JANUARY · 1951

# electronics

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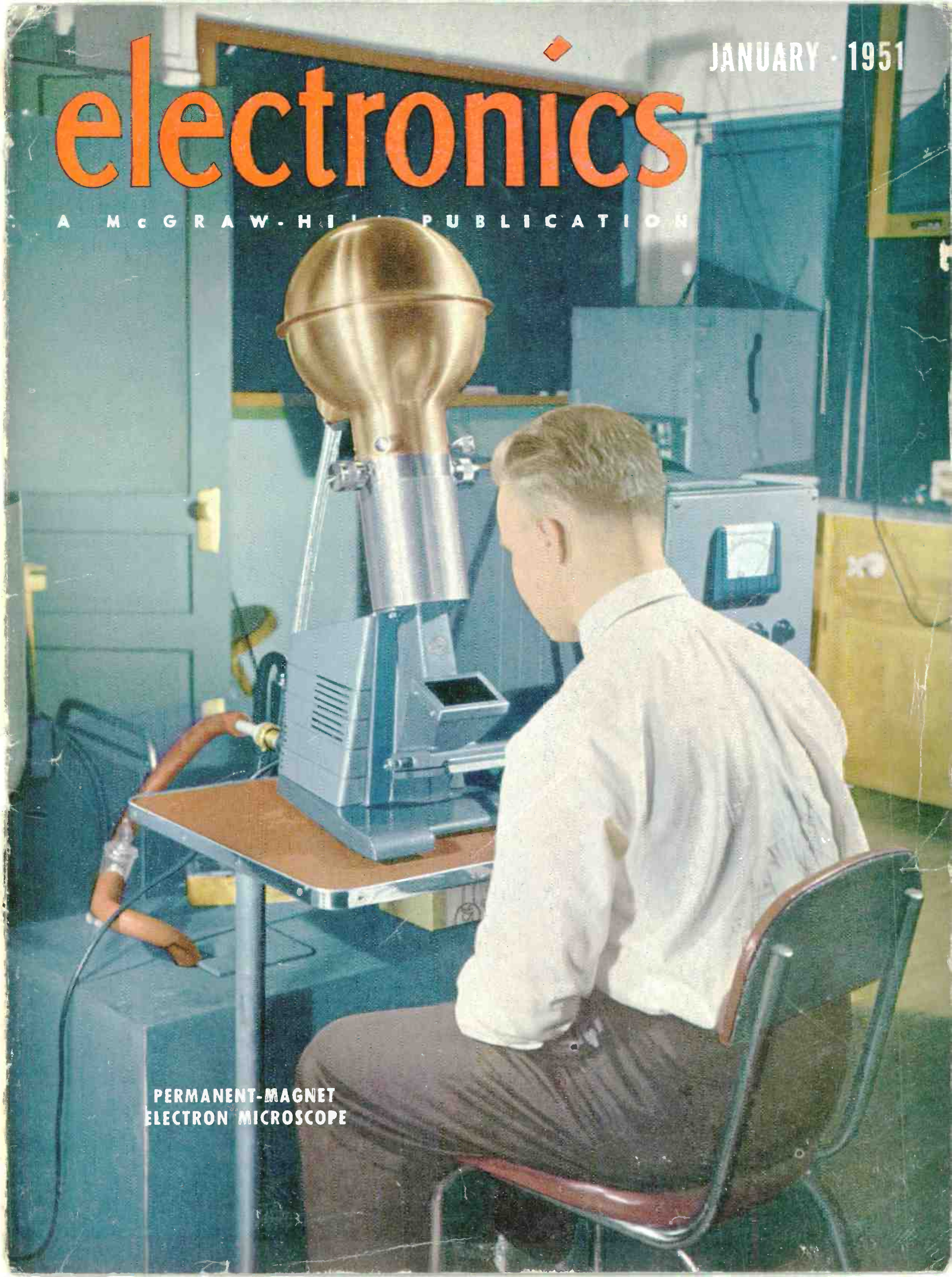
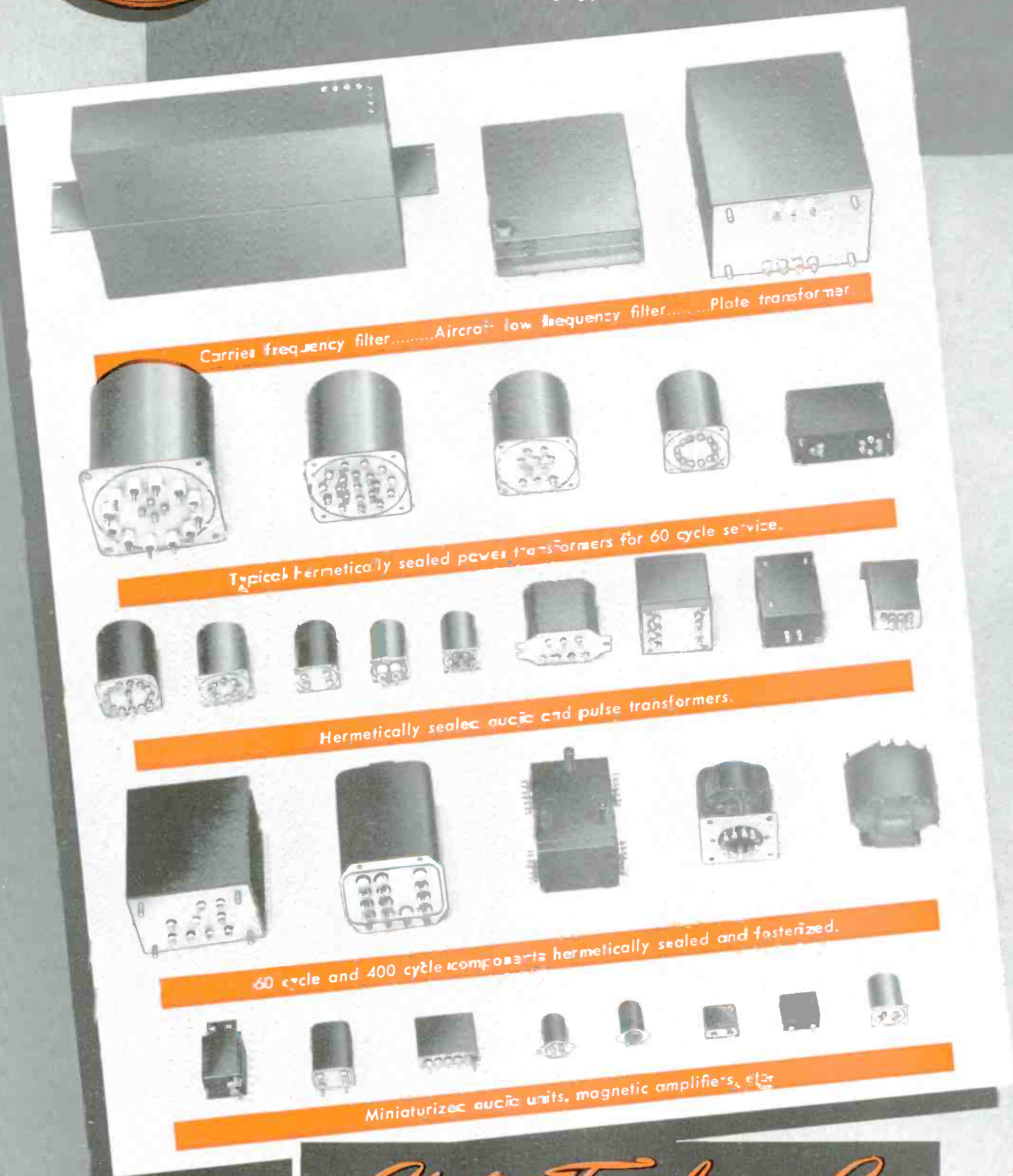


PERMANENT-MAGNET
ELECTRON MICROSCOPE

# for Military Components

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





*United Transformer Co.*

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# electronics

A McGRAW - HILL PUBLICATION

## JANUARY • 1951





January, 1951 — ELECTRONICS — Vol. 24, No. 1

Member ABC and ABP

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# Let MARION help you . . .

## . . . seal components *hermetically*
## . . . speed up sub-assemblies

**Marion portable, bench-type induction soldering unit . . . .**

- SMALL
- COMPACT
- ADAPTABLE
- EFFICIENT
- ECONOMICAL
- EASY-TO-USE

**A PRODUCTION TOOL** This unit was designed to simplify and improve both the quality and quantity of production of many different assemblies in the electronic and electrical fields. It has been used successfully for many years in the manufacture of Marion hermetically sealed instruments. Assembly applications include magnet assemblies, relay armatures, connectors, capacitors and transformer cans and germanium diode assemblies; also jewelry, watches, toys, automotive parts, household fixtures, etc.

**HERMETICALLY SEALED COMPONENTS** Because of the present intense interest in hermetically sealed components, Marion offers the benefit of its experience in true glass-to-metal hermetic sealing with the Marion Induction Soldering Unit and Marion metalized (platinum film) glass. Marion platinum film base glass has been developed to permit higher sealing temperatures, greater thermal shock range and resoldering if necessary.

**PROFIT FROM EXPERIENCE** Investigate now. Submit your requirements. We will be glad to supply samples and quotations. Ask for bulletin. Marion Electrical Instrument Company, 401 Canal Street, Manchester, New Hampshire.

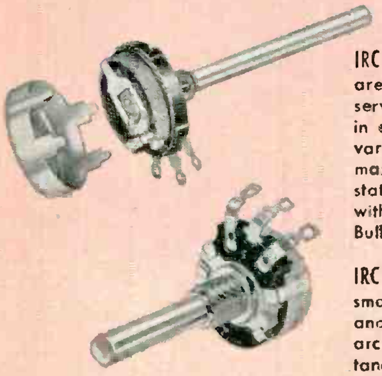

MANUFACTURERS OF MARION RUGGEDIZED INSTRUMENTS

**marion meters**

# A complete line *for resistors too!*

Unusual *combinations of characteristics* required in today's critical electronic circuits demand a complete range of resistor types. Specializing in resistors, IRC makes the widest line in the industry. This means ease of procurement—a single dependable source of supply for *all* your resistance needs. It also means unbiased recommendations—no substitution of units "just as good". IRC's complete line of products; complete research and testing facilities; complete network of licensees for emergency production—all add up to complete satisfaction for you.

## CONTROLS



**IRC Type W Wire Wound Controls** are designed for long, dependable service and balanced performance in every characteristic. These 2-watt variable wire wound units provide maximum adaptability to most rheostat and potentiometer applications within their power rating. Catalog Bulletin A-2.

**IRC New Type Q Controls** feature small 15/16" size, rugged construction and superior performance. Increased arc of rotation permits same resistance ratios successful in larger IRC Controls. Catalog Bulletin A-4.

## PRECISION RESISTORS


**IRC Precision Wire Wounds** offer a fine balance of accuracy and dependability for close-tolerance applications. Extensively used by leading instrument makers, they excel in every significant characteristic. Catalog Bulletin D-1.

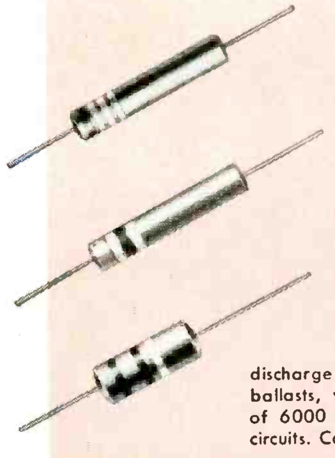
**IRC Deposited Carbon PRECISTORS** combine accuracy and economy for close-tolerance applications, where carbon compositions are unsuitable and wire-wound precisions too expensive. Catalog Bulletin B-4.

**IRC Matched Pairs** provide a dependable low-cost solution to close-tolerance requirements. Both Type BT and BW Resistors are available in matched pairs. Catalog Bulletin B-3.

**IRC Sealed Precision Voltmeter Multipliers** are suitable and dependable for use under the most severe humidity conditions. Each consists of several IRC Precisions mounted and interconnected, encased in a glazed ceramic tube. Catalog Bulletin D-2.

# is essential

## INSULATED COMPOSITION and WIRE WOUND RESISTORS

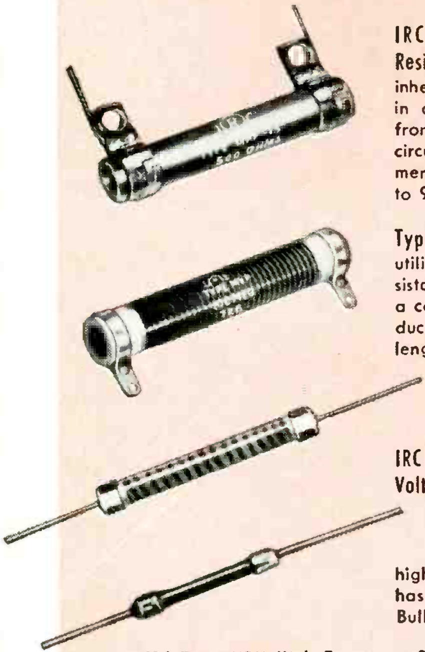


**IRC Advanced Type BT Resistors** meet and beat JAN-R-11 Specifications at ⅓, ½, 1 and 2 watts—combine extremely low operating temperature with excellent power dissipation. Catalog Bulletin B-1.

**IRC Type BW Wire Wound Resistors** are exceptionally stable, inexpensive units for low range requirements. Have excellent performance records in TV circuits, meters, analyzers, etc. Catalog Bulletin B-5.

**IRC Type BTAV High Voltage Resistors,** developed for use as discharge resistors in fluorescent "Quick Start" ballasts, withstand momentary peak surge of 6000 volts. Also suited to TV bleeder circuits. Catalog Bulletin B-1.

## HIGH FREQUENCY and HIGH POWER RESISTORS



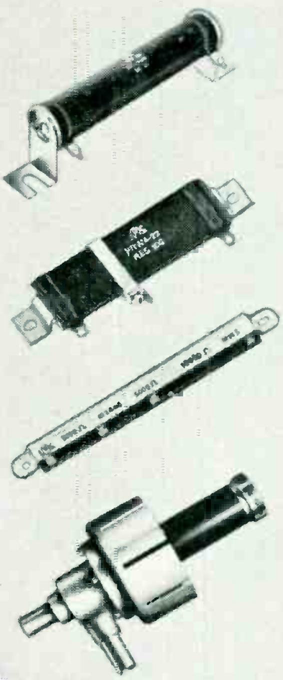
**IRC Type MP High Frequency Resistors** afford stability with low inherent inductance and capacity in circuits involving steep wave fronts, high frequency measuring circuits and radar pulse equipment. Available in sizes from ¼ to 90 watts. Catalog Bulletin F-1.

**Type MV High Voltage Resistors** utilize IRC's famous filament resistance coating in helical turns on a ceramic tube to provide a conducting path of long, effective length. Result: Exceptional stability even in very high resistance values. Catalog Bulletin G-1.

**IRC Type MVX High Ohmic, High Voltage Resistors** meet requirements for a small high range unit with axial leads. Engineered for high voltage applications, MVX has exceptional stability. Catalog Bulletin G-2.

**IRC Type MPM High Frequency Resistors** are miniature units suitable for high frequency receiver and similar applications. Stable resistors with low inherent inductance and capacity. Body only ⅜" long. Catalog Bulletin F-1.

## POWER RESISTORS



**IRC Fixed and Adjustable Power Wire Wounds** give balanced performance in every characteristic—are available in a full range of sizes, types and terminals for exacting, heavy-duty applications. Catalog Bulletin C-2.

**IRC Type FRW Flat Wire Wound Resistors** fulfill requirements of high wattage dissipation in limited space—may be mounted vertically or horizontally, singly or in stacks. Catalog Bulletin C-1.

**IRC Type MW Wire Wound Resistors** offer low initial cost, lower mounting cost, flexibility in providing taps, and saving in space. Completely insulated against moisture. Catalog Bulletin B-2.

**IRC Type LP Water-Cooled Resistors** for TV, FM and Dielectric Heating Applications. Cooled internally by high velocity stream of water; adjustable to local water pressure and power dissipation up to 5 K.W.A.C. Catalog Bulletin F-2.

*Wherever the Circuit Says* -ᴧᴧᴧ-

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- ☐ Bulletin A-2 (W)
- ☐ Bulletin A-4 (Q)
- ☐ Bulletin B-1 (BT)
- ☐ Bulletin B-1 (BTAV)
- ☐ Bulletin B-2 (MW)
- ☐ Bulletin B-3 (M/P)
- ☐ Bulletin B-4 (DC)
- ☐ Bulletin B-5 (BW)
- ☐ Bulletin C-1 (FRW)
- ☐ Bulletin C-2 (PWW)
- ☐ Bulletin D-1 (WW)
- ☐ Bulletin D-2 (MF)
- ☐ Bulletin F-1 (MP)
- ☐ Bulletin F-1 (MPM)
- ☐ Bulletin F-2 (LP)
- ☐ Bulletin G-1 (MV)
- ☐ Bulletin G-2 (MVX)

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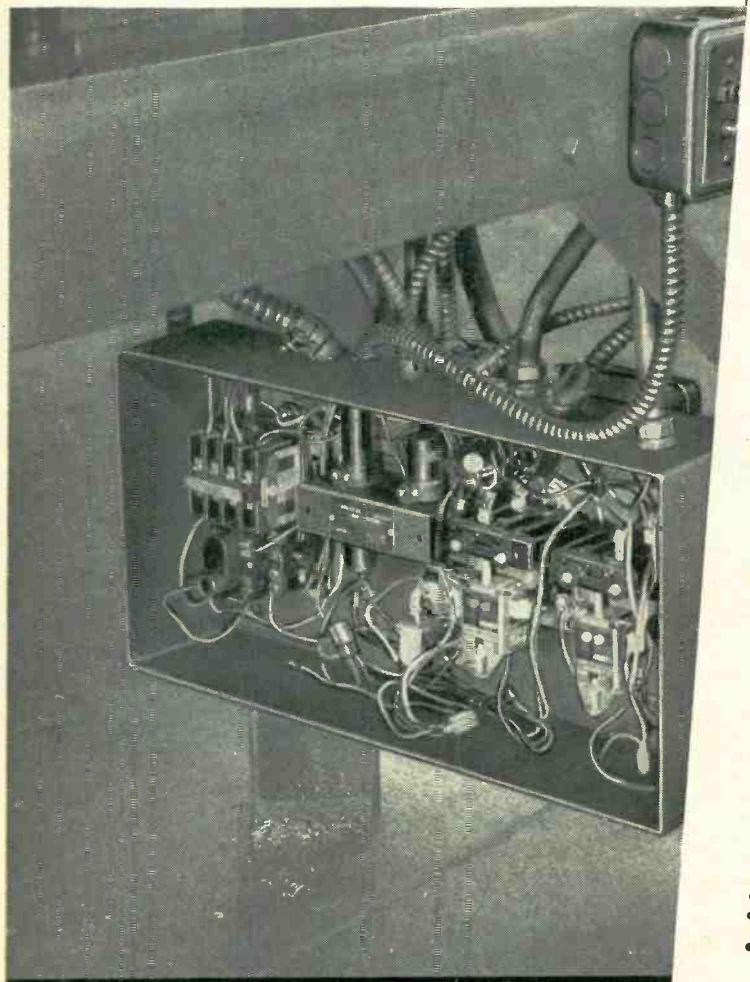

**THE ADLAKE RELAY** in this facing machine control box at the Northern Indiana Brass Co. was installed October 18, 1948. Prior to its installation, the machine had been subject to frequent expensive breakdowns. Yet since it was installed, *the relay has operated continuously 7½ million times with no maintenance whatever—and the machine has had no breakdowns!*

**ADLAKE RELAYS** are designed and built to meet the most exacting needs of industry. Their mercury-to-mercury contact prevents burning, pitting and sticking, and their sturdy construction armors them against outside vibration or impact. And most important of all, *they require no maintenance*, for they are hermetically sealed against dust, dirt and moisture.

**For the full story** on the part ADLAKE Relays can play in *your* business, just drop a card to The Adams & Westlake Company, 1107 N. Michigan, Elkhart, Indiana. No obligation, of course.

**ADLAKE Mercury Relays Bring These Advantages to Every Installation:**

- HERMETICALLY SEALED—dust, dirt, moisture oxidation and temperature changes can't interfere with operation.
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- ABSOLUTELY SAFE
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Established 1857 • ELKHART, INDIANA • New York • Chicago
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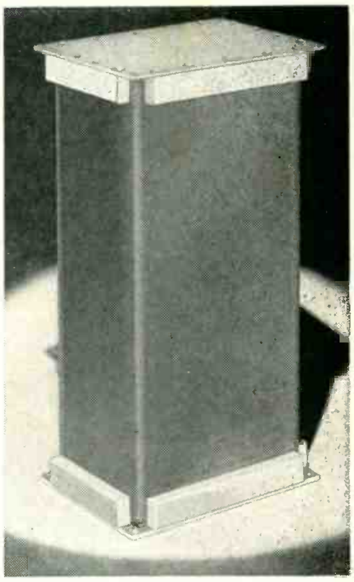
Hermetically Sealed Mercury Relays for Timing, Load and Control Circuits

No. 10 of a Series

# Another Engineer's Problem Solved*



## SUBJECT: X-Ray Power Supply Capacitors

## PROBLEM: To reduce the volume and cost of 50 KV to 200 KV capacitors

## SOLUTION:

We were asked to produce an X-ray capacitor "as small as possible" because our Plasticon Type AO capacitors are known to occupy considerably less volume than paper capacitors. We decided that the conventional cylindrical capacitor could be improved upon by using a rectangular bakelite tube. Our reason was as follows: in this type of high voltage capacitor, the individual series capacitor elements are at right angles to the long axis of the tube. Since the elements are more or less rectangular in shape, in a round tube, only a square cross-section is used. Only 63% of the internal volume is occupied by the elements.

Instead of gasket sealing the round tube by spinning an aluminum cap down on the external thread in the bakelite, aluminum bar stock is bolted to the side walls and pressure is applied to the gasket surface by a plate held by screws in blind tapped holes in the bar stock. This eliminates special machined castings.

A typical example of the volume saved is as follows: a .04 mfd, 75 KV paper capacitor measures $11\frac{1}{2}$ inches in diameter and is 16 inches high. A Type AOB Plasticon rectangular capacitor is the same length, but has a base of only $8\frac{1}{8}''$ by $6''$. Thus, our capacitor utilizes only 37% of the base area required by the paper capacitor. The cost is also less.

*What is YOUR engineering problem?*
*Your inquiries will receive immediate attention.*

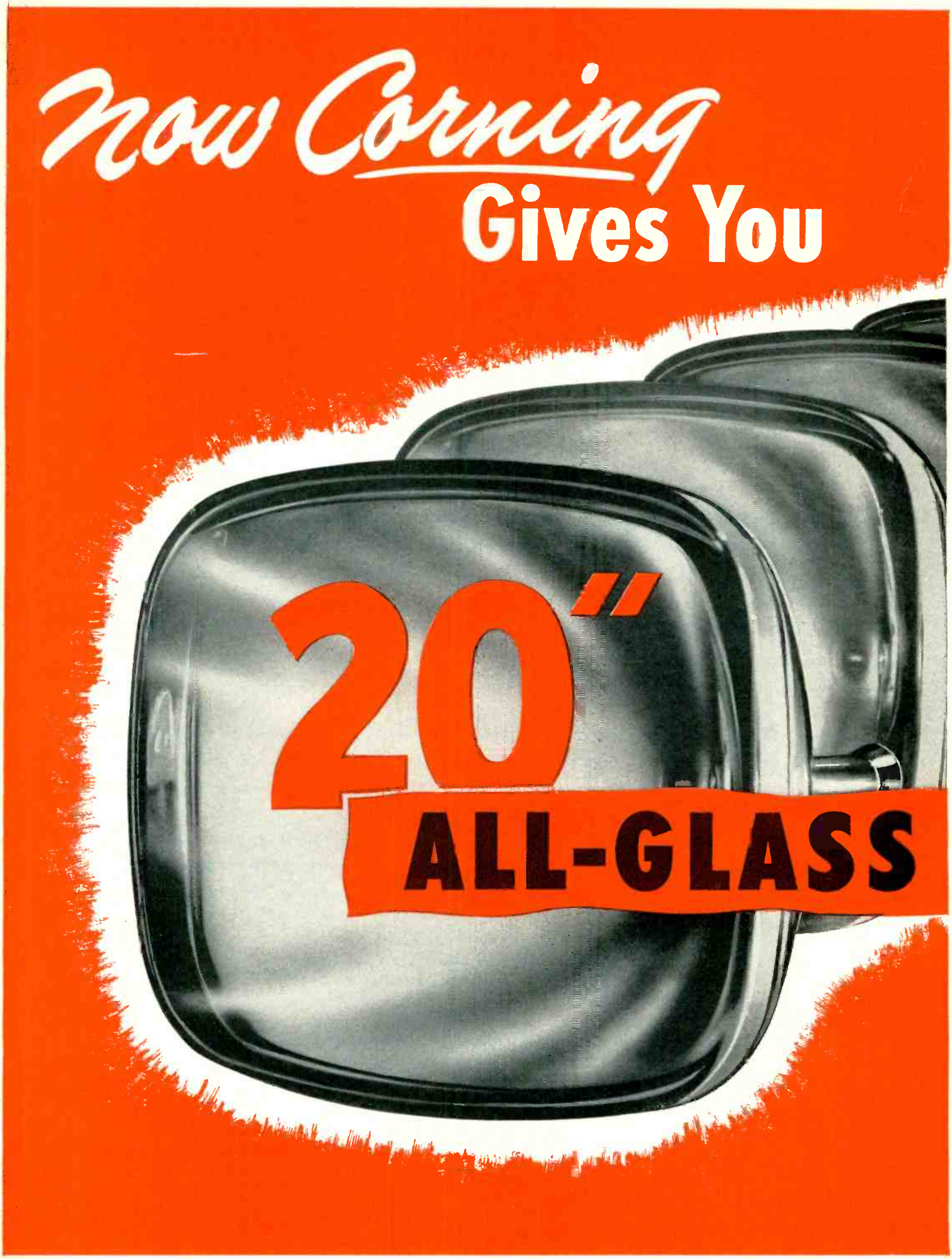
---

**We manufacture a standard line of Plasticon Capacitors, Pulse Forming Networks and High Voltage Power Supplies.**

***Write for our latest catalog.***

# Condenser Products Company

1375 NORTH BRANCH STREET • CHICAGO 22, ILLINOIS


Now Corning
Gives You
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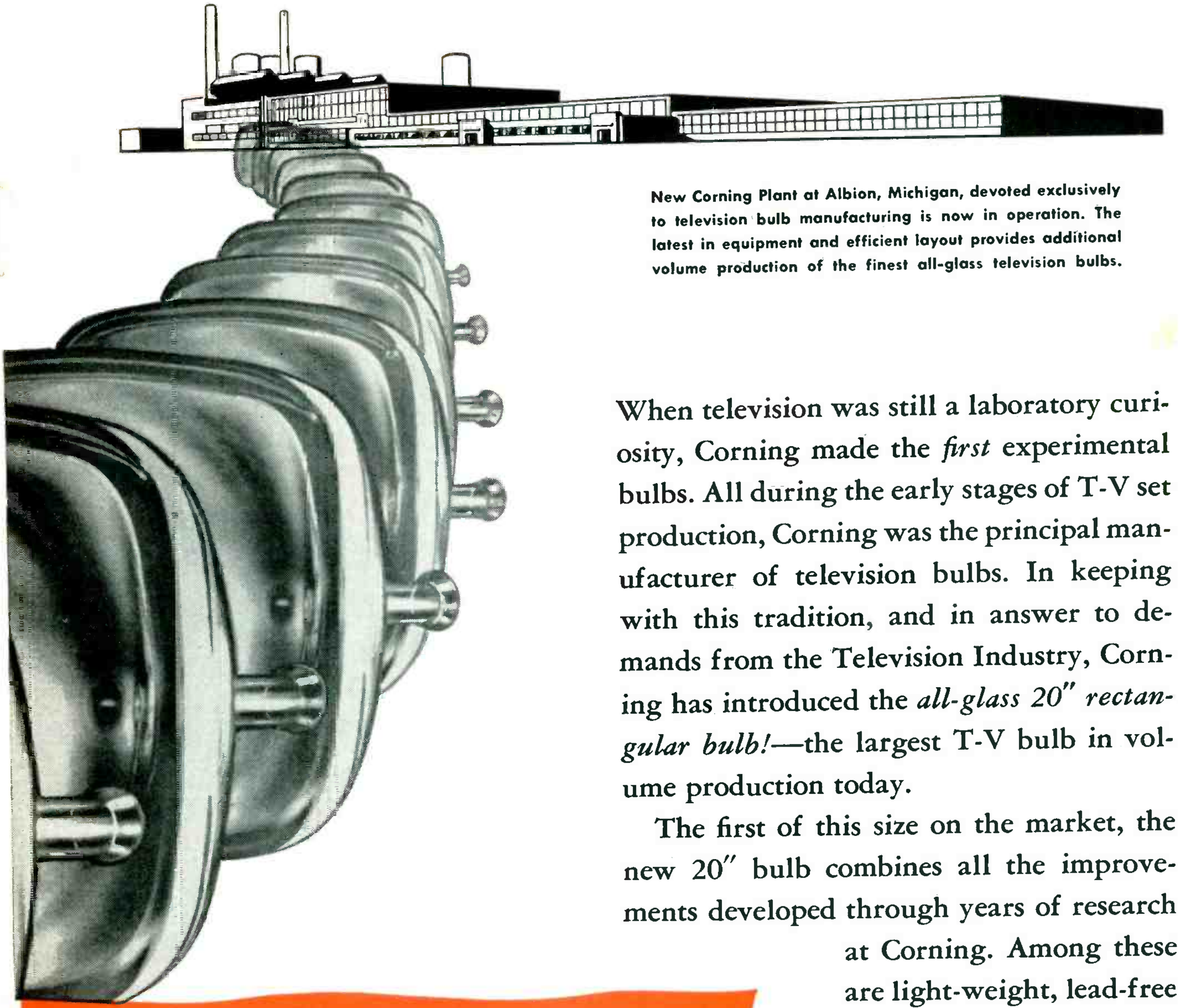

New Corning Plant at Albion, Michigan, devoted exclusively to television bulb manufacturing is now in operation. The latest in equipment and efficient layout provides additional volume production of the finest all-glass television bulbs.

# television bulbs

When television was still a laboratory curiosity, Corning made the *first* experimental bulbs. All during the early stages of T-V 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 T-V 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 from improved glass melting and forming techniques. The new Corning 20″ all-glass bulb is the last word in quality, durability and size.

PYREX T. M. REG. U.S. PAT. OFF.

