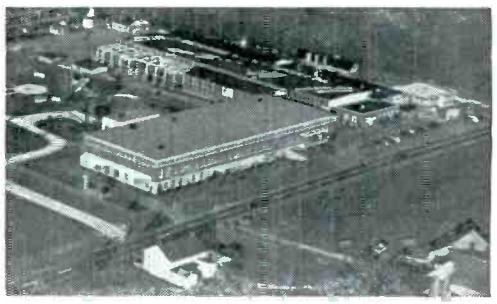
You may already be one of our valued customers and friends —nearly all electronic manufacturers are. If small Seamless or †WELDRAWN tubing can help anywhere in your product Superior can help you. To find out how, write Superior Tube Company, 2500 Germantown Avenue, Norristown, Pennsylvania.



All in a Day's Work—Chemical Laboratory continually samples raw materials; checks and controls quality from suppliers.



Sized and Shaped for TV—Hundreds of tubular parts are produced by Superior from WELDRAWN Type 305 (18-12) stainless steel.



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SEAMLESS . . . ? The finest tubes that can be made. Standard production is .010" to .121" O.D. inclusive, with wall thicknesses of .0015" to .005". Cathodes with larger diameters and heavier walls will be produced to customer specification.

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accurate to count only the dark vertical lines, and use this figure as the number of cycles.

Community TV Antenna System

SURROUNDED by mountains, the town of Franklin, Pa. receives television programs from Pittsburgh, 65 miles away, over a wire service established in the town. Signals are received on multibay antennas installed on nearby mountain tops and fed along a five-mile line to the town.

The installation is owned and maintained by Haren Corp. of Franklin. It serves over 40 outlets in homes and places of business. Householders pay $9.25 a month, clubs and taverns pay $5.00 per month extra for each outlet when using more than one receiver, and retailers, who demonstrate television receivers, pay a flat $25 per month.

Signal strength at the antenna towers from the one station in Pittsburgh varies from 300 to 1,000 microvolts. Amplifiers in the line maintain a 3,500-microvolt level to the outlets. Both coaxial and flat line are used, but 300-ohm flat line is favored.

Results

Many communities have local ordinances governing the installation of wires around the town and over streets. Franklin has no such regulations and the line runs from house to house wherever permission can be obtained. This has necessitated running a line around a block to avoid certain properties whose owners refuse to cooperate.

Reception is reported good to excellent by observers but some difficulty is experienced on the extremes of the feed lines on rainy days. If the rain is followed by freezing conditions, however, the signal comes up to dry-day amplitude.

An example of the improvement the installation has offered is evidenced at the local Moose Club. Here, an investment of $1,500 in a 140-foot tower, antenna, booster amplifiers and rotators produced no usable pictures. Connection to the community line resulted in good reception on four sets in the club.

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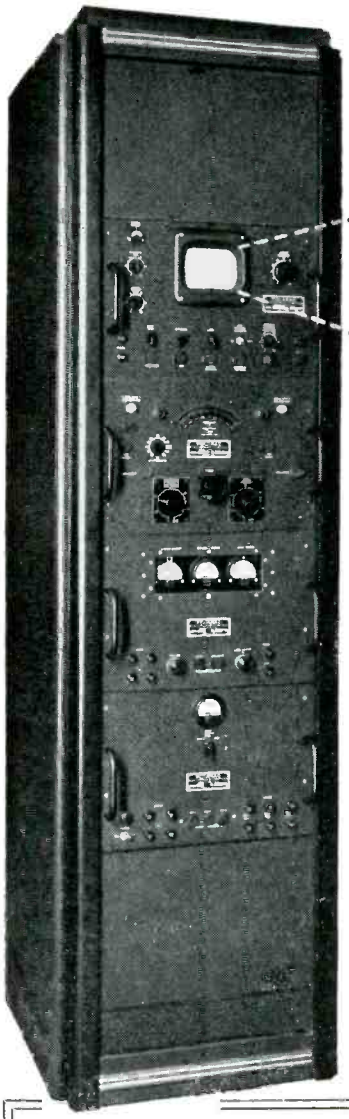
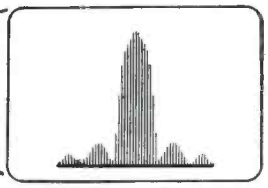
SPECTRUM ANALYZER

10 MCS to 16,520 MCS





Polarad's Model LSA Spectrum Analyzer is the result of years of research and development. It provides a simple and direct means of rapid and accurate measurement and spectral display of an r.f. signal.

Outstanding Features:

- Continuous tuning.
- One tuning control.
- 5 KC resolution at all frequencies.
- 250 KC to 25 MCS display at all frequencies.
- Tuning dial frequency accuracy 1 per cent.
- No Klystron modes to set.
- Broadband attenuators supplied with equipment above 1000 MCS.
- Frequency marker for measuring frequency differences 0-25 MCS.
- Only three tuning units required to cover entire range.
- Microwave components use latest design non-contacting shorts for long mechanical life.
- Maximum frequency coverage per dollar invested.
- 5 inch CRT display.

The equipment consists of the following units:

Model LTU-1 R. F. Tuning Unit— 10 to 1000 MCS.
Model LTU-2 R. F. Tuning Unit— 940 to 4500 MCS.
Model LTU-3 R. F. Tuning Unit— 4460 to 16,520 MCS.

Model LDU-1 Spectrum Display Unit.
Model LKU-1 Klystron Power Unit.
Model LPU-1 Power Unit.

Where Used:

Polarad's Model LSA Spectrum Analyzer is a laboratory instrument used to provide a visual indication of the frequency distribution of energy in an r.f. signal in the range 10 to 16,520 MCS.

Other uses are:

1. Observe and measure sidebands associated with amplitude and frequency modulated signals.
2. Determine the presence and accurately measure the frequency of radio and/or radar signals.
3. Check the spectrum of magnetron oscillators.
4. Measures noise spectra.
5. Check and observe tracking of r.f. components of a radar system.
6. Check two r.f. signals differing by a small frequency separation.

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(continued from p 122)

final results of gain versus spacing and shows that maximum forward gain is obtained with the reflector spaced approximately 0.15 wavelength and the director spaced 0.3 wavelength.

The corrected gain of this array with conventional spacings (reflector spaced 0.15 wavelength and director spaced 0.1 wavelength) was found to be 6.74 db. Reference to 2D shows that the same array using a reflector spaced 0.15 wavelength and a director spaced 0.3 wavelength had a corrected gain of 8.6 db. Thus greater gain may be obtained by using the wider spacings. However, these spacings give higher input reactance (see Fig. 2B); so impedance matching may be necessary. Figure 2A shows that array input resistance increases with

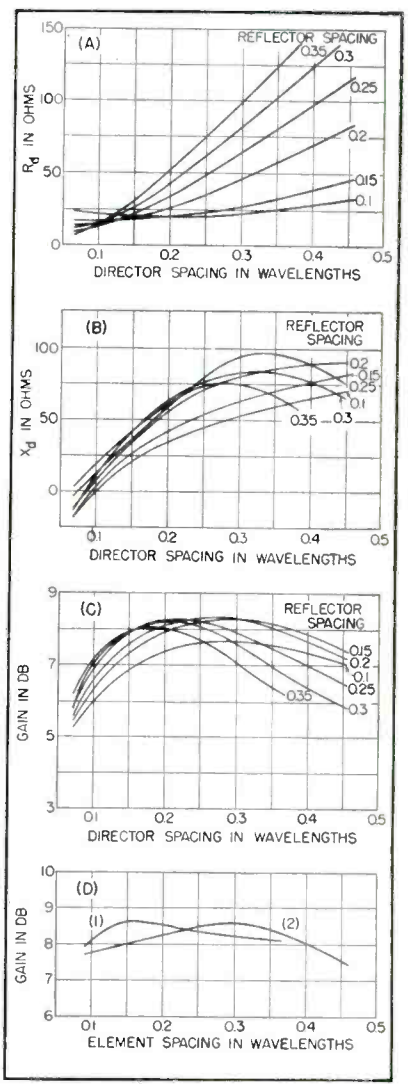
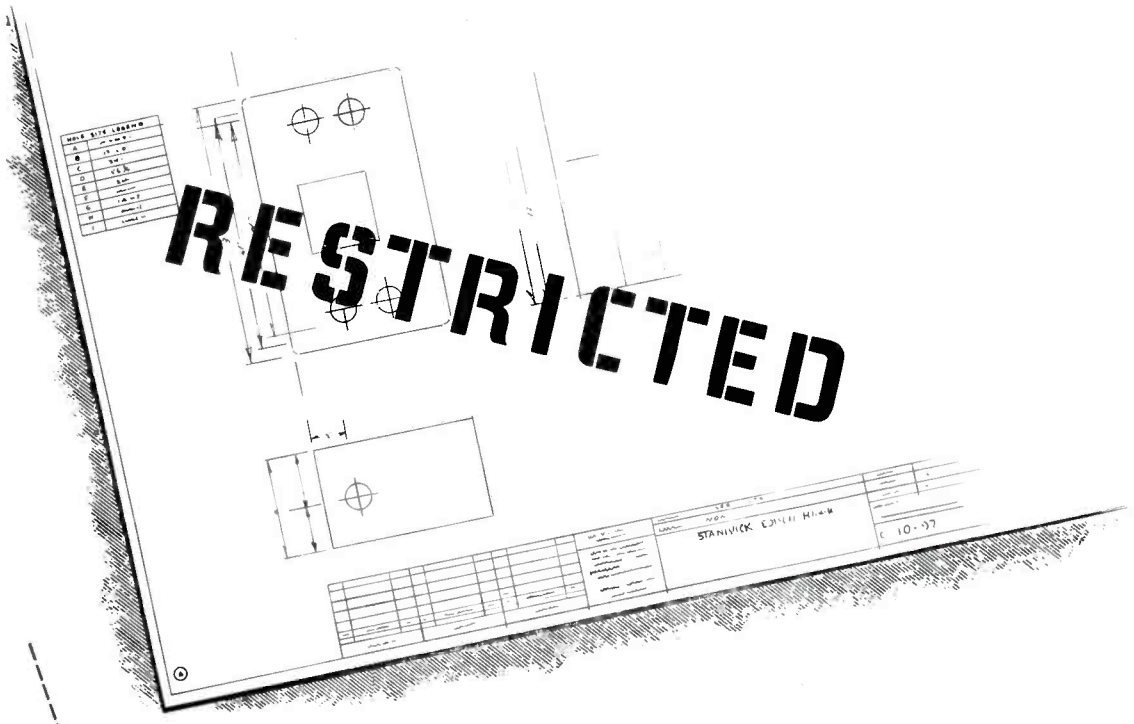


FIG. 2—Resistance and gain curves for various array configurations



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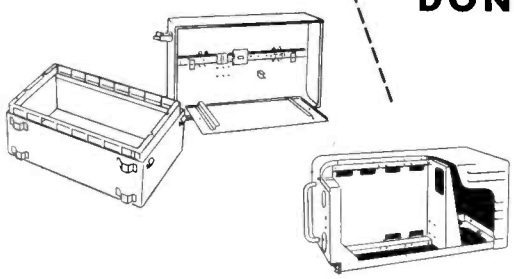

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spacing. This is an additional advantage of wider spacings, if the antenna is to be used over a range of frequencies.

Reference

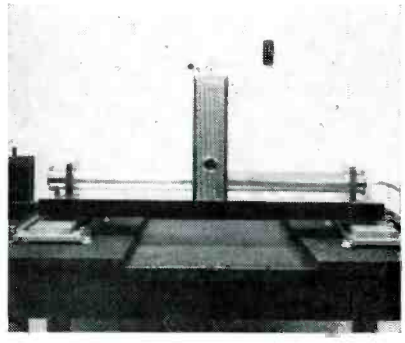
(1) G. H. Brown, Directional Antennas, *Proc. IRE*, 25, p 78, Jan. 1937.

Electrodynamic Ammeter for VHF

IN ESTABLISHING standards for electrical circuits in the very-high-frequency region now so widely used by radio and television services it is important to extend the direct measurement techniques used at lower frequencies as far as possible. Up to 300 mc, the current flowing in a circuit whose physical dimensions are small with respect to wavelength is essentially a uniform quantity, and the electrical characteristics of small circuit elements may be determined directly in terms of voltage and current. This fact makes possible the establishment of a standard electrodynamic ammeter for the vhf range.

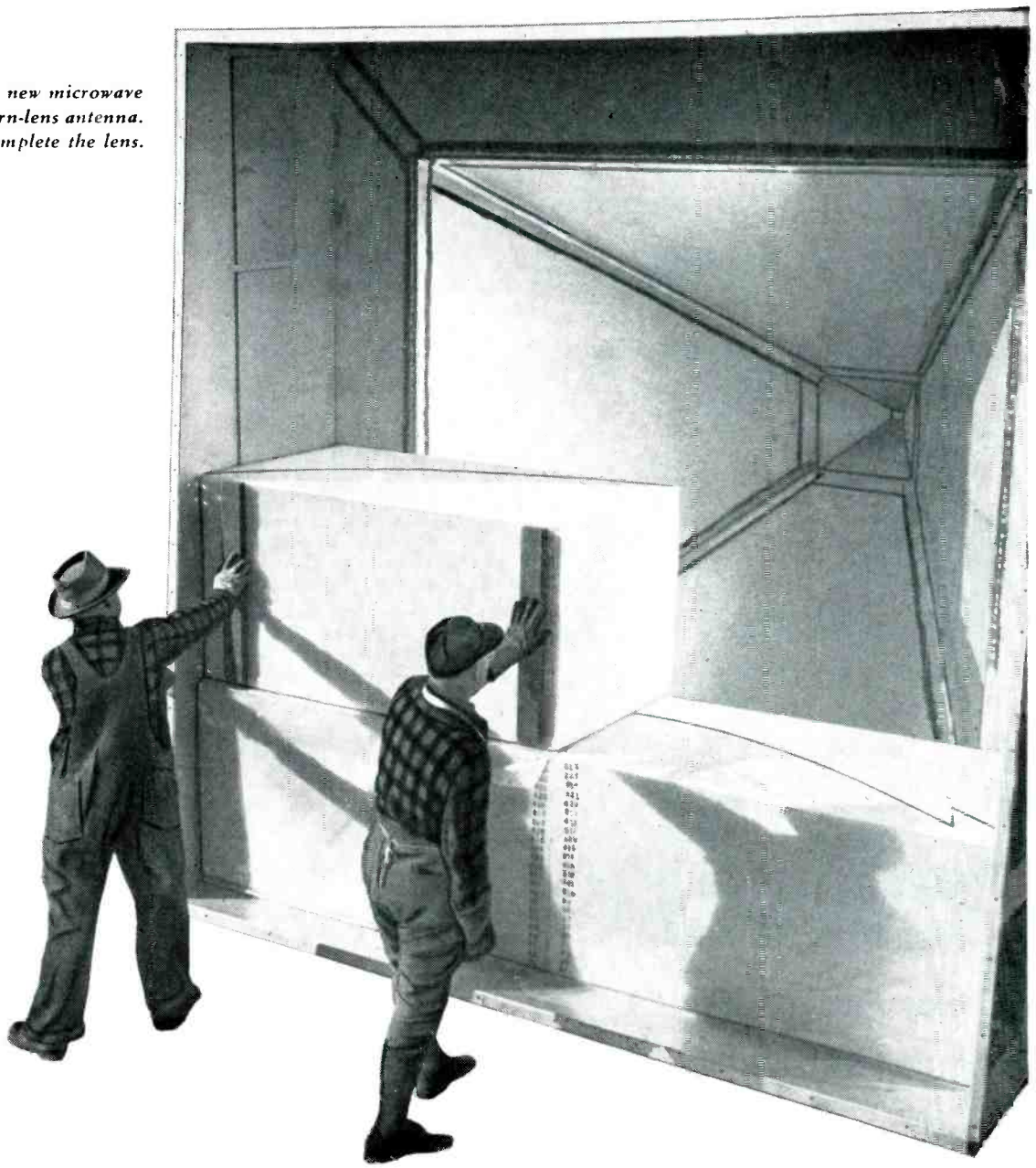
Basically the method depends on a torque measurement on a conducting ring immersed in a field which does not change with frequency. This technique provides an absolute, broad-band measurement of high-frequency current, but several factors are critical in any actual design.

For minimum distributed capacitance and uniform current the short-circuited ring must be only a single turn, and the ring diameter must be small with respect to wavelength. For accurate inductance calculations the ring conductor should have a small cross section, but re-



Experimental model of the vhf electrodynamic ammeter. Deflection of a short-circuited ring in a section of coax tells amount of current flowing

Mounting Bell's new microwave lens in a horn-lens antenna. Other blocks will complete the lens.



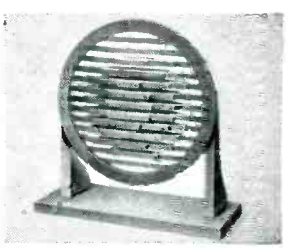
A focus on better, low-cost telephone service

In the new microwave radio relay system between New York and Chicago, giant lenses shape and aim the wave energy as a searchlight aims a light beam.

Reasoning from the action of molecules in a glass lens which focuses light waves, Bell Laboratories scientists focus a broad band of microwaves by means of an array of metal strips. To support the strips these scientists embedded them in foam plastic which is virtually transparent to microwaves. Rigid and light in weight, the plastic is easily mounted on relay towers.

This unique lens receives waves from a wave guide at the back of the horn. As they pass across the strips, the waves are bent inward, or focused to form a beam like a spotlight. A similar antenna at the next relay station receives the waves and directs them into a wave guide for transmission to amplifiers.

This new lens will help to carry still more television and telephone service over longer distances by microwaves. It's another example of the Bell Telephone Laboratories research which makes your telephone service grow bigger in value while the cost stays low.



Laboratory model of the new lens. A similar arrangement of metal strips is concealed in the foam plastic blocks in the large picture.

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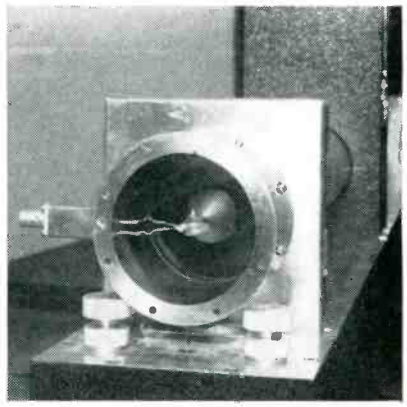
Working continually to keep your telephone service big in value and low in cost.



End view of electrodynamic ammeter shows calibration thermocouple

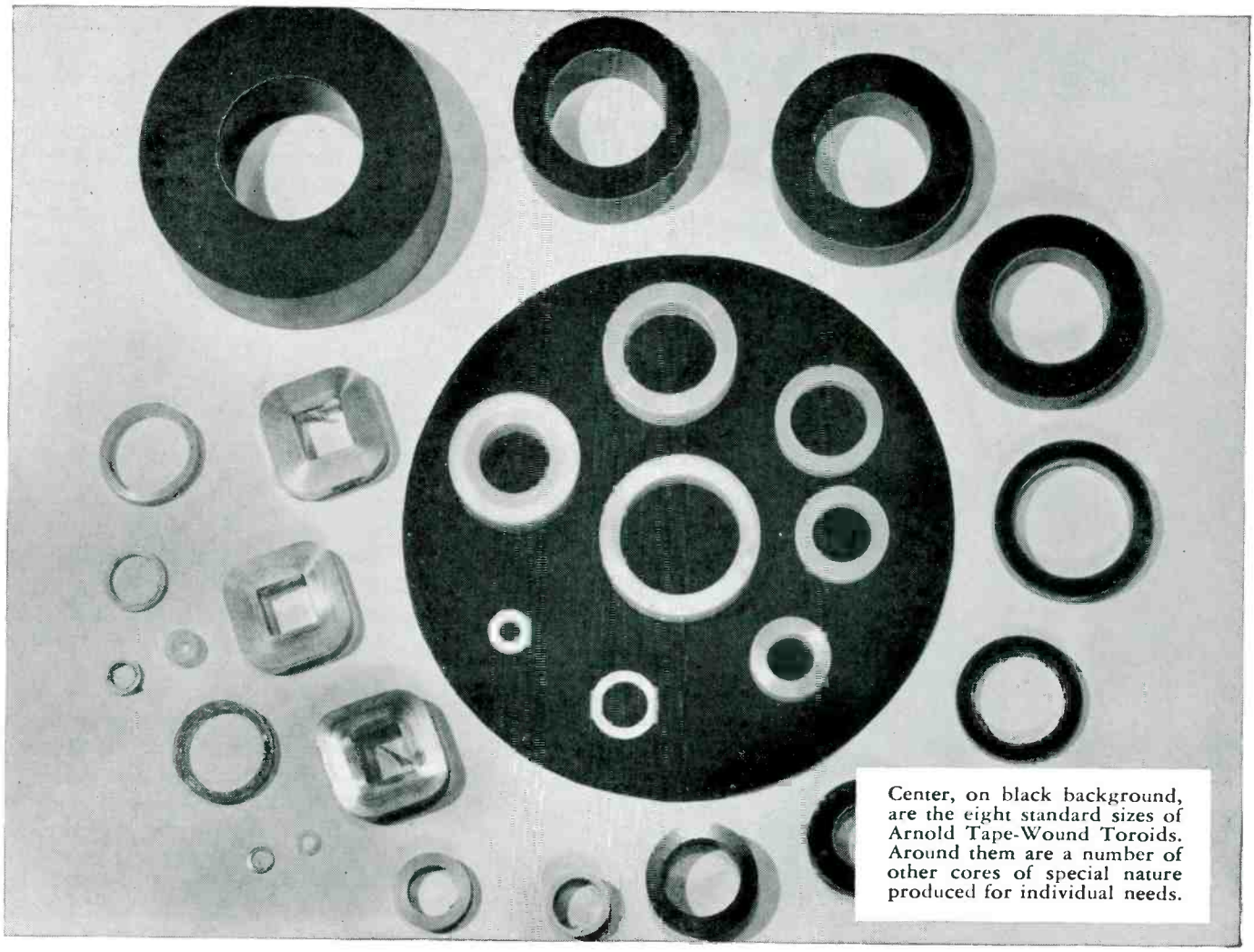
sistance then limits the current. A ring 1 cm in diameter of No. 20 copper wire is a practical size. When the ring current is small, the torque is also small, and the ring must be suspended on a delicate quartz fiber for accurate torque measurements.

The coaxial line, acting as the primary current-carrying element for the electrodynamic ammeter, has several advantages over other forms of conductor. Its electromagnetic field can be calculated in a straightforward manner, and the line may be readily modified for calibration work with different types of r-f ammeters.

Calibration may be accomplished directly and absolutely. A section of the coaxial transmission line, one wavelength long at 300 mc, is arranged with short-circuited ends to form a resonant cavity, and the torque ring is placed midway along the section.

A known value of 300-mc power is fed into an input loop at one end of the cavity. Under these conditions the torque ring will be at a current maximum and a voltage minimum, and the measured torque on the ring will be due almost entirely to the magnetic component of the cavity field. The measurement is then repeated at 150 mc where the current and voltage relations are reversed and the torque is due only to the electric component.

One further measurement is needed for absolute calibration of the ammeter. The cavity resonance frequency is measured at both 300 and 150 mc with and without the torque ring in place. The resulting changes in frequency are then a measure of the field discontinuity



Center, on black background, are the eight standard sizes of Arnold Tape-Wound Toroids. Around them are a number of other cores of special nature produced for individual needs.

ARNOLD TAPE-WOUND TOROIDAL CORES

of DELTAMAX 4-79 MO-PERMALLOY SUPERMALLOY*

In addition to the standard toroids described at left, Arnold Tape-Wound Cores are available in special sizes manufactured to meet your requirements—toroidal, rectangular or square. Toroidal cores are supplied in protective cases.

*Manufactured under licensing arrangements with Western Electric Company.

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Arnold Tape-Wound Toroids are available in eight sizes of standard cores—all furnished encased in molded nylon containers, and ranging in size from ½" to 2½" I.D., ¾" to 3" O.D., and ⅛" to ½" high.

RANGE OF TYPES

These standard core sizes are available in each of the three magnetic materials named, made from either .004", .002" or .001" tape, as required.

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General Office & Plant: Marengo, Illinois

introduced by the presence of the ring. After the torque and discontinuity measurements are completed the instrument can be used as a standard to calibrate other ammeters at very high frequencies.

The electrodynamic vhf ammeter was developed at the National Bureau of Standards.

Matching Loads on a Magic Tee

BY A. C. MACPHERSON AND D. M. KERNS
National Bureau of Standards Washington, D. C.

A MAGIC TEE (Fig. 1) is often used to match a variable load to an arbitrary fixed load. The arbitrary load and the variable load, of reflection coefficients $S_1 = |S_1|\exp j\theta_1$, and $S_2 = |S_2|\exp j\theta_2$ respectively, are placed on arms 1 and 2, respectively of the magic tee. A signal generator feeds power to arm 4, and S_2 is tuned until a null is indicated by a detector in arm 3. If the power delivered to the detector is less than the minimum power the detector can indicate, the null is only apparent and will be observed for a range of values of S_2 in the neighborhood of S_1. There follows a method of evaluating the limits of this range.

Assume that the generator and the detector are reflectionless. Then it can be shown that for a symmetrical lossless magic tee $4P_3/P_4 = [\,|S_1|^2 + |S_2|^2 - 2|S_1|\,|S_2|\cos(\theta_1 - \theta_2)\,]$, where P_3 is the power delivered to the detector in arm 3 and P_4 is the power fed into arm 4. Power P_4 is related to the power that the generator would deliver to a matched load, P_m, by $P_4 \cong P_m(1 - |S_1|^2)$.

Assume that there is some defi-

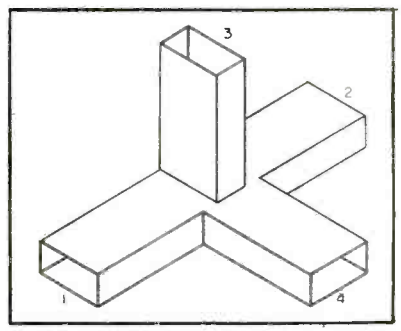

FIG. 1—Magic-tee network used to match variable load to an arbitrary fixed load

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COOLER OPERATION This cell is very cool running. Its low forward resistance results in lower temperature rise and higher efficiency.

SPACE SAVING These 26-volt RMS cells can now be used wherever you have previously used 18-volt cells. This will give you stacks that are smaller, lighter—more compact.

MONEY SAVING This cell will save you money. For any given application, these stacks are usually less expensive than low-voltage stacks. Because they have a higher voltage output throughout their longer life, you can save on the design of transformers, relays and other circuit components.

GET THE FACTS Dollar for dollar, we believe that these cells are the best selenium rectifier buy on the market today.

Get the full story—write Section 461-9 for bulletin GEA-5280A—consult your nearest G-E Apparatus Sales Office for application recommendations.

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GENERAL ELECTRIC

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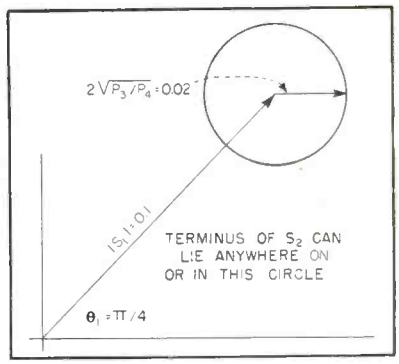

FIG. 2—Geometric solution of magic-tee load-matching problem

nite value of P_3 which is the minimum power that the detector can indicate.

Since the above expression has the form of the law of cosines, a very simple geometric solution presents itself.

On the complex plane, draw S_1 to any convenient scale as shown in Fig. 2. Using the same scale, with the terminus of S_1 as a center, draw a circle of radius $2\sqrt{P_3/P_4}$. Then the locus of the terminus of S_2 will be on or in this circle. (The figure is drawn for the following values: $P_3 = 10^{-6}$ watts; $P_4 = 10^{-2}$ watts; $S_1 = 0.1\exp(j\pi/4)$). It is clear from the drawing that in general the largest possible difference between $|S_1|$ and $|S_2|$ is $2\sqrt{P_3/P_4}$, and the largest possible difference between θ_1 and θ_2 is given by $\sin(\theta_1 - \theta_2) = 2\sqrt{P_3/P_4}/|S_1|$.

Wien-Bridge Network Modifications

By R. Zuidhof
The Hague, Holland

To determine the influence of the stray capacitance in shunt with the series resistor in a Wien-bridge network such as used in a-c bridges, resistance-capacitance oscillators and selective amplifiers[1], an attempt was made to find an expression for the frequency and the ratio of the impedances with an extra capacitance C_s placed in the circuit. Eight modifications of the Wien network were derived. Three of them showing interesting properties appear in Fig. 1.

From Fig. 2 the influence of the capacitance C_s on the frequency can

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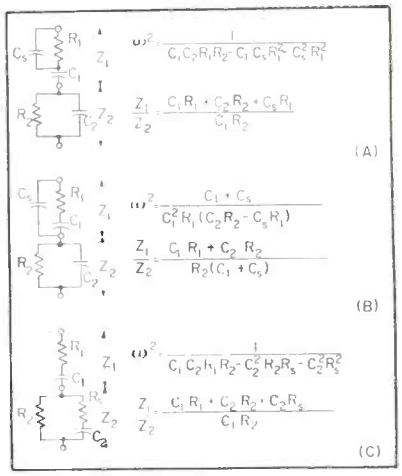

FIG. 1—Three modifications of the Wien-bridge network

be determined when C_1 equals $C_2 = C$. However C_s also has some influence on the impedance ratio. When in an R-C oscillator tuning is done by means of a variable capacitor, the stray capacitance C_s may have a harmful effect when the variable capacitor has its minimum value. Both frequency and impedance ratio will be affected if the value of C_s forms an appreciable part of the value of the variable capacitor in its minimum position.

In a resistor-switching oscillator with three or more ranges[2, 3], the stray capacitance will probably not be the same on all ranges. Therefore at the high-frequency end the scales will not properly coincide.

The effect of C_s on the impedance ratio manifests itself in the output voltage, which will not remain constant. By means of a second capacitance C_s in shunt with C_1 however, this ratio can be made constant. When C_1 is made $C + C_s$, $C_2 = C$ and R_1 equals $R_2 = R$, the impedance ratio becomes

$$\frac{Z_1}{Z_2} = \frac{(C + C_S)\,R + CR + C_S R}{(C + C_S)R} = 2 = \text{constant}$$

The formula for the frequency now becomes

$$f = \frac{1}{2\pi R \sqrt{C^2 - C_S^2}}$$

As can be seen, C_s has an opposite effect on the frequency from C and this property can be used to extend the frequency range.

When on all ranges trimmers C_s are placed over R_1 and C_1, the oscillator can be completely trimmed, so that the scales properly coincide and

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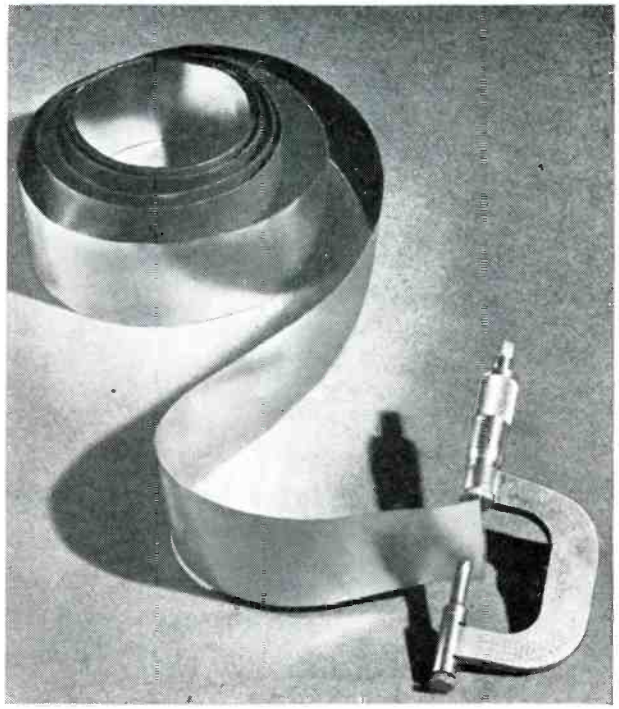

"326" Monel strip is available in standard widths to 12 inches, in thicknesses of 0.005 in. and more. In narrower widths it is rolled to a thinness of 0.001 in.

"326"® Monel is substantially *non-magnetic* at and above room temperatures. The approximate permeability at 68°F. is 1.025 and at 14°F. is 1.1. Neither hot nor cold working appreciably affect its magnetic properties.

"326" Monel is rust-proof and highly resistant to most commonly-encountered corrosives.

"326" Monel possesses high physical properties similar to those of Monel — strength, toughness, and resistance to abrasion.

In addition to these valuable physical characteristics, "326" Monel is a thoroughly *practical* metal . . . economical to buy; easy to use; readily workable. There is less die wear than with materials that work-harden rapidly. Firing temperatures for vacuum tube use are lower (approximately 1500°F.) and "326" Monel can be fired in line hydrogen; dry hydrogen is not needed.

"326" Monel can be welded, brazed, or soldered . . . can be readily machined, formed, drawn, or forged. It is available in standard mill forms. As strip, its most widely used form in the electrical field, "326" Monel is available in standard widths up to 12 inches, in thicknesses of 0.005 in. and heavier. In narrower widths, it is rolled to a thinness of 0.001 in.

Next time you are faced with a problem that demands a tough, non-magnetic, corrosion-resistant alloy . . . specify "326" Monel.

Meanwhile, write for your copy of "*Inco Nickel Alloys for Electronic Uses.*" This valuable 26-page booklet gives the composition, characteristics, and typical applications of 18 helpful Inco Nickel Alloys.

Where Can You Use This Unusual Inco Alloy?

Typical Uses

Cathode ray tube gun structures
Structural parts of special vacuum tubes
Mass spectrometer parts
High voltage cable shielding tape, for use in wet, corrosive, abusive conditions.
Good for voltages up to 50,000

Availability

Mill forms including:
Rods and bars, hot-rolled and cold-drawn
Strip and ribbon, cold-rolled
Sheet, cold-rolled
Seamless tube
Wire, hot-rolled and cold-drawn

"326" Monel
Limiting Composition %

Ni (+ Co)	58-61
Fe	2.50 max.
Mn	2.00 max.
C	.30 max.
Si	.50 max.
S	.02 max.
Cu	remainder

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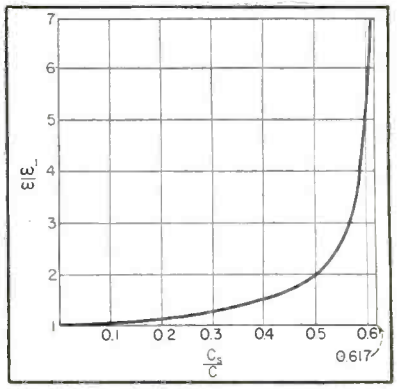


FIG. 2—Influence of capacitance on frequency

even the phase shift in the amplifier on the higher frequencies can be compensated.

The output voltage can also be made constant over the whole range by means of the trimmers. Of course the resistors of all ranges must have the proper ratio and also the ganging of the variable capacitor has to be correct.

Fig. 3A presents the most general form of the first modification. It can be shown that for a constant impedance ratio x must be equal to yz and when this condition has been fulfilled, Z_1/Z_2 will have the constant value $y + 1/z$.

When a Wien-bridge network is designed for optimum frequency stability[4], this property will be useful.

Trimming can also be done according to the modification shown in Fig. 1B. If R_1 and R_2 are both made equal to R, $C_1 = C$ and $C_2 = C + 2C_s$ the impedance ratio $Z_1/Z_2 = 2$ and

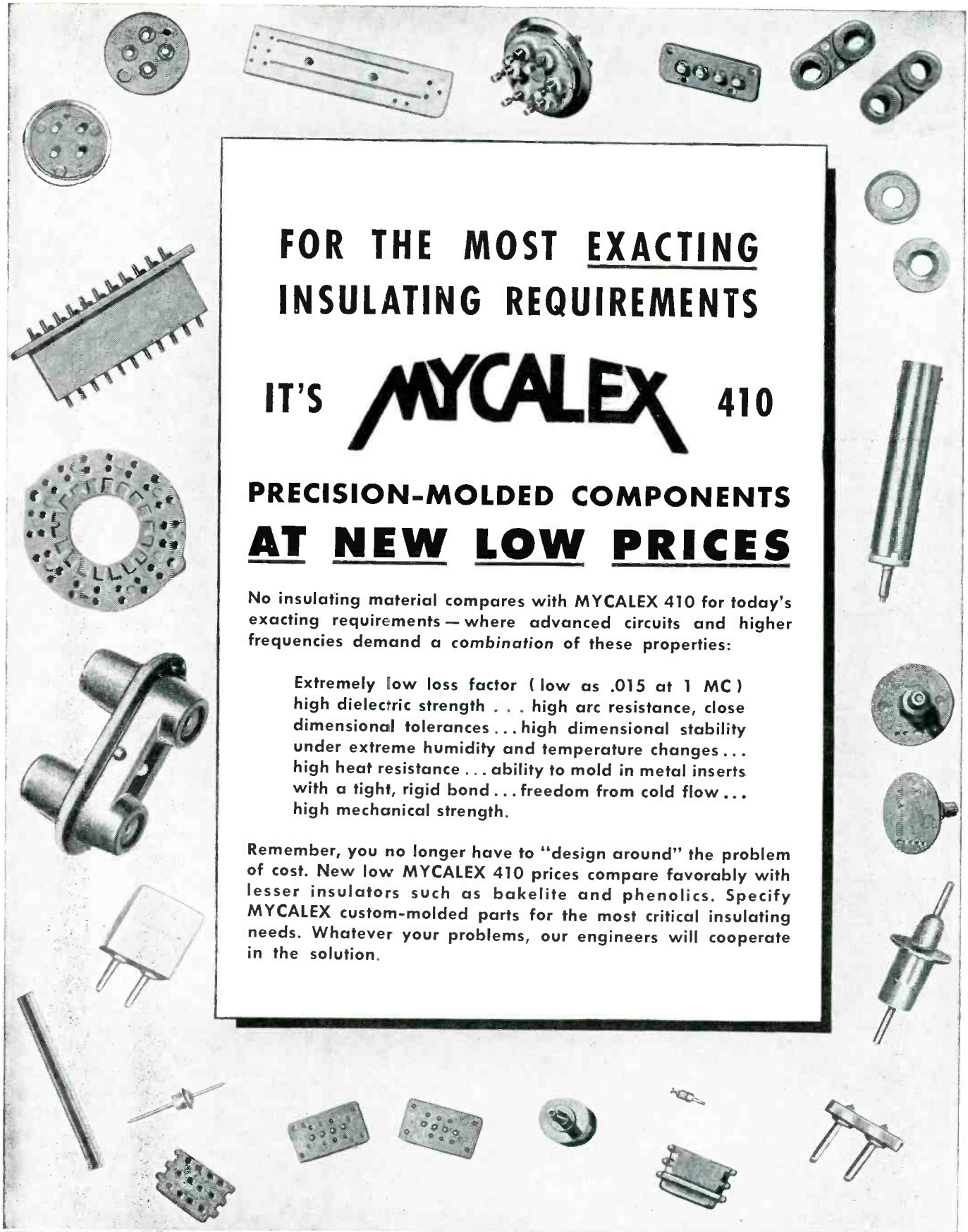
$$f = \frac{1}{2\pi RC}$$

which is the formula of the original Wien bridge. The factor $2C_s$ may consist of the amplifier-input capacitance only and the trimmer C_s must then be half of this capacitance.

Figure 1C shows an interesting property. The values of the components can be chosen such that tuning can be accomplished by variation of one circuit element only. When C_1 and C_2 are both made C, $R_1 = R - R_S$ and $R_2 = R$; the impedance ratio becomes

$$\frac{Z_1}{Z_2} = \frac{C(R - R_S) + CR + CR_S}{CR} = 2$$

thus Z_1/Z_2 is a constant, and



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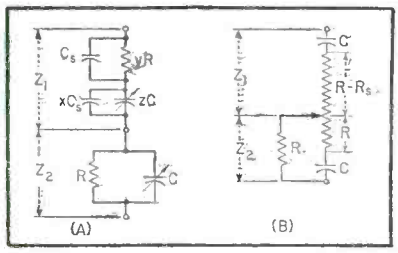

FIG. 3—Trimmers provide frequency and output-voltage control

$$\omega^2 = \frac{1}{C^2 (R^2 - 2RR_S - R_S^2)}$$

From Fig. 3B it can be seen how this is brought into effect. However in practice the output does not remain constant and a good sine wave can only be obtained over a small range.

For the influence of R_s on the frequency variation a similar curve as in Fig. 2 can be drawn. It can be seen from this curve and calculations, that a very slight variation of R_s above a certain value gives a large frequency variation, therefore the selectivity deteriorates rapidly. With a differential variable capacitor a similar solution can be obtained for Fig. 1B.

REFERENCES

(1) F. E. Terman, "Radio Engineers' Handbook" McGraw-Hill Book Co., p 503 and p 904, New York 1943.

(2) W. Noel Eldred, Generator for A-F Measurements, *F-M and Television*, p 31, June 1949.

(3) Charles F. Lober, A Wide-Range Test Oscillator, *QST*, p 40, May 1946.

(4) H. A. Whale, Optimum Conditions for an R-C Oscillator, ELECTRONICS, p 178, Feb. 1948.

Theater Television Projection on Full-Size Screens

AN ELECTROMECHANICAL accumulation process has shown promise for direct projection theater television on full-size screens. This method has been developed at the Polytechnical Institute of Zurich, Switzerland and has been demonstrated successfully in experimental form.

The principle of the system is shown in Fig. 1. Light from an arc is projected through a thin layer of viscous liquid deposited on a thin metallic electrode which is transparent to the light beam. This surface, called the eidophor, is mechanically deformed by the charge accumulating from an electron beam impinging on its surface. The charge produces electrostatic forces

BANK ROBBERS Terrorized

Crime prevention aided by Telechron Timing Motors

Most bank robbers take no chances on a vault that can screech a warning of their presence.

In fact, official records of the Diebold Corporation — makers of Bank Vault Burglar Alarm Systems — show that robbers who have attempted such an attack were so panic-stricken by the alarm, they left their tools behind them, thus leading to their own identification and arrest! These same records also show that nearly 2000 successful bank robberies on unprotected vaults were committed between 1903 and 1948. During the same period, only 97 attacks were made on Diebold-protected vaults—none of them successful.

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Perhaps you, too, need to depend upon a timing device that offers you split-second accuracy. If so, a standard Telechron Timing Motor is probably the answer for you. A Telechron application engineer, backed by the broadest experience in the field, can show you how you can save time and money with Telechron. Consult him *early* in your planning. Meanwhile, send the coupon below for further data. TELECHRON INC. A General Electric Affiliate.

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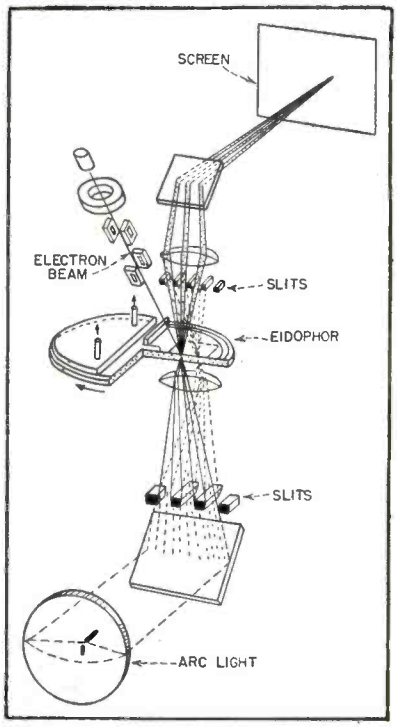

FIG. 1—Eidophor is control element in theater tv projection system

which cause the mechanical deformation.

Between the light source and the eidophor is a slit system (or Schlieren optics system), and a second slit system is positioned between the eidophor and the screen. The light passing to the screen may thus be controlled by applying appropriate mechanical deformation to the eidophor surface.

The method of modulating the

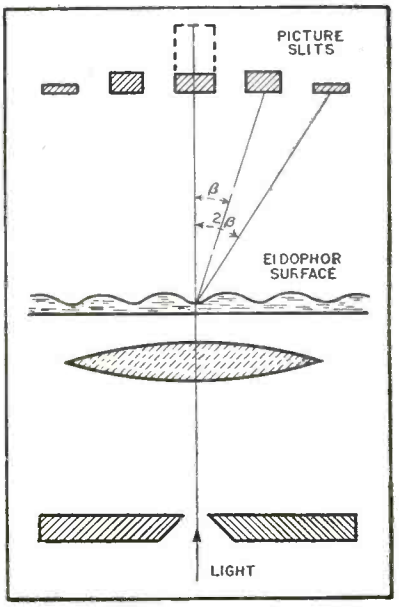

FIG. 2—Electromechanical deformation of eidophor surface controls light flux

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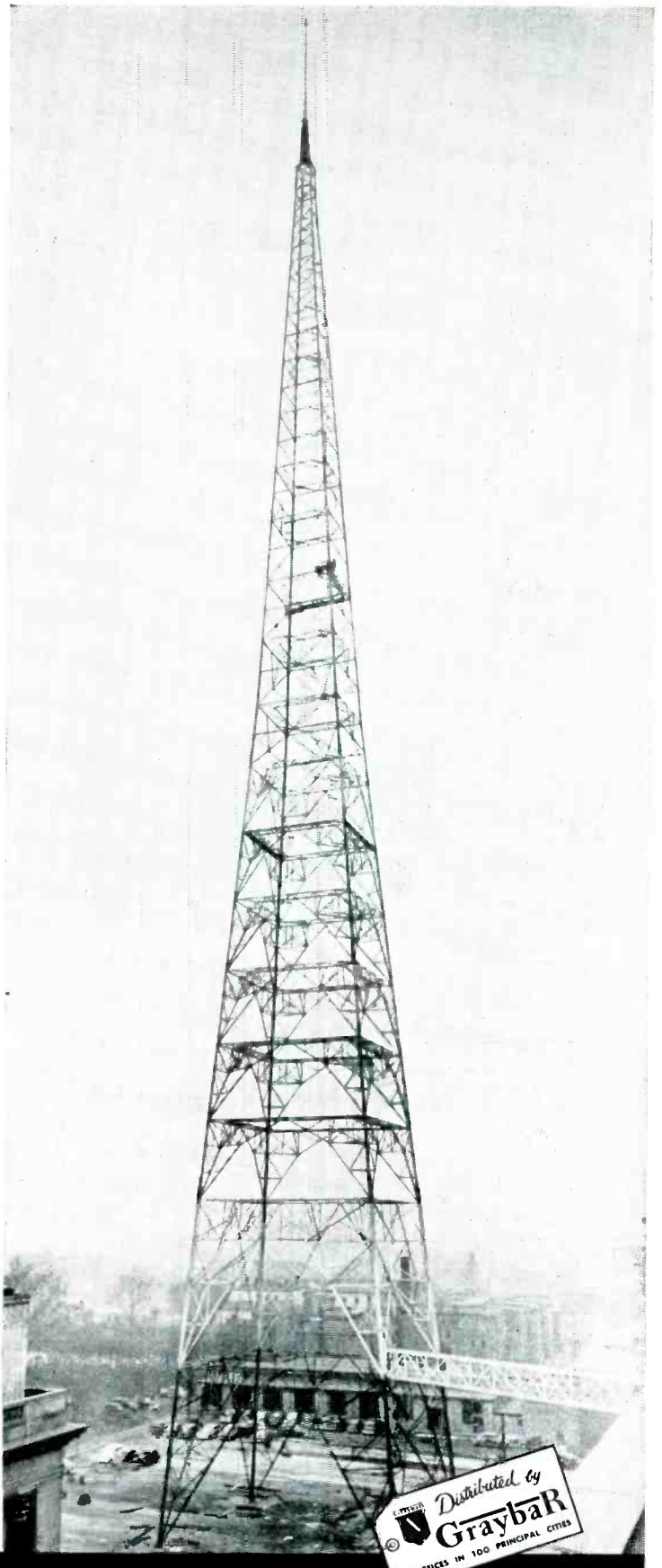

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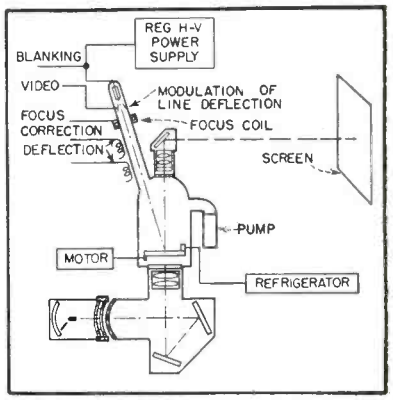

FIG. 3—Entire equipment requires continuous evacuation

electron beam is such that the intensity of the beam remains constant while the scanning speed in the direction of the line is varied to conform to the video signal. The net light efficiency of the system is 20 percent.

