FEBRUARY · 1951

electronics

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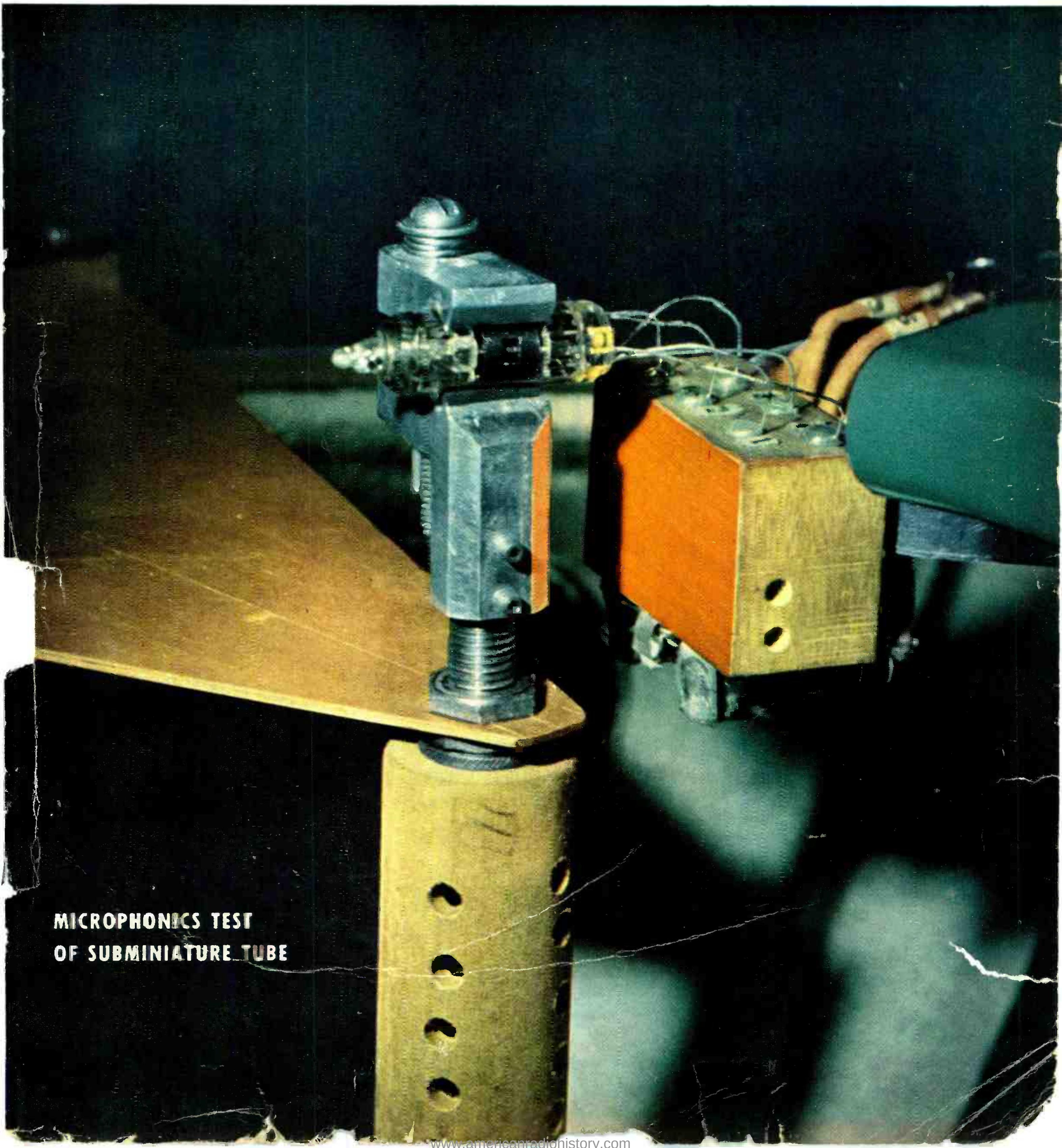
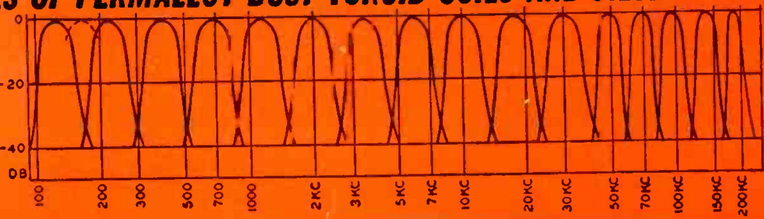
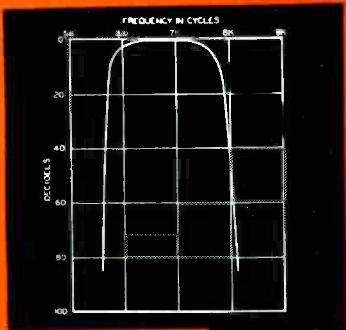


FILTER SPECIALISTS

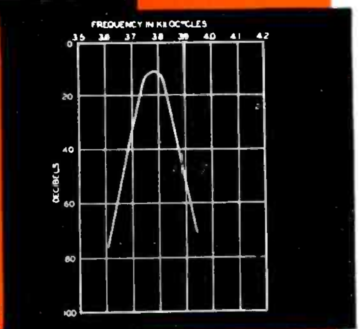
PRODUCERS OF PERMALLOY DUST TOROID COILS AND FILTERS FOR OVER A DECADE



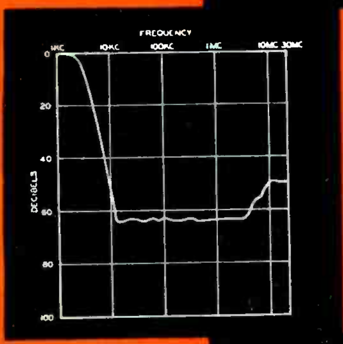
FOR FILTERS



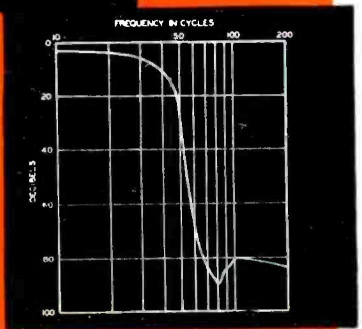
BROAD BAND
SHARP CUTOFF
FILTER



NARROW BAND
SHARP CUTOFF
FILTER



ATTENUATES
10KC TO 30
MEGACYCLES



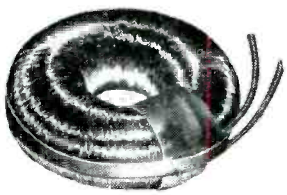
LOW FREQUENCY
— LOW PASS
FILTER

HQA, C, D
TOROID COILS

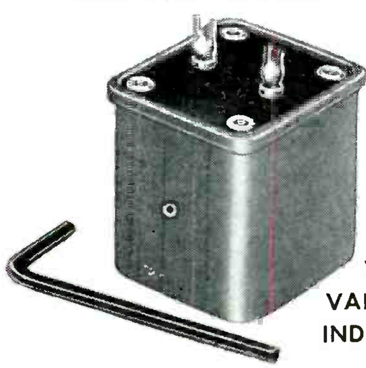
1 1/16" Dia x 1 1/16" High.

HQB
TOROID COIL

2 5/8" L. x 1 5/8" W. x 2 1/2" H.

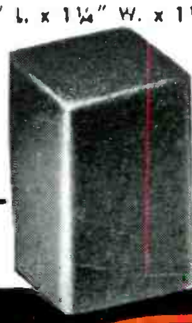


UNCASED TOROIDS

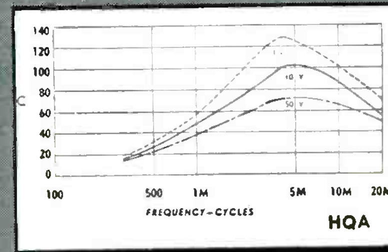


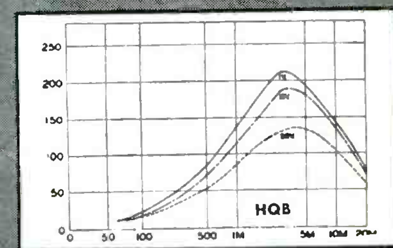
VIC
VARIABLE
INDUCTOR

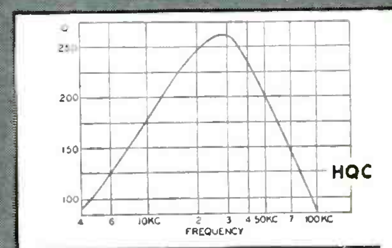
1 3/8" L. x 1 1/4" W. x 1 1/2" H.

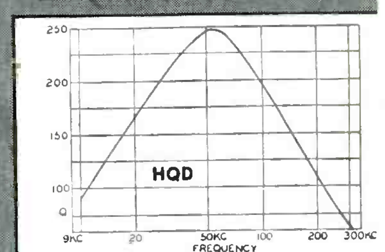


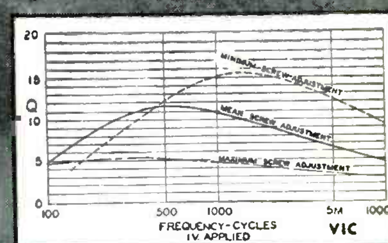
FOR HIGH Q COILS











**SUB-OUNCER
TOROID FILTERS**

Filters employing SUB-OUNCER toroids and special condensers represent the optimum in miniaturized filter performance. The band pass filter shown weighs 6 ounces.

United Transformer Co.

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electronics

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MICROPHONICS TESTS OF SUBMINIATURE TUBE .... **COVER**
Energized tube is vibrated from 25 to 10,000 cps and output signals recorded. (See p 122) Photograph by John Schinkel, Sylvania Electric Products, Inc.

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DATUM STABILIZER FOR RADAR-ALTIMETER SURVEYING, by B. I. McCaffrey **100**
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measure true rms values of non-sinusoidal wave forms

A new aid to true RMS instrumentation is the Reed DIOTRON, developed and manufactured by Reed Research, Inc., of Washington, D. C. This amazing instrument measures true rms values of non-sinusoidal or otherwise erratic wave forms. It is a vacuum tube voltmeter whose indication depends entirely on true rms values. It is a small, compact, portable instrument used by engineers, technicians and scientists interested in the measurement and evaluation of power regardless of wave form.

Marion makes the meter upon which the Reed DIOTRON depends for much of its accuracy of indication. It provides a linear power scale and allows full scale measurements of 1 mw, 10 mw, 100 mw, 1 watt and 10 watts into 600 ohms. A corresponding true root mean square voltage scale is also included.

When you want special or standard instruments for any application that requires accurate indication — think of Marion. Marion Ruggedized Meters are the most advanced electrical indicating and measuring instruments of our time. Advanced in both construction and application, count on them for prolonged peak performance under extreme conditions of temperature, climate and actual physical violence. We invite comparison. Marion Electrical Instrument Company, 401 Canal Street, Manchester, New Hampshire.

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for resistors too!

Specialization in resistors lets IRC concentrate on research and quality control to a greater degree than any other supplier.

Result:—IRC exploration *anticipates* future resistor needs—*improves* existing products—and *controls* quality and uniformity in every IRC unit. Largest resistor manufacturer in the world, IRC attracts the finest of engineering talent. We're using more of such talent than ever, now, to keep step with today's electronic requirements—while we plan for tomorrow's advances.

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For high-wattage dissipation in limited-space applications, IRC Type FRW Flat Wire Wound Resistors have higher space-power ratios than standard tubular units. FRW's can be mounted vertically or horizontally—singly or in stacks. Non-magnetic mounting brackets permit easy, economical mounting, aid in heat distribution along the entire length, and transfer internal heat to the chassis. Available in 9 sizes—fixed and adjustable. Send for full details in Bulletin C-1.

is important

HIGH OHMIC RESISTORS

Engineered for high voltage applications where high resistance and power are required, IRC Type MVX Resistors are particularly suited to many types of television and electronic circuits. Unique application of IRC's proven filament resistance coating in helical turns on a ceramic tube provides a conducting path of long, effective length. Result: A unit of high resistance value with resistance materials having relatively low specific resistance. Type MVX's have 2 watt rating, are exceptionally stable—permit the use of high voltage on the resistor while keeping voltage per unit length of path comparatively low. Send coupon for complete details in Bulletin G-2.

DEPOSITED CARBON PRECISTORS

A unique combination of accuracy, stability and economy makes IRC Deposited Carbon PRECISTORS ideal for applications where carbon compositions are unsuitable or wire-wound precisions too expensive. Instrumentation, advanced electronics and critical television circuits also benefit from their wide range of values, low voltage coefficient, excellent frequency characteristics, predictable temperature characteristics, high voltage rating, low noise level and small size. Coupon brings full particulars in Bulletin B-4.

VOLTMETER MULTIPLIERS Sealed-precision IRC Type MF Resistors are completely impervious to moisture—have proved themselves dependable voltmeter multipliers for use under the most severe humidity conditions. Each multiplier consists of a number of IRC Precision Resistors, mounted, interconnected, and encased in a glazed, hermetically sealed ceramic tube. MF's are compact, rugged, stable, easy to install, and may be used with very little drain on the power supply. Individual precision resistors may be either inductive or noninductive, so that they may be used on AC as well as DC. Mail coupon for full data in Bulletin D-2.

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Power Resistors • Voltmeter Multipliers • Insulated Composition Resistors • Low Wattage Wire Wounds • Volume Controls • Voltage Dividers • Precision Wire Wounds • Deposited Carbon Precistors • Ultra-HF and High Voltage Resistors • Insulated Chokes

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QUICK, RELIABLE
impedance measurements up to 500 megacycles

FTL-42A IMPEDOMETER

Any signal generator with 0.1 volt maximum into 51.5 ohms output furnishes sufficient power for operation.

Crystal detector and audio amplifier with output meter have sufficient sensitivity as a detector above 100 megacycles.

Compact, simple, accurate instrument for the measurement of impedance, attenuation, reflection coefficient and standing-wave ratio at frequencies up to 500 megacycles.

Read relative voltages of incident wave, reflected wave, and resultant. Plot diagram of voltages on Smith Chart and impedance can be determined to $\pm 5\%$.

Requires no unusual accessories – only those found in every laboratory and test shop working in the frequency range of the instrument: signal generator with 0.1 volt maximum output, crystal detector, audio amplifier, and output meter. Below 100 megacycles a radio receiver is desirable for its greater sensitivity.

In addition, the FTL-42A Impedometer can be operated with input power up to several hundred watts when it is desired to drive the load in this manner.

Adapters for $1\frac{5}{8}$ inch line to type N are furnished so that the instrument can be used with flexible cables.

The FTL-42A Impedometer can be used directly with $1\frac{5}{8}$ inch line, or with other sizes of lines or cables by use of various adapters that are available.

It can be built for other impedances such as 72 ohms coaxial, according to requirements of user.

Dimensions of cabinet: $6\frac{13}{16}$ inches long by $5\frac{9}{16}$ inches wide by $5\frac{7}{8}$ inches high. Net weight including adapters is 7 pounds.

Price – $400.00

Write for FTL-42A brochure.

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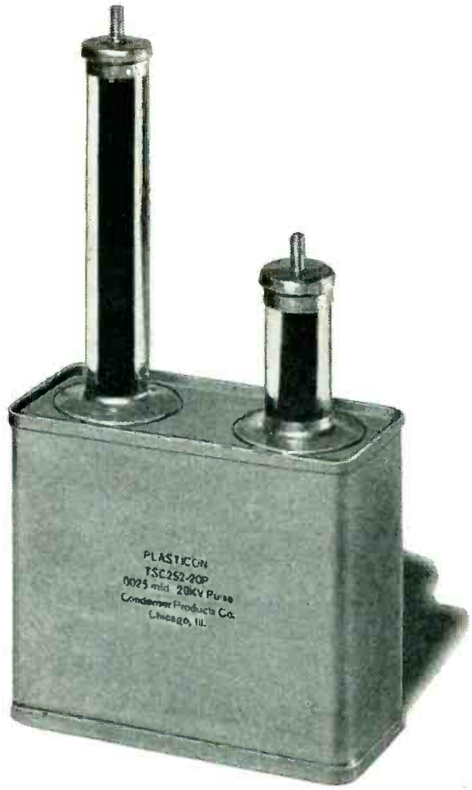
Federal Telecommunication Laboratories, Inc.

500 Washington Avenue *Nutley 10, New Jersey*

No. 11 of a Series

Another Engineer's Problem Solved*



SUBJECT:

High Power Pulse Capacitors

PROBLEM:

To supply a small capacitor handling peak pulses of 630,000 VA

SOLUTION:

An .0025 mfd. capacitor was required to pass 70 Amp. pulse at 9,000 volts and withstand occasional peaks as high as 18 K.V. The pulse repetition rate was 1500 pulses per second with a pulse duration of .25 microseconds. The equivalent wavefront approximated 10 mc.

We designed a teflon film dielectric, silicone fluid filled capacitor which has no internal corona under the above operating conditions. The size of this type TSC252-20P metal can is $3\frac{3}{4}''$ x $1\frac{1}{4}''$ base x $3\frac{1}{4}''$ high. A JAN-C-5—CM95 size mica capacitor ($8\frac{1}{2}''$ O.D. x $10''$ high) was not recommended for the above electrical specifications.

Send us your specifications on pulse capacitors and other capacitor and power supply problems.

Your inquiries will receive immediate attention.

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Write for catalog on our standard line of Plasticon Capacitors, Forming Pulse Networks and High Voltage Power Supplies.

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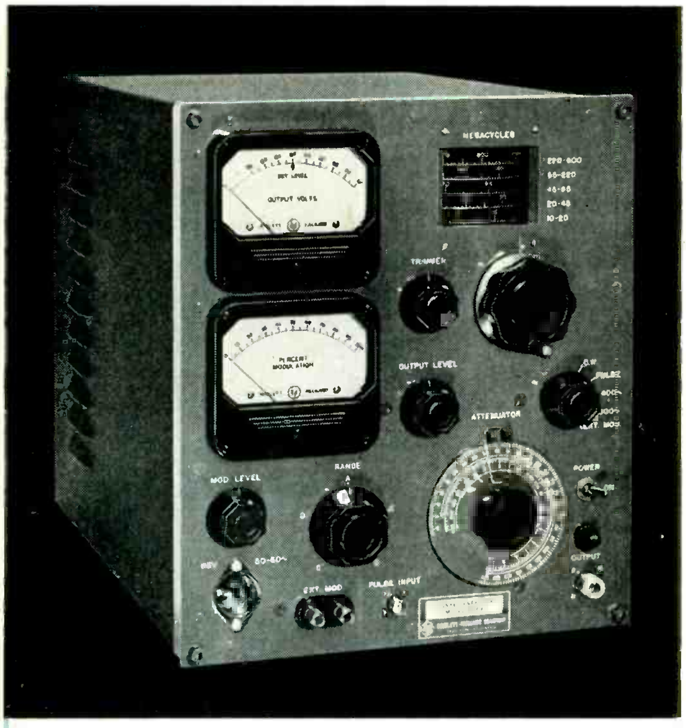

–*hp*– **608A VHF SIGNAL GENERATOR**

SPECIFICATIONS

FREQUENCY RANGE: 10 to 500 mc. in 5 bands.
ACCURACY: Calibration ±1%. Re-setability better than 1 mc, at high frequencies. Total scale length approx. 90″.

OUTPUT: 0.1 μv to 1.0 v. continuously variable. Calibrated in volts and dbm.
IMPEDANCE: 50 Ω. Maximum VSWR 1.2.
ACCURACY: ±1 db entire range.

MODULATION:
AMPLITUDE: From 0 to 90% indicated by front panel meter.
ENVELOPE DISTORTION: 1% to 30% modulation.
INTERNAL: Fixed modulation at 400 and 1,000 cps.
EXTERNAL: Any frequency 50 cps to 1 mc. 4.0 v. input.

EXTERNAL PULSE: Positive, 4 v. peak. Good pulse shape. Square wave to 1 μsec length (At 100 mc. and above).

LEAKAGE: Less than 1 μv.

RESIDUAL FM: Not over .0025% at 30% modulation.

POWER: 115/230 v. 50/60 cps. 150 watts.

SIZE: 12″ x 14″ x 18″ deep. –*hp*– grey finish. Cabinet mounting.

PRICE: $850.00 f.o.b. Palo Alto

Data Subject to Change Without Notice

....THE BASIC TOOLS YOU

VHF SIGNAL GENERATOR

10 to 500 mc

High power output...Constant internal impedance...Wide frequency range...Broad modulation capabilities...Master oscillator power amplifier circuit...Microsecond pulses ...Small residual FM...CW, AM or pulsed output

Here is a new general purpose laboratory generator of broadest application. It offers a directly calibrated output from 0.1 μv. to 1 v. for measuring gain, selectivity, sensitivity or image rejection of receivers, I-F amplifiers, broad band amplifiers and other VHF equipment. The 1 v. output (to a 50 ohm load) is available throughout the entire frequency range for driving bridges, slotted lines, antennas, filter networks, etc. The output circuit is directly calibrated in volts and dbm for fast reading. No charts are necessary.

DIRECT CALIBRATION

Frequencies from 10 to 500 mc. are covered in 5 bands, and calibrated directly in mc. on a drum-type dial having effective scale length of 90″. The single-dial, ball-bearing frequency control insures maximum convenience and accuracy in tuning and re-setting.

Master oscillator and power amplifier circuits are enclosed in a heavy cast aluminum shield, insuring high stability and low electrical leakage.

–*hp*– 417A VHF DETECTOR

This new –*hp*– instrument is a super-regenerative (AM) receiver covering all frequencies between 10 and 500 mc. in 5 bands. It is designed for use with the –*hp*– 803A VHF bridge. It offers 5 μv sensitivity over entire band, quick, easy operation, and a direct-reading frequency control. The instrument is thoroughly shielded, and is suitable for general laboratory use; for making approximate frequency checks, determining noise, interference, etc. Price $200.00 f.o.b. Palo Alto.

HEWLETT *hp* PACKARD

FOR THE *10 to 500 mc* BAND!

ASKED US FOR!

VHF BRIDGE

50 to 500 mc

First commercial VHF bridge...Based on an entirely new principle...Direct impedance readings, 2 to 2,000 ohms...Wide phase angle ...Useful to 700 mc...Makes every kind of VHF impedance measurement

The new *-hp-* 803A VHF Bridge is the first commercial instrument built to give you fast, direct impedance readings in the 50-to-500 mc. band. It can be used for any type of VHF impedance measurement. This includes characteristics of transmission lines, antennas, resistors, rf chokes and condensers; impedance of connectors, standing wave ratios; percentage of reflected power, VHF system flatness, etc.

BROAD FREQUENCY RANGE

The Model 803A operates on an entirely new principle suggested by Mr. John Byrne of the Airborne Instrument Laboratories.* It determines impedance by sampling the magnetic and electric fields of a transmission line. Phase is measured by determining the point of cancellation of these samples along a second transmission line. This method effectively overcomes the narrow frequency limitations of conventional bridges, and permits the new *-hp-* VHF bridge to make readings at frequencies up to 700 mc and down to 5 mc.

**A complete description of this principle and its application in the* -hp- *VHF Bridge appeared in a recent issue of the* -hp- *Journal. Free copy on request.*

SEE THESE AND OTHER NEW -hp- INSTRUMENTS

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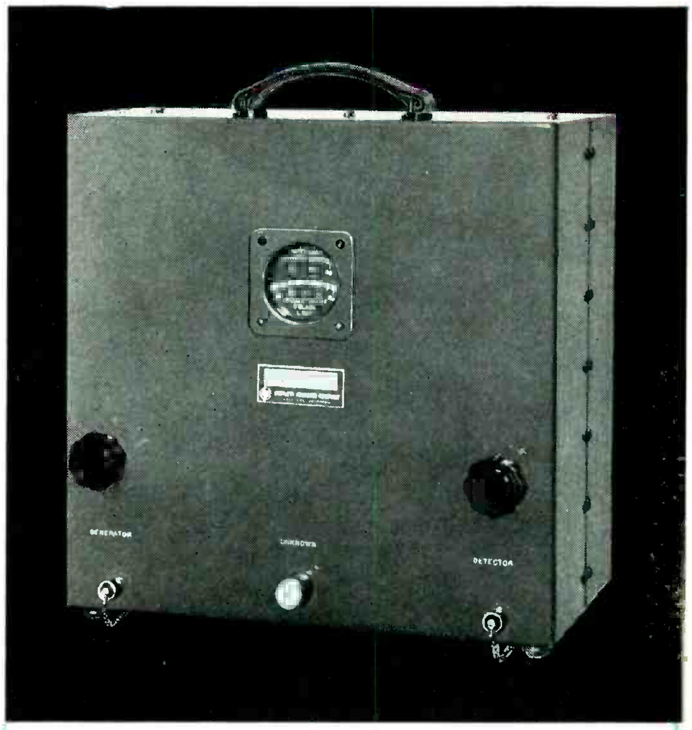

-hp- 803A VHF BRIDGE

SPECIFICATIONS

MEASUREMENT RANGE: Impedance magnitude, 2 to 2,000Ω. (Higher and lower values may be measured by using a known length of transmission line as an impedance transformer.)
Phase angle from $-90°$ to $+90°$ at 50 mc and above.

CALIBRATION: Impedance: Directly in ohms.
Phase angle: Directly in degrees at 100 mc. May be readily computed at other frequencies.
[Θ (actual) $=$ Θ (read) x Frequency, mc/100.]

ACCURACY: Impedance magnitude, approx. $\pm 5\%$.
Phase angle, approx. ± 3 degrees (over range 50 to 500 mc).
With calibration chart provided, accuracies of 2% and 1° are possible.

FREQUENCY RANGE: Maximum accuracy 50 to 500 mc. Useful down to 5 mc and up to 700 mc. Maximum measurable phase angle at 5 mc is $-9°$ to $+9°$.

EXTERNAL rf GENERATOR: Requires an AM signal source of at least 1 mw. High signal level is desirable. (*-hp-* Model 608A VHF Signal Generator is ideal for this purpose.)

rf DETECTOR: Requires a well-shielded VHF receiver of good sensitivity. (*-hp-* Model 417A VHF Detector is designed for this use.)

SIZE: 14" x 14" x 8" deep. Smooth *-hp-* grey finish. Cabinet mounting.

PRICE: $495.00 f.o.b. Palo Alto.

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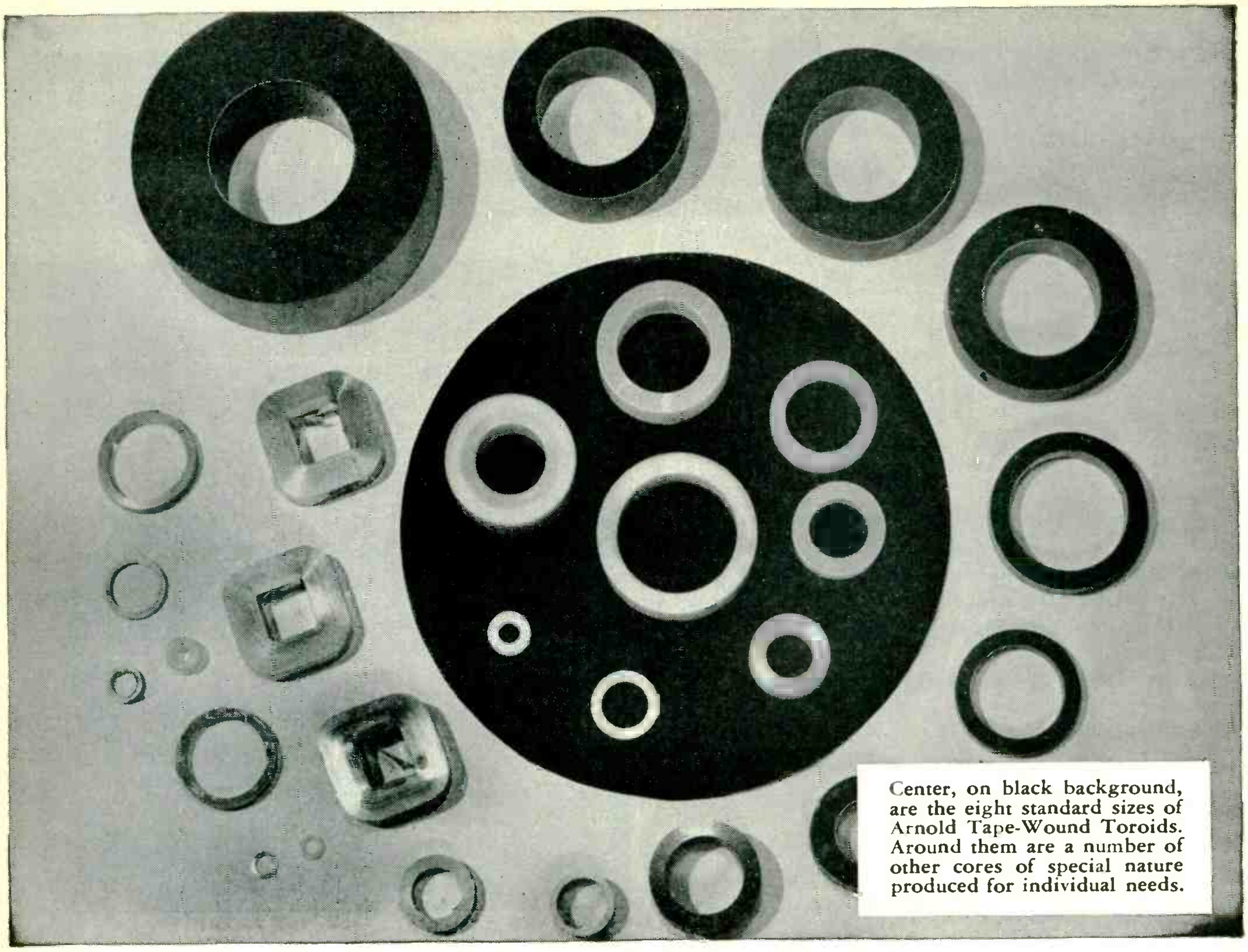
HEWLETT hp PACKARD



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*

APPLICATIONS

MAGNETIC AMPLIFIERS
PULSE TRANSFORMERS
NON-LINEAR RETARD COILS and TRANSFORMERS
PEAKING STRIPS, and many other specialized applications.

RANGE OF SIZES

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.

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.

W&D 3182

THE ARNOLD ENGINEERING COMPANY

SUBSIDIARY OF ALLEGHENY LUDLUM STEEL CORPORATION

General Office & Plant: Marengo, Illinois

WILKOR

FIRST IN THE INDUSTRY WITH CARBOFILM RESISTORS

AND NOW

FIRST AGAIN WITH BORO-CARBOFILM RESISTORS

★ Greatly Increased Range of Resistance

★ Temperature Coefficient as Low as 20 Parts Per Million Per Degree C

★ Increased Stability

★ Lower Noise Level

Attention All Electronic Engineers

We are in production on the most advanced development in the history of resistors. It is the BORO-CARBOFILM RESISTOR. After over two years of intensive laboratory work the introduction of Boron in the making of Deposited Carbon Resistors has been perfected.

The result of this new development assures greatly increased range of resistance, temperature coefficient as low as 20 parts per million per degree C, greater stability and lower noise level.

What This Means to You

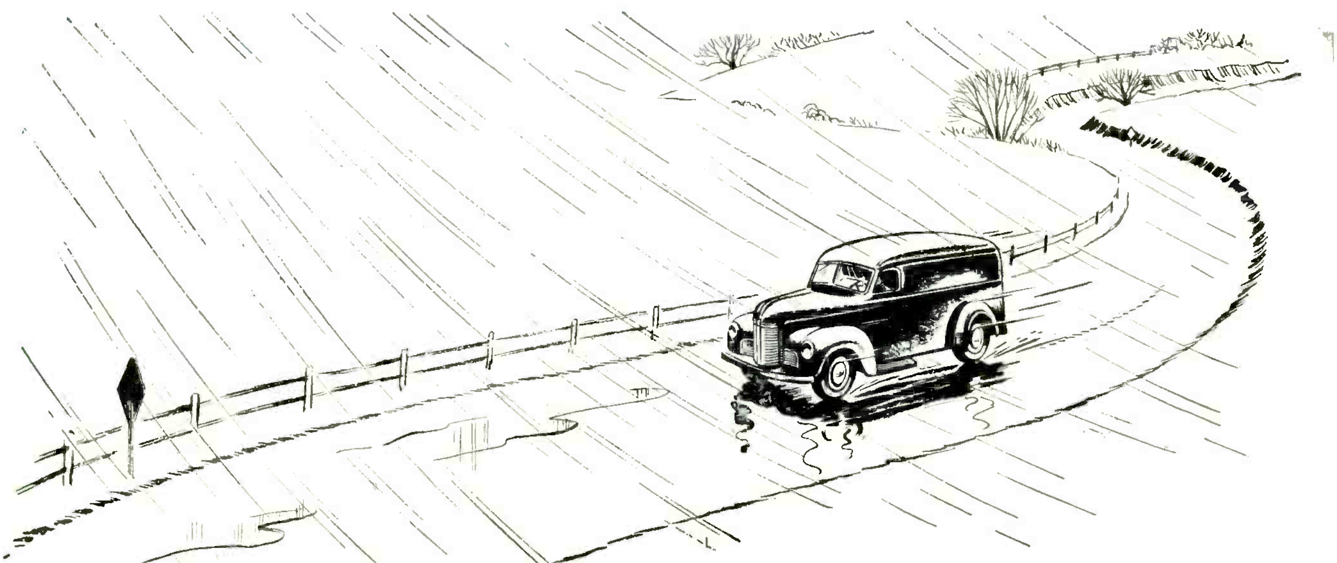
Briefly, this makes it possible for you to use the new, much improved BORO-CARBOFILM RESISTOR in place of larger and more costly wire-wound types. It also provides access to resistance ranges heretofore impossible to attain in film-type resistors. With their low temperature coefficient and small aging you will find wide-spread use for these new resistors in communications and nearly all types of electronic applications. Remember the name "BORO-CARBOFILM". Available in ¼, ⅓, ½, 1 and 2-watt sizes.

In writing, kindly give your requirements in sizes and volume.

BORO-CARBOFILM RESISTORS are made under license arrangement with Western Electric Co., Inc.

WILKOR PRODUCTS, INC.

2882 Detroit Avenue • Cleveland 13, Ohio



"...and George had to drive 8 miles"

It was Sunday afternoon—and raining cats and dogs. The phone rang. It was Mrs. Gilbert from Fairlawn, a new subdivision about eight miles from town . . . She had just spilled some hot grease on her brand new Electric Stove—and the whole thing had short-circuited . . . And her guests were due to arrive in two hours! . . . So George hauled out the truck—and in half an hour he was at Mrs. Gilbert's . . . It was the same old story—somebody in order to save a few pennies had used an electrical insulation that was not grease-proof.

An electric kitchen is wonderful—when it's working. But, let the insulation short out and failure is complete.

That's why America's leading manufacturers of home appliances use BH Special Treated Fiberglas Sleeving at every critical insulation point . . . like the unit leads for an electric range, or the leads to the clock mechanism of a toaster.

BH Special Treated Fiberglas Sleeving is the same high heat insulation that protects electrical equipment for industry. Consider these safety factors: withstands temperatures up to 1200° F without stiffening or cracking—combustion resistance—freedom from crystallization at -67° F.

Here is insulation that spreads readily over knobs and terminals, and doesn't ravel or fray when cut to lengths. Extreme flexibility plus tubular shape means easy handling, faster production.

BH Special Treated Fiberglas Sleevings are only a branch of the BH Insulation Family. There are many others. We'll be glad to send you testing samples if you'll tell us your requirements—write today!

Address Dept. E-2
Bentley, Harris Manufacturing Co.
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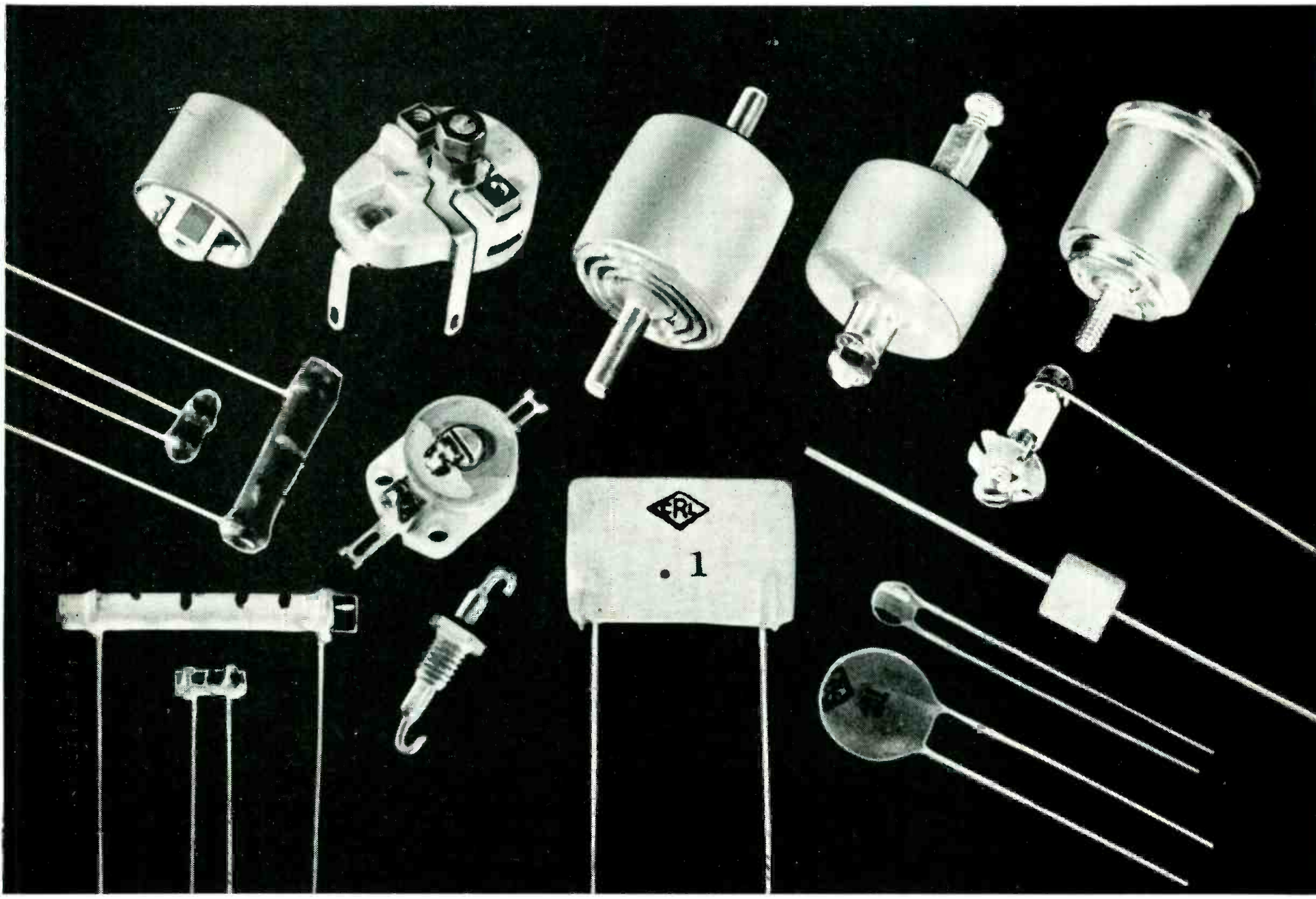
BH Fiberglas* SLEEVINGS

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

CENTRALAB CERAMIC CAPACITORS GIVE YOU THE WIDEST CHOICE PLUS FINEST QUALITY AT ANY PRICE!



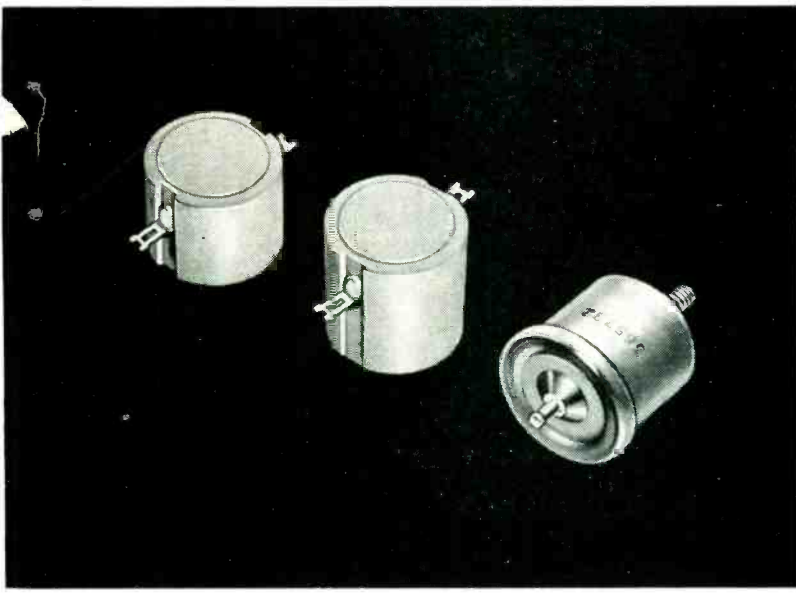
HERE'S WHAT YOU GET FROM CENTRALAB CERAMICS

Centralab ceramic capacitors provide a permanence never before achieved with old-fashioned paper or mica condensers. The ceramic body provides imperviousness to moisture, plus unmatched ability to withstand any temperatures normally encountered in electrical apparatus. What's more, ceramics make possible tremendous savings in space; many Centralab ceramic capacitors are ⅐th the size of ordinary capacitors. This is particularly important where new design requirements call for less bulk. You can rely on Centralab ceramic capacitors for close tolerance, high accuracy, low power factors, and excellent temperature compensating qualities. Compare Centralab Ceramic capacitors for small size, wide range of ratings, variety of types and top quality characteristics. Compare their price. The results will show you why you'll standardize on Centralab — first in the field of electronic ceramics.

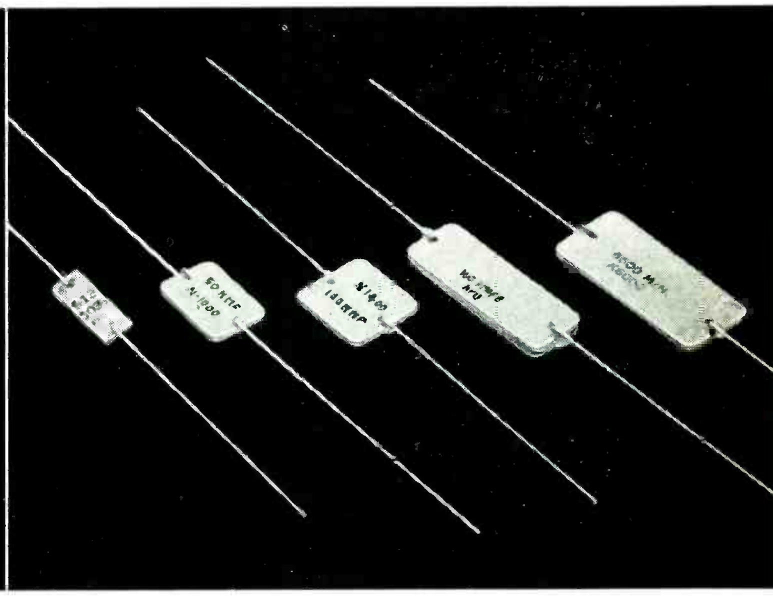
WANT MORE INFORMATION? SEE NEXT TWO PAGES ➡

Complete Line of Ceramic Capacitors

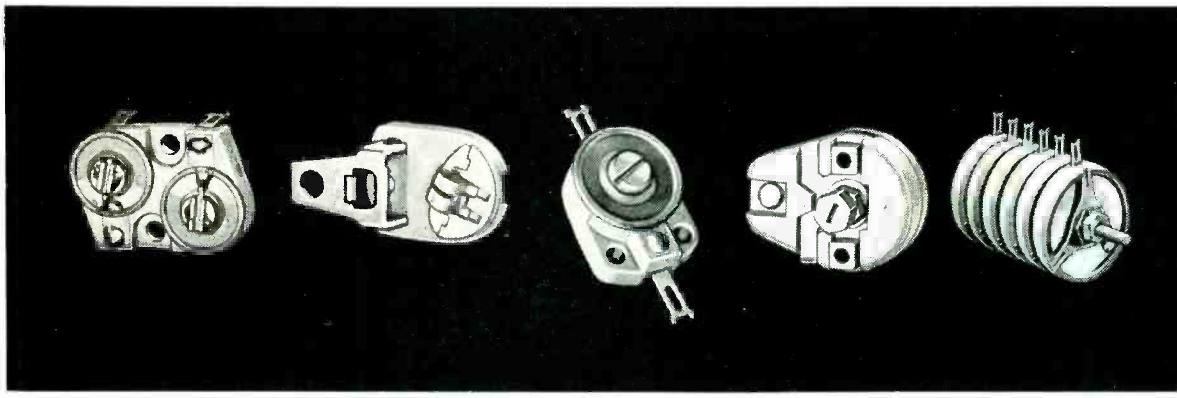
(JAN) MILITARY APPLICATION



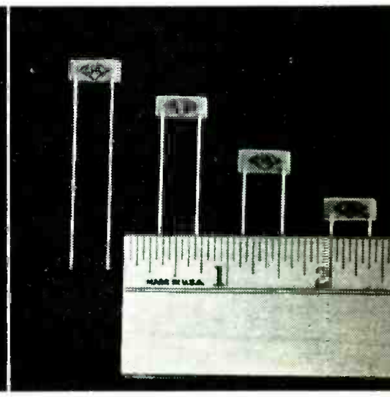
High Accuracy capacitors. Precision units to meet exacting requirements involving extremely rigid frequency control. Extensively used for holding oscillator frequencies to close limits. For complete information, check Bulletin No. 42-123 in coupon below.



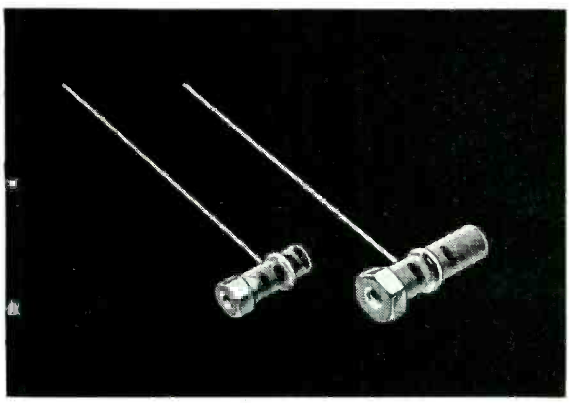
Flat Plate, end-lead capacitors. Temperature compensating. Capacitances: 5, 10, 20, 50 and 100 mmf., 500 volts D. C. working. Temperature Compensating Tolerance: 15% or 30 PPM whichever is larger. For complete information Check Bulletin No. 42-124 in coupon below.



Centralab Ceramic and Steatite Trimmers provide high quality stable capacitors, with small size, light weight, easy mounting. Readily adjustable with screw driver and give full capacity range with 180° rotation. Equal stability mantained in any position — minimum to maximum. Have excellent stability under vibration. Rotor and stator contact under spring pressure on optically ground flat surface Check Bulletin No. 42-101 for more data.



Min-Kaps are very tiny capacitors used where space is at extreme premium. Ask for Bulletin No. 42-24.



Stand-off ceramic capacitors — both Bypass Coupling and Temperature Compensating types. One end threaded. For complete information check No. 42-121 in coupon below.

Centralab ®

Division of GLOBE-UNION INC. • Milwaukee

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Division of Globe-Union Inc.
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Yes — I would like to have the CRL bulletins, checked below, for my technical library!

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☐ 42-123	☐ 42-18	☐ 42-24	☐ 42-59	

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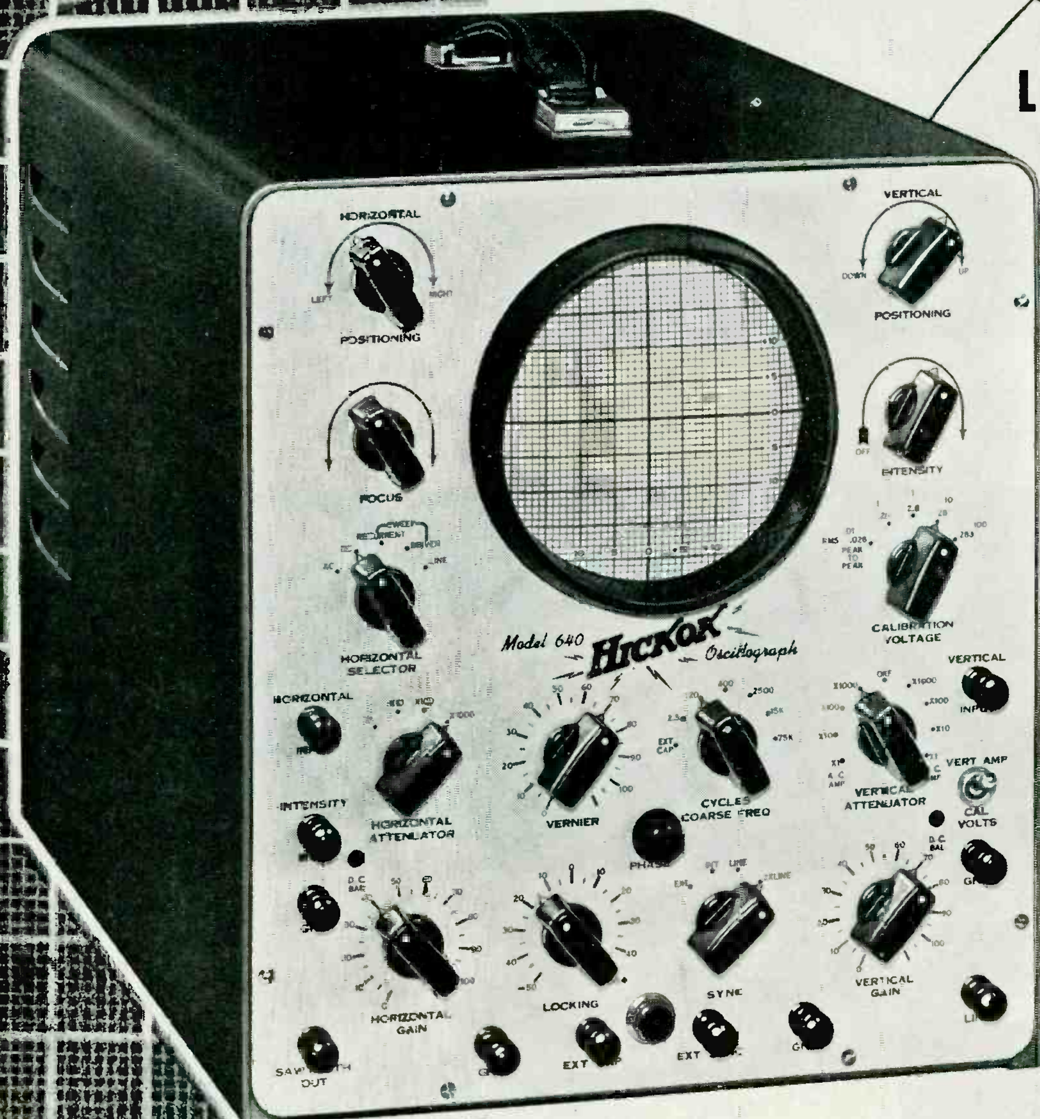
HICKOK announces

For Industrial and Electronic Laboratories



MODEL 640

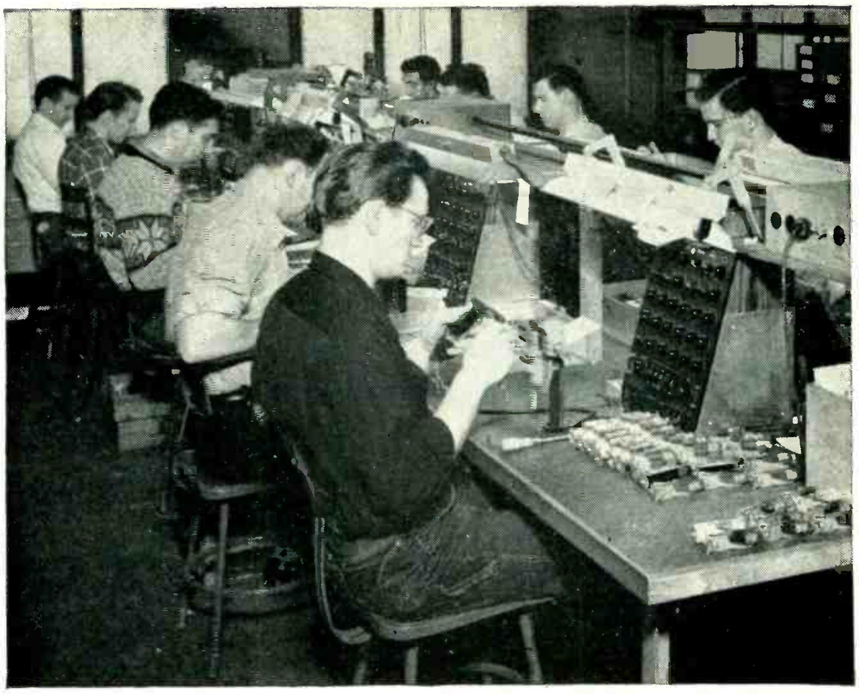
The new HICKOK Model 640 Oscillograph with its exceptional design features and characteristics provides an outstandingly versatile instrument for the engineer in observing regular recurring or transient phenomena.

The Model 640 has been rigidly field tested and proved in the HICKOK laboratories. All components are the best obtainable and in keeping with the HICKOK 40-year reputation for highest quality, accuracy and dependability.

STABLE • ACCURATE • VERSATILE

Here's Why...

you now get *Quick Delivery* on these *Top Quality*



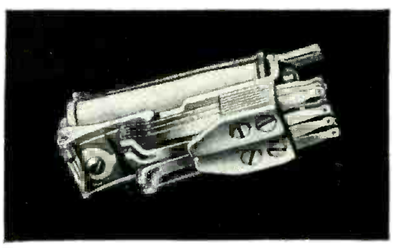
One of the assembly lines in our Relay Department

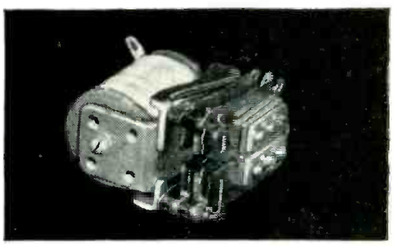
AUTOMATIC ELECTRIC

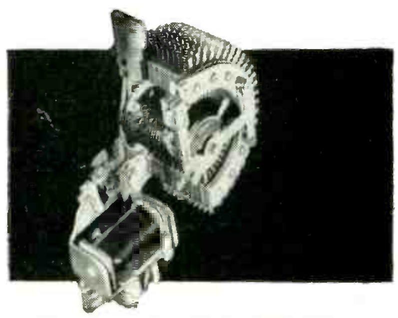
RELAYS **SWITCHES**

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

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







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

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

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

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

RELAYS **SWITCHES**

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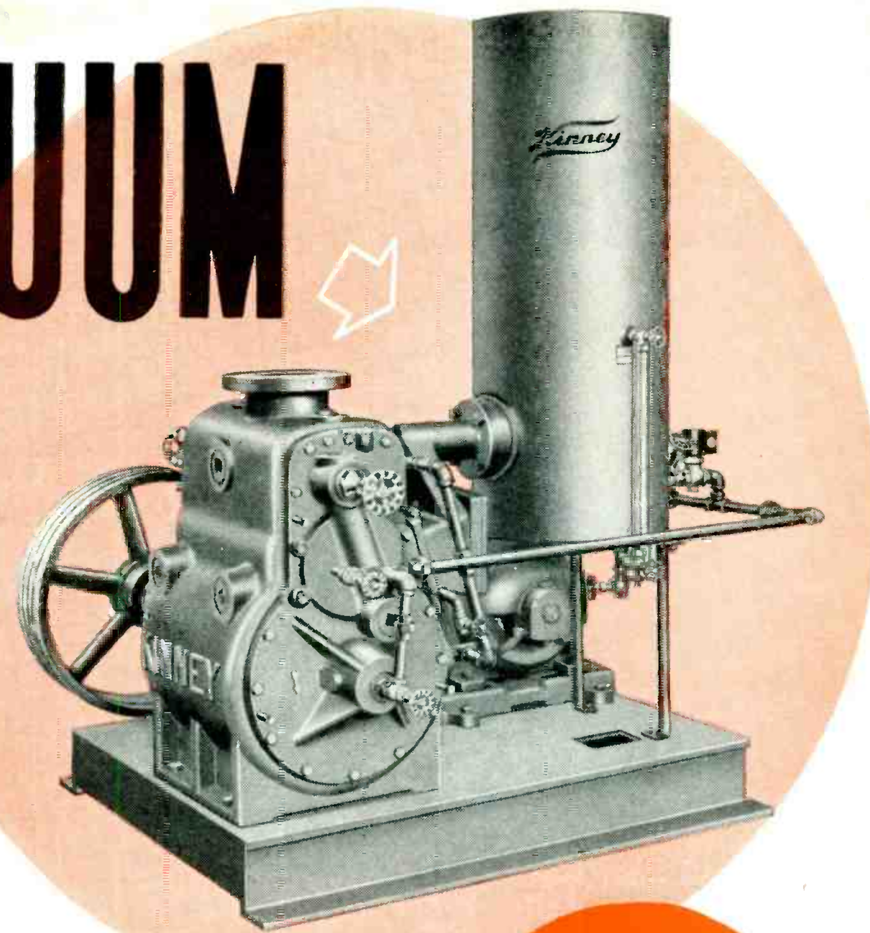
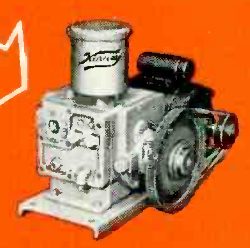


. . . OR VACUUM



Come to KINNEY for the vacuum pump that's *right* for your vacuum problem.

Kinney High Vacuum Pumps range from the big 40 HP unit with 702 cu. ft. per min. displacement to the little 1/3 HP pump rated at 4. 9 cu. ft. per min. Kinney offers two basic pump designs — Single Stage and Compound — for low absolute pressures to 10 microns or 0.1 micron, respectively. You can also choose the type of outlet valve that's best for your job — for extremely low pressures, the efficient feather valve, or for air-vapor mixtures, the exclusive stainless steel poppet valve. Return the coupon today for your copy of Bulletin V45 . . . the full story on Kinney's complete line of vacuum pumps. KINNEY MANUFACTURING COMPANY, 3565 Washington St., Boston 30, Mass. Representatives in New York, Chicago, Cleveland, Houston, New Orleans, Philadelphia, Los Angeles, San Francisco, Seattle.

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Name .... *Company* ....
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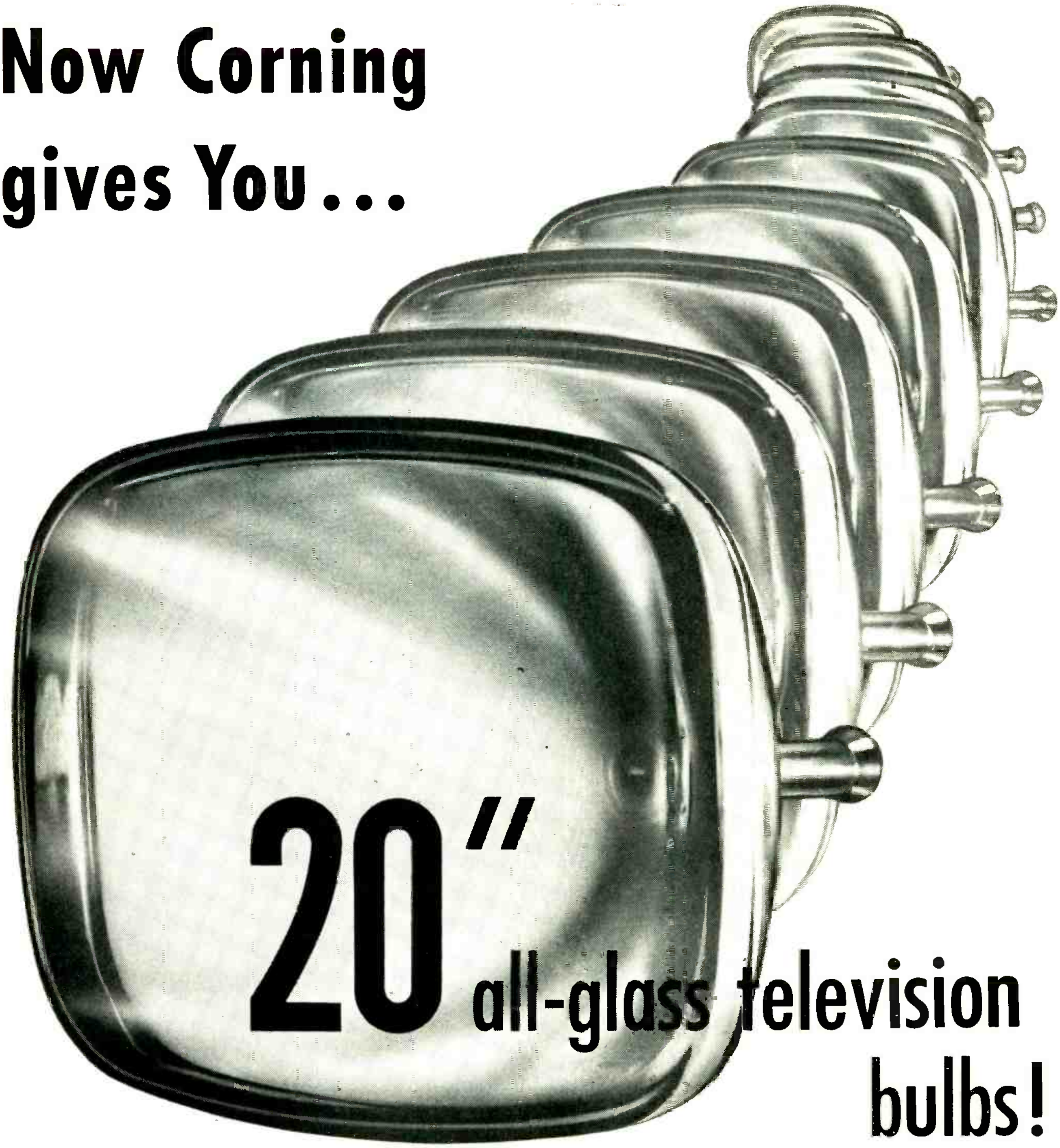
Now Corning gives You...



20" all-glass television bulbs!

When television was still a laboratory curiosity, Corning made the *first* experimental bulbs. All during the early stages of television set production, Corning was the principal manufacturer of television bulbs. In keeping with this tradition, and in answer to demands from the Television Industry, Corning has introduced the *all-glass 20" rectangular bulb!*—the largest television bulb in volume production today.

The first of this size on the market, the new 20" bulb combines all the improvements developed through years of research at Corning. Among these are light-weight, lead-free glass ideally suited to electronic applications, stronger bulb assemblies from electric sealing, and constant quality and color transmission from improved glass melting and forming techniques. The new Corning 20" all-glass bulb is the last word in quality, durability and size.

CORNING GLASS WORKS **CORNING, N. Y.**

Electronic Sales Department, Electrical Products Division

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OVER 90%

of the TRANSMISSION MEASURING SETS Used Today Are Made by DAVEN

DAVEN TRANSMISSION MEASURING SET 7A

Equipment specially designed for use by utilities, telephone and power companies. May be directly applied to measuring gains or losses through amplifiers, repeaters, attenuating networks or communication lines.

TRANSMISSION SECTION

GENERATED FREQUENCIES: 500, 1000, 2500 cycles per second.
OUTPUT LEVEL: —13, 0, +4 and +10 dbm.
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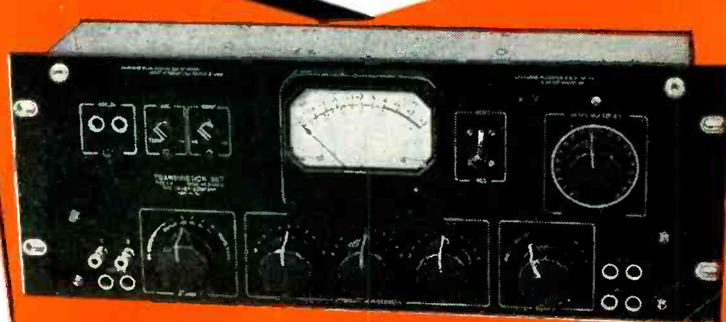
FREQUENCY RESPONSE: Within ±1.0 db from 50 to 15,000 cps.
AMPLIFICATION RANGE: —10 to +30 db in 2 db steps.

Not only is the Daven Company the largest supplier of transmission measuring sets, but it is also a source for every needed type of instrument for the measurement of the transmission characteristics of communication systems. It furnishes units to check all types of broadcast equipment and audio devices for commercial and industrial use as well as for organizations such as utilities, telephone and power companies. Therefore, whatever your requirements are in this field, write to Daven for complete catalog material, and outline your own particular problems for specific assistance from our engineering staff.

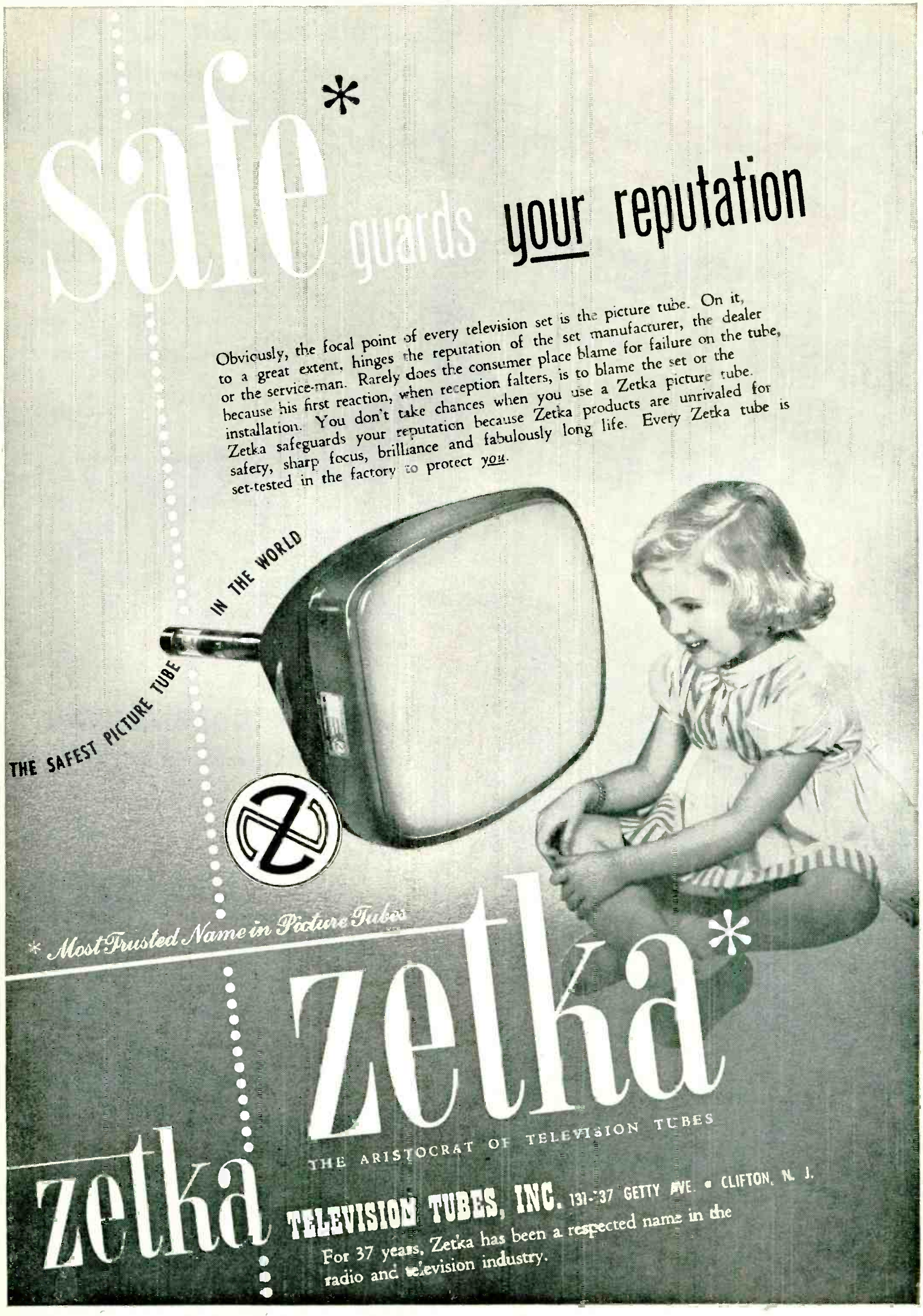
DAVEN TRANSMISSION MEASURING SET 11A

A moderately priced instrument for broadcast equipment. A simplified, accurate, direct reading instrument, designed to make measurements in accordance with FCC regulations.

FREQUENCY RANGE: 20 CY to 20 Kc.
ACCURACY: ±0.1 db, 20 CY to 20 Kc.
RANGE OF LEVEL:
+ 4 to —110 db, —10 to —124 db — in steps of 0.1 db.
APPLICATIONS:
(a) Audio gain and loss measurements.
(b) Measurements of matching and bridging devices.
(c) Complex circuit measurements.
(d) Measuring mismatch loss.
(e) Frequency response measurements.



THE DAVEN CO.
191 CENTRAL AVENUE • NEWARK 4, NEW JERSEY


safe* guards your reputation
Obviously, the focal point of every television set is the picture tube. On it, to a great extent, hinges the reputation of the set manufacturer, the dealer or the service-man. Rarely does the consumer place blame for failure on the tube, because his first reaction, when reception falters, is to blame the set or the installation. You don't take chances when you use a Zetka picture tube. Zetka safeguards your reputation because Zetka products are unrivaled for safety, sharp focus, brilliance and fabulously long life. Every Zetka tube is set-tested in the factory to protect you.
THE SAFEST PICTURE TUBE IN THE WORLD
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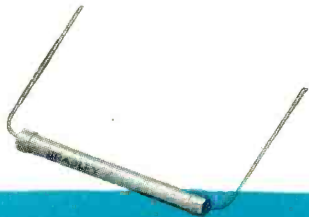
For 37 years, Zetka has been a respected name in the radio and television industry.

WHY BRADLEY RECTIFIERS CONSISTENTLY EXCEL IN PERFORMANCE



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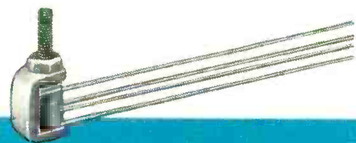

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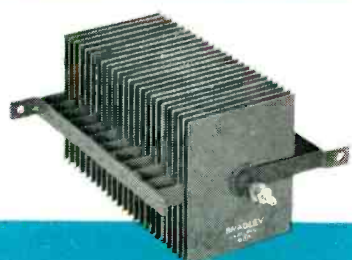

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Bradley Luxtron* photoelectric cells convert light directly into electrical energy without external power source. Wide range of models, sizes and shapes available.

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PERFORMANCE AS RATED is not a hoped for characteristic with Bradley selenium or copper oxide rectifiers. It can be counted upon and planned for.

THROUGHOUT MANUFACTURE our rectifiers are subjected to the most rigorous quality control technique ever developed for rectifiers — the Bradley Vacuum Process.

IN BRADLEY SELENIUM RECTIFIERS, our unique and exclusive vacuum method eliminates impurities in the raw selenium, prevents contamination during manufacture and assures a secure, even bonding of selenium to the plates.

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PERFORMANCE AS RATED is thus an inherent characteristic of Bradley rectifiers — a constant that assures stability of power conversion in your product under all conditions.

BRADLEY RECTIFIERS . . . FOR PERFORMANCE AS RATED

BRADLEY LABORATORIES, INC.

82 MEADOW STREET, NEW HAVEN 10, CONNECTICUT

December 21, 1950

Antara Products Division
General Dyestuff Corporation
435 Hudson Street
New York 14, N. Y.

Gentlemen:

Miniaturization is a word that has become ever more important in our business. Over the past four years we have received one assignment after another of this type. The solutions to these problems do not always go by formula; they are not exactly simple. But -- on each and every occasion -- G A & F Carbonyl Iron Powders have been one of our major tools in the successful completion of these assignments.

A typical application was for the translation receivers which permit a United Nations delegate to select the language in which he wishes to hear any talk.....Another was for the tuning coils on a hearing-aid, radio-receiving attachment. Another was for I.F. coils for a tiny personal receiver. And the nation's armament program -- to which we hope we are making full contribution -- calls for sub-miniature coils. These, too, we are developing with the help of your product.

At all times, our design work is aimed at top quantity production of top quality items. In every assignment of this type, we rely on the fully dependable properties of Carbonyl Iron Powders.

Sincerely yours,

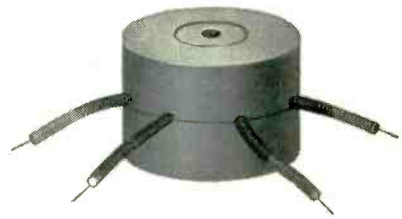
ESSEX ELECTRONICS

Bernard M. Goldsmith

Bernard M. Goldsmith
President

(EXACT SIZE)

ESSEX PERMEABILITY-TUNED I.F. COIL for personal radio (455 kc.)—measuring ½″ x ½″ x 1½″. In spite of its small size, there is no sacrifice in performance.



ESSEX PERMEABILITY-TUNED R.F. TRANSFORMER for United Nations translation receiver—measuring ⅞″ in diameter and ⅝″ in height. Same type of construction has been made in 262 kc. I.F. Transformer—measuring ½″ x ½″.

G A & F® Carbonyl

Each and every problem of MINIATURIZATION solved with the help of CARBONYL IRON POWDERS

Essex Electronics ranks today as one of the major suppliers of coils to the leading makers of receiving sets. Their reputation is based upon sound engineering and efficient production. With ten years of experience in this field, Essex Electronics testifies that G A & F Carbonyl Iron Powders have been one of the major tools in the successful completion of their many assignments. . . . .

Other makers—of both cores and coils—have testified that *it costs less* to work with these top quality materials and that major gains are effected in both weight reduction and increased efficiency. We urge you to ask your core maker, your coil winder, your industrial designer, how G A & F Carbonyl Iron Powders can improve the performance of the equipment you manufacture. It will cost you nothing to get the facts.

THIS FREE BOOK — fully illustrated, with performance charts and application data — will help any radio engineer or electronics manufacturer to step up quality, while saving real money. Kindly address your request to Department 21.

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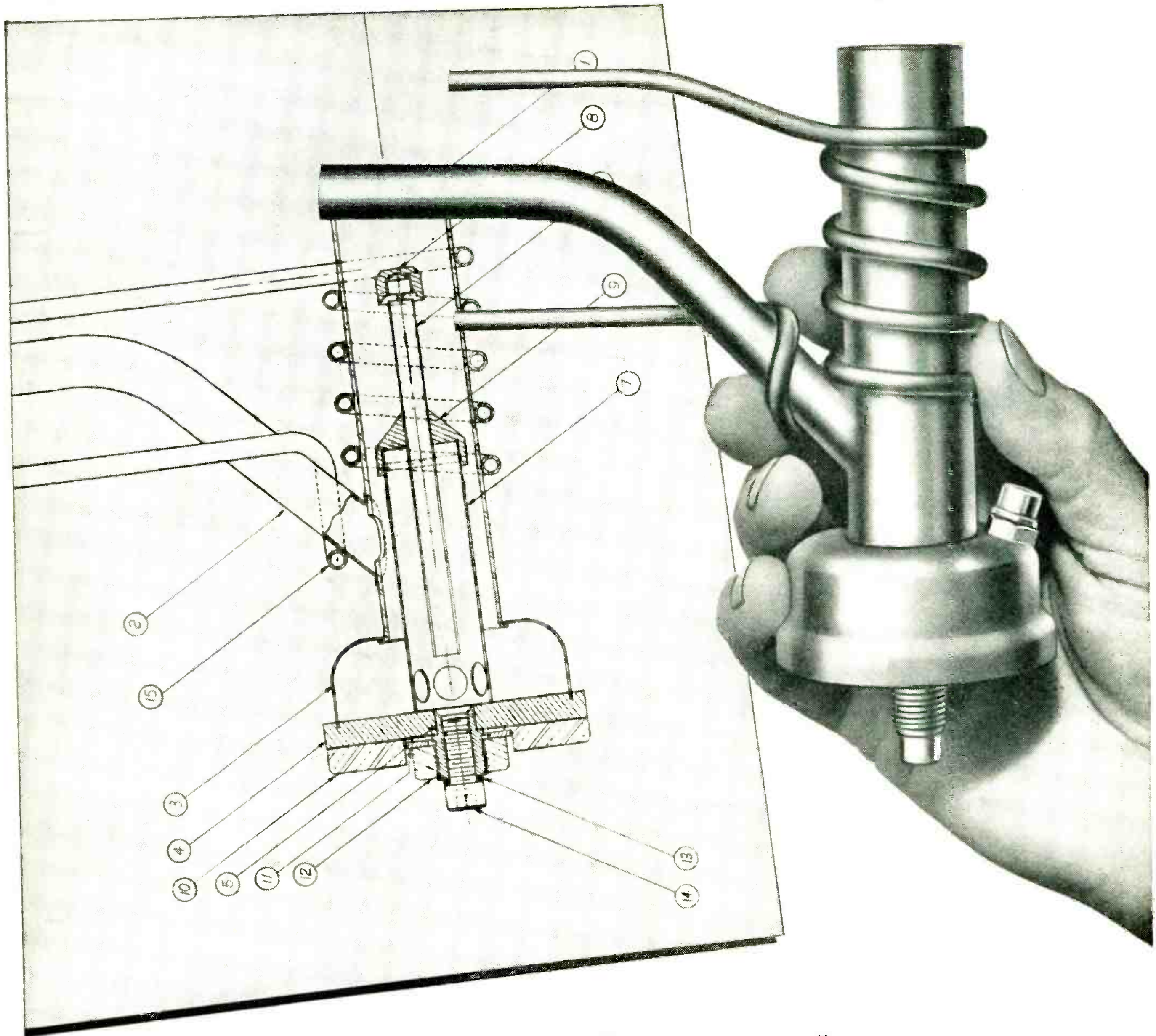

New Booster Pump reduces the exhaust cycle of rotary units

This tiny booster pump was specially designed to increase the efficiency of rotary exhaust units. It is able to produce a total pressure of 0.5 μ, or less, in one-half the time of other available equipment because it has high pumping speed in the *right range of pressure.* It is ideally small — only 2½" in diameter by 6" long. You'll have no trouble mounting it at each exhaust port on most rotary equipment.

Because of its speed, this new diffusion pump can cut your exhaust cycle. At the same time, it gives the higher vacuum needed in the production of better quality tubes. Write today for complete information.

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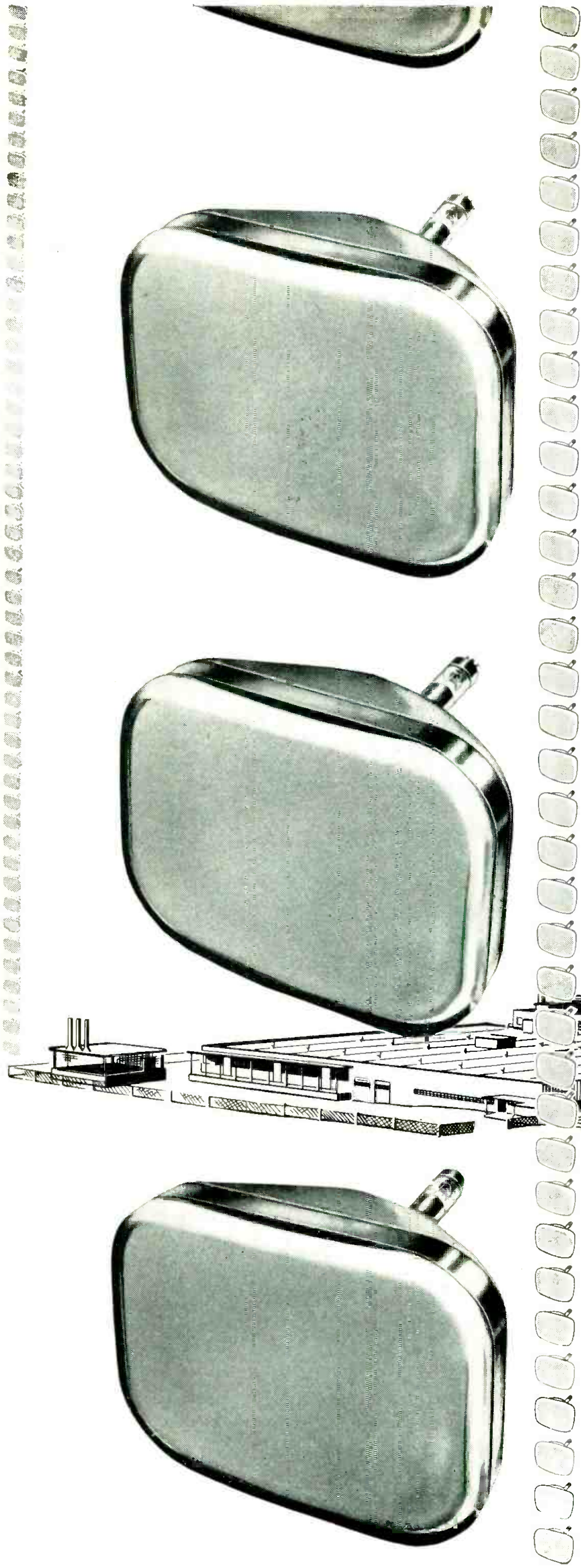
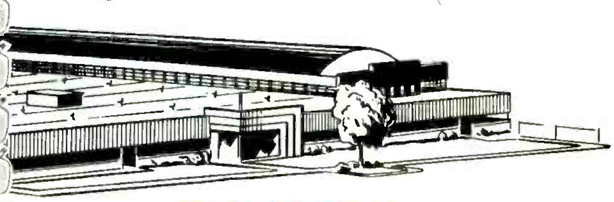


uniform

Yes, UNIFORM! There's no such thing as a "better tube" or a "poorer tube" when you insist on Du Mont Teletrons. Advanced engineering, precise mechanization second to none, and the most rigid quality control account for *uniformly dependable performance* that has made the Du Mont label symbolic of the finest in TV tubes. Best of all, with a productive capacity in excess of one million BIG picture tubes a year, the giant Du Mont Allwood plant meets *quantity* as well as *quality* requirements. Literature on request.



DUMONT

*Teletrons**

*TRADE-MARK

FIRST WITH THE FINEST IN TV

ALLEN B. DU MONT LABORATORIES, INC.

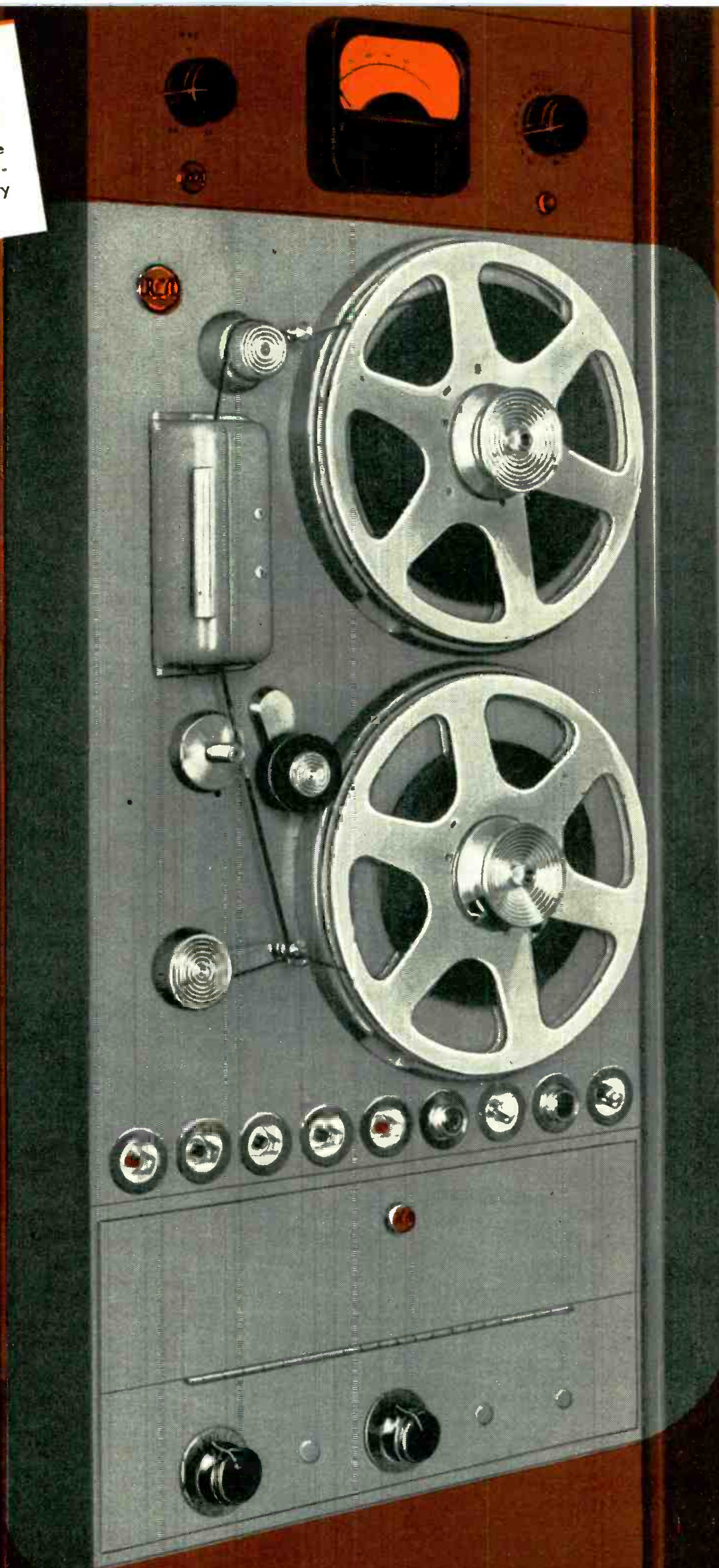
Cathode-ray Tube Division, Clifton, N. J.

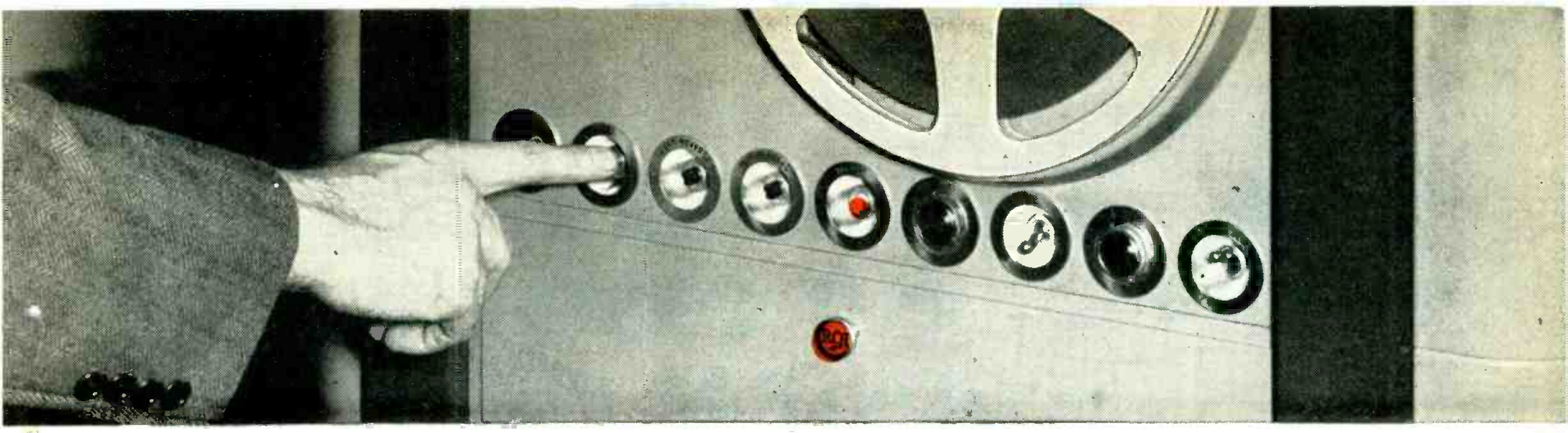
RCA TAPE RECORDER Type RT-11A

50 to 15,000 c.p.s. (±2 db) at 15 in/sec
50 to 7,500 c.p.s. (±2 db) at 7½ in/sec

COMPLETE—with motor board, plug-in type recording amplifier, plug-in playback amplifier, two standard NAB reels, power supply and panel and shelf.

- **Split-second start and stop**
- **Push-button operation**
- **Extremely accurate timing—with synchronous capstan**
- **Smooth tape runs—via sapphire guides**
- **Automatic tape lift for fast "forwards" and rewinds**
- **Microswitch "tape-break" control—no tape spills, snarls**
- **Remote control of all operations**
- **Rack or console mounting**
- **Plug-in amplifiers**
- **Interlock system for vital controls**
- **3 heads—Erase—Record—Playback**





PUSH-BUTTON CONTROL puts tape recording facilities at your fingertips.

NEW—

High-Fidelity Tape Recorder

—the finest money can buy!

Remote Control Unit, MI-11948. Available extra.

This is the world's foremost professional tape recorder, the one recorder that has *everything*—accurate timing, low wow and flutter, plus quick starting. All operations are push-button controlled. All functions—including cueing—can be extended to remote positions.

Designed for applications where operating TIME and RELIABILITY are prime factors, the new Type RT-11A Recorder offers a number of exclusive features. For example, you can start or stop the tape in 0.1 second. You can jockey the tape back and forth for cueing without stopping. You can rewind a standard 10½-inch reel in one minute!

A synchronous capstan makes it practical to hold recording time to ±2½ seconds in a 30-minute run. And with synchronizing equipment . . . for which provision is made . . . *timing can be held to 0.3 second on any length program!*

Many more important features, too.

Self-centering "snap-on" hub adaptors assure perfect reel alignment with either RMA or NAB reels. A complete system of control interlocking virtually eliminates the possibility of accidentally erasing a program—makes it impossible to snarl or "spill" the tape. "Microswitch" control stops the machine if the tape is severed—applies reel brakes instantaneously. The tape automatically lifts *free and clear* of heads during fast forward runs or rewinds. Tape alignment over the heads is held precisely by a floating casting. Starting wow is reduced to the vanishing point.

BY ALL MEANS, *call your RCA Broadcast Sales Engineer for complete details. Or mail the coupon.*

RCA Engineering Products,
Department N36,
Camden, New Jersey

Send me more information (including price and delivery) on your new De Luxe Tape Recorder, Type RT-11A.

NAME____________________

ADDRESS____________________

STATION OR FIRM____________________

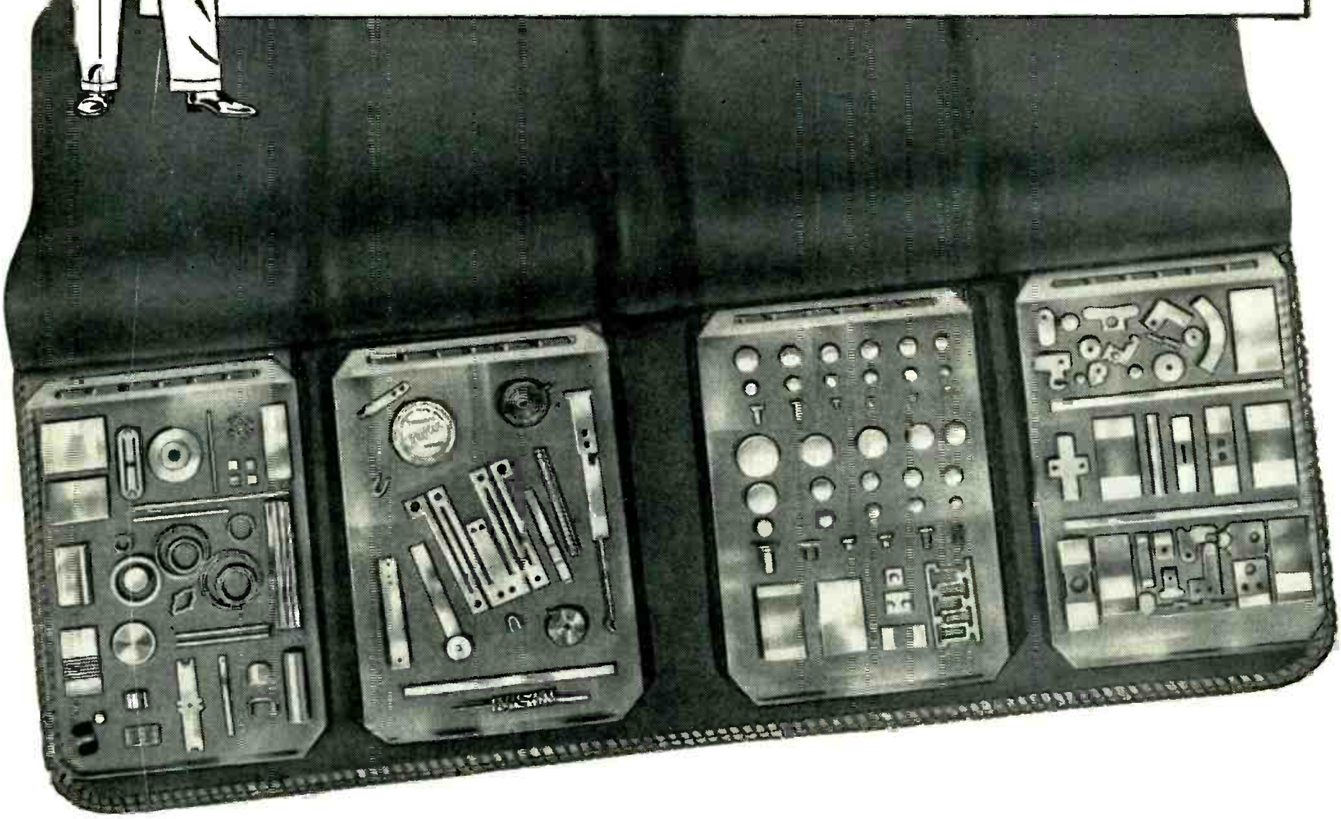
CITY____________________STATE__________

RCA

AUDIO BROADCAST EQUIPMENT
RADIO CORPORATION of AMERICA
ENGINEERING PRODUCTS DEPARTMENT, CAMDEN, N.J.

In Canada: RCA VICTOR Company Limited, Montreal

Here's the Man That Can Help You
CUT COSTS
with GENERAL PLATE
Precious and Composite Metals and Assemblies



The best opportunity for cutting costs, increasing production and at the same time obtaining maximum performance is to investigate other metals or metal combinations. That's why we say, "A General Plate Field Engineer can help you cut costs."

Especially trained in the application of precious and composite metals for industrial uses, he is able to work with you on your specific problems. He will not give you a build-up on generalities, but will talk your problem over with you and come up with an answer that usually means savings for you.

A General Plate Field Engineer will show you how base to precious combinations save dollars by eliminating a large waste of precious metal . . . how base to base metals provide physical properties not found in single metals. And best of all, he can help you apply them to your products. He will also show you proof where General Plate Composite metals and products have provided an economical solution to the problem.

Remember, too, General Plate Field Engineers are backed-up by an extensive resident research laboratory that is always available for help on your unusual requirements.

Look for the General Plate Field Engineer and his "proved performance list." He'll show you how you can benefit at a savings with General Plate Products. Write for his services, today.

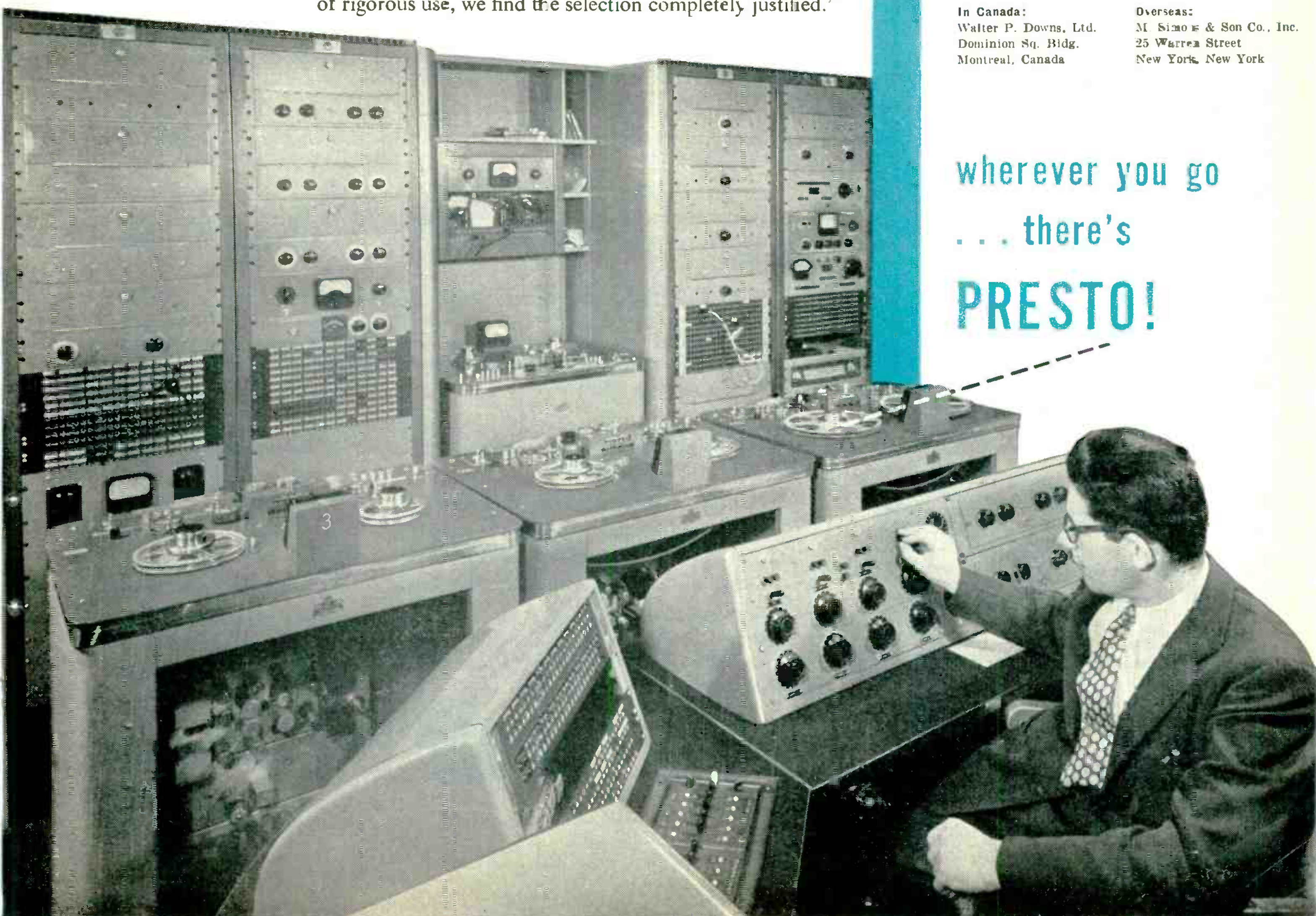
GENERAL PLATE PRODUCTS INCLUDE:

- Truflex Thermostat Metals
- Precious to base metal laminations
- Base metal laminations
- Alcuplate (copper on aluminum)
- Silver solders
- Laminated contacts, buttons, rivets
- Platinum — fabrication — refining
- Age-hardening Manganese Alloy 720

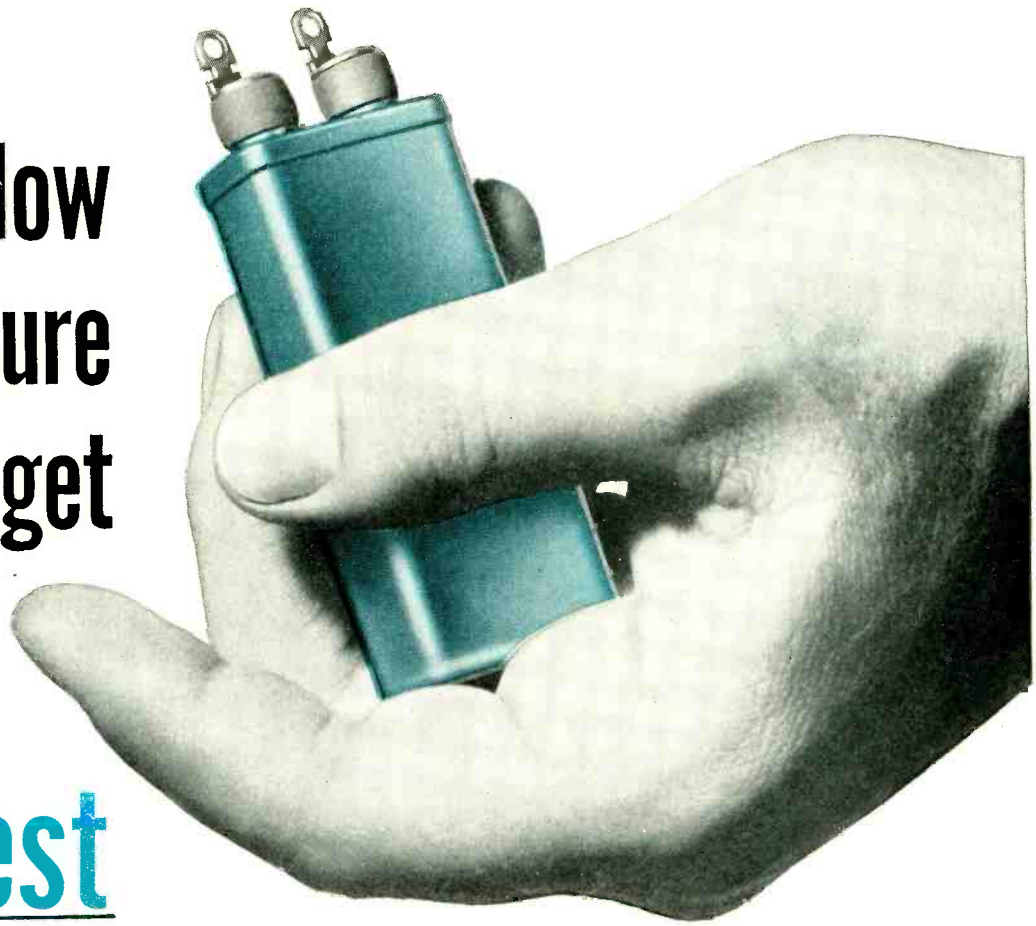
GENERAL PLATE

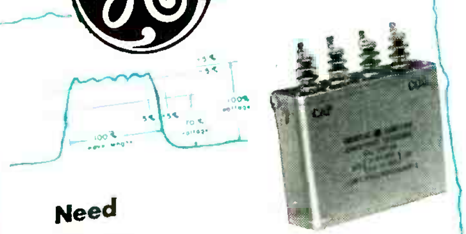
Division of Metals & Controls Corporation

30 FOREST STREET, ATTLEBORO, MASSACHUSETTS



How to be sure you get the Best Capacitor





Need square waves?

Pulse-forming networks are used where the normal capacitor discharge wave shape is not suitable, and where an impulse must have definite energy content and duration. Their design involves several tricky problems—one being suitability for high temperature operation. Nevertheless, networks are one of our specialties—we have built them by the thousands, and our ex[illegible]erienced and capable engineers will b[illegible] glad to discuss any of your design pro[illegible]ems. We invite your inquiries.

YOU CAN test the paper for density . . . thickness . . . porosity . . . power factor . . . chloride content . . . dielectric constant . . . dielectric strength.

And then test the foil for thickness . . . purity . . . softness of the anneal . . . freedom from oil . . . cleanliness of surface . . . absolute smoothness.

And then test the liquid dielectric for specific gravity . . . viscosity . . . power factor . . . color . . . acidity . . . flash point . . . dielectric strength . . . dielectric constant . . . insulation resistance . . . water content.

And after that, test every single finished capacitor for shorts, grounds, and opens at overvoltage between terminals and between terminals and case . . . and measure the capacitance of every single unit . . . and then check every single capacitor to see that it has a leak-proof hermetic seal.

OR YOU CAN buy General Electric capacitors . . . product of outstanding research and know-how . . . which have already passed every one of these tests

. . . on the materials when they were made.

. . . and again before they were used.

. . . and on the capacitors during manufacture.

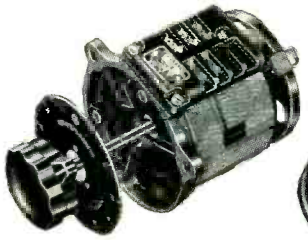
. . . and then, finally, on every single capacitor before shipment.

For full information on types, ratings, dimensions, types of mounting, and prices of capacitors, address the nearest *General Electric Sales Office or Apparatus Department, General Electric Company, Schenectady 5, N. Y.*

GENERAL ELECTRIC

407-170

POWERSTAT
TYPE 20

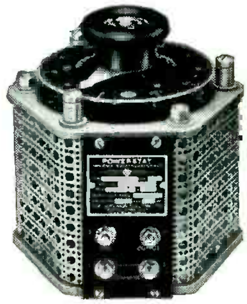


POWERSTAT
TYPE 116U

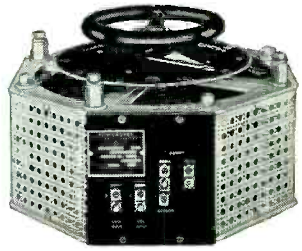
POWERSTAT
TYPE 116

POWERSTAT
TYPE MZ1126-3Y

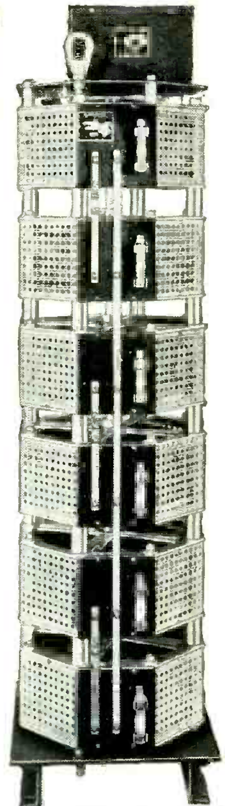
POWERSTAT
TYPE 2PF1126



POWERSTAT
TYPE 1126



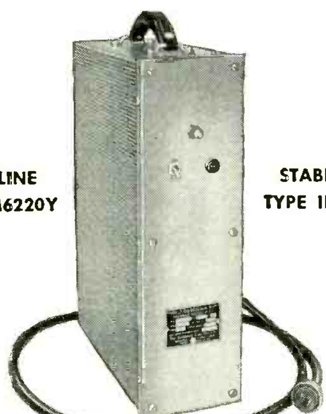
POWERSTAT
TYPE 1256



POWERSTAT
TYPE MW1156-6Y

ONE SOURCE FOR ALL

STABILINE
TYPE EM6220Y



STABILINE
TYPE IE51005

STABILINE
TYPE IE5101R

STABILINE
TYPE EM4115

VARICELL
TYPE 13015

VOLTBOX
TYPE UC1M

POWERSTAT Variable Transformers

For variable a-c voltage control, a complete line of standard POWERSTAT variable transformers is available in air-cooled, oil-cooled and explosion-proof models for manual or motor-driven operation. They are the ideal source of continuously adjustable voltage from a-c power lines — featuring excellent regulation, high efficiency, conservative ratings, zero wave-form distortion, rugged mechanical construction, smooth control and easy mounting. The standard types are offered in 115, 230 and 460 volts, 25 and 50/60 cycles, single and three phase ratings in capacities from 405 VA to 100 KVA. For 400 cycles and higher frequency applications and for those requirements involving JAN specifications, there is a line of non-cataloged POWERSTAT variable transformers. Bulletin P550 describes in detail the complete line of standard POWERSTATS.

STABILINE Voltage Regulators

For maintaining constant output voltage from fluctuating a-c power lines STABILINE automatic voltage regulators are offered in two models — Type IE (Instantaneous Electronic) and Type EM (Electromechanical) to suit the needs of individual requirements. Type IE provides almost instantaneous correction . . . is completely electronic in action with no moving parts. Waveform distortion never exceeds 3%. Output voltage is held to within ± 0.1 percent of nominal for wide line variations; to within ± 0.15 percent of nominal for any load current change or load power factor change from lagging .5 to leading .9. Capacities range from 250 VA to 5 KVA. Type EM is ideal for those applications where zero waveform distortion, low cost and high efficiency is required but instantaneous correction is not essential. They feature insensitivity to magnitude and power factor of load and do not affect the system power factor. Numerous types are available in ratings to 100 KVA. Bulletin S351 fully describes both types of standard STABILINES. For information on STABILINES built to JAN requirements and for 400 cycle operation, send the engineering details of your application to Superior.

VOLTAGE CONTROL EQUIPMENT

VARICELL D-C POWER SUPPLIES

The VARICELL is the ideal source of low d-c voltages. It operates from an a-c power source to deliver a stabilized and regulated variable range of d-c voltages. Stabilization and regulation is ± 0.25 volts and R.M.S. ripple voltage never exceeds 0.1 volts. More engineering data in SECO form 2504.

VOLTBOX A-C POWER SUPPLIES

The VOLTBOX is a much needed instrument in the laboratory, inspection, test and plant maintenance departments. It is a compact, portable source of variable a-c voltage with all the necessary components in a lightweight case. Further information is found in Bulletin P550.

The Superior Electric complete line of voltage control equipment provides from one source apparatus to meet any and all requirements. With Superior equipment, you are assured of the highest quality and top electrical performance. If you are in doubt regarding your requirements, SECO engineers are in your territory to assist you. Meanwhile, use the coupon below to obtain complete information on any voltage control equipment in which you are interested.

THE SUPERIOR ELECTRIC CO.
BRISTOL, CONNECTICUT

THE SUPERIOR ELECTRIC CO., 402 CHURCH STREET, BRISTOL, CONNECTICUT

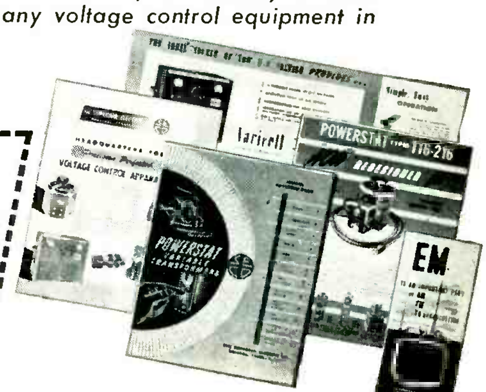
Please send me more information on ____________

My Name ____________

Company Name ____________

Company Address ____________

City ____________ Zone ______ State ____________

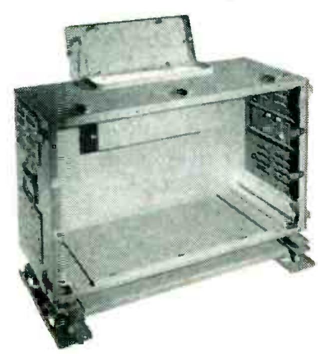


We're Racing with Time on Defense Production

BUT WE CAN FILL *SOME* ORDERS FOR CIVILIAN NEEDS

The majority of our customers in the electronics field are making equipment needed for our expanding national defense program.

We are manned and have the facilities to produce increased quantities of cabinets, chassis, and housings for this equipment—and as rapidly as possible. Speed, however, is not being gained at the sacrifice of quality, for American industry cannot put "jerry-built" equipment in the hands of our Armed Forces.



It is still possible for us to handle certain types of civilian orders, provided they are of such a nature that they will not tie up that part of our facilities engaged in more urgent operations.

Defense production must come first—but we are not closing the door on any customers whom it is possible to serve.

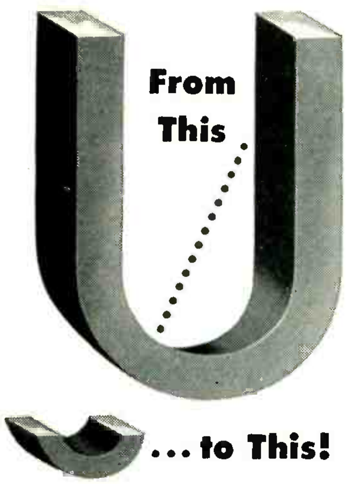
KARP METAL PRODUCTS CO., INC.

215 63rd STREET, BROOKLYN 20, NEW YORK

Specialists in Fabricating Sheet Metal for Industry

Let INDIANA Magnet Engineers Help Make Your Change-Over Easier

Permanent magnets are indispensable in many types of equipment used by the armed forces. Thus, an early discussion of your plans with INDIANA engineers is advisable. Recent improvements give "packaged energy" even greater utility.



THESE TWO MAGNETS PRODUCE THE SAME AMOUNT OF ENERGY. Above is a chrome magnet, the best of fifteen years ago; below, as made of INDIANA'S exclusive HY-FLUX Alnico V—strongest of today's magnet materials—introduced in 1950.

Quick conversion to Defense Production requires *seeing* problems and solving them without false starts or delay. So, if your "tomorrow's products" involve permanent magnets (or, if permanent magnets would simplify their manufacture or use) confer *now* with the industry's *leading* magnet designers and application specialists . . . The Indiana Steel Products Company's experienced staff of engineers.

INDIANA'S engineers established an enviable record in World War II for their work on permanent magnets used in radar, sonar, ranging equipment, aircraft magnetos, proximity fuses, guided missiles, etc. For example, they aided in the development of the *first* "packaged" magnetron tube, and—working with the Signal Corps—made portable telephones practical by reducing both the size and weight of the ringing generator required.

BENEFITS LIKE THESE CAN BE YOURS

INDIANA Permanent Magnets are components of many mechanical and electrical devices because they are so compact, easy to install, and deliver *uniform energy* without heat or operating parts. And improvements in materials and design have resulted in a wide range of wholly new uses.

INCREASED CAPACITY

As the world's largest producer of permanent magnets, with the accumulated know-how of more than 30,000 different applications . . . with facilities and personnel that won the Army-Navy "E", *now expanded by 50%* . . . The Indiana Steel Products Company offers you many unequalled facilities. Many types and sizes of magnets are immediately available for experimentation. Write or phone INDIANA today.

INDIANA PERMANENT MAGNETS

THE INDIANA STEEL PRODUCTS COMPANY

VALPARAISO, INDIANA • • • Sales Offices Coast to Coast

SPECIALISTS IN "PACKAGED ENERGY" SINCE 1908

We know only too well what is modern today in Electronics can be obsolete tomorrow. We can retard obsolescence by designing our products with an eye toward the future and what future applications may demand of our products.

Burnell & Company has shaped its engineering policy with this viewpoint – by striving to keep well ahead – not just abreast of developments in the Hi Q Coil and Filter business.

We search constantly for new design ideas that will permit the reduction of size and weight of Filters that "fly"; new circuits and components that will give our customers "more for their money" – and new production methods that will speed output and guarantee the reliability and life of our products.

Even our price structure has been streamlined to conform with the increasing industry-wide demand for economy, with no sacrifice in our high standard of quality.

We say that modern applications demand Burnell & Company's toroids and toroidal filter products because we are modern in every sense of the word: modern in outlook and technique as well as in price.

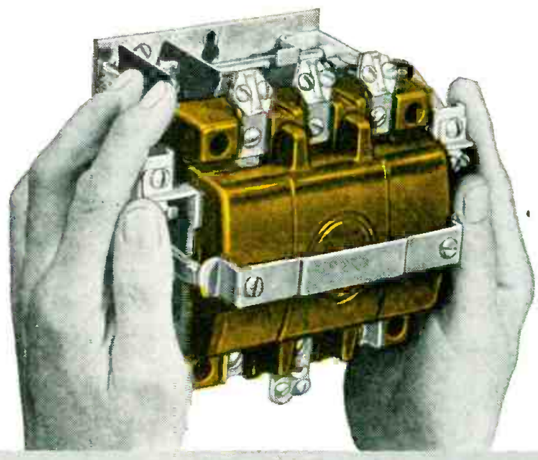
Exclusive Manufacturers of Communications Network Components

We particularly invite your inquiries concerning difficult filter applications

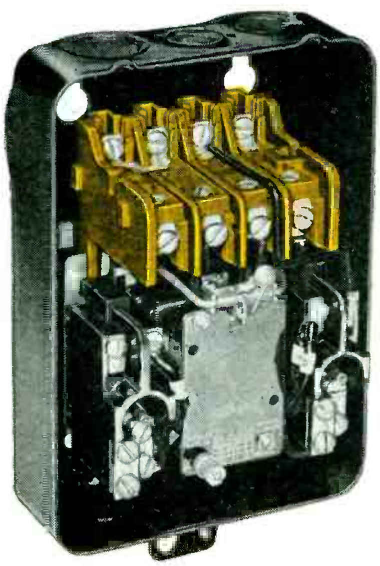
Burnell & Company
YONKERS 2, NEW YORK
CABLE ADDRESS "BURNELL"

CUTS REJECTS 70%. High voltage capacitors made by Centralab for use in television sets are subjected to a high voltage breakdown test. Rejections were cut 70% when Centralab switched to Plaskon Alkyd.

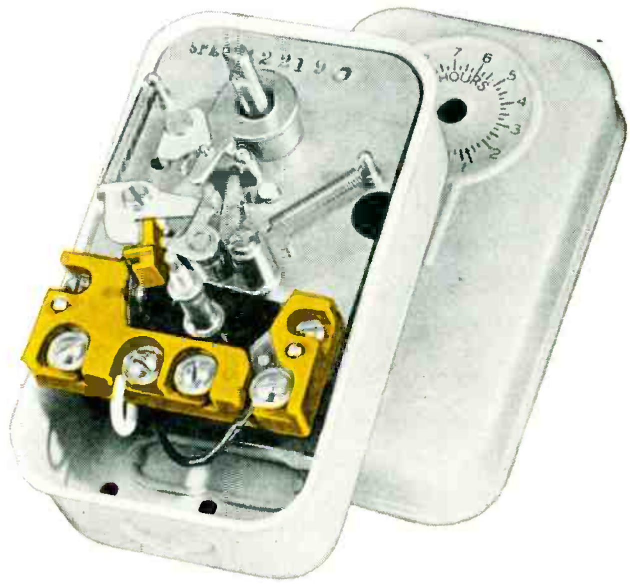
REDUCTION IN SIZE. Exhaustive arc resistance tests faithfully reproducing actual service conditions convinced Arrow, Hart & Hegeman engineers of the unexcelled arc resistance of molded Plaskon Alkyd. This benefit enabled them to redesign and reduce the overall size of their complete line of magnetic starters.



more evidence of savings with PLASKON ALKYD



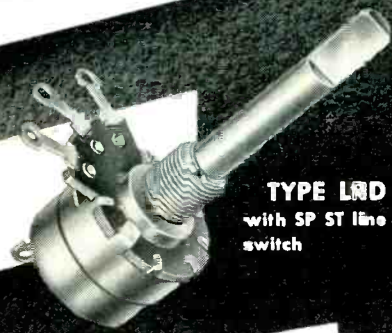
TIME SAVING 50%; MONEY SAVING 25%. Furnas Electric Company found that the fast molding characteristic of Plaskon Alkyd cut production time 50%. A cost saving of 25% has been realized on the cost of the finished product.



PRODUCTION INCREASED 392%. Switching to Plaskon Alkyd enabled Sangamo Electric Company to produce plastic parts for their time switch nearly 4 times as fast as was possible with a competing material.

Space and Cost Savers...

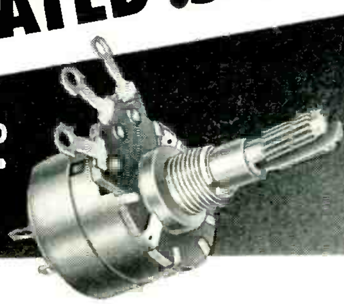
TYPE LR
without line switch



TYPE LRD
with SP ST line switch

Only 57/64" in diameter...

CONSERVATIVELY RATED .5 WATT



TYPE LRA-10
with DP ST line switch

DUAL CONCENTRICS FOR TV

These sturdy little Stackpole LR type controls handle higher wattages more dependably than most controls that are a good bit larger in size. Less than an inch in diameter, they're conservatively rated at .5 watt for use where voltage across the units does not exceed 350 volts for linear tapers, or for non-linear ones having a taper of no less than 10% of the total resistance at 50% rotation, provided that 225 volts is not exceeded. Thus there is plenty of wattage capacity for a wide variety of present day uses including many television applications. Stackpole LP type controls, slightly larger, are rated .6 watt at linear taper if 500 volts is not exceeded and also at .6 watt if the resistance is not less than 10% at 50% rotation, provided that 250 volts is not exceeded.

LR controls are available as concentric shaft duals.

Electronic Components Division

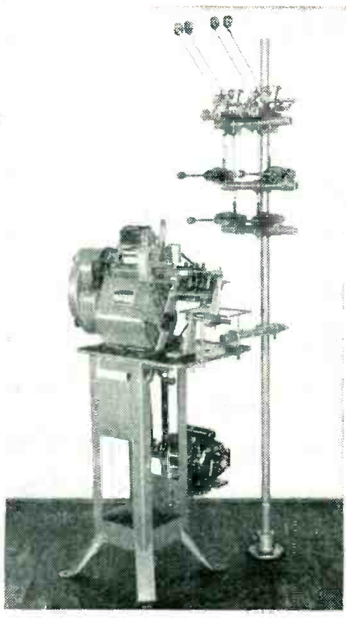
STACKPOLE CARBON COMPANY

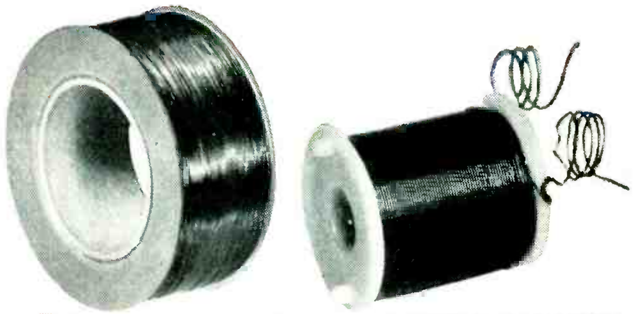
ST. MARYS, PA.

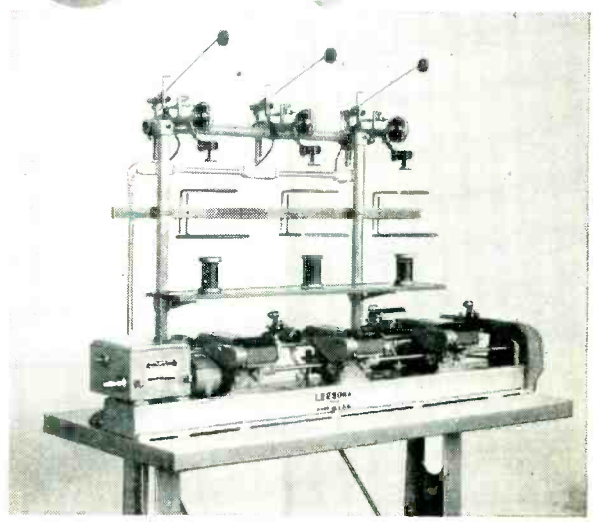
STACKPOLE

If You Need Coils Like These...

you need UNIVERSAL Coil Winders







Lattice-type coils for television and radio. Wind one to four coils at once on the Universal No. 84 Coil Winder, with (in most cases) a single operator for two machines.

Speeds are from 400 to 950 rpm, and a counter control provides instant automatic stop upon completion of coil.

Quickly-adjustable "gainer" mechanism, which accurately positions wire turns, and strap-type tensions help you get accurate, uniform winding. In-built calibration facilitates change-over.

Write for Bulletin 84-LM.

Non-insulated spool-wound coils. Wind coils on several heads at once, using the new Universal 102 High Speed Coil Winder, and synchronize output on the basis of handling time per coil.

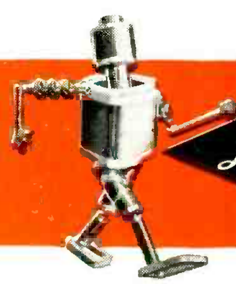
Each head is individually operated, and you can so schedule the winding that certain heads will be producing while manual operations are performed on other heads.

With a maximum speed of 5000 rpm, the High-Speed 102 is efficient for coils having up to 15,000 turns. Oil seals make the machine *oil-tight*.

Write for Bulletin 102-LM.

UNIVERSAL WINDING COMPANY

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



LEESONA

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

A NEW Insulating Laminate...

INSUROK*
GRADE T-812

COMBINES:

- SUPERLATIVE INSULATION RESISTANCE
- LOW MOISTURE ABSORPTION
- VERY HIGH STRENGTH
- EXCELLENT PUNCHABILITY

*Reg. U. S. Pat. Off.

INSUROK T-812 is a new paper-base punching stock that laughs at heat and humidity! It has outstanding properties that have never before been combined in one insulating laminate. T-812 has excellent electrical characteristics, plus a spectacular ability to retain them through extremes of heat and humidity. Its insulation resistance after humidity conditioning is particularly noteworthy.

INSUROK T-812 retains all of the properties of the well-known INSUROK T-725 and, in addition, has lower moisture absorption and much higher insulation resistance. It punches readily into intricate shapes. Investigate INSUROK T-812 for your product. Information upon request.

T-812's *Property Combination* —Unmatched by any other material!