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

*Corning means research in Glass*

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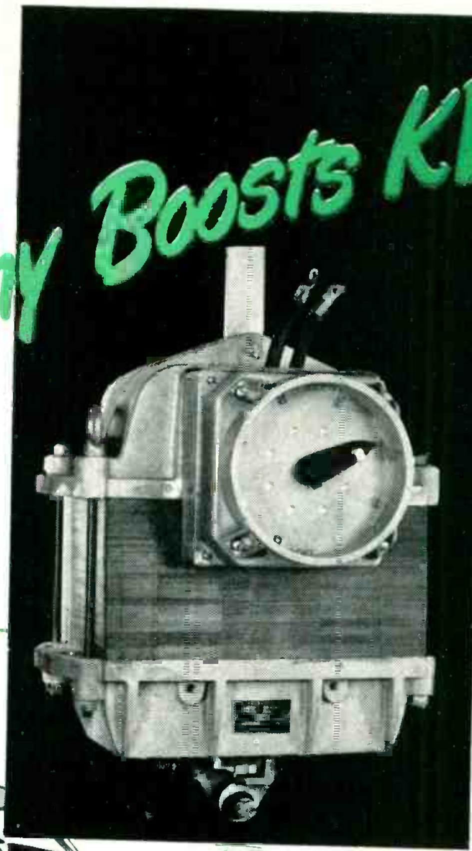
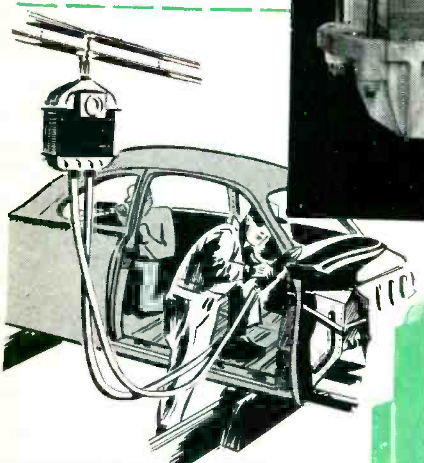
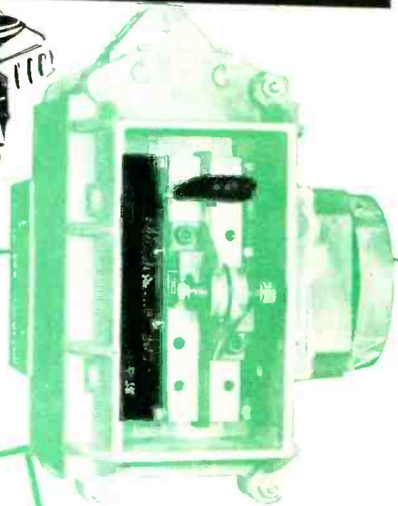
# McCarthy Boosts KVA Rating 30%

## with NATVAR VARNISHED FIBERGLAS







This McCarthy Type 525-PG welding transformer is compact and weighs only 458 pounds, yet it is rated 75KVA, 220 or 440 primary volts (not interchangeable), 60 cycle, 1 phase, 108°C temperature rise, at 50% duty cycle. An extra heavy heat selector switch gives secondary voltages in eight steps from 5.00 to 9.16, parallel connection, or 10.0 to 18.32, series connection.

Primary coils are insulated between turns with Natvar varnished Fiberglas tape, dipped and baked. The wound coil is then insulated with mica and Natvar varnished Fiberglas tape, again dipped and baked, and finished with air drying varnish. Secondary coils are heavy wall square copper tubes through which cooling water circulates. Leads are insulated and protected with Natvar 400 heat resistant extruded vinyl tubing.

McCARTHY ELECTRIC CO., Detroit, manufactures welding transformers used extensively on production lines in the automotive industry for welding bodies and various fabricated parts, and in the refrigerator industry for welding boxes. Since it is more practical to weld large assemblies with guns rather than on stationary machines, portability is important. Size and weight of the transformer must therefore be kept at a minimum. And because many of these units are in continuous service 24 hours a day, long life is important, too.

By designing and building these transformers for higher continuous operating temperatures, McCarthy has succeeded in raising capacity 30% without increasing the size or weight. McCarthy has standardized on Natvar varnished Fiberglas and Natvar 400 Extruded Vinyl Tubing because of their uniformly high resistance to heat, and because both have exceptional aging characteristics, which means longer life.

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

Natvar

**Natvar Products**

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- Slot insulation
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- Extruded vinyl identification markers

Ask for Catalog No. 21

**THE NATIONAL VARNISHED PRODUCTS Corporation**

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# ADVENTURES IN ELECTRONIC DESIGN

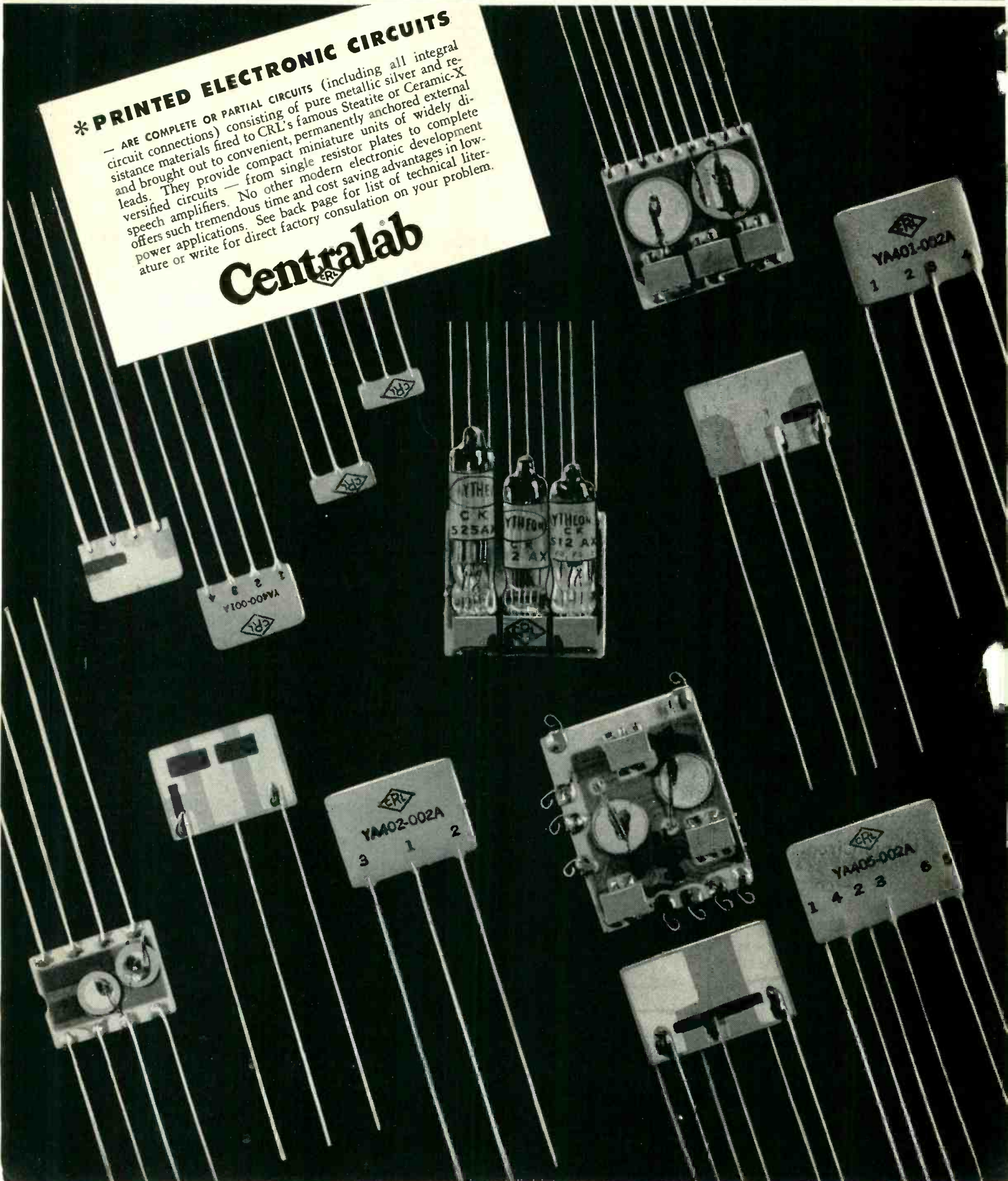
## Centralab's Printed Electronic Circuits May Solve a Problem for You

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

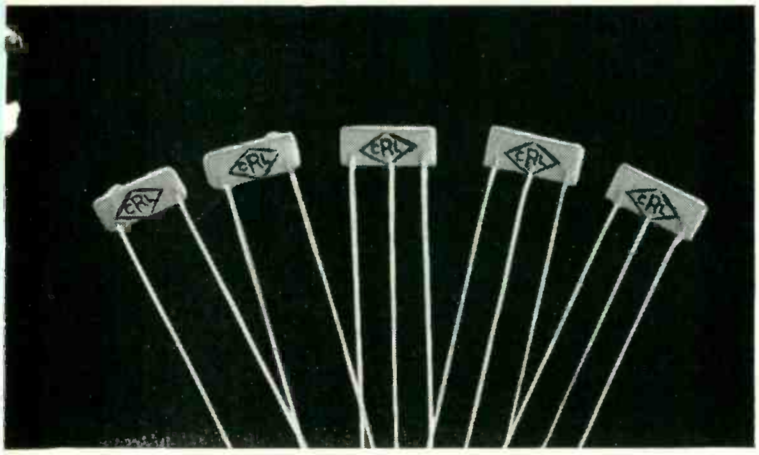
**Centralab** ® — **DEVELOPMENTS THAT CAN HELP YOU** ➡

*Division of* **GLOBE-UNION INC., Milwaukee**

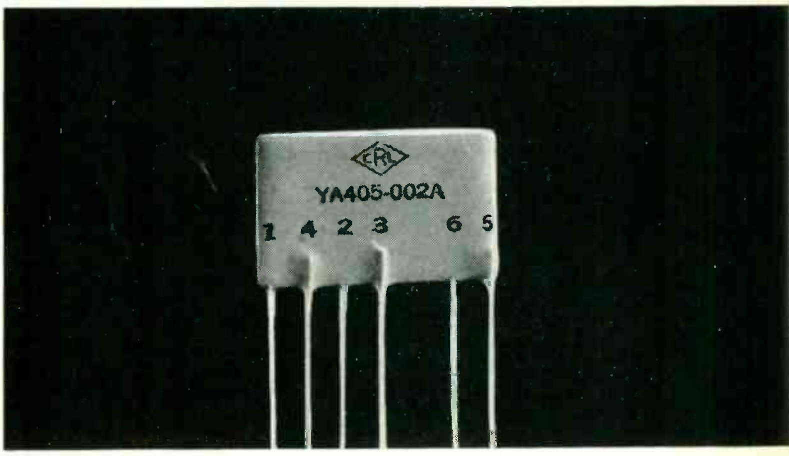
# SPEED PRODUCTION...
# Use P.E.C.'s *...



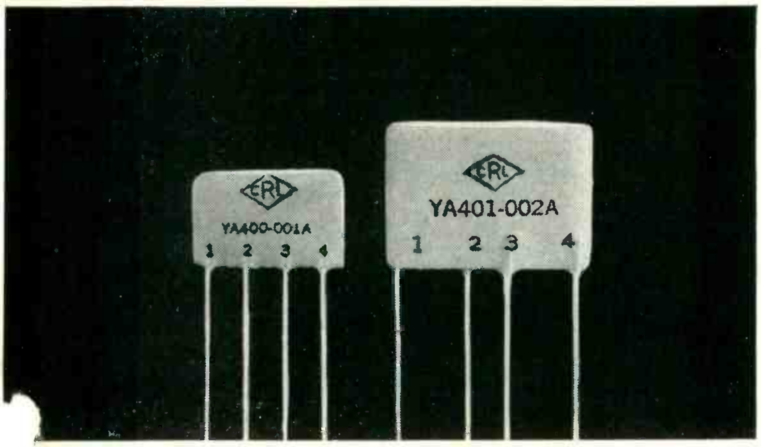
# CUT ASSEMBLY COSTS
## Conserve Resistors



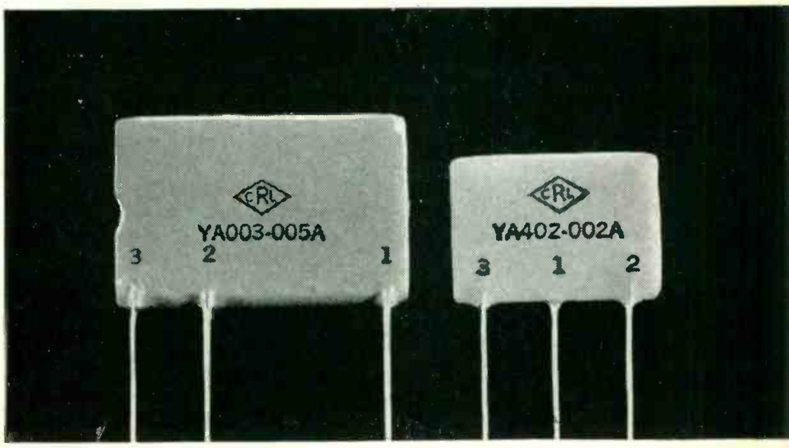
Actual size photo of plate capacitor, resistor, and resistor-capacitor units. Because of size and ease of installation, they easily fit miniature and portable electronic equipment — overcome crowded conditions in TV, AM, FM, and record-player chasses. For complete data, check coupon No. 42-24 — Ceramic Plate Components.



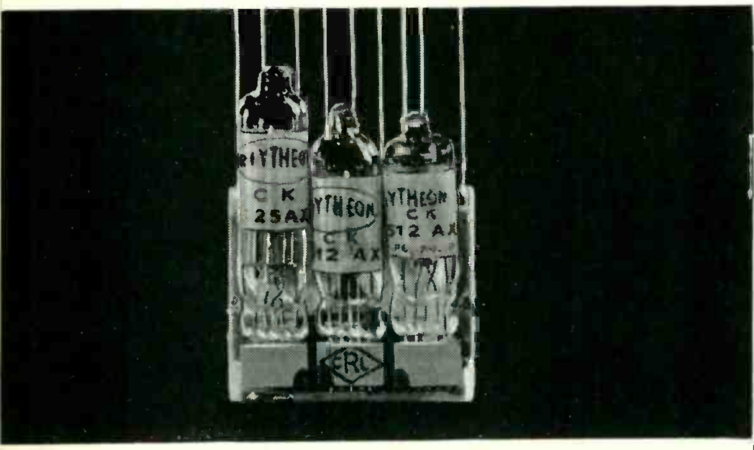

Pentode couplates are complete interstage coupling circuits consisting of 3 capacitors and 3 resistors on a small 6 lead ceramic plate. Compared with old-style audio circuits, they reduce soldered connections 50% — wiring errors accordingly. Big saving in space and weight. For complete data, check coupon No. 999—Pentode Couplate.




Centralab Triode Couplates save space and weight, replacing 5 components normally used in audio circuits. They consist of 3 capacitors and 2 resistors bonded to a dielectric ceramic plate. Available in variety of resistor and capacitor values. For complete data, check coupon No. 42-6 — Couplate, and No. 42-27 — Model 2 Couplate.




Centralab Vertical Integrators give you big savings in assembly costs in TV vertical integrator networks. One type consists of 4 resistors and 4 capacitors brought out to 3 leads . . . reducing formerly required 16 soldered connections to 3! There're less parts handled, too! For complete data, check coupon No. 42-22—Vertical Integrator.




Ampec is a full 3-stage, 3-tube speech amplifier with amazingly efficient, reliable performance. Size 1¼" x 1⅛" x .340" over tube sockets! Used in hearing aids, mike preamps and similar applications where small size and outstanding performance counts. For complete data, check coupon No. 973 — Ampec.

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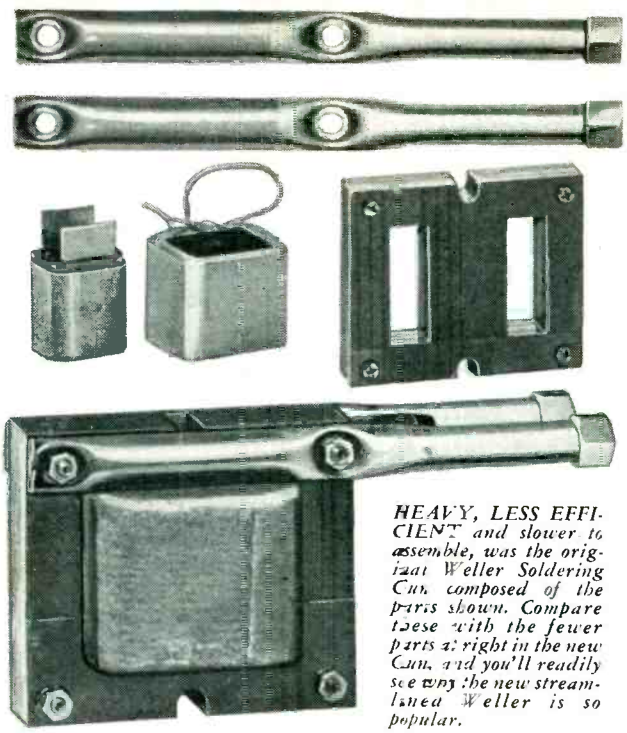
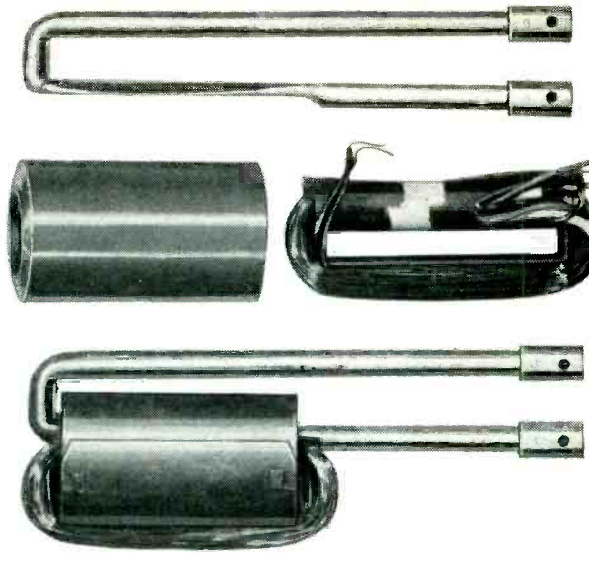


*HEAVY, LESS EFFICIENT and slower to assemble, was the original Weller Soldering Gun composed of the parts shown. Compare these with the fewer parts at right in the new Gun, and you'll readily see why the new streamlined Weller is so popular.*



*THE NEW WELLER SOLDERING GUN handles 250 watts; heats, ready for use, in five seconds; has longer range to get into the tight spots, and is equipped with spot light. Uses current only when trigger is operated. It is assembled faster. Requires no bolts or nuts. The 3/8" Revere Copper Rod that replaces the secondary coil in the transformer is sheared, flattened, and bent at right angles in a 200-ton press in a single operation.*


**COPPER TREATS YOUR PRODUCT BETTER WHEN YOU**

# Control Your Temper

*Revere Copper Rod replaces Secondary Coil in Soldering Gun Transformer . . . reduces number of parts, makes for a speedier, more efficient assembly . . . also makes possible a lighter, more compact unit of increased capacity.*

WHEN the Weller Manufacturing Company, Easton, Pa., was completing the development of its new electric soldering gun, they were confronted with this problem: The 3/8" Revere Copper Rod used to replace the secondary coil in the transformer had to maintain its rigidity yet be sufficiently soft so that during the shearing, coining, and bending operations there would be no breaking or splitting of the rod.

Revere's Technical Advisory Service recommended a certain temper copper rod. It was discovered that Weller was getting a twist in the rod when it was installed in the assembled gun. Other tempers were tried and tested. Then a copper rod of a slightly harder temper than the first was recommended. That was it! Proper temper was the key. Proper temper was also the key to the .291 dia. copper rod used for the Soldering tip itself. For this, too, had to retain its rigidity and yet remain soft enough to be coined, punched, and formed without fracture.

"In addition to being extremely helpful in arriving at the proper tempers, Revere also recommended that we specify our rod in multiple lengths, and thus save considerably on scrap. They were also helpful in solving the problem of attaching the brass sleeve to the secondary rod in our Soldering Gun," the Weller Manufacturing Company tells us.

So you see, Revere's interest in your problem does not stop with the recommendation of its products. Perhaps Revere can help you. Why not take your current problem to the nearest Revere Sales Office and see?

**REVERE**

**COPPER AND BRASS INCORPORATED**

*Founded by Paul Revere in 1801*
230 Park Avenue, New York 17, New York

• • •

*Mills: Baltimore, Md.; Chicago, Ill.; Detroit, Mich.; Los Angeles and Riverside, Calif.; New Bedford, Mass.; Rome, N. Y.*
*Sales Offices in Principal Cities, Distributors Everywhere.*


OHMITE
Has Just the Resistor You Need
Ohmite offers fixed, adjustable, tapped, non-inductive, and precision resistors in more than 60 sizes and 18 types of terminals, in a wide range of wattages and resistances.
These rugged resistors have proved their dependability under the toughest conditions. Write on company letterhead for Catalog 40.
OHMITE
2 OHMITE
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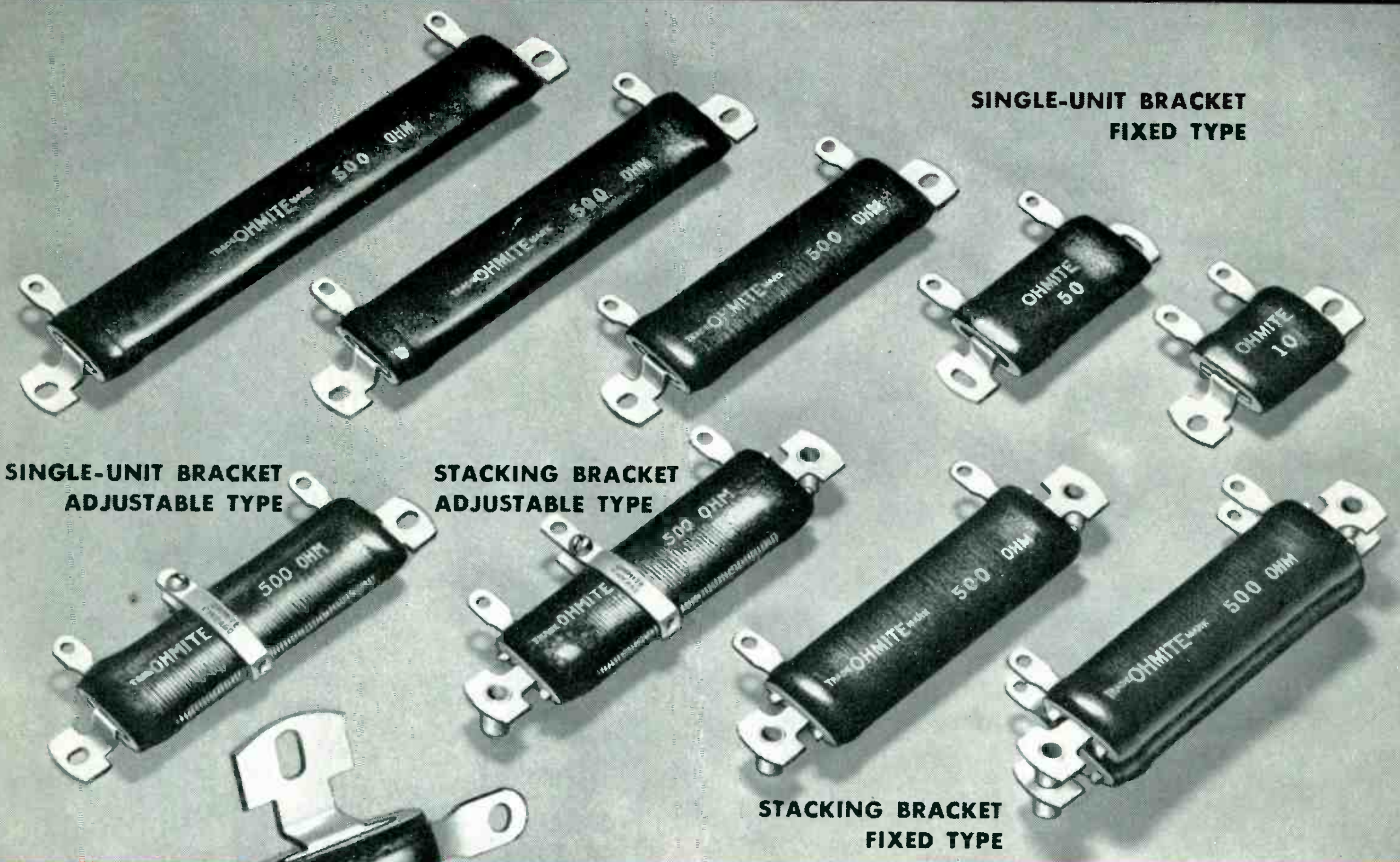
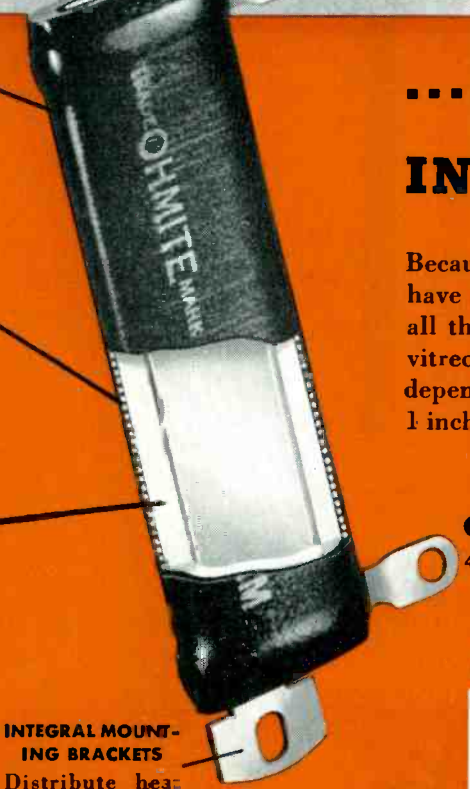
Be Right with
OHMITE
Reg. U. S. Pat. Off.
RHEOSTATS · RESISTORS · TAP SWITCHES
OHMITE MANUFACTURING COMPANY
4816 Flournoy St., Chicago 44, Ill.

# OHMITE THIN RESISTORS



**VITREOUS-ENAMEL COVERING**
Winding is rigidly held in place and protected from damage by Ohmite special vitreous enamel.

**EVEN, UNIFORM WINDING**
"Hot spots" and resultant failures are prevented by the resistance winding's unsurpassed uniformity.

**STRONG CERAMIC CORE**
Unaffected by cold, heat, fumes, or high humidity its core provides a strong base for winding.

**FIVE WATTAGE SIZES**
Lengths range from 1¼ inch to 6 inches, corresponding to ratings of 30 to 75 watts.

**INTEGRAL MOUNTING BRACKETS**
Distribute heat more evenly throughout resistor and conduct heat away quickly.

## ...PACK HIGHER WATTAGE INTO LESS SPACE

Because of their compact design, Ohmite Thin Type Resistors have a higher wattage rating per unit of space. They provide all the time-proven superiority of conventional Ohmite vitreous-enamel resistors—giving you a compact unit you can depend upon. Available in four types—all only ¼ inch thick by 1 inch wide—in five lengths and a wide range of resistance values.

Send for Bulletin No. 138
**OHMITE MANUFACTURING CO.**
4816 W. Flournoy St., Chicago 44, Ill.

*Be Right with*

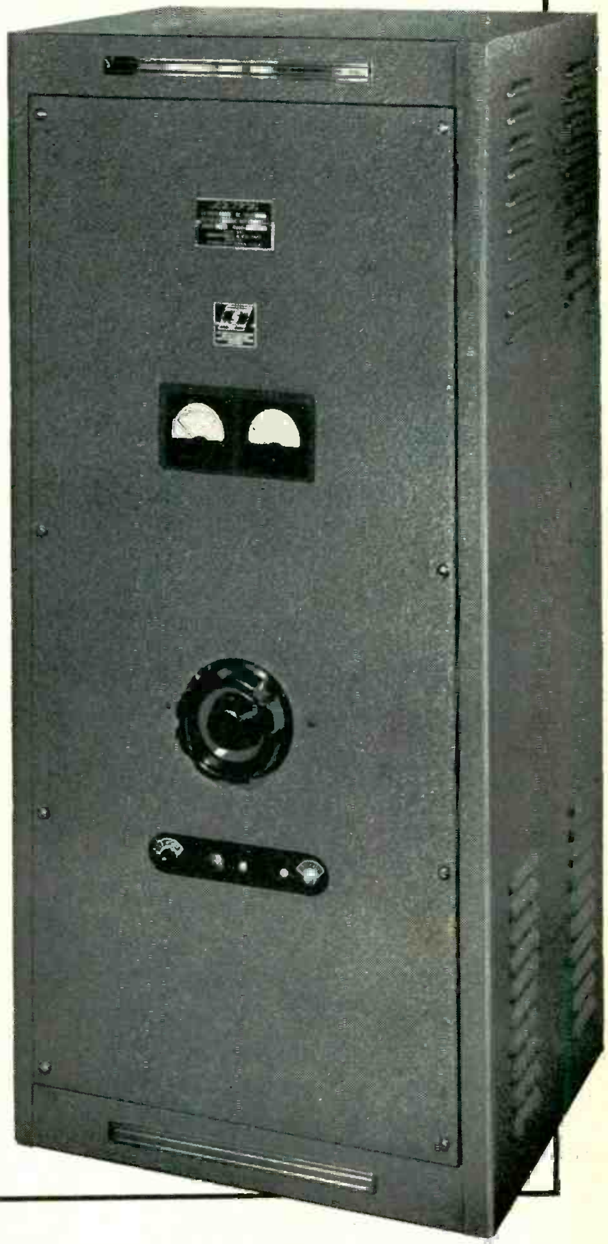
# OHMITE

RHEOSTATS • RESISTORS • TAP SWITCHES

*specify Sorensen*

# RANGERS

## (FULL-RANGE-VARIABLE DC SUPPLYS)



**This versatile supply is a combination of the widely used Sorensen NOBATRON and a filter-variable output circuit.**

**The result gives a continuously variable output voltage regulated against line and load changes through the full range of the instrument.**

**Look at the specifications tabulated below — check them against your requirements. Where range of output, adaptability to diverse applications is essential, the Sorensen RANGER may well be your instrument of choice.**

ELECTRICAL SPECIFICATIONS

| Model No. | SR-10 | SR-30 | SR-50 |
|---|---|---|---|
| Output range | 0 - 135 VDC | 0 - 30 VDC | 0 - 13 VDC |
| Current range | 1 - 10 amps | 3 - 30 amps | 5 - 50 amps |
| Input voltage | 95 - 130 VAC, 50 - 60 cycles, single phase | | |
| Regulation accuracy | ± 0.25 **percent** at any voltage setting from 3 VDC to top rating | | |
| Ripple | RMS max. 1% of output setting | | |

Meters — standard. Coarse and fine adjustment available.

***Write for complete information.***

For other regulated DC supplys, investigate Sorensen's line of NOBATRONS (low voltage) and B-NOBATRONS (high voltage).

POWER controlled converted

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


*Longer life at 105°C!*

Temflex 105 extruded plastic tubing affords longer retention of flexibility and original insulation characteristics. Use it for higher operating temperatures, for high voltage conductors, for oil-cooled transformers. For details, test reports, samples, write today.

**ENDURES HEAT** – Temflex 105 is Underwriters' Laboratories approved for continuous operation at 105°C!

**SUPERIOR INSULATION** – Temflex 105 maintains consistently high dielectric strength!

**MOISTURE RESISTANT** – Temflex 105 effectively seals out moisture – is Underwriters' approved for use in damp locations!

**STRONG, TOUGH** – Temflex 105 gives you tensile strength of 3,000 p.s.i. – with minimum elongation of 300%!

**FLEXIBLE WHEN COLD** – Temflex 105 stays flexible down to temperatures as low as –40°C!

**RESISTS CHEMICALS** – Temflex 105 shows good resistance to solvents, is unaffected by strong acid or alkali!

**WITHSTANDS HOT OIL** – Temflex 105 retains flexibility and dielectric properties after prolonged immersion in oil over 100°C!