The size of the present model, which occupies two floors, is prohibitive for projection room installation. However, Professor Baumann of Zurich, has planned a new model whose expected dimensions are: height, 5 ft; length, 5½ ft; width, 2½ ft and weight 1,800 lb, according to an article by E. Labin, entitled, Eidophor Theatre Television, in the *Journal of ASMPTE*, April, 1950.

Air-Core Betatron

McGraw-Hill World News

A NEW BETATRON constructed by the Philips Laboratory for Scientific Research at Eindhoven, Holland, is considerably lighter in weight than existing models because it has no closed iron yoke for producing the required magnetic field. Instead,

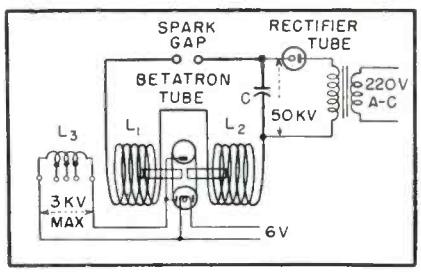

FIG. 1—Capacitor-discharge current flowing in air-core coils produces required magnetic field

Seletron

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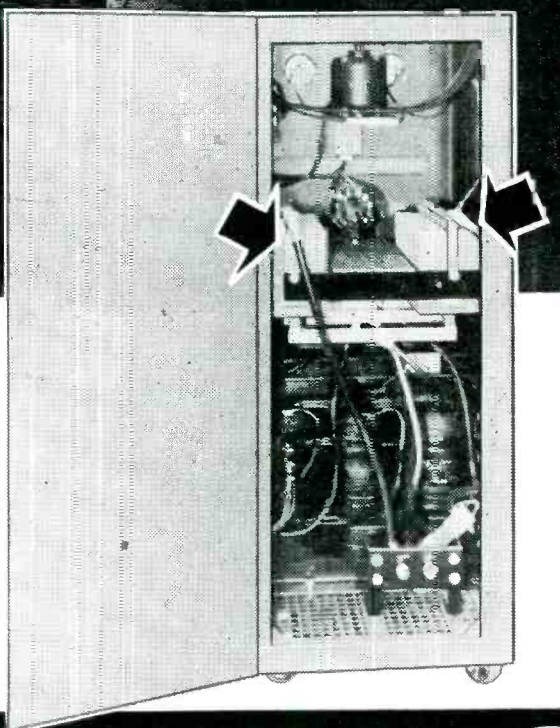
Here's another example of the flexibility of SELETRON Selenium Rectifiers. In the heart of New York's Times Square, Eveready Flashlight's giant new "spectacular" thrusts its 800,000,000 candle power beam 5½ miles into the night sky . . . Of course Richardson-Allen Corporation chose SELETRON Rectifiers for the D.C. power supply installation they designed and built for this job!



THIS D.C. POWER SUPPLY INSTALLATION SUPPLIES CURRENT TO THE ARC LAMP WHICH PROVIDES A BEAM OF 800,000,000 CANDLE POWER. RECTIFIER RATING 65 V, 150 AMPS.

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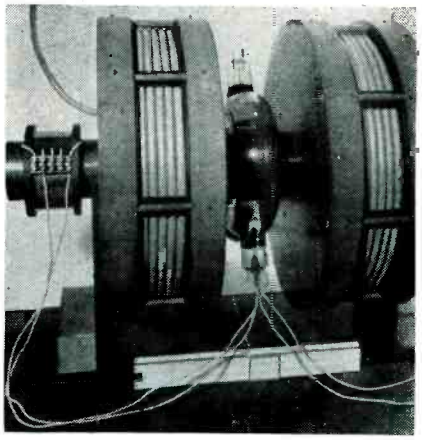

Air core betatron offers possibility for portable x-ray units

air-core coils energized by the capacitor discharge circuit of Fig. 1 are employed.

Each discharge of the capacitor produces a short pulse of current having a peak value of 5,000 amperes, but the heat developed by this current is so great that the discharge rate can be only 1 pulse per second. This limitation restricts applications for the air-core betatron at present, even though its lightness offers possibilities for portable x-ray units. Intensity of the pulsed irradiation is particularly high because a much larger number of electrons take part in the accelerating process in the annular tube during each pulsing cycle.

Sterilizing Pharmaceuticals

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1A60	213409-1	60	24	0.18	2.0	0.33±5%	900	0°±1.5°	10	10	10	0.22	1.5	0.2
5E	213315-1	60	90	0.15	5.0	1.0 ±1%	600	0°±0.5°	5	5	15	2.60	6.3	0.75
NEW 1A400*	213480-2	400	115	0.100	8.0	0.20 Nom.	Note 1	Note 3	10	20	20	0.57	2.0	0.2
NEW 1B400*	213480-1	400	115	0.100	8.0	0.20 Nom.	Note 2	Note 4	3	10	10	0.57	2.0	0.2
03ADC	715772-1	DC	24	0.15	3.5	0.070 V.D.C. (approx.) for an accel. of 1400 Radians/Sec.²						0.019	0.54	0.1
3	213151-1	DC	38-46	0.12	5	0.1 V.D.C. (approx.) for an accel. of 1400 Radians/Sec.²						0.25	3.0	1.0

NEW NEW NEW NEW

Types 1A400 and 1B400 are furnished with an external auxiliary unit which is considered in the statement of characteristics and in all quotations.

	1A400	1B400
Max. linearity deviation in % of max. specified speed	0.10%	0.15%
Max. phase variation, 0 to max. specified speed	0.3°	0.3°
Effect of ambient temperature change from 15° to 70° C. approx. variation of magnitude	1%	0.15%
approx. variation of phase	1°	0.3°

Notes
1 — Max. speed for specified performance ..... 1800 R.P.M.
2 — Max. speed for specified performance ..... 4000 R.P.M.
3 — Standardized output ... Volts 3.60±5% at 1800 R.P.M.
Phase 0°±1.5° at 1800 R.P.M.
4 — Standardized output Volts 7.200±0.1% at 3600 R.P.M.
Phase 0°±0.1° at 3600 R.P.M.

FEATURES **Rugged construction • High mechanical accuracy • Characteristics stable with time and handling • Low shaft runout • Low friction and inertia • High output to inertia ratio • Precision output.**

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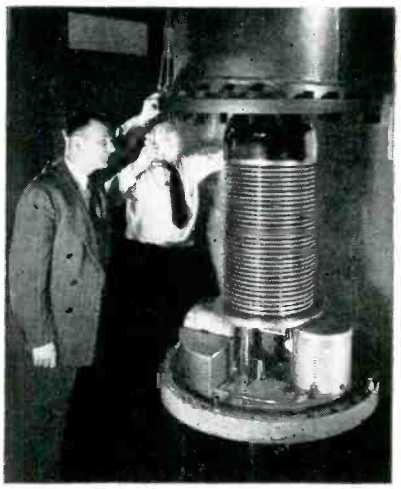

Lowering hood over 3,000,000-volt electrostatic generator used with MIT sterilizing equipment

at Massachusetts Institute of Technology for sterilizing a wide variety of pharmaceuticals after their final packaging. Penicillin, streptomycin, surgical sutures, anticoagulents such as heparin, and many other substances can be sterilized in their final sealed glass containers without detectable adverse effect on their potency or other properties.

The amount of cathode-ray energy that will completely destroy all bacterial and virus contaminants raises the temperature of the pharmaceutical less than 8 degrees. As a result, sterility of many heat-sensitive pharmaceutical products can now be achieved on a practical and economic basis by irradiation with such high-energy x-rays.

Ultrasonic Vibration Accelerates Polymerization

EMULSION polymerization reactions used in the production of synthetic rubber have been speeded up by ultrasonic vibration. Both a magnetostriction oscillator operating at 15 kc and a 500-kc piezoelectric oscillator were used in tests con-

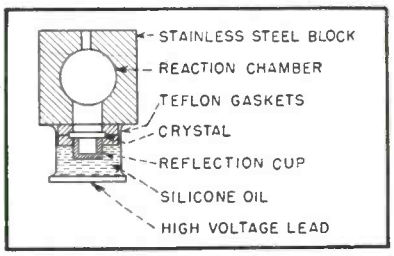

FIG. 1—Piezoelectric method requires reaction cell

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With the I-T-E Adjustable Shunt PM-EM Focus Coil you can adjust PM strength over a wide range, compensating for most tube and set variations. This feature virtually eliminates assembly line rejects caused by out-of-tolerance PM strength. Flexibility of the adjustable shunt makes it possible for you to use one focus coil design to focus several types and sizes of tubes.

Design features greatly reduce magnetic interference with ion magnet on new short neck tubes. Among the many other advantages of I-T-E Adjustable Shunt PM-EM Focus Coils is their low operating temperature — gained through lower focus current requirements. I-T-E Adjustable Shunt PM-EM Focus Coils retain proper focusing over a wide range of line voltage variations.

I-T-E makes Adjustable Shunt PM-EM Focus Coils for use with 10″, 12″, 14″, 16″ and 19″ picture tubes. They are available in a variety of standard or special mountings, and any special mounting can be furnished upon request. Information needed to manufacture: Type of tube; second anode voltage; focusing current desired; special considerations for mountings and leads.

I-T-E's design engineers will be glad to work with you on your applications or requirements — consult them without obligation. For complete information of I-T-E Adjustable Shunt PM-EM Focus Coils — or any other I-T-E wire-wound products — write, wire, or call, specifying your needs.

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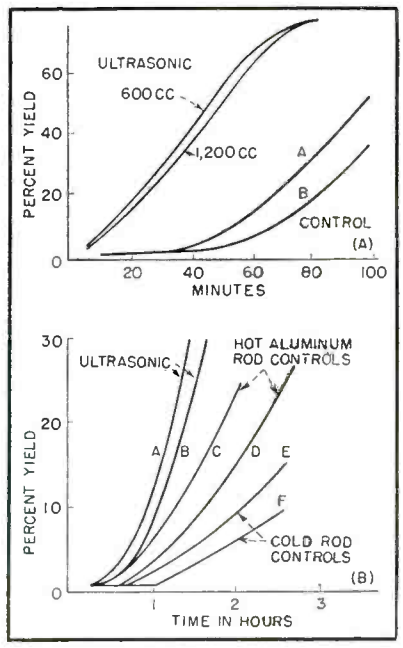

FIG. 2—Ultrasonic vibration eliminates induction period

ducted by the Goodyear Tire and Rubber Co.

The special reaction cell shown in Fig. 1 uses an X-cut quartz crystal as the source of 500-kc energy. Drive is supplied by a 300-watt oscillator. An efficiency of 50 percent has been realized. Since the reaction chamber limits the charge to 200 cc, a 10-liter thermostated reservoir is used together with a circulating diaphragm pump.

In the magnetostriction method, a water-cooled coil is fed by a 1,000-watt vacuum-tube oscillator. A d-c

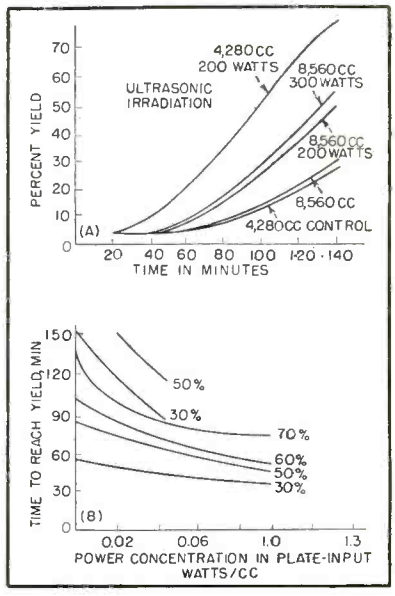

FIG. 3—Power concentration determines reaction time

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polarizing current of 20 amp at 400 volts is impressed upon the coil and the coil-and-bar assembly immersed in the emulsion to be treated. The process is carried on at atmospheric pressure under a stream of nitrogen.

The principal effect at 50 C (Fig. 2A) is elimination of the induction period with only a slight increase in the rate of reaction. At 40 C (Fig. 2B) the effect of irradiation is more pronounced. To show that the reaction was not due to heating of the nickel bar by hysteresis and eddy-current loss, a hot aluminum control bar was introduced. The nickel bar furnished 50 watts of acoustic power for a 1,000-watt input to the amplifier.

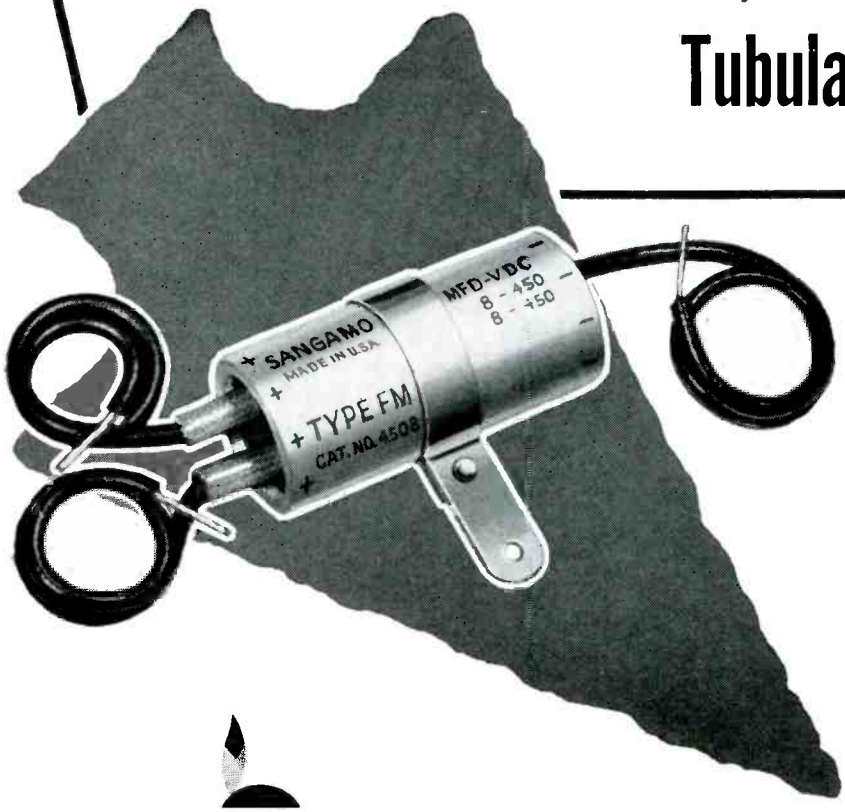
Curves indicating the effect of power concentration on reaction time are shown in Fig. 3.

SURVEY OF NEW TECHNIQUES

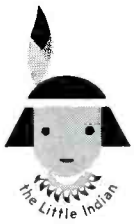
ANALYSIS OF water and gas pipeline systems has been carried out by use of an electric network analogy. Cornell University researchers announce that the device permits pressures and rates of flow to be represented easily by proportional electrical quantities. Each pipeline is represented by a fluistor, a special resistor consisting of a tungsten filament enclosed in an evacuated glass tube. Heavily loaded lines are indicated by bright fluistor filaments whereas underloaded lines fail to glow.

SEQUENTIALLY ARRANGED dots of red, blue and green-emitting fluorescent material form the basis of a direct-view color television tube for which a patent was recently issued to Allen B. Du Mont Laboratories, Inc. The single electron beam of the tube sweeps over the color dots of each line in synchronism with the beam of the camera tube at the transmitter, the screen of which has correspondingly colored and spaced photoelectric dots, each sensitive to one of the three colors. The tube is still under development even though the patent was applied for almost five years ago.

The New Sangamo *Arrowhead* Tubular Electrolytic



SMALLER THAN ANY OTHER DUAL TYPE



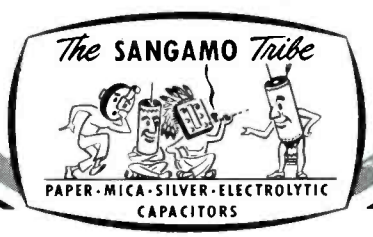
THE LITTLE INDIAN SAYS: "terrific for TV!"

The new Sangamo Type FM "ARROWHEAD" tubular electrolytic capacitor is equipped with flexible, insulated wire leads and stud terminals to make installation easier by eliminating the problem of crossed wires and the need for insulating sleeves. Sangamo Arrowheads are much smaller than wax end filled types with insulated leads—*smaller than any other type with dual leads!*

These capacitors are housed in round aluminum containers which are encased in heavy insulating sleeves with mounting strap attached, and they are especially designed for the rugged television requirements where 85° C operating temperatures are encountered.

A trial of these new dry electrolytic capacitors will convince you. See your Jobber, or write for Catalog No. 800, which gives full information on the Arrowhead and the rest of the Sangamo Tribe.

Your Assurance of



Dependable Performance

SANGAMO ELECTRIC COMPANY

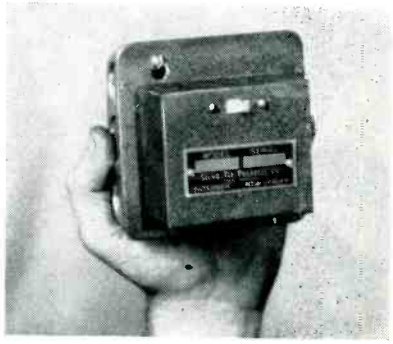
SPRINGFIELD, ILLINOIS

SC50-10A

IN CANADA: SANGAMO COMPANY LIMITED, LEASIDE, ONTARIO

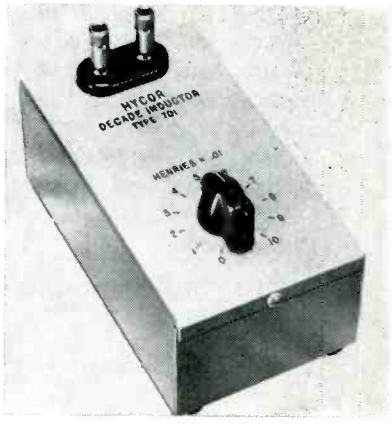
(continued from p 126)

in 5 steps (1.5, 5, 15, 50 and 150 v, full scale). Accuracy is ± 3 percent. Frequency error is 10 percent at 120 mc, and correction curves are supplied by means of which rated accuracy can be obtained up to 200 mc.



Ultrasensitive Relay

SERVO-TEK PRODUCTS CO., 4 Godwin Ave., Paterson 1, N. J., has developed a new electronic relay system to provide supersensitivity in industrial control applications. The miniature unit illustrated operates from the 115-volt 50 or 60-cycle line and uses no filament to draw standby power with the relay circuit energized. Maximum current flow through the initiating resistance is in the order of microamperes.



Decade Inductors

THE HYCOR CO., 7116 Laurel Canyon Blvd., North Hollywood, Calif. The 700 series decade-inductor units are used for design and experimentation work on audio filters, equalizers and tuned circuits. Units may be connected in series to obtain

STANDARD RI-FI* METERS

14kc to 1000mc!

DEVELOPED BY **STODDART** FOR THE ARMED FORCES.

AVAILABLE COMMERCIALLY.

VHF!
15 MC to 400 MC
NMA - 5

Commercial equivalent of TS-587/U.
Sensitivity as two-terminal voltmeter, (95 ohms balanced) 2 microvolts 15-125 MC; 5 microvolts 88-400 MC. Field intensity measurements using calibrated dipole. Frequency range includes FM and TV Bands.

VLF!
14 KC to 250 KC
NM - 10A

Commercial equivalent of AN/URM-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.

HF!
150 KC to 25 MC
NM - 20A

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, WWV, and communications frequencies.

UHF!
375 MC to 1000 MC
NM - 50A

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.

Since 1944 **Stoddart RI-FI*** instruments have established the standard for superior quality and unexcelled performance. These instruments fully comply with test equipment requirements of such radio interference specifications as JAN-I-225, ASA C63.2, 16E4(SHIPS), AN-I-24a, AN-I-42, AN-I-27a, AN-I-40 and others. Many of these specifications were written or revised to the standards of performance demonstrated in Stoddart equipment.

The **rugged and reliable** instruments illustrated above serve equally well in field or laboratory. Individually calibrated for consistent results using internal standard of reference. Meter scales marked in microvolts and DB above one microvolt. Function selector enables measurement of sinusoidal or complex waveforms, giving average, peak or quasi-peak values. Accessories provide means for measuring either conducted or radiated r.f. voltages. Graphic recorder available.

***Radio Interference and Field Intensity.**

Precision Attenuation for UHF!

Less than 1.2 VSWR to 3000 MC.
Turret Attenuator:
0, 10, 20, 30, 40, 50 DB.
Accuracy ± .5 DB.
Patents applied for.

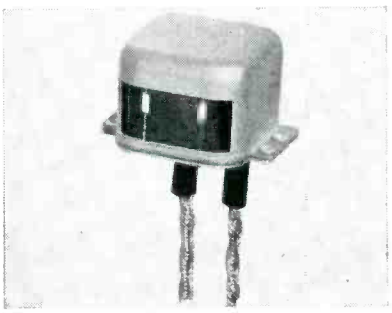
STODDART AIRCRAFT RADIO CO.

6644 SANTA MONICA BLVD., HOLLYWOOD 38, CALIF.
Hillside 9294

inductance ranges up to 10 henrys in 0.001-henry steps. Toroid coils are used as elements to obtain high Q and low pickup from external fields.

Cardioid Microphone

THE ASTATIC CORP., Conneaut, Ohio. Model DR-10 Sinabar microphone is a unidirectional cardioid crystal type which uses a special sintered metal to cancel out 15 db front to back. Frequency range, from 50 to 10,000 cps, is enhanced by a response selector switch which provides choice of ideal pickup characteristics for either crisp voice or general voice and music. A high-impedance microphone, its output level is -54 db.



Tape Recording Head

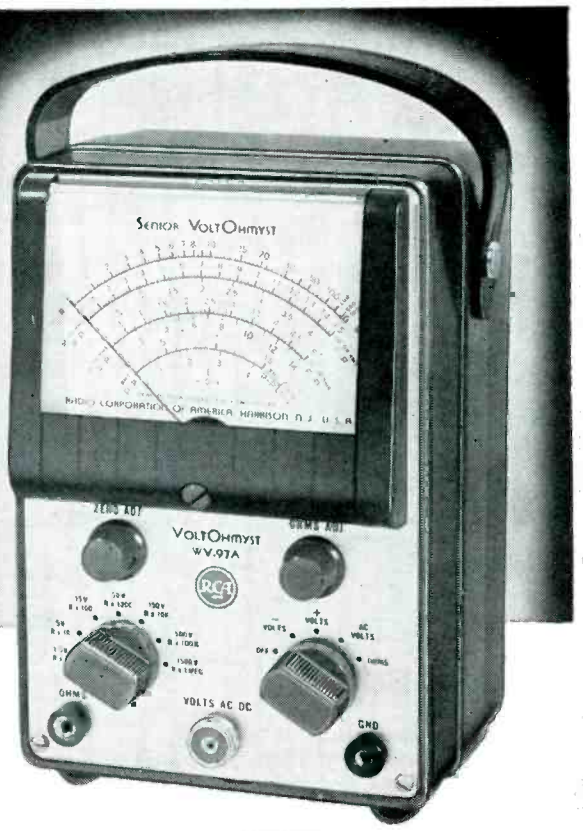
SHURE BROTHERS INC., 225 W. Huron St., Chicago, Ill. Model TR5 tape recording head combines the functions of record, playback and

Announcing

RCA WV-97A
Senior VoltOhmyst*
reading peak-to-peak voltages

ONLY $62.50 Suggested User Price

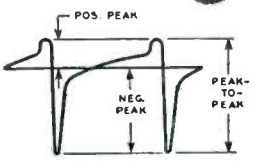
Includes direct probe and cable, dc probe, ohms lead, and ground lead



TEN WAYS BETTER!

1. Directly measures complex waves from 0.2 volt to 1400 volts, peak-to-peak.
2. Has an over-all accuracy for dc measurements of ±3% of full scale.
3. Measures dc voltages from 0.02 volt to 1500 volts.
4. Measures rms values of sine-wave voltages from 0.1 volt to 1200 volts.
5. Has 7 non-skip ranges for both resistance and voltage.
6. All full-scale voltage points increase in a uniform "3-to-1" ratio.
7. Frequency response flat from 30 cps to approximately 3 Mc.
8. Negative-feedback circuit provides better over-all stability.
9. Fully enclosed metal case shields sensitive electronic-bridge from rf fields.
10. More convenient to use because of smaller size and new slip-on probes.

The WV-97A measures peak-to-peak voltages directly. Hence, it quickly provides information essential for servicing TV receivers with their pulse-type waveforms.



The WV-97A has a range of usefulness extending beyond that of any other instrument in the field. Its quality, dependability, and accuracy make it a true laboratory instrument; it is exactly what is needed for television in the design laboratory, factory, and service shop.

The new Senior VoltOhmyst measures dc voltages in high-impedance circuits, even with ac present. It reads the rms values of sine waves and the peak-to-peak values of complex waves or recurrent pulses, even in the presence of dc. Its electronic ohmmeter has a range of ten billion to one.

Like all RCA VoltOhmysts, it features high input resistance, electronic protection from meter burn-out, zero-center scale for discriminator alignment, molded-plastic meter case, a 1-megohm isolating resistor in the dc probe, and sturdy metal case for good rf shielding.

An outstanding feature is its usefulness as a television signal tracer . . . made possible by its high input resistance, wide frequency range, and direct reading of peak-to-peak voltages.

For complete information on the new RCA WV-97A Senior VoltOhmyst, see your RCA Test Equipment Distributor, or write RCA, Commercial Engineering, Section 142Y, Harrison, New Jersey.

*Reg. U. S. Pat. Off.

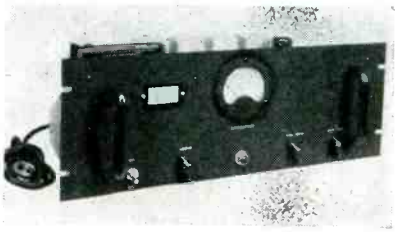
SPECIFICATIONS

DC Voltmeter:
Seven continuous ranges . . . . . 0 to 1.5, 5, 15, 50, 150, 500, 1500 volts
Input resistance (including 1 megohm in dc probe):
All ranges . . . . . 11 megohms
Sensitivity for the 1.5-volt range . . . . . 7.3 megohms-per-volt
Over-all Accuracy . . . . . ±3% of full scale
AC Voltmeter—Fourteen continuous ranges:
Peak-to-peak ranges . . . . . 0 to 4, 14, 40, 140, 400, 1400, 4000 volts
Maximum peak-to-peak input voltage . . . . . 1400 volts
RMS ranges (for sine waves) . . . . . 0 to 1.5, 5, 15, 50, 150, 500, 1500 volts
Maximum rms input voltage . . . . . 1200 volts
Input Resistance and Capacitance with WG-218 Direct Probe and Cable:
1.5, 5, 15, 50, 150-volt ranges
0.83 megohm shunted by 85 μμf
500-volt range . . . . . 1.3 megohms shunted by 85 μμf
1500-volt range . . . . . 1.5 megohms shunted by 85 μμf
Frequency Response with WG-218 Direct Probe and Cable:
1.5, 5, 15, 50, 150, 500-volt ranges flat from 30 cps to 3 Mc for voltage source having 100-ohm impedance
Overall Accuracy:
1.5, 15, 50, 150, 500, 1500-volt ranges . . . . . ±5% of full scale
5-volt range . . . . . +0%-10% of full scale
Ohmmeter:
Seven continuous ranges . . . . . 0.2 ohm to 1000 megohms
Center scale values . . . . . 10, 100, 1000, 10,000 ohms; 0.1, 1, 10 megohms
Dimensions: 7¾" high; 5¼" wide, 3¾" deep
Available Accessories:
WG-264 Crystal Diode Probe. Extends range to 250 Mc ($7.75 suggested user price)
WG-289 High-Voltage Probe and WG-206 Resistor to extend range to 50,000 volts. ($9.95 suggested user price)

Available from your RCA Test Equipment Distributor

RADIO CORPORATION of AMERICA
TEST EQUIPMENT **HARRISON, N.J.**

erase in one unit. It employs an effective deep-drawn mu-metal shield for optimum hum reduction. Record and playback coil impedance is 1,650 ohms at 1,000 cps. Erase coil impedance is 1,000 ohms at 40 kc. Output level is 5 db above 1 mv at 1,000 cps at tape speed of 3.75 in. per second. Dimensions are 0.685 in. high × 1.240 in. wide × 1.031 in. deep.



Radio Cue System

POLARAD ELECTRONICS CORP., 100 Metropolitan Ave., Brooklyn 11, N. Y. Model AB radio cue system, for use in directing personnel via a radio link, has found applications in television studios whereby personnel on the studio floor may move about freely without trailing communication wires. Illustrated above is the transmitter which operates on a low r-f frequency into a loop antenna—the transmitted information thus being restricted to a closely confined area. The pocket receivers are small and lightweight. Several r-f channels are available, should simultaneous transmission for separate activities be desired.

Industrial Tubes

SYLVANIA ELECTRIC PRODUCTS INC., 500 Fifth Ave., New York 18, N. Y., has made available three new elec-

Here are some of the many reasons why there are more Simpson 260 high sensitivity volt-ohm-milliammeters in use today than all others combined. The Simpson 260 has earned world-wide acceptance because it was the first tester of its kind with all these "Firsts":

Simpson 260 SET TESTER

WORLD FAMOUS FOR ALL THESE "FIRSTS"

- First high sensitivity instrument to use a metal armature frame.
- First to use fully enclosed dust proof rotary switch with all contacts molded in place accurately and firmly.
- First to do away with harness wiring.
- First to provide separate molded recesses for resistors, batteries, etc.
- First to cover all resistors to prevent shorts and accidental damage and to protect against dust and dirt.
- First with a sturdy movement adapted to the rugged requirements of a wide range of service work or laboratory testing.
- First to provide easy means of replacing batteries.
- First to use all bakelite case and panels in volt-ohm-milliammeters.
- First volt-ohm-milliammeter at 20,000 ohms per volt with large 4½" meter supplied in compact case (size 5¼" x 7" x 3⅛").
- First and only one available with Simpson patented Roll Top Case.
- First to provide convenient compartment for test leads (Roll Top case).
- First to offer choice of colors.

RANGES

20,000 Ohms per Volt DC, 1,000 Ohms per Volt AC

VOLTS: AC & DC—2.5, 10, 50, 250, 1,000, 5,000

OUTPUT: 2.5, 10, 50, 250, 1000

MILLIAMPERES, DC: 10, 100, 500

MICROAMPERES, DC: 100

AMPERES, DC: 10

DECIBELS: (5 ranges)—12 to +55 DB

OHMS: 0-2,000 (12 ohms center), 0-200,000 (1200 ohms center), 0-20 megohms (120,000 ohms center).

Prices: *$38.95 dealers net; Roll Top $45.95 dealers net.*

The Model 260 also is available in the famous patented Roll Top safety case with built-in lead compartment. This sturdy, molded, bakelite case with Roll Top provides maximum protection for your 260 when used for servicing in the field or shop.

25,000 volt DC Probe for television servicing, complete, for use with 260, $12.85

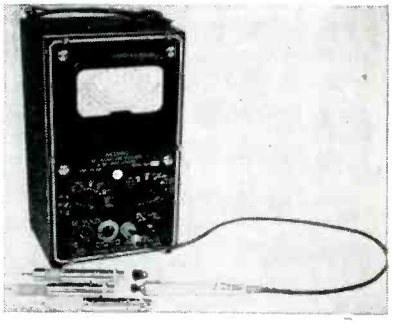
Simpson
INSTRUMENTS THAT STAY ACCURATE

SIMPSON ELECTRIC COMPANY • 5200-18 W. Kinzie St., Chicago 44, Ill. • *In Canada: Bach-Simpson, Ltd., London, Ontario*

tron tubes suitable for a wide range of industrial services where dependable operation and a service life up to 10,000 hours is required. Type 5691 is a high-mu twin triode recommended for voltage amplifier use and supplied with series-unit heaters; type 5692, a medium-mu twin triode, suitable for balanced d-c amplifier, multivibrator, blocking oscillator and resistance-coupled amplifier applications; and the 5693, a sharp-cutoff pentode designed particularly for high-gain resistance coupled amplifier service.

Diffusion Pump

EITEL-MCCULLOUGH, INC., San Bruno, Calif. The HV-1 oil diffusion-type vacuum pump features: speeds up to 67 liters per second attainable vacuum of 4×10^{-7} mm Hg, glass barrel, no liquid cooling, no charcoal trap, no mechanical wear, and simplicity of mounting and maintenance.



R-F VTVM

MILLIVAC INSTRUMENTS, P.O. Box 3027, New Haven, Conn. The MV-18b h-f v-t millivoltmeter measures frequencies from 1 mc to 200 mc flat with direct calibration and higher frequencies up to 2,500 mc with calibration charts. The instrument contains a new carrier-type d-c amplifier having heavy negative feedback to insure accuracy and stability. Germanium crystal probes are used to rectify weak r-f signals with minimum cir-

cuit loading. The new probes are designed to have 1.0-μμf input capacitance with a ± 25-percent tolerance.

Double-Triode Subminiature

SYLVANIA ELECTRIC PRODUCTS INC., 500 Fifth Ave., New York 18, N. Y. A new double-triode subminiature tube has been designed for applications in tv receivers, industrial electronics, servomechanisms and radio communications receivers. Available with pigtail leads as type 6BF7, and with short pins for socketing as type 6BG7, it is supplied in a T-3 bulb measuring only 0.400 in. in diameter and 1½ in. long. Transconductance is 4,800 μmhos. Amplification factor per triode section is 35 when 100 volts are used on plates. Input capacitance per plate is 2.0 μμf; output capacitance, 1.0 μμf.

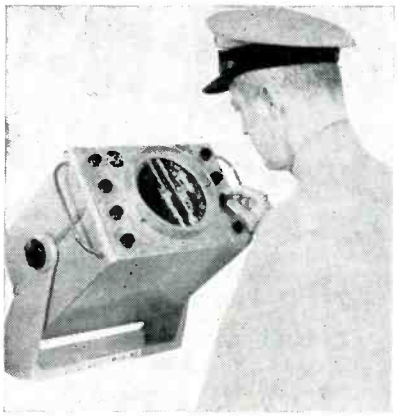
UHF Tetrode

EITEL-MCCULLOUGH, INC., 252 San Mateo Ave., San Bruno, Calif. The 4X150G uhf tetrode can be operated as either a conventional r-f amplifier or oscillator over a wide range of plate voltages at frequencies up to 1,000 mc. In pulse service efficient performance is obtained to above 1,500 mc. Typical performance in amplifier service at 750 mc is 100 watts output power per tube with a stage power gain of 11. In similar service at 1,000 mc output

power is reduced to 50 watts with a stage power gain of 5.

Crystal Calibrator

MEASUREMENTS CORP., Boonton, N. J. Model 111 crystal calibrator was designed for the frequency calibration of signal generators, transmitters, receivers, grid-dip meters and other equipment in the 250 kc to 1,000-mc range. Frequency accuracy is ±0.001 percent. The dual-purpose calibrator provides a test signal of crystal-controlled frequency and has a self-contained receiver with a 2-μw sensitivity. A new circuit arrangement uses the cross-modulation products of three separate oscillators operating



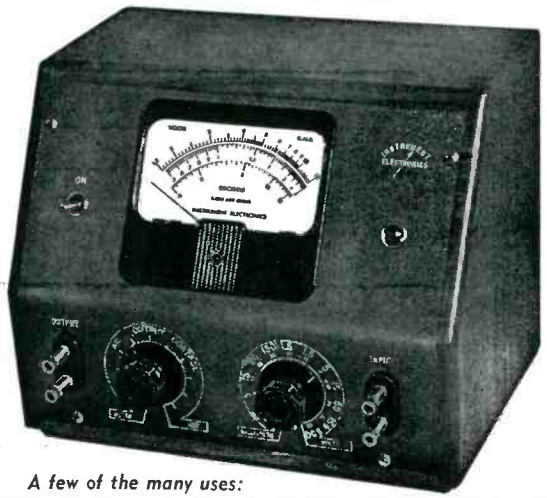
YACHTSMEN with big boats and matching pocketbooks will be interested in this small new radar unit that detects headlands and other large objects up to 20 miles, picks up buoys at 75 yds. *Radiomarine Corp. of America, 75 Varick St., New York 13, N. Y.*

High Sensitivity . . Logarithmic

AC VOLTMETER

40 MICROVOLTS TO 500 VOLTS

MODEL 47 VOLTMETER



SELF-CONTAINED
ALL AC OPERATED UNIT
An extremely sensitive amplifier type instrument that serves simultaneously as a voltmeter and high gain amplifier.

- Accuracy ±2% from 15 cycles to 30 kc.
- Input impedance 1 megohm plus 15 uuf. shunt capacity.
- Amplifier Gain 40000

Also MODEL 45 WIDE BAND VOLTMETER .0005 to 500 Volts! 5 Cycles 1600 kc.

A few of the many uses:

- Output indicator for microphones of all types.
- Low level phonograph pickups.
- Acceleration and other vibration measuring pickups.
- Sound level measurements.
- Gain and frequency measurements for all types of audio equipment.
- Densitometric measurements in photography and film production.
- Light flux measurements in conjunction with photo cells.

Write for Complete Information

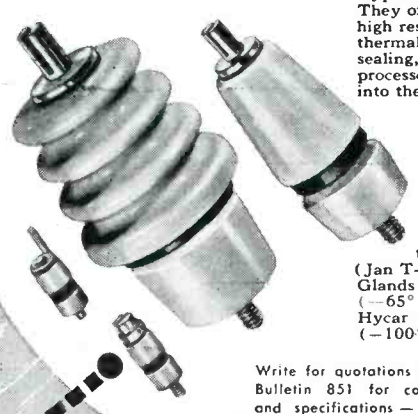
Instrument Electronics

45-17 Glenwood Street
LITTLE NECK, L. I., N. Y.

E-I HERMETIC SEALING COMPONENTS

Easy to Install — High Dielectric

GASKET TYPE BUSHINGS



For heavier equipment requiring larger terminals, E-I Gasket Type Bushings are recommended. They offer high dielectric strength, high resistance to mechanical and thermal shock, complete hermetic sealing, easy installation. Specially processed gland penetrates deeply into the L-5 Steatite insulator, seals against the mounting surface, resists oil and pitch and is unaffected by high heat. Hot-tinned brass studs provide excellent electrical conductivity.

E-I Bushings meet all government specifications for sealed transformers and condensers (Jan T-27, Jan C-25)
Glands available in Neoprene (−65° to +227°F)
Hycar (−90° to +350°F) Silastic (−100° to +500°F)

Write for quotations and descriptive Bulletin 851 for complete details and specifications — no obligation.

ELECTRICAL INDUSTRIES
INCORPORATED
44 SUMMER AVENUE • NEWARK 4, N. J.

---

record patterns from your OSCILLOSCOPE

with the new Oscillo-Tracer

— as easy as writing your name!

— simpler than a photo record!

Here is a new, inexpensive accessory to multiply the usefulness of your 'scope . . . fits *any* standard 'scope . . . useful with *every* 'scope. Puts pattern on paper for *accurate* tracing, all in just a few seconds!

Many new and valuable uses

- Read traces on graph paper, log, semi-log, decrement, etc.
- Compare traces by super-position.
- Detect small, slow pattern changes.
- Measure amplitude and wave forms accurately.

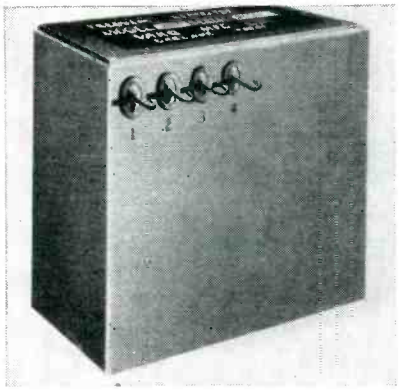
The OSCILLO-TRACER is a precise optical instrument that superimposes the cathode-ray image on a sheet of paper or right in your lab note book. Uses a newly developed, double-coated lens — high-reflection upper surface, high-transmission lower surface. Heavy, cast base contains lamp to light record paper.

This useful accessory to every 'scope costs only $19.50. *The first cost is the last cost.*

ORDER TODAY from

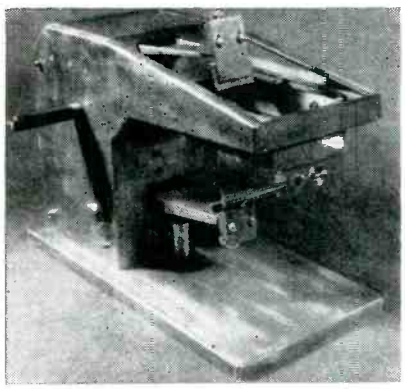
Robert A. Waters, Inc.
4 Gordon Street, Waltham 54, Mass.

at the fundamental frequencies of 0.25, 1.0 and 10 mc. Power supply is 117 v, 50 or 60 cycles.



Frequency Generator

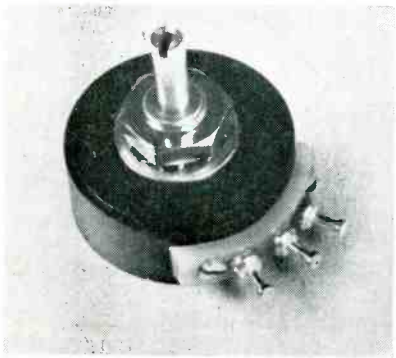
VARO MFG. CO., INC., Box 638, Garland, Texas. Model 622B frequency generator operates from conventional 28-volt d-c aircraft power supply and delivers a 15-volt sinusoidal voltage to a 1-megohm load. It is hermetically sealed. Frequency is 400 cps ± 0.1 percent from −55 to +110 C. Measurements are 3 1/16 in. high, 1 1/16 in. wide and 3 3/8 in. long, and weight is 11 ounces.



Screen Process Printer

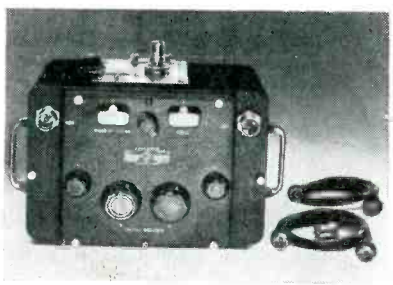
MECH-TRONICS EQUIPMENT CO., Box 510, Silver Spring, Md., announces availability of the model 20 screen process printer, a machine that automatically applies wiring and capacitors to cylinders up to 1¼ in. in diameter. Screen sizes can be accommodated up to the dimen-

sions of the 5 in. × 9 in. frame. Additional information can be had by writing for bulletin No. 21.



Miniature Potentiometer

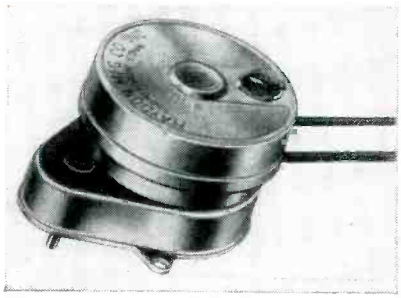
GENERAL RESEARCH ASSOCIATES, 99 Grandview Ave., White Plains, N. Y. Model GR-2 is a small, lightweight potentiometer designed to be used for setting the zero or null in aircraft instruments of the self-balancing bridge type. It is ¾ in. in diameter and projects ⅜ in. back of the mounting surface. It weighs approximately 10 grams and is available in overall resistance values from 50 to 5,000 ohms. It is provided with stops which limit the rotation to 330 deg.



VHF Impedance Bridge

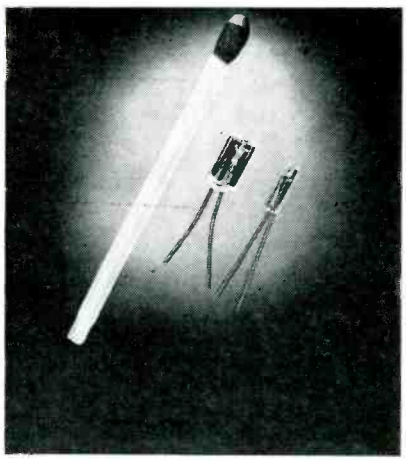
GENERAL RADIO CO., 275 Massachusetts Ave., Cambridge 39, Mass. Type 1601-A impedance bridge extends the frequency range of conventional bridge techniques up to 165 mc. Similar in basic circuit to the type 916-A r-f bridge, the new instrument measures the impedance of antennas, lines, networks and components between the frequencies of 10 and 165 mc. Overall

accuracy is ± 2 percent for resistance and ± 5 percent for reactance. Terminals are type 874 coaxial connectors.



Timing Motor

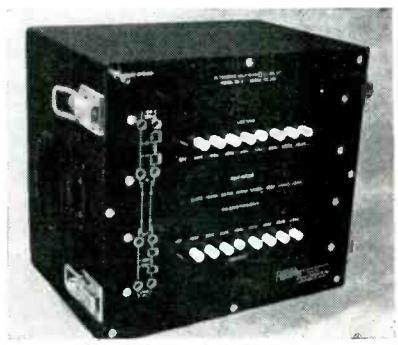
HAYDON MFG CO., INC., Torrington, Conn. The 4400 series timing motor is an extra-slow-speed motor available in standard speeds of 6, 8, 12 hours, 1 day and 1 week per revolution. Nonstandard speeds are available on quantity orders in the ranges of 5, 9, 10, 15, 16, 30, 32 and 36 hours, and 2, 4, 10 and 30 days per revolution. Typical applications are in day-night thermostats, daily program timers and refrigerator defrosting mechanisms. Overall depth of the unit is 1⅛ in.



Tiny Photoelectric Unit

SYLVANIA ELECTRIC PRODUCTS INC., Bayside, N. Y., has developed a tiny photocell which uses the photosensitivity of germanium. The units are expected to find wide use in such applications as decoding punched tape, electronic computing and sort-

ing, and in the direct operation of relays such as for opening and closing doors. Featuring compactness and high sensitivity, the new photoelectric device is essentially a germanium diode especially designed to permit use of the photoelectric properties of germanium and similar semiconductors. Average sensitivity in the point-contact region is about 0.1-ma change in current per lumen for light in the near infrared region.



Half-Octave Filter

GERSCH PRODUCTS, INC., 11846 Mississippi Ave., Los Angeles 25, Calif. Model SA-3 ultrasonic one-half octave filter has a range of 10 to 160 kc in half-octave steps and attenuation rate is 80 db per half octave. Minimum rejection outside the pass band is 40 db. It utilizes a passive network, without vacuum tubes, is not subject to overload and has the lowest possible distortion with excellent transient response.

Miniature Seismograph

SOUTHWESTERN INDUSTRIAL ELECTRONIC CO., 2831 Post Oak Road,

"Wow-Meter"

Newly developed direct-reading instrument simplifies measurements of wow and flutter in speed of phonograph turntables, wire recorders, motion picture projectors and similar recording or reproducing mechanisms. It is the only meter in existence giving direct steady indication of meter pointer on scale.

The Furst Model 115-R "Wow-Meter" is suitable for both laboratory and production application and eliminates complex test set-ups.
A switch on the front of the panel permits selection of low frequency cut-off and corresponding meter damping for use on slow speed turntables.

Frequency Response: ½ to 120 cycles or 10 to 120 cycles

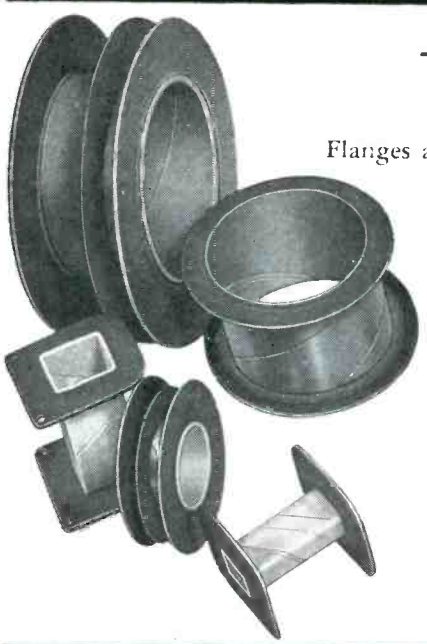
Inquiries Invited on our line of

Regulated Power Supplies

FURST ELECTRONICS

10 S. Jefferson St., Chicago 6, Ill.

See the New Precision Coil Bobbins



—*with* Anchored Flanges *that can't come loose!*

Flanges are securely locked in place on a plastic-coated core to assure coils wound to closer tolerances and fewer rejects. Flange cannot slide to allow crowding of turns, and wire cannot slip off coil form. Insulation is improved. Bobbins made any shape—round, square, rectangular—any size, of finest dielectric Kraft, fish paper, cellulose acetate, or combinations. Low die costs cut unit prices surprisingly

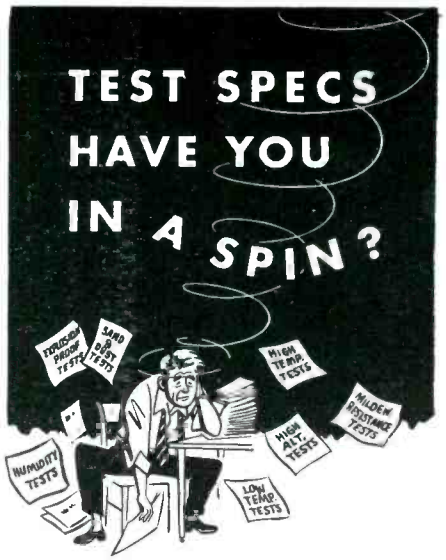
Let us make up a free sample for you! Write today for full information.