Thickness tested......1/16"
Moisture Absorption (24 hours)......0.38%
Expansion after 24 hours' immersion in water at 77°F. Center....0.0001" Edge..............0.0002"
Tensile Strength, psi.......Main Direction..........19,500..........Cross Direction............14,500
Flexural Strength, psi.......Main Direction..........23,000..........Cross Direction............18,000
Dielectric Strength (perpendicular to laminations) V/Mil, Short Time......725 Step by Step......625

	Tests at Room Conditions	After 96 hrs. at 90% Rel. Hum. at 104°F.
Power Factor at 1 megacycle	0.028	0.030
Dielectric Constant at 1 megacycle	4.4	4.5
Loss Factor at 1 megacycle	0.13	0.14
Insulation Resistance, megohms		1,000,000

The RICHARDSON COMPANY

FOUNDED 1858—LOCKLAND, OHIO

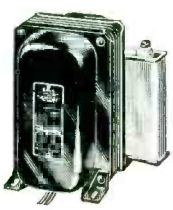
2797 Lake St., Melrose Park, Illinois (Chicago District)

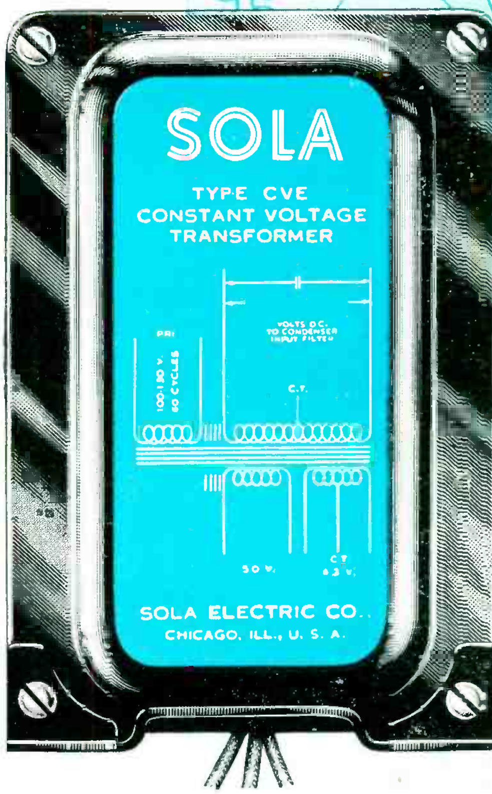
SALES OFFICES: CLEVELAND • DETROIT
INDIANAPOLIS • LOCKLAND, OHIO • MILWAUKEE
NEW BRUNSWICK, (N. J.) • NEW YORK
PHILADELPHIA • ROCHESTER • ST. LOUIS

Built-in VOLTAGE REGULATION *at Moderate Cost*

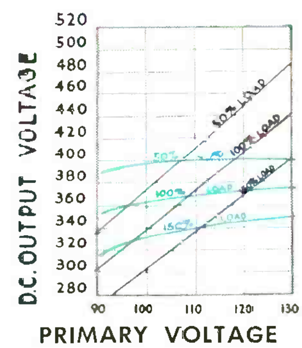
Insure constant plate and filament voltage for your electronic products with standard SOLA "CVE" POWER TRANSFORMERS.

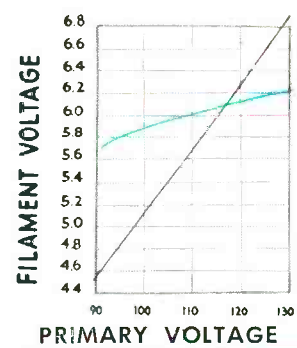
Specify the new SOLA "CVE" Constant Voltage Power Transformers in your circuit design to eliminate the variable of fluctuating line voltage at unusually low cost. Regulation of filament and plate supply is ±3% at line voltage variations from 100 volts to 130 volts.





REGULATION COMPARISON
SOLA "CVE" Power Transformer—





The SOLA "CVE" standard Power Transformers are completely automatic and continuous in regulation . . . have no moving parts or tubes . . . and are self-protecting against short circuit. They are stocked in 42 V.A., 75 V.A. and 210 V.A. capacities to cover most electronic power supply requirements. We invite your inquiries on the application and benefits of the moderately priced "CVE" Constant Voltage Power Transformers to your product. For full electrical and mechanical specifications write for Bulletin D-CVE-138.

SOLA *Constant Voltage* TRANSFORMERS

"CV" for high precision voltage regulation. "CVE" for regulated electronic power supplies. "CVH" for constant voltage with less than 3% harmonic distortion. "CVA" for constant voltage on television receivers.

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

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

Something New

NEW OVAL SELECTOR SWITCHES

Several new oval rotary selector switches are described in Bulletin L13 just issued by the Shallcross Manufacturing Co., Collingdale, Pa. Six basic plates and three rotor types produce switches having from one to three poles per deck or gang and with other desired mechanical and electrical details. As many as 18, 9 or 6 positions may be obtained in single-, double-, or triple-pole types respectively. These may be single-, double, or triple-pole decks exclusively or a combination of different types.

VERTICAL STYLE PRECISION RESISTORS FOR JAN USES

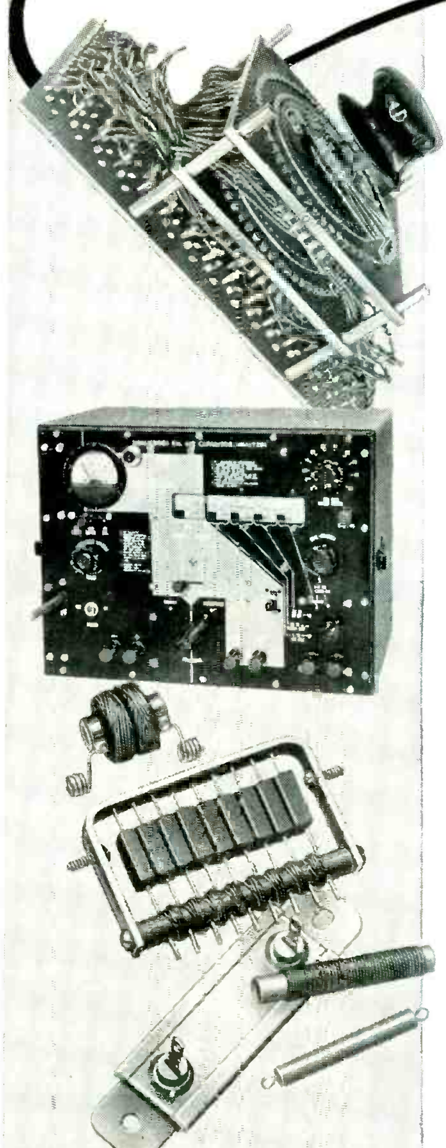
Improved vertical style precision wire-wound resistors for use where mounting requirements make it desirable to have both terminals at the same end of the resistor have been introduced by the Shallcross Manufacturing Co., Collingdale, Pa. These units provide a longer leakage path from the mounting screws to the terminals. Known as Shallcross Types BX120, BX140, and BX160, they are designed to meet JAN requirements for styles RB40B, RB41B and RB42B respectively. For commercial uses, the resistors carry somewhat higher ratings than for JAN applications. Wire leads instead of terminals can be furnished if desired. Complete details will gladly be sent on request to the manufacturer.

FLAT, METAL-ENCASED WIRE-WOUND RESISTORS

Flat, metal-encased, Type 265A wire-wound power resistors introduced by the Shallcross Manufacturing Company, Collingdale, Penna. are space wound, have mica insulation, and are encased in aluminum for mounting flat against a metal chassis. At 175° C. continuous use they are conservatively rated for 7½ watts in still air and 15 watts when mounted on a metal chassis. Write for Bulletin 122.

ADV.

A RELIABLE SOURCE FOR YOUR *Custom Built* Electric-Electronic Specialties



Leading equipment manufacturers find that it pays to turn specialized assignments over to Shallcross for development, design or production . . .

From critical components to sub-assemblies and instruments, Shallcross' broad experience and precision facilities assure better results . . .

Often, they assure an appreciable cost saving as well.

- A capable staff of electrical, electronic, mechanical, chemical and instrumentation engineers . . .
- A fully equipped plant . . .
- Plus over 20 years of specialization in high quality products for military, industrial and public utility use . . . are here at your disposal.

AMONG RECENT SHALLCROSS CUSTOM-BUILT ASSIGNMENTS HAVE BEEN:

ROTARY SWITCHES
POTTED AND THERMALLY-CONTROLLED R-C NETWORKS
PRECISE DECADES AND NETWORKS FOR COMPUTER DEVICES
CALIBRATING INSTRUMENTS FOR STRAIN GAUGE BRIDGES
HIGH RESISTANCE STANDARDS
CRITICAL COIL ASSEMBLIES
HERMETICALLY SEALED CHOKES
HIGH-VOLTAGE MEASURING EQUIPMENT, ETC.

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ENGINEERS
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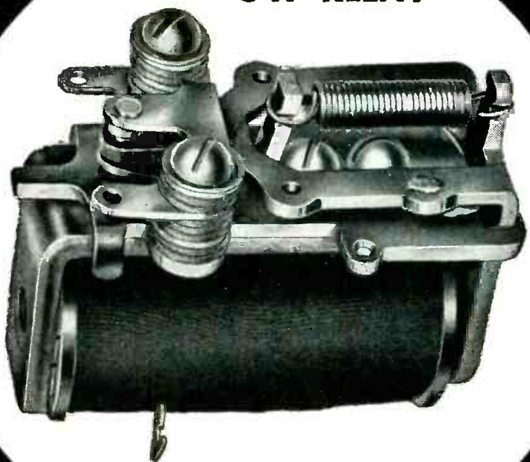
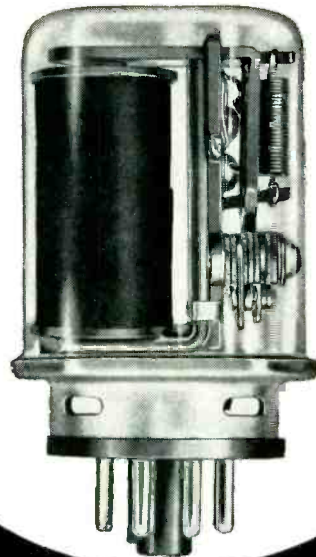
SHALLCROSS MANUFACTURING CO.
COLLINGDALE, PA.

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 →

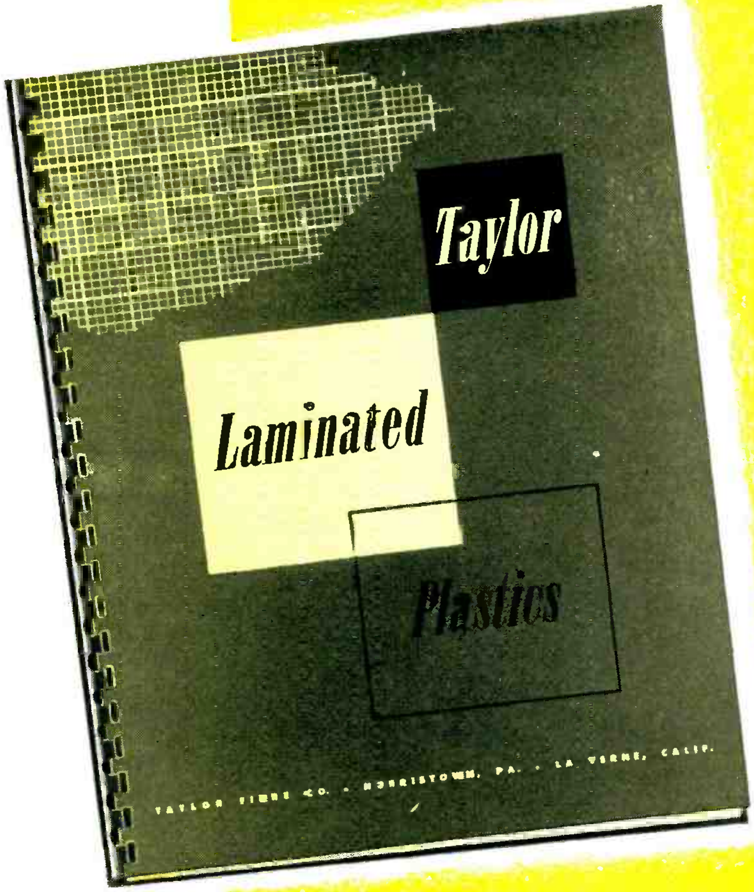
Bulletin SW gives complete details. Send for your copy today.

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

ALLIED CONTROL COMPANY, INC.

2 EAST END AVENUE, NEW YORK 21, NEW YORK



HERE'S HELP

FOR THE PLASTICS USER

It's the new Taylor Catalog . . . 48 fact-filled pages of descriptive and engineering data on Vulcanized Fibre, Phenol Fibre and Special Laminates. If you are looking for new ways and means to improve your product, *and save money too,* here's an idea source guaranteed to spark the imagination and give you a hat full of hints, tips and suggestions.

In this new Taylor Catalog you will find all the details you need to know about electrical, physical and chemical properties of sheets, tubes and rods. It tells you how to design, plan, and buy for maximum economy. It offers valuable tips and suggestions on how to select the right Taylor material for the job. It shows you how to machine these versatile materials . . . gives you weights, suggested applications . . . specifications.

And that's not all! There's a lot more information as well . . . tables, diagrams and technical data that you'll find of constant value.

This new Taylor Laminated Plastics Catalog should be in your files. For your free copy, just fill in the coupon below . . . mail it *today* . . . we'll do the rest!

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HERMETIC SEALING COMPONENTS

NEO-SIL
CORPORATION

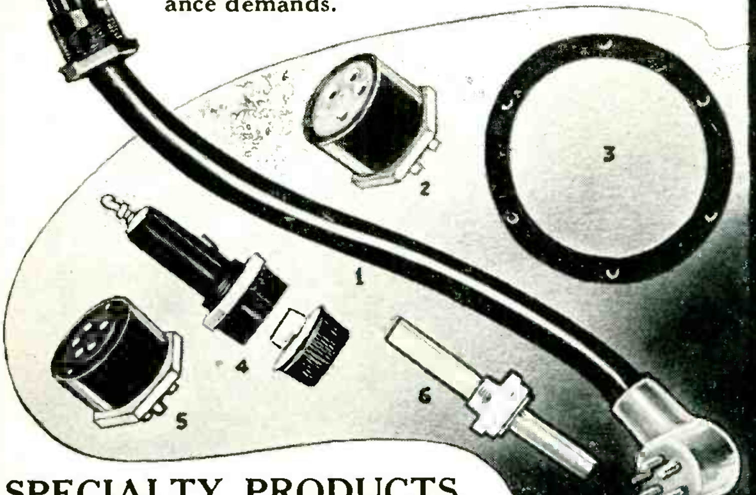
Welcomes Exacting Demands

NEO-SIL is the result of ten years of engineering research and development. Its application to our hermetic sealing components has been proven under severe and exacting tests in both our own and our customers laboratories. NEO-SIL components will help reduce your rejects resulting from breakage, strain, cracks, physical shock, etc.

NEO-SIL components will pass the grade one, class A requirements for Army, Navy and aircraft military equipment.

It costs no more to use these hermetic sealing components and their use will save you money.

For performance, quality and economy—specify NEO-SIL hermetic sealing components. Manufactured by NEO-SIL Corporation—to meet the most exacting performance demands.



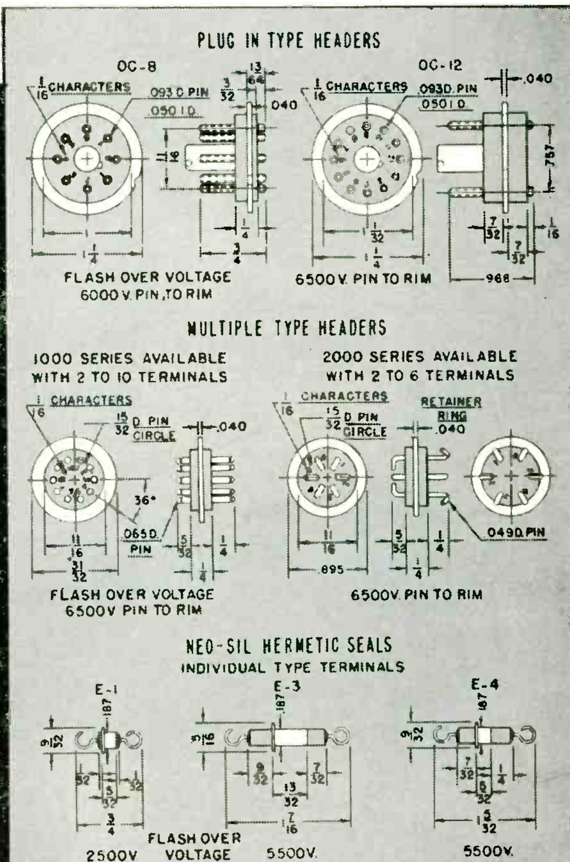
SPECIALTY PRODUCTS

1 Molded Cables With Plugs Attached
2 Female 4 Pin Panel Connector
3 Meter Hermetic Seal Gasket
4 Panel Type Hermetic Seal Fuse Holder
5 5 Pin Female Panel Connector
6 Rotary Hermetically Sealing Panel Bushing

The above items are all pressure checked at 25 pounds per square inch.

The materials and processes used in the manufacture of all sealed components are made to conform to the most rigid JAN specifications.

Your special problems are solicited.



NEO-SIL TECHNICAL DATA

NEO-SIL is a synthetic compound, which was developed expressly for the purpose of providing a suitable insulating material, which could be satisfactorily bonded to various metals, under a wide range of temperatures, be impervious to most acids and alkalies, provide a comparatively non-wetting surface, have a high insulation resistance, and meet the exacting requirements of the Janization program of the Armed Services. These compounds, in their various forms, produce component parts which are able to meet these exacting requirements.

TEST DATA

The result of the Electrical Testing Laboratories Inc., Report #330655, dated March 18, 1949, on this material shows the following:

Volume Resistivity at 800 Volts d-c

Room Temperature 25°C	R.H. 30 percent
Megohm-inches	*ohm-centimeters*
1.4×10^{6}	3.5×10^{12}

Dielectric Constant and Dissipation Factor

Dielectric Constant	*Dissipation Factor*	*Loss Factor*
	@ 60 cycles per second	
9.22	.058	5.32
	@ 1 megacycle per second	
6.17	.0455	.28
	@ 50 megacycles per second	
5.35	0.20	1.1

Dielectric Strength at 60 cycles
Volts per mil — 370

Durometer Average — 80 ± 5

Temperature — Rated as a Class A material conservatively + 105° to —70° centigrade.

The Flashover Voltages indicated were taken at a temperature of 68° Fahrenheit, and 47% Relative Humidity.

NEO-SIL
CORPORATION

26 CORNELISON AVE., JERSEY CITY 4, N. J.

ASK *Erie* RESISTOR

. . . about custom designed trimmers

Pictured above are several custom designed trimmers that incorporate the elements of standard Erie Disc and Tubular Ceramicon Trimmers. Each has been developed for a specific purpose, and each does its job efficiently and economically. Proper design and precision manufacturing, plus our years of experience, are the keynote to Erie quality.

Look at these units carefully. They should suggest the possibility of using Erie Resistor know-how and facilities to make your equipment more compact and more efficient.

Erie has the most complete trimmer line in the industry. We would like to work with you on combining trimmers, fixed capacitors, and other circuit elements into integrated sub-assemblies. Inquiries should specify complete mechanical and electrical requirements.

(1) Standard Style TD2A Dual Trimmer with mounting pillars.

(2) Special ribbon type terminals on standard Style TS2B Trimmer for direct connection to other components.

(3) Compact Trimmer—Capacitor—Resistor—Coil Design. A complete oscillator unit.

(4) (5) (6) Where special mounting is desired, standard Erie Style TS2A and Style 557 Trimmers can be supplied mounted on brackets.

(7) (8) Two trimmer elements become an integral part of this coil form and I. F. top section.

(9) Special bracket and terminal arrangements on dual trimmer unit.

(10) A compact pluggable assembly for mounting a trimmer in parallel with a plug-in crystal.

(11) Special tubular ceramic trimmer and variable inductance having one common terminal.

(12) Special steatite tubular dual trimmer.

(13) Standard Erie Style 557 Trimmer with special bent rotor terminal.

Electronics Division

ERIE RESISTOR CORP., ERIE, PA.

LONDON, ENGLAND . . . TORONTO, CANADA

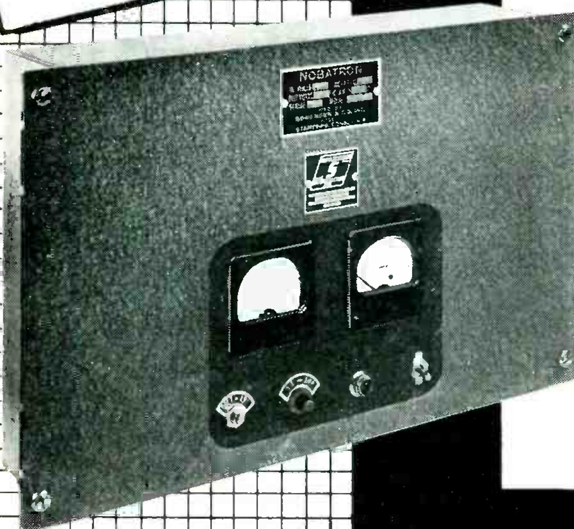
Specify Sorensen

NOBATRONS

(DC VOLTAGE REGULATORS)

DO YOU WANT the *advantages* of storage battery characteristics without the *disadvantages?* Then equip with Sorensen NOBATRONS! You get adjustable output voltage, stabilized against changing line AND LOAD conditions. You eliminate battery charging and maintenance, gas, acid hazard.

Like all Sorensen regulators, the NOBATRON is a painstakingly engineered combination of fine workmanship and top-quality components. That means accurate, trouble-free operation; long life!



MODEL NO. E-6-15

STANDARD MODELS

6-VOLT SERIES

E-6-5	E-6-40
E-6-15	E-6-100

12-VOLT SERIES

E-12-5	E-12-30
E-12-15	E-12-50

28-VOLT SERIES

E-28-5	E-28-70
E-28-10	E-28-150
E-28-30	E-28-350

48-VOLT SERIES

E-48-15

125-VOLT SERIES

E-125-5	E-125-10

Model numbers indicate voltage and current; for example, E-5-5 indicates 6 VDC with 5 amp total capacity.

COMMON ELECTRICAL SPECIFICATIONS

Input voltage range	95-130 VAC; adapter transformers available for 230 VAC operation*
Output voltage range	Adjustable ± 10%
Regulation accuracy and load range	± 0.2% from 1/10 load to full load
Ripple voltage RMS max.	1%
Recovery time	0.2 second—this value includes charging time of filter circuit for the most severe change in load or input conditions
Input frequency range	50-60 cycles

*Some high current units require three-phase input

Write for Complete Literature

For other regulation problems investigate Sorensen's line of AC Voltage Regulators, Voltage Reference Standards, DC Power Supplys.

POWER controlled converted

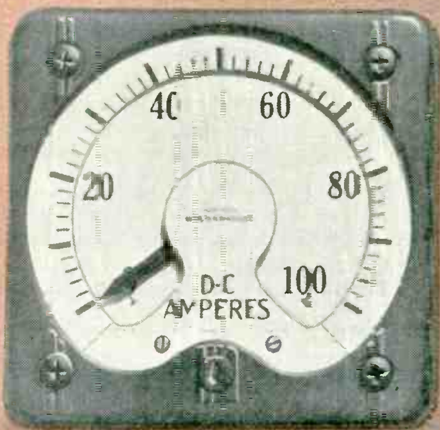
Sorensen and company, inc.
375 FAIRFIELD AVE. • STAMFORD, CONN.

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

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

Westinghouse

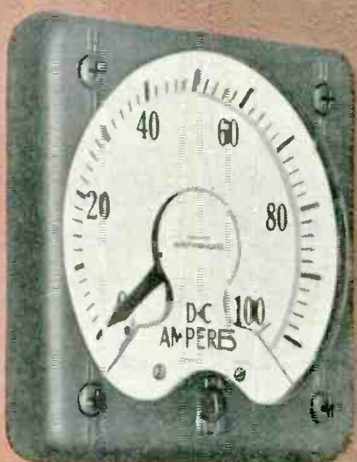
GREATER HEAD-ON READABILITY



NEW

OLD

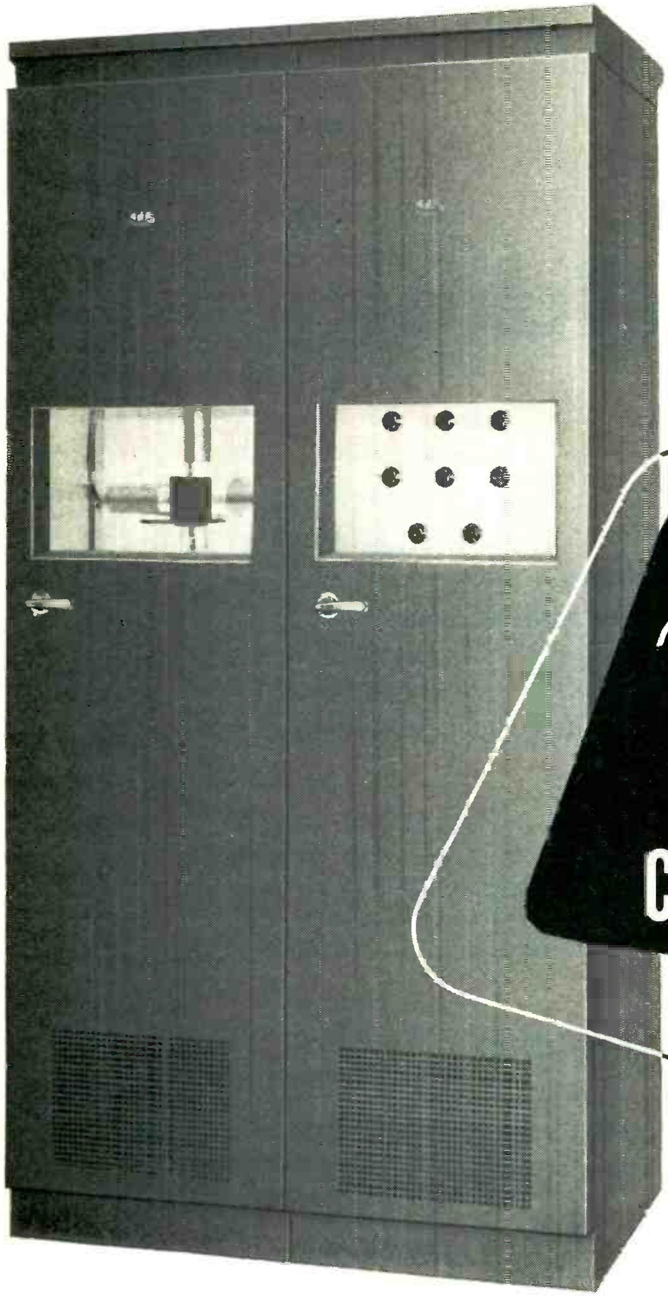
GREATER ANGLE READABILITY



NEW

OLD

The New, Full-View Type K-24 is another example of the constant effort Westinghouse is making to meet customer requirements for better instruments. It is typical of the extreme attention that goes into every detail . . . *for better performance and better usability.*



what about color TV?
what are you doing about it?

Du Mont Announces the UNIVERSAL COLOR SCANNER

A SIGNAL SOURCE FOR ALL TV COLOR SYSTEMS

Operating on the principle of the flying spot scanner, the Du Mont Universal Color Scanner provides for the Broadcaster, Receiver Manufacturer, Development Laboratory — tri-color signals from any 35 mm. 2 x 2" color transparency. Available as outputs are an FCC approved field sequential video color signal and three simultaneous video color signals which may be fed to any external sampling equipment for experimental work with line or dot sequential systems. Horizontal line frequencies may be set at 15.75 or 29.16 kc and vertical field rates at 60 or 144 fields per second (intermediate values may be specified as desired). This assures a flexible equipment embracing both present black and white standards as well as FCC approved color standards and adaptable for use with any of the other presently proposed color systems.

SEND FOR DETAILED TECHNICAL LITERATURE

DUMONT

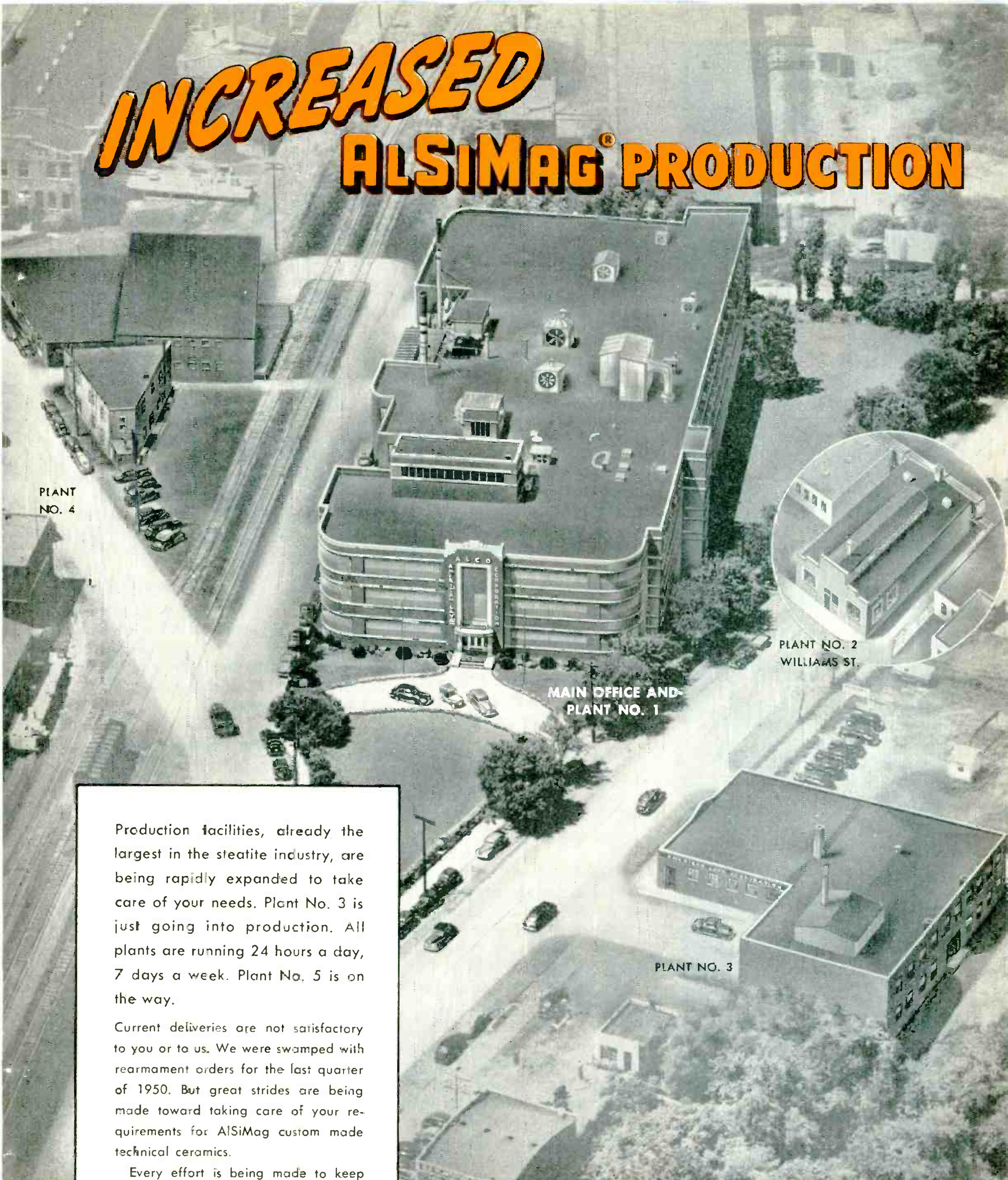
First with the Finest in Television

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

Containers . . . coin machines . . . compressors . . . corn-husking machines . . . (or what have you?) . . . all these and scores more count to the greater advantage of their users or producers, *or both* . . . with Veeder-Root Counters. These infinitely useful devices, electrical or mechanical . . . may be either applied to a process or *built into a product* as original equipment. WRITE: Veeder-Root Inc., Hartford 2, Conn. (New Phone: 7-7201). *In Canada:* Veeder-Root of Canada, Ltd., 955 St. James St., Montreal 3. *In Great Britain:* Veeder-Root Ltd., Kilspindie Rd., Dundee, Scotland.

"VEEDER-ROOT COUNTS EVERYTHING ON EARTH"

INCREASED ALSiMAG® PRODUCTION



Production facilities, already the largest in the steatite industry, are being rapidly expanded to take care of your needs. Plant No. 3 is just going into production. All plants are running 24 hours a day, 7 days a week. Plant No. 5 is on the way.

Current deliveries are not satisfactory to you or to us. We were swamped with rearmament orders for the last quarter of 1950. But great strides are being made toward taking care of your requirements for AlSiMag custom made technical ceramics.

Every effort is being made to keep American Lava Corporation your most dependable source for quality and for delivery according to promise.

AMERICAN LAVA CORPORATION

49TH YEAR OF CERAMIC LEADERSHIP

CHATTANOOGA 5, TENNESSEE

OFFICES: METROPOLITAN AREA: 671 Broad St., Newark, N. J., Mitchell 2-8159 • CHICAGO, 223 North LaSalle St., Central 6-1721
PHILADELPHIA, 1649 North Broad St., Stevenson 4-2823 • LOS ANGELES, 232 South Hill St., Mutual 9076
NEW ENGLAND, 38-B Brattle St., Cambridge, Mass., Kirkland 7-4498 • ST. LOUIS, 1123 Washington Ave., Garfield 4959

BUSINESS BRIEFS

By W. W. MacDONALD

National Emergency pulls the teeth of the FCC's color-television decision; producing black-and-white sets will be difficult enough. By the time the question comes up again technical advances will have altered the picture and, from what we have seen and heard recently in Washington, compatibility will be part and parcel of it.

The industry has, in a sense, been saved by the bell.

Military Equipment Contracts often include maintenance manuals and many a bidder has stubbed a financial toe by failing to include in his figures enough to cover their production. Others have had equipment acceptances delayed because manuals were not ready to go with the gear.

There are several satisfactory ways of handling the production of manuals, but all of them are expensive. Take it from us that technicians who can write are becoming hard to find and that printing and paper costs are steep. More important still, securing the approval of government agencies on anything so subject to differerences of opinion as the quality of the written word can be a long-drawn-out proposition.

Some Civilian Services are vital to the emergency effort. We know of no better proof than the fact that two manufacturers were recently directed to expedite shipment of 12,000 tubes to civilian airlines, the directive taking priority over military orders.

November Land Hurricane that ripped and tore the eastern part of the country damaged a lot of antenna towers. Among the stations requesting FCC permission to reduce power or to use temporary skywires were WAAT, WALD, WAWZ, WBRY, WDAS, WLVA, WMGM, WMID, WNEW, WOV and WPRO.

By one of those rare coincidences gratefully accepted by editors, the storm hit on the very day that our December issue containing the article "How to Select Antenna Towers and Masts" went into the mails.

Computer Tubes most frequently used appear to be the following:

Beam Tetrodes	Pentodes	Switch Tubes	Gating Tubes
6AN5	6AG7	2C51	6AS6
6AQ5	6AK5	6J6	6BE6
6L6	6AU6	6SN7	7AK7
25L6	6SJ7	6SL7	5915
50B5	7AD7	12AT7	
		12AU7	
		12AX7	
		5687	
		5963	
		5964	

This, at any rate, was the consensus of opinion around the recent Joint Conference on Electron Tubes for Computers at Atlantic City.

Creeper, dancer, dillidallier, wiggler, up-drifter and down-drifter. These words are currently being used to describe the antics of malfunctioning germanium diodes, further enriching our technical vocabulary.

Long Island Railroad wreck investigators have suggested that the management might look into, among other things, the possible use of radar to avoid future collisions. The suggestion is indeed flattering to the electronics industry, but it seems to many of us who ride the line that it might first be necessary to jack up the radar and build a railroad under it.

Highway Maintenance is greatly facilitated by the use of radiotelephones, according to **H. A. Radzikowski** of the Department of Commerce, who furnishes the following interesting statistics;

Some 68 State, County and City highway departments are already using or are planning to use radio. Forty of them report that present facilities cover a combined operating area of 709,784 square miles and 129,075 miles of highways. Installations for statewide coverage cost as much as $500,000; smaller county installations cost between $10,000 and $20,000, about

Now 6

SYLVANIA GERMANIUM DIODES SEALED-IN-GLASS

They're individually engineered to meet YOUR circuit requirements

1N34A—General Purpose Diode. The workhorse of the Sylvania line. *New* higher quality standards guarantee back resistance higher than ⅓ megohm at −10 volts.

1N38A—High-Resistance, 100-Volt Diode. *Now* specially engineered to guarantee still higher back resistance at both high and low voltage levels. 0.6 megohm at −3 volts; 0.2 megohm at −100 volts.

IN54A—Here's a real high back resistance crystal. *Now* guaranteed to show at least 1.4 megohms at −10 volts—averages better than 2! Use it for high efficiency in high load resistance circuits.

1N55A—150-Volt Diode. *New* more rigid specifications guarantee at least 0.3 megohm back resistance at −150 volts.

1N56A—Low Forward Impedance Diode. Average forward resistance less than 60 ohms at one volt. Ideal for high efficiency operation into low impedance loads.

1N58A—General Purpose 100-Volt Diode. *Now* guaranteed to have resistance of at least 0.16 megohm at −100 volts. Use it for gating or clamping circuits where dependable high voltage hold-off is required.

Try these new, finer-quality Sylvania "Sealed-in-Glass" Germanium Diodes. You'll find them ideal for scores of applications calling for low power rectification at frequencies up to several hundred megacycles.

Mail the coupon today for a new FREE, 8 page booklet describing Sylvania's complete line of both glass and ceramic style Germanium Diodes and for Varistor types.

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

SYLVANIA ELECTRIC

Sylvania Electric Products Inc.
Dept. E–1002
Emporium, Penna.

Please send me full information concerning the complete line of Sylvania Germanium Diodes.

*Name*________________
*Company*________________
*Street*________________
*City*________ *Zone*____ *State*______

the same as one heavy motor grader.

Onondaga County, New York, recently figured interest on investment, depreciation, repair and operation of its single-base-station and 54-mobile-unit system at 8 cents per hour for each radio-equipped vehicle. The system is used to manage a fleet of 100 trucks and other road equipment.

Receiver Sales by licensees for the first nine months of 1950 totalled 14,684,184, worth $1,061,641,271. Here's the way the total broke down:

Type	Units	Dollars
Electric		
Table (under $12.50 billing price)	1,984,752	$20,662,085
Table (over $12.50 billing price)		
A-M	1,855,986	33,221,330
A-M/F-M	264,617	8,083,812
F-M (including converters)	10,078	226,603
Consoles		
A-M	6,219	409,026
A-M/F-M	3,874	433,695
Table-Radio-Phonos		
A-M	267,186	11,121,908
A-M/F-M	14,644	947,257
Console-Radio-Phonos		
A-M	55,089	4,611,161
A-M/F-M	343,502	42,154,949
Battery		
Portable A-C/D-C	1,240,872	22,053,471
Table	72,150	1,134,132
Consoles	42	3,799
Auto	3,473,837	89,846,277
Television		
Converters	4,060	482,171
Radio Table Models	1,995,522	274,816,075
Radio Consoles		
Direct Viewing	2,196,957	409,326,839
Projection	8,633	2,170,634
Radio Phonos		
Direct Viewing	474,245	126,902,582
Projection	37	17,915
Phonographs		
Phono only	310,644	5,334,496
With radio attachment	19,769	620,182
Without Cabinets		
A-M	11,432	259,991
A-M/F-M	13,883	597,578
Television	56,154	6,203,303

Viennese Engineers dial B 34-504 and hear a 1,000-hertz (1,000-cps) audio tone, very handy for testing. Dialing A-069 produces the musical note "A" (440 hertz). Austrian Telephone Company picks up the tones from the Austrian Bureau of Standard's quartz-crystal-controlled clock, which is correct within one-tenth of a million of one hertz scale degree.

Reliable Tubes for industry, about which we have long harped in this column, are exemplified by those used in a recently publicized telephone company submarine-cable repeater unit. Why are these tubes reliable? Among the many reasons, they are operated *well below ratings.*

Other users please copy.

A Reader out in Palo Alto has invented a crash-locator beacon that is automatically ejected and sends out a continuous radio signal when an airplane cracks up. He's looking for a manufacturer.

Ray Guy, president of IRE, thinks that eastern television programs will reach Pacific Coast receivers by way of telephone lines and microwave relays early in 1952.

Slip Showing in the columns of one of our contemporaries but noted only by people with a penchant for proofreading: "Modern comical antennas are so effective on all bands that in some instances they even outperform separate high-band antennas."

Radio Free Europe broadcasts by Crusade for Freedom (National Committee for a Free Europe, Inc.) have been in progress since July 4th. Several new transmitters are planned and at least one is understood to be on order in Switzerland.

Overseas: Danish-made television receivers have been demonstrated to the public. Components, with the exception of picture tubes, can be made by some 30 plants and assembled by about 20 others, the two groups at present employing 25,000-odd people. Copenhagen and Malmo are within range of the first station to render regular program service, which is scheduled to start about the time this item goes to press, operating one hour three times a week. Set owners will pay a license fee.

The Philips-Valve Works in Hamburg, Western German Republic, has turned out 10,000,000 radio tubes since the end of World War II. Production, which totalled 600,000 tubes in 1946, has now reached an annual rate of 6,000,000.

This Month's Understatement: "West German radio manufacturers say there is no immediate danger of overproduction of radio sets." (*Reuters*)

Mallory Engineering Experience

Solves Power Supply Problem With Unique Vibrator Application

The versatility of the Mallory Vibrator and the practicality of Mallory engineering have been demonstrated in a growing variety of power supply applications.

One customer had been experimenting with germicidal lamps in produce trucks to retard bacterial action...but was stumped by the need for an efficient power supply. Mallory tackled the problem and came up with an ingenious application of the Mallory Vibrator . . . plus complete technical data for producing the complete power unit assembly.

That's service beyond the sale!

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

MALLORY VIBRATORS

Mallory Vibrators are based on exclusive design and manufacturing methods that assure long, trouble-free service. Send the details of your application. Get Mallory's recommendation on the Vibrator or Vibrapack* power supply best suited to your needs.

**Reg. U.S. Pat. Off.*

Vibrators and Vibrapack* Power Supplies

P. R. MALLORY & CO., Inc.

MALLORY

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

SERVING INDUSTRY WITH

Electromechanical Products
Resistors *Switches*
TV Tuners *Vibrators*

Electrochemical Products
Capacitors *Rectifiers*
Mercury Dry Batteries

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Contacts *Special Metals*
Welding Materials

CROSS TALK

▶ **WATCHES** . . . Suppose piezoelectricity were a property of materials as yet undiscovered. Without quartz crystals and the like, how would we maintain the frequencies of radio transmitters to the accuracy required for full occupancy of the spectrum? Tuning forks? General Radio has a 100-cps temperature-controlled fork accurate to 0.001 percent, relative to a mean frequency specifiable to 0.0001 percent. This is plenty good enough, even for television broadcasting, for which the allowed tolerance is 0.002 percent. For vhf television frequencies, frequency multiplication of the order of 200,000,000 times from fork to final amplifier would be required, but experience with f-m broadcast stations has proved this practical, if somewhat more expensive than a quartz slab.

Dr. J. A. Van Horn, in a fascinating article "Physics in the Watch Industry" (December issue of *Physics Today*) suggests that the job can be done in still another way, by a pocket watch! A good watch has an integrated error over a 24-hour period better than 0.006 percent, and a chronometer is at least ten times better, or in the class of the temperature-compensated tuning fork. At first glance this seems an attractive idea. One would divide the carrier frequency down to the audio range and run an electric clock, comparing its second hand with the second hand of the chronometer.

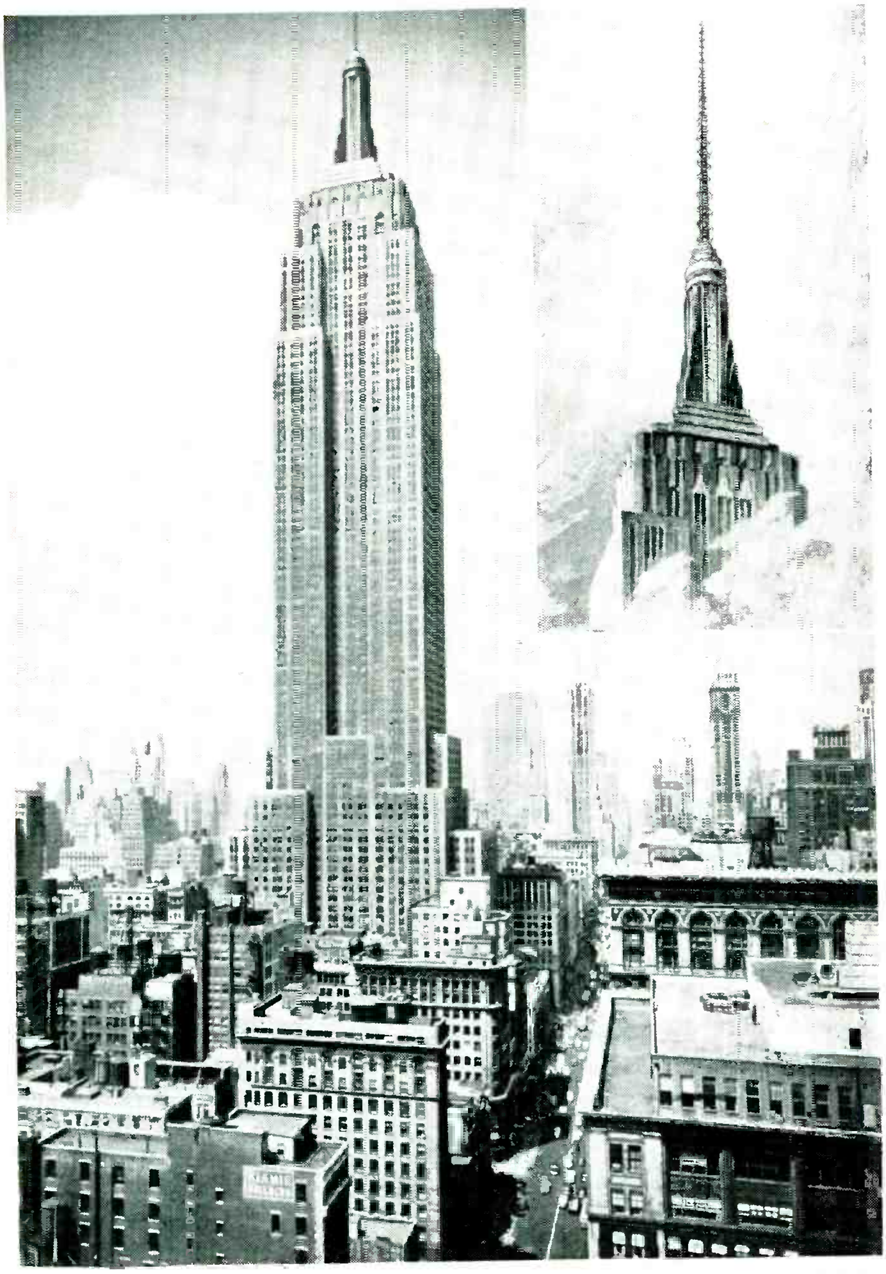
This might work, provided the transmitter had very good short-time stability, so that one could safely wait several hours for a visible discrepancy to appear between the two second hands. But this begs the question, since a transmitter without crystal control would probably drift in random fashion by ten times the allowed tolerance in a few seconds or minutes. This would never show up without microscopic examination of the relative position of the second hands. For example, the maximum allowable a-m broadcast drift of 20 cycles at a carrier frequency of one megacycle, occurring in 10 seconds, would advance or retard the second hand only 20 millionths of a radian, a quite undetectable amount. Under the assumed circumstances, the fellow who discovered the electrical activity of quartz (actually Pierre and Jacques Curie in 1880) would find a ready purchaser of the patent rights in Cambridge, Mass.

▶ **DX** . . . We understand that Bill Crawford, the weather reporter on station WFBM-TV in Indianapolis, is conducting a post-card survey on a 10:00 PM nightly telecast. As in many another one-station town, viewers in Indianapolis (281,000 families, 84,000 tv sets) are simply crazy about dx (long-distance to youse physicists) reception from tv stations a hundred or so miles away in Cincinnati, Louisville, and Dayton. So said weathercaster is asking his televiewers to send him a postcard whenever dx is visible, telling what station, the date and time when seen, and the quality of reception. And what is the weather man going to do with the cards? Yep, he's going to correlate the reports with temperature inversions and other weather conditions, eventually may try his hand at predicting good dx weather. A cute idea which, if followed in other cities, might well develop a great deal of badly needed information on tropospheric propagation.

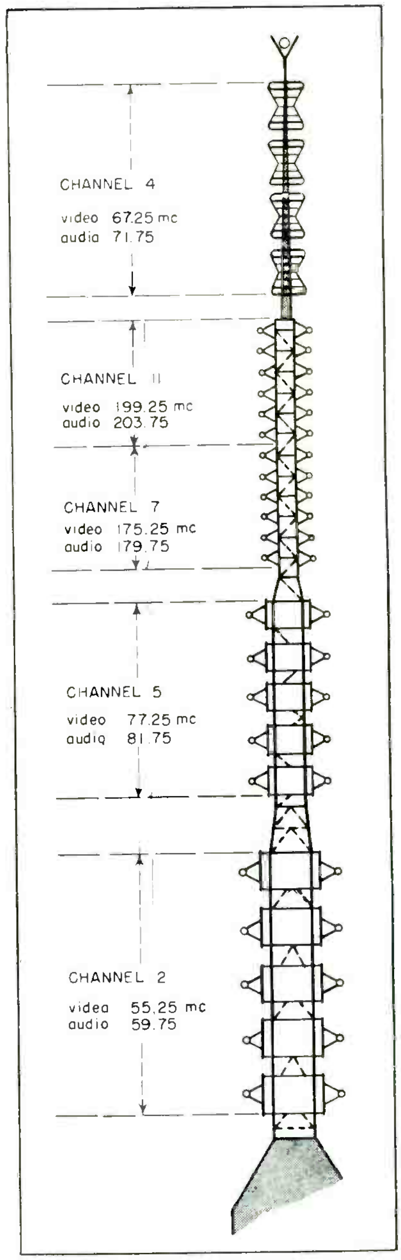
▶ **STANDARDS** . . . Amid the current welter of invective regarding the function of government in setting standards for an industry, it is refreshing to report that the late lamented 81st Congress enacted into law new electrical and photometric standards about which there is no argument. In effect, the new law adopts the recommendation made by the AIEE in 1928 that electrical units be defined in terms of the absolute (c-g-s or m-k-s) units, thus eliminating the column of mercury and the standard cell as standards of resistance and voltage. The largest change amounts to less than 1/20th percent of the old values, which have been on the books since 1894. While they were at it, the Congressmen also got around to legalizing the units of light which had not been written into Federal law. The standard candle, which used to be referred to a set of incandescent lamps, is now 1/60th of the intensity of the radiation from one square centimeter of a black body at the temperature of freezing platinum, and the standard lumen is the flux radiated within a unit solid angle by such a source.

All of which sounds sufficiently like the accepted language of the experts to be very reassuring, even if it did take 22 years.

TELEVISION



New York's 1,250 foot Empire State Building as it looked when topped by WNBT's 62-foot pole and, in the insert, architect's sketch of the new 222-foot structure which will serve five television stations



Simplified sketch of the television totem pole, showing areas to be occupied by various antennas

TALLEST MANMADE STRUCTURE in the world, New York's 1,250-foot Empire State Building achieved a pinnacle of publicity during construction when it was topped off with a tower on which dirigibles were expected to moor. But the almost continuous presence of severe wind gusts, together with the disappearance of commercial dirigibles, nullified the plan.

Aviation's loss was electronics' gain, for today the tower supports a 222-foot "television totem pole" upon which five of the seven locally licensed stations are erecting their transmitting antennas, with considerable benefit to the public and to the trade as well as to themselves. Service areas will in all cases be increased, shadows and ghosts will be reduced, and orientation of receiving antennas made very simple indeed in a market containing more than 15,000,000 people. Location of transmitters high up in the building itself, near the antennas, permits the use of short transmission lines and other innovations resulting in important operating economies.

Men, Money and Motivation

Leasing exclusive television broadcasting privileges since 1931, the National Broadcasting Company (WNBT) early in 1950 agreed with Empire State, Inc. that the building's unique facilities should

TOTEM POLE

Five stations will operate into their own individual arrays coaxially mounted on a 222-foot structure atop New York's 1,250-foot Empire State Building. Common-point signal source and comparative freedom from shadows and ghosts benefits broadcasters, trade and public. Substantial antenna gains are obtained without detrimental interaction

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be made available to other companies. Applications for antenna and transmitter space were received during the year from American Broadcasting (WJZ-TV), WPIX, Inc., Columbia Broadcasting (WCBS-TV) and Allen B. DuMont (WABD) in this order.

Overall responsibility for the design, construction, erection and proper initial operation of the required multiple-antenna structure was placed in the hands of a refreshingly small committee * consisting of the two authors, who were authorized to consult Shreve, Lamb & Harmon on architectural problems, Edwards & Hjorth on structural, Radio Corporation of America on electronic and Starrett Brothers & Eken on general contracting problems. The committee developed preliminary specifications and RCA, employing Wayne Masters of Ohio State University as a consultant, contracted to check the electronic aspects experimentally, recommend revisions where experience with mock-ups indicated their desirability and perform final on-location tests for antenna gain, pattern circularity and mutual coupling. Mock-up tests are still in progress.

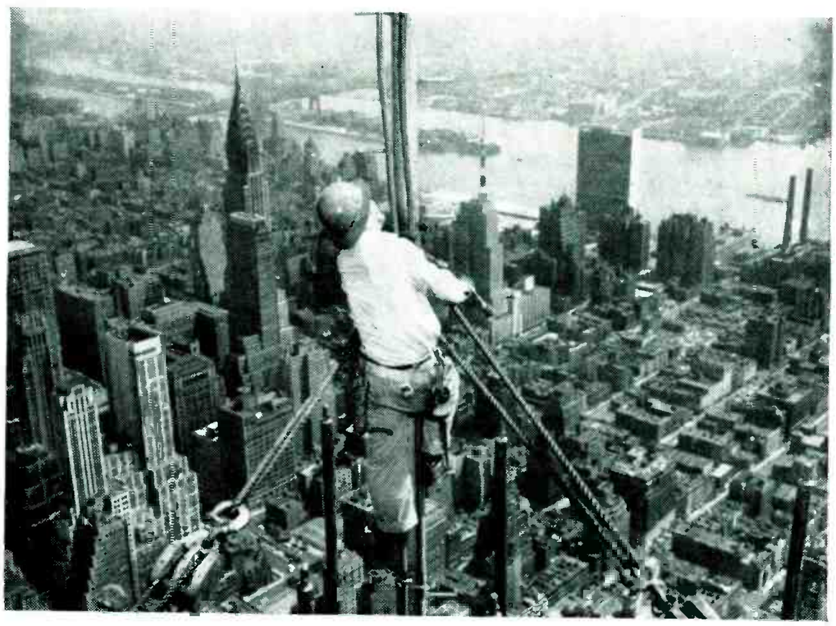
The cost of the entire structure, the mast, antennas, transmission lines and associated fixtures will be approximately $850,000. Empire State itself paid $250,000 of this total for the mast and necessary building reinforcement and shares antenna design, development and test expense with its five television tenants. The stations pay for fabrication, installation and adjustment of their own antennas and transmission lines.

Major Technical Considerations

Winds above 90 mph have been recorded at the top of the mid-Manhattan skyscraper and the roof area upon which an antenna-loaded rectangular mast topped by a similarly cluttered steel pole can be mounted is limited. These two factors, primarily, determined the maximum safe height of the structure.

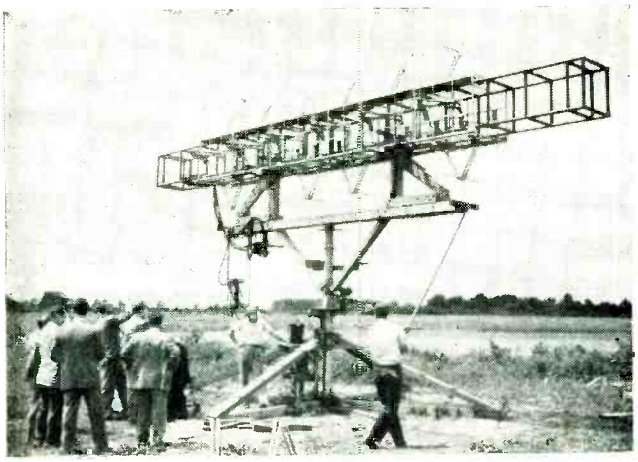
Mast height determined the total number of vertically stacked antenna elements that could be accommodated and the desire for approximately equal overall antenna-system gains dictated the number of bays allocated to each station. Physical considerations indicated that five systems, each providing an overall power gain of about four, could be accommodated and this figure will probably be bettered in actual practice despite the different transmission-line lengths and operating frequencies. Aside from the impracticability of obtaining greater gain by further extending the height of the mast and installing additional bays, calculations on more highly directive arrays operated 1,472 feet above street level disclosed that in all likelihood the resulting decrease in vertical radiation component would create a shadow area within a radius of a mile or more of the building, in a heavily populated area.

Some departure from optimum

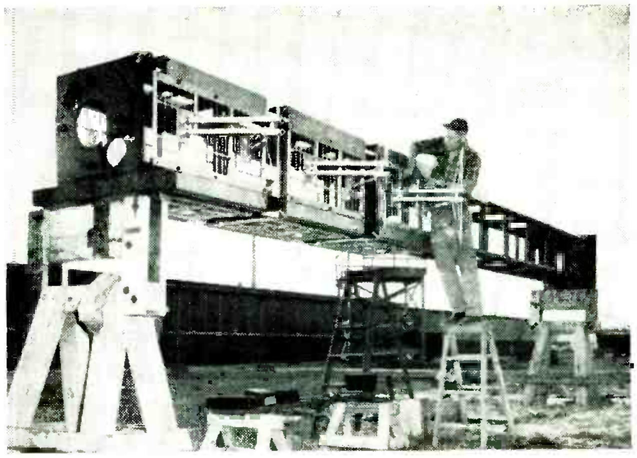


Looking northeast over Manhattan toward Long Island. WCBS-TV at present operates from the Chrysler Building, the spike of which is visible just to the left of the construction worker, while WPIX uses a mast on the Daily News Building seen just to the right

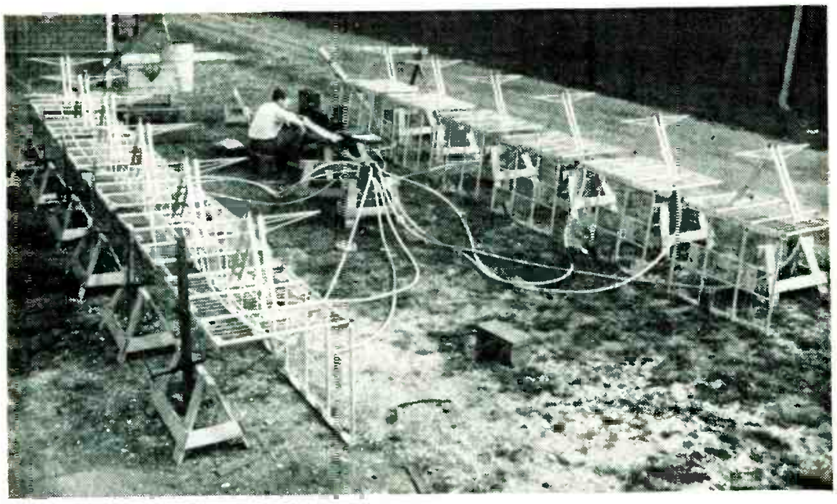
* Bruce S. Old, On the Mathematics of Committees, Boards and Panels, *Scient. Month.*, August 1946.



A completed array is tested for gain and directivity at Medford Airport, near Camden, New Jersey



The bays are assembled around a mock-up of the mast section upon which they are eventually to be installed



East-west elements of a supergain array are tested for termination at Camden

circularity of individual antenna radiation patterns was anticipated as a possible effect of other closely adjacent antennas and setbacks in the mast, which decreases in size between the base and the top. This has not materialized in tests, and noncircularities of horizontal pattern are in no instance expected to be greater than 2 db from the mean value for the video signal.

Mutual coupling between antennas, the possibility that one might pump inordinate amounts of r-f into others, was an early design consideration. Two items in an otherwise lean larder of technical experience provided the answer; first, the fact that existing television transmitters function satisfactorily when video and audio signals are decoupled by 20 db or more and, second, the fact that horizontally directive and coaxially mounted antennas on the crowded "islands" of aircraft carriers exhibit remarkably little tendency to interact due to their small vertical radiation component. Adjacent bays of the various Empire State antennas are being mounted a noncritical distance of about one-half wavelength apart and decoupling between any two at video-transmitter fundamental frequencies will be held to 26 db or better without employing special isolation tricks. There are no shields or other gimmicks between adjacent arrays. Coupling at harmonic frequencies is of secondary order and inconsequential; conventional filters are used at the output of final amplifiers in any event where appreciable radiation at some multiple of the fundamental might prove generally troublesome.

For those who wish to pursue the subject of mutual coupling further, a study undertaken by RCA during preliminary design stages of the job will be of interest. It produced a mathematical expression for predicting the amount of power received on one tv broadcasting antenna from another mounted coaxially on the same mast, expressed as the ratio of power received to power transmitted:

$$\frac{P_R}{P_T} = \left(\frac{\lambda}{4\pi}\right)^2 \frac{G_T\, G_R}{n_t\, n_r\, R^2} \quad \frac{(E_L/E_R)^2}{1 + (E_L/E_R)^2}$$

where

λ	= wavelength
G_T, G_R	= directivities of transmitting and receiving bays in each other's direction and at each other's frequency relative to an isotrope
n_t, n_r	= number of bays in the transmitting and receiving antennas
E_L, E_R	= right and left-hand components of an elliptically polarized wave
R	= distance between centers of the adjacent bays of the two antennas, in wavelengths

It is assumed that first-order coupling occurs between the two adjacent bays only, that inverse-distance-squared laws hold, that each element of each antenna is perfectly matched to its feed line at the frequency of the transmitting antenna, and that all feed lines of each antenna are effectively in parallel at a common junction point for that antenna. In practice, the fact that individual elements of a transmitting array do not match their branch lines at the frequencies of other nearby transmitting antennas provides additional isolation. Also, any coupling between bays other than adjacent ones acts in a favorable direction, since it tends to increase the random nature of phase amplitudes of received signals on the various individual antenna elements.

Calculations using this formula indicated that the degree of isolation required would be attained by the proposed configuration. Subsequent measurements proved the calculations to be substantially correct.

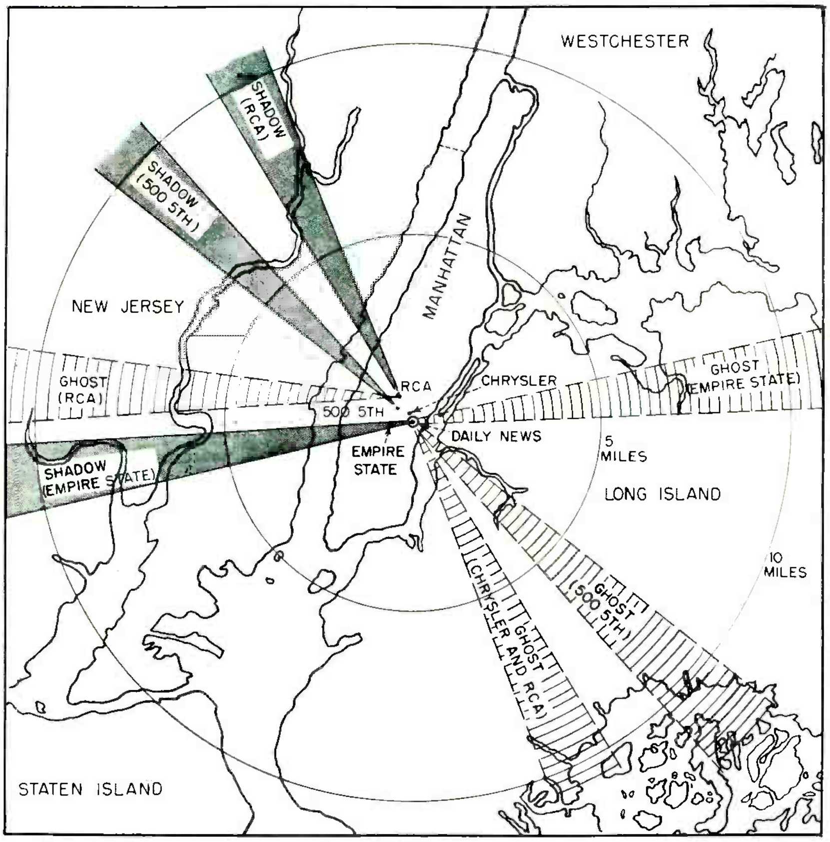
Individual Antenna Details

In solving the problem of accommodating a maximum number of television antennas on a structure the dimensions of which were determined by mechanical load considerations, while at the same time employing previously developed antennas, it was determined that the topmost antenna should be one of the familiar superturnstile types. The four lower arrays are to be of the relatively new supergain or "ladder" type, each of their bays consisting of four broad-band horizontal dipoles backed up by infinite-screen reflectors 0.3-wavelength away and arranged around the sides of the tower. There are five bays spaced 0.77-wavelength apart for the lower-frequency channels and six bays spaced 0.8-wavelength apart for the higher channels. The increase in the number of bays for the higher-frequency channels offsets, by providing increased antenna gain, the additional transmission-line loss at the higher frequencies. The resulting effective gain determined at the transmitter source is substantially the same for all channels. Electric heating elements are incorporated in all antennas.

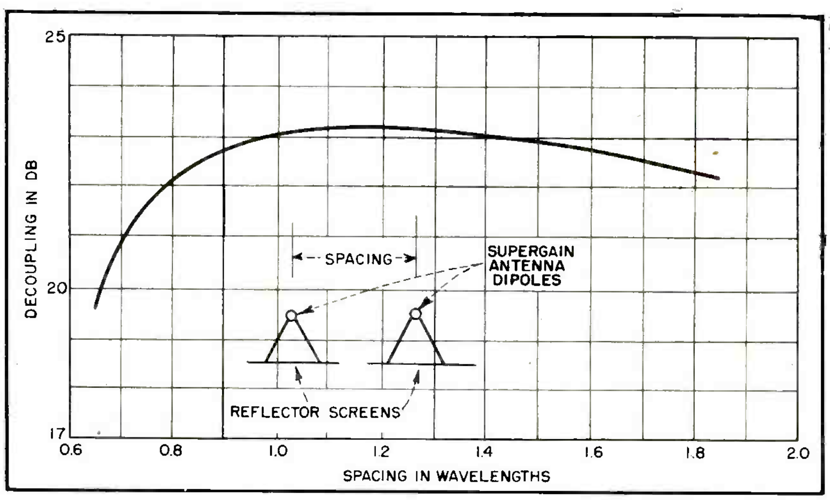
Video and audio signals are diplexed on all five antennas, WCBS-TV and WABD avoiding detrimental interaction between their picture and sound transmitters by using dual-bridge diplexers, gas-filled single coaxial lines between equipment and mast and power-equalizing bridges up at the junction boxes for their respective bays. WJZ-TV, WPIX and WNBT employ conventional bridge diplexers with two lines each between transmitters and antenna-array junction boxes to accomplish the required balance. Transmitter-to-array lines are 3⅛ inches in diameter except in the case of WPIX, which uses a 6⅛-inch line. The vswr is 1.1 or better over each visual band and 1.5 or better over each aural. All phasing and feed lines between junction boxes and individual antenna elements or bays are to be RG-35/U flexible solid-dielectric coaxial cable, or similar special cable.

Because of the manner in which the Channel-2 and Channel-5 arrays are connected for diplexing with a single coaxial-line feed, it is possible to isolate portions of these arrays in the event of failure of components, or for normal servicing. Coaxial switching is provided at the transmitter room so that power can be fed to the two top bays, the three bottom bays or all five bays, as desired. The switching is designed so that power normally fed to the section to be isolated can be diverted to an equivalent dummy load and so maintain a constant load on the transmitter and avoid overloading of the feed lines when operating at maximum power. This is not true of the three top arrays, so two of their users will install simple stand-by antennas on the building's tower parapet.

Columbia's video transmitter is located on the 83rd floor and feeds its antenna through 275 feet of line, DuMont is on the 82nd operating into 338 feet, American on 85 with 324 feet, PIX on 81 with 405 and National puts its energy into a 385-foot-long line from the 85th floor. All transmitters are rated at 5 kw;

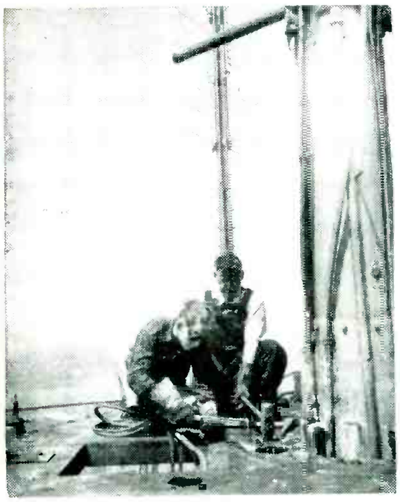


Shadows and ghosts experienced by WPIX due to nearby higher buildings before its move to Empire State

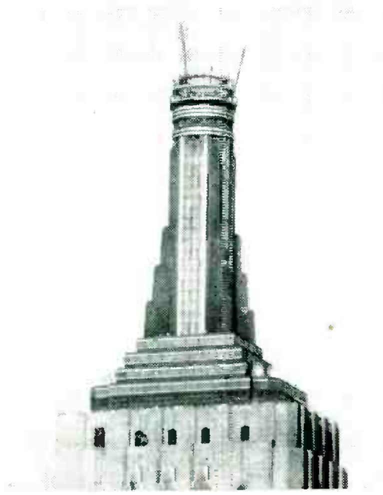


Interaction between two dipoles tuned to exactly the same frequency. This condition does not apply in multiple-transmitting-structure practice and isolation of 26 db or more is readily obtained

HOW IT WAS DONE

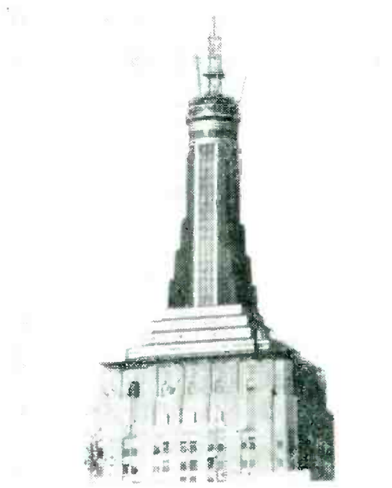


WNBT's old 4½-ton pole was telescoped into the tower, cut up and lowered beneath building elevators. New steel came up the same way



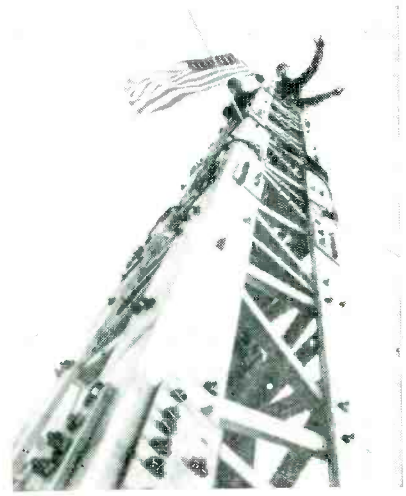
Temporary antennas were erected for WNBT (left) and WJZ-TV (right). Concentric work platforms provided an assembly point for materials

A scaffold encircling the mast went along as 57 tons of steel capable of withstanding at least 110 mph of wind pressure moved skyward



The first mast section was assembled piece by piece as it rose with the aid of the movable scaffold and a small but sturdy crane

Second section was assembled much like the first, while the third was partially assembled below. Painting started at this stage



End of steel, insofar as the mast is concerned. WNBT's pole is to be raised in one piece and superturnstile elements installed later

but actual power output has not yet been determined because of feed problems and uncertainty as to FCC standards.

Other Important Facilities

While no actual tests have yet been made, there appears to be no technical reason why two or more television transmitters operating on closely related channels cannot use the same antenna. Thus a Channel-13 station might share the array for Channel 11 (WATV, at present operating in nearby Newark, N. J., is already negotiating along these lines). The affected arrays could readily be retuned by means of available stubs to a satisfactory compromise frequency and additional transmission-line bridging installed to achieve the required isolation. Filters having some slight insertion loss might also be involved. Main coaxial lines were designed to handle 100 kw of effective radiated power. The RG-35/U cable, however, must work near its safe limit so any material increases in power require the development of new cable or techniques for this highly specialized application. The perfect solution is proving evasive.

If FCC licenses uhf television stations in New York City it will probably be possible to accommodate several antennas required for such service between present vhf antennas on the mast and on the pole. Columbia, American and National have, in fact, already installed simple antennas for their respective local frequency-modulation stations in such positions without ill effect on television transmissions.

Arrays for uhf theatre television, should this service materialize, would be installed around the building tower, rather than on the mast. AT & T's microwave-relay receiving antennas remain undisturbed on the balcony just below the tower.

Approaching technical perfection, with outstanding advantages for broadcasters, the trade and the public alike, Empire State's new skyhook will undoubtedly inspire other cities to erect similar television totem poles.

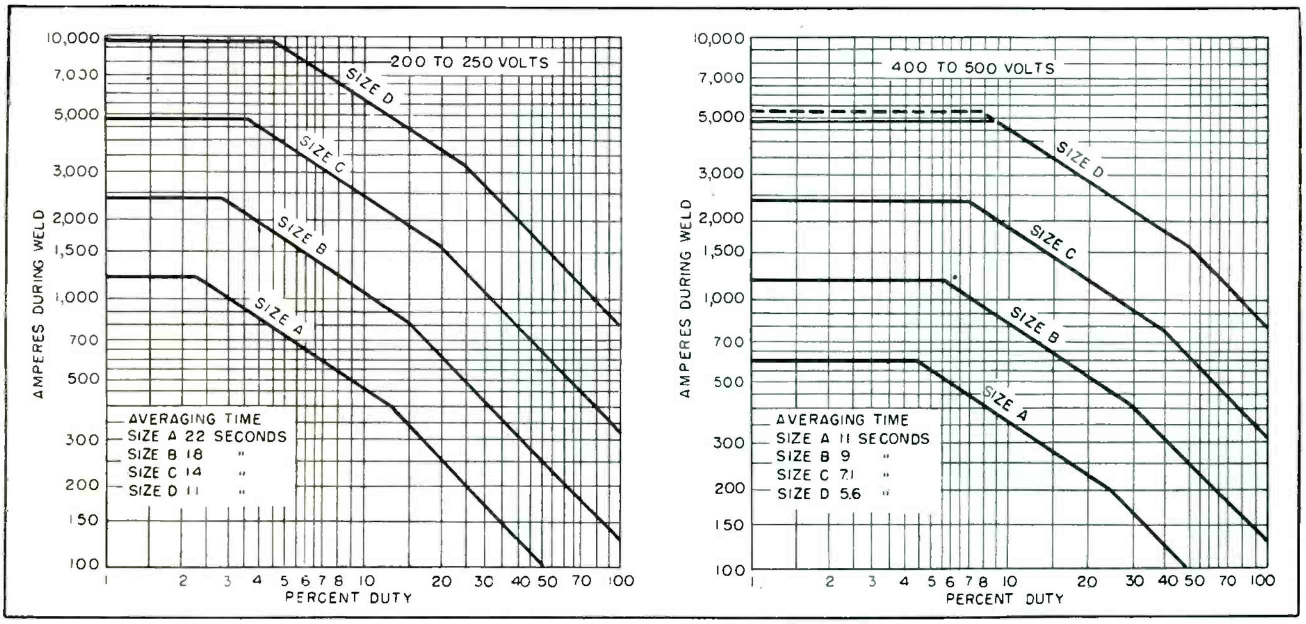


FIG. 1—Rating curves for the four sizes of welder ignitrons, for 220-volt service (left) and 440-volt service (right). Percent duty is computed from ratio of on-time to on-plus-off time, provided the on-plus-off time is greater than the averaging time specified for the size of tube in use; if it is not, percent duty is computed from ratio of on time to averaging time

Load Sharer for Welder Ignitrons

Flip-flop thyratron circuit transfers the welding load automatically from one pair of ignitrons to another every two seconds. This reduces duty cycle per tube, permitting use of a given welder for a heavier weld or a longer time than was originally specified

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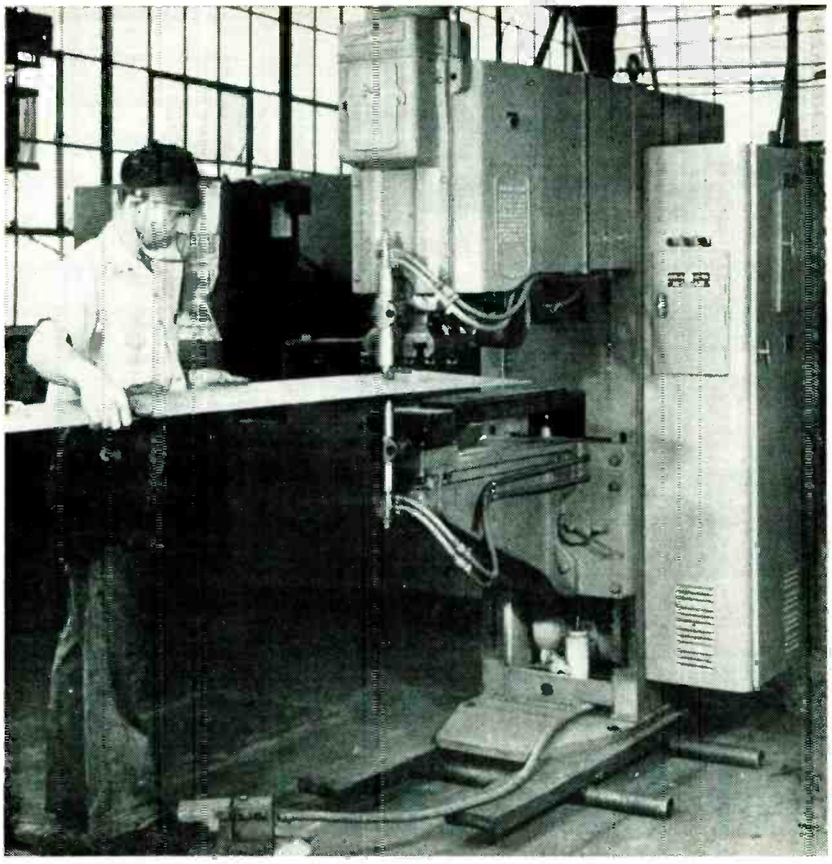
IN A HEAVY-DUTY electronic welding control, the ignitron tubes may be easily overloaded when the welding machine is used for a heavier weld or a longer time than first intended. Figure 1 shows the rating curves for each of the four sizes of welder ignitrons, with size A being the smallest and size D the largest. At 220 volts (left-hand chart) these tubes often may carry greater current than at 440 volts (right-hand chart). However, when operating continuously (at 100-percent duty, shown at right-hand edge of each chart) the tubes have the same rating at both voltages. Size-D ignitrons are the largest now available for welding service.

Figure 1 shows that a pair of size-B ignitrons may carry 130 amperes continuously at 220 volts. At 30-percent duty at 220 volts, however, the current that can be handled increases to 400 amperes. In 60-cycle service, for example, this 400-ampere current may flow to make two 9-cycle welds per second or 120 welds per minute. Here current flows 18 cycles out of each 60 cycles, which is 30-percent duty.

These same tubes must not be expected to carry a 400-ampere current for a weld 9 seconds long, twice per minute, even though the duty cycle still is 30 percent. The reason for this is that the rated averaging time for size-B tubes is 18 sec at 220 volts.

For size-B tubes at 220 volts, the operation must be figured within a total time not greater than 18 sec. Since a 9-sec weld is 50 percent of 18 sec, these tubes are working at 50-percent duty; here Fig. 1 shows 250 amperes as the highest load. Similarly, in a 440-volt circuit, the operation of these same tubes must be figured within 9 sec. If a single weld is 9 sec long, the tubes are working during the whole averaging time, or at 100-percent duty, and their load should be only 130

This article is based on material in a book by the author, "Electronic Motor and Welder Controls," soon to be published by McGraw-Hill Book Co.



Example of press-type spot welder whose capacity can be increased by adding a flip-flop load-sharing control so that the duty cycle is shared by two pairs of ignitrons each operating well within safe limits

amperes. This holds true even if the welder rests a minute or an hour between welds.

Now let us see if size-C tubes will handle this 400-ampere load for a 9-sec weld. At 220 volts the size-C averaging time is 14 sec. Since 9 sec ÷ 14 sec is about 65-percent duty, Fig. 1 shows that nearly 500 amperes may be carried; size-C tubes are thus large enough at 220 volts.

At 440 volts the size-C averaging time is only 7.1 sec. To make a 9-sec weld, the tubes are firing during the whole 7.1 sec so they are working at 100-percent duty. Since Fig. 1 permits only 330 amperes of load for size-C tubes at 100-percent duty, the 400-ampere 9-sec weld will overload size-C tubes in a 440-volt circuit. Capabilities of other sizes of ignitrons for various duty cycles can similarly be found from Fig. 1.

Ignitron Controls for Larger Loads

If a new welding machine will require say 6,000 amperes from a 440-volt supply feeder, Fig. 1 shows this current to be greater than size-D tubes can carry even at very low duty. Nothing is gained by connecting together several pairs of size-D tubes and firing them all at the same time. Ignitrons do not divide the total current in the manner of high-vacuum tubes; whichever ignitron is first to fire will carry the whole load, sharing none of it with another tube in parallel. Ignitrons sometimes may divide large-current loads only if reactors are added in their anode circuits.

For the 6,000-ampere load, it is best to supply two separate welding transformers, each controlled by its pair of ignitrons carrying 3,000 amperes (at less than 18-percent duty, from Fig. 1). The secondary windings of these two transformers should not be connected together; their separate sets of electrodes should not be close together where they press onto a single piece of work.

Consider another heavy welding load, such as 2,000 amperes for 3.8 sec at 440 volts. Here size-D tubes have 5.6-sec averaging time, and they would be working at 3.8 sec. ÷ 5.6 sec or 68-percent duty. The tubes are badly overloaded, for Fig. 1 shows that size-D tubes must not work above 35-percent duty at 2,000 amperes. But why not use two pairs of size-D tubes arranged so that each pair carries the 2,000 amperes for half of the weld time, as described below? In this way each pair of tubes works 1.9 sec ÷ 5.6 sec or 34-percent duty; this is within the rating of size-D tubes.

Flip-Flop Control

A separate equipment may be added to two ignitron contactors and a single heat control, so as to fire the tubes of each contactor in turn for about 2 sec each. In this way two pairs of size-D tubes may share the heavy load of the preceding example by dividing the weld time between them. This added control includes two relays which flip-flop in and out every 2 sec during the entire weld time. Relay 1 connects the heat control to the first ignitor circuit so as to fire one pair of ignitrons; 2 sec later, relay 2 connects the heat control to the other ignitor circuit so as to fire two other ignitrons, and relay 1 drops out. The contacts overlap, so that the contacts of relay 2 close before those of relay 1 open. When these contacts operate during a continuous weld, current flows to the welder without interruption.

The two pairs of ignitrons are connected in parallel as shown at the right in Fig. 2, so each pair in turn passes current into the single large welding transformer when the tube ignitor circuits are completed by the relay contacts. The relay coils are in the plate circuits of the thyratrons in the flip-flop control circuit. The 200-volt d-c plate voltage is applied to both tubes continuously, so that each can fire when its grid permits. When VT_1 fires, its plate current pulls in relay 1, closing the contacts that fire ignitrons VT_5 and VT_6. When VT_1 is conducting, its anode is about 15 volts more positive than its cathode.

When plate voltage is applied to the flip-flop control, VT_1 fires first because of C_1. Next VT_2 fires, turning off VT_1. These tube circuits alternate every 2 seconds, as determined by the sizes of C_2, R_1, C_4 and R_4. This timing action may be seen in Fig. 3, which shows the voltage wave shapes in various parts of the circuit.

To hold the operation of this circuit still for a moment, let us open the plate circuit of VT_2, right at the tube. In this condition, corresponding to the start of the curves at the left in Fig. 3, no electrons flow through R_2 so point B is at + 200 v. Electrons flow from the cathode to the control grid of VT_1, then through R_3 and R_4 to $B+$. Since this grid is positive, VT_1 is firing and relay 1 is picked up. Since the plate of VT_1 is only 15 volts above its cathode, C_3 has a high-voltage charge that is + at point B.

Point C is also about 15 volts above the cathode, so timing capacitor C_4 is charged to the same voltage as C_3. The 10,000-ohm resistance of R_3 is very small compared with the 6.2 meg of R_4, so voltage drop across R_3 is negligible; the arc drop holds the grid of VT_1 about 15 volts above the cathode. Meanwhile, point D likewise is about 15 volts above the cathode of VT_2, so both ends of C_2 are at the same potential; C_2 has no charge. The grid of VT_2 is positive, so this tube is ready to fire at once when its anode circuit is reclosed.

Now suppose we let VT_2 fire (by reclosing its plate circuit); relay 2 then picks up. At once the potential at B drops to K in Fig. 3, which is 15 volts above the cathode (the arc drop), and C_3 starts discharging. Since a capacitor cannot lose its charge instantly (unless shorted), this charge on C_3 forces the potential of terminal A down from +15 v to L in Fig. 3; in this way the plate of VT_1 is driven negative long enough to stop the plate current, deionize the tube and permit its grid to regain control. At the same time the charge on C_4 forces C down from +15 v to M in Fig. 3; grid current in VT_1 stops and the grid remains negative for several seconds.

This high negative grid voltage keeps VT_1 from firing, even though C_3 quickly recharges (by electrons flowing up through VT_2 to C_3 and from the other terminal of C_3 through R_5 or relay coil 1 to B+), thereby letting the plate of VT_1 again become positive. While VT_1 is shut off, relay 1 is of course dropped out. The new charge on C_3 is reversed; terminal A now is + and B is —.

The contacts of relay 2 fire ignitrons VT_7 and VT_8, but there is a time delay of two seconds while C_4 loses its charge, letting point C rise gradually from M to +15 v in Fig. 3. As C_4 changes its charge, electrons flow from terminal C through R_4 to $B+$. The potential at point C rises at a rate set by the RC time constant ($R_4 \times C_4$, which is 3.1 sec). When point C has risen about 15 volts above the cathode, grid current of VT_1 again flows through R_3, preventing C from rising higher.

When the potential of point C approaches N (cathode potential) during its rise to +15 v, the grid of VT_1 is high enough to fire the tube, which then picks up relay 1. At once the plate of VT_1 is pulled down to P, so the charge on C_3 now forces point B negative to Q in Fig. 3, shutting off VT_2 and dropping out relay 2. This time the charge on C_3 forces point D to the negative potential at R, so VT_2 will not refire when its anode quickly returns to B+. Capacitors C_3 and C_4 recharge. Again there is a two-second delay while C_2 discharges through R_1, letting point D rise from R to S. At S, VT_2 fires again, picking up relay 2; the anode of VT_2 drops and the C_3 charge again turns off VT_1. In this manner thyratrons VT_1 and VT_2 will continue to fire in turn. At the end of the weld, machine controls open the relay connections to B+ to prevent further operation,

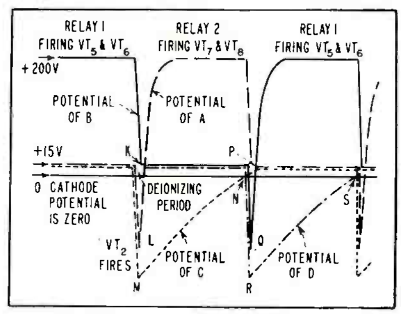


FIG. 3—Voltage wave shapes at points A, B, C and D of flip-flop circuit of Fig. 2

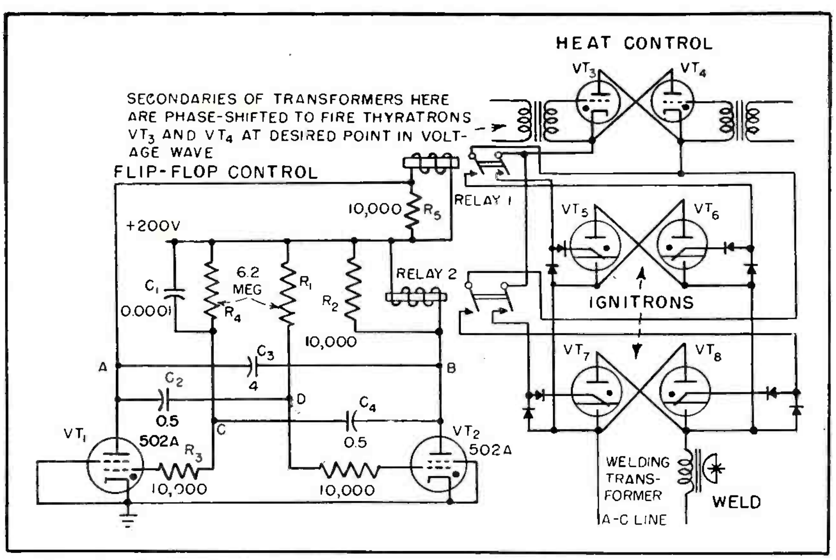


FIG. 2—Circuit of thyratron flip-flop control circuit for two pairs of ignitrons

but VT_1 and VT_2 continue to fire at 2-sec intervals since they still get plate voltage through R_5 and R_2.

When taking turns every 2 sec, size-D ignitrons may be overloaded during a higher-current short-time weld (such as 3,500 amperes at 440 volts flowing for $1\frac{1}{2}$ sec, once every 8 sec). For such service, the flip-flop control may be furnished with time-delay action of only $\frac{1}{3}$ second (or 20 cycles); relays 1 and 2 operate several times each second, firing the ignitrons for shorter periods and letting them rest more often. To produce this faster action, C_2 and C_4 are changed to 0.05 μf, while R_4 and R_1 are increased to 10 meg.

Defense Communications

The pattern developing for the largest metropolis in the U.S. can be modified for application to smaller cities and towns. This plan for establishing emergency essential warning broadcasts and emergency communications facilities makes most efficient use of presently available stations and equipments

THE POSSIBLE DISLOCATIONS to what is generally considered normal metropolitan life are many and blow with an exceedingly warm breath upon the neck of any city dweller. However, the occasional subway tieup, the blockage of subfluvial tunnels and the rush-hour opening of a drawbridge are as nothing compared to the fury of modern warfare with its methodical, high-explosive bombing.

In the opinion of civilian defense experts, atomic bombing of New York City would result in incalculable destruction and loss of life. With proper warning and precautions, together with an organized followup after the disaster, upwards of fifty percent of the possible loss of life might be averted.

There are many facets to the problems arising from a major disaster. Our particular concern is communications, with emphasis on radio. The foremost means is the telephone system that hourly handles many thousands of calls. Normal major dislocations to this service are few, owing to preventive maintenance, alternate emergency circuits, stockpiles of materials and a nationwide standardization of equipment and operating practice.

Failure of the telephone system can arise by accident or design when too many calls are placed for the central office equipment to handle. As a classic example, when a rear-end collision between two Long Island Railroad trains occurred Nov. 20, 1950, with 78 people killed, an unprecedented number of calls was handled by the VIrginia 7 exchange. The greatest previous demand upon the equipment was 40,000 calls an hour. After the rail wreck, calls were completed at a rate of 82,000 an hour. During this period, many subscribers were unable to obtain dial tone—including a number of lines assigned to the emergency police and medical groups.

If the telephone system were to be destroyed or sabotaged, relatively small quantities of information could be transmitted in message services employing existing vhf radiotelephone equipment. Again, the example of what occurred after the Long Island wreck serves as a warning against too great dependence upon these services. The frequencies available to all citizens for common carrier and limited common carrier radiotelephone service in and around New York City were jammed with calls to doctors who are subscribers, to the exclusion of all others.

Broadcasts of information to the general public could probably be made not too long after any disaster. Although individual receivers might be damaged in large numbers, or, more probably, commercial power to operate the receivers would be lacking, community receivers with strategically located loudspeakers can spread accurate information better than word of mouth.

Basic System

Although the exact plans can not be revealed, the general block diagram (Fig. 1) shows the essentials of the New York City warning system. In the warning phase, Police Headquarters, or an alternate Headquarters already established outside the heart of Manhattan, will send appropriate warnings not only to the public via the municipal broadcasting system of WNYC, as shown, but also to the various fire stations and to police divisional headquarters. The sirens on the police cars (now muted for normal traffic-clearing use) can either be keyed on directly through the police mobile radio equipment or by the driver on order. Police headquarters will also notify all strategic city officials so that they can assume their appointed tasks in the defense setup.

Fortunately, most New York City a-m radio broadcast transmitters are located out of the center of the city. In many cases they have auxiliary power plants. The f-m transmitters are not so favorably dispersed and most of them have no independent power.

The city has planned to make available a relatively large number of mobile vhf studio-transmitter link equipments that can be used from within a disaster area to program the a-m broadcast stations that are generally located on the periphery of the city. Such means can be used during a period when destroyed studio facilities and telephone lines are being replaced.

There are presently three types of signals employed in civilian defense. The YELLOW is a confidential warning for key personnel and may be followed by the WHITE all-clear signal. The RED signal, acccompanied by sounding of sirens, is the first and only warning received by the general populace. Owing to the swift and unknown hazards of disaster or modern warfare, only a very short time may elapse between the RED and the eventual disaster.

Many of the wire connections shown are regularly in existence, others have been installed for defense purposes and are already in

in New York City

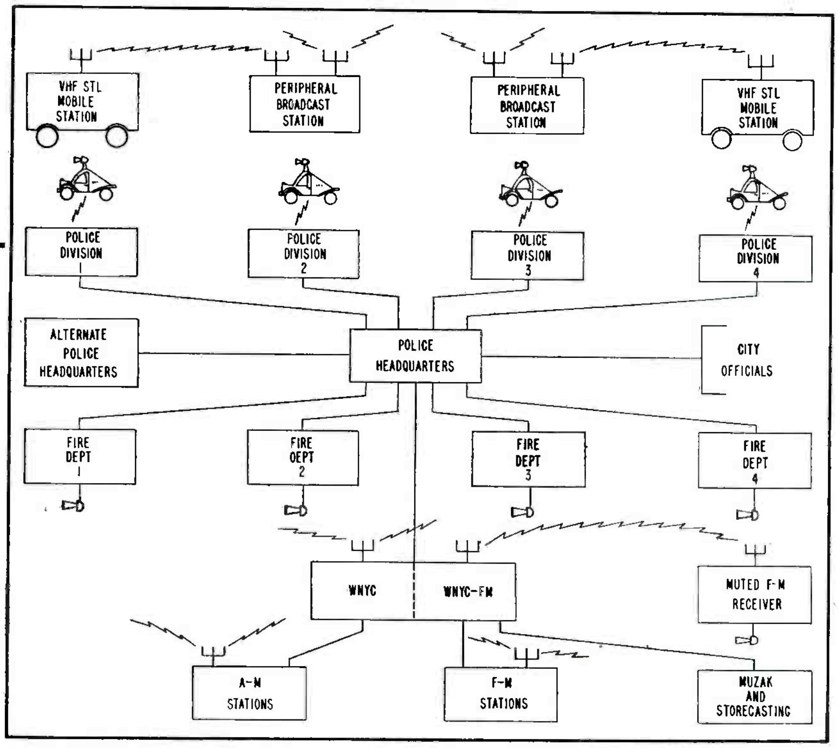


FIG. 1—Block diagram to show the interconnection of warning facilities that can be set into operation from a central headquarters

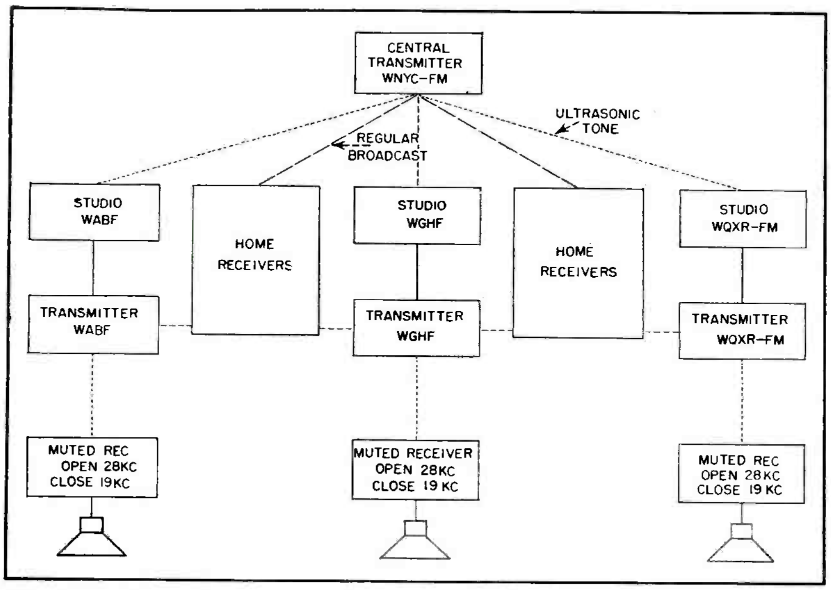


FIG. 2—Tentative plan for controlling a large number of normally muted warning receivers from a central point by use of ultrasonic tones

use for tests. For example, at a specified time each hour, all broadcast stations now receive a test tone from the control room of WNYC and WNYC-FM. Each broadcast control has available specially marked patch cords and, if so directed, can feed this test tone or other program material to the various broadcast transmitters.

Arrangements are being completed to furnish a warning tone or siren recording to all Muzak and Storecasting controls so that these facilities can be used to warn patrons and their customers.

Ultrasonic tones ranging between 15 and 35 kc are now in use to mute or to raise the gain on certain types of f-m broadcast receivers on buses and in stores. Tentative plans are being formulated to utilize such receivers, normally muted, together with giant loudspeakers. A recording of a siren played at the WNYC studio could be keyed on by an ultrasonic tone or combination of tones for the RED warning.

Central Control

The manner in which the system would be operated is suggested in Fig. 2. The warning tone sent out from the central transmitter could be used to shut off normal program and key in the output of a special receiver tuned to the central station. Retransmission of the tone would unlock the muted receivers. These tones would be in addition to the normal tones used in some cases for commercial service. The warning tone indicated is merely representative. Although this system is technically feasible, it has some hazards. A saboteur or prankster could spread panic by gaining control of the central control for even a few seconds.

The means of emergency communications after a disaster are still in a formative stage. There is the possibility that the military would insist upon taking over all communications. However, since there is evolving a philosophy that local needs must be met locally, it is likely that the local civilian defense organizations will be allowed to solve their own problems. Only when it is determined that operation of transmitters will not serve for homing missiles and aircraft will the answer be clear.

Health, welfare, policing and similar functions will each have their own communications needs. These needs will probably be served, in the disaster stage, by police, taxi, public service, industrial and amateur radio working together under Red Cross or Civilian Defense authorization.

The kind assistance of Seymour Siegel, Director of the Municipal Broadcasting System and Director of Civil Defense Communications, New York City, is gratefully acknowledged.—A. A. McK.

—ELECTRONIC MUSIC

By L. A. MEACHAM

Bell Telephone Laboratories, Inc.
Murray Hill, N. J.

FIG. 1—The wobble organ and its first four players: Ann Codington, Phyllis Taylor, the author and B. McMillan, all of Bell Labs

At one time or another, every musically inclined communications engineer has connected a laboratory oscillator to a speaker and twiddled the frequency dial to play himself a tune. But did anyone ever provide four people with four oscillators, so that they might play like a barber-shop quartet?

Here is a facet of electronics which up to now, so far as the author has been able to discover, has been left unexplored. The question occurred to him while searching for a novelty to entertain members of a glee club at their annual party. The results of preliminary research (conducted in the author's cellar, since it was not an official company project) were received so enthusiastically that improved models were designed (in the same cellar), playing techniques were improved, and concert experience was obtained before several surprised and delighted audiences.

The present state of the art is represented by the "wobble organ" described in this article. It uses inexpensive radio parts, and offers interesting possibilities for home recreation of the participation kind, as well as for various entertainment fields involving large groups.

The four players sit around three sides of a card table, as shown in Fig. 1. The fourth side is turned toward the audience, and may conveniently be faced by a music rack if desired. In front of each player is a small "playing console". On the floor near the table is a cabinet containing a power supply, an amplifier, and a speaker. Pairs of consoles which are adjacent to one another are plugged together mechanically (see Fig. 2), and electrically, the whole set of four being connected to the speaker cabinet by a single 6-conductor cable.

Each console contains a thyratron sawtooth oscillator, with suitable control circuits and a simple waveform-shaping network which emphasizes or suppresses various harmonics in the complex sawtooth wave and thus affords a distinctive and different tone quality for each player. The physical arrangement of a console is shown in Fig. 3. The main control device is the "wobble arm", carried on a potentiometer shaft which extends through the sloping front. This control is designed to vary the pitch over a range of about 2½ octaves (about 6-to-1 in frequency). The range is at least that of the human voice,

TIME OUT TO PLAY

AUTHOR TO EDITORS: "Once in awhile we engineers need a light touch in the midst of our serious striving for progress and profit. With this in mind, it seems to me that the attached paper would not be out of place in ELECTRONICS."

EDITORS TO AUTHOR: *When we first read your paper it immediately created a desire to build a wobble organ in our own basement. So here it is in print. We think it will create the same desire among many of our readers*

for FOUR

Novel "wobble organ" has separate soprano, alto, tenor and bass oscillators and a common power pack, amplifier and loudspeaker. The instrument plays anything from barbershop ballads to Bach with a pleasing vibrato quality from which it gets its name

and in the present model is located differently on the frequency spectrum for each console, so that the four of them cover the vocal ranges of soprano, alto, tenor and bass respectively. (A male quartet model could be obtained merely by changing capacitance values.) The pitch control, or wobble arm, is operated by the right hand of the player in relation to the musical scale designations on the sloping scale quadrant. These designations need be used only as a rough guide, but they are of great value even to an experienced player in making rapid and accurate changes over large musical intervals, and they are indispensable to a beginner.

Operation of the tone source or oscillator is not continuous; each console can be turned on and off at will by the individual performer. The four consoles are normally silent. Oscillation is started by a slight downward pressure of the player's left hand on the knob at the left front of the console. This pressure closes a contact applying plate voltage to the oscillator. Thus the player may use a "portamento" between notes (leaving the tone on) or "detache" (momentarily interrupting it) as desired. The volume of sound delivered by the individual console to the common speaker is also under the control of this same knob, which may be turned as well as pressed by the player's left hand. The rotation can be calibrated in musical symbols, *pp*, *p*, *mp*, *mf*, *f*, and *ff*, indicating different degrees of loudness from pianissimo to fortissimo, but in the present model this is left to the musical taste of the player and only *p* and *f* are marked as rough guides near the opposite ends of the range. The

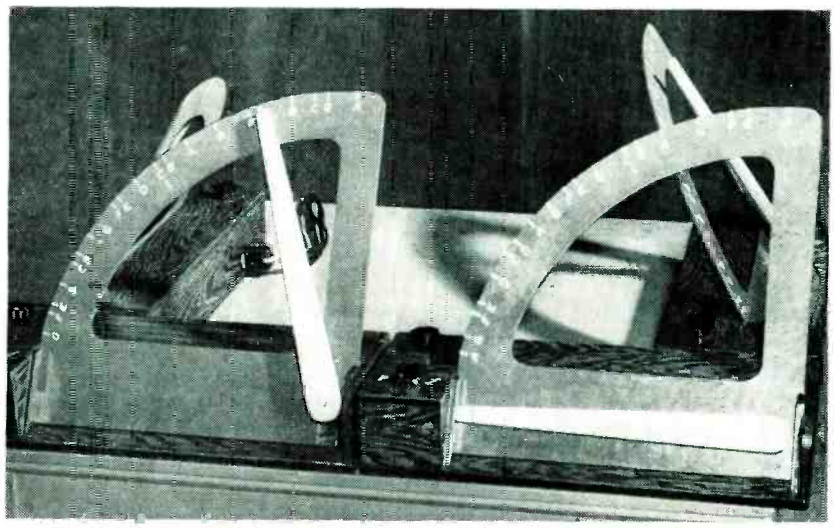


FIG. 2—The four-man (or woman) instrument from the players' point of view

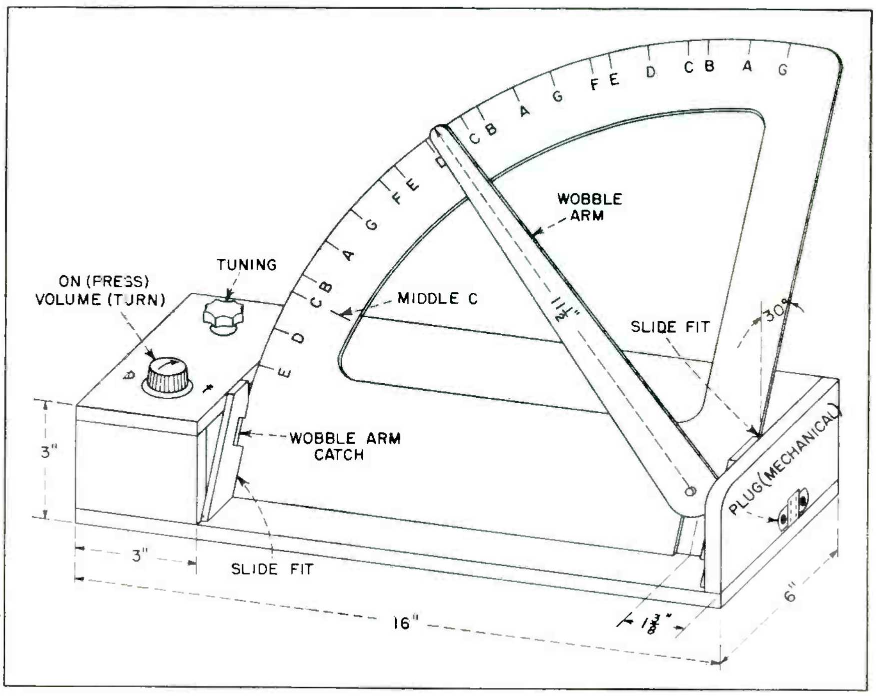


FIG. 3—The bass console. Others are similar mechanically except for calibration of the scale quadrant and placement of interconnecting plugs

switch action mentioned above is obtained very simply by mounting the potentiometer near the free end of a flat cantilever spring, the fixed end of which is screwed to the underside of the console top. A downward motion of about $\frac{1}{32}$-inch brings the free end into electrical contact with a fixed metal contact that also limits travel.

One other control, a tuning adjustment to compensate for such variables as temperature and aging, is required, as in almost any other musical instrument. This tuning knob is initially adjusted by the player's left hand while the corresponding wrist presses down the "on" knob and his right hand aligns the wobble arm with a scale mark (such as middle C) corresponding to the pitch of the reference source to which he wishes to tune.

The present consoles are made of $\frac{3}{8}$-inch plywood, with scale quadrants of $\frac{1}{8}$-inch pressed hardboard. Each scale quadrant is made removable to facilitate storage, being mounted in slides at its edges. A simple catch is provided to support the free end of the wobble arm when not in use. The bottom of the console is made removable for access to component parts. Principal dimensions are shown in Fig. 3.

The layout of the speaker cabinet is conventional, the only novel feature being the provision of storage space for the four consoles, two at each side of the loudspeaker as shown in Fig. 4.

Circuits

Complete schematics are given of the consoles in Fig. 5 and the power supply and amplifier in Fig. 6. The thyratron relaxation oscillator in each console is of the type commonly used in oscilloscope sweep circuits, with the variable timing resistance used for the main pitch control and the grid bias for tuning. Different timing capacitors and waveform-shaping networks are shown (terminals *A*, *B*, *C*) for the respective consoles. When the consoles are plugged together a common shielded path is formed from the networks to the amplifier input.

The use of a 1-megohm logarithmic potentiometer in series with a fixed 10,000-ohm resistor for each frequency control provides a relationship between shaft angle and musical pitch which is substantially linear over a resistance range of 16,000 to 450,000 ohms, with a slope of about 30 degrees per octave. Accordingly, each half-tone occupies 2.5 degrees and each whole tone 5 degrees. The wobble arm swings over more than 75 degrees, giving the desired $2\frac{1}{2}$ octaves, and is set on its shaft so that the minimum total resistance actually used is 75,000 ohms. The potentiometer should have a molded carbon element or equivalent so as to minimize effects of mechanical wear on scale calibration.

A voltage divider across the 150-volt supply (resistors R_1 and R_2 in Fig. 5) is arranged to hold the plate of the thyratron at about 40 volts above cathode potential while the "on" contact is open. The tube does not conduct in this condition, because its firing point for normal tuning is designed to be near 80 volts. The effect of the bias is to make the d-c potential at point *A*, while the oscillation is off, substantially equal to the d-c component of the sawtooth wave at the same point when it is on. Figure 7 shows how the bias eliminates a starting transient in the sawtooth wave as it is delivered to the input of the shaping network. If present, the transient would give a noticeable thump at the beginning of each note, particularly if the volume were turned up until excessive initial voltage rise overloaded the final stage of the amplifier.

A voltage-doubling selenium-rectifier type of power supply (Fig. 6) delivers 100 milliamperes at 250 volts, and two voltage regulators are arranged in series to provide stable plate and bias potentials. This regulation is quite important, not only to avoid fluctuations of pitch with line voltage, but to keep the four consoles independent of one another in spite of the fact that their mean plate currents change as they are started and stopped or as their pitches are varied.

The audio amplifier is conventional; it includes a volume control, allowing the over-all instrument to be adjusted to a room of any size.

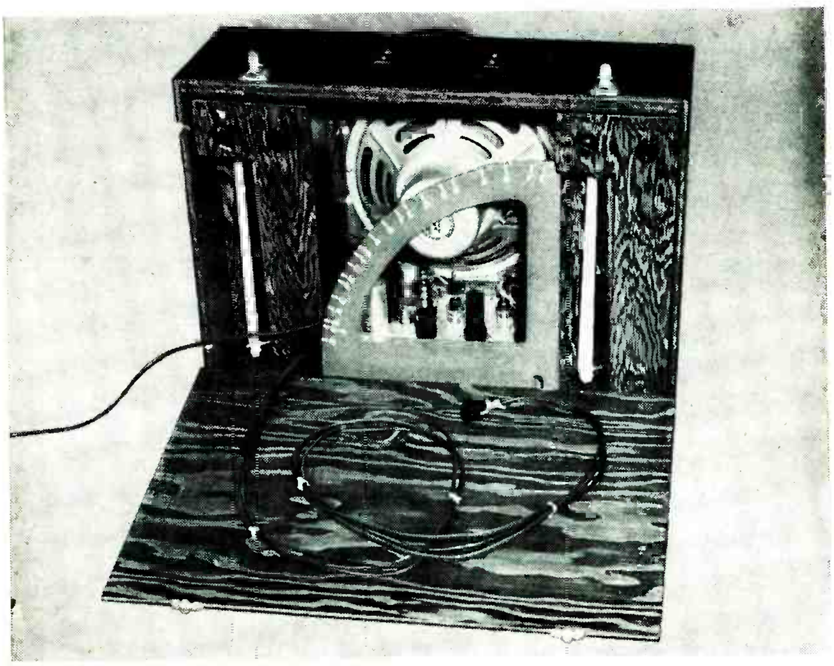


FIG. 4—Rear view of portable case containing the wobble organ's common power supply, speaker and amplifier, with the four individual consoles knocked down and stowed away

Playing Techniques

Several interesting facts have developed from playing and experimenting on this instrument. First, although steady tones, without vibrato, are desirable in some kinds of music, a much more live effect can be obtained by wobbling the pitch control smoothly through a small range above and below the position of true intonation. This corresponds to the vibrato used in playing a violin or trombone, or occurring naturally in the human voice. All who have learned to play thus far agree that a vibrato of small extent (less than a quarter tone peak-to-peak) and at a rate of about 4 or 5 per second is desirable. This motion, as may be guessed, accounts for choice of the name wobble organ.

To allow the player's right hand to produce vibrato with a comfortable wrist motion the notes should be spaced well apart on the dial. A spacing of about one inch per whole tone appears to be a reasonable minimum. This figure, taken with the potentiometer calibration of 5 degrees per whole tone noted earlier, leads to a figure of about one foot for the length of the wobble arm.

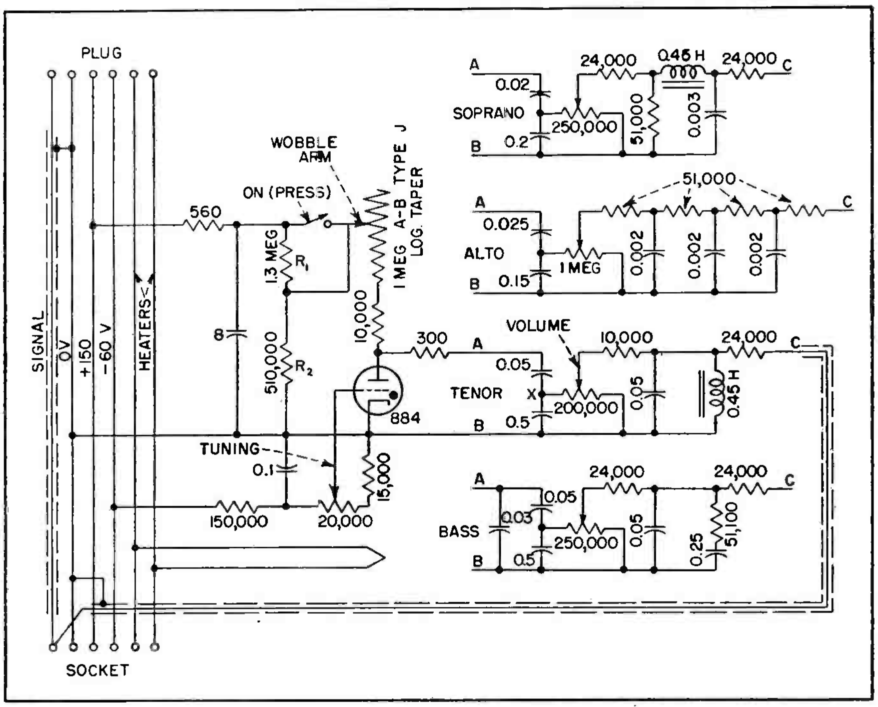


FIG. 5—Circuit of one of the four consoles, in this case the tenor console. The other three are identical electrically except for timing and waveform-shaping networks. Component-part values and circuits are shown for the soprano, alto and bass units

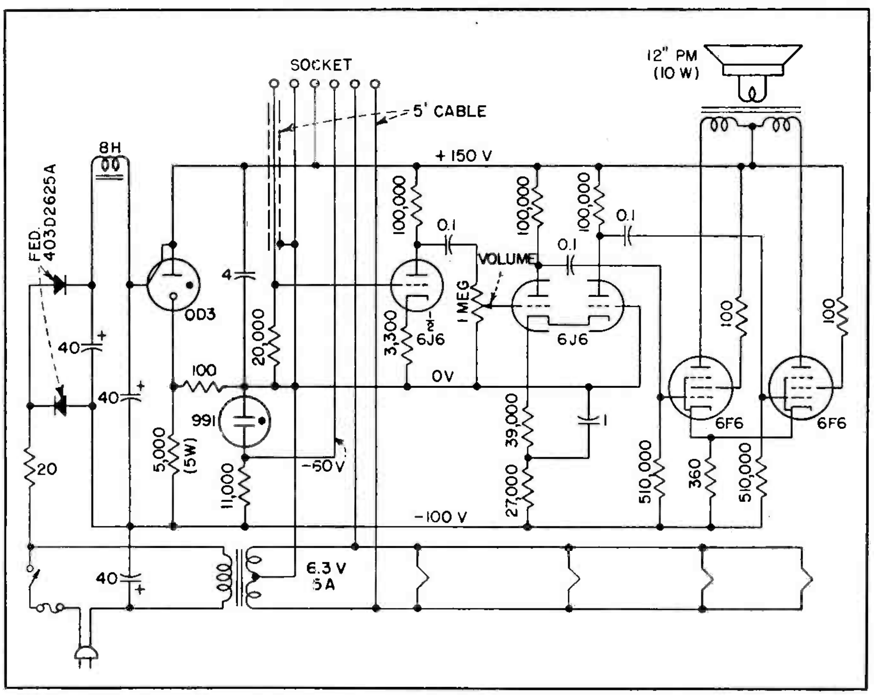


FIG. 6—Circuit of the common power supply, amplifier and loudspeaker unit

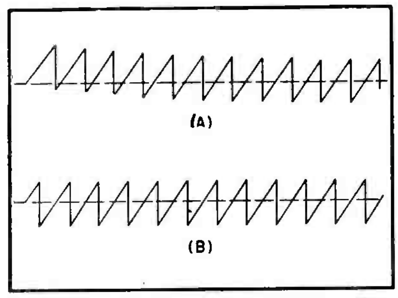


FIG. 7—Waveform at point *X* of Fig. 5 at start of oscillation (A) without bias derived from the bleeder R_1 R_2 and (B) with the bias

It may be noticed in Fig. 3 that the scale quadrant (in this bass console) is calibrated with high notes toward the left and low notes toward the right. This comes about because logarithmic potentiometers having a left-handed taper are not commonly stocked in suitable sizes. Although players quickly become accustomed to this arrangement, it has been found that most of them would prefer to have the scale reversed to match the convention of the piano keyboard.

Experience has been obtained both with family groups playing for their own entertainment, and with quartets well rehearsed for public performance. Some solo work has also been done using a single console with piano accompaniment. In every case enjoyment and recreation value have been strikingly evident. Even two professional symphony players who took part in one of the quartets were highly entertained and, incidentally, behaved like the amateurs in that they played awkwardly at first but improved very rapidly.

The music used has varied from simple "rounds" and folk songs to Bach chorales. Although no suggestion is intended that the wobble organ may ever join the ranks of the serious musical instruments, nevertheless it can do things with Bach that are actually rather satisfying. It has a voice-like quality, and yet overcomes certain vocal restrictions. The soprano never strains for high passages, the alto cannot possibly run short of breath, the tenor never cracks and the bass has power at his command for his very lowest note.

Progress in Dot-Sequential Color TV

New tricolor tube, having nearly double resolution of earlier model, shown to press and industry at Washington in "status-report" demonstration. New phosphors and by-passed monochrome circuit produce marked improvement in color fidelity and image structure

THE CURRENT STATUS of the dot-sequential color television system was revealed to the press and industry groups in a series of demonstrations by RCA-NBC at the Translux Theater Building in Washington. Noteworthy progress has been made in the nine-month interval since the last press showing, based on three new developments: a new tricolor tube having higher resolution and improved red and blue phosphors, the introduction of the by-passed monochrome system of transmission, and improved circuitry designed to stabilize the brightness and chromaticity values of the image. The net results are a substantial gain in the brightness, resolution and color fidelity of the images, and virtual elimination of spurious patterns due to beats between the image structure and the dot structure.

New Tricolor Tube

The new tricolor tube operates on the same basic principle as the earlier version. It contains three separate electrostatically-focused electron guns, arranged symmetrically in the neck of the tube, parallel to its axis. The beams from the guns pass through holes in a flat nickel plate ("mask"), arranged parallel to and about one-half inch behind the phosphor screen. In the new tube this mask contains 200,000 dots arranged in the form of about 480 horizontal lines of 420 holes each. Each hole corresponds to one picture element in the image and the total number, 200,000, corresponds roughly to the maximum number of picture elements which can be transmitted over a 6-mc channel at 60 fields per second. The earlier tube had only 117,000 holes in the mask plate, owing to the limitations of processing which have since been overcome.

The phosphor screen consists of small dots which fluoresce individually in each of the three primary colors. Three such prosphor dots are grouped as a cluster in front of each hole in the metal plate, making 600,000 phosphor dots in all. The phosphor dots and the holes are so aligned that the electron beam from one gun passes through the hole and hits a phosphor dot of one color, to the exclusion of the other two in the cluster. The other two electron guns and phosphor dots are similarly paired off, so that each gun is capable of exciting light of one primary color only, but the three guns together can produce any combination of the primaries in each cluster of three phosphor dots.

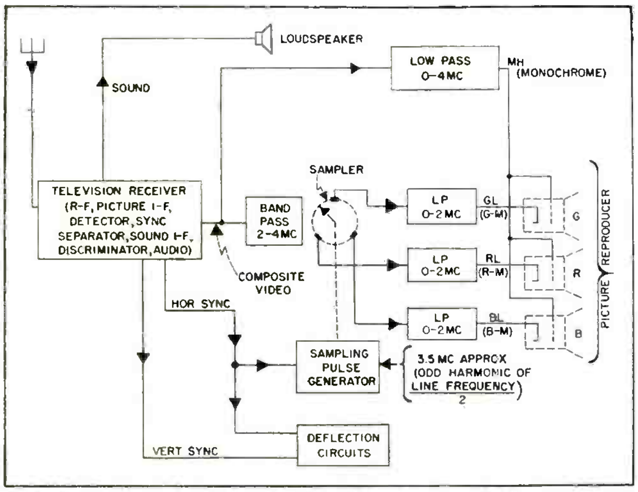
The difficult problem of aligning the 600,000 elementary areas of three different phosphors with the 200,000 holes in the mask has been solved by mounting the mask and viewing screen on a metal collar prior to assembly in the picture tube. The mask and screen form a subassembly which is joined to the metal shell of the tube, the collar forming a part of the shell. The viewing screen proper lies within the tube, about one inch behind the clear-glass face of the tube, which forms the forward wall of the envelope.

The outer dimensions of the tube are similar to the 16AP4 metal picture tube, except that the neck is thicker to accommodate the three guns and the overall length is about 4 inches greater. The scanning angle is about 55 degrees. The useful diameter of the phosphor screen is 13½ inches. No details of the manufacture of mask or screen have been announced, but it is understood that techniques akin to photoengraving and three-color printing are used to form the mask and to deposit the phosphor dots on the viewing screen.

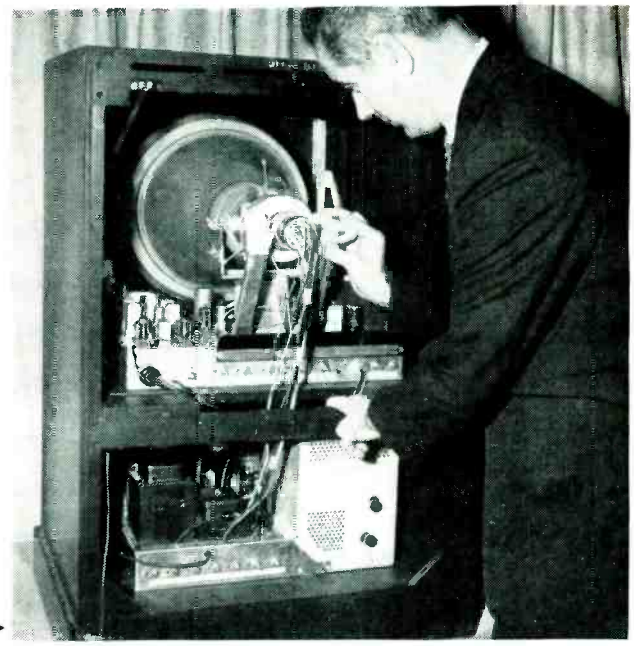
In the earlier demonstrations the brightness of the image was limited to about 5 footlamberts, due primarily to the inefficiency of the then-available phosphors. New red and blue phosphors having higher light output were developed for the new tube, which permits a proportionate increase in the brightness of the red and blue primary images. Highlight brightness in the range of 10 to 15 footlamberts was measured at the press demonstration, and values up to 20 footlamberts were reported later.

Another forward step appeared in the red phosphor. When the initial model of the tube was constructed, only orange phosphors of suitable brilliance were available. To produce the required red light with the early tube a subtractive (minus-yellow) optical filter was used. The new version of the tube employs a red phosphor having the required chromaticity, and no optical filter is required.

As a result of these changes, it was the consensus of observers that



Block diagram of by-passed monochrome color receiver. Primary-minus-monochrome signals (*G-M, R-M, B-M*) introduce color values



Rear view of 43-tube color receiver. The viewing screen is 13½ inches in diameter, contains 600,000 phosphor dots

very considerable improvement had been made in rendering the color and texture of objects. In the press demonstration the tricolor tube did not reproduce highly saturated reds and blues as well as the rotating-disk receivers currently demonstrated in New York by CBS. But the gap between phosphor colors and filter colors has been narrowed to such an extent that either can be considered satisfactory from a commercial standpoint. This fact is considered to be of great importance, since a tricolor tube will be an essential part of any future color system, irrespective of the method of scanning used.

By-Passed Monochrome

Apart from the improvements in resolution, brightness and color fidelity, the most striking aspect of the images was the substantial reduction in the visibility of the dot-structure. In the earlier version of the system, the conventional mixed-highs transmission was used, that is, the image structure corresponding to video frequencies higher than 2 mc was transmitted in monochrome. Larger areas, corresponding to frequencies below 2 mc, were transmitted by three separate interspersed color signals. When the color signals are transformed into corresponding dots of color on the viewing screen, the image displays a dot structure having a coarseness corresponding to 2 mc. This structure appears even in areas having no color (that is, white or gray) since these areas were formed by adding successive amounts of the three primaries at each point.

In the latest version of the system, the by-passed monochrome transmission method developed by Hazeltine (see p 92 this issue), has been adopted. In this method, the whole video frequency range from 0 to 4 mc is transmitted in monochrome, in the form of a continuous (nonsampled) monochrome signal derived continuously from all three camera tubes and applied continuously to all three guns of the tricolor tube. This part of the transmission is essentially identical to the standard black-and-white transmission, and it renders white and gray areas in the color image without dot structure.

To introduce the colors in the larger areas (2-mc coarseness), the color signals are arranged to subtract, from the white light of the monochrome signal, an amount which produces the required intensity of each primary color. That is, for the red primary, the signal applied to the red electron gun from the color sampler circuit corresponds to a red-minus-monochrome value which, when added to the monochrome value already present, produces a net red output.

In the Hazeltine system the technique of constant-luminance sampling (ELECTRONICS, August 1950, p 154), is used to reduce the effect of interference. In this method, the sampling vectors have unsymmetrical angles and amplitudes, so arranged that the color signals carry no brightness information, but hue and saturation information only. The constant-luminance method had not been introduced into the RCA system at the time of the demonstrations.

Receiving Equipment

The receiving units demonstrated included two color receivers, having 43 tubes each, a 16-inch black-and-white table model receiver converted for color, and a color companion unit, intended to operate as an attachment to a black-and-white receiver. Neither the converted receiver (standard 24-tube black-and-white chassis plus an auxiliary chassis of 13 tubes) or the companion unit performed as well as the 43-tube color receivers in color fidelity. In all receivers a small degree of misregistration was noticeable in portions of the image, but the fact that good registration was maintained at the corners of the images showed that this difficulty is being brought under progressively greater control.—D.G.F.

AUTOMATIC GCA

Simultaneous control of five aircraft spaced at two-mile intervals along a ten-mile approach corridor is provided. Azimuth, elevation and range information are converted into phase displacements at ground station and automatically transmitted to plane where information is used by auto-pilot to perform blind approach

By JOSEPH T. McNANEY*

Senior Electric Engineer
Consolidated Vultee Aircraft Corp.
San Diego, California

GCA RADAR is being pressed into more and more widespread use by aviation throughout the world. More than 150 military air bases are now depending on GCA for blind-landing purposes.