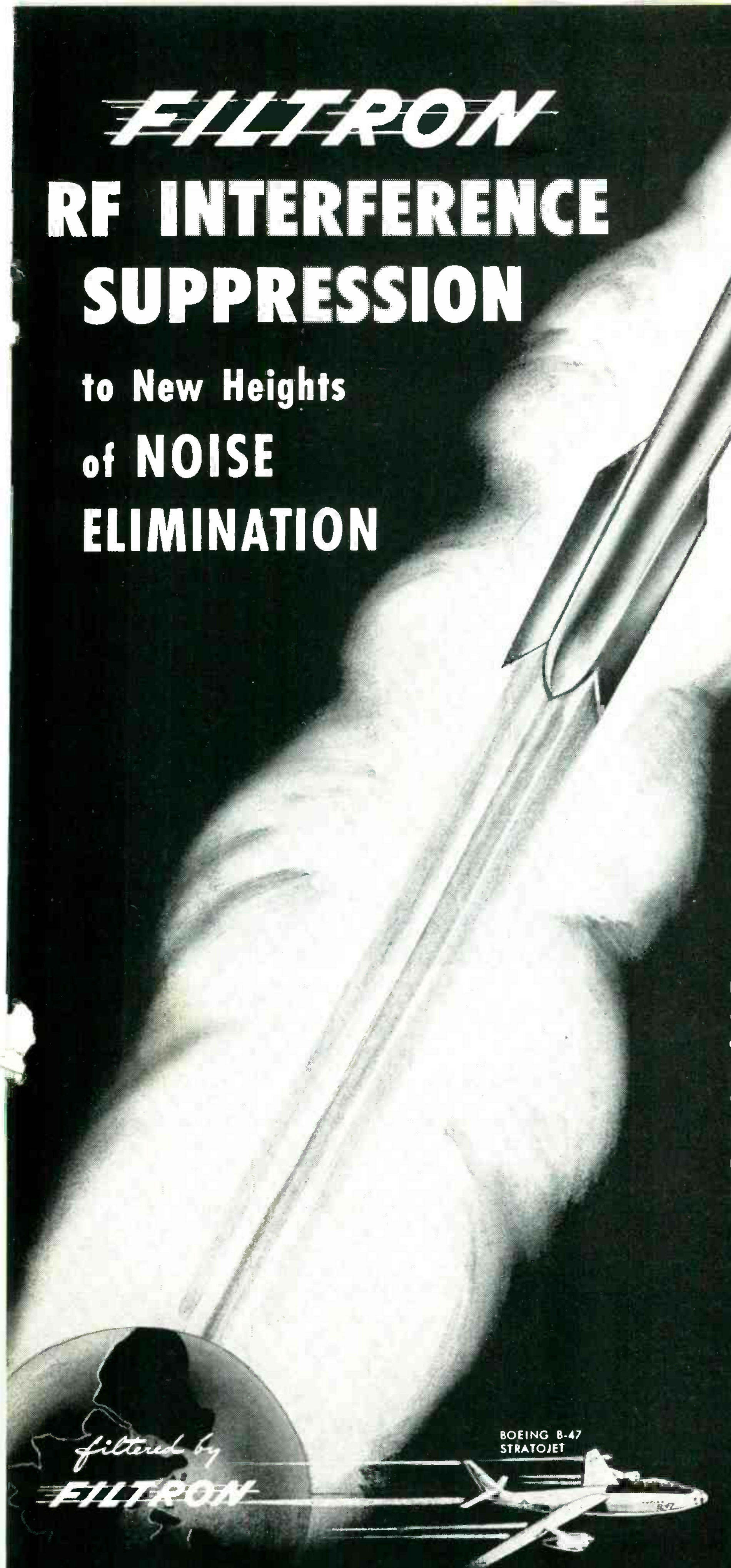
*Look to Irvington*
***for Insulation Leadership***

**IRVINGTON** VARNISH & INSULATOR COMPANY
Irvington 11, New Jersey

# FILTRON

# RF INTERFERENCE SUPPRESSION

## to New Heights of NOISE ELIMINATION




**FILTRON IS SPECIFIED ON THE MAJORITY OF MODERN AIRCRAFT, GUIDED MISSILES, SIGNAL CORPS, ORDNANCE AND NAVAL EQUIPMENT**

FILTRON will design the right filter for your circuit conditions to meet size, weight and electrical characteristics — and meet RF Interference Suppression Specifications wherever RF Interference must be eliminated.

FILTRON'S advanced engineering, due to constant research and development, together with FILTRON'S production know-how, insures quality components to meet your delivery requirements.

**RF INTERFERENCE SUPPRESSION FILTERS FOR:**

- Motors
- Generators
- Inverters
- Electronic Controls
- Dynamotors
- Power Plants
- Actuators
- Gasoline Engines

And other RF. Interference producing equipment

*An inquiry on your Company letterhead will receive prompt attention*

**THE FILTRON CO., INC.**
FLUSHING, LONG ISLAND, N. Y.

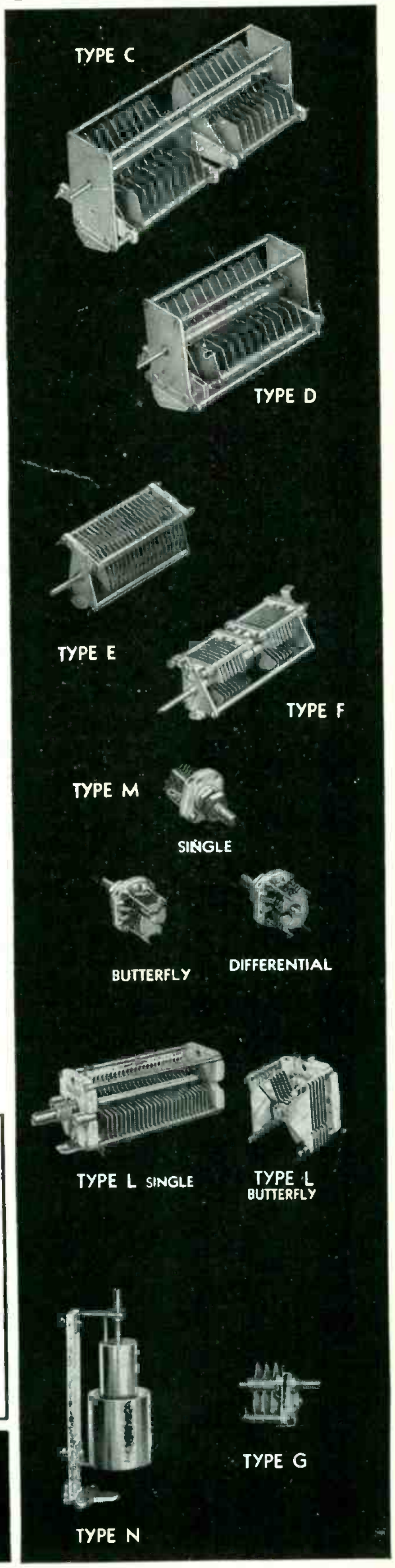
**LARGEST EXCLUSIVE MANUFACTURERS OF RF INTERFERENCE FILTERS**

Choose **JOHNSON** Variable Condensers For

# DEPENDABLE EFFICIENCY

Excellent design, careful workmanship and quality materials are combined in the manufacture of JOHNSON Variable Condensers to assure highest stability of the tuned circuit.

The entire JOHNSON line features high quality steatite insulation and sturdy construction — your assurance of long, dependable service.




**Type C&D**

Unusually economical for quality condensers, Types C and D have .051" thick, rounded aluminum plates, large laminated rotor brushes. Air gap from .080" to .250" (Type D) and .125" to .500" (Type C). Panel space, Type C, 5½" W x 5⅜" H. Type D, 4¼" W x 4" H.

**Type E&F**

Rugged, compact units for low and medium power transmitters. Aluminum plates .032" thick, rounded edges. Stainless steel shafts. Air gap from .045" to .125" (Type E) and .045" or .075" (Type F). Panel space, Type E, 2⅝" square; Type F, 2-1/16" square.

**Type M**

MINIATURE — SMALLEST EVER BUILT!

Ideal for VHF, miniature test equipment, etc. Soldered construction, silver plated beryllium copper contact spring, split sleeve rotor bearings — no shaft wobble. Made in single and differential models up to 19.6 mmf and butterfly up to 11 mmf. Panel space only ⅝" x ¾". Air gap .017".

**Type L**

Ceramic soldered — no eyelets or rivets to loosen. All brass, soldered construction. "Bright alloy" plated. Ideal for rough service. Beryllium copper contact spring, silver plated. Made in butterfly, single and differential types. Panel space 1⅜" square. Air gap .030". Also furnished in .020", .060" and .080".

**TYPE N**

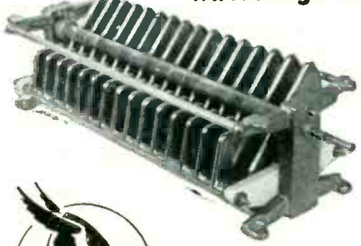
**Small mounting space requirements, extremely high voltage rating and fine adjustment make these neutralizing condensers ideal.**

**TYPE G**

**Extremely popular as neutralizing condensers for medium and low power stages. Also widely used for grid and plate tuning at high frequencies.**

***WRITE TODAY FOR JOHNSON CONDENSER CATALOG!***

## TYPE BC . . . for Commercial and Broadcast use where high voltage, high current conditions prevail.



New aluminum die cast plates have heavy beaded round outer edge for maximum voltage breakdown. Cast aluminum end plates, with rounded edges, rugged steatite insulators with long creepage path. Width 7⅛", height 7-5/16". Voltage ratings up to 18,000 volts peak breakdown.

***Many other types, including pressurized units, are made for high voltage, high power applications.***

**JOHNSON** *a famous name in Radio*

**E. F. JOHNSON CO.** **WASECA, MINN.**

# NEW INDICATOR ION TRAP

*a Rauland "Exclusive"*


## Helps you Cut Production Costs

Rauland's new Indicator Ion Trap can help you in your battle to cut pennies off production costs and thereby to price receivers competitively.

First of all, the Indicator Ion Trap completely eliminates the need for any equipment and any trained judgment in the adjustment of ion trap magnets. Adjustment can be made faster than equipment could be attached. The ion trap magnet is simply moved until the green glow signal is reduced to minimum. It can be done in seconds with absolute accuracy—without even seeing the front of the picture tube.

Second, the Rauland Tilted Offset Gun which incorporates this Indicator Ion Trap requires only one Ion Trap Magnet instead of two, nibbling a little more off production costs. Yet it gives better results—the electron beam is bent only once and is focused to maximum sharpness.

Specify Rauland tubes with these exclusive advantages, and get the benefits that only Rauland offers.

For further information, write to . . .

**RAULAND**

**The first to introduce commercially these popular features:**

- Tilted Offset Gun
- Indicator Ion Trap
- Luxide (Black) Screen
- Reflection-Proof Screen
- Aluminized Tube

## THE RAULAND CORPORATION

*Perfection Through Research*

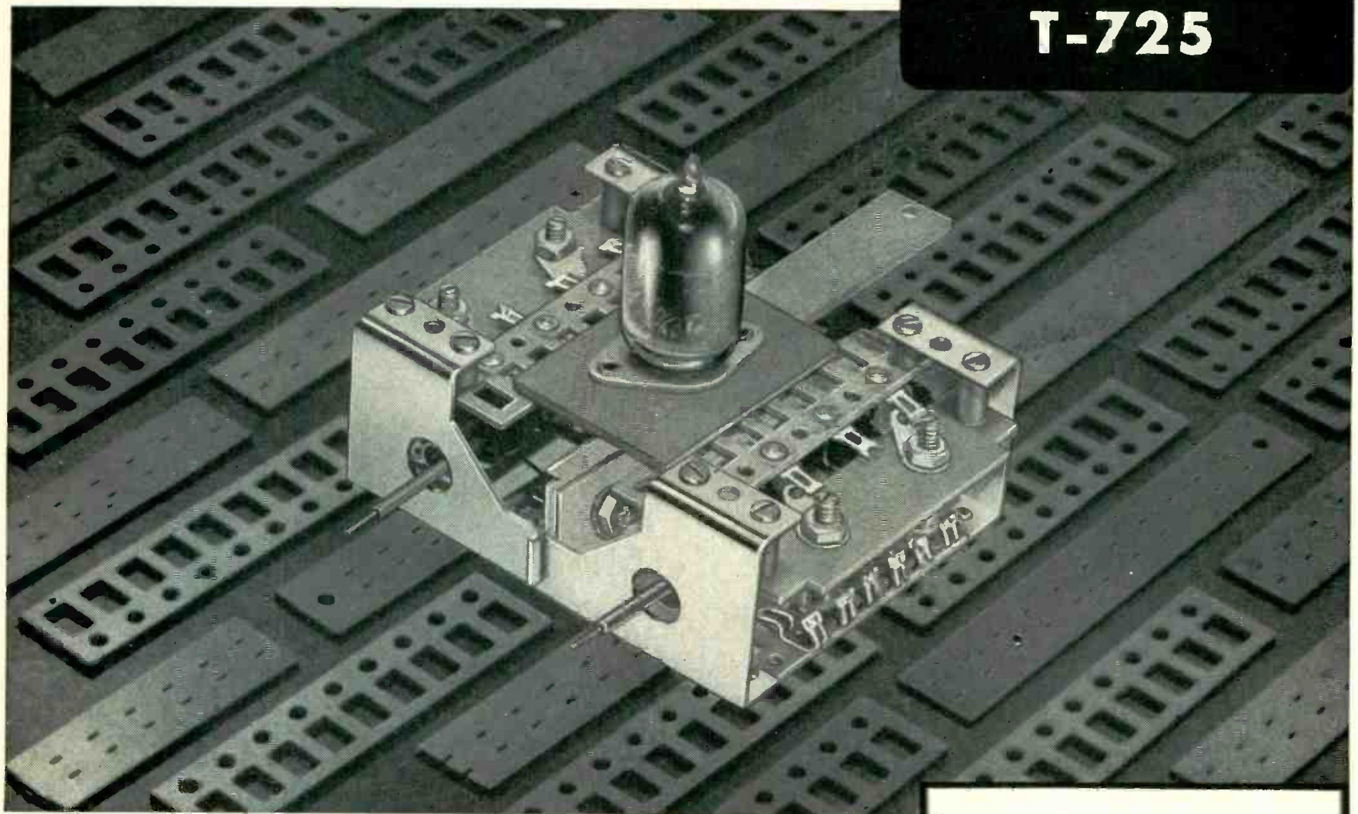
4245 N. KNOX AVENUE • CHICAGO 41, ILLINOIS

**Another**

# "DESIGN HEADACHE"

**solved by**

## INSUROK*
## T-725



**Centralab**† **required a superior combination in the insulation for this unique slide switch used in Anchor Radio's TV preamplifier**

1. Uniform quality
2. Low electrical loss
3. Resistance to moisture
4. Electrical stability over a wide temperature range
5. Mechanical strength
6. Close tolerances

At the high frequencies encountered in TV equipment, insulating materials must possess a unique combination of many properties. To find such a material for its intricate slide switches, used in Anchor Radio's TV preamplifier, was the problem faced by Centralab engineers.

INSUROK T-725 laminated plastic insulation proved to be the answer. It had the necessary physical strength and electrical properties. It was stable under elevated temperatures and high humidity. And, from piece to piece, it remained uniform.

In hundreds of similar applications, laminated and molded INSUROK are solving difficult problems for industry. Richardson's years of experience in the engineering application of plastics are available to you without obligation. Write, today.

*Reg. U. S. Pat. Off.

†DIVISION OF GLOBE-UNION INC., MILWAUKEE

*Write for*

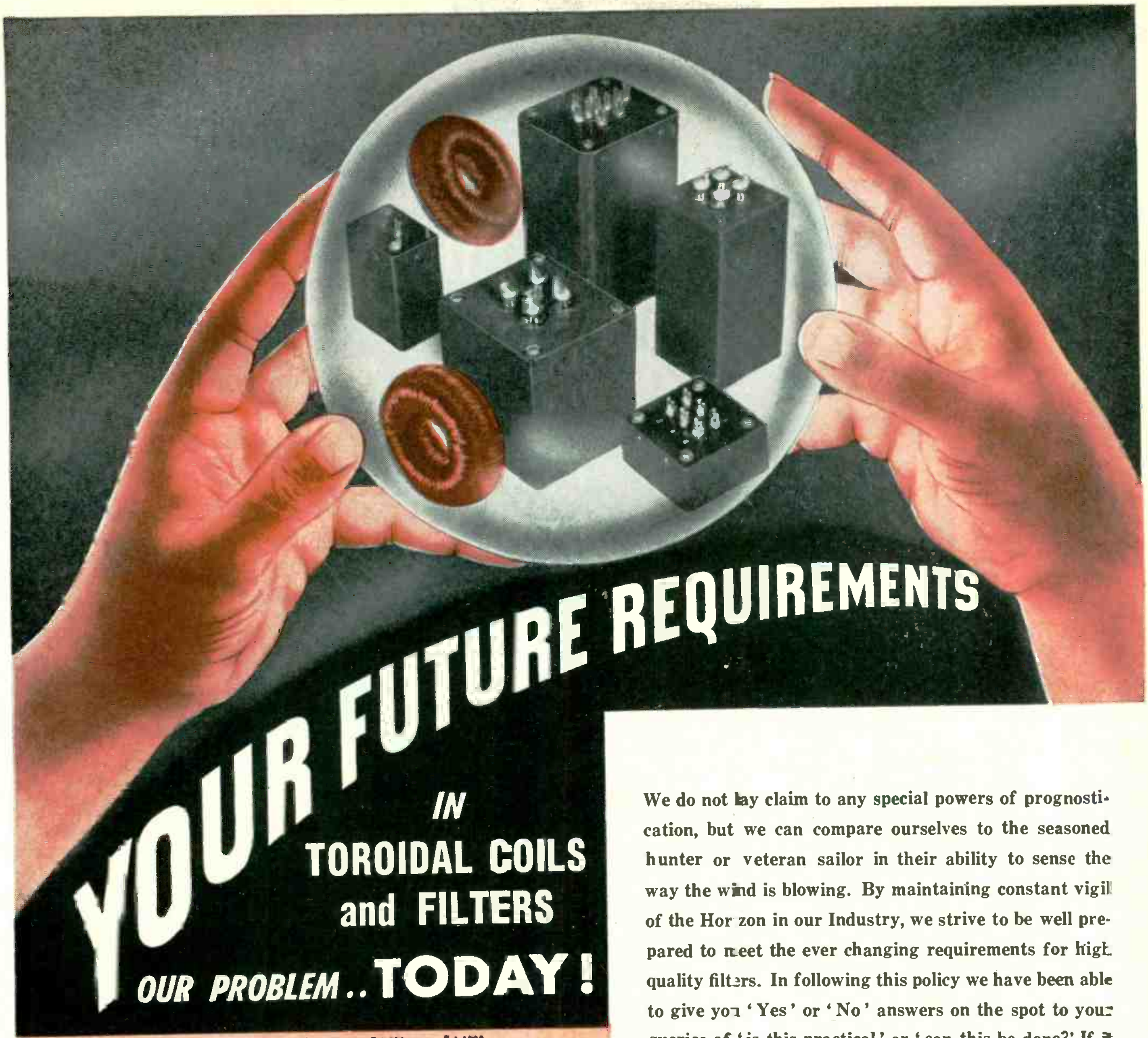
**Descriptive Data Sheet T-725**

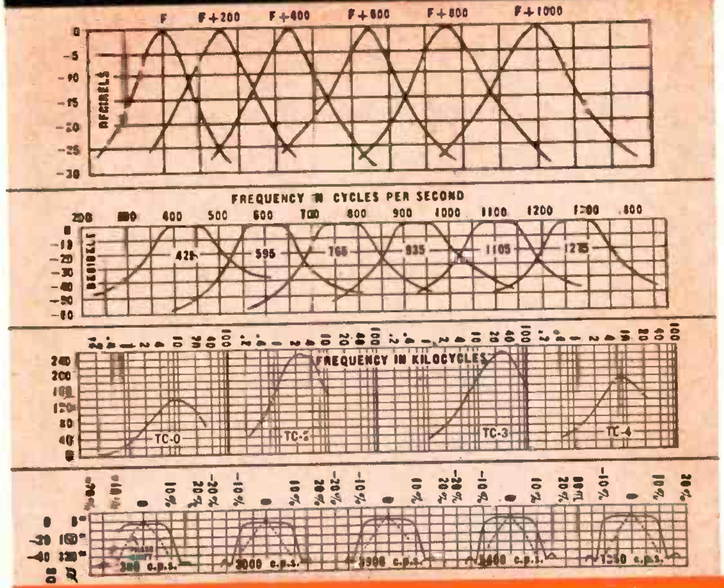
# *The* RICHARDSON COMPANY

FOUNDED IN 1858—LOCKLAND, OHIO

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



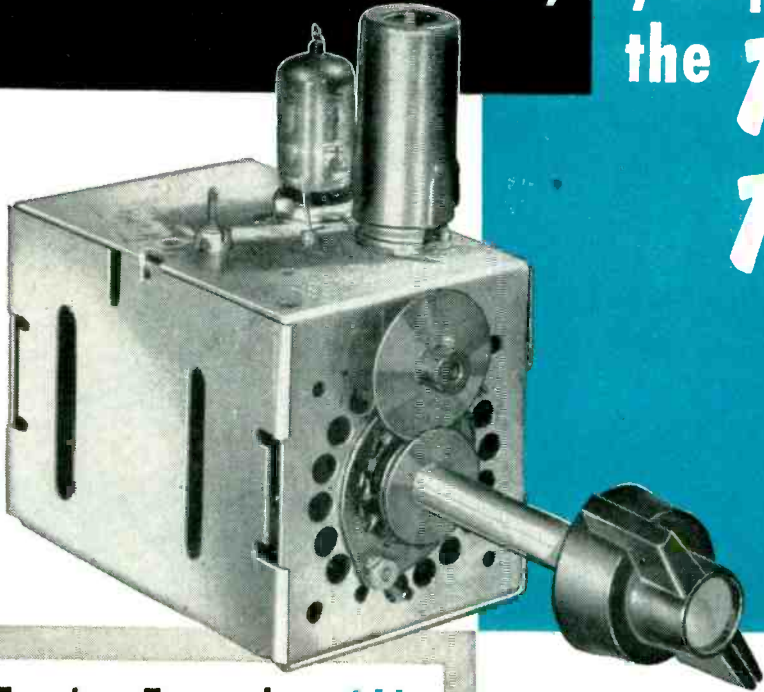




We do not lay claim to any special powers of prognostication, but we can compare ourselves to the seasoned hunter or veteran sailor in their ability to sense the way the wind is blowing. By maintaining constant vigil of the Horizon in our Industry, we strive to be well prepared to meet the ever changing requirements for high quality filters. In following this policy we have been able to give you 'Yes' or 'No' answers on the spot to your queries of 'is this practical' or 'can this be done?' If it can be done, we have probably tried it. If it cannot be done we are still trying to do it. This has obviated unnecessary expenditure of our customers' time and money, and has helped expedite the development of new equipment by eliminating the several blind alleys that can be so costly. In these times, especially, the continued application of foresight, ingenuity and new ideas, as well as the constant expansion of production facilities, will be the key note of our 'Burnell Customer Service.'

**Exclusive Manufacturers of Communications Network Components**

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

# For PERFORMANCE, PRICE, ADAPTABILITY, you just can't beat the Tarzian Tuner!



A compact, precision-built "package," offering maximum performance per dollar cost. And, backed by TARZIAN engineering "know-how."

## Only Tarzian Tuner has ALL of these desirable Features

- Low oscillator radiation
- High gain and low noise
- Designed for 21 or 41 megacycle I.F. systems
- Insulated shaft design available at low cost
- Anti back lash, air dielectric fine tuning, giving uniform coverage on low and high channels
- Three tube performance with two tubes
- Each channel individually aligned for maximum performance
- Good input balance—no tracking difficulties
- Completely shielded
- Oscillator tube shield provides rigid horizontal and vertical positioning of the tube
- Extra terminals provided for tie-points

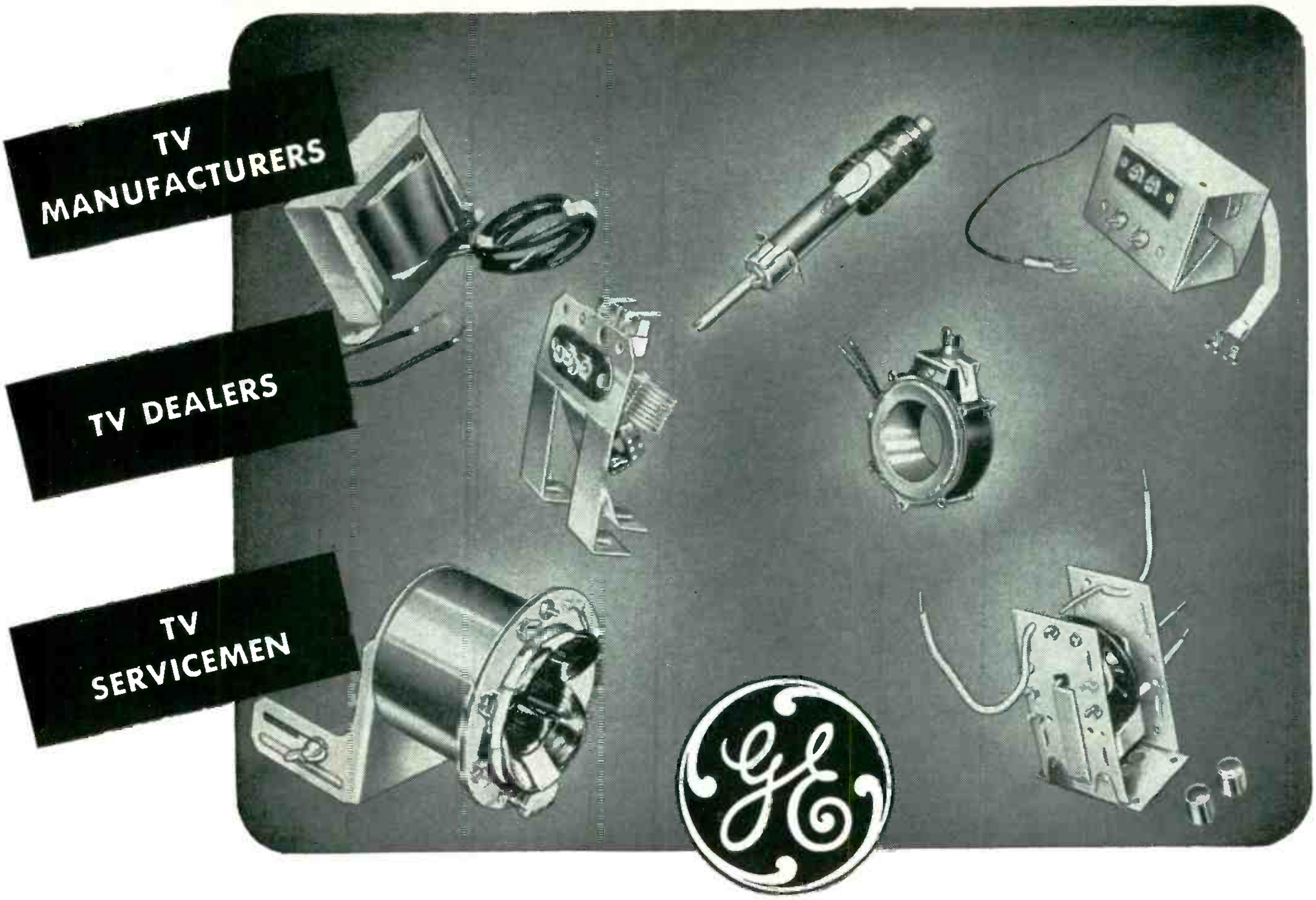
Write for complete information, specifications and technical data.

Since the time it was first introduced, the TARZIAN front-end tuner has won the acclaim of the industry. It is small, skillfully designed, well-built and low-priced. That's why 17 of the nation's set manufacturers today are specifying the TARZIAN tuner as a component for their products.

**Engineering service available upon request**

**Sarkes Tarzian, inc.**
TUNER DIVISION, DEPT. E-1
537 South Walnut Street • Bloomington, Indiana

The SARKES TARZIAN stations in Bloomington
**WTTS - WTTV**
5000 Watts — Channel 10




## *Available Now!* CRITICAL TV COMPONENTS

**DEALERS AND SERVICEMEN**—Your share of today's multi-million dollar TV replacement market is limited only by your ability to handle it. Now you can get *ferrite transformers, ferrite core yokes,* linearity controls, focus coils—the vital TV components you need—from one dependable source—General Electric! Don't wait to cash in on the biggest *new* business in television history—call your distributor today and stock the General Electric line!

**RECEIVER MANUFACTURERS**—Here's a way to cut production headaches and manufacturing costs! You simplify ordering and delivery when you design G-E components into your sets. Remember, too, that your sets will be serviced *in the field* because G-E distributors and dealers everywhere stock these parts. Let us review your requirements for next year's production right now. General Electric application engineers are at your service.

# GENERAL ELECTRIC


MAIL COUPON
FOR NEW
**FREE**
**CATALOG**

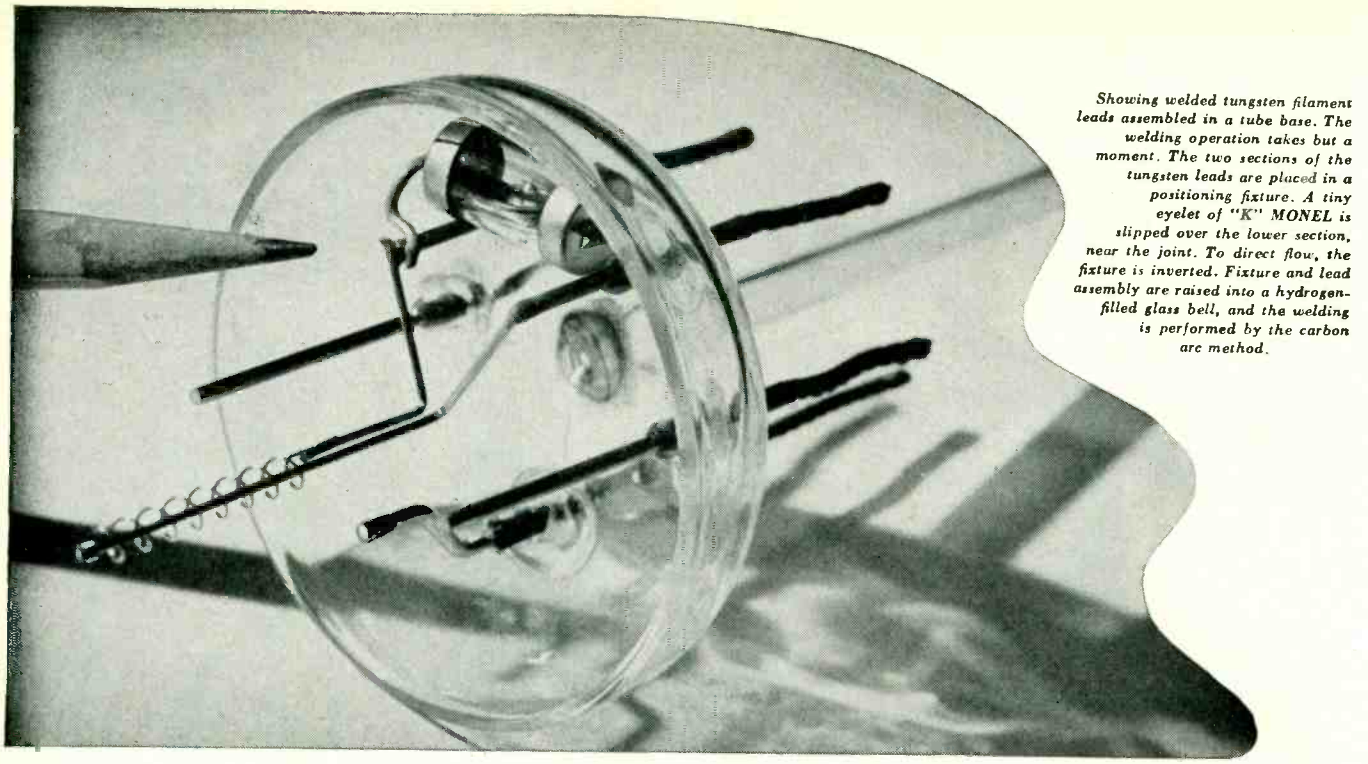
General Electric Company, Section 411
Electronics Park, Syracuse, New York

Rush me the new G-E Catalog of TV Components.

NAME___________________________

ADDRESS___________________________

CITY_______________STATE__________



*Showing welded tungsten filament leads assembled in a tube base. The welding operation takes but a moment. The two sections of the tungsten leads are placed in a positioning fixture. A tiny eyelet of "K" MONEL is slipped over the lower section, near the joint. To direct flow, the fixture is inverted. Fixture and lead assembly are raised into a hydrogen-filled glass bell, and the welding is performed by the carbon arc method.*

# How a problem in welding tungsten was solved

While improving the design of their VHF beam tetrodes, the United Electronics Company ran into a difficult technical problem.