PRECISION PAPER TUBE CO.

2041 W. Charleston St. Chicago 47, Ill.

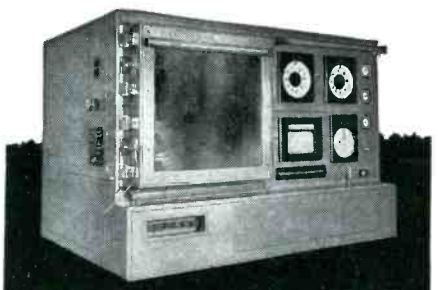
PLANT #2: 79 Chapel St., Hartford, Conn.

Also mfrs. of dielectric paper tubes



If complicated USAF Specs or other Government Test Specifications have got you stymied, Bowser can put you in trim. Bowser Chambers for testing equipment under simulated environmental conditions meet all Govt. Test Specs, and some Bowser Units, like the Laboratory Units, provide facilities for testing under several conditions such as High or Low Temperature, High Altitude, Relative Humidity, etc. Bowser Units are custom built to meet individual testing, storage and processing requirements.

Why don't you capitalize on Bowser's experience in building Testing equipment of all kinds? Write NOW.



BOWSER INC.

Refrigeration Division

TERRYVILLE • CONN.

Send me free information on Bowser environmental simulating units.

Name_____ Pos._____

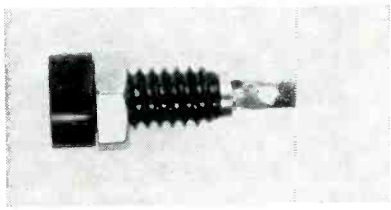
Company_____

Street_____

City_____ Zone____ State_____

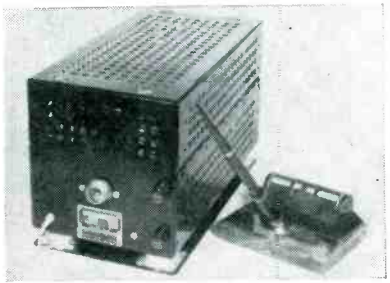
E

Houston 19, Texas. Type PSU-11 miniature seismograph unit contains twelve type GA-11 amplifiers plus a control unit. Amplifiers gain is 120 db. It features a 2-section L-C filter for 1-f rejection and a 1-section L-C filter for h-f rejection. Oscillograph specifications are: 25 traces; 6-in. paper; barrel-type electromagnetically-damped galvanometers; viewing screen; built-in timing system; built-in paper knife; removable take-up magazine and governor-controlled cranking motor.



Test-Point Jack

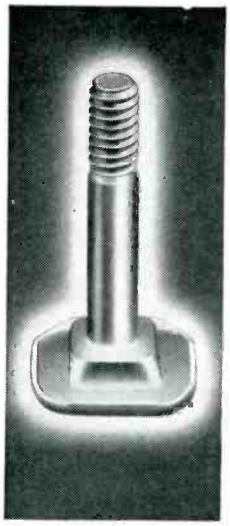
ALDEN PRODUCTS Co., 117 N. Main St., Brockton 64, Mass. Model 110BCS miniature test-point jack was designed for bringing out circuit leads for instantaneous check of any critical voltage in circuit while equipment is in operation. It measures $\frac{3}{8}$ in. in diameter $\times$ 1 in. overall length, provides 100-percent insulation to a beryllium copper spring contact and will pass the fungus and salt-spray test.

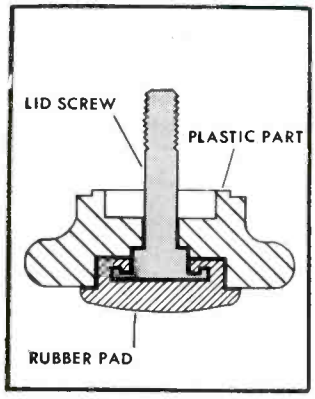


Electronic Inverter

VARO MFG. Co., INC., BOX 638, GARland, Texas. Model 421 electronic inverter transforms 28 volts d-c to 400 cps $\pm$0.1 percent, 115 $\pm$1.0 percent single phase and/or 115 v $\pm$3.0 percent three phase. Features are exceptional frequency and voltage stability over extreme

Cold heading was the only logical way to make this special part





Cross-section drawing shows how lid screw fits into rubber pad and plastic mating part.

This refrigerator lid screw *might* have been made by other methods. With cold heading, however, in the hands of Scovill engineers, toolmakers and operators, this special part is produced in one piece, to close tolerances, with a better finish and greater strength, at lower cost.

Cold heading may open new possibilities for you to save money, speed production and improve your product. It's worth a try. Send your sample or blueprint for further information.

"Guide to the Profitable Use of Cold Heading" —Bulletin No. 2 describes the advantages and limitations of this process for the designer. It's free for the asking.

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Recessed Head Screws • Sems
Tapping Screws • Standard
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SCOVILL FASTENERS AND SPECIAL PARTS

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★ **HIGH SPEED COUNTING**—Any mechanical, electrical or optical events that can be converted to changing electrical voltages can be counted at rates up to 10,000 per second.

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★

Complete description **and specifications are yours for the asking.**

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a + value for industry

Development and Production of

SPECIAL PURPOSE VACUUM TUBES BY ECLIPSE-PIONEER

TT-1 3000 mc Temperature Limited Noise Diode Tube.

Y-Type Position Convectron—Vertical Sensing Tube.

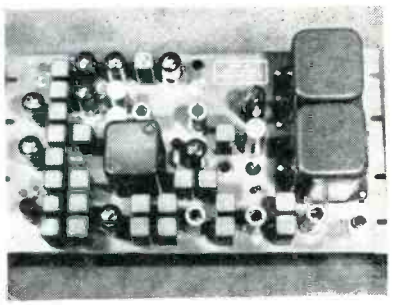
Chronotron Thermal Time Delay Tube.

We're not in the standard vacuum tube business. But we are definitely in the business of developing and manufacturing special purpose vacuum tubes — tubes that are not generally available. During the past three years, for example, our facilities have produced, such devices as the Chronotron thermal time delay tube, the Convectron* vertical sensing tube, the TT-1 3000 mc temperature limited noise diode tube, counter tubes, glass enclosed spark gaps, and phono pickup tubes. Quantities of all these are now serving many phases of industry in a wide variety of applications. We invite your use of our facilities to develop and produce your requirements of special purpose vacuum tubes. Your inquiries concerning the scope of our facilities or details of any of our tubes will be given immediate attention.

*REG. U.S. PAT. OFF.

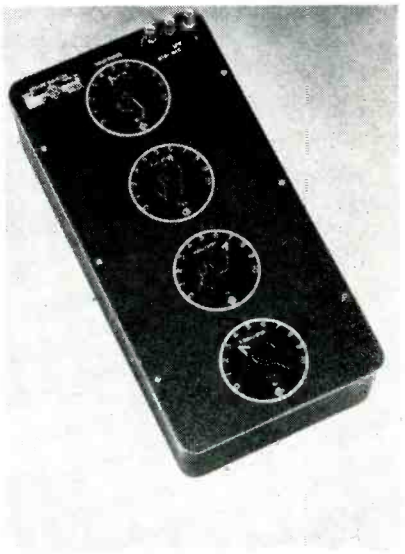
Eclipse-Pioneer Division of
TETERBORO, NEW JERSEY
Bendix AVIATION CORPORATION
Export Sales—Bendix International Division, 72 Fifth Avenue, New York 11, N. Y.

ranges of temperature and altitude, load and input ranges, and complete absence of moving parts. Output is 100 va, power factor 0.4 to 0.8 lag.



F-M Relay Receiver

RADIO ENGINEERING LABORATORIES, 36-40 37th St., L. I. C., N. Y., are in production on a new f-m relay receiver model 722 for the 88 to 108-mc band. It is a rack-mounted single-frequency crystal-controlled double i-f superhet unit. Distortion is less than 0.5 percent from 50 to 15,000 cycles; sensitivity noise factor, better than 6 db; and sputter point, less than 2 μv.



Decade Inductors

GENERAL RADIO CO., 275 Massachusetts Ave., Cambridge 39, Mass. Available in single-decade units for building into other equipment and in three- and four-decade cabinet assemblies for laboratory use, the decade inductor illustrated provides

NATIONAL

- Proven
- Dependable
- Quality

COILS and COIL FORMS

COILS. AR-2 and AR-5 h.f. coils are high-Q permeability-tuned RF coils on low-loss molded bakelite forms. AR-2 coil tunes from 75 mc. to 220 mc. with capacities from 100 to 10 mmfd. AR-5 coil tunes from 37 mc. to 110 mc. with capacities from 100 to 10 mmfd. Other windings may be substituted to modify range.

COIL FORMS. Molded of mica-filled bakelite permitting grooving and drilling. XR-50 ($\frac{1}{16}$" long, ½" dia. form; ½" long, ⅜" dia. iron slug) may be wound as desired to provide a permeability-tuned h.f. coil. XR-4 (1½" long, 1" dia.) is standard four-prong form. XR-6 (2¼" long, 1½" dia.) is six-prong form for use with special National XC-6C socket. Other types include XR-1 with four prongs, XR-2 and XR-3 without prongs.

Address export inquiries to
Exp. Div., Dept. E-950

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NATIONAL COMPANY, Inc.
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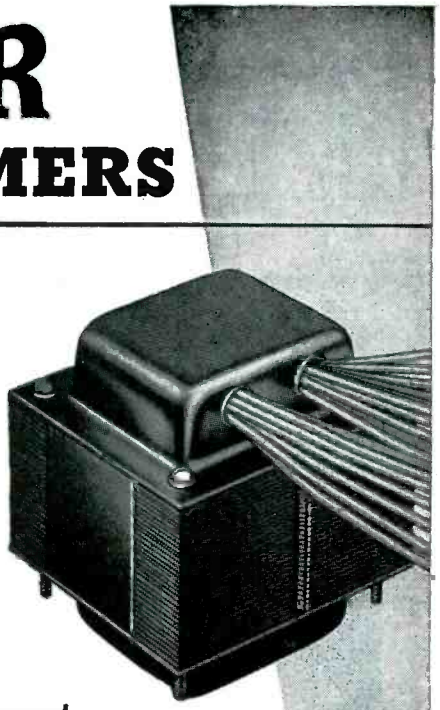
STANCOR TRANSFORMERS

Specified as original components by the biggest radio and TV set makers in the industry. They have to be good!



WRITE.
inquiries promptly answered

STANDARD TRANSFORMER CORPORATION
3578 ELSTON AVENUE, CHICAGO 18, ILLINOIS

MODEL 204A REGULATED POWER SUPPLY

0-500 VOLTS D.C. AT 300 MA. WITH POSITIVE OR NEGATIVE GROUND

The Model 204A Regulated Power Supply will provide from 0-500 volts of well regulated and well filtered D.C. The output voltage is continuously variable without switching and either positive or negative side may be grounded.

SPECIFICATIONS:

OUTPUT VOLTAGE
High Voltage: 0-500 Volts D.C. continuously variable (Without switching).
Current: 300 Ma.
Low A.C. Voltage: 6.3 Volts A.C. at 6 amps. center-tapped, unregulated.

REGULATION
Within 1% for voltage between 30-500 volts, from no load to full load.
Within 1% for line voltage variations from 105 to 125 volts at full load current for any voltage between 30-500 volts and within 2% at 10 volts.

HUM VOLTAGE
Within 10 Millivolts at any voltage or load within ratings.

LINE INPUT
105-125 Volts A.C. 50-60 cycles.

OUTPUT TERMINATIONS
High and low voltage outputs available from front and rear of unit. Positive or negative terminal of high voltage output may be grounded as desired.

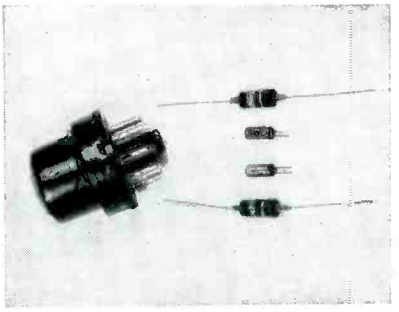
Detailed specifications will be forwarded upon request without obligation.

E/M
ELECTRONIC MEASUREMENTS COMPANY
RED BANK • NEW JERSEY

precise decade steps of inductance from one mh to one henry per step. Temperature coefficient of inductance is —24 parts per million per deg C over the normal range of room temperatures, and maximum storage factor, Q, is between 200 and 330. Accuracies range from 2 percent for the 1-mh steps to 0.25 percent for the 1-henry steps.

Driver Unit

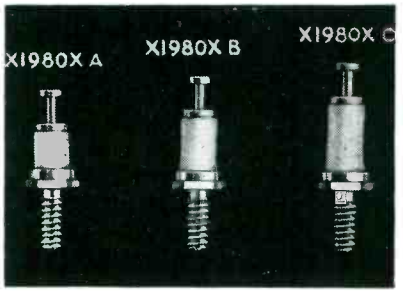
RACON ELECTRIC CO., INC., 52 E. 19th St., New York 3, N. Y. Model PM-708th all-purpose driver unit for speech and music features a built-in 25-watt vacuum-impregnated line matching transformer. Available impedances are 15, 500, 1,000, 1,500 and 2,000 ohms. The voice coil is wound with aluminum wire for greatest efficiency and coil terminals are welded instead of soldered. Overload capacity is 75 to 100 percent; list price, $37.50.



New Germanium Diodes

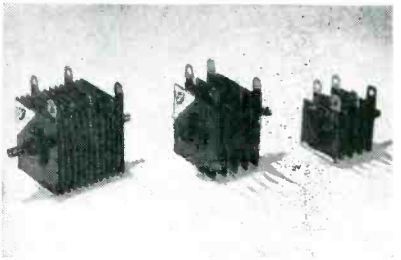
GENERAL ELECTRIC CO., Syracuse, N. Y., has added five new types to

its line of welded germanium diodes. Types SX-4A and Z-2 transistors use a metal case with two silver-plated phosphor bronze connecting pins. Each type SX-4A is checked for power gain of between 13 and 20 db with 0.1 volt input at 5 kc. The Z-2 units are checked for characteristics suitable for trigger circuits. Types 1N69 and 1N70 germanium diodes are built to JAN specifications. Type G-9 Quad is a combination of specially selected germanium diodes with matched characteristics. The diodes are hermetically sealed in a metal radio tube shell with standard octal base.



Miniature Insulated Terminals

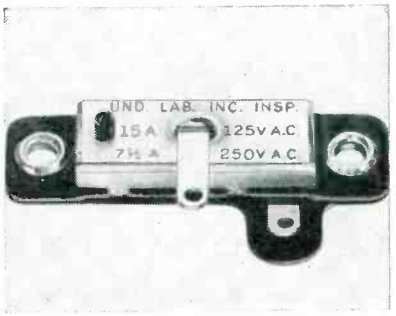
CAMBRIDGE THERMIONIC CORP., 437 Concord Ave., Cambridge 38, Mass. The miniature insulated terminals illustrated are available in three lengths of dielectric and with voltage breakdown ratings up to 5,800 volts. The X1980XA is the smallest terminal, having an overall height of only $\frac{3}{8}$ in. including terminal. Insulators are grade L-5 ceramic, silicone impregnated for maximum resistance to moisture and fungi.



Dry Disc Rectifiers

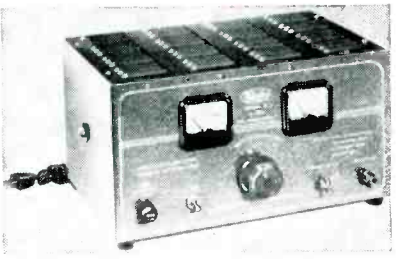
ELECTRONIC RECTIFIERS, INC., 2104 Spann Ave., Indianapolis, Ind., has introduced three new sizes in mag-

nesium-copper sulphide dry disc rectifiers. New models include the H-12, a rectifier of four to two amperes capacity, the FT-12 with six to four amperes capacity, and the FS-12 with ten to six amperes capacity. Designed for use in small battery chargers and trickle chargers, in addition to other low-voltage d-c power supply applications, the rectifiers have instant operation from temperatures as low as —40 to +284 F.



Miniature Switch

TYNISWITCH ELECTRONIC SALES CO., 8 West St., Meriden, Conn. The snap-action miniature switch illustrated has pure silver contacts. It features a new spring structure, operation at high speed, bounceless closure and maximum load rating for a given operating pressure. It is currently obtainable in either normally open or normally closed, single-pole, single-throw action.



D-C Power Supply

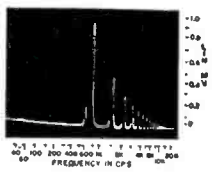
ELECTRO PRODUCTS LABORATORIES, INC., 4501 N. Ravenswood Ave., Chicago 40, Ill. The BJ Junior unit illustrated supplies 1 to 12.5 amperes, 6 volts, continuous duty, with an intermittent rating up to 25 amperes. It supplies 3 to 9 volts at other ratings, operating from

In Only 1 SECOND!

COMPLETE
AUDIO WAVEFORM ANALYSIS
with the

AP-1 PANORAMIC SONIC ANALYZER

Oscillograph of waveform to be analyzed



Panoramic Sonic Analysis of the same wave

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, intermodulation, acoustics or other sonic phenomena, investigate the overall advantages offered by AP-1.

Write NOW for complete specifications, price and delivery.

BOOTH 428
National Instrument Conference and and Exhibit, Buffalo, N. Y.
September 18-22, 1950

PANORAMIC RADIO PRODUCTS INC.
10 SOUTH SECOND AVE. MOUNT VERNON, N. Y.

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Coil Products

Coils to JAN Specifications
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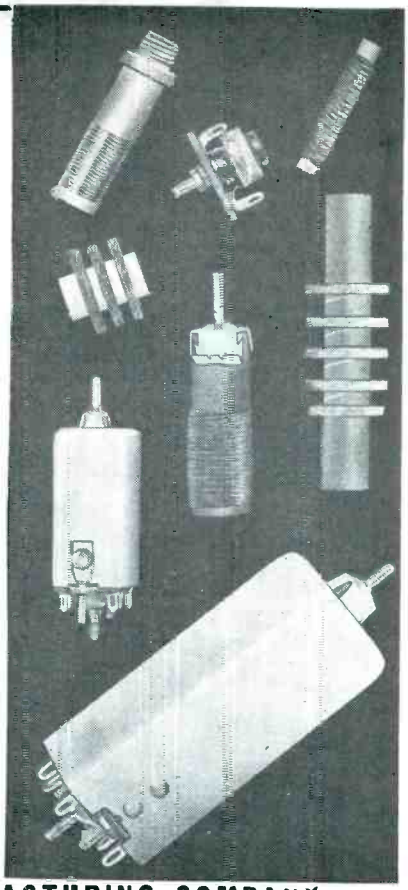
Universal wound coils—single, multiple pie and progressive construction
SOLENOIDS - TOROIDS - UNIVERSALS

The engineering department of Desco is equipped fo give you the finest . . . . . Design, Development and Production.

We have the facilities to give you the exact coil to fit your every requirement. And, best of all...RIGID QUALITY CONTROL assures you of ECOMOMY - through reduced rejects.

WRITE - PHONE - WIRE. Your coil needs and problems will receive prompt, expert attention from our trained engineers.



DIETZ DESIGN & MANUFACTURING COMPANY
Inductance Specialists
Grandview, Missouri **Dwight 7216**

NEW MODEL DYNAMIC MICROMETER

Accurately Measures Dynamic or Static Displacement, Vibration or Movement of Any Metal Body

Only the Electro Dynamic Micrometer measures static or dynamic displacement due to eccentricity, axial vibration, radial whip, bearing clearance, radial expansion with acceleration and reciprocating movement. Measurements are independent of acceleration or speed of rotation and are made without any mechanical contact between sensing unit and moving object. Not only measures static distance, but amplitude of dynamic movement down to .0001 inch. Sensitivity equal to 1% of total displacement.

UNIQUE FEATURES

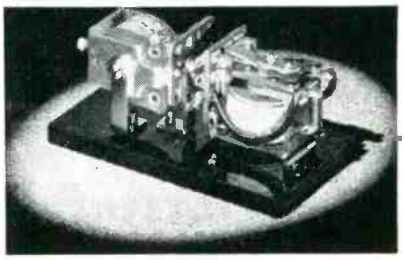
Direct reading from conventional mechanical micrometer (no calibration of electronic components necessary). Independent of acceleration or speed of rotation. Easy to operate, (only 5 minutes instruction necessary). Measures movement of any metal body over range up to .075 inch with standard unit. Greater distances can be measured with special adapters.

Send for New Literature Today!

Makers of Precision **Electro** ELECTRONIC EQUIPMENT *Electronic Instruments*

ELECTRO PRODUCTS LABORATORIES, Inc., 4513-DM RAVENSWOOD AVE., CHICAGO 40, ILL.

115 volts, 50 or 60-cycle power source. The unit features new heavy-duty selenium rectifiers, an 8-position tap switch, a 0 to 10-v voltmeter with 5-percent accuracy and a 2,000-μf filter capacitor.



Latch-Type Relay

LEACH RELAY CO., 5915 Avalon Blvd., Los Angeles 3, Calif. Type 9061 relay is used where current is to be applied to the coil momentarily, the mechanical latch holding the armature closed until the latching coil is energized. Upon energizing the latching coil the mechanical latch is released, allowing the armature to open. Contacts are ⅜ in. diameter, rated 8 amperes 115 volts a-c, or 10 amperes 24 volts d-c, noninductive. Arrangement of contacts is dpdt.

Heavy-Duty Chopper

AIRPAX PRODUCTS CO., 1024 Greenmount Ave., Baltimore 2, Md. The A586 60-cycle chopper is a rugged unit designed for amplification of low-level d-c signals. It is supplied hermetically sealed to plug into an octal header. Contacts are spdt. Maximum coil voltage is 26 v at 60 cycles, standard 6.3 v. Contacts lag a driving sine wave by 45 deg. Life is in excess of 1,000 hours.

Portable Instruments

WESTINGHOUSE ELECTRIC CORP., P.O. Box 2099, Pittsburgh 30, Pa. Type P-12 portable instruments, in the 2-percent accuracy class, use both moving-iron and permanent-magnet moving-coil mechanisms in

CORRECTION

RE: SEALS, HERMETIC

Your attention is called to the *correct* page number of the full page advertisement of:

HERMETIC SEAL PRODUCTS CO.
29-37 South 6th Street, Newark 7, N. J.

in the 1950 Mid-June Electronics Buyers' Guide

The above mentioned advertisement appears on page 87

Please make this correction on page D-100 of the Directory section of your Buyers' Guide issue.

a compact molded case. The line includes single and multiple range models. Ammeters are available in full-scale ranges from 20 μa to 50 amperes d-c, and from 5 ma to 50 amperes a-c. For d-c voltages, the full-scale ranges run from 10 mv to 800 v, with a-c ranges from 1.5 to 300 v. Rectifier milliammeters are available in full-scale ranges from 0.5 to 10 ma, and rectifier voltmeters from 2 v to 800 v.

Diffusion Pump

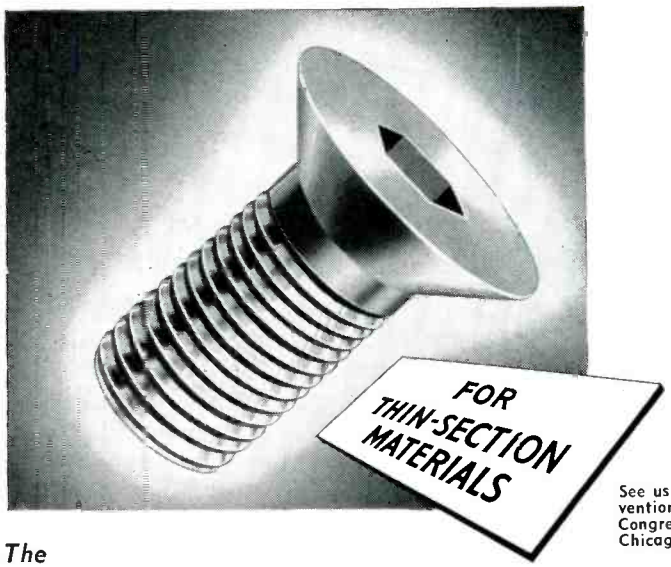
DISTILLATION PRODUCTS INDUSTRIES, Rochester 3, N. Y., has designed the MCF-60 high-vacuum fractionating diffusion pump for electron tube exhaust machines and high-vacuum research. It provides a speed of 60 liters per second in the 10^{-5} to 10^{-3} mm Hg range and the ultimate vacuum is 5×10^{-7} mm.

Literature

Time Delay. Cook Electric Co., 2700 North Southport Ave., Chicago 14, Ill. Issue No. 14 of the Newsletter covers the new 2-cubic inch time delay incorporating a take-over relay. The unit described can be set to operate in a range from 3 to 15 seconds ±10 percent and is factory adjusted. Its current carrying capacity is 5 amperes d-c inductive.

Television Booster. Electro-Voice, Inc., Buchanan, Mich., has published a bulletin describing the new high-gain, self-tuning Tun-O-Matic television booster. It explains the many unique features of the all-channel broad-band booster, giving complete data and specifications.

D-C Power Supplies. The Superior Electric Co., Hannon Ave., Bristol, Conn., has available a four-page folder on its new Varicell d-c power supplies, an instrument that pro-



See us at Booth 2434, Convention of National Metal Congress and Exposition, Chicago, Oct. 23 to 27.

The

UNBRAKO *Flat Head Socket Cap Screw*

Maximum head contact, flush surface finish and non-slip internal wrenching make these screws ideal for assembly of thin-section materials. Available in National Coarse and National Fine Threads. Sizes from #4 to ¾".

Knurled Head Socket Cap Screws
Flat Head Socket Cap Screws
Self-Locking Socket Set Screws

SOCKET UNBRAKO SCREWS

Knurled Head Stripper Bolts
Precision Ground Dowel Pins
Fully Formed Pressure Plugs

SPS STANDARD PRESSED STEEL CO.
JENKINTOWN 10, PENNSYLVANIA

ULTRA-SENSITIVE D. C. AMPLIFIER

0-10 cycles response

Model 53

The Model 53 Breaker-type D.C. Amplifier was developed for the measurement of d.c. and low frequency a.c. voltage in the microvolt and fractional microvolt region. It is compact, portable, and makes an excellent replacement for the suspension galvanometer. The output of the amplifier is sufficient to operate standard meters and recording devices directly.

It has been employed for the amplification of infrared detectors, thermocouples, voltaic photocells, and the like, both in research and industrial applications.

CHARACTERISTICS:

1. Noise level that approaches the theoretical limit imposed by Johnson noise.
2. Extremely low zero drift (less than .005 uV after warmup.)
3. Freedom from the effects of vibration such as found in moving vehicles.
4. Response characteristics permitting overall amplification flat from 0 to 10 cycles per seconds.

THE PERKIN-ELMER CORPORATION

GLENBROOK, CONN.

Leading manufacturers of Infrared Spectrometers, Continuous Infrared Analyzer, Universal Monochromator, Flame Photometer, Tiselius Electrophoresis Apparatus, D. C. Amplifiers, and other electro-optical instruments for analysis and research.

For AC CURRENT ANYWHERE . . . .
NO MAGIC *just use* ATR INVERTERS

ATR

STANDARD AND HEAVY DUTY
INVERTERS

For Inverting D. C. to A. C.

Specially Designed for operating A. C. Radios, Television Sets, Amplifiers Address Systems, and Radio Test Equipment from D. C. Voltages in Vehicles, Ships, Trains, Planes and in D. C. Districts.

✓NEW MODELS ✓NEW DESIGNS ✓NEW LITERATURE

"A" Battery Eliminator, DC-AC Inverters
Auto Radio Vibrators

ATR *See your jobber or write factory*

AMERICAN TELEVISION & RADIO CO.
Quality Products Since 1931
SAINT PAUL 1, MINNESOTA—U.S.A

vides stabilized and regulated variable d-c voltage from a-c power lines. A circuit drawing illustrates how the unit operates. Ratings, outline dimensions, stabilization and regulation data are given.

Wide-Band D-C Amplifier. Furst Electronics, 12 S. Jefferson St., Chicago 6, Ill. Model 120 wide-band d-c amplifier is fully described in a recent catalog sheet. The instrument was especially designed to serve as a stable preamplifier, extending the range of c-r oscilloscopes, v-t voltmeters and other measuring instruments for a-c and d-c. It can also be used in connection with paper strip recorders to increase their sensitivity.

High-Fidelity Audio Equipment. Stephens Mfg. Corp., Culver City, Calif., has released an 8-page booklet giving installation instructions and suggested uses for a line of high-fidelity audio equipment. Included are wiring diagrams for the speaker systems and suggestions for most efficient wiring of speaker systems in general.

Germanium Diode. Sylvania Electric Products Inc., 1740 Broadway, New York 19, N. Y. A recent catalog sheet describes and illustrates the type 1N60 germanium diode, a point contact rectifier designed for service as a video detector diode for tv receivers. Electrical and mechanical features and specifications are included.

Air System Socket. Eitel-McCullough, Inc., San Bruno, Calif., has available a catalog sheet covering the 4X150A/4000 air system socket which was developed in order to provide adequate air cooling of the 4X150A tetrode. The air system socket also makes possible improved circuit arrangements in high-frequency applications.

TV Replacement Guide. Standard Transformer Corp., 3580 Elston

Ave., Chicago 18, Ill. The seventh edition of the company's television catalog and replacement guide, form 338, is now available. The 26-page booklet gives complete specifications and list prices for a line of transformers and related components for tv replacement or conversion, indexed for use in 618 tv chassis and receiver models made by 64 manufacturers.

Variable Transformers. The Superior Electric Co., Hannon Ave., Bristol, Conn., has announced availability of a folder describing the newly redesigned Powerstat variable transformer types 116 and 216. The bulletin illustrates in detail the new features offered by the redesigned assemblies. It discusses the new brush assembly, fusing arrangement, cast-aluminum terminal box, coil and core design and polarity identification.

Photoelectric Amplifiers. De-Tec-Tronic Laboratories, Inc., 1227 N. Clark St., Chicago 10, Ill., has published an 8-page folder describing and illustrating a line of photoelectric amplifiers for smoke control, fire detection, counting, production line control, inspection, burglar alarms, warning devices and many other industrial applications.

Soldering Circular. National Bureau of Standards, U. S. Dept. of Commerce, Washington 25, D. C., has published circular 492 which describes in detail types of solders and soldering procedures. All common soldering alloys are listed and their component elements, together with their melting ranges, are given. The circular is available from the Supt. of Documents, U. S. Govt. Printing Office, Washington 25, D. C., for 15 cents a copy.

Hermetically - Sealed Relays. Guardian Electric Mfg. Co., 1621 W. Walnut St., Chicago 12, Ill. Catalog 5-H covers a line of her-

metically-sealed relays which are recommended for applications where humidity or dust conditions present a hazard to continuous operation. Through the development of a new method of sealing and the use of aluminum containers, the weight of the units described is extremely low. Included in the catalog is technical information on the performance of units conforming to requirements of the ANR-20b and the 10-G vibration tests.

Humidity-Proof Capacitors. Cornell-Dubilier Electric Corp., South Plainfield, N. J. Bulletin RT349 describes and illustrates the Royal Tiger paper tubular capacitors which use Polykane, a solid synthetic thermosetting compound. The humidity-proof capacitors can be used at ambient temperatures from −35 to +100 C, and are available in ratings at 100, 200, 400, 600 and 1,000 volts d-c. Insulation resistance of the units described exceeds 10,000 megohms per unit or 2,000 megohms per μf at 25C.

Broad-Band Amplifier. Electro-Mechanical Research, Inc., Ridgefield, Conn. Two sides of a sheet recently issued give a description of the model 36B amplifier, a versatile broad-band instrument designed for operation in the frequency range from d-c to 1,000,000 cycles. An illustration of the unit, quantitative data on performance and applications are included.

Electronic Stop-Watch. American Chronoscope Corp., 316 W. First St., Mount Vernon, N. Y. A recent 4-page publication treats of the electronic stop-watch which indicates time intervals from 10 μsec to 3 seconds. Operating principle, methods of measurement and time ranges of models 100 and 110 chronoscopes are shown. Also included are discussions of accessories known as the model 211 input adapter and model 301 photoelectric adapter. Prices and specifications for the four units are given.

NEWS OF THE INDUSTRY

(continued from page 130)

Bros., Inc.; Herbert C. Clough, Belden Mfg. Co., all of Chicago, and H. L. Kunz, Sangamo Electric Co., Springfield, Ill. Blacklidge named Kenneth C. Prince as legal counsel and S. I. Neiman as public relations counsel for the committee.

Mobile Radio Serves as Game Warden

EQUIPMENT for the largest two-way mobile radio communication system to be established by any fish and game commission in the United States will be supplied by the RCA Engineering Products Department to the Arkansas State Fish and Game Commission.

Under terms of a contract recently awarded to RCA, six 250-watt Fleetfone main station equipments, twelve 30- to 50-mc station receivers, one hundred and twenty-five 60-watt mobile Fleetfone units, two complete microwave radio relay stations, and remote control units and test equipment are being supplied to the fish and game authorities.

The Arkansas State Fish and Game Commission plans to operate a microwave relay station, station receiver, and remote control unit from headquarters in the State Capitol at Little Rock. The other microwave station, as well as station receiver and transmitter units, will be situated at Shinall Mountain, Ark. Six communication stations, located at Star City, Hope, Magazine Mountain, Iron Mountain, and Forest City, Arkansas, will be provided with 30- to 50-mc station receiving, transmitting, and remote control units.

Tower installations for the two-way radio communication system have already been started by the Arkansas authorities. Double Yagi antennas for the RCA type CWTR-5A microwave relay links and dielectric whip antennas for the commission's mobile equipment fleet are scheduled to be installed soon.

Frequencies assigned to the fish and game commission provide for 957- and 959-mc operation of the microwave relay equipments. The mobile transmitter units will operate on 46.74 mc and 46.82 mc, and

Model 99

VARIABLE HIGH VOLTAGE DC RF POWER SUPPLY

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Dept. A 236 West 55th St. New York 19, N. Y.
Inductograph Equipment now in use at leading universities, laboratories and industrial firms.

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TUBE CLAMPS

Stainless Steel — Corrosion Proof

83 VARIATIONS

Where vibration is a problem, Birtcher Locking TUBE CLAMPS offer a foolproof, practical solution. Recommended for all types of tubes and similar plug-in components.

More than three million of these clamps in use.

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FALSTROM service is fast, competent, complete. It includes forming, punching, welding and finishing. Piping, wiring and accessories can be built in when desired. Falstrom engineers will even procure and install your instruments to your specifications. All work performed by Falstrom is done by engineers and technicians thoroughly familiar with each phase of production. Mechanics skilled in working with steel, aluminum and stainless steels assure finest workmanship. Falstrom installations are in service throughout the electrical, chemical and petroleum industries — have been an accepted standard of excellence since 1870. For a practical, economical solution to your metal forming problems, go to Falstrom!

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Whether you require untreated coil windings or specially treated vacuum impregnated coils with wax or varnish, Dano is always ready to furnish you with quality coils.

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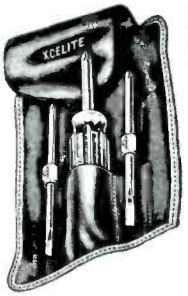
FOR ORIGINALITY LOOK TO XCELITE

Why this CK-3 Set is a BEST SELLER WITH RADIO & TV MEN

- 6 tools in one handy roll plastic kit!
- Quick-change blades (Nos. 1, 2 and 3 Phillips and 3/16", 1/4" and 5/16" regular screwdrivers) fit big XCELITE handle!
- Roll kit has two *extra* pockets for XCELITE detachable reamers, nut drivers, other screwdriver blades you can get to fit the XCELITE handle at a saving over getting separate tools!



Quality Tools PREFERRED BY EXPERTS

THIS 6-TOOL KIT, YOURS FOR ONLY **$4.35**

ASK YOUR SUPPLIER OR WRITE:
PARK METALWARE CO., INC.
Dept. C, Orchard Park New York

the mobile receivers on 46.74 mc. The fixed station 250-watt transmitters will transmit on 46.74 mc, while the fixed station receiver units will operate on both 46.74 mc and 46.82 mc.

RTMA TV Committee Appointed

PRESIDENT and chairman of the board, Robert C. Sprague has appointed W. R. G. Baker chairman of the television committee of the Radio-Television Manufacturers Association. Dr. Baker, director of the RMA engineering department and chairman of the National Television System Committee, succeeds past RMA president Max F. Balcolm, new chairman of the RTMA reorganization committee.

The complete membership of the RTMA Television Committee, together with their company affiliations, is as follows:

W. R. G. Baker (chairman) of General Electric Co.; B. Abrams of Emerson Radio and Phonograph Corp.; M. F. Balcolm of Sylvania Electric Products Inc.; W. J. Barkley of Collins Radio Co.; H. C. Bonfig of Zenith Radio Corp.; R. C. Cosgrove, past president of RMA; J. W. Craig of Avco Mfg. Corp.; A. B. Du Mont of Allen B. Du Mont Laboratories, Inc.; J. B. Elliott of RCA Victor; P. V. Galvin of Motorola Inc.; G. M. Gardner of Wells-Gardner & Co.; W. J. Halligan of The Hallicrafters Co.; and L. F. Hardy of Philco Corp.

VHF-ADF Installation Planned

THE CAA has announced a contract award to Bendix Aviation Corporation for 44 "Very High Frequency Aircraft Direction Finders" (VHF-ADF). They are to be installed at airports now equipped or to be equipped with surveillance radar equipment. These devices will enable air traffic controllers to identify aircraft within range of their surveillance radar screen during communication with that aircraft.

The ADF operation is linked with the scope of surveillance radar and

actuated by the VHF radio impulses from the aircraft being contacted. A line of light is drawn on the screen from the aircraft pip to the center of the scope which enables the airport traffic controller talking to the aircraft to be certain which of the pips on his screen represents the plane with which he is in communication. He is, thus, able to give the pilot directions for entering the landing pattern. These installations require no additional equipment aboard the aircraft.

BUSINESS NEWS

TECHNICAL PRODUCTS & SERVICES CO., Santee, Calif., was recently formed to manufacture and distribute a comprehensive line of radio, electronic and nucleonic products or services for schools and laboratories.

STATION WPIX recently bought $160,000 worth of new equipment from RCA for television transmitter installation on the Empire State Building, N.Y.C. Full time broadcasting from the new site is expected to start early in December.

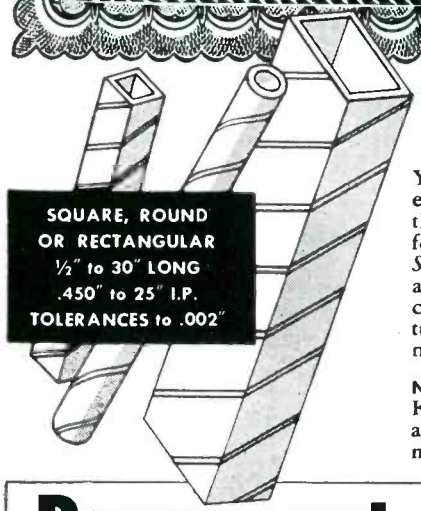
SYMPHONIC RADIO & ELECTRONIC CORP., Cambridge, Mass., recently moved its entire plant and facilities

Symphonic Radio & Electronic Corp.'s new building

to a larger building at 160 Washington St. North, Boston, Mass., to increase production of radios and record players.

SPRAGUE ELECTRIC CO., North Adams, Mass., and Philips Industries, Inc., Hartford, Conn., have formed a new corporation, the Ferroxcube Corp. of America, to be located at 50 E. 41st St., N.Y.C. The new corporation will manufacture

Coil Insurance
FOR FAMOUS PRODUCTS



PARAMOUNT Spiral Wound PAPER TUBES
Protect Coil Accuracy and Stability in Countless Applications

Years of specialized "know-how" easily enable PARAMOUNT to provide exactly the shape and size tubes you need for coil forms and other uses. *Hi-Dielectric. Hi-Strength.* Kraft, Fish Paper, Red Rope or any combination wound on automatic machines. Wide range of stock arbors. Special tubes made to your specifications or engineered for you.

NEW! Moisture-Resistant *Shellac-Bonn* Kraft Paper Tubing. Heated shellac forms a bond which prevents delaminating under moisture conditions.

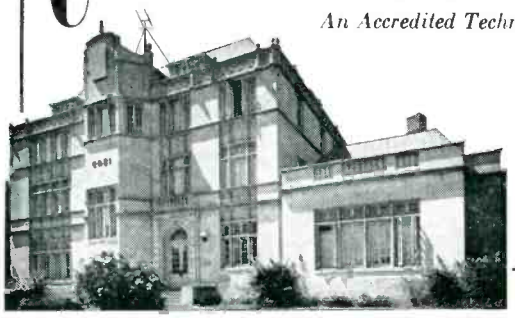
Paramount PAPER TUBE CORP.
616 LAFAYETTE ST., FORT WAYNE, IND.
Manufacturers of Paper Tubing for the Electrical Industry

WRITE ON COMPANY LETTERHEAD FOR STOCK ARBOR LIST OF OVER 1000 SIZES

Pioneer in Radio Engineering Instruction Since 1927

CAPITOL RADIO ENGINEERING INSTITUTE

An Accredited Technical Institute



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PRACTICAL RADIO-ELECTRONICS
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Request your free home study or resident school catalog by writing to:
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16th and PARK ROAD, N. W.
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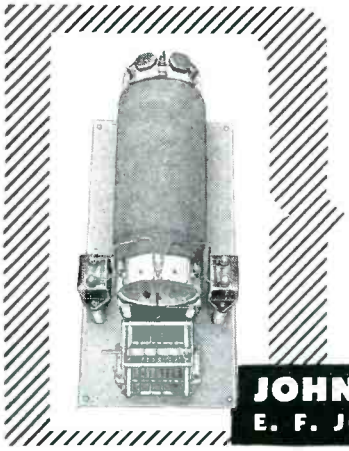
Approved for Veteran Training

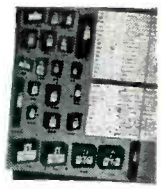


JOHNSON
TOWER LIGHTING FILTERS
★
High Impedance To RF!
Low Impedance To 60 Cycle Current!
★

Using JOHNSON Lighting Filters, antenna radiation resistance is changed less than 1% in compliance with FCC regulations. Filters also serve as a static drain device when used with grounded AC circuits. Variable tuning capacitor for maximum RF reactance. Can be adjusted for high impedance over the standard broadcast band.

Write today for specification sheet which gives complete details.

JOHNSON... *a famous name in Radio!*
E. F. JOHNSON CO., WASECA, MINN.

SPECIALTY


LAB-BILT DRY BATTERIES

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RADIO AND IGNITION

Write for New FREE CATALOG

Here are complete descriptions of 78 Lab-Bilt Batteries of industrial and hard-to-get types. Specification Sheet enables you to order batteries especially designed to your own requirements. No order is too small. Specialty makes and ships FRESH Lab-Bilt Batteries without delay. Get this new catalog today.

SPECIALTY BATTERY COMPANY
Ray-O-Vac **RAY-O-VAC** Subsidiary
MADISON 10, WISCONSIN

WHITNEY METAL
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41 YEARS EXPERIENCE

WHITNEY-JENSEN
No. 247
PRESS BRAKE

Production shops turning out quantities of small formings in large presses and job shops requiring a small brake, will find the No. 247 a cost reducing, space-saving piece of equipment. Capacity of the machine is 14 ga. mild steel over ⅞" 90° V die or 4½ tons.

Strokes per minute — 47
Throat height — 11-1/2"
Throat depth — 6-1/4"

WHITNEY METAL TOOL CO.
150 FORBES ST., ROCKFORD, ILL.

a ferromagnetic ferrite that is particularly useful as a core material in high-frequency coils and transformers.

ARMOUR RESEARCH FOUNDATION of Illinois Institute of Technology recently organized a nucleonics section in the physics department. The new section will apply radioactive tracer techniques to research problems.

THE EQUIPMENT & SERVICE CO., Dallas, Texas, is a recently established organization devoted to industrial electronic, broadcast and electrical engineering problems. It has manufacturing facilities for the building of small electrical equipments.

THE BERKELEY SCIENTIFIC CO., manufacturer of high-speed electronic counting devices, has moved to a new 15,000-sq ft building in Richmond, Calif.

CONSOLIDATED ENGINEERING CORP., Pasadena, Calif., manufacturers of electronic analysis instruments, have begun construction of a new 66,000-sq ft plant scheduled for completion Jan. 1, 1951.

PERSONNEL

A. W. PARKES, JR., vice-president in charge of field engineering and sales for the Aircraft Radio Corp., Boonton, N. J., has been elected chairman of the Northern New Jersey unit of the IRE for the 1950-51 season.

JOHN R. DUNNING, scientific director of Columbia's new cyclotron, has been appointed dean of the school of engineering, Columbia University, New York City.

RICHARD G. LEITNER, for the past four years chief engineer of the Lear, Inc., California division, has resigned to take a similar post with the U. S. Electronics Corp., Los Angeles, Calif., manufacturers of sound specialties.

ERIC WALKER, on leave of absence from Penn State, where he directs the Ordnance Research Laboratory and heads the electrical engineering

department, is the new executive secretary of the Research and Development Board.

FRANCIS X. RETTENMEYER, for the past five years chief engineer for Federal Radio and Telegraph Co., has joined Philco Corp. as executive engineer to assist in the engineering administration of the company's government and industrial electronics program.

F. X. Rettenmeyer

S. Freedman

SAMUEL FREEDMAN, formerly new developments engineer and in charge of sales engineering for the microwave firm of DeMornay Budd Inc. of New York and Calif., is now owner and manager of the recently organized firm of Technical Products & Services Co., Santee, Calif.

DONALD E. SMITH, formerly an engineer for the electronics division of Sylvania Electric Products Inc., Boston, Mass., has been transferred to the renewal tube sales department of the radio tube division.

D. E. Smith

C. A. Robson

C. ARTHUR ROBSON, formerly associated with the Crosley Broadcasting Corp., has been appointed to the engineering staff of The Turner Co., Cedar Rapids, Iowa.

Editor's Note: Page 227 of the August issue in error reported Mel Byron as President of Electronic Instrument Co. Mr. Byron, at one time a manufacturers' research consultant, actually has been appointed chief engineer.

eract customer dissatisfaction by using 7 inch tv sets as loaners free of charge while their set is in the shop, and honestly find that most of our customers prefer that repairs be done outside their home.

There is nothing more embarrassing to a service man than to have an obvious trouble that can be fixed in 10 minutes turn out, after an hour of work in front of the customer, to be a shop job.

We originally had top grade men do all repairs in the home. We then tried the other method of having experienced radio men (learning tv) do the house calls. Our books show balance in favor of the latter method for two main reasons: first, the initial cost of equipping new trucks as business expands, and secondly, the total payroll (besides miscellaneous other reasons). This is also balanced by the apparent scarcity of good tv men located in our area.

Your Table III techniques were thoroughly analyzed by the undersigned, and you might be interested in knowing that out of the 37 items listed, we are for 14, against 13, and have no comment on others.

About cabinets — we are thoroughly in favor of placing all controls on the front; those seldom used controls behind a removable panel or available by removing the volume control knob or some such feature. We are also in favor of having the cabinet built so that the yoke is accessible without removing the chassis and we are also in favor of having the safety glass easily removable for cleaning the picture tube face, as the electric charge on the screen does make tubes collect dust rather badly.

It makes little difference to us as to whether parts are standardized; provided the distributor keeps a substantial inventory of those special parts on hand. However, we feel that those manufacturers who do not use distributors, should use standardized parts or provide Rider and other circuit diagram sources with a substitute parts list on their models. It is easy to fit a standard RCA vertical or horizontal transformer in most orphan brands, but when an XYZ set comes to the shop with a defective component, and nothing in the standard parts di-

rectory seems to fit, you are up the proverbial creek; especially if the customer is a bit in a hurry and you can only get said part from a manufacturer who is either too busy or just hasn't the common courtesy to answer a letter. I'd say for all manufacturers to use standard parts only, if they have no distributor (wholesaler) setup.