This paper describes a system for eliminating completely the human element. The ground link between radar presentation and transmitter is replaced by an electronic link, the necessary information being presented to the pilot by means of instruments. Finally, this same information is fed through suitable equipment to allow the automatic pilot in the plane to perform the approach. The pilot guides his plane to the glide path by conventional means, and takes over controls just before touchdown when visual contact is established.

The success of such a system depends on the ability of the radar to select a specific target and to lock itself to that target in order to control its approach. All measurements in range, elevation and azimuth are based on a phase difference between a reference and a signal current. Airborne and ground indicators are simple phase meters, thereby eliminating the complexities of c-r tubes and their associated circuits.

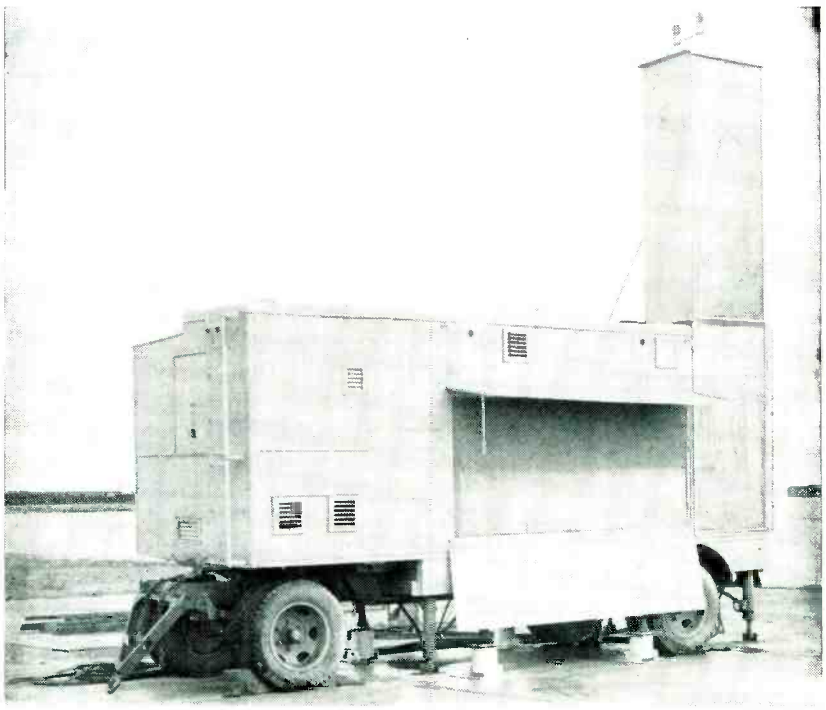


FIG. 1—Standard precision approach radar furnishes data for operation of automatic approach system

Conventional precision approach radar, illustrated in Fig. 1, is used to obtain the required radar information. A single radar unit may be used to control the approaches of five planes simultaneously. There are actually six independent servo loops, five of which are in operation at any one time, while the sixth awaits the entrance of the next plane into the approach corridor as the first in line lands. The planes are spaced at two-mile intervals.

Figure 2 shows the pick-off units and a selector switch in the antenna scan mechanisms. Synchro-resolver R_1 is geared to azimuth mechanism, and R_2 is geared to elevation mechanism. These units replace, in certain respects, angle coupling capacitors normally used in conventional GCA equipment. Switch S_1, which is operated in unison with the T-R switch, controls the switching of selected target video to azimuth and elevation indicator systems, while the r-f switch controls the switching of the transmitter to azimuth and elevation antennas.

Antenna Switching

While the r-f switch and S_1 are in the positions shown, the elevation antenna is radiating and receiving r-f energy, and synchro resolver R_2 is being supplied with selected target signal current. Under these conditions the output of R_2 represents the angular position of the elevation antenna at

*Preliminary research on the work described was conducted by the author while associated with Bendix Radio Division of Bendix Aviation Corporation, which organization furnished the above photograph.

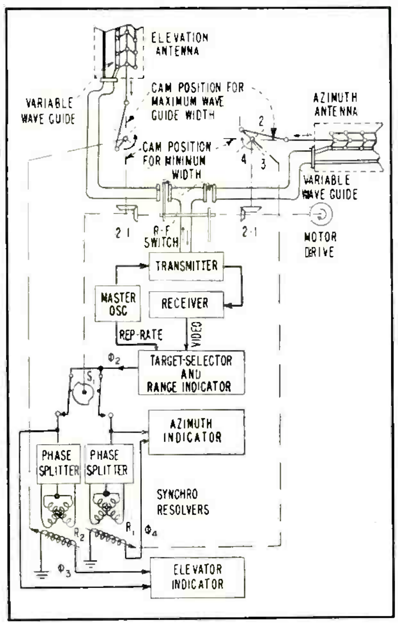


FIG. 2—Azimuth and elevation antennas are used with a common transmitter and receiver on a time-shared basis

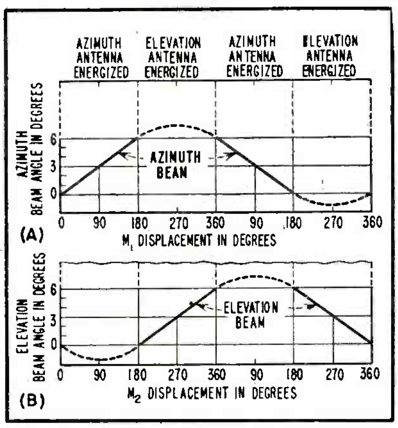


FIG. 3—Azimuth and elevation are swept alternately in opposite directions to reduce target to a point source

those instants that r-f energy is being returned from the plane under control. In this manner, the elevation approach angle of the desired aircraft is determined.

When R_1 and R_2 are initially adjusted they are set to provide zero output signal conditions when respective antenna beams are at the start of a normal sweep. For zero output conditions, for instance, current phase ϕ_3 from R_2 will be leading current phase ϕ_2, applied to the input circuits, by 90°. Current phase differences are therefore used as a measure of azimuth and elevation glide angles.

Figure 3 shows angular relationships between azimuth and elevation antenna beam angles and the angular positions of R_1 and R_2 respectively. These curves represent a tentative arrangement where, in the case of the elevation antenna, the relationship of beam angle travel to current phase ϕ_3 angle of travel is 30 to 1. A similar relationship of the azimuth angles is also 30 to 1.

The r-f switch positions are also shown as a function of antenna beam angles. Two revolutions of the r-f switch blades are shown. During the first 180 degrees the azimuth antenna is energized. During the next 180 degrees, the elevation antenna is energized. This procedure of antenna energization is again repeated during the second switch revolution.

It should be noted that the antenna beam scans are made at one-half rate. This arrangement allows a target to be swept, alternately, from one direction and then from the other. Such action aids in reducing a target to a point source. The antenna beams are made to scan through two complete cycles per second, giving four looks per second, each look being ⅛ second in duration. Through the use of a 4,000-cycle antenna beam repetition rate each scan duration will contain 500 pulses of r-f energy.

Figure 4 shows the indicating system. Video from the radar receiving system is coupled to the target selector. A repetition rate from the master oscillator is fed to the range indicator. Azimuth information is transferred to the azimuth indicator from synchro R_1, and elevation information is coupled to the elevation indicator from synchro R_2.

Target Selector

The target selector allows an aircraft to be selected by virtue of its range and speed. Video representing the aircraft brought under control is then used to actuate the range, azimuth and elevation indicators. The three indicators are essentially servo-type phase meters. The range meter measures the phase between the time a radar pulse is generated and the time it is returned from a target. The azimuth meter measures the phase of a pulse return in azimuth with respect to a known reference angle, and the elevation meter measures the phase of a pulse return in elevation with respect to a known reference angle.

The theoretical dimensions of the two beams at ten miles are similar, and it is assumed that, between half-power points, the beams are 2 degrees in width and 0.5 degree thick. At ten miles a box-like opening, 200 yards by 200 yards, represents the start of an approach corridor. With the aid of a radar search system, a plane is talked into the opening of the corridor. Upon entry, it is immediately detected by the range, azimuth and elevation equipment on the ground.

Under normal operating conditions, the corridor will assume a fixed location in space. The center of the box-like opening at ten miles represents the location of the glide path at this point. When a plane enters the corridor at 10 miles, ±0.5 mile, a range indicator in the ground equipment becomes essentially locked to the plane. The azimuth and elevation indicators very rapidly measure the plane's deviation from the prescribed path.

The range indicator synchro resolver (R_3 in Fig. 4) is adjusted to 154 degrees with respect to a zero angle of reference; a 154-degree adjustment is equal to 10 miles. Resolver R_3, through suitable phase splitting means, is supplied from a 4,000-cycle sine-wave oscillator. This supply of current is designated as phase ϕ_1. The 4,000-cycle oscillator is under the precise control of the repetition-rate frequency from the master oscillator.

Each cycle of a 4,000-cps signal is completed in 150 μsec, or 1.44 deg per μsec. Since r-f travels 1 mile in 10.7 μsec, 10.7 × 1.44 deg, or 15.4 deg of each cycle is equal to 1 mile.

Current phase ϕ_5, taken from R_3, is therefore made to lag current phase ϕ_1 by 154 deg. By means of a pulse generator each cycle of current ϕ_5 is converted into 10-μsec pulses and applied to the grid of a range gate. The midpoints of the 10-μsec pulses are made to coincide with a cross-over point of phase ϕ_5 sinusoidal currents. Therefore each midpoint lags behind the initiating pulse from the master oscillator by 107 μsec. The latter time is equal

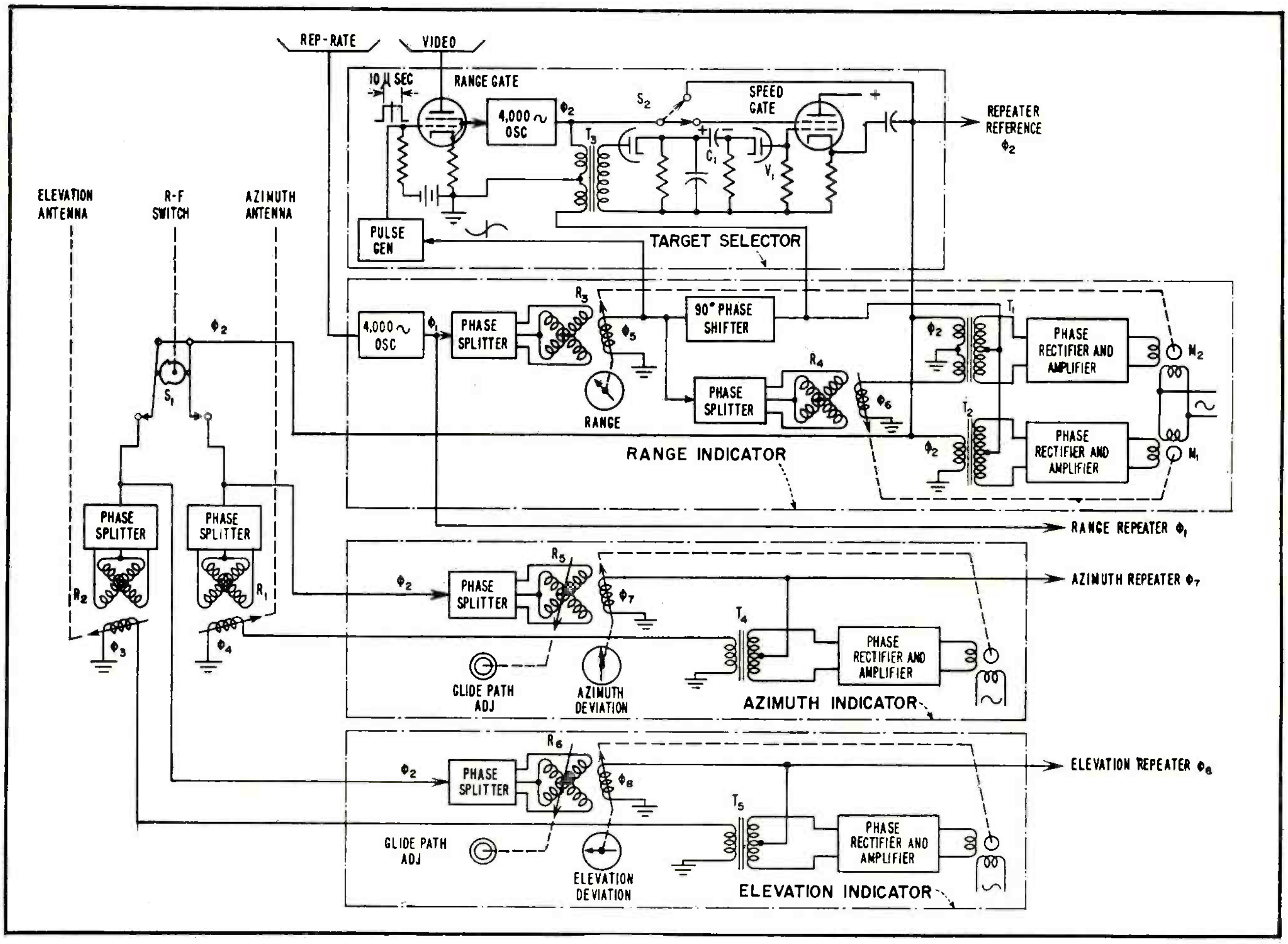


FIG. 4—Indicating system provides range, azimuth-deviation and elevation-deviation data

to video returning from a target 10 miles away.

All video received is applied to the anode of the range gate, but the latter is normally biased to cutoff. However, when the 10-μsec pulses are applied to the control grid, the tube is made conductive. This means that for 10 μsec out of every cycle of 250-μsec duration, the range gate is receptive. The only video conducted through the gate during a ten-mile adjustment of R_3, therefore, will be that returning from targets at ten miles out, ±0.5 mile.

When a plane is talked into the approach corridor opening at a ten-mile range, video is applied to input control circuits of another 4,000-cycle sine-wave oscillator through the range gate. Through the use of a video repetition rate of 4,000 per second, the start of every cycle generated by the oscillator will be under the control of a video pulse. If a plane is flying in at a speed of 120 miles an hour, for example, the phase of the output currents ϕ_2 will be changed at a rate of 0.5 deg per second, or 0.000125 degree for each succeeding video pulse.

Until a plane reaches a 9-mile point in the corridor the contact arm of S_2 is in the dotted position. Currents ϕ_2 are thereby connected to servo amplifier coupling transformers T_1 and T_2. Circuits associated with T_2 may be referred to as an integral control loop, while circuitry associated with T_1 will function as a proportional plus integral control loop. Phase ϕ_5 currents are applied to the two control circuits continually, and serve as a reference current. Currents ϕ_5 are shifted 90 deg for this purpose.

Video-controlled ϕ_2 currents may be considered in phase with ϕ_5 currents when the plane is at ten miles and when R_3 is set at 154 deg. Under these conditions motor M_1 will be stationary.

If the speed of the plane is 120 miles per hour at the instant it is passing the ten-mile point, R_4 will be set at an angle necessary to produce a corresponding M_2 motor speed. The phase angles of synchro R_3 rotor current ϕ_5 and current ϕ_2 will be changing in unison at a rate of 0.5 deg per second. The only conditions under which M_1 and R_4 will have assumed a different angular setting are when the plane changes its forward speed.

Range Indication

An indication of aircraft range is taken from the synchro R_3 rotor shaft. Because of the integral control servo in the range indicator loop, the range of the aircraft under control will be followed with a high degree of accuracy. The integral signal ϕ_6 actually replaces the proportional signal ϕ_2 in the primary of T_1. During a constant-speed approach, a signal current ϕ_2–ϕ_5 differential is zero, while a ϕ_6–ϕ_5 differential functions as the constant-velocity servo error.

When the plane reaches the nine-mile point S_2 is automatically thrown to the position of the solid line connection. This puts ϕ_2 potentials on the grid of the speed gate tube. Although ϕ_2 currents are now coupled to T_1 and T_2 through this cathode follower, the operation of the range indicator is essentially the same.

While the phase of ϕ_5 currents is shifting at the rate of 0.5 deg per second, the 10-μsec pulses are kept in synchronism with the video. Very close synchronism is again maintained by virtue of the integral control loop in the range indicator. By this process, the trailing and leading sides of a control box in the space occupied by the approach corridor escort the plane to within approximately 50 feet of the runway.

The speed gate distinguishes speed differences between the aircraft under control and all other targets. Currents ϕ_2 and ϕ_5, which are of approximately equal magnitudes, are combined in the primary of T_3. Currents ϕ_5 are applied as a reference, and ϕ_2 serves as the signal current; ϕ_2 currents are applied intermittently, at antenna scan rates. The two currents are combined 90 degrees out of phase, and are each changing their phase with respect to ϕ_1 currents, at a rate of 0.5 deg per second. Current ϕ_5 is used as the reference since it is the constantly applied current. The output of T_3 is rectified and places a constant charge on capacitor C_1.

Because of the phase relationship of ϕ_2 and ϕ_5, there is no appreciable alteration in the charge on C_1 during the applications of ϕ_2 currents. In the event the charge on C_1 is increased, a positive potential is impressed on the cathode of V_1. When the charge on C_1 is decreased, the polarity of this potential will be reversed. Current will then flow through V_1. Negative voltage, which is a function of the rate at which the charge on C_1 is decreasing, is placed on the control grid of the speed gate tube. When the presence of ϕ_2 currents represent video of a plane under control, this tube functions as a normal cathode follower. Signal currents, as previously explained, will be applied to T_1 and T_2.

Stationary Targets

If a stationary target is detected within the control box, resulting ϕ_2 currents will be allowed to flow in the primary of T_3. Since the control box is traveling in the direction of the touch-down point at the speed of 120 miles per hour, ϕ_2 current flow in T_3 will be shifting phase with respect to ϕ_5 at a rate of 0.5 deg per second. This change will be in the direction which increasingly opposes the current flow of ϕ_5. Under these conditions the charge on C_1 will be decreasing also. A resulting negative voltage on the speed gate tube introduces a blocking action. In this manner, undesired targets are isolated from the indicator circuits.

Az-El Indicator

Target video in the form of ϕ_2 current, selected by virtue of an aircraft's range, its speed, and its position in azimuth and elevation, is now coupled to azimuth and elevation indicating circuits through S_1. This switch allows the azimuth indicator to receive signal currents when the azimuth antenna is in operation, and then allows the elevation indicator to receive similar currents when the elevation antenna is in operation.

Again referring to Fig. 3, the start of each antenna scan coincides with a synchro zero reference angle. A mechanical relationship may allow, for example, the synchro to rotate 180 deg during a beam angle scan of 6 deg. If during the sweep of a beam the controlled aircraft's position corresponds with a 3-deg beam angle, it will be repeated as a 90-deg synchro rotor position. This 90-deg position will be the only angle at which ϕ_2 currents are coupled to the respective indicator systems.

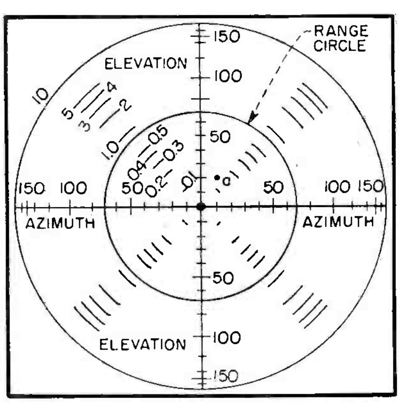


FIG. 5—Indicator dial proposed for use in automatic GCA system. Target *a* is 10 yards to the right of the correct glide path, 20 yards high, and the range circle indicates he is 0.75 mile from touch-down

Target and beam dimensions in the directions of scan are reduced to a point source, insofar as the indicators are concerned, by sweeping the target from opposite directions. During one sweep the beam angle and the synchro angle are increasing together, from a zero reference. In the following sweep the beam angle reverses its direction while the synchro repeats in the same direction. The response characteristics of the servo loops in the indicators provide an averaging process of the beam angle currents.

In the azimuth unit (Fig. 4) ϕ_2 current is fed through a phase splitter to R_6. Output current ϕ_7, from the rotor of R_6, is supplied to the midtap of T_4 as a reference current. Current ϕ_4 from R_1 is coupled to the primary of T_4. In combination, ϕ_4 and ϕ_7 currents are coupled to phase rectifier and amplifier circuits wherein phase differences are amplified and used to energize the azimuth indicator motor which is geared to R_5. The latter is servoed to an angular setting which satisfies an equilibrium condition in T_4.

A state of equilibrium is reached when the rotor of synchro R_5, from a zero reference angle, is given a position of 90 deg. This angle coincides with the 90-deg angle of R_1, at which angle video is returned from the plane on the approach path. A brief sampling during each sweep of the antenna beam is sufficient for keeping R_1 and R_5 in step. By means of integration the servo loop remembers its adjustment from one antenna sweep until the next, and assumes an average of broad target effects.

If for example a 3-deg azimuth beam angle represents the correct glide path, a corresponding angle of R_1 will be 90 deg. By means of a glide-path adjustment, R_5 may be turned until the azimuth deviation indicator reads zero. A similar adjustment is provided for in the elevation indicator. These glide-path adjustment shafts may be linked in with the range mechanism, in the event a glide angle is required to change as a function of range.

Connecting points are provided

for range, azimuth and elevation repeaters. Currents of ϕ_2 are used as a reference in each case.

A complete automatic system contains six independently controlled range-azimuth-elevation indicator units, all of which are operated in parallel and supplied with range information from a common radar receiving system. The units are also furnished with azimuth and elevation data from a common pair of radar antennas.

A type of indicator presentation is shown in Fig. 5. In combination, and on a single dial face, Az-El position deviation and aircraft range are presented.

Aircraft range is shown by means of a circle of reflected green light on the underside of the translucent dial. Range is indicated by the diameter of the circle. When a plane enters the approach corridor at ten miles, the circle appears and then becomes progressively smaller as the plane proceeds from the ten-mile point.

The plane's position in the approach corridor will be indicated on the dial face by a dot of white light. The position shown at point a is at ¾mile in range, 20 yards high in elevation and 10 yards to the right of the approach path. The dot of light (a), under properly controlled conditions, will be kept as close as possible to the point of cross-over. However, the importance of holding the plane on the glide path increases with the nearness to the touch-down point. Therefore, this type of presentation will prove to be highly desirable, in that the pilot, or the control operator, will extend every effort to at least keep the dot of light, which represents his plane, within the circle.

Aircraft Spacing

The pilot or control operator is supplied with the position in range of the plane directly ahead of him by means of a red range circle on the dial face. The red circle in Fig. 5 has been reduced to a dot in the center of the scales, which indicates that the other plane has already touched down.

An indicator of the above type is representative of the instrumentation carried in the plane. A set of six such indicator dials will be employed on the ground. Under actual operating conditions, the instrument in a plane is made to function as a repeater of a corresponding unit on the ground, after the plane reaches the ten-mile point. If a plane is not equipped with such a unit, the pilot may be supplied with oral instructions from the ground.

The circuit in Fig. 6 illustrates the aircraft spacing system. As previously stated in connection with Fig. 5, there are six independently controlled range-azimuth-elevation indicator units in the ground equipment. Certain essential range-measuring components of the six units are again represented in Fig. 6. Components of the respective units are identified by letters. The independent range circuits are supplied from a single source of video and master oscillator currents of the radar set.

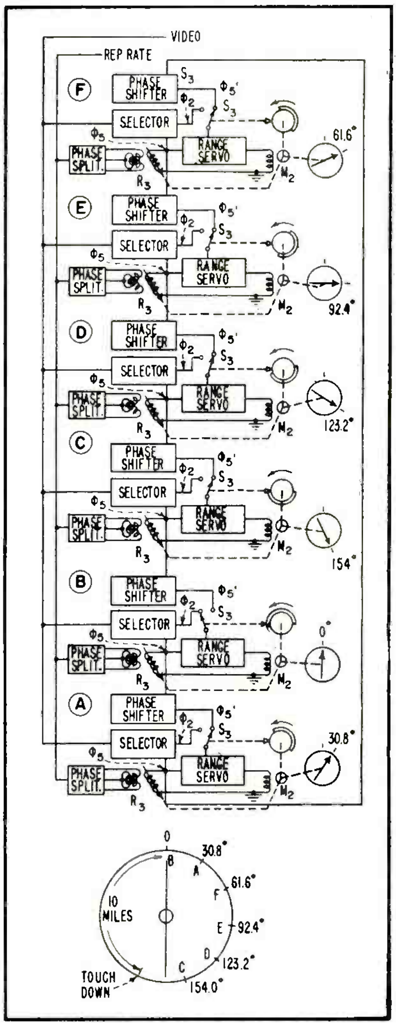


FIG. 6—Aircraft spacing equipment maintains approximately 2-mile intervals, which corresponds to 30.8 radar degrees

With reference to any one range unit, it will be noted that video is coupled to a selector, and the repetition rate is coupled to synchro R_3 through phase-splitting circuits. Current ϕ_5 from R_3 and current ϕ_2 from the selector are coupled to a range servo. In response to phase differentials a motor M_2 corrects for misadjustments of R_3. To this extent, the system was more fully described in conjunction with Fig. 4.

Important additions to these range circuits include a switch S_3, actuated by a cam and follower, and a phase shifter. Switch S_3 allows either ϕ_2 currents from the selector, or ϕ_5' currents from another range unit, to be coupled as a reference to the range servo. By means of S_3, the six range units may be connected in series.

When two range units are connected by an S_3, a synchro R_3 of one unit operates as a director and a similar synchro R_3 of the second unit functions as a responder. The phase shifter between each synchro rotor ϕ_5 output and switch contact of S_3 provides for a 30.8-deg differential between ϕ_5 currents of respective rotors when a condition of balance is established. A series of phase meters may therefore assume alignment differentials of 30.8 deg. A range of one mile is equivalent to 15.4 deg.

An examination of the entire system will show a series connection of range units *C, D, E, F, A* and *B*. There is a disconnection between *B* and *C*. The cam assembly of unit *B* is in a position which connects ϕ_2 current to the range servo. The associated dial indication of zero is equal to a range setting of ten miles. This is further indicated on the sample dial face shown at the bottom of Fig. 6. The range indicator *B* retains its ten-mile setting until a plane enters the approach path. When the latter occurs ϕ_2 currents under control of the plane allow the range meter *B* to follow the plane in toward the touch-down point.

The range unit *A*, under the control of range unit *B*, had previously assumed an adjustment of 30.8 deg behind unit *B*. Unit *A* will remain in this position until a plane takes over the control of unit *B*. In this event, a rotation of R_3 in unit B will be closely followed by R_3 in unit A. In the process, a cam is rotated in the arrow direction until a follower rides upon the larger-diameter portion of the cam. A director control current ϕ_5 from unit B is disconnected by S_3, and unit A will then have assumed a setting of ten miles. While this action is taking place the remainder of the range units in the complete system will have likewise advanced 30.8 deg.

Aircraft Equipment

The diagram of Fig. 7 shows the equipment included in the plane. If a plane is merely equipped with a communication receiver, the pilot may be talked in. If an indicator is included in the plane the various data, in the form of phase-displaced currents, will be used to control the indicator. Or, if the plane is equipped with an auto-pilot, the latter data may be coupled directly to it for control of the plane.

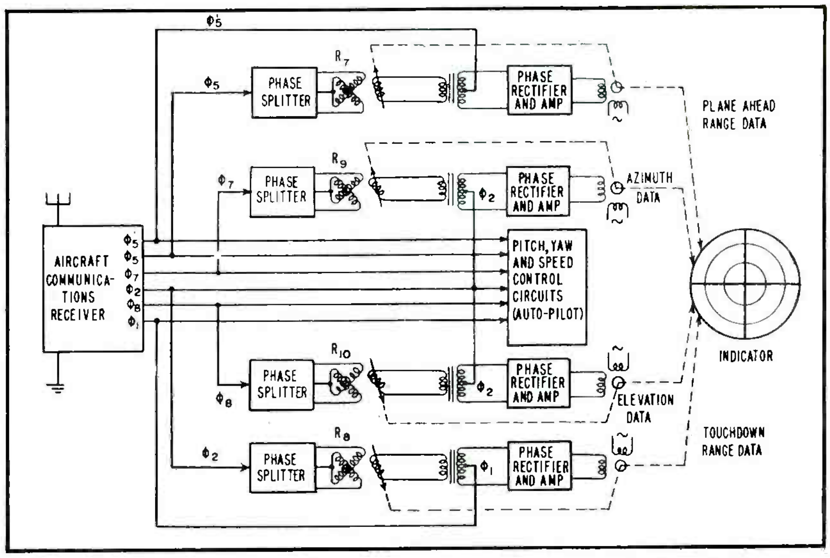


FIG. 7—Airborne equipment. Information may either be applied to indicator or to automatic pilot for completely automatic approach

Plane-ahead range data will consist of phase-displaced currents ϕ_5 and ϕ_5'. Phase ϕ_5 represents range from touch-down of the pilot's own plane, and phase ϕ_5' represents range from touch-down of the plane ahead. The resultant information furnished the pilot will be the distance between his plane and the one directly ahead of his plane. Phase differences between ϕ_5 and ϕ_5' currents are coupled to a servo-type phase meter. The latter consists of a synchro resolver R_7 and its associated control circuits and motor. An assumed position of R_7 is a measure of aircraft spacing, which is mechanically transferred to the indicator.

Touch-down range is represented by currents ϕ_1 and ϕ_2. Phase relationships of these currents are detected by means of a second servo-type phase meter, and converted into an indication of distance to the touch-down point. This phase meter consists of synchro resolver R_8 and its control circuits and motor. Aircraft range is closely followed by a changing angular position of R_8, which is transferred to the indicator.

Azimuth position deviation data consists of phase-related currents ϕ_2 and ϕ_7, and elevation position deviation data consists of phase-related currents ϕ_2 and ϕ_8. These currents are likewise coupled to phase-meter circuits, wherein electrical differentials are converted to positional information. The mechanical output of each meter is likewise transferred to the indicator. The indicator is similar to that described in connection with Fig. 5.

Conventional auto-pilot equipment may be modified to respond to the same control data supplied to the indicator. The auto-pilot is shown in Fig. 7 by a block diagram. Current phases ϕ_2, ϕ_7 and ϕ_8 will be used to control the plane in pitch and yaw. Current phases ϕ_1 and ϕ_2 in combination with ϕ_5 and ϕ_5' will be used to control the plane's speed.

Potential Advantages

In summarizing, it will do well to point out that systems in the past, for the most part, have been limited to the control of aircraft singularly and have involved the use of several skilled operators to interpret cathode-ray scope indications and then convey the results of their interpretations to the craft under control. The means provided by these systems for the indications of the location of the craft with respect to the glide path require, at best, the interpretation and correlation of separate indications for each of the coordinates used to determine the position.

There is no certainty with existing systems that an indication of a craft on the glide path will not be confused with indications of other craft or objects in the vicinity.

The indicating facilities of the present system, however, portray on one instrument face a correlated indication of the position of an aircraft with respect to a desired glide path. The indication obtained is assuredly representative of the plane under control, by virtue of the inherent ability to discriminate against targets having a velocity relative to the desired glide path, which differs from that of the desired target.

The indicators are mechanically actuated devices that respond to signal inputs which lend themselves readily to the actuation of repeater indicators. When such repeaters are located in aircraft, the pilot may make his approach by radar-controlled instrument readings. For a more accurately controlled approach the pilot may couple the received signals to the auto-pilot for a completely automatic operation.

As explained, the system is adapted for the simultaneous control of as many as five aircraft by the provision of a plurality of sets of range, azimuth and elevation determining circuits mechanically interlocked through their range-responsive servo motors. This is accomplished in a manner such that each in turn becomes responsive to the reception of target echo signals from targets at a predetermined range limit.

TELEMETERING SYSTEM

Snowfall in isolated mountain areas is measured in terms of radiation between slug of Cobalt-60 embedded in ground and Geiger-Muller tube suspended above it. Unattended f-m transmitters and repeaters forward data to central recording station. Commitments for hydroelectric power and irrigation water are made on basis of measurements

By JOHN A. DOREMUS

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THE ECONOMIC IMPORTANCE of efficient use of natural precipitation in the western part of our country has become well known in recent years. This requires accurate measurement of precipitation as it falls and as it is stored in the snow pack in mountainous areas.

Commitments for both hydroelectric and irrigation water supplies are made on the basis of snow measurements. Snow-survey and precipitation-gage data give only limited information because of the inaccessibility of many important watersheds during the winter.

Instrumentation

During the past two years, R. W. Gerdel and B. Lyle Hansen of the U. S. Weather Bureau and W. C. Cassidy and Forrest L. Rhodes of the U. S. Army Corps of Engineers[1] have developed a thickness gage, using radioactive isotopes of common metals, to measure the water equivalent of snow cover in isolated areas.

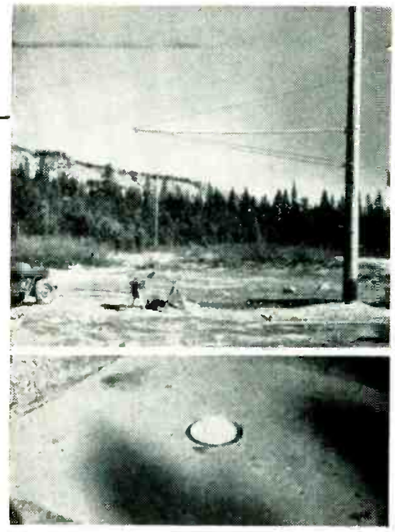
Only gamma rays appear to have sufficient energy to penetrate a deep snow pack. The intensity of radiation, after passing through an absorbing medium, depends upon the original intensity and the thickness of the medium, in accordance with Lambert's law $dI = \mu I_0 dx$. The proportionality constant, μ, (also called the linear-absorption coefficient) is the reciprocal of the thickness of the medium which will reduce the intensity of radiation to $1/e$ of its original value. The linear-absorption coefficient, when divided by the density of the substance, ρ, produces the mass-absorption coefficient, μ/ρ, which is constant regardless of the state of the medium whether it be solid, liquid, or gaseous.

The water equivalent of a snow pack may be expressed in terms of measured attenuation through the snow, provided three conditions are met in the measuring equipment:

(1) Cosmic radiation must be determined, and subtracted from the measurement, unless it is very small compared to the intensity from the source being measured.

(2) Radiation must be essentially monochromatic, since the absorption coefficient is constant only for a specific wavelength.

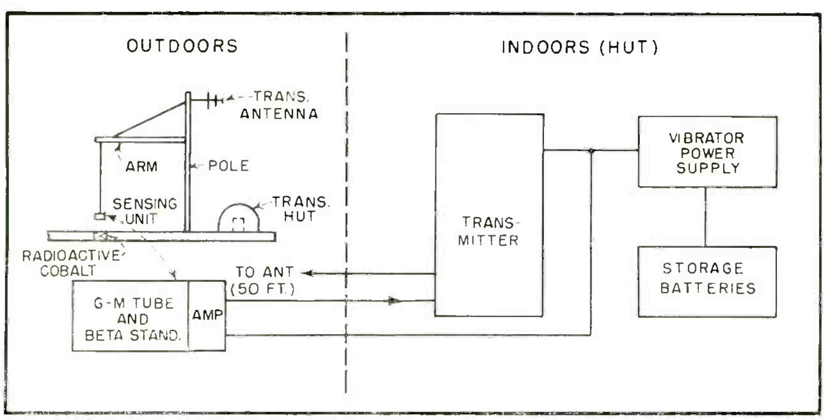
(3) The beam of radiation must be collimated to reduce excessive scattering, which would produce an apparent variation in the absorption coefficient.



Sensing-unit arm and, below, radioactive Cobalt-60 and collimator set in concrete base under sensing unit

After investigating all available sources of gamma radiation, Dr. Gerdel and his associates chose Cobalt-60 because it has high activity, its radiation is essentially monochromatic (1.1 and 1.3 mev) and it has a long half-life (5.3 years). Decay correction within a season is small.

Two units (40 millicuries) of Cobalt-60 were mounted at the lower end of a heavy lead tube. The tube was installed vertically in the ground, with the upper end flush



Physical arrangement of equipment at a data-transmitting station. A single pole supports the sensing unit and antenna

This article is based on a paper presented at the 1950 National Electronics Conference. The conference paper will appear in the *NEC Proceedings*.

for Radioactive Snow Gage

Typical unattended repeater that receives signals from several radioactive-snow-gage data-transmitting stations located in remote mountain areas and relays them to a more accessible recording station

with the surface. This method of mounting effectively collimates emission so that at 15 feet the principal energy is contained within a circle approximately 1½ feet in diameter.

A Geiger-Muller tube was chosen as the sensing device because it is rugged and can readily withstand conditions of operation imposed upon it by this application. It provides an output that can be readily used in electronic circuits. To provide continuous calibration, a small sample of Strontium-90 is included in the housing with the G-M tube. Emission is essentially beta radiation, with a half life of 25 years. The sample is placed close to the G-M tube but separated from it by a magnetically-operated metal shield. The radiation from the beta standard is superimposed on the count rate for a portion of the sampling period, as a means of checking the entire system from the sensing element to the recorder.

Calibration of the radioactive snow gage has been undertaken both by the use of hand-packed snow piles and by the use of known depths of water between the radiation source and the sensing tube. The linear-absorption coefficient obtained was very close to the theoretical value for absorption of 1.2-mev energy by water. Slight differences can be attributed to unequal distribution of 1.1 and 1.3-mev energy from the Cobalt-60 and to the finite resolving power of the self-quenching tube.

Unlike most instruments, the radioactive snow gage has an error which increases in percentage as the quantity measured increases. However, practical measurements show that up to a reading of 45 inches of water equivalent the error is less than 5 percent. This is far better accuracy than can be attained by other methods of measurement.

Telemetering System

To form a useful system, the information from many gaging stations must be transmitted to a central collecting station far removed from the data-transmitting sites. These sites are by their nature at locations inaccessible to pole line facilities. Radio is the only practical medium for transmitting data to the recording station. For simplicity, a one-way radio system is used and data stations are actuated according to a program controlled by a time clock at each station.

A count rate as high as 20,000 per minute or as low as 120 per minute (background rate) must be transmitted. Since the lower count-rates represent the maximum depth of snow cover and since minimum count is limited by background count, it is important to study the probable error due to the random nature of the background count. This follows the well-known distribution of random events, where the maximum deviation is $D = \sqrt{N}$. Thus a maximum deviation of 11 counts might be expected with a background count of 120 cpm. A longer counting period would improve the accuracy of reading. Using five minutes as a counting period, $D = \sqrt{600}/5$, or 4.9 counts per minute. A five-minute counting period was therefore chosen as a practical compromise between the number of stations to be handled in a given period of time and the probable error incurred due to the random nature of the impulses.

The bandwidth required of the transmission system is directly proportional to the rate of data transmission. However, the noise power affecting the system is also proportional to the system bandwidth. It is desirable, therefore, to reduce the bandwidth of the system

Receiving equipment used at central recording station to handle the audio subcarriers of remote repeater stations

to a minimum, provided that this reduction does not incur an intolerable error in the reading.

In the data-transmission system chosen, an audio subcarrier is used to frequency-modulate an r-f carrier in the 169 to 173-mc range. The frequency of the audio subcarrier is shifted from its nominal value to a second value by the first count signal from the G-M tube. The next count shifts it back to its original value. Each count is identified as a point in time when received at the recording station. However, the average frequency of modulation of the audio subcarrier is only half the count rate.

If a further division by two is incorporated, using a conventional divider circuit, an error of + zero to minus-one count is incurred. Dividers can be used, with the following errors being incurred:

Division by	Maximum errors in count	Maximum error in count rate (cpm in 5-min. period)
2	−1	−0.2
4	−3	−0.6
8	−7	−1.4
16	−15	−3.0
32	−31	−6.2

It should be noted that the error incurred by the use of dividers is an error in basic count. When taken over a five-minute period, the maximum error in counts per minute is only one-fifth of the basic count error as shown above. Since the quantity being measured was shown previously to have a possible error of 4.9 counts per minute (at minimum counting rate) it is practical to divide the basic count-rate by eight and incur a maximum error that is small compared with the uncertainty already existing.

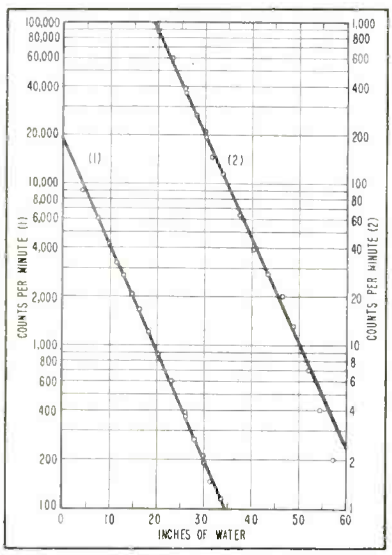
The maximum expected average count-rate of 20,000 cpm is equivalent to 333 counts per second. However, with currently-available Geiger-Muller tubes having a dead time of 150 microseconds the maximum frequency of pulses could be as high as 6,667 per second. Since two pulses are required to provide a full cycle of frequency-shift modulation, this is equivalent to 3,333 cycles per second. A further division by eight reduces the requirement to 416 cycles per second. The bandwidth required to transmit this modulation width is generally taken as 2.3 times the highest modulating frequency.[2] Thus a 1,000-cycle-wide system would provide practical operation.

The system used is equivalent to a double-frequency-modulation system. The signal-to-noise improvement factor is represented by the relation[3]

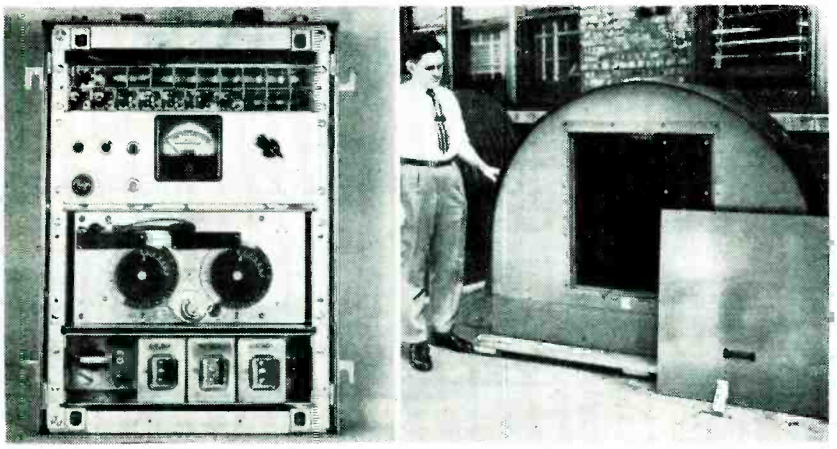
$$F = \sqrt{\frac{3}{2}}\left(\frac{D_1}{fm}\right)\left(\frac{D_2}{fsc}\right)$$

Signal-to-noise ratio improvement is set at 12 db over an equivalent amplitude-modulated system.

The use of frequency-modulated subcarriers has two more important attributes. In a practical snow-gaging system, many data-transmitting stations are spread over a wide area. Repeater stations are required to receive and to retransmit the signals to the recording station. Simultaneous reception at a repeater station of two or more data-transmitting stations



Calibration of radioactive gage in counts per minute above cosmic background versus water equivalent of snow



Half-watt f-m transmitter and Quonset-type hut that protects it from the elements, bears and other animals at remote data-transmitting locations

is possible through the use of multiple receivers on separate r-f carrier frequencies. If the audio subcarriers of these several stations are at different selected points in the audio spectrum, then the audio signals may be combined and sent to the recording station simultaneously on a single r-f circuit. At the recording station, separate decoding equipments, one operating at each of the audio subcarrier frequencies, provide simultaneous records of data. This greatly simplifies the radio network needed to handle large volumes of data in a given period.

The second important attribute of the audio-frequency subcarrier is that it can be transmitted through one or more repeater stations without demodulation and, therefore, without materially affecting its signal-to-noise ratio and without affecting in any way the accuracy of the reading which it is carrying.

Station Equipment

When designing equipment for transmission of meteorological data, the system and components must be the most dependable possible within limitations imposed by physical location. Of major importance is the primary power source, since it will materially affect circuit design, transmitter power-outputs and operating program.

In the system under discussion the nickel-cadmium storage battery was chosen because of its freedom from self-discharge and its effectiveness at low temperatures. This battery shows 70 percent of nominal capacity at −20F, while a charge-retaining type of lead battery shows 50 percent and a vehicular-type lead battery less than 20 percent.

A jewelled-escapement time switch was developed for this application. It is wound periodically by a small electric motor. Compensation is included for operation at very low temperatures.

Miniature Quonset-type shelters are provided for each of the data-transmitting stations. They are rugged enough to stand the elements and attacks by brown bears and other animals.

The G-M tube and beta standard are mounted at the end of a Hubbard truss arm. The arm is mounted on a standard telephone pole which also supports the antenna.

Antennas of both directional and nondirectional types are used. All are ruggedized to stand the severe torture of the elements.

The battery-operated transmitters and receivers are mounted in small stainless-steel cases which themselves are weather proof. Power is brought in through gasketed glands. Individual sections such as oscillators, dividers, transmitter and receiver stages and the time switches are individually removable for easy servicing in the field.

Storage batteries and power supplies are mounted in wooden chests to facilitate recharging. It is expected, however, that recharging will be done on location during summer months by a gasoline-driven charger mounted on a jeep.

At the recording station, data is taken in terms of counts over a five-minute period using a conventional scaler-divider and time clock. These data need only be multiplied by the division factor of the system and referred to the calibration data for the station to obtain water equivalent of the snow pack.

This system is being constructed under contract with the Corps of Engineers and is being installed at the Central Sierra Snow Laboratory in California. It will be operated through the 1950–1951 snow season. Following satisfactory tests and acceptance by the contractor, a detailed report on design and operation characteristics will be prepared for publication through the contract agency.

Future Development

Future aims of this project are in the direction of providing more accurate data at a faster rate.

The use of scintillation detectors will provide a great improvement in efficiency and resolution of the sensing device. Counting efficiencies of 50 percent and a dead time of less than a microsecond can be obtained, as compared to the currently-used self-quenching Geiger-Muller tube with an efficiency of ½ percent and a dead time of 150 microseconds.

Evaluation of the data at the field station will allow transmission of a quantity representing only the count rate rather than the actual count. This will greatly shorten the time required to obtain data from a given station. Automatic recording will be possible, precluding the need for an operator to be constantly monitoring the system.

The author wishes to acknowledge the assistance of Edward Bauman, Robert Q. Stanton, Walter A. Kelley and William Bowman, all of Motorola, in developing the data transmission system which makes this complete system possible.

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Comparative Analysis of

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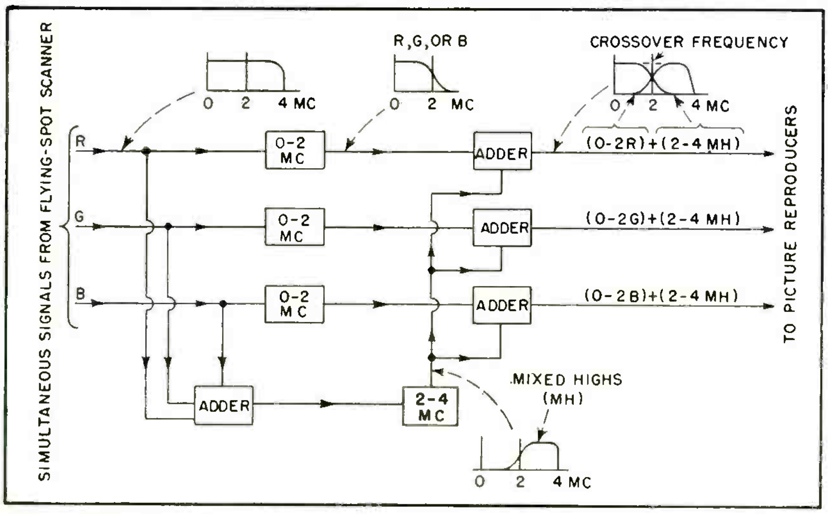

FIG. 1—Experimental arrangement of components for transmission of the mixed-highs signal, based on a 2-mc crossover frequency

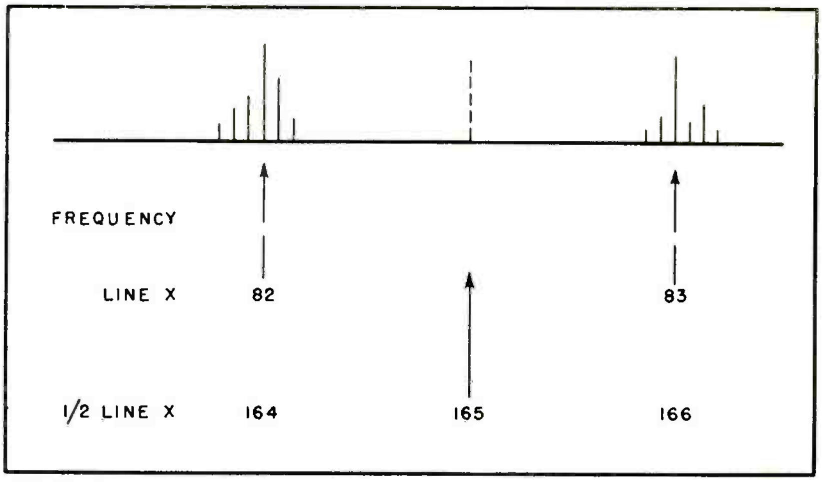

FIG. 2—Spectrum occupancy arising from scanning. Shown solid are the spectrum components of the 82nd and 83rd harmonic of the line frequency. Odd harmonic of half the line frequency, shown dashed, falls midway between and can be transmitted over same channel with little interference

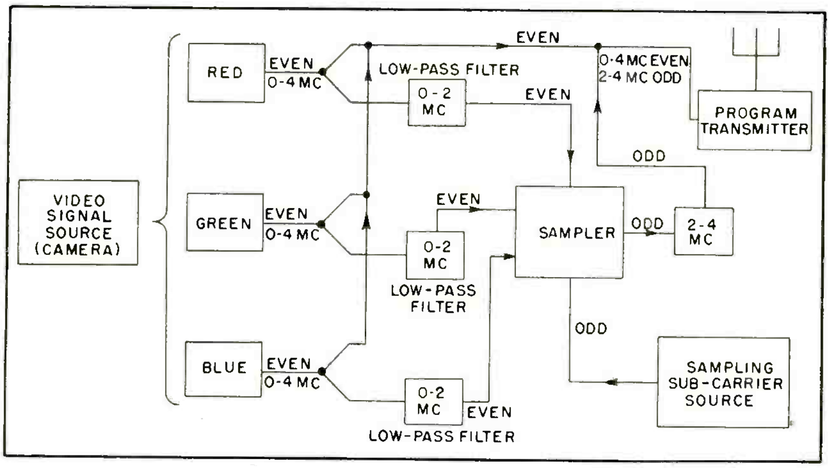

FIG. 3—Method of synthesizing by-passed mixed-highs signal at transmitter. Even and odd designations refer to order of harmonic of half the line frequency

THIS ARTICLE presents some of the facts basic to color television and the numerical consequences of these facts as they affect color television system performance.

As a starting point for the analysis, consider the monochrome pictures produced by the present FCC standards. These are broadcast in a 6-mc channel with 525 lines per picture and 30 pictures per second. The bandwidth effectively useful for picture information is about 4 mc. Counting positive and negative alternations, pictorial information to the extent of 8,000,000 elements per second may thus be transmitted. With the rate of thirty pictures per second, this permits 267,000 elements per picture. The acceptance of present television by the public indicates that pictures of the grade now provided are acceptable in quality.

In a monochrome picture each distinguishable element requires for its description a single number, to represent the element's brightness. If a color picture is to be produced, however, three quantities must be given with respect to each distinguishable element if reasonably true reproduction is to result. Practical three-color reproduction systems can be made to give color rendition which is highly satisfactory to the public.

If all that is known about color vision were what is implied by the foregoing remarks, then it is apparent that to reproduce a color picture with detail equivalent to that now given in black and white television and with color rendition as good as that offered by Kodachrome, the amount of information transmitted per picture must be

Color TV Systems

Based on the color-system research of the Hazeltine Laboratories, this review specifies numerically the improvement resulting from the use of band-sharing and mixed-highs transmission in the dot-sequential system, and compares its performance with that of the field-sequential system

trebled. If for comparative purposes we assume that the picture repetition rate shall be maintained, then the system bandwidth must also be trebled. Pictures transmitted on this basis should however, have all of the resolution exhibited by the presently acceptable monochrome pictures and should show this resolution in full color with color rendition which is at least potentially equal to that afforded by Kodachrome.

The color plate which appeared on the cover of ELECTRONICS for December 1950 shows as Fig. A the reproduction of a color television picture in which a separate 4-mc band was devoted to each of the three primary colors, or 12 mc in all. In the original television reproduction the resolution is in all respects as good as that which is currently satisfying the public in our monochrome television. The color behavior is at least potentially the equal of that which has been found acceptable to the public in Kodachrome. It seems appropriate, therefore, to say that color television performance of this grade would be found acceptable to the public. This 12-mc simultaneous picture may therefore be looked on as a yardstick.

It is undesirable to have to treble the system bandwidth to introduce color into a monochrome picture. Is it necessary that this increase in bandwidth be provided? The viewing of a colored image is highly subjective in character, and for this reason both the characteristic of the eye that sees the picture and the mind that interprets it must be taken into consideration.

Figure B of the cover plate shows the effect produced when the bandwidth is increased only 5 percent rather than 200 percent. Although this picture contains such a small amount of color information added to the full detail monochrome picture, it gives reasonable satisfaction to the viewer. If one had not seen Fig. A, one would not realize that the color has disappeared from areas of fine detail such as the awning stripes. Since there has inevitably been some small degradation of all pictures in the photographic and magazine printing processes, the comparison is even more striking when seen on the tube face.

Mixed Highs

The detailed circuit arrangements by which the picture of Fig. B is produced are based upon the concept of "mixed highs." This concept and its physiological basis are described by its originator, A. V. Bedford, in his paper in the September 1950 issue of the *IRE Proceedings*. The principle is based on the physiological fact that the eye is insensitive to color in fine areas. In other words, it is less sensitive to changes in hue and saturation than to changes in brightness.

From the point of view of mixed highs, it can be said that in Fig. B individual information was provided for each of the primary colors in the range between 0 and 0.1 mc and that common information was provided for all three in the range between 0.1 and 4 mc. Figure C shows all the color information present in Fig. B. It consists of 0.1 mc of each primary color, or a total of 0.3 mc.

Figure D shows the components of Fig. B lying between 0.1 and 4.0 mc; these are a mixture of the information picked up in all three colors in the range 0.1 to 4.0 mc. Figure B therefore requires a total bandwidth of 4.2 mc, which is made up of 0.1 mc each of red, green, and blue, and 3.9 mc of mixed highs. This represents an increase of 5 percent in required bandwidth over the requirements of a 4-mc monochrome picture. Figure A requires an increase of 200 percent.

The frequency at which the change from color to mixed highs takes place is called the crossover frequency. A schematic circuit arrangement for using mixed highs is shown in Fig. 1, with the crossover frequency set at 2 mc. This illustration shows that mixed highs can be used advantageously only in a simultaneous (or essentially simultaneous such as the dot-sequential) system, because the heart of the method lies in using one signal simultaneously for the fine detail in all three colors.

The numerical relations between total effective bandwidth, resolution, and color information for a number of crossover frequencies

FULLER EXPLANATION

The cover of the December issue of Electronics illustrated the spectrum-saving property of mixed-highs transmission of color images in terms of the final result, a direct comparison in color between full-simultaneous and mixed-highs renditions of the same subject. This paper, based on the material presented at the 1950 Syracuse Fall Meeting, goes into detail on the theoretical and practical background of this comparison and extends it to cover the field-sequential system.—The Editors are shown in more detail in Table I.

Subjective comparisons under critical conditions by a number of observers at a normal viewing distance of four times picture height led to the following conclusions:

First, at a 2-mc crossover, with an effective band of 8 mc, the reproduction is virtually indistinguishable from the 12-mc yardstick picture; for most scenes, no difference is exhibited. Second, at a 1-mc or 0.5-mc crossover, with total bands of 6 and 5 mc respectively, reproduction is as good as the 12-mc picture in all respects save that very small colored areas are partially desaturated. Third, a crossover as low as 0.1 mc may not be fully satisfactory on some subjects. Other observers might reach even more liberal conclusions favoring values under 0.1 mc.

The evidence, such as the pictures in the cover plate, supports completely the statement that, by means of the mixed-highs technique, color television pictures can be produced fully as sharp as the best monochrome pictures, with excellent general color rendition, using a band not materially greater than that required for monochrome television. However, to obtain this bandwidth advantage, the color television system must be essentially simultaneous in character.

Possibilities for Band-Sharing

Consideration of the frequency spectrum of a television transmission indicates that over the major portion of the band, say from line frequency on up, the spectrum consists (as shown in Fig. 2) of components at the successive harmonics of the line frequency, and groups of sidebands associated with each of these components and spaced apart by the field frequency and its harmonics.

Each group occupies only a minor fraction of the frequency space between successive component groups. The scanning of any television picture always results in a spectrum of this character, the differences between one picture and another being represented by changes in the relative amplitudes and phases of the various components. In no case does any component arise midway between successive harmonics of the line frequency.

Let us now interject artificially a component midway between two harmonics of line frequency (and therefore at an odd harmonic of one-half the line frequency, as shown dotted in Fig. 2). If such a component is added to a television picture signal and the result viewed on a display, the amplitude of the injected component at each point in the picture is of opposite polarity in one frame from the polarity of the preceding and succeeding frames.

To idealize the situation slightly, by regarding the display as linear in its amplitude characteristic and by saying that the eye will integrate perfectly over a two-frame interval, then this artificially-injected component integrates out completely and is invisible. In practice, these two idealizing assumptions are only moderately well approximated. The component at an odd harmonic of half the line frequency is of low visibility rather than being completely invisible. However, to the extent that we are satisfied that the visibility is low enough to be unimportant, use may be made of a substantial portion of the television signal band to insert a complete new set of components derived in any fashion and transformed to frequencies which are odd multiples of one-half the line frequency.

Transmitter for Composite Color Picture

For example, consider the method of deriving a color signal shown in Fig. 3. Signals are generated for each of three primary colors. These signals consist primarily of components which are harmonics of the line frequency and which are therefore even harmonics of one-half the line frequency. The word "EVEN" adjacent to the signal paths indicates this.

The outputs of the three channels are combined in one path to form a brightness signal. In another path the outputs are fed to a three-phase sampling device. This sampling device is also a heterodyning device. Its output includes the sampling frequency as a subcarrier and sidebands about the subcarrier spaced from it by the frequencies present in the sampled signals.

The frequency of sampling (frequency of the subcarrier) is chosen to be an odd harmonic of one-half the line frequency. All of the output of the sampler (of such frequencies as to be transmitted through the bandpass filter) consists of odd harmonics of one-half the line frequency, since all these components represent frequency sums or differences between the odd subcarrier and the even modulation components. Moreover, the addition of an odd and an even component produces an odd component.

All of these components are therefore suitable for direct addition to the signal from the brightness branch of the transmitter where they will interleave between the components of that branch. In other words, the composite color picture signal consists of a mono-

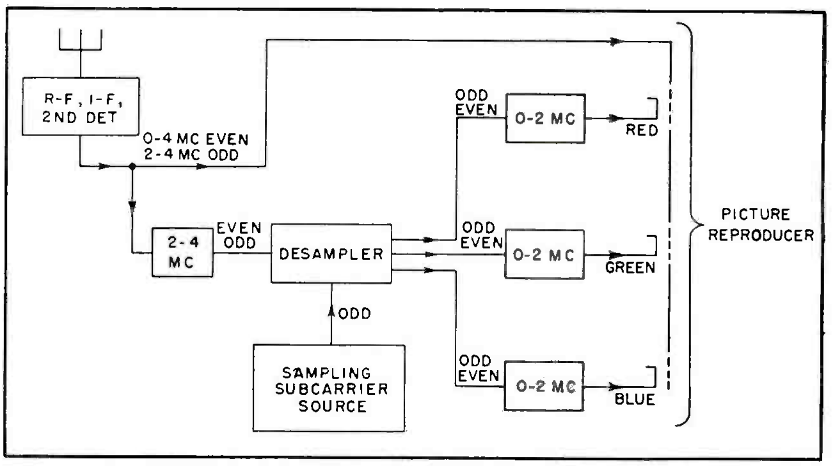

FIG. 4—Method of utilizing by-passed mixed-highs signal at receiver. Upper path carries full monochrome signal, while sampled signals below introduce color components

chrome picture signal to which has been added a low-visibility color picture signal.

In the typical receiver shown in Fig. 4, the video signal branches into two paths. One of these paths applies the entire signal to one set of terminals of some form of 3-color display. The even components applied through this path affect the display visibly but the odd components produce only low-visibility effects.

In the other path, the portion of the signal containing the odd components is selected by the bandpass filter and is then heterodyned in the receiver desampler, using the same heterodyne frquency as before. Since this frequency is an odd multiple of one-half the line frequency, the subtraction from it of odd-order components in the signal produces visible even-order components in the output. The subtraction from it of even-order components produces low-visibility odd-order components in the output.

The three outputs of the sampler provided at different phase positions in the sampler cycle are applied through filters to their respective terminals in the second set of input terminals of the three-color display. At the transmitter we have included an additional signal of 2-mc total bandwidth in the transmission and at the receiver we have rederived this signal and the original signal free of interference with each other except for the approximations of receiver linearity and perfect integration by the eye. This added 2 mc of information may, by system proportioning, be applied in any desired fashion to the transmission of information descriptive of the hue and saturation of the original picture.

Table 1—Economy of Bandwidth Obtained by Use of Mixed Highs

Crossover Frequency Where Mixed Highs Start, mc	Effective Video Band, mc	Elements per Second	Elements per Picture: Total	Contributing to Fine Detail	Used for Color
0.0 (Standard Monochrome)	4.0	8,000,000	267,000	267,000	——
0.1 (Simultaneous Color)	4.2	8,400,000	280,000	267,000	13,000
0.5	5.0	10,000,000	333,000	267,000	67,000
1.0	6.0	12,000,000	400,000	267,000	133,000
2.0	8.0	16,000,000	533,000	267,000	267,000
4.0	12.0	24,000,000	800,000	267,000	533,000

Bandwidth Requirements for System

We have noted that a 4-mc band produces good monochrome pictures and that in an independent three-color simultaneous system a 12-mc band is needed to produce pictures which are in all respects as good as the 4-mc monochrome pictures. Further, in a simultaneous system employing mixed highs, pictures in all respects as good as the monochrome picture can be obtained in an 8-mc band and that pictures as sharp as a monochrome picture and lacking only in small-area color saturation can be obtained with a 5-mc band. Also, by a process of band-sharing, taking advantage of the gaps in the spectrum of a simple television signal, appreciable amounts of information can be added over and above what had been contained in the monochrome signal.

It is clear therefore, that a signal of full color and full definition compared to good monochrome can be transmitted within the 4-mc effective band of a standard 6-mc television channel, and that to the extent that the approximations previously mentioned are valid, there will be no spurious patterns. The system operates in such fashion that, for white or neutral gray shades, equal signal amplitudes reach the sampler from the three primary channels and the sampler therefore exhibits no output. A substantial advantage results from this, since in white and gray areas even the residual imperfections vanish.

A practical aspect of color television systems is their susceptibility to interference.

In the diagram of Fig. 4, the direct channel by which the composite signal reaches the display is no more or no less susceptible to interference than a monochrome receiver would be. The channel with the sampling unit represents a different case. Consider, for example, a c-w interfering signal at approximately 3 mc, with a sampling frequency of 3.5 mc. The sampling process being also a heterodyning process, it follows that the sampler output will contain the difference frequency of 0.5 mc. This frequency of course produces a much coarser interfering pattern in the display than the original 3-mc signal would produce.

In small areas, the eye is much less sensitive to changes in hue and in saturation than it is to changes in brightness. A similar statement may be made with respect to short time intervals, regardless of area; that is, a flicker produced by brightness modulation is far more readily perceptible than is flicker of equal energy content representing a change in hue or saturation only. It seems reasonable, therefore, so to proportion the system that the output of the sampler conveys information with respect only to hue and saturation, thus deriving all brightness information from the signal which takes a direct path from receiver to display.

For instance, an interfering signal, such as the c-w interference mentioned, which brightens the green element of the display at a given instant shall at the same time decrease the combined brightness of the red and blue elements of the display by the same amount, thus keeping the total brightness constant. It is practical to design a system on this basis. Such an arrangement, originated by B. D. Loughlin, has been constructed.

This system, called the Constant-Luminance System, reduces the susceptibility of the receiver to interference in the color picture by 6 to 8 db. The improvement is apparent both on the interfering signals from external sources and on the inter-

Table II—Comparison of Color Television Systems

Channel Width, mc	Effective Video Band, mc	Elements per Second	Pictures per Second	Elements per Picture: Total	Elements per Picture: Contributing to Fine Detail	Elements per Picture: Used for Color	Relative Fine Detail
Standard Monochrome							
6.0	4.0	8,000,000	30	267,000	267,000	———	1.0
Simultaneous Color							
15–18	12.0	24,000,000	30	800,000	267,000	533,000	1.0
Simultaneous Color							
6.0	4.0	8,000,000	30	267,000	89,000	178,000	0.33
Field-Sequential Color							
6.0	4.0	8,000,000	24	330,000	110,000	220,000	0.41
Field-Sequential Color with Dot Interlace							
6.0	0–4*	8,000,000	24	330,000	110,000	220,000	
	2–4	4,000,000	24	165,000	55,000	110,000	
				495,000	165,000	330,000	0.62
Band Shared Color with Mixed Highs							
6.0	0–4*	8,000,000	30	267,000	267,000	———	
	2–4	4,000,000	30	133,000	———	133,000	
				400,000	267,000	133,000	1.0

* 0–4 band transmitted normally
2–4 band transmitted as interleaved low-visibility components

ference produced by the fact that the interleaved components are of low rather than zero visibility.

For a quantitative comparison of interference susceptibilities, it may be said that field-sequential color as proposed by the FCC and dot-sequential color (as shown recently in Washington) appear to be about equal. Monochrome is only two-thirds as susceptible, and dot-sequential color using the constant-luminance principle is nearly as good as monochrome.

Ability of Color Systems to Supply Detail

Table II shows the data on which a comparison of color systems can be based quantitatively. Column 1 shows the bandwidth which would have to be assigned to each system to transmit the full television picture complete with sound and guard bands. Column 2 gives the effectively available video band, and column 3 the number of pieces of information which can be reproduced within such a band in one second. Column 5 is obtained by dividing column 3 by the numbers in column 4 and gives the total amount of information available in a complete picture. Of these, column 6 states those which contribute to geometrical resolution and column 7 those which carry the color information. The last column gives the ratio, relative to present monochrome standards, of the number of elements available for reproducing the fine detail.

The most important comparison is to note that the slow-switching-rate field-sequential color systems devote twice as many elements to color information as to black and white, as do also the simple simultaneous color systems. This is forced by their inability to use the mixed-highs techniques, requiring that each separate color picture be painted as a unit, rather than a composite. This drastically limits the elements available for fine detail.

In the simple field-sequential system, there are 110,000 elements per picture carrying the all-important fine detail as compared to 267,000 elements in the present monochrome pictures. This is about 41 percent.

The band-shared system using mixed highs also has available 267,000 elements to portray the detail. On the other hand, the field-sequential system devotes 220,000 elements to carrying color information as contrasted with 133,000 in the band-shared system and 13,300 in Fig. B of the cover plate.

Conclusions

We believe, from the evidence upon which this paper is based, that these points are established:

Color vision requires only slightly more information than monochrome vision (5 percent to 50 percent more). Television systems can take advantage of this fact by using mixed highs, which allow the effective bandwidth to be reduced from 12 to 8 mc at no sacrifice of quality in any respect, and with a trivial sacrifice, reduced further to 6 or even 5 mc.

By band-sharing techniques, moderate additions may be made to the transmission capacity of the television band.

The combination of band-sharing techniques and mixed highs permits the transmission in a 4-mc effective band (6-mc channel) of a good three-color picture having the full resolution and detail which the public has come to expect from monochrome television.

No other system so far known comes at all close to this result.

With a fully simultaneous three-color system, or a slow-sequential three-color system, only one-third of the transmitted information contributes to detail and sharpness. If the picture is to avoid degradation, compared to present monochrome, it must occupy an effective band of 12 mc.

The use, for color television broadcasting in a 6-mc channel, of any system incapable of using that channel to the fullest effectiveness which present knowledge permits is a wasteful squandering of a precious national resource—our frequency spectrum—and to that extent is clearly not in the public interest.

Production-Line Frequency Measurements

Simplified equipment allows relatively inexperienced personnel to make extremely accurate measurements of frequencies up to 10 mc. Entire system is standardized against WWV by simple adjustments while frequency measurement is being made

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MOST MODERN frequency-measuring devices depend, to a great extent, on the skill and experience of the operator. In cases where qualified operating personnel is readily available, these systems are satisfactory, but in most instances, skilled labor is at a premium.

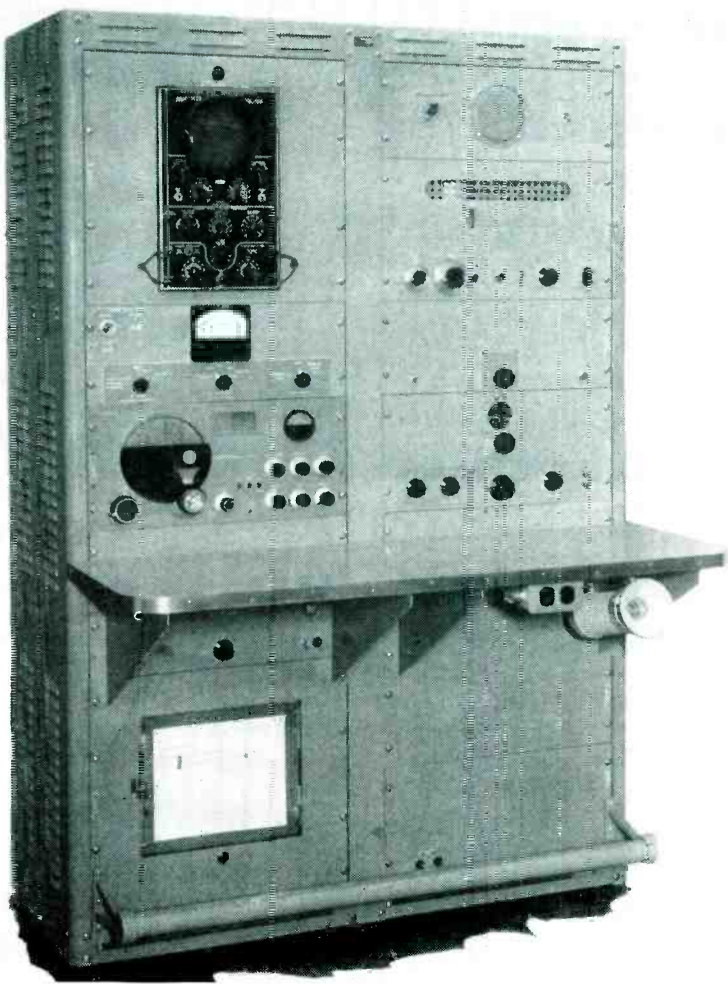
The equipment described here and illustrated in the photographs permits accurate frequency measurements to be made by relatively inexperienced operators. After about twenty hours training and practice, an operator can make rapid measurements at 100 kc to 10 mc within 1 or 2 cps.

Method of Measurement

Frequencies are measured by a system of bracketing. The first digit (usually 2 to 10 mc) is determined by the calibration of a communications receiver. The second digit is determined by bracketing the unknown signal between known harmonics of a 100-kc harmonic generator whose fiftieth harmonic is constantly kept at zero beat with WWV. Subsequent digits are obtained by a combination of brackets and finally the last two significant figures are taken from a calibrated audio oscillator using a scope and Lissajous figures.

A block diagram of the equipment involved is shown in Fig. 1.

The frequency standard consists of a 100-kc oscillator and a series of three 10-to-1 frequency dividers. The beat between the 5-mc signal of WWV and the fiftieth harmonic of the 100-kc oscillator is heard constantly by the operator from a loudspeaker connected to the receiver. In this way, the 10-kc, 1-kc and 100-cps subharmonics and the 100-kc fundamental are all kept standardized during the measure-



Frequency-measuring equipment. First significant figure is obtained from communications receiver calibration. Subsequent digits are found by a system of 100-kc oscillator subharmonic brackets and an accurately calibrated audio interpolation oscillator

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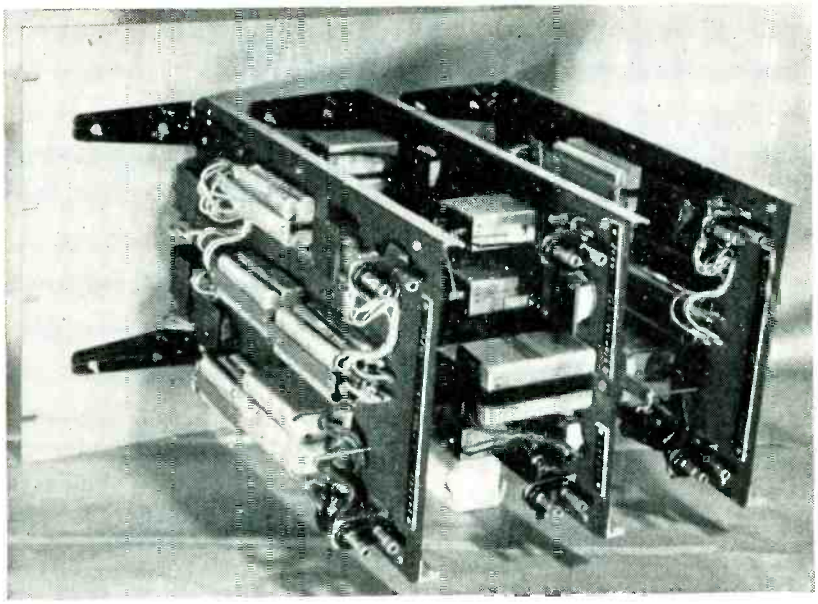
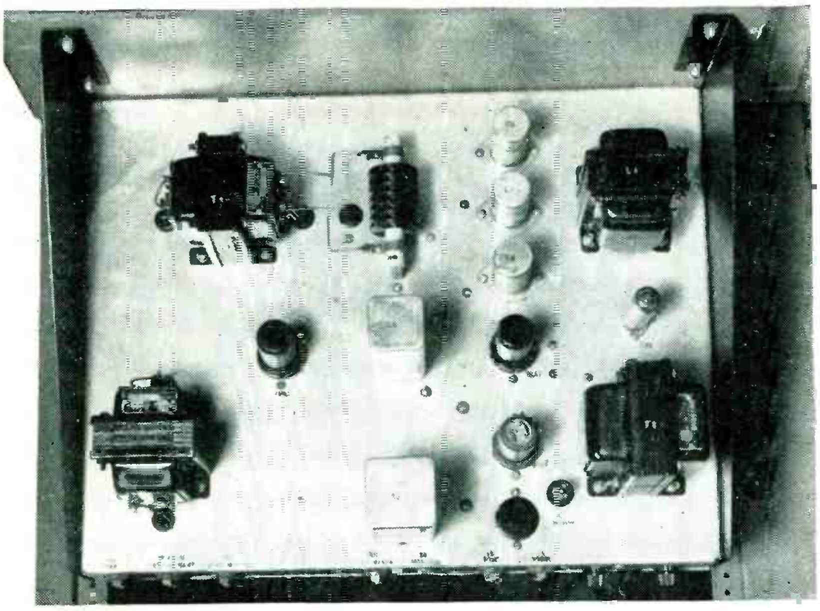


The three filter circuits are contained on a separate chassis and panel



Top view of frequency generator and mixer chassis

ment procedure. When the standard is so adjusted, the receiver is tuned to the unknown frequency f_x radiated by the apparatus under test. The first digit of f_x is read from the receiver tuning dial and the second digit approximated from the tuning dial setting. Then, the unknown signal is bracketed between two harmonics of the 100-kc oscillator, thereby verifying the second digit. The next digit of the unknown frequency is then found by bracketing between harmonics of the 10-kc standard, which are readily identified also by tuning the receiver to each harmonic in turn. The 10-kc harmonic f_h' that is closest to the unknown frequency is recorded.

The unknown, and all of the 10-kc harmonics, are then injected into the first mixer. Out of the numerous beats, a low-pass filter selects the lowest, $f_b' = f_h' - f_x$ or $f_x - f_h'$ depending on whether f_h' is higher or lower than f_x. Beat frequency f_b', always between 0 and 5,000 cps, is applied to the Y terminals of an oscilloscope through SW_1 set at 1. A calibrated audio interpolation oscillator is connected to the X terminals of the oscilloscope, and by means of Lissajous figures, an approximate measurement is made.

Beat note f_b' is then applied to the second mixer. Knowing the approximate value of f_b' from the reading of the interpolation oscillator, the operator selects the 1-kc harmonic that is closest to that frequency by means of the frequency booster. This signal he applies to the second mixer. A high-attenuation low-pass filter selects the lowest beat $f_b'' = f_h'' - f_b'$ or $f_b' - f_h''$ depending on whether f_b' is higher or lower than f_h''. The second beat frequency f_b'' is always between 0 and 500 cps.

When f_b'' is between 0 and 25 cps, difficulties with a-f transformers arise. Therefore the harmonic of 1 kc is selected which produces beat f_b'' between 975 and 1,000 cps. A band-pass filter for this frequency range is provided for such cases.

The output f_b'' is applied to the scope through SW_1 and measured in the same way as in the approximate measurement. To obtain maximum accuracy at this point, the frequency standard is now kept at exact zero beat with WWV, as indicated aurally over a loudspeaker. In this way, the last two digits are found, and the fine measurement step is completed.

Description of Equipment

The frequency standard used is basically accurate within ± 0.001 percent. The frequencies of all outputs of this standard are adjusted simultaneously by means of a vernier-operated trimmer, thereby providing a momentary accuracy of better than 1 part in 10 million.

The 100-kc and 1-kc harmonic generators are of the germanium diode type. The separate 100 and 10-kc harmonic generator employs a 6SJ7 and provides sufficient harmonic output that the 2,000th harmonic can be identified in the receiver. Harmonics up to the 1,000th have been used for measurments.

The first mixer employs a pentagrid converter type 6SA7. The three filters discriminate against unwanted beats produced by adjacent harmonics of 10 kc and 1 kc. Figure 2 shows the characteristics of the two low-pass filters. The sum of the wanted and main unwanted beats is always 10 kc or 1 kc. The curves show the desired beat f_b' or f_b'' plotted on the abscissa against the attenuation of the unwanted frequency. Other unwanted beats are either more attenuated or too weak to interfere with operation.

The second mixer is shown in Fig. 3. The important advantage of the push-pull germanium diode balanced-bridge arrangement is that only odd mixing modulation product frequencies appear in its output. Also, both f_b' and f_h'' disappear from the output of the mixer.

The receiver used has a main dial that is accurately calibrated in 100-kc steps. Vernier and bandspread dials facilitate the measurements. A crystal-controlled variable-selectivity circuit provides a very narrow pass band. This feature is important, since in some measurements the receiver is used both as a mixer and filter. The S meter allows the operator to count and identify the harmonics as well as to estimate the relative strengths of the measured signal and harmonics.

The audio-frequency interpolation oscillator covers a band of frequencies from 6 to 6,000 cps. Its dial is broad enough to permit evaluation of about 2 cps on the most congested range below 500 cps. The oscilloscope is conventional.

Applications

The equipment described is used mainly for measurement and calibration of fundamental frequencies of crystals in frequency monitors and oscillator circuits. It is also used for adjusting crystals and for calibrating and measuring frequency drift of signal generators and audio oscillators.

The percent accuracy of measurements depends on the measured frequency. Since at the instant of measurement the 10-kc and 1-kc harmonics are standardized against WWV, the main source of inaccuracy lies in the interpolation oscillator. As has already been mentioned, the inherent accuracy of this apparatus is better than 1 percent. However, by means of a switch, the interpolation oscillator can quickly be checked by comparing it with the outputs of the 1-kc and 100-cps standards. When utmost accuracy is needed, this calibration may be performed immediately after the reading is made using Lissajous patterns.

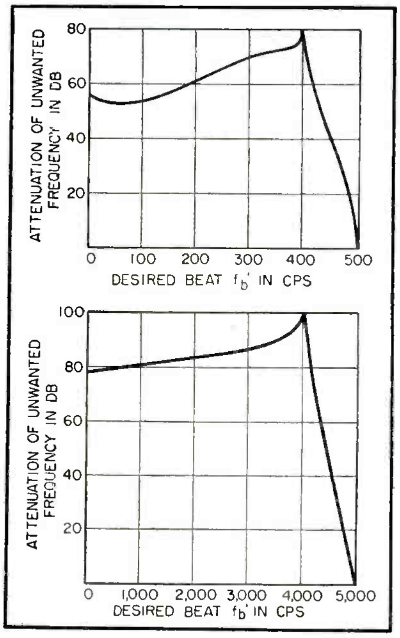


FIG. 2—Curves show characteristics of 0 to 500 and 0 to 5,000 low-pass filters

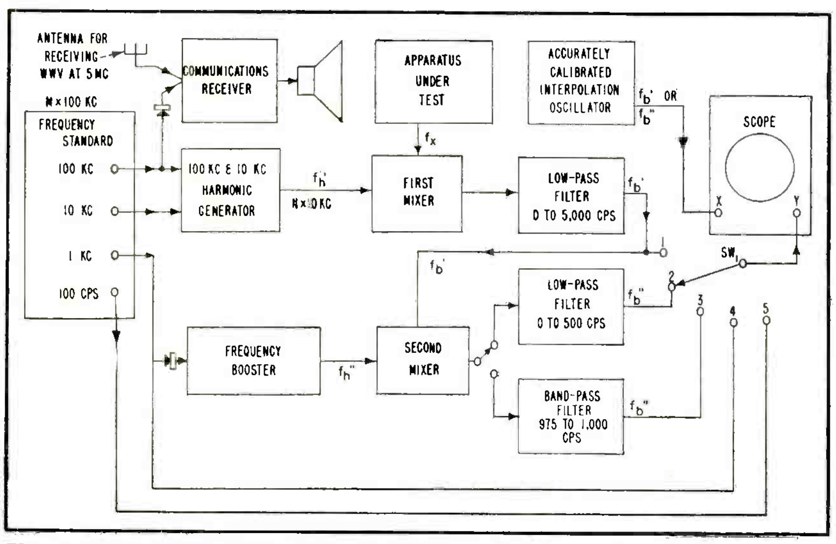


FIG. 1—Equipment is standardized by beating fiftieth harmonic of 100-kc oscillator with 5-mc signal from WWV. Interpolation oscillator calibration may be checked against 1,000 and 100 cps subharmonics of 100-kc oscillator

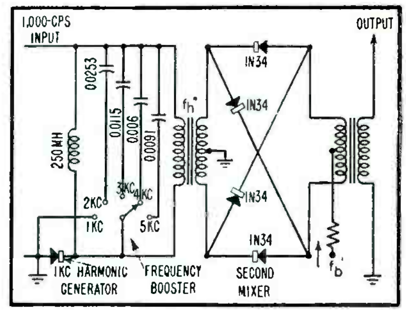


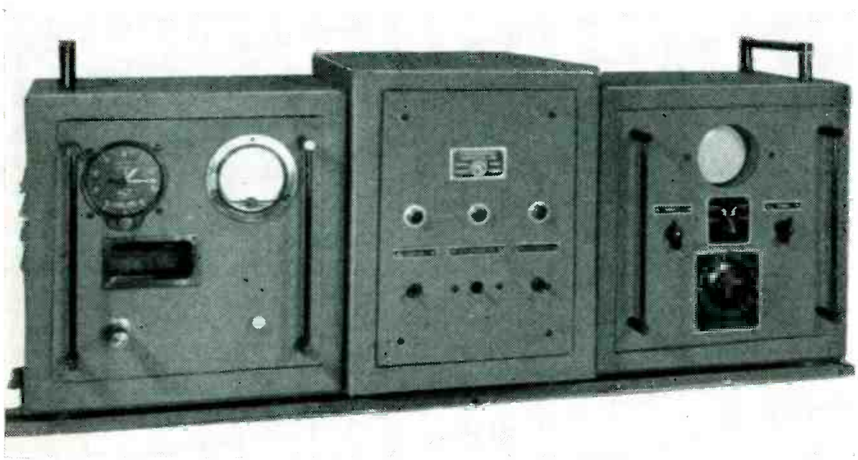
FIG. 3—Frequency booster circuit picks out desired harmonic of 1-kc harmonic generator. Push-pull crystal mixer produces only odd mixing modulation products

It has been established in practice that maximum error made when measurements are performed is about ± 2 cps. This happens only when f_b'' is close to and below 500 cps. In most other cases the error is about ± 1 cps. Thus when referred to the frequencies usually measured, namely from 2.5 to 10 mc, the average error is from 4 to 1 part in ten million. The higher the measured frequency, the smaller the percent error.

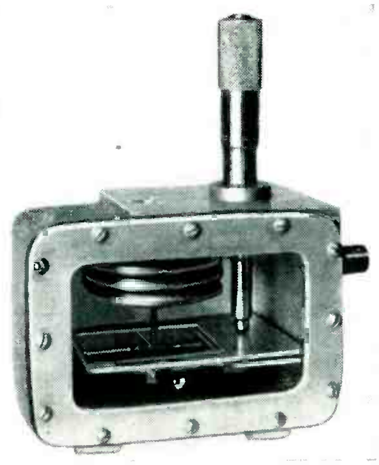
After the identification of the harmonics producing the wanted beats, the main operations that the operator has to perform are: to zero beat from the speaker, to stop simultaneously the elliptical pattern on the oscilloscope screen and immediately after that to read the dial of the interpolation oscillator. Then, he simply fills in the readings on a form and performs two simple additions or subtractions.

Actual in-use experience with the equipment for the past two years indicates that results of measurements of the same frequency, independently obtained by different operators, do not differ by more than 1.5 cps.

The author wishes to thank Brynjulf Berger whose suggestions and cooperation contributed greatly to the success of this project, and Joseph Bagdon for his constructive criticism. He also wishes to express his appreciation to Ernest Reuther for his assistance in construction and adjustment of this equipment.



Complete airborne profile recorder instrument, with datum stabilizer in left-hand bay



Aneroid-driven capacitor

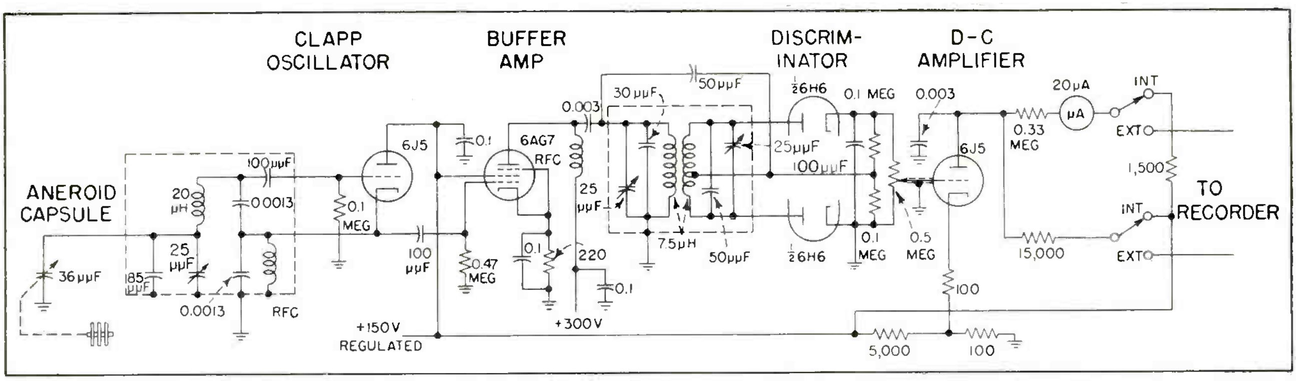


FIG. 1—Circuit of datum stabilizer. Power supply uses 5Y3GT in full-wave circuit with 310 v each side of power transformer secondary center tap, with pi filter for high voltage and VR 150 for regulated output

DATUM STABILIZER for

To correct for altitude fluctuations due to turbulence when using airborne profile recorder, electronic stabilizer circuit operating from aneroid element senses deviations of aircraft from level flight and applies corrections automatically to radar record of terrain elevation

By B. I. McCAFFREY

Project Engineer
The Photographic Survey Corp., Limited
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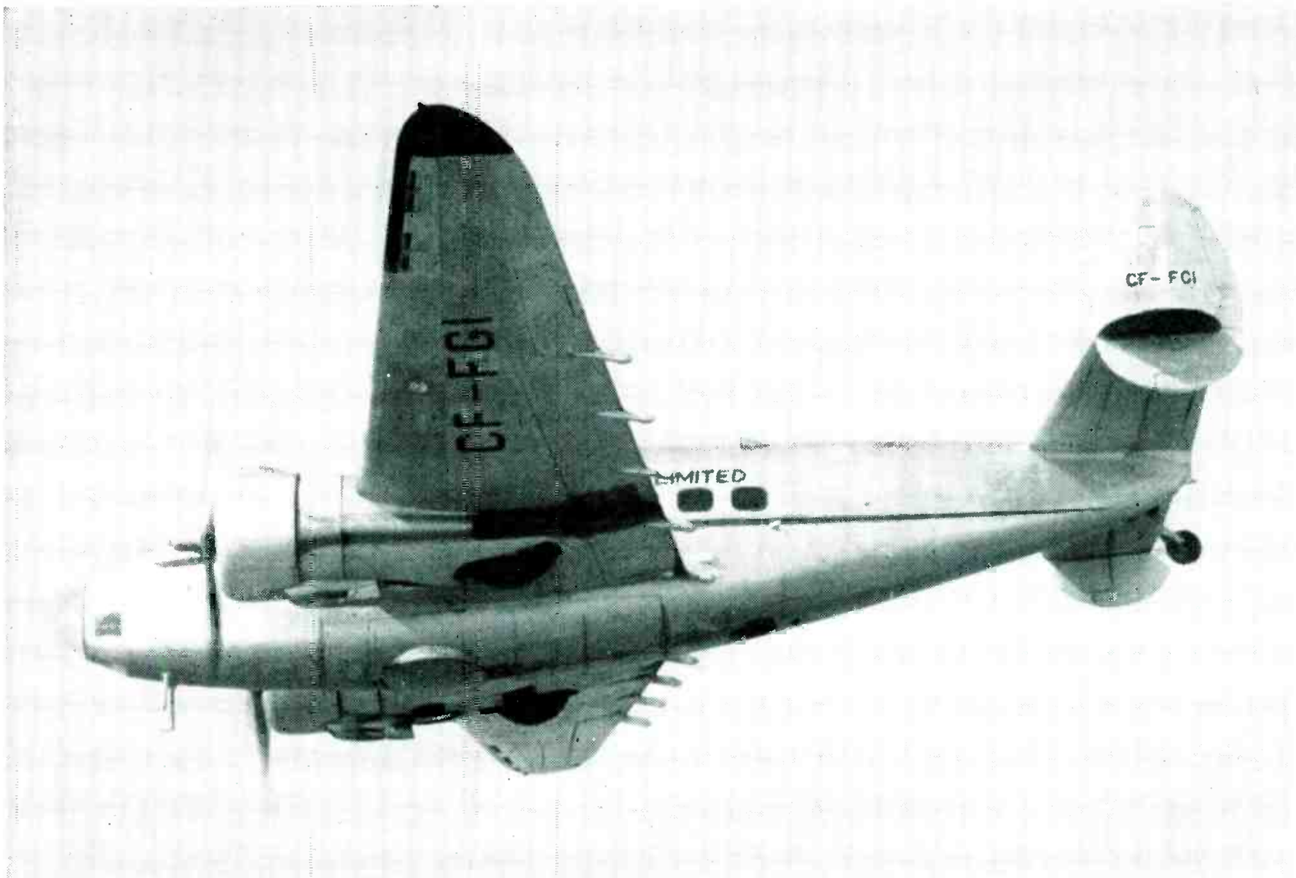
IN THE PAST, the discrepancy between the rate at which planimetric maps could be produced using airborne vertical photography, and the rate at which these maps could be transformed into topographic maps by the addition of ground elevation information obtained by field parties using spirit levels, caused the production of topographic charts to lag years behind the planimetric.

The expediency of an airborne method for obtaining ground elevation information has led to the development of a radar instrument known as an airborne profile recorder, capable of measuring terrain elevation with an accuracy of ± 10 feet.

The technique of surveying by this method employs an aircraft flying at constant-pressure altitude while a radar altimeter measures the terrain clearance below. A permanent record of the measurements is made on a graphic milliammeter using a constantly moving chart. The result is a continuous ground elevation profile along the flight path, the scale of the graph depending on the speed of the airplane.

While it is quite feasible to produce a ground radar instrument for measuring distances with great precision, difficulty arises in an airborne instrument in attempting to determine accurately the air position of the aircraft above sea level.



Lockheed Hudson equipped for elevation-profile surveying, with 4-foot parabolic reflector for radar altimeter mounted in bomb bay. New datum stabilizer circuit corrects for vertical excursions of plane in turbulent air, giving elevations accurate to within 10 feet

Radar-Altimeter Surveying

The airplane's position with respect to sea level must be constant to make the system practicable. That is to say, the reference datum must be stable if the graphic record is to be a true profile of the ground.

Constant-Altitude Flying

Obviously it is impossible for a pilot to maintain a perfectly constant flying altitude over long periods. Moreover, it is impossible to avoid vertical excursions due to turbulence. It therefore becomes necessary to record the vertical deviations and apply appropriate corrections. A photographic process is satisfactory for small-scale operations. Such a process necessitates the photographing of aircraft instruments at the rate of at least 30 frames per minute or about 2,000 times per hour. Following this the film must be processed, instrument readings tabulated, and corrections deduced and applied.

An automatic compensator became very expedient at an early date. This paper describes a device designed to record continuously any deviations of an aircraft from level flight and apply these corrections automatically to the radar record during the survey.

The datum stabilizer is an electronic device which produces an electrical output current proportional to a change in altitude. The resonant frequency of a high-stability oscillator is varied by a small capacitor plate driven by a three-element aneroid of the type used in aircraft instruments. A discriminator and d-c amplifier transform the resulting frequency changes to current variations which are proportional to height modulations. Simultaneously with the radar signals and by the same recording pen, the datum stabilizer current is recorded. Then, in spite of any excursions from level flight, the ground profile along the flight track is faithfully plotted by the airborne profile recorder.

Years of observations have demonstrated the consistency of the earth's atmospheric pressure. For heights up to almost eight miles above sea level, height and pressure bear the relationship

$$h = 18{,}400 \log_{10} \frac{b_o}{b} (1 + at_m) \qquad (1)$$

where h is height in meters, b_o is atmospheric pressure at sea level,

b is atmospheric pressure at height h, a is coefficient of gas expansion and t_m is mean temperature. Humidity produces a third-order effect and is insignificant, especially in this application where relatively small differential pressures, not absolute altitudes, are being measured. Temperature could affect the equation in some regions but not over the range of height change experienced in profile recording.

Datum Stabilizer Design

Design of the datum stabilizer circuit is straightforward and standard techniques are used, as shown in Fig. 1. The only special components are the variable capacitor and associated parts driven by the aneroid capsule.

Discriminators are reasonably flexible so far as bandwidth and response curve are concerned. The chief obstacle was considered to be the construction of a variable capacitor for the oscillator circuit to have a convenient physical size and yet give adequate frequency swing with the limited motion available from the aneroid unit. The capacitor must have small physical dimensions but must undergo measureable capacitance changes for minute displacements of the plates. In addition, the plates must impose a minimum inertia load on the aneroid in order to maintain high speed of response.

Taking the practical formula for capacitance

$$C = 0.2244\ K\ A/D \qquad (2)$$

where C is in $\mu\mu$f, A is area of plate in sq in., K is dielectric constant (1 for air) and D is spacing in inches, and differentiating gives an expression for the rate of change in capacitance with spacing

$$\frac{\Delta C}{\Delta D} = 0.2244\ A/D^2\ \mu\mu\text{f per inch} \qquad (3)$$

A solution of Eq. 3 is not difficult since some of the variables can be set by certain arbitrary conditions. The instrument was intended to operate over a range of $\pm$ 175 feet. The displacement of the aneroid for the full swing from $-$ 175 to $+$ 175 feet is 0.002 in. We have, then,

$$\Delta D = 0.002\text{ in.},\ A = 2.5\text{ sq in.},$$

and therefore

$$\Delta C = 11.2 \times 10^{-4}/D^2\ \mu\mu\text{f} \qquad (4)$$

Final solution was effected by plotting ΔC versus D as in Fig. 2 and choosing a suitable value from the curve to give a measurable ΔC.

Accuracy Requirement

It was not considered feasible to measure a smaller change than 0.1 $\mu\mu$f in an airborne instrument with the accuracy required. Such a measurement would have to correspond to a change in height not greater than 10 feet, and this would produce less than 0.0006-inch displacement of the aneroid. While the instrument is accurate within one or two feet under laboratory conditions, considerations of limits closer than $\pm$ 10 feet are precluded by effects of pitch, roll and yaw. These maneuvers produce changes in wind velocity across the static head, introducing apparent errors in pressure altitude of that order.

The tremendous increase in C as the spacing becomes of the order of 15 thousandths or less is useful where microinches are to be measured. On the other hand, along with sensitivity must be considered the danger of having the plates touch under severe vibration and acceleration conditions. Insertion of a dielectric insulation is not advisable due to temperature and humidity effects. It is not permissible to dampen the action by increasing friction on the bearings since doing so would restrain the aneroid and introduce hysteresis. Slight vibration of the aneroid is essential to overcome gravity and other acceleration effects.

A spacing of 0.02 inch was arrived at as a suitable design figure for the capacitor assembly. Experiments later showed that a closer spacing of 0.015 inch could be safely used, with the advantage of increased sensitivity. The assumed vibration factor was overly pessimistic, and closer spacing did not cause the plates to touch.

Choice of Frequency

In choosing the operating frequency of the oscillator, physical dimensions were again important. The choice of oscillator circuit defined a high-Q coil of rather large physical size to meet stability requirements, and even at frequencies of several megacycles the dimensions proved to be rather large. However, decreasing the value of inductance to maintain small physical size would have required increasing the capacitance.

Differentiating the equation for

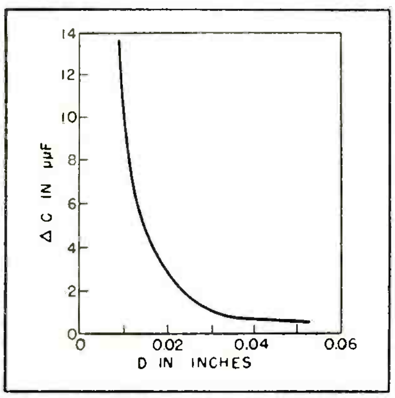


FIG. 2—Effect of spacing of aneroid capacitor plates on capacitance change produced by 350-ft change in altitude when plate area is 2.5 sq in.

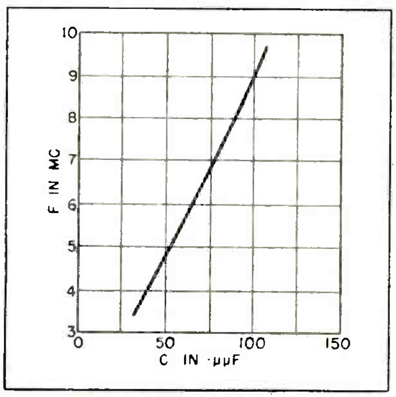


FIG. 3—Relation between aneroid capacitor value C and oscillator frequency, showing that operating frequency is not critical

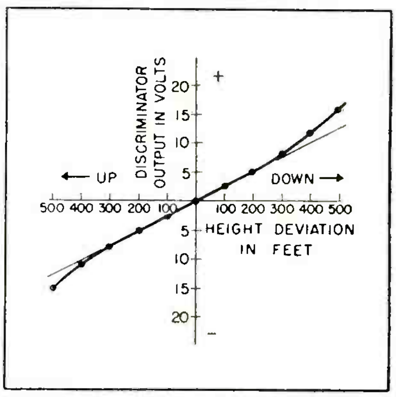


FIG. 4—Discriminator response curve, showing linearity for altitude fluctuations up to 200 feet up or down. This is ample for normal flying

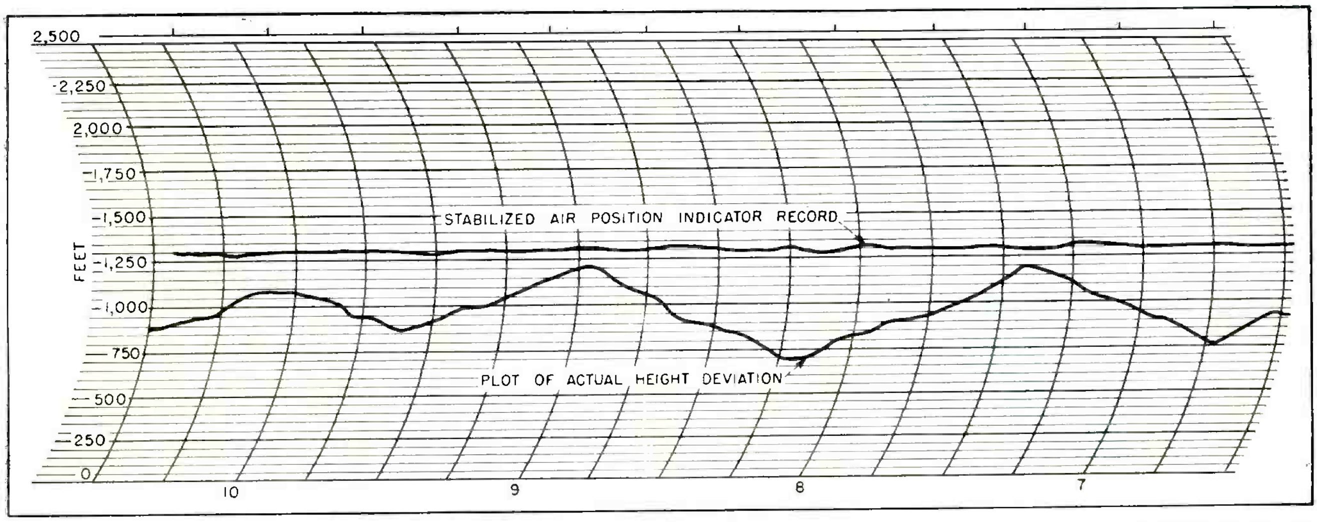


FIG. 5—Test record showing how datum stabilizer irons out altitude deviations when flying over level terrain and maneuvering the plane up and down to simulate air bumps

the frequency of a tuned circuit, with L constant, gives

$$\frac{dF}{dC} = -\frac{1}{4\pi\sqrt{LC^3}} \quad (5)$$

This shows that increasing C decreases the quantity dF/dC.

We can expect a change in capacitance of about 3.0 μμf for a change in height of 350 ft (plus or minus 175 ft about a given mean). Such a capacitance variation must ultimately result in useful linear output from a discriminator. Standard f-m technique is to design a discriminator to be linear over a range of 150 kc (± 75 kc). Using the values dC = 3.0 μμf and dF = 150 kc (corresponding finally to a height change dh of 350 ft) and rearranging Eq. 5 gives

$$LC^3 = 2.53 \times 10^{-36} \quad (6)$$

This equation lends itself to graphical solution since values for C have a limited practical range. Values of L were determined for various practical values of C. Corresponding values of frequency F were then found and used to plot the frequency—capacitance curve of Fig. 3.

Apparently any frequency between 2.5 mc and 10 mc is suitable but experiments showed that, from the standpoints of Q and size, 3.5 mc was the most satisfactory choice.

Circuit Stability

In the interests of stability it is not advisable to extract large amounts of power from the oscillator circuit, hence a buffer amplifier was found necessary between the oscillator and discriminator. In anticipation of possible regeneration between amplifier and oscillator the frequency was doubled in the buffer stage. This served to prevent interaction, make shielding unnecessary and reduce sizes.

The discriminator is a Foster-Seeley circuit adjusted to compensate for the nonlinearities of the aneroid capacitor. Whereas the barometric pressure varies logarithmically with height, the sensitive aneroid has been constructed in such a way that height and displacement bear a straight-line relationship. However, the frequency of the oscillator changes inversely as the square root of the capacitance. In addition, the capacitance varies inversely as the plate spacing and is not symmetrical about its mean position.

By suitable adjustment of the discriminator padders a balance is achieved which produces in the indicating meter a current directly proportional to height. This indication is linear over a range of ± 200 feet, as shown in Fig. 4. By using a good grade of steatite as a former for the discriminator coil and by using high-quality padding capacitors, excellent stability was realized. In fact, after six months of field operations no adjustments were required in any of the tuned circuits.

Temperature compensation has proven unnecessary. For a rise of 30 deg from a cold start the maximum frequency drift was 20 cps. This corresponds to an error in indicated height of less than 5 inches.

For anode supply voltage changes of ± 50 volts the corresponding error in recorded height is ± 2 inches.

Performance

Many hours of flying have proven the worth of this instrument as a means for ironing out air bumps. Results of initial tests are shown in Fig. 5. In this case the datum stabilizer was used as a component of the airborne profile recorder system. Flying over a flat surface (Lake Ontario) so that any deviations from a straight line on the record could be assessed as errors, the aircraft was caused to execute vertical excursions of ± 250 feet from an arbitrarily chosen zero level. Simultaneously a calibrated aircraft-type altimeter was photographed at the rate of 20 times per minute. Height information recorded photographically was later plotted adjacent to the radar line on the recorder chart. Comparison of the two lines reveals that the datum stabilizer is capable of correcting for height deviations of ± 200 feet with an accuracy of ± 10 feet; and up to ± 250 feet with an accuracy of ± 15 feet.

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COLOR

PART III of a series

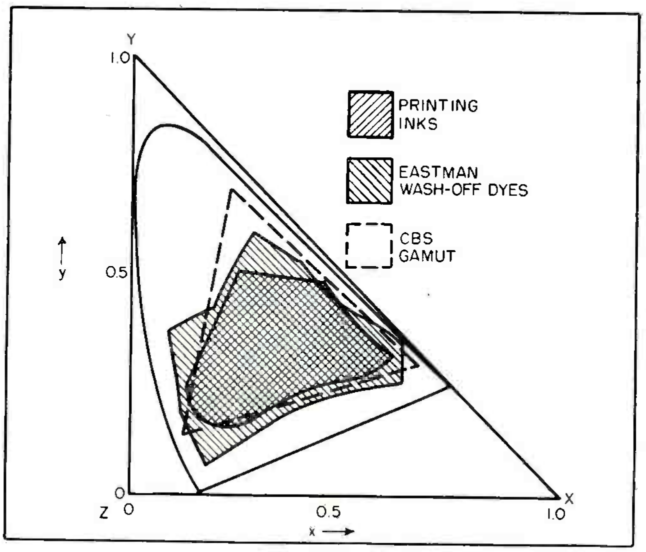

FIG. 22—Color gamuts covered by printing inks and dyes used in color photography, compared with the range covered by the CBS television primaries

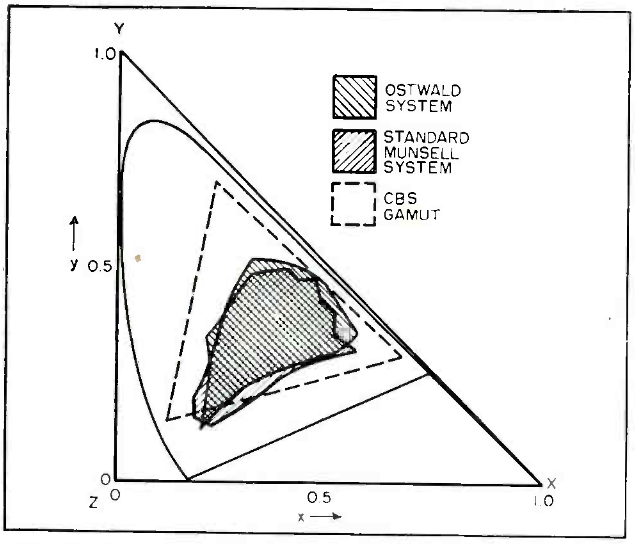

FIG. 23—Gamuts covered by the Ostwald and Munsell color-atlas cards. These permit specification of colors by direct visual comparison with printed samples

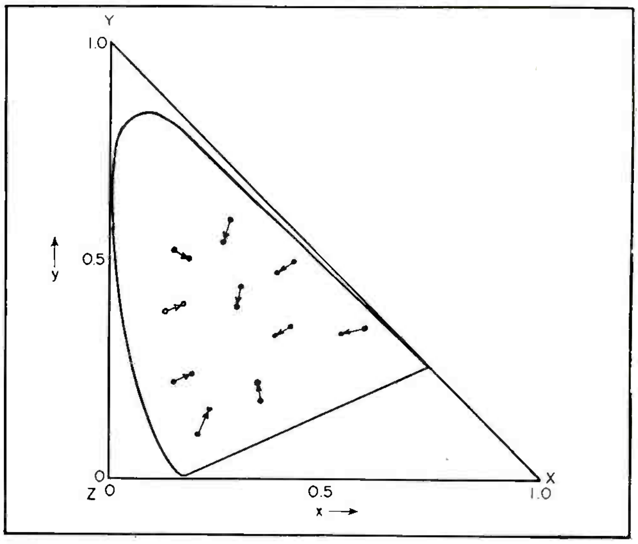

FIG. 24—Color distortion vectors. The point at the base of each vector represents the color in the object, that at the head the color in the corresponding portion of the reproduced image

By DONALD G. FINK
Editor, ELECTRONICS

THE COLOR-TELEVISION primaries cover a considerably wider gamut than that of color printing, indicating that the color rendition in a television system can be more comprehensive than that of this widely accepted method of reproduction. This is illustrated in Fig. 22, which shows the gamut of colors covered by color printing and color photography (Eastman washoff relief dyes).

Figure 23 shows the gamut on which the color cards of the Munsell and Ostwald systems are based. These are printed cards, numbered in accordance with a system of specification. This method of specification is particularly convenient for color matching outside the laboratory where quantitative measurements with a colorimeter are not feasible.

Specification of Color Distortion

The ability of a television or other color reproduction system to recreate the hues and saturations of an object can be represented by pairs of points on the x-y diagram. One point represents the color coordinates of a particular portion of the televised object, the other the coordinates of the same portion of the reproduced image. A line connecting the two points, with an arrow head attached to the image point, indicates the color distortion introduced by the system. Strictly speaking this indicates only the chromaticity distortion, since no indication is given of the brightness distortion which may also be present. The brightness distortion is indicated by the over-all transfer characteristic.

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FUNDAMENTALS for Television Engineers

In this concluding installment are treated the specification of color distortion in a tv system and its relation to brightness distortion, the color standards specified in the "reference receiver", congruence requirements in the primary images, and the color-transfer process

A systematic comparison of the coordinates of different colored objects and the corresponding image color coordinates provides a number of color-distortion vectors at various positions on the chromaticity diagram. An example is shown in Fig. 24. Unfortunately, the magnitude and direction of these vectors, while providing a numerical index of color distortion, do not give an accurate indication of the subjective effect of the color distortion. This is true because the eye is much more tolerant of a color mismatch in certain regions of the diagram than in others.

A comprehensive study of this effect has been made by Wright, with the result shown in Fig. 25. This is the x-y diagram, covered by a series of lines within the area enclosed by the spectral locus, the length of each line being three times as great as the just perceptible visual color difference, when the field of view is 2 degrees. In the regions where the line segments are short (as at the blue end of the spectral locus) the eye can detect slight differences in the hue or saturation of a color.

A transformation of the x-y diagram to other coordinates (x'' and y'') has been proposed by Breckenridge and Schaub which gives a more nearly uniform distribution of color-distortion vectors. This is shown in Fig. 26, the data being replotted from Fig. 25.

Grays and Gray Mixtures

A class of subjective color impressions not previously discussed comprises the grays and gray mixtures, including browns, olive greens and the like. Colors do not appear grayish unless they are viewed in the presence of colors of greater luminosity.

A simple experiment will verify this fact. Consider two identical sheets of white paper, viewed simultaneously, one illuminated by an intense beam of white light, the second by a substantially weaker beam of the same color. The first sheet then appears white, the second gray. If the beams are interchanged, the first sheet appears gray, the second white. If pieces of orange paper are substituted, the piece receiving the weaker illumination appears brown. Finally, if the stronger beam is turned off, as the pupil of the eye adjusts itself to the weaker illumination, the brown color changes to orange.

It thus appears that rendition of grays and gray mixtures depends on the scale of luminosities of the various colors in a scene. Accurate reproduction of such colors requires, therefore, that the scale of luminosities be transmitted accurately, that is, that brightness distortion be kept to a minimum. It is on this account, among others, that the transfer characteristic applicable to the reproduction of each primary color (object brightness versus image brightness plotted on log-log coordinates) should be a straight line of unity slope.

The distortionless condition must apply equally to the rendition of each of the primary colors. Stated differently, the brightness of each primary color (say red) in the image, expressed in foot-lamberts, must be directly proportional to the brightness of the corresponding (red) color in the camera. When this condition obtains, the values of brightness of the three primaries in the image bear a fixed relationship to each other throughout the scale of brightness, and balance between the primaries is maintained, whether the absolute brightness of the image is equal to, greater, or less than that of the object.

The statement that the transmission of each primary color must be wholly free of brightness distortion is a technical criterion, not an artistic one. It may suit the convenience of the program director to alter the appearance of the image with respect to the object to create a particular effect. Such alterations may often be obtained more quickly and at less expense by adjusting a transfer control ("gamma") amplifier or the d-c level than by changing the lighting, sets and costuming in the studio. But the program director may also call for, and in the majority of cases may require, accurate rendition in the technical sense. Accordingly, the television system should be capable of distortionless transmission, and the settings of the transfer gradient and d-c level which correspond to the distortionless condition should be identified as references from which artistic departures can be made.

A convenient method of testing a system for brightness distortion and color balance is to transmit a scale of grays (photographic step wedge). This is a card or trans-

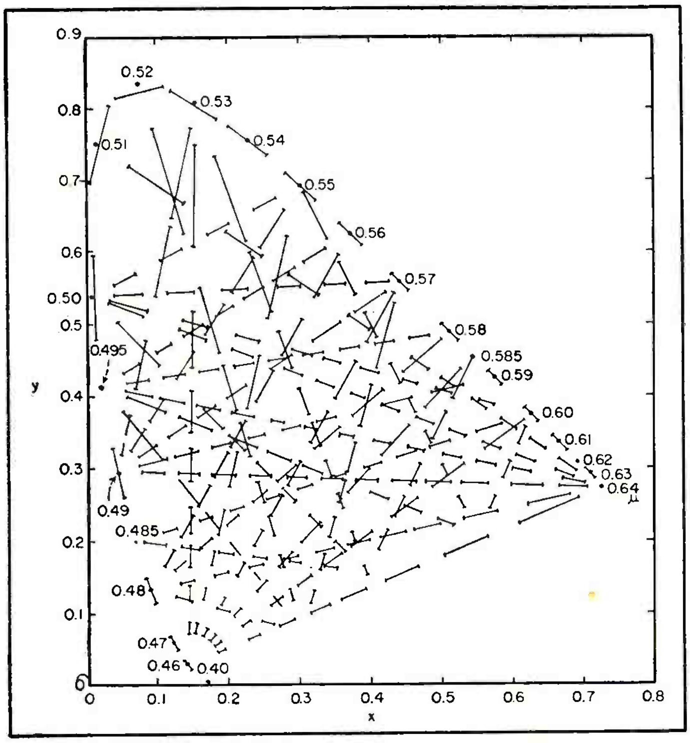


FIG. 25—Relative perceptibility of color distortion in different regions of the chromaticity diagram, after Wright. The length of each line is about three times the just-perceptible difference in chromaticity

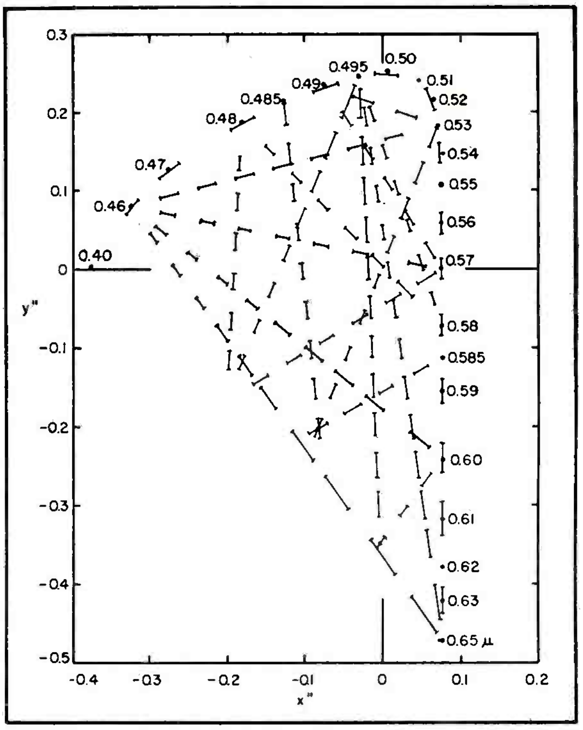


FIG. 26—The Breckenridge-Schaub diagram, a transformation of Fig. 25 in which the lines representing equally perceptible color differences are of approximately equal length

parency having patches of neutral gray whose photographic density (logarithm of transmission or reflectance) increases in uniform steps from black to white. The gray scale should be illuminated with a white light source which has substantially no hue (saturation zero).

When such a card is viewed as the object, inspection or measurement of the brightness and hue (if any) of the corresponding patches in the image will reveal the presence of brightness distortion and color imbalance. If all steps in the scale appear as neutral tones of gray, the color balance is correct. This result implies that the shape of the transfer characteristic in the transmission of each primary is the same, but does not necessarily indicate that brightness distortion is absent. The latter condition is satisfied only if the brightnesses of the successive steps in the image of the scale of grays are in logarithmic progression, as may be determined by measurement with a photometer.

Color Standards and the Reference Receiver

The color standards for television are set up in terms of a hypothetical reference receiver, whose characteristics are stated for the guidance of receiver and transmitter designers. The characteristics required to specify the color performance of the reference receiver are (see Fig. 27): (1) the trichromatic coefficients (x and y values) describing the primary colors produced by the receiver; (2) the trichromatic coefficients of a reference white light ("characteristic white"); (3) the gain, from the antenna terminals to the picture tube or tubes, applicable to the respective primary colors (relative voltage gain expressed as ratios among the primaries, not absolute gain); and (4) the brightness transfer characteristics applicable to the primary colors.

The first standard indicates not only the gamut of the colors which may be reproduced by the receiver, but also indicates (through the value of the y coordinate of each primary) the relative luminosity of the primary colors. The third standard specifies the relative amount of voltage, at the antenna terminals of the receiver, needed to actuate each primary color so as to reproduce the white light specified in the second standard. The fourth standard indicates the brightness distortion present in the receiver.

It is not expected that commercial receivers will necessarily possess the characteristics of the standard reference receiver, since it may prove uneconomical to meet brightness distortion specifications, or to reproduce precisely a standard characteristic white.

Essential Aspects of a Color Television Image

We proceed now to consider a composite television image (in full color) and to analyze its essential aspects. To the four basic aspects of a black-and-white image (gross structure, fine structure, continuity, and tonal gradation) must be added two others, the *chromaticity values* and *congruence*. The chromaticity values (hues and saturations) in an image, taken together with the tonal gradation (brightnesses), specify the colors reproduced in the image.

The congruence characteristic refers to the fact that color television images are superpositions of three images in the primary colors. Congruence, " the condition of fitting exactly when superimposed", exists when each primary color image is precisely positioned with respect to the others. There are a variety of faults exhibited by color television images in respect to congruence, of which faulty register, color break-up and color fringing are the most prominent.

So far as the individual primary-color images are concerned, each can be described in terms of its gross structure, fine structure, continuity and tonal values, as if it were a black-and-white image.

When the primary images are superimposed to form the composite color image, the color-image characteristics must be re-examined. If the gross structure of each primary-color image is not identical, and if it does not so remain continuously, errors of congruence occur. A similar requirement exists with respect to fine structure. Finally, the continuity (motional continuity and flicker) of the composite image may differ markedly from that of the primary images, particularly if the primary images are presented in time sequence, as they are in the sequential color systems. In particular, lack of continuity in the full-color image can produce apparent errors of congruence, if one image differs in shape from the next successively scanned or if the successively scanned images do not occupy the same position in the retina of the eye.

The signal representing an image in a primary color is generated, transmitted and reproduced by the basic process illustrated in Fig. 28. The object is viewed by a camera fitted with a color filter, the filter allowing light to pass in a limited region of the visible spectrum, say red light. The sensitive plate of the camera has response to light of this color and hence the camera generates a video signal corresponding to the red light in the object. This video signal is transmitted, as faithfully and as free from disturbances as possible, to a picture tube. The tube produces red light L_r which bears a known relationship to the red light L_r' on the sensitive plate of the camera tube. The image so reproduced is the red primary-color image.

In a similar manner, another chain of equipment (the same equipment in the sequential systems) can reproduce an image in blue light, representing the blue light in the object, and a third chain can reproduce an image in green light. If care is taken to see that the images in the three cameras have precisely the same shape and precisely the same orientation with respect to the respective camera scanning patterns, and if the scanning patterns in the cameras are in themselves precisely congruent, it is possible to reproduce three primary color images having the same size and shape.

Finally, if the over-all brightness transfer characteristics of the three chains are identical and distortionless, the three primary-color images will display corresponding scales of brightness and identical black levels. Then, and only then, the three images may be superimposed (either simultaneously or interspersed in time) to form a full-color composite image having proper color values, correct gross structure and fine structure, and freedom from congruence defects. If the primary images are free of continuity errors, that is, if the field scanning rate of the primary images is high enough, the combined image will also be free of continuity errors, and the resulting image may be said to be a satisfactory full-color image of the object.

The Color-Transfer Process

Faithful color reproduction involves a color match between the light entering the camera and the light emerging from the receiver screen. If the trichromatic coefficients x and y of the entering light are the same as those of the emerging light, within the tolerances indicated in Fig. 25 and 26, the color match is satisfactory. We now relate this over-all color-matching requirement to the characteristics of the transducers in the television system. We are concerned, in other words, with the *color-transfer process*.

The color transfer process involves the following seven items of the system (see Fig. 28): (1) the *light source*, which illuminates (2) the *object* before the camera, (3) the *"taking filter"* through which the light passes from the object to the camera tube, (4) the *sensitive plate* of the camera tube, (5) the *transmission system* which connects the camera and the picture tube, (6) the *phosphor* which generates the light on the receiving

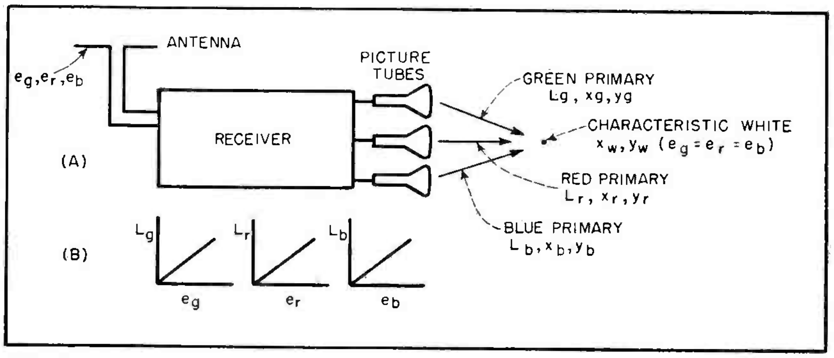


FIG. 27—Block diagram of the reference receiver (A) of a color system, showing the standard trichromatic coefficients, voltages, luminosities and transfer characteristics (B) necessary to specify the performance of the system

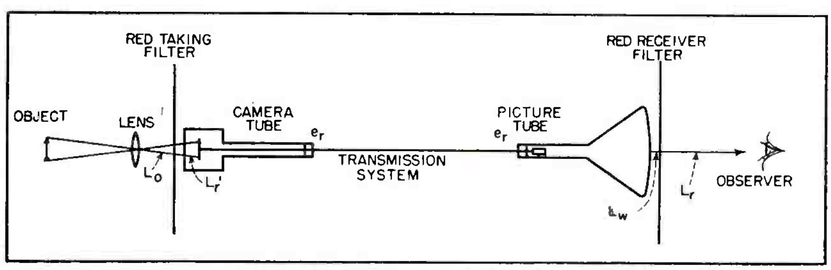


FIG. 28—Essential elements of the color system on which the color-transfer process depends. Correct color transfer implies a definite relationship between the light entering the camera tube and that entering the observer's eye

screen and (7) the *receiver filter*, if one is used in conjunction with the phosphor.

Each of these items, except (5), can be described by a spectroradiometric curve which represents the relative amount of radiant power generated, reflected, transmitted or converted as a function of the wavelength.

Figure 29 shows typical examples of the six spectral curves in a typical chain of equipment designed to reproduce the green primary image. The first four curves, describing the light source, televised object, filter, and camera tube are multiplied together, ordinate by ordinate, to determine the magnitude of the halftone (video) signal generated during the scanning of the object. Of these, the product of the taking filter curve and the camera spectral sensitivity curve, for a particular primary, is known as the *taking characteristic* for that primary.

The amplitude of the video signal varies not only as the intensity of the light source changes (its color remaining unchanged), but also as the color of the light source of the object changes. It is evidently essential that the receiver be capable of following independently both types of change (brightness and chromaticity), although both are represented by one quantity.

The distinction between brightness changes and chromaticity changes can be made only if there is a particular relationship between the spectral curves of taking filter and camera tube at the transmitter on the one hand, and the spectral curves of the phosphor and receiver filter on the other. This "particular relationship" between the taking and reproducing characteristics is computed in terms of (1) the trichromatic coefficients describing the primary colors and characteristic white of the reference receiver and (2) the relative antenna voltage amplitudes required to actuate each primary so as to produce the characteristic white. The complete computation is so complicated as to be beyond the scope of the present treatment, but the general approach is as follows:

The characteristic white is produced by contributions from all three primaries, that is, the x-coordinate of the characteristic white may be considered as being created by the sum of the x-coordinates of the primaries, multiplied by constants descriptive of the amount of each primary present. We have then the following set of equations:

$$k_r x_r + k_g x_g + k_b x_b = k_w x_w \quad (15)$$

$$k_r y_r + k_g y_g + k_b y_b = k_w y_w \quad (16)$$

$$k_r z_r + k_g z_g + k_b z_b = k_w z_w \quad (17)$$

where the subscripts r, g and b refer to the coefficients of the primaries and w to the characteristic white. These equations may be solved simultaneously to obtain k_r, k_g and k_b in terms of the x and y coordinates of the primaries and a unit amount of the characteristic white ($k_w = 1/y_w$). If the transmission system is linear (free from brightness distortion), and if it is taken as a standard condition that equal amounts of voltage applied to the receiver to actuate each primary will create the characteristic white, it is possible to convert the k_r, k_g and k_b values into corresponding amounts of video signal, required to be generated at the camera output, when the characteristic white is present in the object.