In their tube types 5D22 and 4D21, tungsten filament leads are brought out to conventional base prongs. However, to locate the filament at the center of the structure, the two internal filament leads had to be sharply offset. It was necessary, also, that the leads be accurately aligned with the base outlet holes, to eliminate stresses which might crack the glass envelope when the tube was put in service.

Bending the tungsten leads to shape proved too inaccurate a method. So it was decided to make the leads in two sections — one straight, and one bent — welding them together in precision positioning fixtures.

This method of assembly proved satisfactory, but difficulty was immediately encountered in finding a suitable joining metal.

Several metals were tried without success. Either they failed to "wet" the tungsten, or caused it to embrittle.

*VHF beam tetrode tube, manufactured by the United Electronics Co., Newark, N. J.* ▶

Finally, United Electronics Company engineers tried "K"® MONEL—*and it proved to be the answer to their problem.*

"K" MONEL "wet" the tungsten satisfactorily; flowed well; made strong, smooth joints; was resistant to oxidation and corrosion. In addition, "K" MONEL's melting point was safely above both exhausting and tube operating temperatures.

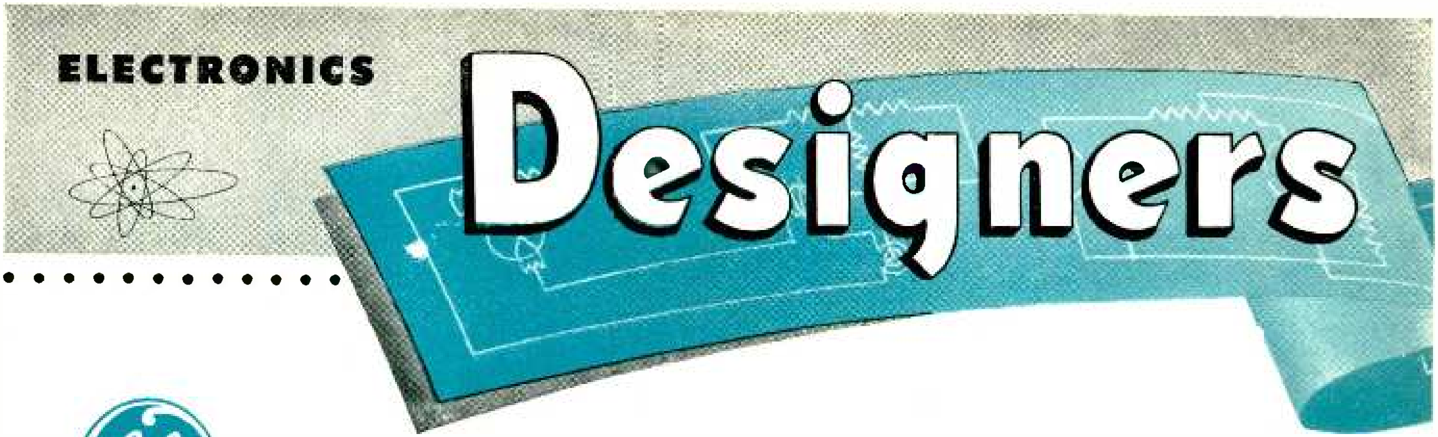
* * *

*If you have a problem in metal selection, get to know the family of INCO Nickel Alloys with their unique combination of properties. Our technical department is always ready to assist you. Write for "66 Practical Ideas for Metal Problems in Electrical Products."*

**The International Nickel Company, Inc.**
**67 Wall Street • New York 5, N.Y.**

EMBLEM OF SERVICE
NICKEL INCO ALLOYS

MONEL® • "K"® MONEL • "S"® MONEL • "R"® MONEL • "KR"® MONEL • NICKEL • LOW CARBON NICKEL • DURANICKEL® • INCONEL® • INCONEL "X"®




# AMPLIDYNES—500 to 25,000 WATTS

▲ 1-kw Amplidyne motor-generator set.

▼ 5-kw Amplidyne generator

◀ 3-kw Amplidyne motor-generator set

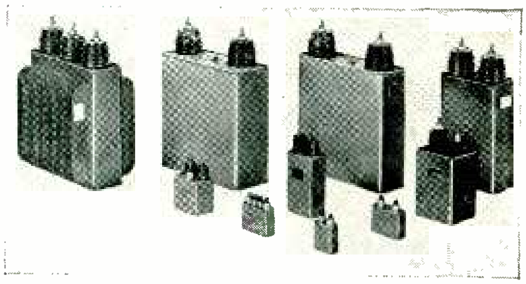
**PRECISE CONTROL OF position · torque · speed tension · power factor · voltage · current**

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.

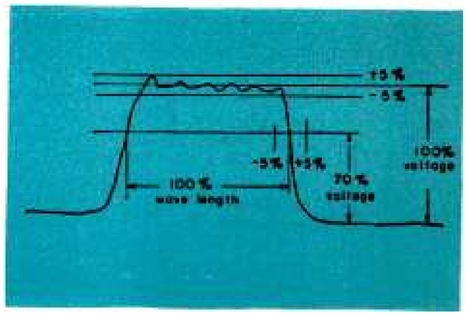
What are your requirements? For further data, write, giving complete details, to *Electrical Industries Sec., Resale Industries Div., Apparatus Dept., General Electric Co., Schenectady 5, N. Y.*

A G-E 25-KW AMPLIDYNE AMPLIFIES A 9/10 WATT INPUT 22,200 TIMES



## PULSES —MADE TO ORDER

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.

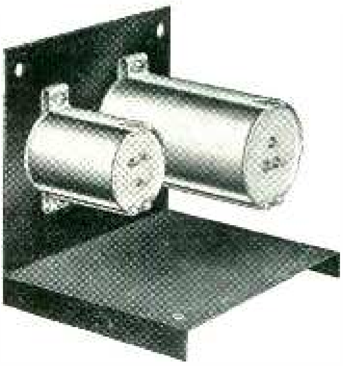



Typical design and operational limits of G E Type-E pulse-forming network: Ripple at top of pulse ±5%; Wave length ±5% measured at 70% amplitude; Capacitance tolerance ±10%

**GENERAL ELECTRIC**

# Digest

## TIMELY HIGHLIGHTS ON G-E COMPONENTS



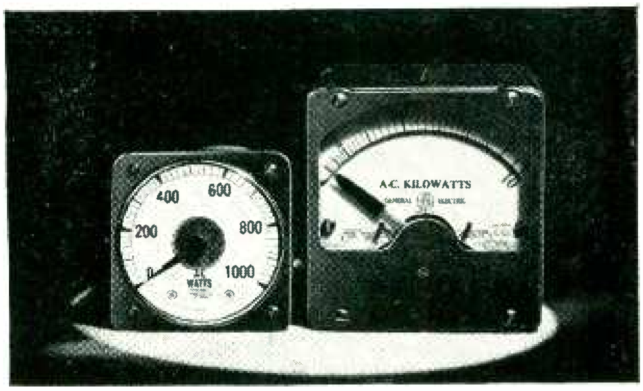
### OIL-IMMERSED SELENIUM RECTIFIERS —use them "ANYWHERE"!

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.*

### PUSH-BUTTON STATIONS—make your selection from the COMPLETE G-E LINE

There's a General Electric push-button station or unit for virtually any electronic application. The complete line includes dozens of types. All stations have sturdy nonbreakable steel frames and covers with ample clearance between terminals. G-E units for built-in applications have terminals anchored to a molded base for firm support. Contact maintenance on all stations and units is virtually unnecessary because large fine-silver double-break contacts are used. For full data, check Bulletin GEA-3469.

## NEW! SHADOW-PROOF DIALS MAKE SWITCHBOARD INSTRUMENTS EASIER-TO-READ




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 667-10**
**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

Name____________________

Company____________________

Address____________________

City____________ State________

# flexite

# APPROVED by the UNDERWRITERS LABORATORIES under their reexamination service

## ABOVE 105° C

## 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<br>#20 — #17 incl. — less than 8%<br>#16 — # 6 incl. — less than 5%<br># 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:<br>#20 — #10 incl. — .016″ ± .003″<br># 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, 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.


## MITCHELL-RAND INSULATION CO. Inc.

51 MURRAY STREET • COrtlandt 7-9264 • NEW YORK 7, N. Y.

A PARTIAL LIST OF M-R PRODUCTS: FIBERGLAS VARNISHED TUBING, TAPE AND CLOTH • INSULATING PAPERS AND TWINES • CABLE FILLING AND POTHEAD COMPOUNDS • FRICTION TAPE AND SPLICE • TRANSFORMER COMPOUNDS • FIBERGLAS SATURATED SLEEVING • ASBESTOS SLEEVING AND TAPE • VARNISHED CAMBRIC CLOTH AND TAPE • MICA PLATE, TAPE, PAPER, CLOTH, TUBING • FIBERGLAS BRAIDED SLEEVING • COTTON TAPES, WEBBINGS AND SLEEVINGS • IMPREGNATED VARNISH TUBING • INSULATED VARNISHES OF ALL TYPES • EXTRUDED PLASTIC TUBING

A MESSAGE TO AMERICAN INDUSTRY • ONE OF A SERIES

# America's Road to Victory

## ... Let's Increase Production

This is the time to speak out—now—at the beginning.

*Our industrial program for re-armament is getting off on the wrong foot.*

The talking and writing about it emphasize the wrong things.

Its headline words are "cuts" and "controls."

Those words make bad propaganda for the cold war.

"Cuts" and "controls" are no words to challenge the imagination and energy of our own people. They won't impress the masters of the Kremlin. And they can only make it appear to the rest of the world that America thinks it can defend the free way of life by abandoning it.

America stands as the world's champion against aggression because America has become the most powerful free nation in the world.

How did we get that way?

Not by putting ceilings on wages; not by rationing or clamping iron-clad government controls all over business and industry.

To be sure, some temporary controls are necessary to channel very scarce materials speedily to use for defense. So, too, are special taxes and credit restrictions needed to combat inflation. But they will be fatal if they blind us to this fact:

*We became the strongest nation in the world by out-producing every other nation.*

### Production—The Final Answer

Next year our government is planning at least a $40 billion military program. Instead of planning only on controls to divert $40 billion of production from the making of civilian goods to the making of military supplies, we should be figuring out also ways to push up total production.

Of course, our industrial plant is running at close to "capacity" now. And our labor force has reached almost full employment. There isn't much slack to be taken up.

Can even the United States add a $40 billion miracle of production on top of what it is already doing?

Our answer is "Yes"—and within two years. It can be done by adding about $6 billion each year to our program of capital investment which now runs about $22 billion a year.

Part of this added production will come from expanding our industries. The steel companies, for example, already have plans to increase their capacity almost ten per cent in the next two years.

*But by far the largest part of that $40 billion of added production must come from higher productivity—raising industry's efficiency.*

*continued on next page*

To meet our goals we need to raise our productivity five per cent a year.

Can it be done?

The answer is an emphatic "Yes."

## Raise Industry's Productivity

McGraw-Hill's studies of industry's equipment show that there are countless opportunities for improving efficiency. Our manufacturing industries alone need at least $35 billion of new equipment to raise their facilities to first class technical standards.

Here are some of the broad possibilities reported by the trained editors of McGraw-Hill's business magazines:

In many manufacturing plants as much as 40 per cent of workers' time goes into moving materials and parts—shifting things about within the plant between processes and to and from shipping platforms.

*FACTORY estimates that improved materials handling equipment and methods might well cut handling costs twenty-five per cent and save annually over 650,000 man-years of unnecessary labor.*

Modern machine tools designed since World War II are 40 per cent more productive, on the average, than is old equipment. But AMERICAN MACHINIST surveys show that 95 per cent of industry's machine tools are of designs at least ten years old. Replacing them could raise productivity of the metalworking industries at least ten per cent—enough to absorb a major share of the metalworking industries' part of the defense program as now planned.

In coal mining, latest equipment and methods can raise productivity sharply. The editors of COAL AGE estimate that production of bituminous coal could be raised from seven tons per man-shift to ten within three to five years.

Many new textile production techniques are 50 per cent to 75 per cent more efficient than those in use now. If plants could be fully modernized, and full use made of latest management methods, TEXTILE WORLD estimates that output-per-manhour would rise 20 per cent. *A FOOD INDUSTRIES study indicates that modern equipment plus the best management techniques could raise productivity in food processing at least 20 per cent.*

These are just some of the opportunities that industry can seize and by which the nation can profit.

## A Nation-Wide Effort

Of course, industry itself can't do the whole job. Labor, government and all the rest of us must cooperate.

Government's part is to see that its emergency controls are so applied that they will increase productivity and thus make possible an early lifting of such controls.

Labor's part is to help in the development of labor-saving methods and machinery and to welcome their adoption as the only sure way of continuing to advance the American standard of living while maintaining the American free way of life.

*For all of us the job is to work constantly for an expanding, ever-stronger America with constantly growing productivity; not a pinched and shackled America cooped up under wage and price ceilings and tied to a ration card.*

## Challenge to Industry

Here is a sharp challenge to industry to study the best work-methods that are being reported—to use every minute and every dollar it can to replace obsolete equipment.

Here is a sharp challenge to government to do everything within its power to make its control policies and its fiscal policies strengthen the incentives to industrial modernization—to demand sacrifice for a purpose and not for effect.

The job to which such opportunities point will take time—though nothing holds back adoption of some of the simpler improvements in work-methods reported in business magazines all the time.

But increasing production is our one best hope that we may be spared the full array of price, wage and production controls now and be freed eventually from all controls.

General Omar Bradley has said that the protection of our national independence calls for "long-range commitments that we are willing to carry out."

*A long-range commitment to fight this battle for peace with America's most powerful weapon—industrial productivity—is the surest guarantee of victory for the free world.*

Let's make that commitment—now—at the beginning.

***McGraw-Hill Publishing Co., Inc.***

# COMPLETE, WIDE-BAND INSTRUMENTATION FOR DISTORTION-FREE, FAST-PULSE MEASUREMENT!


New *-hp-* 460B Fast-Pulse Amplifier

*-hp-* 46A Connectors and Accessories

*-hp-* 460A Wide-Band Amplifier

UP TO 90 DB GAIN IN CASCADE! AMPLIFIES MILLI-MICROSECOND PULSES! RISE TIME .0026 μSEC! 125-VOLT OPEN-CIRCUIT OUTPUT! GIVES OVER 100 MC BANDWIDTH TO YOUR STANDARD OSCILLOSCOPE!

## SPECIFICATIONS

### –hp– 460B PAST PULSE AMPLIFIER

**FREQUENCY RESPONSE:** Closely matches Gaussian curve. Hf 3 db point is approx. 140 mc. Lf 3 db point is approx. 50 kc into 200-ohm load.
**MAXIMUM OUTPUT VOLTAGE:** High bias, approx. 125 v. negative open circuit. Normal bias (linear amplification) approx. 8 v. peak into 200-ohm load or 16 v. peak open circuit, pos. or neg. pulses.
**GAIN:** Approx. 15 db into 200-ohm load.
**INPUT IMPEDANCE:** Approx. 200 ohms.
**RISE TIME:** Approx. 0.0026 μsec.
**DELAY:** Approx. 0.016 μsec.
**DUTY CYCLE:** 0.10 max. for 125 v. output pulse.
**LINEARITY PULSE OPERATION:** See Figure 1.
**MOUNTING:** Relay rack. 5¼" x 19". 6" deep.
**POWER SUPPLY:** 115 v. 50/60 cps. 35 watts.
**PRICE:** $225.00 f.o.b. factory.

### –hp– 460A WIDE-BAND AMPLIFIER

*(Specifications same as Model 460B except:)*
**MAXIMUM OUTPUT VOLTAGE:** Approx. 8 v. peak open circuit; 4.75 v. peak into 200-ohm load.
**GAIN:** Approx. 20 db with 200-ohm load.
**DELAY:** Approx. 0.012 μsec.
**PRICE:** $185.00 f.o.b. factory.

### –hp– 46A ACCESSORIES

–hp– **46A-16A PATCH CORD** – 200-ohms, 2' long. $18.50.
–hp– **46A-16B PATCH CORD** – 200-ohms, 6' long. $25.50.
–hp– **46A-95A PANEL JACK**—For 200-ohm cables, low capacitance. 1⅛" dia. $7.50.
–hp– **46A-95B CABLE PLUG**—For 200-ohm cables, low capacitance. $7.50.
–hp– **812-52 CABLE**—200-ohm cable in lengths to specification. Per foot $1.75.
–hp– **46A-95C 50-OHM ADAPTOR** – Type N connector for coupling 50-ohm line into –hp– amplifiers. $15.00.
–hp– **46A-95D ADAPTOR**—Bayonet sleeve for connecting –hp– 410A VTVM to output of 460A/B amplifiers. $15.00.
–hp– **46A-95E CONNECTOR SLEEVE**—Joins two 46A-95B CABLE PLUGS. $7.50.
–hp– **46A-95F ADAPTOR**—For connecting to 5XP CRT. $10.00.
–hp– **46A-95G ADAPTOR**—For connecting to Tektronix type 511 oscilloscope. $12.50.

*Data subject to change without notice.*

**Here at last** is complete instrumentation for true amplification of fast pulses at high power levels sufficient to operate scalers or counting meters, cathode ray tubes, or to give more than 100 mc band-width to your present oscilloscope. New *–hp–* 460B Fast-Pulse Amplifiers, in cascade with *–hp–* 460A Wide-Band Amplifiers, amplify up to 125 volts, open circuit (limited duty cycle). This permits full deflection of 5XP cathode ray tubes, or 2-inch deflection of 5CP tubes. Ultra-short rise time of 0.0026 μsec, combined with zero overshoot, insures distortion-free amplification of pulses faster than 0.01 μsec.

New *–hp–* 460B Amplifier, cascaded with *–hp–* 460A provides linear amplification of 16 volts peak output and pulse amplification of 125 volts output (slight non-linearity). This combination provides maximum usefulness in fast-pulse study for nuclear radiation work, television or VHF research; for increasing frequency range of your oscilloscope, or general wide-band laboratory amplification. In addition to the above instrumentation, *–hp–* also offers series 46A accessories—a complete set of 200 ohm cables, adapters and fittings for inter-connecting amplifiers or patching to oscilloscopes.

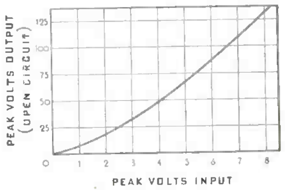



Fig. 1: Linearity of -hp- 460B Fast-Pulse Amplifier

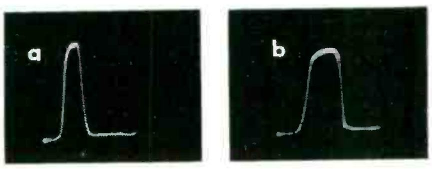
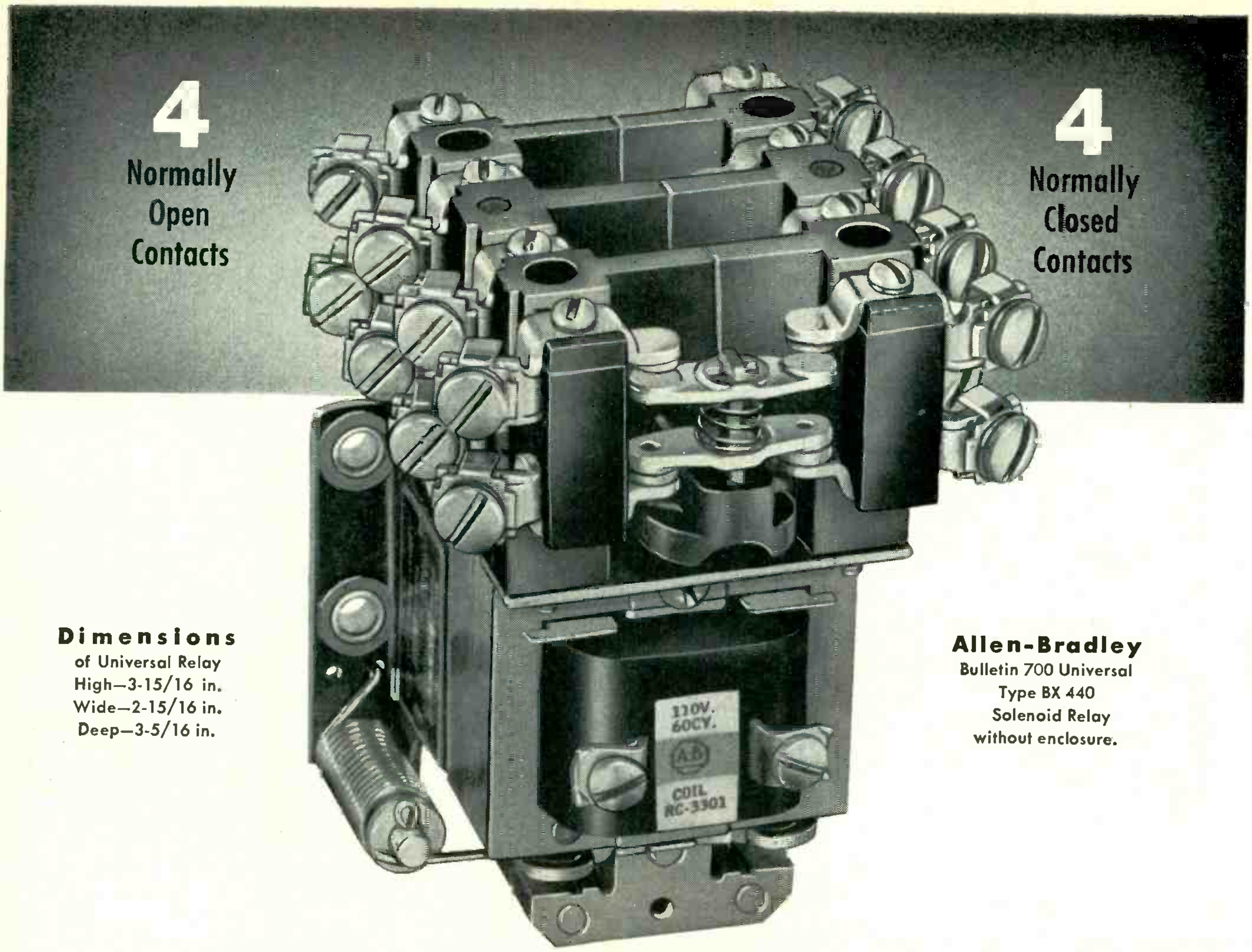



Fig. 2: (a) 0.01 μsec pulse through -hp- 460B Amplifier (b) 0.02 μsec pulse through 3 amplifiers in cascade

*Get complete details. Write direct or see your -hp- sales representative.*

**HEWLETT-PACKARD COMPANY**
2177A Page Mill Road • Palo Alto, California, U.S.A.
Sales Representatives in all principal cities.
**Export:** Frazar & Hansen, Ltd., San Francisco, New York, Los Angeles

HEWLETT-PACKARD *hp* INSTRUMENTS




**Dimensions**
of Universal Relay
High—3-15/16 in.
Wide—2-15/16 in.
Deep—3-5/16 in.

**Allen-Bradley**
Bulletin 700 Universal
Type BX 440
Solenoid Relay
without enclosure.

# These SMALL UNIVERSAL RELAYS

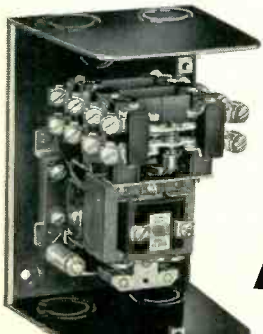
## are instantly adaptable for switching a wide variety of power supply circuits

There are literally thousands of places for these small, dependable solenoid relays in electronic power circuits. These Bulletin 700 relays are built in an amazing variety of contact arrangements . . . normally open and normally closed . . . from one to eight poles. Enclosures are available for almost any service requirement.

The Type BX 440 Universal Solenoid Relay has four normally open and four normally closed contacts which may be used interchangeably for handling a wide variety of circuit arrangements.

It will pay you to get a full listing of Allen-Bradley Bulletin 700 A-C Relays. And for heavier currents, Allen-Bradley solenoid contactors are available up to 900 amperes . . . with or without enclosures. Investigate the Allen-Bradley line.

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



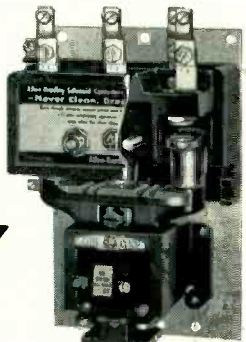
Allen-Bradley Relay in general purpose enclosure.

A-B
Quality

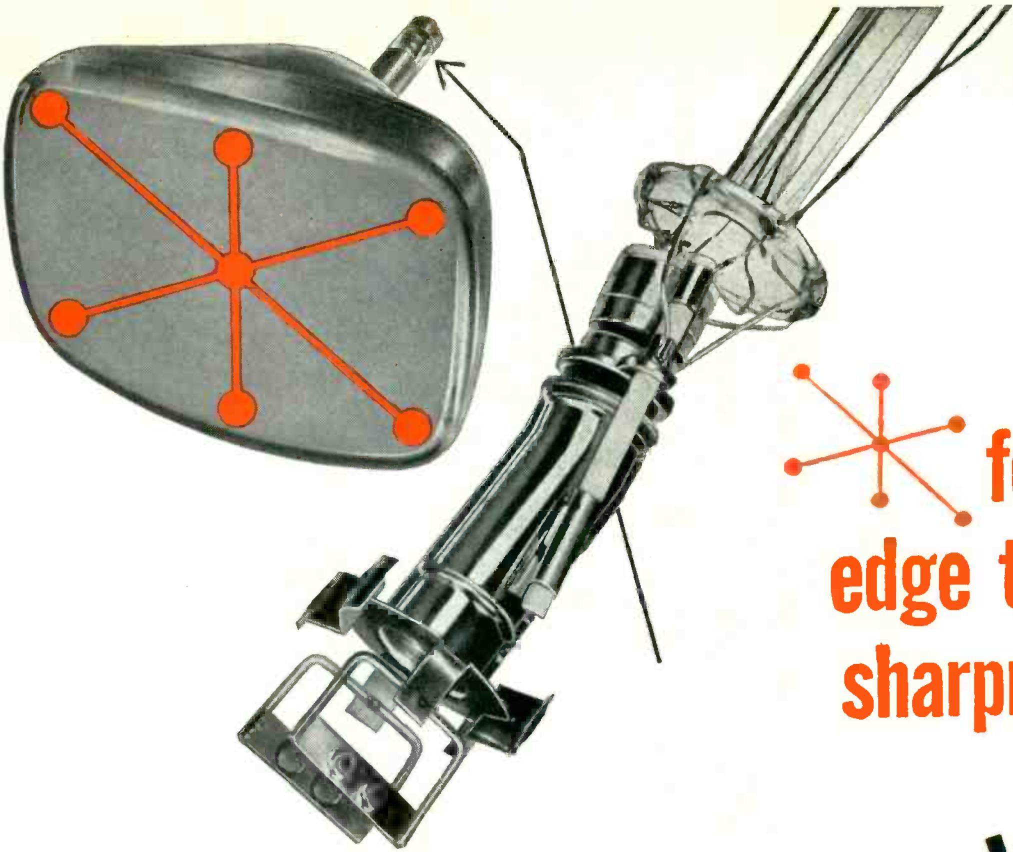
**ALLEN-BRADLEY**

**RELAYS • RESISTORS**

QUALITY



Bulletin 702 Solenoid Contactor—50 ampere rating.



## for edge to edge sharpness...

# the New Du Mont Bent-Gun

## the latest refinement in the most copied gun structure

Uniform sharpness of trace to the very edges of the screen distinguishes the new Du Mont Bent-Gun.

A higher degree of pre-focusing passes a smaller-diameter beam through the deflection field. Spot distortion is reduced and a uniform overall focus results. Other design changes are: Improved bulb spacer insures proper anode contact and electron gun centering; rounded corners on pertinent gun parts eliminates stray emission at higher anode voltages; new grid-cathode assembly allows a longer G-2 (second grid) without increasing overall length.

This new Du Mont Bent-Gun is now being incorporated in ALL Du Mont Teletrons. Therefore, whether planning a new TV receiver or modifying an old one, be sure to include the Du Mont Teletron for the best in TV pictures. Simply specify DU MONT.

FIRST WITH THE FINEST IN T-V TUBES

DUMONT

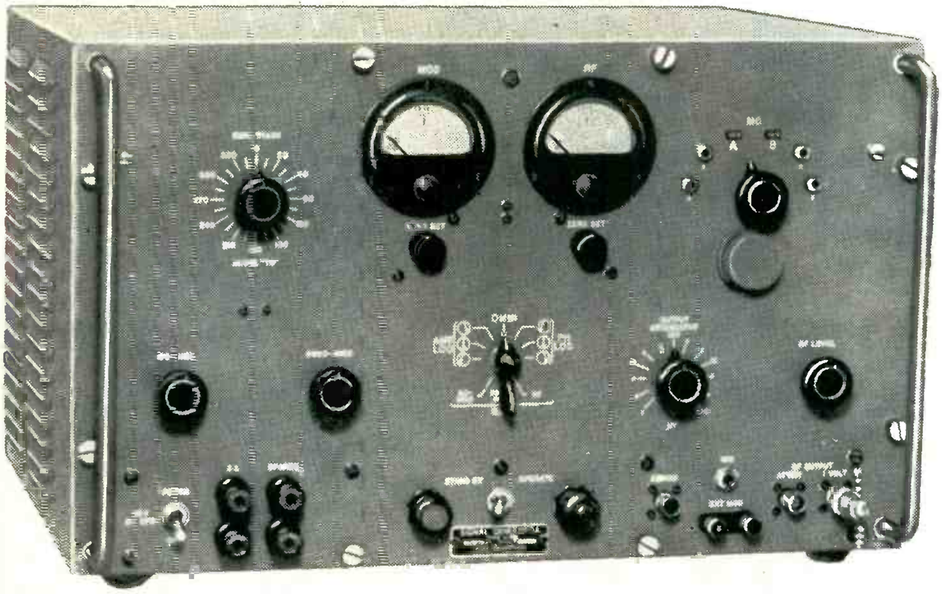
Teletrons*

ALLEN B. DU MONT LABORATORIES, INC.,
Tube Division, Clifton, N. J.

*Trade-mark.

# SIGNAL GENERATORS by ARC

## AIRCRAFT RADIO CORPORATION



## TYPE H-14

**108-118 MEGACYCLES**

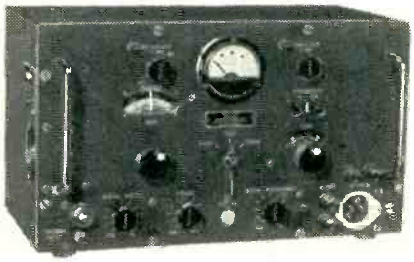
**Tests OMNI Receiving Units in Aircraft or on the Bench**

Checks on:

- 24 Omni courses
- Left-center-right on Phase-localizer
- Left-center-right on Amplitude-localizer
- Omni course sensitivity
- To-From and Flag-alarm operation
- All necessary quantitative bench tests

The Type H-14 Signal Generator, 108-118 megacycles, provides a standard signal source for the complete testing of VHF airborne omnirange and localizer receivers in aircraft or on the bench. It provides for testing 24 omni courses, plus left-center-right checks on both amplitude and phase localizers. Aircraft may be checked out quickly and accurately just before take-off. RF output for ramp checks, 1 volt into 52 ohm line and for bench checks, 0-10,000 microvolts. Provision for external voice or other modulation. AF output available for bench maintenance and trouble shooting.

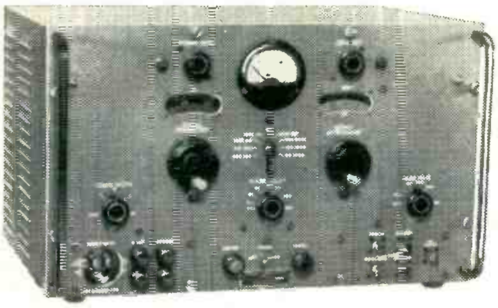
**Price: $885.00 net, f.o.b. Boonton, N. J.**



### TYPE H-10—Microwave Test Set; 23,500-24,500 Megacycles

Provides source of cw or pulse frequency—modulated RF, power level −37 to −90 dbm. RF power meter measures levels from +7 to +30 dbm. Frequency meter for measuring output or input RF accurate to better than 20 mc. Primary purpose of the H-10 is to measure receiver sensitivity, bandwidth, frequency, recovery time, and overload characteristics, plus transmitter power and frequency. Recommended as a standard source of RF for research or production testing. Equal to military TS-223/AP.