In closing let me state that television is a wonderful business, but already it needs a housecleaning. Not by New York City's licensing proposal, however, but by all the manufacturers just getting together and setting up a system of standards. A survey by said manufacturers, or by ELECTRONICS, among the service agencies would bring to light some of their pet gripes and perhaps some good ideas. This letter contains some of my ideas, what are yours?

CHARLES R. MADVELL, JR.
Consulting Electronic Eng.
Delta Electronics, Inc.
New Orleans, La.

An Illuminating Question

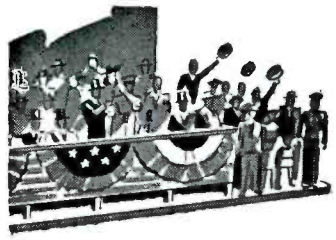
DEAR SIRS:

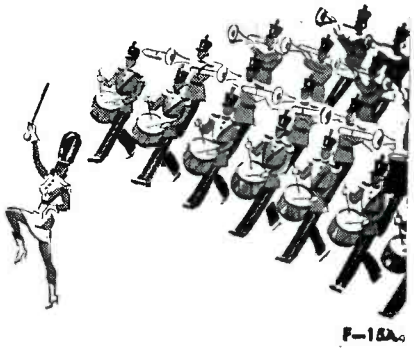
YOUR COMMENTS on the developments in electron tubes during the life of ELECTRONICS made very interesting reading.

The paragraphs on the 931A and 1P21, in particular, were appreciated by this group. However, I should like to inquire whether "a billionth" by ELECTRONICS standards is a thousandth of a millionth or a millionth of a millionth, when you say the 1P21 "goes down to half a billionth of a lumen." I believe that on reflection you will find us even more conservative than you thought. Or have I missed a congressional redefinition of our billion to conceal the increase in the national debt?

ALAN M. GLOVER
Engineering Section
Tube Dept.
Radio Corporation of America
Lancaster, Pennsylvania

(Editor's Note: As far as ELECTRONICS is concerned a billion is still one thousand million. We wonder, however, if the British definition might not come in handy if the current trend toward increased photosensitivities continues.)





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Box Numbers—Care of publication New York, Chicago or San Francisco offices count as 1 line.
Discount of 10% if full payment is made in advance for 4 consecutive insertions.

Individual Spaces with border rules for prominent display of advertisements.

The advertising rate is $12.80 per inch for all advertising appearing on other than a contract basis. Contract rates quoted on request.

An advertising inch is measured ⅞" vertically on one column. 3 columns—30 inches—to a page.

The publisher cannot accept advertising in the Searchlight Section which lists the names of the manufacturers of resistors, capacitors, rheostats, and potentiometers or other names designed to describe such products.

REPLIES (Box No.): Address to office nearest you
NEW YORK: 330 W. 42nd St. (18)
CHICAGO: 520 N. Michigan Ave. (11)
SAN FRANCISCO: 68 Post St. (4)

POSITION VACANT

ENGINEER WITH minimum of five years experience, familiar with television and uhf. design to take complete charge of laboratory in central Connecticut area. Excellent opportunity with fast-growing concern. Give complete details including age, education, experience, references, availability and salary desired. P-7232, Electronics.

ELECTRONIC PHYSCIST for research and development work on instrumentation problems with major petroleum refiner. Degree in physics essential, M.S. or Ph.D. preferred. Must have a minimum of 5 years' research experience on a variety of electronic problems and demonstrated ability to develop new and ingenious electronic devices. Age 28-40. Location Chicago. Salary dependent upon training and experience. Reply in confidence giving full details to P-7361, Electronics.

SELLING OPPORTUNITY OFFERED

SALESMAN TO organize and promote sales of high quality radio resistors now being produced by a company well established in radio and electrical component industry. Give summary of experience and availability in reply. SW-7239, Electronics.

EMPLOYMENT SERVICE

SALARIED PERSONNEL, $3,000-$25,000. This confidential service, established 1927, is geared to needs of high grade men who seek a change of connection under conditions assuring, if employed, full protection to present position. Send name and address only for details. Personal consultation invited. Jira Thayer Jennings, Dept. L, 241 Orange St., New Haven, Conn.

OPENINGS:—EE's, BS or equiv. Electronic, Chief Engrs. (const.-maint.), Instructors, Anncr.-tech. (Exp. or student), Xmitter Engrs. 1st fone lic. nec. RRR-Radio-TV Employment Bureau, Box 413, Philadelphia, Pa.

POSITION WANTED

AVAILABLE JANUARY first or earlier radio engineer over twenty-five years experience communications and aeronautical fields. foreign and domestic. Speak, read and understand Spanish. Prefer Latin America. PW-7409, Electronics.

SELLING OPPORTUNITY WANTED

ELECTRONIC COMPONENT Part Salesman, 30, presently selling to radio, TV and electrical manufacturing industry in East. 12 yrs. selling experience. SA-7373, Electronics.

MANUFACTURERS REPRESENTATIVE seeks additional electrical or electronic account. New York, New Jersey territory. Good following in industry. Will consider sales management. SA-7426, Electronics.

SPECIAL SERVICE

Technical Illustration (Airbrush)
exploded views, cutaway rendering, and top quality photo-retouching. For instruction manuals, advertising, and catalogues. Hirshon, 113 West 42nd St., N.Y.C. LO 4-8163.

SENIOR ELECTRONIC CIRCUIT PHYSICISTS

for

Advanced Research and Development

MINIMUM REQUIREMENTS:

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2. Not less than five years experience in advanced electronic circuit development with a record of accomplishment giving evidence of an unusual degree of ingenuity and ability in the field.

3. Minimum age 28 years.

Hughes Aircraft Company

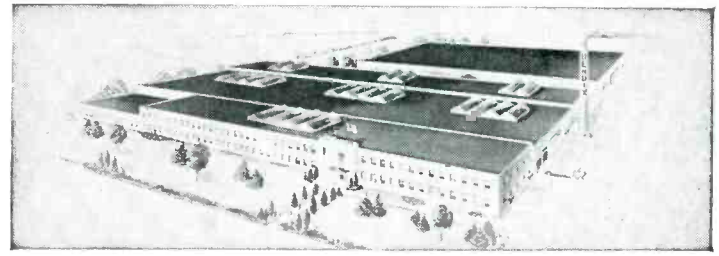
Attention: Mr. Jack Harwood

CULVER CITY, CALIFORNIA

ELECTRONIC ENGINEERS

BENDIX RADIO DIVISION

Bendix Aviation Corporation



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Bendix Radio Division, a leader in the field of high quality radar and communications equipment, has positions for engineers experienced in the design and development, for production, of radio and radar equipment or electronic research.

Positions are available at all salary levels.

Good advancement opportunities, air-conditioned plant in suburban location, excellently equipped laboratories, technical library, large experimental engineering model shop.

Housing and rentals in Baltimore are plentiful.

Interviews will be held in Baltimore, Chicago and New York. Please send resume of experience promptly to:

MR. W. L. WEBB, *Director* Engineering and Research

BENDIX RADIO DIVISION

Bendix Aviation Corporation • Baltimore 4, Maryland

ENGINEERS RESEARCH and DEVELOPMENT

Career Positions for Top Engineers and Analysts

SENIOR ELECTRONICS AND ELECTRONICS ENGINEERS—B.S. or M.S. degree; 2 to 7 years experience in radar, television, pulse, video or display circuit design.

DIGITAL COMPUTER DESIGN ENGINEERS.

AUTOMATIC TELEPHONE SWITCHBOARD DESIGN ENGINEER.

SENIOR ELECTRO-MECHANICAL ENGINEERS—Degree and at least 4 years experience in servo-mechanism analogue computers, special weapons or system design.

Submit detailed resume. Personal interview will be arranged.

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Employment Department

BALTIMORE 3, MARYLAND

WANTED

Distributor for our telephone-type inter-office communication equipment. Fully inter-communicating push-button handset instruments, loud-speaking. Only first class, well established sales and installation organization need apply.

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THE FRANKLIN INSTITUTE

Laboratories for Research and Development

have openings for personnel with 2-10 years experience. Advanced degrees are desirable in certain of the positions. Fields of interest covered are: Mathematical Analysis of Physical Problems, Statistical Theory of Communications, Electromagnetic Theory, Circuit Analysis, Servomechanism Theory, Electrical Computing, Advanced and Fundamental Circuit Development, Radar and Pulse Circuits, Supervision of Operation of G.C.A. or Tracking Radar, Air Traffic Control Air Navigation, Automatic Controls, Industrial or Marine Power Drives, and Electrical Machinery.

Send resume of education and experience, salary requirements and photograph to:

Personnel Department

THE FRANKLIN INSTITUTE

Philadelphia 3, Pennsylvania

RCA VICTOR Camden, N. J.

Requires Experienced Electronics Engineers

RCA's steady growth in the field of electronics results in attractive opportunities for electrical and mechanical engineers and physicists. Experienced engineers are finding the "right position" in the wide scope of RCA's activities. Equipment is being developed for the following applications: communications and navigational equipment for the aviation industry, mobile transmitters, microwave relay links, radar systems and components, and ultra high frequency test equipment.

These requirements represent permanent expansion in RCA Victor's Engineering Division at Camden, which will provide excellent opportunities for men of high caliber with appropriate training and experience.

If you meet these specifications, and if you are looking for a career which will open wide the door to the complete expression of your talents in the fields of electronics, write, giving full details to:

National Recruiting Division
Box 900, RCA Victor Division
Radio Corporation of America
Camden, New Jersey

WANTED:

RESISTORS
and Potentiometers

SINGLE J—DUAL JJ—TRIPLE JJJ

made by **ALLEN BRADLEY CO**

RESISTORS OTHER MAKES ARE ALSO ACCEPTABLE
ALSO CAPACITORS: MICA & SILVER MICA & CERAMIC

LEGRI S COMPANY, INC
130 West 102nd St., New York 25, N. Y.

Phone: ACademy 2-0018

WANTED

MICROWAVE TEST EQUIPMENT

W-7142, Electronics
330 W. 42nd St., New York 18, N. Y.

WANTED

900—Fixed Paper Capacitors
± CP53BIFB405K-4 MF

Various Rated 6 Watt Wire Wo. Dejur-Amsco Potentiometers ± 10%

Micro-Switches—BZ-2RW2
BZ-7RQ IT
YP-27
YP-2
9-11063

Wire or Mail Quantities Available - Prices

W-7408, Electronics
330 W. 42nd St., New York 18, N. Y.

WANTED

Any Quantity:

SCR-284 & BC-375

A) Surplus, complete, brand new, unused.
B) Surplus, complete, reconditioned, excellent shape & working order.

OFFERS: F.O.B. New York to be submitted with detailed description of condition & complete list of items composing each unit to . . .

W-7414, Electronics
330 W. 42nd St., New York 18, N. Y.

WANTED

WESTERN ELECTRIC VACUUM TUBES

Types 101F, 102F, 272A, 274A or B, 310A or B, 311A, 313C, 323A, 328A, 329A, 348A, 349A, 352A, 373A, 374A, 393A, 394A, 121A Ballast Lamps.

W-6863, Electronics
330 W. 42nd St., New York 18, N. Y.

WILL BUY SUBSTANTIAL QUANTITY OF DM-35

DYNAMOTORS

new or used but in good working order

ROCKE INTERNATIONAL CORPORATION
13 East 40th St. New York, N. Y.

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INSULATORS; POLE LINE HARDWARE; GUY STRAND WIRE; COPPERWELD WIRE; WESTERN ELECTRIC TOOLS; SPLICING SLEEVES.

VICTOR-BERNARD INDUSTRIES
NE Cor. 22nd & Lehigh Aves., Phila. 32, Pa.

WANTED

Teletypewriters complete, components or parts. Any quantity and condition.

W-6864, Electronics
330 W. 42nd St., New York 18, N. Y.

CONDENSERS

MICA
SOLAR XMB
TAPPED HOLES

Mfd.	Price
2500 V Test	
.00001	$0.35
.000025	.35
.00003	.35
.00005	.35
.000075	.35
.0001	.35
.00015	.35
.00025	.35
.0003	.35
.0004	.35
.0005	.40
.00075	.40
.00085	.40
.001	.50
.0015	.50
.0016	.50
.0017	.55
.002	.65
.0022	.65
.003	.75
.004	.95
.005	.95
.006	.98
.0063	.98
.0069	.98
.007	.98
.0075	.98
.0076	.98
.008	1.05
.01	1.25
.015	1.25
.02	1.30
.025	1.30
.027	1.35
.03	1.45
5000 V Test	
.0015	1.75
.002	2.00

SOLAR XO
Solder Lugs
2500 V Test

.01	1.25
.015	1.30
.02	1.50
.04	1.75
.001	.60
.0015	.60
.002	.75
.0022	.75
.0023	.75
.0024	.75
.0025	.75
.0027	.80
.003	.80
.004	.85
.005	.90
.0056	.95
.006	.95
.0063	.95
.0075	1.00
.0076	1.00
.008	1.05
.0085	1.20
.0005	.60
.00085	.70
.00015	.60

Write For Many Others

SCREW MTG
Wirleads D TYPE

Mfd	Volt	Price
4	600	$0.35
8	250	.25
8-8	450	.50
16	450	.40
20	450	.45
30	450	.50
29	250	.45
12	250	.30
8	600	.60
8	450	.30
16	600	.80
30	450	.50
20	150	.30
240	250	.80
30-30	450	.75

MINICAPS
PIGTAIL

Mfd.	Volt	Price
30	450	$0.49
30	300	.45
30	350	.48
40	450	.50
16	525	.70
16	350	.35
16	525	.45
16	450	.49
16	100	.24
20	25	.20
20	80	.25
20	450	.49
24	350	.30
8	400	.39
8	150	.15
10	150	.20
10	50	.15
4	50	.10
4	150	.14

ELECTROLYTICS
Prong Mount
D. Y. Type
18c ea.
10 for $1.75

Mfd.	Volt
40	150
80	150
10	200
8	450
16	450
20-20	25
10-10	150
20-20	150
40-40	150
20-30	250
3x20	450
40	250
30	300
80	350
10	450
15	450
30-30	25
20-10	150
40-20	150
50-30	150
20-1	350
10-1	300

29c ea.
10 for $2.75

6	400
50	400
40	450
30-20	150
50-50	150
20-20	350-25
20-20	400-25
40-20-10	150
40-30-20	150-25
50-50-20	150-25
60-40-10	150-25
60	300
30	450
32	450
30-30	150
70-30	150
30-20	350-25
10-10	450
40-20-20	150
40-30-20	150
3x50	150
40-10-100	150-10

AC CONDENSERS

75-84	125	1.30
20-24	110	1.00
26-30	110	1.00
31-37	110	1.00
38-42	110	1.00
43-48	110	1.00
43-65	110	1.25
50-75	110	1.25
72-87	110	1.25
86-96	110	1.45
88-106	110	1.50
107-129	110	1.75
124-138	110	1.75
130-150	110	1.75
130-180	110	1.90
161-180	110	1.75
158-191	110	2.00

Ceramicons

Mmf	
1	25
3	27
3.4	35
4	30
5	47
6	50
7	57
8.5	58
11	60
15	62
20	67
24	70
79	220
115	240
125	250
150	350
180	1000
200	8.50 per 100
100	Feed Thru 50
Button	
49 100	
150 200	
175 500	470
185 100	
9.50 per 100	

RECTIFIER CAPACITORS

Mfd	Volt	Price
6000	12	$2.75
1900	15	.90
3040	15	1.95
2x500	15	1.75
300	25	.95
500	25	.95
100	30	.70
1000	35	1.39
1000	35	3.49
2000	50	3.00
3x200	50	2.25
500	80	1.40
125	150	1.40
250	150	1.69
2x1000	6	1.10
75	250	.75

Wholesale Qtys Available

OIL CONDENSERS

Mfd.	Volt	Price
15	220AG	$2.20
.5.5	400	.50
1	600	.45
6	600	.98
7	600	1.05
.5	750AC	1.69
7	800	1.20
.5	1K	.69
1.5	1K	.75
2	1K	.99
4	1K	.98
.25	1.5K	1.05
1	1.5K	.89
1.5	1.5K	.95
2	1.5K	1.03
6	1.5K	2.25
1	2K	.98
.1	2.5K	1.20
.15	4K	2.95
.1.4	4.8K	2.95
.4	5K	2.95
.1	6K	2.79
.15.15	6K	3.95
1.5	6K	9.75
.1.1	7K	3.39
.1	7.5K	2.95
1	7.5K	12.95
.15.15	8K	4.95
.1	10K	14.95
.0016	15K	7.95
1	15K	30.95
.015	16K	6.95
.25	20K	16.95
.5	25K	36.95
1	25K	83.95
4	50	.29
1	100	.15
2.5	100	.23
	200VDC	
2x.1	2ST	.15
2x.1	3TT	.15
2x1	4ST	.16
2	2ST	.20
.5	2TT	.15
.5	2ST	.15
	400VDC	
2x.25	3ST	.21
2x.1	3ST	.21
2x.1	2TT	.20
3x.1	3ST	.25
.1	2TT	.19
.5	1TT	.19
1	2ST	.23
2	2ST	.26
	600VDC	
.1	2BT	.20
.1	2ST	.21
2x.1	3ST	.27
2x.1	3BT	.25
2x.1	2ST	.26
3x.1	3T	.25
2x.25	3ST	.23
.25	2TT	.20
1	2ST	.30
2x1	3ST	.35
2	2ST	.40
2	2BT	.39
1	1000VDC	
1	2ST	.45

MANY OTHERS

ARR2 HOMING REC.
Tunes 234-258 Mc. Contains 4-6AKS, 6-300I, 1 — 12A6. Ideal for 2-0-10 Meter Conv. Less Dyn. As is fair $4.95

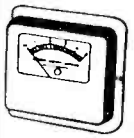
BC-659 Mobile FM TRANSCEIVER — P.O. SCR-610. Includes 10 meter band. Excellent condition with tubes $15.95
PE-120 Power Supply — Less vibrator tubes and Cond. $6.50
Combination BC-620 and PE-120, Both for $20.95

R5/ARN 7
Compass Rec.
ADF Rec. 100 to 1750 KC, in 4 Bands 5-Gang Tuning Capacitor w/15 Tubes. 4-6K7, 1-6L7, 1-6J5, 2-6B8, 2-6F6, 1-6N7, 1-6SC7, 2-2051, 1-524, Exc. ..$55.00
Good $30.00

ARC 5 Xmtrs
VFD Drivers
40 Watts Output 3 — 4 Mc
$6.95
Used Fair Cond.

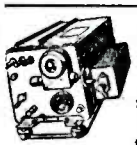
Superhet Recvrs W/Dyn - Used - Fair. Can be converted to 110v 60 cy. 190-550 Kc $6.95
3-6 Mc $4.95

METERS



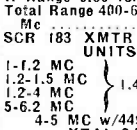
0-5 MA & 0-5 V Scale w/110V Movement 2" Metal Case Readrite Meter 98c ea.
10 for 9.00

0-250V 3½" Rd Bake Weston 476 .....$4.25
0-5 MA Basic 4½" Rect Bake 100 Meg/600V/60V/30 VDC $5.95
0-150 VAC 3½" Rd Bake Weston 476 .....$4.25
0-5 MA Basic "S" Rd Metal Simpson Mod 23 w/mult. scales 0-100 Meg. 0-600V 0-500/50/10 VDC $4.25
0-5 MA Basic 3" Rd Bake Simpson Mod 23 w/mult. scales 3-100 Meg/600V/5MA $4.25
100-0-100 Microamps 4½" Rect. Bake. Weston Mod 801 $8.95
0-200 Microamp 4½" Rect Bake $7.10
0-200 Microamp 3½" Rd Bake $4.25
0-200 Microamp 4" Rect Bake. Weston 741 ..$13.95
0-300 VDC 4" Rect Bake Weston 741 .....$13.95
0-1 MA 3" Sq GE Mod DO 53 .....$5.95
0-10 MA 3½" Rd Bake Dejure 5310 .....$3.95



RU 19/ GF11 or SCR 183 Recvr & Xmtrs Designed for Mobile and Aircraft 2000 to 9050 Kc or Xmlting 187-13950 for Recvg. Jsing T-U. 12-15 watt Rec Less T.U...$3.95
Xmtr Less T.U..... 3.95

SCR 183 Rec Tuning Units
D Range 850-1330 KV
E Range 1336-2040 KC
F Range 2.04-3 MC
G Range 3-4.5 MC
H Range 4.6 MC
K Range 9.05-13.5 MC
Total Range 400-600 KC 6-9 Mc .....$1.79 ea.
SCR 183 XMTR TUNING UNITS
1-1.2 MC
1.2-1.5 MC } 1.49
1.2-4 MC
5-6.2 MC
4-5 MC w/4495 KC XTAL 2.79



BC 223 XMITER
30 Watt
Transmitter with crystal oscillator control on four preselected channels—also master oscillator. Frequency coverage 2000 KC to 5250 KC. by use of three plug in coils. Five tube operation, 807 oscillator, 807 power amplifier, two 46 modulators, and one 46 speech amplifier. Price with TU-17 Tuning Unit, 2000 to 3000 KC 32.95

SCR 522 VHF XMTR-RCVR

10 Tube Xtal Controlled Recvr. 7 Tube Xmtr. Makes ideal 2 Mtr. 2 way mobile rig for Cabs., etc. 100-150 MC w/Tubes $34.95
DC 221 Freq Meter Cabinet, wood $2.96

0-30 Volt DC Meter. Westinghouse Type AX. 1209830 Aircraft E30. Special Price $2.49

Chromalox Heating Unit Monel 115V, 7¾"L x 1½" x ⅝", 7 Amp. 5 ohms, 250 Watt. Price $1.25

Birtcher Tube Clamps

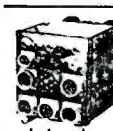
926-C
926-16
926-B1
926-B2
926-B8
926-C15
926-C-13
926-C-19
926B-16
926A-14
926C1
926A11
926-B31
926C-23
929-1
926B-10
926B-18
926-K2
Each 15¢
10 $1.40
100 $12.00

BC-605 INTERPHONE AMPLIFIER
Easily converted to an ideal inter-Communications set for office-home-or factory. Original. New w/oonversion. Diagram $4.75

ARC 5 M.O. COILS

6029	3-4 MC
6030	4-5.3 MC
6031	5.3-7 MC
6032	7-9.1

Price 39¢ ea. 4 for $1.50



Interphone AMPLIFIER RL-2
Convert to high fidelity phone Amp. or special Amp. Complete with tubes and dynamotor, for 24 V. DC operation. Used but in good condition. SPECIAL PRICE $2.29

Spec Xfrm 110V 60CY Input
30v/3.5A for Rect. etc. $2.75
24v/1.5A for ARC/ S, etc. $1.95
2300v/4Ma. 2.5/2A $5.79
1980 Vct / 55Ma. 2x6v/1.2A ...$4.49
720Vct/220Ma, 6.4 7.7A, 6.4/6, 5v/ 3A, 1.25/.3A $3.25
645Vct / 90Ma, 5v/ 2A e.3v / 1.2A. Tapped Pri. $2.25
2.5v/5A, 2.5v/5A for 866 Tubes 9000 Vt. ...$2.95
350Vct 70 Ma 6.3/ .6 6.3v/1.8A $1.75

DYNA-MOTORS AT SURPLUS PRICES

Type	Input Volts	Amps.	Output Volts	Amps	Radio Set
PE86	28	1.25	250	.060	RC 36
DM416	14	6.2	330	.170	RU 19
DY-2/ARR-2	28	1.1	250	.060	ARC-5
DM36	28	1.4	220	.080	SCR 508
DM25	12	2.3	250	.050	BC 367
	28	1.25	275	.070	BC 348
DM33A	28	7	540	.250	BC 456
DM42	14	46	515	.110	SCR 506
			1030	.050	
			2/8		
PE101C	13/26	12.6	400	.135	SCR 515
		6.3	800	.020	
BD AR 93	28	3.25	375	.150	
23350	27	1.75	285	.075	APN-1
35X045B	28	1.2	250	.060	
ZA .0515	12/24	4/2	500	.050	
ZA .0516	12/24	8/4	12/275	3/110	
B-19 pack	12	9.4	275	.110	Mark II
			500	.050	
D-104	12		225	.100	
			440	.200	
DA-3A*	28	10	300	.060	SCR 522
			150	.010	
			14.5	.5	
#5053	28	1.4	250	.060	APN-1
PE 73CM	28	19	1000	.350	BC 375
DM21	14	3.3	235	.090	BC 312
CW21AAX	13	12.6	400	.135	
	26	6.3	800	.020	
			9	1.12	
BD 77KM	14	40	1000	.350	BC 191
PE94	28	10	300	.260	SCR
			150	.010	522
			14.5	.5	

BC 929 SCOPE

3" Oscilloscope using 9 tubes, 3BP1, 6SN7, 6H6, 6BGG, 6X5, 2X2, (Now 400 cy) easily converted to 60 cy. Complete w/ tubes $24.95

PE 157 VIBROPACK FOR BC 745

Runs on 2V DC. Obtained from small Willard Rechargeable battery contained in case which is charged from 6 Vac or DC. Also contains 5" PM Speaker & Jacks for Mike Hdsets. Used, excellent $9.95

LP2I LM Radio Compas Loop. Excellent Cond. $10.95

BC 434 CONTROL BOX

Remote Control for ADF Rec. BC 433. Contains 0-5 Mill Tuning Meter, Dial Control, 4 Sub Min Grain of Wheat, 24V Pilot Lights. Brand New.....$3.95

BC 620 Mobile Rec. 20-27 MC w/Tubes. Excellent Cond..$15.95

PE117 Power Supply Less Vibrator Cond. & Tubes. Price...$5.95

HORSIE TALKIE BC745 Xmttr Recvr. 3-6 MC w/I T.U. Less Power Supply $12.00

866 Filament Xfrmr

2 x 2.5v 6 Amp 8000 V Test Size. Approx 3½" SQ. Easy to Mount. Price $2.95

Trimmer Cond. Variable

15 MMF
5 MMF
20 MMF
40 MMF
50 MMF
60 MMF
} 21¢ ea.

HIGH CURRENT MICAS

Ceramic Case

120 MMF	10KVW	$19.00
30 MMF	10KVW	19.00
.08 MFD	1500 ...	10.00
.045MFD	2000 ...	12.00
.0001	20 KVW	24.00
.0051	15 KVW	21.00
.001	25 K	35.00

Available in Stock
Large Qtys.
Amphenol Connectors
Write for List

POTS

Mod J	225Ω	.47A	$1.10
Mod J	1000Ω	.22A	1.10
Mod H	15Ω	125ω	.89
Mod J	800Ω	50ω	1.10
	5Ω	250ω	2.79
	5000Ω	4ω	.89
	20KΩ	8ω	1.10
	100KΩ	10ω	2.25

Voltage Stabilizer VR3

95-130V 2.4A 60Cy 1ϕ Out. 115V 120 Watt 100% Mfg. Raytheon w/Ext. Bx Box. Sockets & cable used but good $19.95

Voltage Regulator VH623

95-130V 1.75A 60Cy 1ϕ CU 115V 150 Watt 100%. Slightly used, excellent $19.95

BC-733D SUPERHET RECEIVER

w/10 Tubes, 6 Selector-Relays operate on Xtal Controlled Freq. 108.3-110.3 MC. Can easily be converted to 2 Mtr. ham bands $7.95 ea.

TUBES! Outstanding Values

01-A	$ .45	7E5	1.00	615	.89	EF50	.79
1B26	4.85	7E6	.72	704-A	.75	F-127	20.00
2C21	.69	10Y	.60	705-A	2.85	FC258A	
2C22	.69	12A6	.35	724B	1.75		165.00
2X2/879	.69	12K8Y	.65	800	2.25	GL532	7.50
3BP1	2.25	12SF7	.49	801-A	1.10	FC271	40.00
2C24	.60	12SR7	.72	804	$9.95	GL562	75.00
3C30	.70	15P	1.40	815	2.50	GL623	75.00
3D6	.79	28D7	.75	836	1.15	GL697	75.00
3CP1	3.50	30 (Spec.)	.70	837	1.95	ML100	60.00
3D21-A	1.50	45 (Spec.)	.59	843	.59	QK59	65.00
3DP1	2.25	39/44	.49	860	15.00	QK60	65.00
3EP1	2.95	35/51	.72	861	40.00	QK61	65.00
3FP7	1.20	227A	3.85	874	1.95	QK62	65.00
3Q5	.79	225	8.80	876	4.95	VR91	1.00
5BP1	1.95	268-A	20.00	1005	.35	VR130	1.25
5BP4	4.95	355-A	19.50	1619	.21	VR135	1.25
5CP1	3.75	417A	25.00	1624	.85	VR137	1.25
5FP7	3.50	530	90.00	1629	.35	VU120	1.00
5J30	39.50	531	45.00	1961	5.00	VU134	1.00
6G	2.00	532	3.95	9002	.65	WL532	4.75
6SC7	.70	559	4.00	9004	.47	WN150	3.0
7C4	1.00	562	90.00	CEQ72	1.95	WT260	5. 0

LAMPS

#1488 - 14V 10/50¢
#623 — 24-28V 10/50¢
125! — 24-28V 10/50¢
LM37 13V 10/50¢
Red 10W 60V 8¢ ea. 5 for Gtd. New $1.00

CHOKE SWINGING

9/60 Hy 400/.05 MA. 10000 volt test. Mfg Super Elect. $8.95

1619—1619—1619 Octal Base Pentog Aversatile High Perveance Tube, 21¢

TUNING UNITS FOR BC 191

TU 5—	1500	to	3000	KC.....$2.95
TU 6—	3000	to	4500	KC..... 2.95
TU 7—	4500	to	6200	KC..... 2.95
TU 8—	6200	to	7700	KC..... 2.49
TU 9—	7700	to	10000	KC..... 2.49
TU-10—	10000	to	12500	KC..... 2.49
TU 26—	200	to	500	KC..... 2.49

All merch. guar. Mail orders promptly filled. All prices F.O.B. N. Y. C. Send MO or Chk. Only shipping chgs. sent C.O.D. Rated concerns send P.O.

COMMUNICATIONS EQUIPMENT CO.

131 Liberty St., New York, N. Y. **Dept. E-9** CHAS. ROSEN **Phone: Digby 9-4124**

MICROWAVE TEST EQUIPMENT

THERMISTORS

D-167332 (tube) ....$.95
D-170396 (bead) ....$.95
D-167613 (button) ..$.95
D-164699 for MTG in "X" Band Guide $2.50
D-167018 (tube) ....$.95

WRITE FOR C.E.C. MICROWAVE CATALOG NOW AVAILABLE

VARISTORS

D-170225 .....$1.25
D-167176 .....$.95
D-168687 .....$.95
D-171812 .....$.95
D-171528 .....$.95
D-171528 .....$.95
D-168442 .....$3.00
D-165593 .....$1.25
D-98836 .....$2.00
D-161871A $2.85
D-171121 .....$.95
D-98836 .....$1.50
D-162356 (308A) .....
D-163357 .....$2.00
D-99946 .....$2.95

23,000 to 27,000 mc. BENCH TEST PLUMBING—½" to ¼" Waveguide

Precision Slotted Line. DeMornay Budd type 337 .....$400.00
Complete with adjustable probe and crystal output. Square flanges.
Precision Slotted Line. Adjustable probe. Humble Oil type. CPK-2111U $200.00
Directional Coupler-Wavemeter Mnt. 12DB..$60.00
Precision Var Attenuator, mfg. Bernard Rice..$90.00
Tunable Xtal Mnt. DB423 less tuning plung. $30.00
Flap Attenuator. DB405 10DB attenuation..$25.00
Low Power Load.....$20.00
Screw Tuner $25.00
Shunt Tee $35.00
Waveguide Lengths. 2" to 6" long, gold-plated with circular flanges and coupling nuts....$2.25 per inch
APS-34 Rotating Joint.....$49.50
Right Angle Bend E or H Plane, specify combination of couplings desired.....$12.00
45° Bend E or H Plane, Choke to cover.....$12.00
Directional coupler CU-103/APS32.....$49.50
Mitered Elbow, cover to cover.....$4.00
TR-ATR Section, choke to cover.....$4.00
Flexible Section 1" choke to choke.....$5.00
"S" Curve Choke to cover.....$4.50
Adaptor, round to square cover.....$5.00
Feedback to Parabola Horn with pressurized window $27.50
Low Power Load, less cards.....$18.50
K Band Mixer Block.....$45.00
Waveguide ½ x ¼".....$1.00 per ft.
Circular Flanges .....50¢
Flange Coupling Nuts.....50¢
Slotted line, DeMornay-Budd #397, new....$450.00
90° Twist $10.00
"K" Band Directional Coupler CU104/APS-34 20 DB .....$49.50 ea.
K BAND 2K33 w/cav.....$115.00
3J31 Magnetrons $55.00

8500 Mc to 9600 Mc Bench Test Plumbing—1" x ½" Waveguide

Slotted Line. Complete with adjustable probe, crystal output, precision vernier adjust. Humble oil type $220.00
Klystron Mount. DeMornay Budd type DB380 for 2K25, etc., includes tunable termination....$70.00
Variable Attenuator. DeMornay Budd type DB383. Maximum attenuation 35DB.....$120.00
Variable Stub Tuner. DB536. 180 degree phase shifting capability $70.00
Flap Attenuator. DB385. Maximum Attenuation 16DB $25.00
Magic Tee. DB539 .....$42.00
Wave Guide to Type "N" Adapter. DB377..$15.00
Low Power Termination. DB381.....$18.50
Uni-Directional Coupler. DB390. 23DB type "N" output $18.50
Pick Up Horn. Type "N" output.....$4.50
Wavemeter, 8500 to 9400 mcs. with calibration. Micrometer adjust head. Reaction type.....$85.00
Waveguide Lengths. Plated and fitted with couplings available in 6", 12", 24", 30", 60" sections .....$2.00 per ft.
90 Degree Elbows. E or H plane, 2½" radius..$12.50
Mitered Elbows. E or H plane.....$10.00
45 Degree Offset Elbows. E or H plane....$10.00
90 Degree Twist. 6" long.....$8.00
Bulkhead Feed-Thru Assembly.....$15.00
Pressure Gauge Section. 15 lb. gauge and press. nipple $10.00
Pressure Gauge. 15 lbs.....$2.50
Crystal Mount. 1N23 type crystal holder....$17.50
Dual Oscillator-Beacon Mount. P/O APS10 Radar for mounting two 723A/B klystrons with crystal mts. matching slugs, shields.....$42.50
Dual Oscillator Mounts. (Back to back) with crystal mount, tunable termination, attenuating slugs $18.50
Directional Coupler, UG-40/U Take off 20 DB $17.50
Directional Coupler, APS-6 type "N" take off 20 DB calibrated $17.50
Flexible Section 18" long.....$12.00
Rotary Joint Choke to Choke.....$10.00
2K25/723 AB Receiver local oscillator Klystron Mount, complete with crystal mount, Iris coupling and choke coupling to TR.....$22.50
TR-ATR Duplexer section for above.....$8.50

1¼" x ⅝" WAVEGUIDE

Slotted Line. Complete with adjustable probe, crystal output, precision vernier adjust. Humble Oil type $225.00
Tunable Termination. Precision adjust.....$65.00
Low Power Termination.....$25.00
Magic Tee $45.00
Transition. 1¼" x ⅝" to 1" x ½".....$19.50
Oscillator Mount. for four 723AB klystron..$38.50
90 Degree Elbows. E or H plane.....$12.50
Waveguide Lengths. Cut to size and supplied with 1 choke, 1 cover. per length.....$2.00 per ft.
Wavemeter. Absorption type. Precision micrometer adjust. Very high "Q".....$150.00

MAGNETRON MAGNETS

Gauss	Pole Diam.	Spacing	Price
4850	¾ in.	⅝ in.	$12.50
5200	11/32 in.	¾ in.	$17.50
1300	1⅝ in.	1 5/16 in.	$12.50
1860	1⅝ in.	1½ in.	$14.50

Electromagnets for magnetrons.....$24.50 ea.

GE Magnets type M7765115. GI Distance Between pole faces variable. 2 1/16" (1900 Gauss) to 1½" (2200 Gauss) Pole Dia.1 ⅝" New Part of SCR 584 .....$34.50

MAGNETRONS

QK 61	2J32	2J61	720CY
QK 60	2J37	2J62	725-A
2J21	2J38	3J31	730-A
2J22	2J39	5J30	728
QK 915	2J26	2J40	714AY
QK 62	2J27	2J49	718DY
QK 59	2J31	2J34	720BY

Klystrons 723A, 707B, 417A, 2K41

COUPLINGS—UG CONNECTORS

UG/15U	$ .75	UG 117 Choke	$2.50
UG206U	.90	UG 51 Cover	1.00
UG87U	1.25	UG 52 Choke	1.35
UG27U	1.69	UG 210 Cover	1.85
UG21U	.89	UG 212 Choke	2.40
UG167U	2.25	⅞ Coax Female Ring	.50
UG29U	.90	⅞ Coax Male Fitting	.95
UG254U	1.69	X Band Circ. Choke Flange	.50
UG86U	1.40	X Band Flat Contact Flange ⅛ Thk.	.25
UG342U	3.25	Contact Ring ¼" Thk 1⅜ dia. hole	.25
UG85U	1.45	UG 53/U, Cover	4.00
UG58U	.60	UG 54/U, Choke	4.75
UG9U	.89	UG 55/U, Cover	4.00
UG102U	.45	UG 56/U, Choke	4.75
UG103U	.45	UG 65/U, Contact	6.50
UG255U	1.65	UG 149/U, Cover	3.00
UG 40/U Specl. for Mixer Assy.	.75	UG 148/U, Choke	4.00
UG 40A	1.10	UG 150/U, contact	3.00
UG 343 Cover	2.35	UG 39/U, Cover	.60
UG 344 Choke	3.00	UG 40/U, Choke	.80
UG 425 Contact.	2.00		
UG 116 Cover & Coup Ring	1.95		

Write us your needs.

6000 Mc. to 8500 Mc. Bench Test Plumbing

1½" x ¾" Waveguide

Klystron Mount. DB356 complete with shield and tunable termination $125.00
Flap Attenuator. DB361.....$45.00
Precision Wavemeter. DB358. Micrometer adjust head $190.00
Variable Stub Tuner $90.00
Waveguide to Type "N" Adapter.....$18.50
Wavemeter Tee. DB352.....$32.50
Slotted Line. DB354 Precision vernier adjust, less probe $320.00
Magic Tee $80.00
Directional Coupler., two hole 25DB coupling, type "N" output $25.00
Precision Crystal Mount. Equipped with tuning slugs and tunable termination.....$125.00
Tunable Termination. Precision adjust.....$70.00
Low Power Load.....$35.00

4000 to 6000 mcs. Bench Test Plumbing

2" x 1" Waveguide

Slotted Line. DEMornay type 332 complete with probe, etc. $600.00
Flap Attenuator $48.00
Variable Stub Tuner and Low Power Termination $48.00
Wavemeter Tee $48.00
Adapters: Choke to choke.....$18.00
Cover to cover.....$14.00
Choke to cover.....$16.00
Waveguide to Type "N" Adapter.....$45.00
Directional Coupler. Two hole type, type "N" output $48.00
Klystron Mount. Equipped with tunable termination and micrometer adjust. klystron antenna tuning $110.00
Crystal Mount. Equipped with tunable termination and micrometer adjust crystal tuning.....$125.00
Tunable Termination. Precision adjust.....$90.00

3000 MC. BENCH TEST EQUIPMENT

10 CM Wavemeter WE type B435490 Transmission type, type N Fittings, Veeder Root Micrometer dial., Gold Plated W/Calib. Chart P/o Freq. Meter X66404A. New $99.50
AS14A/AP-10 CM Pick up Dipole with "N" Cables $4.50
LHTR. LIGHTHOUSE ASSEMBLY, Part of RT39 APG 5 & APG 15. Receiver and Trans Cavities w/ assoc. Tr. Cavity and Type N CPLG. To Revr. Uses 2C40, 2C43, 1B27, Tunable APX 2400-2700 MCS. Silver Plated $49.50
Beacon Lighthouse cavity 10 cm with miniature 28 volt DC FM motor. Mfg. Bernard Rice..$47.50 ea.

S. BAND

90° Twist, circular cover to circular cover...$25.00
Magnetron to Waveguide Coupler with 721A Duplexer Cavity, gold-plated $45.00
721A TR Box complete with tube and tuning plungers $12.50
McNally Klystron Cavities for 707B or 2K28. Three types available $4.00
F-29/SPR-2 Filters, Type "N", input and output $12.50
726 Klystron Mount, Tunable output, to type "N" complete, with socket and mounting bracket $12.50
WAVEGUIDE TO ⅞" RIGID COAX "DOOR-KNOB" ADAPTER, CHOKE FLANGE, SILVER PLATED BROAD BAND $32.50
WAVEGUIDE DIRECTIONAL COUPLER, 27 db. Navy type CABV-47AAN, with 4 in. slotted section $32.50
SQ. FLANGE to rd choke adapter, 18 in. long OA 1½ in. x 3 in. guide, type "N" output and sampling probe $27.50
AN/APR5A 10 cm antenna equipment consisting of two 10 cm waveguide sections, each polarized. 45 degrees .....$75.00 per set.
POWER SPLITTER: 720 Klystron input dual "N" output $5.00

⅞" RIGID COAX

10 CM FEEDBACK DIPOLE ANTENNA, in lucite ball, for use with parabola ⅞" Rigid Coax Input $8.00
721A TR cavities, heavy silver plated.....$2.00 ea.
Magnetron Coupling with TR Loop.....$7.50
Sperry Rotating Joint, pressurized.....$22.50
5 Ft. Lengths Stub Supported, gold-plated, per length $7.50
Short Right Angle Bends (for above).....$2.50

GENERAL TEST EQUIPMENT

Multi Frequency Generator. American Time Product type SC-16. Frequency 10 to 190. Precision Standard "Watch-Master".
UHF Signal Generator. R.C.A. type 710A. 370 to 560 mcs.
Wheatstone Bridge. Industrial Inst. type RN-1.
FM Signal Generator. Boonton Radio type 155A. Freq. range 1 to 10 mcs., 38 to 50 mcs.
Condenser Weld Power. Cap. 56 mfd. max., max. chg. 1500 Volts.
Frequency Meter. Laroie Model 105-300 to 600 mcs.
Megohm Bridge. Industrial Instruments type MB.
Visual Alignment Signal Generator. General Electric—0 to 60 mcs.

NEW TEST EQUIP. IN STOCK

I-185A Oscillator
I-158 Range Calibrator
I-233—Range Calibrator
BC 438 Freq. Meter
RF Preamp
G.R. Capacity Brdg #216
G.R. Uni Galvo Shunt #229
G.R. 1000 Aud. Osc. #213
TS 226A/AP Pwr. Mtr. 0-1000W.
Sig Gen #804 8-330 MC

Write or Phone for Data and Price

PULSE EQUIPMENT

G.E.K.—2745 .....$39.50
G.E.K.—2744-A. 11.5 KV High Voltage, 3.2 KV Low Voltage @ 200 KW oper. (270 KW max.) 1 microsec. or ¼ microsec. @ 600 PPS.....$39.50
G. E. K2450A. Will receive 13 KV .4 micro-second pulse on pri., secondary delivers 14KV. Peak power out 100KW G. E.....$34.50
TPS10 Modulator X Band.....$350.00
SO-4 Thyraton Modulator $600.00
SCR-268 Keyer units.....$95.00
715B Tubes $12.00
705A Tubes $2.85
705 Sockets .....70¢
Complete line of high voltage pulse transformers, networks and dual lines.

ARMY-NAVY TEST SETS

TS-45/APM—3 cm Signal Generator.
TS-226A/AP Power Meter.
TS62/AP 3 centimeter precision echo box.
TS36/AP 3 centimeter Thermistor Bridge—Power Meter.
TS89/AP Voltage divider.
TS268/U Crystal checker for 1N23 type crystals etc.
CW-60ABM 10 Centimeter Wavemeter. Coaxial type micrometer adjust cavity, Resonance indicating meter, carrying case (similar to TS117/GP).
TS235/UP High Power Load. "L" band (1000 mcs.)
LU-1 FREQ. Meter and Test Oscillator. Type CRV-60ACL.
TVN-9HU POWER SUPPLY. MIT Rad. Lab.
TVN-8SE KLYSTRON POWER SUPPLY. MIT. Rad. Lab.
CS60ABW WATT METER—Wavemeter, 3 CM.
APR5 RECEIVER—1000 to 6000 mcs.
AN/CPN-8—10 centimeter 40 kw. output RF package. Includes magnetron oscillator, complete modulator, complete receiver, complete signal and power analyzer with 5" scope. 115V AC Input.
Dehydrator Unit CPD 10137 Automatic cycling. Compressor to 50 lbs. Compl. for Radar XSMN. Line. New $425.00
SO-3 Receiver, 30 mc. IF. 6 stages 6AC7, 10 MC. Band width inpt. 5.1 mc B.W. per stg. 9.6 volt gain per stage as desc. in ch. 13 vol. 23 M.I.T. Rad. Lab. Series.....$99.50

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SONAR

QCQ2. ECHO RANGING AND LISTENING EQUIPMENT
Use: Medium ASW ships.
Keying interval. 1,000, 2,000, 4,000, 8,000 yards and manual.
Projector. Magnetostrictive, permanent magnet polarization. resonant frequency about 25 kc.
Transmitting system. The electron tube driver oscillator and two amplifier stages are contained in the receiver chassis; the variable tuning condenser being ganged with the receiver tuning condensers in order to give uni-control of receiver and driver tuning. In another chassis are located the output tubes and the high voltage rectifier. Sweep frequency modulation is provided, giving a shift from 400 cycles below to 600 cycles above the operating frequency during the transmission.
Receiving system. The receiver is of the tuned-radio-frequency type. It includes time varied gain, to reduce the volume of reverberations immediately following the transmission, and has a "Flat-Peak" audio filter, and an adjustable BFO to give an audible note above or below 800 cycles.
Keying and indicating system. Keying is mechanical; cams in the indicator unit determine the pulse length and keying interval. Ranges are indicated by the flash of a neon lamp.
Complete sets available less hoist. Also stacks alone.

QBF AND QJA. ECHO RANGING AND LISTENING EQUIPMENT
Use. Large ASW ships.
QBF may be converted by field modification, to QJA available.
Keying interval. 1,000, 2,000, 3,000, 4,000, 5,000, 10,000 yards and manual.
The electrical train system consists of a handwheel on the stack which selects, by commutation, three voltages from the secondary of a transfomer-like device called a Commutator Transmitter.
Projector. The projector is of the Rochelle salt crystal type with a single element used for both listening and ranging. The frequency is 22 to 28 kc.
Transmitting system. The receiver-driver oscillator unit contains two electron tube oscillators, one fixed at about 150 kc and one tunable over the range from 160 to 180 kc. The outputs of the two are mixed, producing a difference frequency, which is then fed to the driver-amplifier unit and thus to the projector.
Receiving system. The receiver is a superheterodyne type covering the range from 10 to 30 kc.
Keying and indicating system. Ranges are indicated by the flash of a neon lamp which revolves at a constant speed, driven by a synchronous motor.

QCU, QCU-1 ECHO RANGING AND LISTENING EQUIPMENT
Use. Small ASW Ships.
Intended to be used as a replacement for the obsolete WEA-1 equipment the old hoist.
Keying interval. 1,000, 2,000, 4,000, 8,000 yards and manual.
Training is electrical, controlled by hand crank at the remote station.
Projector. Magnetostrictive, permanent magnet polarization, resonant frequency about 25 kc, split for BDI.
Transmitting system. The electron tube driver oscillator and two amplifier stages are contained in the receiver chassis; the variable tuning condenser being ganged with the receiver tuning condensers in order to give uni-control of receiver and driver tuning. In another chassis are located two type 811 output tubes and two type 836 high voltage rectifier tubes. Sweep frequency modulation is provided, giving a shift from 400 cycles below to 600 cycles above the operating frequency during the transmission.
Receiving system. The receiver is of the tuned radio frequency type. It includes time varied gain, to reduce the volume of reverberations immediately following the transmission, and has a "Flat-Peak" audio filter, and an adjustable BFO to give an audible note, above or below 800 cycles.