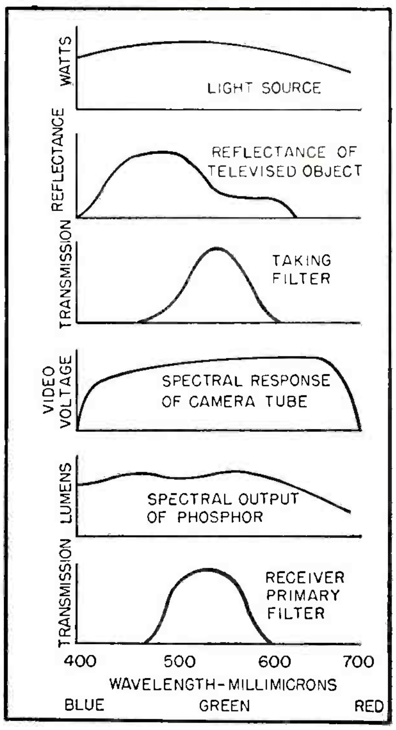


FIG. 29—The six spectroradiometric curves on which the color-transfer process depends. The product of the taking filter curve and camera response curve is known as the "taking characteristic"

When this computation is carried out it is found that negative values of voltage are required in certain regions of the taking characteristics (product of taking filter curve and camera sensitivity curve for the respective primaries). Consider for example the receiver primaries given in Fig. 30A. These are produced by the white light of illuminant C in conjunction with Wratten color filters numbered 25 (red), 58 (green) and 47 (blue). If the characteristic white is taken as illuminant C (Fig. 21) and the above-described computation is performed it is found that the required transmitter output, in volts per lumen, during the scanning of the red primary is

$$S_r = K(2.284\bar{x} - 0.796\bar{y} - 0.375\bar{z}) \quad (18)$$

and similarly for the green and blue signals

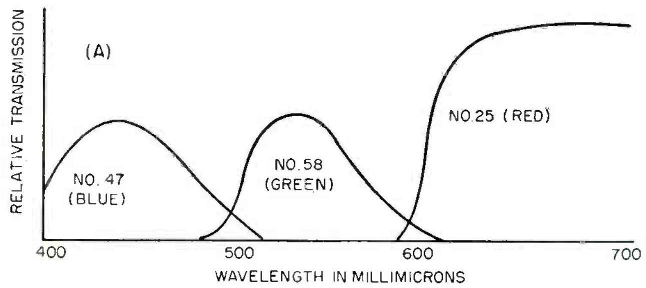
$$S_g = K(-0.808\bar{x} + 1.721\bar{y} + 0.0597\bar{z}) \quad (19)$$

$$S_b = K(0.045\bar{x} - 0.096\bar{y} + 0.891\bar{z}) \quad (20)$$

These equations uniquely determine the required taking characteristics. The red taking characteristic is formed by adding the distribution coefficient curves of Fig. 17 (Part II), each multiplied by the factor given in Eq. 18 and similarly for the green and blue taking characteristics. The resulting taking characteristics are shown in Fig. 30B.

It will be noted that negative values of output voltage are required at certain wavelengths in each of these taking characteristics, and that the red curve has two peaks or "lobes", a major lobe at about 600 millimicrons and a minor lobe at 440 millimicrons. Unless the negative values of voltage are produced, and unless the minor lobe is present in the red taking characteristic, it is not possible to reproduce all the colors in the gamut bounded by the receiver primaries.

It is customary to omit transmission of the negative values of voltage and the minor lobes. At first glance it might appear that the negative values correspond to negative values of light and hence are



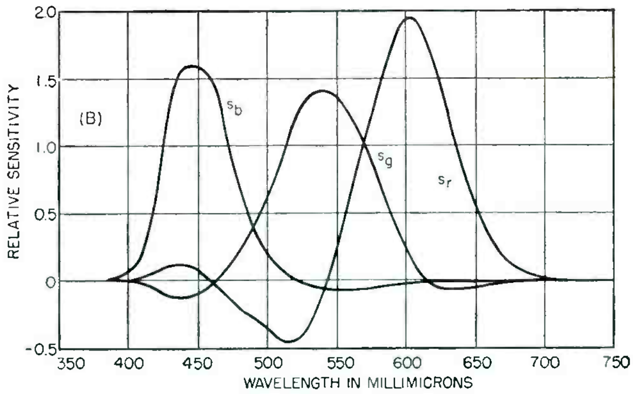


FIG. 30—Transmission curves (A) of the standard Wratten filters used in color receivers and the corresponding taking characteristics (B) for distortionless transfer of color values. Negative portions and minor lobes are omitted in practice

physically unrealizable in any case. However, in color photography a technique known as "masking" has been developed in which a negative image is combined with a positive image in printing, thus effectively introducing negative light in the final result. A similar technique may be used in color television, in which a negative image, formed from the positive image by reversing polarity, is combined with the positive image before transmission. This technique is feasible in the simultaneous and dot-sequential systems, but not in the field-sequential system (unless frame-storage devices are used).

Even when the negative and minor-lobe portions of the taking characteristics are disregarded, it is possible to find taking filters which, in conjunction with the spectral sensitivity curve of the camera tube, match the required taking characteristics sufficiently closely to limit the magnitudes of the color distortion vectors to those of the size shown in Fig. 25.

In summary we note the following general requirements which must be met to produce a satisfactory color-transfer from object to image: (1) the camera must have no response outside the visible region of the spectrum; (2) the taking characteristic applicable to each primary color must bear a definite relationship to the primaries, the characteristic white, and the relative gain proportion of the reference receiver. The ideal taking characteristics involve negative values and minor lobes which may be safely omitted in practical applications; (3) the relative gains applicable to the three primaries, from camera to picture tube, must remain in fixed proportion irrespective of signal level; and (4) the brightness transfer must be distortionless.

Resolution Requirements

In the early development of color television systems it was commonly supposed that the fine structure of each primary image should be the same. The effective resolution of the composite image would then be equal to that of each primary image, provided that the primary images were perfectly superimposed. Physiological studies of vision had proved at a much earlier date that the ability of the eye to distinguish fine detail varies markedly with color, under usual viewing conditions.

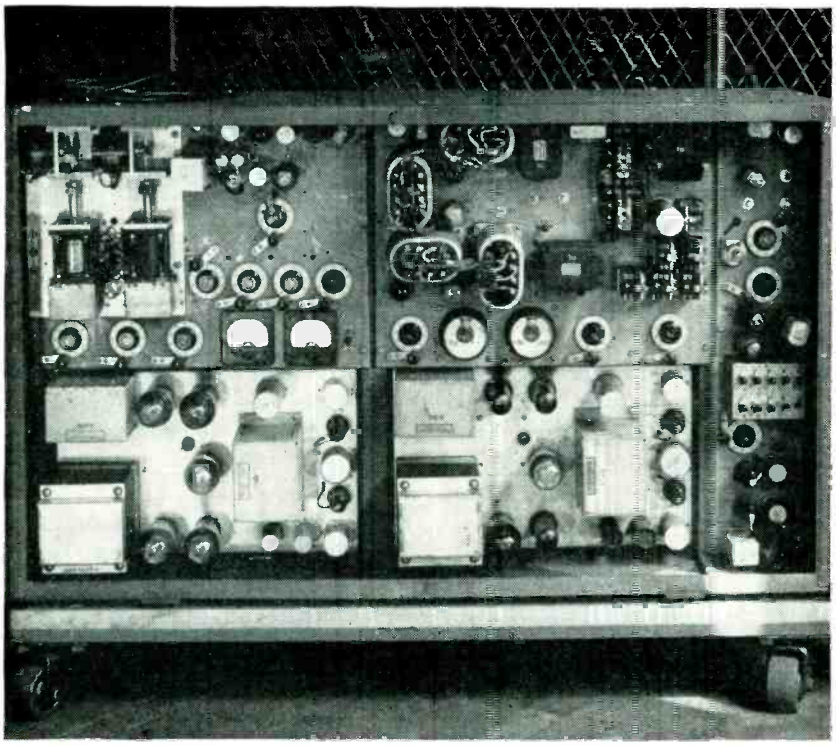
According to measurements reported in 1911 by Luckiesh, the visual acuity at a brightness of 4 foot-lamberts is highest for yellow and white light, about 90 percent as great for red and blue-green, and 75 percent as great for violet. Later tests by Baldwin showed that the acuity increases by a factor of about two when the brightness is increased from 1 to 10 foot-lamberts. The luminosity of the blue (violet) image in color television does not exceed ten percent of the green primary (the y-coordinates, representing luminosity, of primaries C for example, are in the ratio $0.6885/0.0412=16.7$ for the green and blue respectively). It thus appears that the acuity for the blue image is not greater than 35 percent of that for the green. Similar experimental studies lead to the conclusion that the visual acuity for the red image is not greater than 75 percent of that for the green image.

It follows that the resolution of the three primary images need not be the same. In fact, if the resolution of the blue image is equal to that of the green, a large part of the resolution provided in the blue image is wasted, since the eye cannot perceive it at the limiting viewing distance set by the resolution of the green image. This fact has been abundantly proved in tests of color television systems.

If the color television system is such that the resolution of the primary images can be adjusted until each satisfies the corresponding value of visual acuity, and if the lower resolution of the red and blue images can be realized as a reduction in bandwidth, it follows that an image of greater resolution can be transmitted over a given channel, with a given excellence of continuity, than can be transmitted by a system in which the resolutions of all primary images are the same. This ability to economize on bandwidth is not possessed by all systems to the same degree. In particular the simultaneous system and the dot-sequential system can make use of this technique, whereas the field-sequential and line-sequential systems cannot (that is, not without the use of image-storage devices not now available).

Permission to reproduce certain diagrams from "Color Television and Colorimetry" by W. T. Wintringham of the Bell Telephone Laboratories is gratefully acknowledged.

AUTOMATIC



Production-line test equipment using a self-balancing Owens bridge, at top left, which contains motor-driven standards

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PRODUCTION EQUIPMENT performing continuity, insulation breakdown, d-c resistance and simple a-c impedance tests is readily made automatic. But in the measurement of inductance, capacitance and effective resistance, manually operated a-c bridges are still widely employed in spite of costly operator time.

Partly or fully automatic bridges have been developed which perform such tests with accuracy comparable to that of manual bridges.

In the design of any measuring device there are two general approaches. In one method, a quantity is measured accurately and figures are presented to the operator. An example is a bridge with a calibrated indicator. In the second method, no effort is made to determine actual magnitude. It is simply determined as being less than a set upper limit, and greater than a set lower limit, or within limits.

Most industrial requirements are stated in the form of limits. (For example, inductance of a particular coil must not exceed 0.51 henry and must not be less than 0.50 henry). This would seem to make the limit-type of measurement the solution to most problems of industrial testing. However, the necessity of measuring reactance or effective resistance introduces certain limitations. If the inductance of a coil is to be measured on a limit bridge with one-percent accuracy, then the effective resistance of the coil must lie within a certain range. Usually, the wider this range can be made the more dependable the test will be. Proper attention to the design of the limit-bridge-plus-detector system can materially extend this range.

Phase Discriminator

Detectors for automatic a-c bridges almost universally depend on the principle of phase discrimination. The circuit of Fig. 1 shows a simple phase discriminator. A d-c output voltage E_o is obtained which is a measure of the phase difference between e and e_R. The voltages supplied to the rectifiers are $e + e_R$ and $e - e_R$. The rectified voltages across the load resistances are proportional to the amplitudes of these two voltages. The d-c difference is E_O.

It can be shown from the vector diagram that

$$E_O = K \bullet e_R \, (e \cos \theta) \qquad (1)$$

where θ is the phase angle between e and e_R. Thus if e_R is constant, E_O is directly dependent only on the component of e in the direction of e_R. In practice, this relationship is somewhat modified by rectifier characteristics and other factors.

The conditions for proper operation of the phase discriminator must usually be set up by shifting the phase of one of the input voltages. Figure 2 shows a simple phase shifter. This circuit has the virtue of allowing easy shifting of phase up to 180 degrees without

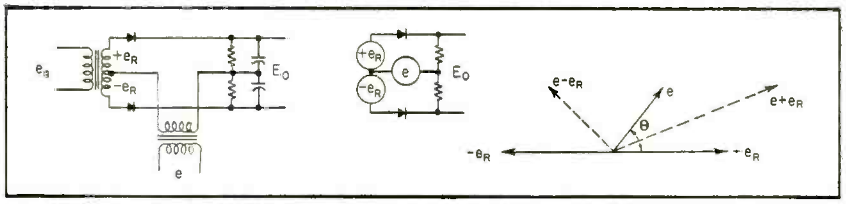


FIG. 1—Simple phase discriminator and vector relationship of voltages involved

A-C BRIDGES

Design of bridge and detector circuits used in production lines for automatic measurement of inductance, capacitance, and effective resistance. To cut down computations required, a graphical method of determining phase and amplitude of bridge unbalance voltage is included

changing signal amplitude. It is, however, frequency sensitive.

Typical System

Figure 3 shows a typical arrangement of various elementary circuits. Output E_o is a measure of bridge unbalance and can be made to depend chiefly on signals of preferred phase, discriminating against those of unfavorable phase.

Figure 4 is an idealized version of a bridge output-voltage chart. The chart is drawn relative to the bridge input voltage $E = A'C'$. Let the potential of the bridge corner B be represented by the point B' (more correctly, by the vector $A'B'$). Since the ratio arms, which are not necessarily resistive, are considered here to be fixed, then the point B' is fixed.

The potential of the bridge corner D, however, depends on the value of the unknown, the settings of the standards, and the supply frequency. Let the standard settings and the frequency be held constant. Then the potential of point D can be located by means of the grid of labelled lines In this example, resistance R of the test is allowed to vary from 100 to 700 ohms. Inductance L of the test is allowed to vary from 0.1 to 0.7 henry. Unbalance voltage e is the

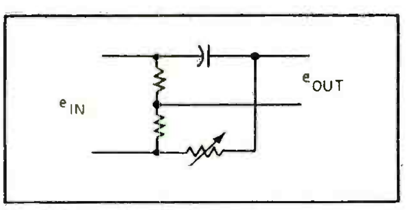


FIG. 2—Capacitor and resistor form simple phase shifter

difference between the potentials of corners B and D. In this case, balance is achieved when $R = 400$ ohms and $L = 0.4$ henry. Vector e,

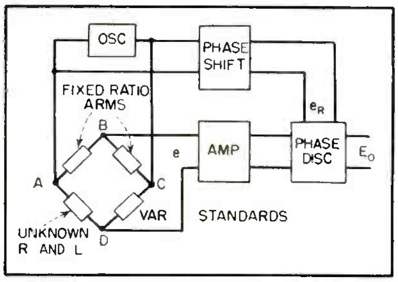


FIG. 3—Arrangement of basic elements for obtaining data of Fig. 4

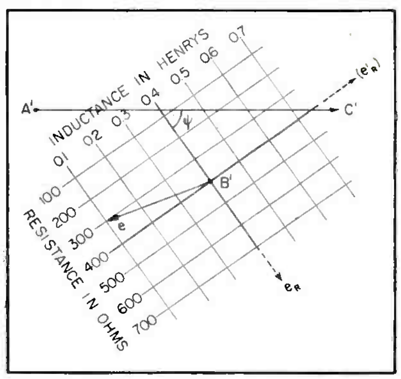


FIG. 4—Ideal bridge output voltage

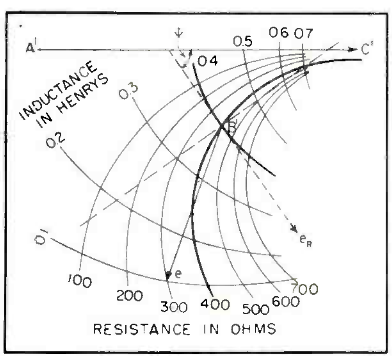


FIG. 5—Grid-type of bridge-voltage chart, with arcs replacing straight lines

drawn on the chart, is the result of R becoming 300 ohms and L becoming 0.1 henry.

Assume a desire to measure R with minimum dependence on L. A voltage is taken from supply E and revolved through an angle ψ to get e_R. Then by Eq. 1, voltages of this phase will have maximum effect on E_o, and those at 90 degrees will have zero effect.

Furthermore, the only component of e that registers on E_o is the component $B'N$. Now, $B'N$ is of exactly the same magnitude as the unbalance voltage which would result from the unbalance of the resistance alone. Thus variations of inductance have zero effect on the output voltage E_o, as required. A positive E_o means that R is greater than 400 ohms; a negative E_o means that R is less than 400 ohms. A voltmeter reading E_o could be calibrated linearly in ohms resistance unbalance.

A separate discriminator and phase shifter could be used in the same way to measure inductance (reference voltage e'_R).

Such a system would lend itself ideally to an automatic limit test set, say rejecting all product with resistance above 400 ohms, and/or inductance below 0.4 henry. Unfortunately, the rectangular character of the voltage chart of Fig. 4 can seldom be approximated for practical bridges.

Behavior of Typical Bridges

Practical bridge voltage charts appear here in two forms, the grid type of Fig. 5, and the calibrated-arc type of Fig. 6. Figure 5 is read in the same manner as the chart of

Fig. 4, with arcs replacing the straight lines.

Figure 6 is read in the following manner: each end of the unbalance-voltage vector e is located by a point on one of the calibrated arcs. The example shown is for $L = 0.2$ henry, $R = 600$ ohms.

For measurement of R, with a minimum of error caused by variations of L, let e_R be the same phase as the line tangent to the balance-arc $L = 0.4$ as drawn in Fig. 5. The unbalance voltage e is shown for the same case as in Fig. 4, $L = 0.1$ henry and $R = 300$ ohms. But this time the component of e in phase with e_R is positive in direction. Hence E_o is positive, erroneously indicating that R is greater than 400 ohms.

The correct negative polarity is not assumed by E_o until the inductance is increased to about 0.3 henry. Voltage E_o, which should be an accurate index of the constant resistance unbalance, varies widely as the inductance changes, and it even assumes the wrong polarity for large deviations of inductance.

Assume the precision of the test must be ± 1 percent. Product having a resistance of 404 ohms would be accepted were L to increase slightly from 0.4 henry; or resistances of 396 ohms would be rejected were L to decrease slightly from 0.4 henry. Inductive unbalance here can result in two undesirable actions: rejection of good product and acceptance of defects.

An alternative setting of e_R suggests itself: at a phase angle such that e_R is normal to the balance-arc $R = 400$ ohms. In such a case, inductive unbalance could not lead to the acceptance of faulty product. But it could lead to rejection for resistance under 400 ohms, an equally unsatisfactory condition.

A judicious choice of the phase of e_R is desirable. The main factors influencing this choice are the precision demanded in measurement of R, the expected deviation of L in normal production runs, and the relation of one variable to the other. For instance, other things being equal, R could reasonably be expected to be larger when L is larger.

A helpful step would be redesign of the bridge to have more favorable characteristics. In this example, the $R =$ constant arcs should be made flat enough that the phase angle of e_R is not critical. However, this special bridge design might lead to unfavorable characteristics in the measurement of L. Failing an acceptable compromise, the easiest solution is to switch the product into another bridge designed specifically for the measurement of L.

Self-Balancing Considerations

The preceding discussion applies primarily to a limit-type measurement. However, suppose the roles of the standard and unknown elements in the bridge are reversed. An impedance is to be measured and the grid chart of Fig. 5 applies to the settings of the variable bridge standards. Further, let each standard be driven by a servomotor whose direction of rotation depends on the polarity of E_o in its own particular channel, and which tends to reduce the unbalance, as in Fig. 7.

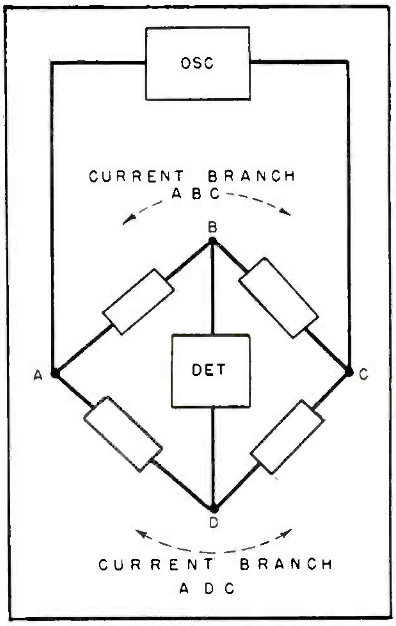


FIG. 8—Current branches set up by high-impedance detector

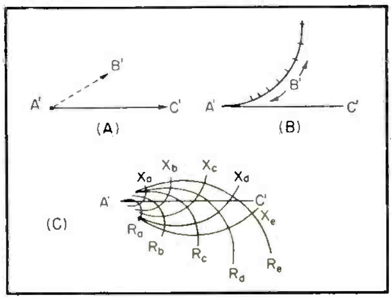


FIG. 9—Charts of corner potentials

The reference voltage is E and the phase shifting is done, as is generally preferable, in the bridge signal circuits. (The net operation of the system remains identical to that with the shifting done in the reference voltage circuit). For an average bridge, e_{SL} and e_{SR} are set about 90 degrees different in phase.

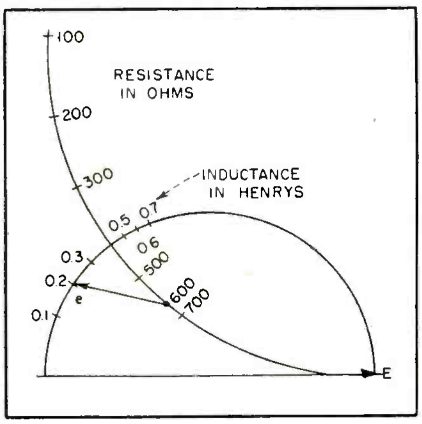


FIG. 6—Calibrated-arc chart for another bridge circuit

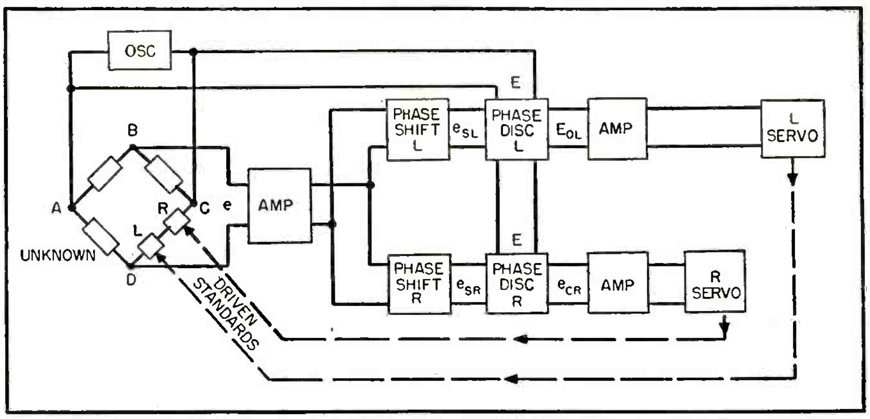
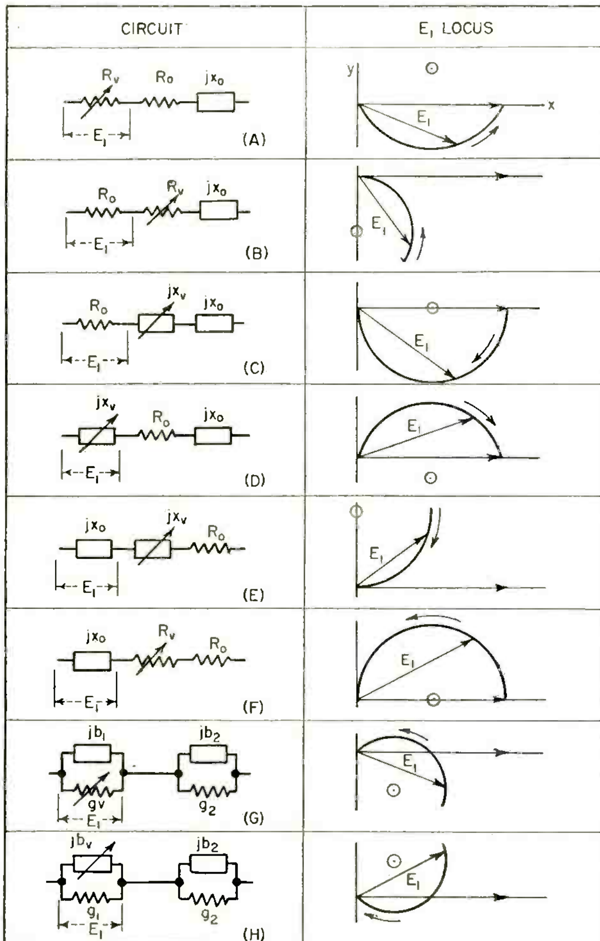


FIG. 7—Self-balancing bridge arrangement in which servomotors drive the variable standards



Case	Center coordinates x_c	Center coordinates y_c
(A)	$\frac{1}{2}$	$\frac{R_o}{2X_o}$
(B)	0	$\frac{-R_o}{2X_o}$
(C)	$\frac{1}{2}$	0
(D)	$\frac{1}{2}$	$\frac{-x_o}{2R_o}$
(E)	0	$\frac{x_o}{2R_o}$
(F)	$\frac{1}{2}$	0
(G)	$\frac{1}{2}\frac{b_2}{b_1+b_2}$	$\frac{1}{2}\frac{-g_2}{b_1+b_2}$
(H)	$\frac{1}{2}\frac{g_2}{g_1+g_2}$	$\frac{1}{2}\frac{b_2}{g_1+g_2}$

Applied voltage = (1+j0) volts v = variable elements
All loci pass through point (0,0) o = fixed elements

FIG. 10—In cases (B) and (C) if E_1 is across R_a, where $R_o = R_a + R_b$, multiply both center coordinates by R_a/R_o.
If E_1 is across X_a in (E) and (F), where $X_o = X_a + X_b$, multiply both center coordinates by X_a/X_o.
In (G) and (H) b is susceptance and g is conductance

In general, both servomotors will run in the correct direction for a prompt balance. It is possible, however, for one motor to run in the wrong direction temporarily. But final balance is nevertheless achieved. To illustrate, in Fig. 5, the unbalance voltage e for $R = 300$ ohms, $L = 0.1$ henry, has a positive component along e_R. But it should have a negative one, because R is less than 400 ohms, and since the servo in Fig. 7 is connected to decrease resistance for positive E_o. The variable resistance standard would seemingly be driven to its lower limit and stay there. But meanwhile, the L servo has steadily been reducing the inductance unbalance. As this happens, the R servo slows down, stops, and then begins to rotate in the right direction. Thus balance is finally obtained.

As both servos approach balance, they become progressively more independent of each other, due to the phase discrimination in each channel. This works against interactive hunting, which, however, is not a great problem at moderate sensitivities. Thus the self-balancing bridge always reaches a true null if the unknown impedance is within the range of the bridge. The effect of one test component on the accuracy of measurement of the other component is eliminated, precisely as in the case of a manually operated bridge. This is the main advantage of this type over the simpler, cheaper limit bridge.

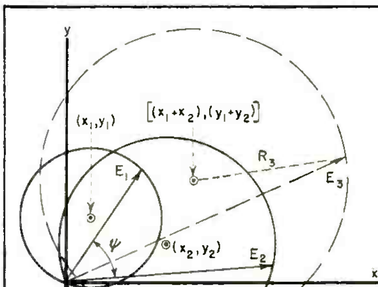
For limit-type measurements, a directional relay is the usual terminal device. It may be of the meter type or of the standard sensitive relay type.

The use of germanium diodes such as the 1N35 in the discriminator results in a very stable zero point. In general, d-c amplification of E_o means a sacrifice of this stability, so that E_o should be impressed directly on the terminal device when possible. For self-balancing bridges, unless a d-c servo is used, E_o must drive a d-c to a-c converter.

In the equipment illustrated in the photographs, one of four sections includes a self-balancing Owens bridge. The variable standards are both resistive.

The true terminal device in a self-balancing test is the one which electrically indicates the position of the driven standards when null is obtained. An arrangement of contacts actuated by the driven shafts is a possible solution. This may mean a critical mechanical setup, however.

In the equipment illustrated, the problem has been met on an electrical basis. Achievement of balance is signified by the operation of a relay which senses the absence of unbalance voltage via an auxiliary



$$R_3^2 = x_1^2 + y_1^2 + x_2^2 + y_2^2 + 2\left[(\cos 2\psi)(x_1x_2+y_1y_2) + (\sin 2\psi)(y_1x_2 - x_1y_2)\right]$$

FIG. 11—Addition of the two voltage vectors to provide E_3

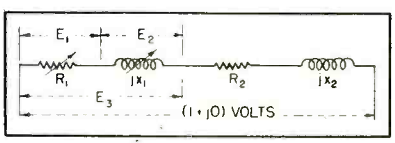


FIG. 12—Circuit employed in text Example 1

circuit; this relay initiates a switching system which transfers each Helipot into a simple d-c limit bridge. The d-c resistance indications then actuate the proper subsequent accept-reject circuits. The d-c bridges themselves are accurate to 0.1 percent and are easily adjustable.

The overall action of the test is analogous to the use of calipers to transfer a certain length from an awkward to a convenient location for measurement. Here, inductance and effective resistance are translated into d-c resistance, and then transferred to convenient measuring circuits as separate items. The same principle can be used, no matter what the driven variable standard is, by mounting a pilot rheostat on the driven shaft.

Unbalance Voltages

Numerical computation of bridge unbalance voltages is notoriously tedious. Since the voltage to be determined is the difference between two much larger potentials (the potentials of the corners across which the detector is connected), any error in the calculation of corner potentials represents a much larger error in unbalance voltage. Thus a series of slide-rule calculations is apt to be significantly in error. Also, an attempt to correlate such a series of results usually leads to some form of graphical representation. For these reasons, a direct graphical approach is generally simplest and most flexible. A vectorial method especially applicable to bridge problems will be presented here. Better than slide accuracy is readily obtainable on letter size paper.

Accurate determination is best obtained by direct experiment or detailed algebraic analysis. For this reason we will neglect small residuals. In practical cases, a vacuum-tube detector is used. The resultant high detector impedance permits a valuable simplification in bridge calculations: the bridge can be considered to consist of two entirely separate current branches as shown in Fig. 8.

We are interested in the relative potentials of two points, one in each current branch. These points are the two bridge corners across which the detector is connected. The other two corners are common to both current branches. Let one be assigned zero potential, and the other 1.0 volt. The frequency will not be specified, since it enters directly into the expressions for reactance. The majority of bridges do not have intentional coupling between current branches, therefore this complicating case will not be treated here.

Unbalance-Voltage Charts

Considering one current branch only, we may represent the potential of the mid-way corner as follows:

(1) No variables. The potential of corner B is represented by a point on the plane as in Fig. 9A (more precisely, by vector $A'B'$).

(2) One variable. The potential is represented by a point which travels along a calibrated arc as in Fig. 9B. The calibration marks correspond to the value of the variable.

(3) Two variables. The potential of corner B is represented by a point which is located by means of a grid of labelled arcs as shown in Fig. 9C.

Because of the large number of possible locations and types of variables, no further effort will be made to list the combinations of variables and the corresponding types of voltage charts. The examples to be given will show typical results.

Basic Voltage Arcs

In Fig. 10, a number of arcs are shown and the location of their centers is given. All these arcs pass through the origin. They are the loci of the voltage vector E_1 as the variable element in the corresponding circuit varies without limit. The curved arrow shows which way the vector head travels as the variable element increases in a positive direction.

The arcs drawn represent the loci when all circuit reactances are positive. The coordinates for the arc-centers are correct providing the correct signs are used for the various reactances. The locus may shift to another segment of the circle if negative reactances are present. However, the only information usually needed is the expression for center coordinates.

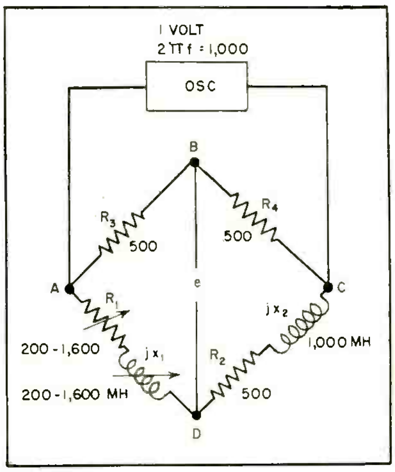


FIG. 14—Chart of Fig. 13 can be applied to this bridge circuit

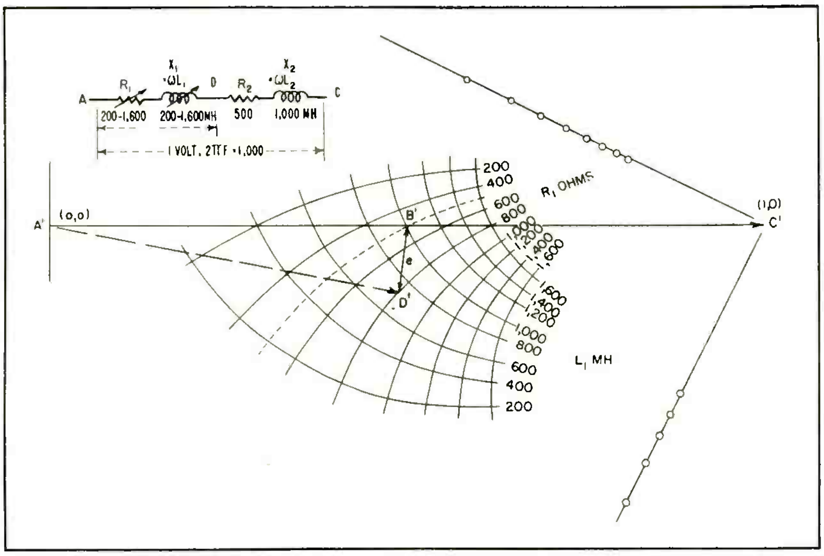


FIG. 13—Grid chart provides E_3 for any value of R_1 and L_1

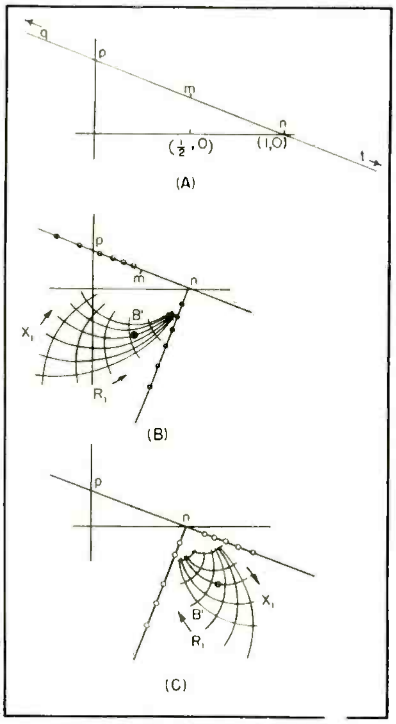


FIG. 15—Grid charts constructed for text Example 2

The voltage vectors associated with the elements along a common current branch will always bear a constant phase relation to one another since the same current flows in each element.

Theorem I: Consider two vectors E_1 and E_2 which have a constant angle ψ between them, and whose ends are defined by circles passing through the origin, the circle centers being at (x_1, y_1) and (x_2, y_2) respectively, as in Fig. 11. Addition of E_1 and E_2 results in a vector E_3 which also follows a circular locus. The center of the E_3 locus is at $[(x_1 + x_2), (y_1 + y_2)]$. Further, the radius R_3 is given by the expression shown.

Two important cases are:

(a) When $\psi = 0$,
$$R_3^2 = (x_1 + x_2)^2 + (y_1 + y_2)^2$$

(b) When $\psi = 90°$,
$$R_3^2 = (x_1 - x_2)^2 + (y_1 - y_2)^2$$

The radius is seldom computed, since it usually can be determined by inspection.

EXAMPLE 1. Required, Fig. 12: find E_3 as R_1 and X_1 vary. This will be done for two conditions: (a) R_1 free to vary, X_1 takes temporary values X_1':

Center E_1 arc (Fig. 10A) at $\left[\frac{1}{2}, \frac{1}{2}\frac{R^2}{X_1' + X_2}\right]$

Center E_2 arc (Fig. 10F) at
$$\left[\frac{1}{2}\frac{X_1'}{X_1' + X_2}, 0\right]$$

Center E_3 arc (Theor I) at
$$\left[\frac{1}{2} + \frac{1}{2}\frac{X_1'}{X_1' + X_2}, \frac{1}{2}\frac{R_2}{X_1' + X_2}\right]$$

The radius need not be computed, since by inspection, whenever R_1 approaches ∞ the E_3 locus approaches (1, 0).

(b) X_1 free to vary, R_1 takes temporary values R_1'

Center E_1 arc (Fig. 10C) at
$$\left[\frac{1}{2}\frac{R_1'}{R_1' + R_2}, 0\right]$$

Center E_2 arc (Fig. 10D) at
$$\left[\frac{1}{2}, -\frac{1}{2}\frac{X_2}{R_1' + R_2}\right]$$

Center E_3 arc (Theor I) at
$$\left[\frac{1}{2} + \frac{1}{2}\frac{R_1'}{R_1' + R_2}, -\frac{1}{2}\frac{X_2}{R_1' + R_2}\right]$$

Again, the radius need not be computed, since whenever X approaches ∞ the E_3 locus approaches (1,0).

The arc centers can now be plotted for various numerical values of R_1 and X_1. The graphical construction can be speeded up by noting that in each case above the E_3 arc-centers fall on a straight line. The line is easily drawn for each case. (a) When $X_1' = \infty$, the line passes through (1,0); when $X_1' = 0$, through $\left(\frac{1}{2}, \frac{R_2}{2X_2}\right)$. (b) When $R_1' = \infty$, the line passes through (1,0); when $R_1' = 0$, through $\left(\frac{1}{2}, \frac{-X_2}{2R_2}\right)$

Only the abcissa of each arc-center need be computed, since the center must lie on the associated line. Further, each arc may be quickly drawn since each is known to pass through (1,0).

Fig. 13 shows a plot of E_3, the elements having been given numerical values. The grid allows E_3 to be found for any R_1 and L_1.

An immediate conclusion is that the chart also applies to the bridge of Fig. 14. Output voltage e is the difference in potential between corners D and B. The grid gives the potential of D, and that of B is a fixed point at $\left(\frac{1}{2}, 0\right)$ for the element shown. Any ABC branch could be accommodated, whether the potential of B were defined by a fixed point, a calibrated arc, or another grid.

EXAMPLE 2. It is of interest to let X_1 of Fig. 12 become negative (substitute a capacitor for coil X_1). The line tmq of Fig. 15A contains all the centers for condition (a) of Example 1, plus those appearing for X_1 negative. As X_1 decreases from 0 to $-\frac{1}{2}X_2$, the center travels from m to p. (See the expression for the arc-center coordinates). As X_1 closely approaches $-X_2$, the center retreats to q at an infinite distance; the circuit approaches resonance.

As X_1 takes up values more negative than $-X_2$, drawing away from resonance, the center appears along tn. Finally, as X_1 approaches $-\infty$, the center again approaches (1,0).

The arcs being swung off from these centers must still pass through (1,0) as before. This results in the grids of Fig. 15B, where X_1 is between 0 and $-X_2$ ohms; or of Fig. 15C, where X_1 is between $-X_2$ ohms and $-\infty$.

For the case of Fig. 15B, a convenient potential B' is needed. This is readily obtained by putting a capacitor in arm AB and a resistance in arm BC. The completed bridge circuit becomes the standard Owens bridge of Fig. 16.

In Fig. 15C, it is more difficult to obtain a suitable balancing potential B' since it must be larger than the supply voltage feeding the other current branch ADC. However, it can be obtained in a number of ways, and some practical advantage may accrue from the fact that X_1 represents a relatively small capacitance. If DC is the test arm, and X_1 and R_1 are variable standards, a variable air capacitor will suffice for X_1 at fairly low frequencies.

EXAMPLE 3. The Owens inductance bridge is often operated in a different mode from that mentioned in Example 2.

By writing out the standard balance equations for Fig. 16, it appears that $\frac{X_1}{R_2} = \frac{X_3}{R_4}$ = constant; and $\frac{R_1}{X_2} = \frac{X_3}{R_4}$ = constant, so that R_2 is balanced by X_1 and X_2 is balanced by R_1. Rather than make X_1 a variable, R_2 is held constant. This is done by adding resistance from a calibrated variable to the effective resistance of the test so as to make up the correct balance resistance. The resistance of the test can be deduced from the setting of the variable. Thus both inductance and effective resistance of the test appear in terms of a resistance setting.

Required: draw a voltage chart for the bridge of Fig. 16 as R_1 and R_2 vary over their ranges.

(a) R_1 free to vary, R_2 takes temporary values R_2'

Center E_1 arc (Fig. 10F) at
$$\left[\frac{1}{2}\left(\frac{-177}{953}\right), 0\right] = \left[-0.093, 0\right]$$

(continued on p 116)

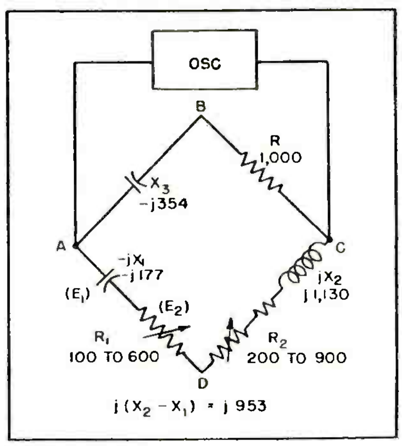


FIG. 16—Circuit of Owens bridge

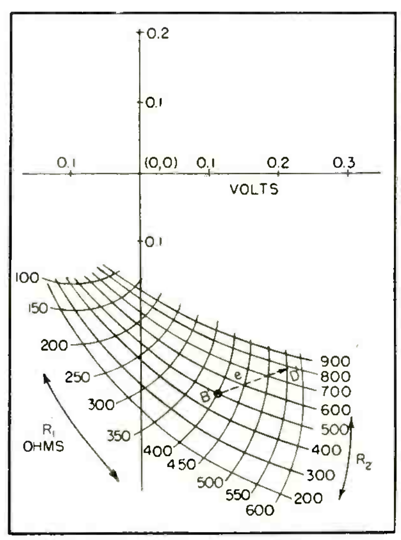


FIG. 17—Grid chart constructed for Owens bridge in text Example 3

Center E_2 arc (Fig. 10A) at

$$\left[\frac{1}{2}, \frac{R_2'}{2(953)}\right] = \left[0.5, \frac{R_2'}{1,906}\right]$$

Center E_{AD} arc at $\left[0.407, \frac{R_2'}{1,906}\right]$

When R_1 approaches ∞, E_3 approaches (1,0), so all arcs pass through (1,0).

(b) R_2 free to vary, R_1 takes temporary values R_1'.
Center E_1 arc (Fig. 10F) at

$$\left[\frac{1}{2}\left(\frac{-177}{953}\right), 0\right] = \left(-0.093, 0\right)$$

Center E_2 arc (Fig. 10B) at

$$\left[0, \frac{-R_1'}{2(953)}\right] = \left(0, \frac{-R_1'}{1,906}\right)$$

Center E_{AD} arc at $\left[-0.093, \frac{-R_1'}{1,906}\right]$

When R_2 approaches ∞, E_2 approaches (0,0), so all arcs pass through (0,0).

Figure 17 is a grid drawn for the bridge with the numerical values as shown. Point B' is located for the ratio arms specified.

EXAMPLE 4. Fig. 18 is the circuit of a conventional capacitance comparison bridge. Let C_1 and g_1 be the capacitance and conductance of arm AD and let them be free to vary. Fixed values C_2 and g_2 are in arm DC. To draw an output voltage chart:

(a) g_1 free to vary, C_1 takes temporary values C_1'.
Center of E_{AD} arc (Fig. 10G) at

$$\left(\frac{1}{2}\frac{\omega C_2}{\omega C_1' + \omega C_2}, \frac{1}{2}\frac{-g_2}{\omega C_1' + \omega C_2}\right)$$

All arcs pass through (0,0) per Fig. 10G.
The line containing the arc-centers is easily drawn in: when C_1' approaches ∞, line passes through (0,0); when $C_1' = 0$, through $\left(\frac{1}{2}, \frac{-g_2}{2\,\omega C_2}\right)$

(b) C_1 free to vary, g_1 takes temporary values g_1'.
Center of E_{AD} arc (Fig. 10H) at

$$\left(\frac{1}{2}\frac{g_2}{g_1' + g_2}, \frac{1}{2}\frac{\omega C_2}{g_1' + g_2}\right)$$

All arcs pass through (0,0) per Fig. 10H.
To draw the line containing the arc-centers: when g_1' approaches ∞, line passes through (0,0); when $g_1' = 0$, through $\left(\frac{1}{2}, \frac{\omega C_2}{2\,g_2}\right)$

Figure 19 is a grid drawn for this bridge with the elements having values as shown. It is a matter of choice whether the grid is regarded as applying to the excursions of the test impedance, a given comparison standard being used, or the excursions of variable standards, the test impedance being fixed.

EXAMPLE 5. Figure 20A is the circuit of a Maxwell inductance bridge. The test item is in the D-C arm. A common mode of operation is to vary C_1 for reactive balance, and to add a calibrated resistance to that of the test item such that the total resistance in the D-C arm is correct for balance.

Required: draw an unbalance-voltage chart for this bridge, the test item having specified characteristics while C_1 and R_2 vary throughout their ranges.

There is only one variable per current path so this will lead to a calibrated-arc type chart. A calibrated arc is merely a rudimentary grid in which one family of arcs is reduced to a single arc, and the other is reduced to a set of calibration marks. The simplest way to draw and calibrate an arc is to proceed as if a grid were being drawn.

ABC branch:

(a) C_1 varies, g_1 constant. (Main arc)

Center E_{AB} arc (Fig. 10H) at $\left(\frac{1}{2}\frac{g_2}{g_1 + g_2}, 0\right)$

(b) Although g_1 is not a variable, let it be free to vary, that is, not defined. C_1 takes values C_1'. (Calibration arcs)

Center E_{AB} arcs (Fig. 10G) at $\left(0, \frac{1}{2}\frac{-g_2}{\omega C_1'}\right)$

ADC branch:

(a) R_2 varies, X_2 constant. (Main arc)

Center E_{AD} arc (Fig. 10B) at $\left(0, \frac{1}{2}\frac{-R_1}{\omega L_2}\right)$

(b) As above, let X_2 be free to vary, R_2 takes values R_2' (calibration arcs).

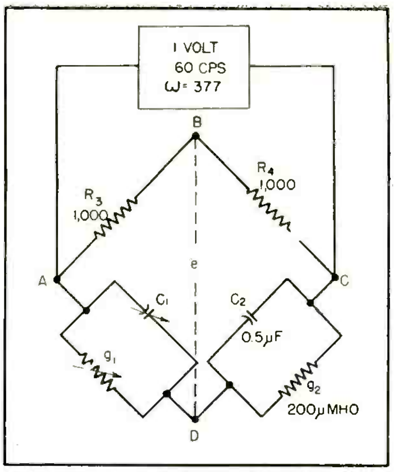


FIG. 18—Circuit of capacitance-comparison bridge

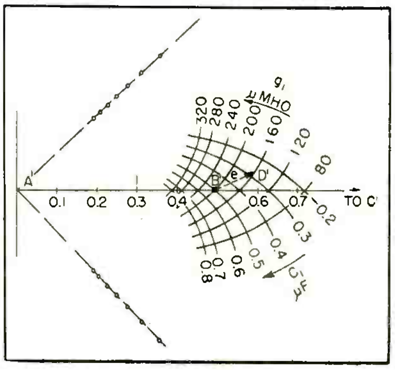


FIG. 19—Grid chart constructed for capacitance bridge of text Example 4

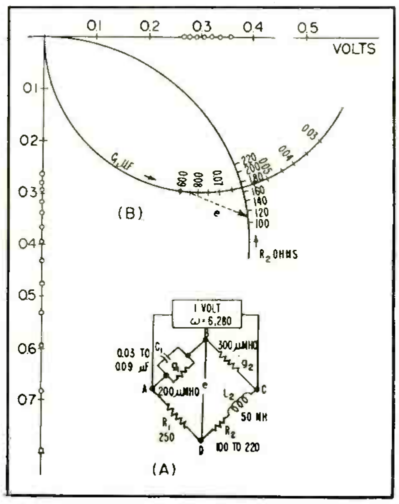


FIG. 20—Circuit of Maxwell inductance bridge, and unbalance-voltage chart

Center E_{AD} arcs (Fig. 10C) at $\left(\frac{1}{2}\frac{R_1}{R_1 + R_2'}, 0\right)$

Figure 20B is a chart drawn for the numerical values shown.

Each example presented the behavior of bridge unbalance voltage e as bridge parameters varied. However, the number of variables was limited to two. A chart might be required for, say, the inductance bridge of Fig. 14, when there are four variables present, two variables in the item under test plus the two variable standards.

For Cases Involving More Than Two Variables

The test item and the variable standards may be in different current branches. This is the current-bridge connection, so-called because at balance the current through the test is readily computed when the total supply current is known. A grid can be drawn for each current path, and e is thus determined, each end of the vector being located by one of the grids. Thus up to four variables per bridge can be accommodated providing that there are no more than two per current branch.

The test item and the variable standards may be in the same current branch. This is the voltage bridge connection, so-called because at balance the voltage across the test is readily computed when the supply voltage is known. (While a balanced bridge remains balanced for either supply connection, the unbalance voltages in general do not correspond.) Here, the presence of four interacting variables precludes two-dimensional graphical representation; we must resort to the determination of voltages for particular conditions of interest.

In such a case, graphical determination of voltages, one by one, presents about the same amount of labor as straight algebraic methods. However, if entirely complete data is not essential, much pertinent information on voltage trends can be obtained by drawing several grids, selecting values of interest for two of the variables and letting the other two vary freely. If a large number of points were computed algebraically and then correlated graphically, we would finally arrive at just such a set of grids.

Acknowledgment

The author wishes to thank R. M. Lester for his valuable criticism during preparation of this paper.

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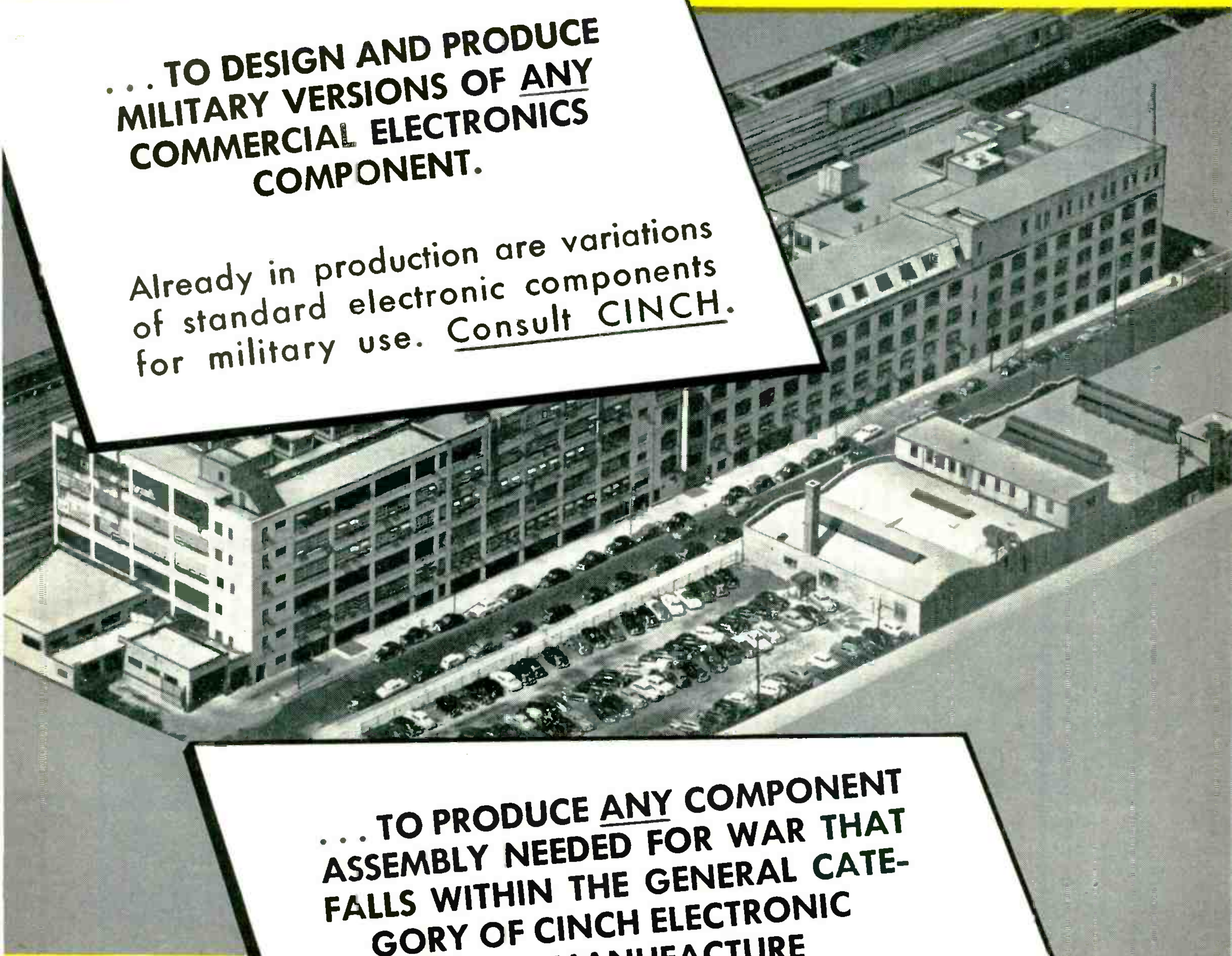

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Minimum-Loss Matching Pads

Simple nomograph gives the two resistance values needed in an L-type network for matching unequal impedances with minimum power loss, and also gives directly the amount of loss in db. Multiplying factors are easily used to extend ranges

By JOSEPH C. BREGAR
Engineer
Western Electric Company Radio Shops
Winston-Salem, N. C.

A TWO-RESISTANCE network for matching two unequal impedances provides proper matching with a minimum of power loss. The accompanying nomograph solves for the resistance values needed.

Example 1. Match a 72-ohm line to a 52-ohm line with a minimum of power loss. Determine the loss in db.

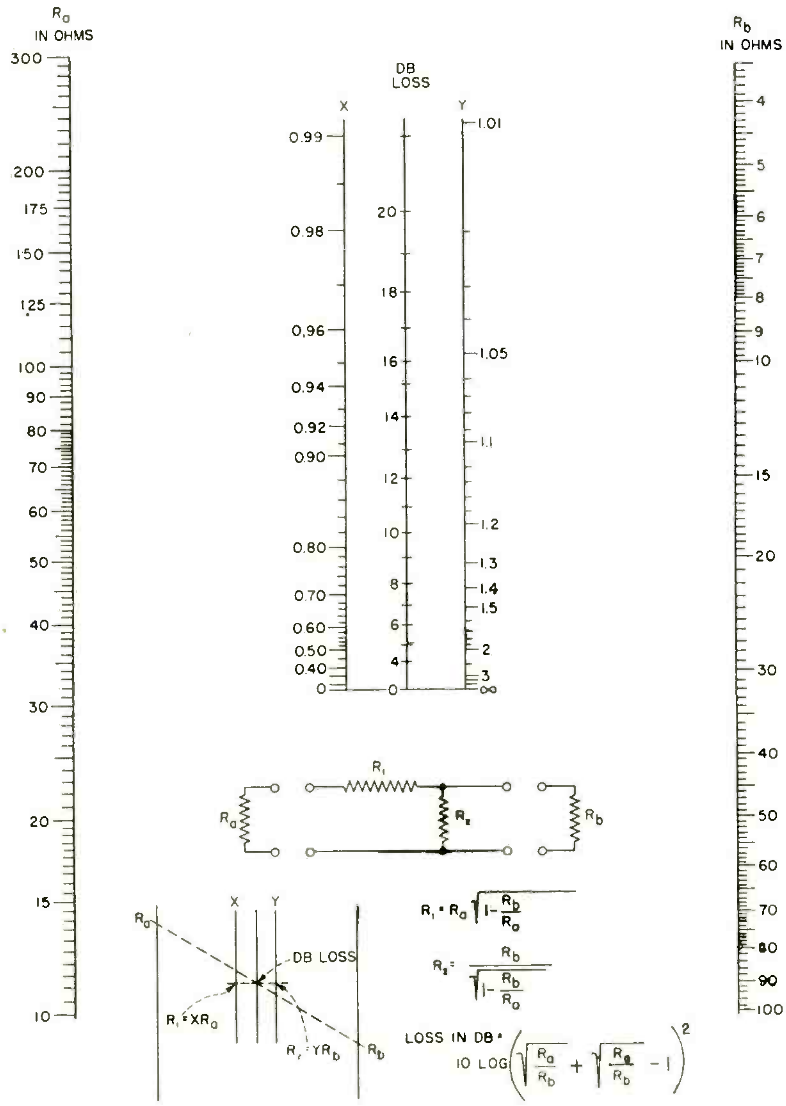
Solution. Adjust a straightedge to connect 72 on the R_a scale and 52 on the R_b scale (R_a must be greater than R_b, and therefore $R_a = 72$ and $R_b = 52$). The intercept on the db loss scale shows the matching-pad loss as 5.1 db. Next, adjust the straightedge at right angles to the loss line and through the 5.1-db point, and read the X and Y values as $X = 0.53$ and $Y = 1.9$. The desired resistor values are then $R_1 = XR_a = 0.53 \times 72 = 38$ ohms, and $R_2 = YR_b = 1.9 \times 52 = 99$ ohms.

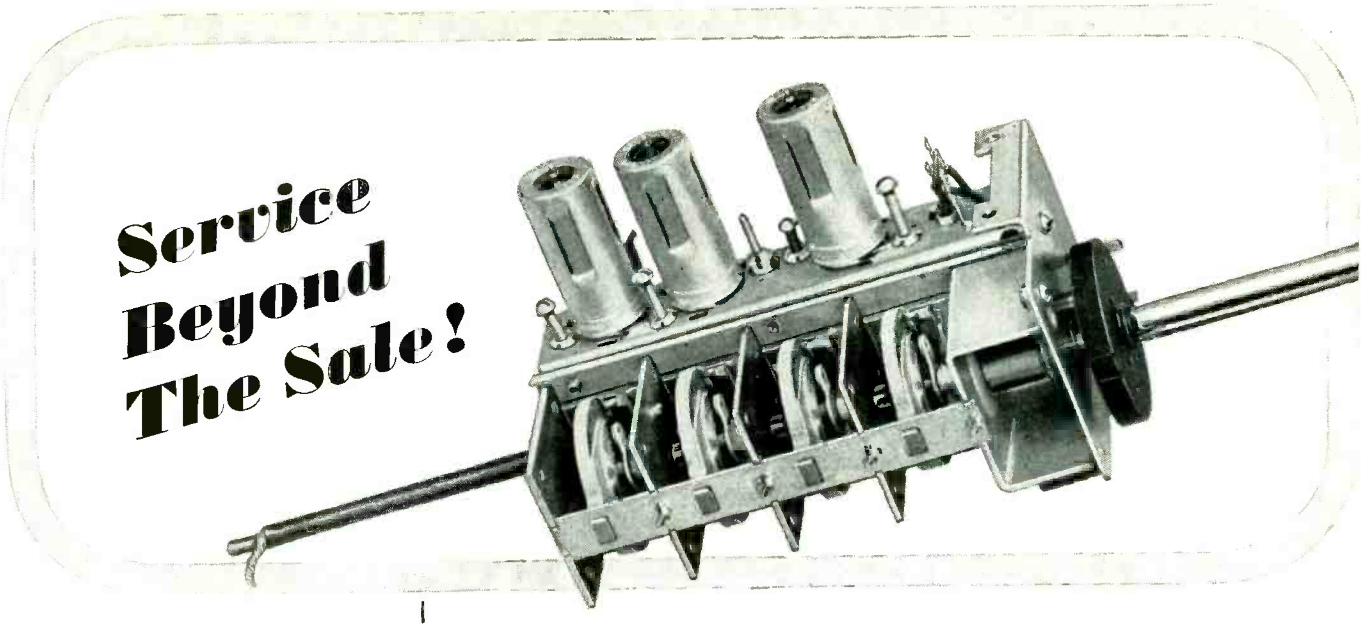
The scale ranges are chosen for common impedance values. The nomograph may be used for any values by the application of the same multiplier to the R_a and R_b scales. No multipliers are required for the loss scale or the X and Y values. The X and Y values are applied to the original problem values of R_a and R_b in determining R_1 and R_2.

Example 2. Match a 3,000-ohm source to a 600-ohm load with a minimum of loss. Determine the loss.

Solution. A convenient scale factor is 1/10. Applied to the problem values, R_a becomes 300 and R_b becomes 60. Connect these points with a straightedge and read the pad loss as 12.5 db. Next, read the X and Y values as 0.89 and 1.12 respectively. Applying these values to the original problem impedances of 3,000 and 600 ohms gives $R_1 = 0.89 \times 3{,}000 = 2{,}700$ ohms and $R_2 = 1.12 \times 600 = 670$ ohms.

The matching of impedances of more than 30-to-1 ratio involves high power losses, and other types of coupling networks are employed. For impedance matching when power loss is unimportant and the ratio of impedances is more than 30-to-1, the X and Y values approach 1; then $R_a = R_1$ and $R_b = R_2$ for proper matching.





Mallory TV Front End Limits Oscillator Radiation

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TUBES AT WORK

Including INDUSTRIAL CONTROL

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Improved Ramberg Vacuum-Tube Acceleration Pickup

THE RAMBERG vacuum-tube accelerometer (previously reported in the January, 1947, issue of ELECTRONICS, p 152) has been further developed at the National Bureau of Standards so that the new pickup tube provides more sensitive and reliable acceleration measurements than did the earlier version.[1,2]

Field tests of the improved device have provided results that suggest the wide variety of uses to which the instrument may be applied in industry. For example, vibrations of a structural model of an airplane wing have been measured. The laboratory setup is shown in Fig. 1. The accelerometer at the wing tip on the back at the left is used to keep the vibration at a constant level. The other accelerometer on the front at the left is moved from station to station to measure the variation of vibration amplitude with position along the length of the model.

With the accelerometer clamped to the dashboards in 1936 and 1947 automobiles and a filter used to eliminate natural frequency response, comparative records were obtained of the vertical accelerations to which the vehicles were subjected when crossing multiple streetcar or railroad tracks.

Variations in the vertical accelerations of a freight elevator going from the first to the second floor were revealed by the accelerometer as well as vertical accelerations experienced by the rear cockpit of a TBD airplane during takeoff, approach and landing. The natural frequency response of the instrument itself at 160 cps in these records is small compared to the response proportional to the imposed accelerations.

The vacuum-tube pickup is a twin diode consisting of a fixed, indirectly heated cathode and two plates, one on each side of the cathode. The plates are elastically mounted so that they will be deflected if the base of the tube is accelerated in a direction perpendicular to the plane of the plates. The new model differs from earlier versions in having stops to limit the motion of the plates, support rods 0.010 inch in diameter to increase the sensitivity of the tube and a second getter.

Improved vacuum-tube pickup contains stops that limit plate excursions

The primary design requirement met by the Ramberg accelerometer is its provision for an electrical signal of sufficient strength to drive directly a high-frequency recording galvanometer and, at the same time, have a relatively high natural vibration frequency.

In the operation of the original model erratic changes or zero shifts in its balance point were sometimes encountered. The source of this difficulty has been eliminated in the new model. The zero shift resulting from excessive accelerations to

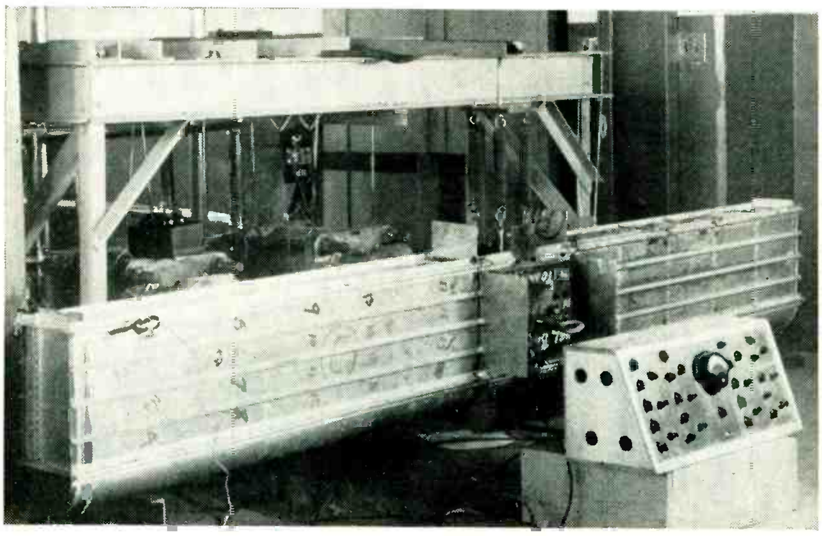
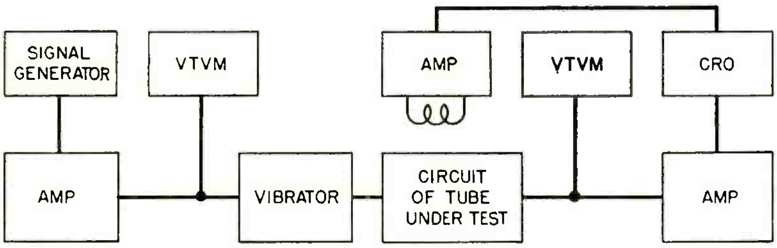


FIG. 1—Laboratory setup for measuring vibration of the structural model of an airplane wing. Note the two pickup tubes at the front and rear of the left end of the wing

THE FRONT COVER



THE COVER PHOTOGRAPH shows a method of investigating subminiature tubes for microphonism used in the Product Development Laboratories of Sylvania Electric Products Inc., Flushing, N. Y. The apparatus imparts a controlled motion to the tube and measures the mechanical displacement of the various parts and the electrical response of the tube.

The tube is rigidly held in a fixture which is firmly attached to a moving coil in a magnetic field. The motion of the moving coil is controlled in frequency and amplitude by a signal generator and amplifier as shown in the block diagram. About 5 watts of power is required at frequencies from 25 to 10,000 cps. Displacement of the parts within the tube is observed by a calibrated telescope (cathetometer) in conjunction with a stroboscope to slow down the motion optically.

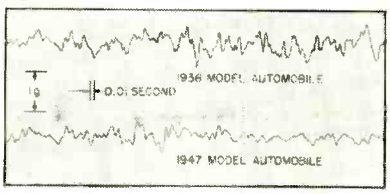
Circuit connections are made by placing the ends of the lead wires of the tube into small pools of mercury. Normal voltages are applied and the output signal due to microphonism is developed across the plate load resistor and measured with a vtvm. A check on the motion of the system is maintained by observing the waveform on an oscilloscope.

the pickup while handling and installing is prevented by the stops added to limit the plate excursion and thus prevent overloading.

Zero drift, believed to be due to small fluctuations in the cathode electron emission, has been effectively reduced by three steps. First, the accelerometer was given an aging treatment which made its emission nearly constant. Second, two getters instead of one were used to improve the electrical characteristics and, third, the sensitivity was increased by a factor of 25 to make the remaining random output negligible compared with the output due to acceleration.

The circuit used in field tests of the improved pickup is an adaptation of the Kelvin double bridge designed to minimize the effect of contact resistance both in the tube socket and in the adjustable rheostats. A blocking filter was used ahead of the galvanometer to eliminate the possible 160-cycle output at the natural frequency of the device.

Characteristics of the over-all circuit are flat within five percent up to 20 cps and attenuate gradually to nearly 100 percent at 160 cps.



Oscillogram tracings showing the vertical accelerations experienced by a 1936 and 1947 automobile crossing multiple streetcar tracks

REFERENCES

(1) Walter Ramberg, "Vacuum Tube Acceleration Pickup", *Journal of Research*, National Bureau of Standards, 37, p 391, 1946.

(2) Walter Ramberg, "The Measurement of Acceleration With a Vacuum Tube", AIEE *Transactions*, 66, p 735, 1947.

Multiple-Output Predetermined Counter

By D. L. Gerlough and H. R. Kaiser*

Institute of Transportation and Traffic Engineering
University of California
Los Angeles, Calif.

IN CERTAIN INDUSTRIAL applications, single-output predetermined counters[1,2] are not suitable and multiple-output predetermined counters must be used. In the multiple-output counter, output signals may occur at several predetermined points during the counting process whereas in single-output counters an output signal occurs only when a single predetermined count is reached.

The circuit of a counter having a counting capacity of 2^n and m predetermined outputs is shown in Fig. 1. This counter consists of two

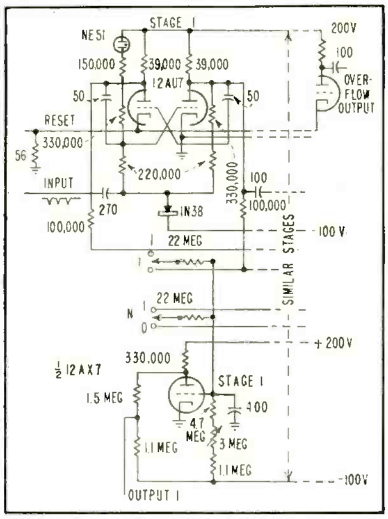


FIG. 1—Schematic diagram of a multiple-output predetermined counter having a capacity of 2^n and m predetermined outputs. Each NE51 socket contains a 50,000-ohm series resistor

parts, a binary counter section and an interpretation section. The counter may have as many stages as necessary to give the desired counting capacity but with the component values shown there is a limit of about twelve stages.

The binary counter uses a standard circuit except for crystal diodes in the bias return of each stage to increase the ability of the stage to

(Continued on p 168)

* H. R. Kaiser is now with Hughes Aircraft Co., Culvert City, Calif.

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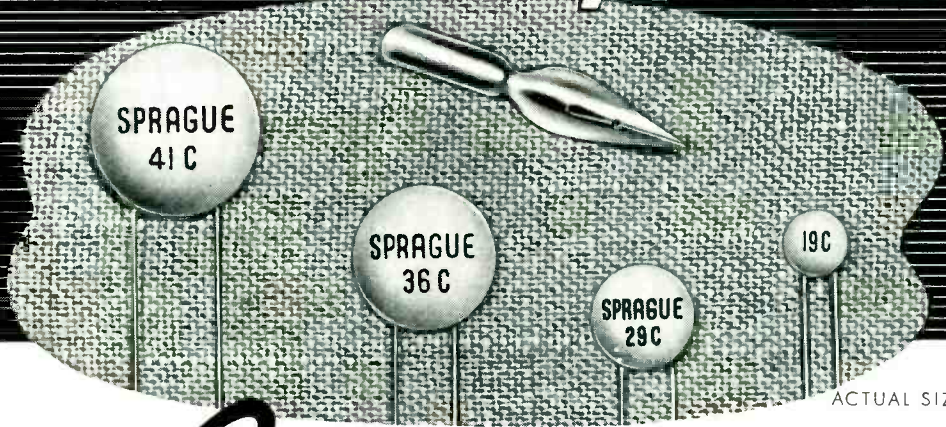

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THE ELECTRON ART

Edited by JAMES D. FAHNESTOCK

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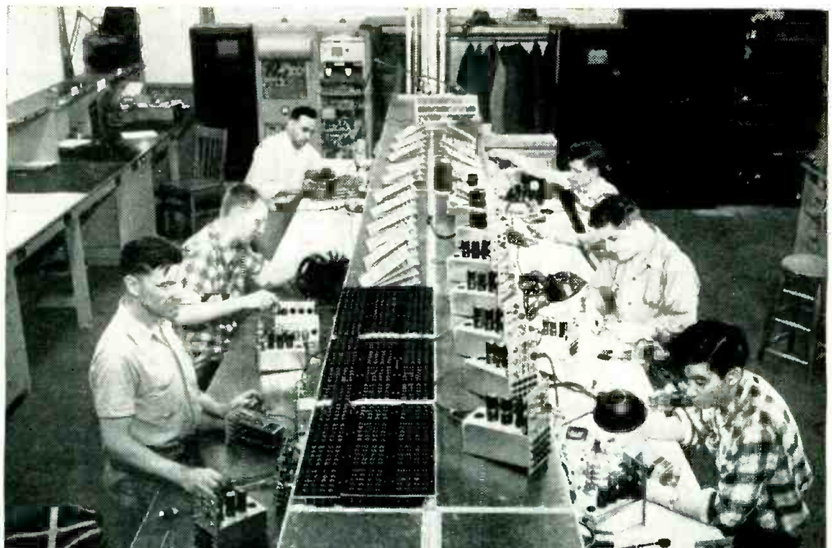
Inexpensive Analog Computer

AN ELECTRONIC analog computer costing less than $5,000 but with a six-variable capacity in solving dynamic problems has been developed by the Boeing Airplane Co., with five units now being used in as many of the company's engineering research departments.

The computer requires but five basic operational components—coefficient potentiometers, integrators, a limiter, two voltmeters and a volt box. Twelve integrators and 24 coefficient potentiometers are used to attain the six-variable capacity.

To solve a typical problem, the engineer writes a set of differential equations which describes the actual dynamic system under investigation. Then the computer's "erector" units are interconnected in such a manner that they satisfy this same formal mathematical description. Because the computer, under these conditions, becomes analogous to the dynamic system under investigation, it will react to any stimulus in the same manner as would the dynamic system. Each component can be reused to make new analogies in succeeding problems.

The new computer is expected to become a companion instrument to the slide rule and desk calculator to engineers dealing in problems of dynamics. In a recent study, use of a single computer enabled the completion by one man in one week of problems whose solution normally would require more than a year.



Boeing Airplane Company's new BEAC computer was made on this small assembly line basis by workmen in the company's physical research unit. The computer units (on workbenches and right table top) can be interconnected to make different analogies through the switchboard-like panels in left-center

The computer may be used to simulate a change in gear ratio, relocation of a wing, an airspeed change or a new rudder installation. One computer is capable of solving the lateral and longitudinal rigid body flight equations of an airplane and its control surface actuators simultaneously.

Nicknamed BEAC for Boeing Electronic Analog Computer, the machine is patterned after a similar computer (BEMAC) developed by Boeing in connection with its guided missile program. BEMAC has a mechanical element, however, while BEAC is entirely electronic, basically an electronic erector set in which each component can be reused to make new analogies in succeeding problems.

Automatic Stabilization of High-Impedance D-C Amplifiers

By FRANCIS RAWDON SMITH
Scientific Director
Reed Research, Inc.
Washington, D. C.

IN DESIGNING an analog computer for the analysis of transient heat flow (the Simulator), the problem of standardizing current-measurement circuits arose. Most current measurements have to be made at levels so far above ground (10^{12} ohms and over) that special tube d-c amplifiers seemed a logical solution. The use of such amplifiers, however, means that over-all computer accuracy can only be assured by effectively counteracting amplifier drift.

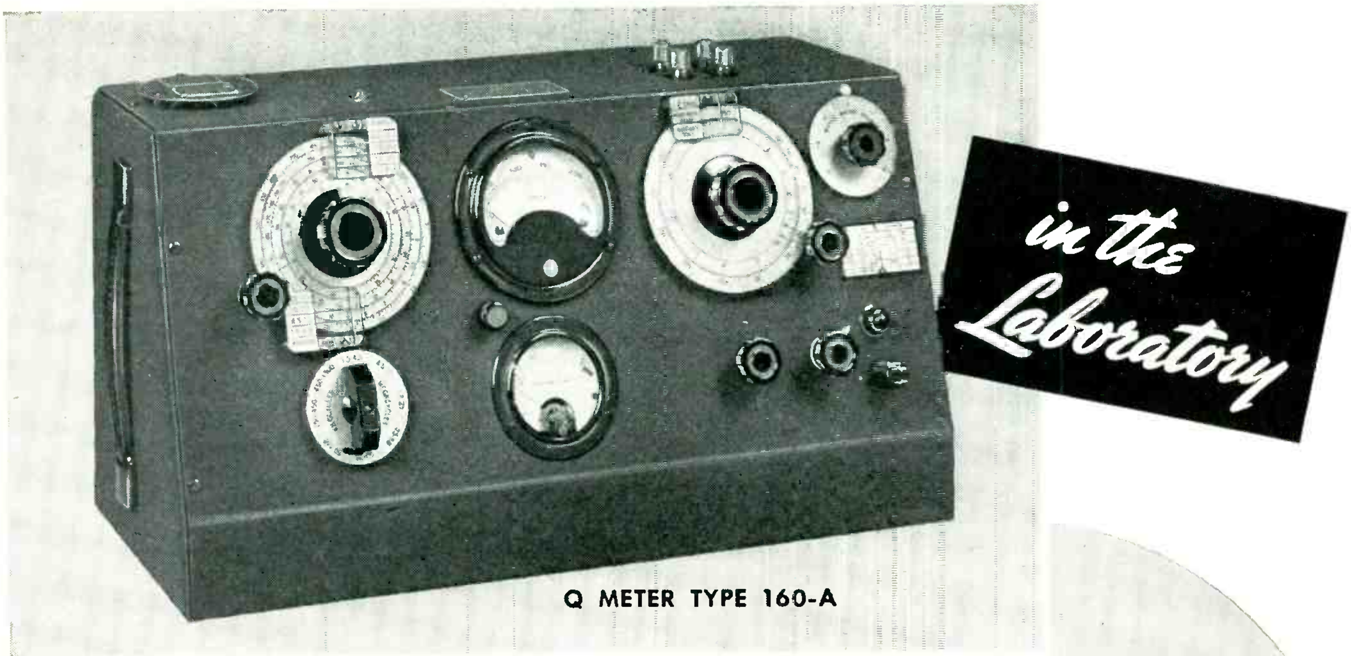
One way to accomplish this is to standardize each amplifier periodically. However, to do so manually—and sufficiently often—on a system of the scope of the computer would be impossible. An automatic method of standardization, therefore, was indicated.

Computing Procedure

Most computations with the Simulator involve a greatly expanded time scale. Thus, amplifier drift in the measuring circuit is a more than usually serious menace to sustained accuracy.

In practice, known data such as skin temperature, solar radiation

For the Measurement of Q and Inductance



Q METER TYPE 160-A

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QX CHECKER TYPE 110-A
(ALSO TYPE 110-B)

The Type 160-A Q-Meter offers the electronic engineer a simple, reliable means of measuring Q, inductance, and capacitance, at any frequency within the range of 50 kc. to 75 mc. Each component part and assembly used in the manufacture of this instrument is designed with the utmost care and exactness. Circuit tolerances are held to values obtainable only in custom built instruments.

The Type 110-A QX-Checker has been designed as the production counterpart of the Type 160-A Q-Meter to rapidly and accurately compare the relative Q and reactance of components with established standards. Manufacturers of television receivers and those engaged in producing R. F. components will appreciate the time and effort saved by employing this unit for production line use or at incoming inspection points.

Be sure to include both of these versatile and dependable instruments in your new equipment plans for 1951.

160-A Q-METER SPECIFICATIONS

OSCILLATOR FREQUENCY RANGE: 50 kc. to 75 mc. in 8 ranges.
OSCILLATOR FREQUENCY ACCURACY: ± 1%, 50 kc.—50 mc.
± 3%, 50 mc.—75 mc.

Q MEASUREMENT RANGE: Directly calibrated in Q, 20-250. "Multiply-Q-By" Meter calibrated at intervals from x1 to x2, and also at x2.5, extending Q range to 625.

Q MEASUREMENT ACCURACY: Approximately 5% for direct reading measurement, for frequencies up to 30 mc. Accuracy less at higher frequencies.

CAPACITANCE CALIBRATION RANGE: Main capacitor section 30-450 mmf, accuracy 1% or 1 mmf whichever is greater. Vernier capacitor section +3 mmf, zero, −3 mmf, calibrated in 0.1 mmf steps. Accuracy ± 0.1 mmf.

110-A QX-CHECKER SPECIFICATIONS

FREQUENCY RANGE: 100 kc. to 25 mc. in 6 ranges using plug-in coils.
ACCURACY OF COIL CHECKS: May be checked against standard to within about 0.2% with coil values of 10 microhenries to 10 millihenries and Q of 100 or greater.
CAPACITANCE RANGE: Capacitance values ranging between approximately 2-1000 mmf may be checked against a standard to an accuracy of a few tenths of one mmf if the Q of the capacitor is high.

• • •

TYPE 110-B QX-CHECKER also available for accurate comparison of very small inductors.

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GENERATOR AND OTHER DIRECT READING INSTRUMENTS

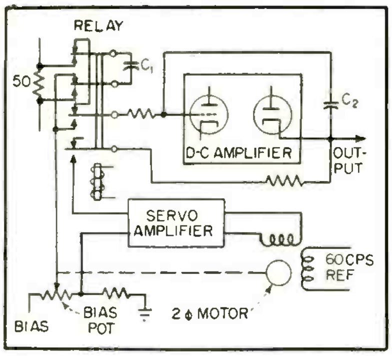


FIG. 1—Block diagram of automatic d-c amplifier stabilizing circuit

and the thermal conductivity of the materials involved are fed into the computer, and precise values of temperature distribution as a function of time are computed by the machine. In the circuits of the computer, voltage is proportional to absolute temperature—current is proportional to heat flow—resistance is proportional to the thickness of the material in the object under test, and inversely proportional to its thermal conductivity; values of electrical capacitance are proportional to thermal capacity.

Once the proper values are set up, the equipment produces an analogous record of heat flow on an extended time basis. The final data are furnished in graph form, on a specially designed, 30-channel, electric-stylus recorder. These data comprise four records of current-versus-time and 24 records of voltage-versus-time (two spare circuits are left for future modifications).

The final recorded values of voltage and current flow in the R-C networks of the computer are obtained through d-c amplifiers, as noted previously. The current amplifiers measure current flow into capacitors, as they charge. Thus it is essential, from the standpoint of accuracy, to standardize the zero of these d-c amplifiers in the various measuring circuits and, because of the extended time basis, to keep them standardized throughout the entire computation. A convenient method of doing this is by using a servo system to change a bucking or bias voltage, thereby automatically standardizing each d-c amplifier as often as is necessary.

Operation

The d-c (current-measuring) amplifier system is shown schematically in Fig. 1. In the over-all computer circuit, the input to this amplifier is inserted into certain R-C networks in the computer. So as not to disrupt the circuit into which it is inserted, the input resistor has a value of 50 ohms—very low by comparison with the value of R in the R-C circuit.

The voltage developed across the 50-ohm resistor is used to charge C_1, which is connected across the moving contacts of the relay. When the relay moves to the position in Fig. 1, C_1 is connected across the input of the current amplifier, the output of which is therefore proportional to the charge across C_1.

In practice, with any ordinary amplifier this condition would, of course, prevail only momentarily, since C_1 would discharge, more or less rapidly, into the input resistance of the amplifier. In the present instance this would be wholly unsatisfactory, since the recorder would not necessarily be at the point of record at the instant at which the output reading was at its initial, peak value. This has been overcome, in the present case, in two ways: by the use of a special electrometer-type tube for the amplifier input, in which the grid-current is far lower than with normal tubes; and, secondly, by the use of a somewhat elaborate integrating circuit, of which the capacitor C_2, which goes from amplifier output to input, is the principal component.

Note that the phasing of the amplifier is such that the resultant loop is degenerative, thereby becoming an integrating circuit of very long time-constant.

When the relay is energized—during the time that C_1 is being charged by the passage of current through the 50-ohm resistor—the input of the amplifier is switched to the bias potentiometer. At the same time, the output of the d-c amplifier is connected to the servo amplifier input, to provide the automatic zero-setting.

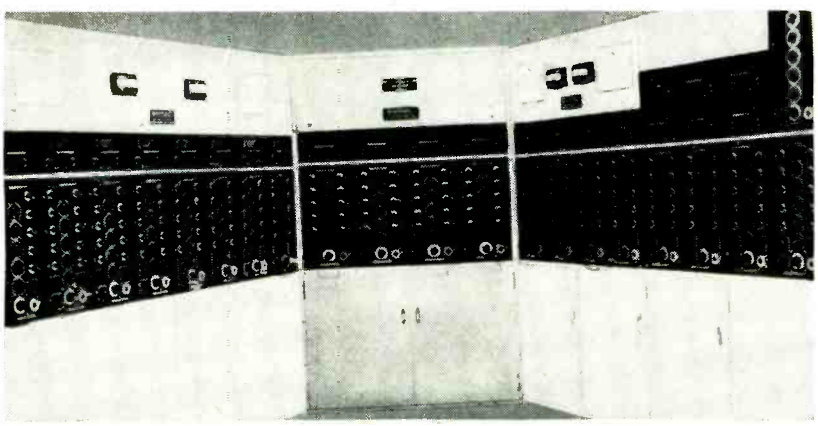
Automatic Standardization

The grid bias of the current-measuring amplifier is varied by positioning the potentiometer as shown in Fig. 1. Mechanical positioning is accomplished by means of a servomechanism which comprises a Brown converter, ElectroniK amplifier, and balancing motor. The output of the servo amplifier is applied to one field winding of the two-phase balancing motor which, in turn, is geared to the grid bias potentiometer, adjustment of which will correct for drift in the d-c amplifier.

Any drift in the current-measuring amplifier produces an error signal in its output. The error signal is a d-c voltage whose polarity is determined by the direction of drift, and whose size is determined by the magnitude of drift. The magnitude of the d-c signal is equivalent to input signals of the order of microvolts.

In the servo amplifier, the d-c error signal is changed to a-c by the converter or chopper. The resulting a-c error signal differs in phase by 180 degrees according to the direction of the amplifier drift. The

(Continued on p 218)

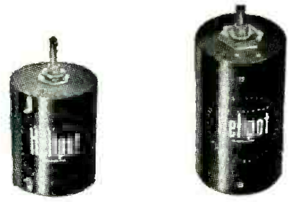


Operation of analog computer for the analysis of transient heat flow depends on measurement of d-c currents at very high impedance levels. Automatic stabilization of d-c amplifiers facilitates accuracy and speed of measurements

In this panel are illustrated standard models of HELIPOT multi-turn and single-turn precision potentiometers—available in a wide range of resistances and accuracies to fulfill the needs of nearly any potentiometer application. The Beckman DUODIAL is furnished in two designs and four turns-ratios, to add to the usefulness of the HELIPOT by permitting easy and rapid reading or adjustment.

A B C

MODELS A, B, & C HELIPOTS
A—10 turns, 46″ coil, 1-13/16″ dia., 5 watts—resistances from 10 to 300,000 ohms.
B—15 turns, 140″ coil, 3-5/16″ dia., 10 watts—resistances from 50 to 500,000 ohms.
C—3 turns, 13-1/2″ coil, 1-13/16″ dia., 3 watts—resistances from 5 to 50,000 ohms.



D E

MODELS D AND E HELIPOTS
Provide extreme accuracy of control and adjustment, with 9,000 and 14,400 degrees of shaft rotation.
D—25 turns, 234″ coil, 3-5/16″ dia., 15 watts—resistances from 100 to 750,000 ohms.
E—40 turns, 373″ coil, 3-5/16″ dia., 20 watts—resistances from 200 ohms to one megohm.

F G

MODELS F AND G PRECISION SINGLE-TURN POTENTIOMETERS
Feature both continuous and limited mechanical rotation, with maximum effective electrical rotation. Versatility of designs permit a wide variety of special features.
F—3-5/16″ dia., 5 watts, electrical rotation 359°—resistances 10 to 100,000 ohms.
G—1-5/16″ dia., 2 watts, electrical rotation 356°—resistances 5 to 20,000 ohms.

LABORATORY MODEL HELIPOT
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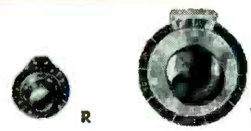

R W

MODELS R AND W DUODIALS
Each model available in standard turns-ratios of 10, 15, 25 and 40 to 1. Inner scale indicates angular position of HELIPOT sliding contact, and outer scale the helical turn on which it is located. Can be driven from knob or shaft end.
R—2″ diameter, exclusive of index.
W—4-3/4″ diameter, exclusive of index. Features finger hole in knob to speed rotation.

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For many years The HELIPOT Corporation has been a leader in the development of advanced types of potentiometers. It pioneered the *helical* potentiometer—the potentiometer now so widely used in computer circuits, radar equipment, aviation devices and other military and industrial applications. It pioneered the DUODIAL*—the turns-indicating dial that greatly simplifies the control of multiple-turn potentiometers and other similar devices. And it has also pioneered in the development of many other unique potentiometric advancements where highest skill coupled with ability to mass-produce to close tolerances have been imperative.

In order to meet rigid government specifications on these developments—and at the same time produce them economically—HELIPOT* has perfected unique manufacturing facilities, including high speed machines capable of winding extreme lengths of resistance elements employing wire even less than .001″ diameter. These winding machines are further supplemented by special testing facilities and potentiometer "know-how" unsurpassed in the industry.

So if you have a problem requiring *precision potentiometers* your best bet is to bring it to The HELIPOT Corporation. A call or letter outlining your problem will receive immediate attention!

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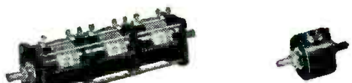
The versatility of the potentiometer designs illustrated above permit a wide variety of modifications and features, including double shaft extensions, ganged assemblies, the addition of a multiplicity of taps, variation of both electrical and mechanical rotation, special shafts and mounting bushings, high and low temperature operation, and close tolerances on both resistance and linearity. Examples of potentiometers modified for unusual applications are pictured at right.



A C

3-GANGED MODEL A HELIPOT AND DOUBLE SHAFT MODEL C HELIPOT
All HELIPOTS, and the Model F Potentiometer, can be furnished with shaft extensions and mounting bushings at each end to facilitate coupling to other equipment.
The Model F, and the A, B, and C HELIPOTS are available in multiple assemblies, ganged at the factory on common shafts, for the control of associated circuits.

B F

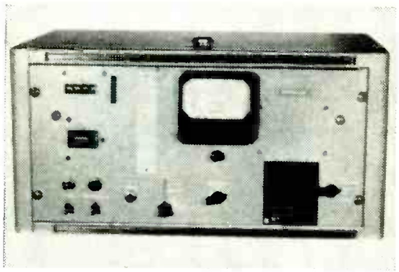
MULTITAPPED MODEL B HELIPOT AND 6-GANGED TAPPED MODEL F
This Model B Helipot contains 40 taps, placed as required at specified points on coil. The Six-Gang Model F Potentiometer contains 19 additional taps on the middle two sections. Such taps permit use of padding resistors to create desired non-linear potentiometer functions, with advantage of flexibility, in that curves can be altered as required.

THE Helipot CORPORATION, SOUTH PASADENA 2, CALIFORNIA

NEW PRODUCTS

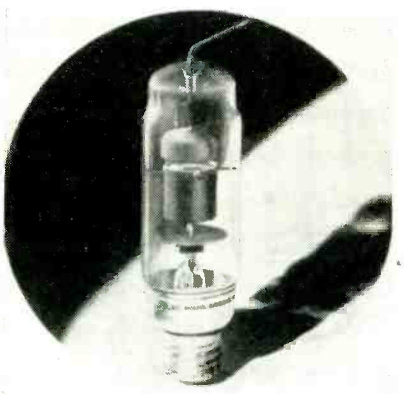
Edited by WILLIAM P. O'BRIEN

Nondefense Production Continues High Despite Materials Shortage . . . Audio Equipment Is Prominently Featured . . . Forty New Literature Items Are Covered



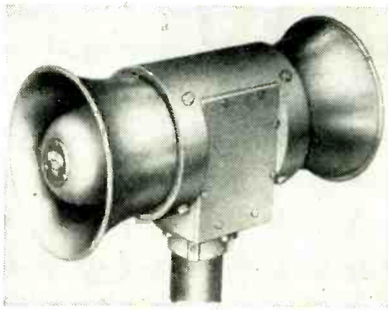
Scintillation Counter

R-C SCIENTIFIC INSTRUMENT CO., 335 Culver Blvd., Plaza Del Ray, Calif. Model CX14 Scintiscaler incorporates a scintillation counting chamber and is provided with inputs for use with external scintillation or G-M counters. It is intended to be used in the laboratory as a universal scaler for use in the detection of alpha, beta and gamma radiation. The instrument's stable, electronically regulated h-v supply is variable from 700 to 1,500 v. It has a scale of 64 and operates on a 115-v, 60-cps line, requiring 150 watts of power. Cost is $960.00.



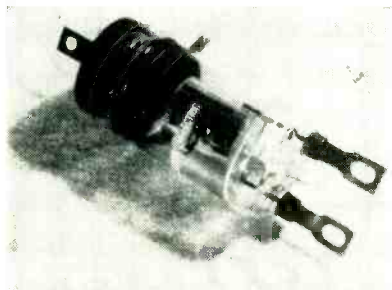
Mercury Rectifier

NATIONAL ELECTRONICS, INC., Geneva, Ill., has introduced a new quick-heating, 15-ampere rectifier tube for heavy-duty industrial applications. Designated as NL-643, it is mercury-vapor filled and has a peak inverse voltage rating of 700 volts. Filament voltage is 2.5 volts at 23 amperes; filament heating time, 120 seconds; and maximum peak current, 90 amperes.



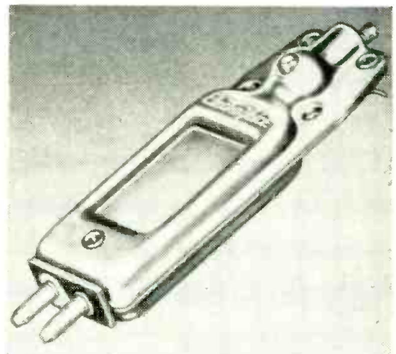
Dual Speaker

RACON ELECTRIC CO., INC., 52 E. 19th St., New York 3, N. Y. Model RR40 dual speaker designed for railroad and industrial sound systems consists of a heavy noncorrosive-center aluminum casting with a weatherproof steel-bell re-entrant speaker at each end of the opening. Magnet material is Alnico 5; dispersion angle per speaker, 45 deg; frequency range, 350 to 6,000 cycles; total operating capacity, 40 watts; peak capacity, 70 watts; impedance (speakers in parallel), 8 ohms; and sensitivity (4 ft, 1-watt input, 1,000 cycles), 108.5 db.



Gas Thyratron

GENERAL ELECTRIC CO., Syracuse, N. Y. Model GL-5855 three-electrode inert-gas-filled thyratron is designed mainly for general control-circuit applications. It has a quick-heating cathode that takes only a minute to reach operating temperature. A commutation factor rating of 200 makes it useful in motor control without the need for snubber circuits and without the occurrence of gas clean-up. Maximum ratings include: maximum peak anode voltage, 1,500 volts; maximum cathode current, peak 150 amperes, average, 12.5 amperes; maximum negative control-grid voltage, 250 volts before conduction and 10 volts during conduction.



Phono Cartridge

ELECTRO-VOICE, INC., Buchanan, Mich. Model 60 Econo-Cartridge has a tracking force of $\frac{3}{4}$ oz on 78 rpm and 8 grams on $33\frac{1}{3}$ and 45 rpm; and a frequency response to 6,000 cps. The unit weighs 7.3 grams, and measures 13/16 in. wide x 5/16 in. high x $2\frac{5}{8}$ in. long. Price is $5.50.

Predetermining Counters

STREETER-AMET CO., 4101 N. Ravenswood Ave., Chicago 13, Ill., has developed an electrical predetermined counter having wide application in industrial control problems. When the preset count has been

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2. Shock ratings similar to the "W" Military Ruggedized tube types **450 G**

3. Fatigue tested the same as Military Ruggedized tubes **2.5 G for 96 hrs.**

4. Long Life Reliability Rating **5000 hrs.**

5. Centrifuge acceleration ratings for any position **1000 G**

This chart gives you at a glance the characteristics of representative Raytheon Subminiature Tubes

Type No.	Remarks	Maximum Diameter Inches	Maximum Length Inches	Filament Or Heater Volts	Filament Or Heater Ma.	Mutual Conductance umhos	Power Output MW	Typical Operating Conditions Plate Volts	Plate Ma.	Screen Volts	Screen Ma.	Grid Volts
HEATER CATHODE TYPES												
CK5702/CK605CX	Characteristics of 6AK5	0.400	1.5	6.3	200	5000		120	7.5	120	2.5	Rk = 200
CK5703/CK608CX	Triode, UHF Oscillator, ¾ watts at 500 Mc	0.400	1.5	6.3	200	5000		120	9.0			Rk = 220
CK5704/CK606BX	Diode, equivalent to one-half 6AL5	0.315	1.5	6.3	150			150ac	9.0			
CK5744/CK619CX	Triode, High mu.	0.400	1.5	6.3	200	4000		250	4.0			Rk = 500
CK5784	Characteristics of 6AS6	0.400	1.5	6.3	200	3200		120	5.2	120	3.5	-2.0
CK5829	Similar to 6AL5	0.300x0.400	1.5	6.3	150			117ac	5.0 per section			
CK5995	Half Wave Rectifier	0.400	1.75	6.3	300				45	inverse peak 850 volts		
FILAMENT TYPES												
1AD4	Shielded RF Pentode	0.300x0.400	1.5	1.25	100	2000		45.0	2.8	45.0	0.8	Rg = 2meg
CK571AX	10 ma. filament Electrometer Tube, Ig = 2x10⁻¹³ amps. max.	0.285x0.400	1.5	1.25	10	1.6†		10.5	0.20	Triode Conn.		-3.0
CK573AX	Triode, High-Freq. Osc.	0.300x0.400	1.5	1.25	200	2000		90.0	11.0			-4.0
CK574AX	Shielded Pentode RF Amplifier	0.290x0.390	1.25	0.625	20	160		22.5	0.125	22.5	0.04	-0.625
CK5672	Output Pentode	0.285x0.385	1.5	1.25	50	650	65.0	67.5	3.25	67.5	1.1	-6.5
CK5676/CK556AX	Triode, UHF Oscillator	0.300x0.400	1.5	1.25	120	1600		135.0	4.0			-5.0
CK5677/CK568AX	Triode, UHF Oscillator	0.300x0.400	1.5	1.25	60	650		135.0	1.9			-6.0
CK5678/CK569AX	Shielded RF Pentode	0.300x0.400	1.515	1.25	50	1100		67.5	1.8	67.5	0.48	0
CK5697/CK570AX	Electrometer Triode Max. grid current 5x10⁻¹³ amps.	0.285x0.400	1.25	0.625	20	1.5†		12.0	0.22			-3.0
CK5785	High voltage rectifier	0.300x0.400	1.5	1.25	15				0.1	Inverse peak 3500 volts		
VOLTAGE REGULATORS												
CK5783	Voltage reference tube — like 5651	0.400	1.625	Operating voltage 87. Operating current range 1.5 to 3.5 ma.								
CK5787	Voltage regulator	0.400	2.06	Operating voltage 100. Operating current range 5 to 25 ma.								

CK ® RK ®

†Voltage Gain Ratio.

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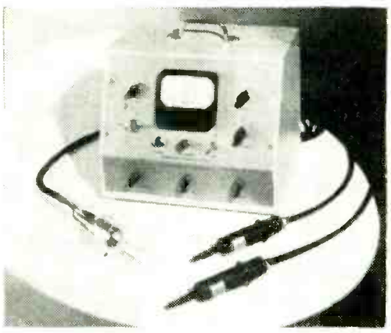
RAYTHEON MANUFACTURING COMPANY

SPECIAL TUBE SECTION • Newton 58, Massachusetts

SUBMINIATURE TUBES • SPECIAL PURPOSE TUBES • MICROWAVE TUBES • CATHODE RAY TUBES • RECEIVING TUBES reached a circuit is put into operation which may be used to actuate various other electrical equipment. The counter may be operated when a set of external normally-open contacts are closed. Thus it may be used with photoelectric cells, limit switches and like equipment. It can count accurately at a rate of 1,000 counts per minute, and this rate may be extended by use of a decade scaler unit. An automatic reset to zero is provided in preparation for the next counting operation.

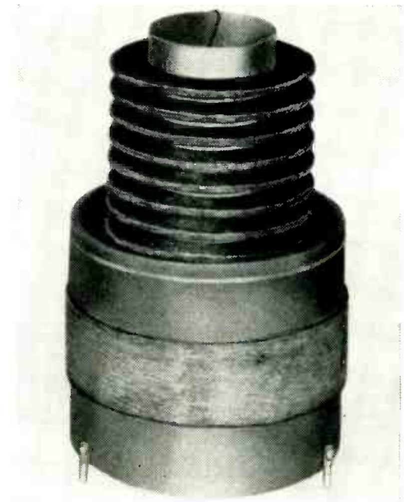
D-C Power Supplies

OPAD-GREEN CO., 71 Warren St., New York 7, N. Y. has introduced a new series of general purpose, low-voltage d-c power supplies featuring continuously variable outputs and carrying continuous duty ratings of 10 amperes. They are available in ranges of 0 to 8 v, 0 to 12 v and 0 to 28 v d-c. The a-c input requirements are 115 v, 60 cycles single phase. The d-c voltage and current may be read directly on two 3-in. meters. The ammeter is calibrated in steps of 200 ma and has a full scale value of 10 amperes. Descriptive bulletin GPA1 is available on request.



High-Vacuum Gage

NATIONAL RESEARCH CORP., 70 Memorial Drive, Cambridge, Mass. Type 710 thermocouple and emission-regulated ion gage control is designed to fill all the needs of the laboratory or plant high-vacuum installation. Pressure range covered is 1 mm Hg absolute to 1×10^{-8} mm Hg absolute. A specially designed low-leakage shielded connecting cable eliminates errors at pressures below 10^{-6} mm where the ionization currents are less than 10^{-7} amperes. Filament emission is regulated at 1, 5 or 10 ma at the operator's choice.

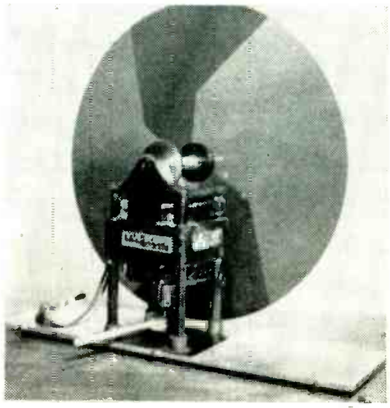


R-F Step-Up Coil

SPELLMAN TELEVISION CORP., 3029 Webster Ave., Bronx 67, N. Y. By using the h-v r-f step-up type coils illustrated in a special circuit, voltages as high as 90 kv can be obtained. Rated at 35 kv, the coils find application in tv circuits, electrostatic paint spraying, insulation testing, spectroscopic analysis, nuclear fission, and so on. The primary is separate from the secondary winding, which is 7 in. high and consists of 10 pie windings 3 in. in diameter. The primary is 4 in. high and 4½ in. in diameter. Secondary voltage output is 35 kv, secondary current is 5 ma and the approximate frequency is 70 kc.

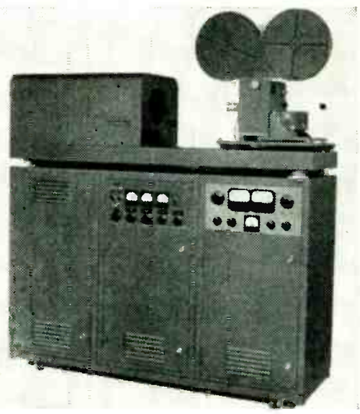
Half-Wave Rectifier Tube

GENERAL ELECTRIC CO., Syracuse, N. Y. Type 1X2A half-wave rectifier tube, designed for tv receivers, is suitable for use in both radio-frequency and flyback types of power supplies. Maximum ratings and characteristics include: peak inverse plate voltage, 20 kv; peak plate current, 11 ma.



TV Converter Kit

CELOMAT CORP., 521 W. 23rd St., New York, N. Y., has developed a color tv converter kit to receive CBS color television. The Vue-Scope uses a color disk of Fibestos cellulose acetate plastic sheeting made up of three primary colors—red, blue and green. The kit includes a manual synchronization unit, a fractional horse-power motor and assembly brackets. It will produce about a six-in. picture and retail under $15.00.

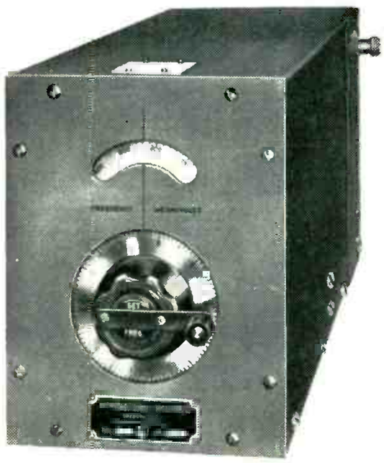


Video Recorder

GENERAL PRECISION LABORATORY, INC., Pleasantville, N. Y., has developed a video recorder with electronic control that will record tv programs with picture quality equal to the original live telecast. The electronic design eliminates double exposures, under exposures, film fuzziness, garbled sound and vibration. A counter setup to monitor

(Continued on p 244)

SOMETHING NEW has been ADDED



FREQUENCY METERS

NEW precision coaxial frequency meters cover frequencies from 550 to 3950 megacycles per second with stability and accuracy previously available only in high frequency waveguide units.

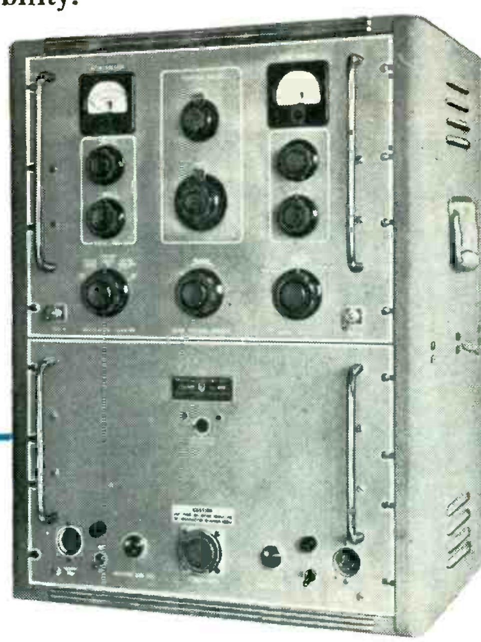
—extending the coverage of PRD Test Equipment to new limits

POWER SUPPLIES

NEW low voltage range in the Type 801-A Universal Klystron Power Supply permits the use of 300 volt oscillator tubes with convenience and stability.

ATTENUATORS

NEW fixed coaxial pads now provide coverage over the entire spectrum from 10,000 megacycles per second right down to DC in three ranges. Other designs include units rated up to 5 watts of average input power.



See these instruments and others on display at the 1951 IRE SHOW — BOOTHS 268 & 269
For full specifications write for a copy of the new PRD catalog to Dept. E-11 today.

Polytechnic RESEARCH & DEVELOPMENT COMPANY, Inc.

202 TILLARY ST., BROOKLYN 1, NEW YORK

NEWS OF THE INDUSTRY

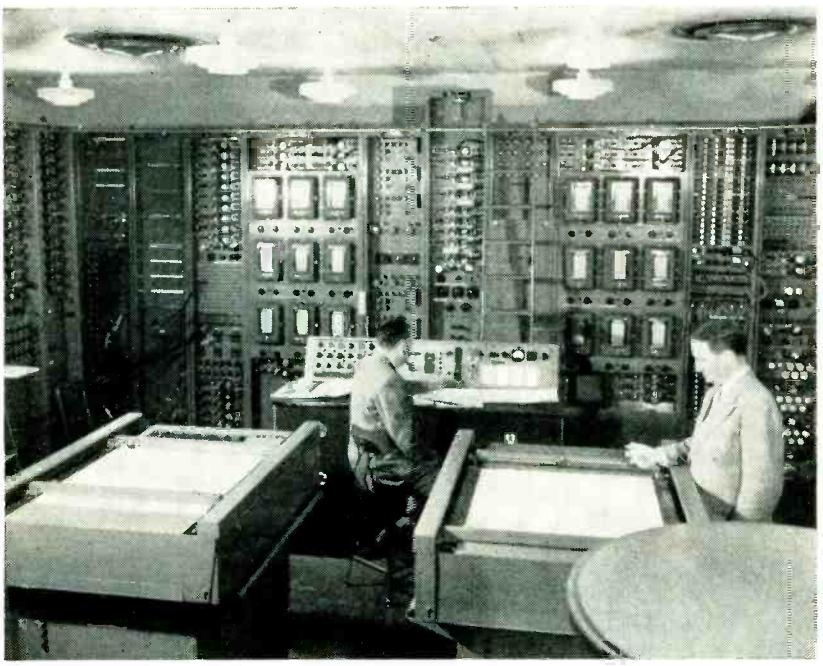
Edited by WILLIAM P. O'BRIEN

New Computer Aids Air Defense

PROJECT TYPHOON, a new electronic analog computer for evaluating the performance of guided missiles, ships, planes and submarines and aiding in the air protection of American cities, was recently shown in operation at a joint Navy Special Devices Center—RCA demonstration in Princeton, N. J. The calculator, which employs 4,000 electron tubes, several miles of intricate wiring and components that are exact to better than one part in 25,000, can solve in one minute problems that would require two mathematicians six months.

The apparatus obviates the need of building costly models and testing them in flight. A staff of nine engineers and mathematicians as well as six technical assistants are required to operate the unit while it solves complex problems. By setting dials and switch-board plugs scientists can represent the physical features of a projectile in the form of mathematical equations. That section of the machine becomes a mathematical picture of the missile. Then the missile, flying 1,600 mph, is given a problem such as intercepting an 800-mph high-flying bomber which has been tagged by a radar beam. Just such a problem was solved at the recent demonstration.

Under contract with the Special Devices Center of the Office of Naval Research, engineers of RCA Laboratories designed and built the instrument for use by the Navy Bureau of Aeronautics. To keep it free of climatic influences, Typhoon is housed in a special air-conditioned room at RCA Laboratories which has a constant temperature of 75F and a relative humidity of not more than 50 percent.



A. W. Vance of RCA Laboratories operates the Typhoon computer from the control console while R. S. Holmes checks the missile and target projectory on one of the plotting boards. Shown in the background are some of the panels containing thousands of electron tubes and miles of intricate wiring

SMPTE Establishes New Award

ESTABLISHMENT of the David Sarnoff Gold Medal as an annual award for an outstanding contribution to television engineering was announced recently by Earl I. Sponable, president of the Society of Motion Picture and Television Engineers. The award was proposed by Frank M. Folsom, president, on behalf of the Radio Corporation of America, and named for General Sarnoff, chairman of the board of directors of RCA.

The medal will be presented at the society's fall meeting each year to that individual selected by a special award committee who has done outstanding work in some technical phase of the field of television engineering, whether in research, development, design, manufacture or operation, or in any similar phase of theater television.

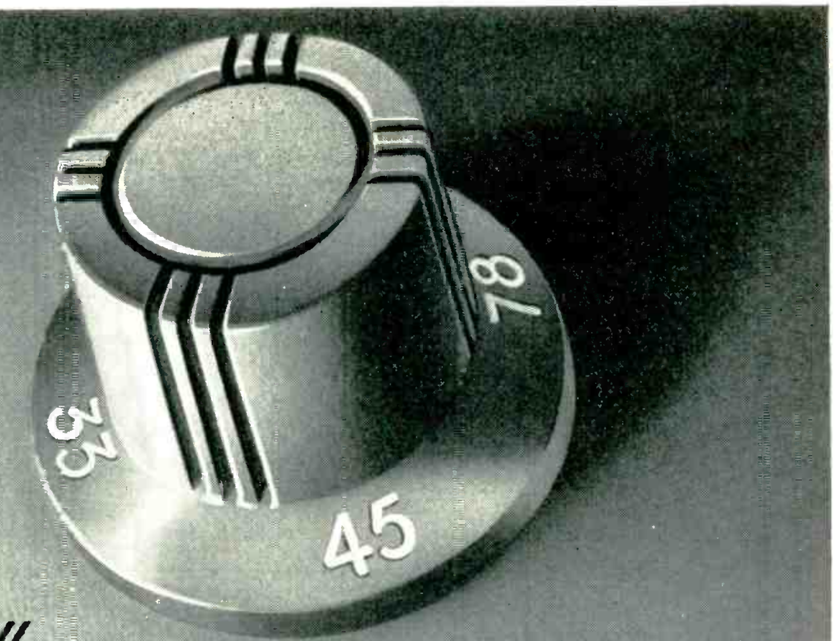
In addition to the gold medal, the award will include a bronze replica and a citation describing the recipient's qualifications. The recipient will be selected by a special committee to be appointed each year by the president of the SMPTE, consisting of a chairman and four members who are fellows or honorary members of the society or previous recipients of some formal society award, and each of whom is qualified to judge the importance or value of current work in some technical phase of television.

In the selection of candidates for the award, it is stipulated in the terms under which it is to be administered, contributions which have led to greater fidelity in reproduction of an original scene, or to simplification of the processes involved, shall be important considerations. The purpose of the award, it is stated in these terms of administration, is to recognize recent technical contributions to the art of television, and to encourage the development of new techniques, new methods, and new equipment which hold promise for the continued improvement of television.

IRE's 1951 Convention

THE INSTITUTE of Radio Engineers is holding its 1951 National Convention on March 19-22 in New York City. Its theme will be "Advance with Electronics in the National Emergency."

Headquarters for the convention will be a new location, the Wal-



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3 speed phonomotors

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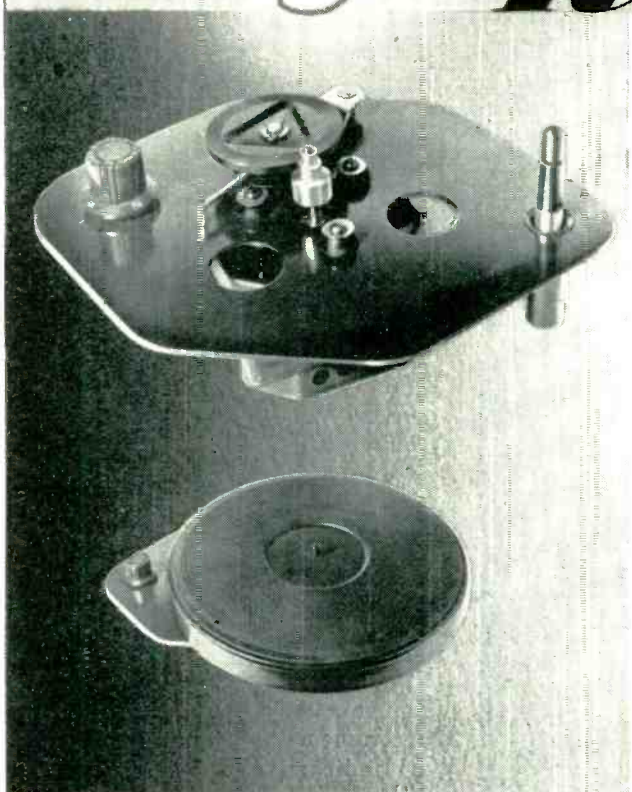

- Speed change is simple, foolproof and reliable.
- No rubber belts to stretch or perish.
- Smooth constant speed. 'Wow' negligible (under 0.2%)
- Incorporates the well-known B.S.R. 4 pole motor.
- Heavy 10" turntable fitted on precision ground taper steel spindle.
- Turntable fitted with special removable rubber mat—pioneered by us to meet the exacting "hygiene" demanded by the L.P. records.

Transcription quality at competitive prices.

Illustrated is the popular MU14 3 speed unit. Other 3 speed models are available complete with pickup and automatic stop.
Advanced design and a modern well equipped factory enable us to offer good delivery at moderate prices.

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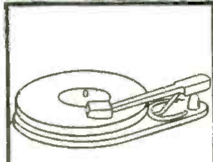
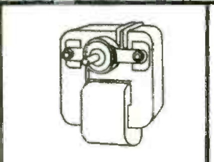
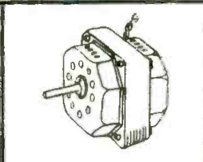


Three speed gramophone units complete with pickup and auto-stop.



Heavy duty two pole, shaded pole induction motors for every application.



Precision engineered well balanced 4 pole shaded pole induction motors.

BIRMINGHAM SOUND REPRODUCERS LTD.
CLAREMONT WORKS. OLD HILL, STAFFS. ENGLAND. GRAMS: 'ELECTRONIC, OLD HILL, CRADLEY HEATH'

dorf-Astoria Hotel. The Radio Engineering Show will, as in prior years, occupy the Grand Central Palace, two blocks south of the Waldorf on Lexington Ave. Technical sessions will be held in both locations.

A speaker of national prominence will address the banquet on Wednesday, March 21. The luncheon on Tuesday, March 20, and the cocktail party on Monday evening will both be held in the Starlight Roof of the Waldorf.

MEETINGS

MARCH 5-9: ASTM Spring Meeting and Committee Week, Cincinnati, Ohio.

MAR. 19-22: IRE Annual Convention, Hotel Waldorf Astoria and Grand Central Palace, New York City.

APR. 20-21: Southwestern IRE Conference, Southern Methodist University, Dallas, Texas.

APR. 30- MAY 4: SMPTE Spring Convention, Hotel Statler, N Y

MAY 23-24: Fifth National Convention, American Society for Quality Control, Hotel Cleveland, Cleveland, Ohio.

JUNE 18-22: ASTM Annual Meeting, Atlantic City, New Jersey.

JUNE 25-29: AIEE Summer General Meeting, Royal York Hotel, Toronto, Ontario, Canada.

AUG. 28-SEPT. 8: Eighteenth British National Radio Show, Earls Court, London, England.

AUG. 29-31: Seventh Annual Pacific Electronic Exhibit and West Coast Annual IRE Convention, San Francisco Civic Auditorium, San Francisco, Calif.

TV Engineers Attend Antenna Symposium

MORE than twenty-five broadcasting engineers and television consultants recently attended a symposium dealing with practical considerations in the use of superturnstile and supergain antennas conducted at the RCA Victor plant in Camden, N. J.

The engineers later made an inspection of the plant to view work in progress on the multiple antenna for the Empire State Building in New York City. The symposium was led by Herman E. Gihring, manager of the broadcast antenna design section of the RCA Engineering Products Department.

Those present at the symposium were: Edward Talbott of KROD, El Paso; J. M. DeBell, Jr., of DuMont Laboratories, Passaic, N. J.; Ray Craig of WCAU, Philadelphia; John G. Preston of American Broadcasting Co., New York; J. E. Mathiot of WGAL, Lancaster, Pa.; Henry L. Dubrowski of WATV, Newark; A. M. Hopwood of WPTZ, Philadelphia; James W. Kyle of WTVR, Richmond; T. W. Howard of WPIX, New York; Henry E. Rhea of WFIL, Philadelphia; P. B. Laeser of WTMJ-TV, Milwaukee; Ralph N. Harmon of WRC, Washington; Charles H. Singer of WOR-TV, New York; N. F. Smith of WOR-TV, New York; George E. Hagerty of Westinghouse, Washington; Louis H. Stantz of WNBF, Binghamton; Benjamin Wolfe of WAAM-TV, Baltimore; Carl J. Nopper of WMAR-TV, Baltimore; E. J. Love of WWJ, Detroit; Albert Preisman of Preisman and Biser, Washington; A. Josephsen of RCA, New York; Glenn D. Gillett of Gillett and Associates, Washington; Oscar Reed, Jr. of Jansky & Bailey, Washington; Millard M. Garrison of Chambers and Garrison, Washington; George C. Davis, consultant, Washington; George P. Adair, consultant, Washington; Robert E. Baluta of McIntosh & Ingles, Washington; Julius A. Renhard of RCA, Washington; and William L. Foss, consultant, Washington.

Among the television engineers and consultants attending a symposium dealing with antenna poblems at the RCA Little Theatre in Camden recently were (left to right): Edward Talbott, KROD, El Paso; James W. Kyle, WTVR, Richmond; Phillip B. Laeser, WTMJ-TV, Milwaukee; Al Josephsen, RCA broadcasting field sales representative, New York; Glenn D. Gillett, Gillett and Associates, consultants, Washington; and Henry L. Dubrowski, WATV, Newark

Radioactivity Monitor Specifications Released

THE Federal Civil Defense Admintration has released specifications for two basic types of monitoring instruments to determine the extent of radioactive contamination following an atomic attack. These specifications have been sent to all state governments, civil defense directors, and manufacturers in the instrument field.

Manufacturers are being urged to put special effort toward developing a high-intensity instrument based on the published specifications. Such an instrument, measuring up to five hundred roentgens per hour, would be needed in area

(Continued on p 280)

THESE LIFE LINES OF AMERICA...

use long life dependable Sylvania Tubes

Progressive railroads everywhere are now using Sylvania radio tubes for multiple communications systems.

In engine-caboose-signal-tower networks, where clear tone and unfailing dependability are of utmost importance, Sylvania tubes are winning increased acceptance. These tubes are designed, built and tested to take more than their share of vibration and rough treatment.

Also, their clarity and freedom from internal noises make them ideal for critical transportation applications . . . in trains, buses, police cars, taxi cabs.

The Sylvania quality tube line is a complete line. Made in miniature and standard sizes. Also low-drain battery tubes for efficient, compact portable sets.

Get new listings

Call your distributor for new listings and full information. If he cannot serve all your needs immediately, please be patient. Remember, the tube situation is still tight and your distributor is doing his best to deal fairly with all his customers. For further information address: Sylvania Electric Products Inc., Dept. R-1102, Emporium, Pa. *Sylvania representatives are located in all foreign countries. Names on request.*

SYLVANIA ELECTRIC

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

NEW BOOKS

Antennas

By John D. Kraus. *McGraw-Hill Book Co., Inc., New York,* 1950, 553 *pages,* $8.00.

Any review of this book would be incomplete without a word of warning to the prospective buyer that it will be of little value unless he is able to juggle integral calculus and to interpret and understand theoretical analyses.

The book is intended for use as a text and reference for senior or graduate courses in antenna theory. As such, it serves admirably, in that it is in line with texts now used in parallel courses in other phases of the science of communications. The practical aspects of antenna engineering have, however, been overshadowed by the more theoretical ones.

The material presented is based on a series of lectures given by the author at Ohio State. It reflects his vast knowledge of the subject and his experience at teaching. There is probably no more complete book on the various types of very-high and ultrahigh-frequency antennas now in print.

The antenna is first treated as a point source and then as an aperture, after which the text methodically presents in turn thin linear antennas, loops, helical antennas, biconicals, cylindricals, reflector types, slot and horn antennas and all the special versions and combinations that are in use today. A special section is devoted to antenna measurements, and a generous appendix provides a wealth of reference information in exceptionally convenient form. Abundant references are given for further study on specific subjects.—J.D.F.

RELEASED THIS MONTH

Applied Nuclear Physics; E. Pollard and W. L. Davidson; Wiley; $5.00.

Electronic Fundamentals and Applications; J. D. Ryder; Prentice-Hall; $9.00.

Propagation of Short Radio Waves; Vol. 13 of Radiation Lab Series; Donald E. Kerr; $10.00.

Waveguide Handbook; Vol. 10 of Radiation Lab Series; M. Marcuvitz; $7.50.

Traveling Wave Tubes

By J. R. Pierce. *Bell Laboratories Series. D. Van Nostrand, Inc., New York,* 1950, 260 *pages,* $4.50.

More and more communication engineers are desirous of understanding the principles of operation of one of the latest members of the family of microwave tubes—the traveling-wave tube. This is due to the fact that with the expansion of the frequency spectrum the question of bandwidth has become of great importance and the tube's outstanding feature is its enormous bandwidth.

Until the appearance of Pierce's book any information about traveling-wave tubes had to be gained by reading scattered articles. The author's clearly organized and well digested treatise on the subject has largely dispensed with this task. The author is well-known for his many contributions to the theory of these tubes as well as to other fields of electronics, and his presentation

(Continued on p 140)

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

More References

Dear Sirs:

As is borne out on page 275 of the November 1950 issue and otherwise, Electronics is always anxious to give the reader as many and as good references as possible.

I refer to the excellent paper by Cunningham, May and Skalnik, "Integration Noise Reducer for Radar", published in the September 1950 issue of Electronics. In this paper, my research work since 1945 in the signal integration field is referred to via the Government Report E5038. Actually, I never issued report E5038, since it contains a number of technical and printing errors, but instead, in 1948, gave a lecture in the National Electronics Conference in Chicago, entitled "Extraction of Weak Signals from Noise by Integration", which was published later in the *Proceedings of the NEC,* Vol. 4, 1948. This paper also bears the names of Dr. Dickey and Dr. Emslie, who contributed much to the final results. Since my *NEC* paper is technically correct, properly issued, and generally available, it should as a reference take the place of the erroneous report E5038.

Still further technical information may be derived from the fact that I conceived of the integration method as described in reference (3) of the Cunningham-May-Skalnik paper when doing research work for USAF in 1946, and submitted a patent application via USAF, Wright Field, which describes my early integration system, applied to a radar receiver. Later this system, in less elegant form than the one described in Electronics, yielded an improvement in signal-to-noise ratio of 24 decibels, and I, therefore, took steps to bring the invention into the experienced hands of Professor Cunningham of Yale University, who later carried

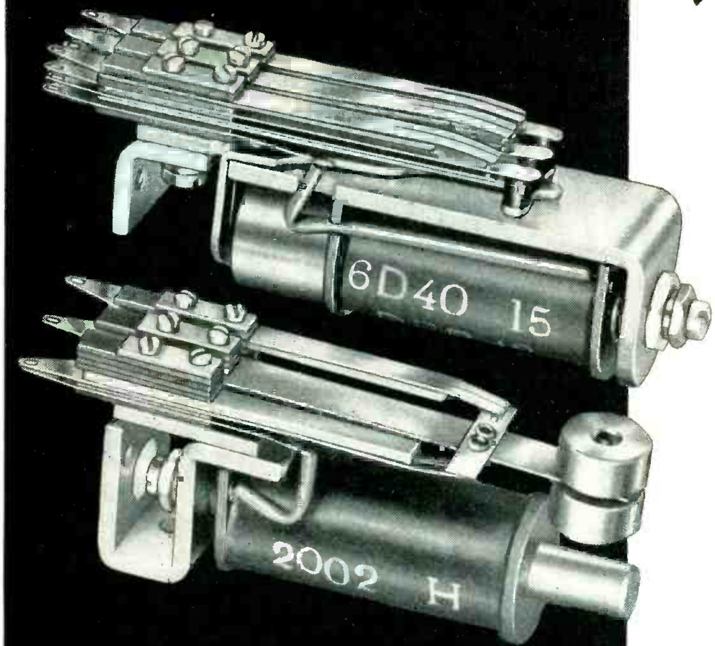
(Continued on p 292)

NORTH'S

"Wigglestick"

IS A VERSATILE

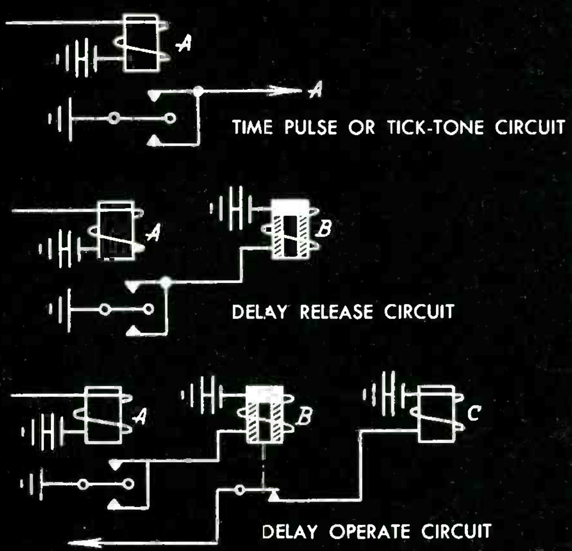
RELAY



The odd little relay at left with the protruding schnozzle was nicknamed "Wigglestick" by an engineer in one of his lighter moments. Its usefulness to designers of electrical circuits is not to be regarded lightly, however.