**Price: $1692.00 net, f.o.b. Boonton, N. J.**



### TYPE H-12—VHF Signal Generator; 900-2100 Megacycles

Provides source of cw or pulse amplitude-modulated RF, power level 0 to −120 dbm. Internal pulse circuits with controls for width, delay, and rate, and provision for external pulsing. Single dial tuning, frequency calibration accurate to better than 1%. Built to Navy specifications for research and production testing. Equal to military TS-419/U.

**Price: $1950.00 net, f.o.b. Boonton, N. J.**

**ARC Communication and Navigation Equipment**

Aircraft Radio Corporation also manufactures LF and VHF airborne communication and navigation equipments—all CAA-Type-Certificated for scheduled air-carrier use or for those whose type of flying requires a high degree of reliability and performance. Equipment consists of light, small units which can be combined to provide the required operation, whether it be the 1 Receiver/1 Transmitter (15 pound) installation in a 2-place helicopter, or a 3 Receiver/2 Transmitter/ VHF Omni installation (70 pounds) in larger 2-engine aircraft.

**WRITE TODAY** for descriptive literature on A.R.C. Signal Generators or airborne LF and VHF communication and navigation equipments, CAA Type Certificated for transport or private use.

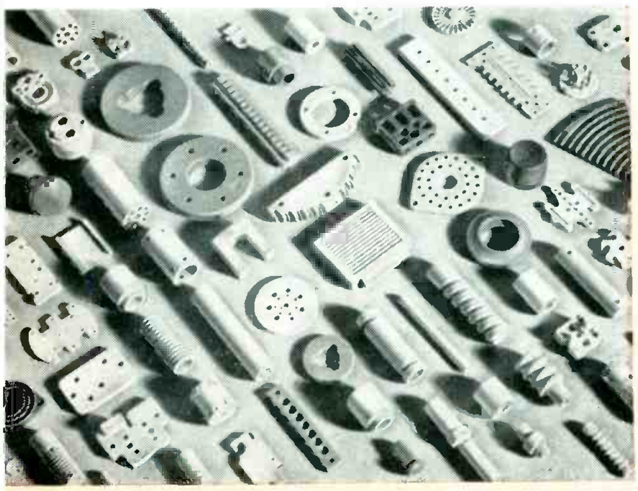
**Aircraft Radio Corporation**

**Boonton, N. J.**

*Dependable Electronic Equipment Since 1928*

# It's a fact that

- The American Lava Corporation has one of the best equipped Research Divisions in the industry. The American Lava Staff has graduate engineers from all leading engineering schools. Ceramic, electrical and mechanical engineers are preponderant but every engineering degree currently being awarded by U. S. Engineering Schools is held by one or more men on this staff.
- Almost every month, the Research Division successfully completes the development of a new AlSiMag composition to comply with special requirements. These developments are in close cooperation with the customer. When requested, all details are kept confidential.
- Continuous operation of kilns at 12 different temperatures, at temperatures ranging from 1400° F. to above 3000° F., permits the firing of each AlSiMag composition at its optimum temperature.



## ALSIMAG

TRADE MARK REGISTERED U. S. PATENT OFFICE

At American Lava Corporation, you are most apt to find the answer to any question involving technical ceramics. American Lava Corporation is composed of MEN who give intelligent, sympathetic consideration to customer problems—backed by specialized experience gained in 49 years of concentrating entirely on custom made technical ceramics. The knowledge of these men is available to you on request. If requested, all customers' information is kept strictly confidential.

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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.

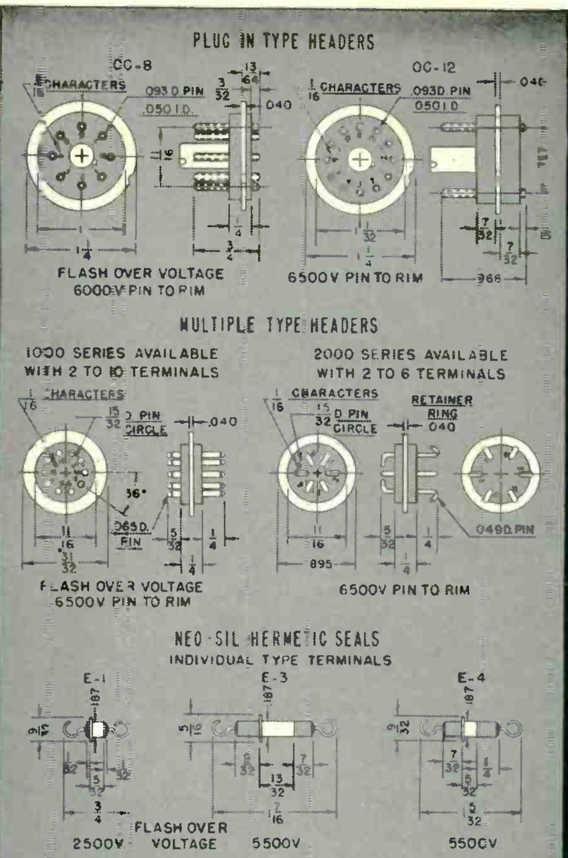

## SPECIALTY PRODUCTS

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 *Megohm-inches* | R.H. 30 percent *ohm-centimeters* |
|---|---|
| $1.4 \times 10^6$ | $3.5 \times 10^{12}$ |

Dielectric Constant and Dissipation Factor

| *Dielectric Constant* | *Dissipation Factor* | *Loss Factor* |
|---|---|---|
| | at 60 cycles per second | |
| 9.22 | .058 | 5.32 |
| | at 1 megacycle per second | |
| 6.17 | .0455 | .28 |
| | at 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.**


# 12.5-AMP THYRATRON

**General Electric's GL-5855 is designed for control work that requires high current capacity . . . toughness and stamina . . . utmost dependability.**

HERE'S a new motor-control tube that handles big currents, and can take the punishment of full-time, heavy-duty operation . . . on through a long life span which squeezes value out of every dollar.

Study the clean, sturdy design. Under the heavy glass envelope is a structure so simple, so inherently braced, that vibration and shocks have little effect. Bolts fasten the tube to the panel, assuring firm support and providing tight, solid electrical contacts.

Cleanness and simplicity go further . . . right through to application needs. No snubber circuit is required. The high commutation factor (200) means that the anode gas absorption from inductive loads is negligible. This makes for long tube life with a straightforward, economical circuit.

To a husky 12.5-amp rating are added high anode voltage, high peak-to-average current ratio, stable control characteristics, and short heating time. This pattern has made the earlier, smaller GL-5544 and GL-5545 popular; assures enthusiastic acceptance for the new thyratron. Also, the GL-5855 has a wide temperature range, making the tube virtually climate-proof.

Wire or write for complete ratings and performance data. Or better, ask for an across-your-desk talk with an experienced G-E tube engineer! *Electronics Department, General Electric Company, Schenectady 5, N. Y.*

## GL-5855

**12.5-amp control thyratron**

| | |
|---|---|
| Filament voltage | 2.5 v |
| Filament current | 34 amp |
| Peak anode voltage, forward and inverse | 1,500 v |
| Peak cathode current | 150 amp |
| Avg cathode current | 12.5 amp |
| Current averaging time | 15 sec |
| Ambient temp range | −55 to +70 c |
| Commutation factor | 200 |

* * *

**NOTE**—Commutation factor is the product of the rate of current decay in amperes-per-microsecond just prior to commutation and the rate of inverse voltage rise in volts-per-microsecond just after commutation.

**GENERAL ELECTRIC**

180-K1

# Looking for trouble before it starts...

## *with an* MB VIBRATION EXCITER

One of the many instruments produced by the Sperry Gyroscope Company is here undergoing a "shake test" on the MB model S-3 Vibration Exciter. Such vibration testing contributes to the dependability in service for which Sperry instruments are noted. The instrument is fastened to the shake table of the exciter, which is controlled from panel. Amplitude, velocity and acceleration are being read directly on an MB Vibration Meter.

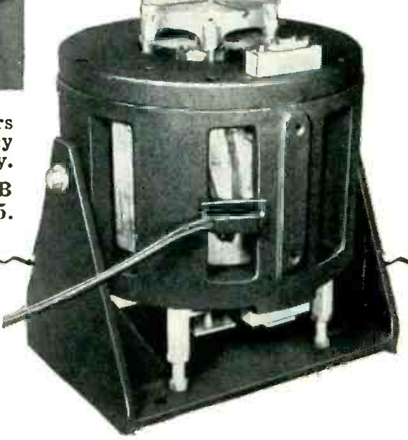
WHEN PRODUCTS GIVE unexpected trouble in service, you'll find too often that it's due to vibration.

Foresighted concerns take no chances with this enemy of equipment life. At Sperry Gyroscope Company, possible troubles due to vibration are ferreted out in the laboratory. By means of an MB Vibration Exciter, which has quick, easy adjustments for force and frequency, instruments are checked for vibratory response – for ability to resist fatigue. Result: Trouble is eliminated in the design stage, *before* it starts.

This shaker is adaptable to countless situations. You can test miniature electrical assemblies to mammoth wing structures; filaments to heavy axle shafts. In one of its jobs – fatigue testing – the shaker reproduces vibratory effect of years within hours. One company, for example, reduced the time of spot-checking bellows to 10 minutes – a job which formerly took 12 hours per unit!

Location of noise sources . . . actual observation of the motions of vibrations . . . study of damping characteristics of materials... these are but a few other important jobs where an MB Exciter pays off.

Models which deliver forces of 5, 25, 50, 100, 200, 300 pounds and higher are now available – all electromagnetic. We'd like to explain the technique of their use in detail, show you how to use one on your own problems. Write us without obligation.



**The Model S3 Vibration Exciter** illustrated delivers peak force of 200 pounds. Operates in frequency range of 3 to 500 C.P.S. Has rotating power supply.

Write us for more detailed information on MB Vibration Exciters, and ask for **bulletin 410 M5.**

**THE MB MANUFACTURING COMPANY, Inc.**

**1060 State Street, New Haven 11, Conn.**

**PRODUCTS AND EQUIPMENT TO CONTROL VIBRATION . . . TO MEASURE IT . . . TO REPRODUCE IT**

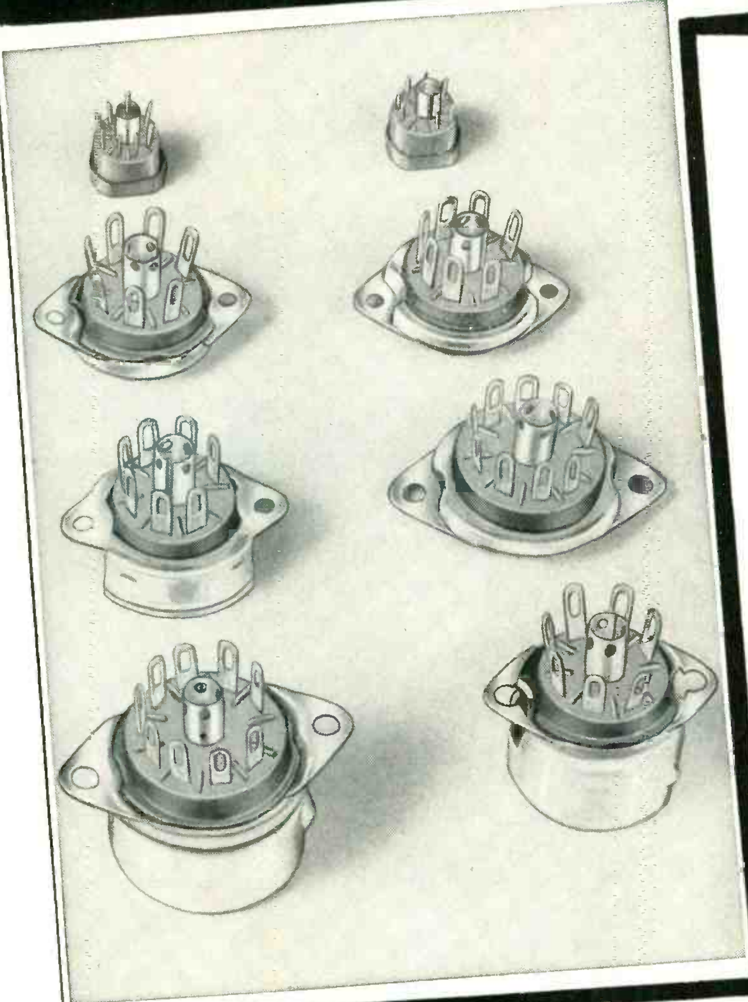
Most Trusted Name
in Picture Tubes...
THE SAFEST PICTURE TUBE IN THE WORLD
Only Zetka utilizes the power-tube method of producing picture tubes. This means custom-processing, long pumping, set-testing. Zetka tubes are superior, more sharply focused, safe. Rectangulars and rounds in 16", 17", 19" and 20"
zetka
zetka
TELEVISION TUBES, INC. 131-137 GETTY AVE. • CLIFTON, N. J.
For 37 years, Zetka has been a respected name in the radio and television industry.

# MYCALEX

## MINIATURE TUBE SOCKETS

### 7-PIN and 9-PIN . . . and SUBMINIATURES

**PREMIUM INSULATION PRICED COMPETITIVELY**



Now MYCALEX offers both 7-pin and 9-pin miniature tube sockets . . . with superior low loss insulating properties, *at new low prices* that offer ceramic quality for the cost of phenolics.

MYCALEX miniature tube sockets are injection molded with precision that affords uniformity and extremely close tolerances. MYCALEX insulation has high dielectric strength, very low dielectric loss, high arc resistance and great dimensional stability.

Produced in two grades: MYCALEX 410 conforms to Grade L4 specifications, having a loss factor of only .015 at 1 MC. It is priced comparably with mica filled phenolics.

MYCALEX 410X is for applications where low cost of parts is vital. It has a loss factor only one-fourth that of "everyday" quality insulating materials, and a cost no greater.

Prices gladly quoted on your specific requirements. Samples and data sheets by return mail. Our engineers will cooperate in solving your problems of design and cost.

**Mycalex Tube Socket Corporation**

*"Under Exclusive License of Mycalex Corporation of America"*

30 Rockefeller Plaza, New York 20, N.Y.

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

**MYCALEX CORP. OF AMERICA**

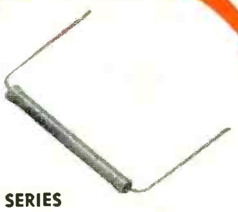
*"Owners of 'MYCALEX' Patents"*

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

# BRADLEY RECTIFIERS *perform as rated!*

YOU CAN COUNT on performance exactly as rated with Bradley rectifiers — whether your requirements involve one unit or a hundred thousand units. Our exclusive vacuum process—as applied to selenium and copper oxide rectifiers — provides the highest type of quality control. You get the rectifier you need, predictably accurate, true to rating and long-lived even under extreme operating conditions.

SPECIAL POWER CONVERSION PROBLEMS — the kind that get you shrugs elsewhere — are challenges that we accept and handle with speed and competence. Bradley has helped many leading manufacturers use rectifiers in new ways that have led to improved product performance. We can help you, too, on either standard or special requirements. If your product involves a rectifier — see Bradley to get the performance desired.



**SE8L SERIES**
Selenium for high voltage uses.

**CX14 SERIES**
Copper oxide for instruments.

**SE11X SERIES**
Selenium for high current uses.

**PHOTOELECTRIC CELLS**

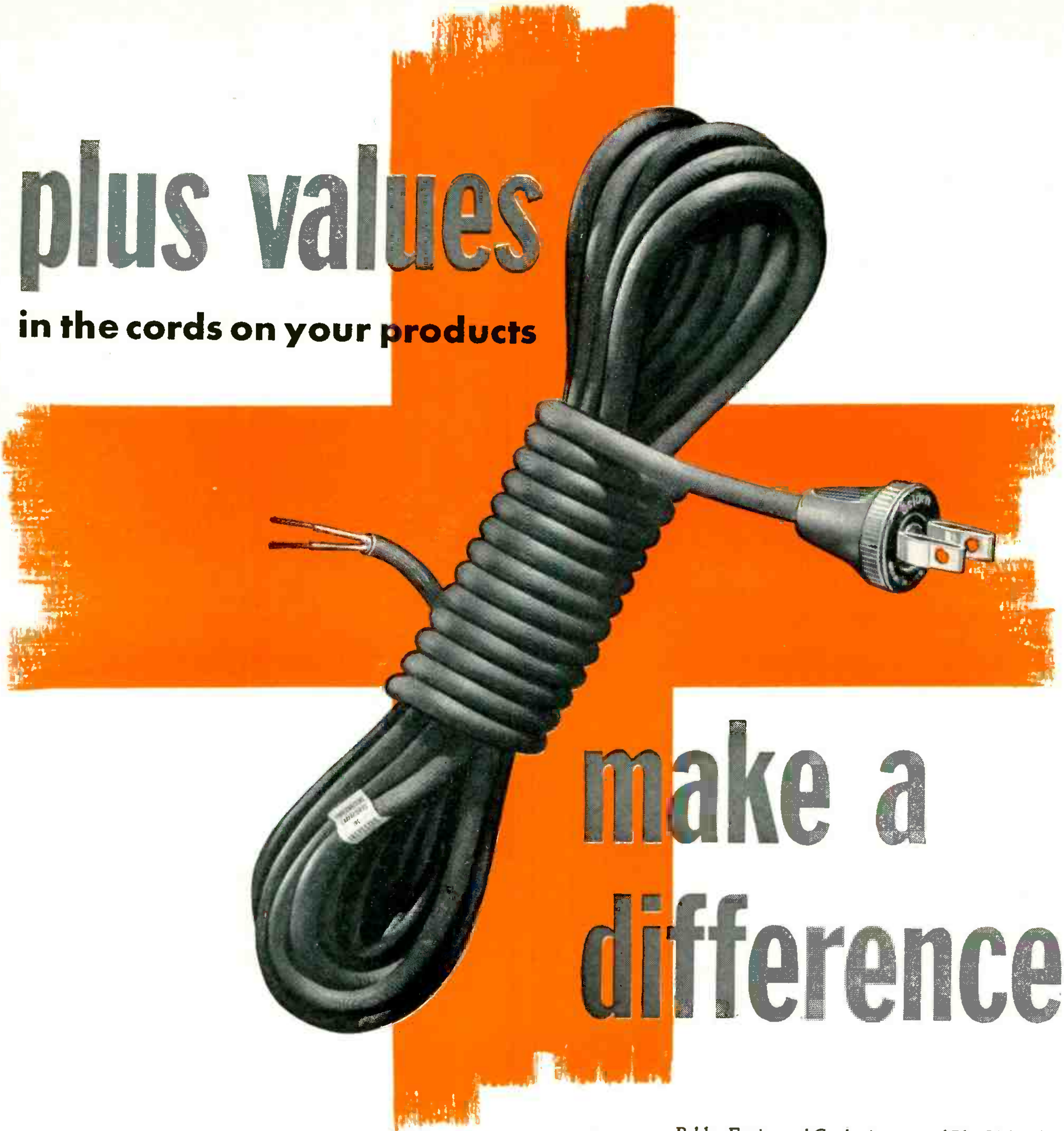
Bradley Luxtron* photoelectric cells convert light directly into electrical energy without external power source. Wide range of models, sizes and shapes available.

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

**BRADLEY LABORATORIES, INC.**
**82 MEADOW STREET NEW HAVEN 10, CONNECTICUT**

# plus values

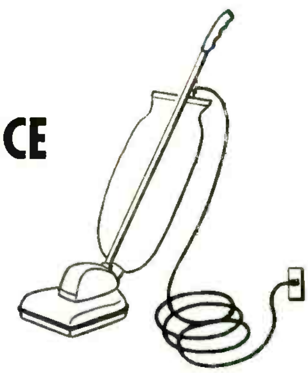
**in the cords on your products**




# make a difference

**a Belden Cord Means**

- **+ SAFETY and APPEARANCE**
- **+ QUICK ASSEMBLY**
- **+ FEWER REJECTIONS**
- **+ LONG LIFE IN SERVICE**



Belden Engineered Cords give you real Plus Values because they are engineered to your product, complete with molded plugs or connectors. They are built far above minimum standards, to give your product a chance to operate without cord failure and to maintain your customer's good will.

All Belden Cords are factory tested to eliminate cord grief—extra assembly operations—rejections—extra cost. Investigate Belden Cords, today. Write

Belden Manufacturing Company
4625 W. Van Buren Street
Chicago 44, Illinois

CORDITIS-FREE CORDS BY

# Belden

WIREMAKER FOR INDUSTRY


ADWAY
BROADWAY
SUNSET BLVD
ARIDGE

# THE CERAMIC CORES THAT PAVED THE WAY TO BETTER TV


**STACKPOLE** *Ceramag*®

- **Lower losses with higher efficiency and lower operating temperatures**
- **Lighter weight, smaller sizes for more compact construction, lower costs of finished equipment**
- **Much higher permeability**
- **Less corona effect**
- **Lower cost**

***Technically,*** Stackpole Ceramag Cores are molded from a metallic oxide powder mixture which, when properly handled during processing, promotes cubic crystal growth. This results in a non-metallic material having low eddy current loss and exceptionally high permeability.

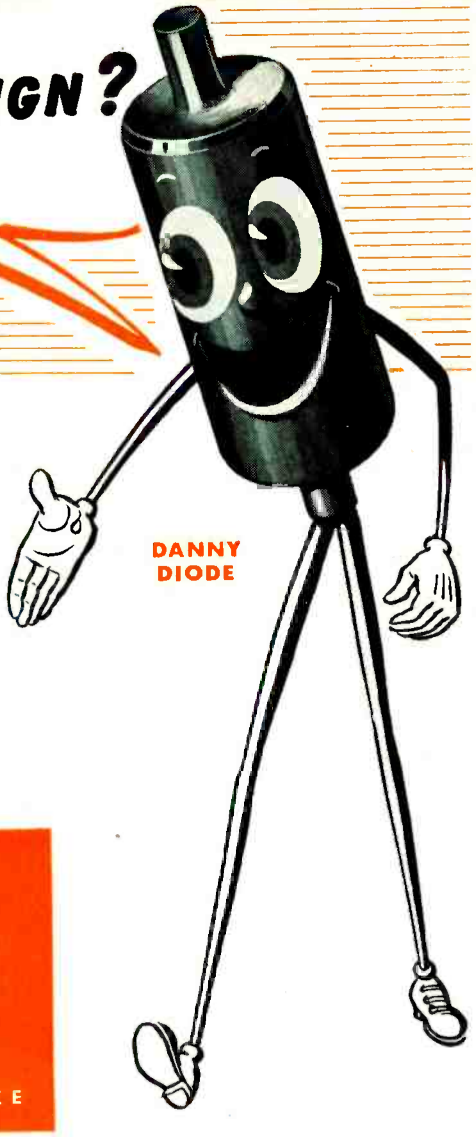
***Practically,*** Stackpole's skill in the highly critical fabrication of these cores in production quantities has resulted in lower costs and higher standards of performance and dependability for the nation's leading television receivers.

Besides the more popular standard Ceramag core types illustrated above, many specials are regularly supplied.

*Electronic Components Division*

**STACKPOLE CARBON COMPANY, St. Marys, Pa.**

# NEED A MIXER FOR YOUR UHF TV CONVERTER DESIGN?




## SPECIFY GENERAL ELECTRIC 1N72* UHF GERMANIUM DIODES

**Designed specifically for the TV market and performance tested for a full year, this low noise, high stability diode is now available in production quantities at new low prices.**

**CHARACTERISTICS:** Low noise factor . . . improved burn-out resistance . . . operation not affected by overloads . . . snap-in design for use with miniature clips to avoid inductive leads . . . input and output impedances approximately 100-500 ohms . . . no contact potential . . . welded whisker construction.

**New Plant Facilities To Meet Total Industry Requirements** —A complete new G-E plant devoted exclusively to the manufacture of diodes is now in operation near Syracuse, New York. These facilities enable us to handle the total industry requirements for UHF television mixer crystals. General Electric application engineers are at your service to help your designers interpret the characteristics of this crystal to your circuit's advantage. For full information, call the G-E electronics office nearest you or write for Bulletin X57-015A: *General Electric Company, Section 411, Electronics Park, Syracuse, New York.*


*formerly designated G-7

### SPECIFICATIONS

**UHF TYPE 1N72 (Formerly Designated G-7)**

**Specifications at 25° C:**

Design frequency . . . . . . . . 500 mc
Useful frequency range . . . . . . DC to over 1,000 mc
Noise figure . . . . . . . . 14 to 19 db*

*Measurements made with Measurements Corp. Model 84 Signal Generator, R.C.A. Model A Converter with 0.7ma 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.

**Maximum Ratings:**

Average rectified current . . . . . . . . 25 ma max.
Peak rectified current . . . . . . . . 75 ma max.
Temperature range . . . . . . . . —50 to +75°C

**. . . Other Applications, Too**

For example, as harmonic generators to provide local oscillator injection from the low frequency local oscillator . . . As detectors in high frequency RF voltage measurements . . . and in low frequency circuits where a low impedance crystal is needed.

### COMPLETE LINE OF GENERAL ELECTRIC WELDED GERMANIUM DIODES

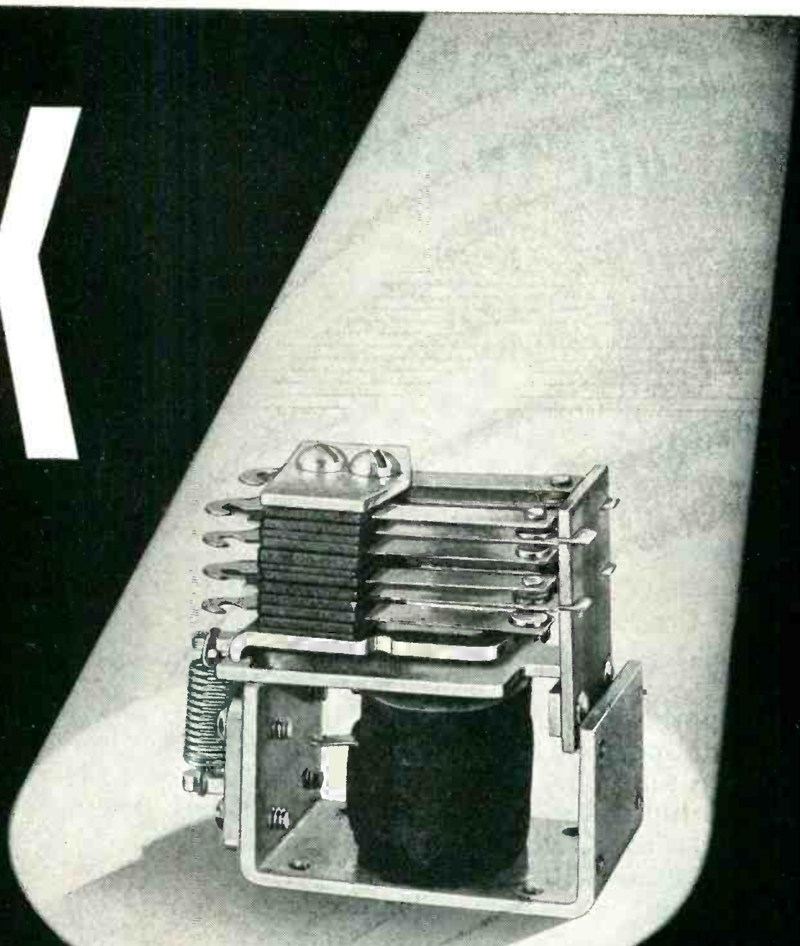
| General Purpose | | Television | JAN | UHF | Quads | Transistors |
|---|---|---|---|---|---|---|
| 1N48 | 1N63 | 1N64 | 1N69 | 1N72 | 1N73 | SX-4A |
| 1N51 | 1N75 | 1N65 | 1N70 | | 1N74 | Z-2 |
| 1N52 | | | | | | |

*You can put your confidence in—*

**GENERAL ELECTRIC**

# PEAK

## IN POWER VERSATILITY QUALITY PERFORMANCE



TYPE PK RELAY

**HERE ARE THE FACTS AND FIGURES:**

**CONTACTS:** 10 amp. standard. 24 volts D.C., 115 volts A.C.
15 amp. contacts available.

**SENSITIVITY:** D.C.: 4 pole 1.5 watts
2 pole .7 watts
A.C.: 4 pole 5 volt amperes
2 pole 2.5 volt amperes
Can also be furnished in 6 pole AC and DC up to 4000 Ohms.

**COIL:** To 115 volts D.C., 230 volts A.C.

**NOMINAL HEAT USE:** D.C. 30°C above room ambient
A.C. 45°C above room ambient

**MAX. INPUT FOR 85° RISE:** D.C. 5 watts
A.C. 11 volt amperes

**MOUNTING:** Base or end mounting

**WEIGHT:** 4.5 oz. 4 P.D.T.

**WEIGHT HERMETICALLY SEALED:** 7.7 oz.

**DIMENSIONS:** Open Relay—2 1/16", 1 1/8", 2 1/16"
Sealed Relay—3 1/8", 1 1/2", 2 5/16"
Overall Mounting Flange—3 1/8"
Center to Center Mounting Holes—2 11/16"

## A Quality Relay

The new Allied PK Relay is designed to offer versatility in a power relay where quality and low cost are factors. Besides stability in operation its reliability allows a range in applications from high quality instruments to vending machines. The PKU relay will comply with Underwriters' Laboratories requirements and can also be supplied hermetically sealed.

**Bulletin PK gives complete details. Send for your copy today.**

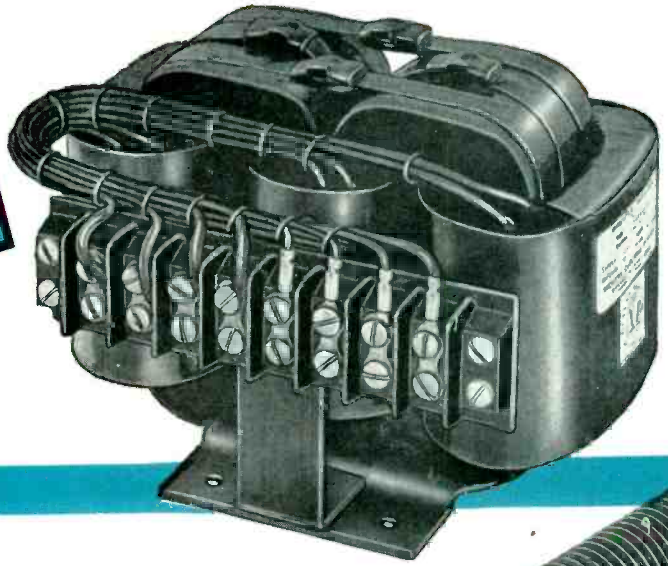
Be sure to send for your copy of Allied's Relay Guide. It gives the engineering data for 27 Allied relays in a concise tabular form for easy reference.

**ALLIED CONTROL COMPANY, INC.** 2 EAST END AVENUE, NEW YORK 21, N.Y.

# Improve Your Controls with

# VICKERS MAGNETIC AMPLIFIERS

SELF-SATURATING

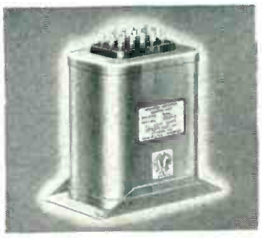


### HIGH POWER

For 60 cps power sources—27 styles—maximum output powers from 62 watts to 4200 watts.

### HIGH PERFORMANCE

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



### HIGH GAIN

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

All amplifiers furnished complete with Vickers special Selenium Rectifiers.

### Now More Than 90 STANDARD Styles Offer These Advantages

- HIGH PERFORMANCE
- NO MAINTENANCE
- RUGGED CONSTRUCTION NO MOVING PARTS
- NO WARM-UP TIME
- A-C OR D-C CONTROL A-C OR D-C OUTPUT
- RESPONDS TO SUM OR DIFFERENCE OF SEVERAL SIGNALS
- ALLOWS ELECTRICAL ISOLATION BETWEEN CIRCUITS

### TYPICAL APPLICATIONS

Servomechanisms — Line-To-Line Voltage Regulators — Hydraulic Transmission Controls—A-C and D-C Generator Voltage Regulators—Speed and Frequency Regulators — Lamp and Furnace Controls—Temperature Regulators—Time Delay Devices.