QCS, QCS-1, QCT-1 ECHO RANGING AND LISTENING EQUIPMENT
Use. ASW ships.
Keying interval (original).—1,000, 2,000, 5,000, 10,000 yards and manual (field modification added 3,000 and 4,000 yards)
Transmitting system. The driver-rectifier unit contains an electron-tube oscillator tunable over the range of 17 to 25.5 kc, and electron-tube amplifier and a rectifier power supply.
Receiving system. The superheterodyne receiver covers the range from 13 to 37 kc and may be connected by a selector switch to either the "QCQ" or the "JK" face of the projector. It has separate audio amplifiers for the range indicator lamp and for the loud-speaker. The audible note may be adjusted over the range from 0 to 1600 cycles. Three degrees of i-f selectivity and two of audio are provided by selector switches connected to filters.
Keying and indicating system. Keying is mechanical; cams driven by the range indicator disc shaft determine the pulse length and keying interval.

THE MUST OF THE MONTH

Complete 3 CM Radar System equipment 40 KW peak transmitter, pulse modulator, receiver, using 723AB, power supply operating from 115V 800 Cycle, antenna system. Complete radar set neatly packaged in less than 16 cubic feet, all tubes, in used but excellent condition—$350.00. This price for laboratories, schools, and experimental purposes only.

High Voltage Power Supply

15 KV at 30 Ma DC, Bridge Rectifier, Western Electric....$125.00

FM STATION

General Electric Kilowatt Amplifier
Model 4BT2A1 Type BT2A Serial RC25
General Electric 250 Watt Exciter
Model 4BT1A1 Type 3T1A Serial CC833
General Electric Station Monitor
Model 4BM1A1 Type BM1A Serial WC268
General Electric Power Supply
Model BP241 Type BF2A Serial WC547
General Electric Transmitter Console
Model 4BC3A1 Type BC3A Serial WC5
Type BX-2A Two Bay Circular Antenna with Mast, Transmission Line, Elevators and Matchers.
100 Feet of 1⅝ coax. transmission line including 90° elbows.
Dehydrator for transmission line.
Desk and Chair for Transmitter Console.
Write or phone for data & price.

RADAR

APS-2. 10 cm. airborne radar set designed for navigation and high altitude bombing. The antenna rotates through 360 degrees. Presentation is PPI and A Scope. The following units of the set are supplied: Antenna, transmitter-receiver, modulator, indicator, 24VDC input power unit. New with all tubes, incl. 714AY magnetron, 417A klystron.

APS-3. 3cm. airborne radar set designed for intercept of enemy aircraft and nominal navigation. Antenna is sector scan. Remote as well as master indicator is supplied. 725A magnetron operates the set at 45kw. Complete sets available with all tubes incl. magnetron and 723AB klystons. Both new and used condition.

APS-4. 3 cm. airborne radar set designed for sector scan surface search, mapping and navigation, weather forecasting, intercepting of enemy aircraft. Entirely enclosed in a streamlined housing for optional mounting on aircraft bomb rack, or on nose of large bombers. Complete sets with indicator equipment, and power unit ready for installation

APS-6. 3 cm Night Fighter radar with pencil beam antenna. Transmitter-receiver packages and antennas available in equal to new condition.

APS-6A. 3 cm airborne radar RF package, 45kw, using 725A magnetron, IF strip using 6AK5's, 723AB beacon and local oscillator.

ASP-10. 3 cm airborne radar using 2J42 magnetron. Modulator decks and low voltage power supply, only, available, less tubes. Beacon-local oscillator klyston mounts are available.

APQ-13. 3 cm airborne radar complete RF package in excellent condition including all tubes.

APS-15. 3 cm airborne radar designed for high altitude bombing, navigation, intercept of enemy aircraft weather forecasting. Antenna rotates 360 degrees. Presentation is PPI and A scope. The following units are supplied: Antenna, transmitter-receiver, modulator, indicator, slant-range computer. 24VDC input power unit. New with all tubes including 45kw 725A magnetron, 723AB local oscillator-beacon.

CPN-6. 3 cm Navigation Beacon ground station. Complete installation. High power coded beacon of latest JAN design. 115VAC input.

CPN-8. 10cm Navigation Beacon ground station. Complete and partial installations available. High power beacon of long range capability. Complete power, frequency, operation analyzer (5" scope) included.

CXBR. 10cm MIT navigation beacon equipment. Complete, in excellent condition.

FD & Mark IV. 800mc gunlaying radar mfg and designed by Western Electric for battleships. Complete consoles available with all tubes including 700A magnetron and modulator thyratron.

Mark 10. 10cm gunlaying radar, complete, for automatic firing of guns as antenna tracks target. 250 KW.

SA. 200mc Air Search radar especially designed for shipboard or mobile installation. Ideal for ground intercept and control of aircraft. PPI 7" indicator. Long range.

SD. 200mc radar similar to SA but designed for installation on submarines. New.

SE. 10cm shipboard Surface Search radar, using thyratron modulator. Complete installation available including spare parts. "A" scope presentation. 250 KW.

SF-1. 10cm shipboard Surface Search radar with PPI and A scope. Used for navigation and target range information on naval vessels. 250 KW.

SG. 10cm shipboard Surface Search radar with PPI and A scope. Heavy, rugged equipment designed for large naval and merchant vessels. 250 KW.

SJ-1. 10cm radar designed for installation on Submarines. Equipped with PPI and A scope. Complete installations.

SL. 10cm radar designed for Surface search on shipboard. PPI indicator console.

SN. 10cm portable radar. Lightweight, easily transportable complete radar installation using lighthouse tubes with a 25 mile maximum range. 115 VAC operation.

SO-1. 10cm shipboard radar for navigation on all types of vessels. 4, 20, and 80 mile range. PPI indicator. Large antenna. 115 VDC input.

SO-8. same as SO-1 but with a lightweight antenna.

SO-13. same as SO-1 but with lightweight antenna, 28VDC input. Designed for PT Boat installation.

SCR 518. Radar altimeter using pulse-echo-time principle, 400mc, 28 VDC input, CR tube altitude indication.

SCR 520. Airborne radar RF package, 10cm, complete with pulser, hard tube, 714AY magnetron.

SCR 533. IFF/Air Search trailer, complete, 500mc operation, A scope.

SCR 663. Sperry searchlight training, aircraft tracking ground installation. Used condition.

SQ. 10cm portable radar designed for use on landing barges and beach-heads. PPI, B, A indication on 3" scope. 115 VAC operation.

TPS-2. 1000mc Portable Early Warning System. Bedspring antenna. Complete with portable generator.

RT73/UPN-2. 10cm Portable Beacon Equipment.

RADIO SYSTEMS

White Radio Telephone Model #WRM55. Ship To Ship—Shore To Ship—Small Airports—Mines—Plantations—Inter Island—Ranches. 10 channel Fix Tuned Receiver & Transmitter XMTR Pwr Output in excess of 100W unmodulated into antenna of 18 & 100 MMF. Freq. Range 2-12 MC. Can be modified to increase range. Xtal controlled. 110V 60 Cy or 220V 60 or 25 Cy. Meas. 24" H x 19" W x 14" D. 125 lbs. Write or phone for data.

TAJ. 500 Watt Low Frequency Transmitter, 150-550 KC, C.W., M.C.W.

TBK. 500 Watt High Frequency Transmitter 2 to 18 MC, A1, A2, A3, Emission. Mfg. by RCA.

RADAR RADAR RADAR RADAR

R A D A R

SONAR SONAR SONAR SONAR

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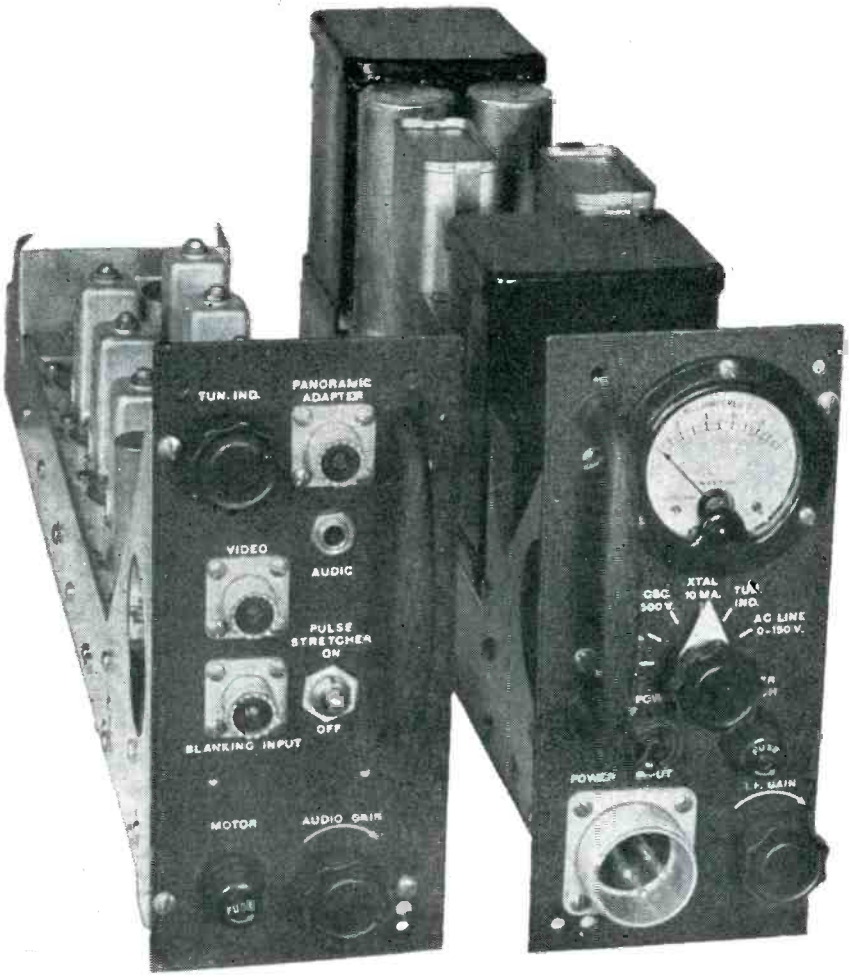
TEST EQUIPMENT



30 MC I.F. STRIP, VIDEO, and AUDIO AMPLIFIER AND 110 Volt 60-2600 cps POWER SUPPLY, Bandwidth 10 mc, new, part of APR-5 Receiver . . . . . $65.00 less tubes

AMPLIFIER STRIP AM-SSA/SPR-2 contains I. F. amplifier, detector, video amplifier, pulse stretcher and audio amplifier and Rectifier Power Unit PP-155A/SPR-2 bandwidth 10 mc, center frequency 30 mc, sensitivity 50 microvolts for 10 milliwatts output. Power supply 80/115 V ac, 60-2600 cps 1.3 amps.

X Band Spectrum Analyzer 8500-9600 Mc., calibrated linear below cut-off attenuator, calibrated frequency meter, tuned mixer, 4 i.f. stages, 3 video stages overall gain 125 db., regulated power supply.

S Band Spectrum Analyzer 2700-3900 Mc., similar to above.
The above Spectrum Analyzer also available with S and X band tuning units.

K Band Test Load low power **$20.00**

X Band Power, Frequency and SWR Measuring Equipment complete with R.F. source, A.S.D. equipment.

X Band Below Cut-Off Wave Guide Attenuator, with calibrated dial, type N input connector, output connects to ½" x 1" wave guide **$55.00**

X Band Test Load, low power **$15.00**

TS-62 X Band Echo Box with r.f. cable and pick-up antenna.

TS-33 X Band Frequency Meter, 8500-9600 Mcs. Crystal detector and 50 micro-amp. meter. Indicates Resonance. Connection for scope available.

APR-1 or APR-4 Radar Search Receiver, 30 mc I.F., 2 mc wide.

Tuning Units For APR-1 or APR-4 Receivers (can be used with any 30 mc amplifier):
TN-19, range 1000-2000 mc, tuned mixer cavity **$150.00**
TN-54, range 2000-4000 mc, tuned mixer cavity **$150.00**

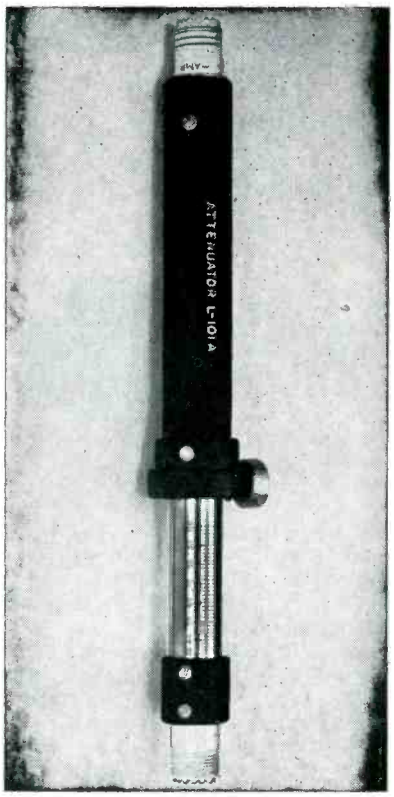
TS-110 S Band Echo Box 2400-2700 mc, portable **$110.00**

TS-184 Echo Box and Attenuator for APS-13

TS-170 Test Oscillator for ARN-5

TS-226 Peak Power Meter for APS-13

TS-89 Voltage Divider for measuring high video pulses, ratios, 1:10 and 1:100, transmission flat within 2db 150 c.p.s. to 5 mc., with cable for attaching to syndroscope.



Waveguide Below Cut-off Attenuator L-101-A U.H.F. Connectors at each end, calibration 30-100 db. **$10.00**

X Band Test Load, 50 watts, average power, ½" x 1" waveguide, Sand load **$35.00**

HI POWER X BAND TEST LOAD, dissipates 280 watts of average power for ⅛" x 1¼" waveguide, VSWR less than 1.15 between 7 and 10 KMC. . . **$150.00**

TS-45A/APM-3 Signal Generator, 9200-9600 mc, 110 V, 60-800 cps.

TS-35/AP X Band Signal Generator, pulsed, calibrated power meter, frequency meter, 8700-9500 mc.

X Band VSWR Test Set TS-12/AP, complete with linear amplifier, direct reading VSWR meter, slotted waveguide with gear driven traveling probe, matched termination and various adapters, with carrying case, NEW UNITS I and II are available separately or together as a test set.

Standard Signal Generator Measurements 65B, 100 kc to 30 mc, 1-2,000,000 micro-volts, good working order. **$400.00**

S Band Crystal Mixer, Variable Oscillator Injection **$12.50**

S Band Mixer, tunable by means of slider type N connector for the R.F. and local oscillator input, U.H.F., connector for the I.F. output, variable oscillator injection **$30.00**

Waveguide Below Cut-Off Attenuator, type N connectors, rack and pinion drive, attenuation variable 120 decibels, calibrated 20-120 db. frequency range 300-3000 mc **$35.00**

ELECTRO IMPULSE LABORATORY

P. O. Box 250 **Eatontown 3-0768** **Red Bank, N. J.**

1000 KC crystal BT cut.....$3.95
3" scope shield 1.29
2 speed dial drive for ¼" shaft ratios 5:1 1 to 1 .39
ATC 100 mmfd air trimmer screwdriver shaft.... .29
—10 +5 Weston modulation meter Weston 301. 8.95
J37 key 69
500 watt 12.5 ohm power rheostat.....3.49

R-H-S
SPECIALS OF THE MONTH

50 mmfd 5 KV GE vacuum condenser.....$1.49
2v, 6v, 12v vibrators any type..... .98
Rotary switch GE Mycalex, 2 deck SP3T..... .39
1 mfd 5000v oil condenser Micamold..... 2.98
2 mfd 3000v oil condenser Aerovox..... 3.25
3 mfd 4000v oil condenser Micamold..... 3.95
24 mfd 1500v DC 3KV flash. Excellent for speed lamp 3.95

TUBES!! BRAND NEW! STANDARD BRANDS! NO SECONDS! COMPARE! TUBES!!

0A3/VR75	$ 1.05	3C24/24G	$ .39	227A/5C27	$2.49	812	$2.45	8014	$19.95	0A2	$1.29	5Z4	$ .74	6SN7GT	$ .89	12SL7	$ .55
0B3/VR90	.89	3C31/C18	3.49	249C	1.75	812H	6.90	8020	.89	0A4G	.95	6A3	.92	6SQ7	.47	12SN7	.57
0C3/VR105	.74	3C45	12.75	250R	5.95	813	6.85	8025	3.69	0B2	1.52	6A4LA	1.05	6SR7GT	.49	12SQ7	.59
0D3/VR150	.48	3CP1	1.39	250TH	18.95	814	2.25	9001	.39	0Z4	.61	6A6	.79	6SS7	.49	12SR7	.55
1B22	2.95	3CP1-S1	2.25	250TL	18.95	815	2.25	9002	.32	01A	.41	6A7	.65	6ST7	.72	12Z3	.72
1B23	8.75	3DP1	3.10	274A	5.50	816	1.05	9003	.45	1A5	.75	6A8	.75	6ST7GTY	1.25	14A4	.79
1B24	4.95	3DP1A	3.95	274B	1.95	826	.39	9004	.34	1A4P	1.05	6AB7	.79	6SV7	.79	14A7	.59
1B26	2.95	3DP1-S2A	4.75	276A	6.95	828	9.95	9005	1.49	1A5GT	.65	6AC5GT	1.15	6T7G	.89	14B6	.67
1B27	24.50	3D21A	.98	293A	2.98	829	7.45	9006	.18	1A6	.78	6AC7	.98	6T8	.85	14B7	.72
1B29	2.75	3E29	9.95	299A	3.95	829B	9.95	C4A	9.95	1A7GT	.72	6AD7G	1.09	6U5G	.62	14B8	.79
1B32	1.79	3EP7	1.15	300B	9.95	830B	3.19	C5B	6.75	1B3	.59	6AE6G	.79	6U6GT	.63	14C7	.59
1B36	24.96	3GP1	4.45	304TH	3.65	832	4.95	C6A	7.95	1B3/8016	1.29	6AF6G	.81	6U7G	.49	14J7	.87
1B38	32.50	3HP7	2.89	304TL	1.29	832A	7.95	C6J	4.45	1B4	1.19	6AG5	.74	6V6	.89	14N7	.85
1N21 Xtal	.59	4-65A	14.21	305A	24.95	833A	33.95	C100D	1.49	1B5/25S	.79	6AG7	.98	6V6GT	.57	14Q7	.53
1N21A Xtal	.89	4-125A	26.95	307A/RK75	6.95	836A	1.25	CK502AX	2.95	1B7GT	1.65	6AH6	1.19	6W4	.63	14R7	.65
1N21B Xtal	1.39	4-250A	29.95	310A	6.95	837	1.35	CK503AX	2.95	1C5GT	.65	6AL5	.75	6W7G	.77	19	.74
1N22 Xtal	.89	4AP10	3.95	316A	.45	838	2.35	CK505AX	2.25	1C6	.72	6AK5	1.25	6X4	.55	24A	.57
1N23 Xtal	.79	4B24/EL3C	4.75	323A/B	24.50	841	.33	CK506AX	2.25	1C7G	.84	6AL6	.80	6X5GT	.51	25L6GT	.55
1N23A Xtal	.79	4B25/6CF	7.50	327A/5C37	2.49	843	.27	CK507AX	2.25	1D5GP	.95	6AL5	.75	6Y6G	.63	25Z5	.52
1N23B Xtal	2.95	4B26/2000	4.95	328A	12.95	845	3.75	CK512AX	2.25	1D7G	.89	6AQ5	.65	6Y7G	.85	25Z6GT	.49
1N27 Xtal	1.69	4B28	2.95	331A	12.95	851	13.95	CK517AX	8.45	1D8GT	.89	6AQ6	.59	6Z7G	1.05	26	.52
1N34 Xtal	.79	4B32	9.95	350A	1.98	852	6.25	CK1005	.15	1E5GT	1.29	6AI5	.54	6ZY5G	.59	27	.46
1N34A Xtal	.85	4C27/CV92		350B	1.69	860	6.95	CK1006	.62	1E7G	1.19	6AT6	.47	7A4/XXL	.55	28D7	.39
1P23	2.95		49.50	368AS	2.39	861	10.95	E1148	.29	1F4	.72	6AU6	.65	7A5	.59	30	.49
1P24	.79	4C35	22.50	371A	.59	864	.29	EF50	.69	1G6G	.72	6AV6	.45	7A6	.59	31	.57
1P26	2.69	4D22	9.95	371B	.39	865	1.45	F123A	7.95	1G6GT	.75	6AW6	.89	7A7	.59	32	.85
1R21	3.79	4D32	12.95	388A	.79	866A	1.05	F128A	89.50	1H5GT	.65	6B6G	.72	7A8	.69	32L7GT	.85
2AP1	4.95	4E27/257B		393A	3.49	866B	1.05	F166	37.50	1H6GT	.65	6B8G	.59	7AF7	.69	33	.65
2AP5	4.95		14.95	394A	3.49	869B	26.50	F460	49.50	1H6GT	.63	6BA6	.55	7B5	.55	34	.32
2C21/RK33	.35	5AP1	1.79	417A	8.95	872A	1.25	F892	39.50	1J6GT	.78	6BE6	.59	7B6	.55	35A5	.52
2C22/7193	.19	5AP4	1.79	434A	2.95	874	.89	FG17	3.95	1L4	.57	6C2G	.54	7B7	.55	35B5	.65
2C26A	.19	5BP1	2.29	446A	1.25	876	.35	FG27A	8.75	1LA4	.75	6C2GG	1.45	7C4	.34	35C5	.55
2C34/RK34	.27	5BP4	2.39	446B	1.79	878	1.69	FG32	7.95	1LA6	.95	6C3G	.55	7C5	.48	35L6GT	.59
2C39	24.50	5CP1	1.39	450TH	19.95	879	1.39	FG57	12.95	1LB4	1.05	6C4	.55	7C6	.72	35W4	.62
2C40	3.45	5CP7	3.49	450TL	44.50	885	1.39	FG81A	3.29	1LC5	.74	6C4	.45	7C7	.59	35Y4	.43
2C43	8.95	5C22	49.50	527	9.75	902	3.39	FG105	8.95	1LC6	.91	6C5	.51	7E5	.67	3523	.47
2C44	.98	5D21	18.95	559	.98	905	2.59	FG172	29.50	1LD5	.79	6C6	.57	7E6	.54	3524	.55
2C46	6.95	5EP7	1.19	562	97.50	908	7.95	GL446	8.95	1LE3	.75	*C8G	.69	7E7	.54	3525	.44
2C51	5.75	5GP1	2.69	575A	11.95	918	1.49	GL446A	2.69	1LG5	.89	6D6	.48	7E7	.57	3526	.59
2D21	1.25	5JP1	24.45	701A	2.95	919	1.95	GL451	.89	1LH4	.79	CD8G	.72	7H7	.59	37	.67
2E22	1.19	5JP2	8.95	702A	2.69	923	.72	GL502A	1.85	1LN5	.78	6K5	.69	7K7	.89	38	.35
2E24	4.69	5JP4	24.45	703A	2.39	927	1.09	GL562	49.50	1N5GT	.71	6K5	.47	7L7	.65	39/44	.39
2E26	3.39	5J23	12.95	704A	1.05	930	.79	GL592	14.95	1P5GT	.58	6F6	.55	7N7	.65	41	.28
2E30	2.29	5J29	12.95	705A	3.59	931A	3.59	HF125	14.95	1S4GT	.75	6F6GT	.57	7Q7	.54	42	.49
2J21A	7.95	5JP9	49.50	706B	24.95	954	.19	HF300	19.95	1R4	.49	6F7	.65	7R7	.65	43	.47
2J22	8.45	5LP1	11.95	706CY	16.95	955	.24	HY114B	.79	1R5	.79	6F8G	.82	7S7	.85	45	.49
2J26	6.50	5NP1	2.49	706FY	42.50	956	.24	HY115	.79	1S4	.82	6G6G	.72	7V7	.75	45Z3	.55
2J27	10.95	6C21	18.95	706GY	42.50	957	.22	HY615	.19	1S5	.55	6H6	.43	7W7	.79	45Z5	.51
2J30	39.50	6F4	5.79	707B	14.95	958	.22	KC4	37.50	1T4	.65	6J6GT	.42	7X7	.79	46	.64
2J31	8.49	6J4	4.59	708A	3.59	959	.49	KU610	6.95	1T5GT	.72	6J5	.47	7Y4	.48	47	.65
2J32	12.95	7BP7	4.49	709A	3.95	991/NE16	.22	ML101	49.50	1U4	.72	6J5GT	.42	7Z4	.54	48	1.49
2J33	18.95	9GP7	8.95	710A/8011	.85	1603	1.98	RK21	.98	1V	.65	6J6	.89	12A	.49	49	.85
2J34	18.95	9JP1	5.95	713A	.79	1614	.49	RK30	7.95	3A3	.92	6J7	.63	12A6	.24	50A5	.74
2J36	97.50	9LP1	19.95	714AY	3.52	1616	1.29	RK35	4.19	3A4G	1.07	6J7GT	.59	12A7	.89	50B5	.63
2J37	12.75	9LP7	3.49	715A	6.49	1616	.59	RK33	.24	3A5	.64	6K7GT	.79	12AH7GT	.49	50C5	.59
2J38	9.95	10HP4	18.95	715B	6.85	1619	.24	RK34	.27	3A6	.69	6K8GT	.49	12AH7GT	.91	50L6GT	.65
2J39	19.95	7DP4	17.95	715C	22.45	1622	1.49	RK38A	14.95	3A7	.69	6K7	.46	12AL5	.79	50Y6	.59
2J40	24.50	10	.25	717A	.55	1625	.98	RK59	1.49	3B7	.75	6K8	.79	12AT6	.52	53	.87
2J46	49.50	12DP7	11.95	721A	2.25	1626	.18	RK65	24.50	3V3G	.54	6L5G	.85	12AT7	1.02	56	.45
2J48	15.75	12GP7	12.75	722A	2.95	1626	.24	RK72	.59	2X2	.37	6L6	1.10	12AU6	.65	57	.44
2J49	39.50	12HP7	12.75	723A	6.75	1629	.25	RK73	.59	2X2A	.65	6L6G	.99	12AU7	.98	58	.49
2J50	22.50	12LP4	22.50	723A/B	12.95	1630	.98	RK81A	2.39	3A4	.34	6L6GA	.97	12AV6	.54	59	.85
2J54B	22.95	15E	1.19	724B	2.69	1631	.85	RK200	8.95	3A5	.75	6L7	.79	12AV7	.59	70L7	.99
2J55	69.50	15R	.59	725A	6.45	1632	.79	V70D	7.35	3A8	1.75	6L7G	.87	12BE6	.59	71A	.62
2J61	24.50	16AP4	42.50	726A	4.95	1633	.69	VR78	.29	3B7/1291	.29	6N7	.79	12C8	.47	75	.53
2J62	34.50	16CP4	42.50	726B	29.50	1634	.75	VR91	1.10	3D6/1299	.29	6Q7	.69	12E5GT	.55	76	.37
2K25	19.75	19T8	.87	726C	49.50	1636	2.95	VR92	.69	3LF4	.79	6R7	.69	12H6	.31	77	.43
2K28	24.95	21HB4	.19	730A	8.95	1638	.65	VT127A	1.98	3Q4	.58	6S7G	.79	12J5GT	.34	78	.44
2K29	24.50	28D7	.39	750TL	79.50	1641	.98	VT158	14.95	3Q5GT	.67	6S8GT	.85	12J7GT	.67	80	.43
3AP1	4.59	30 SPEC	.25	800	1.69	1654	2.39	VU29	2.95	3S4	.65	6SA7	.49	12K7GT	.52	82	.84
3B22/ELIC	1.35	35TG	5.95	801A	.25	1665	1.19	VU111	.49	3V4	.72	6SC7	.59	12K8	.55	83	.87
3B23/RK22	4.85	45 SPEC	.19	802	3.89	1851	.88	WL468	5.95	5R4GY	1.25	6SD7GT	.44	12Q7	.55	89Y	.87
3B24	1.59	53A	5.95	803	3.10	1860	.79	WL530	12.75	5Y3G	.49	6SF5	.52	12SA7GT	.67	84/6Z4	.59
3B24W	2.89	75TL	5.95	804	6.45	1961	4.99	WL531	1.75	5U4G	.72	6SF5GT	.49	12SC7	.57	85	.62
3B25	4.39	100R	.89	805	3.65	2050	1.19	WL532	1.89	5V4G	1.05	6SF7	.55	12SF5	.55	89Y	.35
3B26	1.49	100TH	9.95	806	29.95	2051	.39	WL578	.89	5W4	.79	6SG7	.59	12SF7	.49	1171.7/M7	1.21
3B27	1.95	121A	2.65	807	1.49	8005	4.59	WL616	37.50	5X4G	.57	6SH7	.49	12SG7	.52	117N7	1.29
3B28	7.95	203A	5.95	808	1.29	8011	.49	WL619	18.95	5Y3GT	.41	6SH7	.52	12SH7	.35	117P7	1.19
3BP1	2.59	211	.39	809	2.25	8012	1.29	WL677	34.50	5Y4G	.51	6SJ7	.52	12SJ7	.57	117Z3	.53
3C22	39.50	212E	49.50	810	9.55	8013	1.39	WL681	22.50	5Z3	.52	6SL7GT	.52	12SK7	.67	117Z6	.69
3C23	5.95	215A	.19	811	2.10												
		217C	6.75												

SELENIUM RECTIFIERS
FULL WAVE BRIDGE TYPE

Input 0-20V AC Type No.	Current	Output 0-14.5V DC Price
20D1	1.2 Amps.	$ 2.49
20E1	2.4 Amps.	3.49
20F1	6.4 Amps.	4.95
20K1	13.0 Amps.	8.95
20J1	17.5 Amps.	11.95
20K2	26.0 Amps.	17.95
20K3	39.0 Amps.	24.95
20K4	52.0 Amps.	29.95
20K5	65.0 Amps.	35.95
0-40v AC	**Current**	**0-34v DC**
40D1	.6 Amps.	$ 2.95
40E1	1.2 Amps.	3.89
40F1	3.2 Amps.	5.25
40K1	6.0 Amps.	9.95
40J1	9.0 Amps.	12.95
40K2	12.0 Amps.	18.95
40J2	18.0 Amps.	22.45
40K4	24.0 Amps.	32.50
40K5	30.0 Amps.	34.95
40J4	36.0 Amps.	39.50
0-120v AC	**Current**	**0-100v DC**
40D1A	.6 Amps.	$ 7.85
40E1A	1.2 Amps.	10.76
40F1A	3.2 Amps.	16.65
40K1A	6.0 Amps.	24.75
40J1A	9.0 Amps.	32.95

CENTER TAPPED RECTIFIERS
Single Phase Full Wave Bridge

10-0-10v AC	Current	0-8v DC
10D1	1.2 Amps.	$ 1.89
10E1	2.4 Amps.	2.25
10F1	6.4 Amps.	3.87
10K1	12.0 Amps.	4.95
10J1	16.0 Amps.	7.95
10K2	24.0 Amps.	10.75
10K3	36.0 Amps.	14.75
10K4	48.0 Amps.	17.75
10K5	60.0 Amps.	19.95
10K6	72.0 Amps.	25.57
10K7	84.0 Amps.	27.95
10J6	96.0 Amps.	32.50
10K10	120.0 Amps.	42.50

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HI-VOLTAGE INSULATION

6250v or 3850v or 2600v @ .056 amps.....$13.95
2700v @ 2 MA; 6.3v @ .6A; 2.5v @ 1.75A.. 4.95
2500v @ 15 MA 3.49
1600v @ 4 MA; 350-0-350v @ 150 MA; 6.3v @ 9A 4.45
1540v @ 5 MA; 340-0340v @ 300 MA..... 4.35
1120-0-1120v @ 500 MA; 12v CT @ 14A; 2.5v @ 10A; 177 @ 2.5A; 32v @ 25 MA; 115/230 Pri 16.95
925v @ 10 MA; 525-0-525v @ 60 MA; 2X5v @ 3A; 6.3v CT @ 3.6A; 6.3v @ 2A; 6.3v @ 1A 5.55
700-0-700v @ 200 MA 7.55
500-0-500v @ 175 MA 4.55
430-0-430v @ 340 MA; 6.3v CT @ 6.3A; 5v @ 6A 4.85
425-0-425v @ 75 MA; 6.3v @ 1.5A; 5v @ 3A 3.65
415-0-415v @ 60 MA; 5v CT @ 2A; 115/230 Duel Pri 4.97
405-0-405v @ 150 MA; 6.3v CT @ 2½A; 5v @ 3A; 2.5v CT @ 5A 4.35
400-315-100-115v @ 200 MA; 2x6.3v @ 9A; 5v @ 3A; 2.5v @ 2A 5.35
500-385-0-385v @ 200 MA; 3x6.3v @ .6A; 5v @ 3A; 2.5v @ 2A 4.75
325-0-325v @ 12 MA; 255-0-255v @ 240 MA; 300-0-300v @ 65 MA; 6.3v @ 2.5A; 6.3v @ 1A; 2x5v @ 2A 4.25
80-0-80v @ 225 MA; 5v @ 2A; 5v @ 4A..... 3.25
0-17.4/21.6/25.8v @ 400 MA; 6.4v @ .5A; 2.6v CT @ 2.5A Pri 115/230 ..... 2.97
18 or 36v @ 15A.. $8.75 13.5v CT @ 3.25A.. 3.85
12.6v CT @ 10A; 11v CT @ 6.5A..... 2.17
3x10.3v CT @ 7A. $6.95 6.3v @ 1A..... 6.35
6.5v @ 12A; 6.3v @ 2A; 115v @ .1A..... .77
6.4v @ 10A; 6.3v @ 6A..... 3.50
6.3v @ 8A; 5v @ 6A; 2.5v @ 1.75A..... 2.27
6.3v @ 1A; 2.5v @ 2A..$2.29 4-0-4v @ 1A .87
6.3v CT @ 3.5A; 2x2.5v CT @ 3A..... 2.97
5v CT @ 20A; 10 kV INS 8.95
.6v @ 15A RMS 1.47

TRANSFORMERS—220v 60 Cyc

512.5-0-512.5 @ 427 MA .....$ 5.35
3x5v @ 6A; 4v @ 25A 2.95
3x6.3v CT @ 3A; 6.3v CT @ 1.6A..... 2.95
10v CT @ 6.5A; 6.3v CT @ 2.5A; 6.3v CT @ 1.8A 220/440 Pri. 3.95
Step Up/Down 110/220 500 watt..... 10.95
Step Up/Down 110/220, 220/440 600 watt.... 14.95

EQUIPMENT SPECIALS

APN-1 Altimeter Xceiver	Like New	$ 7.95
ATR Inverter 12v DC in 110v AC Out 125 w Int. 100 w Cont.	New	14.95
AN/CRW-2 UHF Receiver	New	5.95
BC357 Beacon Receiver	Good	3.45
BC433 Receiver	Good	24.94
BC456 Modulator	Good	1.98
BC434A Control Box/BC433	Used	1.95
BC458 Transmitter	New	8.95
BC602A Control Box/SCR522	Used	.39
BC778 Gibson Girl	Good	3.95
BC958-121 Xmitter 100-156 MC	New	39.50
BC1016 Tape Recorder	New	459.50
BC1206A Beacon Receiver	Good	4.95
CF1 Navy Unit w/200KC Crystal	New	14.95
DM 19 Dynamotor 12v DC in 500v 200 MA Cont. Out	Good	4.95
EE8 Foundation Unit	Good	4.95
MN26C Compass Receiver	Good	24.95
M110 Dynamic Chest Mike	New	3.95
PE94 Dynamotor/SCR522	Good	1.98
PE97A Vibrator Power Supply	New	6.95
PE104 Vibrator Supply	Excellent	24.95
R89/ARN5 Receiver	New	9.95
R89/ARN5 Receiver Less Tubes, Covers	Good	4.95
SCR518 Altimeter Complete	New	39.95
T17 Carbon Mike	New 1.98 Used	1.29
TU25 Tuning Unit/BC223	New	1.79

FILTER CHOKES HI V INS

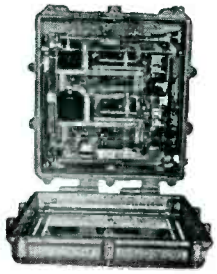
.025 HY @ 1.36A..$1.98
.05 HY @ 15A.... 7.95
.065 HY @ 2.5A... 2.49
.1 HY @ 5A..... 6.95
2 HY @ 175 MA.. 1.49
3 HY @ 50 MA..... .39
3/30 HY @ 250 MA 3.65
5 HY @ 70 MA/2 HY 350 MA Duel. 2.39
5.3 HY @ 775 MA 9.95
10 HY @ 55 MA... .89
10 HY @ 100 MA. 1.49
10 HY @ 200 MA..$2.15
10/20 HY @ 85 MA 1.49
13 HY @ 130 MA. 1.55
13 HY @ 250 MA. 2.95
14/3.5 HY @ 40/400 MA 6.95
15 HY @ 25 MA.. .59
15 HY @ 70 MA.. 1.15
26.5 HY 125 MA.. 1.98
200 HY @ 10 MA. 2.95
325 HY @ 2 MA.. 2.95
600 HY @ 1 MA.. 2.95

RADIO HAM SHACK Inc.
189 GREENWICH STREET . NEW YORK, N. Y.

PHONE DIGBY 9-0347
WRITE FOR QUANTITY PRICES
Prices subject to change without notice
F.O.B. NYC. Minimum order $5.00
20% Deposit Required
All Merchandise Guaranteed

IMMEDIATE DELIVERY • LOW PRICES • FULLY GUARANTEED

BROWN TELEPLOTTER RECEIVER



Model 791X1R

115 volt 60 cycles

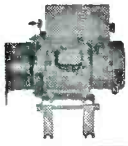
Contains a pen driven by two balancing motors which writes on rear of a translucent chart. Pen arm position is in terms of two coordinates supplied balancing motors thru two amplifiers. Originally intended for recording plotted or written data from central plotting board. Writes at one half scale on 18 in. chart. Discriminator input circuit designed to operate unit as function of two varying R.F. frequencies varying about mean of approx. 430 KC. Further data on request. (Shipping weight 435 lbs.)

Price $375.00

SAWTOOTH POTENTIOMETER

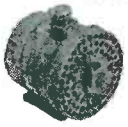
W.E. KS-15138

Type RL-B-R. 100 ohm element. Non linear ring gives linear output with CRT deflection coil load. Cont. rotation. 2 brushes 180 degrees opposed. 2 taps 180 degrees opposed. Stock #SA-288. **Price $6.50 each.**



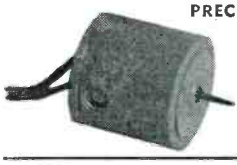
400 Cycle Generators

Homelite 18A120D28-1 400 cycle out at 1 phase 115 v. 39 amps. Also a d-c output of 28 v. and 17.9 amps. **Special at $175.00 each.**



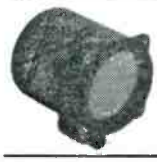
G. E. 5ASB31JJ3, 400 cycles out at 115 volts 7.2 amps. Ideal for lab. 6" lg. x 6" diam. 8000 rpm. Stock #SA-292. **Price $79.50 ea.**

PRECISION AUTOSYN



Pioneer Type AY-150 Control Autosyn. Precision type. 26 v. 400 cycle. Stock #SA-297. **Special low price $14.50 each.**

A-5 Autopilot Indicator



Autosyn Type Pilot Indicator for A-5 Autopilot. 26 v. 400 cycles. Stock #SA-299. **Price $12.50 each.**

SYNCHROS

Navy Types

1G, 1F, 1CT, 5G, 5F, 5CT, 5DG, 5HCT, 5SF, 5HSF, 5SDG, 6DG, 6G, 6DG, 7G, etc.

Prices on Request

ALSO IN STOCK

Subfractional Horsepower AC Motors

Haydon 36228—115 v. 60 cy. 1 rpm.
Eastern Air Devices-J-72B—115 v. 400 cy. 1/50 hp. Cont. duty. 4700 rpm.
E. A. D. J-31—115 v. 400 cy. 1/100 hp.
E. A. D. J-49B—115 v. 400 cy. 1/250 hp.
Diehl FBF-24-1—115 v. 400 cy. 1/100 hp.
Synchron-600—110 v. 60 cy. 1 rpm.
E. A. D. J-33—115 v. 3 ϕ 400 cy. Int. duty.

400 CYCLE AC BLOWERS

E. A. D. J-151—115 v. 400 cy. 22 c.f.m.
Westinghouse Type FL—115 v. 400 cy. 17 c.f.m.

DC MOTORS

Haydon-0366. ½ rpm. 29 v. d-c. 100 ma.
Delco 5069625—120 rpm. Gov. cont. 27 v.
General Electric 5BA50LJ66—½ hp. 27 v. field. Arm. v. 60. Amplidyne controlled.
Delco-A-7155—1/30 hp. 3600 rpm. Gov. cont.
W. E. KS-5603-LO2—1/100 hp. 4 lead shunt.
National Mineral—90600. 1 hp. Int. duty. Fan cooled.
Diehl FDE-53-5—3600 rpm. Gov. cont. 1/30 hp.
G. E. 5BA25MJ409—24 v. 7500 rpm. Cont. duty.
Airsearch—Actuator—25800-24. 2" travel.
Barber Colman—Actuator—YLc-2066-2. 200 in/lb. 135 degrees in 45 seconds.
Airsearch—Actuator (Manual Flap) 25080.
Airsearch—Actuator—(Automatic Flap) 25040.
Holtzer Cabot—RBD-2220—½ hp. 27 v. 3600 rpm.
Arma Latitude Motor — 8413-30 (Step motor)
Elinco B-64—1/165 hp. 3100 rpm. 27 v. f. 80 v. armature. (Thyratron control)
John Oster—A-21E-12R—Split field series reversible. 28 v. 0.4 amps. 2 watts output.
General Electric 5PS56HC18 — Split field series rev. 60 v. 1.4 A. 5500 rpm.

AC SERVO MOTORS

Kollsman—776-01—400 cy. 2 ϕ drag cup type.
Diehl FP-25-3—2 ϕ 60 cy. 20 v. 2.5 watts out.
Pioneer CK-2—2 ϕ 400 cy. 1.05 in/oz. stall.
Pioneer 10047-2A—2 ϕ 400 cy.
Minneapolis Honeywell G303AY2CA4. Built in gear reduction. 2ϕ 400 cy.

AUTOSYNS (Pioneer)

B-9A—Dual Oil Pressure Indicator (6007-4F-7A)
B-9A—Oil Pressure Transmitter. (4150-3B3)
Pioneer Types—AY-1, AY-14, AY-54, 2320, etc.
C-14A—Fuel Pressure Transmitter.
Pioneer 1-81A and 1-82A Compass Indicators.

MAGNESYNS

Pioneer Type C1-3. 6 power.
Pioneer 1006-1E-B1 Indicator. AN-5730-2.
General Electric Selsyns 2J1G1, 2J1F1, 2J1H1, 2J1F3, 2J5FB1, 2J5R1, 2JD5R1, etc.
Army Ordnance Synchros 1V, V, X, 11, V11, XV, XV111, XX1, etc.
400 Cycle Synchros Kollsman 775-01, 1F (special. W. E. KS-5950-LO-2.
Aircraft Amplidynes General Electric 5AM31NJ18A and 5AM31NJ9A.

INVERTERS

Pioneer 12117-2, 12117-5.
Wincharger PU-7/AP, PU-16 (MG-750).
Holtzer Cabot—MG-149F, MG-149H, MG-153, MG-153F.
Leland—10285. PE-218.
General Electric—PE-218D, 5AS131JJ11A, 5D21NJ3A, etc.

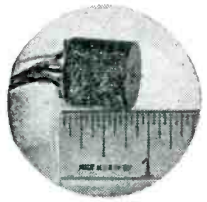
C-1 AUTOPILOT COMPONENTS
A-5 AUTOPILOT GYROS
GENERAL ELECTRIC D-C SELSYNS
AC and DC RATE GENERATORS

MICROWAVE ANTENNA

AS-217-APG 15B, 12 Cm dipole and 13 inch Parabola housed in weatherproof Radome 16" dia. 24 v. DC spinner motor for conic scan. Stock #SA-95. Shipping wt. 70 lbs.

Price $9.95 ea.

MINIATURE DC SELSYN INDICATOR



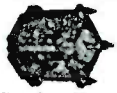
G.E. miniature indicator. 24 v. d-c operation with G.E. Position Transmitter or with Ohmite 360° type potentiometer. Has iron plug for zero dial adjustment. Stock #SA-268. **Price $12.50 each.**

Autosyn Indicator

1-82F Compass Indicator. 0-360°-5 in. dial. 26 v 400 cy. 8-12 v. 60 cy. Ideal position indicator. Stock #SA-284.

Price $6.50 each

SWEEP GENERATOR CAPACITOR



Hi-speed bearings. Split stator. Silver-plated coaxial type. 5-10 mmf.

Stock #SA-167 **Price $2.75 each**

OSTER PM MOTOR

Alinco Field

27.5 v. d-c Can also be used as rate generator. #SA-281. **$4.75 each**

Gyro and Housing Mirror Assembly. For K-14A sighting head. Gyro stabilized mirror assembly. Stock #SA-294. **Price $9.75 each.**

12 V.D.C. Motor John Oster B-9-2

1.4 amps.
5600 rpm.

1¾" Diam. x 3¾" Lg. Spline shaft. C.W. rotation. Stock #SA-46. **Price $3.75 each**

FORD SERVO MOTOR

115 volt 60 cycle two phase low inertia motor. 15 watts output. BuOrd. 207927. Stock #SA-291. **Price $19.50 each.**

ANTENNA TILT INDICATOR

D-C Selsyn type tilt indicator. G.E. 8DJ29AAK. 24 volt. Stock #SA-296. **Price $3.75 each.**

Prices F.O.B. Paterson
Phone ARmory 4-3366
WRITE FOR LISTING

Servo-Tek products co.
4 Godwin Ave. Paterson, N. J.

SPECIALISTS IN FRACTIONAL HORSE POWER MOTOR SPEED CONTROL

Reliance Specials

WIRE WOUND PRECISION RESISTORS, 1% OR BETTER

¼ WATT—25c

6.68Ω	12.32Ω	16.37Ω	125Ω	414.3Ω
10.48	13.02	62.54	147.5	705
10.84	13.52	79.81	220.4	2193
11.25	13.89	105.8	301.8	10,000
11.74	14.98	123.8	366.6	59,148
				100,000

½ WATT—25c

.250Ω	1.53Ω	75Ω	260Ω	4,000Ω	8,500Ω
.334	2.04	90	270	4,451	14,825
.444	11.1	97.8	298.3	5,000	15,000
.502	13.15	100	400	5,900	15,750
.557	18.75	125	723.1	6,500	17,000
.627	46	180	2,500	7,000	30,000
.76	52	210	2,850	7,500	37,000
1.01	55.1	235	3,427	8,000	79,012
					100,000

1 WATT—30c

1.01Ω	5.21Ω	270Ω	7,000Ω	50,000Ω
2.58	10.1	1,250	9,000	55,000
3.39	10.9	3,300	18,000	65,000
			20,000	70,000

1 WATT—40c

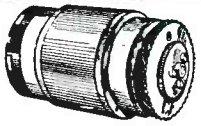
100,000Ω	128,000Ω	320,000Ω	522,000Ω
120,000	130,000	470,000	600,000
125,000			700,000

1 Megohm—1 Watt 1%—65c; 5%—40c

100 pieces—10% off; 1,000 pieces—20% off.