Used alone, this vibrating reed relay in a self-interrupting circuit will generate time pulses. Hooked up with a slow-release relay, like the one shown above it, the pair may be used in special delayed circuits, adjustable to any value from one to eight seconds. Other combinations provide a still wider range of application.

These stock relays are typical of a wide variety made by North, one of the oldest manufacturers of relays and switching equipment in the country. The choice ranges from midgets to multiples, from single-makes to pile-ups controlling up to thirty-two circuits with one double-wire control circuit.



NORTH RELAYS

Set a high standard of performance and permanence because this company specializes in all-relay switching equipment. North relay engineering service is second to none.

SPECIAL RELAYS? Let North Engineer Them For You

THE NORTH ELECTRIC MANUFACTURING CO., Galion, Ohio, U. S. A.

Originators of ALL RELAY *Systems of Automatic Switching*

FOR PROMPT REPLY
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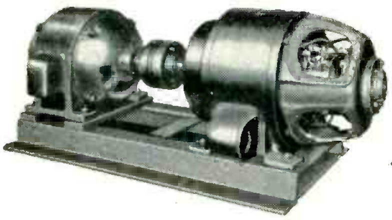
ELECTRONICS

Designers

AMPLIDYNES— 500 to 25,000 WATTS

▲ 1-kw Amplidyne motor-generator set.

▼ 5-kw Amplidyne generator



◀ 3-kw Amplidyne motor-generator set

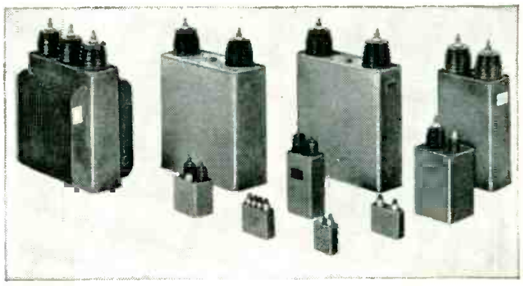
PRECISE CONTROL OF position · torque · speed tension · power factor · voltage · current

The General Electric amplidyne is a simple d-c generator which, through the arrangement of field and armature circuits, possesses extremely high speed of response and amplification.

First used in radar and fire-control apparatus, it now has many new jobs. That's why G-E amplidyne generators and motor-generator sets are made in a wide variety of sizes and frames with output ratings from 500 watts to 25 kilowatts.

What are your requirements? For further data, write, giving complete details, to *Electrical Industries Sec., Resale Industries Div., Apparatus Dept., General Electric Co., Schenectady 5, N. Y.*

A G-E 25-KW AMPLIDYNE AMPLIFIES A 9/10 WATT INPUT 22,200 TIMES



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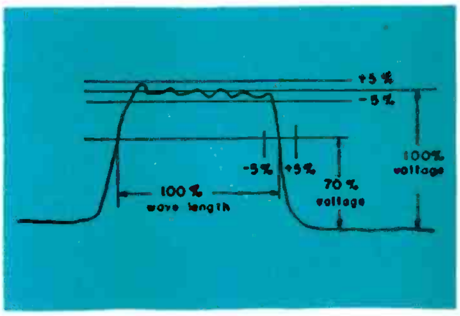
Specially designed General Electric Type-E networks will generate pulses within ±5 per cent of any length you require from 0.1 to 40 microseconds. These networks consist of capacitor and coil sections adjusted to close tolerances and hermetically sealed in single metal containers. In the last war G-E Type-E networks were produced on a large scale to meet radar demands. Now they are available for commercial or military use in a wide variety of designs, impedances, ratings, and sizes. See Bulletin GEA-4996.



Typical design and operational limits of G E Type-E pulse-forming network: Ripple at top of pulse ±5%; Wave length ±5% measured at 70% amplitude; Capacitance tolerance ±10%

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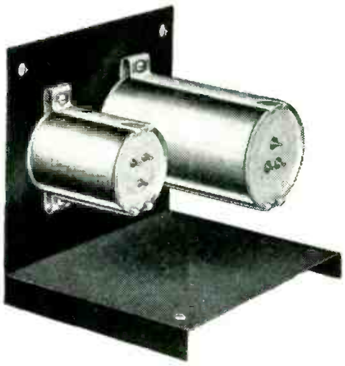
TIMELY HIGHLIGHTS ON G-E COMPONENTS



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G-E hermetically sealed, oil-immersed selenium rectifier stacks make it possible for you to design metallic rectifiers into equipment that will be subjected to corrosive fumes, salt air, dust, fungus, or other atmospheric conditions. Because they're immersed in oil, these stacks will stand higher current drains than equivalent-size "open" units. Available in single- or full-wave circuits. Ratings: from 12 to 180 d-c volts output, 15.5 to 270 a-c volts input, .25 to 27.0 d-c amps. Write for complete data on ratings and dimensions to *Electrical Industries Section, Resale Industries Division, Apparatus Dept., General Electric Co., Schenectady 5, N. Y.*

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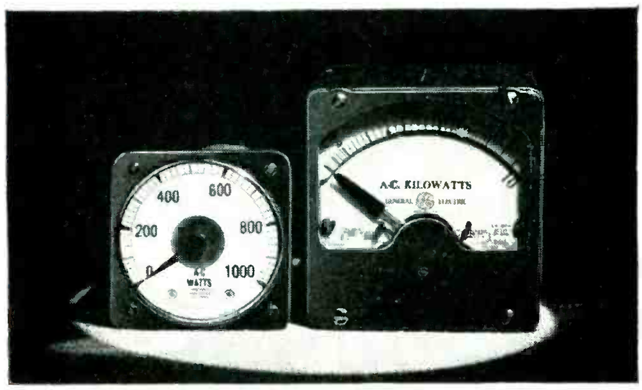

Here is a new switchboard instrument that can be read easily—anytime. Its dial can be clearly illuminated from almost any angle because it is set forward flush with the front of the case. A protruding anti-glare convex-type glass front prevents reflections. The new meter is available in 4¼- or 8¾-inch models, both with long 250-degree scales. D-c ammeters, volt-ammeters; a-c ammeters, voltmeters, wattmeters, frequency and power-factor meters, temperature indicators, and synchroscopes. Send for Bulletin GEC-218.

General Electric Company, Section B667-10
Apparatus Department, Schenectady 5, N. Y.

Please send me the following bulletins:

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

- ☐ GEA-3469 Push-button stations
- ☐ GEA-4996 Pulse-forming networks
- ☐ GEC-218 Switchboard instruments

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reveals this intimate relationship with the subject.

Traveling-wave tubes consist of a circuit which is capable of supporting electromagnetic waves whose phase velocity is much lower than that of light. The book contains several chapters on the theory of these waveguiding structures such as helices, linear arrays of coupled resonant slots and cavity or filter-type circuits. Wherever possible field solutions are given, while in other cases the circuits are treated by considering the behavior of lumped-circuit analogies.

The term impedance, which requires special definition for the case of hybrid waves, is well explained and thus much misunderstanding should now be cleared up.

Small-Signal Theory Used

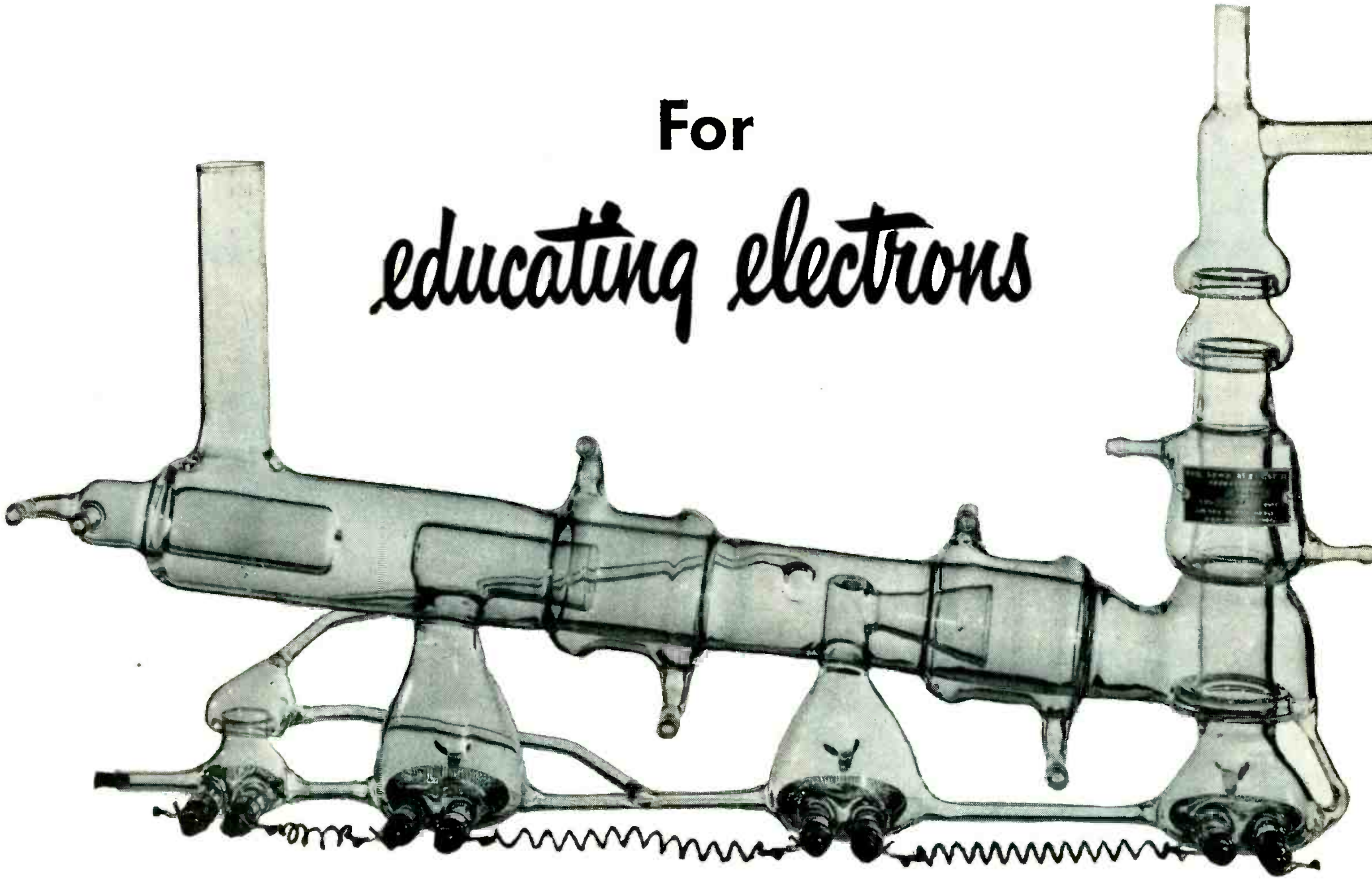
Interacting with the slow wave are the electrons which travel in beam formation along the axis of propagation. This interaction is of the nature of an energy exchange between the beam and the electromagnetic field all along the axis. Because of it such quantities as current, space charge and velocity may be described by d-c terms superimposed by a-c terms which are of wave nature. In describing the process of interaction, small-signal theory is used throughout the book with the exception of one short chapter on power output where reference is made to some results of Nordsieck's large-signal computations.

When the electrons travel with a d-c velocity equal or nearly equal to the phase velocity of electromagnetic waves which the guide is capable of supporting, waves with increasing amplitude appear and the whole structure may function as an amplifier. An extensive theory on the gain of the tube is presented. The influence of various factors such as the velocity of the electrons, the d-c beam current, the attenuation of the guide and space-charge properties of the beam are investigated. The design engineer will find there a method for the computation of the gain for a helix-type traveling-wave tube.

The question of relative merit of various possible traveling-wave tube

For

educating electrons



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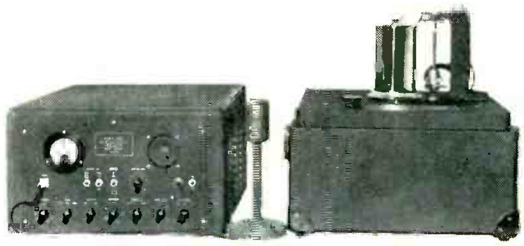

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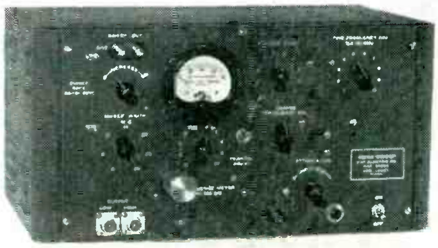

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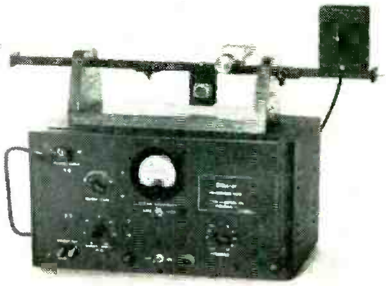

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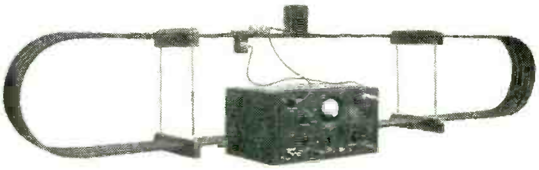

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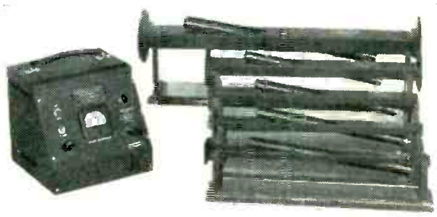

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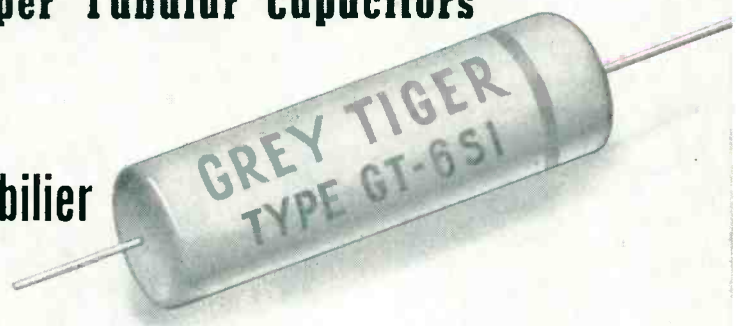

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For further details on the "Grey Tiger" line of paper tubulars, write for Bulletin No. NB116. CORNELL-DUBILIER ELECTRIC CORPORATION, Dept. K-21 South Plainfield, New Jersey. Other plants in New Bedford, Brookline and Worcester, Mass.; Providence, R. I., Indianapolis, Ind., and subsidiary, The Radiart Corp., Cleveland, Ohio.

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circuits is taken up. As may be expected, the amplifier will have wideband properties if the phase velocity of the circuit waves does not vary much with frequency.

One of the important properties of an amplifier is its noise characteristic. The book outlines an approximate method of approach to a noise theory for the traveling-wave tube. The subject discussed here, however, is still controversial in nature, a fact which does not stand out too clearly in the author's discourse.

Two close relatives of the traveling-wave tube are also dealt with. One of these is the double-stream amplifier, also known as the electron-wave tube, which does not employ a circuit but produces amplification by the interaction between two electron streams traveling at different speeds. The other one is the magnetron amplifier, which is of interest chiefly because of its higher efficiency compared with traveling-wave tubes.

This reviewer can highly recommend the book to anyone interested in communication engineering and microwave electronics.—RUDOLF G. E. HUTTER, *Head of Electronics Section, Physics Laboratories, Sylvania Electric Products Inc.*

Receiving Tube Substitution Guide Book

BY H. A. MIDDLETON. *John F. Rider Publisher, Inc., New York,* 1950, 224 *pages, paper-covered,* $2.40.

EQUALLY valuable for designers and servicemen in periods of tube shortages is this compilation of permissible substitutions for approximately 750 different receiving tube types, with detailed diagrams to simplify the changing of sockets or construction of adapters where necessary. Each substitution is rated E, G or P according to the performance of the substitute tube in the circuit of the original tube. Where changes in filament or heater wiring are required, they are described, along with any other electrode voltage changes required. As a rule, however, the author presents only practical substitutions that do not demand redesigning of circuits.

The author uses the rating E to

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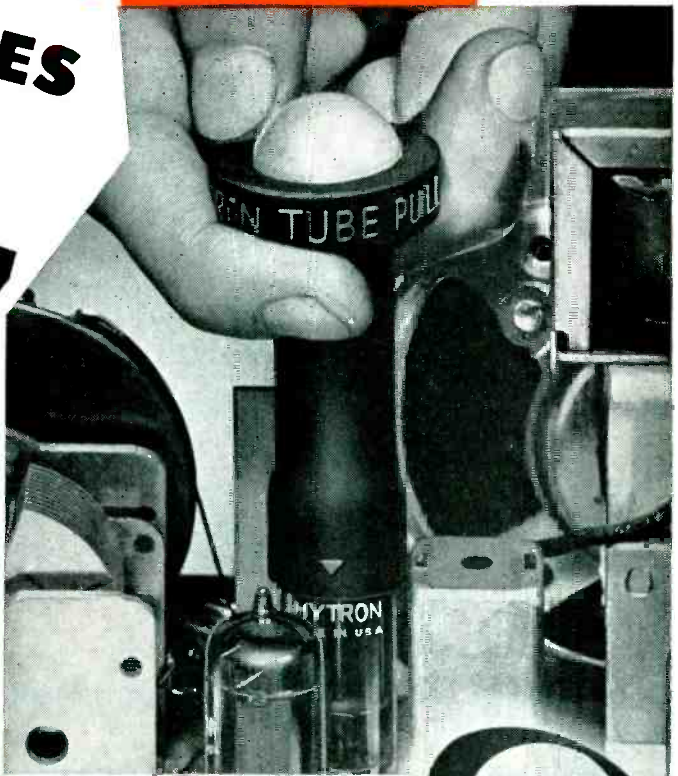

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It's Easy! **TO PULL:** Push Tube Puller onto top of 7-pin miniature. Just enough for firm grip, and without depressing release button at top. Pull straight up and out; no need to bend pins by violent rocking. Hold tube securely in one hand. With other, push release button quickly. Compressed air pops out tube. Or, holding down release button, remove Tube Puller by rocking it. To insert: Align arrow on skirt of Tube Puller with keyway of tube. Push tube into Tube Puller. Using arrow as guide, insert tube. Push button quickly to release. Maintain pulling action at peak. Wipe inside of Puller occasionally with clean cloth to remove dirt and grease.

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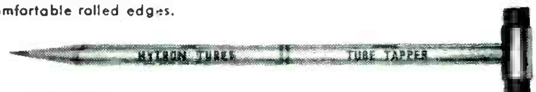

TUBE TAPPER — 5¢ net. Handy combination pencil, eraser and tube tapper. Discovers microphonism, shorts, and opens in tubes, etc. Compact, non-metallic, rugged. Doubles in brass for writing orders, etc.

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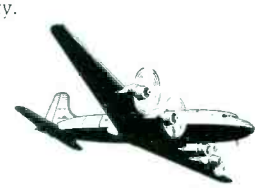

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signify an excellent electrical equivalent that may either be directly interchangeable or merely require basing changes and/or filament or heater voltage changes. The G rating calls for examination of the electrical characteristics of both tubes and evaluation thereof in connection with the circuit being used, as there is a strong likelihood that circuit requirements are not completely met by the substitute tube. For convenient reference, a table of receiving tube characteristics is included in the book. Although a G substitute may give some deterioration in performance, it can definitely be used where necessary to continue operation of a device. Substitutions bearing a P (poor) rating are to be used only as a last resort where performance of sorts is better than nothing at all in an emergency.

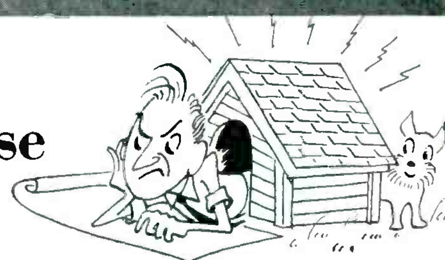
Other features of this book include an excellent theoretical section discussing one by one the problems of making substitutions of tubes and other components in oscillator systems, r-f and i-f amplifiers, audio amplifiers, signal rectifiers, power rectifiers, wideband amplifiers and other circuits. A separate table lists identical tubes with unlike heater voltage and current ratings. An entire section covers television receiver filament circuit arrangements, with diagrams giving the basic circuits employed in parallel, series and series-parallel filament systems. An accompanying tabulation that includes most television receiver models tells which type of circuit is used in each, for convenience in making substitutions involving filament circuit changes. All in all, this manual is a must for anyone anticipating trouble in getting a needed tube for radio, television or electronic equipment.—J. M.

Ionization Chambers and Counters

BY D. H. WILKINSON. *Cambridge University Press, New York,* 1950, 265 *pages,* $4.50.

THIS book treats the three classical particle counters, namely, the ionization chamber, the proportional counter and the Geiger counter. In

Get out of the Magnetic Doghouse



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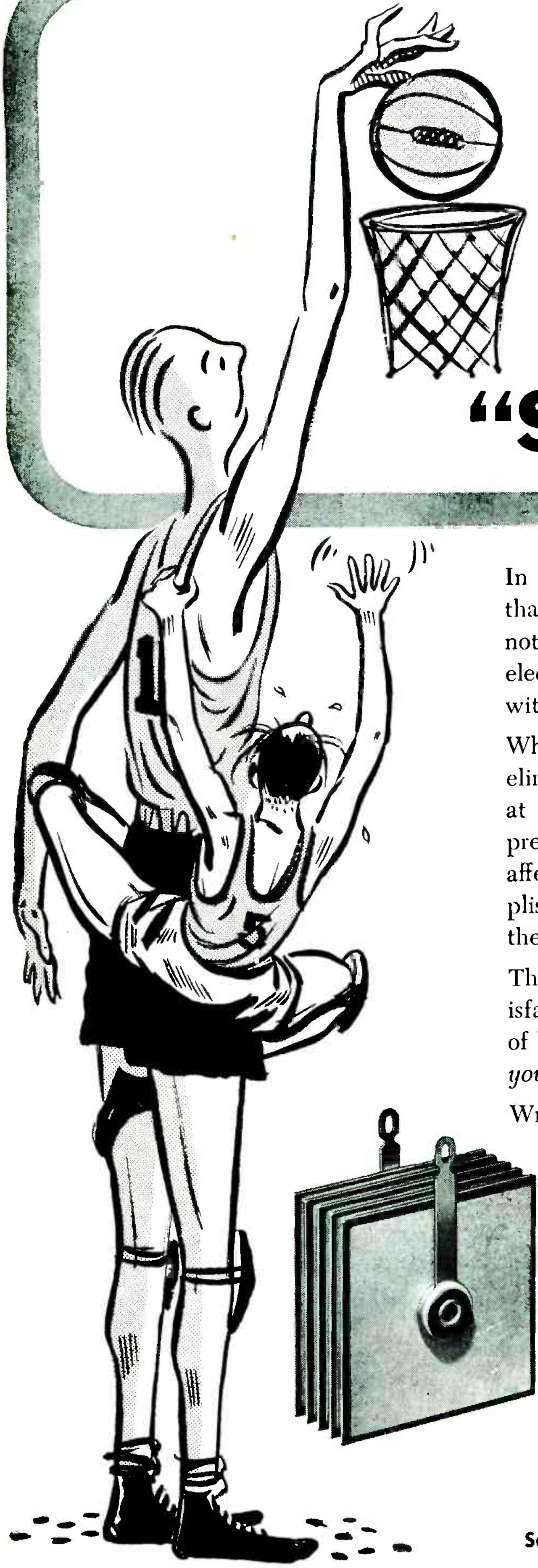

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the words of the author: "It will be the aim of this book to expose the principles of operation and construction of these devices, and to present the relevant theoretical considerations rather than to give a detailed account of applications."

This aim has been achieved in an excellent fashion, for the book gives a well-documented account (including over 200 references), which details the theoretical aspects of such topics as build-up and decay of the ionization in the counters, formation and shapes of the pulses, pulse differentiation, counter speed and the errors that may arise in quantitative work. Many practical matters related to counter design, such as the choice of geometrical arrangement, electrode materials, insulators and of the gas and gas pressure are also treated.

The author considers the amplifier input circuit arrangements and the relation of such matters as amplifier rise time and noise to the counting problem, but otherwise does not discuss the electronic circuits used with these counters. Furthermore, the more recently introduced devices such as the crystal counter, the spark counter and the scintillation counter are not treated.

This volume should prove of great value to the specialist concerned with the design and application of counters, and to those who wish to make a serious study of counter theory and behavior.—R. R. BENEDICT, *Electrical Engineering Dept., University of Wisconsin.*

Response of Physical Systems

BY JOHN D. TRIMMER. *John Wiley and Sons, Inc., New York,* 1950, 268 *pages,* $5.00.

THIS excellently written, well-integrated, nicely printed book comprises preface, 11 chapters of content, 3 appendices and a comprehensive index. The carefully-detailed mathematical analyses, the illustration of each major point of theory by solution of one or more interesting physical systems, the number and diversity of these illustrative examples, and the general clarity

Simplify analysis

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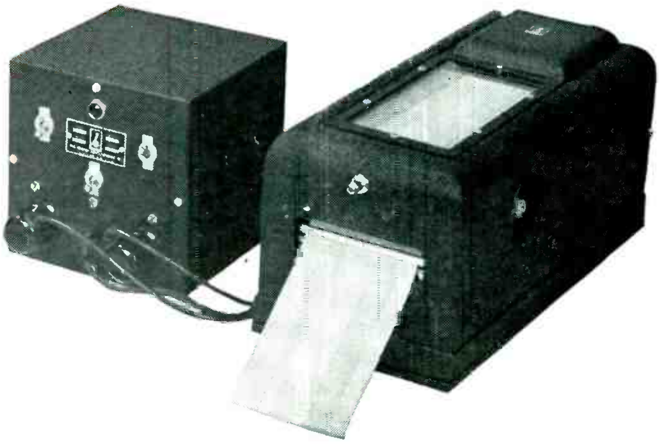


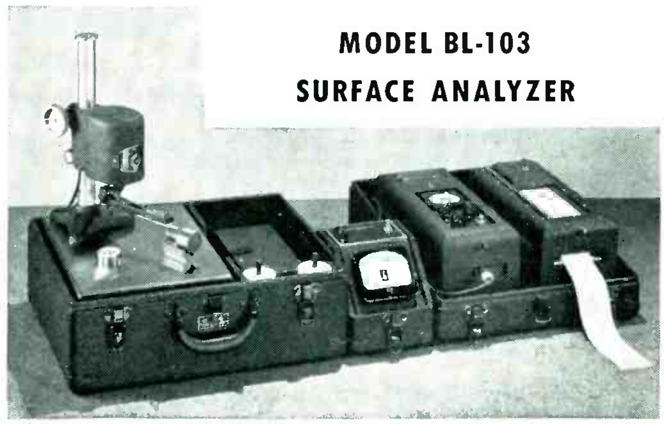
COMBINATION MAGNETIC OSCILLOGRAPH

The Model BL-221 Single Channel Magnetic Combination Oscillograph is similar to the Model BL-201 unit, except that circuit changes have been made to permit use of either a standard inking pen or an electric stylus. Magnetic penmotor Model BL-943 is used on the BL-221 Oscillograph and includes the proper connections for use of the electric stylus. A Power Supply, Model BL-944, furnishes voltage for the electric stylus operation. A switch on the front panel of the Power Supply permits the operator to increase the stylus voltage when recording high frequency phenomena. The main switch opens circuit to Power Supply to eliminate the possibility of receiving electric shock when handling stylus. Instruments are supplied with a standard pen and inkwell as well as the electric stylus. The Model BL-222 Double Channel Oscillograph (shown in illustration) is supplied on the same chassis as the BL-221.

BL-932 D-C AMPLIFIER

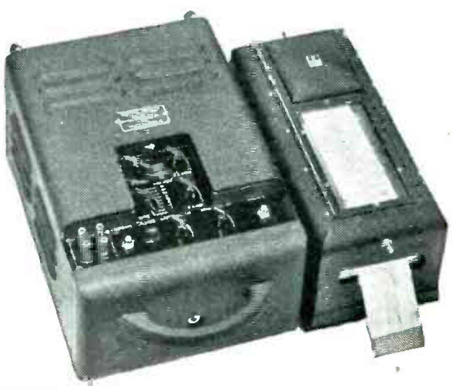
Designed for use with the Brush Magnetic Direct Inking Oscillograph, and used to make recordings of many types of phenomena heretofore measured only with the aid of complicated intermediate equipment. Studies of such static or dynamic conditions as strains, displacements, pressures, light intensities, temperatures, d-c and a-c voltages or currents, and many others, are simplified by the use of the Brush Direct Inking Oscillograph with the BL-932 Amplifier. Voltage gain is sufficient to give one chart mm deflection per millivolt input. Novel design features reduce the effects of power line fluctuation. Zero signal drift amounts to not more than one chart mm per hour. Frequency response is essentially uniform from d-c to 100 cycles per second. The control panel at the front of the amplifier contains a factor-of-10 attenuator, gain control, calibrating meter, and controls for determining input voltages. A balancing potentiometer is provided for electrically biasing the oscillograph pen to any position on the chart.

MODEL BL-103 SURFACE ANALYZER



For exploration and instantaneous charting of surface finishes—metals, glass, plastics, paper, plated and painted surfaces from less than 1 to 5000 micro-inches. Complete with PA-2 Pickup Arm, Drive Head, Amplifier, Magnetic Oscillograph, Surface Plate, Carrying Cases, Glass Calibration Standard, 2 V-Blocks, 6 rolls Chart Paper, one 2 oz. bottle Red Ink, connecting cords and operating instructions. Brush RMS METER: "average reading" type calibrated in terms of the "RMS" of an equivalent sine wave. It provides a constant visual check of "RMS" surface roughness in cases where "hill and dale" chart profiles are not needed. Large illuminated dial is set at an easy reading angle. "RMS" Meter may be purchased separately or with the Surface Analyzer.

UNIVERSAL STRAIN ANALYZER



The BL-320 Universal Strain Analyzer, when used with the Brush Magnetic Direct Inking Oscillograph, provides a complete package unit for the measurement of strain or other phenomenon where a resistance sensitive pickup is employed. It can be simply operated, producing records which are immediately available and easily interpreted. This combination equipment records either static or dynamic strains up to 100 cps, and direction as well as magnitude of the measured strain can be read from the chart. Connections are brought out so that one to four active gages may be used. Provision is made for connecting an internal calibrating resistor in the bridge circuit and adjusting the overall gain.

Write for complete details.

THE *Brush* DEVELOPMENT COMPANY
DEPT. K-1, 3405 PERKINS AVENUE • CLEVELAND 14, OHIO, U. S. A.
Canadian Representatives:
A. C. Wickman (Canada) Limited, P. O. Box 9, Station N, Toronto 14, Ontario

STRAIN
VIBRATION
VOLTAGE
PRESSURE
SURFACE
CONTOUR
ETC.

Put it in writing with a

BRUSH RECORDING ANALYZER

STRAIN ANALYZERS • SURFACE ANALYZERS • CONTOUR ANALYZERS • UNIVERSAL ANALYZERS • UNIFORMITY ANALYZERS and quality of the exposition bespeak the soundness of the text.

Chapter 1 (A Pattern for Systems) formulates terminology sufficiently broad to encompass various kinds of systems yet specific enough in meaning to suggest the essential structure and action of particular systems, and advances general statements of the five types of problems associated with a system. Chapter 2 (Physical Systems) comprises classification of systems on the basis of the nature of the differential equations governing their performance and the parametric structure of the system. Chapters 3 (First-Order Systems), 4 (Second-Order Systems) and 6 (Higher-Order Systems) detail the classical mathematical solution of the responses of systems governed respectively by first, second and third-order ordinary linear constant-coefficient differential equations to step, pulse and sinusoidal forcing; physical interpretation of certain important terms in the solutions; algebraic and graphic investigation of stability; and illustration of application of this theory by solution of appropriately ordered systems chosen from various physical domains.

Chapter 5 (Sinusoidal Forcing of Linear Systems) details the important role of the response to sinusoidal forcing in ascertaining the general character and quality of a transmitting system. Chapter 7 (Measuring Instruments) discusses the philosophy and basic terminology of measurements in general, the quality of performance of certain indicating instruments, and the nature of various kinds of error. Chapter 8 (Feedback Systems) comprises good discussion of the essentials of single-loop feedback systems. Chapter 9 (Parametric Forcing) details the basic concepts of parametric forcing through time-variation of one or more system parameters and illustrates, through several examples, the analytical difficulties encountered in solving such systems. Chapter 10 (Distributed Systems) embraces an account of the method of solving partial differential equations by separation of variables and illustrative solution of several sys-

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*

Proper Annealing for Cost Reduction

Work-hardened metal can be softened by annealing—that is, by raising its temperature high enough to affect its microstructure. Different degrees of softness are obtained by controlling the temperature which the metal attains in the furnace and the length of time it is exposed to the heat. Under the microscope a piece of annealed metal that has been prepared by polishing and etching for microscopic examination appears to be made up of irregularly shaped crystals or grains — the higher the annealing temperature, the larger the crystals, the softer the metal, and the greater its elongation or ductility.

Annealing Hints for Fabricators

Variable factors such as the weight and distribution of load, size and shape of article and/or sequence of anneals, type and condition of furnace play such an important part in maintaining uniform metal temperature that it is impossible to set up specific rules for the fabricator on time and temperature for annealing copper and its alloys.

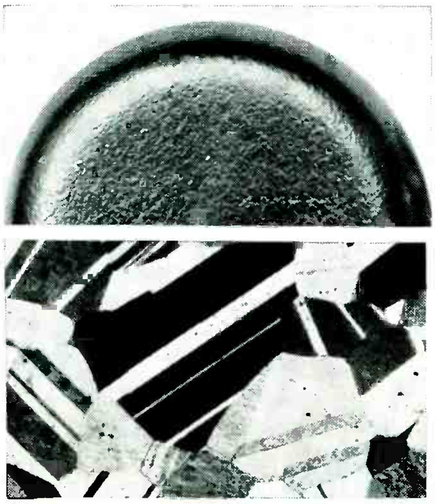
The table, shown below, on suggested temperatures should only be used as a guide.

Included also in these variables are the amount and method of cold-working, previous grain size and severity of operations to follow. Because of these variables, it is advisable to experiment with sample lots to determine correct time and temperature for annealing before setting up a schedule for volume production.

Danger of Too High Temperature

Extra large grain size and orange peel effect are usually products of temperatures that are too high with subsequent increase in finishing costs. Excessively high temperatures will also increase the amount of oxidation of the metal (if non-atmosphere controlled furnaces are used) and thereby necessitate longer pickling and dipping operations, with the associated danger of pitting and thinning of the material.

It is safer to anneal at the lowest temperature possible. Work can always be returned to the furnace if not annealed sufficiently, but the damage done by too high a temperature cannot be corrected.



Orange-peel surface on the bottom of drawn brass cup was caused by excessively large grain structure resulting from annealing at too high a temperature. Micrograph: mag. 75 x etch NH_4OH and H_2O.

Good Annealing Practice

Thorough cleaning of work to remove drawing compounds before annealing especially at low temperatures, will help to maintain cleaner surfaces. Dirt and dust picked up from the air and held on the work by compounds, can also produce stains and scale which if not completely removed, will cause scratching of work and dies as well as loading of tools.

The ability to obtain uniform metal temperatures in the work being treated is essential. For this reason convection-type annealing furnaces are widely used for temperatures from 1200° F and lower. By placing the thermocouple at the hottest location of the incoming gases and being careful not to exceed the desired temperature is an assurance metal will not be overheated.

The practice of speeding up the annealing operation by first operating the furnace at temperatures considerably above the desired annealing temperature is dangerous because the top or edges of the load may become overheated while the rest of the load is coming up to the desired annealing temperature. In other words, there is time lag in heat penetration. It is advisable to bring the furnace to heat before starting the day's annealing operations. This method reduces the danger of local overheating and facilitates uniform heating.

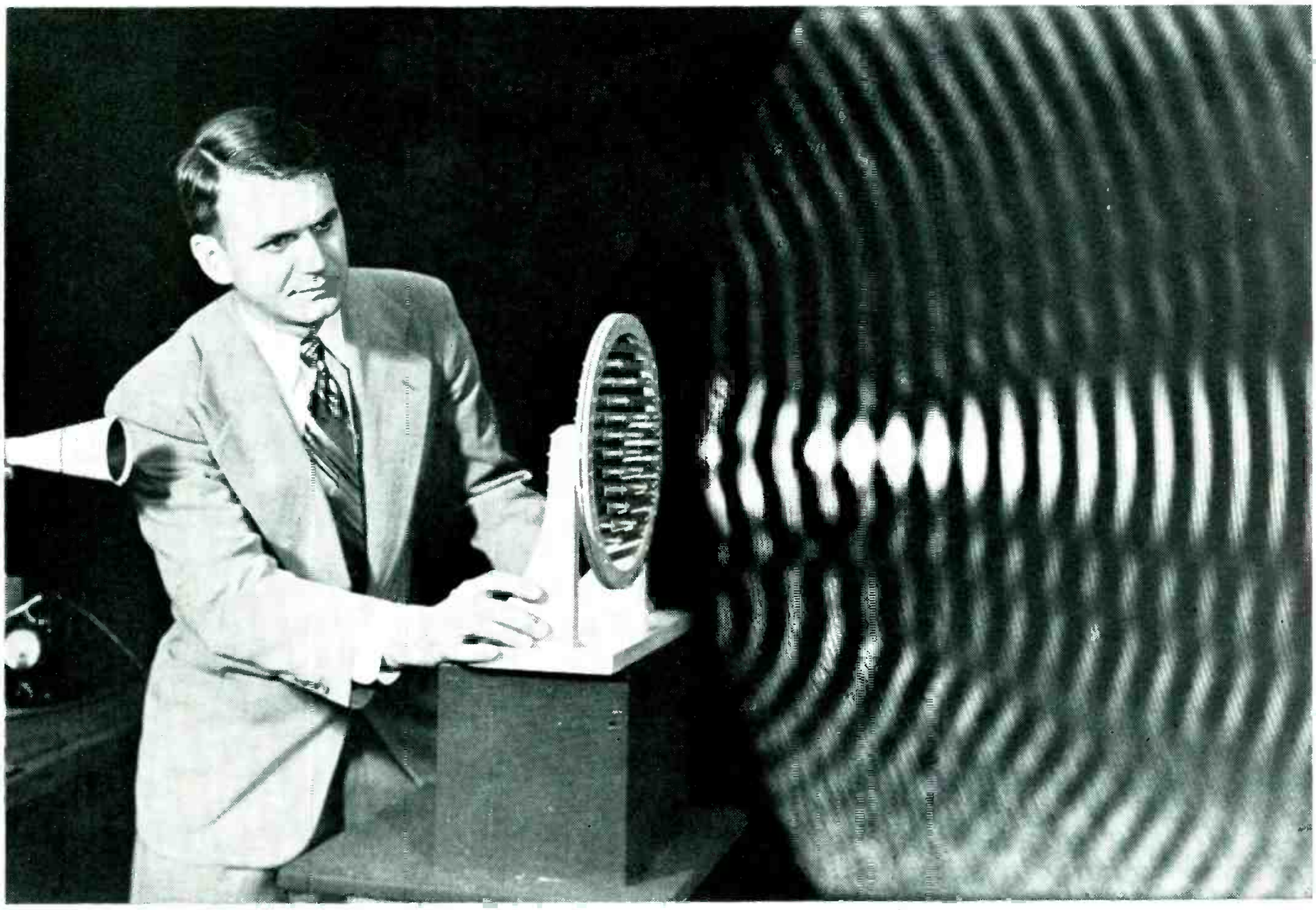
The influence of time in an annealing operation after the metal reaches the desired temperature throughout does not seriously increase grain growth or softening and this factor permits uniformity of heating in convection furnaces even when section or portions of a load are of uneven mass. Direct-fired furnaces, on the other hand, are usually operated with a thermal head and are more susceptible to uneven heating of a load, especially if the masses are uneven.

Suggested Annealing Temperatures for Fabricated Articles

Approximate Metal Temperatures

Material	*Alloy No.*	*Anneal for Additional Cold Working*	*Fine Grain Anneal for Finishing*	*Stress Relief Anneal*
Copper	102	750- 950F	650- 800F	400F*
Red Brass—85 copper, 15 zinc	85	900-1150F	750- 900F	400F*
Cartridge Brass—70 copper, 30 zinc	37	850-1100F	700- 850F	400F*
High Brass—66 copper, 34 zinc	1	850-1100F	700- 850F	400F*
Commercial Bronze—90 copper, 10 zinc	25	925-1175F	775- 975F	400F*
Silicon Bronze—97 copper, 3 silicon	632	1000-1200F	925-1000F	400F*
Silicon Bronze—98 copper, 2 silicon	609	1100-1200F	925-1000F	400F*
Phosphor Bronze—Grade A—94.35 copper, 5.5 tin, 0.15 phosphorus	36	1080-1200F	900-1050F	400F*
Nickel Silver—18% Grade A—65 copper, 18 nickel, 17 zinc	565	1100-1300F	1050-1150F	400F*

*Stress Relief Annealing Temperatures and Time depend upon the amount of cold working on the part and the alloy. A nominal temperature of 400F for a one hour anneal may be tried and the parts so treated then checked for residual stress by a mercurous nitrate test. Should failure occur, a higher temperature would be indicated.



WAVE MAKING

–for better telephone service

Waves from the sound source at left are focused by the lens at center. In front of the lens, a moving arm (not shown) scans the wave field with a tiny microphone and neon lamp. The microphone picks up sound energy and sends it through amplifiers to the lamp. The lamp glows brightly where sound level is high, dims where it is low. This new technique pictures accurately the focusing effect of the lens. Similar lenses efficiently focus microwaves in radio relay transmission.

At Bell Telephone Laboratories, radio scientists devised their latest microwave lens by copying the molecular action of optical lenses in focusing light. The result was a radically new type of lens – the array of metal strips shown in the illustration. Giant metal strip lenses are used in the new microwave link for telephone and television between New York and Chicago.

The scientists went on to discover that the very same type of lens could also focus sound . . . thus help, too, in the study of sound radiation . . . another field of great importance to your telephone system.

The study of the basic laws of waves and vibrations is just another example of research which turns into practical telephone equipment at Bell Telephone Laboratories . . . helping to bring you high value for your telephone dollar.

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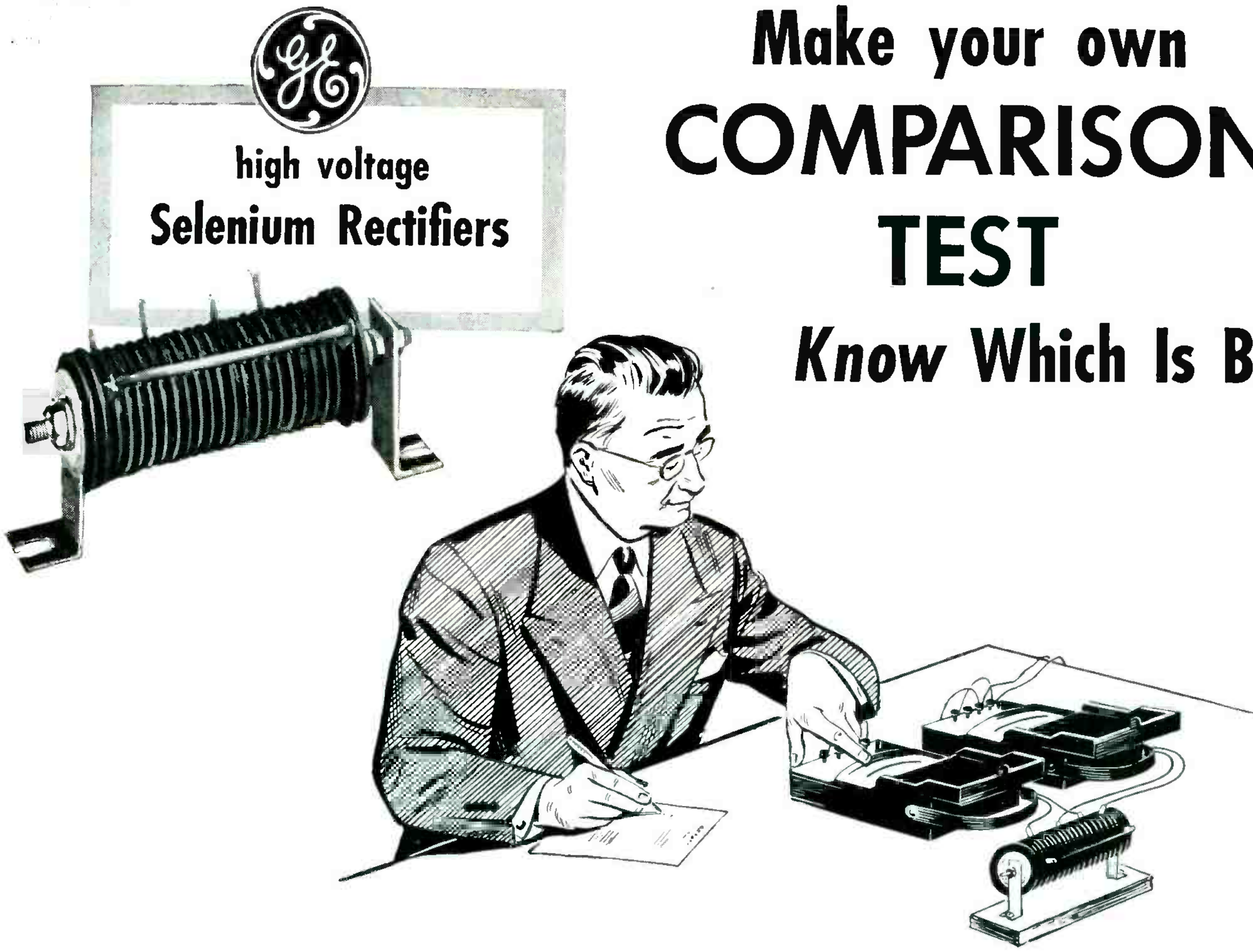
• WORKING CONTINUALLY TO KEEP YOUR TELEPHONE SERVICE ONE OF TODAY'S GREATEST VALUES

Make your own COMPARISON TEST

Know Which Is Best



Since most selenium rectifiers look alike, but vary greatly in quality, it is important to the user to have some simple means of determining quality. Side-by-side comparison tests are the time-honored way to compare quality. Take any 26-volt RMS selenium rectifier stack on the market—get a new G-E high-voltage stack of similar ratings and see for yourself which is the better.

These new G-E 26-volt cells thrive on comparison tests because they are outstanding in the three characteristics which mean quality in selenium rectifiers.

LOW FORWARD RESISTANCE

G.E.'s new 26-volt cells have extremely low forward resistance. This means a low voltage drop giving higher output, cooler operation, and greater rectifier efficiency. This often results in savings to you in the design and costs of other circuit components.

LOW BACK LEAKAGE

Since reverse current through a rectifier serves no useful purpose but does increase losses and heating, the low back leakage of these cells results in higher output, higher efficiency, and cooler operation.

DEPENDABLE LONG LIFE

These cells are the slowest aging of any selenium cells we have tested. These dependable cells have a life expectancy of well over 60,000 hours.

Prove for yourself the superiority of these new G-E selenium cells. *Write Section 461-13, Apparatus Department, General Electric Company, Schenectady 5, New York* for a copy of GEA-5524 which gives complete instructions for comparative testing. Contact your local General Electric Apparatus Sales Representative or authorized G-E agent to arrange your sample purchase.

GENERAL ELECTRIC

461-13

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the flexible, extruded plastic tubing that resists high temperatures

YES, FLEXITE is the electrical insulation tubing that sets new standards for resistance to extreme high temperatures. Compounded of a plasticized copolymer of vinyl chloride and vinyl acetate and manufactured with a true wall thickness, smooth inside and outside, FLEXITE PLASTIC TUBINGS offer the greatest resistance to high and low temperatures, are extremely flexible and have great tensile strength.

FLEXITE compares more than favorably with tubings of similar nature. Check the specifications of FLEXITE, compare them with the requirements for your products and against other insulations for identical use . . .

YES, you will find that FLEXITE sets a new high standard for protection against high temperatures, high dielectric, stretching, tearing, abrasion, exposure to acids, oils and alkalies, flammability, etc. — samples and additional information will be sent upon request.

And for a Plastic Tubing to Withstand Normal High Temperatures Mitchell-Rand Offers Flexite-Norm . . . write for specifications.

flexite physical & electrical properties

a. tensile strength, minimum average	2500 PSI
b. ultimate elongation, min. average	300%
c. dielectric strength, minimum	800 v/mil
d. flammability	non-inflammable
e. heat resistance	After 100 hrs. at 300° F. the tubing is not brittle and when flexed does not crack.
f. heat endurance	Recommended for continuous operating temperatures up to 105° C., and when baked at 125° C. for 2,000 hours does not become brittle.
g. low temperature flexibility	−30° C.
h. heat shrinkage	ASTM Standards #20 — #17 incl. — less than 8% #16 — # 6 incl. — less than 5% # 5 and larger — less than 3%
i. oil resistance	Highly resistant to effects of transformer and lubricating oils, does not stiffen when continuously exposed to them.

Colors	Black, white, red, green, yellow and blue are standard colors.
Dimensions and Tolerances	Standard sizes to fit B & S wires #20 to #0 inclusive, as specified by ASTM Spec. D922-47T.
Wall Thickness	In accordance with ASTM Spec. D922-47T, as follows: #20 — #10 incl. — .016″ ± .003″ # 9 — # 0 incl. — .020″ ± .003″
Standard Lengths	Standard 36″ lengths or continuous lengths in coils. Sizes #20 — #10 incl., will be supplied on paperboard spools when so ordered.
Quality	Uniform in quality and condition, free smooth on both inside and outside, free of defects such as pin-holes, blisters, foreign inclusions and other imperfections.
Test Methods	Properties enumerated in above specifications shall be determined according to Tentative Methods of Testing Non-rigid Polyvinyl Tubing, American Society for Testing Materials, Designation D876-46T.

WHATEVER YOUR ELECTRICAL INSULATION PROBLEM MITCHELL-RAND HAS THE ANSWER

And for a Plastic Tubing to Withstand Normal High Temperatures Mitchell-Rand Offers • Flexite-Norm • write for specifications.

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NEW BOOKS (continued)

data. German equivalents are given for most of the terms. Each member of the known radioactive families has an entry, indicating symbol, atomic number, mass number, parent isotope, daughter isotope, type of radiation and half-life.

POWER SYSTEM STABILITY. Volume II—Power Circuit Breakers and Protective Relays. Edward W. Kimbark. John Wiley & Sons, Inc., New York, 1950, 288 pages, $8.00. For graduate students and engineers.

CAPACITORS FOR INDUSTRY. By W. C. Bloomquist, C. R. Craig, R. M. Partington and R. C. Wilson. John Wiley & Sons, New York, 1950, 246 pages, $4.50. Practical data on use of capacitors to correct power factor of industrial electric power loads, with methods of determining most economic capacitor installation for each job.

SYMPOSIUM ON DYNAMIC STRESS DETERMINATIONS. Publication No. 104, American Society for Testing Materials, 1916 Race, Philadelphia, 64 pages, $1.50. Scope, applicability, possibilities and limitations of electronic measuring and recording devices, as summarized in four papers presented at an ASTM meeting in Oct. 1949.

TELEVISION, Vol. V (1947-1948) and Vol. VI (1949-1950). RCA Review, Princeton, N. J., 1950, 461 and 422 pages respectively, $2.50 each. Compilations of selected published papers by RCA authors on television, grouped in six categories in each book: Pickup; Transmission; Reception; Ultra-High Frequencies; Color Television; General. Suitably balanced presentation is achieved by including some papers in full, some in summary form, and omitting others entirely to avoid duplication of content. Appendix in Vol. VI has bibliography of some 506 technical papers on television written by RCA authors and published during the period 1929-June 1950.

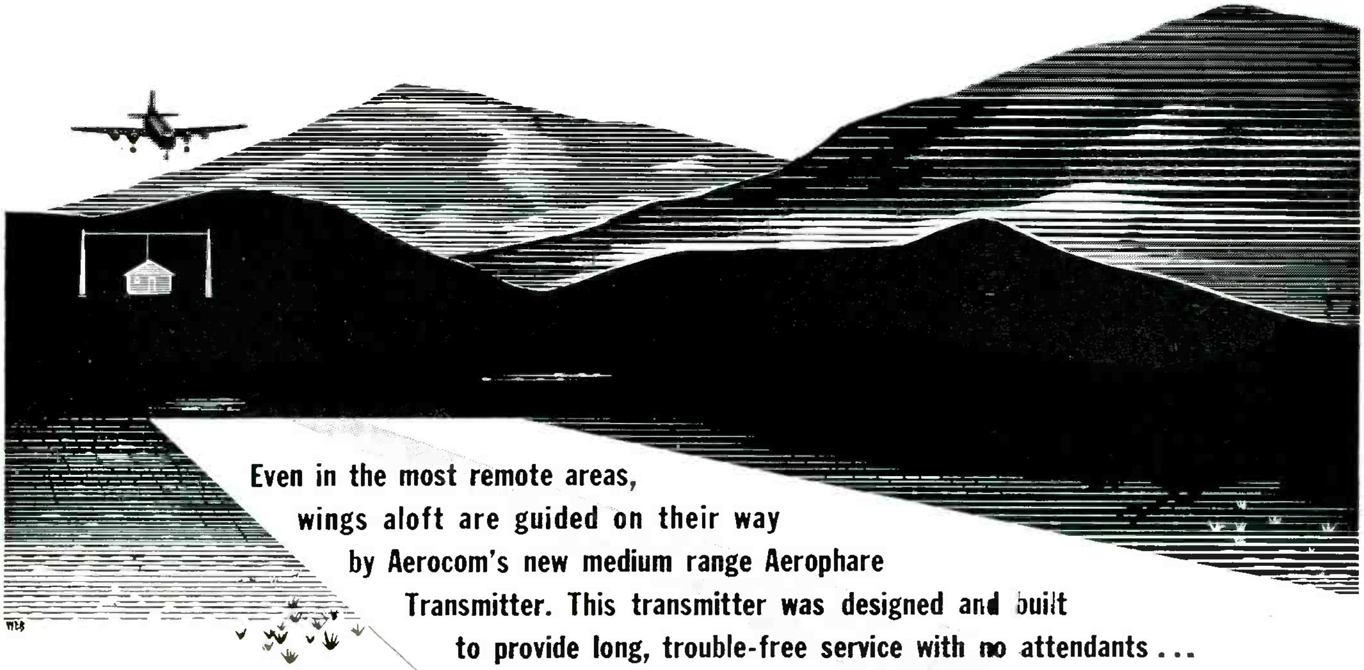
DESIGN OF ELECTRICAL APPARATUS. By John H. Kuhlmann. John Wiley & Sons, Inc., New York, 1950, 3rd edition, 512 pages, $6.50. Revised to include new wire insulating materials, new ASA calculating procedures, new methods for determining motor dimensions, and method of designing small transformers used in electronic control circuits and for power supplies for electronic devices.

TELECOMMUNICATIONS AND EQUIPMENT IN GERMANY, 1939-1945. British Information Services, 30 Rockefeller Plaza, New York, 56 pages, paper-cover, $0.40. Summary of status of research and development in various branches of wire and radio communication.

A GLOSSARY OF TERMS IN NUCLEAR SCIENCE AND TECHNOLOGY. American Society of Mechanical Engineers, 29 W. 39, New York. Section III—Reactor Engineering, 48 pages, $0.75; Section V—Chemical Engineering, 36 pages, $0.60; Section VI—Biophysics and Radiobiology, 52 pages, $0.60. First three of the nine sections eventually to be published, each containing encyclopedia-type discussions as well as definitions of terms in that branch of nucleonics. Each book contains a 20-page alphabetical arrangement of terms, giving the section in which each term is defined.

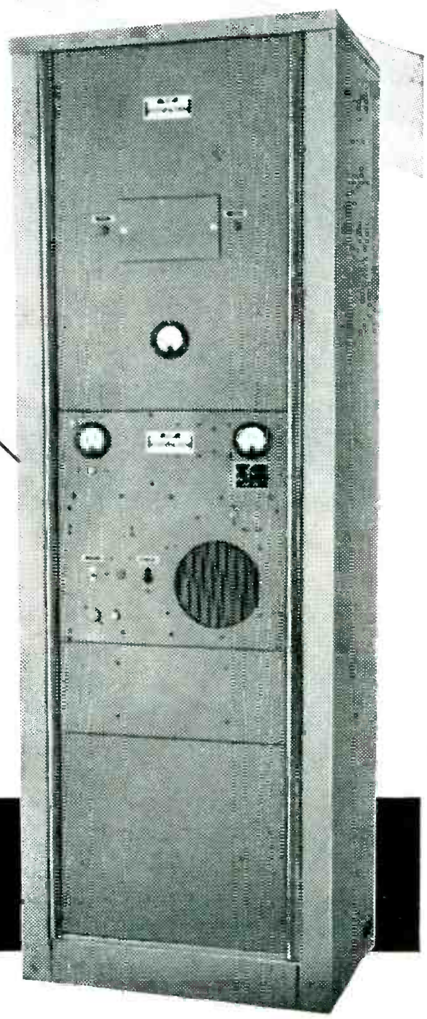
INDUSTRIAL AND SAFETY PROBLEMS OF NUCLEAR TECHNOLOGY. Edited by M. H. Shamos and S. G. Roth. Harper & Brothers Publishers, New York, 1950, 368 pages, $4.00. Compilation of contributions of some twenty authors who presented lectures at a conference conducted by New York University on the same subject early in 1950. Arrangement is in four parts: U. S. Atomic Energy Commission Activities; Radiochemistry and Isotopes; The Radiochemical Laboratory; Hazards, Safety and Insurance. A 37-page appendix presents panel discussions.

POPULATION-



Even in the most remote areas, wings aloft are guided on their way by Aerocom's new medium range Aerophare Transmitter. This transmitter was designed and built to provide long, trouble-free service with no attendants . . . even where the total population is Zero.

AEROPHARE



The 100 Watt Aerophare illustrated consists of the following units -- AK-3 automatic keyer; Model 100 XL transmitter, (100 Watt carrier power, 35% high level tone modulation for identification); and antenna tuner.

The smaller unit is the same physical size except transmitter carrier power is 50 Watts with 35%-50% high level tone modulation for identification.

Voice modulation can be used with either unit, with peaks to 50%-60% for the 100 Watt unit and 75%-80% for the 50 Watt unit. When Microphone P-T Switch is depressed tone is interrupted, permitting voice operation.

For both units, permanently mounted final amplifier circuit covers 200-415 kcs. "Plug-in" oscillator coils cover 200-290 kcs. and 290-415 kcs; (these are available with crystal for .02% stability or self-excited for 0.1% stability).

Continuous duty operation in air temperatures: 0°c to +45°c with mercury vapor rectifiers; − 35°c to +45°c with gas filled rectifiers.

Engineering data on this unit and other AEROCOM products is available upon request.

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

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

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

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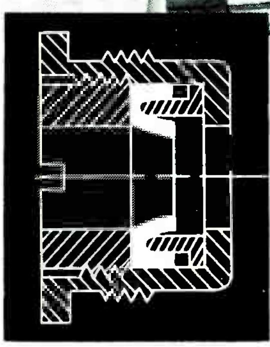
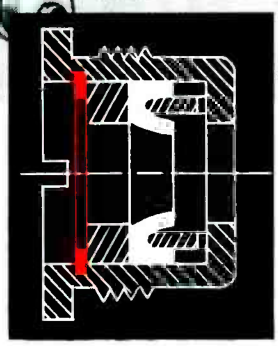
CUT UNIT COST 25%
PROLONG PRODUCT LIFE 9 YEARS



OLD WAY

A typical air or hydraulic sealing problem: Inadequate or excessive pressure of threaded gland nut on seal caused distortion. Result: binding of piston rod, troublesome leaks, constant maintenance, shortened product life.



NEW WAY

Waldes Truarc Internal Retaining Ring (Series 5000) is held in correct position by pre-determined groove. Proper pressure on seal is insured for life of unit, increasing number of cycles from 10,000 to 100,000!

Using 4 Waldes Truarc Retaining Rings in their Check-N-Spect Air Power Units (for tire inspection and repair) saves Bowes Seal Fast Corp., Indianapolis, 40% in assembly time, 25% in cost. With Waldes Truarc Rings, assembly is simple... maintenance unnecessary. New design increases unit life from 1 to 10 years!

Redesign with Truarc Rings and you too will cut costs. Wherever you use machined shoulders, bolts, snap rings, cotter pins, there's a Waldes Truarc Retaining Ring designed to do a better job of holding parts together.

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

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

Waldes Truarc Retaining Rings are available for immediate delivery from stock, from leading ball bearing distributors throughout the country.

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- **Eliminates skilled-labor milling and threading operations ....**
- **Eliminates maintenance ....**
- **Gives greater accuracy in positioning seal .**
- **Saves 40% in assembly time .... $.09**
- **Cost of old-type parts .... .24**
- **Less Cost of four Waldes Truarc Rings . .08**
- **Net savings on parts .... .16**

TOTAL UNIT SAVING . . . $.25

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WALDES TRUARC

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WALDES TRUARC RETAINING RINGS ARE PROTECTED BY THE FOLLOWING PATENT NUMBERS:
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Waldes Kohinoor, Inc., 47-16 Austel Place E-023
Long Island City 1, N. Y.

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(continued from p 122)

One of the authors, D. L. Gerlough, records data from the vehicle speed-distribution recorder

discriminate between positive and negative input pulses. Resetting of the binary counter on completion of any operation is accomplished by means of a positive pulse applied to the cathode of the left-hand triode of each stage.

The interpretation section contains a separate circuit for each predetermined output, consisting of a resistance-type voltage-adding network and a coincidence detector. Each voltage-adding network is made up of n 22-meg resistors and n double-throw switches, where n is the number of stages in the binary counter.

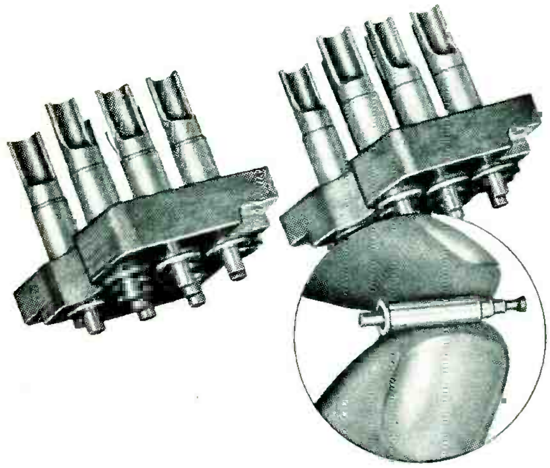
Each switch connects its associated resistor with one of the stages of the binary counter. Switch positions 0 and 1 are connected to the normally conducting and normally nonconducting plates of the counter stage. In setting up the predetermined count for an output a switch has the same binary value as the counter stage with which it is associated. The predetermined setting for any output is the total binary value of all switches related to that output.

Circuit Operation

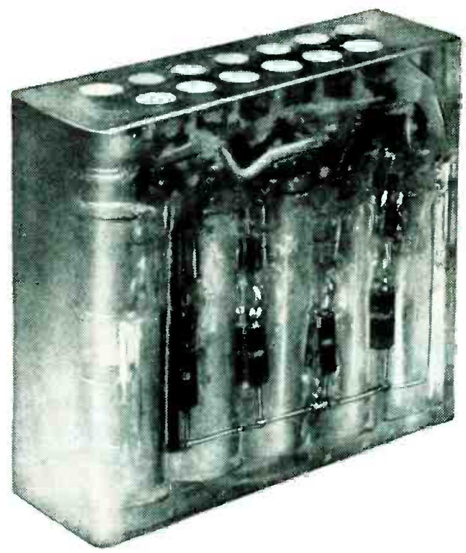
The coincidence detector consists of a triode ($\frac{1}{2}$ a 12AX7) whose apparent grid voltage at any instant is the resultant of the voltages applied to the n 22-meg resistors and the -100 volts applied to the grid-return resistor.

When the contents of the binary counter are such that all plates con-

These examples of GRAY product engineering ...typify GRAY results!



SPRING PIN CONNECTOR: made on centers of .01 inch. Some types carry current through spring; on one design, the connection to the pin is made directly to an extension of plunger. Contact surfaces Silver or Palladium for lower contact resistance, greater contact life. Contacts are arc-resisting. Spring pressure 5 oz. at full depression of .21". Pin is coin (75%) silver. Spring of Beryllium Copper, heat treated, silver flashed. Barrel and cap silver-plated on brass.



POTTED ASSEMBLY: Containing 29 resistors and condensers and 5 thyratrons. GRAY does its own potting, wiring.

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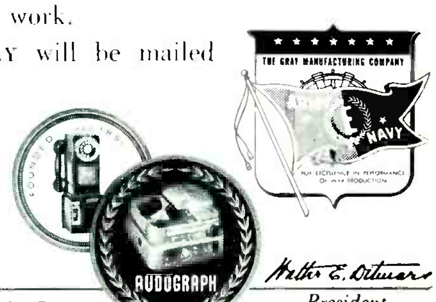
More often than you might surmise GRAY RESEARCH designers and engineers come up with ideas and components that become important factors in product improvement and performance. The exclusive products shown above are but two examples. Many can be cited.

GRAY scientific know-how on product development and engineering plus modern plant facilities are available to organizations and laboratories seeking this specialized type of work.

A brochure describing GRAY will be mailed on request.



Walter E. Ditmars
President

GRAY RESEARCH

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Division of The GRAY MANUFACTURING COMPANY—Originators of the Gray Telephone Pay Station and the Gray Audograph

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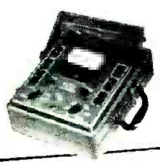
test and Research Instruments

Equally valuable in electronic research, production testing or special circuit investigation, these versatile Weston instruments are available through your local Weston Representative. Consult him, or write for booklet on WESTON Test Instruments, Weston Electrical Instrument Corporation, 595 Frelinghuysen Avenue, Newark 5, New Jersey ... *manufacturers of Weston and Tagliabue instruments.*

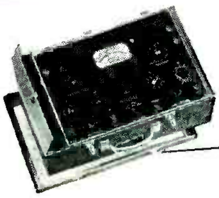
Model 564 Volt-Ohmmeter provides a broad selection of resistance and d-c voltage ranges. Self-contained battery for resistance measurements. Sensitivity 1,000 ohms per volt.

Model 697 Volt-Ohm-Milliammeter combines a-c and d-c voltage, direct current, and resistance ranges. Self-contained battery. Sensitivity 1,000 ohms per volt.



Model 769 High Frequency Electronic Analyzer makes most electronic measurements for FM, AM and TV service work in the vhf and uhf fields. Three instruments in one: volt-ohm-milliammeter, high impedance electronic volt-ohmmeter, probe type vacuum voltmeter.

Model 779 Supersensitive Analyzer checks tube circuits in electronic control equipment, transmitters, receivers. Measures current, potentials; indicates power levels in decibels in audio, public address and communications equipment. Sensitivity 20,000 or 1,000 ohms per volt ... 26 practical ranges.



Model 798 Proportional Conductance Tubechecker for industrial, laboratory and general testing of receiving tubes, voltage regulator tubes, low power Thyratron tubes. Uses differential frequency system; provides mutual conductance ranges to 12,000 micromhos.

Model 686 Mutual Conductance Electronic Tube Analyzer tests tubes under exact operating potentials. Accurately determines true mutual conductance of all tubes, both in accordance with manufacturers' rated operating conditions and at other values for non-standard applications.

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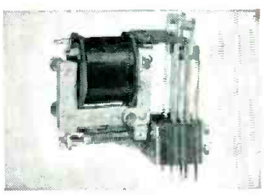
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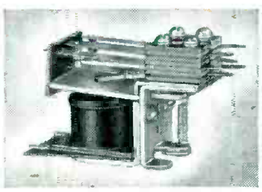
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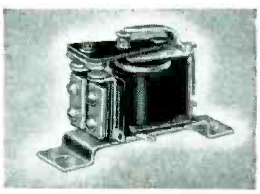
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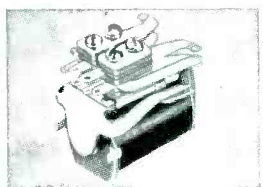
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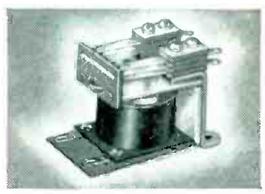
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nected to the n 22-meg resistors are nonconducting, representing a total disagreement between the counter contents and the switch settings, the apparent grid voltage of the coincidence detector measured with the tube removed from the socket is approximately 77.5 volts. With the tube in the socket the actual grid voltage will go only slightly positive because of grid current flow.

When the contents of the binary counter are such that all plates connected to the n 22-meg resistors are conducting, representing total agreement between the counter contents and the switch settings, the apparent and actual grid voltages will be approximately −6.5 volts. Between total agreement and total disagreement the apparent grid voltages will change in increments of approximately 10.5 for a counter of eight stages.

Changing the grid voltage from a positive value to −6.5 volts will cause a 12AX7 to go from full conduction to cutoff, resulting in an output signal. This signal may be adjusted to the proper level for succeeding equipment by means of a voltage divider.

Because of the variations in the exact cutoff voltage of 12AX7's, a potentiometer is provided in the grid return to adjust the bias for maximum output signal.

In addition to the predetermined output signals, there is an output signal when the binary counter overflows. The multiple-output predetermined counter with the component values shown has been op-

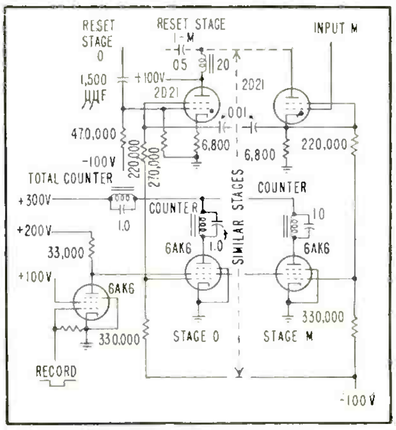
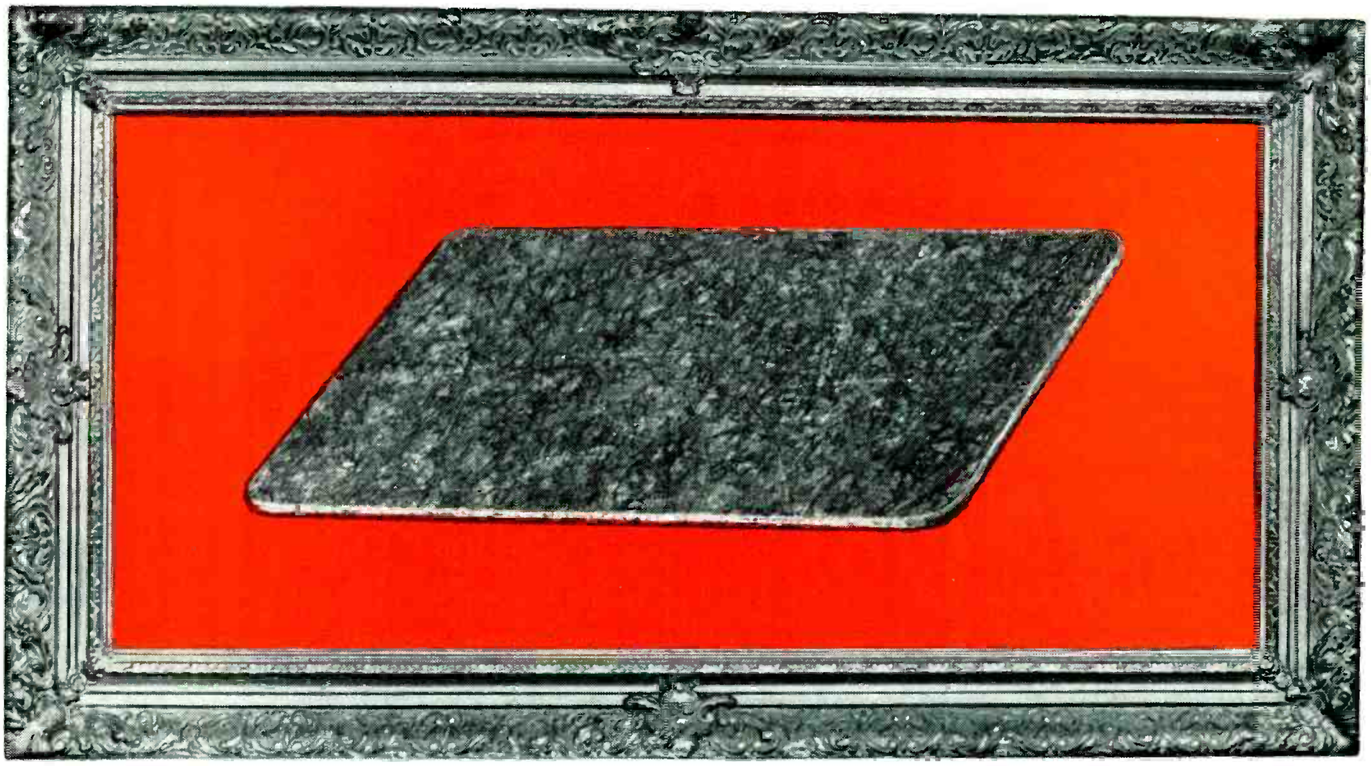


FIG. 2—Schematic diagram of statistical frequency-distribution recorder having $m + 1$ groups and m inputs



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Metals play an important part in the design of electronic equipment and components—important from a technical as well as a dollar and tonnage standpoint. The photo and detailed description on the opposite page provide an idea of the amount required based on *an average company's needs.*

But remember this, metals in this field are not just ordered—they are carefully selected before they can be designed-in. Why? Because electronic products are the results of a highly specialized science and all metals must meet the most rigid requirements as to electrical or mechanical characteristics. Purchasing specifications are prepared by engineers who, by their very training, are precise and particular as to products. You will find no such loophole phrases as "or equal" and "or comparable" in specs ...products specified are the products bought.

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If you feel the metal market in electronics is not big enough to warrant close attention, the facts on the next page may prove an eye opener.

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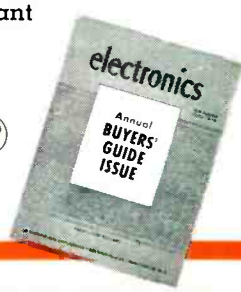

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Pictured above is what might be called a drop in the ELECTRONICS' metals markets bucket . . . the current inventory in one stock room in one plant. 40 tons of metals a month — 20,000 lbs. brass, 10,000 lbs. stainless steel, 40,000 lbs. nickel and tin coated steel, and lesser amounts of beryllium, phosphor bronze, copper coated steel and other metals — and the plant* is not a big metals user. It is engaged in the production of miniscular metallic components for use in tv picture tube electron guns: flange spacers, anode and grid assemblies, cathode spacers and supports — average piece size about that of a dime. Assuming, as the management does, that this plant supplies one-third of the industry's needs for these tiny tv tube parts we arrive at a figure of one thousand four hundred and forty TONS of metals a year for these tiny items alone.

Visualize, if you can, the variety and quantity of metallic products such as these, designed and specified for by ELECTRONICS' engineer readers . . . and the amount of metals they require. To help in that take the U. S. Census figures for 1947, latest and best available. They show that the big users of metals in the radio, related products and miscellaneous communications industry alone bought 242,481 tons of certain selected types and shapes of iron, steel, copper and aluminum in 1947, a quarter of a million tons. The Census doesn't tabulate the multitudinous small frys' metals use. For comparison, take the Census figures for the also ELECTRONICS-reading-engineer-dominated telephone and telegraph equipment industry, an acknowledged big metal market. It used only half as much of the same Census-selected types and shapes in 1947 — 136,712 tons, and that was probably the total figure. There are no small fry in that business.

But all that was 1947. Tv set production totalled less than 200,000 units. It topped six million in 1950. Forty-seven figures no longer tell the story in television or any other segment of the economy. But it is sales, not statistics, that are important to you as a marketer of metals. That's where ELECTRONICS specializes — taking sales stories to the important buying factors for metals in every industry — and returning sales. That's ELECTRONICS' full time job: Taking products to market.

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erated successfully at frequencies up to 50 kc.

In one application, an m-output predetermined counter has been used to distribute automatically counts into $m + 1$ class intervals of a statistical frequency distribution using a special recorder. This recorder, whose circuit is shown in Fig. 2, employs $m + 1$ electromechanical counters.

The electromechanical counter of stage 0 records the number of items having counts 0 or greater, but less than a_1; the counter of stage 1 records items having counts greater than a_m up to the maximum capacity of the binary counter, where a_1 to a_m are the predetermined output settings of the m-output counter. Thyratrons are used to "remember" the greatest class interval to which counting has progressed.

Sequence

Initially, in the operation of the predetermined counter and recorder circuits, the thyratron of stage 0 of the recorder is fired and the thyratrons of all other stages are extinguished. As counting takes place, stage 0 remains fired indicating class interval 0 to a_1, until stage 1 receives a signal from the first output of the predetermined counter. At this point the thyratron of stage 1 fires and extinguishes the thyratron of stage 0 by means of the 0.01-μf commutating capacitor.

The thyratron of stage 1 remains fired until the recorder receives a signal from the second output, a_2, of the predetermined counter through stage m. If counting continues after a_m, the memory thyratron of stage m remains fired indicating a count of a_m or greater.

The overflow signal from the

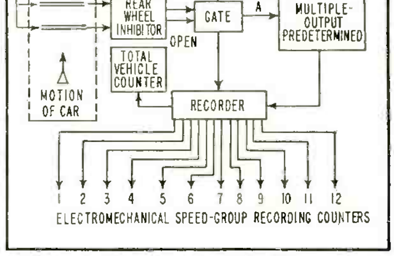

FIG. 3—Block diagram of vehicle speed-distribution recorder

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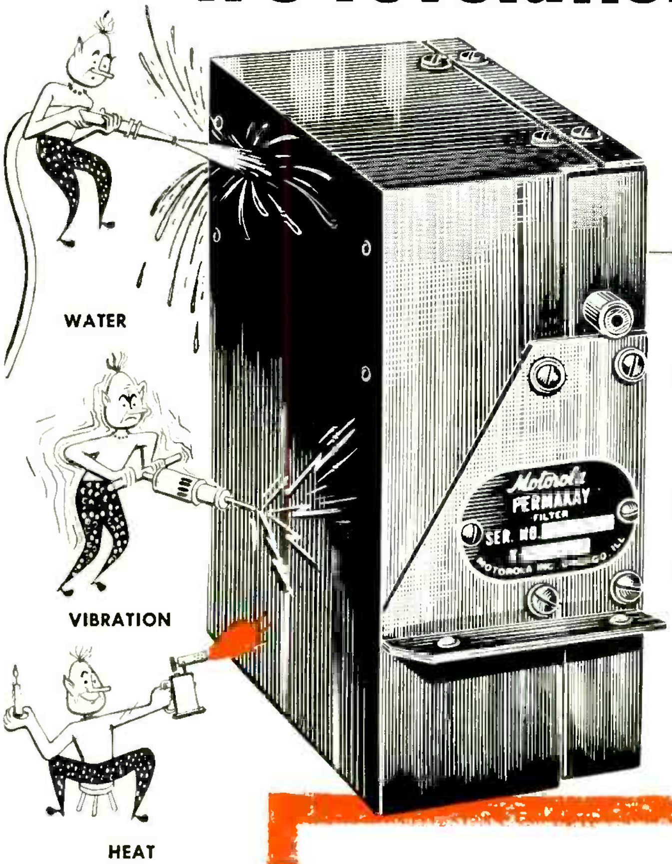

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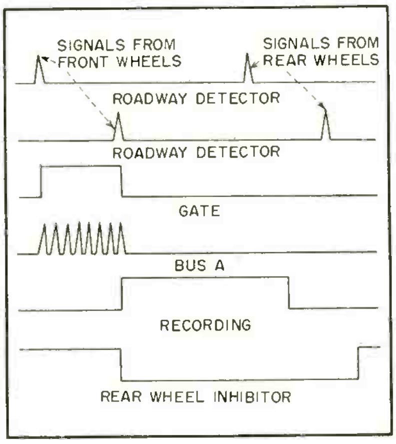


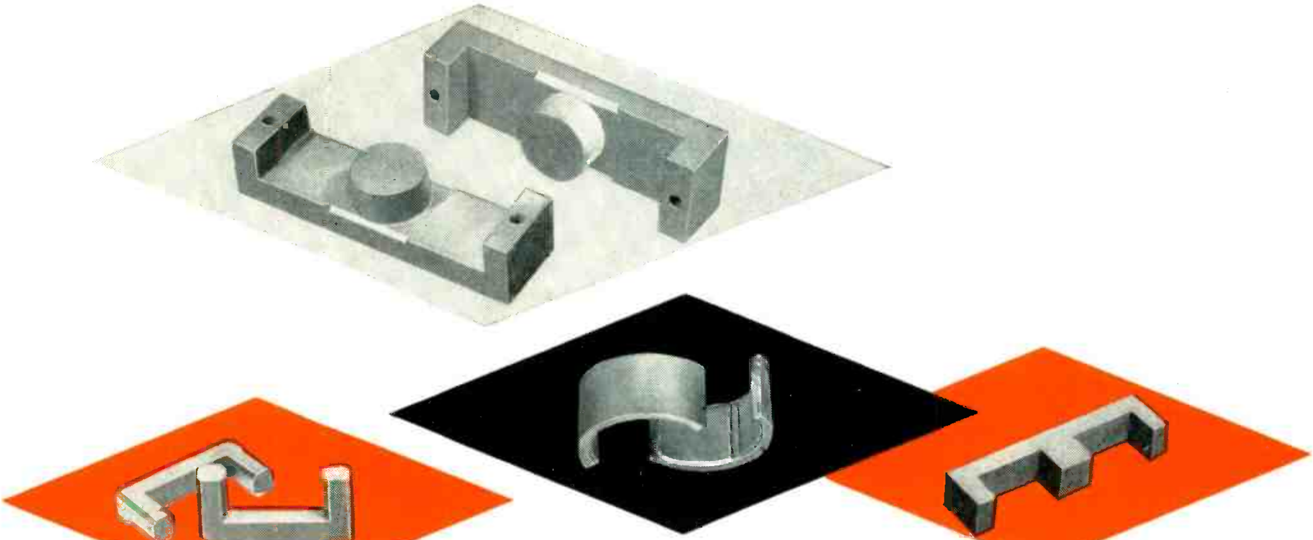
FIG. 4—Diagram showing sequence of operations within the speed-distribution recorder. The rear-wheel inhibitor blanks out signals from the roadway detectors long enough to permit the rear wheels to pass

binary counter may be used to cut off the counter input so that recycling will not occur. When counting is completed, a 0.1-sec negative signal is applied to the grid of the 6AK6 at the left in Fig. 2, raising the screen potential on the 6AK6's of stages 0 to m. This allows any of these tubes not biased to cutoff to conduct.

The only tube not biased to cutoff will be the 6AK6 associated with the 2D21 thyratron which has remained fired. When this 6AK6 fires, its associated electromechanical counter in series with the electromechanical counter for totals is energized and a record of the count in the appropriate class interval and a cumulative record of the number of items in all class intervals is produced. After the recording operation is completed, resetting signals are sent to the binary counter, the thyratron of recorder stage 0 and the thyratrons of the other stages.

The multiple-output predetermined counter and recorder described have been used as principal elements of a vehicle speed-distribution recorder.[3] In this instrument, block diagram in Fig. 3, the times required for vehicles to traverse a specified distance are translated into counts by means of a 1-kc gated oscillator.

Impulses from the roadway detectors pass through the rear-wheel inhibitor to open and close the gate. While the gate is open, pulses from the 1-kc oscillator pass through the gate into the multiple-output



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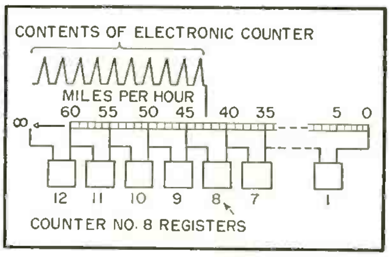

FIG. 5—Diagram showing typical electromechanical counter settings as set up by toggle switches on front panel of instrument

counter via bus *A*, as shown in Fig. 4. As the gate closes, counting is stopped and the recorder is set in operation. The recorder registers the counts, Fig. 5, on an electromechanical counter for the appropriate speed group.

Speeds are divided into twelve class intervals by setting up the time equivalents of the desired speeds. The upper panel of the instrument contains the electromechanical counters for the twelve class intervals and the total. The center panel contains the toggle switches for setting up the predetermined counter and the neon indicators for the binary counter. The lower panel contains the power-supply controls and meters.

Credit is due J. Robert Hall for most of the construction of the vehicle speed-distribution recorder.

REFERENCES

(1) John J. Wild, Predetermined Counter, ELECTRONICS, p 121, March 1947.
(2) Richard J. Blume, Predetermined Counter for Process Control, ELECTRONICS, p 88, Feb. 1948.
(3) Robert Bromberg and D. L. Gerlough, Applications of Electronic Techniques to Traffic Instrumentation, *Proc. Highway Research Board*, 28, p 348, 1948.

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BY FRANK A. BRAMLEY

Supervisor of Radio Maintenance
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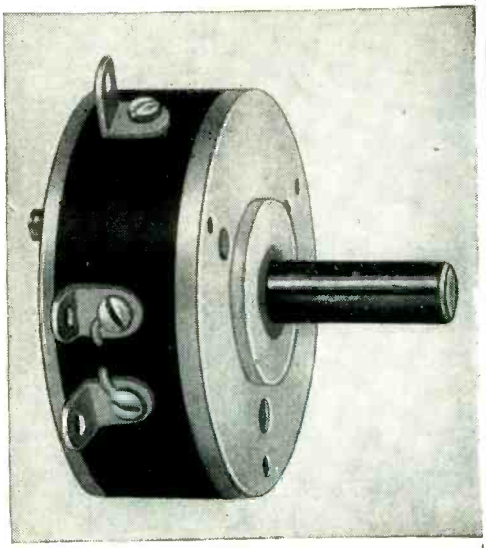

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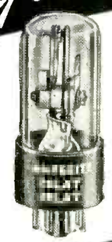

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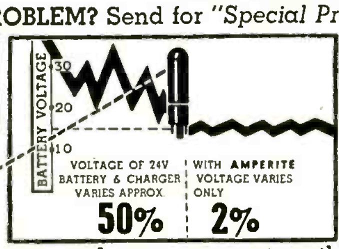

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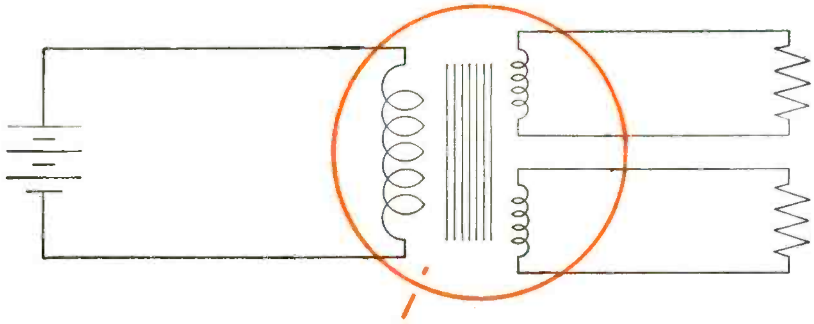

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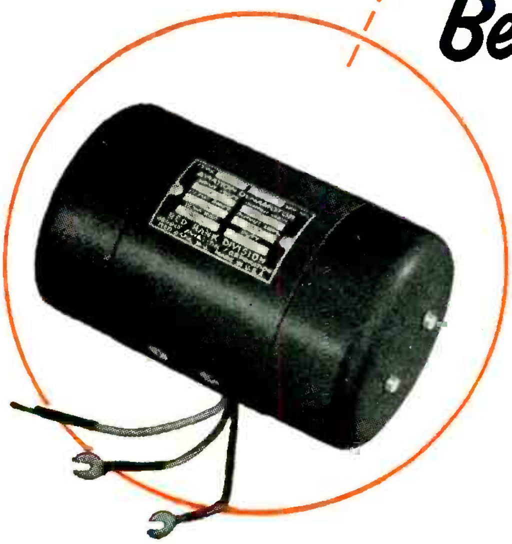

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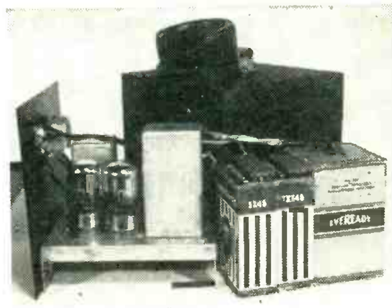

Chassis and case for the deviation test device

deviation measurements due to modulation very simple, but this solves only half the problem. If tone is used in making deviation tests the measurements are quite consistent, but with voice it is difficult to get the same results twice even with the same voice used to make all tests.

Preliminary tests with new type deviation meters prove that there are wide differences in the amount of deviation caused by various operators' voices even when compression or modulation limiters are used.

Older sets are usually not provided with any adjustments whatever and parts must be replaced in order to standardize the circuit. New sets with compression and limiter circuits provide some adjustment, but these circuits do not operate the same on tone as they do with voice. The amount of compression produced with tone differs just as deviation produced by tone differs from that produced by voice.

If average settings on a given piece of equipment are used, and the equipment has no limiter or compression circuits, a fair sample of voices will be found to cause deviations that vary up to twice the required deviation. Adjustments are difficult to arrive at in such cases and some means of standardization is essential.

In many early type f-m transmitters the adjustments provided to tune the oscillator circuit not only cause considerable center frequency change but can cause deviation changes from practically zero to as much as three times the required deviation.

The device to be described makes it possible for one man to make ac-

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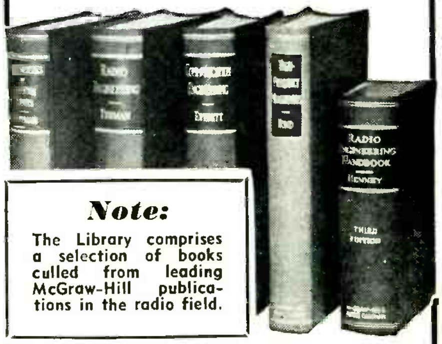

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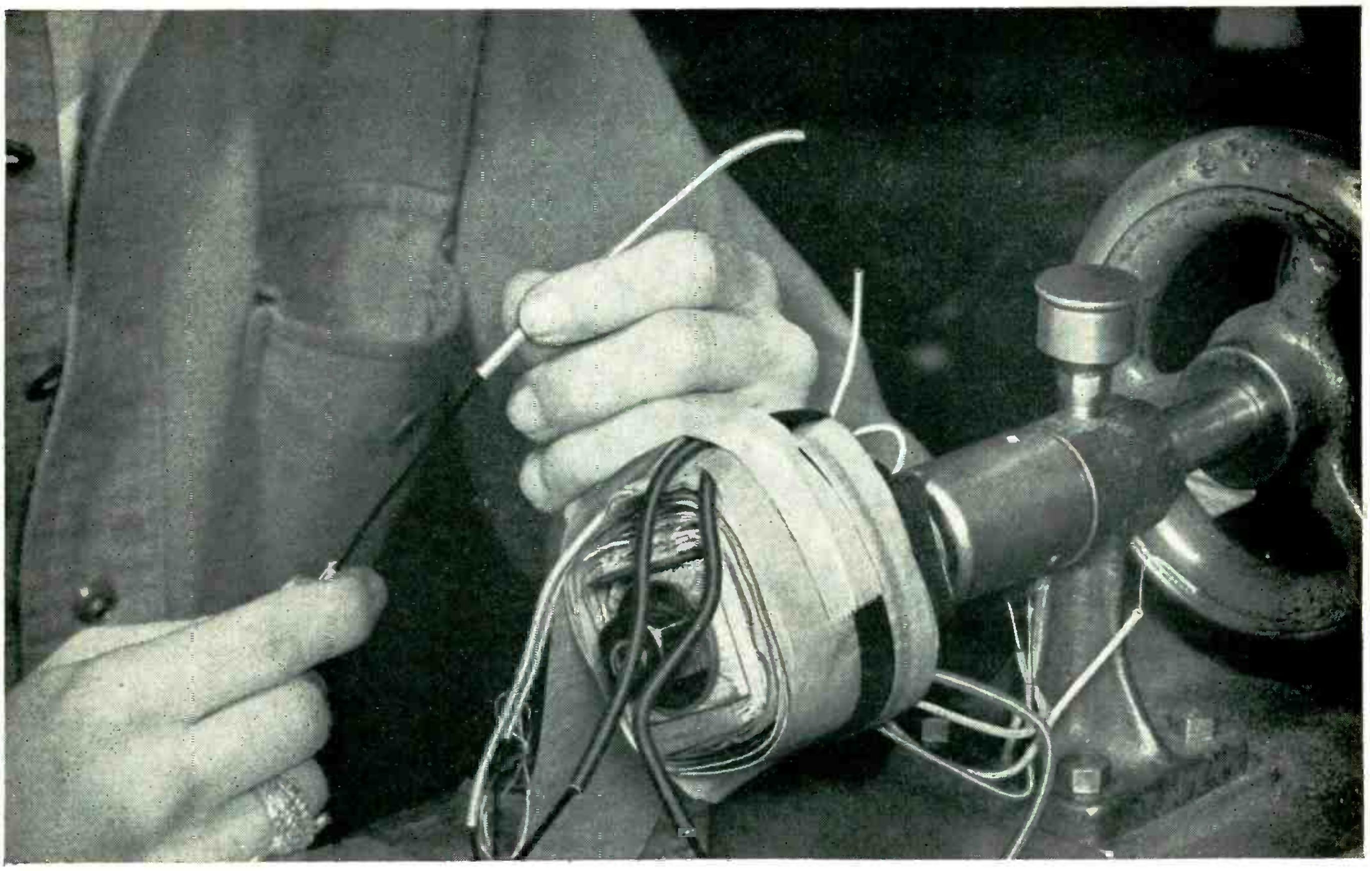

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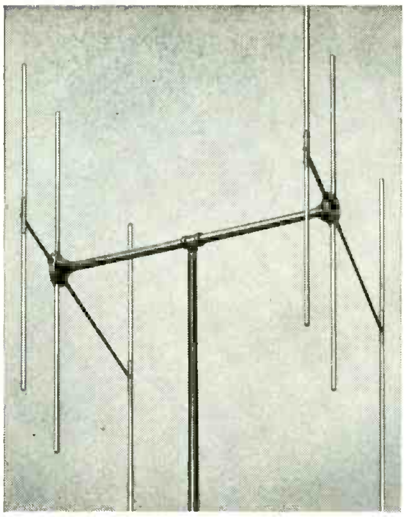

curate, consistent adjustments that can be standardized. It consists of a two-tube battery-operated complex tone generator arranged to start automatically when a microphone is inserted in a special holder, see Fig. 1.

Insertion of the microphone depresses a snap-action switch in the filament circuit of the instant-heating tubes. A headphone unit placed just below the holder supplies the microphone with a complex tone. A volume control is provided to adjust the output to a level that will cause a standard amount of deviation. A jack is installed for connection of an external db meter so that standard output can be maintained. The volume adjustment may be recessed or provided with a locking device.

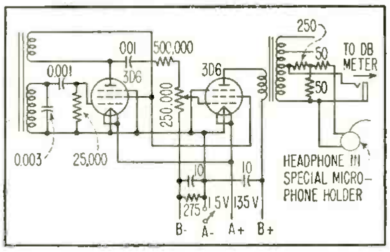

FIG. 1—Circuit of the complex tone generator

The oscillator-amplifier circuit used is not as simple as it might be but is stable and reasonably simple to build. It consists of a tickler-type feed-back oscillator and is adjusted by means of the grid-circuit constants to generate a complex tone having components over a wide band of frequencies. In this way the human voice is simulated to some degree and a more realistic measurement is provided.

The amplifier stage is necessary to isolate the transducer and volume-control circuits from the oscillator. Simpler circuits cause the tone to change when the volume is adjusted; the resistance-coupled amplifier eliminates this tendency.

The device shown was built to be used with Western Electric type-F3 handsets or the equivalent, but the circuit may be easily adapted to most other types of microphones.

It is important to place the microphone in a stable position over the reproducer. This can be further insured by mounting a leaf-actu-

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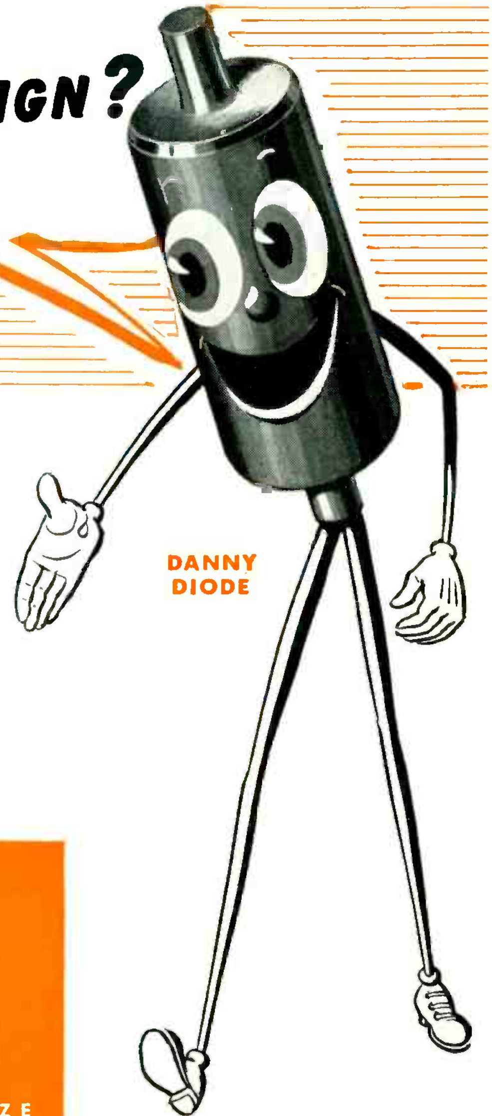

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Noise figure....................14 to 19 db*

*Measurements made with Measurements Corp. Model 84 Signal Generator, R.C.A. Model A Converter with 0.7 ma rectified local oscillator current and G-E Model 814 television receiver with television channel 3 used as IF frequency with noise band width of 3.5 mc. Noise figure is measured by noting signal required to double zero signal noise power output of converter. Similar measurements made on average 1N21B diodes indicated noise figure of 16 db.

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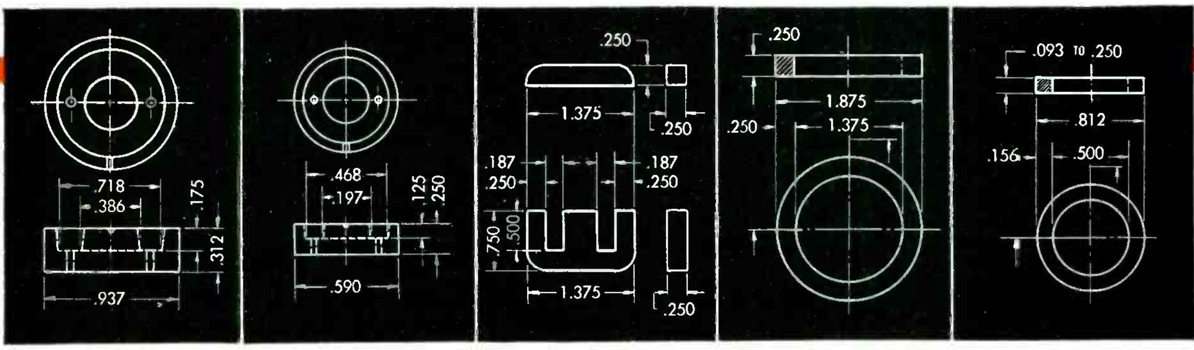
Saturation flux density	Gauss	840	1900	3800	3100	3800	3200	3400	1540	2900
Residual magnetism	Gauss	615	830	2700	1320	1950	1050	1470	660	1600
Coercive force	Oersted	3.7	3.0	2.1	1.0	0.65	0.25	0.18	0.40	.80
Temperature coefficient of initial permeability	%/°C.	0.65	0.04	0.4	0.3	0.25	1.3	0.66	0.3	0.22
Curie point	°C.	280	260	330	165	160	160	150	70	180
Volume resistivity	Ohm-cm	$1x10^9$	$2x10^5$	$2x10^3$	$3x10^7$	$4x10^5$	$1.5x10^8$	$1x10^4$	$2x10^5$	—
Loss Factor: at 1 mc/sec	—	—	.00016	.00007	.00005	.00008	.00008	.00030	.0003	.000055
at 5 mc/sec	—	.0004	.0011	.0008	.0012	.002	.00075	.00155	.005	—
at 10 mc/sec	—	.0005	—	—	—	—	.0017	.00275	—	—



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The reproducer is mounted inside the metal case just under the microphone holder and a hole is cut in the box to release the sound.

A gimmick may be fastened to the box by means of a short chain to hold the pushbutton down.

The oscillator transformer may be any low or medium-grade transformer having a turns ratio of two or three to one. Low-grade units usually oscillate better. It is not possible to specify the exact size of the other grid circuit components because they will be dependent on the transformer used.

The output transformer matches the output pentode to a pad in the 500-ohm range so that standard db meters can be used without a correction factor. The pad reduces the level and matches the 50-ohm earpiece.

Standard portable batteries fit within the case and since the device operates only when the microphone is inserted in the holder, battery life is long.

In deciding upon grid-circuit values, it may be helpful to view the waveform on an oscilloscope while listening to the reproducer. A pleasing tone of apparent medium frequency seems desirable, one that looks quite complex but does not have any one predominating component. Strong high frequency or supersonic components are undesirable and very low frequencies are unnecessary.

By comparing the deviation produced by this device with a number of average voices that produce satisfactory deviation, a standard setting can be reached. If compression and limiting are employed the result should be a satisfactory and uniform deviation for all units.

Antenna Installation for Stratovision Airplanes

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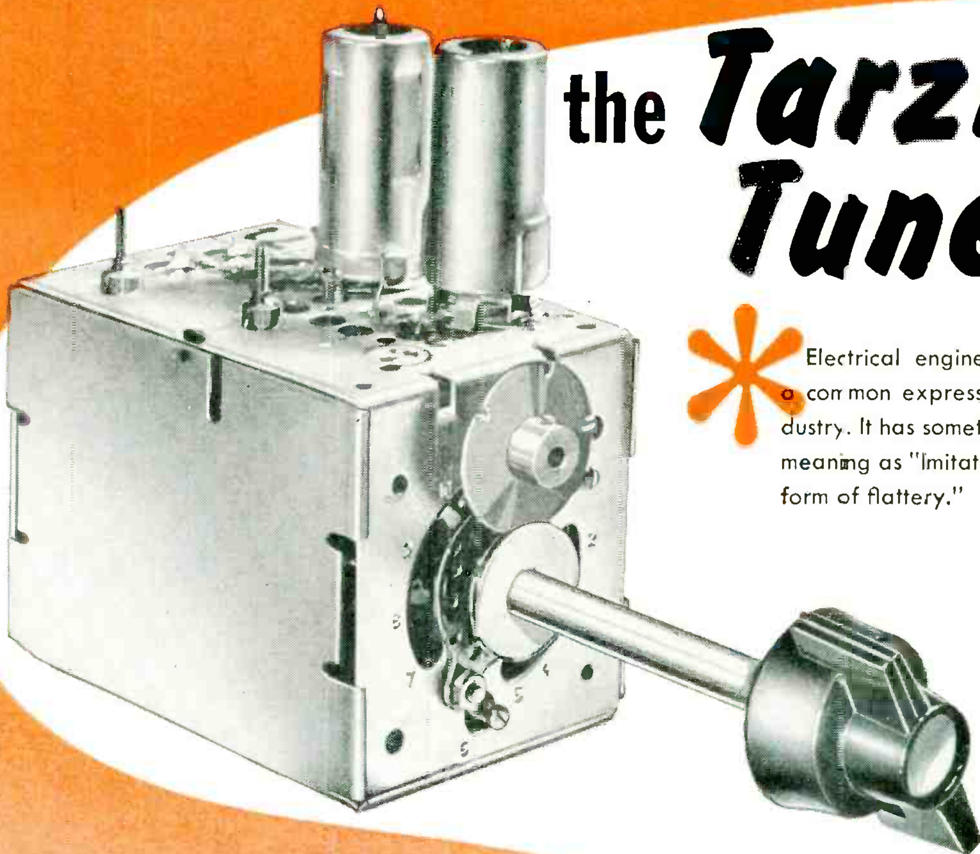

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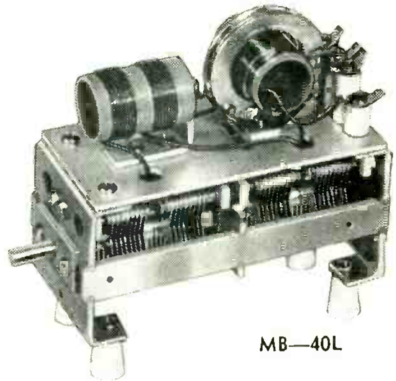

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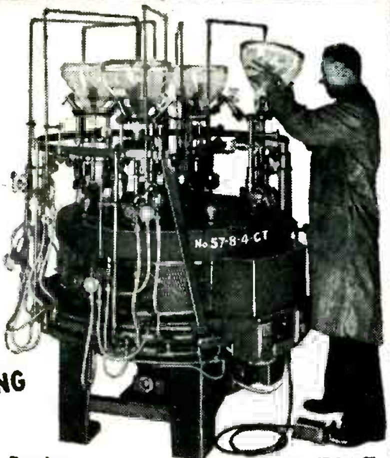

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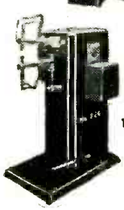

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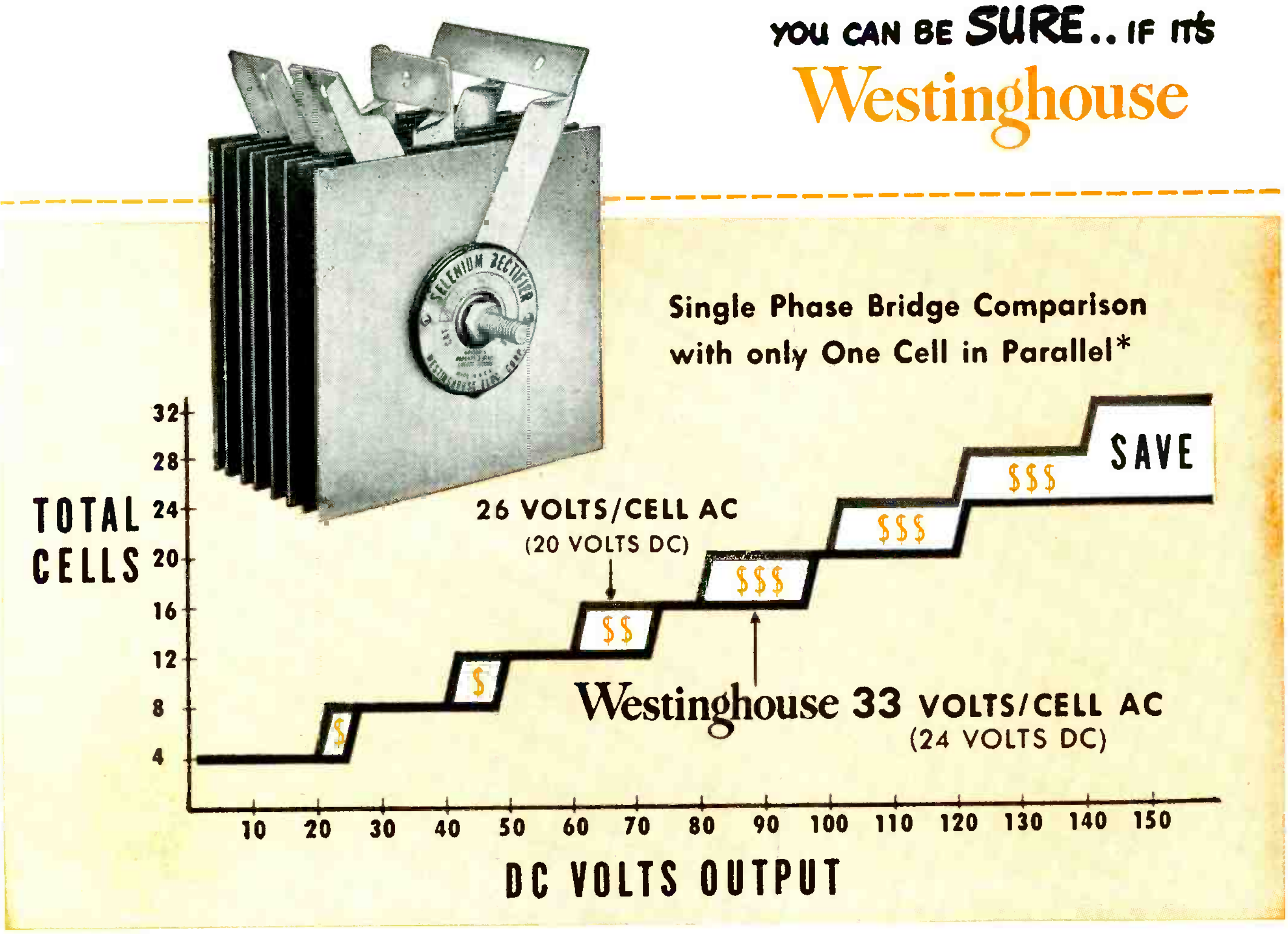

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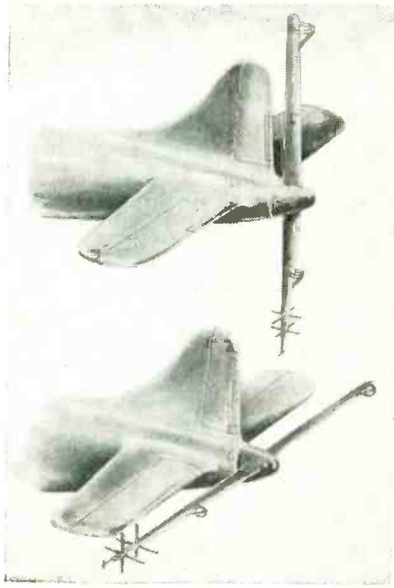

The new Stratovision antenna in vertical operating condition (above) and horizontal position (below) for landings, takeoffs and when plane is on the ground

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An antenna installation designed by Carroll H. Matson of The Glenn L. Martin Co. and recently patented possesses many advantages over installations previously developed.

The new installation provides a mast which will support an antenna below the airplane and at a point widely spaced from the wings and motors of the plane without interfering with landing. The mast is mounted for rotation so that it may be swung from a vertical operating position extending below the airplane to a horizontal landing position.

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Chief Engineer
Radio Stations WAAF, WAAF-FM
Chicago, Illinois

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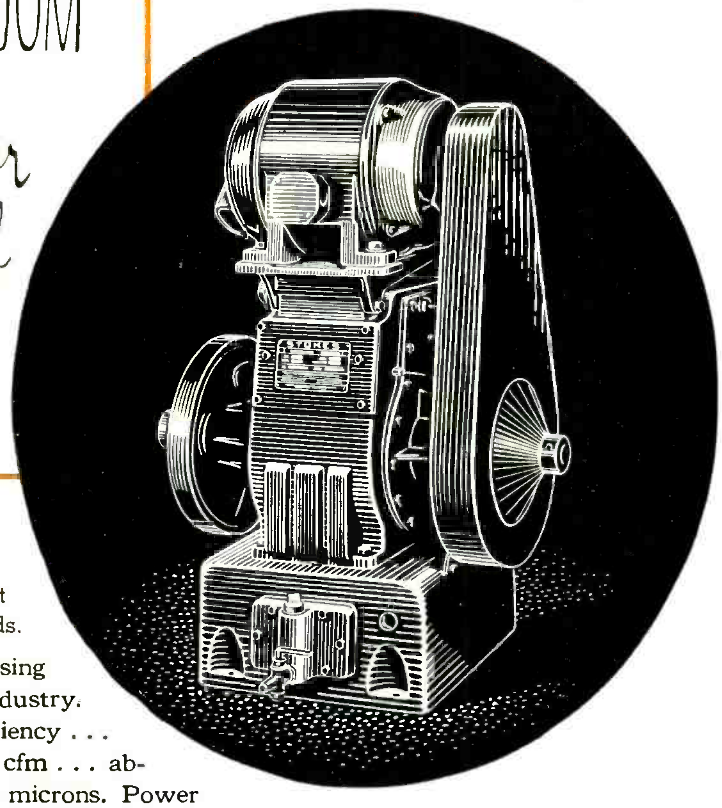

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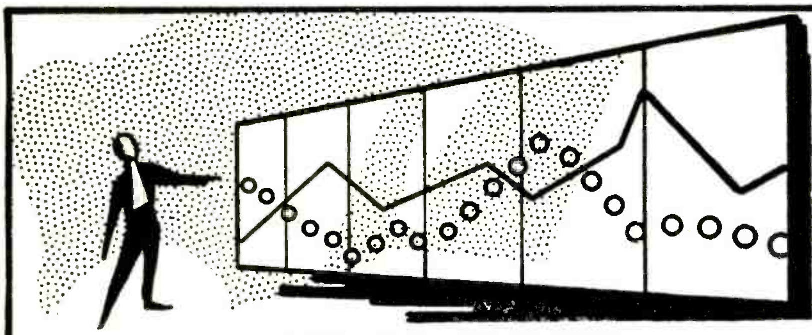

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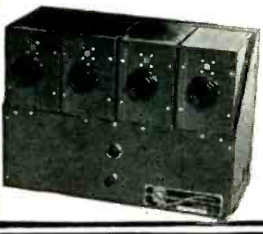

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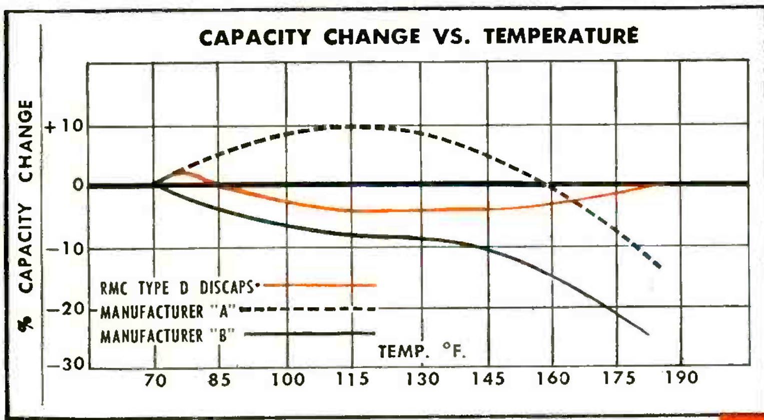

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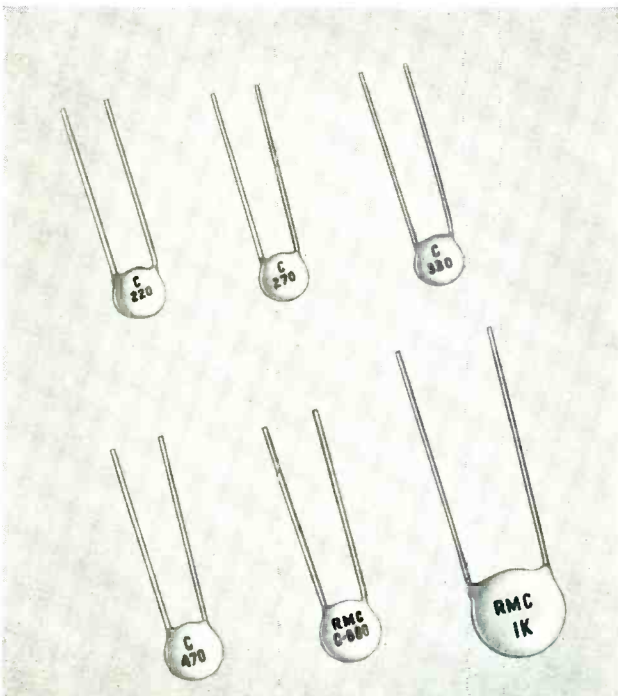

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Every DISCAP is 100% Tested for Capacity, Leakage Resistance and Breakdown

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Specify RMC Type D DISCAPS when a more stable capacity is required for coupling and by-passing in filter networks. The actual capacity between +75°F and +185°F is +1% at 75°F, −4% at 130°F and ±0% at 185°F.

These new Type D DISCAPS, available in a capacity range between 220 MMF and 1000 MMF with a tolerance of ±20% at 25°C offer the advantage of low self inductance, small size and low cost.

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TEST VOLTAGE	1200 V.D.C.
INSULATION	Durez Phenolic—Vacuum Waxed
RESISTANCE	Initial 5000 Megohms After Humidity 1000 Megohms
LEADS	#22 tinned copper (.026 DIA.)
BODY SIZE	220 MMF to 330 MMF 1/4" DIA. 330 MMF to 800 MMF 5/16" DIA. 800 MMF to 1000 MMF 1/2" DIA.
CAPACITY TOLERANCE	±20% at 25°C.

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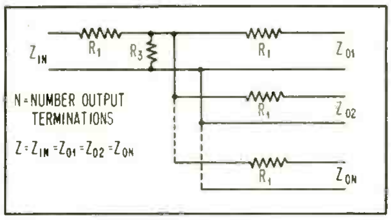

FIG. 1—Attenuator network for feeding one or more outputs from a single source

an input or an output. Thus a network designed to feed three outputs from one input can also be used to feed two inputs to two outputs or three inputs to one output.

The insertion loss between any two branches is equal to that between any other two branches. There is a certain minimum insertion loss dependent on the number of branches. The attenuator can be designed for any loss, equal to or greater than the minimum loss. This feature may be of value in controlling the degree of isolation between any two output branches.

Design Equation

Since input and output impedances are equal

$$\frac{E_{in}}{E_{out}} = \text{Log}_{10}^{-1} \frac{\text{db loss}}{20} = B$$

Insertion loss in db $= 20 \log_{10} \dfrac{E_{in}}{E_{out}} =$ $20 \log_{10} B$

$$Z_{in} = Z = R_1 + \frac{\left(\dfrac{R_1 + Z}{N}\right) R_3}{\dfrac{R_1 + Z}{N} + R_3} =$$

$$R_1 + \frac{R_3 (Z + R_1)}{Z + R_1 + NR_3}$$

From which,

$$R_3 = \frac{Z^2 - R_1^2}{Z - NZ + R_1 + NR_1}$$

$$\text{or } \frac{Z^2 - R_1^2}{(N + 1) R_1 - (N - 1) Z} \qquad (1)$$

$$\frac{E_{out}}{E_{in}} = \frac{1}{B} = \frac{\dfrac{R_3 (Z + R_1)}{Z + R_1 + NR_3}}{\dfrac{R_3 (Z + R_1)}{Z + R_1 + NR_3} + R_1} \left(\frac{Z}{Z + R_1}\right)$$

this reduces to,

$$R_1 (Z + R_1) = R_3 (BZ - Z - R_1 - NR_1)$$

substituting for R_3 the value obtained in Eq. 1

$$R_1 (Z + R_1) = \frac{Z^2 - R_1^2}{NR_1 + R_1 - NZ + Z} (BZ - Z - R_1 - NR_1)$$

or

$$R_1 = \frac{(B - 1) Z}{B + 1} \qquad (2)$$

(Continued on p 208)

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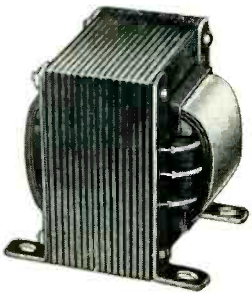

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The condition for minimum possible loss is realized when R_3 = infinity. This condition is obtained when the denominator of Eq. 1 = 0.

Equating the denominator to 0 and substituting for R_1 the value obtained in Eq. 2

$$(N+1)\frac{(B-1)Z}{(B+1)} - (N-1)Z = 0$$

$$B - N = 0, \qquad B = N$$

This means that the minimum possible loss is obtained when $B = N$. If B is less than N, R_3 will be negative and not physically realizable. If B is greater than N, R_3 will be positive and have a finite value. Therefore B may be equal to, or greater than N and the minimum possible insertion loss in db $= 20 \log_{10} N$

Pad Design

To design a pad using this method, determine the minimum insertion loss for the desired value of N output terminations.

Suppose $N = 4$, then minimum insertion loss in db $= 20 \log_{10} 4 = 20(.602)$ or 12 db

The pad may now be designed for any value of insertion loss equal to or greater than 12 db. Suppose a loss of 20 db is desired and $Z = 600$ ohms.

$$\text{Then, } B = \log_{10}^{-1}\left(\frac{20}{20}\right) = 10$$

$$R_1 = \frac{9}{11}(600) \text{ or } 490.9 \text{ ohms}$$

$$\text{and } R_3 = \frac{600^2 - 490.9^2}{5(490.9) - 3(600)} = 181.8 \text{ ohms}$$

For the special case where minimum loss is desired $B = N$ or 4

$$\text{and } R_1 = \frac{3}{5}(600) \text{ or } 360 \text{ ohms}$$

$$R_3 = \frac{600^2 - 360^2}{5(360) - 3(600)} = \text{infinity}$$

Thus it is evident that for the minimum loss condition, when $B = N$, resistor R_3 can be eliminated.

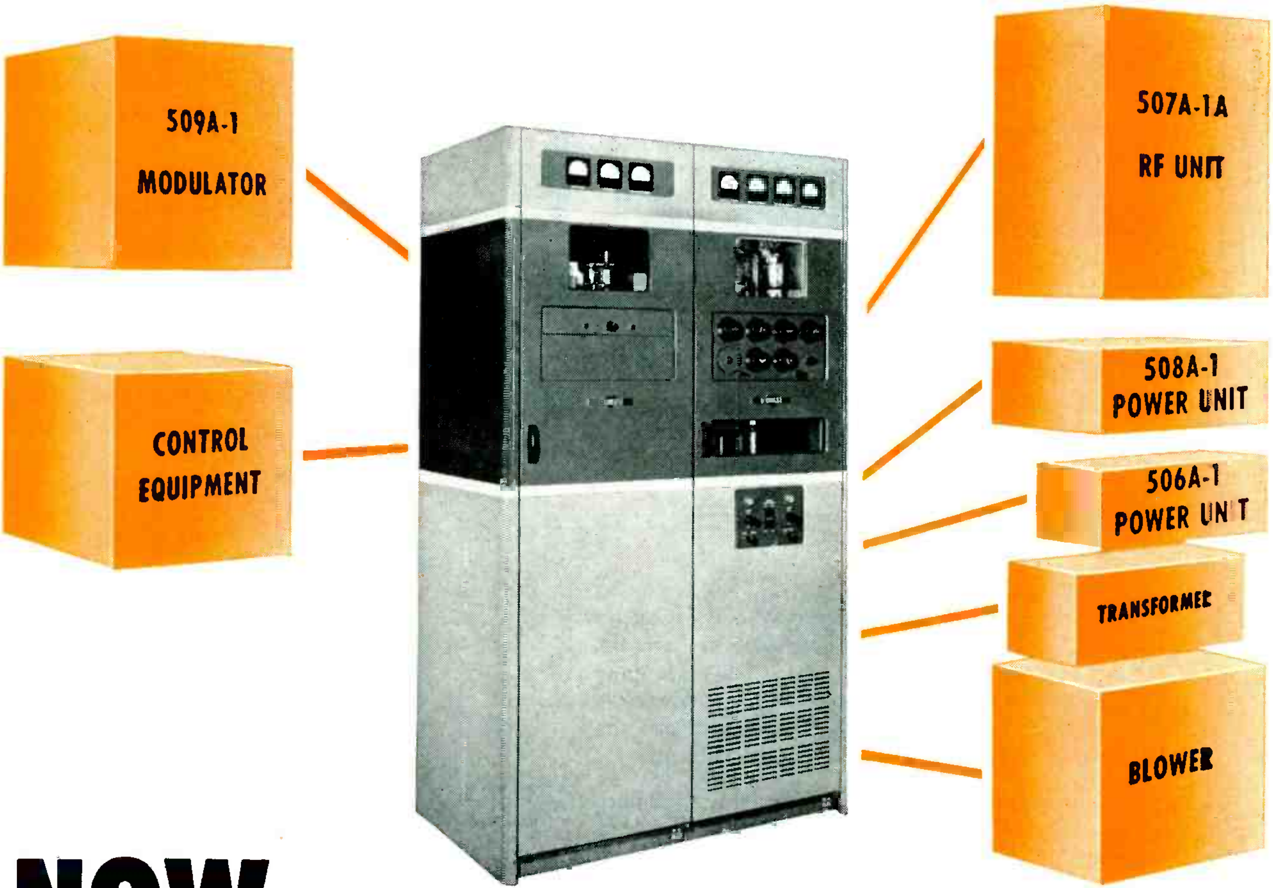
Another special case occurs when $N = 1$. If B is also 1 then $R_1 = 0$ and R_3 = infinity, and a direct connection is indicated without a network.

For any other value of B greater than 1, R_1 can be determined as before by means of Eq. 2.