***WRITE FOR BULLETIN 20-A***

for information on the *complete* line of Vickers Standard Magnetic Amplifiers. Please make request on your letterhead.


VICKERS ELECTRIC DIVISION

**VICKERS ELECTRIC DIVISION**

VICKERS Inc.

**1801 LOCUST STREET • ST. LOUIS 3, MISSOURI**

# 85° BELOW ZERO

**would freeze an eskimo**

**. . . WON'T FREEZE VARGLAS SILICONE**

**SEND FOR THIS FREE SAMPLE FOLDER**

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

# 500° ABOVE

**would roast the devil**

**. . . WON'T ROAST VARGLAS SILICONE**

**Electrical Insulating Tubing and Sleeving lead wire and tying cord**

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

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

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

**Clip and mail this coupon TODAY!**

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

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

Name____________________

Company____________________

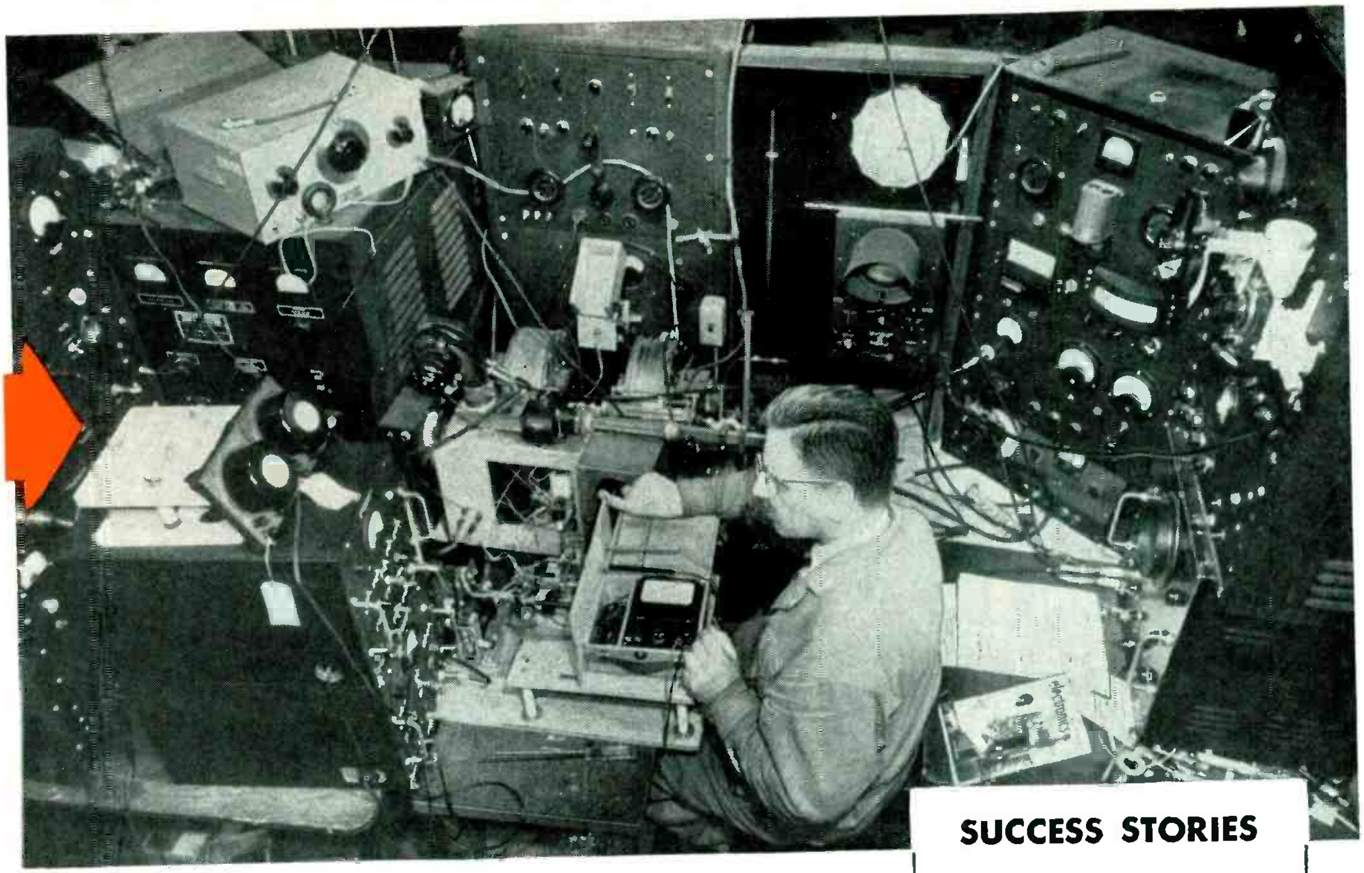
Address____________________

City__________ Zone____ State______

**Varflex CORPORATION**

*Makers of Electrical Insulating Tubing and Sleeving*


OHMS
OHMS PER VOLT
20,000 D.C.
1000 A.C.
SIMPSON ELECTRIC CO.
CHICAGO, ILL. U.S.A.
2.5 V. A.C. ONLY
-10 A.
OUT PUT
A.C.
D.C.
Simpson
500 M.A.
2.5 V. +0 DB
10 V. +12 DB
50 V. +26 DB
250 V. +40 DB
1000 V. 5000 V. +52 DB
100 M.A.
10 M.A. AMPS
100 MICRO AMPS
R×1
R×100
R×10,000
+10 A.
ZERO OHMS
COMMON
MODEL 260
D.C. 5000 V.
A.C. 5000 V.
THE SAME LOW PRICE
$38.95
the Volt-Ohm-Milliammeter
that needs no introduction!



## SUCCESS STORIES

**Following is a partial list of allied products currently being advertised successfully in ELECTRONICS . . .**

- BEARINGS
- BLOWERS
- BOBBINS
- BUSHINGS
- CARBON
- CERAMICS
- COUPLINGS
- DRAFTING EQUIPMENT
- FASTENERS
- GASES
- GEAR TRAINS
- GRAPHITE
- HAND TOOLS
- HEATING TANKS
- INSULATION
- IONIZATION CHAMBERS
- LIGHTING EQUIPMENT
- METAL STAMPINGS
- METALS & ALLOYS
- MOLDINGS
- MOTORS
- MOUNTINGS
- PAPER
- PHOTOGRAPHIC EQUIPMENT
- PLASTICS
- RINGS
- SEALS
- SOLDER
- SOLDERING GUNS
- SPRINGS
- TAPES
- TUBING
- WASHERS
- WIRE & CABLE

# What is YOUR PRODUCT?

With ELECTRONICS' blanket coverage of all industry, it doesn't matter whether your product is a material, component or a piece of electronic gear — a getter or a gear train, a capacitator or a cabinet, a servo or a spring, a motor or a motor control.

Both designers and users of electronic equipment find ELECTRONICS their best source of information. Manufacturers find it their best source of sales to both.

Take instrumentation for example. ELECTRONICS research department recently completed a survey of reader purchasing in that one, only partially electronic field. Returns were from every segment of industry and revealed that 116,395 instruments of 53 specified types are used by the four hundred and fifty-nine respondents. A copy of the complete results is yours for the asking.

Similar documented evidence that ELECTRONICS is not only the market place for all things electronic but also for all manner of other products used in conjunction (allied) with electronic products is available in another survey study we would like to show you, "The ELECTRONICS Audience — What is its buying scope?" Ask your ELECTRONICS representative for details.

*Further evidence is the list at the right showing some of the allied products currently being advertised successfully in ELECTRONICS. Positive evidence of the market offered by ELECTRONICS for your particular product can be obtained profitably by advertising it in ELECTRONICS.*

**— — — A $2,000,000,000 MARKET PLACE**

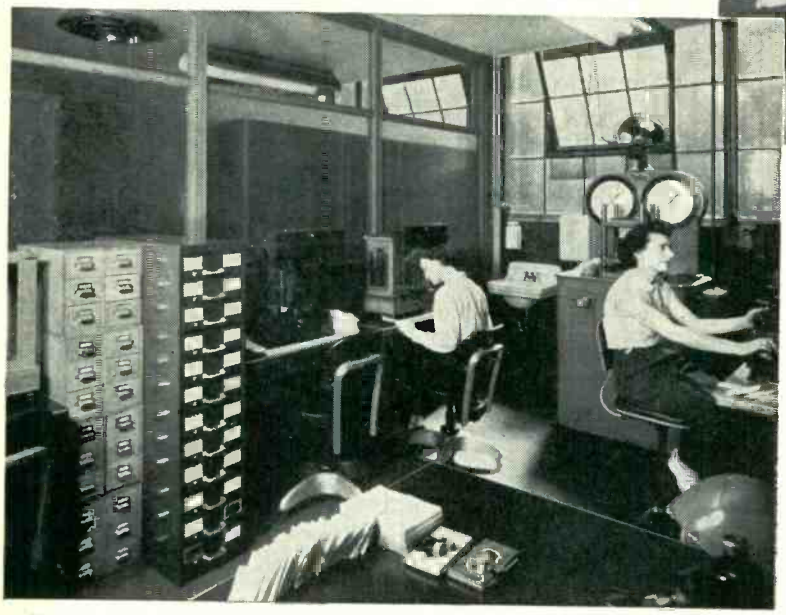

**ANNUAL BUYERS' GUIDE**

supplying all basic product source and technical specifying data

# CARBOLOY
## assures uniform

**1** Pouring molten Carboloy Permanent Magnets from electric furnace at 1600°C. Samples of every melt are checked for physical, chemical, and metallurgical qualities before release for fabrication.

**3** Every Carboloy Alnico Permanent Magnet is subjected to countless quality checks like this flux test to assure you of outstanding uniformity and performance.



**2** As permanent magnets move from one production step to the next, every batch is quality checked and recorded.

**LOOK TO**
**CARBOLOY CO., INC.**
***for the finest in versatile metals***

# continuous quality control Alnico permanent magnets


4 Carboloy's rigid quality tests pay off in uniform high quality Carboloy Permanent Magnets for peace-time uses like this television tube. You are assured of the same high quality for radar and other defense applications.

FOR OVER 22 years the name "Carboloy" has been a synonym for uniformity and outstanding quality with users of cemented carbide. Today, the same exacting standards of quality control that have earned this reputation for Carboloy Company, Inc., are being applied to the production of permanent magnets, (among them Alnico) and other versatile metals, mass-produced for industry.

**Your inquiries or orders for Carboloy Permanent Magnets for use in essential goods will receive immediate attention.**

The trade-mark "Carboloy" identifies manufacture by Carboloy Company, Inc.

**CARBOLOY**
**THE QUALITY BRAND**

**PERMANENT MAGNETS**

**(Alnico and other types)**

GREATER VALUE

# WITH BENDIX ELECTRICAL CONNECTORS

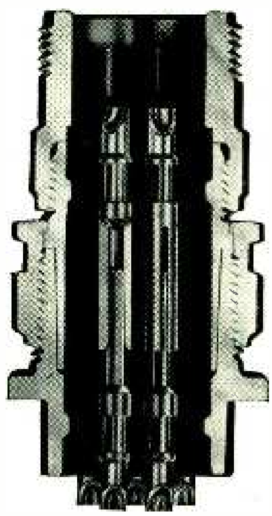
## PRESSURE TIGHT SOCKET CONTACTS

**PLUS**

- Moisture-proof
- Radio Quiet
- Single-piece Inserts
- Vibration-proof
- Light Weight
- High Insulation Resistance
- Easy Assembly and Disassembly
- Fewer Parts than any other Connector
- No additional solder required

Outstanding design and precision workmanship assure completely pressurized electrical connectors for all sizes of contacts. A truly important feature, but only one of the many exclusive advantages that contribute toward making Bendix outstanding in the electrical connector field. Increased resistance to flash over and seepage is made possible by the use of Scinflex dielectric material—an exclusive development of Bendix. In temperature extremes, from −67°F. to +300°F. performance is remarkable. Dielectric strength is never less than 300 volts per mil. Remember, for the greatest value in electrical connectors, it pays to specify Bendix. Our sales department will gladly furnish complete information on request.

**PLUS**



*Pin and socket arrangements available for all sizes of contacts.*

**SHELL**
High strength aluminum alloy . . . High resistance to corrosion . . . with surface finish.

**CONTACTS**
High current capacity . . . Low voltage drop.

**SCINFLEX ONE-PIECE INSERT**
High dielectric strength . . . High insulation resistance.

Bendix

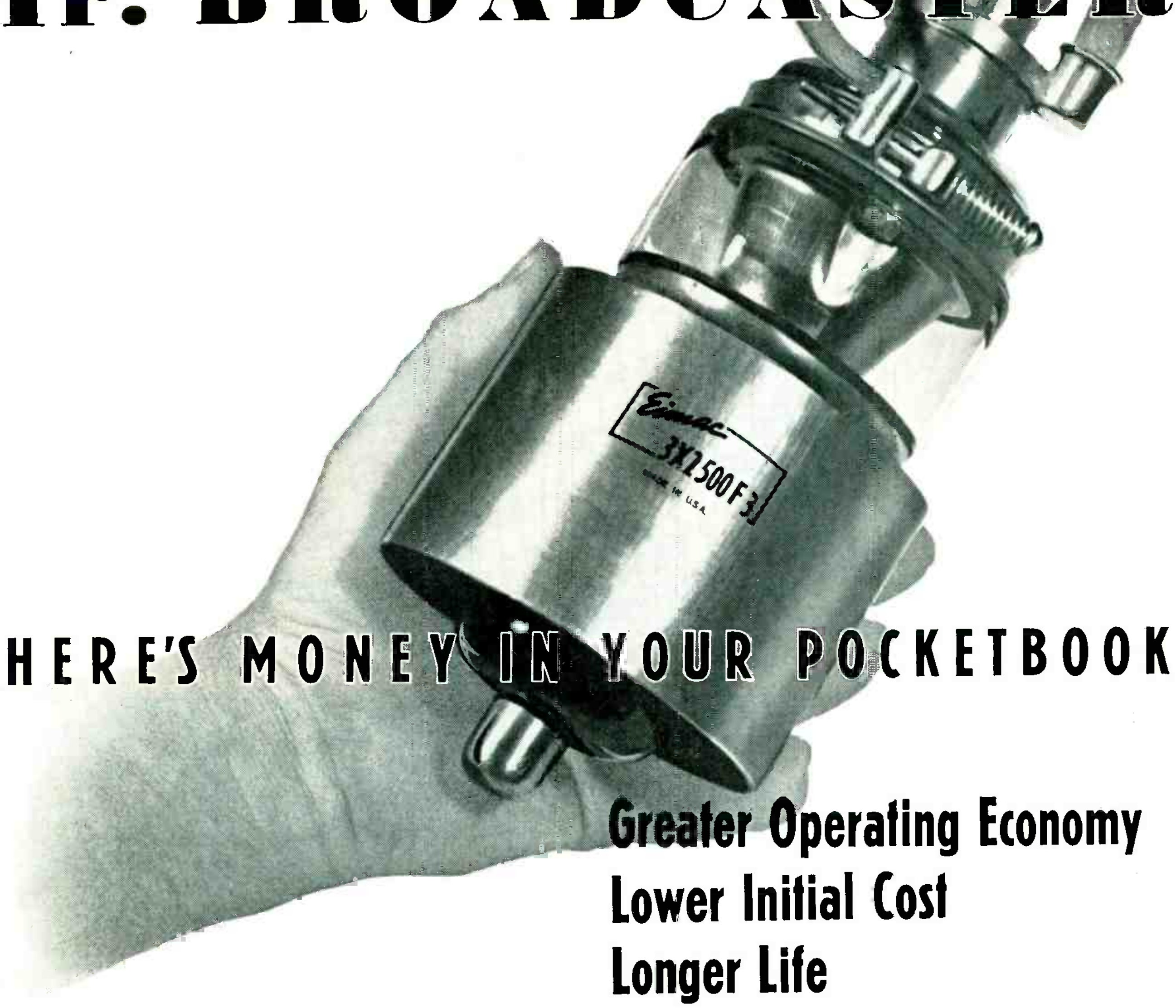
**SCINTILLA MAGNETO DIVISION of**
SIDNEY, NEW YORK

Bendix Aviation Corporation

Export Sales: Bendix International Division, 72 Fifth Avenue, New York 11, N. Y.

FACTORY BRANCH OFFICES:
117 E. Providencia Ave., Burbank, California • 23235 Woodward Ave., Ferndale, Michigan • 7829 W. Greenfield Ave., West Allis 14, Wisconsin.
582 Market Street, San Francisco 4, California

# Mr. BROADCASTER




## HERE'S MONEY IN YOUR POCKETBOOK

### Greater Operating Economy
### Lower Initial Cost
### Longer Life

You save from every angle when you buy and use transmitters employing Eimac tubes. Saving starts with the initial tube cost . . . you save again every hour you're on the air because of higher tube operating efficiency . . . and you save still further by staying on the air more hours without service shutdown.

Take as an example of Eimac tube economy the rugged 3X2500F3 triode pictured above. Initial cost is $198.00 each, yet as power amplifiers they will provide 5 kw output per tube . . . that's lots of watts per dollar cost. The dependability of this tube and its high frequency version (type 3X2500A3) has been proven over many years by thousands of hours of life in AM, FM, and TV service.

These tubes are the nuclei around which modern transmitter circuits have been developed and built.

Let us send your engineering staff complete data on the 3X2500F3 and other Eimac tubes for broadcast service. A letter to us will bring the material by return mail.

249

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

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

BROWN INSTRUMENTS ACCELERATE RESEARCH

| | 27 RPM MOTOR | 54 RPM MOTOR | 162 RPM MOTOR |
|---|---|---|---|
| MAXIMUM TORQUE | Approx. 85 inch-ounces | Approx. 43 inch-ounces | Approx. 19 inch-ounces |
| MAXIMUM POWER | Approx. 6300 inch-ozs. per minute at approx. 17-18 rpm. | Approx. 6700 inch-ozs. per minute at approx. 30-32 rpm. | Approx. 8150 inch-ozs. per minute at approx. 100 rpm. |
| POWER REQUIREMENTS | Line field—approx. 9.5 Watts. Amplifier field—approx. 4.0 Watts. Total power—approx. 13.5 Watts. | | |

*Combines*

# Reversibility and Low Inertia

## ...THE BROWN 60 CYCLE BALANCING MOTOR

Available in the 3 speeds indicated in the table, this totally enclosed and self-lubricated motor is ideal for service where positive positioning is required. Its low inertia eliminates coasting, promotes maximum effectiveness from any dynamic braking. The motor is designed to have a tapered curve of speed versus voltage and, at the same time, to maintain high torque at low speeds. Your local Honeywell engineer is qualified to discuss your application. Call him in, today . . . and write for a copy of Data Sheet #10.20-2. MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, 4428 Wayne Ave., Philadelphia 44, Pa. Offices in more than 80 principal cities of the United States, Canada and throughout the world.

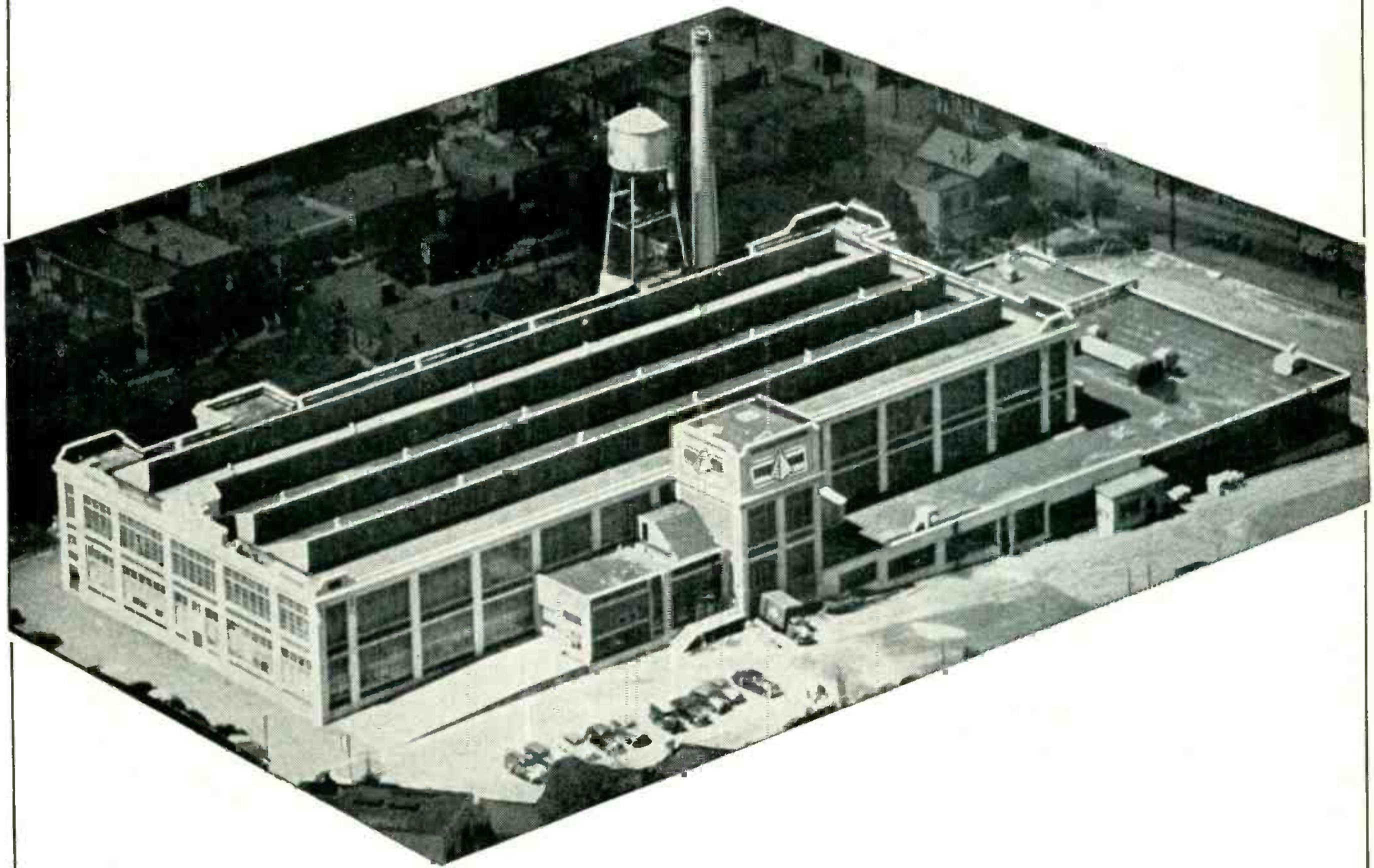
MINNEAPOLIS Honeywell

BROWN INSTRUMENTS

THE **NEW HOME** OF

# PYRAMID CAPACITORS

will be in full operation by **FEBRUARY 1, 1951**



| | |
|---|---|
| **LOCATION** | **1445 HUDSON BOULEVARD, NORTH BERGEN, N. J.** |
| **SIZE** | **137,000 SQUARE FEET** |
| **PRODUCTS** | **ELECTROLYTIC CAPACITORS**<br>**PAPER CAPACITORS**<br>**RF INTERFERENCE FILTERS** |

*Your inquiries are invited*

**PYRAMID ELECTRIC COMPANY**

# BUSINESS BRIEFS

By W. W. MacDONALD

**Audio Fair** has made a place for itself among important annual meetings, national in one sense and local in another. Second shindig conducted under the auspices of the relatively young Audio Engineering Society at the Hotel New Yorker pulled more engineers from greater distances to hear technical papers, had 50 percent more exhibits and a larger overall attendance than in 1949. But local dealer-distributors rented many of the rooms and metropolitan-area hobbyists swelled the gate.

Men and women attending moved in a world consisting largely of corner speakers and magnetic amplifiers, amid weird sounds such as those generated by a showpiece recording aptly entitled "Ionisation" that rattled the rafters. There appeared to be a growing trend toward the use of separate remote-control boxes for high-fidelity amplifiers. Incidentally, the desirability of standardized input and output connectors for such amplifiers is becoming evident.

**Difficulty** of deciding how high high-fidelity should be in new sound system designs is illustrated by the story about a recent listener test in which two units, one cutting off at 5,000 cycles and the other going on up, were compared. A white light indicated when one unit was playing and a yellow light showed when the other was in use. Study of ballots indicated only one thing . . . that people prefer white lights.

Engineers make poor test audiences. Two identical amplifiers were played but when using one of them needle scratch was deliberately introduced into the recording. The technicians assumed that because they heard scratch one amplifier was doing a better job on highs, and voted for it.

**United Nations** has until recently rented American cameras to handle televising of meetings at Lake Success and Flushing. Now, according to H. B. Rantzen, who is Director of the Telecommunications Services Division, British units are being tried out too. Most attractive appears to be a type employing an image orthicon, first because equipment must perform at low light levels and, second, because replacement tubes are more readily available.

Specifications for new electronic equipment for UN Headquarters have been written and requests for bids are not internationally. We understand that there are severe financial restrictions so that it is a question of fitting new gear in with equipment already on hand rather than provision of entirely new systems.

**650 Radio Patents** were the subject of 1,500 suits between 1910 and 1942. Some 35 percent were dismissed or settled out of court, and 30 percent involved consent decrees, validity not being determined. Information regarding the remainder of the suits is obscured in the records.

Of the patents involved, 16 percent were declared valid and infringed, 3 percent valid but not infringed, and 2 percent invalid.

**Public Relations** are very important to a large lab operating in the midst of a nice residential neighborhood near New York. So before shutting down last Christmas eve the timer on a high-power electronic carillon was set to spread carols over the countryside at 2 o'clock the following afternoon. The thing went off at 2 a.m.

**Wayne Coy** of the FCC says there are now 1,200 American ship-borne radar installations.

**A Subscriber** who works for a southern broadcast station has worked out some of the details of an idea that might be useful to chiropractors. He thinks that if low-voltage a-c is applied each side of a patient's backbone amplified bridge output potential might

# The A-B-C's of

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

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

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

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indicate differences in tissue resistance associated with nerve impingement and that this might help when diagnosing spine defects.

**Component Parts** made by electronic equipment manufacturers find their way into an extremely wide variety of end products. Vic Mucher says Clarostat's are used in the following:

Air cleaners
Aircraft de-icer controls
Aircraft wing flap controls
Alarm systems
Analyzers
Antenna dummy loads
Antenna rotor controls
Atomic program
Attenuators
Audio-frequency amplifiers
Audio-input amplifiers
Battery-charging equipment
Battery-testing equipment
Boosters
Cathode-ray oscillographs
Colorimeters
Communication systems
Compasses
Computers
Cyclotrons
Diathermy equipment
Direction finders
Electric dryers
Electrical bridges
Electrocardiographs
Electronic dictation machines
Electronic heating equipment
Electronic sorters and counters
Fire-control apparatus
Fire detectors
Fuel gages
Gas detectors
Graphic recording instruments
Guided missiles
Heat-controlling equipment
Intercommunication systems
Loran navigational devices
Meteorological studies
Microwave amplifiers
Microwave landing systems
Mine-detection apparatus
Monitors
Optical equipment
Power amplifiers
Precision measuring instruments
Radar microwave amplifiers
Radar recording cameras
Radar systems and equipment
Radiation counters
Receivers
Recorders
Rockets
Servo amplifiers
Servomechanisms
Signal generators
Sonar
Sonobuoy
Spectrophotometers
Speech scramblers
Synchroscopes
Transceivers
Transmitters
Transmitter input controls
X-ray cameras

**Advertising** of radio and television sets increased sharply in the last half of 1950. An informal poll of RTMA Advertising Committee members indicates that at least 9 percent more will be spent by the average manufacturer in 1951 than in 1950.

**Reader** who liked our September wheeze about the new AN-system of definitions points out that CU/SBW-8 would indicate the eighth model of a coupling unit for a remote-controlled shipboard carrier pigeon.

**Industrial Television** is already at work, according to Bill Norvell of Remington Rand, in the following applications:

Remote handling of explosives
Adjustment of bombs
Rocket-motor testing
Telemetering
Atomic research
Structural testing of aircraft
Helicopter rotor testing
Teaching of surgery
Navy training programs

Other possible industrial applications of television equipment include:

Observation under water
Microscopic and telescopic observations
Night-watchman operations
Time studies
Manufacturing production control
Department-store merchandising
Sales promotion
Factory training
Transmission of business records
Monitoring of motion-picture sets
Teaching of dentistry
Observation of sports fouls
Transmission of race results
Transmission of weather charts
Traffic control
Civilian defense
Police-record transmissions
Railroad-yard inspection
Reservation information

First widescale use of industrial color television, Norvell thinks, may be in the medical field.

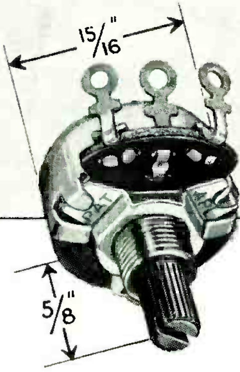
**Rectangular Picture Tubes** represented 47 percent of all cathode-ray tubes sold to television set makers in July, the first month in which detailed statistics were compiled by RTMA. Eighty-four percent of all c-r tubes sold to manufacturers were 16 inches or more in size.

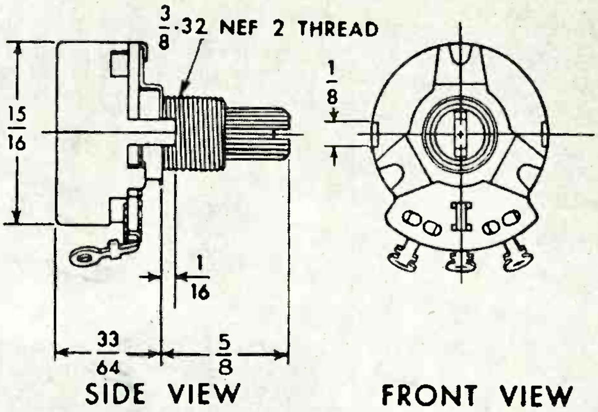
**Business Booster** that might appeal to other distributors of electronic equipment is the Electronic Industrial Equipment Show recently staged for the third time in three years by Sam Poncher of Chicago's Newark Electric. Sam displayed the products of 27 manufacturers in Hotel Stevens rooms, served drinks and smorgasbord, attracted over 1,500 potential customers.

**Gold Bricks** are well known. Not so well known are recently marketed lead bricks simplifying the construction of shielding in radioactivity and other research projects.

**Computer Makers,** we are told, soon learn to think in terms of microseconds and megabucks.

**Service Beyond The Sale!**




### 15/16" MALLORY MIDGETROL*

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

*Trade Mark

# Design Standardization By Mallory

## *effects real customer savings!*

Mallory goes beyond the basic research and development work which results in totally new products . . . and utilizes every opportunity to pass on to customers the savings effected by product standardization.

Such is the case with the well known Mallory Midgetrol. Standardizing its diameter and shaft design resulted in cost reductions for radio and television manufacturers. The standard molded phenolic shaft provides a combination hand knurl and screwdriver slot adjustment at no extra cost . . . and it is available with either 1/4" or 3/8" bushing length. In addition, the Mallory Midgetrol occupies less space than larger controls, with no sacrifice in wattage rating.

*That's service beyond the sale!*

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

Television Tuners, Special Switches, Controls and Resistors

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Electromechanical Products
*Resistors* *Switches*
*TV Tuners* *Vibrators*

Electrochemical Products
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Metallurgical Products
*Contacts* *Special Metals*
*Welding Materials*

# CROSS TALK

► **COBALT** . . . The first real taste of shortage in the electronics industry due to conflict with military needs came last month when the supply of cobalt for civilian production was sharply cut back. Since Alnico 5 magnets are 25-percent cobalt, and since less than 30 days supply of this material was on hand, things looked (and still look) black for production of radio and television sets. An understandable hue and cry arose, to the effect that television and radio production would be shut down tight unless the government relented and diverted cobalt from jet engines to television.