SELSYNS

115 V., 60 Cyc.
#C78248
3⅜" dia. x 5⅜" long
$7.95 pair



Mounting Brackets — (Bakelite) for selsyns, and differentials shown above ..... 35¢ pair

DIFFERENTIAL

115 V., 60 Cyc.
#C78249
3¼" dia. x 5⅜" long
$2.95 ea.

Used between two #C78248's as dampener. Can be converted to 3600 RPM Motor in 10 minutes. Conversion sheet supplied. (Converted) $3.50

CAPACITORS

POSTAGE STAMP MICAS

MMF	MMF	MMF	MMF	MMF	MFD	MFD
1	33	82	240	560	.0012	.005
5	35	85	250	580	.0013	.0051
6	39	90	270	600	.00136	.0056
8	40	100	300	620	.0015	.006
8.2	43	110	330	680	.001625	.0062
10	47	125	350	750	.0018	.0065
15	50	130	370	800	.002	.0068
18	51	150	390	820	.0023	.007
20	56	160	400	910	.0025	.0075
22	60	175	430		.0026	.008
24	62	180	470	MFD	.0027	.0082
25	68	200	500	.001	.003	.009
30	75	220	510	.0011	.0047	.01

Price Schedule

1 MMF to .0011 MFD ..... 5¢
.0012 MFD to .002 MFD ..... 7¢
.0023 MFD to .009 MFD ..... 12¢
.01 MFD ..... 18¢

SILVER MICAS

MMF	MMF	MMF	MMF	MMF	MMF	MFD
8	50	120	270	466	815	.0027
10	51	125	300	470	820	.00282
18	60	130	325	488	875	.002826
22	62	150	330	500		.003
23	66	180	360	510	MFD	.0033
24	68	200	370	525	.001	.0039
30	75	208	390	560	.0012	.005
33	82	225	400	680	.001625	.0051
39	100	240	410	700	.0022	.0056
40	110	250	430	750	.0023	.006
45	115	260	450	800	.0024	.0082

Price Schedule

8 MMF to .001 MFD ..... 10¢
.0012 MFD to .0027 MFD ..... 20¢
.00282 MFD to .0082 MFD ..... 50¢

OIL FILLED

MFD	V. D. C.	Price
.25	20,000	$15.75
.03	16,000	1.95
.1	7,500	1.55
.1-.1	7,000	1.55
.02-.02	7,000	1.25
1	6,000	5.25
3	4,000	4.35
2	4,000	2.25
.25	3,000	1.10
.2	750 AC	.49
8	2,000	4.85
4	2,000	3.95
1	2,000	.95
3	1,000	.80
2	1,000	.65
1	800	.39
10	600	1.00
4	600	.69
2	600	.39

METERS

Brand New—Guaranteed

0–1 Amp, RF, 2½" $3.29
0–300 V. D.C., 2½" 3.50
0–500 Microamp. 2½" 3.85
0–7.5 V. A.C., 3½" 3.46

TRANSMITTING MICA SPECIAL

Faradon .002 mfd. 20,000 VDC working. 22A @ 3,000 KC $25.00

JONES BARRIER STRIPS

Type	Price	Type	Price	Type	Price
2–140Y	$0.10	4–141W	.25	17–141Y	.96
2–140¾W	.11	4–141¾W	.25	3–142	.17
3–140¾W	.15	5–141	.22	4–142Y	.30
4–140Y	.19	5–141¾W	.30	5–142	.26
8–140W	.36	5–141Y	.30	6–142	.31
10–140¾W	.44	7–141	.29	6–142¾W	.44
11–140	.34	7–141¾W	.41	10–142¾W	.71
11–140¾W	.48	7–141Y	.41	10–142Y	.71
12–140¾W	.53	8–141	.33	11–142Y	.78
13–140	.40	8–141¾W	.47	14–142Y	.98
14–140Y	.61	9–141Y	.52	2–150	.31
2–141	.10	10–141	.41	2–150¾W	.38
3–141¾W	.19	10–141Y	.58	3–150	.44
3–141W	.19	15–141Y	.85	4–150	.57

PRECISION CONTROLS

6 WATT

20,000Ω	Muter	314A	*1.70
20,000	GR	314A	2.50
6,000	De jur	260	1.70
6,000	Muter	314A	1.70
5,000	Muter	314A	2.50
5,000	GR	214A	1.40
2,000	De jur	260	1.70

25 WATT

100K	GR	433A	$4.95

4 WATT

500Ω	Centralab	48-501	$.90
50	De jur	292	.75
50	GR	301	1.10
25	GR	301	1.10
20	De jur	292	.75
12	GR	301	1.10

12 WATT

10,000	Muter	471A	$2.00
10,000Ω	De jur	271T	2.00
5,000	De jur	271T	2.00

THROAT MIKE—MT 81-A

Two Mikes in leather zipper case with 56" cord and PL-58—Brand New ..... 49¢

Gear Assortment $6.50

Experimenters dream, 100 pieces, many stainless steel.

2J1G1 SELSYNS

BRAND NEW

400 Cycle
Can be used on 24 V.D.C. or 110 V.A.C.

$1.65

3AG FUSES

AMP	Per 100	AMP	Per 100	AMP	Per 100
⅛	$4.00	1½	$2.50	5	$2.50
¼	4.00	2	2.50	10	3.00
¾	4.00	3	2.50	15	3.00
1	2.50				

Fuse Holder—for 3AG Fuse. (Littlefuse or Buss) .... 20¢

4AG FUSES

AMP	100	AMP	Per 100	AMP	Per 100
1/10	$4.00	3	$2.00	15	$2.50
1/2	3.50	3.2	2.00	20	2.50
1	2.00	5	2.00	25	2.50
2	2.00	10	2.50	30	2.50

Fuse Holder—for 4AG Fuse. (Littlefuse of Buss) .... 18¢

Wrapped—BALL BEARINGS—New

Mfg	ID	OD	Width	Price
Fafnir 33K5	3/16"	1/2"	5/32"	$0.25
N.D. 38	5/16"	7/8"	9/32"	.45
Fafnir K8A	1/2"	1 1/8"	5/16"	.60
N.D. 5202C13M	1/2"	1 3/8"	1/8"	1.00
Fafnir 7308W	1 37/64"	3 9/16"	5/16"	2.00
SKF 466430	6"	8"	1"	5.00
SKF170645	3 11/32"	4 1/8"	7/16"	1.50
Fafnir 545	2 1/16"	2 5/8"	15/32"	1.00

ALLEN SET SCREWS

4–40 x 1/8	8–32 x 1/8	8–32 x 5/16
4–40 x 3/16		8–32 x 3/8

ALL SIZES ..... $1.50 per 100

VERNIER DRUM (from BC 221)

3⅛" Dia. 0-50 in 180°. Black with silver marks .... 85¢

VERNIER DIAL (From BC-221)

2 5/8" Dia. 0-100 in 360°. Black with silver marks. Has thumblock ..... 85¢

BC 348's—C, H, J, L, O, P, Q; BC 224-D
Write for prices

DELAY NETWORK—ALL 1400Ω

T 113—Approx. 1.2 micro sec. delay ..... 85¢
T 114—Approx. 2.2 micro sec. delay ..... 85¢
T 115 Similar to T 114 with tap brought out ..... 85¢

Write for Monthly Bulletin

COAXIAL CABLES

GUARANTEED!! NEW!!

	Ohms	Price per 1,000 ft		Ohms	Price per 1,000 ft
RG-5/U	53.5	$70	RG-29/U*	53.5	$50
RG-6/U	76	150	RG-34/U	71	175
RG-7/U*	97.5	65	RG-35/U	71	450
RG-8/U*	52	60	RG-37/U	55	40
RG-9/U*	51	135	RG-39/U	72.5	180
RG-10/U	52	125	RG-41/U	67.5	550
RG-11/U*	75	120	RG-54/U	58	65
RG-13/U*	74	125	RG-54/AU	54	75
RG-15/U	76	160	RG-55/U	53.5	65
RG-18/U	52	450	RG-57/U*	95	100
RG-21/U	53	100	RG-58/U*	53.5	50
RG-22/U*	95	110	RG-59/U*	73	40
RG-24/U	125	240	RG-62/U*	93	50
RG-25/U	48	575	RG-74/U	52	250
RG-26/U	48	75	RG-77/U*	48	100
RG-27/U	48	290	RG-78/U	48	80
RG-28/U		160			

*No min. order—others 250' min.

Add 25% for orders less than 1,000 feet

COAXIAL CABLE CONNECTORS

Angle Adapter	Plug	Socket	Hood
15¢	35¢	35¢	9¢
M-359	PL-259A	SO-239	83-1H
83-1AP	83-1SPN	83-1R	

Adapter for PL-259 A for use on small coax. 12¢ each ..... $10.00 per 100

83-1AC	$0.42	UG-19/U	.73	UG-85/U	.62
83-1F	1.48	UG-21/U	.60	UG-87/U	.68
83-1J	.80	UG-22/U	.60	UG-102/U	.60
83-1KTY	.45	UG-23/U	.63	UG-103/U	.48
83-1SP	.35	UG-24/U	.60	UG-104/U	.85
83-1T	1.12	UG-25/U	.60	UG-107/U	2.25
83-22AP	.72	UG-27/U	.60	UG-167/U	2.00
83-22F	.88	UG-28/U	2.10	UG-171/U	1.33
83-22R	.48	UG-29/U	.83	UG-175/U	.15
83-22SP	.60	UG-30/U	.94	UG-176/U	.15
83-168	.15	UG-33/U	14.80	UG-180A/U	3.82
83-185	.15	UG-34/U	12.80	UG-191/AP	.57
UG-7/AP	2.14	UG-36/U	12.80	UG-197/U	1.33
UG-12/U	.63	UG-37/U	12.80	UG-206/U	.58
UG-13/U	.60	UG-58/U	.57	UG-255/U	.82
UG-18/U	.63	UG-59/U	.60	UG-264/U	1.74
		UG-61/U	.60	UG-281/U	.60

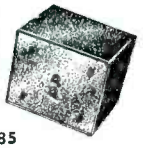
CERAMICONS

2 MMF	30 MMF
5.6	39
10	45
12	82
15	150
20	

$4.50 per hundred

CHOKE

400 MA
12 Hy.
90 OHM
HIGH
VOLT
TEST



$3.85
10 for $34.00

PULSE TRANSFORMERS

X 124 T2, UTAH, marked 9262, 9340, small gray case. Ratio 1:1:1: hypersil core $2.25

D161310, 50 Kc to 4 Mc. 1¾" dia. x 1⅞" high. 120 to 2350 ohms $1.50

352-7178—Spec. 10, 111 Chicago Trans. equivalent to 9262 (above) $1.50

D-166638 W. E. Permalloy core, Semi-toridal windings $1.25

KS9800, Ratio, 1:1:1, 2:1, Freq. range 380 to 520 C.P.S. $3.50

D106173. W.E. Freq. resp. 10KC to 2 MC. 9.80

800 KVA G.E. K2731, 28000 Volt pk. output: Biflar: one microsecond pulse width $28.50

HAYDON TIMING MOTORS

1 R.P.M., 115 V., 60 Cycle $1.79

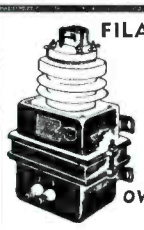
SOUND POWERED HANDSET

Brand New!
Includes 6 ft. cord.
$8.92 ea. — $17.60 pr.

FILAMENT TRANSFORMER

Pri., 115 V., 60 Cyc.—Sec., 5V., 115 A. 6000 volt insulation ..... $9.95 each

FILAMENT TRANSFORMER



Amertran Type WS

For High Voltage Rectifiers. PRI. 115V., 60/60 Cycle.

SEC. 5V., C/T @ 10 Amp.

35 KV R.M.S. Test 12 KV D.C. Operating. Uses 872A Tube or other tubes.

NEW **$10.95**
OVERSEAS PACKED
872-A Tube **$1.88**

Minimum Orders $3 ..... All orders f.o.b. PHILA, PA.

RELIANCE MERCHANDIZING CO.

Arch St. Cor. Croskey Phila. 3, Pa. *Telephone RIttenhouse 6-4927*

SEPT. SPECIAL
8 MFD 2000 VDC
OIL
FILLED
capacitor
$2.95 ea.

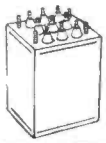
PEAK ELECTRONICS CO.

COMPONENTS

Phone COrtlandt 7-6443 7-6486

SELECTED AND GUARANTEED SURPLUS AT A FRACTION OF ORIGINAL COST.
188 WASHINGTON ST., NEW YORK 7, N.Y.

SEPT. SPECIAL
FILTER CHOKE
8 Henry 175 MA
120 Ohms
Herm. Sealed
$1.49 ea.



POWER TRANSFORMER

550 volts CT, 125 ma. 5 V. @ 2 A, 6.3 V @ 4A, Pri. 117 V 60 cy. Fully cased .....$1.95 ea.

POWER SUPPLY KIT

Uses transformer described & illustrated plus (1) 150 ma. choke (1) dual oil capacitor, (1) socket. All for only $2.99

POWER TRANSFORMER

Pri. 110 V 60 cy. Sec 880 V. CT @ 100 ma. 6.3 V. @ 4 A. 5V @ 3 A. Fully cased.....$2.49 ea.

POWER TRANSFORMERS

Hermetically sealed. Pri 110 volts 60 cy.
1020 volts CT 400 MA, 6.3V 10A, 5V 3A...$5.95 ea.
175V 50 Ma..... .69 e.a
940 volts CT, 125MA, 6.3V 8A, 6.3V, 2.5A, 6.3, 1.2A, 6.3V, .5A, 5V, 3A..... 3.95 ea.
1110 volts CT 60 MA, 920 volts CT 160 MA, 6.3V, 18A, 6.3V, 1.25A, 5V2A, 5V2A.... 4.95 ea.
300 volts CT 300 MA, 2.5V7A, 2.5V7A, 6.3V, 1.5A 2.75

CHOKE BARGAINS

6 Henry 50 Ma 250 Ohms, open frame.....3 for .99
6 Henry 60 Ma 220 Ohms, open frame..... .69
8 Henry 150 Ma 140 Ohms, open frame..... .99
6 Henry 400 Ma 97 Ohms, fully cased..... 3.69
4.3 Henry 445 Ma 39 Ohms, fully cased..... 4.25
10 Henry 350 Ma 125 Ohms, tapped, full case 2.95
15 Henry 250 Ma 290 Ohms, tapped full case.. 2.20
20 Henry 36 Ma 350 Ohms, fully cased..... .69
12 Henry 250 Ma 190 Ohms, fully cased..... 2.00
5 Henry 170 Ma 110 Ohms, fully cased..... 1.35

HIGH CURRENT MICAS

Type G4 Ceramic Case 5¾" High, 5" Diameter Tolerance 5% or Better.

CAP MFD	Amps 1 Mc	KV DC	Price Each	CAP MFD	Amps 1 Mc	KV DC	Price Each
.08	60	4	$27.50	.009	40	15	$29.50
.1	70	4	29.50	.0097	40	15	29.50
.65	60	5	24.50	.01	43	15	29.50
.037	45	6	26.50	.0025	23	20	29.50
.02	40	9	29.50	.0031	26	20	29.50
.02	55	10	29.50	.004	30	22	33.50
.0117	40	14	24.50	.0033	25	25	35.50
.0075	39	15	24.50	.001	12	30	27.50
	TYPE G1				TYPE G2		
.00024	4	6	3.95	.001	10	10	5.95
.0003	4	6	3.95	.002	13	10	5.95
.0005	5	6	3.95	.01	25	7	6.95
.001	7	6	4.95		G3		
.002	11	6	4.95	.001	10	20	14.50

HIGH VOLTAGE VACUUM CONDENSERS

12 MMF 32KV, EIMAC VC 12-32..... 4.95
50 MMF 32KV, EIMAC VC 50-32..... 5.50

BAKELITE CASED MICAS

MMF	VDC	Price	MMF	VDC	Price
D .001	600	$ .18	C .001	3 KV	$ .90
E .01	600	.26	C .002	3 KV	.95
D .02	600	.26	D .005	3 KV	.70
E .027	600	.26	C .005	3 KV	1.24
C .01	1 KV	.45	C .006	3 KV	1.50
C .07	1 KV	.55	D .002	3 KV	.70
D .02	1200	.35	C .0001	5 KV	.70
C .024	1500	.65	C .0005	5 KV	.85
C .033	1500	.75	C .0015	5 KV	1.60
C .015	2 KV	.80	C .003	5 KV	1.90
C .02	2 KV	.90	C .005	5 KV	2.50
D .002	2500	.45	C .002	6 KV	2.90
E .005	2500	.55	B .002	8 KV	5.95
C .025	2500	1.25	B .0005	8 KV	2.90
			B .0012	8 KV	4.50

SCR 522 TRANSMITTER RECEIVER

Complete with tubes and separate Dynamotor Power Supply. Excellent condition $36.50

MOTOR & GEAR BOX

Type RL42B. Motor 24 Volts DC, ⅛ HP—1 min. with Gear Reduction Box.....$2.25 each

NON INDUCTIVE RESISTORS

250 Ohm 100 Watt..... .75
500 Ohm 100 Watt..... .75
12500 Ohm 150 Watt..... .95

METER MULTIPLIERS

2 Meg 1/5 of 1% Cage Enclosed 2 KV.....$3.95
2 Meg 1/2 of 1% Tubular 2 KV..... 1.95
4 Meg 1/2 of 1% Tubular 4 KV..... 3.75

1N21B SILICON DIODES

.35 each: 10 for $2.90

HEAVY DUTY CERAMIC RF SWITCH

Single Pole 11 pos..... .99 ea.
UTC type PA 5000 ohm plate to 500 ohm line and 6 ohm voice coil. 10 watt. 60 to 10,000 cps +1 DB. .....CLOSE OUT AT $1.99

PANEL METERS

BRAND NEW GOVERNMENT SURPLUS

2" Simpson 0-200 Microamps (Mill Scale).....$4.50
2" Simpson 0-500 Microamps (Volt Scale)..... 2.95
2" GE 0-5 Ma (Amp Scale)..... 1.95
2" Simpson 0-5 MA, Basic, Square..... 2.25
2" Simpson 0-20 MA (Amp Scale)..... 1.95
2" Sun 0-25 MA (0-100 Scale)..... 1.95
2" GE 0-50 MA..... 2.45
2" Sun 0-50 MA, Square (0-100 Scale)..... 1.95
2" GE 0-1 Amp RF..... 1.95
2" Simpson 0-2 Amp RF (Square)..... 1.95
2" GE 0-4 Amp RF..... 1.95
2" GE 0-250 MA AC..... 3.50
2" Sun 0-20 Volts DC..... 1.75
2" Weston 0-20 Volts DC..... 2.45
2" GE 0-30 Volts DC (1000 ohms/volt)..... 2.95
2" Triplett 0-300 Volts AC..... 2.95
2" GE 0-30 Amps DC..... 1.95
2" GE 0-25 Volts AC, Linear (0-100 Scale)... 3.50
3" Westinghouse 0-2 MA..... 3.75
3" Westinghouse 0-15 MA (Square)..... 3.75
3" Westinghouse 0-20 MA..... 3.75
3" Western Electric 0-80 MA..... 2.75
3" GE 0-200 MA DC..... 3.75
3" GE 0-15 Volts AC..... 3.95
3" GE 0-1 Amp DC..... 3.95
3" Westinghouse 0-2 Amps DC..... 3.95
3" Westinghouse 0-1 MA (Basic) KV Scale.... 3.95
3" Westinghouse 0-750 VDC (1000 Ohms/V)... 4.50
3" Weston 0-150 Volts AC Mod 301..... 5.95
3" Weston 0-150 Volts AC..... 5.95
3" Weston 0-1 Volt DC, Model 301..... 3.95
3" Simpson 75-0-75 Microamps..... 6.75
3" GE 0-300 MA DC Square..... 3.95
3" GE 0-100 MA DC Square..... 3.95
3" GE 0-5 MA DC Square..... 3.95
3" GE 0-30 MA DC Square..... 3.95
3" GE 0-20 MA DC Square..... 3.95
3" GE 0-2 Amp DC Square..... 3.95
3" GE 0-300 VAC Square..... 3.95
3" GE 0-1.5 Amps. DC Square..... 3.95
3" GE 0-150 MA DC Square..... 3.95
3" GE 0-50 MA DC Square..... 3.95
3" GE 0-3 Amp DC Square..... 3.95
3" GE 0-5KVDC Square, with Multip..... 9.95
3" GE Running Time meter 220v 160 cy..... 6.95
3" GE 0-3VKDC with multip..... 8.95
4" GE 0-300 Volts AC..... 5.95
4" GE 0-8KVDC with multip..... 11.95
4" McClintock 0-200 microamps..... 9.95
6" GE 0-12 KVDC with multip. Mod. 8DE... 12.95
6" GE 0-20 Volts AC Model 8AB..... 6.95
6" GE 0-10 Amo DC Model 8DB..... 6.95
6" GE 0-15 Amps DC Model 8DB..... 6.95
6" GE 0-25 Amps DC, Model 8DB..... 6.95
6" GE 0-1.5 Amp DC Model 8DB..... 6.95
2" Westinghouse 0-9 Amp. RF..... 1.89
3" McClintock 0-1 Ma (10 Ma Scale)..... 3.95
3" Westinghouse 0-10 Ma (Amp Scale)..... 2.75
3" GE 0-300 VDC, 1000 Ohms/Volt..... 4.50
3" GE 0-75 Microamps..... 12.50

LINK TEST SET

Type #1410. Contains two 3½" meters—a 75-0-75 microamp Galvanometer and a 0-1 MA multi-scale meter. Has tap switch for changing range. Ranges are as follows: 75-0-75 microamps, 1 MA 2.5 MA, 50 MA, 25 volts, 500 volts. Ideal for balancing discriminators and general lab use. Housed in hard wood case with hinged cover. 10" x 8" x 4½". Only .....$14.95 ea.

MOSSMAN SWITCHES

4 Pole Single Throw $.95

GUARDIAN LATCHING RELAY

Type RC 100. 110 volt 60 cycle coil. S.P.D.T. each impulse reverses the position of the contacts. Locks automatically. Contacts rated 1500 watts at 110V 60 cycles. Size 3" long, 2⅛" wide. 1½" high. Only .....$1.95 ea.

HIGH WATTAGE ANTENNA RELAY

110/220 volt 60 cycle Solenoid. D.P.D.T. rated at 5000V. 15A. Heavy duty paralleled contacts. Sturdy construction. Isolantite insulation. Base 8" x 10½".
Made by Monitor Controller.....$18.50
Same specs. as above but DPST..... 12.50
Same specs. as above but SPDT..... 12.50

SENSITIVE RELAY

Breaks at 3 MA. Beautifully Constructed and delicately poised. Approx. 2000 ohms resistance. Housed in dustproof aluminum can. Plugs into 5 prong socket. Only .....99¢ ea.

500 MICROAMP RELAY

Delicately balanced. S.P.D.T., 10,000 ohm coil Trips at .4 to .5 MA. 2⅝" x 2⅝" x 1⅝" high..$2.95

General Electric Overload Relay. Electrical Reset 110 Volts 60 Cycle

Breaks at 640 Milliamps but easily adjustable for other currents. Terrific values at only.....$1.95

FILAMENT TRANSFORMER

6.3 volts at 12 amps. Primary 110 volts 60 cy. Size 3¼"H x 2⅞"W x 3"D. Wt. 3½ lbs. As illustrated. Worth $4.50. Only.....$1.69 ea.

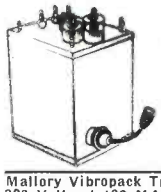
RAYTHEON SWINGING CHOKE

2 to 12 Henrys, 1 Amp to 100 Ma. 15 Ohms DC fully cased. High voltage insulation, ceramic insulators. Very conservatively rated. Weight 60 Lbs. $14.95 ea.

THORDARSON PLATE TRANSFORMER

CHT Series, Model T15P 22. 110/220 volt 60 cy. Primary: 3500V. 3000V, 2500V, 2000V C.T. Secondary: 625 watts. Weight 70 Lbs.....$22.50 ea.

SCOPE AND FIL. TRANSFORMER



Pri. 115 volts, 60 cycles, Sec. 4400 volts RMS 4.5 MA., 5 volts. CT 3 amps. Fil. Ins. 15 KV. RMS test. Hermetically sealed. Has insulated plate cap for rectifier. Made by Raytheon. 4½ x 5 x 5½.....Only 4.95

Mallory Vibropack Transformer 6 Volt Input. Output 300 Volts at 100 MA.....$3.95

WESTINGHOUSE SELENIUM RECTIFIER

Hermetically sealed. Oil Immersed Full Wave Bridge. 30 Volts AC Input. 24 Volts at 2 Amps Output. Size 2⅝x2⅝x3⅞ hi.....$3.75 ea.

50 megohm 35 watt Resistor with mount. $1.49 each: 10 for $9.90. 10 Meg 10 Watts 49¢; 2 Meg 5 Watt 35¢

30 WATT WIRE WOUND RESISTORS

Ohms: 100-2500-3k-4k-4500-5300-18k.....8 for .99

Precision 15 Meg. 1% Accuracy Resistor, Non-inductive, 1 watt, hermetically sealed in glass .25 ea. 10 for.....$1.90

WIRE WOUND RESISTORS

5 watt ohms: 25-50-200-470-2500..... .09 ea.
10 watt ohms: 25-40-84-400-470-1325-2K-4K .15 ea.
20 watt ohms: 50-70-100-300-750-1K-1.5K 2.5K-2.7K-5K-10K-16K-20K ..... .20 ea.

SLIDER ADJUSTABLE RESISTORS

20 Watt: 1, 5, 50 Ohms..... .25
50 Watt: 100, 500 Ohms..... .35
75 Watt: 100, 150, 200 Ohms..... .39
100 Watt: 20, 50, 75, 120, 500 Ohms..... .49

MIDGET VARIABLE CONDENSERS

15 MMF (HF 15)..... .39
Dual 15 MMF (HF 15 D)..... .69
250 MMF (MC 250 S)..... .69

CERAMICONS

MMF: 1.5.2, 3, 8, 10, 20, 22, 120, 500..... .05 ea.

SILVER MICA CAPACITORS

MMF: 10, 47, 50, 60, 340, 750, 780, 1000..... .09 ea.

OIL CONDENSERS

56	mfd	220 vdc—3.95	2	mfd	2000 vdc—2.25
4	mfd	600 vdc— .59	10	mfd	2000 vdc—4.95
6	mfd	600 vdc— .79	2	mfd	4000 vdc—4.90
3/3	mfd	600 vdc— .79	4	mfd	4000 vdc—6.75
8/8	mfd	600 vdc—1.39	1	mfd	5000 vdc—4.50
10	mfd	600 vdc— .89	.1/.1	mfd	7000 vdc—2.25
4	mfd	1000 vdc— .95	2	mfd	6000 vdc—9.95
10	mfd	1000 vdc—2.50	1	mfd	7500 vdc—6.50
2	mfd	1500 vdc—1.25	.01/.01	mfd	12 kv 5.75
6	mfd	1500 vdc—2.95	2	mfd	7500 vdc—12.75
10	mfd	1500 vdc—3.50	.65	mfd	12,500 vdc—12.95
1	mfd	2000 vdc—1.45	1	mfd	15kv dc—15.95

FILAMENT TRANSFORMERS

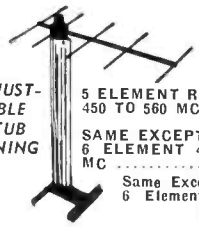
110 V 60 CY Pri. Cased.
5 Volt 15 Amp.....$2.75
2.5 Volt 10 Amp..... 3.49
2.5 Volt CT 21 Amps..... 4.75
5 Volt 4A, 6.3V, 3A..... 2.45
2.5V CT 20A, 2.5V CT 20A..... 6.95

H. V. SCOPE TRANSFORMER

Pri. 110V 60CY—Hermetically Sealed
1050V @ 20MA, 20V 4.5A, 2.5V 5A.....$2.95

MISCELLANEOUS BARGAINS

2mfd 250 volts ac oil cond..... 6 for .99
Ceramicon .0005 mfd..... 20 for .99
.01 600 volt dc pigtail micas..... 10 for .90
.001 600 volt dc pigtail micas..... 15 for .99
.006 600 volt, pigtail micas..... 12 for .99
Butterfly cond. 2 to 11 mmf ball brngs.... 3 for .99
CO type 4 micas .001 600vdc..... 10 for .99
10,000 ohm potentiometers..... 6 for .99
50 K 1% W. W. Resistors, Precision..... .14
.1 MFD 7500 VDC Oil Cond..... .89
.05 MFD 7500 VDC Oil Cond..... .75
7 MFD 330 VAC Oil Cond..... .69
25 ohm 6.5 Watt Rheostat..... 2.95



ASB YAGI ANTENNA

ADJUSTABLE STUB TUNING

5 ELEMENT ROTATABLE ARRAY—450 TO 560 MC **$7.00**

SAME EXCEPT DOUBLE STACKED 6 ELEMENT 450 TO 560 MC **$12.70**

Same Except Double Stacked 6 Element 370 to 430 MC **$29.40**

Double stacked antennas can be supplied with hydraulic remote controls at $29.50 per set additional.

PULSE TRANSFORMERS

UTAH 9262	$2.25
UTAH 9278	$2.25
G. E. 68G-627	$3.75
AN/APN-9 (901756-501)	$1.25
AN/APN-9 (901756-502)	$1.25
AN/APN-4 Block, Osc	.88

GENERAL ELECTRIC TUBE SPECIALS

Brand New Mfd. by G.E.

12GP7	12.85	FG-95	20.60	GL-415/	
1P24	.29	FG-105	9.95	5550	22.00
FG-32	4.25	FG-172	14.50	8020	1.39
FG-33	11.95	FG-190	12.15	189048	3.79
FG-81A	4.95	2C39	13.50	189049	3.79

SPRAGUE PULSE NETWORKS

7.5 E3-1-200-67P, 7.5 KV, "E" Circuit 1 microsec. 200 PPS, 67 ohms imped. 3 sections.....$4.30

7.5 E3-3-200-67P, 7.5 KV, "E" Circuit 3 microsec. 200 PPS, 67 ohms imped. 3 sections.....$6.75

7.5 E4-16-67P, 7.5 KV "E" Circuit 4 sections. 16 microsec. 60 PPS, 67 ohms imped.....$8.25

15—E4 1.5-600-50P, 15 KV "E" Circuit 1.5 microsec. 600 PPS, 50 ohms imped. 4 sections..$12.00

15—E6 5-180-50P, 15 KV "E" Circuit 5 microsec. 180 PPS, 50 ohms imped. 6 sections.....$25.00

KOLLSMAN INSTRUMENT LOW INERTIA SERVO MOTORS

Type 937-0240—85/68 Volts—100 Cycles 2 Phase—5 Watts—2650 RPM
Will Operate Satisfactorily at 60 Cycles
Original Price $34.50—Our Price—$8.22 ea.

$7.50 EACH—Lots of 10

COAXIAL CONNECTORS

83-1AC	.42	UG-12/U	.63	UG-86/U	1.22
83-1AP	.15	UG-21/U	.67	UG-87/U	.68
83-1F	1.12	UG-22/U	.86	UG-171/U	1.33
83-1H	.10	UG-23/U	.63	UG-175/U	.15
83-1J	.80	UG-24/U	.67	UG-176/U	.15
83-1R	.35	UG-27/U	.68	UG-180A/U	3.82
83-1SP	.35	UG-29/U	.83	UG-191/AP	.57
83-1SPN	.35	UG-30/U	.94	MX-195/U	.41
83-1T	1.12	UG-34/U	12.80	UG-197/U	1.33
83-22AP	1.10	UG-36/U	12.80	UG-206/U	.58
83-22F	1.48	UG-37/U	12.80	UG-255/U	.82
83-22R	.48	UG-58/U	.57	UG-264/U	1.74
83-22SP	.85	UG-85/U	.62	MX-367/U	.15

FULL LINE OF JAN APPROVED COAXIAL CONNECTORS IN STOCK

CONSTANT VOLTAGE TRANSFORMERS

Federal Constant Voltage Transformer Input 95-135V 50/60cy Output 115V 210W.....$34.00

Raytheon VR-5 Constant Voltage Transformer Input 95-130V 60cy-Output 115V 500W.....$38.50

Sola Constant Voltage Transformer Input 95-125V 60cy-Output 15.8V 285VA.....$24.70

Sola Constant Voltage Transformer Input 105-125V 60cy-Output 115V 80VA.....$15.95

COAXIAL CABLE

RG-8/U—$60.00 per 1000 ft.—Other types in stock

SELENIUM RECTIFIER STACKS FULL WAVE BRIDGE

MAXIMUM RATINGS AC VOLTS INPUT 18 DC VOLTS OUTPUT 14.5		MAXIMUM RATINGS AC VOLTS INPUT 40 DC VOLTS OUTPUT 34	
1.2 Amps.	$2.64	0.6 Amps.	$3.00
2.4	3.07	1.2	3.44
6.4	4.09	3.2	5.15
13.0	7.67	6.0	9.32
17.5	8.69	9.0	10.05
26	15.33	12	18.64
39	23.00	18	20.12
52	30.67	24	35.96
65	38.33	36	41.24

All voltage and current ratings based on continuous operation in 35°C. (95°F.) ambient, self-cooled. Current ratings can be increased up to 2½ times normal ratings by intermittent operation or forced cooling.

GENERATORS

- Eclipse-Pioneer type 716-3A (Navy Model NEA-3A) Output AC 115V 10.4A 800 to 1400 cy 1 ϕ, DC 30 Volts 60 Amps. Brand New — Original Packing $38.50
- Eclipse-Pioneer type 1235-1A. Output—30 Volts 15 Amps. Brand New—Original Packing.....$9.50

NAVY MODEL AIA ANTENNAS

3 CM Conical Scan Aircraft Intercept Antenna Assys. Brand New.....$120.00

TEST EQUIPMENT

- Alfred W. Barber Labs. Mod. VM-25 VTVM * $86.00
- General Radio Model P-500A Standard Signal Generator (Same as G. R. 805A except covers 9KC to 32 MC) ..... * $450.00
- Galvin Model CES-1 Standard Crystal Test Set * $45.00
- TS-10A/APN Delay Line Test Set.....$25.00
- TS-19/APQ-5 Calibrator $75.00
- AT-48/UP "X" Band Horn.....$3.95
- REL W-1158 Frequency Meter 160-220 MC..$32.95
- CWI-60AAG Range Calibrator for ASB, ASE, ASV and ASVC Radars.....$39.95
- CRV-14AAS Phantom Antenna for Transmitters up to 400 MC.....$11.75
- TS-146/AP X-Band Test Set. Price on request.
- TS-184/AP. .....Price on request.
- CPR-60AAJ and CPR-60AAK—IFF Test Sets, (pair) $16.95
- General Radio Model 804-B Signal Generator—8 to 330 MC ..... ★ $300.00
- Hewlett Packard Model 200-C Audio Oscillators (10 available) ..... ★ $87.50
- C-D Quietone Filter Type IF-16 110/220 V AC/DC 20 Amps ..... * $9.00

All Items New Except Where Noted * (Exc. Used Condition)

W. E. MERCURY CONTACT RELAYS

Glass sealed mercury wetted SPDT contact assemblies. Magnetically operated. Used in Western Electric D-168479 high speed plug in relays. Supply your own coil .....$2.00 each

TYPE "J" POTENTIOMETERS

50¢ each

Resis.	Shaft	Resis.	Shaft	Resis.	Shaft
100	SS	10K	SS	100K	3/8"
200	SS	15K	SS	100K	7/16"
500	½"	20K	SS	100K	SS
650	½"	25K	SS	150K	½"
1000	SS	30K	1 1/8"	200K	SS
6500	SS	50K	5/8"	250K	SS
10K	3/8"	50K	SS	1 MEG	SS
10K	½"	100K	5/16"		

Triple 100K - 3/8" Shaft - 1.47
All shaft lengths beyond bushing - SS (screw slot)

TUBE SPECIALS

STANDARD BRANDS ONLY

RECEIVING TUBES

OZ4G	.59
1A3	.45
1AB5	.73
1B3GT	1.18
1L4	.66
1R4	.29
1S4	.86
1S5	.64
1T4	.64
2X2/879	.49
2X2A	.79
3A4	.61
3A5	.96
3A8GT	1.76
3B7/1291	.29
3D6/1299	.29
3Q5GT	.79
3S4	.61
5R4GY	1.30
5T4	.89
5U4G	.59
5V4G	.84
5Z3	.65
6AB7/1853	.99
6AC7/1852	.79
6AC7W	1.45
6AG5	.89
6AG7	1.19
6AJ5	.89
6AK5	1.60
6AK6	.82
6AL5	.69
6AQ6	.65
6AS7G	4.22
6AT6	.54
6AU6	.72
6AV6	.55
6BA6	.65
6BA7	.86
6BE6	.65
6BG6G	1.72
6BJ6	.72
6C4	.50
6F6	.69
6H6	.49
6J5	.49
6J6	.89
6J7	.72
6K6GT	.52
6K7	.54
6K8	.83
6L6	1.22
6L6G	1.11
6L6GA	.87
6S87Y	.79
6SC7	.66
6SF7	.72
6SG7	.69
6SH7	.44
6SJ7	.59
6SL7GT	.69
6SN7GT	.79
6SN7W	1.45
6V6	1.07
6V6GT	.59
6W4GT	.65
6X4	.59
6X5GT	.59
7F7	.79
7N7	.79
10Y	.19
12A6	.24
12AH7GT	.87
12AT6	.59
12AU6	.72
12BA6	.64
12BA7	.86
12BE6	.64
12C8	.59
12SG7	.69
12SH7	.49
12SJ7	.49
12SK7	.59
12SL7GT	.69
12SN7GT	.79
12SR7	.69
28D7	.61
83	.95
83V	1.15

CATHODE RAY

2AP1	3.65
2AP5	5.95
3AP1	4.63
3AP4	5.94
3BP1	2.59
3CP1	1.87
3DP1A	5.75
3EP1	2.92
3FP7	.98
3HP7	4.91
4AP10	5.35
5AP1	3.75
5AP4	4.75
5BP1	2.40
5CP1	2.87
5CP7	3.76
5FP7	1.05
5HP4	3.35
5JP1	29.00
5JP2	9.55
5JP4	29.00
5LP1	13.95
5MP1	10.65
7BP1	12.87
7BP7	4.95
7BP14	14.95
9GP7	9.85
9LP7	3.88
10BP4	21.95
10FP4	28.88
12DP7	12.85
12GP7	12.85
902P1	3.95
905	4.47

PHOTO CELLS

1P24	.29
918	.88
919	1.79
923	.97
927	1.67
931A	3.22
1645	1.67

THYRATRONS AND IGNITRONS

OA4G	.95
EL-C1A	3.35
1C21	1.85
2A4G	1.15
2D21	1.09
3C23	3.20
3C31/EL-C1B	3.35
4C35	21.00
EL-C5B	8.95
C6J	4.44
FG-17	2.89
FG-33	11.95
FG-41	93.00
FG-67/1904	8.85
FG-81A	4.95
91	5.85
FG-95	20.60
FG-105	9.95
FG-172	14.50
RX-233A	2.95
WE 355A	14.15
393A	5.77
394A	3.77
GL-415/5550	22.00
KU-610	6.35
KU-622	39.50
KU-628	16.90
KU-634	17.20
WL-652/5551	38.00
WL-672	13.25
WL-677	24.00
WL-681/5550	22.00
722A	3.75
873/973	6.95
884	1.35
885	1.20
1665	.97
1904	8.85
2050	1.18
2051	.49

TRANSMITTING & SPECIAL PURPOSE TUBES

OA2	1.32
OB2	1.75
1B22	3.87
1B23	8.95
1B24	4.90
1B26	4.50
1B29	2.90
1B32	3.15
1B35	17.50
1B36	4.50
1B42	9.80
1H20	.58
2B22	1.41
2C22	.22
2C26	.27
2C34	.28
2C39	13.50
2C40	4.95
2C44	.79
2E22	1.25
2J21A	8.95
2J22	8.95
2J26	7.80
2J27	13.70
2J31	9.60
2J32	14.45
2J33	19.90
2J34	19.90
2J37	13.70
2J38	12.70
2J41	132.50
2J48	14.95
2J61	36.20
2K23	23.95
2K25	19.95
2K28	23.50
2X2A	.79
2B22/EL-1C	1.12
3B23	4.75
3B24	1.65
3B26	1.75
3B27	1.29
3C24	.44
3J31	39.25
4-125A	26.95
4-250A	36.75
4A1	.58
4B22/EL-5B	5.20
4B25/EL-6CF	8.70
4C28	21.65
4E27	12.75
5D21	26.50
5J23	14.20
5J29	14.20
6C21	19.88
6J4	5.20
7-7-11	.89
10T1	.58
10Y	.19
15E	1.25
15R	.75
REL-21	3.25
24G	.44
RK-25	2.11
FG-32	4.25
RK-34	.28
REL-36	.78
RK-47	4.92
EF50	.45
VT-52	.36
53A	3.82
RK-59	2.44
RK-60/1641	.59
RK-72	.92
RK-73	.92
VR-75/-OA3	1.25
75T	3.80
VR-78	.34
VR-90/-OB3	.81
VT-98-(BR)	29.90
C100E	2.30
100R	2.90
100TH	10.25
WE-101D	1.65
WE-101F	3.62
VR-105/-OC3	.72
WE-113A	1.32
WE124A	3.80
VT-127A	2.40
VR-150/-OD3	.65
FG-190	12.15
203A	6.40
203B	4.33
204A	27.90
CE-206	3.15
211	.62
WE-215A	.24
221A	1.95
227A	2.40
WE-231D	1.25
WE-244A	4.20
WE-245A	1.35
WE-249C	3.30
WE-252A	4.65
WE-254A	4.90
WE-257A	2.77
WE-271A	6.75
WE-275A	6.95
WE-283A	1.27
WE-285A	4.57
WE-286A	6.90
WE-301A	5.95
304TH	3.86
307A	3.90
WE-309A	6.45

BRAND NEW FIRST QUALITY

WE310A	7.50
WE-313C	3.15
316A	.66
WE-331A	8.75
350A	2.80
350B	1.95
354C	19.50
WE-356B	4.45
361A	4.75
371B	.82
388A	2.95
417A	10.65
434A	3.65
446A	.79
446B	1.95
450TH	19.70
450TL	32.50
451	1.75
471A	2.75
SS-501	11.50
503AX	1.47
506AX	1.47
507AX	1.47
527	9.75
530	17.20
531	17.80
532A	3.15
559	1.41
561	1.45
579B	5.85
HY615	.29
WL-670A	8.70
700B	16.70
700C	16.90
700D	16.90
701A	3.67
702A	2.95
702B	3.87
703A	3.90
704A	2.75
705A	1.17
706AY	45.00
706BY	45.00
706CY	17.95
706FY	45.00
706GY	45.00
707A	5.22
707B	12.25
708A	4.85
709A	4.87
710A	2.25
713A	1.45
714AY	6.95
715A	6.75
715B	9.95
717A	.97
WE-719A	22.95
721A	3.93
723A	6.95
723A/B	11.95
724A	3.22
724B	3.22
725A	8.95
726A	14.50
730A	10.95
731A	2.45
WL-787	9.80
800	1.88
801A	.48
802	4.25
803	4.87
804	8.95
805	4.75
806	17.70
807	1.60
808	2.19
809	2.40
810	7.95
811	2.65
813	7.25
814	3.79
815	1.72
816	.97
826	.57
828	13.48
829	4.91
830B	3.35
832	4.91
832A	5.50
836	.89
837	1.38
838	2.93
841	.49
843	.59
851	27.50
852	6.40
860	8.50
861	17.70
864	.19
865	.88
866A	1.15
869B	27.00
872A	1.88
874	1.65
876	.39
878	1.85
954	.39
955	.39
956	.49
957	.49
958A	.49
959	.49
991	.29
1005	.24
CK-1006	.85
1201/7E5	.29
1203/7C4	.19
1294/1R4	.29
1299/3D6	.29
1602	.68
1613	.61
1616	.87
1619	.19
1624	.69
1625	.19
1626	.29
1629	.29
1630	3.11
1631	1.38
1636	3.77
1638	.70
1641/RK-60	.59
1642	.39
1644	1.17
1960	1.21
UX-6653	.65
7193	.22
8011	.87
8012	1.45
8012A	1.91
8013	.92
8013A	1.42
8014A	22.50
8016	1.18
8020	1.39
8025	3.95
9001	.52
9002	.39
9003	.45
9004	.39
9005	1.40
9006	.29
189048	3.79
189049	3.79
199698	2.69

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ELECTRONIC RESEARCH LABORATORIES

1021-A CALLOWHILL ST. PHILA. 23, PA

Telephones - MARKET 7-6590 and 6591

TEST EQUIPMENT

I 135 Test Set
BC 771 Frequency Meter
BC1287 Scope
TS 62/AP
TS 13/AP
TS 102A/AP
TS 251
BC 221 Freq. Meter
I 222 Signal Generator
LM Frequency Meters

RC 150 EQUIPMENT

Receiver BC 1161 A
Transmitter BC 1160 A
Control Unit BC 1162A
Signal Generator I-198A

Miscellaneous Specials

1D6/APN4 - Scope
R78/A PS 15 - Scope
R7/APS 2 Receiver and Scope
ASB7 Scope
SCR 522 Receiver-Transmitter
MN26 C- or Y Receiver
RA 10 Receiver
BC 639 Receiver } RA 42 Rectifier }
TA2J24 Transmitter
SCR 269 G Compass Installation
ARN7 Compass Installation
MN 26 Compass Installation
ILS Installation (BC733 & R89)
R 132/TPS10 Radar Receiver
MD22 - URA/T1 Modulator
AN/APR1 Receiver and Tuning units
ASB 7 Complete Radar Installation
BD 71—6 position Field Switchboard
EE8 Field Phones
RM 29 Remote Phone Control
SCR 183 complete
ARC/1 Transceiver
ART 13 Transmitter
BC348 Receiver
RTA1B Transceiver
Model 15 Radar Trainer
BC-906-Frequency Meter

PRICES OF ABOVE UPON REQUEST

T-85/APT5 UHF TRANSMITTER

Operating over a frequency range of 300 to 1400 MCPC with a nominal output of from 10 to 30 watts. Unit is equipped with 110 V 60 CPS filament transformer; blower; lecher wire test frequency set, and 8 tubes —1-931A; 2-6AC7; 2-6AG7; 1-6L6G; 2-829B; 1-3C22 (GL522) (oscillator).
New in original box with Operating Instruction Manual..... **$69.50**

Portable VHF Communication Unit

Two-way radio telephone equipment designed for operation between 152 and 162 megacycles. Adaptable for many uses, a complete unit including the rechargeable storage battery weighs but fifteen pounds, and is housed in a sturdy case 11½" x 9" x 4¼", provided with shoulder straps.
This brand new set of big name manufacture comes complete with battery, battery tray, and handset but less crystal $89.50.
Battery charger is extra at $19.95.

Mobile VHF Communication Unit

Adaptable for many mobile uses, this is a compact unit 3½" x 8" x 15½" operating on 152 to 162 megacycles. It is six volt powered direct from storage battery, and is complete with the tone filter and crystal; handset, control box, antenna and installation kit.
Brand new, ready to go **$129.50**
Extra 18" stub type antennae are available, $2.95

BC-603 Receiver—Good, Used..... $19.95

BC-604 Transmitter FM 20-28 MC
11 and 15 meters. Can be operated on 10 meters-10 channel push button crystal. With all tubes and meter but less dynamotor. Excellent condition $14.95
Crystals—Set of 80..... 14.95

IS-185 Weston Voltmeter Model 433 0 to 150 VAC, 25 to 2400 cycles. New $24.95

Condensers

	Each
2 mfd. 4000 VDC. OIL FILLED.....	$2.95
1 mfd. 6000 VDC. OIL FILLED.....	1.98
.25 mfd. 15000 VDC. OIL FILLED.....	4.95
.00025 mfd. 25000 VDC. OIL FILLED.....	2.95
.4 mfd. 1500 VDC. OIL FILLED.....	.29
10 for	2.49
2 mfd. 600 VDC. OIL FILLED.....	.39
3 for	1.00
1 mfd. 600 VDC. OIL FILLED.....	.24
5 for	1.00
.1x.1x.1—1200 VDC. OIL FILLED.....	.59
2 for	1.00
50 mmfd—5KV—5 Amp. Vacuum Cond...	1.19

ARROW has the VALUES!

RADIO EQUIPMENT R. C.-100-B

This equipment made by General Electric, was designed for ground use as an identification of friendly aircraft.

Radio equipment RC-100-B consists of Cabinet CH-118 in which are mounted Transmitter BC-769, Keying unit BC-770, Radio Receiver BC-768, Rectifier RA-52, Wave Trap FL-25, wiring and Blower. Additional equipment consists of Antenna unit AN-82B; Transmission line MC-377, air compressor M-349, Oven M-348, control box BC-773, Amplifier BC-783B and associated cords and hardware.

Primary requirements are 110 to 120 volts, 50 to 60 cycle for the entire unit and accessories.

Cabinet CH-118 is of the Standard 19 inch rack type structural steel frame with runner angles for each of the units. A full length access door with safety interlocks forms the rear of the cabinet.

Transmitter BC-769 is designed to transmit RF pulsed signals at 470 megacycles with the use of two type 15E Tubes operating in push-pull with resonant grid, plate and filament lines.

Keying unit BC-770 furnishes the pulse of the Transmitter.

Receiver BC-768 was used to detect the 493.5 megacycle reply pulses from the interrogated station and to sufficiently amplify these signals for oscilloscope observation.

Rectifier RA-52 produces the high voltage. An 0-15 kilovolt DC Meter is connected across the output of the filter to measure the voltage fed to transmitter BC-769, while an 0-20 milliammeter is connected to the ground return to measure the average current drawn.

Antenna AN-82B consists of 24 vertically polarized, half wave radiating elements, a reflecting screen, open-wire transmission line sections and a concentric-line terminating section or elevator.

Wave trap FL-25 is used to separate received and transmitted signals.

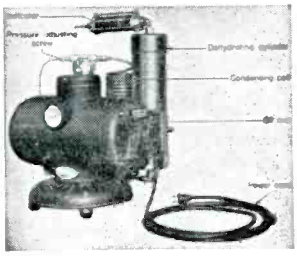
Transmission line MC-377 is of ⅞ inch air-dielectric, 70 ohm concentric line type and is assembled by means of solderless air tight connectors.