Equation 1 reduces to

$$R_3 = \frac{Z^2 - R_1^2}{2R_1} \text{ or } \frac{Z^2}{2R_1} - \frac{R_1}{2}$$

It is believed that this method



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RF units can be supplied with or without Autotune* control. Manual tuned RF units may be worked in multiple to provide a multiplicity of fixed tuned instantly selectable channels or simultaneous transmissions on two or more frequencies.

Among the combinations available are the Type 431D one kilowatt, ten channel CW-FSK and phone autotuned transmitter illustrated here. It is made by combining a 507A-1A RF unit, a 506A-1 power unit, a 508A-1 power unit, a 509A-1 modulator unit, a 2-bay cabinet and a 1 KW blower.

Another combination, not illustrated, is the Type 434B-1 one KW, two simultaneous-channel CW-FSK only, manual tuned transmitter, which is made by combining two 507A-1 RF units, two 506A-1 power units, a 508A-1 power unit, a 2-bay cabinet, and a 1 KW blower. Several other combinations are available, one of which is certain to satisfy your exact needs.

Final assembly, and testing, may be accomplished at the Collins plant or at the installation site. We will be glad to give you details about the 430 series transmitter to fulfill your own requirements.

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involves less computation for T pads having equal input and output impedances.

To convert to balanced attenuators simply use $\frac{R_1}{2}$ on each side of the terminations instead of R_1 on one side.

Wide-Band Amplifier for Central Antenna Installations

By J. B. CRAWLEY

Chief Engineer
Station WTCO
Campbellsville, Ky.

ADDITIONAL AMPLIFICATION is needed in central antenna locations such as display areas of radio stores and final test areas in radio-receiver production to overcome the inherent high noise level produced by streetcar lines, neon signs and fluorescent lighting systems. Signal strength of the desired station may also be weak because of steel building structures which decrease signal-to-noise ratio.

This problem has been magnified in recent years because of the increased use of built-in loop antennas in radios. Connecting an outside antenna might work in some cases but in others would offer little improvement.

The circuit shown in Fig. 1 was designed to solve this interference problem. The system consists of an antenna installed as far away from the noise field as possible. It may

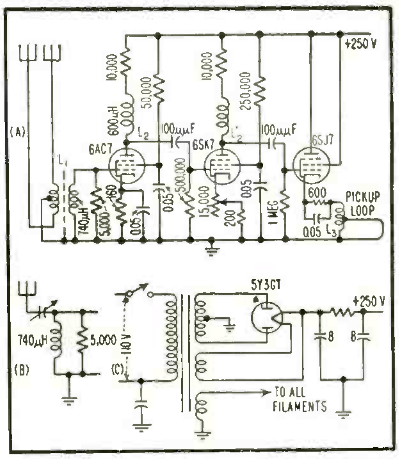

FIG. 1—Circuit of wide-band amplifier with noise-rejecting doublet antenna (A), alternate lead-in for straight-wire antenna (B) and amplifier power supply (C)

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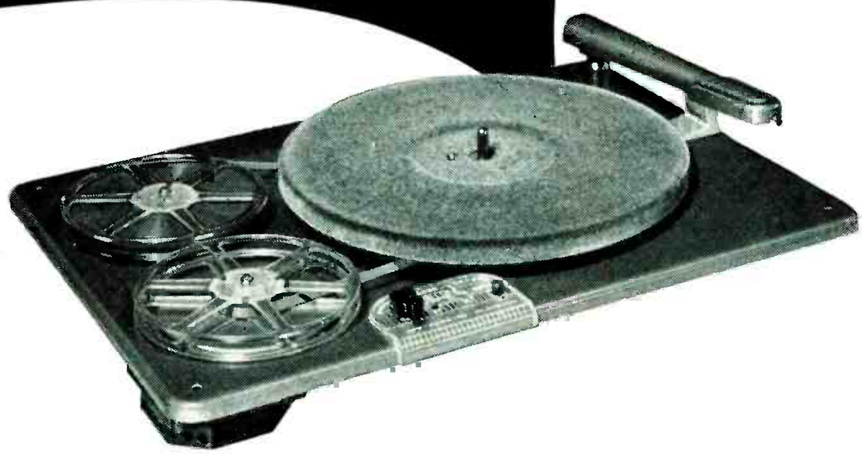

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be a noise-rejecting doublet type or preferably the straight-wire type because most noise is horizontally polarized in contrast to the broadcast signal which is vertically polarized.

Coil construction details for the circuit are as follows: L_1 secondary is made up of 255 turns on 1-in. form in a 2-in. winding space, the primary is 20 turns center tapped; L_2 and L_2' are made up of 213 turns of No. 38 enameled wire on a 1-watt 500,000-ohm resistor and L_3 is made up of 92 turns on ½-in. form in a 1½-in. winding space with the tap 37 turns from ground.

The system has a balanced lead-in and an input transformer to the amplifier with a Faraday shield between primary and secondary. The amplifier itself is a two-stage high-gain broad-band amplifier followed by a cathode-follower stage.

Circuit

Design of the amplifier section is similar to the front end of many broadcast sets employing untuned r-f stages. A 6AC7 is used in the first stage to provide high gain. The second stage is a 6SK7 or similar remote-cutoff type. Remote cutoff is necessary because the gain control is incorporated in the second stage and a sharp-cutoff tube might show nonlinearity with a resultant garbling of signals.

The amplifier is designed to cut off slightly above the broadcast band. By changing the values of the plate resistors and the peaking coils, shortwave coverage may be obtained. However the over-all gain of the amplifier would be less.

To couple the amplifier output to the loop antenna of the receiver or receivers without a physical connection, a low-impedance output loop is used. This stage is matched by a 6SJ7 operated as a cathode follower fed to a single-turn loop.

The output loop may consist of any reasonable length of wire running under a shelf or table near the sets to be operated. It acts as the primary of a coil which inductively couples the signal into the secondary or loop of the receivers.

Care must be taken to prevent regeneration by keeping the input and output wires of the amplifier

from running side by side. A wave trap may be installed if a strong local station should tend to overload the amplifier.

Tests made on a five-tube Sentinel radio showed that with the volume control set at normal it was possible to receive six stations fairly well and four others were barely audible. Turning on the amplifier allowed the same set to receive a total of 18 stations without noise.

Electronic Christmas Tree

A GRADUATE STUDENT of Case Institute of Technology, Richard C. Hahn, designed an electronic Christmas tree with its lights thyratron-controlled to respond to Christmas carols for Tomlinson Hall of the school's campus.

The electronic tree graduates color and brightness of five dozen bulbs while its color organ amplifies traditional music. The control mechanism sorts out the music signals into bass, middle range and treble frequencies. Blue lights on the tree are controlled by bass tones, yellow by the middle range and red by treble.

The device consists of three a-f filters feeding their output into a phase-shift thyratron control circuit which, in turn, controls the firing of a thyratron regulating lamp brightness.

New Version of Schering Bridge

BY JOHN H. JUPE
Middlesex, England

A VARIATION of the Schering bridge, an instrument commonly used for measuring capacitance and power loss in dielectrics at high voltages, has been developed here.

The bridge is intended for use at voltages up to 200,000 and has visual indication of the null condition. To obtain high sensitivity and to avoid the use of an a-c galvanometer, the detector unit was designed with a three-stage R-C coupled amplifier, a thermionic rectifier and

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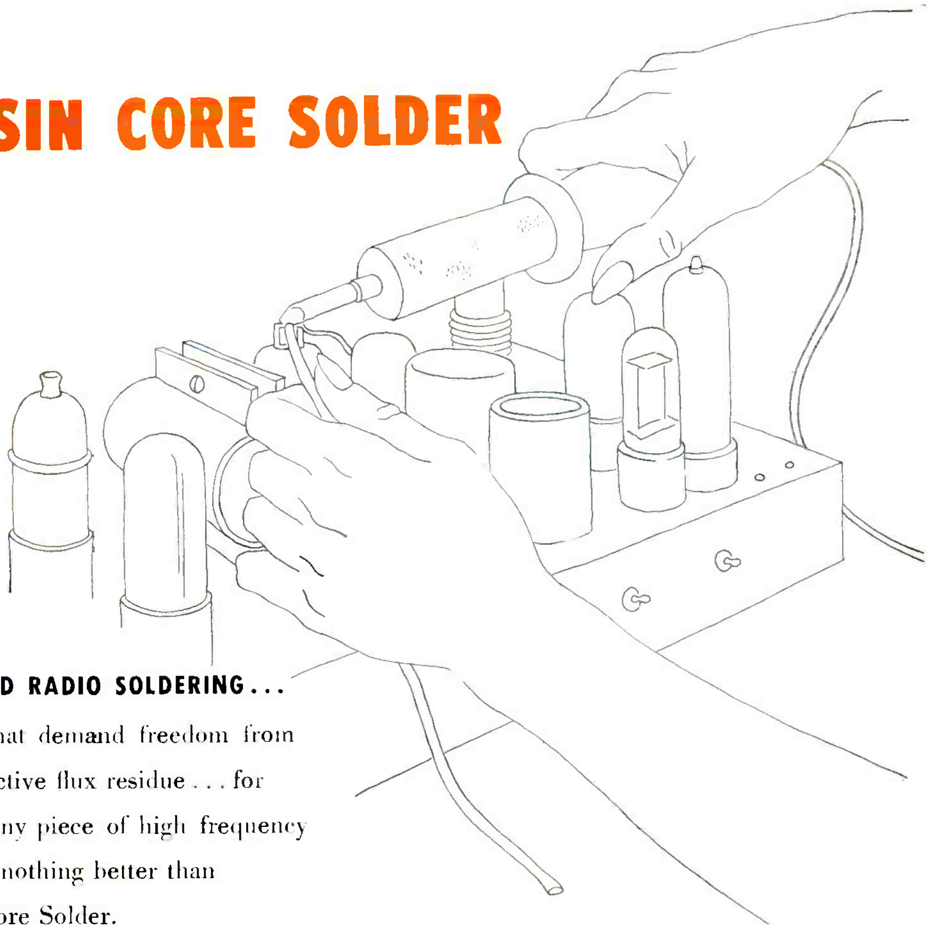

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a d-c moving-coil milliammeter.

The first stage of the amplifier has a feedback filter in order to attenuate any harmonics that may be present. A parallel-T filter between the second and third stages provides a frequency-selective feedback circuit. Variable sensitivity is provided by means of a potentiometer located between the last amplifier stages.

Cathode-follower networks are employed between the bridge, test specimen and standard capacitor to counteract the effects of stray capacitance and the capacitance of connecting cables.

The type of decade switch in the variable arms of the bridge must be considered carefully if accurate and consistent results are to be obtained. Also, inductive loops must be kept to a minimum.

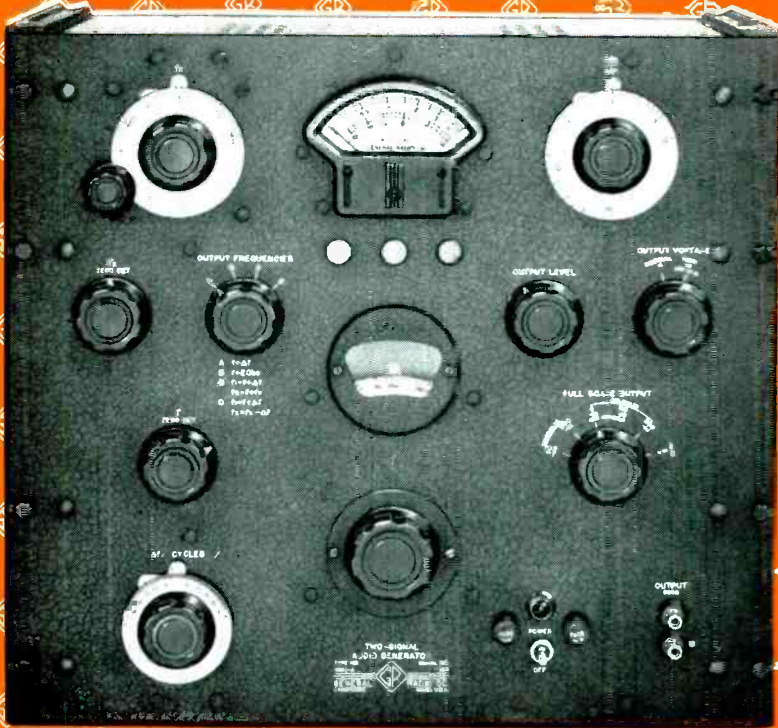
The power supply unit used with the bridge is designed to supply smooth d-c to the detector unit and to the cathode-follower networks housed in the ratio-arm unit. Direct filament voltage is supplied to tubes in the ratio-arm and detector units so that any interference with the detector because of a-c pickup and hum will be eliminated. This arrangement permits the use of separate a-c supplies for the detector and high-voltage parts of the bridge.

The high-voltage arms of the bridge, comprising the standard capacitor and test object, are placed in a protected test area remote from ratio-arm and detector units.

Spark-gap protective devices are mounted on both the standard capacitor and test object.

The standard capacitor has a value of 98.5 $\mu\mu$f and can withstand 200,000 volts rms. It consists of two concentric polished brass cylinders mounted vertically and housed in an insulating cylinder. The inner tube is the high-voltage electrode and is supported from a top casting. The outer tube is the low-voltage electrode and is connected to the center pin of a socket mounted on the base of the capacitor.

Guard rings arranged at the termination of the low-voltage electrode are used for stress control. Metal shields minimize the effects of stray capacitance. The dielectric is dry nitrogen at 200 psi.



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TWO-SIGNAL GENERATOR
$1050

a *New* Two-Signal Audio Generator

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The new G-R Type 1303-A Two-Signal Audio Generator supplies signals by the beat-frequency method. Three oscillators and three mixers are used to provide a number of output-signal combinations. The output of the mixers are combined in a linear adding network and then amplified through a very low-distortion power amplifier. The output from the amplifier is fed into a 600-ohm attenuator system, with a voltmeter to monitor the level at the input of the attenuator. The harmonic content and inter-modulation products in the final output are at a very low level. High stability of voltage and frequency are provided. The frequency drift from cold start is only a few cycles.

This A-F Signal Generator will supply the following signals:

- A single low-distortion sinusoidal voltage, adjustable in frequency from 20 cycles to 40 kilocycles, in two ranges.
- Two low-distortion sinusoidal voltages, each separately adjustable, one to 20 kc and the other to 10 kc.
- Two low-distortion sinusoidal voltages with fixed difference in frequency maintained between them as the frequency of one is varied. The fixed difference frequency is adjustable up to 10 kc, and the lower of the two frequencies is adjustable up to 20 kc.

The output is continuously adjustable and is calibrated both in volts and in db with respect to 1 mw into 600 ohms. The frequency calibration can be standardized within one cycle at any time. Its accuracy is ± (1% + 0.5 cycle).

This generator is an excellent and versatile signal source for the three standard non-linear distortion tests:

1. The widely used harmonic distortion test.

2. The intermodulation method that evaluates distortion in terms of the resultant modulation of a high-frequency tone by a low-frequency tone.

3. The difference-frequency intermodulation test, which evaluates distortion in terms of the amplitude of the difference-frequency components produced by intermodulation of two sinusoidal test signals of equal amplitude.

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THE ELECTRON ART
(continued from page 126)

balancing motor will rotate in a direction determined by the phase of the servo amplifier output. By appropriate circuit arrangement, the motor can be made to rotate the grid bias potentiometer in the direction necessary to compensate for the existing drift.

An Incremental Delay Pulse Generator

By G. Franklin Montgomery

Radio Engineer
Ionospheric Research Section
Central Radio Propagation Laboratory
Washington, D. C.

A PULSE GENERATOR was completed in the summer of 1949 at the Central Radio Propagation Laboratory of the National Bureau of Standards for use in high-frequency radio propagation experiments.

Operation of the instrument depends on the combination of a series of harmonic waveforms to generate a waveform of fundamental frequency and variable phase[1].

Spaulding and Rod[2] have described a loran indicator using this method, and the technique itself has been discussed by Freas[3]. The CRPL generator or a modification may be useful for radar range calibration or in any application where delay times must be measured, and therefore this description has been prepared.

The generator is driven by the

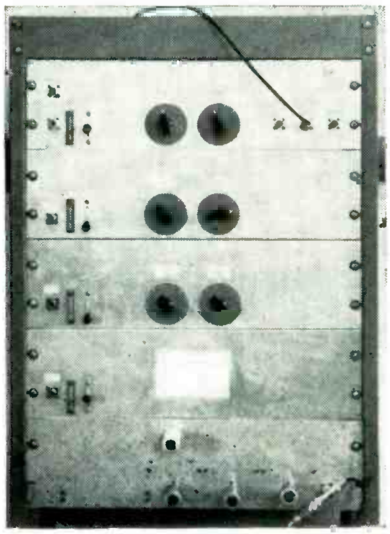

FIG. 1—Front panel view of incremental delay pulse generator. Three coax outlets at upper right provide reference pulse and two pulses of variable phase

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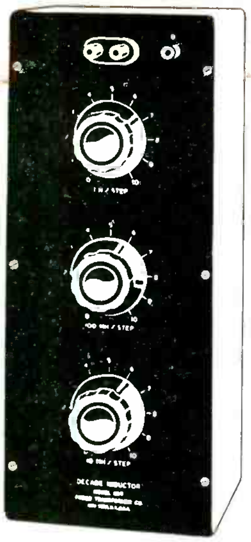

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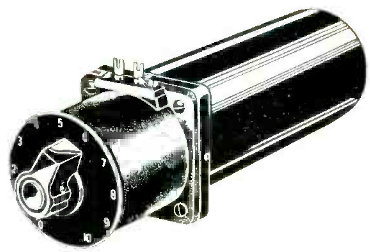
Special silver alloy contacts insures very low con-tact resistance.



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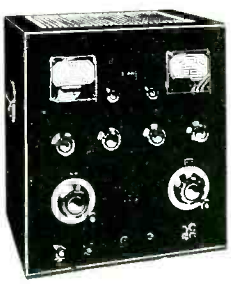

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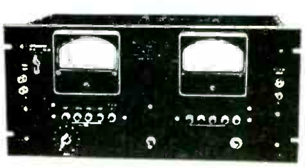

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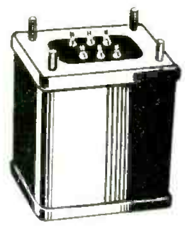
FREQUENCY RANGE 100-2000 CYCLES — Q = 80 @ 500 CYCLES					
#1341	DECADE INDUCTOR	100	Henry total in steps of	10	Henry
FREQUENCY RANGE 500-20,000 CYCLES — Q = 60 @ 1000 CYCLES					
#1160	DECADE INDUCTOR	11.1	Henry total in steps of	.01	Henry
#1163	DECADE INDUCTOR	1.11	Henry total in steps of	.001	Henry
#1260	DECADE INDUCTOR	11.11	Henry total in steps of	.001	Henry
FREQUENCY RANGE 500-20,000 CYCLES — Q = 160 @ 1000 CYCLES					
#1220	DECADE INDUCTOR	.01	Henry total in steps of	.001	Henry
#1230	DECADE INDUCTOR	.1	Henry total in steps of	.01	Henry
#1240	DECADE INDUCTOR	1	Henry total in steps of	.1	Henry
#1260	DECADE INDUCTOR	11.11	Henry total in steps of	.001	Henry
#1270	DECADE INDUCTOR	10	Henry total in steps of	1	Henry
#1280	DECADE INDUCTOR	1.11	Henry total in steps of	.001	Henry
#1290	DECADE INDUCTOR	11.11	Henry total in steps of	.001	Henry
#1310	DECADE INDUCTOR	11.1	Henry total in steps of	.01	Henry
FREQUENCY RANGE 2000-50,000 CYCLES — Q = 200 @ 10,000 CYCLES					
#1161	DECADE INDUCTOR	1.11	Henry total in steps of	.001	Henry
FREQUENCY RANGE 10,000-300,000 CYCLES — Q = 200 @ 100,000 CYCLES					
#1162	DECADE INDUCTOR	.111	Henry total in steps of	.1	millihenry

*#1164 DECADE INDUCTOR is wound on a special nickel alloy core.



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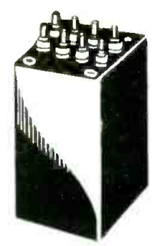

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output of a 100-kilocycle oscillator. Three pulse outputs at 25 pulses per second are provided—a reference pulse of constant phase, and two pulses whose phases may be adjusted independently to any part of the 40-millisecond period in 0.1-millisecond steps. A marker scale output provides selectable markers at 0.1, 1, 10, and 40-millisecond intervals, and a 50-cycle counter and amplifier are included to power a 50-cycle clock.

Figure 1 is a front panel view of the instrument. The three coaxial connectors at the upper right furnish the reference pulse and the two variable-phase outputs. Two vertical sets of three decade dials in the panel center are used to set the delay from the reference pulse in steps of 10, 1, and 0.1 milliseconds. The coaxial connectors along the left edge furnish marker scale and auxiliary synchronizing outputs, and markers are selected by means of the adjacent toggle switches.

Synthesis Principle

Consider a voltage e_1 of rectangular waveform having a frequency f_1 and duty cycle $1/N_1$ (see Fig. 2). Voltage e_2 has a frequency f_2 (greater than f_1) and duty cycle $1/N_2$. Now suppose that e_2 is passed through an amplifier that is gated on by e_1. Then in order that one, and only one, pedestal of e_2 shall appear in the amplifier output per cycle of e_1, it is necessary that the period

$$\frac{1}{f_2} = \frac{1}{N_1 f_1}$$

and therefore

$$f_2 = N_1 f_1 \qquad (1)$$

But if the pedestal is to appear at the same point in each successive gate, N_1 must be an integer. Thus f_2 is a harmonic of f_1. (Over a cer-

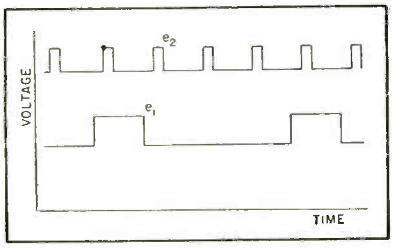

FIG. 2—Basic waveforms illustrate synthesis principle

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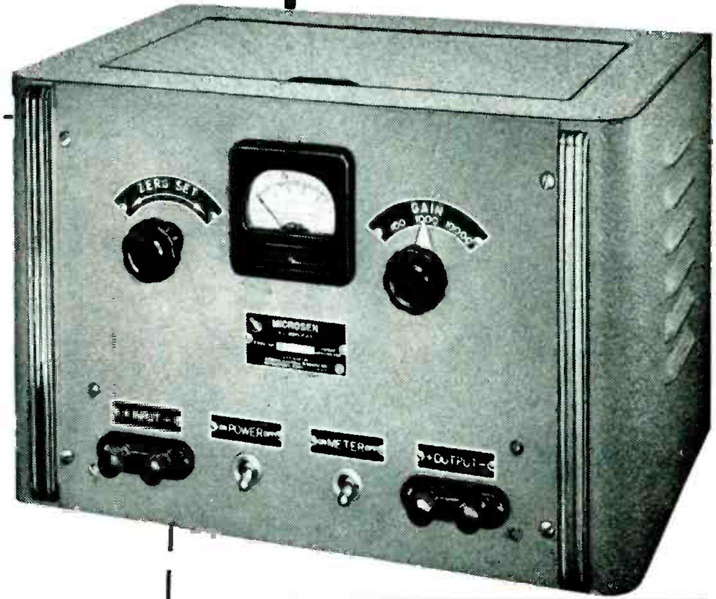

Simple in operation, the Microsen D. C. Amplifier is designed to meet the need for stable and accurate amplification. It is compact to provide easy portability and convenient general use, is moderate in cost. The amplifier has many applications in both laboratory and field work. Three different ranges are furnished in a single model. The Microsen Balance, an electro mechanical feedback amplifier, combines the advantages of high torque to current input ratio with rugged, shock-resistant construction. Available models include Voltage, Current and Potentiometer Type Amplifiers, Direct Current Converters, Direct Current Transformers, and Engineered Designs to meet special requirements.

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Photometry	Photo Cell	Recorder	Polarimetry Physiology of Blood Fluid Flow & Turbulence Density	Stability Sensitivity Responsive Accuracy
Gas Analysis	Catalytic Filament Thermocouple	Recorder	Detecting Explosive Mixture Efficiency of Filters Mixture Control	Sensitivity Stability Accuracy High Speed Response
Electrical Bridges	Resistors Resistance Elements	Recorder	Resistor Inspection Moisture Detection Conductivity Measurements	Sensitivity Stability Accuracy Fast Response
	Pirani Gauge		Vacuum Gauging	Stability
	Strain Gauge		Transient Stresses	Accuracy
Electronics	Inductance Ionization Thermionic	Recorder	Wave Guide Studies Vacuum Gauging Tube Development	Sensitivity Stability Low Resistance Input
Electrolysis	Electrolytic Cells Current Shunt	Recorder	Production Control Electrolytic Plating Electrolytic Process	Isolated Input Stability Accuracy

In each of the above applications, the Recorder could be replaced with a suitable milliammeter indicator, or the output can be used to actuate automatic control relays or signal devices. Inquiries for modification within the useful scope of the Microsen D. C. Amplifier are invited. If possible, such inquiries should contain complete application specifications.

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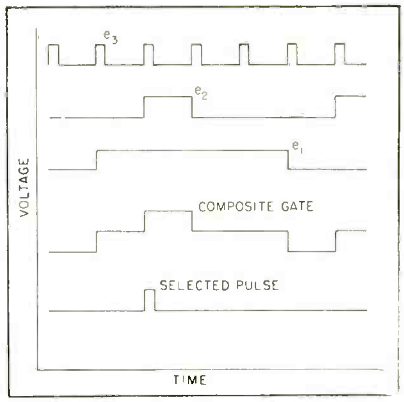

FIG. 3—Coincident leading edges for e_3 and e_2 prevent pulse splitting

tain range of positions the pedestal appearing within the gate may be split, a part of one pedestal appearing at the end of the gate and the corresponding remainder of the previous pedestal appearing at the beginning.)

This argument can be extended to a series of any number of harmonic rectangular waveforms; for, if a harmonic voltage e_n is gated by the peak voltage of a sum of e_1 and harmonic voltages e_k such that

$$f_k + 1 = N_k f_k \quad k = 1, 2, \ldots, (n-1) \qquad (2)$$

then one, and only one, pedestal of e_n will appear per cycle of e_1. This result is illustrated in Fig. 3.

A consequence of Eq. 2 is that

$$F_n/f_1 = N_{n-1} \ldots N_2 N_1 \qquad (3)$$

If the phases of the fundamental and harmonic voltages comprising the gate are independently adjustable, then f_n/f_1 is the number of possible positions of the e_n pedestal within the e_1 period. If, as in Fig. 3, the phase adjustments are so constrained that each low-frequency pedestal has a leading edge coincident with a leading edge of e_n, it will be impossible for a split e_n pedestal to appear; the number of possible positions of the pedestal remains the same.

The Circuit

In the CRPL generator, $n = 4$, $f_1 = 25$ cps, $N_1 = 4$, $N_2 = 10$, and $N_3 = 10$. The instrument is essentially a frequency divider consisting of a cascade of ring counters of the type described by Sharpless[4]. Ring counters divide an in-

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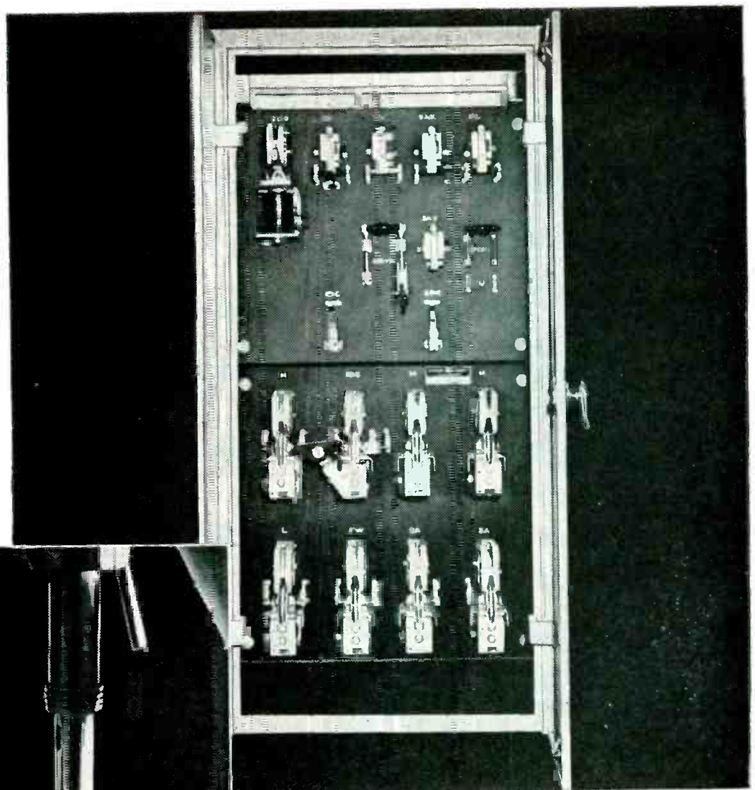

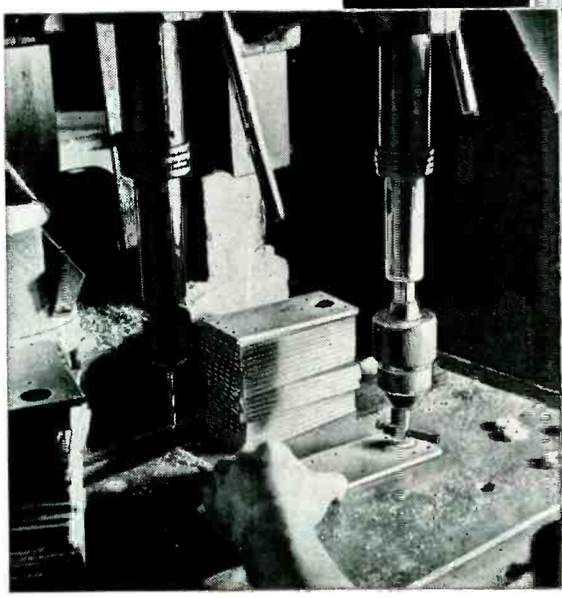

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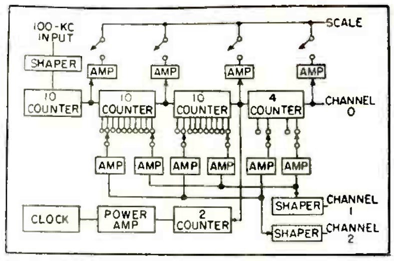
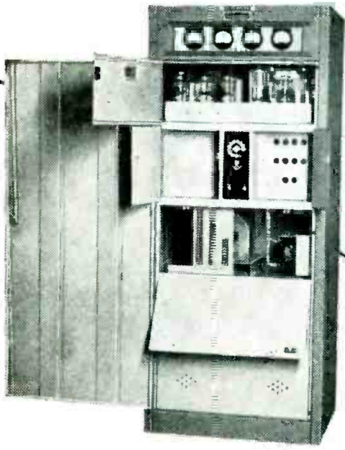


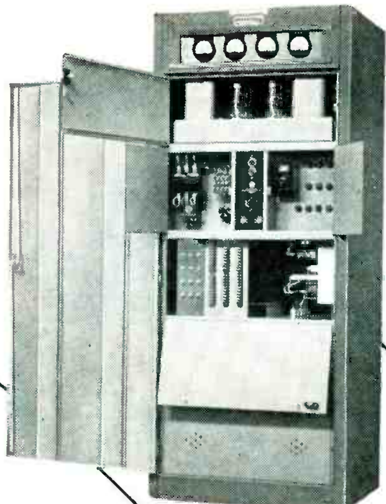
FIG. 4—Block diagram of incremental delay pulse generator

coming frequency by a count N equal to the number of units in the ring, each unit being in operation for $1/N$ times the counting period. Such a counter is therefore ideal for generating the rectangular waveforms required for synthesizing the incrementally delayed pedestal.

A block diagram of the generator is shown in Fig. 4. An initial count-of-ten provides the 10-kc input to the delay portion of the circuit. Plug-in scale-of-two counters using type 12AU7 or 12AT7 tubes form the last two count-of-ten rings and the count-of-four. Connections are made to the normally cut-off plates of the scale-of-two counters in each ring, and these connections are arranged on a tap switch, seen as one of the dials in Fig. 1. The movable contact on this switch receives a variable-phase pedestal which is added in a mixing stage to the pedestals from the two other rings. This sum voltage is connected to a clipper stage that responds only to the peak of the sum. The clipper output is therefore a 25-per-second pedestal, 0.1 millisecond long, that is variable in phase in 0.1-millisecond steps.

In this case, the gating action has been accomplished by simple clipping rather than by actually gating an amplifier stage. In Fig. 4, clipping and differentiating operations are represented by the blocks labeled shaper. The leading edge of the pedestal is differentiated and amplified to form the output pulse. Two such channels are furnished. With suitable isolation, any number of independent channels could be provided. Without isolation, continued addition of connections directly to the plates of the ring counter will increase shunt capacitance at each plate and eventually





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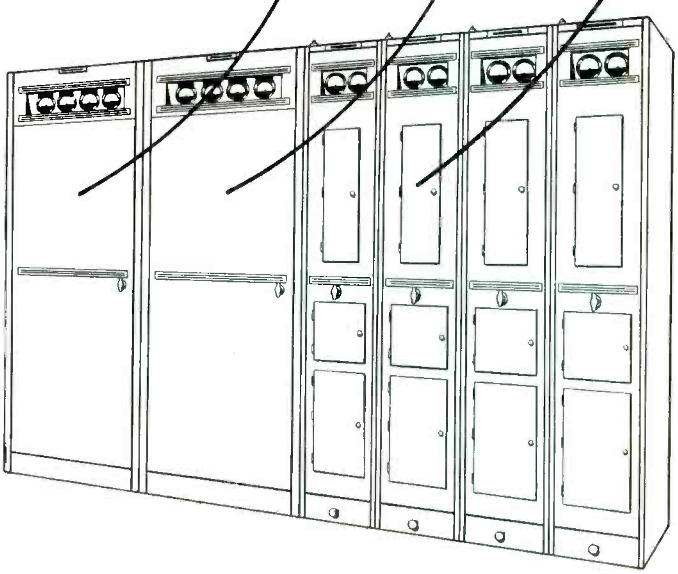

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cause faulty operation of the rings.

The reference pulse is the output, suitably differentiated and amplified, of the count-of-four. The marker scale is generated by combining the differentiated outputs of the rings in a mixing stage, markers being added separately to the scale, as desired, by means of the front panel toggle switches. The pulse output of each ring is available at a separate connector for auxiliary synchronizing service.

Uses

In radio propagation experiments, a high-frequency pulse transmitter is keyed with the reference pulse output of the generator. The variable-phase outputs are then used to trigger auxiliary circuits, such as an oscilloscope sweep generator, at predetermined delays. Large, stable delays are obtained easily in this manner. The marker scale output is used to place range or transmission-delay markers on a monitor oscilloscope. The delay flexibility of the generator should make it useful in other kinds of experimental work.

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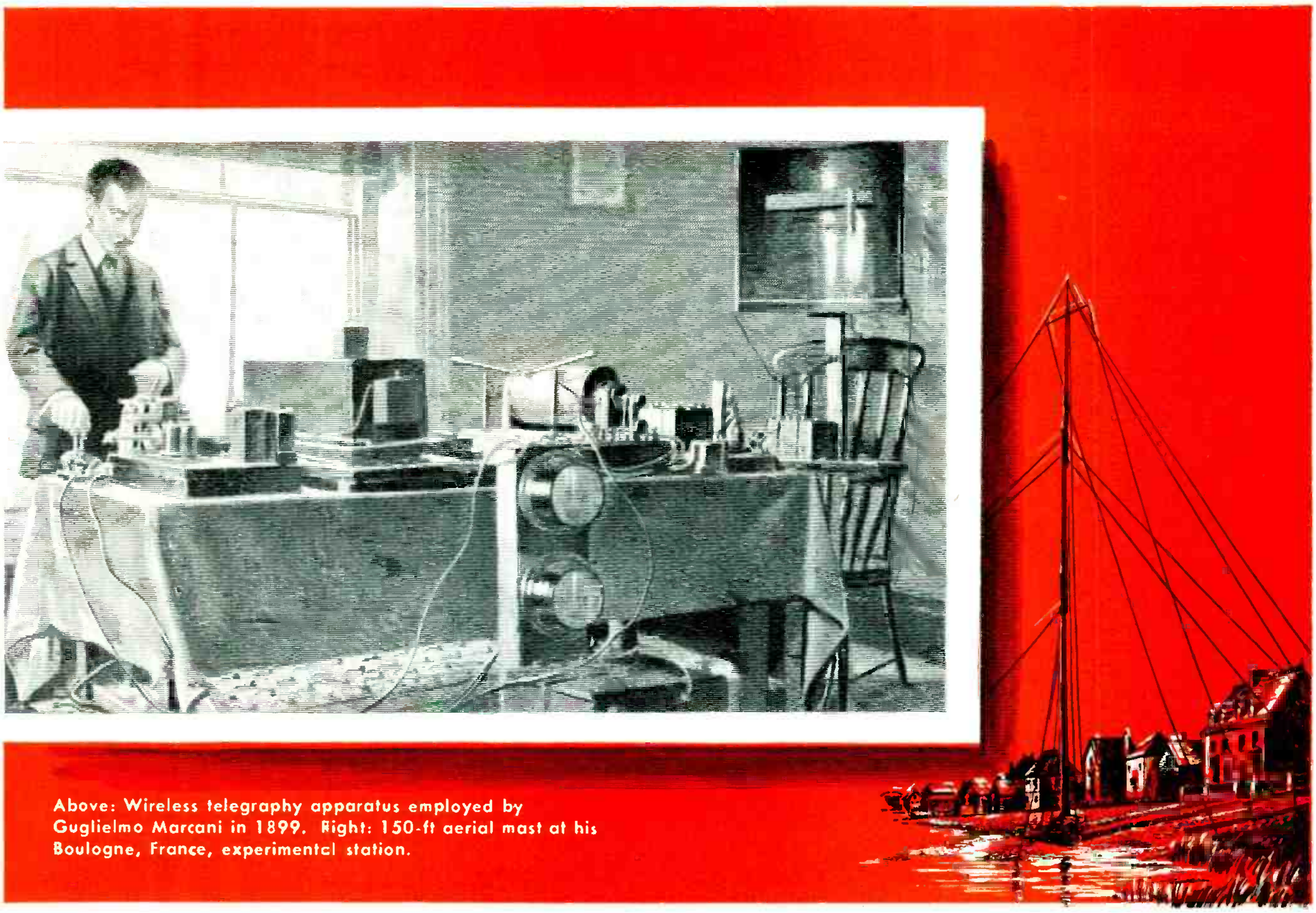
(3) R. R. Freas, Direct-Reading Electronic Timer, *RCA Review*, **10**, p 554, December 1949.
(4) T. K. Sharpless, High-Speed N-Scale Counters, ELECTRONICS, **21**, p 124, March 1948.

Aids to CRO Display of Phase Angle

By L. FLEMING
Falls Church, Virginia

AUDIO-FREQUENCY NETWORKS are commonly measured in terms of transmission level versus frequency, without particular reference to phase angle. The use of the ordinary elliptical Lissajous figure on a cathode-ray oscilloscope screen suffers from the drawback of poor precision, and difficultly in conveniently determining the phase angle in degrees from measurements made on the elliptical display. Where the amount of work to be done justifies the fairly large cost, a direct-reading phase meter



Above: Wireless telegraphy apparatus employed by Guglielmo Marconi in 1899. Right: 150-ft aerial mast at his Boulogne, France, experimental station.

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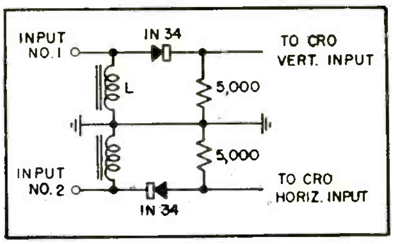

FIG. 1—Half-wave rectifier circuit for displaying phase angle between two sine waves as shown in Fig. 2

or a Z-angle meter is ideal[1,2,8]. Sulzer has described an instrument[3] for use in conjunction with a cro to give vectorial display of voltages in the form of radial lines. Wide-band phase splitters[4,5] are employed to derive a circular sweep from one signal, and Z-axis modulation of the cro is obtained from both.

These devices are all somewhat complex. Where only occasional measurements are made, one may look for a simpler instrument. Such simple devices can be built in at least two ways, without using any tubes. The principle involves half-wave clipping of one or both signals, or sharpening into pips.

Half-Wave Clipping

A simple arrangement of considerable utility is shown in Fig. 1. The positive half of one sine wave is clipped off, and the negative half of the other, by means of two identical circuits. One output is fed to the horizontal input of a cro, and the other to the vertical input. The two voltages appear alternately. The resulting display is an L-shaped figure when the two voltages are in phase, as shown in Fig. 2. When the phase angle is between 0 and 90 degrees, the display takes

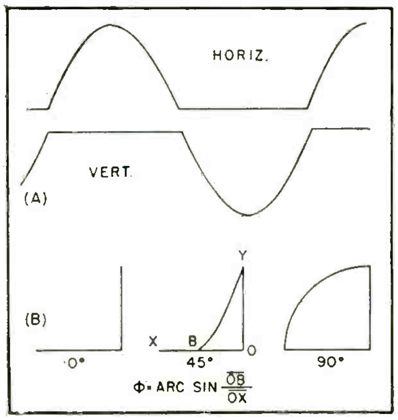

FIG. 2—Oscilloscope voltages and resulting display for circuit shown in Fig. 1

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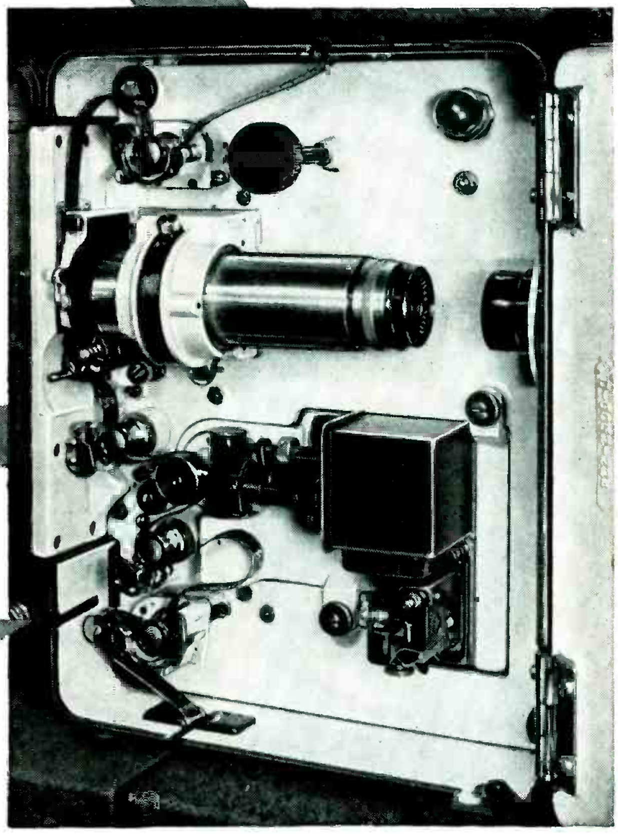

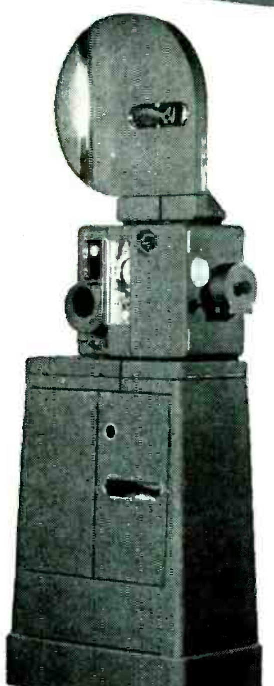

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TV Camera Chains • TV Film Chains • TV Field and Studio Equipment • Theatre TV Equipment the form of a shelf-bracket, due to the difference between trace and retrace paths of the beam. In this range between 0 and 90 degrees, the lengths of the two legs of the L measure the relative amplitudes of the respective input voltages. The phase angle is measured by the location of the intercept of the fillet along the horizontal leg of the L. As indicated in Fig. 2, the sine of the phase angle is equal to the intercept distance *OB* divided by the length of the base line *OX*.

This display is ambiguous about 0 degrees, that is, it will not distinguish between lead and lag. Above 90 degrees the legs of the L shorten, and the figure is not readily interpreted. Its value is in the measurement of small angles, less than about 60 degrees, and its accuracy is greater for the smaller angles.

In order for clipping to occur accurately at the zero line, the d-c resistance on the source side of the rectifiers must be low compared to the load resistance. Inductances L (Fig. 1) are shown for this purpose. For work between about 50 and 10,000 cps these inductances may be ordinary radio replacement type filter chokes, of 15 henrys or so.

Sharpening Into Pips

Another useful accessory in indicating phase is a differentiating network that sharpens one of the two signals into pips. The pip breaks at the positive-going zero-axis crossing of the voltage wave in the circuit illustrated, Fig. 3. This circuit is intended to operate out of a source such as an audio oscillator, supplying 10 volts or more with a source impedance of a few hundred ohms or less. The first crystal rectifier clips off the negative halves of the wave. Following the crystal load resistor are two R-C differentiators C_1R_1 and C_2R_2, each with a back-connected shunt

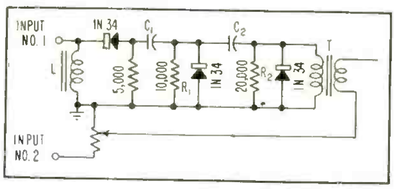

FIG. 3—Tubeless circuit for converting sine waves into pips for crt indication of phase angle between two signals

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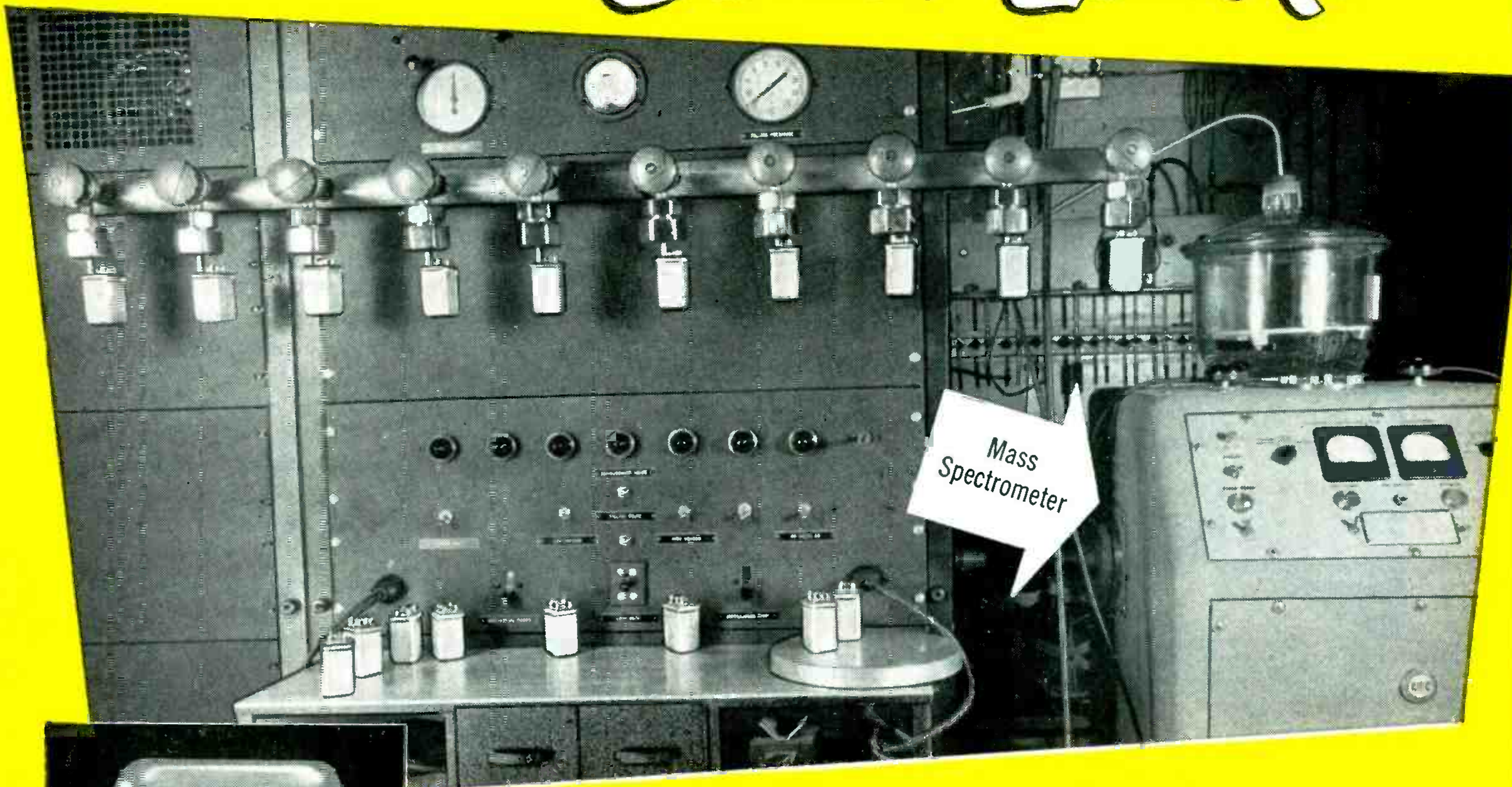

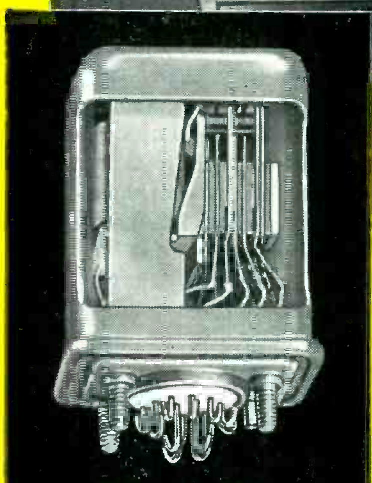

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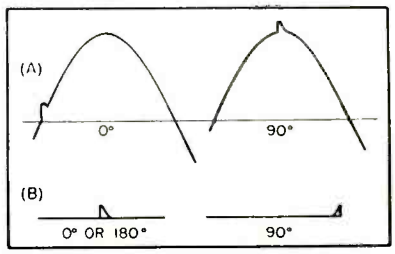

FIG. 4—Typical phase-angle indication using pip method. In **A** a saw-tooth sweep is used—in B sweep in sinusoidal

rectifier to permit only the positive pips to appear in the output. The transformer *T* (a standard 500 to 500 ohm audio unit) is a convenient means for mixing the pips with the other signal.

The pips so derived are mixed or added directly with the other signal and fed to the vertical input of a cro. The display consists of a sine wave with a pip superimposed on each cycle at a location dependent on the phase relation between the two voltages. Figure 4 illustrates the type of figure obtained. Since the pips start at the positive-going zero-axis crossing, the occurrence of pips at this point on the composite wave indicates zero phase angle. This type of display is unambiguous all the way to 360 degrees.

A differentiator of this sort, unfortunately, has a large signal loss. With a 10-volt input, the height of the pips, by the time they have been made suitably short, is only about 50 millivolts. Hence the comparison voltage should be adjusted in level to around 0.5 volt or perhaps less. The upper frequency limit of Fig. 3 is about 3,000 cycles, due to the difficulty in obtaining sharp pips with such a simple tubeless circuit. The time constants of the differentiators are usable over a frequency range of about 2 to 1. For the range 250 to 500 cps the best value for C_1 is 0.002 μf, for C_2, 0.001 μf. For other frequencies the capacitances should be varied accordingly.

The true zero-axis crossing point is announced by the left-hand or leading edge of the pip. If the pip is a bit long, the crest and the trailing edge should be ignored.

At a gain in simplicity of operation and a loss in clarity, the cro connections may be changed to give the type of display illustrated at

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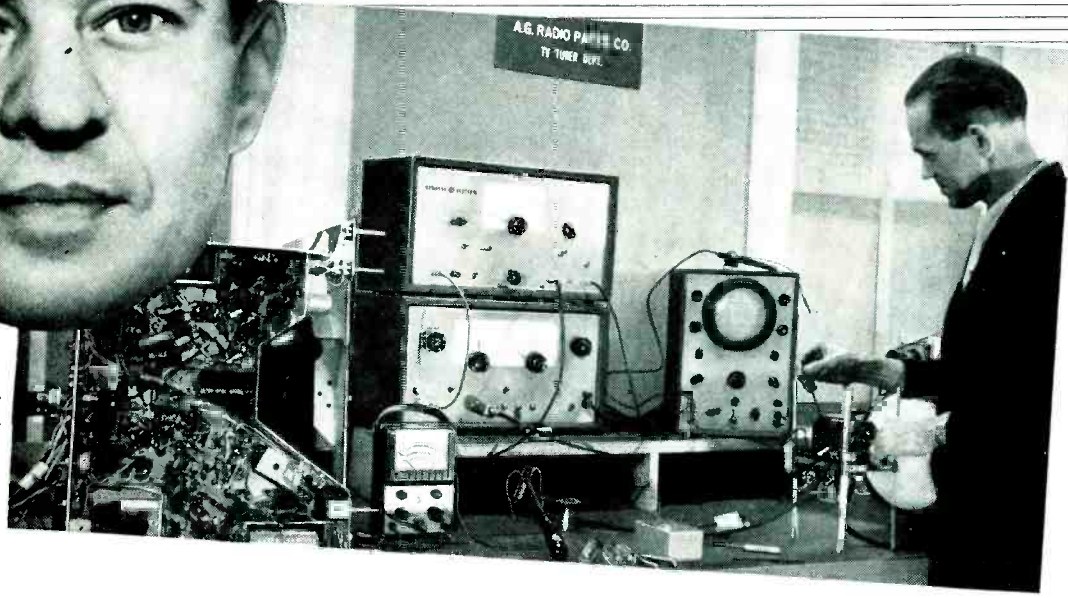

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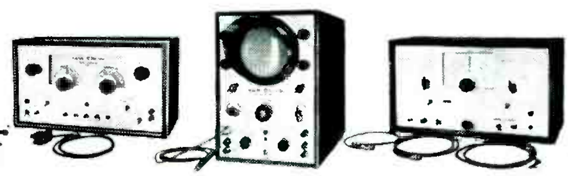

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the bottom of Fig. 4. Here, instead of the internal sweep of the cro being employed, one of the sinusoids is used to provide horizontal deflection. The pips obtained from the other signal are fed to the vertical input. When the phase angle is zero, the leading edge of the pip will appear at the middle of the horizontal line. With lagging or leading angles, the pip will move to the right or left. The loss in clarity lies in the ambiguity of this display about 180 degrees.

An attractive possibility for phase measurement lies in the scheme of sharpening both signals into pips, using one pip to trigger the sawtooth sweep of a cro, and applying the other pip to the vertical cro input. The display would consist of a horizontal line carrying a pip, and the position of the pip along the line would be a direct linear measure of the phase angle. The accuracy would depend entirely on the linearity of the cro sweep and the relative shortness of the retrace time.

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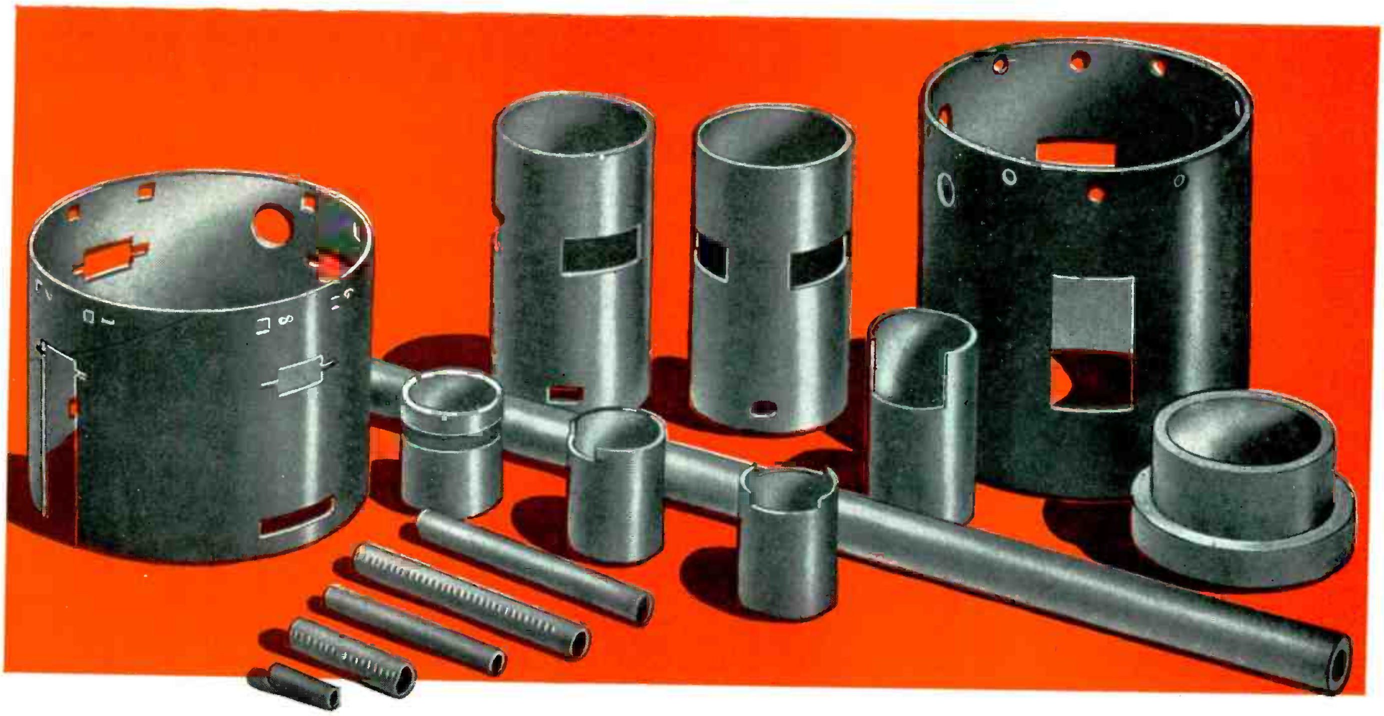
Theoretical Limitations to Impedance Matching

By ROBERT L. TANNER

Stanford University
Stanford, California

THIS PAPER outlines a procedure whereby the theoretical limitations to impedance matching of simple circuits can be determined. It is shown that many antennas can be represented with adequate accuracy by a simple RLC circuit. Curves are included which show the relation between attainable vswr and a factor equal to (Bandwidth × Q). An example is worked out showing



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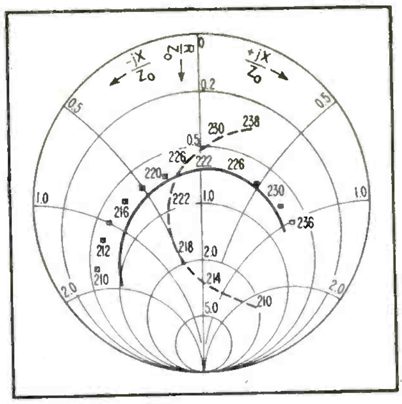


FIG. 1—Smith Chart shows antenna characteristic before (dashed) and after (solid) compensation

the agreement between theory and experiment for a flush antenna with a 10-percent bandwidth.

The dotted line on the Smith Chart (Fig. 1) is the measured impedance curve for an antenna before compensation. Rotation through a section of 50-ohm line, the impedance takes the form of the solid line curve. This latter impedance can be quite accurately represented by the equivalent circuit of Fig. 2A.

When the shunting susceptance of the parallel resonant circuit has been subtracted, the impedance follows the curve defined by the square points. This curve represents the series resonant circuit shown in the figure.

Inspection of the series resonant impedance curve shows the circuit to have a Q of approximately 15. This is determined from the definition for Q, $Q = f_r/\Delta f$, where Δf is the frequency band between the half-power frequencies, and f_r is the resonant frequency. The half-power frequencies are the frequencies at which the series resistance is equal to the series reactance. Inspection of the Smith Chart shows

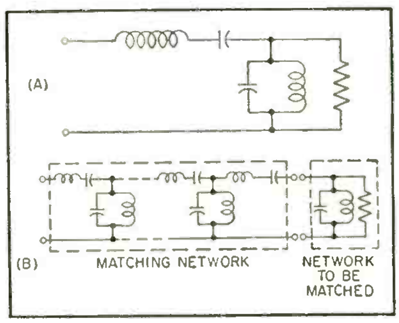
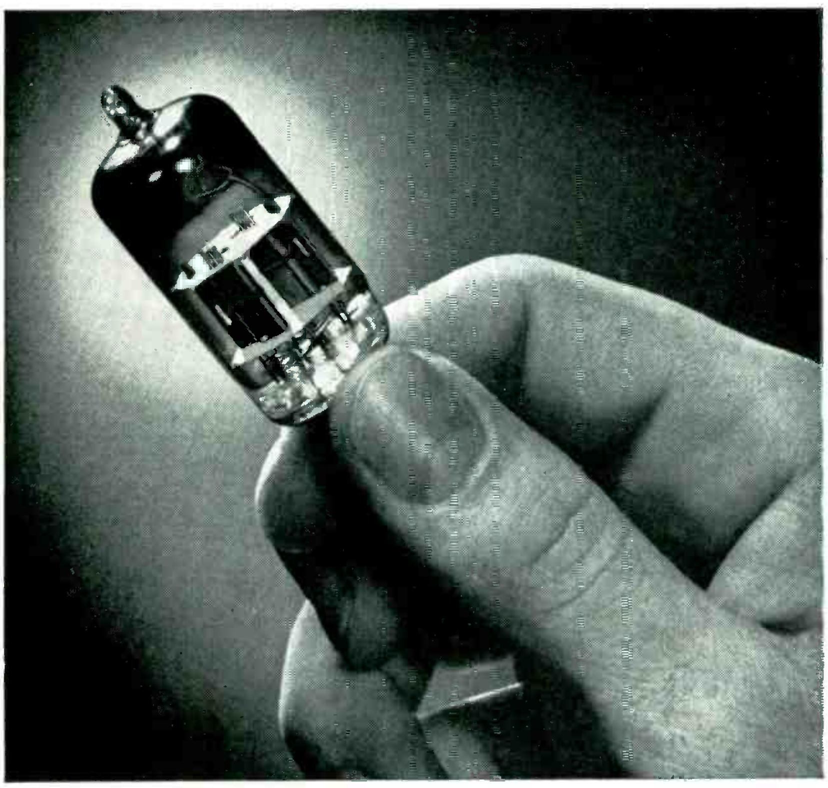
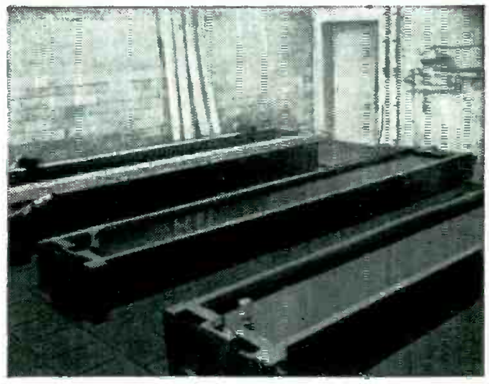


FIG. 2—Equivalent circuit of antenna after rotation through section of line (A) and equivalent circuit (B) of antenna and matching network

Inside Information on the Inside of a Tube





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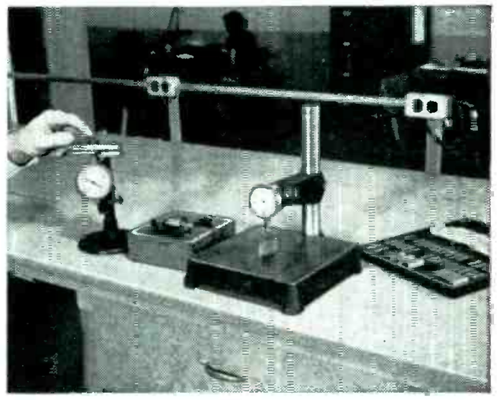

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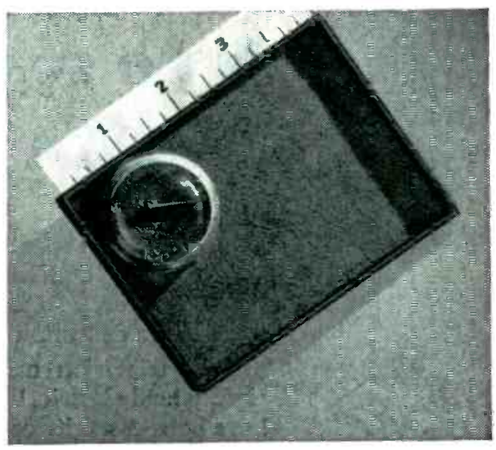

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Electronic Products for export through Driver-Harris Company, Harrison, New Jersey • Harrison 6-4800 these frequencies to be approximately 216.5 mc and 230 mc, while the resonant frequency is approximately 222 mc. Thus

$$Q = \frac{222}{230 - 216.5} = 15.3$$

Fano has shown[7] that optimum matching to a simple series resonant circuit is achieved by a matching network of the form shown in Fig. 2B, which consists of alternate shunting parallel resonant circuits, and series circuits.

When the network to be matched already includes, as in this case, a shunting circuit of smaller susceptance than the first element of the matching network, this susceptance can be considered as being lumped with the first element of the matching network. For such a condition the match which can be achieved is the same as when the series circuit alone is to be matched.

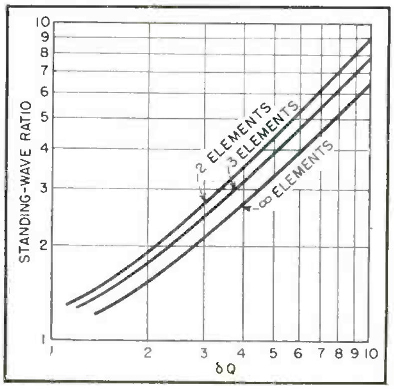


FIG. 3—Optimum matching to simple resonant circuit obtainable with network of *n* elements

The curves of Fig. 3, which are derived from results obtained by Fano, give the optimum match to a simple resonant circuit which can be achieved with a matching network of *n elements*. For the present example the circuit to be matched has a Q of 15.3. The fractional bandwidth δ over which the match is required is defined by the formula $f_2 - f_1/\sqrt{f_2 f_1}$, and in the present instance has the value

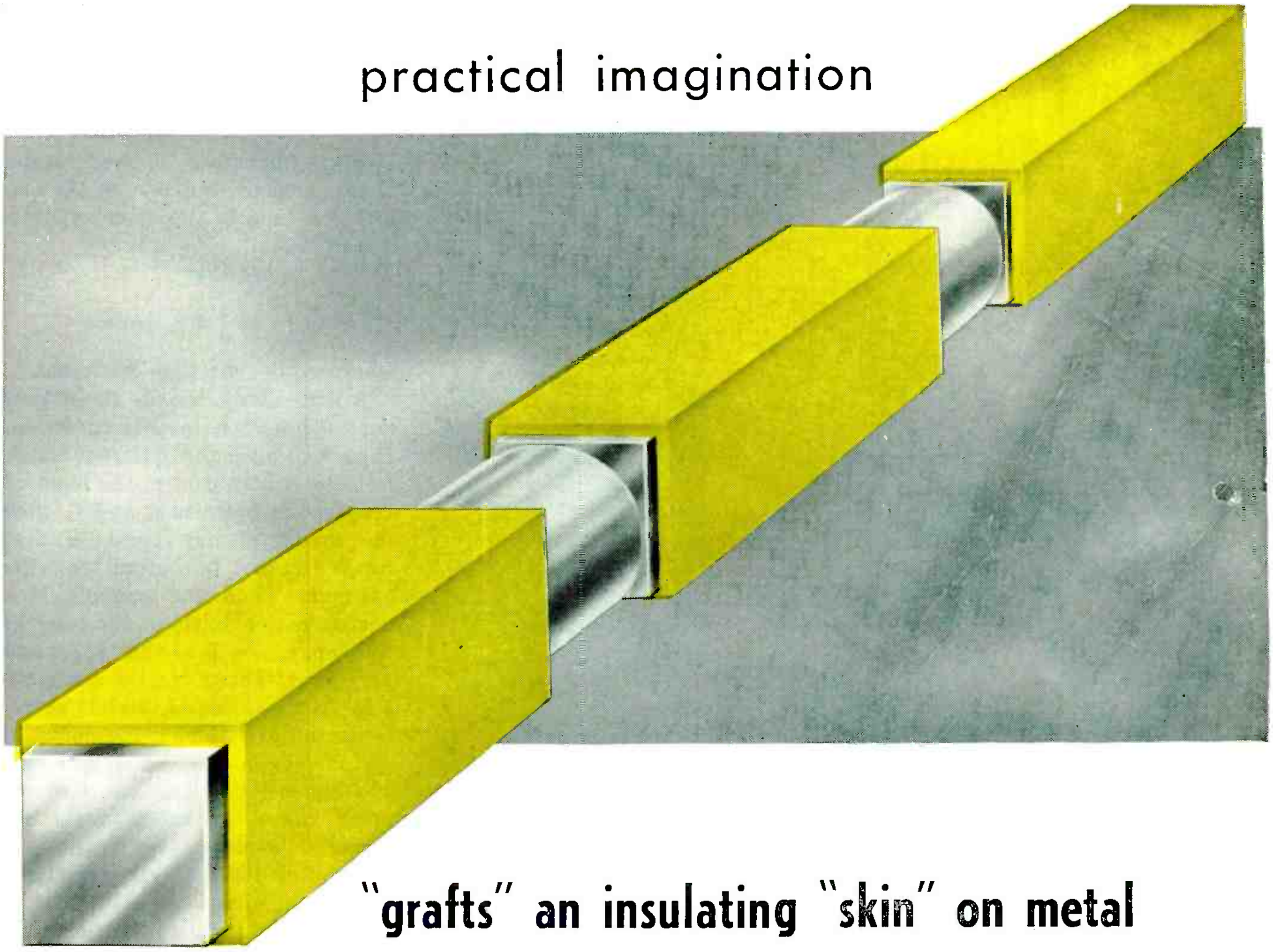
$$\delta = \frac{f_2 - f_1}{\sqrt{f_2 f_1}} \quad \frac{234 - 214}{\sqrt{234 \times 214}} = 0.0895$$

thus δQ has the value

$$\delta Q = 15.3 \times 0.0895 = 1.37$$

Referring to the curves of Fig. 3

practical imagination



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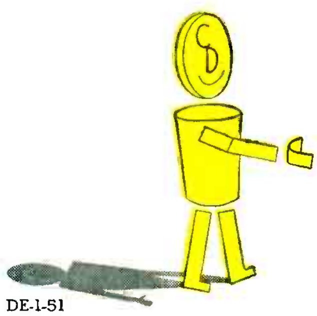

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Fano shows that

$$\int_{f_1}^{f_2} \ln \frac{1}{\rho}\, df \leq \text{constant}$$

where ρ = reflection coefficient.

A little study reveals an importance application in this condition. It shows that if the optimum match is to be achieved over the band of frequencies between f_1 and f_2, then the match at any point in that range can not be better than the optimum. Thus, for example, if a perfect match exists at one point in the range, $\rho = 0$ at that point and $1/\rho \rightarrow \infty$. Therefore, the contribution to the integral, which represents the area under the curve ln $1/\rho$, is very large for a small range of frequencies in the vicinity of the point. Since the value of the integral is bounded, this means that the contribution at other sections of the range must be small; that is, $1/\rho$ must be small, ρ large, and the match poor.

The performance of the antenna after matching gives substantial confirmation of the theory. The vswr oscillates about the value 1.5. A match better than optimum at the ends of the band has been obtained at the expense of a match poorer than optimum in the center.

The foregoing discussion applies to impedances which can be represented by the circuits of the type shown in Fig. 2A, in which the

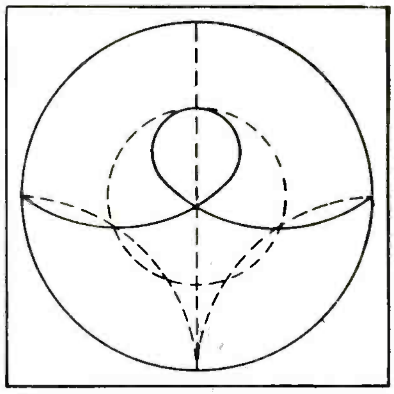
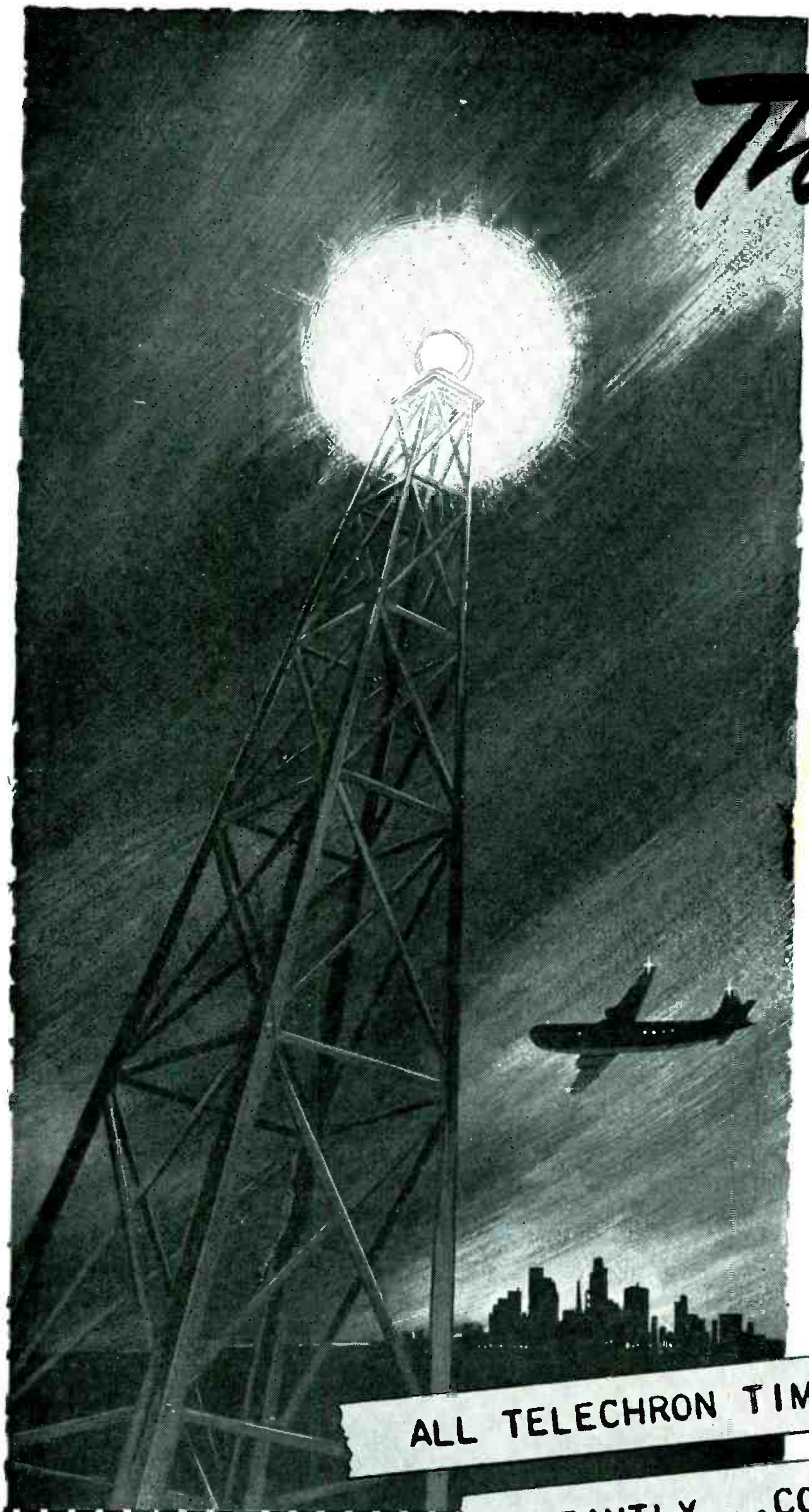


FIG. 4—Impedance curve of network which cannot be matched to value given by Fig. 3



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shunting element has susceptance smaller than that required for the first element of the optimum matching network. If the susceptance of the shunt element is larger than this value, the excellence of the match which can be achieved is poorer than the value indicated by the curves of Fig. 3. In terms of the impedance curve on the Smith Chart, too large shunt susceptance means that the impedance curve of the uncompensated impedance is already wrapped too tightly as shown in Fig. 4.

Although the example which has been considered in the above discussion was a series resonant circuit shunted by a parallel resonant circuit, the curves of Fig. 3 apply equally well to an impedance of the type shown in Fig. 5A.

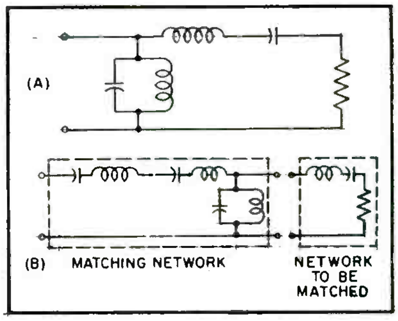

FIG. 5—Counterpart of impedance of Fig. 1 for which matching criteria apply is shown in A. Associated matching network is shown in B

Furthermore, all the arguments which were applied to the matching of a series resonant circuit apply equally well to the matching of a parallel resonant circuit if reactance is substituted for susceptance, and so on.

Thus, a parallel resonant circuit is best matched by a network such as the one shown in Fig. 5B which begins (at the load end) with a series element.

The match to a circuit such as the one in Fig. 5A is only as good as is indicated by the curves of Fig. 3 if the reactance of the series element is smaller than that required for the first element of the optimum matching network of Fig. 5B.

REFERENCE

(1) R. M. Fano, "Theoretical Limitations on Broadband Matching of Arbitrary Impedances," Technical Report No. 41, MIT Research Lab. of Electronics.


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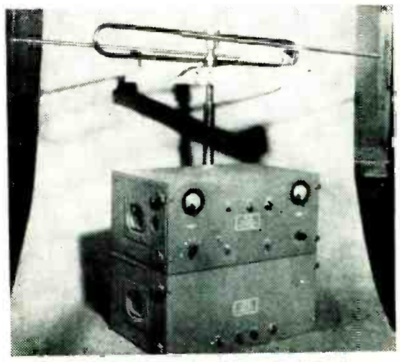

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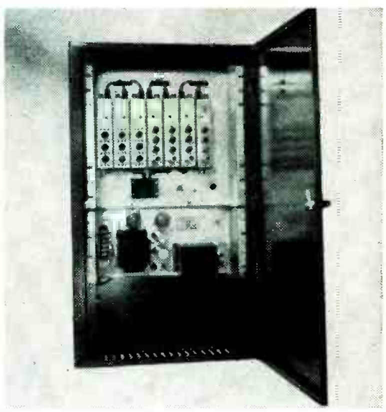

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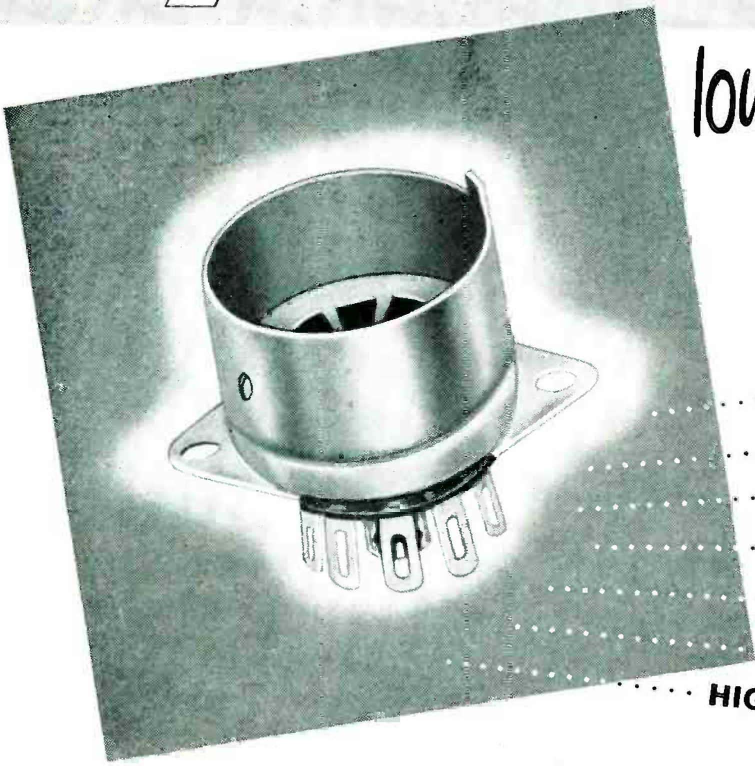

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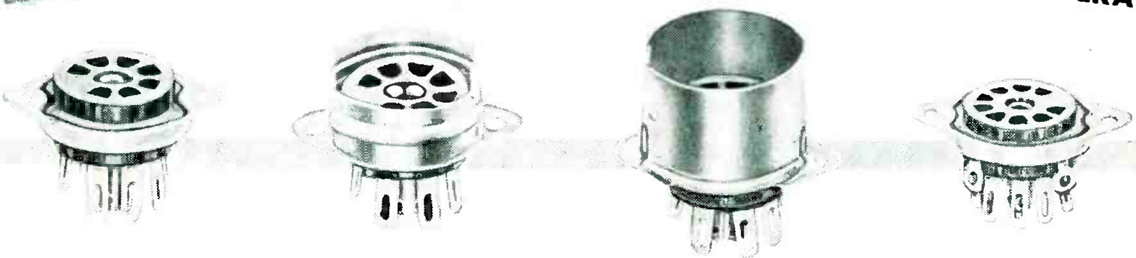

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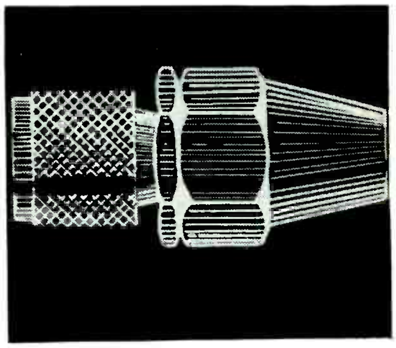

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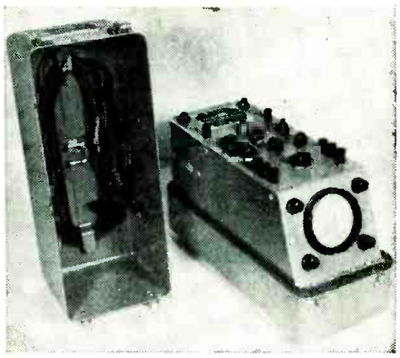

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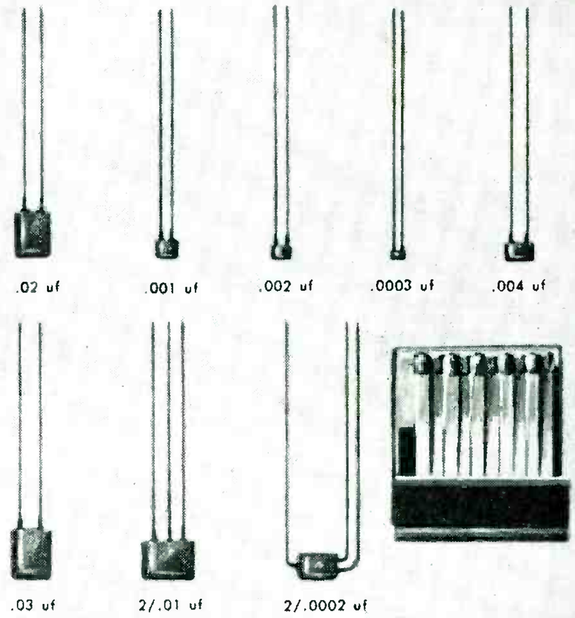

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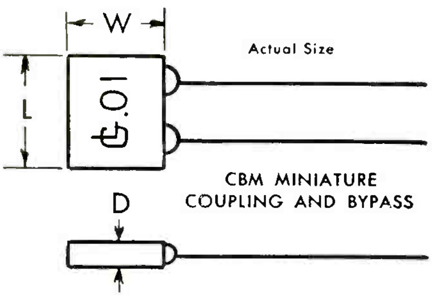
.50	.40	.28	.25	.005				
.70	.52	.50	.40	.01	.30	.19		
		.80	.60	.05	.61	.43	.48	.33
				.10	.88	.62	.65	.45
				.50			.70	.55
				1.0			1.0	.80
D=.120		D=.080			D=.120		D=.150-.800	

SPECIFICATIONS FOR CBM AND SMCB* COUPLING AND BYPASS CAPACITORS

- FLASH TESTED AT 3 TIMES RATED D.C. VOLTAGE
- POWER FACTOR LESS THAN 1%
- INSULATION RESISTANCE EXCEEDS 10,000 MEGOHMS
- MEET ALL RMA SPECIFICATIONS

*Types CBM and SMCB are shown as typical examples of the space saving possible with GLENCO capacitors. Many more standard types, including a great variety of temperature compensating ceramic capacitors, are available. Quotations on these or types to customers' specification will be supplied promptly on request.



CBM MINIATURE COUPLING AND BYPASS

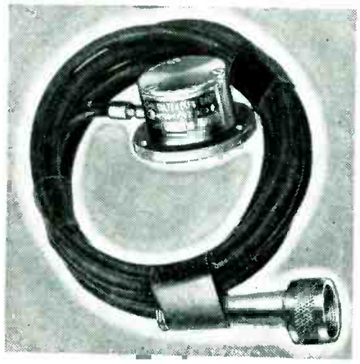
GLENCO CORPORATION
DURHAM AVENUE, METUCHEN, NEW JERSEY

TYPE TC **— TEMPERATURE COMPENSATING CERAMIC PLATE CAPACITORS**

TYPE CBM **— MINIATURE COUPLING AND BYPASS CAPACITORS**

TYPE SMCB **— SUB-MINIATURE COUPLING AND BYPASS CAPACITORS**

GLENNITE ACCELEROMETER*



MODEL A403
(ILLUSTRATED)

We are currently designing a number of other types of accelerometers and strain gauges. We invite inquiries concerning units of special design. Electronic equipment can also be supplied for use in conjunction with this equipment—cathode followers, amplifiers, filters and recording equipment.

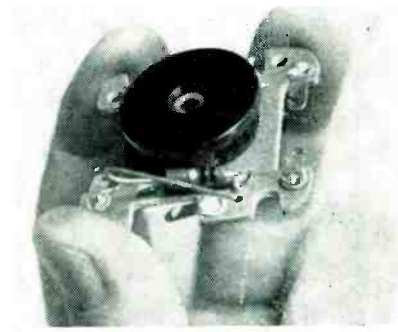
*Registered Trademark

- SENSITIVITY: 10 mv/g
- RESONANT FREQUENCY: 8 kc
- USEFUL FREQUENCY RANGE: 3 to 4000 cps
- CAPACITANCE: 1500 mmf
- SIZE: 1¼" diam. x ¾"
- WEIGHT: Approx. 1 ounce
- MOUNTING: 3—2 x 56 machine screws spaced 120° apart on a 1¼" diameter circle
- MAX. DIRECTIVITY: Perpendicular to mount
- TEMPERATURE RANGE: —60°C to +90°C
- ACCELERATION RANGE: 0.1 to 600g
- CABLE: 4 ft. shielded cable supplied
- CALIBRATION: Instruments individually calibrated at 2g from 20 to 1500 cps
- MOVEMENT: Compressional

GULTON MFG. CORP.
METUCHEN • NEW JERSEY

NOTE! A FEW TERRITORIES ARE STILL OPEN FOR WIDE AWAKE REPRESENTATIVES IN SELECTED AREAS — INQUIRIES INVITED.

x 14½ in. long. The circuit contains 9 tubes including rectifiers. Sweep frequency range is from 3 cycles to beyond 50,000 cps. Vertical amplifier response is flat within 3 db from d-c to 2 mc, while horizontal response is flat within 2 db from d-c to 100 kc. It also features faithful reproduction of wave forms with 3-μsec rise times and 100-kc square waves. Deflection sensitivity exceeds 0.5 v per in. at all line voltages from 105 v to 125 v and at all line frequencies from 50 cycles to 1,000 cycles.



Static Magnetic Memory

ALDEN PRODUCTS CO., 117 North Main St., Brockton 64, Mass. Model 5100RA static magnetic memory, a device for recording and storing information in digital calculating machinery, has a built-in coupling circuit in each unit to facilitate two-core operation. Pulse handling rate ranges from 0 to 25 kc. The device operates essentially as a magnetic trigger pair which requires no vacuum tubes to maintain position. Illustrated is a single unit showing the damping resistor and rectifier tab.

H-V Resistors

RESISTANCE PRODUCTS CO., 714 Race St., Harrisburg, Pa. Type T high-voltage resistors are specially designed to withstand the high d-c,

We are ready NOW...

Can we serve YOU?

For **IMMEDIATE ACTION**, phone—wire—or write direct to the attention of Mr. Albert Finkel, Vice-President.

JFD . . . One of the world's largest producers of television antennas and accessories, has allocated a most substantial portion of its facilities for prime and sub-contract orders.

We offer:

EXPERIENCE! Leaders in the industry whom we have serviced in the past, include such outstanding organizations as RCA, PHILCO, ADMIRAL, MOTOROLA, BENDIX, EMERSON, PILOT, STROMBERG-CARLSON, etc.

80,000 square feet of floor space with modern production machinery and high-speed assembly lines.

TRAINED manufacturing personnel geared to the type of mass-production that meets "deadlines" and lowers costs.

EXCELLENT sources of supply for raw material.

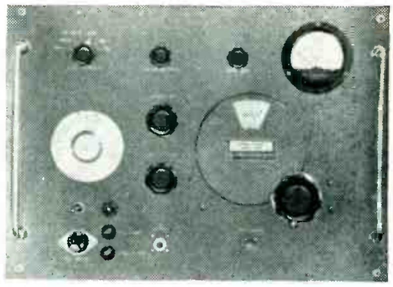
KNOW-HOW in purchasing and delivery expediting.

FINANCIAL resources that are ample and liquid.

DIVISION OF CONTRACT OPERATIONS

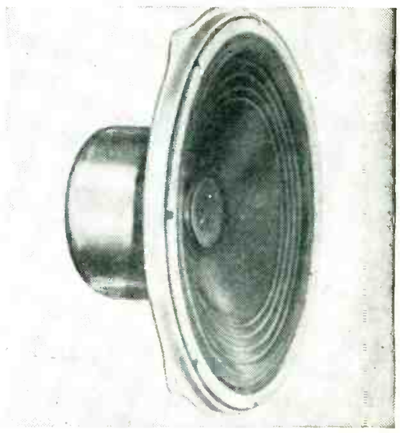
JFD MANUFACTURING CO., Inc.
6145-B 16th AVENUE, BROOKLYN 4, N. Y.
FIRST in Television Antennas and Accessories

pulse and transient voltages encountered in tv power supplies. They are of particular use in voltage doubler circuits and as bleeders where ordinary resistors have a limited life. The temperature coefficient of resistance is approximately 0.05 percent per deg C; voltage coefficient of resistance, approximately 0.0001 percent per volt.



SHF Signal Generator

HEWLETT-PACKARD CO., 395 Page Mill Rd., Palo Alto, Calif. Model 618A shf signal generator offers continuous coverage of frequencies from 3,800 to 7,600 mc. It provides a 1-mw signal into a 50-ohm coaxial load at zero dbm. The instrument also offers a variety of output types. It may be externally frequency modulated with maximum deviation of 10 mc. It may be externally pulse modulated with a positive or negative peak voltage of approximately 15 v. Internal square wave modulation is also provided within the frequency range of 400 to 1,000 cps.

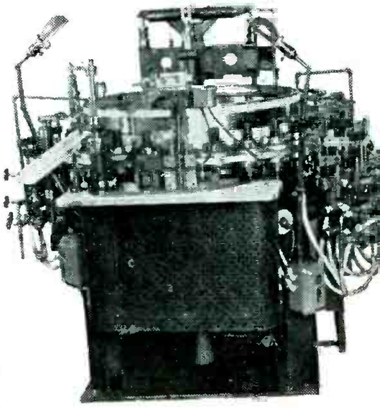


High-Fidelity Speaker

RADIO CORP. OF AMERICA, Harrison, N. J. Type 515S2 is a new 15-inch duo-cone loudspeaker designed for

Kahle *specialists in custom-built, ultra-precision*

ELECTRON TUBE MACHINERY

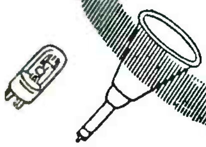


KAHLE CUSTOM-BUILDS machines to make the exact tubes you require—from big 20-inchers to tiny sub-miniature—from laboratory types to those for high-speed production. Kahle puts each unit through exhaustive trial runs in our plant to assure trouble-free operation in yours.

#337 BUTTON STEM MACHINE FOR MINIATURE AND SUB-MINIATURE TUBES

This 24-head machine has two upper moulds for making non-tubulated stems with short lead wires. Important features include: dual-motor drive, one for heads, one for indexing and cam mechanisms, independent of each other; optional automatic wire feed; optional automatic glass feed (not shown); automatic unloader; individual head units, readily removable; harmonic barrel cam and roller index. Capacity: 1000 per hour.

Production-boosting, labor-saving equipment for complete manufacture of cathode ray tubes, standard, miniature and sub-miniature radio tubes, sub-miniature tubes, fluorescent lamps, photocells, x-ray tubes, glass products.



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1309 Seventh Street, North Bergen, New Jersey

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an insuline cabinet or chassis for every need

ICA is the leading manufacturer of metal goods. Our line consists of hundreds of styles and sizes for relay racks, transmitters, amplifiers, speakers, meters, etc. . . . many with decorative chrome trim.

Prompt delivery of all sizes of standard chassis bases and bottom plates (steel and aluminum) plus all necessary accessories and hardware.

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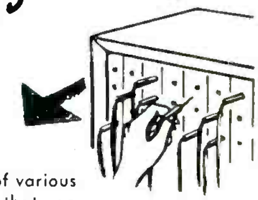
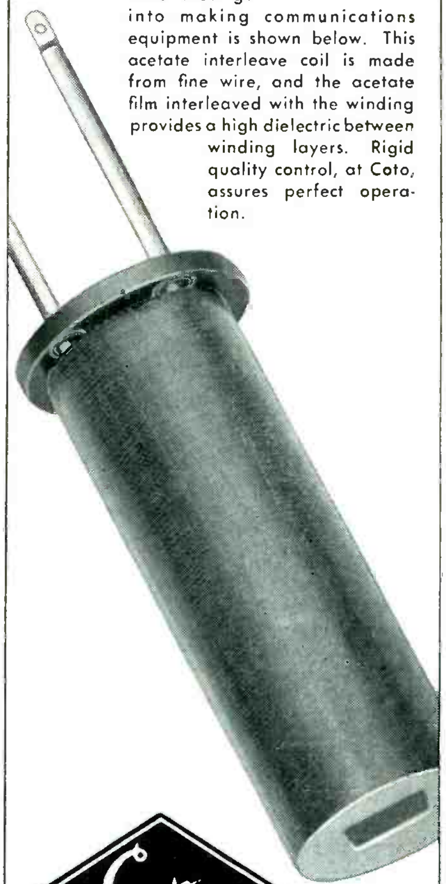
ONLY SPECIFIC COILS CAN DO THIS JOB-



One of various coils that go into making communications equipment is shown below. This acetate interleave coil is made from fine wire, and the acetate film interleaved with the winding provides a high dielectric between winding layers. Rigid quality control, at Coto, assures perfect operation.



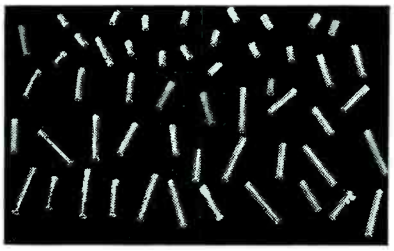
Coto SINCE 1917

Builds Them!

When you need electrical coils, why not take advantage of 34 years of experience, engineering competence, and modern production facilities. Coto coils are built for you, to your specifications.

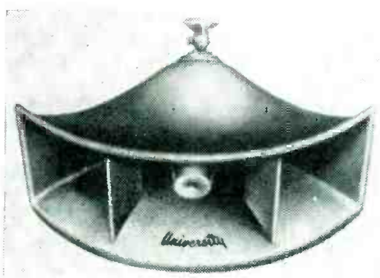
COTO-COIL CO., INC.
COIL SPECIALISTS SINCE 1917
65 PAVILION AVE
PROVIDENCE 5, R.I.

high-quality reproduction at both high and low-power levels. The permanent-magnet-type unit features high sensitivity between 40 and 12,000 cps and is capable of handling a 25-watt input. It is intended particularly for use in equipment such as high-quality radios, phonographs, tv receivers and monitors. The duo-cone arrangement avoids the crossover interference characteristic of conventional high-low speaker combinations in which the woofer and tweeter are spaced apart. Each cone is mounted in its own housing and is driven by its own voice coil operating in its own air gap.



Insulator Bushings

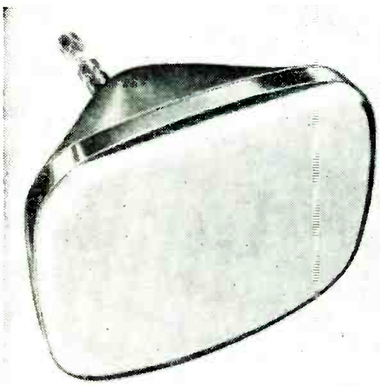
AMERICAN PRODUCTS CO., 1652 No. Honore St., Chicago 22, Ill., are now making molded Nylon and Styron insulator bushings for the radio and electronic industries. They feature low moisture absorption, easy assembly and retention of shape. The bushings are available in lengths from $\frac{1}{8}$ in. to $1\frac{3}{16}$ in. x $\frac{3}{32}$ in. Outside diameter is 0.187 in. to 0.188 in., and inside diameter is 0.126 in. to 0.128 in. Other sizes are made to order.



Paging Speaker

UNIVERSITY LOUDSPEAKERS INC., 80 S. Kensico Ave., White Plains, N. Y., has introduced model Cobra-12 paging-type speaker of radically

new design. With power input capacity of 12 watts continuous, and a frequency response of 250 to 10,000 cps, it is capable of unusually wide-angle dispersion of sound in the horizontal plane, while limiting the vertical dispersion to the optimum degree for paging and talk-back purposes. Impedance is 8 ohms. The speaker features heavy-gage metals, die castings, and hermetically sealed integral driver unit design.



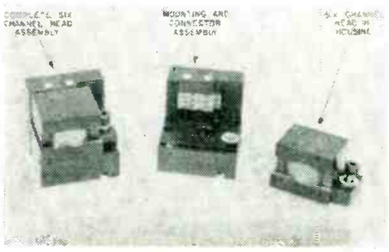
Rectangular Picture Tube

ALLEN B. DU MONT LABORATORIES, INC., 750 Bloomfield Ave., Clifton, N. J. Model 20CP4 rectangular Teletron is a new tv picture tube featuring the bent gun that results in sharper over-all trace, and the dark face plate that enhances contrast. Screen size is 17 in. wide x 12¾ in. high. Deflection angle is 70 deg. Heater voltage is 6.3 v at 0.6 ampere; maximum anode voltage, 18,000 v. Ion trap magnet strength is 52 gauss at 14-kv anode voltage.

Intermodulation Meter

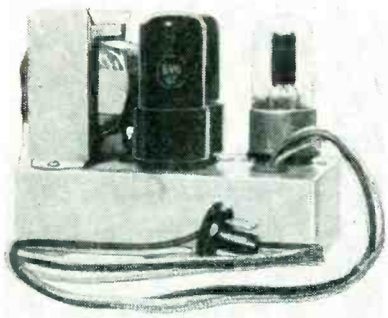
MEASUREMENTS CORP., Boonton, N. J. Model 31 intermodulation moni-

tor consists of two principal sections, a test signal generator and an analyzer. The generator section produces two sinusoidal voltages, one a low frequency and the other a high frequency, which are mixed in a 4-to-1 voltage ratio and applied to the apparatus under test. The signal from the equipment being tested is then received by the analyzer section to be filtered, amplified, demodulated and metered. The instrument is useful for evaluating the performance of audio systems and for checking the linearity of film and disc recordings and reproductions.



Magnetic Recording Heads

RAYTHEON MFG. CO., Waltham 54, Mass., is producing magnetic recording heads for use in multichannel digital recorders. They feature good performance, relative thinness, interchangeability and adaptability for fabrication of multichannel assemblies by a stacking process where recording and reproduction of data on magnetic tapes or drums is desired on parallel tracks. The units are intended primarily for the recording and reproduction of scientific or statistical data in such broad fields as research, computation, measurement and control.

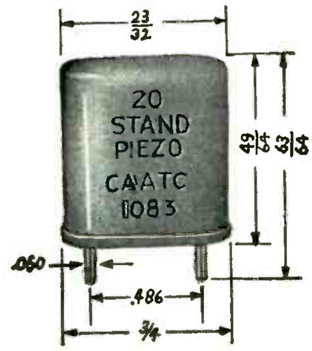


Audio Amplifier

MILO SOUND, 200 Greenwich St., New York 7, N. Y. Model 10MT

STANDARDIZE ON *Standard* • STANDARDIZE ON *Standard* • STANDARDIZE ON *Standard* • STANDARDIZE ON *Standard* • STANDARDIZE ON *Standard*

Eliminate CRYSTAL TEMPERATURE CONTROL COSTS . . .



Now you can forget temperature control. Just specify Standard's Type 20 Crystal Unit for your products.

In addition to lowering power requirements and weight, it increases compactness, durability and dependability. Type 20 meets all Government specifications, too.

Discover how the Standard Type 20 can cut costs and increase sales for you. A letter will bring Engineering data and complete details by return mail.

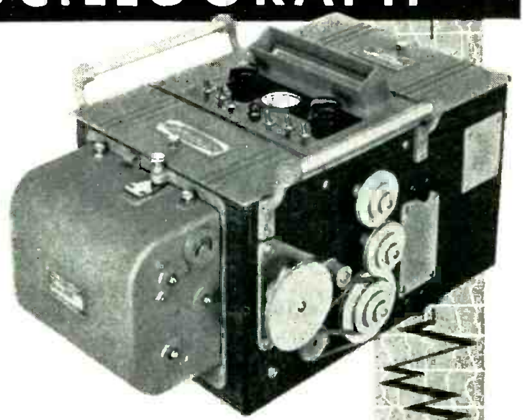
Standard Piezo COMPANY
CARLISLE, PENNSYLVANIA

SP CO.

THE NEW

'Economy' OSCILLOGRAPH

Long the world's most popular oscillograph, the Type S-14 has been redesigned and improved to meet exacting demands of modern research. The NEW Type S-14C 'Economy' Oscillograph is the simplest to operate and maintain, and the most versatile in application. No research or testing laboratory is complete without it.



- Wide range of galvanometer types and characteristics. Natural frequencies to 10,000 cps; sensitivities to 50,000 mm per ma; single and polyphase watts.
- Precision optical system for very high writing speeds and high-quality records.
- Continuous-drive magazine for records to 100 or 200 feet long.
- Wide range of record speeds. Any of 9 speeds available by shifting single external belt. Standard speeds: 40, 20, 10, 4, 2, 1, 0.4, 0.2 and 0.1 in./sec.
- Internal motor and gear reducer shock mounted and vibrationless.
- Light-socket operation.
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- Automatic transiend recording attachments.
- Complete list of accessories for extreme versatility.

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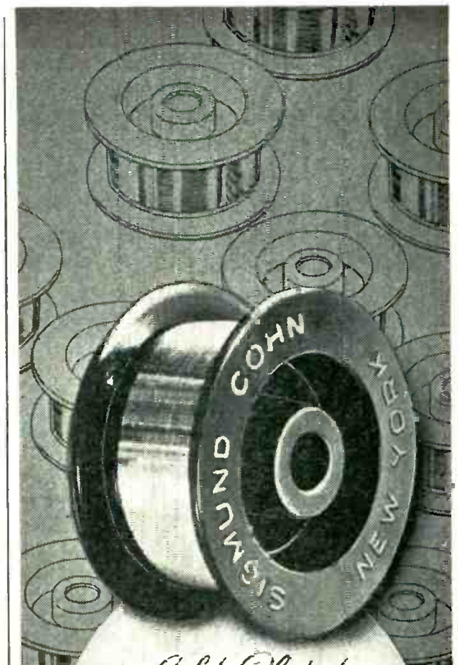


Gold Plated

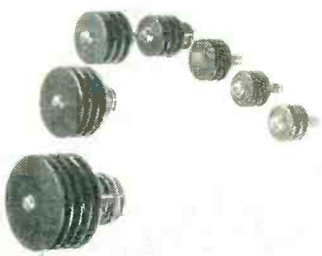
TUNGSTEN and MOLYBDENUM GRID WIRE

Made to meet your specifications . . . for gold content, diameter and other requirements.

SINCE 1901

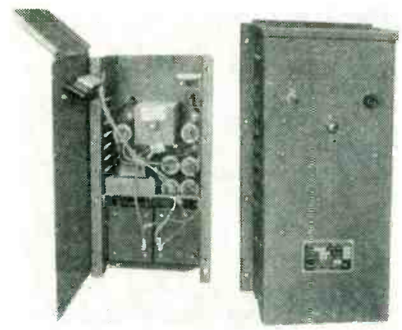
SIGMUND COHN CORP.
44 GOLD ST. NEW YORK

audio amplifier, specially designed for television and the 630TS chassis, is used either with the receiver's given speaker or a higher quality reproducer. With the tv set's own speaker, a 75-percent aural improvement is noted; with a quality speaker, it delivers its full range of 100 to 13,000 cps. It uses two 6K6 or two 6V6 tubes in push-pull; one 6J5 driver. Harmonic distortion is less than 3 percent. Power output is 6 to 8 watts, current consumption, 45 ma. Price is $12.95.



Power-Tube Caps

NATIONAL Co., 61 Sherman St., Malden, Mass., has announced new heat-radiating caps for use with all popular types of power tubes. Designed to government specifications, the new caps feature aluminum contact fingers that are integral with the radiating fins. Tension on the fingers is maintained by an encircling steel spring. A 6/32-in. tapped center hole is provided for attaching grid ribbon or other lead. A crimped, silver-plated beryllium copper grid ribbon, 3¼ in. long, is supplied with each cap. Special lengths can be supplied in quantity.



Telephone Battery Eliminator

ELECTRONIC RECTIFIER CO., INC., Rochester, N. Y. Type ZF3DP tele-

TWO-in-ONE

D·C·P* adds or subtracts two input variables

**Differential Computing Potentiometer*

"Two potentiometers in one" most aptly describes the Fairchild Differential Computing Potentiometer. This versatile unit makes it possible to combine two input variables and obtain an output that is proportional to their sum or difference.

Available in quantity, the D-C-P costs less than two separate type 748 units while offering high resolution and accuracy of a single potentiometer. Linearity of ±0.10%, high resolution, long life, low noise level, and low torque—all Fairchild Linear Potentiometer features—are built into the D-C-P.

Suggested applications include servomechanisms, instrument controls, and computing and analyzing instruments. The D-C-P will directly replace two single potentiometers when one is used for compensation or correction purposes. For more data, write to Fairchild Camera and Instrument Corporation, 88-06 Van Wyck Boulevard, Jamaica 1, N. Y. Dept. 140-12A1.

FAIRCHILD
PRECISION POTENTIOMETERS

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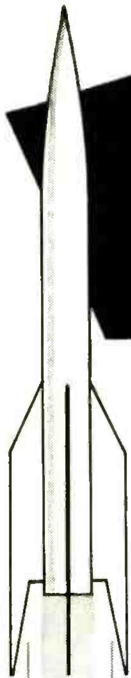
for ELECTRONIC Applications

You can specify LOUTHAN low-loss Steatite products with complete confidence in the high quality and dimensional accuracy of the parts. Made to exacting standards, Louthan Steatite insulations have the mechanical and electrical characteristics needed for electronics applications and other electrical service. They are formed to meet your needs and made to close tolerances. Surfaces are smooth, hard, clean and non-absorbent.

Write for Catalog 49-E, describing Louthan Insulations.

THE LOUTHAN MANUFACTURING COMPANY
A Subsidiary of Harbison-Walker Refractories Co.
EAST LIVERPOOL, OHIO
Representatives: H. B. Zeiger, New York 17, N. Y. Glenn Garner Company, Chicago 6, Ill.



Where the Requirements are Extreme...

Use SILVER GRAPHALLOY*

For extraordinary electrical performance

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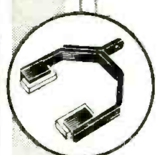
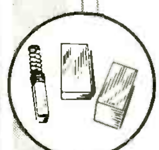
THE SUPREME BRUSH AND CONTACT MATERIAL

IN BRUSHES





- for high current density
- minimum wear
- low contact drop
- low electrical noise
- self-lubrication

IN CONTACTS

- for low resistance
- non-welding character

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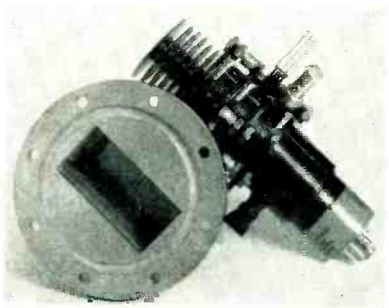
Accumulated design experience counts—call on us!

GRAPHITE METALLIZING CORPORATION
1055 NEPPERHAN AVENUE, YONKERS 3, NEW YORK

phone power supply is designed to eliminate the nuisance of dry-cell batteries on private phone systems such as are used in factories, apartment houses, office buildings and schools. The power supply consists of a properly filtered full-wave selenium rectifier that is designed for long life without maintenance. Operation is from 115-v 60-cycle a-c line with 3 amperes d-c output capacity. Taps are provided for 8, 10 and 12 volts. Also provided is an 8-volt a-c tap for operation of a-c buzzers or other equipment. Another model is rated at 1½ amperes 24 volts.

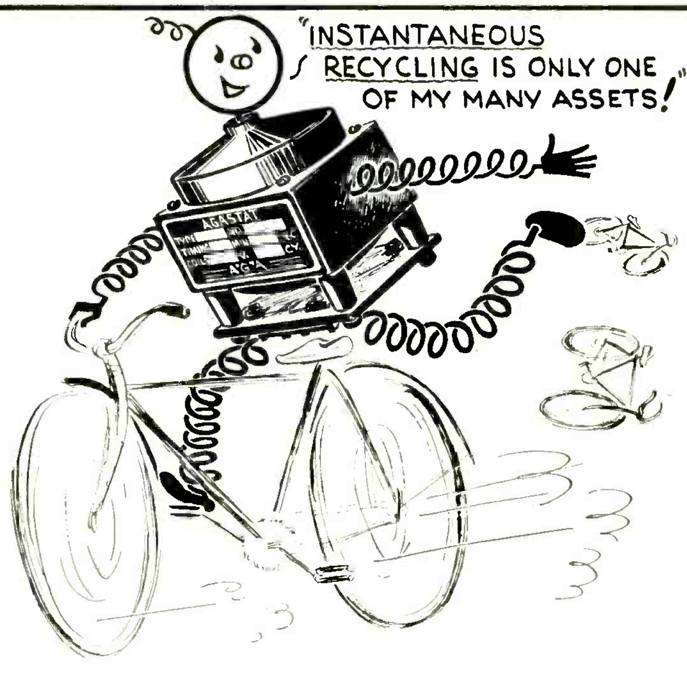


Microwave Amplifier Tube

SPERRY GYROSCOPE Co., Great Neck, N. Y., has developed a three-cavity klystron amplifier tube that has wide-band modulation characteristics with high power output for operation in the 4,000-mc common carrier band. It increases the output of transmitters to 10 watts. The tube also may be used as a synchrodyne or heterodyne mixer which makes it possible to avoid distortion in telegraph and television use by transmitting through stations in the tall towers about 30 miles apart without demodulation. Thus large numbers of repeaters may be connected in tandem to provide high quality long distance circuits.

Literature

Dynamic Pressure Measurement. Electronic Associates, Ltd., 778 El Camino Real, San Carlos, Calif., describes in form SA5-950 a newly developed measuring system for directly obtaining true dynamic



All types of

AGASTAT TIME DELAY RELAYS

are solenoid actuated – pneumatically timed. For AC and DC service. It will pay you to take time out to investigate Agastat Time Delay Relays. Information and literature on request.

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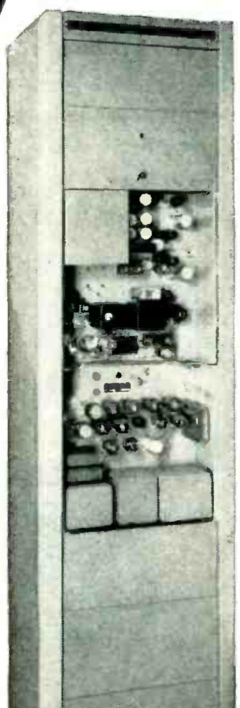

Model PT-102

Used in transmitting stations, laboratories and in receiver factories where a reliable standard video signal in the form of a test pattern is a prime requisite for testing overall video performance.

- Composite Video Signal.
- Wide Band Video Amplifier, 3 db down at 7 mc.
- Dual outputs for feeding two 75 or 100 ohm lines.
- Black positive or Black negative output.
- Resolution greater than 500 lines.

INPUT: Vertical and Horizontal Driving Pulses. Camera and Kinescope Blanking Pulses.

OUTPUT: Composite Video Signal, 2 Volts peak to peak. Complete with tubes, high and low voltage power units, cabinet rack.

Polarad Electronics Corporation

100 Metropolitan Ave. • Dept. E-2 • Brooklyn 11, N. Y.

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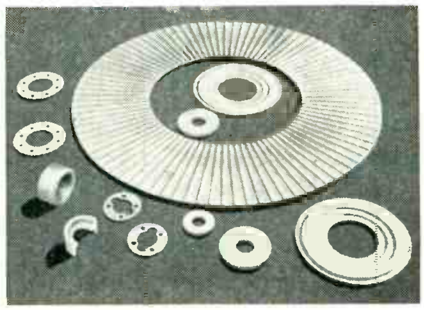
TEFLON

has outstanding insulating properties



Power factor, less than 0.0005; dielectric constant, only 2.0—over entire frequency measured to date. Excellent dielectric and mechanical strength; zero water absorption. Serviceable in the temperature range –90°F. to 500°F. Tough, resilient, unaffected by outdoor weathering, and completely chemical-proof.

Teflon is ideal for high-voltage, high-temperature, high- or ultra-high-frequency service in TV transmitters, radio, radar and other electrical equipment. We supply Teflon spacers for coaxial cables, Teflon inserts for coaxial connectors, *all types of molded and/or machined Teflon parts.*

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Cylinders
Rods
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Immediate delivery—experimental or production quantities—from the country's most complete selection of Teflon stock. Also, variations of stock shapes and sizes or special molded or machined parts exactly to specifications.

Teflon Products Division

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Camden, New Jersey

pressure variations. It contains a discussion of the problems involved in correcting conventional measurements for phase and amplitude errors inherent in tubing-connected pressure-sensing cells. Types and capacities of cells are tabulated from the ± 2.5 to ± 10-psi ratings and from the $\frac{1}{4}$ in. long x $\frac{1}{2}$-in. diameter to the $1\frac{1}{2}$ in. long x $\frac{1}{2}$-in. diameter sizes, including special wedge-shaped units for difficult mounting situations such as near an airfoil trailing edge.

Electronic Cores. Metal Powder Association, 420 Lexington Ave., New York 17, N. Y., has released Standard 11-50T defining the terms commonly associated with electronic cores made from iron powder. It also specifies the preferred dimensions of standard insert iron cores and threaded iron cores. Specifications include core diameters, lengths, screw inserts, insert size of tuning and insert cores, screw driver slots for inserts, spaded inserts and screw driver slots molded in cores. Price is 25 cents per copy.

Geophysical Transformers. Triad Transformer Mfg. Co., 2254 Sepulveda Blvd., Los Angeles 64, Calif. Catalog GP-51 discusses a new line of miniaturized Geoformers (geophysical transformers) designed for use in the frequency range from 5 to 500 cycles. By the use of improved winding techniques more efficient magnetic materials, and new shapes in core and case, the units described perform all the functions of the items they replace in one-seventh the volume and one-sixth the weight.

Selenium Rectifiers. Syntron Co., Box 220, Homer City, Pa., has available a four-page bulletin dealing with metallic, dry-cell selenium rectifiers. It gives illustrations, advantages, applications, a table showing cell sizes and ratings, and ordering information. Thirty-eight applications are listed.

Distribution Transformers. Marcus Transformer Co., Inc., 32-34 Montgomery St., Hillside 5, N. J. Safety in avoiding explosion and

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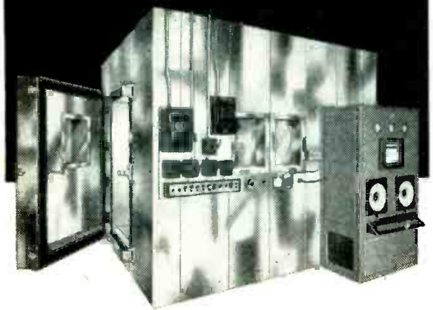

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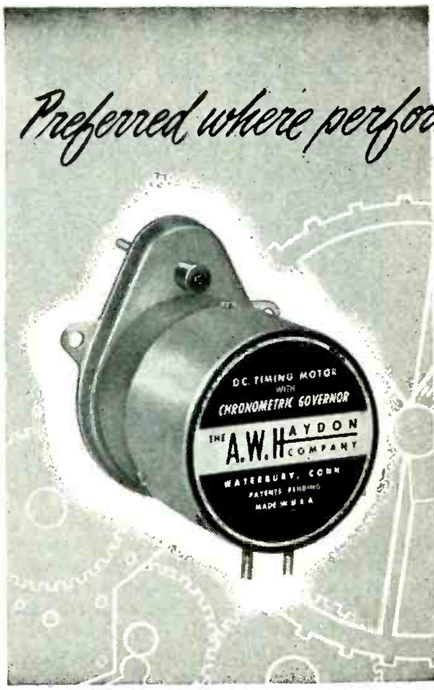

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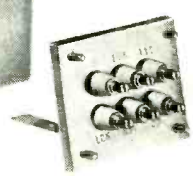

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fire hazards, economy of installation and maintenance are the keynotes of bulletin 50-FC on air-cooled distribution transformers. The four-page bulletin illustrates and describes the 1,000 kva, type F, unit substation showing a cutaway picture of a transformer section. It also shows various types of air-cooled power-center and packed-power units. Included are details about a line of lighting transformers, single and three-phase types.

Control Apparatus. Electrical Remote Control Co., Ltd., 13 Evanston Ave., Highams Park, London, E. 4, England, has available bulletins dealing with the type TPH heavy-duty photoelectric control apparatus, type PRP time control unit, type MDC, synchronous cam-operated timers and type DS heavy-duty relays. Write for list numbers 72, 31, 26 and 11.

Precision Instruments. Dawe Instruments Ltd., 130 Uxbridge Rd., Hanwell, London W7, England, has available a catalog containing over forty bulletins giving full details on a wide range of precision electronic instruments for scientific, industrial and photographic applications. Illustrations and specifications for each instrument are included.

High-Fidelity Sound Equipment. Hudson Radio & Television Corp., 212 Fulton St., New York 7, N. Y. The latest catalog contains complete descriptions of all the standard brand components required to assemble a high-fidelity sound system for home or professional use. It includes an explanation of high fidelity, what it is, how it functions, how to evaluate the performance of the various components, explanation of terminology, how to install, and so on. It also gives a complete description of each unit, with prices.

Phono Accessories. General Electric Co., Syracuse, N. Y., has prepared a 16-page phono accessory catalog, with descriptions and data on variable reluctance cartridges, replacement baton styli, tone arms and phono preamplifiers. Photographs, characteristics charts and outline drawings are shown.

Voltage Measurement. Hewlett-Packard Co., 395 Page Mill Rd., Palo Alto, Calif. Volume 2, No. 3 of the Journal covers the model 410B h-f vtvm, a unit designed to have an input capacity of approximately 1.5 $\mu\mu$f. Frequency range of the instrument described is from 20 cps to 700 mc, and its a-c voltage range is from 1 volt full scale to 300 volts full scale in six ranges.

Scintillation Counting Equipment. R-C Scientific Instrument Co., 335 Culver Blvd., Playa Del Rey, Calif., has issued a brochure containing information on an entirely new line of instruments for scintillation counters. Models covered are the CX14 Scintiscaler, AX10 Scintimonitor, LAX12 gamma Scintimeter and TAX11 Scintilocalizer. Illustrations, applications, description, features, specifications and prices for all are given.

Sand Core Drying. Allis-Chalmers Mfg. Co., 935 South 70th St., Milwaukee 1, Wisc. A recent four-page folder deals with the advantages involved in the use of the new electronic sand core drying method whereby heat is furnished by a 20-kw dielectric heater and current is transmitted through heavy coaxial cable. The process is completely described and illustrated.

TV and F-M Servicing. Simpson Electric Co., 5200 W. Kinzie St., Chicago 44, Ill., is issuing a small illustrated folder on six instruments for f-m and tv servicing. Included in the group are: model 335 plate conductance tube tester; model 488 field strength meter; model 476 Mirroscope; model 303 v-t voltohmmeter; model 260 a-c/d-c volt-ohm-milliammeter and the model 480 Genescope. Pictures of all six are shown and descriptions include sizes, weights, specifications as to ranges, and prices.

Transmission Lines & Antenna Equipment. Andrew Corp., 363 E. 75th St., Chicago 19, Ill. Bulletin 10-D is a thirty-page description and price list of a long line of coax cables for uhf, transmission lines

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The unique combination of controlled resiliency, stability and conductivity found in Metex "Electronic Weather Stripping" makes it particularly effective as a shielding material for such electronic applications as radar equipment, high frequency heating, television broadcasting and high frequency communication.

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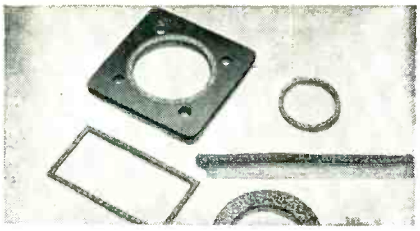

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The base material is a knitted—not woven—wire mesh which is made from any metal that can be drawn into wire. Knitting produces a mesh consisting of a multiplicity of interlaced loops which increase the normal resiliency of the wire and, by their hinge-like action, permit freedom of motion without loss of stability.

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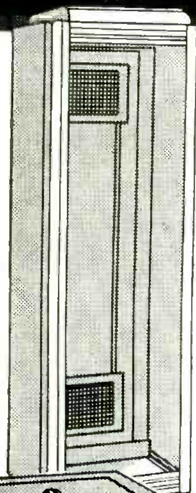

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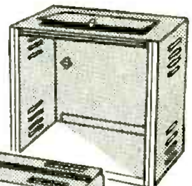

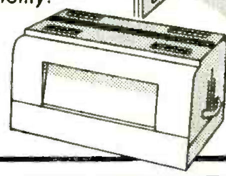

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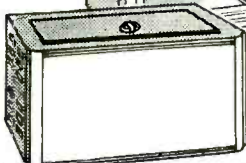

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for tv and microwave, antennas, and antenna-tuning equipment and components. The booklet is cross-indexed.

Radiation-Detection Densitometers. The Atomic Center, 489 Fifth Ave., New York 17, N. Y., has available bulletin 490 describing model 400-R Photovolt self-contained densitometer for the accurate measurement of density of dental-size x-ray films as employed in film badge systems for personnel monitoring in radioactivity laboratories and x-ray installations. Price of the unit discussed in the bulletin is $225. Also available is bulletin 270 describing the model 500-R photoelectric instrument having similar functions, but priced at $370.

Rack-and-Panel Type Connectors. Cannon Electric Development Co., 3209 Humboldt St., Los Angeles 31, Calif. A new bulletin coded DPM-2 covers the two miniature rack-and-panel connectors, types DPM-14 and DPM-A20 for radio, aircraft and special instrument applications. Dimensional sketches and photos are shown.

Broadcast Audio Equipment. Radio Corp. of America, Camden, N. J. Full description, features, uses and specifications of the type RT-11A magnetic tape recorder are outlined in Form 2J6934, a recently issued two-page brochure. Other available literature includes Form 2J6936, describing the Starmaker ribbon-pressure microphone; Form 2J6834-Re, featuring a new wall housing for the LC-1A Olson speaker; and Form 2J6935, which presents information on a new lightweight pickup tone arm combination for use with the type 70-D turntable.

Tube Insulators. American Lava Corp., Chattanooga 5, Tenn. Bulletin 502 discusses the requirements of vacuum-tube insulators and outlines the main facts about various technical ceramics especially adapted to those requirements. A chart gives detailed physical characteristics of the five most frequently used ceramic compositions. Particular attention is

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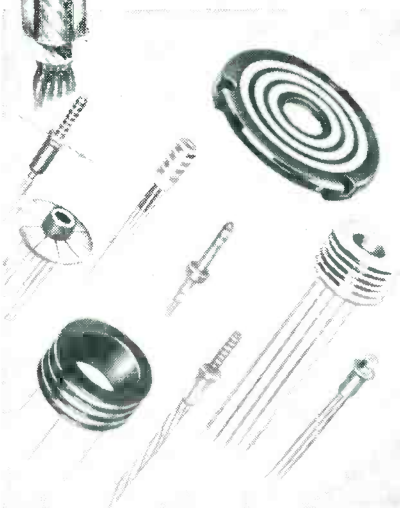

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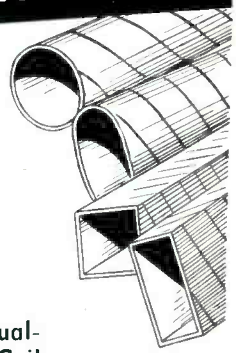

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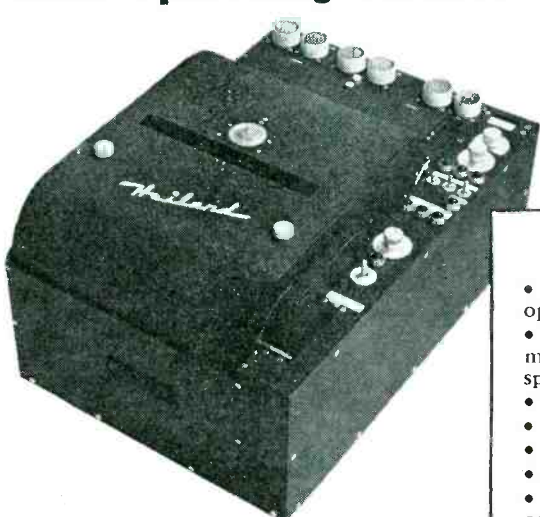

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invited to Al Si Mag 548, the safe temperature of which at continuous heat is 3,452 F.