Alnico is used in television sets in focusing magnets, centering magnets, ion traps and loudspeaker fields. Prewar loudspeakers used electromagnets; centering was accomplished by the d-c components in the scanning yoke. Preware electrostatic electron guns required no focusing coil or magnet; early postwar sets used electromagnetic focusing coils.

If and when the Alnico supply is cut off completely, these older designs must be readopted. The principal problem appears to be the focusing unit, which takes several pounds of Alnico and would take several pounds of copper in a conversion unit. While copper is not so scarce as cobalt, purchasing agents report that getting extra pounds of copper for focus coils is out of the question in today's market. So we may be faced with a return to the electrostatic gun, much longer picture tubes and deeper cabinets.

Since a single jet fighter may be worth a lot of television sets in months to come there is little point in screaming bloody murder. But if civilian production is to continue, both government and industry must adopt a cooperative and flexible frame of mind. Engineers must be ready and willing to redesign around shortages quickly and cleverly. The management must be willing to prepare for and pay the cost of such conversions. The public must foot the bill. The government must understand that advance notice of impending shortages is absolutely essential to permit conversions to be ready when the restriction order is issued. Otherwise our industry, and a dozen others essential to defense mobilization, will grind to a standstill before defense orders take up the slack.

► **TURNOVER** . . . Not many years ago, most engineers in the radio receiver business had a well-traveled look and a brand new mortgage, the result of too short tenure in too many jobs. Since the war, the turnover has been slower. Our guess is that the majority of radio engineers now 15 years out of college have been in their present job for at least five years. A record of some sort has been hung up by Mark Glaser of DeWald, who recently completed 20 years as chief engineer of that company. During this time he has designed over a thousand different radio and tv sets.

All of which brings up a question: How many different jobs, or changes of employment, should an engineer in electronics anticipate during his professional life? The different-job-every-year pace that afflicted so many before the war is evidently wrong; it is fraught with insecurity. But is it not also true that the engineer who stays in one company for 20 years (chief engineers excepted) does so at a lower average salary level than the man who makes, say, three changes in that time?

Does the occasional change of job lead to the fuller life, pension rights to the contrary notwithstanding? We solicit opinions, especially from men over fifty (who have had the experience) and under thirty (who may be wondering what the answer is).

► **CURTAIN** . . . About a year ago, we received a letter from a reader who lives in Eastern Europe in which he described an idea for a new type of phototube. In his letter, he explained that he had no means for investigating his ideas, and furthermore, so strict were the rules and regulations behind the iron curtain, that he dared not reveal his identity. This letter was published in the *Backtalk* department of ELECTRONICS. After it appeared in print, we received a letter from engineers of the Rauland Corporation, S. Pakswer and W. O. Reed, who had taken up the idea and had actually built a tube according to the proposed specifications. A series of tests were run, and while the results will probably not change the course of world affairs, they proved that the author's predictions were correct. A detailed account of the findings appears this month on page 126. Our correspondent is anxious to find a place in our industry. Any job offers?

# MILLIMETER

There is a need for tubes and circuits that will operate in the unexploited millimeter wavelength region between microwaves and the infrared. Present unsatisfactory methods using incoherent sources are reviewed and new techniques suggested

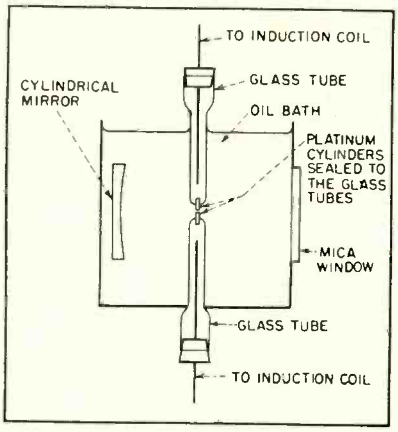



**FIG. 1—Lebedew's 0.6-mm spark oscillator used in experiments at the University of Moscow in 1895**

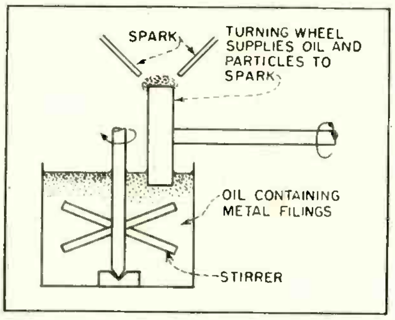



**FIG. 2—Glagolewa-Arkadiewa's source of millimeter waves from which radiations from 129 to 50,000 microns were obtained**

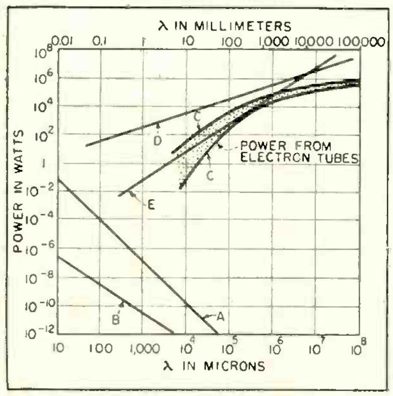



**FIG. 3—Present state of tubes at millimeter wavelengths. The dotted area shows the range of average power output available from electron tubes. Pulsed tubes give higher average powers than c-w tubes**

ELECTRONIC ENGINEERS and physicists have worked extensively with radiations at most wavelengths available in the spectrum. There is, however, a little-exploited gap, that between the longest infrared and the shortest microwaves. This is the region of millimeter waves.

As the physicist pushes his spectroscopic measurements to longer and longer wavelengths, the energy available from his hot source of illumination becomes less and less intense. There is little energy per quantum, not enough to eject electrons, and sensitive photocells give way to heat-detecting bolometers which employ thin wires or films of metals or semiconductors, or to Golay cells which measure heat by the expansion of a small body of confined gas.

Because little energy is available in a given frequency range, carefully designed and efficient lamellar or echelon gratings must be used which conserve all that it is possible to save of the scant energy. Further, energy must be integrated or collected over periods of the order of a second, and measuring equipment becomes sluggish. Finally, at wavelengths of around 1,000 microns or 1 millimeter, infrared spectroscopy peters out.

To pursue their interest at still longer wavelengths, physicists must have more powerful sources of radiation. One possibility is to use incoherent sources of radiation whose properties are similar to the hot-body sources used in the past.

A 60-cycle a-c generator and a vacuum-tube oscillator are coherent sources; they generate a smooth sinusoidal signal of a single frequency. The radiation from an incoherent source consists of many short wave trains of random or unrelated phase. Mathematical analysis or measurement with a spectroscope or a frequency meter shows that such incoherent radiation covers a band of frequencies.

### *Incoherent Sources*

Aside from hot bodies, the most familiar generators of incoherent radiation are spark-excited oscillators such as Hertz used in his original experiments. Indeed, P. Lebedew generated 0.6-mm waves with a spark oscillator at the University of Moscow in 1895 (Fig. 1), and in the 1920's Nichols and Tear generated 0.22-millimeter (220-micron) radiation with a similar device, thus invading the field of the long infrared with an electric generator. More recent spark generators have used tiny ball bearings bouncing between charged electrodes, or a stream of mercury droplets striking an electrode.

Mass radiators have also been used in the electrical generation of incoherent millimeter waves. From 1924 to 1929 Mme. Glagolewa-Arkadiewa of Moscow used a device in which metal particles suspended in oil were carried into a spark by a rotating wheel (Fig. 2) and obtained radiation of wavelengths ranging from 129 to 50,000 microns. Similar work has been carried out by Lewitsky (1924–27) and more recently by Cooley and Rohrbaugh (1945).

The exact mechanism of mass radiators seems somewhat in doubt. Recently H. A. Prime, following a suggestion of Frohlich, dropped copper powder through an arc and obtained enhanced radiation in the vicinity of an ionic resonance of the copper crystal.

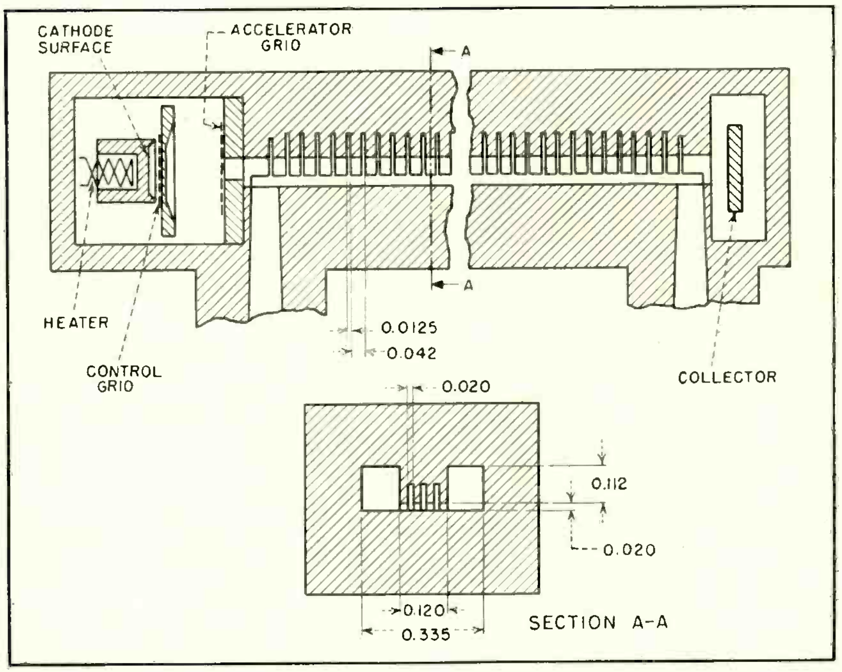
Although spark generators or mass radiators might be used to extend the range of infrared spectroscopy, they suffer from the limitation of all incoherent sources.

# WAVES

By JOHN R. PIERCE

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

The spectroscopist wishes to measure absorption or reflection versus frequency. For finer detail, a spectrometer of higher resolving power must be used and a smaller fraction of the total radiation selected. Thus, the spectroscopist who uses an incoherent source must build a larger spectrometer which will have greater resolution, but he has less energy left to work with as he does so. He envies radio-frequency and microwave spectroscopists who have available sources (electron tubes) which are essentially monochromatic (single-frequency).




Cross-sectional view of a spatial-harmonic traveling-wave tube operating at 1.25 cm

### Need Coherent Source

With a monochromatic or coherent millimeter source, physicists could obtain the higher resolutions they need to untangle the behavior of matter. Physicists are delighted that molecules in vapor form in the atmosphere and molecules of liquids and solids as well absorb millimeter waves for this enables them to study these molecules. Although this pronounced absorption of millimeter waves is something of a nuisance to communication engineers, it is not such as to rule millimeter waves out of consideration for short-range communication through the atmosphere or perhaps even for longer-distance communication through evacuated or gas-filled waveguides. Thus, both physicists and engineers are anxious to obtain electron tubes which will operate in the millimeter range.

Unfortunately, as electron tubes are made smaller to operate at shorter wavelengths, they are harder to build. Circuit losses increase as the square root of the frequency, an irremediable defect which can prevent some sorts of tubes from operating at all. The required small cathodes can scarcely furnish the currents necessary to make the tubes operate. Millimeter-wave tubes thus tend to be inefficient and short lived. But worst of all, the tubes can scarcely dissipate by conduction or radiation the large part of the electric input which is converted into disorganized heat rather than into millimeter-wave energy.

### Spectrum Range

Curve *A* of Fig. 3 shows the characteristics of the radiation per cm² from a black body at a temperature of 5,000 Kelvin for infrared radiation. This is in a frequency range of one percent, which would allow a spectral resolution of one part in 100. Curve *B* is for the same black body at the same temperature but with radiation per cm² lying in a bandwidth of one megacycle, a broad band in terms of radio, but a narrow bandwidth in terms of spectroscopy.

The dotted region of Fig. 3 is intended to include, roughly, the average powers presently attainable with electron tubes, in an easily assimilable form. The spread is partly a confession of ignorance or uncertainty. However, at the shorter-wavelength end of the range the spread is such as to include the average power of pulsed tubes as well as that of c-w tubes. Pulsed tubes tend to have the higher average powers, but their radiation is not monochromatic; it covers a bandwidth of around a megacycle.

Electron tubes as millimeter-wave sources have an advantage beyond that of being monochromatic or coherent; they also give a power tremendously greater than that available from hot bodies for any reasonable bandwidth or resolution. The fact that physicists have been able to use thermal sources at all for measurements, even in the slightly submillimeter range, is a tribute to their care and ingenuity in making slow and painstaking observations.

The other striking feature is the rapidity with which the power output of tubes falls off at short wavelengths, see curves *C* of Fig. 3.

Suppose we consider an electron tube of a given type, say, a magnetron, which has a diameter $D$, which operates at a voltage $V$, a current $I$ and a magnetic field $B$ at a wavelength $\lambda$, and gives at that wavelength a power output $P$. Now imagine that we made a magnetron just half as big in every respect. Suppose the circuit Q (or loss) were unchanged by this scaling (something which will be disclaimed later). If the operating conditions in the following table were observed, the power output would, as indicated, be unchanged.

| | Original Tube | Scaled Tube |
|---|---|---|
| Diameter | $D$ | $D/2$ |
| Voltage | $V$ | $V$ |
| Current | $I$ | $I$ |
| Magnetic field | $B$ | $2B$ |
| Wavelength | $\lambda$ | $\lambda/2$ |
| Power | $P$ | $P$ |

Of several things wrong with this picture, the worst is that of carrying away the heat produced because the tube is not a perfectly efficient converter of direct current into alternating current.

In the scaling process the size is proportional to the wavelength. Moreover, in millimeter-wave tubes the size tends to be comparable with a wavelength. For a given structural part, the heat conducted through it for a given temperature difference is proportional to the linear dimension. Curve *D* of Fig. 3 shows the power conducted through a copper cube a wavelength on a side for a temperature difference of 1,000 C.

Power can also be carried away by radiation, and curve *E* of Fig. 3 shows the power radiated from a black surface a wavelength square at 1,000 Kelvin. It is no coincidence that the available power tends to be low at short wavelengths, where the conducted and radiated powers are small.

### Need for Large Tubes

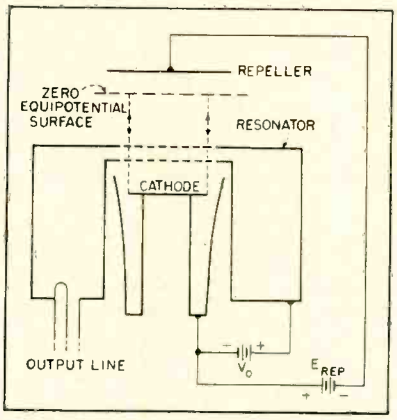
A typical miniature pentode which can be used at a frequency of 500 megacycles is about an inch long. The grid is wound of wire 0.001 inch in diameter, and the spacing between cathode and grid is about 0.002 inch. The following table shows what the dimensions would have to be if the tube were scaled for operation at 6 millimeters (50,000 mc).

| | 500-mc Tube | 50,000-mc Tube |
|---|---|---|
| Length | 1 inch | 1/100 |
| Grid wire diameter | 1/1000 inch | 1/100,000 |
| Cathode-grid spacing | 1/500 inch | 1/50,000 |

This is clearly ridiculous.

The vital circuit portion of a 6-millimeter traveling-wave tube of somewhat less power output scaled for operation at 500 mc, would be 6 inches by 17 inches in cross-section, and 17 feet long, which is equally ridiculous.

All of the tubes used in the millimeter range are large for the wavelengths at which they operate. Klystrons, magnetrons and traveling-wave tubes are used in the millimeter range in preference to triodes not because they are better tubes in any fundamental sense, but because they are large enough to be built and to carry away the heat generated in their rather inefficient operation. If a tube could be evolved whose smallest part or closest tolerance was still larger compared with the wavelength of operation, on these grounds, at any rate, it would be a good candidate for the millimeter region.




**Basic circuit of a reflex klystron, an oscillator which has been used down to wavelengths of about 5 mm**

Besides matters of thermal dissipation and of ease or indeed feasibility of fabrication, two important considerations are cathode current density and circuit loss. If the current density rather than the current were kept constant in going to shorter wavelengths, the current itself would vary inversely as the square of the frequency, and the power would vary accordingly, if the tube would oscillate at all. Usually, a sort of compromise is made, and the cathode current density is raised in going to shorter wavelengths, but not inversely as the square of the wavelength. This compromise tends to degrade the performance of the tubes.

Coupled with this is the fact that the circuit loss varies inversely as the square-root of the wavelength. This, combined with compromises as to current density and feasibility of construction make it hard to build operable tubes of some types (notably, klystrons) for the millimeter range.

Pulsing offers a way out of this dilemma. Momentarily, cathodes will emit large currents, and while the temperature of the parts rises steadily during the microsecond or so of operation, the parts have a chance to cool down again in the interval between pulses. Finally, high-voltage tubes are larger and easier to build than low-voltage tubes, and pulsing enables one to go to high voltages as well as high currents.

### Experimental Tubes

Some of the best tubes in the millimeter range have been pulsed magnetrons. The table below shows some of the results which have been achieved at the Columbia Radiation Laboratory.

| Wavelength in mm | Peak Power in kw | Efficiency in percent |
|---|---|---|
| 6.3 | 30–40 | 15–20 |
| 4.3–4.8 | 5–15 | 4–10 |
| 3.0 | 1–2 | 1–5 |

Even higher frequencies have been obtained as harmonics of the frequency oscillation, the shortest wavelength being 1.45 mm (207,000 mc), as the third harmonic of a 4.35 mm tube. The powers obtained are, however, very small.

The output of a pulsed tube consists of a band of frequencies of width inversely proportional to the pulse length. For some purposes a steady, single-frequency signal is desirable. So far, reflex klystrons have been chiefly used to produce continuous waves in the millimeter region. Tubes operating at several thousand volts have produced several tens of milliwatts at around 8 millimeters wavelength and a few milliwatts around 5 millimeters. Tubes operating at 400 volts have also operated at wavelengths a little longer than 6 millimeters. In this part of the millimeter range, however, resonator losses are so great that the tubes barely oscillate.

While no tubes are completely immune to the bad effects of circuit losses, some, like the traveling-wave tube, suffer less than others. In a traveling-wave tube, a beam of electrons moves along near to a circuit which can guide a slow electromagnetic wave. The electrons are given a velocity nearly equal to that which the wave has in the absence of electrons. If the circuit or the electron stream is excited, the signal is found to increase in amplitude as it travels along the combination of circuit and electron stream. The signal always increases if the circuit and stream are long enough; loss merely makes the increase somewhat less.

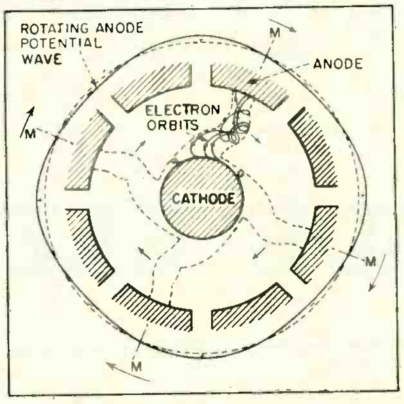
Traveling-wave tubes have been built in many physical forms for many frequency ranges. In the millimeter range, gain has been obtained around 6 mm both with a tube using a helix or coil of wire as a circuit, and also with a more rugged circuit consisting of slots or resonators cut in a ridge of metal.

The traveling-wave tube can be regarded as made up of two systems, each capable of sustaining waves. One is the electromagnetic circuit, which can carry electromagnetic waves. The other is the electron stream, along which waves of charge density, velocity and potential called space charge waves can travel. When one system (the electron beam) moves with respect to the other (the circuit) at such a speed that the backward wave on the moving system is in synchronism with the forward wave on the fixed system, the waves interact or combine to form an increasing wave which gives gain. This suggests using two electron streams of different velocities rather than one electron stream and a circuit.

### Possible Solutions

In the double-stream amplifier, two nearby or interpenetrating streams of electrons of different speeds interact to sustain a wave which increases in amplitude as it travels. This indicates a possibility of obtaining gain at millimeter waves without the fragile and lossy circuits which are used in other tubes. Unfortunately, circuits are still necessary to put the signal onto and take it from the electron stream. This, together with some difficulties in intermingling the electron streams, have so far stood in the way of making double-stream tubes for the millimeter range.

In the double-stream amplifier, the two streams of electrons are drawn from two cathodes held at different potentials. Experimental and theoretical work by Haeff, Macfarlane and others indicates that gain can be obtained when all the electrons come from one cathode, provided electrons in different parts of the stream have different velocities, as they do because of space-charge effects. Both beams of electrons traveling in the direction of a magnetic field, and electrons traveling normal to crossed electric and magnetic fields, as in the magnetron, have been considered. As yet, such single-stream amplification is little explored and imperfectly understood, and it is possible that substantial progress is yet to be made.




Electron paths in a magnetron oscillator, showing spokes formed by bunching effect of r-f fields of the anode

Another device related to the traveling-wave tube is the multiresonator klystron, in which a beam of electrons is shot past or through a series of uncoupled resonators and an increasing wave is so obtained. In one device, the easitron, the resonators are merely a series of half-wave wires, arranged like the rungs of a ladder.

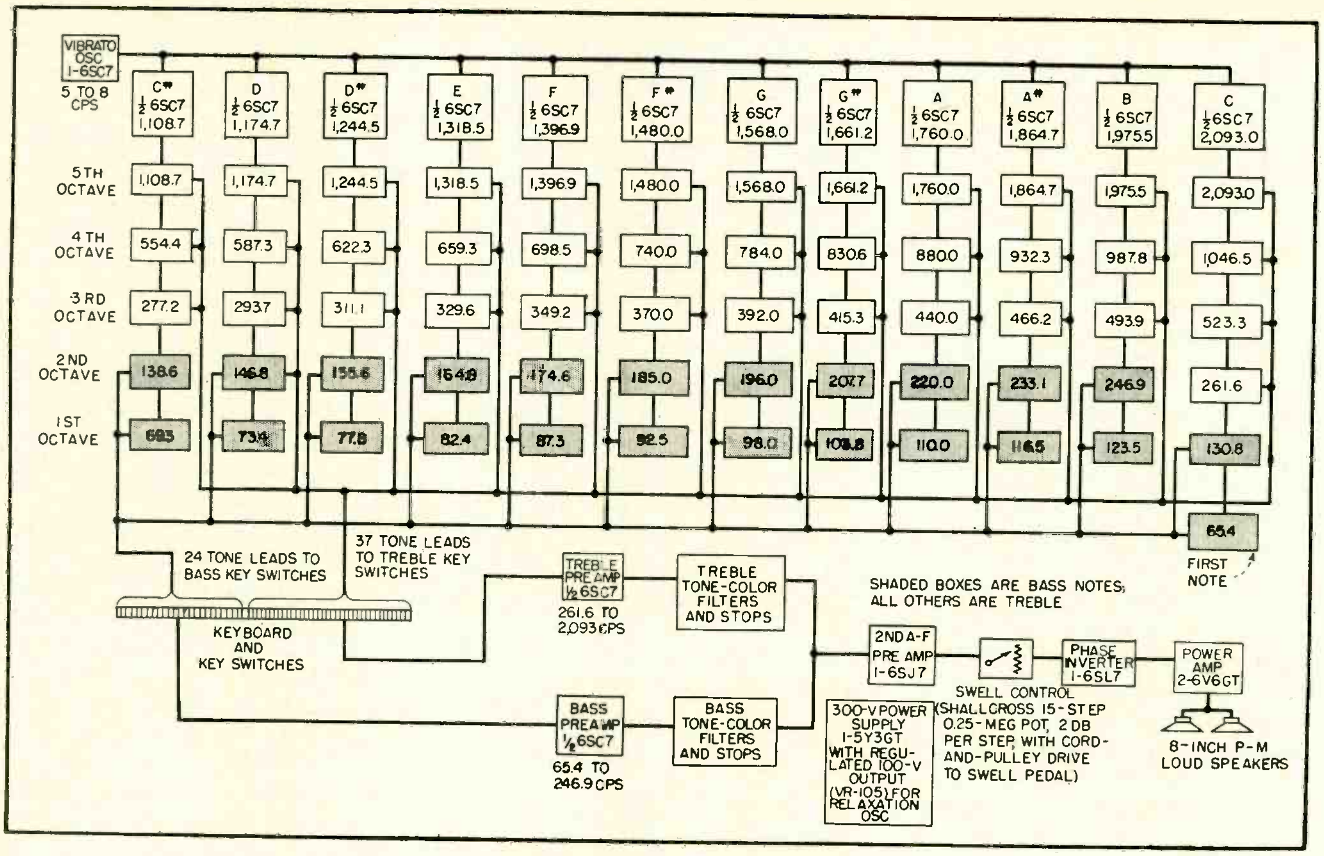
The operation of the traveling-wave tube may be related in some way to the phenomenon of Cherenkov radiation. This radiation takes place when a charged particle moves through a medium at a speed faster than the velocity of light in that medium. In traveling-wave tubes the electrons travel faster than the increasing wave. No more detailed comparison has been worked out. It has been proposed that Cherenkov radiation of electrons traveling close to the surface of a dielectric might form a source of millimeter wave power.

One scheme has been called the "relativistic doppler" method of generating millimeter waves, on which Coleman at MIT has been working. Electrons which oscillate back and forth radiate. If the electrons move toward the observer, the frequency of the received radiation is larger than the frequency of electron oscillation; this is the doppler effect. Suppose a stream of high-velocity electrons is shot between the poles of a series of magnets which alternately produce magnetic fields in opposite directions. These fields deflect the electrons back and forth (normal to the direction of motion) at a high frequency as the electrons travel.

Electromagnetic waves of an even higher frequency will be generated and radiated in the direction of electron motion. Fortunately, it turns out that most of the radiation lies in a narrow cone in the direction of electron motion. While some radiation will be obtained from the individual electrons of a smooth beam, the radiation is greater if the electrons travel through the magnetic field in groups or bunches, and hence it is planned to bunch the electron beam as in a klystron before it enters the magnetic field.

Electrons which circle in a magnetic field radiate at harmonics of the rotational frequency, and this radiation has been suggested as a source of millimeter waves. Finally, various combinations of electron acceleration and slowing of waves by dielectrics have and will be considered.

While the most pressing problem in connection with millimeter waves is that of generation, there are other problems as well. Methods of detection must be somewhat different from those which are used at longer wavelengths. Competing means of handling millimeter waves such as optical, waveguide, and others must be worked out and evaluated. Finally, there is the field of application, in spectroscopy, in communications and in radar.




# GAS-DIODE ELECTRONIC

**Chains of sawtooth tone generators using 10-cent neon lamps are synchronized to master oscillators for frequency control. Undesired harmonics are removed with tone filters to give five octaves of organ-like music with two vibrato stops and six tone-color stops**

ELECTRIC-KEYBOARD musical instruments may be classified into two main groups according to their means of tone production: (1) electromechanical generators; (2) electric-circuit generators. Mechanical systems are either rotary or vibratory. Both means have been used to modulate electrostatic or magnetic fields or beams of light. Electric circuit types have employed both vacuum and gas-tube oscillators as tone generators.

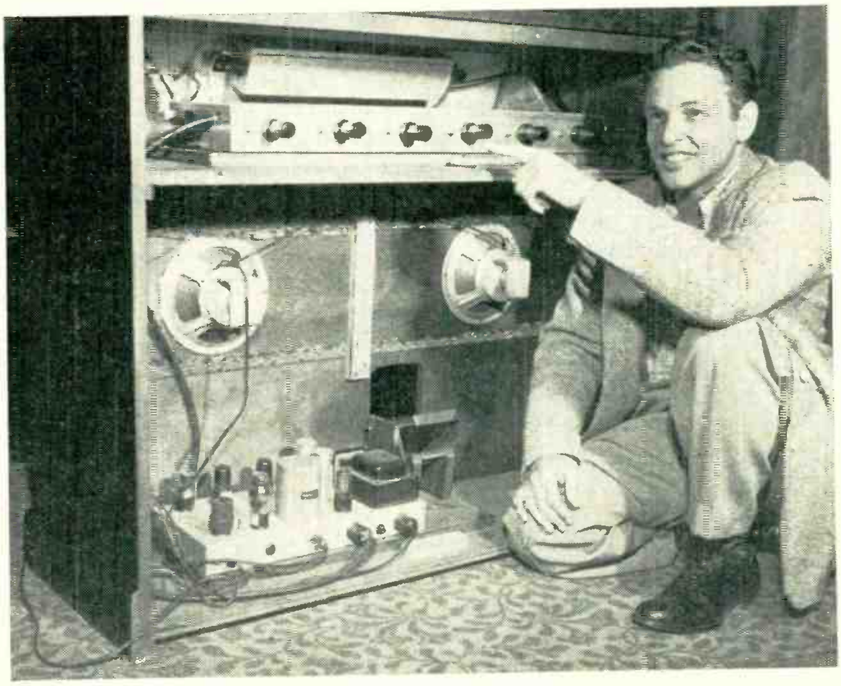
Designers of new instruments have either imitated existing instruments or have devised completely new pleasing tonal qualities and controls. However, one of the greatest complaints against electric instruments is that they are generally too perfect, and therefore unnatural. Variation is the essence of musical expression and variations in pitch, loudness, tone color and vibrato should be within easy control of the musician. On the other hand, too many controls confuse or discourage the performer. In general, new instruments should be easily operated by masters of similar existing instruments.

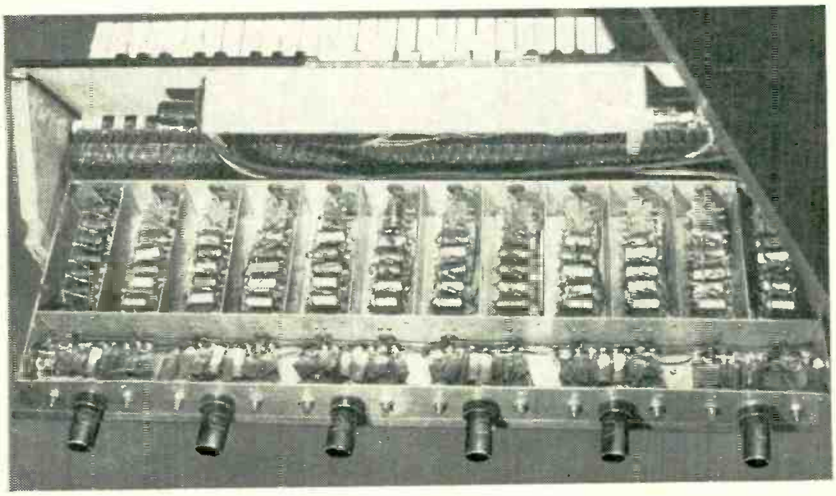
It was required to develop an organ-like electronic instrument that would retail for $800, whereas the cheapest all-electronic organ then available sold for about $3,000. Since mechanical economies in the design and construction of the console and keyboard would classify the equipment as a toy rather than a musical instrument, it was necessary to retain the standard form of the other low-priced organ-like instruments. The main savings were effected in parts and production costs, with minimum sacrifice in performance. A standard organ keyboard of five octaves or 61 notes covering the range from C 65 to C 2,093 cycles is used. The controls consist of eight organ stops; two are used to select vibrato rates and the remaining six are for tone color. A swell pedal is provided for output level or volume control.

The cheapest double-triode vac-

FIG. 1—Arrangement of stages in complete organ. Frequency value in cycles is given for each master oscillator (top row) and each of the 61 synchronized NE-2 neon-tube relaxation oscillators comprising the five octaves. Shaded boxes represent bass notes

TOP: Complete organ being played; CENTER: Rear view of console, showing general arrangement of electronic units; BOTTOM: View of chassis containing the twelve master oscillators and twelve octave chains. Total tube complement is eight 6SC7, one 6SJ7, one 6SL7, two 6V6GT, one 5Y3GT, one VR105 and 61 NE-2 neon diodes





# ORGAN

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uum tube, the 6SC7, lists for $2.00. The cheapest gas diode, the NE-2, lists for 10¢. For this reason, gas-tube methods of tone generation were thoroughly investigated. As it happens, the sawtooth waveform of the gas-discharge relaxation oscillator has a high harmonic content, permitting wide variation in tone color by removing the undesired harmonics with suitable filters. The main difficulty was, of course, with frequency stability.