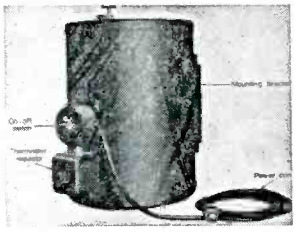
Control Box BC-773 contains necessary controls for operation.

Amplifier BC-783-B is used to amplify the output of Receiver BC-768 for suitable oscilloscope presentation.

Air Compressor M-349

together with 12 feet of ¼ inch soft copper tubing and necessary hardware is used to fill and maintain transmission lines with dry air under pressure. Operation is direct from 110 V AC 60 Cycles.

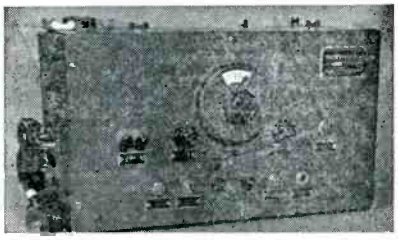




Oven M-348

is furnished for removal of moisture from the dehydrating cylinders of the compressor. It too operates from 110V AC 60 cycles.

Frequency Meter BC-771



Frequency Meter BC-771 is used for frequency checking and for tuning operations on Radio Transmitter BC-769 and Radio Receiver BC-768. It is a separate unit mechanically and has its own power supply, which requires a 110 to 120 Volt, 50 to 60 cycle source.

The circuits consist of an r-f oscillator, a crystal oscillator, a 30,000 cycle oscillator and associated mixer, multiplier, and amplifier tubes. The crystal oscillator is used to set the r-f oscillator to exactly 94 or 98.7 megacycles.

For tuning Radio Transmitter BC-769 to 470 megacycles, the signal from the radio transmitter is mixed with the fifth harmonic of the r-f oscillator, operating at 94 megacycles, to produce an audio-beat frequency. For tuning Radio Receiver BC-768 to 493.5 megacycles, the fifth harmonic r-f oscillator, operating at 98.7 megacycles and modulated by the output of the 30,000 cycle oscillator, is fed into the radio receiver.

The entire RC 100 as described above—
all brand new—complete—
Technical Manual TM11-1113B is furnished with the complete set.

$595.00
F.O.B. Warehouse

Prices on individual components will be furnished on request.

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LAVOIE FREQ. METER MICRO-WAVE 375 to 725 MCS

Model TS-127/U is a compact, self-contained, precision (± 1 MC) frequency meter which provides quick, accurate readings. Requires a standard 1.5V "A" and 45V "B" battery. Has 0-15 minute time switch. Contains sturdily constructed HI-"Q" resonator with average "Q" of 3000 working directly into detector tube. Uses 957, LS6 and 3S4 Tubes. Complete, new with inst. book, probe and spare kit of tubes. Less batteries.
Write for descriptive circular..... **$59.50**

MOTOR GENERATORS DYNAMOTORS, INVERTERS, ETC.

2.5 KVA MG SET. Diehl Elec. Co.
120V DC to 120V AC, 60 cy, 1 Ph. Complete with Magnetic Controller, 2 Field Rheos and Full Set of Spare Parts including Spare Armatures for Generator and Motor.
Full specs. and price on request. New.

2 KVA MG SET. O'Keefe and Merritt.
115V DC to 120V AC, 50 cy. Idles as 3 Ph. syncs motor on 208V, 50 cy. New. Export crated $165.00

1.25 KVA MG SET. Allis-Chalmers.
115V DC to 120V, AC, 60 cy, 1 Ph. Fully enclosed. Splashproof. Ball Bearings. Centrifugal Starter. New..... $97.50

Same machine but for 230V DC operation. $110.00

Spare Parts for either machine..... $15.00

MG SET FOR NAVY TBS TRANSMITTER. Type CG-21302.
440V AC, 60 cy, 3 Ph, 1500VA to 875V DC and 300V DC. New..... $69.50

DYNAMOTOR. Navy Type CAJO-211444.
105/130V-DC to 13V DC at 40A or 26V DC at 20A. Radio filtered. Complete with Line Switch. New $69.50

DYNAMOTOR. Elcor. 32V DC to 110V AC. 60 cy, 1 Ph. 2.04 Amps. New..... $24.50

DYNAMOTOR. Elcor. 32V DC to 110V AC, 60 cy. 1 Ph, 0.43 Amps. New..... $17.50

MISCELLANEOUS SMALL MOTORS INVERTERS, AMPLIDYNES

AMPLIDYNE—G. E. Model 5AM31NJ9A. 530 Watts. 7500 R.P.M. Input: 27V. DC, Output: 60V. DC. Weight 34½ lbs. New..... $10.50

AMPLIDYNE—G. E. Model 5AM21JJ7. 4600 R.P.M. Motor Compound wound. 150 Watts. Input: 27V. DC. Output: 60V. DC Sig. Corp. U. S. Army MG-27-B. New..... $26.50

INVERTER—Leland Elec. Co. Model PE206A. Input: 28V. DC, 38 Amps. Output: 80V., 800 cy, 485 VA. New..... $12.50

INVERTER—G. E. Model 5D-21NJ3A. Input: 24V. DC, Output: 115V. 400 cy, 485 Va. New $12.50

D.C. MOTOR—G. E. Model 5BA 50LJ2A 0.5 HP. Armature: 27V. at 8.3 Amps. Field: 60V. at 2.3 Amps. R.P.M. 400. New..... $12.50

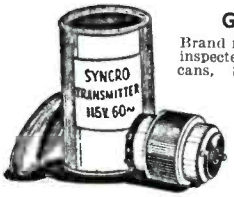
DYNAMOTOR—Type PE94C. For use with SCR522 Transmitter-Receiver. Brand new in export cases $9.50

U. S. NAVY SOUND POWERED BATTLE PHONES

Western Electric No. D173312, Type O. Combination headset and chest microphone as illustrated. Brand new including 20 ft. of rubber covered cable..... **$17.50**

Automatic Elec. Co. No. GL843AO. Similar to above but including Throat microphone in addition to chest microphone. Brand new with 20 ft. rubber covered cable **$13.50**

SYNCHRO GENERATORS



Brand new—Gov't. sealed and inspected—Packed in overseas cans, Synchro Transmitters 115 V., 60 cy. operation. Precision accuracy made for gun fire control. Cost Gov't $90.00 each. Wgt. 5 lbs. Dimensions: 4½" L x 3¼". **Brand New $14.75 Per Pair**

S. G. RADAR EQUIPMENT

Navy Yard Spares for Model SG Radar

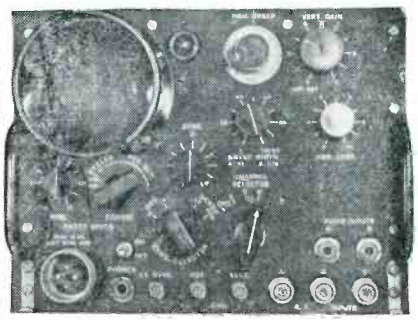
Consisting of the following:

2—CRP-20ABM Rectifier Power Units for modulation generators.
2—CRP-20ABM Rectifier Power Units for Radar Receivers
2—CRP-35AAH Modulation Generators.
2—CRP-46ABD-1 Radar Receivers (including R-906 Gain Controls for Range and Train Indicators)
2—CRP-60AAN Signal Monitors.
2—Complete Transmitter R.F. System coupling assemblies including—10087 magnets and Duplexing tube cavity assemblies.
1—Complete Power Control Chassis.
2—Complete Driver and modulator assembly including driver chassis with delay line, Modulator and Driver Rectifier Tube Assembly and Driver Rectifier Power Unit.
2—Complete sets of equipment spare parts consisting of R.F. Assemblies, motors and acessories, switches, interlocks, fuses, fuse holders, fuse links, relays, contacts, crystals, thermostats, R.F. inductors, capacitors, sockets, test equipment, cables, resistors, etc., as listed in Navy Spare Parts List WX3885.
All above in new and unused condition packed in original metal spare parts boxes.

RADAR COMPONENTS

CRP-23AGC Load Dividers for use with S.G. Modernization Kits. New.
CBM-50AFO Navy type Radar Repeater Adapters. New and complete with 14 tubes, coax fittings, installation plans and wiring diagram.
Synchro Amplifiers. New.
Type CARD 23AFK Bearing Control Units. New.
Type T.D.Y., SO-1, SO-13, SO-3 Radar Antenna Assemblies. New.
T.D.Y. Antenna Control Units.
Radar Crystals Raytheon 98.35 KC.
Type SO-11 Radar Modulator.
Type SO-1 Transmitter Receivers.

MODEL AN/APA-10 PANORAMIC ADAPTER



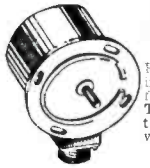
Provides 4 Types of Presentation:
(1) Panoramic (2) Aural
(3) Oscillographic (4) Oscilloscopic

Designed for use with receiving equipment AN/ARR-7, AN/ARR-5, AN/APR-4, SCR-587 or any receiver with I.F. of 455kc, 5.2mc. or 30mc.
With 21 tubes including 3" scope tube. Converted for operation on 115 V. 60 cycle source.
PRICE..... $245.00

MICROWAVE TUNING UNITS

Tuning Units for APR-1 or APR-4. TN-16 (38-9[illegible] mc.) TN-17 (74-320 mc) TN-18 (300-1000 mc.)
These front ends may be used with any 30 mc. IF amplifier or as converters into receivers tuned to 30 mc.

LINEAR SAWTOOTH POTENTIOMETER

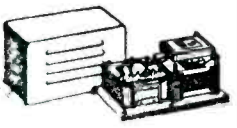


W.E. KS-15138

Has continuous resistance winding to which 24 volts D.C. is fed to two fixed taps 180° apart. Two rotating brushes 180° apart take off linear sawtooth wave voltage at output.
Brand New $5.50

LINE VOLTAGE STABILIZERS

RAYTHEON—Navy Type, CRP-301407 Input: 92-138V, 57/63 CPS., 1 PH Output: 115V, 0.82 KVA., 1% Reg. 0.96 PF. Weight 385 lbs. Overall size—36" high x 20" wide x 12¼" deep. Enclosed in Navy Grey Ventilated Cabinet for Wall Mounting.
Brand New $69.50



RAYTHEON Adj. input taps 95-130V., 60 cy. 1 Ph Output: 115V., 60 Watts. ½ of 1% Reg. Wt. 20 lbs. 6⅛" H x 8¼" L x 4⅝" W. Overload protected. Sturdily constructed. Tropicalized.
Special.... **$12.50**

400 CYCLE TRANSFORMERS

AUTO. 400 cy. G.E. Cat. No. 80G184 **KVA** .945S—.520P. Volts 460/345/230/115. New $3.45
FILAMENT. 400/2600 cy. Input: 0/75/80/85/105/115/125V. Output: 5V3A/5V3A/5V3A/5V3A/5V6A/5V6A/6.3V6A/6.3V5A. New $1.95
THYRATRON POWER. 400/1600 cy. Raytheon UX-8876. 400/1600 cy. Pri: 115V, Sec: 50-0-50V at 0.5A, 6.3V at 1.2A. Test r.m.s. 1780. New $2.75
PLATE WECO KS9560. 400/800 cy. Pri: 115V. Sec: 1350-0-1350 at .057A (2700V Total). Elecstat shilded. Wt. 2.3 lbs. New..... $2.95
SCOPE PL. & FIL. WECO 9556. 400/2400 cy. Pri: 115. HV. Wdg. 1125V at .008A. Fil. Wdgs. 6.4V4A/2.5V1.75A/6.4V.6A. Elecstat shilded. Wt. 1.4 lbs. New $2.75
FILAMENT. 400/2400 cps. WECO KS9553. Pri: 115V. Sec: 8.2V1.25A/6.35V1.5A. Elecstat shilded. Wt. 0.5 lbs. New..... $1.65
PLATE & FIL. 400/2600 cy. Pri: 0/80/115V. Sec #1=1200VDC at 1.5MA. Sec#2=400VDC at 130MA. Fil Secs: 6.4V4.3A/6.35VO.8A. (ins 1500V)/5V2A/5V2A $3.95
RETARD. 400 cy. WECO KS9598. 4 Henry 100MA $1.00

400 CY. SERVO TRANSFORMERS

G.E. #68G665X Pri: 57.5V. Sec:#1=28.75V. Sec: #2=28.75V $1.50
G.E. #68G666X Pri: 57.5V. Sec: 115V C.T. $1.50
G.E. #68G667 Pri: 220V C.T. Sec: 220V C.T. $1.50
G.E. #68G668X Pri: 115V. Sec: 275V/275V/275V/275V/230V/230V/6.3V CT/ 6.3V CT..$3.50

60 CYCLE TRANSFORMERS

1.5 KVA STEPDOWN. G.E. Cat. No. 76G173. Pri: 115/230V Sec: 23/11.5V. Either high voltage connection may be used with either low voltage connection $23.95
50KVA STEPDOWN. Standard Trans Corp. Oil trans type MD. Pri: 450V111A. Sec: 117V427A. Navy type. Ambient temp. 50 Deg. C.... $125.00
FILAMENT. Raytheon Hypersil Core. Pri: 115V. Sec: 6.3V22A/6.3V2.4A/6.3V2.25A/6.3VO.6A Ins. for 1700V $3.95

PULSE TRANSFORMER

PULSE. WECO KS-9563. Supplies voltage peaks of 3500V from 807 tube. Tested at 2000 Pulses/sec and 5000V peak. Wdg. 1-2=18 ohms. Wdg. 1-3=72 ohms. L of Wdg. 1-3= .073-.082H at 100 cps $5.50

High Voltage Capacitors Oil Filled

.25 MFD., 20KV..... $17.75
.25 MFD., 15 KV..... $15.75
.5 MFD., 25 KV..... $26.50
1 MFD., 15KV..... $18.50
1 MFD., 7.5KV..... $ 7.95

All brand new. Made by prominent manufacturers.

SWEEP GENERATOR CAPACITOR

High speed ball bearings. Split stator silver plated coaxial type 5/10 mmfd. Brand new.
$1.00

PARABOLOIDS

Spun Magnesium dishes 17½" dia., 4" deep. Mounting brackets for elevation and azimuth control on rear. 1½" x 1⅝" opening in center for dipole. **Brand new per pair..... $8.75**

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All Prices Subject to Change Without Notice

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Unsurpassed Value

1 MILLIAMP, G.E. DW-51, 2½" Round flush metal case @ $3.50

1 MILLIAMP, TRIPLETT 0321, 3½" Rd. flush bake. case, sc. calib. 0-100, no caption @ $4.00

1 MILLIAMP, GENERAL ELECTRIC DW-41 Round fl., bake. case, scale calib. 130 volts & 500 MA, supplied with paper volt-ohm milliammeter scale @ $3.00

1 MILLIAMP, SUN 3AP259, 3½" Round flush bakelite case @ $4.00

1 MILLIAMP, MARION, 3½" Round fl. bakelite case, knife edge pointer @ $4.00

1 MILLIAMP, WESTINGHOUSE NX-35, 3½" Round fl. bakelite, (JAN type MR35W 001DCMA) approx. 53.7 ohms resistance @ $7.50

1 MILLIAMP, WESTINGHOUSE NX-33, 2½" Round flush bake. case, special black scale calib. 200 MA, caption PA PLATE, grid. battery @ $3.00

1 MILLIAMP, DEJUR AMSCO 310, 3½" Round fl. bakelite @ $4.95

1 MILLIAMP, DEJUR AMSCO, 3½" Round flush bake. case, sc. calib. 0-4 kilovolts D.C., supplied with paper V. O. M. A. scale, parts list & circuit diagram to make a volt-ohm-milliammeter @ $4.50

2 MILLIAMPS, GENERAL ELEC. DW-55, 2½" Round fl. bakelite case, (JAN MR25WOO2DCMA) @ $3.95

2 MILLIAMPS, WESTINGHOUSE NX-35, 3½" Round fl. bakelite case, (JAN MR35WOO2DCMA) @ $5.50

3 MILLIAMPS, WESTON 506, 2½" Rd. flush bakelite case @ $3.95

3 MILLIAMPS, GRUEN G.W. 580, 2½" Round flush bakelite case, scale calibrated 30 & 450 MA & 3000 volts @ $2.50

3 MILLIAMPS, SIMPSON 126, 2½" Rd. flush bakelite case, (JAN type MR25 WOO3DCMA) @ $3.95

5 MILLIAMPS, WESTON 301, 3½" Round flush bakelite case @ $4.95

5 MILLIAMPS, Simpson, 2" Square flush bakelite case, with red mark at 3 volts @ $3.50

5 MILLIAMPS, WESTINGHOUSE RX-33, 2" Square flush bake., with red mark at 3 volts @ $3.50

5-0-5 MILLIAMPS, WESTERN ELECTRIC, 3½" Round fl. bakelite case, concentric style movement approx. 160° deflection, sc. calibrated 50-0-50 @ $3.00

15 MILLIAMPS, GENERAL ELECTRIC DO-58, 4" x 4½" rectangular fl. bakelite case @ $4.95

15 MILLIAMPS, SIMPSON 26, 3½" Rd. flush bakelite case (JAN type MR25W015-DCMA) @ $4.95

20 MILLIAMPS, GENERAL ELECTRIC DO-53, 3" Sq. fl. bake @ $3.75

30 MILLIAMPS, WESTON 506, 2½" Rd. flush bakelite case (JAN type MR24-W30DCMA) @ $3.95

50 MILLIAMPS, GENERAL ELECTRIC DO-58, 4" x 4½" rectangular flush bakelite case @ $4.95

50 MILLIAMPS, GENERAL ELECTRIC DO-41, 4½" Rd. fl. bake @ $4.00

113 MILLIAMPS, BURLINGTON 31 B, 3½" Round fl. bake. case, special POWER INDICATOR scale with 2 colors, green (from 0 to 80 MA) marked OPERATING RANGE, RED (from 80 MA to end scale) marked DANGER @ $2.50

150 MILLIAMPS, GENERAL ELECTRIC DO-41, 3½" Rd. fl. bake @ $4.95

150 MILLIAMPS, ELECTEL 350, 3½" Rd. fl. bake. case, (Elect. Div. of U.S. Time Corp.) @ $4.00

150 MILLIAMPS, TRIPLETT, 2" Square fl. bake., black sc. @ $2.95

150 MILLIAMPS, GRUEN 508, 2½" Round flush bakelite case @ $3.00

150 MILLIAMPS, GRUEN 508, 2½" Round Round fl. bakelite case (JAN type MR25W200DCMA) @ $3.00

200 MILLIAMPS, GENERAL ELECTRIC DO-41, 3½" Rd. fl. bake @ $4.50

300-0-300 MILLIAMPS, GENERAL ELECT. DO-40, 3" Rd. fl. bake., ring-clamp (non-flanged) @ $3.00

500 MILLIAMPS, GENERAL ELECTRIC DW-41, 2½" Round fl. bake. case, black scale (Signal Corps Stock No. 1S-22) @ $3.50

500 MILLIAMPS, DEJUR, AMSCO 312, 3" Square fl. bakelite @ $4.50

800 MILLIAMPS, DEJUR AMSCO 310, 3½" Round fl. bakelite @ $3.50

1000 MILLIAMPS, WESTON 301, 3½" Round fl. bake. case @ $4.95

1000 MILLIAMPS, WESTERN ELECTRIC, 3½" Rd. flush bakelite, concentric style movement, with 190° sc. length @ $3.50

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MIDGET RELAYS

GUARDIAN 300 ohm SPST 24VDC ceramic insul 3 amp cont. #R106 39¢ ea.

ALLIED 300 ohm 24VDC DPDT 1 amp cont. #R67 .....55¢ ea.

CLARE #BAI0059-3 275 ohms SPDT 24VDC Micalex Insul 1 amp cont. #R73 .....45¢ ea.

G. E. 7472679-1 30 ohms SPST N. C. 3VDC 1 amp cont. #R59A .....39¢ ea.

ALLIED 55837 250 ohms SPST N. O. Double break 15 amp cont. #R108 .....98¢ ea.

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W. E. 4850 ohms 6MA SPDT 1 amp cont. #R92 .....$1.25 ea.

CLARE 2000 ohms 3PST N. O. 1 amp cont. #R94 .....98¢ ea.

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TIME DELAY RELAY—Amperite 24N02 24V AC or DC. SPST N. O. 5 amp. cont. 2 sec. delay #R316 .....89¢ ea.

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BO-13D35 24VDC SPST NO. Dble Br 230 ohms #R06 .....98¢ ea.

ANTENNA SWITCHING RELAYS

115 VAC DPDT 10 amp cont., manual release latch 200 ohms. Allied...$1.49 ea.

G. E. #37843 50 ohm 12VDC ceramic insulation 10 amp, cont. #R57.$1.25 ea.

LEACH 1054B, 265 ohms 24VDC DPST N. O. 10 amp cont. #R110 89¢ ea.

WRITE US YOUR NEEDS FOR OUR QUOTE—We Have It.

SAVE 50% AT U.S.

FERRULE RESISTORS

Over 200,000 in our stock all sizes all wattages.

H-F TIE POST

LOW-LOSS BAKELITE INSULATION, pictured actual size (4-40 Thread) $7.50/C $60.00/M

SINE — COSINE — SQUARE WAVE POTENTIOMETER
W. E. CO# D169100 for very low freq. sweep circuits $9.95 ea.

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1K, 4K, 60K, 100K, 500K. All 1 watt $10.00/C

SOLENOIDS A-B type B5A

Aircraft starting relay 24 VDC 50 amp. 100 ohm coil totally enclosed. #R105 $1.35 ea.

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Ceramicons	Iron Core Slugs	Spaghetti
Ceramics	Knobs	Switches
Chokes	Potentiometers (sine-cosine)	Transformers
Circuit Breakers	Pulse Xfmrs.	Tubes
Coils		And Others

Write Us Your Needs for Immediate Quote
PRICES FOB OUR PLANT Min. Order $5.00

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PULSE XFMRS

T151 is a 3 winding Pulse input xfmr with hypersil core. 1000-ohm windings carefully balanced for operation in series with filament. Pulse modulation fed to low impedance winding.

W. E. type KS9565 40 to 1000 to 1000 W. V. 7.5 KV #T151 .....$3.25 ea.

DONGAN TR 1043-A461 Ratio 1:1 high power pulse modulation driver xfmr for final. Ea. winding approx. 8 ohms d-c; 200mh; 260T #30 wire #T152 .....$3.25 ea.

W.E. (coreless type) A quasi-differentiating xfmr. Pri. when tuned with a .01 mfd resonates at 5630 cps. Split wound secondary terminates into 10000 ohms Army SC# 2C2270/T2 .....$2.25 ea.

W.E.—KS9562 3 windings Blocking Osc. xfmr. .....$1.75 ea.

W.E. KS9564 1:1 ratio—high repetition rate .....$1.19 ea.

FREED #12524 2:1 ratio—high repetition rate .....$1.49 ea.

HORIZONTAL blocking osc. xfmr.....69¢ ea.

VERTICAL blocking osc. xfmr.....69¢ ea.

SERVO OUTPUT XFMRS

PP6L6 to Servo mechanism with 10% feed-back winding. MU metal core $2.95 ea.

DUAL unit PP6L6 to Servo mechanism with 10% feedback winding and 6SN7 to Servo mechanism. Both in 1 can.....$3.25 ea.

KENYON S13377 XFMR 5V. C.T. 60 Amp #T301 .....$11.50 ea.

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AN 3106-40-9s .....69¢ ea.
AN 3108-36-15s .....69¢ ea.
AN 3108-18-1P .....39¢ ea.
AN 3108-12S-3S .....25¢ ea.
AN 3102-10S-2P .....20¢ ea.
AN 3106-10S-2S .....18¢ ea.
And many others.

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All Stock new or in good condition. We will ship order. Notify sight draft B/L attached, or check with order. Inspection authorized can be arranged.

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TS33 AP 3 CM	75.00
TS 36 AP 3 Cm	55.00
TS 45A/APM	95.00
TS 48/AP	95.00
TS 53/AP 2 Tuning unit	95.00
TS 59/APN	35.00
TS 60	12.00
TS 69 300 to 1000 Mc	25.00
TS 87 (xa) (AP) RF Watm	85.00
TS 89 Voltage Divider	15.00
TS 98	15.00
TS 100 for APS 15	50.00
TS 101	5.00
TS 102	65.00
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TS 110 10 Cm	50.00
TS 111 10 CM	100.00
TS 125 Wattmeter	150.00
TS 143/CPM 1	175.00
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TS 204 XA/AP	25.00
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I 135 B	35.00
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I 139 P/O le 19 TS	12.50
IE 7 a Tunning Equip	35.00
IE 19 522 TS	165.00
IE 36 522 TS	27.50
G R 758 Wave Mters 55 to 400 MC	27.50
Range Calibrator Bc988	75.00

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MN 26 LB	9.00
MN 26 y	9.00
RA 10	17.50
BC 433 G	9.00
BC 229	3.75
BC 639 With RA 42	185.00
BC 348	75.00
BC 224 12 Volt 348	65.00
BC 453	12.50
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R-26/ARC5 W Automatic Tuning	10.00
BC 1066 Dual Chan VHF	5.00
Arr 1 Homing	5.00
ARR 2	12.50
BC 357, 301	3.50

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BC 797 Ground to Aircraft, VHF 50 Watts Complete with Auto transformers, ready for Operation weight about 400 pounds in Black Crackle case	$285.00
TA 12 Bendix	27.50
RTA 1 B	125.00
TA 2-J-24	75.00
TA 2-JB-24CAATC 773	125.00
BC 696 3 to 4 Mc	15.00
BC 457	4.75
BC 458	4.75
BC 459 7 to 9.1 Mc	15.00
T-18-ARC5	10.00
T-23-ARC 5 VHF	22.50
ATC (ART) 13 W/Low Freq Coil	200.00
AVT 112A	25.00
Power Unit PE214B Gas driven 110 or 240 V 60 Cycle 300 Watts	100.00
Power unit Gas driven 28 V 2 KW	100.00

RADAR

APS-4 Includes, RT*5Aps-4. MX40/APS4, AM5/A APS4, MT 113 C12/APS4, J5-APS4, Id11APS4 ..... $385.00
Components of APQ-5; APQ 13, APS 2; APS 3; APS 15. SF1; SG; Sd; T28 APT 1 BC 1237; Bc 717, 720; T 26 APT 2; T 27 APT 3; T 85 APT5;

RECEIVERS TRANSMITTERS

SCR 522	$27.50
RT 7 APN 1	4.50
RT 21 APN 7 W/Coder	45.00
BC 788 a—AM	7.50

MISCELLANEOUS

EE 8 Field Phones	$ 8.50
BC 221 W/ Calib & Crustal	78.50
BC 1236—15 to 40; 95 to 115 195 to 230 MC	100.00
BC 1277 S Band Sig Gen	85.00
BC 1287 Indicator	60.00
Ferris Model 18B	80.00
Ferris Model 18D	150.00
Ferris Model 22A	160.00
Dumont 224 Scope	110.00
W 110B 1 Mile Spools	8.50
MR 9 B for RA 10	6.50
Mn 28 C and LB; Each	3.50
BC 442 W Condenser	1.50
BC 1155 Synchronizers with 25 tubes and 30 Mc if Strip	28.00
Mn 31 c Auto Loop Control	75.00
Tn 17 APR 4	95.00
Tu 56 for APR 4	45.00
Tu 57 for APR 4	45.00
3206 Bendix Power sup	19.50
PU 16 AP. Dynamotors	22.50
Bc 638 Freq Meter 100 to 160	85.00
Tuning Units for Bc 375	.75
BC 939 Ant Tuning for BC610	30.00
DM 32 for command	1.00
3206 Power supply	19.50
Link Trainers	250.00
85 KC for command set	1.25
BC 602 Control for 522	.75
RCA Scopes Model 155a	35.00
TN 18 For APR 4	125.00

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TUBES

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Microwave K Band 2400 MC.

TSKI-SE Spectrum Analyzer
K Brand Flap Attenuator

X Band

TSX-4SE Spectrum Analyzer
TS 12 Unit 1 USWR Measuring Amplifier, 2 channel
TS 12 Unit 2 Plumbing for above TS13
TS16AA VSWR Measuring Amplifier Navy type TS 12 Unit 1
TAA-11BL VSWR Measuring Amplifier, Browning
TS 33 X Band Power and Frequency Meter
TS 35 X Band Pulsed Signal Generator
TS 36 X Band Power Meter
TS 45 X Band Signal Generator
TS 146 X Band Signal Generator
TS 263 Navy Version of TS 146
TS 108
X Band Magic T Plumbing
X Band Tunable Crystal Mounts
TVN-8SE MIT Klystron pulse and power Supply

S Band

TS3A/AP S Band Power and Frequency Meter
RF 4 Electrically Tuned S Band Echo Box
BC 1277/60ABQ S Band Pulsed Signal Generator
PE 102 High Power S Band Signal Generator

L Band

Hazeltine 1030 Signal Generator 145 to 235 Megacycles
TS 69, 300 to 1000 MC Frequency Meter
Measurements Corp. type 84 Standard Signal Generator
TS 47, 40 to 400 MC Signal Generator

Broadcast Wave Bands

162C Rider Chanalyst Short Wave Adapter for 162C
Ferris 22A, Signal Generator
TS 174 Signal

Oscilloscopes

BC 1287A used in LZ sets
TS 34 Oscilloscopes WE
Supreme 564

Audio Frequencies

RCA Audio Chanalyst
Hewlett Packard

Other Test Equipment and Meters

TS 15/A Magnet Flux Meter
General Radio V T Voltmeter 728A
Calibrator WE 1-147
Hazeltine Pulse & Sweep Generator
UHF Radio Noise & Field Strength Meter Measurements Corp type 58
General Radio 1000 cycles type 213
Limit Bridges
Boonton Standard Inductances
Weston Meters types 430, 429, 741
Model 40 Pyrometer
Rawson, meters 0-10 Microampere 0-2 Millivolt

RADAR Sets & Parts

APS 3—APS 4—SCR 284
R-111/APR5A Receivers

LIBERTY ELECTRONICS, INC.

PHONE WORTH 4-8262 — 135 LIBERTY ST., NEW YORK 6, N.Y.

COMMUNICATION TRANSMITTERS

2000 to 20,000 KCS
350 Watts C.W.
250 Watts Radiotelephone
Model MI-8167 Manufactured by R.C.A.

The MI-8167 was made for US Army point-to-point ground communications use. Extremely compact (size: 60 in. High, 17 in. Wide, 27 in. Deep), and shock mounted. High speed keying and High Level Class "B" modulation incorporated. Input 190 to 250 Volts AC 50/60 cycles. No external coils needed—built in band switching and antenna tuning included. Complete with tubes, built-in shielded oscillator unit (choice of crystal or M.O. units), with or without Speech Amplifier. Fully metered with instantaneous switching. Net weight 570 pounds. Quantities available.

BRAND NEW! ORIGINAL PACKING! COMPLETE!

RADIOTELEPHONES

5 WATT, Model JT-52 by Jefferson-Travis, 2 channel, crystal controlled recvr-transmitter, built-in speaker, hand microphone, 6 Volt DC power supply. Freq: 2000-3000 KCS. in compact steel cabinet, complete less xtals. New in original cartons. In dealer quantities.

50 AND 75 WATT. by Harvey-Wells, SIX channel xtal controlled recvr-transmitter, 2000-3000 Kcs, with built-in speaker, telephone hand set, (provisions for selector-ringer and external deck calling system) in handsome steel cabinet, for 32 and 115 Volt DC input. Complete, less crystals. NEW.

RADAR SEARCH RECEIVER

ARD-2

Has continuous frequency range from 80 to 3000 MCS and pulse repetition rates from 50 to 8000 cycles. It can locate any RF signal source by either visual or aural indicators. Ideal as a frequency meter and perfect for operational communications requirements, researchers and manufacturers.

Operates from 115 V. AC at 60 to 2400 cycles input! Extremely versatile on the ground or airborne.

BRAND NEW! ORIGINAL PACKING! COMPLETE!

Price, each.....$175.00

RADIO BROADCAST TRANSMITTERS

PORTABLE—"TWT PB-50A"

Here is a complete portable broadcasting station made for the US Army. Operates from either 110 or 220 V. AC 50/60 cycle source. Has exceptionally high fidelity, extreme compactness and incorporates modern circuit design. Power output is 50 Watts in frequency range 1100 to 1500 Kcs, crystal or MO controlled. 100% modulation. Complete as follows:

1 Transmitter PB-50A with tubes
1 Power Supply PB-50
1 Cooling and Voltage Selector B-2
1 Contr. Console Mixer 2C4
1 Phonograph Turntable (2 speed)
2 Dynamic microphones
1 Complete set spare tubes
1 Complete set spare parts and tools
1 Set cables and Antenna Kit
1 Complete library of 16 inch recordings
2 Technical Manuals

All the above in five trunks for portability. New.

WALKIE-TALKIES
HANDY TALKIES

OTHER STOCK ITEMS

BC-610 'phone-CW 450 W.
BC-325 'phone-CW 400 W.
BC-365 Radio Range 350 W.
W.E. 34A Carrier Shift CW 350 W.
TCS Recvr-Trans. 40 W.
SCR-508 & 528 V.H.F. 35 W.
SCR-608 & 628 V.H.F. 35 W.
CW-3 Fixed Freq. Recvr & coils
RBZ Portable S.W. receiver
SN Portable Radar
DAS US Navy Loran
AVT/R/A Aircraft, Mobile 6 & 12 V. and many others

COMMUNICATION DEVICES CO.

2331 Twelfth Ave. N. Y. 27, N. Y.
Cable: COMMUNIDEV Tel: AD-4-6174, 5

THE BEST IN ELECTRONIC SURPLUS

The following list of Surplus Electronic Equipment is, we believe, the finest and most diversified stock of hard-to-get material in the country. This is material that we own, in our possession and available for immediate delivery. All material is guaranteed as represented, and offered Subject to prior sale.

Prices quoted are net, FOB N.Y.C. our warehouse. Export packing extra, except where included in specifications.

9 BC-610 Transmitters with BC-614 Speech Amplifier, 4 Plug-in Coils and Exciter Units for 10, 20, 40, and 80 meter operation. Output 400 watts A1, 300 watts A3. Operates from 110/1/50-60 cycles AC. Used in SCR-299, 399, 499 eqpt. Spares available at extra cost. Condition Excellent to like new. Export Packed. **PRICE, EACH** $900.00

4 SF-1 Radar Eqpts, 10 Centimeter. Brand NEW with complete spares to insure over 10 years of continuous operation. Includes motor-generator set in each, all wave-guide plumbing, instruction books, etc. 19 cases per set, export packing. **PRICE, EACH** $2,500.00

20 TCS-9. Collins Ship Transmitter-Receivers, for 12 V. DC operation, radio telephone and radiotelegraph at 20 & 40 watts, 1:5 to 12.0 mc. Complete with all accessories. Excellent, like new condition. **EACH** $300.00

50 SCR-610 Transmitter-Receivers for vehicular installation, new, with PE-97, or BF-117, or 120 Power Supply (for 6, 12, or 24 volt operation), tubes, handset, Freq. Modulation, 27.0 to 38.9 mc. **EACH** $51.45

75 SCR-510 FM Transmitter-Receivers, same specifications as above, but 20.0 to 27.9 mc. **EACH** $49.50

50 BC-684, 25 Watt FM Transmitters, 27.0 to 38.9 mc, 10 Channels Push-Button Selection. X'tal control. With tubes and 12 or 24 V. DC dynamotor. NEW condition. **EACH** $55.00

75 BC-604, Same as above except 20.0 to 27.9 mc. **PRICE, EACH** $39.50

50 BC-603 Receivers, companion to BC-604, with 10 Push-Buttons for frequency selection, or Tuning Control for continuous tuning over 20.0 to 27.9 mc range. With tubes, built-in loudspeaker. 12 or 24 V. DC dynamotor. New condition. **EACH**....$42.50

125 FT-237 Mounting Plates, for above receivers and transmitters, to form SCR 508/528 or 608/628 equipments. **PRICE, EACH**.....$4.50

20 Beachmaster, 250 watt Portable Sound Amplifier Systems, with nine speaker rack, tubes, mike, cables, and spares. Operation from 110 volts, one phase, 60 cycles AC. Excellent and New condition units. **PRICE, EACH** $495.00
PRICE, less case of spares.....$395.00

20 Western Electric Model HLAS, 500 watt Sound Amplifier Systems, consisting of 40 watt Pre-Amplifier; 500 watt Power Amplifier with built-in power supply, expander-compressor circuit, internal blower-ventilation, 30 kc erasing oscillator circuit for magnetic tape recording, volume and meter controls; two speaker racks, each with 6 60 watt dynamic horn units. Operation from 115/3/60 AC. New, Unused. Complete with tubes, cables, connectors and instruction manual. **EACH** $695.00

5 SD-5 Radar Transmitters, only; 200 cm. Contains variable co-ax for tuning hi-power to frequency, numerous transformers (except plate), meters, variac, capacitors, etc., in fact complete transmitter but less tubes & plate transformer. Excellent Condition. **Price, Each** $115.00

9 YJ-1 I.F.F. Eqpt. Consists of dual transmitters and dual receivers, each working in "A" and "B" bands, 176 and 515 mcs respectively. Includes power supply (115-230 volts, 60 cycles AC) and tubes, all in one metal cased unit. UNUSED eqpt. **Price, Each** $165.00

25 T-9/APQ-2 Radio Transmitters, Noise-modulated Jamming Transmitter, using Electron-Multiplier Photocell. For Jamming certain types radar eqpt. New unused transmitters only, with Electron-Multiplier tube, less other tubes. **EACH**.....$32.50

4 SB-23/GTA-2 & SB-14/GY Switchboards & Power Supply, for operation from 110V. 60 cycles AC (with storage batteries). Each in individual metal cabinet. NEW. **Price, Each Set**.....$300.00

2 BC-319-A Transmitter, CW only 300 watts output. Freq. range 4.0 to 13.4 mc. Operates from 110/220 volts, 60 cycles AC. Excellent condition. Less tubes. **PRICE, EACH** $300.00

Wilcox, 96-200-A 2-KW RF section. Large cabinet with complete RF end containing the VFO, intermediate sections and PA stage. Almost new, but lacks PA inductance only. Less tubes. **PRICE** $300.00

10 Wilcox 96C 3 KW RF Units, 2.0 to 20.0 mc, crystal controlled. Four of these units with Rectifier 36A and Modulator 50A make a complete 4-channel Point-to-Point and Radiotelephone fixed station. Good Condition, less tubes. **LOT PRICE, EACH..$400.00**

TBK-10, 500 watt, 2-18.1 MC, CW Telegraph Transmitter designed for ship installation. Almost new condition, complete with tubes, less MG set and accessories. **PRICE, EACH** $350.00

Wilcox 98-A, Ground Station, A-3 emission 50 to 200 mc, 50 W. output, 4-channels dial telephone selection, with receiver for above frequency coverage, and remote control unit. For 110 volts AC. Excellent condition. With tubes. **PRICE, EACH**.$600.00

2 Link FM Transmitter-Receiver, 70-100 mc, 50 watts output. Model 1498 DC. Wall style cabinet containing transmitter, receiver and 14 V.D.C. power supply, handset. Dim.: 34" x 21" x 11". NEW Condition. Complete with tubes, crystals, special telescopic antenna, instruction book. **PRICE EACH** $500.00

Model SVC-100-L/110 Transmitter. Output A-1 150-watts, A-2-A-3-50 W. Mfd. by Phillips. Freq. 2 to 20 mcs., with 6 pretuned channels. Operates from (90-260) volts 50/60 cy. AC. COMPLETE with tubes. **PRICE** $450.00

5 RMCA, Model 8010 I.F. Ship Main Radio Transmitter, 325 to 500 KC, types CA & E. Excellent condition. Less motor generators. **PRICE EACH** $475.00

6 RMCA, Model 8019A/H.F. Ship Transmitter, complement to 8010 above, for H. F. transmission A1 and A2. 200 watts output. Excellent Condition, less tubes and MG (mg with 8010 powers this unit.) **PRICE EACH** $400.00

5 RMCA, 8003 Emergency Transmitter, 500 KC, 50 watts output with 12/115 V.DC, motor generator set, and battery charging unit. Excellent Condition. Complete with tubes. **PRICE EACH**.....$275.00

2 RMCA, 8007 Lifeboat Transmitter-Receiver, 500 KC, for permanent installation. Complete with installed 12 V. Dynamotor. Excellent Condition. **PRICE, EACH** $100.00

3 RMCA, 8600X Auto Alarm Receivers, 500 KC Automatic SOS (4-second dash actuated) Alarm Unit. Complete with Relay Control Box and warning light. For 110 V. DC operation. Excellent Condition, with tubes. **PRICE, EACH**.....$250.00

2 RMCA, 8506B H.F. Receiver, 2 to 23 mc., low-radiation superheterodyne. With tubes. Excellent Condition. **PRICE, EACH** $200.00

RMCA, 8707 Direction Finder, (Int. Freq.) consists of receiver, loop, shaft, rotating wheel. Excellent Condition except shaft housing not available (can be easily improvised). With tubes. **PRICE** $750.00

4 Mackay, Model 150-AY, I.F. Ship Transmitter, 325 to 500 KC, A1 and A2 emission. Excellent Condition.
PRICE with MG, 115 V.DC. EACH.....$350.00
PRICE without MG. EACH.....$275.00

50 RC-163 Radio Beacon Eqpt. 20-40 MC. Converts SCR-508/528/608/628 to directional transmitters and receivers. Ideal for airports; for homing application. NEW and complete eqpt. Export packed. **EACH** $90.00

BC-1100 (RC-263), 75 watt, A1, 50 watt, A3, 4 channel dial selection of frequencies. 1.5-10 mcs. 110-260 V. 25-60 cycles. AC, with remote control. Excellent condition. **EACH** $575.00

Supreme ship-to-shore transmitter-receivr. 100 watt output, 9 channel, 2-3 mcs., crystal controlled for 110 V., 60 cycles AC. Condition like new. Complete with tubes and microphone. **PRICE**...$450.00

4 DZ-2 Direction-Finding Receiver Equipment with loop assembly, 28 V. DC operation, 15-70 and 100-1500 Kcs, less dynamotor. NEW.
PRICE EACH $100.00

30 SCR-511 "Pogo Stick" Walky-Talky. Portable low-power AM radiotelephone for 2 to 6 mc operation, with 13 plug-in tuning coils containing crystals for crystal control of both receiver and transmitter. Traansmitter-Receiver BC-745 of this SCR-511 includes telescopic antenna and "Press-Talk" Switch as well as all cables. Range 5 miles, plus. With PE-157 Vibrator Power Supply 2-volt battery (less electrolyte), T-17 mike, ready for immediate operation. NEW. **PRICE EACH** $75.00

100 32 Volt DC to AC Rotary Converter, mfd. by Kato. For yachts, workboats, or farm installation. Output 110 V., 60 cycles AC, rated 225 watt but good to 300 watts. All NEW Units. **PRICE EACH** $39.95

1,000 Deck Entrance Insulators, bowl and flange type. 8-⅞" dia. with heavy galvanized metal flange and bell. Top bell 6-¼" dia. x 11"; brass feed-thru rod. Very high voltage insulation. Individually packed in cartons, all NEW. **12 FOR**.....$18.00

60 General Electric Amplidyne M. G. Set, generator type #Y-5875677, motor type #73AB58, Navy #CG-21ABU, 115/230 V., 60 cycles, motor rated at ¾ HP., generator output 250 V. DC at 375 watts. NEW. **PRICE EACH** $60.00

15 Jefferson Travis 10-Channel Ship-to-Shore Radiotelephones, 2-3 mc, with Selective Ringers which automatically calls your station when Shore Operator has a call for you. 15-20 watts output. For 32 and 110 V. DC operation, but easily convertible to 6 or 12 volt operation. Good Condition. **LOT PRICE, EACH** $150.00

2,500 British Infra-Red Image Converter Tubes, For "Snooperscopes", Etc. For infra-red detectors, devices that see in the dark, camera work, laboratories, etc. Six for $25.00. Discount on larger quantities.

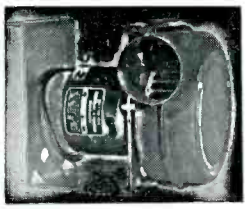
Hundreds of other items, including: AN/CRT-1A Sonobuoy Transmitters 67.7 mc, excellent condition to new, 40 available; APQ-2 Transmitters, new condition; TCR Control Boxes; 12 V. DC to 110 V. AC Rotary Converters; Transformers of all types; Capacitors; Relays; Insulators: Bowl, Egg, Strain, and Stand-Off in large quantities, Etc., Etc. **WRITE US YOUR REQUIREMENTS.**

TELEMARINE COMMUNICATIONS COMPANY

CABLE ADDRESS:
TELEMARINE, N. Y.

540 W. 27th St., N. Y. 1, N. Y.

Brand New BLOWERS



115 Volt 60 cycle, approx. 100 Cubic Ft. dis. 3¼" intake, 2" outlet. Motor size: 3½" x 3". 1525 RPM. Complete with mounting bracket. Gov't surplus. Brand new and Boxed.

Order No. E-3604 **$7.95**

GASOLINE ENGINE GENERATORS:

HOMELITE HRU-28—28.5 Volt DC, 2000 Watts. Used, Tested $69.50
HOMELITE 7D28-11—30 Volt DC, 1500 Watts. Used, Tested $59.50
AIRCRAFT PORTABLE G-1B—110 Volt DC, 3000 Watts. Used, Tested $175.00
HOMELITE PU-6—110 Volt AC, 400 cycle, 1400 Watts and 24 VDC 14.3 A. Unused $195.00
DELCO 7B12—12 Volt DC, 750 Watts $69.50

WRITE TODAY FOR QUOTATION ON YOUR DYNAMOTOR OR INVERTER NEEDS!

METERS

0-150 Volt 400 Cycle 2½" Round $2.95
0-5 Amp. AC 3" Rd. 0-100 A. Scale 3.95
0-5 Amp. AC 3" Rd. 0-75 A. Scale 3.95
0-5 Milliamp DC 2½" Square 2.95
0-500 Microamp 2½" Rd. w/0-15 & 0-600 DC Volt Scale 3.95

SELENIUM RECTIFIER UNITS

HEAVY DUTY—30 VOLT DC OUTPUT:

115/200 V. Three Phase 400 Cycle input:
TYPE 143 w/Transformer & VR 100 amp. ... $89.50
TYPE 3FS-5 w/Trans., VR, & Blower 200 amp. $99.50
TYPE 52A-11 Rectifier only, Cased 200 amp $49.50
TYPE A1 Rectifier only, Cased 300 amp. ... $59.50
TYPE RE-60 Rectifier only, Cased 400 amp. . $69.50

HAMMETT RECTIFIER

MODEL SPS — 100 B — Input 220 Volts AC 60 cycle 3 Phase 13 Amps.: Output DC 15/30 Volts 130/65 Amps. Price — NEW $175.00

Address Dept. E • • • All Prices Are F.O.B. Lima, O. • 25% Deposit on C.O.D. Orders

FAIR RADIO SALES

132 S. Main St. LIMA, OHIO

RADIO & RADAR EQUIPMENT

Prompt Shipment

BRAND NEW

670 AN/CRW-2 VHF RECEIVER
121 RADIO RECEIVER B C—688-A
16 RADIO TRANSMITTER B C—689-A
230 ANTENNA AS-5/APS-2

SUBJECT TO PRIOR SALE

CIMCO

2432 West 3rd St. Cleveland 13, Ohio

GOV'T SURPLUS

Ceramicons, micas, bathtubs, oils, sockets, trimmers, chokes, Xformers, pots, relays, synchros, Link Xmitters.

EMPIRE ELECTRONICS

Box 102

LEFFERTS STATION, BROOKLYN 25, N. Y.

HIGH TENSION CABLE

Portable, Shielded, #10 AWG. Neoprene Jacket. Will bury 25,000-VAC or 35,000-VDC.

$364.00/1000-ft.

CUNNINGHAM ENGINEERING CO.

Beaumont, Texas

ARMY • AIR FORCE • NAVY

SURPLUS EQUIPMENT

BUY NOW . . . AND SAVE 50% TO 85%!