Insulation Resistance Testing. Associated Research Inc., 3758 West Belmont Ave., Chicago 18, Ill. Bulletin 2-A covers a line of Vibrotest models for insulation resistance testing. The units described require no cranking or levelling and are fully portable and rugged. Illustrations and complete technical specifications are given.

Isometric Engineering. The Isometric Co., 1819 Broadway, New York, N. Y. Great need for acceleration in today's production line prompted publication of a booklet describing Isometrics, a method which shows the untrained worker, by means of illustrated charts, the correct rotation of assembled parts. The method described, which eliminates special training and supervisory aid is adaptable for use in radio wiring assembly, radar mechanical assembly, the aircraft industry and essential government work. Also discussed is the company's engineering service.

Audio Equipment. Sun Radio & Electronics Co., Inc., 122-124 Duane St., New York, N. Y. The second edition of the audio equipment catalog contains much technical information written for the layman on the principles involved in fine music reproduction. A large section of the 100-page book is devoted to questions and answers most common to high-fidelity aspirants or owners. The balance contains listings, prices and specifications on hundreds of components and subassemblies relative to high-fidelity music reproduction in the home or public places.

Bolometer Amplifier. Pickard & Burns Inc., 240 Highland Ave., Needham, Mass. Bulletin No. L100 deals with model 100 bolometer amplifier which is designed to meet the basic problem of amplification and metering of testing devices for antenna systems and various r-f networks. The instrument described incorporates a tunable variable-bandwidth filter,

an eighth power voltage ratio expander, automatic normalization of input signals and an undecaded output voltage for operating automatic recording equipments.

Precision Instrument. Kalbfell Laboratories, Inc., 1076 Morena Blvd., San Diego 10, Calif. A recent mailing piece discusses the model 402A dynamic Micro-Miker, a precision instrument for the measurement of capacitance and inductance in video amplifier design and maintenance. Description, important features and chief uses, as well as illustrations, are included.

TVI Suppression. Don Good, Inc., 1014 Fair Oaks Ave., South Pasadena, Calif. A small brochure deals with a line of accessories that will effectively eliminate or reduce interference to tv reception from such sources as: amateur radio stations, diathermy equipment, x-ray, industrial induction heaters, household appliances, neon signs and the like. Included are a Telepass (a tv high-pass filter), two variable Teletraps and two variable TVI Traps (one high and one low band).

Test Systems for TV Manufacturers. Radio Corp. of America, Harrison, N. J. Custom-built test systems which provide complete facilities for mass-production test and alignment of tv receivers are described in a new brochure available to television manufacturers. The system discussed can be adapted to a wide range of production requirements varying from as few as 100 units to over 1,000 units per day. It provides three major test operations: i-f and trap alignment, r-f alignment, and video, chassis and final tests.

Tiny Volt-Ammeter. Pyramid Instrument Corp., 49 Howard St., New York 13, N. Y. The 16-page manual No. 110 tells how to make one's job easier with the Amprobe, a pocket-size snap-on a-c volt-ammeter. It describes the functions of the new tool for anyone who installs, repairs, services or maintains electrical equipment. The unit discussed measures only 7⅛

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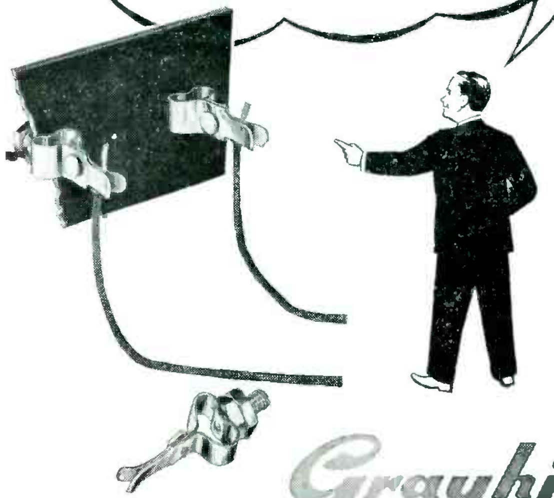

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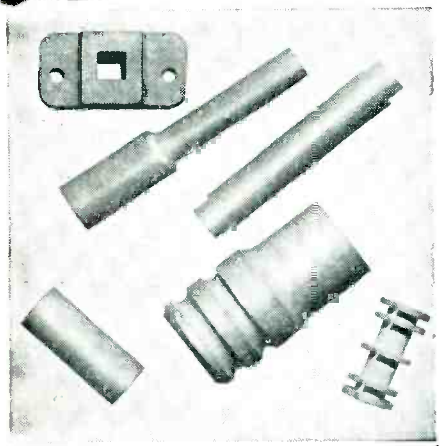

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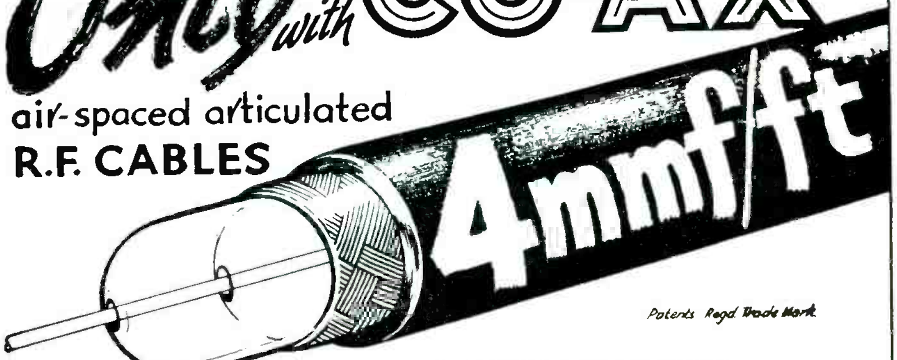

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C 11	6.3	173	3.2	0.36	
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C 22	5.5	184	2.8	0.44	
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in. x. 2 9/16 in. and is one-third the usual weight of such instruments.

Automatic Controls. Barber-Colman Co., Rockford, Ill. The Control Story is a new booklet outlining in nontechnical language the operation of automatic controls for heating, ventilating and air conditioning. Cartoons scattered through the text highlight the points covered. Copies are available free for the writing.

Electronic Voltmeters. Ballantine Laboratories, Inc., Boonton, N. J. Catalog 14 tells the story of the company's line of sensitive precision vacuum-tube voltmeters. This issue is a revision of the previous catalog and in addition features two new voltmeters, models 302B and 310, and a new line of multipliers. Chief features, illustrations and specifications for all types are included.

All-Band Generator. The Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland 8, Ohio. A recent 4-page folder illustrates and completely describes the model 292X microvolt signal generator which covers all a-m, f-m, tv and mobile frequencies in 7 ranges. The unit discussed herein is crystal controlled and has a modulated and unmodulated output from 0.2 to 100,000 μv through a 10 to 1 attenuator.

Solderless Connectors. Buchanan Electrical Products Corp., 1290 Central Ave., Hillside, N. J. Bulletin 750 gives a four-page treatment of a line of Underwriters' approved "pres-Sure-connectors" for solderless splicing and terminating of electrical wires. It contains detailed descriptive data, installation instructions and ordering information on splice caps, insulators, Termend lugs and a four-way "pres-Sure" crimping tool.

Mercury Plunger Relays. Ebert Electronics Corp., 185-09 Jamaica Ave., Hollis 7, N. Y. A four-page catalog illustrates and lists a line of heavy-duty one-, two- and three-pole mercury plunger relays and

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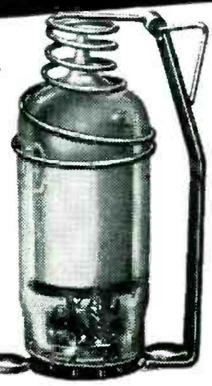

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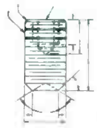
Nationally Known Washing Machine!



A puzzling set screw problem on a new nationally known Washing Machine was successfully solved with ZIP-GRIP* Self-Locking Set Screws. In less than a year, over 100 manufacturers have adopted ZIP-GRIP* for the same reason. Perhaps ZIP-GRIP* is the answer to your puzzling set screw problems, too.

Send for Free ZIP-GRIP* Action Demonstrator that shows exclusive, Contra-Thrust Action; we'll also include ZIP-GRIP* Data Sheet and tell you how to get Free Engineering Test Samples. Write today.

*PAT. PENDING

Makers of SETKO SET SCREWS

Set Screw & Mfg. Co.

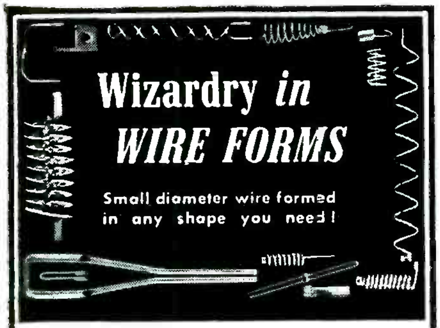
470 Main St. Bartlett, Ill. (Chicago suburb)

We specialize in Solving Puzzling Set Screw Problems.

6372

Wizardry in WIRE FORMS

Small diameter wire formed in any shape you need!



STRAIGHTENING & CUTTING
Perfect straight lengths to 12 ft.
.0015 to .125 diameter

WIRE FORMS
.0015 to .080 diameter

SMALL METAL STAMPINGS
.0025 to .035 thickness
.062 to 3 inches wide

Here's the "know how" and mass production capacity to turn out any quantity of small wire forms, parts and stampings in ferrous and non-ferrous metals and alloys—accurately, economically, speedily!

★

Specializing in Production of Parts for Electronic and Cathode Ray Tubes

Write for Illustrated Folder
Send Blueprints or Samples for Estimate

ART WIRE & STAMPING CO.
227 HIGH STREET, NEWARK 2, N. J.

DYNAMIC WIRE WOUND RESISTORS

Each is precision wound to close tolerance. DEVITRIFIED MOISTURE-PROOF ENAMELED, will stand salt-water tests, a quality product. Standard or custom types to meet your requirements.

Whatever your resistor requirements DYNAMIC has the resistor you need, or will produce it on short notice.

DYNAMIC
RESISTOR CORPORATION
6 Cutter Mill Road Great Neck, N. Y.

sensitive relays. It contains an outline of typical features and prices, as well as relay hookups and dimensional diagrams.

D-C Indicating Amplifier. Leeds & Northrup Co., 4901 Stenton Ave., Philadelphia 44, Pa., has published an 8-page folder describing and illustrating a stabilized d-c indicating amplifier that can be used as a direct-reading microvoltmeter, a preamplifier for recorders to extend range down to low levels, and a high-sensitivity, short-period null point detector. Diagrams and specifications are included.

Soldering Booklet. Weller Electric Corp., Easton, Pa., has announced a new revised edition of Soldering Tips, a 20-page pocket manual discussing in nontechnical language a variety of difficult operations, time-saving methods, fluxes and solder tables. Step-by-step illustrations make each point clear and easy to remember. Price is 10 cents.

Tube Engineering. Electrons, Inc., Newark, N. J., has published a new engineering manual and catalog completely covering the subject of gaseous discharge rectifier and control-rectifier tubes. Amply illustrated with diagrams, it includes data on the ratings, applications and life expectancy. Information is also given on tube protection, efficiency, regulation, filters, load, mechanical design and tube variations.

Precision Potentiometers. The Gamewell Co., Newton Upper Falls 64, Mass. A new engineering bulletin comprised of 11 data sheets describes a line of precision potentiometers. General features, linear and nonlinear units, condensed specifications and special applications are covered. Curves representing interesting functions are included.

Magnetic Amplifiers. Vickers Electric Division, Vickers Inc., 1815 Locust St., St. Louis 3, Mo., has issued a new group of Service Sheets for the DH-2 handbook dealing with magnetic amplifier output characteristics. It is quite

similar to the plate-characteristics type of presentation used for vacuum tubes and allows easy determination of magnetic amplifier performance for any value of load resistance. Output characteristics are given for each of the standard 400-cycle high-performance magnetic amplifiers in the individual bulletins of the issue. A 4-page supplement to bulletin 2000 is also available.

Electrical Resistance Instruments. Tech Laboratories, Inc., Bergen and Edsall Blvds., Palisades Park, N. J., has issued bulletin 431, a catalog made up of a series of bulletins showing a variety of precision resistance instruments. Included are several types of attenuators and potentiometers, microhmmeters, special transmitters and oscillators, and special electronic control devices.

Instrument Catalog. Wheelco Instruments Co., 847 W. Harrison St., Chicago 7, Ill. In the new condensed catalog just released, a selection of typical indicators, controllers and combustion safeguards are illustrated and briefly described. An accompanying 4-page price list contains the listing, description and current price applying to nearly all of the company's standard instruments.

Plug-In Assemblies. Dietz Design & Mfg. Co., Grandview, Mo. A single-sheet bulletin announces and illustrates a complete line of plug-in housings and assemblies—for coils, relays, filters, crystals and so on. Catalog numbers and dimensional drawings for the thirty standard models are given. Use of the units described will benefit any electronic equipment subject to frequent servicing.

Tape Drive Recording Mechanism. Cook Research Laboratories, 1457 Diversey Parkway, Chicago, 14, Ill. Bulletin PD-14 treats of the type MR-12, a portable 12-information channel tape drive recording mechanism for use in geophysical seismic analysis work. The unit described is also useful for high-quality audio recordings. Complete specifications are given.

ALLISON RADAR

FOR

MULTI-ENGINED AIRCRAFT

Military
Airline
Executive

Models E ES ESB

58-65 lbs. Overall Weight

1. Long range. 80-150 miles.
2. Exclusive scanning method.
3. Compact. Sturdy.
4. Easy to operate. Pilot control.
5. Simplicity of maintenance.
6. Gyro-stabilized.
7. JAN components.
8. RACON beacons.

ALLISON RADAR CORPORATION
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MEG **Cheaper** by the dozen with
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JELLIFF ALLOY 1000 RESISTANCE WIRE

This new material packs 1000 ohms/cmf—48% more than the widely-used nickel-chromium alloys.

And what's more, there's no loss of other important physical and electrical properties. High tensile strength—excellent solderability—TC of Resistance is 20—EMF vs Copper + 7 micro-volts—Coefficient of Expansion 13.9—remarkable Surface-Corrosion Resistance—and many more vital characteristics make ALLOY 1000 a money-making, prestige-building component of compact, precision resistors. For complete data, get Bulletin 17

LEKTROMESH • RESISTANCE WIRE • FILTERS • STRAINERS • WIRE CLOTH • PARTS • WIRE MESH • DIPPING BASKETS

THE C. O. JELLIFF MANUFACTURING CORPORATION SOUTHPORT, CONN.

WIRE PRODUCTS Jelliff SINCE 1880

AT LAST...

a sensibly priced VHF R-F

POWER METER

The COMCO 232-F 110^{00}
FOB Factory

Invaluable instrument for the VHF technician! Designed especially to provide direct reading, in watts R-F (0-50 watts), of VHF transmitters. Suitable for use with any transmitter using 52 ohm load, operating on frequencies from 30 to 175 Mc. Ideal for fast bench testing of output of VHF mobile and aircraft equipment -- no conversion tables necessary. Accurate to within 10%. Quickly detects aging tubes. Finished in attractive, durable grey hammertone.

WRITE, WIRE or PHONE TODAY for prompt shipment!

COMCO

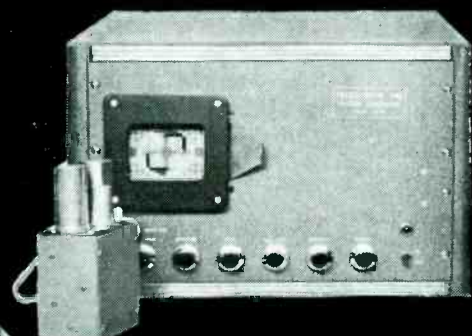
COMMUNICATIONS CO.
Inc.
300 Greco Avenue P. O. Drawer 6250
Coral Gables, Florida

NEW!

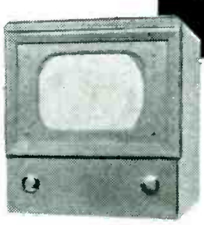
TELECHROME

FLYING SPOT PICTURE GENERATOR

Model 300-A



Used in TV stations, development laboratories, schools, factories, service organizations and wherever a reliable, easily changed video picture source is required



Supplied with driven sweep 10" monitor
965^{00}
Complete

- Resolution greater than 500 lines
- Supplied with standard RMA 3x4" test pattern
- Slide Holder for positive or negative transparencies
- Excellent picture tonal rendition
- Supplies pictures without driving pulses from a sync. generator
- Low and high impedance outputs, black positive or negative polarities

Complete with all tubes, self-contained high and low voltage regulated power supplies, sweep and video circuits, in rack width metal cabinet.

LIMITED PRODUCTION ON ABOVE MODELS

Write today for catalog of our color equipment line.

TELECHROME INCORPORATED
88 Merrick Rd, Amityville, L.I., N.Y.

NEWS OF THE INDUSTRY

(continued from page 134)

survey work and personnel protection immediately following an atomic attack.

Specifications are also given by Civil Defense for a low-intensity instrument measuring up to five hundred milliroentgens for long-range surveys, which probably would not start for several days following an atomic disaster. Existing low-level and middle-range instruments are described.

A procurement pool for states wishing to purchase training instruments of the kind recommended will be provided by Civil Defense. This would enable states to purchase the instruments at a lower cost than would be available to them otherwise.

Specifications for the instruments were determined by a special NSRB Civil Defense Radiological Committee composed of representatives from the Atomic Energy Commission, the Armed Forces Special Weapons Project of the Department of Defense, the U. S. Public Health Service, the National Bureau of Standards, and the Federal Civil Defense Administration.

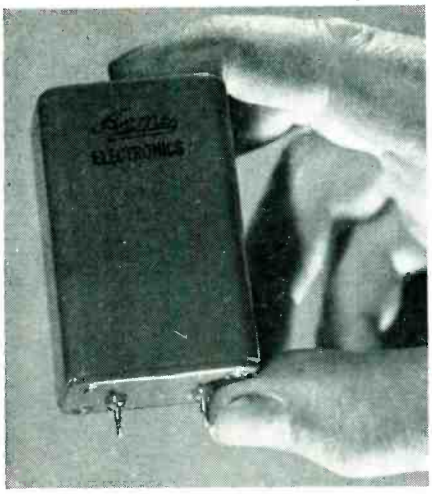
Personal dosage indicators now existing are not considered suitable for civil defense. Research is under way to modify these instruments or develop new ones.

New Recommended Standards Published

THE RTMA recently issued new standards for home phonograph playback needles. Designated as REC-126-A, the publication specifies that for 78-rpm records the needle tip shall have the following radius: (a) for metal point 0.0027 in. with tolerance + 0.0003 in., − 0.0002 in.; (b) for jewel points 0.003 in. with tolerance + 0.0002 in., − 0.0003 in.

Needles for 45-rpm and 33⅓-rpm l-p records shall be 0.001 in. plus 0.0001 in. minus 0.0002 in. Needles with a 0.001-in. radius shall be color-coded red and their pickup cartridges are to be color-coded with a red dot.

Radius of the needle tip shall be determined by comparison with a series of circular segments of



ACME

500 CYCLE LOW PASS FILTER

Acme solved one major manufacturer's problem by designing and producing this miniature filter with extremely low insertion loss within the pass band and 60 DB attenuation.

This is an example of what Acme is doing. Your problems will receive prompt attention. All wave filters and other products are built in careful conformance to military specifications. Your inquiry is invited.

Acme ELECTRONICS

Division of Acme Metal Die, Inc.
212 E. 17th St., Los Angeles 15, PRospect 7457

Wave Filters • Delay Lines • Magnetic Amplifiers • Special Transformers & Chokes • Toroidal, Universal & Solenoid Wound Inductors

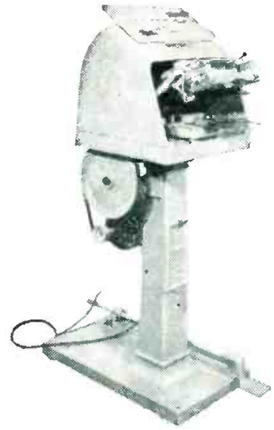
ENGINEERS

ELECTRONICS RESEARCH AND DEVELOPMENT
In Baltimore, Maryland
Career Positions
for
Top Engineers and Analysts
in

Radar Pulse, Timing and Indicator Circuit Design
Digital and Analogue Computer Design
Automatic Telephone Switchboard Design
Also
Electro-Mechanical Engineers

Experience in servo-mechanism, special weapons, fire control, and guided missile design.
Recent E.E. graduates and those with at least one year electronics research and development work will also be considered.
Salary commensurate with ability. Housing reasonable and plentiful. Submit resume outlining qualifications in detail. Information will be kept strictly confidential. Personal interviews will be arranged.

THE GLENN L. MARTIN COMPANY
Employment Department
Baltimore 3, Maryland

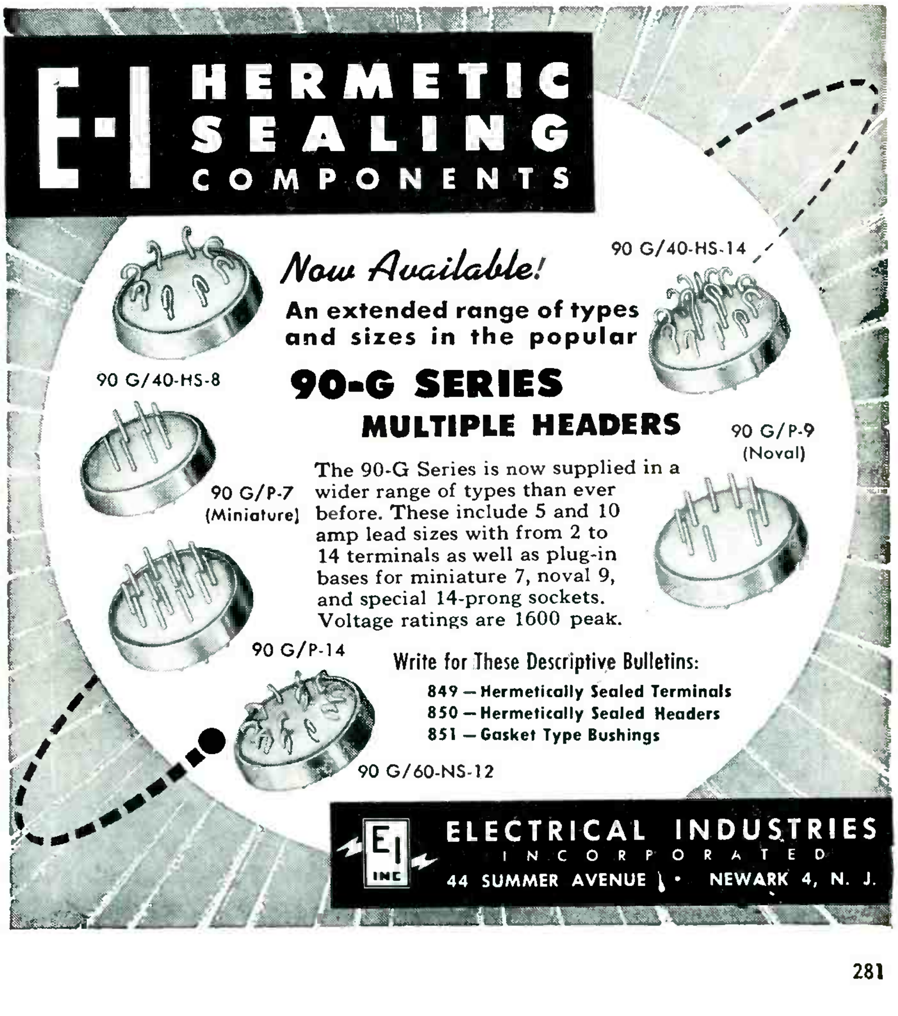


crystal cases
relay boxes
selenium rectifier stacks
transformers
parts identification on boxes and cartons

YOU CAN MARK THEM ALL WITH THE KD 8

Here's a really versatile machine—the Markem KD 8. And its talents are particularly suited for saving money in the electronics field. With a KD 8, you can mark many different sizes of parts, containers, labels, tags with imprints up to 2 7/16″ wide by 6 11/16″ long. Type changes, using either rubber plates or metal type, are quick and easy. That means you can imprint exactly the quantity of articles you want, when and where you want them. The KD 8 is a really flexible, money-saving production tool that will cut marking bottlenecks in your plant. Write today for more details that will pleasantly surprise you.

MARKEM MACHINE COMPANY — **Keene 27, New Hampshire**



known radii and an angular length of 110 deg. Included angle of tip of the needle shall be no less than 40 deg and no more than 50 deg.

The publication is available from Radio-Television Manufacturers Association, 1317 F Street, NW, Washington 4, D.C. Price is 25 cents.

Radar Helps Forecast Jet Weather

GETTING ready to provide meteorological services for high-flying jet aircraft, the Australian Department of Civil Aviation is setting up a network of fifteen radar stations at selected points in Australia and New Guinea.

The radars will be used to track the course of meteorological balloons enclosed in a mesh of nylon. The mesh is treated with silver to make it reflect the radar pulses.

Two operators keep the 54-inch parabolic dish of the station trained on the balloon, taking readings of elevation, bearing and range of the balloon at intervals of one minute. Plotting of the balloon's course enables wind velocity to be determined at all altitudes up to 40,000 ft. The altitude correlations are derived from the known rate of ascent.

A second use of the radar is the detection of heavy cumulus clouds, which show up on the screen with a characteristic echo. Thunderclouds approaching an airport can be located with ease and their speed and course can be plotted for the benefit of aircraft flying in the vicinity.

As the network of meteorological radar stations could be turned to defense uses at short notice, their locations will be kept secret.

TV To Aid Test Pilots

A SYSTEM employing tv for testing airplanes has been tried out at Wright-Patterson Air Force Base in Dayton, Ohio. Radio waves from the ground control the maneuvers of the airplane being tested while one or two video cameras focus on the instrument panel, recording the data on screens set up in the ground control station. All tests indicate that the use of tv to replace test

pilots on dangerous flights is entirely practical and it is anticipated that this tv testing will prove effective on even such high-speed planes as the X-1 and the F-86.

Lear, Inc., of Grand Rapids, Mich., and the Philco Corp., of Philadelphia, Pa., are working on the project with engineers of the Air Materiel Command's Equipment Laboratory and Electronic Subdivision.

BUSINESS NEWS

TRACERLAB, INC., Boston, Mass., recently contracted to purchase a site of approximately 17 acres in West Concord, Mass., to construct a new building to house its engineering and manufacturing operations as well as certain phases of its radiochemical program.

MASSA LABORATORIES, INC., Cleveland, Ohio, has announced the opening of its new laboratories and manufacturing plant in Hingham, Mass., for the development and production of electroacoustic apparatus.

HUDSON WIRE CO. will soon establish another magnet plant at Cassapolis, Mich., for the production of bare and insulated wires for electrical and radio-electronic applications.

SONOTONE CORP., Elmsford, N. Y., manufacturer of hearing aids, has started production of miniature tubes for radio and television sets.

RAYTHEON MFG. CO. has started production in its new pilot plant in Quincy, Mass. The new plant is operated by the Receiving Tube Division of the company and is engaged in the manufacture of electronic tubes of subminiature and miniature construction for military requirements exclusively.

H. LESLIE HOFFMAN AND HOFFMAN RADIO CORP.'s bid of $11,200,000 for Don Lee Enterprises has been accepted by the Los Angeles County Public Administrator. Hoffman Radio Corp. will own 100 percent of the stock in Don Lee Enterprises, which include a-m stations in Los Angeles, San Francisco, San Diego,

Santa Barbara, Los Angeles' tv station KTSL, and KHJ-FM, Los Angeles, as well as 45 affiliate stations in California, Washington, Oregon, Nevada, and Idaho. In addition, there is a substantial stock interest in the Mutual Broadcasting System. The transfer is still subject to formal approval of the Los Angeles Probate Court and to permission for transfer of existing licenses to the new ownership by the FCC.

PYROFERRIC Co., New York, N. Y., has acquired a manufacturing plant at 14 N. Bleeker St., Mt. Vernon, N. Y., to meet the increased demands for its iron cores and powdered metallurgy developments.

ELECTRO-VOICE, INC., announces the expansion of their laboratory and research facilities. A new r-f double-screen room for tv-booster research and a polycylindrical-surfaced speaker-comparison room have been added. New test and measurement equipment for the laboratory and additional model-making tools and machinery are included in the program.

LENKURT ELECTRIC Co., San Carlos, Calif., manufacturer of radio and wireline telephone and telegraph carrier equipment, has begun construction on 16,000 sq ft of added production space to its present plant.

SKINNER, HARLAN AND IRELAND, INC., Indianapolis, Ind., is a newly organized consulting engineering firm. The firm will specialize in permanent magnets and soft magnetic materials but will accept consulting projects in any allied field.

THOMPSON PRODUCTS, INC., Cleveland, Ohio, manufacturers of parts for the automotive and aircraft industries, have entered the electronics field to help solve problems arising from coaxial switch needs.

PLATCO RADIO, INC., has been organized as a radio transmitter and receiver manufacturing firm by Murray Platt with quarters at 489 Broome St., New York, N. Y.

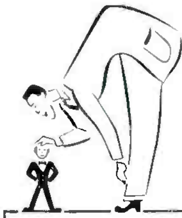
SIMPSON ELECTRIC Co., manufacturers of panel instruments and

We can offer zinc die castings as small as .000004 of a lb. (250,000 to the lb.)

——SMALLNESS UNLIMITED!

GRC's method of die casting *really small* parts has opened up new fields in designs, products and economies for hundreds of manufacturers. Our exclusive, high-speed mass production facilities turn out simple or intricate parts automatically—completely trimmed ready for use—100,000 pieces to many millions. Discover GRC's small parts possibilities for yourself—

Write Today for Bulletin and Samples.



Maximum Weight: ½ oz.
Maximum Lengths: 2 in.
SMALLNESS UNLIMITED

GRIES REPRODUCER CORP.

100 WILLOW AVENUE, NEW YORK 54, N. Y.

Little thought-of facts about capacitors

The short time breakdown voltage of a well-made D.C. capacitor is not less than 5 to 6 times the actual working voltage at 20°—

E = 5 × e min
E = Breakdown voltage
e = Rated d.c. working voltage

INDUSTRIAL CAPACITORS are unvaryingly held to this formula.

Designed for maximum safety and the smallest possible volume, INDUSTRIAL CAPACITORS are the most widely used capacitor in industrial applications.

WRITE TODAY FOR DETAILED CATALOG

Watch this space for other capacitor facts that will help you.

INDUSTRIAL CONDENSER CORP.

Sales Offices in All Principal Cities
3243 N. California Ave.
Chicago 18, Illinois

SPECIAL TUBE SOCKETS

For high power tubes Gates has designed several very attractive tube sockets.

To the left, a socket for the Eimac 3X2500 tube.

To the right, a socket for such tubes as the 889R, 891R, 892R and others.

Available in small or large quantities at proportional prices.

GATES RADIO COMPANY
Manufacturing Engineers Since 1922
QUINCY, ILLINOIS, U. S. A.

ATR

"A" BATTERY ELIMINATORS

Makes it easy to DEMONSTRATE AND TEST D.C. APPARATUS FROM A.C. LINES

for DEMONSTRATING AND TESTING AUTO RADIOS

New Models . . . Designed for testing D. C. Electrical Apparatus on Regular A. C. Lines. Equipped with Full-Wave Dry Disc Type Rectifier, Assuring Noise-less, Interference-Free Operation and Extreme Long Life and Reliability.

✓NEW MODELS ✓NEW DESIGNS ✓NEW LITERATURE

"A" Battery Eliminator, DC-AC Inverters
Auto Radio Vibrators

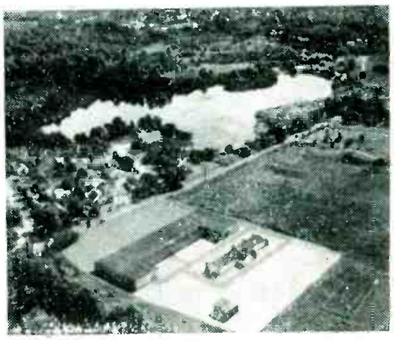
See your jobber or write factory

ATR

AMERICAN TELEVISION & RADIO CO.
Quality Products Since 1931
SAINT PAUL 1, MINNESOTA—U. S. A.

test equipment, recently leased its fifth plant. The new factory is located at 932 Benton St., Aurora, Ill.

MEASUREMENTS CORP., manufacturers of precision electronic testing equipment, is now occupying its



New Measurements Corp. plant

new 25,000-sq ft plant at Intervale Road, Boonton, N. J.

FLEETWOOD LABORATORIES, INC., Bronxville, N. Y., has been formed to manufacture x-ray thickness gages for foil and light-gage metals. President and chief engineer is W. B. Lurie, former design engineer in charge of the high-voltage laboratory at Machlett Labs.

PERSONNEL

THOMAS G. BANKS, JR., former sales engineer, has been appointed to the newly created position of director of research and development at Gates Radio Co., Quincy, Ill.

F. C. CAHILL, supervisor of the receiver section at Airborne Instruments Laboratory, Mineola, N. Y., has been named supervising engineer of a combined engineering group to be known as the radar section. The new group, a combination of the former receiver and radar sections, now comprises about 40 engineers.

J. GILMAN REID, JR., chief of the engineering electronics section of the National Bureau of Standards since 1939, has been appointed chief of the Bureau's electronics division.

JOHN B. LITTLE, for 13 years a member of the technical staff at the Bell Telephone Laboratories, has joined the International Business

OPPORTUNITIES for ENGINEERS — SCIENTISTS

GENERAL ELECTRIC COMPANY, Electronics Dept., has excellent opportunities for experienced technical personnel in the following areas:

ADVANCED DEVELOPMENT

DESIGN—Circuit, component, and product

FIELD SERVICE

TECHNICAL WRITING

These positions available in the following fields:

TRANSMITTERS, RADAR,
TUBE, RECEIVERS—
TELEVISION AND
COMMUNICATIONS

If you have a bachelors or advanced degree in Electrical or Mechanical Engineering, Physics, Metallurgy, or Physical Chemistry and experience in the electronics industry it will be worth your while to investigate these opportunities.

Send complete resume (Listing salary requirements and availability) to: TECHNICAL PERSONNEL, ELECTRONICS PARK, SYRACUSE, N. Y.

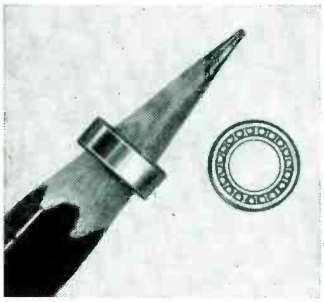
General Electric

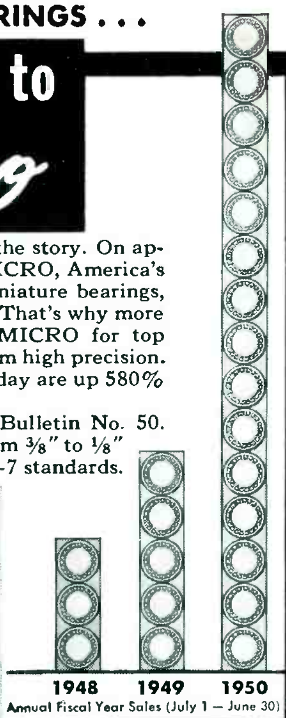
IN MINIATURE BEARINGS . . .

The Trend's to *Micro*

The Sales Chart at right tells the story. On application after application, MICRO, America's first and only *fully ground* miniature bearings, have proved their superiority. That's why more and more engineers specify MICRO for top performance, long wear, uniform high precision. That's why MICRO'S sales today are up 580% over 1948 and still climbing.

Write today for Technical Bulletin No. 50. 70 sizes and types available from 3/8" to 1/8" O.D. with tolerances to ABEC-7 standards.





New Hampshire *Micro* Ball Bearings, Inc.
5 Main St., Peterborough, New Hampshire

The GROUND Miniature Bearing

***For* HEAVY DUTY WORK! Severest Electrical Services!**

JONES PLUGS & SOCKETS

500 SERIES

Proven Quality

P-506-CE
Plug with Cap

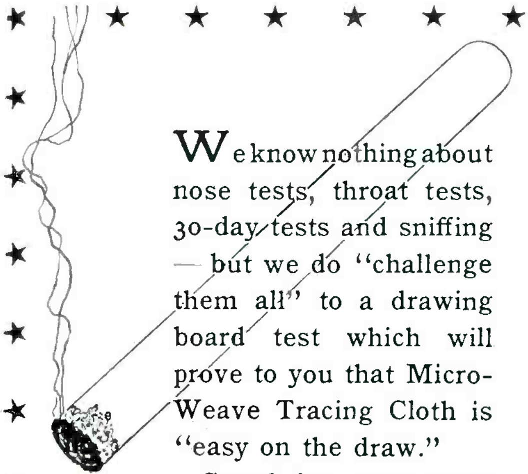
S-506-DB
Socket with deep Bracket

For 5,000 Volts, 25 Amperes per Contact Alterable by circuit Characteristics.

Socket contacts phosphor bronze, knife-switch type, cadmium plated. Plug contacts hard brass, cadmium plated. 2, 4, 6, 8, 10, and 12 contacts. Plugs and sockets polarized. Long leakage path from terminal, and terminal to ground. Caps and brackets, steel parkerized (rust-proofed). Plug and socket blocks interchangeable in caps and brackets. Terminal connections most accessible. Cap insulated with canvas bakelite.

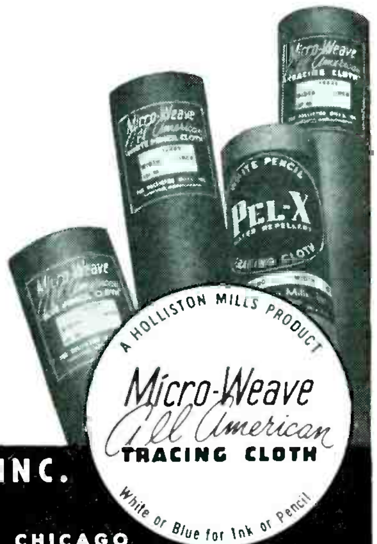
Write for Jones BULLETIN 500 for full details on line.

Jones
HOWARD B. JONES DIVISION
CINCH MANUFACTURING CORPORATION
CHICAGO 24, ILLINOIS
SUBSIDIARY OF UNITED-CARR FASTENER CORP.



We know nothing about nose tests, throat tests, 30-day tests and sniffing — but we do "challenge them all" to a drawing board test which will prove to you that Micro-Weave Tracing Cloth is "easy on the draw."

Send for generous samples and give Micro-Weave any test you please — others have, and they switched to Micro-Weave.



THE HOLLISTON MILLS, INC.
NORWOOD, MASS.
NEW YORK PHILADELPHIA CHICAGO

MICRO-WEAVE is backed by Holliston's 50 years of leadership and experience in developing special cloths for industry.

Machines Corp. as a technical engineer in their engineering laboratories at Poughkeepsie, N. Y. He will be in charge of the mechanical aspects of electron tube research and development.

HARRY R. SMITH, formerly senior development engineer in television broadcasting equipment at the television transmitter division of the Allen B. Du Mont Laboratories, Inc., was recently appointed head of the television transmitter development department of Standard Electronics Corp., subsidiary of Claude Neon, Inc., New York, N. Y.

PHILIPS B. PATTON, former field engineer, has become manager of the sales engineering department of Lenkurt Electric Co., Inc., San Carlos, Calif., carrier equipment and component manufacturer.


P. B. Patton


G. M. Lebedeff

GEORGE M. LEBEDEFF, formerly chief engineer at Heintz and Kaufman and an engineer with Federal Telegraph Co., has taken the post of chief engineer of Lenkurt Electric Co.

WILLIAM J. JACKSON, formerly associated with WPIX television and also the NBC development laboratory in New York, was recently appointed chief engineer of tv station KEYL, San Antonio, Texas.

JOHN W. MCNALL, in charge of the emission section of the Westinghouse Electric Corp.'s Lamp Division Research Department, Bloomfield, N. J., has been appointed division engineer of the department.

BENJAMIN MARGOLIN, formerly engaged in design and development engineering with General Motors and Baird Associates, has been appointed to the Henry P. Segel Co., Boston, Mass., in a sales capacity.

on the basic research attempt on USAF contract W-19-122ac-10.

HARRY STOCKMAN, S. D.
Director of Research
Tobe Deutschmann Corporation
Norwood, Massachusetts

Electronics Quiz

THIS MONTH'S puzzle problem was submitted by William H. Fritz of Mamaroneck, New York.

Several years ago a circuit was needed that would modulate the positive peaks of a carrier wave with one pulse or recurrent wave and at the same time modulate the negative peaks of the same carrier wave with a second and unrelated pulse or recurrent wave . . . and each modulation envelope had to be independend of the other. No vacuum tubes or moving parts were to be used. Design an appropriate "black box" to accomplish the desired purpose.

The solution arrived at by Fritz will be published in next month's *Backtalk* along with a new problem. Readers are encouraged to submit problems. For each problem that is printed in this department, a payment of five dollars will be made. The correct solution must accompany each problem.

Last Month's Solution

Last month's problem was:

After having designed and constructed an entirely conventional full-wave rectifier circuit feeding a purely resistive load, the direct current through which is to be adjusted to exactly one ampere, the ham doing the work is suddenly siezed by a spasm of caution (obviously a purely fictitious person) and decides to fuse the circuit. At first he decides to place a one-ampere fuse in the center leg, that is, between the load and the center tap of the transformer. But then he realizes that this might not prevent damage to the transformer from a short occurring from plate to plate. He wishes to employ the smallest fuses that are just able

to carry the load current.

Assuming that fuses were available in any desired rating, and would blow at exactly this rating, would the choice of one ampere in the center, or presumably one-half ampere in series with each plate, be correct?

Solution: A fuse in the center leg would have to be able to carry at least 1.11 amperes, whereas the two fuses in series with the plates of the rectifier tube would each have to be good for 0.785 ampere.

Engine Analyzers

DEAR SIRS:

IN regard to the article "Aircraft Ignition Tester" by Bauer and Sands published in your October 1950 issue, the authors point out that their tester is the only one that can find intermittently firing spark plugs and bad spark plug connections.

To support this claim, Bauer and Sands cite a case, involving a Wright G-200 engine, in which their tester indicated intermittent ignition in a cylinder where a new spark plug had been installed. Examination showed failure to connect the ignition lead properly to the plug. "No other type of tester could have found this trouble", said the authors in their article.

This statement is not entirely accurate. The criticism presented here is not intended to snipe at or squelch pioneering work in the field of engine instrumentation. On the contrary, more attention to this field of investigation should be strongly encouraged. Perhaps the authors' oversight is due to their enthusiasm or the fact that their work was done earlier than their report indicates. It is, however, desirable to put the record straight.

At least eight other types of ignition testers (sometimes called analyzers) which can locate this type of trouble have been developed in recent years. Two are fairly well known in the United States. The best known of these devices has existed since early 1946 when its first tests were made on the engine stands at Wright Aeronautical Corp. During these tests, more than 20 major types of ignition troubles, including the type referred to above, were detected by the tester.

An "Airborne Engine Analyzer" is described by V. C. Cetrone in a six-page article in the March 1948 issue of ELECTRONICS. This unit is designed so it can be used either as a permanently installed airborne unit or as a ground testing unit for maintenance and engine test stand work. It is used by airlines, the Air Force, Navy, CAA, engine manufacturers, fuel research projects and executive aircraft. In some cases, it has been specified as standard equipment on fleets of certain types of airplanes.

According to Cetrone, "The two principal functions of the engine analyzer are: the location and identification of engine ignition system malfunctions such as fouled plugs, faulty magneto capacitors, and grounded high-tension leads; and the location and identification of what might be termed vibration faults, such as detonation, incorrect valve clearances and valve bounce."

Other Troubles

In addition to grounded high-tension leads, Cetrone also lists among troubles detectable by the analyzer "shorted secondary (identifiable either in individual leads or in the magneto), large plug gap, small plug gap, shorted primary capacitor, no combustion, and magneto mistiming." In addition to "breaker point bounce" Cetrone also shows a photograph of an "open secondary" which the analyzer also can identify specifically as being in the magneto or in a particular plug lead.

Each of the troubles cited here is a possible variation of the intermittent firing condition caused by troubles the same as or different from what Bauer and Sands detected.

These troubles also show the more specific and much finer degree of analysis obtainable with the analyzer described by Cetrone.

In addition, Cetrone noted the necessity of using an analyzer during flight. His article points out that "experience has shown that checks made during actual flight often reveal faults not detectable by ground test methods."

This condition was demonstrated conclusively by Pan American World Airways during an engine analyzer evaluation program begun in 1946. An experimental installation was made on Constellation Clipper NC-"68" and operated in regular scheduled airline service between New York and Johannesburg, South Africa. The analyzer was operated by more than 100 regularly assigned flight engineering personnel only 13 of whom had received any briefing in the operation of the instrument. For the purposes of the program, base maintenance personnel were instructed to ignore analyzer reports and to continue using standard trouble-shooting methods. Analyzer reports were withheld.

In February 1947, enroute from Dakar to Roberts Field, the analyzer showed an "open secondary circuit" to the front plug on No. 1 cylinder of No. 4 engine. At Roberts Field the lead was checked with a tester and no fault was found by the ground crew.

Enroute to Johannesburg, the trouble persisted, showing the same indication on the analyzer. The ground crew at Johannesburg checked the lead again and reported it OK.

The analyzer still indicated the trouble continuously but the ground personnel reported they could find no trouble on the ground.

This sequence of events was duplicated at every base stop on the return trip from Johannesburg to La Guardia, N. Y. At La Guardia the analyzer report was checked by the ground crew. The lead pointed out so many times in flight by the analyzer was removed and carefully inspected. A badly frayed cigarette wire was found and repaired. The trouble then disappeared.

This was only one of the many hard-to-find troubles which the analyzer put the finger on directly. Not long after, ground crews were instructed to follow analyzer reports.

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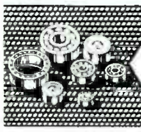

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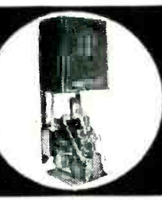

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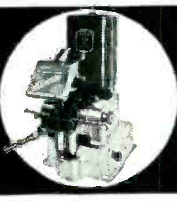

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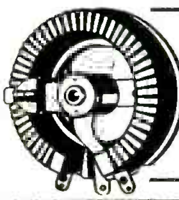

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APP. $56,000 PRECISION TOOLS & TOOL CRIB SUPPLIES OF EVERY DESCRIPTION MISC. EQUIPMENT: Towmotors, App. 1000 Fluorescent Lights—Transformers—Motors—Lift Trucks—Chain Hoists—Conveyors—Shop Cabinets & Bins, etc.

App. $700,000 INVENTORY

Consisting of App. 100 Tons Sheet, Tool & Bar Steel, Aluminum, Bronze & Brass—App. 3½ Million Machine, Allen & Wood Screws—App. 400,000 Ft. of Electrical Wire—App. 6,000 Panels of Glass—Plexiglass Plastic & Lucite—Hardware Hinges, Bolts, Door Stops—Ball Bearings, etc.

CINAUDAGRAPH SPEAKERS: App. 15,500 New Speakers, Huge Quantities of Speaker Cones, Baskets, Magnets & Transformers —

ELECTRONIC & RADIO PARTS: App. 250,000 Resistors — App. 8,000 Potentiometers — App. 10,000 Bakelite Terminal Boards — Radio Tubes — Micro Switches — Ballasts — Fuses — Sockets — Bakelite — Condensers — Starters — Relays, etc.

OFFICE MACHINES, FURN. & EQUIP.: BRUNING & OZALID Drafting & Blueprint Machs. — NATIONAL Payroll and Bookkeeping Machines — **ADDRESSOGRAPHS & MIMEOGRAPHS** — App. 66 **FRIDEN, MONROE, BURROUGHS, I.B.M., UNDERWOOD, FELT & TARRANT** Elec. Calculators, Comptometers, Elec. Typewriters, Elec. Adding Machines — App. 290 All Types of Files — App. 315 Exec. & Secr. Desks & Chairs — etc.

LEASE Arrangement Available to Responsible Parties — Modern One Story Building App. 200,000 Sq. Ft. Floor Space, Sprinklered, and U.P. R.R. Siding With Leasehold Improvements Valued at Approx. $58,000.

SALE BY THE ORDER OF, AND SUBJECT TO CONFIRMATION BY THE RFC.
TERMS of SALE: CASH OR CERTIFIED CHECK. TO BE SOLD IN BULK AND LOTS.
PLANT WILL BE OPEN FOR INSPECTION FROM JAN. 25, 1951 to DATE OF SALE.
FOR ADDITIONAL INFORMATION CONTACT MR. W. ROBERTS, REPRESENTATIVE ON PREMISES, TEL. NO. FAIRFAX 3200, KANSAS CITY, KANSAS.—This advertisement will only appear once—keep it for reference.
FOR FREE BROCHURE AND FURTHER INFORMATION — WRITE — PHONE — WIRE

AARON KROCK & CO. *AUCTIONEERS*

THE ORIGINAL AND ONLY AUCTIONEERING FIRM BY THIS NAME

288 Main St. Worcester, Mass.

Tel. 3-7261—3-7262 *Est. Since 1915—Greater Results Thru Experience*

AARON KROCK & CO. AUCTIONEERS APPRAISERS - LIQUIDATORS

ELECTRONICS Sales Engineers

Positions open for mature graduate sales engineers over 28 years of age, preferably with practical experience in application of dielectric heating to industrial problems. Excellent opportunities for type of individuals interested in affiliation with successful rapidly expanding organization. Locations in Chicago and other territories.

P-8543, Electronics
330 W. 42 St., New York 18, N. Y.

WANTED ENGINEERS

With power and transmitting tube design experience. State draft status and experience

Write Direct To:

TAYLOR TUBES, INC.
2312 W. Wabansia Ave. Chicago 47, Ill.

SURPLUS COMPONENTS FOR SALE

Bathtubs, oils, micas, xformers, chokes, relays, trimmers, sockets, odd items, etc.

Surplus lots purchased.

EMPIRE ELECTRONICS
Box 41, Midwood Stat., Brooklyn 30, N. Y.
Phone BRyant 9-1220

CONDENSERS OUR SPECIALTY

OIL FILLED TYPES

All Values and Voltage Ratings
We Invite Your Inquiries

TECHNICAL RADIO PARTS CO.
557 McDonald Ave., Brooklyn 18, N. Y.

WANTED

(Additional Wanted Ad on Page 326)

WANTED

TUBES TYPE 6AN5 TYPE 6AK5

ANY QUANTITY

W 8594, Electronics
330 West 42nd St., New York 18, N. Y.

WANTED

Sylvania Electric Spectrum Analyzers. Give complete details to

W-8664, Electronics
330 W. 42 St., New York 18, N. Y.

WANTED

Telephone or Telegraph Transmitters.

2.5 kw to 20 kw, 4 to 20 mcs or higher

W-8658, Electronics
330 W. 42 St., New York 18, N. Y.

Will Buy All

BC-348'S WITH DYNAMOTORS

Letters "J" "N" & "Q" ....$60.00 ea.
All others except "C" ....$50.00 ea.
Ship via Express C.O.D. subject to Inspection—TO

H. FINNEGAN
49 Washington St. Little Ferry, N. J.

WANTED

Tubes, Test equipment, Condensers, & general inventories. Highest prices paid.

W-7965, Electronics
330 W. 42nd St., New York 18, N. Y.

WANTED

INSULATORS; POLE LINE HARDWARE; GUY STRAND WIRE; COPPERWELD WIRE; WESTERN ELECTRIC TOOLS; SPLICING SLEEVES.

VICTOR-BERNARD INDUSTRIES
NE Cor. 22nd & Lehigh Aves., Phila. 32, Pa.

WANTED

Equipment for the manufacture of electronic tubes. Make or condition not important. Give details.

W-8651, Electronics
330 W. 42nd St., New York 18, N. Y.

WANTED:

Small lot of

HALLICRAFTER SX-42 RECEIVERS

Serial No. over 90,000. Must be in very good operating condition. Advise selling price and quantity on hand.

W-8593, Electronics
330 W. 42nd St., New York 18, New York

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.

WANTED

Teletypewriters complete, components or parts. Any quantity and condition.

W-6864, Electronics
330 W. 42nd St., New York 18, N. Y.

New Searchlight Advertisements

received by February 1st will appear in the March issue, subject to space limitations.

Classified Advertising Division

ELECTRONICS
330 West 42nd St., New York 18, N. Y.

APS-2 · APS-3 · APS-4 · APS-6 · APS-6A · APS-10 · APQ-13 · APS-15 · APS-31 · CPN-8 · CEXH · FD MARK-4 · MARK-1D · SA · SC · SD
SE · SF · SG · SJ · SK · SL · SN · SO · SO · SW · SCR 518 · SCR 520 · SCR 533 · SCR 545 · SCR 663

RADAR — SONAR

8500 Mc to 9600 Mc BENCH TEST PLUMBING

1" x ½" Waveguide

Variable Stub Tuner. DB536. 180 degree phase shifting capacity $70.00
Low Power Termination. DB381 $18.50
Uni-Directional Coupler. DB390 23 DB 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 Length. Plated and fitted with couplings available in 6", 12", 24", 30", 60" sections $2.00 per ft.
90 Degrees Elbows. E or H plane, 2½" radius $12.50
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
Dual Oscillator-Beacon Mount. P/O APS10 Radar for mounting two 723A/B klystron with crystal mts. matching slugs, shields $42.50
Dual Oscillator, Mount. (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
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
CU 105/APS 31 Directional Coupler 25 DB $25.00
723AB Mixer—Beacon dual Osc. Mnt. w/xtal holder.....$12.00
TR-ATR Sect APS 15 for 1B24 w/724 ATR cavity w/1B24 & 724 Tubes. Complete.....$21.00
Stabilizer Cavity with bellows $21.50
3 cm. 180° bend, with pressurizing nipple .....ea. $6.00
3 cm. 90° bend, 14" long 90° twist with pressurizing nipple ea. $6.00
3 cm. "S" curve 18" long ea. $5.50
3 cm. "S" curve 6" long ea. $3.50
3 cm. right angle bends. "E" plane 18" long cover to cover ea. $6.50
3 cm. Cutler feed dipole. 11" from parabola mount to feed back .....ea. $8.50
3 cm. directional coupler. One way waveguide output ea. $15.00
Circular Choke Flanges, solid brass ..... .55¢
Sq. Flanges, Flat Brass ea. .55¢
APS-10 TR/ATR Duplexer section with additional iris flange $10.00
"X" Band Preamplifier, consisting of 2-723 A/B local oscillator-beacon feeding waveguide and TR/ATR Duplex sect. incl. 60 mc. IF amp.....$47.50
Waveguide Run 1¼" x ½" guide, consisting of 4 ft. long $10.00
"X" Band Pressurizing auge section w/15 lbs. gauge and pressurizing nipple $18.50
45 Deg. Twist 6" long....$10.00
12" Section 45 deg twist, 90 deg bend $6.00
11" straight waveguide section choke to cover. Special heavy construction, silver plated $4.50
15 Deg Bend 10" choke to cover $4.50
5 Ft. Sections choke to cover. Silver Plated $14.50
18" Flexible Section......$17.50
Bulkhead Feed Thru.....$15.00
Waveguide 1" x ½" I. D per foot $1.50
TR Cavity for 724 A TR Tube $3.50
724 TR Tube (41 TR 1)....$2.50
SWR Meas. Section, & L with 2 type "N" output probes MTD full wave apart. Bell size guide. Silver plated $10.00
Rotary Joint with slotted section and type "N" output pickup $17.50
Waveguide Section 12" long choke to cover 45 deg. twist & 2½" radius. 90 deg. bend..$4.50
Twist 90 deg. 5" choke to cover w/press nipple $6.50
Waveguide Sections 2½ ft long silver plated with choke flange $5.75
Rotary Joint choke to choke with deck mounting......$17.50
3 cm mitred elbow "E" plane unplated $12.00

1¼" x ⅝" WAVEGUIDE

Tunable Termination. Precision adjust $65.00
Low Power Termination..$25.00
Magic Tee $45.00
Oscillator Mount, for four 723 AB 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
Bi Dir-Coupler WG output calibrated —25 db nominal..$17.50
Flex sections, 12" Rubber Coated $14.50
Mitred Elbow H Plane UG51-UG52 .....$12.00
6" St. sect. choke to choke $3.50
APQ 13 Constant Z Rotat Jnt. $22.50
CG 98B/APQ 13 12" Flex. Sect 1¼" x ⅝" OD.....$10.00
Wave Gd Run 1¼" x ⅝" Gd. consists of 4 ft. sect. w/RT angle bend on one end. 2" 45 deg bend on other end....$8.000
X Band Wave Gd. 1¼" x ⅝" O.D. 1/16" wall aluminum Per ft. 75¢
Slug Tuner Attenuator W.E. guide. Gold Plated $6.50

3000 Mc BENCH TEST PLUMBING

TEST EQUIPMENT

10 CM Wavemeter WE type B43549 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.
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
WAVEGUIDE TO ⅞" RIGID COAX "DOORKNOB" ADAPTER, CHOKE FLANGE, SILVER PLATED BROAD BAND $32.50
WAVEGUIDE DIRECTIONAL COUPLER, 27 db. Navy type CABV 47AAN, with 4 in. slotted section $32.50
SQ. FLANGE to rd choke adapter. 18 in. long OA 1½ in. x 3 in. guide, type "N" output and sampling probe $27.50
AN/APR5A 10 cm antenna equipment consisting of two 10 cm waveguide sections, each polarized. 45 degrees $75.00 per set.
POWER SPLITTER: 726 Klystron input dual "N" output $5.00

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

4000 to 6000 Mcs BENCH TEST PLUMBING

2" x 1" Waveguide

Flap Attenuator $48.00
Variable Stub Tuner and Low Power Termination $48.00
Wavemeter Tee $48.00

WRITE FOR LIST OF OTHER EQUIPMENT

MAGNETRONS

QK 915
QK 62
QK 59
QK 61
QK 60
2J21
2J22
2J26
2J27
2J31
2J32
2J37
2J38
2J39
2J40
2J49
2J34
2J61
2J62
3J31
5J30
714AY
718DY
720BY
720CY
725-A
730-A
728
706
700

KLYSTRONS

723A,
707B,
417A,
2K41

TEST SETS

TS 12
TS 13
TS 33
TS 35
TS 56
TS 45/APM3
TS 62 3CM
TS 108
1-105A
1-158
1-233
RC 438
RF Preamp.
G. R.
Brdg #216
G. R.
Shunt #229
G. R.
Osc. #213
TS 226A/AP
Sig. Gen.
#804
BC 221
TS 10A/AP
TS 69/AP
1-114
1-126
Meter 43A
Sig. Gen.
78B
Megometer
0-5 Meg
TS 1-49
1-166
Sig. Gen.
9.5-500 MC
CY 81/AP
TS 59/APN1
CW 60/ABM
BC 438

SONAR SYSTEMS and COMPONENTS IN STOCK

QBF
QBG
QC
QCJ
QCL
QCO
QCS
QCU
WEA

23,000 to 27,000 Mc BENCH TEST PLUMBING

½" to ¼" Waveguide

Precision Slotted Line. Adjustable probe $200.00
Directional Coupler-Wavemeter Mnt. 12DB $60.00
Precision Var Attenuator, mfg Bernard Rice $90.00
Low Power Load.........$20.00
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
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
Adapter, round to square cover $5.00
Feedback to Parabola Horn with pressurized window $27.50
K Band Mixer Block....$45.00
Waveguide ½ to ¼" $1.00 per ft.
90° Twist $10.00
"K" Band Directional Coupler $49.50 ea.

⅞" RIGID COAX—⅜" I.C.

⅞" rigid coaxial tuning stubs with vernier stub adjustment. Gold Plated $17.50
⅞ **RIGID COAX ROTARY JOINT.** Pressurized. Sperry #810613. Gold Plated $27.50
Dipole assembly. Part of SCR-584.....$25.00 ea.
Rotary joint. Part of SCR-584.....$35.00 ea.
RIGHT ANGLE BEND, with flexible coax output pickup loop $8.00
SHORT RIGHT ANGLE BEND, with pressurizing nipple..$3.00
RIGID COAX to flex coax connector.....$3.50
STUB-SUPPORTED RIGID COAX, gold plated 5' lengths. Per length $5.00
RT. ANGLES for above $2.50
RT. ANGLE BEND 15" L. OA.....$3.50
FLEXIBLE SECTION, 15" L. Male to female.....$4.25
MAGNETRON COUPLINGS to ⅞" rigid coax. with TR pickup loop, gold plated.....$7.50
FLEX COAX SECT. Approx. 30 ft.....$16.50
CG 54/U—4 foot flexible section ¼" IC pressurized.......$15.00
⅞ **RIGID COAX.** Bead Supported.....$1.20
SHORT RIGHT ANGLE BEND.....$2.50

WAVEGUIDE

½" x ¼" ID	$1.00	per foot
1" x ½" OD	1.50	per foot
⅝" x 1 ¼" OD	1.65	per foot
⅝" x 1 ¼" OD Aluminum	.75	per foot
1½" x 3" OD	3.00	per foot
2½" x 3" OD	3.50	per foot
1" x ½" OD Flexible	4.00	per foot
⅞" rigid coax ¼" IC	1.20	per foot

(Available in 10 ft. to 15 ft. lengths or smaller.)

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. Lavoie Model 105-300 to 600 mcs.
Megohm Bridge. Industrial Instruments type MB.
Visual Alignment—Signal Generator. General Electric—0 to 60 mcs

PULSE TRANSFORMERS

G.E.K.-2745 .....$39.50
G.E.K.-2744-A. 11.5 KV High Voltage. 3.2 KV Low Voltage @ 200 KW oper. (270 KW max.) 1 microsec. or ¼ microsec. @ 600 PPS $39.50
W.E. #166173 Hi-Volt input transformer, W.E. impedance ratio 50 ohms to 900 ohms. Freq. range: 10 kc to 2 mc 2 sections parallel connected potted in oil.....$36.00
W.E. KS 9800 Input transformer. Winding ratio between terminals 3-5 and 1-2 is 1.1:1, and between terminals 6-7 and 1-2 is 2:1. Frequency range: 380-520 c.p.s. Permalloy core $6.00
G.E. #K2731 Repetition Rate: 635 PPS. Pri. Imp: 50 Ohms Sec. Imp. 450 Ohms. Pulse Width: 1 Microsec. Pri. Input: 9.5 KV PK, Sec. Output: 28 KV-PK. Peak Output: 800 KW Riflar 2.75 Amp.........$64.50
W.E. #D169271 Hi Volt Input pulse Transformer $27.50
G.E. K2450A. Will receive 13 KV. 4 micro-second pulse on pri. secondary delivers 14KV. Peak power out. 100KW G.E. $34.50
G.E. #K2748A. Pulse Input line to magnetron $36.00
#9262 Utah Pulse or Blocking Oscillator XFMR Freq. limits 790-810 cy-8 winding turns ratio 1:1:1 Dimensions 1 13/16 x 1⅛" 19/32 .....$1.50
Pulse 131-AWP L-421435..$6.00
Pulse 134-BW-2F L-440895 $3.25
RAY—WX4298F $39.50
G.E.—K6824730 .....$50.00
G.E.—K9216945 .....$50.00
#7766489—9332 ..... —
A 7766490— ..... —
UX-7350— $6.95
#—9350 (218961) $2.00
#352-7181 ..... —
AVAIL. in Stock 9318 9280 — Write

MICROWAVE ANTENNAS

AN-122 Dipole Assy.....$22.50
LP-21-A ADF Loop w/Selsyn and Housings. New......$8.00
DAK Bellino Tossi DF Loops $125.00
Adcock DF Arrays. Complete $65.00
SA Radar 200 MC Bed Springs. Complete with Pedestal, Less Drive $600.00
Dish for Parabola 30"....$4.85
APS-15 Antenna. New..$99.50
AN MPG-1 Antenna. Rotary feed type high speed scanner antenna assembly, including horn parabolic reflector. Less internal mechanisms. 10 deg. sector scan. Approx. 12'L x 4'W x 3'H. Unused. (Gov't Cost—$4500.00 .....$250.00
APS-4 3 cm. antenna. Complete. 14½ dish. Cutler feed dipole directional coupler, all standard 1" x ½" waveguide. Drive motor and gear mechanisms for horizontal and vertical scan. New. complete $65.00
AN/TPS3, Parabolic dish type reflector approx. 10' diam. Extremely lightweight construction. New in 3 carrying cases..$89.50
RELAY SYSTEM PARABOLIC REFLECTORS: Approx. range: 2000 to 6000 mc. Dimensions: 4' x 3' rectangle, now....$35.00
TDY "JAM" RADAR ROTATING ANTENNA. 10 cm. 30 deg. beam, 115 v.a.c. drive. New $100.00
DBM ANTENNA. Dual, back-to-back parabolas with dipoles. Freq. coverage 1,000-4,500 mc. No drive mechanisms....$65.00
AS125/APR Cone type receiving antenna, 1080 to 3208 megacycles. New $4.50

SCR 545 RADAR TRAILER
"L" BAND SEARCH—"S" BAND TRACK

All merch. guar. Mail orders promptly filled. All prices, F.O.B. N.Y.C. Send M.O. or Chk. Only shipping chgs. sent C.O.D. Rated concerns send P.O.

MIN. ORDER $3.00

COMMUNICATIONS EQUIPMENT CO.

MIN. ORDER $3.00

131 Liberty St., New York, N. Y. Dept. E-2 — P. J. PLISHNER — Phone: Main 4-8373

CRYSTALS Low Freq.

FT-241. A holder ½" pin spacing, for ham and general use. Xtal controlled Signal Generators, marked in army Mc harmonic frequencies—Directions for deriving fundamental frequencies enclosed. Listed below by fundamental frequency, fractions omitted.

370 372 374 375 376 377 379 380 381 383 384 385 386 387 388
each **39¢** 5 for $1.90

390 391 392 393 394 395 396 397 398 400 401 402 403 404 405 406 407 408 409 411
each **79¢**

462 463 464 465 466 468 469 470 472 473 474 475 476 477 479 480 481 483 484 485 486 487 488 490 491 492 493 494 495 496 497 498 500 501 502 503 504 505 506 507 508 509 511 512 513

412 413 414 415 416 418 419 420 422 423 424 425 426 427 429 430 431 433 434 435 436

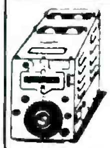
437 438 440 441 442 443 444 445 446 447 448 450 451 453 454 455 456 457 458 459 461

514 515 516 518 519 520 522 523 525 526 527 529 530 531 533 534 536 537 538 540
49c each 10 for $4.50

RL9 or RL7

Interphone Amplifier Convert to High Fidelity Phone Amp. or Spch. Amp. Comp. w/ 12A6, 12SL7, 2 Chokes, 1 XFRMR, DYN for 24v operation, etc. $2.29

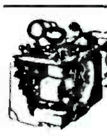
Xmfrs VFO Drivers 40 Watts Output 274N (ARC5)



2.1-3 MC $14.95
3-4 MC 9.95
4-5.3 MC 5.95
5.3-7 MC 5.95
7-9.1 MC 13.95
Used Good Cond.

BC-733D SUPERHET RECEIVER

w/10 Tubes, 6 Selector - Relays operate on Xtal Controlled freq. 108.3-110.3 M C. Can easily be converted to 2 Mtr. ham bands.



EE89A Telephone Repeater

Used to extend range of field telephones. Simplex Teleg. and 20 cycle ringing possible over lines equipped with unit. Supplied w/ 305 tube. Phone supplied. (Featherweight) $9.59

ARC 5 MODULATOR

MD7/ARC5 w/ dynamotor complete w/ Tubes 1-12J5, 2-1625, 1-UR50. Good cond.
Price $8.95

SCR274 Screen Mod. XFRMR for pair of 807's PP — PP or Parll Sidetone Wndg. ....95¢

ARC-5 Mod. XFMR P-P 807 to P-P or PAR 807's #9446 ...$1.65

29¢ ea. 10 for $2.75

MFD.	VOLT
2x 8	450
2x10	450
2x15	450
2x16	450
2x20	350
2x20	450
20-20	400/25
20-20	350/25
20-8	500
20-10	350/300
24-24	400
30-30	350
40-40	400
40-40	450
40-40	475-400
40-10	450
40-10	450/350
40-15	450
40-20	150
40-20	150/25
40-35	450/350
40-50	400/300
50-30	150
50-40	300-250

A.C. Cond.

13-15	220-1.20
20-24	110-1.00
26-30	220-1.35
43-65	110-1.25
43-48	110-1.25
50-75	110-1.25
53-60	220-1.50
61-69	320-1.60
64-72	110-1.25
72-87	110-1.25
75-84	110-1.25
88-106	110-1.50
107-129	110-1.65
130-157	110-1.75
130-150	70-1.50
130-180	110-1.85
158-191	110-1.85
161-180	110-1.75
189-210	110-1.95
200-220	110-1.95
270-300	110-2.10
324-360	110-2.40
378-420	175-3.00
432-480	110-2.75
485-540	110-2.85

MINICAPS PIGTAIL

Mfd.	Volt	Price
2	50	.10
4	50	.10
4	100	.15
4	150	.10
4	220	.18
5	25	.10
5	50	.10
5	150	.10
8	25	.15
8	100	.18
8	150	.18
8	350	.20
10	50	.18
10	150	.20
12	450	.23
16	100	.20
16	150	.22
16	300	.30
16	450	.40
20	25	.10
20	50	.15
20	80	.18
20	350	.30
24	350	.30
25	25	.10
30	300	.25
30	450	.30
40	150	.22
40	450	.40
50	25	.22
50	50	.25
50	150	.39
100	50	.60
250	15	.50
500	8	.60
500	25	.75
1000	6	1.20
2000	6	1.35
1200	1.5	1.10
8-8	450	.60
8-16	450	.65
10-10	150	.30
10-10	450	.35
16-16	450	.70
20-20	150	.40
20-20	450	.50
40-20	450	.55
50-50	150	.40
50-30	150	.35
70-70	175	.85

T. U. for BCAR230 or 430

3.2—4MC
5—6.2MC
1.2—1.5MC
1—1.2MC
Price 95c ea.
4—5MC w/ 4495KC XTAL $1.69 ea.

GIBSON GIRL

The Emergency Radio Transmitter. Sends S O S signals automatically on 500KC. 150-mile range. No batteries required. Has hand-driven generator, tubes, wire. New. It's only $3.40

PHOTO PRINT-DRYERS

Consists of microme element insulated from open frame 9¾"x10" 110V 60 cy 75c

FUSES

Amp.	Volt	Type	Size	Price
1	250V	F2-9	2"x¼"	12¢
10	250V	GN50	2"x¼"	15¢
3	250V	Indicator GX-31	2"x¼"	22¢
30	250V	1130NC44	2"x¼"	15¢
1	1000V		3"x¼"	15¢
1	250V	1110	2"x¼"	15¢
5	250V	Indicator GX-32	2"x¼"	22¢
¼	1000V	Cartridge	3"x¼"	15¢
1½	2500V	Cart	4½"x¼"	18¢
1½	2500V	HVP	4½"x¼"	18¢
2	3000V	HVC	5½"x¼"	20¢
⅛	1000V	Cart	3"x¼"	15¢
1	1000V	Cart	3"x¼"	15¢
1.1	2500V	SP111	4½"x¼"	18¢
.5	1000V	Cart	3"x¼"	15¢
1	3000V	2114	5½"x¼"	20¢
¼	2500V	Cart	4½"x¼"	18¢
1	250V	F29	2"x¼"	15¢
2	250V	FK-65 Indicator	2"x¼"	22¢
1	1000V	HVA	3"x¼"	15¢
6	250V	Indicator HV76	2"x¼"	22¢
4	250V	Indicator FK67	2"x¼"	22¢
1½	1000V	Cart	3"x¼"	15¢
½	3000V	Cart	5½"x¼"	20¢
1	2500V	Cart	4½"x¼"	18¢
¾	2500V	Cart	4½"x¼"	18¢
1	1000V	HVA1	3"x¼"	15¢
1	1000V	78X481	3"x¼"	15¢
150	250V	Clamptype HBO	1½"x½"	35¢
70	125V	Clamp type ACK	2½"x1"	30¢
90	250V	Knife Blade NEC	3½"x1" blade	less 40¢
1	250V	4AB	1¼"x¼"	7 for 25¢

BATHTUBS

Mfd.	Volt	Type	Cat. No.	Price
.01	600	2ST	....	25¢
.02	600			
.1	400	3ST	HC 3755	30¢
.02	1600	2ST	BA31227-E	45¢
.03	1000	2ST	W3-94	45¢
.06-.1	1500	2TTIns	305-1526S	50¢
3x.05	600	3ST	CP50BSOFSO3V	30¢
.05	600	2TT	CSF-481391-10	30¢
.05	600	2ST	DYR 6005	30¢
2x.05	600	3ST	CGF48315B-10	40¢
2x.05	600	3ST	DYR 60055	40¢
.1	600	2ST	A-8B-373	25¢
.1	600	2TT	630T	25¢
.10	600	1ST	NDN	25¢
.1	1000	2ST	CAW48197-B10	30¢
2x.1	400	2BT	1574	25¢
2x.1	400	2TT	1572	25¢
2x.1	600	3ST		30¢
2x.1	400	2TT	CBY48678	25¢
2x.1	600	3BT	305-1133	30¢
2x.1	600	2BT	CSF48680-A20	30¢
2x.1	200	2ST	CP-204D P11	20¢
2x.1	600	3ST	CQU48313-B10	30¢
2x.1	600	2ST	CGF48712B-10	30¢
2x.1	600	3ST	DYR6011	30¢
2x.1	600	2ST	CQU-48712-B10	30¢
2x.1	600	3BT	305-1133	30¢
2x.1	600	3ST	2XDMRW6-.1	30¢
2x.1	600	3ST	CP50B4EF104UX	30¢
2x.1	600	3BT	305-1133	30¢
2x.1	600	3BT	305-1133	30¢
3x.1	600	3TT	7890481-P1	35¢
3x.1	600	3ST	CQU48713-B10	35¢
3x.1	600	3TT	305-1683S	35¢
3x.1	600	3BT	22F462	35¢
3x.1	600	3TT	3XDRTMW6-.1	35¢
3x.1	400	3BT	CAW48709	30¢
3x.1	600	3ST	A-18933-1	35¢
.13	600	2TT	630MT	25¢
.25	400	2TT	430T	30¢
2x.25	400	2ST	7253775	40¢
2x.25	100	2TT	K-7101880	25¢
3x.25	400	3BT	CAW-481372	35¢
.5	120	2TT	C226806-2	20¢
.5	600	2TT	305-1154	25¢
.5	400	1TT		23¢
.5	200	2ST	XDMR2-.5	20¢
.5	600	2ST	DYR6050G	25¢
.5	400	2ST	14862	23¢
.5	600	2BT	CSF48704-A20	25¢
.5	400	2TT	RO5	23¢
.5	400	2ST	48205A	23¢
.5	200	2ST	8A31231-C2	20¢
.5	400	2TT	1573	23¢
3x.5	100	3ST	B-215563-5	25¢
2x.5	250	2TT	A8B-515	25¢
2x.5	400	2ST	Z1065A	30¢
2x.5	300	3TT	541B	25¢
2x.5	400	2BT	1575	30¢
3x.5	400	3BT	CBY48763	30¢
.7	200	1TT	#7157	30¢
1	200	1ST	55907	25¢
1	600	2ST		35¢
1	600	2BT	305-1391	35¢
1	400	2ST	A-8B-361	33¢
1	600	2TT	305-1507SNDO	35¢
1	600	Test 2ST	NDPS	30¢
1	400	2ST	A-8B-1104	30¢
1	600	2ST	W5-13	35¢
2x1	200	4ST	W226671-1	35¢
2x1	200	4ST	W-226671-2	35¢
2.5	100	2ST	K7101881-P1	30¢
4	50	2ST	678687-5	25¢
8	500	2ST	55844	79¢
30	150	2ST	D11206	1.15
25		2BT		
5-20		3TT	5417	
.025	600	2ST	NCN	35¢
2x.1	400	3TT	P8887	25¢
2x.1	600	3TT	CP51B4EF104V	30¢
2x.1	600	3BT	CP52B4EF104V	30¢
2x.1	400	3ST	NKPS	30¢
3x.1	600	3ST	CMR-48849-A	35¢
3x.1	400	3ST	CP50BSEE104V	35¢
3x.1	600	3ST	CP505BEE104X	35¢
3x.1	600	3BT	CSF48709-A20	35¢
.1	400	2TT	CD-1066-11V	23¢
.1	600	2BT	NKP	25¢
.5	600	1TT	7283	30¢
6	400	2TT	CE64B060Q	1.00

ARC/5 BATHTUBS

3x.05	300	3TT	5414	08¢
.05-.01-.05	300	3TT	5415	08¢
3	300	1TT	7582	05¢
3x.22	300	3TT	692643 NAO	20¢

Birtcher Tube Clamps

11¢ ea.
100 for $10.50
1000 for 10¢ ea.

Large Asst. Avail. Write

Write for Latest Flyer

UPRIGHTS

Mfd.	Volt	Type	Cat No.	Price
.0025	1500	2TT	D164209	30¢
.03	600	2ST	RO3	25¢
2x.0515	600	2TT		45¢
05	400	2BT	616M	25¢
.05	600	2BT	C51481918-20	28¢
.05	600	2BT	7700BR	28¢
3x.05	300	3BT	NJOCA195	30¢
3x.05	300	3BT	CA195	30¢
.125-.05	400	2TT	CMR481380-10	25¢
.1	600	2BT	616M-14842	35¢
.1	600	2BT	R11-616MB	35¢
.1	400	2BT	418CB	30¢
.1	600	2BT	7701BR	35¢
.1	600	2BT	CP69B1AF104K	35¢
.1	400	2BT	XMRBW4-.1	30¢
.1	600	2BT	C69B1AF104	35¢
2x.1	600	2BT	P9711	39¢
3x.1	400	3BT	CA255	39¢
3x.1	400	3TT	ROBC	39¢
3x.1	400	3BT		39¢
3x.1	600	3TT	C168B5EF104V	42¢
3x.1	600	3BT	7710BR	42¢
3x.1	600	3BT	CD516	42¢
2x.125	400	2TT		
.25	800	2WTT		69¢
.4	600	2BT	M-7725BR	30¢
.25	600	2BT	C168B1EF254K	30¢
.5	600	2BT	SO1	32¢
.5	600	2BT	PO8	32¢
.5	400	2TT	416T	30¢
.5	600	2BT	616MB	32¢
2x.5	250	2TT	A-8B515	30¢
2x.5	400	3BT	418MCB	35¢
2x.875	400	2BT	CWS-P-72076-503	39¢
1	400	2TT	305-1605S	35¢
1	400	2BT	616MCB	38¢
1	600	2BT	YAB6100	38¢
1	250	2TT	CBV48553-15	30¢
1	100	1BT	104M59	25¢
1	600	2BT	616MCB	38¢
1	400	2BT	418MCB	35¢
1.75	50	2TT	CRV48661	45¢

DS Filter Condensers

40x20	135	10c
20	150	19c
2x20	150	29c
2x30	150	29c
40x20	150	39c
2x40	150	39c
30x50	150	39c
2x50	150	39c
3x20	150	39c
3x30	150	39c
50/2x40	25/150	39c
2x40/12	150	39c
2x40/20	150	39c
3x40	150	39c
2x50/20	150/25	39c
2x50/10	150	39c
60-30/150	150/25	39c
80-40-30/100	150/25	39c
40-30	200	39c
20-16/10	200/25	39c
2x32	250	39c
30	350	39c
2x32	350	39c
50x30	350	39c
20	450	49c
16-8	450	49c
32x16	450	55c
32x16	450	55c
2x8/25	450/75	49c
30-20/20	450/25	49c

Many Others

BC 221 Freq. Meters. Good condition complete w/calibration book tubes xtals & spare parts
$75.00 ea.

1 82A 5" 360 Compass Ind. & Selsyn Receiver New ...$4.95

BC 306A Ant. Tuning unit for BC 375 Excellent Cond.
$150 ea

MS49 and MS50 Fish Pole Antenna, 74" long. Both for 49¢

SELSYN TESTER

Magnesyn Instrument Field Tester AAF 43G23330 Spec. 40772 To test individual mag. Ind. & Xmitters. for isolating Faults in magnesyn systems. Brand new $125.00

Multimeter Mvmt. 0-100 Meg. 0-600/50/14VDC (0-5 Ma Basic) 3" Rd Metal Sim to Sipson #23 ......$3.95
100-0-100 Microamp 4½" Bake. Same as Model 801 (Weston). Mfg. by Sun Elect & Beede Elect. Model 4AW 271. Price ea.$8.75

0-30V DC Meter Westing. Type AX Aircraft type. Price $2.49

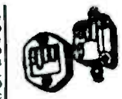
0-1MA 3½" Rd. DeJure Mod S-310. Price ea...$4.75
0-1MA 3½" Rd. Same as above. Mfg. Sun Mfg. Mod 3AP259. Price ea. $3.95
0-10MA 3½" Rd. DeJure Mod S-310. Price ea. $4.65
0-10MA 3½" Rd. Same as above. Mfg. Sun Mfg. Mod 3AP236. Price ea. $3.95

Model 542 Supreme Sensitivity. 5,000 Ohms/v 3" square meter. Reads: D.C. volts, 6-150-300-1,500; AC Volts 6-30-150-600; D C ma., 0.3-6-30-150; Ohms, 2,000-20,000-200,000, 2 megs; db. —6 to +50; Output, 6-30-150-600 volts. Bakelite case, 5-7/8 x 31/16 x 2-1/8" Shpg. wt. 2 lbs. $8.95 ea.
Model 442 Rad City. Same as above. $8.95 ea.
Model 666—SC 56J Triplet VDC 3/30/300/600/1500 VDC ohms 1000/10000/100000/1 meg.....Price $7.95 ea.
Model Same as above Chicago. Price $7.95

All above meters are sold as is. No refund minor repairs required.

HEADSETS & MIKES

HS23 Used Good 8000 Imp. $2.49
HS33 Used Good 600 Imp. $2.49
HS30B Replace Elements 60c ea.
Rubber Earplugs for HS30 ....10 for 25c
Matching XFRMR C110 Less Cords..........59c
T45 Lip Mikes..........98c
T30 Throat Mike....39c
CD508T30 Ext. Cords w/ Switch Sw141 Complete $1.25
Gas Mask Mike Elements 49c
Cords 3 Cond. Color coded approx. 42"....15c ea.
Hdband HBI 25c
Hdband HB30..........25c



MICA XMS TAPPED HOLES

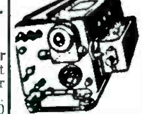
Mfd.	Price
2500 V Test	
.00001	$0.29
.000025	.29
.00003	.29
.00005	.29
.000075	.29
.0001	.29
.00015	.29
.00025	.29
.0003	.29
.0004	.29
.0005	.35
.00075	.35
.00085	.35
.001	.35
.0015	.35
.0016	.35
.0017	.35
.002	.50
.0023	.50
.003	.50
.004	1.79
.005	1.79
.006	1.79
.0063	1.79
.0069	1.79
.007	1.79
.0075	1.79
.0076	1.79
.008	1.79
.01	1.10
.015	1.10
.02	1.10
.015	1.10
.027	1.10
.03	1.10
5000 V Test	
.0015	1.75
.002	2.00

XO Solder Lugs 2500 V Test

.01	.85
.015	.85
.02	.85
.04	.85
.001	.60
.0015	.60
.002	.60
.0022	.60
.0023	.60
.0024	.60
.0025	.60
.0027	.60
.003	.60
.004	.60
.005	.60
.0056	.60
.006	.60
.0063	.60
.0075	.80
.0076	.80
.008	.80
.0085	.80
.0005	.60
.0005	.60
.00015	.60

BC 605 INTERPHONE AMPLIFIER

Easily converted to an ideal intercommunications set for office—home — or factory. Complete w/conversion diagram for 110 V operation.
Brand New..........$4.49
Used $3.95



Aircraft Rec. #429 for Mobile or Aircraft Covers from 201 Kc interchange plug in tuning units includes one Tuning Unit. Less Tubes. Rec. Only a few left. $3.95 ea.

METERS

0.5MA SQ 2" Metal Case or 0-10 volt movement readrite meter.95c

Weston 3½" Rnd. Bake 0-500 Ma. RF Thermocouple Model 425 Res.—1.3 ohms..........$9.95
IS-110 Double range 0-3 & 0-75 V Internal Res. $4.75
Triplett Model 221 2½" rnd. 0-500 Ma....$3.95
2½" rnd. Bake G. E. Model ADF—10 type DW 51 0-500 Ma.....$3.95
McClintock B½" Rnd. Tuning Ind. for S-37 FM Tune, etc. DB over S9. $5.95
2½" rnd. 0-5 ARF Weston 507 ....$3.95
3½" rnd. Bake 0-1V Marked 0-100 and 0-250 Ma. General Electric model VY 412..........$4.95
IN1909 3½" rnd. Bake, 0-3AAC basic. Marked 0-120 A. A. C. Western Electric type NA35.$6.49

CONDENSER TUNING UNITS FOR BC 191

Write up in CCT QST for Conv to vhf freq meter

TU 5— 1500 to 3000 KC
TU 6— 3000 to 4500 KC
TU 7— 4500 to 6200 KC
TU 8— 6200 to 7700 KC
TU 9— 7700 to 10000 KC
TU 26— 200 to 500 KC

Price $2.49 ea.

TUNING UNITS FOR BC 223 XMITTR

TU17A 2000-3000Kc. $2.75
TU18 3000-4500Kc. 2.25
TU25 3500-5200Kc. 2.25

COLLINS ART. 13 FREQ. MULT. UNIT

2-18 Mc for two 1625 Tubes. Comp. Assy less Tubes & Coils w/ ckt dia Price..**$8.95**

AMPLIFIER

AM-32/PRSI less batt w/carry case for Mine Detector AN/PRSI. Price ea. $7.95

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.

MIN. ORDER $3.00 **COMMUNICATIONS EQUIPMENT CO.** MIN. ORDER $3.00

131 Liberty St., New York, N. Y. Dept. E-2 Chas. Rosen Phone: Digby 9-4124

FULLY GUARANTEED

BRAND NEW SURPLUS OFFERED BY A LEADING

A.C. MOTORS

5071930, Delco, 115 V., 60 Cycle, 7000 r.p.m. **Price $4.50 each net.**

36938-2, Haydon Timing Motor, 110 V., 60 cycle, 2.2 w., 4/5 r.p.m.
Price $3.00 ea. net.

Telechron Synchronous Motor, type BC, 110V, 60 cycle, 60 RPM, 6 W.
Price $4.00 each net.

Type 1600 Haydon Timing Motor—110 V., 60 cycle, 2.2 w., 1/240 r.p.m.
Price $3.00 each net.

Type 1600 Haydon Timing Motor 110 V., 60 cycle, 2.3 w., 1 r.p.m.
Price $2.70 each net.

Type 1600 Haydon Timing Motor 110 V., 60 cycle, 2.2 w., 1 1/5 r.p.m.
Price $2.70 each net.

Type 1600 Haydon Timing Motor 110 V., 60 cycle, 3.5 w., 1 r.p.m. With shift unit for automatic engaging and disengaging of gears.
Price $3.30 each net.

Type 1600 Haydon Timing Motor, 110 V., 60 cycle, 2.2 w., 1/60 r.p.m.
Price $3.00 each net.

Eastern Air Devices Type J33 Synchronous Motor 115 V., 400 cycle, 3 phase, 8,000 r.p.m. **Price $8.50 each net**

Telechron Synchronous Motor, Type B3, 115 V., 60 cycle, 2 r.p.m., 4 w.
Price $5.00 each net.

Barber-Colman Control Motor, Type AYLC 5091, reversible 24 volts D.C. .7 amps 1 R.P.M., Torque 500 in. lbs. Contains 2 adjustable limit switches with contacts for position indication. Ideal for use as a remote positioner or a beam or television antenna rotator, will operate on A.C. 60 cycle.
Price $6.50 each net

SERVO MOTORS

CK 1, Pioneer, 2 phase, 400 cycle.
Price $10.00 each net.

CK 2 Pioneer, 2 phase, 400 cycle.
Price $10.00 each net

10047-2-A Pioneer 2 phase, 400 cycle, with 40:1 reduction gear.
Price $10.00 each net

FPE-25-16 Diehl Low-Inertia 20 V., 60 cycle, 2 phase, 1600 r.p.m., 85 amps.
Price $10.00 each net.

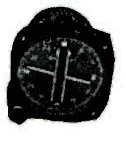
CK2, Pioneer, 2 phase, 400 cycle, with 40:1 reduction gear.
Price $11.50 each net.

MINNEAPOLIS-HONEYWELL TYPE B Part No. G303AY, 115 V., 400 cycle, 2 phase, built-in gear reduction, 50 lbs. in torque. **Price $10.00 each net.**

Kallsman Type 776-01 400 cycle 2 phase drag-cup type, fix phase voltage 29, variable phase 35V. maximum, frequency 400 cycle.
Price $10.50 each net.

REMOTE INDICATING MAGNESYN COMPASS SET

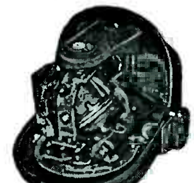
Pioneer Type AN5730-2 Indicator and AN5730-3 Transmitter 26 V., 400 cycle.
Price $40.00 per set new sealed boxes.



Kollsman Remote Indicating Compass Set Transmitter part No. 679-01, indicator part No. 680k-03, 26 V., 400 cycle.
Price $12.50 each net.

GYROS

Schwein Free & Rate Gyro type 46800. Consists of two 28 V. D.C. constant speed gyros. Size 8" x 4.25" x 4.25".
Price $15.00 ea. net.



Sperry A5 Directional Gyro, Part No. 656029, 115 volts, 400 cycle, 3 phase.
Price $20.00 each net.

Sperry A5 Vertical Gyro, Part No. 644841, 115 V., 400 cycle, 3 phase.
Price $20.00 each net.

Sperry A5 Amplifier Rack Part No. 644890. Contains Weston Frequency Meter. 350 to 450 cycle and 400 cycle, 0 to 130 voltmeter.
Price $15.00 each net.

Sperry A5 Control Unit Part No. 644836. **Price $7.50 each net.**

Sperry A5 Azimuth Follow-Up Amplifier Part No. 656030. With tube.
Price $5.50 each net.

Sperry A5 Autopilot Indicator: contains Pioneer AY20 Autosyn 26 V., 400 cycle. **Price $9.50 ea. net.**

Pioneer Type 12800-1-D Gyro Servo Unit. 115 V., 400 cycle, 3 phase.
Price $15.00 each net.

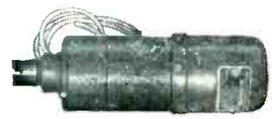
Norden Type M7 Vertical Gyro. 26 V., D.C. **Price $19.00 each net.**

Allen Calculator, Type C1 Bank and Turn Indicator, Part No. 21500, 28 V. D.C. Contains 28 V. D.C. constant speed gyro.
Price $10.00 each net.

Type C1 auto-pilot formation stick, part No. G1080A3. **Price $15.00 each net.**

GOVERNMENT approved instrument repair station No. 3564.

D.C. MOTORS



5069625, Delco Constant Speed, 27 V., 120 r.p.m. Built-in reduction gears and governor. **Price $7.50 each net.**

C-28P-1A, John Oster Series Motor, 27 V., 0.7 amps., 7000 r.p.m., 1/100 h.p. **Price $4.50 each net.**

Jaeger Watch Co. Type 44-K-2 Contactor Motor, Operates on 3 to 4.5 volts D.C. Makes one contact per second. **Price $2.00 each net.**

General Electric Type 5BA10AJ52C, 27 V. D.C., 0.65 amps., 14 oz. n. torque, 145 r.p.m. Shunt Wound, 4 lead reversible. **Price $6.50 each net.**

General Electric Type 5BA10AJ37C, 27 V.D.C., 0.5 amps., 8 oz., in. torque, 250 r.p.m. Shunt Wound, 4 leads reversible. **Price $6.50 each net.**

General Electric Type 5BA10J18D, 27 V. 0.7 amps. 110 R.P.M. 1 oz. ft. torque.
Price $6.50 ea. net.

D.C. ALNICO FIELD MOTORS

S. S. FD6-18, Diehl, 27 V., 10,000 r.p.m.
Price $6.50 each net.

S. S. FD6-21, Diehl, 27 V., 10,000 r.p.m.
Price $6.50 each net.

5069466 Delco 27.5 V. 10,000 R.P.M.
Price $10.00 ea. net

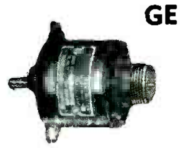
706343 Delco 27.5 V. 10,000 R.P.M. Shaft 0.5 in. long. **Price $7.50 ea. net.**

5068571 Delco 27.5 V. 10,000 R.P.M. with blower assembly.
Price $10.00 ea. net.

5071895 Delco 27.5 V. 250 R.P.M.
Price $10.00 ea. net.

5072400 Delco 27.5 V. 10,000 R.P.M. Shaft 0.5 in. long with worm gear.
Price $6.75 ea. net.

GENERAL ELECTRIC D. C. SELSYNS



8TJ9-PAB Transmitter, 24 V.
Price $3.75 each net.

8DJ11-PCY Indicator, 24 V. Dial marked —10° to +65°.
Price $4.50 each net.

8DJ11-PCY Indicator, 24 V. Dial Marked 0 to 360°.
Price $7.50 each net.

AMPLIFIER

Pioneer Gyro Flux Gate Amplifier, Type 12076-1-A.
Price $25.00 ea. net, with tubes.

G. E. Servo Amplifier Type 2CV2A1, 115 V. 400 cycle. **Price $10.00 ea. net.**

Minneapolis Honeywell Amplifier Type G403, 115 V. 400 cycle. **Price $8.00**

INSTRUMENT ASSOCIATES

37 EAST BAYVIEW AVE., GREAT NECK, N. Y.
Telephone GReat Neck 4-1147

Write for Catalog NE100

U. S. Export License-2140

SUPPLIER OF ELECTRONIC & AIRCRAFT EQUIPMENT

IMMEDIATE DELIVERY

INVERTERS

Wincharger Corp. Inverter PU/16 type MG 750, Input 24 V.D.C., 60 amps. Output 115 V, 400 cycle, 1 phase, 6.5 amps. **Price $60.00 each net.**

Leland type 10285, Input 28 V. D.C. at 60 amps. Output 115 V. 3 phase at 750 V.A., 26 V., 400 cycle, single phase at 50 V.A. **Price $100.00 each net**

149H, Holtzer Cabot. Input 28 V. at 44 amps. Output 26 V. at 250 V.A., 400 cycle and 115 V. at 500 V.A., 400 cycle. **Price $50.00 each net.**

149F, Holtzer Cabot. Input 28 V. at 36 amps. Output 26 V. at 250 V.A., 400 cycle and 115 V. at 500 V.A., 400 cycle. **Price $50.00 each net.**

12117, Pioneer. Input 12 V.D.C. Output 26 V., 400 cycle, 6 V.A. **Price $22.50 each net.**

12117-2 Pioneer. Input 24 V.D.C. Output 26 V. 400 cycle, 6 V.A. **Price $20.00 each net.**

12116-2-A Pioneer. Input 24 volts D.C., 5 amps. Output 115 volts 400 cycle single phase 45 watts. **Price $100.00 each net.**

5D21NJ3A General Electric. Input 24 V.D.C. Output 115 V., 400 cycle at 485 V.A. **Price $25.00 each net.**

PE 218, Ballentine. Input 28 V.D.C. at 90 amps. Output 115 V., 400 cycle at 1.5 K.V.A. **Price $50.00 each net.**

ACTUATORS

White Rodgers Electric Co. type 6905, number 3, 12 V., D.C., 1.3 amps., 1½ RPM, torque 75" in lbs., contains adjustable limit switches. **Price $10.50 each net**

METERS

Weston Frequency Meter, Model 637, 350 to 450 cycles, 115 volts. **Price $10.00 each net.**

Weston Voltmeter. Model 833, 0 to 130 volts, 400 cycle. **Price $4.00 each net.**

Weston Voltmeter. Model 606, Type 204 P, 0 to 30 volts D. C. **Price $4.25 each net.**

Weston Ammeter. Model 506, Type S-61209, 20-0 100 amps. D. C. **Price $7.50 each net with ext. shunt.**

Weston Ammeter. Type F1, Dwg. No. 116465, 0 to 150 amps. D. C. **Price $6.00 each net.** **With ext. shunt $9.00 each net.**

Westinghouse Ammeter. Type 1090-D-120, 120-0-120 amp. D. C. **Price $4.50 each net.**

Westinghouse Ammeter, type E1, part No. 1162965, range 0-300 amps. D.C. **Price $7.50 each net.**

Weston Voltammeter, type 201-P, Mod. 606, range 0-30 volts D.C. and 0-30 amps. with shunt. **Price $12.50 each net.**

CARBON PILE VOLTAGE REGULATOR

Leland Electric Co., type B, Philco Spec. 451-1288, input 21 to 30 Volts D.C., regulated voltage 18.25 at 5 amps. **Price $6.50 each net.**

RECTIFIER POWER SUPPLY

General Electric, Input 230 V. 60 cycle 3 phase. Output 130 amps. at 28 V. D.C. Continuous duty, fan cooled, has adjustable input taps. G.E. model No. 6RC146F. Size: Height 46", width 28", depth 17½". **Price $225.00 each net.** New

PIONEER AUTOSYNS

AY1, 26 V., 400 cycle. **Price $7.50 each net.**

AY14D, 26 V., 400 cycle, new with calibration curve. **Price $15.00 each net.**

AY20, 26 V., 400 cycle. **Price $7.50 each net.**

AY5, 26V., 400 cycle. Has hollow shaft. **Price $7.50 ea. net.**

AY54D, 26 V., 400 cycle, with pointer for I 81 & I 82 Indicator. **Price $10.50 each net**

PRECISION AUTOSYNS

AY131D, new with calibration curve. **Price $35.00 each net.**

PIONEER AUTOSYN POSITION INDICATORS

Type 5907-17. Dial graduated 0 to 360°, 26 V., 400 cycle. **Price $20.00 each net.**

Type 6007-39, Dual, Dial graduated 0 to 360°, 26 V., 400 cycle. **Price $30.00 each net.**

PIONEER TORQUE UNIT

Type 12606-1-A. Price $40.00 each net.

MAGNETIC AMPLIFIER ASSEMBLY

Pioneer Magnetic Amplifier Assembly Saturable Reactor type output transformer. Designed to supply one phase of 400 cycle servo motor. **Price $12.50 each net.**

PIONEER TORQUE UNIT AMPLIFIER

Type 12073-1-A, 5 tube amplifier, Magnesyn input, 115 V., 400 cycle. **Price $17.50 each net with tubes.**

ALL PRICES, F. O. B. GREAT NECK, N. Y.

BLOWER ASSEMBLY MX-215/APG

John Oster, 28 V.D.C., 7000 r.p.m. 1/100 h.p. **Price $5.00 each net.**

Westinghouse Type FL Blower, 115 V., 400 cycle, 6700 r.p.m., Airflow 17 C.F.M. **Price $5.00 each net.**

RATE GENERATORS

F16, Electric Indicator Co., two-phase, 22 V. per phase at 1800 r.p.m. **Price $12.00 each net.**

J36A, Eastern Air Devices, .02 V. per r.p.m. **Price $9.00 each net.**

B-68, Electric Indicator Co., Rotation Indicator, 110 V., 60 cycle, 1 phase **Price $14.00 each net.**

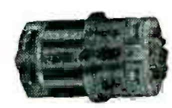
PM-1-M Electric Indicator Co. Same as type B35. 2 V. per 100 R.P.M. Max. speed 5,000 R.P.M. Can be used as D.C. motor, 1/77 H.P. 115 V. D.C. **Price $14.00 ea. net.**

SINE-COSINE GENERATORS

(Resolvers)

FPE 43-1, Diehl, 115 V., 400 cycle. **Price $20.00 each net**

SYNCHROS



1F Special Repeater, 115 V., 400 cycle. Will operate on 60 cycle at reduced voltage. **Price $15.00 each net.**

2J1F3 Selsyn Generator 115 volts, 400 cycle. **Price $5.50 each net.**

2J1G1 Control Transformer, 57.5/57.5 V., 400 cycle. **Price $1.90 each net.**

2J1H1 Selsyn Differential Generator, 57.5/57.5 V., 400 cycle. **Price $3.25 each net.**

W. E. KS-5950-L2, Size 5 Generator, 115 V., 400 cycle. **Price $10.00 each net.**

1G Generator 115 V., 60 cycle. **Price $40.00 each net**

5G Generator 115 volts, 60 cycle. **Price $50.00 each net**

2J1F1 Selsyn Generator, 115 V., 400 cycle. **Price $3.50 each net.**

5SDG Differential Generator 90/90 V., 400 cycle. **Price $15.00 each net.**

1CT Control Transformer, 90/55 volts, 60 cycle. **Price $40.00 each net.**

POSITION TRANSMITTER

Pioneer Type 4550-2-A Position Transmitter, 26 volts 400 cycle, gear ratio 2:1. **Price $15.00 each net**

INSTRUMENT ASSOCIATES

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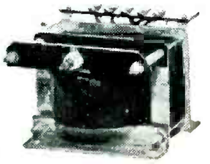
Telephone GReat Neck 4-1147

Write for Catalog NE100

Western Union address: WUX Great Neck, N. Y.

RCA HI-VOLTAGE TRANSFORMER

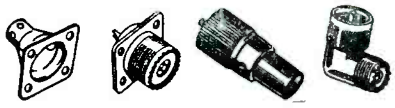


Pri—115/230V. 60Cy
Sec—6000V—80 MA

$14.80

Insulated for Voltage Doubler Use

COAXIAL CONNECTORS



83-1AC	.42	UG-12/U	.63	UG-86/U	1.22
83-1AP	.30	UG-21/U	.67	UG-87/U..	.79
83-1F	1.30	UG-22/U	.86	UG-171/U	1.33
83-1H	.10	UG-23/U	.85	UG-175/U	.15
83-1J	.80	UG-24/U	.67	UG-176/U	.15
83-1R	.40	UG-27/U	.68	UG-181A/U	7.85
83-1SP	.45	UG-29/U	.83	UG-191/AP	.63
83-1SPN	.40	UG-30/U	1.60	MX-195/U	.41
83-1T	1.12	UG-34/U	12.80	UG-197/U	1.33
		UG-36/U	12.80	UG-206/U	.63
85-22AP	1.10	UG-37/U	12.80	UG-255/U	1.22
83-22R	.48	UG-58/U	.63	UG-264/U	1.74
83-22SP	.85	UG-85/U	.88	UG-290/U	1.40

FULL LINE OF JAN APPROVED COAXIAL CONNECTORS IN STOCK

WESTINGHOUSE HYPERSIL TRANSFORMER

PRI-115V. 60CY ¾ KVA
SEC #1 - 240V - 1.56A
SEC #2 - 240V - 1.56A
WT. 30 LBS.

$14.50 EACH

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—

$12.95 EACH—Our Price

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 DC 15 Amps. Brand New—Original Packing....$9.50

STANDARD BRANDS ONLY

TUBE SPECIALS

BRAND NEW FIRST QUALITY

COMPLETE STOCK OF RECEIVING, TRANSMITTING, CATHODE RAY, THYRATRON, IGNITRON, MAGNETRON, KLYSTRON, PHOTOCELL, T-R & ATR TUBES.
QUOTATIONS UPON REQUEST

PULSE TRANSFORMERS

UTAH 9262 and 9340 (X124T-2)..............$3.75
UTAH 9278 .... 2.75
G. E. 68G-627 .... 8.95
AN/APN-9 (901756-501) 1.50
AN/APN-9 (901756-502) 1.50
AN/APN-4 Block, Osc 1.25
Philco 352-7149—Modulator to 50 ohm line. 115 KW peak power 17.95
Philco 352-7150—50 ohm line to magnetron. 115 KW peak power 17.95

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 E4-16-60-67P 7.5 KV. "E" Circuit 4 sections, 15 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

MISCELLANEOUS EQUIPMENT

ID-6/APN-4 Indicator $29.50
R-7/APS-2 Receiver 49.50
R-78/APS-15 Receiver 49.50
SCR-522 Transceiver 36.95
RT-7/APN-1 Transceiver—less tubes.............. 6.95
FL-8 1020 cycle filter.............. 1.37
RM-29 remote control unit.............. 8.95
RM-14 remote control unit.............. 8.95
RTA-1B 12/24 V dynamotor.............. 40.00
BC-1206-CM2 Receiver 7.95
CY-230/MPG-1 Radar Console..............575.00
G.E. Type JP-1 portable current transformer.. 32.50
ASB-4 Radar equip. Complete.............. 69.75
AN/APS-13 less tubes.............. 12.95
T-9/APQ-2 less tubes.............. 16.50
BC-645A complete 18.95
RCA AVR-15 Beacon Recvr.............. 15.50
TBY Trans-Recvr 29.95
T-47/ART-13 Transmitter 165.00
T-47A/ART-13 Transmitter 165.00
G.E. 2CV2A1 Servo Amplifier.............. 6.95
Sperry A-3 Hydraulic Servos.............. 3.95
EIMAC 35 TG Ionization Gauge.............. 5.95
CP-11/APS-J5 Range Unit less tubes.............. 32.50
ATR Inverters 6VDC to 110 VAC 60 cy 75W—Orig. Cartons 19.95
Pioneer Type 800-1B Inverters—28VDC to 120V 800 cy 7 amp AC (used).............. 22.65
G.E. Inverter—28VDC to 120VAC 800 cy 750VA 1 ϕ (new) 39.50

SOUND POWERED TELEPHONES

- U. S. INSTRUMENT Type A-260
- WESTERN ELECTRIC Type D-173013
- AUTOMATIC ELECTRIC Type GL-832BAO

U. S. NAVY TYPE M HEAD AND CHEST SETS
These are high quality heavy-duty units not to be confused with cheaper units now available. Designed to withstand exacting shock, vibration, salt water corrosion, temperature and pressure tests. ANY TYPE ....$14.88 ea., $28.00 per pair.
TS-10 HANDSETS ....$8.92 each

METERS

500 Microamps, DC—2½" round—Sun..........$4.30
1 ma, DC—3½" R. (4 KV scale)—Roller Smith 4.17
1 ma, DC Fan type—4" scale (rem. from equipt) 3.95
500 ma, DC 2½" R.—General Electric........ 2.95
3 amp, RF 3½" R.—Weston........ 4.95
2 amp, RF 2½" Sq.—Simpson........ 3.15
5 amp, AC 4½" R.—JBT........ 4.11
1 ma, DC 4½" Sq.—Marion........ 6.95
50 VAC 3½" R.—General Electric........ 2.95
58-62 Cycles (115 V.) 3½" R.—JBT........ 6.45
10 amp, RF 3½" R.—Simpson........ 4.95
50 amp AC 3½" R.—General Electric........ 4.11

MAGNETRONS

2J21A	$8.95	2J39	24.50	700C	16.90
2J22	8.95	2J40	24.50	700D	16.90
2J26	7.80	2J41	132.50	706AY	45.00
2J27	13.70	2J48	14.95	706BY	45.00
2J31	9.60	2J49	39.50	706CY	17.95
2J32	14.45	2J61	36.20	706FY	45.00
2J33	19.90	4J50	197.00	706GY	45.00
2J34	19.90	4J52	197.00	714AY	6.95
2J36	85.00	5J23	14.20	720B/C/DY	75.00
2J37	13.70	5J29	14.20	725A	8.95
2J38	12.70	700B	16.90	730A	10.95

KLYSTRONS

2K23	$23.95	2K33	295.00	707B	12.95
2K25	23.50	2K54	135.00	723A	6.95
2K26	75.00	2K55	135.00	723A/B	12.95
				726A	14.50
2K28	27.50	417A	10.65	726B	29.50
2K29	29.95	707A	6.95	5611	135.00

TYPE "J" POTENTIOMETERS
$1.00 each

Resis.	Shaft	Resis.	Shaft	Resis.	Shaft
100	SS"	10K	SS	50K	SS
200	SS"	15K	½"	100K	5/16"
500	½"	15K	SS	100K	⅜"
650	½"	20K	SS	100K	7/16"
6500	SS"	25K	1½"	100K	SS"
10K	⅜"	25K	SS	150K	½"
10K	½"	30K	1⅛"	1 MEG	SS

Dual "JJ" Potentiometers..............$1.60 each
50-50 Ω SS 100-100 Ω SS 250-250 Ω SS
Triple 100K "JJJ" Potentiometers—⅜" shaft..$1.95
All shaft lengths beyond bushing—SS (screw slot)

TEST EQUIPMENT

- A.W. Barber Labs. VM-25 VTVM........* $86.00
- TS-10A/APN Delay Line Test Set........$25.00
- TS-19/APQ-5 Calibrator $75.00
- AT-48/UP "X" Band Horn........$4.95
- 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........$595.00
- TS-184/AP $60.00
- CPR-60AAJ and CPR-60AAK—IFF Test Sets, (pair) $16.95
- AN/APA-23 Recorder $147.50
- TN-1B/APR-1 Tuning Unit........$95.00
- C-D Quietone Filter Type IF-16 110/220 V AC/DC 20 Amps ....* $9.00
- TS-127/U Freq. Meter w/spares........$69.50
- TS-143/CPN Oscilloscope ....* $95.00
- Dumont 175A Oscilloscope........* $225.00
- Telrad 18 A Frequency Std........$29.50
- LM-20 Frequency Meter ....* 49.50
- Gen. Radio 757-P1 Power Supply........* $27.00
- Gen. Radio 670-F Decade........* $38.00
- I-130 A Signal Generator........* $70.00
- TS-6/AP Frequency Meter........* $42.00
- L & N KS-9470 Null Volt Test Set........* $60.00
- Measurements 79B Pulse Generator........$200.00
- MIT TTX-10RH 3 cm FM Test Set....* $325.00

All Items New Except Where Noted * (Exc. Used Condition)

SYNCHROS

General Electric 2J1G1........ea. $1.65
Caps for connecting to above........ea. .50
G. E. 2J1F1 Generators........ea. 2.85
C-78248 Transmitters—110V 60 cy........ea. 5.25
C-78411 Transmitters—50V 50 cy........ea. 4.90
C-78249 Differentials—110V 60 cy........ea. 2.95
C-78410 Repeaters—110V 60 cy........ea. 6.75
C-78415 Repeaters—110V 60 cy........ea. 6.75
C-69406-1 Repeaters—110V 60 cy........ea. 12.00
Many additional types in stock including:
Types B, M, N, X, FJE 43-1
Sizes 5CT, 5D, 5DG, 5F, 5G, 5SF, 6G, 7DG

CONSTANT VOLT. TRANSFORMERS

Federal Constant Voltage Transformer Input 95-135V 60cy Output 115V 210W..............$34.00
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

SELENIUM RECTIFIER STACKS
FULL WAVE BRIDGE

MAXIMUM RATINGS AC VOLTS INPUT - 18 DC VOLTS OUT - 14.5		MAXIMUM RATINGS AC VOLTS INPUT - 40 DC VOLTS OUT - - 34	
1.2 Amps	$2.90	0.6 Amps	$3.30
2.4	3.38	1.2	3.78
6.4	4.50	3.2	5.66
13.0	8.44	6.0	10.25
17.5	9.56	9.0	11.05
26	16.86	12	20.50
39	25.30	18	22.13
52	33.74	24	39.56
65	42.26	36	45.36

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

PIONEER SERVO SYSTEM UNITS

- Type 12073-1A Torque Amplifier, Input 115 V 400 cy. Complete with Tubes..............$16.95
- Magnetic Amplifier Assy. Saturable Reactor Type to supply one phase of 400 cycle Servo Motor....$7.95

OIL FILLED CONDENSERS

MFD	VDC	Price	MFD	VDC	Price
2	600	$ .45	2	2000	$2.70
4	600	.95	4	2000	3.95
4	600 R'd)	1.05	.1	2500	.49
8	600 (R'd)	1.39	1-1	2500	3.85
10	600	1.95	32	2500	15.80
10	600 (R'd)	1.52	1	5000	4.88
8-8	600	1.49	.01-.03	6000	1.65
1	1000	.62	.1	7000	1.79
2	1000	.89	2	12500	28.95
3.5-.5	1000	1.39	.045	16K	4.70
1	1500	.89	.05	16K	4.95
4	1500	2.95	.075	16K	8.95
.1-.5	2000	.87	50	220VAC	3.95
.5	2000	.95	60	330VAC	5.75
1	2000	1.50	7	660VAC	3.35

ANTENNAS

AT-38A/APT (70 to 400MC)..............$13.70
AT-49/APR-4 (300 to 3300MC).............. 13.70
AT-48/UP 3 cm horn antenna.............. 4.95
DZ-2 Loop antenna with pedestal.............. 14.50
AN-74B (125 to 150MC).............. 1.65
AN-65A (P/O SCR-521).............. .95
AN-66A (P/O SCR-521) 1.15
AIA—3CM conical scan..............125.00
ASB Yagi—5 element 450 to 560MC.............. 7.00
ASB Yagi—Double stacked 6 element.............. 12.70
ASA Yagi—Double stacked 370 to 430MC.... 29.40

COMPONENT SPECIALS

FUSES	4AG	10 Amp.	$3.00/c
	4AG	20 Amp.	$3.00/c

MOLDED PAPER CONDENSERS—

.02 MFD	200 VDC	$4.50 per 100
.05	200	4.50
.1	200	5.00
.1	400	9.00
.005	600	4.50
.01	600	8.00
.05	600	9.00

CRYSTAL DIODES—

1N21	1.19	1N23	1.49	1N45	.94
1N21A	1.69	1N23A	2.55	1N52	1.05
1N21B	3.25	1N27	1.79	1N63	1.39
1N22	1.09	1N34	.79		

PHASE SHIFT CAPACITOR—Type D—150734—4 stator single rotor.............. $3.30

All material brand new and fully guaranteed. Terms 20% cash with order, balance C. O. D. unless rated. All prices F.O.B. our warehouse, Phila., Penna., subject to change without notice.

LECTRONIC RESEARCH LABORATORIES

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- TRANSMITTING
- RECEIVING
- INDUSTRIAL
- SPECIAL PURPOSE

TUBES *Guaranteed by* WELLS

Many Types Are Now Scarce At These Low Prices. Check your requirements at once for your own protection. All tubes are standard brand, new in original cartons, and guaranteed by Wells. Order directly from this ad or through your local Parts Jobber.

Wide Selection of Electronic Components at WELLS—Tubes • Resistors Condensers • Wire and Cable Volume Controls • Co-ax Connectors • Relays • Rectifiers • Transformers • Chokes • Micro Switches • Toggles • Antennas • Accessories • Electronic Assemblies • Dial Light Assemblies

TYPE	PRICE EACH
1ASGT	$ .85
1B1	1.00
1B4P	1.90
1B22	2.90
1B27	7.75
1B32/532A	1.85
1B42	6.75
1B48	9.90
EL-C1A/	3.95
CE-1C/918	1.45
EL-1C	4.85
CE-1-D/918	1.45
1D8	1.75
1E7GT	1.45
1G6	1.30
1G6GT	1.30
1H4G	.80
1J6G	1.20
1LH4	1.25
1N21 (Xtal Diode)	1.20
1N21A " "	1.40
1N22 " "	1.40
1N23 " "	1.30
1N23A " "	2.25
1N27 " "	3.25
1N29 " "	3.25
1Q5GT	1.25
1R4/1294	.95
1T4	1.40
2B7	1.20
2B22/GL-559	.70
2C21	.75
2C22/7193	.55
2C26	.28
2C26A	.30
2C34/RK34	.40
2C40	5.25
2C44	1.25
2J21	7.95
2J21A	7.95
2J32	12.85
2J33	18.75
2J34	17.50
2J36	95.00
2J37	12.75
2J38	9.85
2V3G	.60
2X2/879	.65
3-16 Ballast	.45
3A4	.35
3B7/1291	.25
3B22	1.95
3BP1	3.45
3C21	4.85
3C24/24G	.45
3CP1-S1	1.95
3D6/1299	.30
3D21A	1.65
3DP1	3.75
3FP7	1.95
3FP7A	2.25
3GP1	4.95
3H-1-7 Ballast	.45
3HP7	2.80
3Q4	1.25
4B24/CE224	3.25
4B25/CE221	7.85
4B26/CE226	1.90

TYPE	PRICE EACH
4B27/CE201A	2.40
4B28/CE225	2.40
4B35/CE212B	7.65
5AP1	3.75
EL-C5B	4.25
5BP1	2.95
5BP4	3.95
5CP1	2.45
5D21	18.80
5FP7	1.75
5GP1	2.95
5H-4 Ballast	.45
B-5H Ballast	.45
5HP4	4.75
5J29	12.85
5MP1	3.75
5NP1	3.75
6-4 Ballast	.35
6-7 Ballast	.35
6A3	1.60
6A6	1.21
6AF6G	1.30
6B7	1.50
6B8	1.30
6B8G	1.20
6C8G	1.30
6G12 Ballast	.45
6H16 Ballast	.45
6J5	1.30
6J8G	1.45
6K7	1.30
6K7G	1.20
6R7G	1.10
6R7GT	1.20
6U7G	.85
7-7-11 Ballast	.35
7A4	.85
7B8	.80
7C4/1203A	.35
7E6	.75
7F7	1.10
7H7	1.80
7L7	1.33
7N7	1.50
7Y4	.80
9-3 Ballast	.35
10 Acorn	.55
10 Spec. VT-25-A	.53
REL-10	
10T1 Ballast	.50
10Y (VT-25)	.45
12AN7GT	1.25
12C8	1.25
12F5GT	.75
12J7GT	.82
12K8	.80
12K8Y	.85
12SF7	.70
18X825 (2 Amp Tungar)	1.45
13-4 Ballast	.35
R-15-A/CE235 (15 Amp Argon Rectifier	6.00
15R	.55
FG-17/CE-309	3.90
19	1.20
20-4 Ballast	.45
CE-20D/927	1.25
CE-21-D/920	2.40

TYPE	PRICE EACH
REL-21	2.10
21-2 Ballast	.45
CE-22D/924	1.20
CE-23-D/923	1.10
23D4 Ballast	.45
HK24/3C34	
24G/3C24	.45
CE-25D/927	1.25
25T/3C34	
30	.40
30/VT-67	.58
CE-30-C/930	1.20
33	1.00
34	.90
RK-34/2C34	.40
35/51	.90
36	.90
37	.75
38	.75
39/44	.75
41	.75
45 Spec. 7 Volt Fil.	.30
46	.90
EF-50	.65
56	.75
59	1.75
RK-60/1641	.80
VT-62 British	1.00
VR-65 British	1.00
CEQ-72	1.45
CRP-72	.95
CYN-72	1.62
RKR-72	.90
RKR-73	1.23
77	.80
VR-78 British	.65
FG-81-A	3.95
83V	1.20
89	.30
89Y	.35
VR-92	.65
100R	.85
100TH	11.50
101/837	1.35
FG-104	14.95
FG-105	9.75
VU-111S	.45
114B	1.20
VT-127 British	.35
VT-127A	2.95
VR-150	.95
V.T.-158	14.95
FG-172	19.25
CE-201A/4B27	2.40
205B	1.35
211	.40
215A	.19
CE-221	7.85
221A	1.75
CE-224	3.25
CE-225	2.40
CE-226	1.90
227A	2.45
231D	1.20
RX-233A	1.95
CE-235	6.00
268A	2.95
274A	5.40

TYPE	PRICE EACH
274B	2.65
282B	7.95
287A/722A	9.50
293A	2.95
304TH	12.95
307A	6.85
CE-309	3.90
316A	.85
327A	2.50
331A	12.85
WL-332 (X-Ray)	90.00
356B	4.95
368AS/703A	3.75
371A	.59
371B	.59
388A	1.60
MX-408-U	.30
417A	8.90
446A	1.15
GL-451	1.90
GL-471A	2.75
507AX	9.90
527	12.85
WL-530	12.20
WL-531	1.75
WL-532	1.85
532A	1.85
559	2.10
KU-610	6.90
HY615	.35
WL-632A	8.75
700B	17.95
700C	17.95
700D	17.95
701A	2.90
702A	2.60
703A	2.35
704A	1.00
705A	.85
706AY	17.50
706CY	16.90
707A	12.95
707B	14.45
708A	3.45
709A	3.95
710A	.80
713A	.75
714AY	3.25
715A	6.25
715B	6.55
715C	20.50
717A	.90
721A	2.20
722A	9.50
724A	3.85
724B	2.50
725A	6.45
726A	4.50
730A	8.50
801	.40
801A	.65
803	3.00
804	6.40
805	5.75
808	1.65
814	2.20
815	2.20

TYPE	PRICE EACH
826	.75
830B	3.00
832	6.50
834	5.75
835/3811A	1.00
836	1.45
837	1.35
838	2.30
841	.40
843	.35
849	29.45
851	39.00
860	6.90
864	.35
865	1.40
866A	1.30
869	19.75
869B	26.35
872A	2.45
876	.35
878	1.65
879/2X2	.65
884	1.50
918/CE-1C	1.45
920/CE21D	2.40
923/CE23D	1.10
927/CE25D	1.25
930/CE30C	1.20
931A	3.95
954	.30
955	.45
957	.35
958A	.50
991/NE-16	.24
1005	.30
CK1089	3.90
CK1090	2.65
1148	.35
1201	.45
1203A	.65
1291	.25
1294	.95
1299	.30
1299A	.60
1616	.70
1619	.35
1624	.95
1625	.35
1626	.35
1629	.35
1630	2.25
1638	.60
1641	.80
1642	.55
1960	.75
2051	.75
7193	.55
8011	1.95
8012	2.25
8013	1.25
8020	1.50
8025	3.65
9003	.95
9004	.50
9006	.50
3811A/835	1.00

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1B27	24.50
1B29	2.75
1B32	8.95
1B36	24.96
1B38	32.50
1N21 Xtal	1.25
1N21A Xtal	2.25
1N21B Xtal	3.25
1N22 Xtal.	1.35
1N23 Xtal.	2.25
1N23A Xtal	3.25
1N23B Xtal	4.95
1N27	1.69
1N34	1.05
1N34A	1.05
1P23	3.95
1P24	1.79
1P36	2.95
1S21	6.95
2AP1	8.95
2AP5	6.95
2C21/RK33	.69
2C22/7193	.49
2C26A	.49
2C34/RK34	.89
2C39	24.50
2C40	4.95
2C43	14.95
2C44	1.49
2C46	7.50
2C51	5.75
2D21	1.79
2E22	1.95
2E24	4.89
2E26	3.69
2E30	2.29
2J21A	9.95
2J22	8.45
2J26	29.50
2J27	29.50
2J30	39.50
2J31	39.50
2J32	39.50
2J33	39.50
2J34	39.50
2J36	97.50
2J37	12.75
2J38	12.75
2J39	39.50
2J40	39.50
2J46	39.50
2J48	29.50
2J49	39.50
2J50	22.50
2J54B	39.50
2J55	97.50
2J61	49.50
2J62	49.50
2K25/723AB	24.95
2K28	39.50
2K29	24.50
3AP1	9.95
3B22/ELIC	2.95
3B23/RK22	4.85
3B24	5.95
3B24W	7.95
3B25	4.65
3B26	3.95
3B27	3.95
3B28	8.95
3BP1	8.95
3C22	64.50

3C23	$9.95
3C24/24G	2.25
3C30	2.95
3C31/C1B	3.49
3C45	12.75
3CP1	2.25
3CP1-S1	2.95
3DP1	4.95
3DP1A	6.95
3DP1-S2A	8.95
3D21A	1.98
3E29	14.95
3EP1	5.95
3FP7	3.95
3GP1	4.75
3HP7	3.95
4-65A	14.21
4-125A	26.95
4-250A	29.95
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4B22/EL5B	9.95
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4B25/6CF	8.95
4B26/2000	8.95
4B28	4.95
4B32	9.95
4C27/CV92	49.50
4C35	29.50
4D22	12.95
4D32	14.95
4E27/257B	17.95
5AP1	3.69
5AP4	3.69
5BP1	5.95
5BP4	5.95
5CP1	4.95
5CP7	4.95
5C22	49.55
5D21	24.50
5FP7	1.95
5GP1	4.95
5JP1	24.45
5JP4	24.45
5J23	12.95
5J29	12.95
5J30	49.50
5J32	99.50
5LP1	13.95
5NP1	5.95
6AS6	3.69
6C21	22.50
6F4	5.95
6J4	5.95
7BP7	8.95
9GP7	14.95
9JP1	14.95
9LP1	19.95
9LP7	14.95
10BP4	18.95
7DP4	17.95
10	.49
12DP7	16.95
12GP7	16.95
12HP7	16.95
12LP4	22.50
15E	1.19
15R	.89
16AP4	42.50
16CP4	42.50
19T8	1.29
23D4	.45
28D7	.98
30 Special	.59
35TG	4.95
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53A	5.95
75TL	6.95
100R	.89
100TH	9.95
121A	2.98
203A	8.95

204A	$69.50
211	.69
212E	49.50
215A	.19
217C	8.95
227A/5C27	5.95
249C	3.95
250R	12.95
250TH	21.50
250TL	21.50
274A	5.50
274B	2.65
276A	9.95
293A	2.98
294A	5.75
300B	9.95
304TH	27.50
304TL	29.95
305A	34.95
307A/RK75	5.95
310A	8.95
316A	.65
323A/B	24.50
327A/5C37	4.95
328A	13.95
331A	12.95
350A	8.95
350B	2.95
368AS	7.95
371A	1.49
371B	.98
388A	2.75
393A	6.95
394A	4.95
417A	12.95
434A	4.95
446A	4.95
446B	1.79
450TH	47.50
450TL	44.50
527	12.75
559	1.39
562	97.50
575A	13.95
701A	5.95
702A	3.95
703A	7.95
704A	1.05
705A	.89
706BY	39.50
706CY	39.50
706FY	42.50
706GY	42.50
707B	17.95
708A	4.95
709A	3.95
710A/8011	1.75
713A	1.45
714AY	6.95
715A	7.95
715B	12.95
715C	24.50
717A	1.69
721A	2.59
722A	2.95
723A	9.95
723A/B	14.95
724B	3.89
725A	7.95
726A	6.95
726B	29.50
726C	49.50
730A	12.95
750TL	79.50
800	1.95
801A	.49
802	4.49
803	4.49
804	9.95
805	4.49
806	29.95
807	1.98
808	4.49

809	$2.45
810	9.95
811	2.95
812	2.95
812H	6.90
813	8.95
814	3.95
815	2.95
816	1.19
826	.98
828	12.75
829	12.95
829B	14.95
830B	3.95
832	5.95
832A	8.95
833A	37.50
836A	3.95
837	1.69
838	2.95
841	.45
843	.39
845	4.95
849	29.50
851	69.50
852	29.50
860	6.95
861	29.50
864	.39
865	1.45
866A	1.39
866JR	1.29
869B	39.50
872A	2.49
874	1.49
876	.59
878	2.25
884	1.49
885	1.49
902	8.95
905	3.59
908	7.95
918	1.69
919	2.79
922	.98
923	1.05
927	1.59
930	1.05
931A	4.95
954	.39
955	.45
956	.45
957	.45
958	.45
959	.65
991/NE16	.39
1603	3.25
1613	1.25
1614	1.95
1616	.98
1619	.29
1622	1.98
1624	1.98
1625	.45
1626	.35
1629	.25
1630	.98
1631	1.29
1632	.79
1633	.75
1634	.75
1636	3.25
1638	.65
1644	.98
1654	2.39
1665	1.45
1851	1.89
1960	.79
1961	4.99
2050	1.25
2051	.65
8005	5.95
8011	1.75

8012	$3.95
8013	2.95
8014	29.95
8020	1.29
8025	5.95
9001	2.25
9002	1.49
9003	1.49
9004	.45
9005	2.35
9006	.29
C1JA	9.95
C5B	9.95
C6A	7.95
C6J	6.95
C100D	1.49
CK502AX.	2.95
CK503AX.	2.95
CK505AX.	2.25
CK506AX.	2.25
CK507AX.	2.25
CK512AX.	2.25
CK517AX.	8.45
CK1005	.89
CK1006	.95
E1148	.35
EF50	.69
F123A	8.75
F127A	22.50
F128A	89.50
F606	37.60
F660	79.50
FG17	3.95
FG27A	8.75
FG32	7.95
FG57	14.95
FG81A	3.95
FG105	8.95
FG172	29.50
FG146	8.95
FG434A	4.95
FG451	.89
FG502A	1.85
GL562	97.50
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HY115	.79
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RK25	4.49
RK33	.69
RK34	.89
RK48A	4.49
RK59	1.49
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RK65	24.50
RK72	.59
RK73	.59
RX21A	2.95
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VR78	.69
VR91	1.49
VR92	.98
VT127A	3.95
VT158	14.95
VU29	2.95
VU111	1.49
WL468	12.95
WL530	12.75
WL531	12.75
WL532	2.95
WL578	1.29
WL616	37.50
WL619	18.95
WL677	34.50
WL681	22.50

0A2, 0A4G, 0B2, 0Z4, 01A, 1A3, 1A4P, 1A5GT, 1A6, 1A7GT, 1AB5, 1B3/8016, 1B4, 1B5/25S, 1B7GT, 1C5GT, 1C6, 1C7G, 1D5GP, 1D7G, 1D8GT, 1E5GT, 1E7G, 1F4, 1F5G, 1G4GT, 1G6GT, 1H4G, 1H5GT, 1H6GT, 1J6GT, 1L4, 1LA4, 1LA6, 1LB4, 1LC5, 1LC6, 1LD5, 1LE3, 1LG5, 1LH4, 1LN5, 1N5GT, 1P5GT, 1Q5GT, 1R4, 1R5, 1S4, 1S5, 1T4, 1T5GT, 1U4, 1V, 2A3, 2A4G, 2A5, 2A6, 2A7, 2B7, 2V3G, 2X2, 2X2A, 3A4, 3A5, 3A8, 3B7/1291, 3D6/1299, 3LF4, 3Q4, 3Q5GT, 3S4, 3V4, 5R4GY, 5T4, 5U4G, 5V4G, 5W4, 5X4G, 5Y3GT, 5Y4G, 5Z3

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6SN7GT, 6SQ7, 6SR7GT, 6SS7, 6ST7, 6SU7GTY, 6SV7, 6T7G, 6T8, 6U5G, 6U6GT, 6U7G, 6V6, 6V6GT, 6W4, 6W7G, 6X4, 6X5GT, 6Y6G, 6Y7G, 6Z7G, 6ZY5G, 7A4/XXL, 7A5, 7A6, 7A7, 7A8, 7AG7, 7B4, 7B5, 7B6, 7B7, 7C4, 7C5, 7C6, 7C7, 7E5, 7E6, 7E7, 7F7, 7H7, 7K7, 7L7, 7N7, 7Q7, 7R7, 7S7, 7V7, 7W7, 7X7, 7Y4, 7Z4, 12A, 12A6, 12A7, 12A8GT, 12AH7GT, 12AL5, 12AT6, 12AT7, 12AU6, 12AU7, 12AV6, 12BA6, 12BE6, 12C8, 12F5GT, 12H6, 12J5GT, 12J7GT, 12K7GT, 12K8, 12Q7, 12SA7GT, 12SC7, 12SF5, 12SF7, 12SG7, 12SH7

DUE TO CURRENT NATIONAL EMERGENCY AND THE CRITICAL RECEIVING TUBE SHORTAGE, TUBES WILL BE SHIPPED AT PREVAILING PRICES. WE WILL QUCTE ON LARGE OR SMALL QUANTITIES.

12SJ7, 12SK7, 12SL7, 12SN7, 12SQ7, 12SR7, 12Z3, 14A4, 14A7, 14B6, 14F7, 14F8, 14H7, 14J7, 14N7, 14Q7, 14R7, 19, 24A, 25L6GT, 25Z5, 25Z6GT, 26, 27, 28D7, 30, 31, 32, 32L7GT, 33, 34, 35/51, 35A5, 35B5, 35C5, 35L6GT, 35W4, 35Y4, 35Z3, 35Z4, 35Z5, 36, 37, 38, 39/44, 41, 42, 43, 45, 45Z3, 45Z5, 46, 47, 48, 49, 50A5, 50B5, 50C5, 50L6GT, 50Y6, 53, 56, 57, 58, 59, 70L7, 71A, 75, 76, 77, 78, 80, 82, 83, 83V, 84/6Z4, 85, 89Y, 117L7/M7, 117N7, 117P7, 117Z3, 117Z6

DUE TO CURRENT NATIONAL EMERGENCY AND THE CRITICAL RECEIVING TUBE SHORTAGE, TUBES WILL BE SHIPPED AT PREVAILING PRICES. WE WILL QUOTE ON LARGE OR SMALL QUANTITIES.

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
40K3	24.0 Amps	29.50
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

Let us bid on your special selenium rectifier wants in any quantity

TRANSFORMERS—115V 60 CY HI-VOLTAGE INSULATION

2700v @ 2 MA: 6.3v @ .6A: 2.5v @ 1.75A	$ 4.45
2500v @ 15 MA	3.49
1600v @ 4 MA: 350-0-350v @ 150 MA: 6.3v @ 9A	4.45
1540v @ 5 MA: 340-0-340v @ 300 MA	4.35
1120-0-1120v @ 500 MA; 12v Ct @ 14A; 2.5v @ 10A; 17v @ 2.5A; 32v @ 25 MA; 115/230 Pri	16.95
925v @ 10 MA: 525-0-525v @ 60 MA: 2X5v @ 3A; 6.3v @ 3.6A; 6.3v @ 2A; 6.3v @ 1A	4.85
@ 3A: 6.3v @ 3.6A; 6.3v @ 2A; 6.3v @ 1A.	4.85
500-0-500v @ 175 MA	4.55
425-0-425v @ 75 MA: 6.3v @ 1.5A; 5v @ 3A	3.65
415-0-415v @ 60 MA: 5v CT @ 2A: 115/230 Dual Pri	4.25
405-0-405v @ 150 MA: 6.3v CT @ 2½A: 5v @ 3A: 2.5v CT @ 5A	4.35
400-315-0-100-315v @ 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
375-0-375 @ 175 MA. 5v @ 3A, 6.3v @ 5A, 78 v @ 1A	3.79
325-0-325v @ 12 MA; 255-0-255v @ 240 MA.	4.25
300-0-300v @ 65 MA: 6.3v @ 2.5A: 6.3v @ 1A: 2x5v @ 2A	3.25
80-0-80v @ 225 MA: 5v @ 2A: 5v @ 4A	2.97
0-17.4/21.6/25.8v @ 400 MA: 6.4v @ .5A: 2.6v CT @ 2.5A Pri 115/230	3.85
13.5v CT @ 3.25A	2.17
12.6v CT @ 10A: 11v CT @ 6.5A	6.35
3x10.3v CT @ 7A. $6.95 6.3v @ 1A	.98
6.5v @ 12A: 6.3v @ 2A: 115v @ .1A	3.50
6.5v @ 8A: 6.5v @ 6A: 2.5v @ 1.75A	4.17
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

EQUIPMENT SPECIALS

ATR Inverter 12v DC in 110v AC Out 125 w Int. 100 w Cont.	New	$14.95
AN/CRW-2 UHF Receiver Less Tubes	New	5.95
BC433 Receiver	Good	24.94
BC456 Modulator	Good	1.98
BC434A Control Box/BC433	Used	1.95
BC459 Transmitter	Good	10.95
BC778 Gibson Girl	Good	3.95
BC950A-121 Xmitter 100-156 MC	New	69.50
BC1016 Tape Recorder	New	459.50
BC1206B Beacon Receiver, Less Tubes	Good	3.95
CF1 Navy Unit w/200KC Crystal	New	14.95
DM 19 Dynamotor 12v DC in 500v 200 MA Cont. Output	Good	6.95
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
PE103 Dynamotor	Like New	29.95
R89/ARN5 Receiver Less Tubes. Covers	Good	14.95
SCR518 Altimeter Complete	New	97.50
T17 Carbon Mike	Used	1.59

FILTER CHOKES HI V INS

.025 HY @ 1.36A	$1.98
.05 HY @ 15A	7.95
.065 HY @ 2.5A	2.49
.1 HY @ 15A	6.95
2 HY @ 175 MA.	1.49
3 HY @ 50 MA.	.39
5 HY @ 1A	13.95
5 HY @ 70 MA/.2 HY 350 MA Dual	2.39
10 HY @ 700 MA.	11.95
10 HY @ 55 MA.	.89
10 HY @ 100 MA.	1.49
10 HY @ 250 MA.	$3.15
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 $10.00. 20% deposit required. All merchandise guaranteed.

Reliance Specials

CAPACITORS

POSTAGE STAMP MICAS

MMF	MMF	MMF	MMF	MMF	MFD	MFD
8.2	43	100	250	580	.0013	.0051
10	47	110	300	600	.00136	.006
15	50	120	330	620	.0015	.0062
20	51	125	350	680	.001625	.0065
22	56	130	370	750	.002	.0068
24	60	150	390	800	.0025	.007
25	62	160	400	820	.0026	.0075
26	75	175	430	910	.0027	.008
30	82	180	470	MFD	.003	.0082
35	85	200	500	.001	.0033	.01
39	90	220	510	.0011	.0047	
40		240	560	.0012	.005	

Price Schedule

8.2 MMF to .001 MFD .... 5¢
.0011 MFD to .002 MFD .... 7¢
.0025 MFD to .0082 MFD .... 12¢
.01 MFD .... 22¢

SILVER MICAS

MMF	MMF	MMF	MMF	MMF	MMF	MFD
10	51	120	270	470	815	.00282
18	60	125	325	488	820	.002826
22	62	130	330	500	375	.003
23	66	150	360	510		.0033
24	68	180	370	525	MFD	.0030
30	75	200	390	560	.001625	.005
39	82	208	400	660	.0022	.0051
40	100	225	410	700	.0023	.0056
50	110	240	430	750	.0024	.006
	115	260	466		.0028	.0082

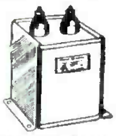
Price Schedule

10MMF to .001625MFD .... 10¢
.0022MFD to .0024MFD .... 20¢
.00282MFD to .0082 MFD .... 50¢

OIL FILLED

MFD	V. D. C.	Price	MFD	V. D. C.	Price
.25	20,000	$16.75	8	1,000	$1.95
.03	16,000	1.95	4	1,000	1.39
.375@	16,000 and		3	1,000	.80
.75 @	8,000	5.95	2	1,000	.65
.1	7,500	1.69	1	800	.39
.1-.1	7,000	1.69	10	600	1.95
.01	6,000	.95	8	600	1.60
.03-.03	6,000	1.25	4	600	.89
.02-.02	7,000	1.25	2	600	.45
1	6,000	5.25			
2	5,000	4.50			
2	4,000	3.95			
2	3,000	2.15			
.25	3,000	1.10			
.2	750 AC	.49			
8	2,000	4.50			
4	2,000	3.85			
2	2,500	1.95			
1	2,000	.95			

2 mfd
4,000
V.D.C.
G.E.
SPECIAL
$3.95



AN CONNECTORS

— IMMEDIATE SERVICE —

PHONE! WIRE! WRITE! YOUR NEEDS

DELAY NETWORK—ALL 1400Ω

T 113—Approx. 1.2 micro sec. delay..........
T 114—Approx. 2.2 micro. sec. delay..........
T 115—Similar to T 114 with tap brought out...
95c EACH

FILAMENT TRANSFORMERS

Pri. 115 V., 60 Cyc.—Sec. 5V., 115A. 6000 volt insulation .... $9.95 each

Pri., 115V., 60 Cyc.—Secondary: 6 V. @ 35 A., 12 V. @ 18 A., 24 V. @ 9 A. $6.50 EACH

PULSE TRANSFORMERS

9262 & 9340 UTAH (X 124 T2) Ratio 1:1:1; hypersil core. **$3.75**

D161310, 50 Kc to 4 Mc. 1¾" dia. x 1⅞" high. 120 to 2350 ohms.... **$1.75**

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. #2731, 28,000 Volt peak output: Bifiar: one microsecond pulse width.......... $37.50

UTAH 9278 .... **$3.75**

SOUND POWERED HANDSET

Brand New!

Includes 6 ft. cord. No batteries or external power source used.
$8.92 ea. .... $17.60 pr.

CERAMICONS

2 MMF	35 MMF
5.6	39
10	45
12	62
15	82
20	110
22	150
30	200

$6.50 per hundred

500 VOLT CERAMIC CONDENSERS

MMF	MMF	MMF	MMF
2	18	56	150
3.44	22	62	180
4.7	27	68	200
8	30	82	220
12	33	91	270
15	40	100	300
16	47	140	1000

$5.00 per hundred

UNIVERSAL JOINT
3/16" hole x 3/8" O.D.
11/8" long
Steel or Aluminum
50¢

Universal Joint—¼" hole x ½" O.D., 1½" long. Aluminum: similar to above.......... 60¢

WATER TIGHT JUNCTION BOX

14 gauge steel. 17"x25"x6½", hinged lid, 2 access panels. Approx. wt., 50 lb. $3.50

WIRE WOUND PRECISION RESISTORS 1% OR BETTER

¼ WATT—30c

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	59.148
11.74	14.98	123.8	366.6	100,000

½ WATT—30c

.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—35c

1.01Ω	5.21Ω	270Ω	9,000Ω	55,000Ω
2.58	10.1	3,300	18,000	65,000
3.39	10.9	7,000		

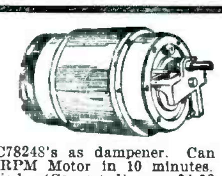
1 WATT—45c

100,000Ω	128,000Ω	320,000Ω	600,000Ω
120,000	130,000	522,000	700,000

1 Megohm—1 Watt 1%—65c; 5%—45c

DIFFERENTIAL

115 V., 60 Cyc.
#78249
3⅜" dia. x 5⅜" long
$3.95 ea.



Used between two #C78248's as dampener. Can be converted to 3600 RPM Motor in 10 minutes. Conversion sheet supplied. (Converted)...... $4.50

Mounting Brackets — (Bakelite) for selsyns and differentials shown above.......... 35¢ pair

2J1G1 SELSYNS

BRAND NEW
400 Cycle
Can be used on 60 cycle
$1.90

3AG FUSES

AMP	Per 100	AMP	Per 100	AMP	Per 100
⅛	$4.00	1	$3.00	5	$3.00
¼	4.00	1½	3.00	10	3.00
½	4.00	2	3.00	15	3.00
¾	4.00	3	3.00	20	3.00

Fuse Holder—for 3AG Fuse. (Littlefuse or Buss).... 25c

4AG FUSES

AMP	Per 100	AMP	Per 100	AMP	Per 100
1/10	$4.00	2	$2.00	10	$2.50
1/4	3.50	3	2.00	15	2.50
1/2	3.50	3.2	2.00	25	2.50
1	2.00	5	2.00		

Fuse Holder—for 4AG Fuse. (Littlefuse or Buss).... 18c

PRECISION CONTROLS

6 WATT

20,000Ω	Muter	314A	$1.70
6,000	De jur	260	1.70
6,000	Muter	314A	1.70
5,000	Muter	314A	2.50
2,000	De jur	260	1.70

12 WATT

10,000Ω	De jur	271T	$2.00
10,000	Muter	471A	2.00
5,000	De jur	271T	2.00

4 WATT

5K	De jur		$2.96
500Ω	Centralab	48-501	1.00
200Ω	GR	301	1.25
50	De jur	292	1.00
12	GR	301	1.10
12	De jur	292	1.00
2	GR	301	1.25

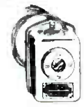
PRECISION CAPACITOR—W.E.

D-161270. 1 mfd @ 200 VDC: —40° +65°C...... $8.50

SELENIUM RECTIFIERS

Full Wave—200 ma., 115 V.......... $1.57
Half Wave—100 ma., 115 V.......... .72

TIME DELAY RELAY



Raytheon CPX 24166 KS 10193-60 Sec. • 115 V., 60 Cycle • Adj. 50-70 Seconds • 2½ second recycling time—spring return • Micro-switch contact, 10A • Holds ON as long as power is applied • Fully cased • ONLY $6.50

CHOKES

30, Henry, 80 ma.......... $1.29
6 Henry, 80 ma.......... .72

Get On Our Mailing List!

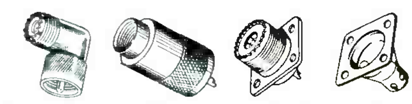
COAXIAL CABLES

GUARANTEED!! NEW!!

	Ohms	Price per 1,000 ft		Ohms	Price per 1,000 ft
RG-6/U	76	$150	RG-34/U	71	175
RG-7/U*	97.5	65	RG-35/U	71	450
RG-9/U*	51	135	RG-37/U	55	40
RG-10/U	52	125	RG-39/U	72.5	180
RG-15/U	76	160	RG-41/U	67.5	550
RG-21/U	53	100	RG-54/U	58	65
RG-22/U*	95	110	RG-54/AU	54	75
RG-24/U	125	240	RG-55/U	53.5	65
RG-25/U	48	575	RG-57/U*	95	100
RG-26/U	48	75	RG-58/U*	53.5	60
RG-27/U	48	290	RG-59/U*	70	
RG-28/U		160	RG-77/U*	48	100
RG-29/U*	53.5	$50	RG-78/U	48	80

*No minimum order—others 250' minimum
Add 25% for orders less than 1,000 feet

COAXIAL CABLE CONNECTORS



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	.88
83-1F	1.30	UG-21/U	.67	UG-87/U	.79
83-1J	.80	UG-22/U	1.10	UG-103/U	.48
83-1SP	.45	UG-23/U	.85	UG-104/U	.85
83-1SPN	.50	UG-24/U	.67	UG-167/U	2.00
83-1T	1.12	UG-25/U	.60	UG-171/U	1.33
83-22AP	1.10	UG-27/U	.68	UG-175/U	.15
83-22R	.48	UG-29/U	.83	UG-176/U	.15
83-168	.15	UG-30/U	1.20	UG-197/U	1.33
83-185	.15	UG-33/U	14.80	UG-206/U	.63
UG-7/AP	2.14	UG-34/U	16.00	UG-255/U	1.22
UG-12/U	.63	UG-36/U	12.80	UG-264/U	1.74
UG-13/U	.63	UG-37/U	12.80	UG-281/U	.60
UG-18/U	.63	UG-58/U	.63		

JONES BARRIER STRIPS

Type	Price	Type	Price	Type	Price
2-140Y	$0.13	5-141Y	.37	2-142	.14
3-140¾W	.19	7-141	.36	3-142	.21
5-140	.21	7-141¾W	.49	3-142Y	.29
6-140	.25	8-141¾W	.58	4-142	.26
2-141	.13	9-141W	.62	5-142¾W	.46
3-141¾W	.24	9-141¾W	.64	11-142Y	.95
3-141W	.24	9-141Y	.64	2-150	.39
4-141W	.30	10-141Y	.71	2-150¾W	.47
4-141¾W	.30	13-141¾W	.89	3-150	.54
5-141	.26	14-141¾W	.96	4-150	.70
5-141¾W	.37	17-141Y	1.17		

Brand New—METERS—Guaranteed

0-1 Amp, RF, 2½".......... $3.29
0-300 V.D.C., 2½".......... 3.50
0-80 Amp, D.C. 2½".......... 2.25
0-7.5 V. A. C. 3½".......... 3.46

VERNIER DIAL or DRUM (From BC-221)

DIAL—2⅝" dia. 0-100 in 360°. Black with silver marks. Has thumblock. DRUM—0-50 in 180°. Black with silver marks .... either, 85¢

VARIAC—General Radio. 100 watts. Removed from equipment $10.00

CARBON MIKE—T-17, slightly used, guaranteed. Has 5 foot cord and PL68 .... 89¢

THROAT MIKE—MT 81-A—2 mikes in leather zipper case with 56" cord & PL68—Brand New.......... 59¢

SPAGHETTI SLEEVING—assortment—99 feet..... $1.00

BLOWER & MOTOR

Blower #1½, motor 27½ V.D.C., 1/100 H.P., 8,500 R.P.M. Continuous duty. Has mounting brackets. Navy inspected $3.50

GEAR ASSORTMENT

100 small assorted gears. Most are stainless steel or brass. Experimenters dream! .... Only $6.50

Wrapped—BALL BEARINGS—New

Mfg	ID	OD	Width	Price
Fafnir 33K5	3/16"	1/2"	5/32"	$0.25
MRC .205R	63/64"	2 3/64"	19/32"	1.10
N.D. 5202C13M	1/2"	1 3/8"	1/8"	1.00
Fafnir 7308W	1 37/64"	3 9/16"	5/16"	2.00
SKF466430	6"	8"	1"	5.00
TIMKEN	4 5/16"	6 1/4"	29/32"	4.25

NEEDLE BEARINGS

B108 1/2" wide 5/8" 13/16" 30¢

ALLEN SET SCREWS

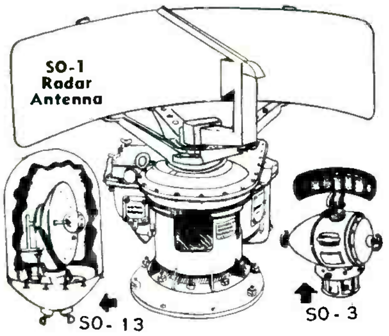
4-40 x 1/8 8-32 x 1/8 8-32 x 5/16
4-40 x 3/16 8-32 x 3/8
ALL SIZES .... $1.50 per 100

Minimum Orders $3...... All orders f.o.b. PHILA. PA.

RELIANCE MERCHANDIZING CO.

Arch St. Cor. Croskey Phila. 3, Pa. *Telephone RIttenhouse 6-4927*

RADAR ANTENNAS



Type SO-1 (10 CM.) Complete assembly with reflector, waveguide nozzle, drive motor and synchros, etc. New in original cases.................$279.50

Type SO-3 (3 CM.,) Surface Search type complete with reflector, drive motor, synchro, etc., but less plumbing. New in original cases.................$189.50

Type SO-13 (10 CM.) Complete assembly with 24" dish with feedback dipole. Complete with synchros, drive motor, gearing, etc. New in original cases. $149.50

Also in stock—spare reflectors, nozzles, probes, right angle bends for SO-1 antennas.

---

400 CYCLE TRANSFORMERS

AUTO. 400 cy. G.E. Cat No. 80G184 **KVA** .945S—.520P. Volts 460/345/230/115. New $4.95

FILAMENT. 400/2600 cy. Input: 0/75/80/85/105/115/125V. Output: 5V3A/5V3A/5V3A/5V3A/5V6A/5V6A/6.3V6A/6.35A. New $2.95

THYRATRON POWER. 400/1600 cy. Raytheon UX-8876. 400/1600 cy. Pri: 115, 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 (2700 V Total). Elecstat shlded. Wt. 2.3 lbs. New...........................$2.95

SCOPE PL. & FIL. WECO 9556. 400/2400 cy. Pri: 115. HV. Wdg. 1125V at .008A. Fil. Wdgs. 6.4V4A/2.5V1.75A/6.4V.6A. Elecstat shlded. Wt. 1.4 lbs. New $2.75

FILAMENT. 400/2400 cps. WECO KS9553. Pri: 115V. Sec: 8.2V1.25A/6.35V1.5A Elecstat shlded. Wt. 0.5 lbs. New $1.95

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 $4.95

RETARD. 400 cy. WECO KS9598. 4 Henry 100MA $1.75

60 CYCLE TRANSFORMERS

FILAMENT. Raytheon Hypersil Core, Pri: 115V. Sec: 6.3V22A/6.3V2.4A/6.3V2.25A/6.3VO.6A Ins. for 1700V $5.95

Plate. Thordarson #T46889. 1650 VA. Pri: 105-120V. 60 cy. 1 PH. Sec: 5600V. Center tapped. 7.5KV insulation. Brand new..................$49.50

High Reactance Trans. G. E. type Y-3502A.—60 cy., Voltage 11200-135. Inductance H.V. Winding 135 Henries. Output Peak Voltage 22.8KV. Cat. 8318065G1. **New** $89.50

High Voltage Trans. Westinghouse 7,500 volt or 15000V Voltage Doubler at 35MA............$24.50

PULSE TRANSFORMERS

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

PULSE. WECO KS-161310, 50 KC, to 4MC. 1¾" Dia. x 1⅞" high. 120 to 2350 ohms. New.....$3.95

SOUND POWERED BATTLE PHONES

Western Electric No. D173312. Type O. Combination headset and chest microphone. 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

U. S. Instrument Co. Navy Type M. Dr. No. A-260 ALT. 1. Complete with 20' cable and navy plug. **Brand new** $17.50

MICROWAVE RECEIVERS

AN/APR-1 Receivers and tuning units TN-1 (38 to 95 MC) TN-2 (76-300 MC) TN-3 (300-1000 MC)
AN/APR-4 Receivers and tuning units TN-16 (38-95 MC) TN-17 (76-300 MC) TN-18 (300-1000MC)
AN/APR-5A Receivers. 1000 to 6000 MC Range.

LAVOIE FREQ. METER

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................................ **$69.50**

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**

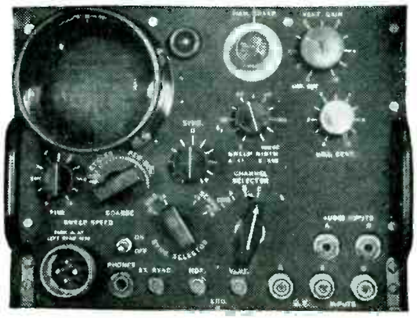
SWEEP GENERATOR CAPACITOR

High speed ball bearings. Split stator silver plated coaxial type 5/10 mmfd. Brand new...... **$2.50**

RAYTHEON VOLTAGE REGULATOR

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........... **$14.75**

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.

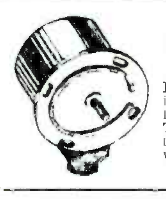
With 21 tubes including 3" scope tube. Converted for operation on 115 V. 60 cycle source.

PRICE **245.00**
AN/APA-10 80 Page Tech Manual......... **$2.75**

G. E. SERVO AMPLIFIER

Type 2CV1C1 Aircraft Amplidyne control amplifier, 115 volts—400 cycles. Dual channel. Employs 2-6SN7GT and 4-6V6GT tubes. Supplied less tubes. **New** $22.50

LINEAR SAWTOOTH POTENTIOMETER



W.E. KS-15138

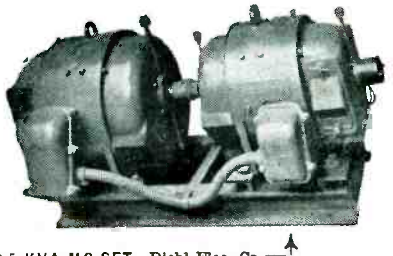
Has continuous resistance winding to which 24 volts D.C. is fed to two fixed taps 180° apart. Two rotating brushes 180° apart take off linear sawtooth wave voltage at output. **Brand New $5.50**

HIGH VOLTAGE CAPACITORS

.25 MFD., 20KV	$17.75
.25 MFD., 15KV	15.75
.5 MFD., 25KV	26.50
1 MFD., 7.5KV	7.95

All brand new. Made by prominent manufacturers.

MOTOR GENERATORS DYNAMOTORS, INVERTERS, ETC.



2.5 KVA MG SET. Diehl Elec. Co. 120V DC to 120V AC, 60 cy. 1 Ph. Complete with Magnetic Controller, 2 Field Rheos and Full Set of Spare Parts including Spare Armatures for Generator and Motor. Full specs. on request. New. $285.00

2 KVA MG SET. O'Keefe and Merritt. 115V DC to 120V AC, 50 cy. Idles as 3 Ph. syncs motor on 208V, 50 cy. New. Export crated..$165.00

1.25 KVA MG SET. Allis-Chalmers. 115V DC to 120V, AC, 60 cy. 1 Ph. Fully enclosed. Splashproof. Ball Bearings. New $125.00
Same machine but for 230V DC operation....$125.00
Spare parts for either machine..............$25.00

MG Set. Onan MG-075. Navy type PU/11. Input 115/230, 60 cy, 1 Ph. Output 115, 480 cy, 1 Ph. 5.3 amps and 26V DC at 3.8 amps. New......$198.50

MG Set. Onan MG-215H. Navy type PU/13. Inut 115/230, 60 cy, 1 Ph. Output 115, 480 cy, 1 Ph, 1200W and 26V DC at 4 amps. New........$295.00

MG SET FOR NAVY TBS TRANSMITTER. Type CG-21302. 440V AC, 60 cy, 3 Ph, 1500 VA 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
Also available for 64 volts input. Same price.

DYNAMOTOR. Elcor. 32V DC to 110V AC. 60 cy. 1 Ph, 0.43 Amps. New.......................$17.50

DYNAMOTOR—Type PE94C. For use with SCR522 Transmitter-Receiver. Brand new in export cases. $9.50

AMPLIDYNE—G. E. Model 5AM31NJ9A. 530 Watts. 7500 R.P.M. Input: 27V DC. Output: 60V. DC. Weight 34½ lbs. New.......................$16.50

AMPLIDYNE—G. E. Model 5AM21JJ7. 4600 R.P.M. Motor Compound wound. 150 Watts. Input: 27V. DC. Output: 60V. DC Sig. Corps. U. S. Army MG-27-B. New $26.50

AMPLIDYNE—Edison type 5AM31NJ18A. Input: 27 volts 44 Amps., 8300 RPM. Output: 60V DC at 8.8 amps. 530 Watts. **New**....................$22.50

INVERTER—Leland Elec. Co. Model PE206A. Input: 28V. DC, 38 Amps. Output. 80V., 800 cy, 485 VA. New $17.50

PE 218 INVERTER—G. E. J8169172. Input: 28V. DC, Output: 115V, 400 cycles at 1.5 KVA....$50.00

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.....................$16.75

Synchro Differential Generator

Ford Inst. Co. Type 5SDG. Brand New........$22.50

WESTERN ELECTRIC CRYSTAL UNITS

Type CR-1A/AR

Available in quantity—following frequencies
5910—6350—6370—6470—6510
6610—6670—6690—6940—7270
7350—7380—7390—7480—7580
9720—Kilocycles
Brand New **$1.29 each**

All prices indicated are F O B Tuckahoe, New York. Shipments will be made via Railway Express unless other instructions issued.

ELECTRONICRAFT INC.

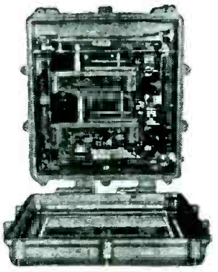
27 MILBURN ST. BRONXVILLE 8, N. Y.
PHONE: BRONXVILLE 2-0044

All merchandise guaranteed. Immediate delivery, subject to prior sale.

All Prices Subject to Change Without Notice

IMMEDIATE DELIVERY • LOW PRICES • FULLY GUARANTEED

BROWN TELEPLOTTER RECEIVER



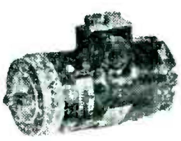
Model 791X1R

115 volt 60 cycles

Contains a pen driven by two balancing motors which writes on rear of a translucent chart. Pen arm position is in terms of two co-ordinates supplied balancing motors thru two amplifiers. Originally intended for recording plotted or written data from central plotting board. Writes at one half scale on 18 in. chart. Discriminator input circuit designed to operate unit as function of two varying R.F. frequencies varying about mean of approx. 430 KC. Further data on request. (Shipping weight 435 lbs.)

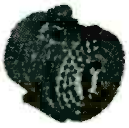
Price $375.00

Aircraft Generator Eclipse NEA-3



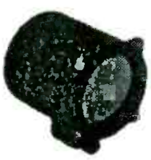
Output 115 VAC; 10.4 amps 800 cycles at 2400 rpm. Also 30 VDC at 6 amps. Stock #SA-306. **Price $39.50 each.**

400 Cycle Generator



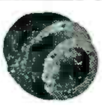
G. E. 5ASB31JJ3. 400 cycles out at 115 volts 7.1 amps, Ideal for lab. 6" lg. x 6" diam. 8000 rpm. Stock #SA-292. **Price $79.50 ea.**

A-5 Autopilot Indicator



Autosyn Type Pilot Indicator for A-5 Autopilot. 26 v. 400 cycles. Stock #SA-299. **Price $12.50 each.**

Pioneer Servo Motor



Type 10047-2A. 2 φ 400 cycle low inertia. 26 v fixed phase. 45 v. max. variable phase. Stock #SA-90. **Price $12.50 each.**

PRECISION AUTOSYN

Pioneer Type AY-150 Control Autosyn. Precision type. 26 v. 400 cycle. Stock #SA-297. Special low price $14.50 each.

SYNCHROS

Navy Types

1G, 1CT, 5G, 5CT, 5DG, 5HCT, 5SF, 5HSF, 5SDG, 6DG, 7G, etc.

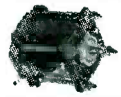
Prices on Request

Compass Indicator

I-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**

ALSO IN STOCK

C-1 AUTOPILOT COMPONENTS
A-5 AUTOPILOT GYROS
GENERAL ELECTRIC D-C SELSYNS
AC and DC RATE GENERATORS

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-0666, ½ rpm. 29 v. d-c, 100 ma.
Delco 5069625—120 rpm. Gov. cont. 27 v.
General Electric 5BA50LJ66—⅙ 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 CK-17—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 I-81A and I-82A Compass Indicators.

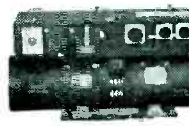
Subfractional Horsepower AC Motors

Eastern Air Devices-J-72B—115 v. 400 cy. 1/50 hp. Cont. duty. 4700 rpm.
E. A. D. J-49B—115 v. 400 cy. 1/250 hp.
E. A. D. J-33—115 v. 3φ 400 cy. Int. duty.
Diehl FBF-24-1—115 v. 400 cy. 1/100 hp.
Synchron-600—110 v. 60cy. 1 rpm.
Haydon 36228—115 v. 60 cy. 1 rpm

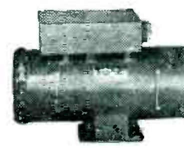
MAGNESYNS

Pioneer Type CL-3, 6 power.
Pioneer 1006-1E-B1 Indicator. AN-5730-2.

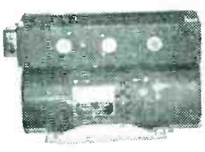
INVERTERS



Wincharger PU-7/AP Input 28 VDC at 160 amps. Output 115 v. 400 cy. 1 φ at 2500 VA. Voltage and frequency regulated. Cont. duty. Stock #SA-164. **Price $89.50 each.**



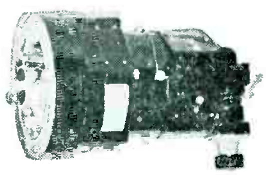
G.E. 5AS131NJ3 (PE-118) Input 26 VDC at 100 amps. Output 115 v. 400 cy. 1 φ at 1500 VA. PF 0.8 W.E. Spec. KS-5601L1. Stock #SA-286. **Price $29.50 ea.**



PE-218E Inverters Russel Electric and Leland. Input 28 VDC at 92 amp. Output 115 v. 400 cycles at 1500 VA. PF 0.9. Stock #SA-112A. **Price $49.50 each.**

Pioneer 12130-4-B Input 28 VDC at 14 amps. Output 120 v. 400 cy. Single Phase at 1.15 amps. (140 VA.) Voltage and frequency regulated. Made 1949. Stock #SA-304. **Price $89.50 each.**

JACK AND HEINTZ STARTER



Dwg.6-950-B Aircraft engine starter. 28 VDC. Stock #SA-305. **Price $19.50 each**

DC SERVO MOTOR

Elinco Type B-64. 1/165 hp at 3100 rpm. Field volts 27.5 Max. armature voltage 80. Ideal for thyratron servo control. Stock #SA-211. **Price $12.50 each.**

MAGNETIC AMPLIFIER ASSEMBLY

Sperry #61824. Saturable reactor type output transformer. Designed to supply one phase of 400 cycle servo motor. Stock #SA-266. Price $6.75 each

FORD INS'T SERVO MOTOR

115 volt 60 cycle two phase low inertia motor. 15 watts output. BuOrd. 207927. Stock #SA-291. **Price $49.50 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

SUPERIOR VALUES FROM

AMERICA'S LARGEST ELECTRICAL CONVERSION HOUSE

HIGH FREQUENCY CONVERSION EQUIPMENT

LELAND-MURRAY MG SET. Motor: 5 H.P. 220/440 Volts, 3 phase, 60 Cy. directly connected to Alternator: 3 KVA. 120/208 Volts, Wye connected. 400 c.p.s. Price $525.00

HOLTZER-CABOT MG149F. Input: 24 VDC, 36 amp. Output: 26 Volts, 400 cycles, 250 VA. Also secondary output of 115 Volts, 400 cycles. 500 VA. Completely rebuilt and guaranteed. Price $25.50
Brand New Units. Price $49.50

HOLTZER-CABOT MG153F. Input: 28 Volts DC at 52 Amp. Output: 115 Volts, 400 cps. 3 phase, 750 va.; .9 P. F. also secondary output of 26 Volts, 400 cycles, single phase at 250 va.; voltage and frequency regulated. **REBUILT LIKE NEW** $65.00

GE MG UNITS. Motor: 110 Volts, D.C. 31.5 Amperes, in a single compact unit with output of 120 Volts, 20.8 Amp. single ph. 500 cycles. Like New. Price....$95.00

500 CYCLE MG SETS. British made motor generator, 8 KW, 2 bearing unit, input 180-240 VDC, output 180 volts, 1 ϕ weight app. 1000 lbs. Price..........$425.00

OUR OWN SPECIAL 400 CYCLE MG SET. Made in our own shop employing 7½ H.P. Motor V belted to Alternator with output of 4.5 KVA, 115 V. 400 cycles. Excitation supplied is selenium rectifier external to unit. With single phase motor, Price..........$695.00
with 3ϕ Motor....................$645.00

ONAN 400 CYCLE MG SET.. Motor: 7½ H.P. operative at 220/440 V. 3ϕ, 60 cy. V belted to self-excited alternator with output of 4 KVA. 115 Volts, single ph. 400 C.P.S. Alternator is self-excited with secondary output of 14 VDC 40 Amp. With Voltage Regulator built-in. Price $592.00
With single phase Motor....................$642.00

ELECTRIC SPECIALTY FREQUENCY CHANGERS Type BFS52/BFRS354 Input: 220 Volts, 3 Ph. 60 cyc. 3600 RPM. Output: 250 Volts, 20 Amp. single ph. 180 Cyc. 5000 VA. 3000 Watts. Brand New. Compact ball bearing units for operation of Hi-cycle equipment. SPECIAL PRICE....................$160.00

ONAN 800 CYCLE MG UNIT. Employing 5 H.P. Motor operative at 220/440 Volts, 3ϕ, 60 Cy. V belted to self-exc. generator with output of 1.5 KVA, 115 Volts, single ph. 800 CPS. and secondary output of 500 Watts, 28.5 VDC 17.5 amperes. PRICE....$289.00

GENERAL ELECTRIC MG SET. 4 Bearing unit directly coupled consisting of Motor of 5 H.P. operative at 220/440 V. 3ϕ, 60 cy. Alternator: 2.5 K.V.A. 115 Volts, single ph. 420 CPS. Brand new factory built units. Price $469.00

INVERTER UNIT PE206A. Input: 27.5 VDC, 38 amp. Output: 80 Volts, single ph. 800 CPS, 500 VA. Price $19.00

KINGSTON-CONLEY MG SETS. Motor: 15 H.P. 220/440 V. 3ϕ, 60 Cy. on which there is flange mounted aero generator with output of 120/208 Volts, 9 KVA 3 Phase, 300 Cycles. Also available for 600 Cycle output. Blast cooled. Completely rebuilt. Either type, price $799.50

G. E. HIGH FREQUENCY MG UNITS. Motor operative at 115 Volts, DC Generator: 2.5 KW, 24/32 Volts, 78 Amp. D.C. Alternator: 120 VAC, 20.8 amp. .9 PF, single ph. 720 cycles. All three components in a single compact housing. Price....................$200.00

800 CYCLE UNIT. Operate at 440 V. 3ϕ, 60 cyc. directly connected to self-ex. alternator with output of 120 Volts, single phase, 6.6 amp. .8 K.W. 800 Cycles. Price ....$119.7[illegible]

CROCKER-WHEELER 500 CYCLE MG SET. Compact 2 bearing Unit. Operative at 120 VDC, 7.3 amps. Output: 250 Volts, 5 amp. 500 cycles. Rebuilt. Price $88.88

RLX DUAL GENERATORS. Flange mounted. Output: 500 Watts, 1300-2600 Cycles, also 12-14 VDC 750 Watts. Price $25.50

HOMELITE 400 CYCLE MG UNIT. Consist of motor and self excited alternator mounted on common bed plate, V belted. Motor: 5 H.P. 220/440 Volts, 3ϕ, 60 Cycles. Alternator: 120 Volts, 11.7 amperes, single phase, 400 cycles. Also output of 28 VDC., 14.3 amps. PRICE $224.00

HOLTZER-CABOT HIGH FREQUENCY MG SETS. Compact 2 bearing units with input of 120 VDC, 7 amps. Output: 120 Volts, 3ϕ 320 Cycles. Has shaft extension permitting use as dual generator. Price $112.90

WESTINGHOUSE HIGH FREQUENCY UNITS. Operate with input of 115 VDC to deliver 17 VAC, 1050 to 1650 cycles. An excellent value....................$25.50

ESCO DUAL FREQUENCY UNITS. Motor operates at 120 VDC. 10 amperes. Delivers 70 Volts at 120 Cycles or 200 Volts at 720 Cycles. Price........$95.00

ESCO 500 CYCLE UNITS. Operate at 100 VDC and deliver 110 VAC 1.38 amp. 150 VA. 500 C.P.S. Price $25.00

GE HIGH FREQUENCY MG SETS. Motor: 250 VDC. 4 amp. Alternator: 600 watts, 125 single ph. 4.8 amp. 500 cycles. Brand new. Price....................$90.00

BENDIX-ECLIPSE 800 CYCLE AERO UNIT. Input: 24-28 VDC. 75 amps. Output: 115 V. 10.5 Amp. 800 C.P.S. Complete filter system mounted thereon. Price $22.50

CROCKER-WHEELER 500 CYCLE SET. Operate at 110 Volts, D.C. 29.6 Amps. Output: 120 Volts, single ph. 500 cycles 2.5 KW. Price....................$146.95

WESTINGHOUSE HIGH FREQUENCY UNITS. Input: 115 Volts, D.C. 2.7 Amps. Output: 14.4 Volts, .139 Amp. 450-2550 Cycles. Frequency variation is obtained with built-in controller on end of unit. Price $48.50

GE DUAL OUTPUT MG SETS. Consist of Motor rated 3 H.P. 220/440 V. 3ϕ, 60 Cy. directly coupled to 2 generators. Output: .5 K.W. 220 Volts, 2.27 Amp. 525 Cycles. Also .5 K.W. 110 Volts, D.C. 4.55 Amp. 3 separate units mounted on common bed plate. Price $150.00

ESCO HIGH FREQUENCY UNITS. Operate at 120 Volts, D.C. 25 Amp. 4 H.P. Output: 2 K.V.A. 115 Volts, 17.4 Amp. 2 K.W. Price....................$175.00

KINGSTON-CONLEY MOTOR GENERATOR SETS. Employs Continental Motor rated at 15 HP. 220/440 Volts, 3 ph. 60 Cy. directly coupled to aero type self-excited alternator rated at 9 KVA with output of 120/208 Volts, 3 Ph. 400 Cycles. Water blower is provided for blast cooling. An exceptionally fine unit completely rebuilt like new. Price..........$1120.00

ONAN 2 BEARING MG UNITS. Motor: 115/230 Volts single phase, 60 cy. Generator: .6 KVA 115 Volts, 5 Amps. 480 C.P.S. Price....................$165.00

ESCO HV-HF UNITS. Operative at 11.5 VDC 28 Amp Output: 575 VDC. .25 Amp. also 55 VAC. .91 Amp. 1ϕ. 500 Cycles. Price....................$39.75

ONAN 800 CYCLE ALTERNATORS. Brand New. Mounted on base with guard for V Belts. Alternator is self-excited, rated at 1.5 KVA. 115 Volts, single ph 800 Cyc. 2666 RPM. Also output of 28.5 VDC 17.5 Amp. 500 Watts. Price....................$199.00

GENERAL ELECTRIC 400 CYCLE UNITS. Operate at 27 VDC 100 Amp. Output: 115 VAC 1ϕ, 400 CPS 1500 V.A. With filter system built-in. Price....$29.50

HOLTZER-CABOT 500 CYCLE MG SET. Motor: 110 VDC. GENERATOR: 5 KVA. 230 VAC, 1ϕ, 500 Cyc Rebuilt. Price ....$271.5[illegible]

MARCONI MG UNITS. Operative at 110 VDC to deliver 500 VAC, 6 Amp. 3 K.W. 240 CYCLES. Extending shaft permits driving complete unit to obtain dual self-excited generator. Price....................$99.00

LOUIS ALLIS FREQUENCY CHANGER SETS. We have 3 sizes in stock, all brand new. (1) Pri: 220/440 3-60; Sec: 30 K.W. 306 Volts. 2 Ph. 500 Cyc. .8 P.F. Units are belted on common bed plate. Price $1250.00
(2) Pri: 25 H.P. 220/440-3-60; Sec: 15/10.8 K.W. 3300/2200 RPM. 306/220 Volts 35/35 Amps. 2 ph. 500/360 C.P.S. Price....................$1050.00
(3) Pri: 10 H.P. 220/440-3-60; Sec: 7.5 K.W. 440/220 V. 17/8.5 Amp. 3000/1200 RPM. 360/180 Cycles, 2 ph. Price $750.00
We can supply these units for 400 cycle output and with transformers to supply 3 phase, wye output. Write for further information.

ECLIPSE 800 CYCLE GENERATORS. Flange mounting with spline shaft. Output is 115 VAC 10.4 Amp. 90% P.F. 800 Cycles, 1200 V.A. with secondary output of 28.5 VDC. 60 Amperes. Self excited. Price $39.00

BRITISH MADE 500 CYCLE MG SETS. Motor: 230 Volts, 3 PH.—50 Cycles. XX-Alternator: 5 K.W. 180 Volts. 27.8 Amp. 500 Cycles, Excitation—110 VDC. When used at 60 Cycle current. Output is 600 cycles 220 Volts. Price $353.00

WINCHARGER PU-7/AP; Input: 28 VDC, 160 Amps. Output: 115 VAC, single ph. 2500 V.A. 400 C.P.S. Frequency and Voltage regulation built-in. Price $87.00

HOMELITE 400 CYCLE POWER PLANTS. PU-6/tps-1 Single cylinder engine, air-cooled governed to operate at 4000 RPM. Generator rated at 1400 Watts, 120 Volts, 400 Cycles also secondary output of 27 VDC, 400 watts. Brand new in original cases with instruction book, and complete spare parts. An exceptional unit to procure 400 cycle current or to be used as a lighting plant. Price $150.00

WESTINGHOUSE 180 CYCLE ALTERNATORS. 750 V.A. Output: 110 Volts, 3 Phase, 180 C.P.S. 3000 R.P.M. Separately excited at 110 VDC. Price..$44.00
Also available with built-in exciter. Price......$78.00

ELECTRIC SPECIALTY HIGH FREQUENCY CONVERTER UNITS. Primary: 32 VDC, 16 amperes, 3000 R.P.M. Ball Bearings. Secondary: 350 volts, 1500 cycles, .75 amps. 275 V.A. Single Ph. Built-in frequency control. Specially Priced at....................$30.00

GENERAL ELECTRIC HIGH FREQUENCY UNIT. Operative at 440-3-60 .75 amp. Output: 70 Volts, 3 ph. 148 cyc. 220 Watts, 1.8 ampheres. An ideal unit for experimental work or for operation of equipment. SPECIAL PRICE....................$34.50

HERE IS EXCEPTIONAL VALUE

Robbins and Myers Motor Generator Units. Operate at 110 Volts, AC, single phase, 60 cyc. and deliver 32/40 Volts, DC. Can be used with field rheostat to supply 24/28 VDC for the operation of aero equipment from lighting line. Rated at 40 watts but will deliver 200 watts for intermittent operation. Gear head built into one end rotates external shaft at 225 RPM. An exceptional value at $18.75 each. With field rheostat $20.00. Also available for operation at 115 VDC at $12.50 and with rheostat at $13.75 each. Both units have 1/4 HP Motor. Stock up on these sets while they are available. Special price on quantity. Rebuilt.

GEN. ELECTRIC AMPLIDYNES

Model 5AM78AB47; 750 watts; Input: 440-3-60; Output: 250 Volts, DC; 3 amperes; 3450 RPM $185.00

Model 5AM49AB30 Input: 440 Volts, 3 phase, 60 cyc. 1 amp. output: 115 Volts, D.C. 3.25 amp. 3450 RPM $88.00

Model 5AM49AB3: Input: 440 Volts, 3 ph. 60 cyc. 1 amp. Output: 250 Volts, D. C. 1.5 amp. 375 watts. $99.00

Model 5AM73AB58: Input: 110/220 volts, single phase, 60 cyc. Output: 250 Volts, D. C. 1.5 amp. 375 watts. 3450 RPM $100.00

Model 5LY132A4: Input: 440 Volts, 3 ph. 60 cy. 3.5 H.P. 7 amps. 3570 RPM; Output: 105 Volts, D. C. 18 amp. 1.9 K.W....................$268.50

Model 5AM610A10 Amplidyne Generator. 3 K.W. 125 Volts, DC 24 amp. 1765 RPM, BB, DP..........$224.00
Input: 27 VDC, 44 amp. 8300 RPM. Output: 60 VDC. 8.8 amp. 530 watts....................$12.95

Model 5AM78AB10: Input: 32 VDC, 60 amp. 2 H.P. 2200 RPM; Output: 250 Volts, D.C. 3 amperes; 750 Watts $190.00

Model 5AM73AB89: Input: 115 VAC, 1ϕ, 60 cyc. 9 amp. Output: .375 K.W. 250 VDC. 1.5 amp......$86.00

Model 5AM65FB2A: Input: 115 VAC, 3ϕ, 60 cyc. 5 amp. Output: 500 watts, 250 Volts, 2 Amp.....$144.00

Model 5AM73AB62: Input: 115/230 VAC 6.2/3.1 Amp. 60 cyc. Output: 250 watts, 125 volts, 2 amp......$65.00

WESTINGHOUSE TRANSFORMERS

390 VA: 115/240 Volts: Brand New.
SPECIAL PRICE $4.90

GENERAL ELECTRIC DC/AC MG SETS

Four Bearing Marine Units: 25 HP 230 Volts, DC coupled to alternator 18.75 KVA; 80% PF; 1800 RPM Output: 115 Volts, AC. Single Ph. 60 cycles. Ball Bearings. 4 bearing set; marine duty. Brand New. $545.00

CENTURY MOTOR GENERATOR SETS

7.5 KVA: 230 Volts, DC to 115 Volts, AC, single phase, 60 Cycles. Complete with automatic controller and push button station $445.00

ALLIS-CHALMERS MOTOR GENERATOR

Input: 115 VDC at 14 amp. 3600 RPM. Ball Bearings. Output: 1.25 KVA; 80% PF 120 Volts, AC. 1 Ph. 60 cyc. 10.4 amp. Centrifugal automatic controller permits line start operation. Fully enclosed. Brand New $99.95. Also available for 230 VDC operation at the same price

RAYTHEON HIGH VOLTAGE TRANSFORMERS: Pri. 214/246 Volts; Sec: 5500 Volts, 1.0 amperes; test 13,500 V. Brand New....................$74.00

ESCO DC/AC MG SETS. Motor: 115 Volts, 1½ HP. line start; built in voltage regulator, frequency control, filtered; ideal for television, radar or any application requiring constant voltage and frequency. Output: 115 V.A.C. 1ϕ, 60 Cyc. 460 V.A. Brand New........$120.00

IF IT'S FROM ONE FREQUENCY TO ANOTHER; FROM DC TO AC OR AC TO DC; IF IT'S FROM ONE VOLTAGE TO ANOTHER, THEN CALL ON US.

Established 1922 **WILLIAM I. HORLICK COMPANY** *Tel. HAncock 6-2480*

409 ATLANTIC AVE. **BOSTON, 10, MASSACHUSETTS**

NIAGARA'S "GIGANTIC" WAREHOUSE CLEARANCE

"ONE OF AMERICA'S GREAT ELECTRONICS STORES"

METER BARGAINS

3 SQ.	Supreme	542	Multimeter	$3.75
3 SQ.	RCP	446	Multimeter	3.75
3 SQ	Hichcock	0-200	Microamps	6.50
3 RD.	Asst'd	0-200	Microamps	6.50
3 RD.	Triplett	0-500	Microamps	6.25
3 RD.	Weston	0-100	Thermo-Galvanometer	10.00
3 RD.	Weston	0-120	Galvanometer	9.80
3 RD.	Asst'd	0-1	MA.	4.95
3 RD.	Asst'd	0-100	MA.	3.95
3 RD.	Weston	0-150	MA.	3.95
3 SQ.	Asst'd	0-150	MA.	3.95
3 RD.	Asst'd	0-300	MA	3.95
3 RD.	G. E.	0-500	MA.	3.95
3 RD.	Weston	0-8	A. C. Volts	3.75
3 RD.	G. E.	0-10	A. C. Volts	3.75
3 SQ.	West'hse	0-10	A. C. Volts	3.85
2 RD.	West'hse	0-15	A. C. Volts (600 cy.)	2.49
3 RD.	West'hse	0-150	A. C. V.	3.95
3 SQ.	Marion	0-150	D. C. V.	3.95
3 RD.	G. E.	0-350	D. C. V.	3.95
3 RD.	Asst'd	0-500	D. C. V.	3.95
3 SQ.	Simpson	0-1000	D. C. V.	3.95
3 RD.	Asst'd	0-1.5	D. C. K. V.	3.49
3 RD.	West'hse	0-3.5	D. C. K. V	3.49
3 RD.	F. E.	0-30	D. C. K. V.	3.49

(AMMETER PRICES ON REQUEST)

OIL FILLED CONDENSERS

All Brand New—Leading Brand Names

CAP.	D. C Volts	No.	Net Each
.005	15,000	14F322	$7.95
.005-.005-.01	10,000	26FH16g2	10.50
.035	10,000	AX1U36	7.50
.02	15,000	14F321	21.95
.01	6,000	143-806	
.15	2,500	26F345	1.10
.2	5,000	C8B2784	2.98
.25	4,000	P9717	3.10
.25	10,000	14F192	19.50
.6	2,500	72041-503	1.25
1	440 AC	KG4010	.59
1	2,500	482616-10	2.55
1	3,000	A1089	2.75
1	3,600	C8B3062	2.95
1	5,000	23F49-G2	3.15
1	6,000	60010GA	4.35
1	12,000	26F628	9.50
2	440 AC	67 x 21	.79
2	600	A14109-2	.85
2	1,000	23F11	1.10
2	2,000	324-138	2.20
2	3,000	2538-16	4.50
2	5,000	C-8B2784	6.50
2.5-2.5-5	600	C8B1256	1.95
4	330 AC	KG3640	.85
4	400	25F785	.95
4	600	B8B1253-1	1.10
4	1,000	10365	1.75
5	1,000	13765	1.85
6	330 AC	67 x 7A	.89
6	44 AC	K64060	.95
6	600	P9718	1.75
8	1,000	143-117	2.50
8	2,000	TJU20080G	4.95
10	400	7DB1AE1D	1.25
10	600	10373	1.85
15	1,000	23F19G2	3.95

MORE OUTSTANDING BARGAINS IN OUR NEW FLYER

WRITE FOR YOUR FREE COPY

70% OFF LIST POPULAR SPLIT-STATORS VARIABLE CONDENSERS

Popular Split Stator Variables at unbelievable low Prices! Well Built, low loss ceramic mounted with bushings at both rotor ends. Ideal for V. F. O., low powered rig and exciter units, receivers, etc. All with ¼" Shafts.

CAPACITY	LIST PRICE	YOUR COST
15-15	$3.80	$1.14
20-35	3.95	1.19
27-27	4.10	1.23
35-35	4.30	1.39
75-75	4.80	1.44

TUBES

NEW—BRANDED
GUARANTEED
LARGE QUANTITIES

RECEIVING—TRANSMITTING INDUSTRIAL

PRICES ON REQUEST

TRANSMITTING TUBE SOCKETS

Famous make Steatite Sockets. Always useful, never old. You can afford to stock up at these prices.

Tube Type	*Net*
4 pr. 10 WATT	.69
4 pr. 50 WATT	.95
715 A, B, or C	.75
4-125A, 4-250 etc	.69
Iso. Wafer—829 or 832	.49
Isolantite Octal Wafers	.29

CRAMER TIME DELAY RELAY MODEL 1 C2H

110 V. A. C. 60 cy. contains two SPST 15 AMP contact switches. Both spring held to normally open position. Cam action holds one switch closed while spring holds other open. Switch positions change once each hour continuously until circuit to time delay mechanism is interrupted. Guaranteed, Brand New in Original Packing.

YOUR COST **$4.95**

SMASHING VALUES IN BLOWERS

(A):—**DUAL BLOWER.** approximately 100 cu. ft., per min., per section. Constant duty 110 V. A. C. 60 cycle, 3400 RPM motor made by HEINZE. 2½" intake, 2" outlet. Measures 6" high x 6½" deep x 10¾" long. NEW—BOXED. **$14.95**

(B):—**SINGLE SECTION BLOWER.** Approximately 100 cu. ft., per min. Constant duty 110 V. A. C. 25 and 60 cy., 3200 RPM HEINZE MOTOR. 2½" intake, 2" outlet measures, 6" high x 6½" deep x 6" long. NEW—BOXED. **$9.95**

(C):—**SINGLE SECTION BLOWER.** Approximately 50 cu ft., per min. Air cooled 110 V. A. C. 60 cycle F. A. SMITH MOTOR. 2" intake, 1¼" outlet. Measures 5" high, 4" deep, 5" long. NEW—BOXED. **$6.95**

(D):—**SINGLE SECTION BLOWER.** Approximately 50 cu. ft., per min. Constant duty 24 V. D. C. 6000RPM A. G. REDMOND CO., MOTOR. 2" intake by 1" outlet. Measures 3¼" high, 3" deep, 5" long. NEW SURPLUS SPECIAL. **$3.95**

AIRCRAFT TYPE

Vibrator power supply delivering 300 V. D. C. at 80 Ma. Filter Built-in, fully wired, tested and guaranteed new $5.95

TRANSFORMER BARGAINS!

Plate

1025-0-1025—500 MA $17.95
2500 V.—4 MA.............. 3.95

Filament

2.5V.10A cased 4.95
5 V.C.T.-3A ....
5 V.C.T.-10.5A 3.95
6.3 V.C.T.-3.5A ....
5V-10A 1.85
5 V.C.T.-15A 5.95
6.4V-8A 2.05
7.5V-5A 2.49

Power

275-0-275—70 MA.—5V-5A, 2.5V-10.5A.. 3.00
325-0-325—40 MA.—5 V.C.T.-2A, 2.5 V.C.T.-4A 2.25
325-0-325—70 MA.—6.3V-1.2A, 5V-3A.. 2.95
350-0-350—100 MA.—6.3V-6A, 6.3V-2A.. 3.25

Modulation

807 to P.P. 6L6.............. $2.49
P.P. 807 to single 6L6, 4D32 (2400 ohms) 3.49
From 200, 500 ohms to 5, 6, 7, 8, 9, 10K ohms at 150 MA. 4.49

Driver Xfmrs.

200, 10,000 ohm P. to single G. .... $ .79
10,000 ohm P. to single G.............. .80
P.P. 45, 2A3, etc. to P.P. 210, 801, etc. .. 1.95
P.P. 6L6, 2A3, etc. to P.P. grids........ 1.65

Output

6V6 to 2, 4, 8 ohms.............. .69
P.P. par 6N7 Class "B" to 8000 ohms... 1.49

Input

600 ohm C.T. to 300 ohm mike........ $1.49

Mike to Line

From and to 50, 125, 200, 330, 500 Ohms $2.49
30 ohm mike to 600 ohm C.T. Bal. line.. 1.65

Chokes

.875	HY.	2.5 Amps	8.95
2.5	HY.	4 Amps	9.95
2.5	HY.	130 MA.	1.10
4	HY.	40 MA.	.25
8	HY.	200 MA.	2.35
10	HY.	180 MA.	3.49
40	HY.	90 MA.	3.49
10	HY.	200 MA.	2.49
12	HY.	150 MA.	1.75
15	HY.	125 MA.	1.60
15	HY.	200 MA.	2.65
20	HY.	125 MA.	1.75

IMPORTANT NOTICE: Minimum Order $5. Quantity prices on request. All items in stock now—subject to prior sale—prices subject to change without notice. 20% Deposit with orders unless rated. All prices F.O.B. our N. Y. C. Warehouse.

Niagara Radio Supply Corp.

Phone Digby 9-1132-3-4

Dept. E-21 160 Greenwich Street, New York 6, N. Y.

BRAND NEW U. S. GOV'T. SURPLUS GUARANTEED

POWER RHEOSTATS

Ohms	watt	ea.	Ohms	watt	ea.
.5	25	1.24	150	50	2.10
.5	50	2.34	175	25	1.87
.5	150	4.45	185	25	1.24
1	50	2.34	200	25	1.24
2	50	2.34	200	100	3.29
2	100	3.51	225	50	2.10
2	225	9.60	250	25	1.86
2	300	6.32	250	50	1.49
3	100	3.51	300	50	2.11
3	225	9.60	300	100	3.29
4	225	9.60	350	25	1.24
5	25	1.24	350	100	3.28
5	100	3.51	370	25	1.24
6	25	1.86	378	150	4.95
6	50	2.10	400	25	1.24
6	75	4.80	400	75	4.80
7	25	1.24	500	25	1.24
8	50	1.49	500	75	4.80
10	25	1.86	500	50	1.49
10	100	3.28	500	100	3.29
12	25	1.86	585	150	3.51
12	50	1.49	750	25	1.86
15	25	1.24	750	150	4.45
15	75	4.80	1000	25	1.24
15	100	3.29	1000	150	4.45
22	50	2.10	1200	225	9.60
25	25	1.86	1250	50	2.22
25	100	3.29	1250	150	4.45
25	150	4.21	1500	25	2.11
32	300	6.42	1500	50	2.22
50	25	1.24	1800	150	4.68
50	50	1.49	2000	25	2.10
60	750	21.30	2000	50	1.49
60	25	1.24	2500	25	2.11
75	25	1.24	2500	50	2.22
75	75	4.80	2500	100	3.51
75	100	3.29	3000	25	1.24
75	150	4.21	3000	100	3.51
80	50	2.10	5000	25	2.22
80	500	9.13	5000	50	2.34
100	25	1.24	7500	50	2.34
100	50	1.49	7500	100	3.98
100	100	3.29	10000	50	2.34
100	225	9.60	10000	100	4.21
125	25	1.86	15000	25	2.67
125	500	9.13	20000	150	6.32

Specify whether shaft required is for knob or screwdriver adjust.

SELECTOR SWITCHES

Pole	Pos.	Deck	Type	Each
1	11	1	Bak-n/shtg	.60
1	21	3	bak-n/shtg	.89
2	2	1	cer-shtg	.50
2	6	2	bak-n/shtg	.60
2	11	2	bak-shtg	.75
3	4	1	bak-n/shtg	.53
5	3	2	Cer-n/shtg	.98
6	11	6	bak-n/shtg	1.95
10	5	5	cer-shtg	2.25
16	2	4	bak-n/shtg	1.35

(many other types in stock)

"AN" CONNECTORS

LARGE VARIETY AVAILABLE AT GREAT SAVINGS

Send your specs and let us quote

BIRTCHER TUBE CLAMPS

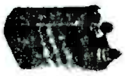
#926-A, #926-A1, #926-A14, #926-B, #926-B1, #926-B7 **35c.** #926-B22, #926-C, #926-C1, #926-C5, #926-C10, #926-C24

MICROSWITCHES

A-#YZ-RS13 SPST 10a/125vac type "S" plunger, metal housing normally open .... .49
B-#B-RS10 SPDT 10a/125vac type "S" plunger, 2-circuits: one open and one closed .... .49
#WZ-RL8 (not illus.) SPST 10a 125 vac, leaf actuator, norm. closed .... .49
#R-RL2T (not illus.) SPST 10a 125 vac roller plunger, norm. closed .... .49
C-G.E. SWITCHETTE 10a/115voltsAC
#CR1070-C103A3 SPST closed... .49
#CR1070-C103E3 SPST open... .49
#CR1070-C103R3 SPST closed... .49
#CR1070-C123C3 DPST op/cl.... .49

(Many other types in stock)

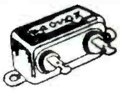
OIL CONDENSERS



Mfd	VDCW
.1	3000
.1	6000
.1	20,000
.25	3000
.5	1500
1	600
1	2000
2	400
2	600
2	1000
4	600
6	400
6	600
10	600
14	600
15	600
15	1000
2 x .1	7000
2 x .5	9000

SPECIAL PRICES QUOTED ON REQUEST

BATHTUBS



mfd	vdcw
.033	400
.05	200
.05	400
.05	600
.1	400
.1	600
.1	1000
.15	600
.25	200
.25	600
.35	400
.5	400
.5	600
.5	1000
1	200
1	600
2	400
2	600
4	50
8	500
25	50
25	75
40	25
50	25
200	12
300	6
.05-.05	600
.05-.05	1500
.1-.05	200
.1-.1	400
.1-.1	600
.16-.16	600
.2-.2	600
.25-.25	600
.5-.5	600
1.0-.1	300
200-200	9
3 x .05	600
3 x .1	400
3 x .1	600
3 x .25	600
3 x 1.0	100

SPECIAL PRICES QUOTED ON REQUEST

"UG" Connectors

UG-12/U...... $1.10
UG-13/U...... 1.49
UG-18/U...... 1.15
UG-19/U...... 1.18
UG-21/U...... .98
UG-22/U...... 1.05
UG-24/U...... 1.10
UG-25/U...... 1.15
UG-27/U...... 1.75
UG-57/U...... .89
UG-58/U...... .63
UG-123/U..... .40

SHOCKMOUNTS

100P-1.....	1 lb.	.15
100P2.....	2 lb.	.15
100PR-2...	2 lb.	.15
100P-3.....	3 lb.	.15
100P-6.....	6 lb.	.20
150P-4.....	4 lb.	.20
150PH-8...	8 lb.	.45
150PH-15..	15 lb.	.49
156P-6.....	6 lb.	.35
200PD-15..	15 lb.	.59
200PHN-35	35 lb.	.75
204P-112...	112 lb.	.98

TERMINAL BOARDS

5 terminal ..... .98
8 terminal 1.67
12 terminal 2.49

TYPE "J" POTENTIOMETERS

TYPE "J" $1.25			TYPE "JJ" $2.25	
ohms	ohms	ohms	ohms	ohms
50*	2500*	100 K*	500–500*†	100 K–100 K*
65*†	4000†	100 K†	600–600†	130 K–130 K*
200†	5000†	125 K*	1500–1500†	150 K-150 K†
300†	10 K*†	200 K*	2000–2000*†	250 K-250 K†
400*†	15 K*†	250 K*	2000–50 K*	350 K-25 K†
500†	20 K*†	250 K†	2200–24 K†	350 K-350 K*
600*†	25 K*†	500k*†	20 K–2000†	500K–8000†
750†	30 K*†	1meg*	25 K–10 K†	800 K-75 K*
1000*†	50 K*†	1meg†	35 K–5000†	2meg-2meg†
1500*†	80 K†	2meg*	50 K–50 K*	5meg-5meg†
2000*†		2meg†		

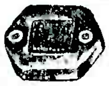
SPECIAL PRICES QUOTED ON REQUEST

TYPE "JJJ" $3.25

ohms	ohms
20K-200K-20K†	750K-750K-750K†
45K-27K-2500†	800K-800K-800K†
700K-700K-700K†	1meg-1meg-1meg†

* ⅛" screwdriver slotted shaft.
† Knob type shaft.

TRANSMITTING MICAS

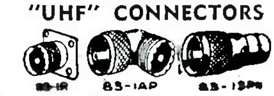

Type 9


Type 4

mfd	vdcw	type	ea.	mfd	vdcw	type	ea.
.00001	600	4	.18	.00162	600	4	.18
.00003	600	4	.18	.002	600	4	.20
.00005	600	4	.18	.002	1200	4	.48
.00005	2500	9	.31	.0022	2500	9	.78
.0001	600	4	.18	.0025	600	4	.23
.0001	2500	9	.31	.003	600	4	.25
.000152	600	4	.18	.0039	600	4	.25
.0002	600	4	.18	.005	600	4	.25
.00025	600	4	.18	.005	1200	9	.60
.0005	600	4	.18	.005	2500	9	1.18
.0051	2500	4	.43	.0062	600	4	.30
.0007	600	4	.18	.01	600	4	.40
.0008	600	4	.18	.01	600	9	.49
.0009	600	4	.18	.01	1200	9	.98
.001	600	4	.18	.0142	600	4	.45
.001	1200	4	.31	.02	600	4	.55
.001	1200	9	.31	.02	1250	9	1.36
.0013	600	4	.18	.027	600	4	.66
.0015	600	4	.18	.043	600	4	.99

(Many other types in stock)

"UHF" CONNECTORS



Cat. No.	Army No.
83-1AC	
83-1AP	M-359
83-1D	PL-271
83-1F	PL-274
83-1R	SO-239
83-1SPN	PL-259A
83-22R	SO-264

PRICES QUOTED ON REQUEST

Connectors

S-302-AB .... .13
S-304-CCT .... .25
P-306-AB .... .16
P-306-CCT-L ..... .33
S-306-FHT ..... .24
S-308-AB .... .21
P-312-AB .... .24
P-312-CCT-L ..... .42
P-315-FHT ..... .40
P-315-EB .... .30
P-315-CCE .... .40
S-315-AB .... .36
S-318-AB .... .43
P-324-FHT ..... .74
P-324-EB .... .58
S-330-AB .... .84
S-404-AB .... .33
P-406-AB .... .33
S-406-CCT .... .58
S-408-CCT .... .69
S-2408-SB .... .53
P-2412-SB .... .61
P-502-CE 1.10
S-502-DB .... .97
P-508-CE 2.55
P-510-CE 3.04
S-510-SB 2.64
P-512-CE 3.52

BARRIER STRIPS

2-140-Y .... .13
5-140-Y .... .28
6-140-Y .... .33
9-140 .... .34
10-140-Y .... .53
10-140-3/4W .... .53
10-240 .... .38
13-140 .... .48
4-141-W .... .30
4-141-3/4W ..... .30
5-141 .... .26
7-141-Y .... .49
11-141-Y .... .76
12-141 .... .58
12-141-Y .... .82
13-141 .... .62
13-141-Y .... .89
15-141-Y 1.02
2-142-Y .... .20
4-142-Y .... .36
8-142 .... .48
10-142-3/4W .... .85
11-142 .... .65
3-150 .... .53
4-150-Y .... .83
4-151 .... 1.30
5-151 .... 1.60
4-152 .... 1.89

Many other types in stock

MALLORY PUSH SWITCH

#2001 S.P., make cont., non-L.......... 45
#2003 S.P.D.T., non-lock .... .48
#2003L S.P.D.T., lock .... .48
#2004 D.P., make 2 non-L.......... .55
#2004L D.P., make 2 lock.......... .55
#2006 D.P.D.T., non-lock .... .65

Open a/c to Rated Concerns. Prices net FOB our whse NYC *and subject to change without notice.*

SEND FOR BARGAINGRAM #503

ALEXANDER MOGULL CO., INC.

161 Washington St., N. Y. 6, N. Y. WOrth 4-0865

Desirable

Select Surplus ELECTRONIC EQUIPMENT

	Price
• BC-375-E Aircraft transmitters complete, new, with all turning units, 24 volt dynamotor, tubes, plugs, etc.	$125.00
• BC-191 same as above for 12 volt operation	$125.00
• TDE Navy model radio transmitters with 230 volts, D.C. power supply, complete with tubes, ready for operation. New	$675.00
• SCR-522 Aircraft radio transmitters-receivers complete with dynamotor, control box, plugs, jackbox, microphone adapter, microphone, headset, extension cord. Newly overhauled, inspected and tested	$130.00
• SF Ships' radar units complete with all components	$500.00
• TCS, Collins type Navy and mobile type transmitters-receivers complete with remote control, antenna coil, cables, key, microphone, for 110 volt A.C. operation including set of parts. New in original cases	$1,275.00
• TCS Collins type, transmitters-receivers, same as above but without spare parts. Refinished, checked-out and guaranteed for operation on 12 or 24 volts D.C.	$575.00
• ET-8023-D1 Radiomarine Corporation telegraph transmitters	$375.00
• BC-348 Receivers, unconverted 24 volt operation	$150.00
• MN-26 Bendix radio compass receivers	$45.00
• BC-221 A.K. Frequency meters with modulation	$125.00
• BC-221 Frequency meters without modulation	$100.00
• LM-15 Frequency meters (Navy version of BC-221 A.K.) with modulation and A.C. power supply	$150.00
• I-100A Test sets for SCR-269	$750.00
• IE-19A Test set for SCR-522	$350.00
• ARP-5 high-frequency oscillators	Price on Application
• JWG-458 Gasoline-engine driven electric generating plants, 5000 watts, Onan, 100-120 or 220-240 volts, rebuilt-factory reconditioned	$590.00
• Telephone or power line insulators, glass Hemingray No. 40, heavy duty	.10
• W-110 B Army field telephone wire	$7.50
• RC-58-B Army Tape Facsimile transmitters-receivers	$250.00
• Link radio transmitters-receivers 1498 including remote control and antenna reconditioned.	Price on Application
• Link-50 UFS receivers, transmitters including remote control and antenna. New	Price on Application

ALL ITEMS ARE OFFERED F.O.B. OUR WAREHOUSE, AND ARE SUBJECT TO PRIOR SALE. ALL ITEMS ARE NEW, UNUSED SURPLUS UNLESS OTHERWISE INDICATED.

FRENCH-VAN BREEMS, Inc.

405 Lexington Avenue New York 17, N. Y.

SPECIAL SURPLUS BROADCAST OF OUR SUPER SPECIALS!!!

REORGANIZATION
NEW MANAGEMENT
NOTE NEW LOCATION

TRANSTATS

11.5 KVA 50/60 cy. Commutator range 0-115 V. Max. Amps 100. Reconnection diagram available for 230 V 50A open $225.00

RELAYS

G.E. #CR2791-B100J4, 3PDT, 6VDC, 15A Contacts $1.25
Allied DO9D28, 3PDT 6 VDC, 15A contacts......$1.35
Leach Type 1054ARV, 3PST on make, SPST on break, 20-32 VDC, 15A contacts......................$1.25
G.E. #CR2791-B100F3, DPDT 24 VDC 5A contacts 75¢
G-M #13013, DPDT, 24 VDC, 15A Contacts.......95¢
Price #311, DPDT, 28 VDC, 10 Amp cont. 1900 ohm coil ....95¢
G-M #13020, DPST on make, 3PST on break, 24VDC, 15A contacts $1.25
Allen Bradley X89309, SPST double make, 24VDC, 200 A $2.50
A-B Bulletin X95545, type B6B, SPST Double Make, 24 VDC, 200 Amp..................................$2.50
Dunco Thermal Time Delay 115 VAC 60 Cy. SPST, 1 min delay $1.95

DECK ENTRANCE INSULATORS
(Bowl and Flange Type)

Mfd. by Ohio Brass Co. heavy galv. metal flange 10½" D., porc. bowl set in rubber gaskets. Top bell 7¾" D. brass feed thru rod 10½" L. Insul. dist. between top bell and flange 6½"...........$3.95

MOTORS AND GENERATORS

G.E. Model 5BA10A522, 24VDC, 0.55A, 10 oz/in torque 1400RPM $5.95
Universal Elec. #523, 115VDC, 1.2A 5000RPM..$4.95
W.E. #KS5603, 24VDC, 0.6A, 5000RPM, Shunt wound $2.95
G.E. #5BY9E8, Permanent Magnet type, 140VDC, .025A 1800RPM $8.95
EMC, SPN37952, 32VDC, 1/30HP, Gear reduced to 21RPM $12.95
Gen'l Industries, 115VAC, 60cy, .65A 80RPM geared to 20-30RPM $3.95
Elec Spec, Type JA1, 24VDC, 15A 1/4HP, 3800 RPM $14.95
Warren Synch. Type B3, 115VAC, 60cy, 4W, 12 RPM $5.95
G.E. #5BN38HA10, 80VDC .25A, 3000RPM, 1/150 HP $7.95
Eicor #M24718, 24VDC, 0.32A, 1800RPM.........$5.95
Flyer Type 1623, 110VAC, 25cy, 30W 78RPM, gov. cont. $7.95
Dynamic HI-Press Axial Flow Fan, Mod 5S6SCR4, 24-28VDC, ½HP, 8000RPM, 225CFM. Used.........$8.95
Lear #CO04, 24VDC, 1.5A 7500RPM 8W..........$8.95
Ford Inst Synchro Generator, 7G, Mk111 Mod. 3 115/90 V 60cy LN $49.95
Arma Synchro Diff. Gen 5DG 60 cy. Oster #C-2BP-1A, 27.5VDC, 1/20HP 1/100HP, 3650RPM..........$9.95
Westinghouse #1171391, 27VDC, 1/8HP, 6.5A, 5000 RPM, Series $9.95
Emerson #1610212, 24VDC, 160 oz/ft torque, 100 RPM $9.95
Elinco F-16 Rate Generator, 2 ph 1.3 volts/100 RPM $17.95
Autosyns, Pioneer AY-59D $24.95

DC SERVO MOTORS

White Rodgers Elec. Co. (6905X-46). 24 VDC @ .65 Amps. Torque 50 in/lbs. ½ RPM reversible, comp. w/limit switch, relays and selenium rectifiers on top of motor, to keep AC out of motor. 5x5x4....$12.95

HIGH VOLTAGE CAPACITORS
Standard Brands

Cat. #14F338 rated 4.5 Mfd. at 7500 VDC......$25.00
Cat. #14F425 rated 3.5 Mfd. at 10 K.V.D.C....$35.00
Cat. #14F13 rated 5.0 Mfd. at 10 K.V.D.C......$45.00
Cat. #14F35 rated 1.0 Mfd. at 20 K.V.D.C......$45.00
Cat. #14F88 rated 0.75 Mfd. at 25 K.V.D.C......$45.00
Cat. #AE6734 rated 1.0 Mfd. at 25 K.V.D.C.....$55.00

REACTORS

G.E. Cat. #7479974. Rated 2.5 Henries @ 2.3 A.D.C. $37.50
G.E. Cat. #7479964. Rated 50 Henries @ .025 A.D.C. $27.50

RECTIFIERS

IT&T Selenium, Bridge, #EE29, 10 plates 1" dia. Input 18VAC Output 14VDC @ .15A..................$2.25
IT&T Selenium, Half Wave, #FE4, 4 plates 1⅝" dia. Input 18VAC Output 7.5VDC @ .45A...........$1.00
Westinghouse #103B, Copper Oxide, Half Wave, 4 plates 1⅝" D. Input 4VAC Output 3VDC @ .25A $1.75
G.E. Model 6RS5F10, Selenium, Full Wave, 24 plates 1" D. Input 54VAC Output 36VDC @ .2A........$3.95
Benwood Lanze #BL202S1, Selenium, Full Wave, 24 plates 1" D. Input 220VAC Output 180VDC @ .0075A $3.95
Westinghouse #S54029A, Copper Oxide 13 plates 3⅝" D. Bridge, Input 65VAC Output 45VDC @ .32A...$9.95

VARIABLE CONDENSERS

Cardwell #5032, Geared 30-100 mmfd...........$1.75
Cardwell #CA256, 50 mmfd.....................$1.25
Cardwell #CA228, 16-400 mmfd.................$2.45
Hammarlund Butterfly 10-37 mmfd..............$1.65
Radio Cond. #959-51, 2-gang 365 mmfd each section $1.85
Gang Capacitor for signal Generator type W2279SC1, 10-385 mmfd $2.35
Johnson #250F20, -255mmfd $2.35
4-Gang Str. Line wave length, #F37946-14, fully enclosed $2.50

SPERRY A-5 VERTICAL GYRO UNIT

#644841. 115V. 400CY 3 ph. Contains gyro assembly, erection motor, erection relay assembly, pick-off assembly, elevator and aileron limit switches, and roll axes. 15 x 12 x 9...........$19.75

Write us your requirements. Send us your listings and we will mail our quotations for furnishing same. We carry one of the largest surplus stocks in the country covering hundreds of hard-to-find items at lowest prices. Meters, fuses, switches, condensers, wire, tubes, potentiometers, transformers, chokes, relays, rectifiers, etc. Write to be put on our mailing list.

DAVEN SOUND ATTENUATORS

Type 350-A, Network, ladder, linear, imped. 30/30 ohms. 2DB attenuation. 10 W dissipation $3.95

TRANSFORMERS

G.E. #69G450. Pri: 500/250 Volt, 60 cy, Sec: 72.5 volt 52.5VA $1.65
G.E. #69G449. Pri: 200V 60 cy. Sec: 260/.130 volt 52.5VA $1.65
G.E. #68G457. Pri: 1/1.5/3/6/8/10V 60 cy. Sec: 50/50 Volts 50 Watt $1.65
G.E. #69G500. Pri: 450 Volts Sec: 6 Volts 3VA. May be reversed. 60 cy..............................$1.00
Raytheon Interstage UX8442. Pri: Minus 40V, Sec: Plus 40V, 1250TV RMS........................$1.25
Federal Driver #RA6407-1. Pri: 15,000 ohms tapped, .006ADC, Sec: 1770 ohms tapped. Freq Resp: 200 to 5000 cycles ± 1½ DB.............................$2.50
Raytheon Filament #UX8302C. Pri: 115V 400 cy. Sec: 6.3V @ 4.7A; 5V @ 3A; 6.3V @ 6A...........$3.00
AC Current Type T-23-3 S.C. #2Z9900.5 Pri: 0.5/1/5/10A Sec: 5-6 Volts @ 1.5MA....................$1.35
Federal #RA-6403-1. Pri: 8000 ohms @ 9MA Sec: 600 ohms $1.25
Federal #RA-6408-1. Pri: 2000 ohms Sec: Less than 1 ohm $1.25
Federal #RA6404-1. Pri: 115/80V 400 cy Sec: 550-0-165-550V; 5V @ 3A; 5V @ 3A; 6.3V @ 2A; 25V @ 2.2A $3.95
W.E. Oscilloscope Input #ES-677584-1. SC#4G167OR/T5 ....95¢
Federal Input #W15-4, S.C. #2Z9631.29 Pri: 300 ohms Sec: 250,000 ohms and 680,000 ohms............$1.25
G.E. #7472410. Pri: 115V 400 cy. Sec: 2.6V @ 6A; 6.9V @ 2.2A; 8V @ 1A.........................$3.50
Sperry #702523. Pri: 115V 400 cy. Sec: 700VCT @ .12A; 2.5V @ 3A; 2.5V @ 3A; 6.3V @ 2.25A; 6.3V @ 2.25A $2.50
RCA #901697-50. Pri: 790V @ .4A; 5.18V @ 6A; 5.18V @ 6A.......................................$2.75

MINE DETECTOR SCR 625

Detects metallic objects (ferrous or non-ferrous) to a depth of approx. 6 ft. Find outboard motors on the bottom of lakes, locate underground piping, treasure, metallic fragments in lumber, etc. New, complete with inst. book, $65.00. Used but like new $45.00

MT/ARC5 MOUNTING BASE, provides anti-shock mtg for any 3 units Trans or Rec. of the ATA or ARC5 equip. $1.75

HEAVY DUTY TRANSFORMERS

G.E. Cat. #7479965. Pri: 230V 60 cy Sec: 16.4/8.2V.O.C.; 11/5.5V @ 60 Amps. 8½"H 9½"L 5½" W $25.00
G.E. Cat. #7471997. Pri: 215/430V 50/60 cy. Sec: 5/2.5V 150VA 8KV test 6" x 4½" x 8"............$5.50
G.E. Cat. #79G365. Pri: 203.5V 60 cy Sec: 6.3V @ 250 Amps. $39.50
G.E. Cat. #7479971. Pri: 230/208V 50/60 cy. Sec: 1365/1300/1235V.M.S. 735VA. 7½" x 5½" x 8½" $29.50
G.E. Cat. #7479972. Pri: 230/208V 50/60 cy. Sec: 2450/2350/2210V.M.S. 2.85 KVA. 7¼" x 8¼" x 11" $49.50
G.E. Cat. #7475695. Pri: 115V 60 cy. Sec: 3530/3720/3910V.M.S. 1.31KVA $47.50

ALL MERCHANDISE BRAND NEW UNLESS OTHERWISE NOTATED

ALL PRICES F.O.B. BOSTON. ORDERS ACCEPTED FROM RATED CONCERNS ON OPEN ACCOUNTS NET 30 DAYS. MINIMUM ORDER $3.00

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AVAILABLE FROM OUR STOCK FOR IMMEDIATE DELIVERY

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

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

TCS, Collins Ship Transmitter-Receivers, for 12/24 V. DC operation, radio telephone and radiotelegraph at 20 & 40 watts, 1:5 to 14.0 mc. Complete with all accessories. Excellent condition. **EACH**....$300.00

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** $545.00

PRICE, less case of spares $445.00

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** $795.00

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

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

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

RMCA, 8007 Lifeboat Transmitter-Receiver, 500 KC. for permanent installation. Complete with installed 12 V. Dynamotor. Excellent Condition. **PRICE, EACH** $100.00

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

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

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

RC-163 Radio Beacon Eqpt. 20-40 MC. Converts SCR-508/528/608/628 to directional transmitters and receivers. Ideal for airports or for homing application. NEW and complete eqpt. Export packed. **EACH** $90.00

SCR-511 "Pogo Stick" Walky-Talky. Portable low-power AM radiotelephone for 2 to 6 mc operation, with 12 plug-in tuning coils containing crystals for crystal control of both receiver and transmitter. Transmitter-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). P-17 mike, ready for immediate operation. **PRICE, EACH** $95.00

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

Dock Entrance Insulators, bowl and flange type, 8⅞" dia. with heavy galvanized metal flange and bell. Top bell 6¼" dia. x 11"; brass feed thru rod. Very high voltage insulation. Individually packed in cartons, all NEW. **12 FOR**....................$18.00

General Electric Amplidyne M. G. Set, generator type #V-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

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

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

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

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**....................$450.00

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. Less tubes. **PRICE**.....$300.00

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 Radioteletype fixed station. Good Condition, less tubes. **EACH**....................$600.00

Wilcox 36A Rectifiers, single cabinet unit containing 4 separate transformer rectifier power supplies, capable of supplying DC voltage to one or more 96C transmitters described above, and one or more Wilcox 50A Modulators (which are designed to modulate a 96C 3 KW RF Output Transmitter). Has terminal connections for 5 96C Transmitters, and for local or remote operation. Measures: 72" high, 29½" wide, and 24½" deep. Operates from 220/3/60 AC. NEW eqpt., complete with control relays, tubes, power transformer (removed for shpmt), instruction manual. **WRITE FOR PRICE.**

Wilcox 4-Channel CW3 Dual-Diversity Receiving Eqpt. Enclosed rack-panel arrangement, with 8 CW-3 receivers and 4 Diversity receiving units to provide 4 channels of dual-diversity simultaneous reception. Range 1.9 to 24.0 mc, frequency determined by plug-in coils and crystals, in shield cans. Includes BFO, sensitivity, and audio output controls on each receiver. Operates from 110/1/50-60 AC. NEW EQPT., with essential spares available. **WRITE FOR PRICE.**

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

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

"SNOOPERSCOPE" TUBE

Infra-Red Image Converter Tube (British) to make "Snooperscopes," "Sniperscopes," and other devices that see in the dark. Has many useful industrial applications. Operates with invisible infra-red rays, without scanning or amplifiers. Supplied with technical data and diagrams. Every tube **guaranteed!**

EACH $4.95

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BAUSCH & LOMB Front-End Lens Assembly, for best images. F2.1, 3.5 in. E.F. **EACH**..........$10.00

MOUNTED LENS UNIT, also for front-end, results as good as B & L unit. Speed F1.9 f. 1, 91.44 mm. outside dia. at one end 60 mm, length of mount 64 mm. **PRICE, EACH**....................$7.00

580-765 MC SUPERHET RECEIVER, WITH WAVEMETER

Easily modified for Citizen's Band reception, or for experimental use on VHF Television. Uses a 955 Autodyne detector-oscillator into 3-stage resistance-coupled IF amplifer. Output is for headphones. Includes VR-150 voltage regulator tube, 6E5 tuning-eye, and 5Y3 rectifier. For 110 volts, 50/60 cycles AC. Calibrated Wavemeter mounted as separate portion, with variable tuning rod and hand-plotted calibration curve for each, permits checking frequency of incoming signal. NEW unused surplus. With instruction sheets and diagram, plus calibration curve, and tubes. **PRICE, EACH** $75.00

RADAR TRAINING SET—MARK V

For Student, Schools, Labs, or actual radar application. Operates in the 580 to 765 mc region, designed especially to illustrate how radar eqpt. functions, and permits making numerous experiments to put over radar fundamentals. Uses above described receiver; separate transmitter using 8025 triode with 1.5 watts at antenna, with 400 KC internal modulator using two 811 tubes; External modulator, generating audio frequencies of 16,000, 4,000, and 1,000 cycles, and RF at 750, 350, and 175 KC, with selection switch for modulation frequency and wave form control, using 3 tubes, 807, 6N7, and 6J5; set of Antenna Dipole rods. Supplied with full instruction sheets, diagrams, calibration curves, tubes, NEW unused surplus. **PRICE, Per Set**....................$175.00

LIMITED QUANTITIES Following: R-89/ARN-5A Receivers, new: APN-4 Indicators: TBY-2 Portable 28-80 mc Transceivers: TAJ-12B Transmitters: Model NAA Underwater Ultrasonic Beacon Transmitters: Model ZB-3 Aircraft Homing Adapter Equipment: Portable Test Oscillators for ZB Eqpt: RT-3/ARN-1 Altimeter Transmitter-Receivers: Receivers for DP-12 or 13 D.F. Receiving Eqpt: Radio Receivers BC-733-D: BC-329 Small Airport Lo-Freq. Transmitters: Model DAG-1 Portable 1.5 to 18.0 mc D.F. Receivers: Model ATD Aircraft Transmitters: BD-72 Switchboards: 500 Watt. 110 DC to 110 AC. 60 cps motor-generators.

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Uses a 0-100 Micro-ammeter with a 1S4 Pentode, to receive signals in the 20-40 mc range. 1.5 volts battery required. Tuning dial has dial lock, for fixing position, and telescopic Antenna permits adjusting for strong or weak signals. Calibration must be self-performed. With instruction sheet and diagram NEW, unused eqpt. Dim: 6⅛" x 4¼" x 5⅛". **PRICE, Each** $14.95

PE-95G & H. 10-12 KVA Gas Engine Generators. 110/220 V. AC, 1-phase, 60 cycles output. NEW, in original export packing, with spare parts and tools. Shpg. wt. 2128 lbs.; cu. ft. 70. **PRICE, EACH.** $1,450.00

HOMELIGHT 1.5 KW GAS-Engine Generators, 110 V., 60 cycles, 1-phase AC. Almost New, all units thoroughly tested and guaranteed. **PRICE, EA** $235.00

AN/CRT-1A Sonobuoy Transmitters, for mine and submarine detection. With parachute, tubes, etc., ready for operation (except standard types dry batteries). Operates at 67.7 mc. Excellent to New condition. **PRICE, EACH**....................$55.00

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EV-10 Precision Vacuum Tube Test Set	used	$28.00
No. 772 Weston Multi Tester	used	40.00
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No. 777 Weston Tube Checker	used	29.00
No. E 200 Precision Signal Generator	used	25.00
No. M-652 Jackson Audio Oscillator	used	30.00
No. 224 A Dumont Oscilloscope	used	80.00
No. 155 A RCA Oscilloscope	used	90.00
No. M-840 Triumph Oscilloscope	used	60.00
BC-221 Frequency Meter	Like New	90.00
Others as Low as		49.50
IE 36 Test set for SCR 522—less meter	New	$19.95

PRICES UPON REQUEST

I-98-A	TS10A/APN
I-114 P/O RC-68	TS16/APN
I-135 P/O IE-17	TS19/APQ5
I-167 Weston Anal. #772	TS27/TSM-1
I-183 Freq. Meter	TS36/AP
I-185 Oscillator	TS47/AP
I-187 Synchronizer	TS59/APN-1
I-189 Calibrator	TS62/AP
IE-19	TS102A/AP
IS-185 Voltmeter	TS126/AP
TS3/AP	TS-251 Less Xtal

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211	$ .59	813	6.95
307A	5.50	832	2.95
703A	1.89	832A	7.95
723A/B	12.95	837	1.19
724B	1.89	841	.49
803	2.89	860	4.95
805	3.29	864	.24
807	1.89	5D21	9.95

SCR 508 RADIO SET—Complete installation includes:

BC 603 Receiver
BC 604 Transmitter
BC 605 Interphone Amplifier
BC 606 Control Box
DM 34—12 volt Dynamotor (Receiver)
DM 35—12 Volt Dynamotor (Transmitter)
Set of 80 Crystals
MP 48 Mast Base
3 Mast sections
FT 237 Mounting Rack
Complete, only $100.00

IS-185 Weston Voltmeter Model 433—02 to 150 VAC 25 to 2400 cycles. New **$24.95**

ID6/APN4 Scope unit complete with 5CP1 cathode ray tube and shield and all parts except smaller tubes and crystal. Used $9.95 ea

CONDENSERS

	Each
1 mfd 6000 VDC. OIL FILLED	$1.98
.00025 mfd. 25000 VDC OIL FILLED	2.95
1 mfd. 600 VDC. OIL FILLED	.24
	5 for 1.00
50 mmfd—5KV—5 Amp. Vacuum Cond.	1.19

AS-138/ARN—10 inch streamline loop as used with direction finding receivers. Fixed position, it is ideal for planes, boats, automobiles. ....New **$1.95**

MISCELLANEOUS SPECIALS!

	Used	New
RA 10 DA Receiver	$17.50	$24.95
RT7/APN1 Transceiver	6.95	9.95
APN 1 Complete	——	24.50
BC 347 Interphone Amplifier	——	2.95
I-70 Tuning Meter		.89
APS 13 UHF Antenna, Pair		.98
FL 8 Filter		2.95
I-97 Bias Meter	3.95	4.95
RL 42 Antenna Gearbox Motor and Reel	4.95	7.50
TS 10—Sound powered phones	6.50	——

BC 1066 B—150 to 225 MC Portable Receiver adaptable to many amateur uses. In Canvas Carrying Bag. Used....................$5.95

BC 709 Battery operated lightweight interphone amplifier. Complete with tube and shock mount, but less battery ....New $3.95

C-18—Antenna coil assembly slug tuned used in BC 603 receiver. Frequency range 20-27.9 Mc.—fully shielded ....New. 10 for $1.95

I 82 F—Five Inch 360 degree compass indicator and Selsyn receiver....................New $4.95

A-81-2 Transmitter selsyn for 182 indicator..$2.45 (Both 182F & Trans. Selsyn for $7.00)

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Full Wave Bridge

Input: 0-18 VAC — Output: 0-12 VDC

Type No.	Current	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 — Output: 0-26 VDC

Type No.	Current	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 — Output: 0-90 VDC

Type No.	Current	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

THREE PHASE
Full Wave Bridge

Input: 0-234 VAC — Output: 0-250 VDC

Type No.	Current	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
3B13-151	15.0 Amp.	120.00

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For Types B1 through B6, and Type C1 .... $.35 per set
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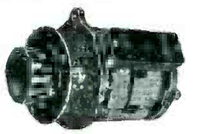

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Smooth, efficient voltage control 0 to 135V. output from 115V. AC line. Type 20. 3 Amps....$12.50
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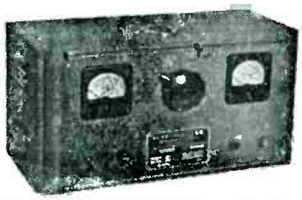

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- √ Long life Full Wave Selenium Rectifiers
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- √ For 115 VAC 60 Cycles
- √ Dimensions 8½" x 16¾" x 8"

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CF-1	1000 MFD	15 DVC	$ .98
CF-2	2000 MFD	15 VDC	1.69
CF-7	3000 MFD	35 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-10	500 MFD	200 VDC	3.25

Mounting clamps for above capacitors..15c ea.

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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.	4.95
TXF36-5	36	5	8 lbs.	6.50
TXF36-10	36	10	12 lbs.	9.95
TXF36-20	36	20	25 lbs.	17.95
XFC18-14	18 VCT	14	10 lbs.	6.95
XFC18-50	18 VCT	50 amp	17 lbs.	18.95

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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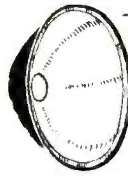

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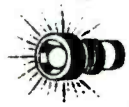

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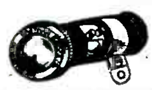
10 for .... .85
100 for $7.50



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0—5,000 volt "Scientific Electric" DC Power Supply, Model PS203, Serial No. 1166. Input—220 volts, 60 cycles single phase, Rating 2.5 KW $300.00

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OA4G	1.35	3B24	3.50	307A	4.95	801A	1.00	884	1.95
OB2	3.00	3B24W	5.50	310A	7.95	802	3.60	885	1.75
OC3	1.08	EL3C	2.95	312A	3.95	803	2.95	889R	99.50
OD3	1.08	3C22	49.50	327A	2.95	804	6.95	913	9.95
1A3	1.00	3C23	5.95	331A	3.95	805	2.95	914	75.00
C1A	4.95	3C24	2.50	350A	3.95	806	12.00	931A	7.95
C1B	4.95	3C45	11.45	350B	2.95	807	1.69	954	.15
1B21A	2.75	3DP1/A	2.95	357A	37.50	808	.95	955	.55
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1B26	1.95	4C27	10.80	388A	2.95	813	7.95	959	.69
1B27	7.95	4J25	99.00	393A	5.95	814	3.95	975A	12.95
1B32	1.10	4J26	99.00	394A	5.95	815	2.25	991	.45
1B38	33.00	4J30	220.00	MX408U	.75	827R	27.50	1280	1.95
1B42	5.95	4J31	99.00	417A	7.95	829	6.95	1611	1.95
1B56	49.95	4J37	99.00	434A	6.95	829A	8.95	1613	1.08
1B60	4.95	4J38	89.00	446A	1.95	829B	11.95	1616	1.95
1N21	1.35	4J39	99.00	446B	2.95	832	4.95	1619	.35
1N21A	1.75	4J41	99.00	450TL	35.00	832A	9.95	1620	4.95
1N22	1.75	4J57	99.00	464A	6.95	833A	39.95	1622	2.75
1N23	2.00	4J62	99.00	471A	2.75	834	7.95	1624	1.00
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1N23B	7.00	5BP4	3.95	WL530	12.50	837	1.95	1851	1.95
1N26	5.00	5CP1	2.95	WL531	3.50	838	2.95	8012	1.25
1N27	5.00	5D21	15.00	701A	5.50	845	5.95	8013	6.95
1N48	1.00	5J23	45.00	703A	2.95	849	22.50	8014A	24.95
1S21	3.95	5J29	9.95	705A	2.95	851	29.50	8020	1.50
2B26	1.75	5JP1	27.50	706AY	18.00	860	2.95	8025	4.95
2C34	.35	5JP2	7.50	706CY	18.00	861	29.50	9001	1.75
2C40	5.75	5JP4	12.50	707A	7.95	866A	1.79	9002	1.50
2C43	21.00	5LP1	15.00	707B	18.00	869B	29.50	9003	1.75
2C44	.90	6C21	39.50	714AY	5.95	872A	2.95	9004	.75
2C51	5.95	C6A	3.95	715A	7.95	874	1.50	9005	1.90
2D21	1.75	7BP7	5.95	715B	9.95			9006	.35
2E22	3.75	7DP4	10.00	715C	25.00				
2E30	2.25	12AP4	55.00	717A	.75				
2F21	40.00	15R	.95	718AY/EY	18.00				
2J21 A	9.95	NE16	.45	720A/B/C/D/Y					
2J22	9.95	FG17	3.95		95.00				
2J26	7.75	RX21	2.95	721A	2.95				
2J27	12.50	RK39	2.95	722A	1.95				
2J31	19.95	RK60	1.95	723A/B	14.95				
2J32	19.95	RK72	1.95	724A	2.95				
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2J49	69.00			726B	36.00				
2J50	39.50	FG105	19.00	726C	69.00				
2J61	45.00	F123	8.95	728AY	27.00				
2J62	45.00	203A	5.95						
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350A is a long life WE807

350B is a long life WE6L6G

WE 701A can be used for a Super 813

$10 Minimum Order

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Microwave K Band 2400 MC.

TSKI-SE Spectrum Analyzer
K Brand Flap Attenuator

X Band

TS 12 Unit I USWR Measuring Amplifier, 2 channel
TS 12 Unit 2 Plumbing for above TS13
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

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
Measurements Corp. type 84 Standard Signal Generator
TS 47, 40 to 400 MC Signal Generator

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162C Rider Chanalyst
Short Wave Adapter for 162C
TS 174 Signal

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TS 34 Oscilliscopes WE
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Audio Frequencies

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TS 15/A Magnet Flux Meter
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TEST EQUIPMENT

Hickock Oscilloscope Model 195........NEW $100.00
BC-1060 Oscillograph—Same as Dumont #224 LIKE NEW 175.00
TS-100/AP Oscilloscope ......EXCELLENT 75.00
TS-224 Dumont Oscillograph..GOOD USED 170.00
Megger—50 megs. 500 volts....EXCELLENT 75.00
Insulation Tester—Superior Model 610B, 200 megohms, Complete ....NEW 49.00
I-100A Test Set for ARN7 and 269 Compass LIKE NEW 595.00
IE-19A Test Set for SCR522—Complete with manual, original factory packing.....NEW 325.00
LM Frequency Meter with calibration books, crystal, tubes ....EXCELLENT 79.50
BC-221 Frequency Meters. Complete with calibration books, crystal, tubes EXCELLENT 79.50
TS-16/APN Test Set....GOOD CONDITION 47.50
TS-323/UR Frequency Meter — Calibrated and complete ....NEW 400.00
Standard Signal Generator — Measurements Corp.—Model 78-B. 15-25MC., 190-230MC LIKE NEW 100.00
McMurdo-Silver Model 904 Capacitance Resistance Bridge with manual.........NEW 29.50
Tube Checker—Model CGI-60067—115V., 60 cycles ....EXCELLENT 49.50
Sweep Generator—Model M for AN/APG13, Made by M.I.T. Radiation Laboratory EXCELLENT 79.50
Weston Model 506 Voltmeter 0-20,000 Volts with 4 Model 505 multipliers........NEW 39.50
LU-1 Radar Test Set..................NEW 79.50
Insulation Tester—Interstate Mfg. Co. Model 1000 ....EXCELLENT 80.00
BC-906 Frequency Meter.......EXCELLENT 17.50
Output Meter CWI 60ABJ. 115V. 60 cycles, P.O. ASB Radar with manual LIKE NEW 49.50
Engine Cylinder Thermometer Tester—Mark II. Wheelco Inst. Co., Iron-Constantan, Copper-Constantan 0-350°C ..EXCELLENT 75.00
Engine Cylinder Thermometer Tester — Wheelco Inst. Co., Iron-Constantan, Copper Constantan, Chromel-Alumel 0-1400°C EXCELLENT 95.00
TS-24A/ARR2 Test Oscillator..EXCELLENT 29.50

Weston Tachometer Generator Model 724 Type C ....GOOD USED 12.95
Weston Electrical Tachometer Model 545 for use with 724 Generator 0-2000 RPM Ratio 2:1 ....NEW 14.50

TRANSMITTERS—RECEIVERS

BC-348—24V. D.C. Aircraft Receiver EXCELLENT 125.00
ART-13 Transmitter — complete installations with dynamotor, loading units, remote, etc. 350.00
ATC Transmitter (Navy ART-13) complete installations with dynamotor, loading units, remotes, etc. 250.00
SCR-522 Transmitter-Receiver Sets—Complete with PE-94 dynamotor, BC-602 Control Box, BC-631 Jack Box, AN-104A Antenna, plugs, racks, and mounts, New Accessories EXCELLENT 70.00

Mine Detector SCR625 for locating metal, underground pipes, prospecting, etc. With Manuals ....GOOD USED 39.50 NEW 69.50

BC-375 Transmitters, Complete with tuning units, plugs, dynamotors, mountings, microphones. Export packed ......LIKE NEW 89.50
ATD-Transmitter 540-9050KC. 50 watt CW and phone. Complete with tubes, coils, dynamotor ....NEW 95.00
BC-222 Walkie-Talkie—Frequency 28-52MC. with crystal; less tubes, battery, and antenna ....EXCELLENT 14.50
FT-167RY Federal Transmitter operating shelf, tubes, crystals. Frequency range 2-24MC ....NEW 195.00
R5/ARN7 Compass—Complete installation EXCELLENT 95.00
BC-464 Target Receiver—5 channel remote, sensitive relays, battery case, antenna—68-73MC. ....BRAND NEW 14.95
APR5AX Reveiver ....LIKE NEW 325.00
RU-19 Receivers—Complete ....NEW 27.50
RA-10 Bendix Compass Receivers LIKE NEW 24.50
BC-640 Transmitter—50 watt rack type—Same Frequency as SCR522..GOOD CONDITION 695.00

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PLQ-171, PL-172, PLQ-60, PLQ-63, PL-147, PL-148, PL-151, PL-152, PL-153, PL-154, PL-156, PLQ-103, Plugs for ARC-1, ARC-3, ARC-5, BC-375, SCR-522, BC-348, GP-6, GP-7, LM Frequency Meters, and many others.

APN-1 Altimeter Indicator, basic movement 0-1 ma., 5 ma. shunt, 270° dial. An excellent basic movement for constructing meters. General Electric. ....NEW 1.95
Crystal and Coil Sets for Handy-Talkie—3885, 4280, 4840, 5327.5, 5437.5, 5500 K.C.—2 crystals and 2 coils per set..........SET 1.95

HS-23 Hi Imp Headset, ear cushions..New 2.45

Sound powered head and **chest sets**—manufactured by U. S. Instrument Co. EXCELLENT USED....$4.95 EACH, PR. 8.50 FAIR USED .... 2.95 EACH, PR. 5.00
CD-605 Cords—6 ft. tinsel rubber covered NEW .15
Matching Transformer for HS-30 Headset NEW .40

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FL-8 Range Filters ....NEW 1.95
BC-709 Interphone Amplifier, tubes, battery operated ....NEW 4.50

Selsyn Transmitter—Pioneer Inst.—AY 14 Excellent for indicator EXCELLENT 3.50
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Onan Motor Generator Set MG G-1 Generates 115V. AC 5.3 amps, 26 DC. 100 watts, 480 cycles 3.8 amps., Motor 115-230V. 60 cycles, Single phase, 2450 RPM 10.5 amps. NEW 170.00
PE-94 Dynamotor Power Supply for SCR-522 USED....$3.50: NEW 5.50
PE-206 Inverter 800 cycle—Will power APN4 and APN9 24V. D.C. Input........USED 3.75 NEW 6.95
RA-62 Rectifier Power Supply for SCR-522 115V. A.C. ....LIKE NEW 120.00
PE-73 Dynamotor Power Supply for BC-375 1000V. D.C. Output ....EXCELLENT 5.95
Delco Motor—27 volts 2.4 amps—3600 RPM Constant Speed Model A-7155 Governor Type Shunt ....NEW 5.95
APR4 Receiver with TN17. BRAND NEW. **Write for Prices.**

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120 Milliamps, Simpson 125, 3½" Rd. flush bake., arbitrary linear sc. calib. 0-10, with caption OUTPUT UNITS, complete with external thermocouple .... @ $7.50
1 Amp, General Electric DO-44, 3½" Round flush bakelite .... @ $11.00
1 Amp, Weston 425, 3½" Round flush bakelite case .... @ $11.00
1.5 Amp, Weston 507, 2½" Round flush metal black scale .... @ $4.50
1.5 Amp, General Electric DW-52, 2½" Round flush metal black scale .... @ $3.50
2 Amp, Westinghouse RT-35, 3" Sq. flush bakelite case .... @ $5.50
2.5 Amp, McClintock MD 3001, 3½" Round flush bakelite (Signal Corps Stock 1S-111) ... @ $4.50
2.5 Amps, Weston 425, 3½" Round flush bakelite .... @ $8.50
3 Amps, Weston 507, 2½" Round flush bakelite, black sc. .... @ $4.50
3 Amps, Weston 425, 3½" Round flush bakelite, with external thermocouple .... @ $9.50
3 Amps, General Electric DO-44, 3½" Round flush bakelite .... @ $6.95
5 Amps, General Electric DO-44, 3½" Round flush bakelite .... @ $7.50
5 Amps, General Electric DO-44, 3½" Round fl. bakelite, with external thermocouple... @ $8.50
6 Amps, General Electric DW-44, 2½" Rd. flush bakelite, black scale .... @ $3.50
8 Amps, Westinghouse RT-35, 3" Sq. flush bakelite case .... @ $7.50
10 Amps, Weston 425, 3½" Round flush bakelite case .... @ $8.50
30 Amps, Triplett 0347-A, 3" Square bakelite case, with external thermocouple .... @ $6.00

A. C. AMMETERS

150 Milliamperes, General Electric AO-22, 3½" Round fl. bakelite case .... @ $4.95
50 Amperes, Westinghouse NA-35, 3½" Round flush bakelite case, 25 to 500 cycles .... @ $5.50
75 Amperes, Burlington 32 C, 3½" Round flush bakelite .... @ $4.95
150 Amperes, Multirange, General Electric AO-22, 3½" Round flush bakelite, 5 Amp movement with external current transformer. This unit can easily be made into a Multirange Ammeter containing any or all of following: 5, 15, 30, 50, 75, 150. Simple wiring diagram furnished with meters or free on request.... COST ONLY $7.95

D. C. MICROAMMETERS

500 Microamperes, General Electric DW-40, 2" Round flush ring-clamp mounted (non-flanged) bake. case, 100 M.V., sc. calib. 0-1 Milliampere, approx. 200 ohms resistance .... @ $3.50
500 Microamperes, Simpson 6103, 2½" Round flush bakelite approx. 300 ohms resistance.... @ $3.50
500 Microamperes, General Electric DO-41, 3½" Round flush bakelite sc. calib. 0-20 Kilovolts D.C. Supplied with paper Volt-Ohm-Milliammeter sc., approx. 250 ohms resistance.. @ $5.95

D. C. MILLIAMMETERS

1 Milliamp, Westinghouse NX-35, 3½" Round fl. bakelite, (JAN type MR35WOO1DCMA) approx. 53.7 ohms resistance .... @ $7.50
2 Milliamps, Westinghouse NX-35, 3½" Round flush bakelite, (JAN MR35WOO2DCMA) @ $5.50
5-0-5 Milliamps, Western Electric, 3½" Round flush bake., concentric style movement approx. 160° deflection. sc. calibrated 50-0-50 .... @ $4.00
15 Milliamps, Simpson 26, 3½" Round flush bakelite (JAN type MR 25Wo15DCMA) .... @ $6.00
20 Milliamps, General Electric DO-53, 3" Sq. fl. bakelite .... @ $5.50
50 Milliamps, General Electric DO-41, 4½" Rd. fl. bakelite .... @ $4.85
150 Milliamps, General Electric DO-41, 3½" Rd. fl. bakelite .... @ $5.50
150 Milliamps, Gruen 508, 2½" Round flush bakelite case .... @ $3.00
200 Milliamps, Gruen GW-511, 2½" Round flush bakelite case (JAN type MR25W200DCMA) .... @ $3.95
200 Milliamps, Simpson 26, 3½" Round flush bakelite, (JAN type MR35W200DCMA) ..... @ $5.95
300 Milliamps, General Electric DO-53, 3" Sq. fl. bakelite .... @ $5.50
500 Milliamps, General Electric DW-41, 2½" Round fl. bake., black scale (Signal Corps Stock No. 1S-22) .... @ $3.95
500 Milliamps, General Electric DO-53, 3" Sq. fl. bakelite .... @ $5.50
500 Milliamps, Dejur Amsco 312, 3" Square flush bakelite .... @ $5.00
800 Milliamps, General Electric DO-41, 3½" Round fl. bake. .... @ $4.95
1000 Milliamps, Electel 350, 3½" Rd. flush bake. case (JAN MR35W100DCMA) Scale calib. 0-100 caption "DC MILLIAMPERES x 10" Mfg. by Electrical Division of U. S. Time Corp. @ $4.50
1000 Milliamp 1 Ampere. Dejur Amsco # 310, 3½" Round flush bakelite case .... @ $4.50

A. C. VOLTMETERS

15 Volts, Westinghouse NA-35, 3½" Round flush bakelite case (JAN MR35WO15ACVV).. @ $5.50
15 Volts, General Electric AO-22, 3½" Round fl. bakelite .... @ $5.50
15 Volts, General Electric AW-41, 2½" Round fl. bakelite, black sc., with markings & calib. at 0, 10, 15 only (Signal Corps Stock 1S-122) .... @ $3.00
15 Volts, General Electric AW-41, 2½" Round fl. bake., black sc., red mark at 10 volts, calib. for 800 cycle .... @ $3.00
40 Volts, Westinghouse NA-33, 2½" Round fl. metal case, black sc. lum. markings (Three were originally calib. for 400 cycle use but have been adj. for 50 cycle) .... @ $3.95
40 Volts, Westinghouse NA-33, 2½" Round fl. metal case, black sc. lum., markings, calib. for 400 cycles .... @ $3.50
75 Volts, Weston 517, 2" Rd. flush metal case ring-clamp type mtg. non-flanged .... @ $2.95
150 Volts, Hoyt Model 584, 3½" Rd. flush bakelite .... @ $5.00

D. C. VOLTMETERS

5/125 Volts, Dual Range, Weston 506, 2" Round fl. metal, ring-clamp mounted (non-flanged) approx. 135 ohms per Volt, plus button for high range .... @ $4.00
35 Volts, Simpson 125, 2½" Round fl. metal case, approx. 110 ohms per volt, made for Homelite Corp. .... @ $4.00
40 Volts, Sun 3AP598, 3½" Round fl. bake. case, 100 ohms per Volt, made for Mallory Co @ $5.95
750 Volts, General Electric DO-41, 3½" Round flush bake. 1 MA movement complete with 1000 ohms per Volt external resistor .... @ $8.95
2 Kilovolts, General Electric DO-53, 3" Square flush bakelite., 1 MA movement complete with 1000 ohms per V. precision ferrule-type multiplier .... @ $10.95
3 Kilovolts, General Electric DO-53, 3" Square fl. bake. 1 MA movement, complete with 1000 ohms per V. precision ferrule-type multipliers.. @ $13.50
20 Kilovolts, General Electric DO-41, 3½" Rd. fl. bake., 1 MA with multiplier .... @ $27.95

D. C. AMMETERS

1 Amp, Westinghouse NX-35, 3½" Rd. flush bakelite case (Jan type MR 34WOO1DCAA) @ $6.00
1.5 Amp, Gen Elec DO-53, 3" Sq. fl. bake.. @ $5.95
15 Amps, Triplett 0321-T, 3½" Rd. flush bakelite case .... @ $4.50
30-0-30 Amps, General Electric DW-51, 2½" Rd. flush metal .... @ $3.50
50-0-50 Amperes, Weston 301, 3½" Rd. flush bakelite .... @ $6.50

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All 115 V, 60 Cy. unless otherwise listed.

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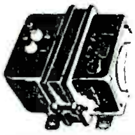

STANCOR P-4086 FILAMENT TRANSFORMER Secondary 5 Volts C.T. 14 amps. Cased Heavy duty. 10 KV, Insulation $4.95
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UTC LS-184 POWER TRANSFORMER, 7000-6000-5000, CT at 500 MA 110 or 220 Primary $69.50
UTC LS-191 POWER TRANSFORMER, 650-500 at 125 MA. 3 filament windings, tapped primary.. $5.95
UTC LS-73 POWER TRANSFORMER 1000-800 CT at 500 MA. 140 CT at 50 MA. 5 filament windings. Tapped primary $12.95
THORDARSON T21F20 FILAMENT TRANSFORMER. Primary 115 V., 60 cycles. Secondary 5 V. center tapped. 15 amps. 10,000 V. Insulation $3.95

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THORARDSON T17R32 Primary 115 v., 60 cycles. Secondary 2300 v., 2½ v., 2½ v., Shielded $3.95	HERCULES 115 V. 60 cycles primary 1800 V.. Secondary 6.3. 2.5, 2.5 Shielded $3.95

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Built for Government Laboratory use. All hermetically sealed with glass terminals.

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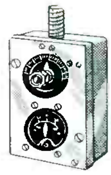

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Ideal for airplanes, boats, autos, home den decoration. Illuminated with 12 or 24 V bulb, but can be changed to cheap 6 V auto bulb without modification. Accurate floating-in-alcohol dial reads directly from the front showing direction being headed into. A wonderful buy at this low, low price!

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See Oct. QST for construction article. Brand new .... $3.95 ea.

THORDARSON SWINGING CHOKE
T-19-C-38 5-20H, 500 ma. Brand new, original wood box $8.95

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TS-47/APR
TS-59/APN
TS-61/AP
TS-62/AP
TS-74/UPM
TS-89
TS-92/AP
TS-100/AP
TS-118/AP
TS-126/AP
TS-131/AP
TS-143/CPM-1
TS-164/AR
TS-170/ARN-5
TS-175
TS-189
TS-192/CPM-4
TS-204
TS-233/TPN-2
TS-278/AP
IE-19 Test Set
IE-46B

I-72-J Signal Generator
78-D Signal Generator
I-83-F Test Set Dynamotor
I-84-A Test Set Dynamotor
I-85-B
I-95-A
I-100
I-104A
I-122-B Signal Generator
I-126 Signal Generator
I-145 Signal Generator
I-151A Signal Generator
I-196 Test Oscillators
I-222 Signal Generators
5" Oscilloscopes—General Electric
AN/CRM-3 Test Set or BC-733D
BC-376 Marker Beacon Trans.
BC-221 Freq. Meters
Bc-67
Bc-753 Course Director Test Set
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Also: Dynamotors, Converters, Invertors; Magnetrons; Klystrons, Special Purpose Tubes; ½-million insulators, all types; Microwave and test equipment.

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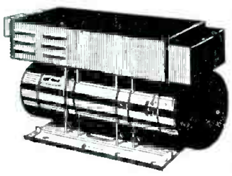
SURPLUS EQUIPMENT

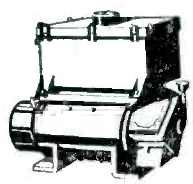
INVERTER UNIT PE 218



Output: 115 VAC; Single phase; PF .90; 380/500 cycle; 1500 V.A. Input: 25-28 VDC; 92 amps; 8000 rpm; Exc. volts 27.5; Leland Electric mfg.

BRAND NEW **$29.95**

ONAN MOTOR GENERATOR SET MG 075-G-1



Generator 115 VAC; 480 cycle; 5.3 Amps; .6KW; PF 1.0; Also 26 VDC; 100 watt; 3.8 Amps; Driven by 115-230 VAC - 2hp motor; 60 cycle; single phase; 3450 rpm; 10.5 amps.

BRAND NEW

$195.00

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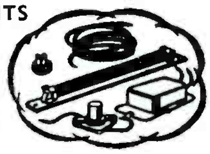
Ultra-Violet Fluorescence



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

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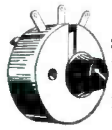

Standard Brands 5 ohms, 100 watt, 4.48 amps

BRAND NEW . . **$1.95 ea.**

Specially Priced . . . $20.00/dozen

G. E. INDUCTION VOLTAGE REGULATOR

Motor Driven (No. 7232100)

Type AIRT; 60 cycle; Form M; Indoor service 55° C. rise; KVA 1.73; Cont. Duty; Primary Volt 115; Load Amp. 10.5; % Raise 82.6— % Lower 82.6; Approx wt. 140 lbs. Original cost more than $600.

BRAND NEW $179.00

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AY 1; 26 Volts; 400 Cycle . . . . $4.95 Each
AY 5; 26 Volts; 400 Cycle (Has hollow shaft) . . . . $5.95 Each

SMALL 400 CYCLE MOTORS

1 P.H..; 115 Volt; 1.1 Amp.; 5500 RPM; H.P. .03; Torque in oz. 6; Requires 2 MFD capacitor; Motor size 2¼" x 1½".

LIKE NEW . . . . . . $3.95 Each

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Single exhaust with squirrel-cage type fan. Intake 2½"; Outlet 2". Delivers approx. 55 cu. ft./min. 115V-AC (60 Cycle) DELCO motor. Simple to install for any use. Govt. cost more than $20.00.

NEW $9.95

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For fast, solderless terminal connections. A combination cutter, wire gauge and connecting tool for servicemen, electricians, electronic technicians and others who must have permanent, trouble-free connections.

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SCR 545A Search and Track. Complete trailer, power supply and spare parts. Nearly new. Write for description and price.

PORTABLE PUMP ASSEMBLY
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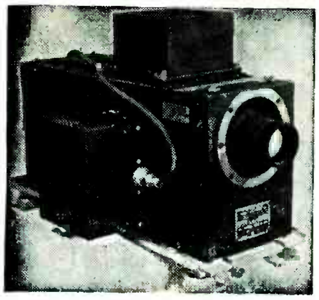

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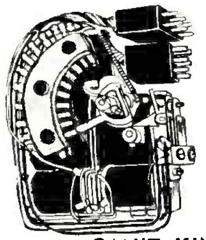

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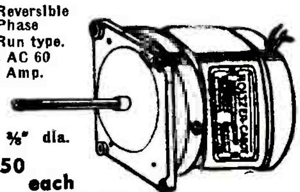

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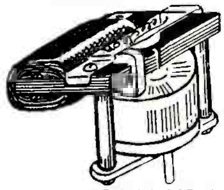

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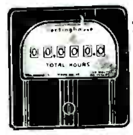

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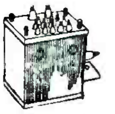

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3x8 4.49
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1000wvdc
.1 .73
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1 .99
2 1.69
4 2.29
5 2.98
10 3.98
15 4.98
1400wvdc
.25 1.29
.5 1.39
1500wvdc
.5 1.59
.75 1.69
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.25 2.29
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.5 2.98
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PUSH-PULL POWER

with REDUCED CAPACITANCES

ACTUAL SIZE

250 mc. 85 watts output
300 mc. 70 watts output
430 mc. 32 watts output

NEW!

AMPEREX AX-9903/5894

UHF and VHF Twin Tetrode for W-I-D-E Band Operation

RF Amplifier, Modulator, Frequency Doubler, Tripler

AX-9903/5894 CHARACTERISTICS

Filament Voltage		
Series	12.6 v.	
Parallel	6.3 v.	
Filament Current		
Series	0.9 a.	
Parallel	1.8 a.	
Maximum		
d.c. Plate Voltage	600	
d.c. Grid #2 Voltage	250	
d.c. Grid #1 Voltage	−175	
Plate Dissipation (w.)	2 x 20	
d.c. Plate Current (ma.)	2 x 100	
		COMPARE CAPACITANCES of this tube with its nearest equivalent type.
Grid to Plate	< 0.08 mmfd.	< 0.12 mmfd.
Input	6.7 mmfd.	14.5 mmfd.
Output	2.1 mmfd.	7.0 mmfd.

MOUNTING POSITION: Base up or down. Horizontal with anode leads in horizontal plane.

Fits 829B Type Socket.

● The AMPEREX AX-9903/5894 is an improved version of the 829B. The design of this tube incorporates features which produce considerably smaller output capacitances and which, therefore, result in higher resonant frequencies (approximately 500 mc. instead of 250 mc.). In addition, because of the low inductances of the connections between the cathode and screen-grid, more stable operation at high frequencies is effected.

● A most desirable design characteristic, also, is the incorporation of internal neutralizing condensers which are connected directly to the control-grids, making impossible self-oscillation in a tuned-plate, tuned-grid transmitter.

● Of importance in this new design are such features as:

1. Direct and short connection between the pins and the anode, causing lower inductance and resistance.
2. No insulating parts (mica or ceramics) between anodes, resulting in lower losses at high frequencies.
3. "Screened" micas, thereby preventing possible losses due to contaminated mica.
4. Zirconium-coated moly anodes, giving a higher degree of vacuum than possible with nickel anodes and barium getters.

● For the full story on how to use the AMPEREX AX-9903/5894 in your particular application, write to Application Engineering, Department N. Or if you prefer, ask for an AMPEREX representative to call.

● IMMEDIATE DELIVERY* Order from your local electronics parts distributor. If unavailable, write direct to our plant.

*Subject to prior sale

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re-tube with AMPEREX