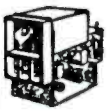
GENERATOR

Brand New

Eclipse-Pioneer Type

716-3A (Navy Model NEA-3A) Output—115 Volts ac, 10.4 amps, 800 cycle, single phase, 28.6 Volts dc, 60 amps @ 2400 rpm, spline drive, self excited, weight 60 lbs., in original carton **$29.95**

BC-605 INTERPHONE AMPLIFIER



Brand New . . . original carton. Can be easily converted to intercommunications set for office or home. It's a real buy for new equipment at special price **$4.49**

BC-683 RECEIVER

With 12 or 24 volt dc supply $39.50

BC-684 TRANSMITTER

With 12 or 24 volt dc supply $39.50
Set of 80 CRYSTALS for BC-684 ..... $15.95

BC-604 TRANSMITTER

With 12 or 24 volt dc supply $29.50
RACKS—for BC-603-604 and 683-684 ..... $7.95

VOLTAGE STABILIZER

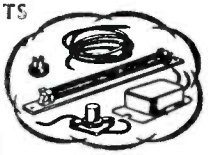
Unit of FC/FD Equipment; input 225/450 volt ac; single phase; 60 cycle; 8.45 amps; output 117 volts; 25.6 amps; 85% PF. Used, Good—shipping wt. 350 lbs. . **$100.00**

CBM TRANSDUCER

Brand New ,shipping wt. 460 lbs $150.00
ARC-1 RACK MT-100/ARC1 ..... $4.95
RA62 RECTIFIER ..... Like New $79.50
BC 312 Brand new, in original cartons. . $150.00

BLACK LIGHT KITS

Ultra-Violet Fluoresence



Now . . . build your own black light lab equipment at a new low cost with these easy-to-assemble components. Kit contains: Ultra - Violet tube, brackets, ballast, starter, wire, plug and wiring diagram.
4-Watt Kit—(5½" tube) $3.00
8-Watt Kit—(12" tube) $4.00

HAYDON TIMING UNIT

An excellent automatic timing device for remote control of electrical equipment. Hundreds of uses. 110V —60 cycle, 2 watts, 1/10th rph. Brand New **$1.95**

TRANSCRIBER-REPRODUCER UNIT

Navy Type PE-1; Mfg. by Memovox, Inc.; Brand New complete with approx. 1000—16" blank recording discs **$395.00**

TELEGRAPH TRANSMITTER

(Radio Marine Corp.)

Power input . . . 440 Volts ac; Power output 200 watts; 3-phase; freq. range 350-500 kc. Used, Good **$150.00**

RADIO TELEPHONE

(Radio Marine Corp.)

Mod. ET 8012-B; 110 volt dc power supply; 2100-2738 kc; 75 watt; Crystal control Like New $395.00

PARALLAX COMPUTOR

For B-29 sighting station; Mod. 2CHLC5-R Unused $98.00

CAMERA, RECORDING

(35 mm, Single Frame)

Type 0-5 with Lens and P-1 Control Box. $269.00
RA 43 RECTIFIER ..... Used, Good $59.50
T/75APT-4 ..... Used, Good $95.00

WRITE FOR PRICES AND INFORMATION ON THE FOLLOWING

We have partial and some complete units of equipment listed.

AIRBORNE UNITS

R50/AP5-6A
T-56/ART2
APN3
AS-17A/APS
AN/APS-2G
R5/ARN7
APS-13
ID-33/APA6
AM-33/ART
T28/APT-1
RT-21/APN-7
AS-97/ART
BC 1148C

SHIPBOARD UNITS

BN-1
SL-1
SF1
QJA
DAB-3
SA
YJ
BN
SQ
SL-a
SN
YL
SD-5
SD-3 (Antenna)
QCQ
AN-/U1Q-2

PORTABLE BEACHMASTER AMPLIFIERS and spare parts.
TEST SET (TS 10A/APA)
TEST SET (TS 118/AP)
CW-60AMB

AUTOMATIC TELEPHONE (TYPE NX-25)
DIAL TELEPHONES (Mfg. NORTH ELECTRIC)
BD 71 SWITCHBOARD
BD 100 SWITCHBOARD

ALL EQUIPMENT F.O.B. PASADENA, CALIFORNIA

PLEASE ENCLOSE FULL AMOUNT WITH ORDER

C and H Sales Company

BOX 356-E EAST PASADENA STATION • PASADENA 8, CALIFORNIA

SELENIUM RECTIFIERS and ASSOCIATED COMPONENTS

SINGLE PHASE

Full Wave Bridge

Input: 0-18 VAC Type No.	Current	Output: 0-12 VDC Price
B1-250	250 Ma.	$ .98
B1-1	1.0 Amp.	2.49
B1-1X5	1.5 Amp.	2.95
B1-3X5	3.5 Amp.	4.50
B1-5	5.0 Amp.	5.95
B1-10	10.0 Amp.	9.95
B1-20	20.0 Amp.	15.95
B1-30	30.0 Amp.	24.95
B1-40	40.0 Amp.	27.95
B1-50	50.0 Amp.	32.95

Input: 0-36 VAC Type No.	Current	Output: 0-26 VDC Price
B2-150	150 Ma.	$ .98
B2-250	250 Ma.	1.25
B2-300	300 Ma.	1.50
B2-2	2.0 Amp.	4.95
B2-3X5	3.5 Amp.	6.95
B2-5	5.0 Amp.	9.95
B2-10	10.0 Amp.	15.95
B2-20	20.0 Amp.	27.95
B2-30	30.0 Amp.	36.95
B2-40	40.0 Amp.	44.95

Input: 0-115 VAC Type No.	Current	Output: 0-90 VDC Price
B6-250	250 Ma.	$ 2.95
B6-600	600 Ma.	5.95
B6-750	750 Ma.	6.95
B6-1X5	1.5 Amp.	10.95
B6-3X5	3.5 Amp.	18.95
B6-5	5.0 Amp.	24.95
B6-10	10.0 Amp.	36.95
B6-15	15.0 Amp.	44.95

Full Wave Center Tap

Input: 10-0-10 VAC Type No.	Current	Output: 0-8 VDC Price
C1-10	10.0 Amp.	$ 6.95
C1-20	20.0 Amp.	10.95
C1-30	30.0 Amp.	14.95
C1-40	40.0 Amp.	17.95
C1-50	50.0 Amp.	20.95

THREE PHASE

Full Wave Bridge

Input: 0-234 VAC Type No.	Current	Output: 0-250 VDC Price
3B13-1	1.0 Amp.	$ 22.00
3B13-2	2.0 Amp.	32.00
3B13-4	4.0 Amp.	56.00
3B13-6	6.0 Amp.	81.50
3B13-10	10.0 Amp.	105.00
3B13-15	15.0 Amp.	120.00

RECTIFIER MOUNTING BRACKETS

For Types B1 through B6, and Type C1 $.35 per set
For Types 3B ..... 1.05 per set

D-C PANEL METERS

Attractive, rugged, and reasonably priced. Moving vane solenoid type with accuracy within 5%. Square case.

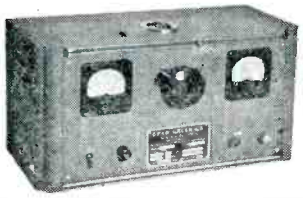
0- 6 Amperes DC
0-12 Amperes DC
0-15 Volts DC
} Any range $2.49 each

CATALOG

Write for our Catalog No. 719, which lists additional Selenium Rectifiers, associated transformers, condensers and filter chokes.

All prices FOB our NYC warehouse. Send M.O. or Chk. ONLY shipping charges sent COD. Rated concerns send P.O., Terms Net 10 days

POWER SUPPLIES



GENERAL PURPOSE Low voltage DC power supplies, with variable outputs. Rugged—Dependable—precision control.

Features

- √ Long life Full Wave Selenium Rectifiers
- √ Output Voltage Continuously Adjustable from Zero to Maximum
- √ 3" Voltmeter and Ammeter 2% acc'y.
- √ Stepless Control
- √ Instant Power—No Warm-Up Period
- √ Assembled and Ready to Operate
- √ For 115 VAC 60 Cycles
- √ Dimensions 8½" x 16¾" x 8"

Write for descriptive bulletin GPA

Model	Voltage	Current	Price
GPA810	0–8 VDC	10 Amps.	$69.50
GPA1210	0–12 VDC	10 Amps.	75.00
GPA2810	0–28 VDC	10 Amps.	85.00

RECTIFIER CAPACITORS

CF-1	1000 MFD	15 VDC	$ .98
CF-20	2500 MFD	15 VDC	1.95
CF-6	4000 MFD	30 VDC	3.25
CF-19	500 MFD	50 VDC	1.95
CF-16	2000 MFD	50 VDC	3.25
CF-21	1200 MFD	90 VDC	3.25
CF-9	200 MFD	150 VDC	1.69
CF-10	500 MFD	200 VDC	3.25

Mounting clamps for above capacitors ..... 15c ea.

RECTIFIER TRANSFORMERS

All Primaries 115 VAC 50/60 Cycles

Type No.	Volts	Amps.	Shpg. wt.	Price
XF15-12	15	12	7 lbs.	$ 3.95
TXF36-2	36	2	6 lbs.	3.95
TXF36-5	36	5	8 lbs.	4.95
TXF36-10	36	10	12 lbs.	7.95
TXF36-15	36	15	20 lbs.	11.95
TXF36-20	36	20	25 lbs.	17.95
XFC18-14	18 VCT	14	10 lbs.	5.95

All TXF Types are Tapped to Deliver 32, 34, 36 volts. XFC Type is Tapped to Deliver 16, 17, 18 Volts Center-tapped.

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Type No.	Hy.	Amps.	DC Res.	Price
HY5A	.028	5	.20	$ 3.95
HY10	.02	10	.30	9.95
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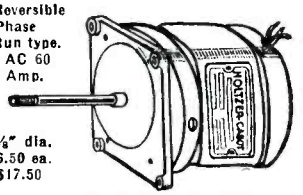
50 R.P.M. Reversible Single Phase Capacitor-Run type. 115 Volts AC 60 cycle 0.3 Amp. Torque 100 oz. inches. 4¾" shaft ¾" dia. 250 left..$16.50 ea. SAMPLE $17.50



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Used for illuminating meters, compass, dials, airplane instruments, etc. Soldering iron removes lamp from base to use in models, doll houses, miniature trains, Xmas trees, etc.
Mazda G.E. 323 3V..19.A Mazda G.E. 328 6V..2A
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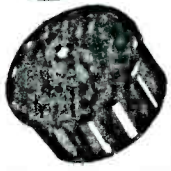

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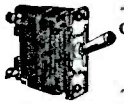

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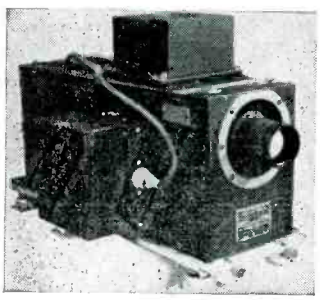

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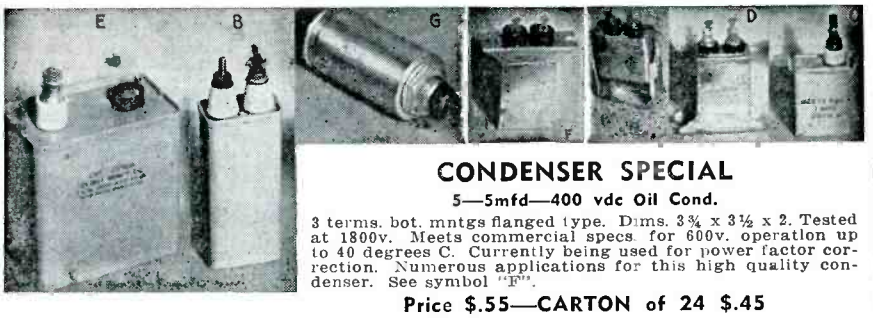

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B	.01	3000V		.50
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B	.05-.05	2000VAC		.95
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E	.1	2000V		.32
F	.1	2500V		.40
G	.1	3500V		.55
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D	.75	1000V		.22
F	1	400V		.18
D	1	500V	#23F266	.24
F	1	500V	#23F225	.24
F	1	600V	CP6881EF105	.28
B	1	600V		.24
B	1	1000V		.30
B	1	2500V	#23F121	1.25

Symbol	Capacity	Voltage	Type	Price
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B	1	15KV		17.75
B	1	20KV	#14F35	28.75
B	1.75	450V		.25
D	2	600V		.33
B	2	600V	#26F407	.38
G	2	600V	TLA	.16
B	2	1000V		.55
G	2	1000V	TLA	.55
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2x.1 mfd	600	ST	.26
3x.1 mfd	400	ST	.24
.25 mfd	600	ST	.23
2x.25 mfd	690	ST	.28
.5 mfd	600	ST	.28
2x.5 mfd	600	ST	.32
1 mfd	300	ST	.18
1 mfd	400	ST	.24
1 mfd	600	ST	.29
2x 1 mfd	400	ST	.30
2 mfd	400	ST	.36
2 mfd	600	TT	.40
2 mfd	600	ST	.45

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SYMBOLS: LS—Locking Type Shaft
S—Screwdriver, R—Round

Ohms	Shaft	Ohms	Shaft
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200	1/8 LS	20,000	1 1/4 R
1000	1/8 LS	25,000	3/8 R
1000	1/4 S	25,000	1/8 LS
2000	3/8 LS	25,000	1/8 S
2500	1/2 R	50,000	1 5/16 R
2000	1/8 LS	50,000	1/8 S
3000	1/8 LS	50,000	1/4 S
3000	1/2 R	50,000	1/8 LS
5000	1/8 S	100,000	1/8 LS
5000	1/8 LS	100,000	1 0 R
10,000	1/4 S	100,000	1/8 S
10,000	3/8 R	150,000	2 1/8 R
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10,000	5/16	250,000	1/8 S
15,000	1/8 S	300,000 (2 Terms)	1/8 S
15,000	1 1/8 R	1 Meg	1/8 S
20,000	3/8 S	1 Meg	1/8 LS

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2000	1/4 R	100,000	1/2 R
1K-SK	3/8 R	10K-50K	1/2 R (10K 2 Terms)

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Wire Wound	10,000	1/2 S	.14
Wire Wound	10,000	1/4 R	.14
Carbon	500	1.0 R	.14
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Carbon	25,000	1/4 S	.12
Carbon	50,000	1/8 S	.12
Carbon	50,000	1/4 S	.12
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Carbon	1 Meg.	1/2 S	.19

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Ohmage	Shaft	Price	Ohmage	Shaft	Price
Dual 1.3	1/8	$.98	225	1/8 LS	.65
15	1/2 R	.45	250	1/2 with knob	
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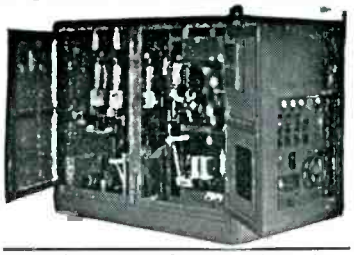

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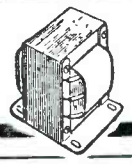

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10	75	200	.79
2½	200	60	1.29
2½	235	60	1.39
8	150	130	1.19
10	150	200	1.39
8	250	95	2.39

Hermetically Sealed

15	60	400	.69
15	70	420	.79

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20 ohms. 3.1 - 3.1 amps. 600 V. Ward-Leonard. 700W. **$7.95**

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Impedance 900 ohms. A pair can be used as either a receiver or transmitter for 2-way communication.

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Pri. 105-115v 50 to 60 cy.
Sec. 6.3v c.t. @ 5 amps.
Cased. An Exceptional buy!
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Input 105-115-125v. 50 to 60 cy.
Sec. 6.3v. @ 4.5 amps.
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6.3v. @ 0.6 amps.
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THORDARSON FILAMENT TRANSFORMER

Pri. 110v. 50 to 60 cy. 32.5 v.a.
Sec. 5v. 6.5 amps 35.5 k.v. insulation
Open frame. 30 lbs. H-9" x W 7¾" x D 7"
Mounting centres 7" x 3¾"
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HEAVY DUTY POWER TRANSFORMER

Pri. #1: 110/220 v. 60 cy. Sec. #1: 410-0-410 @ 400 mils. #2: 6.3 v. @ 3 amps. #3: 6.9 v. @ 13.5 amps. #4: 5 v. @ 3 amps. #5: 2.5 v. @ 1.7 amps. Dimensions: H-6½"—W 6½"—D 5½" Wt. 33 lbs. Made by G. E. for U. S. Navy. Exceptional value! Open frame.
$7.49
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APC AIR TRIMMERS

	Each	Per 100
15 MMFD. screwdriver	.20	$15.00
25 MMFD. with shafts	.30	25.00
25 MMFD. screwdriver	.25	15.00
50 MMFD. with shafts	.45	35.00
50 MMFD. screwdriver	.25	20.00
60 MMFD. with shafts	.50	45.00
60 MMFD. screwdriver	.30	35.00
75 MMFD. with shafts	.50	40.00
75 MMFD. screwdriver	.40	30.00
100 MMFD. with shafts	.60	45.00
100 MMFD. screwdriver	.40	30.00
140 MMFD. with shafts	.75	60.00
140 MMFD. screwdriver	.50	45.00

83-1SP 83-1SPN 83-1R 83-1AP

"UHF" COAXIAL CONNECTORS

No.	AN	Type	Each	Per 100
83-1H	UG-106U	Hood	.12	$.10
83-1R	SO-239	Rec.	.35	.28
83-1AP	M-359	Ang. Adap.	.35	.28
83-1T	M-358	Conn.	1.20	1.12
83-1J	PL-258	Junction	.80	.70
83-22R	UG-103U	Rec.	.45	.40
83-22P	UG-102U	Plug	.45	.40
83-1SP	PL-259	Plug	.35	.28
83-1SPN	PL-259A	Plug	.35	.28
83-168	UG-176U	Red. Adap.	.15	.12

U.G. TYPE CONNECTORS

UG 10/U—	$1.56	UG 26/U—	$1.25	UG 88/U—	$1.17
UG 11 U—	1.45	UG 27/U—	1.75	UG 89 U—	.95
UG 12/U—	1.14	UG 27/AU—	2.25	UG 90/U—	1.05
UG 13/U—	1.56	UG 29/U—	1.22	UG 115/U—	1.35
UG 18 U—	1.25	UG 30/U—	1.75	UG 171/U—	.90
UG 19 U—	1.28	UG 31/U—	34.00	UG 175/U—	.15
UG 21 U—	.99	UG 58 U—	.63	UG 176 U—	.15
UG 22 U—	1.08	UG 85 U—	1.65	UG 206/U—	1.02
UG 23 U—	.99	UG 86 U—	1.69	UG 215 U—	1.25
UG 24/U—	1.15	UG 87/U—	1.40	UG 255 U—	1.85
				UG 273/U—	1.50

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4	600	.69
5	600	.79
6	600	.84
7	600	.89
8	600	1.39
10	600	.99
2	1000	.79
10	330 AC/ 1000v DC	1.49
10	330 AC/ 1000v DC	1.79
12	330 AC/ 1000v DC	1.69
8 + 1	1000	1.49
.5	2000	1.29
1	2000	1.44
.25	3000	1.89
.5	3000	2.29
1	3000	2.89
1.5	4000	1.95
.25	4000	2.39
.5	5000	3.39
.25	6000	3.49
.1	7500	3.95
.03	10,000	6.95

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OA4G	.94	2B7	.97	5Y3GT	.49	6J7	.72	7L7	.67	REL21	4.85	89	.32	724A/B	2.89
OB2	1.54	2B22/GL559	.73	5Y4	.53	6J7GT	.59	7N7	.79	RX21	2.35	VR92	.25	725A	6.39
OB3/VR90	.95	2C21/1642	.81	5Z3	.56	6J8GT	1.20	7O7	.57	PJ22/CE1C	1.49	FG104	14.98	726A	5.98
OC3/VR105	.75	2C22/7193	.15	5Z4	.98	6K5GT	.79	7R7	.89	HY24	1.39	FG105	8.89	726C	29.98
OD3/VR150	.47	2C26	.15	C6A	7.40	6K6GT	.46	7S7	.89	24A	.65	VU111	.49	730A	9.89
OZ4	.59	2C34/RK34	.21	6A3	1.20	6K7	.58	7T7	1.03	24G/3C24	.69	HY114B	1.25	801A	.29
C1A	4.80	2C39	25.98	6A4	1.08	6K8	.75	7V7	.85	25A6	1.04	HY115/145	.57	802	4.69
O1A	.45	2C40	4.90	6A6	.98	6L5	.78	7W7	.97	25A7	2.98	117L7	1.17	803	2.89
1A3	.42	2C43	16.98	6A7	.72	6L6	1.34	7X7/XXFM	.77	25AC5GT	1.08	117N7GT	1.17	804	6.90
1A4	1.28	2C43/464A	7.93	6A8GT	.72	6L6GA	.94	7Y4	.44	25B5	1.39	117P7GT	1.18	805	3.59
1A5GT	.64	2C44	.98	6AB4	.79	6L7	.88	7Z4	.64	25B6	2.49	117Z3	.49	807	1.89
1A6	.78	2C50	3.69	6AB5/6N5	.98	6N4	1.08	10Y	.29	25BQ6GT	.89	117Z4GT	1.15	808	.95
1A7GT	.68	2C51	5.90	6AB7/1853	1.20	6N6G	1.49	12A6	.98	25C6	1.18	117Z6GT	.88	809	2.45
1B3/8016	.98	2C52	3.06	6AC5	.89	6N7GT	.88	12A7	1.20	25L6GT	.55	117Z7GT	1.49	810	11.96
1B4	1.10	2D21	1.10	6AC7	.98	6P5G	.81	12A8GT	.51	25N6	1.69	FJ27A	15.89	811	2.29
1B5/25S	.84	2E5	.89	6AC7W	1.30	6Q7	.72	12AH7GT	.80	25W4GT	.70	CV148	4.98	812	2.50
1B7GT	1.20	2E22	5.50	6AD5	.98	6R7	.68	12AL5	.72	25Y5	1.08	155	.98	813	11.75
1B21/471A	2.85	2E24	4.50	6AD6G	.81	6R8	.79	12AT6	.59	25Z5	.49	FG166	49.00	814	2.39
1B22	4.50	2E25/HY65	4.20	6AD7	1.20	6S4	.79	12AT7	.87	25Z6GT	.43	FG172	29.50	815	1.37
1B23	8.25	2E26	3.38	6AE5	.89	6S7	.98	12AU6	.57	26	.60	FG190	12.80	816	1.18
1B24	4.32	2E30	2.35	6AF5	.89	6S8GT	.86	12AU7	.98	27	.53	205B/VT2	1.69	826	.39
1B26	2.69	2G5	.98	6AF6G	.98	6S8GTY	.81	12AV6	.53	FG27A	6.89	CE206	3.15	SD828	1.98
1B27	7.83	2J21	10.75	6AG5	.69	6S8Y	.91	12AV7	1.89	28D7	.28	211 VT4C	.37	829	6.48
1B29	.84	2J21A	10.75	6AG7	1.20	6SC7	.72	12AW6	.91	30	.42	RK215	9.95	829B	14.98
1B32/532A	1.71	2J22	9.75	6AH6	1.43	6SD7GT	.70	12AX7	.98	HY31Z	4.89	WE215A	.25	832	7.98
1B37	45.00	2J26	8.39	6AJ5	2.25	6SE5	.51	12BA6	.56	31	.57	227A	2.65	832A	10.64
1B38	34.00	2J27	12.69	6AK5	1.05	6SE7	.72	12BA7	.75	32	.85	231	1.20	836	1.25
1B40	4.95	2J31	12.75	6AK6	.88	6SG7	.72	12BD6	.72	35/51	.55	250TH	19.25	837	1.29
1B41	49.95	2J32	12.80	6AL5	.57	6SH7	.57	12BE6	.54	35A5	.61	250TL	17.95	838	2.21
1B42	7.50	2J33	18.45	6AL5W	1.75	6SK7GT	.57	12BF6	.54	35B5	.55	310A	6.98	860	2.75
1B46	3.69	2J34	17.19	6AL7	1.00	6SK7GT	.53	12BH7	1.11	35C5	.55	316A	.29	861	9.89
1B53	49.95	2J37	12.80	6AN5	2.69	6SL7GT	.73	12C8	.32	35L6GT	.55	323A	8.98	864	.29
1B54	49.95	2J38	6.75	6AQ5	.54	6SN7GT	.79	12E5	.98	35W4	.38	327A	2.50	865	1.39
1B56	49.95	2J39	19.63	6AQ6	.76	6SN7WGT	.89	12F5	.64	35Y4	.48	350	1.49	866A	.98
1B59	12.95	2J48	12.70	6AQ7GT	.88	6SQ7GT	.44	12H6	.27	35Z3	.55	350B	1.65	866Jr	1.04
1B60	4.95	2J49	38.70	6AR5	.58	6SR7	.64	12J5GT	.33	35Z4GT	.53	355A	14.15	868/PJ23	1.90
1C5	.73	2J50	29.50	6AR6	4.58	6SS7	.69	12J7GT	.57	35Z5GT	.45	368AS	3.75	869	25.98
1C6	.87	2J55	92.50	6AS5	.71	6ST7	.70	12K7GT	.50	36	.53	371B	.49	872A	1.29
1C7G	.87	2J56	81.00	6AS6	2.89	6SU7GTY	3.37	12K8	.66	39/44	.54	380A	.79	GE872A	2.98
1D5GP	.95	2J61	24.45	6AS7G	4.29	6SV7	.70	12L8GT	1.59	CRC40	.54	388A	.79	874	.35
1D7G	.84	2J62	45.00	6AT6	.44	6T7G	.84	12Q7GT	.48	41	.40	393A	3.45	876	.29
1D8GT	.94	2K25	24.95	6AU5GT	1.19	6T8	.95	12S8GT	.79	42	.53	394A	3.65	878	1.95
1E5	1.47	2K28	24.95	6AU6	.79	6U4GT	1.35	12SA7GT	.55	43	.54	FP400	7.98	884/6Q5G	1.45
1E7G	1.47	2K29	29.95	6AV5GT	1.49	6U5/6G5	.77	12SC7	.80	45S/VT52	.18	GL434/2C40	1.19	927/CE25	1.20
1F4G	.74	2V3G	.49	6AV6	.53	6U6GT	.60	12SF5GT	.54	4573	.54	446A	1.75	929	1.33
1F7GT	1.55	2W3GT	.98	6AX5GT	.69	6U7G	.64	12SF7GT	.63	4575	.53	450TH	19.75	930	.90
1G4GT	.89	2X2	.36	6AW6	.89	6V6GT	.54	12SG7	.72	46	.68	450TL	44.25	931A	2.59
1G5G	.98	2X2A	.89	6B4G	1.20	6V6GTY	.90	12SH7	.34	47	.75	GL451	1.90	954	.39
1G6GT	.69	3A4	.32	6B5	1.49	6V6M	.98	12SJ7GT	.53	50	1.47	HF200	13.95	956	.39
1H4G	.65	3A5	.75	6B6	.75	6V7G	1.18	12SK7GT	.53	50	.37	WL468	5.89	957	.39
1H5G	.55	3A8GT	1.89	6B7	1.20	6W4GT	.59	12SK7M	.59	50A5	.79	CK501AX	1.26	958	.39
1H6G	.86	3B4	3.49	6B8G	.69	6W5GT	.75	12SL7GT	.73	50B5	.55	CK501X	1.26	SD968	1.98
1J5G	.98	3B5	.98	6BA4	1.08	6W7G	.75	12SN7GT	.59	50C5	.59	CK503X	1.26	991	.36
1J6	.73	3B7/1291	.29	6BA6	.52	6X4	.52	12SQ7GT	.59	50C6	1.18	CK505AX	1.29	FM1000	1.20
1L4	.72	3B22	2.45	6BA7	.79	6X5GT	.47	12SR7	.80	50L6GT	.55	CK506AX	1.79	CK1005	.09
1LA4GT	.75	3B24	1.75	6BC5	1.19	6Y5	1.85	12X3	.90	50X6	.98	RH507	9.98	CK1006	.64
1LA6	.88	3B25	4.75	6BD6	.71	6Y6G	.88	12Z3	.68	50Y6	.55	CK509AX	1.26	CK1007	.89
1LB4	.88	3B28	7.85	6BE6	.54	6Y7G	.98	14A4	.99	50Y7GT	1.08	527	8.98	CK1089	3.98
1LC5	.64	3C23	5.85	6BF6	.52	6Z5/12Z5	1.18	14A7/12B7	.51	53	.84	530	12.69	CK1090	2.69
1LC6	.75	3C31/C1B	3.45	6BG6G	1.73	6Z7G	1.08	14AF7	.86	56	.64	WL531	3.75	R1100	5.00
1LD5	.78	3C45	12.85	6BH6	.68	6ZY5G	.67	14B6	.65	57	.48	CK533AX	1.49	R1130B	12.00
1LE3GT	.68	3D6/1299	.29	6BJ6	.57	7A4/XXL	.54	14B8	.77	58	.48	GL534/		HY1231Z	5.39
1LH4	.78	3D21A	.95	6BQ6GT	1.19	7A5	.65	14C5	.86	RK61	1.34	1S21	3.89	HY1269	5.39
1LN5	.62	3E29	10.98	6C4	.45	7A6	.58	14C7	.86	RK61	1.98	544	4.98	1273	1.15
1N5GT	.68	3LF4	.76	6C5	.49	7A7	.79	14E6	.71	RK65	24.95	GL546	1.69	1280	1.15
1N6G	.98	3Q4	.73	6C6	.55	7A8	.79	14E7	.87	HY69	4.95	550P1	19.95	1609	5.98
1P5GT	.97	3Q5GT	.77	6C7	1.26	7AF7	.70	14F7	.87	70A7	1.49	CK551AXA	1.69	1613/6F6X	.45
1P24	.84	3S4	.70	6C8G	1.20	7AG7	.69	14F8	.98	70L7GT	1.08	575A/975	12.65	1614	1.35
1Q5GT	.97	3V4	.71	6C21	19.62	7AH7	.95	14H7	.57	71	.65	601B	.19	1616	.75
1Q26	69.00	4C33	81.00	6CB6	.79	7B4	.64	14J7	.80	72	.95	HY615	.18	1619	.16
1R4/1294	.57	4C35	23.90	6CD6G	3.49	7B5	.65	14N7	.83	CRP72	1.37	WL619	18.90	1620	4.95
1R5	.70	4E27/257	12.39	6D4	2.75	7B6	.64	14Q7	.51	73	1.67	KU627	6.85	1622	1.75
1S4	.88	4J31	95.00	6D6	.59	7B7	.69	14R7	.65	NR74	.29	631P1/SN4	4.65	1624	1.05
1S5	.55	4J42/700	29.85	6D8	.75	7B8	.70	14S7	1.05	75	.52	WL632A	8.98	1625	.19
1T4	.68	4J47	260.00	6E5	.80	7C4/1203A	.33	14W7	1.05	HY75A	4.59	701A	2.90	1626	.25
1T5GT	.99	4T4/2	9.95	6E6	1.90	7C5	.64	14X7	.98	76	.59	702/702B	2.65	1629	.19
1U4/5910	.70	5C22	44.75	6E7	1.20	7C6	.69	14Y4	1.05	77	.59	703A	2.29	1632	.77
1U5	.69	5C30/C5B	8.49	6F5	.49	7C7	.65	15E	1.17	78	.59	704A	1.48	1633	.75
1V	.49	5D21	24.30	6F6	.55	7C23	69.00	15R	.49	79	.84	705A/8021	.65	1634	.77
1V2	.97	5J23	13.45	6F6GT	.52	7E5/1201	.65	FG17	2.98	80	.45	707	9.98	1635	1.49
1X2	.97	5J29	12.40	6F7	1.20	7E6	.65	RK18	.98	81	1.49	710A/8011	.69	1641/RK60	.48
1Z2	3.98	5J32	99.00	6F8	1.20	7E7	.59	19	.89	FG81A	4.45	713A	1.00	2050	1.25
1A3	1.20	5R4GY	1.08	6G6	.98	7E7	.58	19BG6G	1.98	82	.98	715B	6.98	2051	.49
2A4G	1.37	5T4	1.47	6H6	.58	7F8	1.03	19J6	1.89	82V	.95	717A	.61	R4340	36.00
2A5	.80	5U4G	.59	C6J	4.98	7G7/1232	.98	19T8	.96	83	.98	721A	2.19	5514	4.85
2A6	.78	5V4G	.88	6J4	4.41	7H7	.71	20	1.17	83V	.87	722A/287A	9.95	5516	5.85

5656	18.90	L62A	.49												
5686	4.23	KS0B	.36												
5517		WL121A	2.61												
CK1013	1.89	C376	2.98												
CK5697	1.89	ZB583	3.98												
CK5702	5.59														
CK5744	4.98	Mazda Pilots													
CK5784	5.59	44, Box10	.50												
5812	2.99	49 Box10	.60												
UX6653	.69	55 Box10	.50												
8012A	1.25	64, Each	.07												
8013A	7.98	S6 T4/3W	.18												
8020	.87	100W/20V	.25												
9001	.45	291, Box 10	.36												
9002	.39	311/28V	.15												
9003	.49	313/28V	.15												
9004	.24	393/3V	.10												
9005/RC4B	1.95	Sylvania S6/													
9006	.15	6W/120V	.15												
		Wstghs C7/													
C'RAY TUBES		7W/120V	.09												
2AP1	3.55														
2AP5	7.98	Med. Scr. Base													
3AP1	4.69	15W/125V	.08												
3BP1	2.39	25W/125V	.08												
3BP1A	7.98														
3CP1-S1	2.49	NEON BULBS													
3DP1	3.75	NE16/991	.32												
3EP1	2.45	NE32	.39												
3JP7	1.69	NE45/½W	.27												
3GP1	4.89	NE51/NE20	.06												
3HP7	4.80														
3HP14	9.98	Bull's Eyelite													
4AP10	4.70	Dialco Type													
5AP1	3.75	Chromed, Less													
5BP1	2.25	Bulb 59¢:													
5BP4	4.50	2 for	.98												
5CP1	1.75	TEL. SLIDE													
5CP7	3.70	LAMPS													
5FP7	1.26	6/12/24/48/													
5FP14	18.98	55V ea.	.18												
5GP1	6.95														
5HP1	4.95	XTAL DIODES													
5HP4	6.75	1N21	.49												
5JP2	11.75	1N21A	1.00												
5LP1	11.89	1N21B	2.50												
5MP1	4.75	1N22	1.39												
7BP7	4.65	1N23	1.39												
7CP1	12.95	1N23A	1.75												
7JP4	16.49	1N23B	3.75												
7GP7	8.89	1N25	2.69												
9LP7	10.98	1N26	2.98												
10BP4	19.49	1N27	1.75												
10FP4	24.50	1N29	1.75												
12DP7	12.45	1N32	18.00												
12GP1	49.98	1N34	.67												
12GP7	12.70	1N35	1.95												
12JP4	27.00	1N48	.70												
12KP4	34.00	1N51	.70												
12LP4	24.35	1N52	.95												
12QP4	32.00	1N63	.98												
12RP4	36.00														
15DP4	56.00	Thermistors													
16AP4	49.00	D167019 Vol													
16DP4	49.98	Limiter	2.95												
16FP4	57.50	D168391													
16RP4	49.98	Thermal													
16TP4	49.98	Comp	.90												
19AP4	96.00	D168392													
19CP4	85.00	Thermal													
902	3.15	Comp	2.00												
905	2.45	D170396 HF													
910/3AP1	4.63	Pwr Meas	.90												
912	89.98	1C Bulb Time													
914	45.00	Delay	.90												
		VARISTORS													
Tungar Bulbs		CW20259/													
29X672	2.95	USN 38C	2.95												
189048GE	3.49	WEco 41A	1.50												
859483	3.98														
BALLAST		XTAL FREQ													
1P1	.49	Standards													
PM3	.98	100Kc	7.98												
PM4	.98	200Kc	3.98												
4A1	1.29	1000Kc	2.95												
PM5	.98	4700Kc	.98												
6-11	.49	5000Kc	3.98												
PM6	.98	HtrOvenXtals													
PM7	.98	5010/5025/5055													
PM8	.98	Kc, Ea	14.98												
9-3	.49														
10-4B	.49	Tubes Gtd Exc													
13-4	.49	Open Fil &													
20-4	.49	B'kage Via													
K49A	.36	R'Exp Only													
K55B	.36	Min Tube													
M55B	.36	Order $5													

UHF ANTENNA 12"/30Cm AT5/ARR1 Usable Citzn&HamBand Ins CoaxTerm SilvPlCont Wpf Gask&H'ware. New.....39c; 4/$1
PL259 for Above.....35c
MICROWAVE ANT AS125/APR. 1000to3100Mc w/UG58U Term & InBilt Hi-Pass Fltr FlangeMtg InclH'ware, SPECIAL.....$3.98
TV CONICAL (Dubl-X) Sturdy Prefab Const Versatile 72, 150or 300ohmMatch, Incl Selements, CrossBar&H'ware. New .$3.98
ANT AN130B, 33" Whip 98
ANT AN131A, 11ft. 8sect.....$2.89
MS49-52, 12½ft. Whip.....$1.69
MS49-53, 16ft. Whip.....$2.49
MS49-53 & extra 53, 19 ft. Whip.....3.69
MS49-56 (2-53's), 26½ ft. Whip.....5.98
BASES: MP22.....$3.95; MP48.....$3.98
1/30 HP Motor, 117/234V, 47/63cyc, 5/.35 Amps, 2600-3100 RPM, 1 ph. ¼ dia. x 1" Lg Shaft 3 lbs. NEW.....$5.98
1/100 HP Motor, 27.5VDC, 7000 RPM Cont. OSTER. New.....$2.49
24VDC Motor, 1 ⅜"dia.x2¼"lg Shft $1.95
Motor&Switch Assy. 28VDC/.6A/2000 RPM cont. 6½x2¾x4" overall, Cams drive 14 Silv Pl Switches, NEW.....$6.98
PRECISION RESISTORS. Accy to 1%. Up to 950,000 Ohms. Ea. 35c: 10 for $2.98
1 Megohm & Up, Ea.....75c: 10 for $5.98
RADIOACTIVE Markers, 1½"OD, 24/$1.79
CIRCULAR SLIDE RULE, 2 ⅛" Rad. 98c; 6/$5.00

1N34 CRYSTAL DIODE. 67¢

10 for $6.50 • 100 for $63.

35 MM FILM - 36 Exp Cartridges - Guaranteed Gov't Surplus
PLUS-X - 5 Cartridges for $1.
MICROFILE - 5 Cartridges for $1.
TECHNICOLOR - 3 Cartridges for $1.
16 MM PAN FILM - from GSAP Camera, 54 rolls (1320 ft).....$4.98

Snooperscope Infrared Hi-Sensitivity Image Converter Tube. 2" dia. Complete Data & Tube..$4.95; Two for $9.49

MICRO & TOGGLE SWITCH SPECIALS!

SPNC/10A/WZ-RQ11, Plunger.....69¢
SPNO/10A/YZ-7TTC, PinPlunger.....54¢
SPNO/10A/G-7RST1, Plunger.....59¢
SPNC/30A/B-1 HI-ALT, Cased.....$1.25
AH&H Toggle - 6 Amp/125V-UL Appvd Hi-Nickel Finish. Remvd from Equip. BkIteCsd. CLEAN. A real buy.
SPDT 5/$1; **DPDT** 4/$1.
115 Volt 60 Cycle Xformers
15000V'DblrOr7500V/35ma.....$18.95
3400VCT/1A/17Kv/104-126Vin.....$59.50
6800VCT/1A/17Kv/208-251Vin.....$59.50
1000vct/45Ma. 795vct/80Ma&360vct/55Ma, 3x5V/3A. 6.3v/1A. 6.3vct/.3ACsd. ..$3.98
3000v/10Ma..$4.50; **2x330vct/10Ma**...98¢
5v/60Amps...$7.95; **5v/115Amps**...$12.95
7.5V/12A.....$4.98; **24V/6A**.....$3.89

Microwave Lighth's Assy 2400to2700Mc.....$29.95
3CM X-Band Wavemeter $16.95. **Microwave Freq Mtr TS69/AP** Tunes 341 to 1000Mc on FUNDAMENTALS. Calib to 1 Mc. Brand New.....$59.95
Heineman Magn Ckt Bkrs for AC/DC oper Amps: 22, .5, 2, 3, 5, 7, 8, 9, 10, 15, 20, 30, 35, 40, 80, 180 Amps.
Ea. $1.49; 10/$12.98; 100/$120.
Klixon Thermal Push Button C'Bkrs Amps: 5, 10, 15, 30, 35 Amps.
Ea. 79c; 10/$5.98; 100/$45.
Square-D ToggleSw ANtype C'Bkrs Amps: 5, 10, 20, 25 Amps.....Ea. 89c
10 for.....$7.98; 100 for.....$69.

CONSTANT VOLTAGE REGULATORS

60 Watts RAYTHEON Inpt 95-130V/60 cyc; Outpt 115V/.58A/1⅛%Reg.....$14.95
380 Watts GEN ELEC Inpt 115-220V/ 60 cyc; Outpt 115V/380 Watts.....$39.95
500 Watts RAYTHEON Inpt 198-248V/50-60 cyc:Outpt115V/2Kw/17.4A/1% LN $130
NEW USN cost $369, Special.....$162
115V/60cyc RELAYS—Famous Mfrs
CLARE A12280 3SPDT&3SPNC.....$2.98
CLARE OctalBase DPNC&SPNO.....$3.98
S'DUNN 17AXX109 SPNO/6to30Acts $1.98
WECO 263A Telephone 275ohmDualCoil 2sect Ea. 25pole DPNO PalladiumCts 10.95
CLARE STEPPING Slm SD-11, 12rdc, 3 Levels/20 Steps Each.....$15.98

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Best Buy! 5 Ma. DC Tuning Meter G-E. 2½" dia. Bklt Csd SPECIAL.....98¢
0-1 Amp DC, 3½" Wstghs.....$3.69
0-15 Amp DC, 2½" Wstghs.....$2.95
0-30 Amp DC, 2½" Shunt WE/Wstghs $2.98
0-240 Amp DC, 2½" Less Shunt.....$2.49
0-240 Amp DC, 2½" w/Shunt Wstghs $3.98
0-500 Volt DC, 1000 ohms/V WEco..$4.95
0-7.5 Volts AC, 3½" Wstghs B'Csd..$3.98
0-15 Volts AC, 2 1/16" Rd, 800 cyc GE $1.98
0-150 Volts AC, 2½" Wstghs/GE/Simpson 25 to 125 cyc.....$3.49

"WILLIAMSON" 10W Hi-Fi Basic HiFi Amplifier Kit. Write for Details $19.95
Same, With Pre-Amp Kit $29.95
32 page Illustrated "Williamson" Hi-Fi booklet.....98¢
Hi-Fi 10" Duplex Speaker. 20 to 16000 cyc Usable Range. With Unique IntegralConcentric Driven Tweeter. 6 Watts....$14.95

Basic Photoflash Kit Complete w/Lamp&Data 115 vac..$29.95
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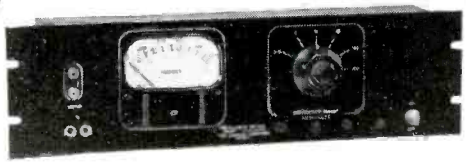
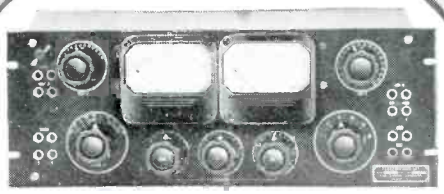
MINIATURE ATTENUATOR — TYPE LA-130
30 STEPS — DIAMETER 1¾ INCHES

30 step ladder network, provided in a minimum of space . . . recommended for use in high quality equipment requiring a wide range of attenuation, where mounting space is limited.



FREQUENCY METER TYPE 838

. . . frequencies read directly to 100,000 cycles with an accuracy of ± 2% of full scale in use . . . 7 ranges available . . . low input voltage requirements . . . large, easy-to-read illuminated meter . . . mounted on a 5¼" relay rack panel.



TRANSMISSION MEASURING SET — TYPE 10A

Direct reading instrument . . . meters and associated range controls can be used independently as VU meters . . . range + 26 to −100 DBM . . . total attenuation 111 DB in steps of 0.1 DB.
(Pat. Pend.)

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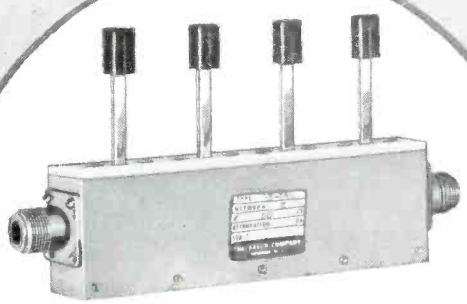
The DAVEN Engineering Department will be glad to discuss these new developments with you. Your inquiry is invited on the units shown or on any other DAVEN product.

THE DAVEN CO.

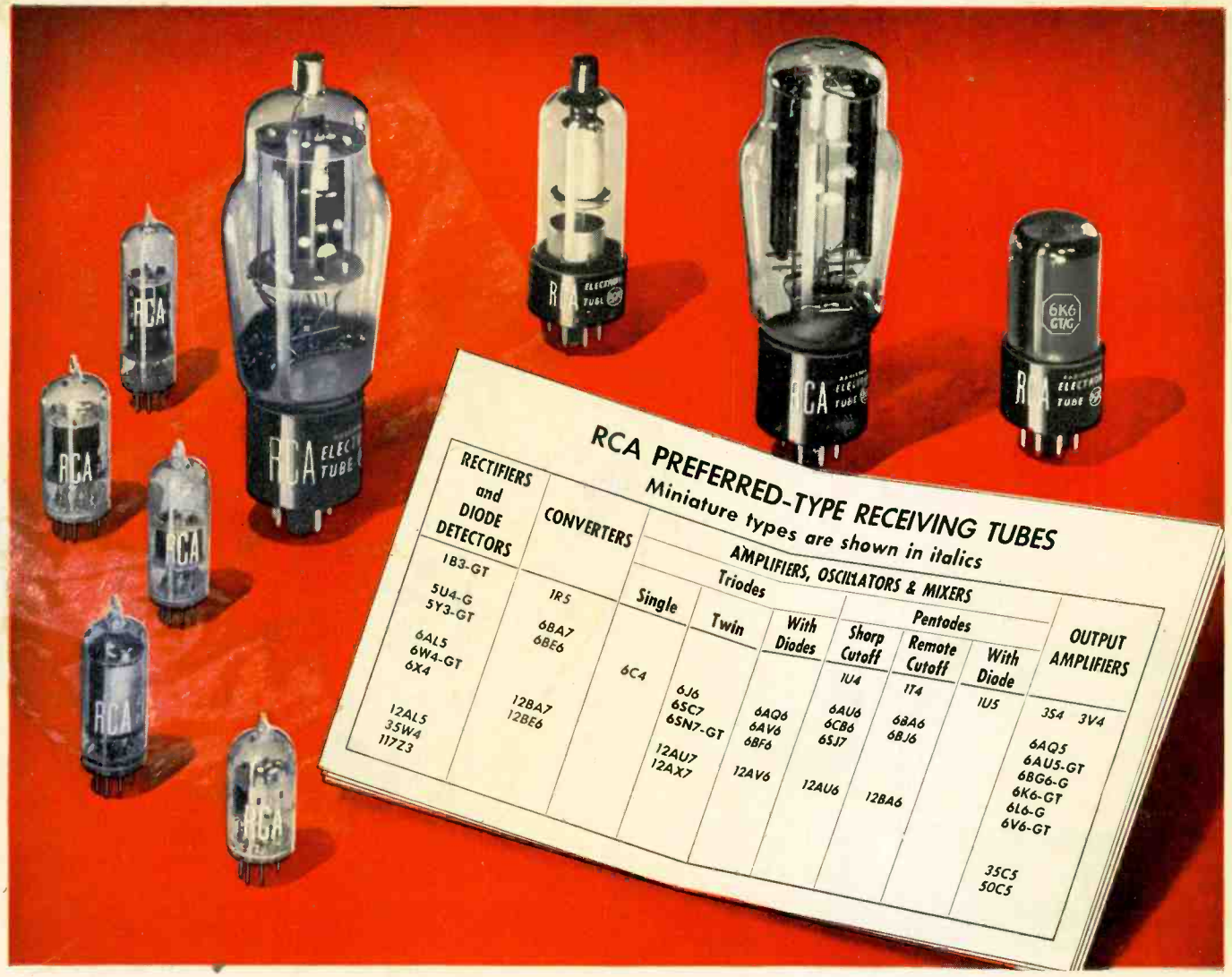
191 CENTRAL AVENUE
NEWARK 4, NEW JERSEY



R.F. VARIABLE ATTENUATORS

Video Range:	0- 10 Mc
RF Range	0-225 Mc

Fixed as well as step rotary and push-button attenuators are available. Technical information available upon request.



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Economy—This group of 44 tube types represents more than half of RCA's current receiving tube volume. By concentrating production on these few types, substantial savings are realized in manufacturing costs which are passed on to the equipment manufacturer . . . and quality and uniformity are sustained at a high level.

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