### *Actual Design*

The block diagram of the complete instrument is shown in Fig. 1. The twelve separately-tuned master oscillators generate continuously the twelve frequencies for the highest of the five octaves provided. For each master oscillator there is a chain of sawtooth tone generators, the first of which is synchronized to the fundamental frequency. Only these harmonic-rich sawtooth generators feed the preamplifiers and tone-color filters; the master oscillators serve only for frequency control and are not heard.

Each master oscillator synchronizes its corresponding submultiple notes in cascade fashion. Of course, octave submultiples are the only frequencies that may be synchronized in a musical instrument, since the others are not exactly related in the equally-tempered scale.

The 61 sawtooth tone generators are continuously in operation, with all their output leads terminating at the keyboard switches. Twenty-four of the generators feed the bass preamp, and the remaining 37 feed the treble preamp. When the musician depresses one or more keys, the corresponding key switches send the tonal combination to the treble and/or the bass preamp. Stops at the control panel select the desired combination of tone color. The bass and treble tone-color filters then separately modify the upper and lower portions of the keyboard and inject their combined outputs at the second preamp grid. The input level to the phase inverter is controlled by a step potentiometer operated by the foot of the performer. The signal continues through the power amplifier to the dual-speaker combination.

The main factors affecting the frequency stability of gas-discharge oscillators were found to be applied voltage and incident light. Voltage was readily stabilized within 2 percent with a VR105 regulator tube. It was necessary to introduce a small amount of light for proper operation at the lower frequencies. This effect was accomplished by placing ordinary six-volt dial lights near the low-frequency gas diodes.

The necessary additional stabilization was obtained by subjecting the tubes to a small electrostatic field at the controlling frequency. By using a portion of the output from one oscillator whose frequency was already under control to synchronize another at a submultiple frequency, octave divider chains were developed. Three or four turns of hookup wire provided sufficient coupling for reliable control within plus or minus 10 percent of the free-running frequency.

Figure 2 shows a typical octave-divider chain. The charging capacitors for the first three stages are connected so that the output voltage to the treble preamplifier approaches −100 volts according to the relation:

$$V = 100\,(1 - e^{-t/RC}) \qquad (1)$$

The time for discharge is extremely short compared with the time required for the voltage to increase from the extinction voltage $V_e$ to the ignition voltage $V_i$, so that the free-running frequency of oscillation is mainly a function of the difference between these two voltages[1]. Substituting $V_e$ and then $V_i$ for $V$ and taking the reciprocal of the difference between the two corresponding values of $t$, the frequency of oscillation becomes

$$f_o = \frac{1}{RC \ln \left(\frac{100 - V_e}{100 - V_i}\right)} \qquad (2)$$

This expression is approximate because $V_e$ and $V_i$ are themselves affected by frequency, incident light, temperature and magnitude of the discharge current.

At the point of ignition, in the first three stages, the output voltage rises very quickly to +100 volts. The last two tubes in the chain, $V_4$ and $V_5$, are connected so that a positive-approaching sawtooth is produced. It was found that the steep time rise at the point of discharge in the negative sawtooth is much more effective in controlling the positive-sawtooth generators than other combinations. Because the lowest frequencies are the more difficult to control, the last two tubes in the chain are both controlled by the steep negative sawtooth. The first three tubes in the chain, $V_1$, $V_2$ and $V_3$, are controlled directly by the master oscillator.

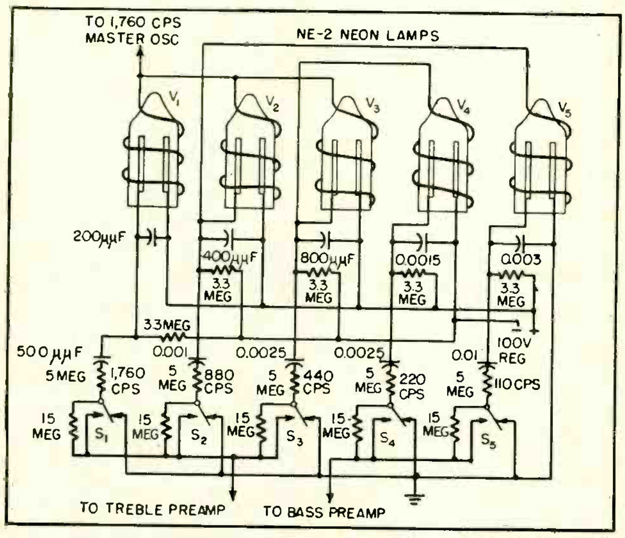


FIG. 2—Example of octave divider chain. For 6-note C chain, sync signals are injected in slightly different order so that the two lowest notes (most difficult to control) are triggered

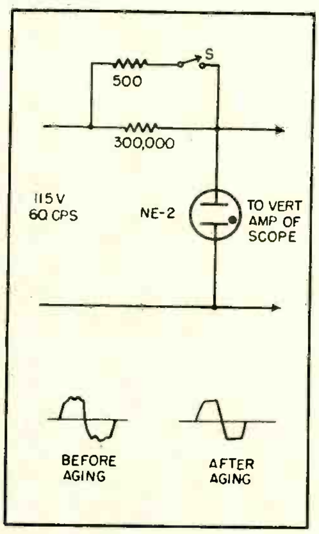


FIG. 3—Neon-lamp test and aging circuit for improving stability of sawtooth oscillators

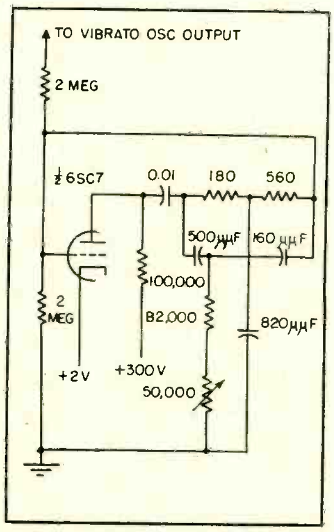


FIG. 4—Typical master oscillator circuit, with component values for the 1,760-cps chain

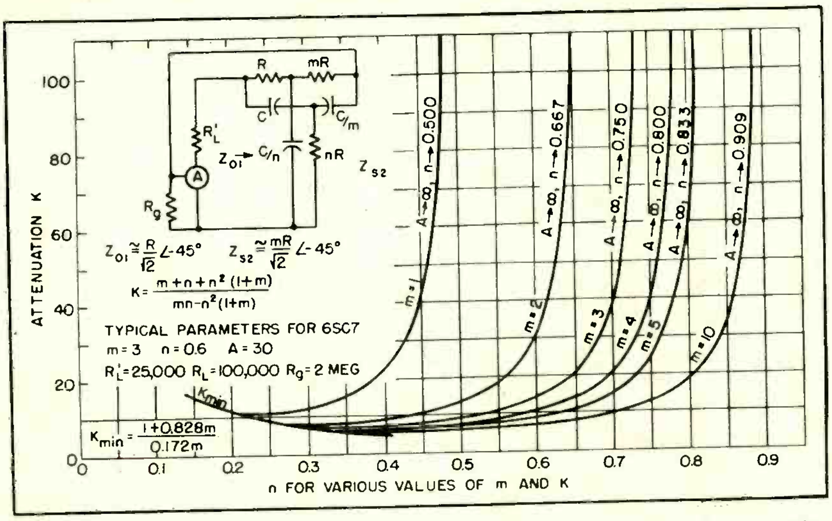

FIG. 5—Design curves for determining parameters of parallel-T networks in master oscillators

The charging resistance was adjusted to about 3.3 megohms in all cases. This value represents a compromise between higher values, which would be more unstable against temperature variations and would limit the discharge current, and lower values that operate the tube too near the border between oscillation and continuous glow. For all other factors remaining constant, Eq. 2 shows that if $R$ is increased, $C$ must necessarily be reduced if frequency is to remain constant. A reduction in $C$ means less energy storage in the capacitor and therefore less discharge current. If $R$ is too low, the charging current will be so high that the tube is unable to extinguish at the completion of capacitor discharge, which results in continuous glow.

Switches $S_1$ through $S_5$ are mechanically linked to the playing keys. When in the up position, these switches ground the outputs of all unplayed oscillators and also parallel the 15-meg resistors from grid to ground of the preamps, giving 0.625 meg and 0.405 meg respectively at the bass and treble inputs. As a key is depressed and the ground connection removed, a 28-db loss of available oscillator output for bass notes and 31-db loss for the treble is momentarily sent to the preamps. When the key has completed ⅔ of its stroke, the 15-meg resistor is shunted, thereby allowing playing level. In this manner the loud transient click that would otherwise be present has been almost completely eliminated.

Despite these precautions against transients, key switches with silver alloy contacts caused considerable clicking. Evidently these high-impedance circuits were extremely sensitive to the slightest oxide coating at the contacts. Even the best silver forms a slight coating under normal conditions. The final switches were formed from Nichrome V wire. Clicking was unnoticeable and these switches have maintained their characteristics for a long period of time.

After the first experimental model had been in use for several months, a few oscillators drifted out of their range of control. It was determined that an aging process within the tubes had taken place. It was observed that the glow in troublesome tubes was irregular and unevenly spread over the electrode area. When these tubes were tested as positive and negative peak clippers in the circuit of Fig. 3 (switch $S$ open), they failed to produce square and symmetrically clipped sine waves. When the switch was closed for several seconds, allowing about 200 ma to flow, the glow started unevenly but gradually spread over the entire area of both electrodes. At the completion of this spread, the switch was opened because continued application of this high current overheats the electrodes and destroys their photosensitive coating. After proper aging, the wave is always symmetrical and squarely clipped. Uniform characteristics throughout the remainder of their life were thereby assured. The experimental model has remained in synchronism for well over a year.

### Master Oscillators

At the frequencies corresponding to the twelve notes in the highest octave, twelve stable oscillators were used to control eleven chains of five notes and one of six to account for the extra C at the low end. Because of its high stability and low parts cost, the parallel-T circuit was chosen. Stabilities of 0.1 percent are possible without supply-voltage regulation. Since only one triode per oscillator is required, two master oscillators may be housed in one double triode tube. Typical circuit constants of the A-chain master oscillator are shown in Fig. 4.

To aid in determining the parallel-T network parameters, the curves for Fig. 5 were plotted from equations already derived[2]. This presentation assumes zero generator impedance and infinite load impedance. Therefore, the network open-circuit input impedance $Z_{o1}$ should be much greater than the generator impedance $R_L'$ and its short-circuit output impedance $Z_{s2}$ should be much less than the load impedance $R_g$ in order that the network balance conditions be least disturbed. After stage gain $A$ has been determined by the tube and load resistor selected, $n$ as a function of $A$ for various values of $m$ may be read directly from the curves.

For sustained oscillation, network attenuation $K$ must be less than stage gain $A$. If there is no loading on the network and constants are to exact tolerance, $K$ could be taken equal to $A$. This is, of course, impossible and for reliable operation, $K$ should not be more than one-half $A$. In most of the literature on the subject, $m$ is taken equal to one.[3,4] It should be noted that increased selectivity as well as decreased $K$ occurs as $m$ is increased.

The more common method of increasing selectivity is to increase $A$ only. With high-mu triodes the upper limit on $A$ is about 35, so that if additional selectivity is desired, increasing $m$ is a convenient method. With these limits in mind the following criteria for the design of a single-stage triode parallel-T oscillator were therefore adopted: (1) $A$ was determined from $\mu$, $R_L$ and $r_p$; (2) $K$ was set equal to $A/2$; (3) the highest value of $m$ that will allow $Z_{s2}$ to remain much less than $R_g$ was selected; (4) $Z_{o1}$ was made much greater than $R_L'$; (5) at the chosen value of $m$, $n$ was found for $K$ calculated above; (6) only points well above the $K_{min}$ curve and below where $K$ changes rapidly with small changes in $n$ were used; (7) $C = 1/\omega R$.

Although the design was time-consuming and the required low-tolerance components are expensive, the production cost per oscillator is less than for other types and stability is comparable with a laboratory standard.

## *Vibrato Oscillator*

Vibrato in most musical instruments is produced by combined frequency and amplitude modulation. However, a rather pleasing effect may be obtained from frequency modulation alone. Figure 6 shows the vibrato oscillator, which is a standard four-section phase-shift variety.[5] Frequency is adjusted to about six cycles per second and is controllable at the stop tabs by simultaneously varying two of the 1-meg resistors in the phase-shift network. Oscillator output is injected through the 2-meg resistors shown in Fig. 4 to the grids of all master oscillators. The extent of the frequency swing or vibrato depth is determined by the amplitude of the injected voltage.

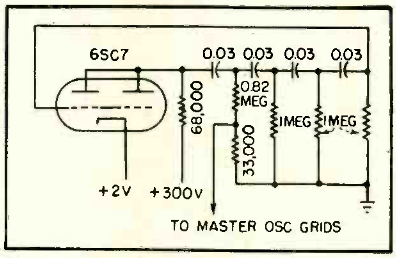


FIG. 6—Vibrato oscillator circuit. Output frequency is approximately 6 cps

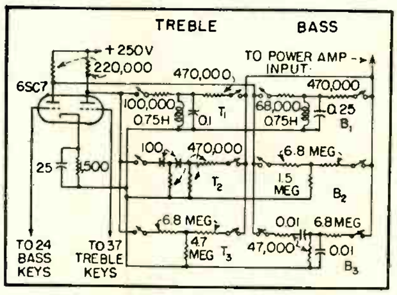


FIG. 7—Bass and treble tone-color filters, each using half of the 6SC7

## *Tone-Color Stops*

The raw sawtooth waveform from the tone generators could hardly pass for music because of its improper harmonic distribution. After this sawtooth has passed through filter circuits that alter its harmonic structure, many pleasing tonal effects are obtained.

The highest note on the keyboard of this instrument is the 32nd harmonic of the lowest. A low-pass filter designed to remove certain harmonics of the treble notes would have negligible effect on bass notes. In like manner, another low-pass filter with a much lower cutoff point would be very effective in coloring bass notes and yet completely attenuate the treble section. If uniform tone color were required, a separate filter for each tone color of each note would be needed. However, few instruments have the same tone color throughout their range.[6,7] A satisfactory tonal balance was obtained by splitting the keyboard at middle C (261 cycles). Two filter sections were provided. The 24 notes below middle C were routed to bass stops or filters and the 37 above to treble stops. When a bass note is played and a bass stop is closed, a tone is produced that in pitch is determined by the note played, in color is designated by the stop closed and is at a level depending on the setting of the swell pedal. Figure 7 shows circuit constants of the tone color unit. One filter in each section is a resonant band-pass type designed to act as a formant-producing element. (Formants are caused by boosting partial tones around a particular resonance frequency.) The others are ordinary R-C networks. These combinations produce horn, string and reed effects. Large amounts of insertion loss were deliberately incorporated in each network in order that output level would be noticeably increased as more stops were closed.

## *Choice of Speakers*

The distortion of the 8-watt amplifier used was held to a minimum consistent with parts cost, but best speaker performance (oddly enough) was realized with one of the least expensive combinations tested. The final choice was a pair of 8-inch p-m speakers, one with a hard cone resonating at 150 cycles and the other soft for a 75-cycle resonance. When these were operated in parallel, their reciprocal damping effects appeared to reduce overall resonance and distortion to a low degree. An 8-watt test signal that produced objectionable distortion in a 25-watt high-fidelity speaker supplied by a prominent manufacturer was easily handled by the 10-watt combination used. The dual system was also chosen because it allowed a more uniform dispersion than could be realized from even a large single speaker.

## *Conclusions*

It was pointed out that the purpose of this project was to design a low-cost, easily-operated organ-like instrument. Low manufacturing cost was accomplished by using inexpensive tone generators whose tiny size lend themselves to small identical subassemblies. Pleasing tone color was the main standard of performance. To this end, comments on the results of listening tests by many musicians and engineers have been most gratifying. Provided reasonable care is exercised in the selection of capacitors and resistors in the parallel-T networks, the instrument should remain in tune indefinitely. Eight organ stops provide 196 combinations of tone color. Any person able to play keyboard instruments can play this instrument with little or no practice.

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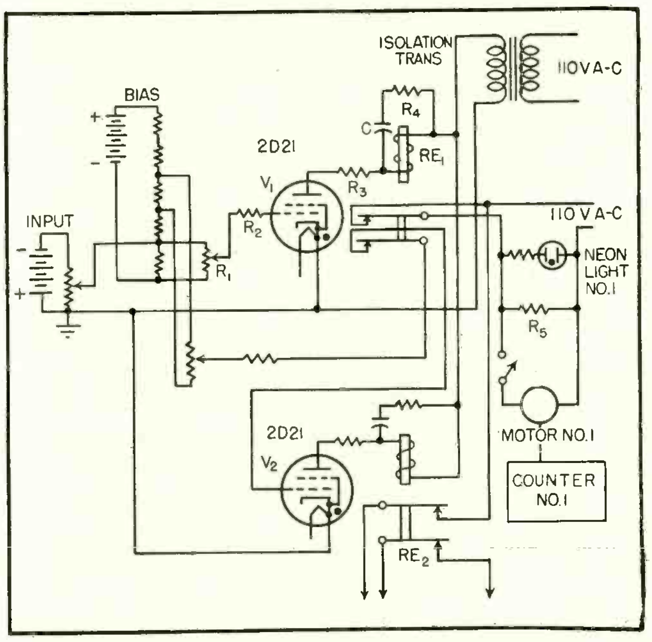
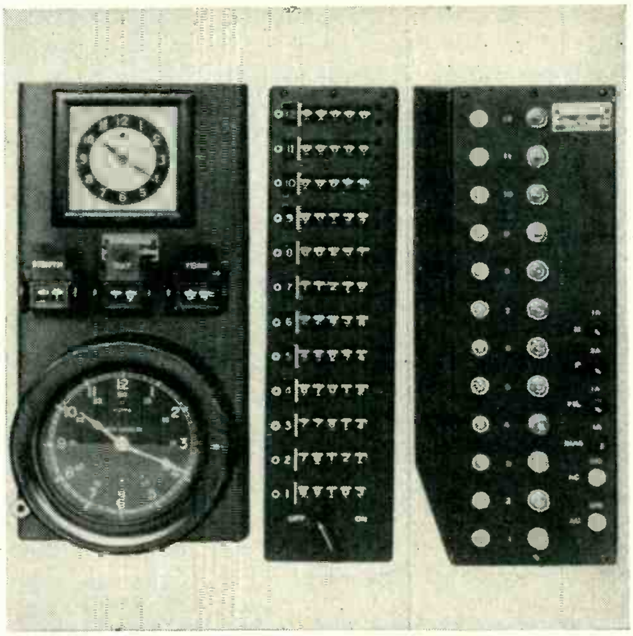



FIG. 1—Simplified schematic diagram of thyratron circuit. Fairly-sensitive, fast-operating standard telephone relays having coil resistances from 2,500 to 14,000 ohms have been used successfully



Mechanical counters (center) show total time signal exceeds each of twelve values as selected and indicated by potentiometers and neon lights in control unit (right). Clock panel is at left

# Signal Strength Analyzer

**System of thyratrons and mechanical counters automatically totals amount of time that any changing d-c voltage exceeds each of twelve chosen values. Provides greater accuracy at fraction of cost and complication of other methods**

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CERTAIN RADIO PROPAGATION studies require continuous records of the percent of time a signal is above, or below, selected values over a range of variation. For example, in measuring television signal strength, it is important to know what percentage of time a usable signal can be received in a certain location.

One method for determining this voltage-time information involves the time-consuming process of going over signal strength recorder charts and adding up the time intervals during which the signal exceeds each level step. The automatic method described here accomplishes the same purpose with improved accuracy and with considerable economy, as compared to other methods. Other applications for the basic principle involved can probably be made to advantage.

The equipment gives a direct reading of the total time that a fluctuating voltage exceeds each of twelve selected values. The total time for each signal level may be read at any desired time interval.

The analyzer is designed for long-term operation. Calibration drift is inherently small. The equipment consists of two units, a control unit and a minute counter unit, the latter showing the total time in tenths of a minute on a separate counter for each voltage level. The counter-operating input voltage is determined by the bias on a miniature type thyratron with associated relay in the control unit. A separate permanent-magnet type synchronous motor, chosen for its fast starting and stopping characteristics, drives each counter.

In laboratory tests, average time measurement errors per on-off cycle have been measured as low as 0.01 second using square-wave keying on one circuit. Under more normal operating conditions, as with an input voltage changing at the rate of about 0.5 volt per second, the error may be as large as 0.1 second per on-off cycle. Test runs were made over various periods of time, from 40 minutes to 24 hours using one on-off cycle per minute.

Input impedance of the control unit is on the order of 1 to 2 megohms, working against ground. When all the thyratrons are cut off, corresponding to maximum input, the input impedance is determined by the overall impedance of the wiring and components to ground. The minimum range of input voltage depends on the use. For signal propagation studies it appears to be on the order of 0 to −15 volts. A larger voltage range will, in general, reduce errors in measurement. Source impedance of the input should be as low as possible and preferably should not exceed 50,000 ohms.

### *Principle of Operation*

The basic functions will be described with reference to the simplified diagram shown in Fig. 1. Thyratron $V_1$ is the first tube to be cut off as the input voltage is raised above zero. A fixed negative bias of something less than 2 volts is obtained from the bias supply and adjusted by means of potentiometer $R_1$ so that an input voltage of the desired value (assumed to be less than 1 volt) will cut off $V_1$.

This de-energizes $RE_1$ which does the following: (1) turns on the synchronous motor driving counter No. 1, (2) turns on the neon light No. 1 to give a visual indication of operation, and (3) connects the input circuit to the grid of $V_2$. Tube $V_2$ has a higher positive bias than $V_1$, hence requires a higher input voltage to cut it off. This operating sequence is carried through 12 stages.

The bias system shown permits an independent and wide range of choice of the input voltage required for operation of each stage. The orderly sequence of operation must be preserved. The fixed bias divider may be eliminated by the use of suitable taps on the bias battery.

Only one thyratron in the conducting condition, which is the only condition in which appreciable grid current can flow, is connected to the input circuit at any time. This fact, and grid resistor $R_2$, keep the maximum grid current flowing in the input circuit down to less than one microampere for normal bias adjustments of a few volts difference between adjacent stages. The conducting condition is maintained by leaving the grids floating when the tubes are not connected to the input circuit. Plate resistor $R_3$ limits the peak plate current to a conservative value. Resistors $R_2$ and $R_3$ are also important in suppressing spurious r-f radiation.

The smoothing filter $R_4$ and $C$, and the series resistor $R_3$, are adjusted to give a minimum differential in grid voltage for on-off operation of the relay.

Stray a-c coupling in the wiring is likely to be sufficient to light the neon light when the counter motor is disconnected and the relay contacts are open. Resistor $R_5$ serves to reduce this voltage, by virtue of the relatively high impedance of the source, to a value insufficient to break down the neon.

The circuit in Fig. 1 can be modified to operate with substantially the same characteristics for a zero to positive input voltage. In this case, the motor-control contacts should be closed when the relay is energized and the grid to the preceding stage should be opened. With zero input voltage, the grids would all be connected to the input and biased beyond cutoff.

A d-c amplifier can be used on the input in those applications where the added instability factor of the d-c amplifier can or must be tolerated.

### *Performance*

The usefulness of the system is determined by (1) its stability with time, (2) the difference in input voltage required to open and close the relay contacts, and (3) the error in time measurement of grid controlled intervals.

The average time measurement error of the present equipment has been found to be less than 1/50 second per time interval, or on-off cycle, for time intervals of a few seconds or more. The fast starting and stopping characteristics of the synchronous motor used account for the small error. This motor has a low-inertia rotor, revolving at 100 rpm, which is damped by a permanent magnet in the field. The above time measurement error will not be detected except with square-wave input.

For maximum long-term stability of this system, the plate supply should be regulated. The 2D21 is relatively insensitive to ±10 percent change from normal heater

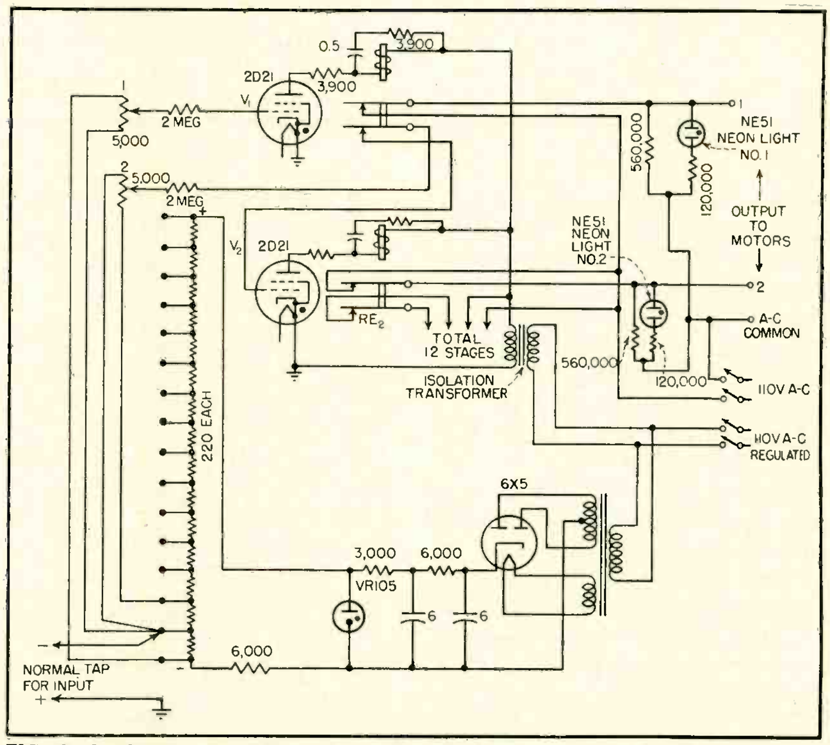


FIG. 2—In the actual equipment, the battery bias supply of Fig. 1 is replaced by an a-c supply as shown

voltage. The tube is operated at conservative values of plate current and should have a long life. The grid operating voltage of the 2D21 is satisfactorily constant over a wide range of ambient temperature. A set of 12 tubes in normal operating service has given satisfactory and trouble-free service during the past year. The bias supply and all resistors must be kept as constant as possible under all conditions.

### Sources of Error

The inherent errors in this measuring system can be made relatively small, as will be illustrated in the following example. Assume a calibration error of ±0.1 volt including operating differential and drift, and a desired maximum error of 0.5 db in a signal recording application. This implies that a change in receiver input of 0.5 db must result in a change of not less than 0.2 volt in the receiver output.

To cover a wide range of signal fading, the receiver output should be a logarithmic function of the input, in which case the output change will be 0.4 volt per db change of input. If the system is calibrated in 6-db steps, starting at 6 db above 1$\mu$v per meter for instance, the 12 steps in the analyzer will accommodate a range of 72 db and require a maximum input voltage of 28.8 volts. In such practice, it is desired to operate the lowest-level stage as low as possible if very deep fading is to be encountered.

The calibration error assumed in the above example is conservative and may be much lower under favorable conditions. During a 7-day test the input voltage required to operate the relay, including the operating differential, was constant to within ±0.06 volt. The line voltage was not regulated and varied between 107.5 volts and 110 volts.

Less than 5 percent of over 100 type 2D21 tubes tested were found to have an appreciable change in operating grid voltage depending on the time the tube was previously in the conducting or nonconducting condition. A half-minute in each condition before checking the on-off operating grid voltage has been sufficient to show this fault.

Hum pickup in the grid circuit of the 2D21 thyratron must be kept at a minimum for optimum operation. This requires some care in the arrangement of the input circuit and wiring The relay should also be so arranged that a separate stack of contacts is used exclusively for switching the grid into the input circuit.

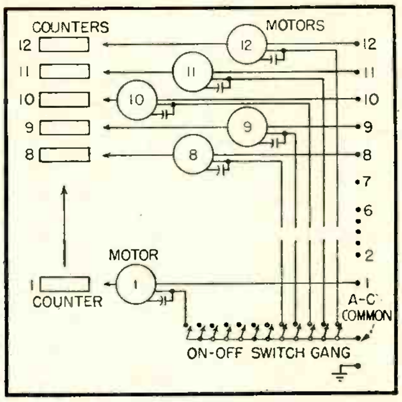


FIG. 3—Separate on-off motor switches are used to eliminate common a-c coupling through motors which would cause all neon lights to light when any motor control relay is closed

### Control Unit

The circuit diagram of the control unit, Fig. 2, is essentially an expansion of Fig. 1 to include the necessary switches, power transformers and an a-c operated bias supply to replace the bias battery used in the simplified version.

A floating, a-c operated, regulated bias supply is used. This supply introduces some hum in the input circuit. The source of this hum is of fairly high impedance and therefore has more serious effects when a high-impedance signal input source is used.

In some cases the hum has been reduced by introducing a compensating voltage to ground from one of the transformer windings not connected to the bias circuit. The electrostatic shield was found to be useless in these transformers. The choice of the a-c plug polarity influences the hum and therefore has an effect on the relay operation and operating differential. An average operating differential not exceeding 0.1 volt was obtained with a 50,000-ohm input signal source.

Tube noise in a signal recording application may give an annoying variation in the signal input operating voltage and operating differential. This is particularly troublesome with weak signals and high receiver gain. A partial remedy may be had in the use of a low-pass filter in the diode output of the receiver. In this case the resulting slower response of the analyzer must be taken into consideration.

### Counter Unit

The counter unit is usually turned off when making calibration adjustments on the control unit. Each motor in the counter unit (Fig. 3) must be disconnected separately to eliminate a common a-c coupling through the motors, which would cause all neon lights to be lighted when any motor-control relay contact is closed.

With five wheels, each counter will register a total of 9,999.9 minutes, or about 166 hours. Zero can be reset manually if desired.

Each counter is driven by its respective motor through a gear system giving a speed reduction of 100 to 1, so the right-hand counter wheel rotates at 1 rpm and reads direct to 1/10 minute. The numbers on the counter wheels are about ¼ inch high. The loads on the motors are so light that they are capable of starting and running backwards if there is a slight chatter in the closing of the relay contacts. This was avoided by means of a simple ratchet stop engaging 4 teeth cut in the hub of the worm mounted on the motor shaft. Thus, if started in reverse, the motor is stopped in not more than ¼ revolution at which point it starts in the forward direction. The maximum resulting error, which will occur rarely, will be about ½ revolution or 0.3-second time lost.

The compact arrangement of the counter unit permits as many as 3 counter units, and a panel containing reference time clocks, to be set side by side so that a photographic record of three measuring systems can be made with one camera. Signal-strength recording systems in use at present employ a 16-mm movie camera with an exposure rate of 1 frame every hour. A synchronous, motor-driven timer turns on flood lights a few seconds before operating the camera shutter. A 7-day clock and a 60-cycle line-controlled clock are used so that errors due to power failures will be apparent.

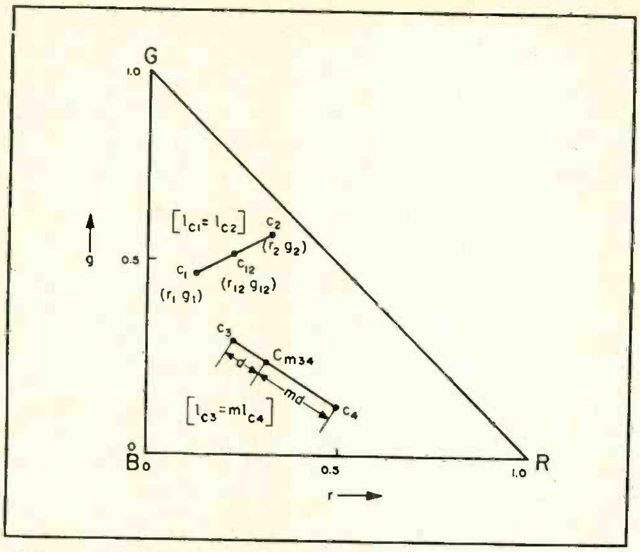


FIG. 10—Color mixture properties of the RGB chromaticity diagram. When two colors are combined, the point representing the mixture color lies on the line connecting the points representing the two combined colors

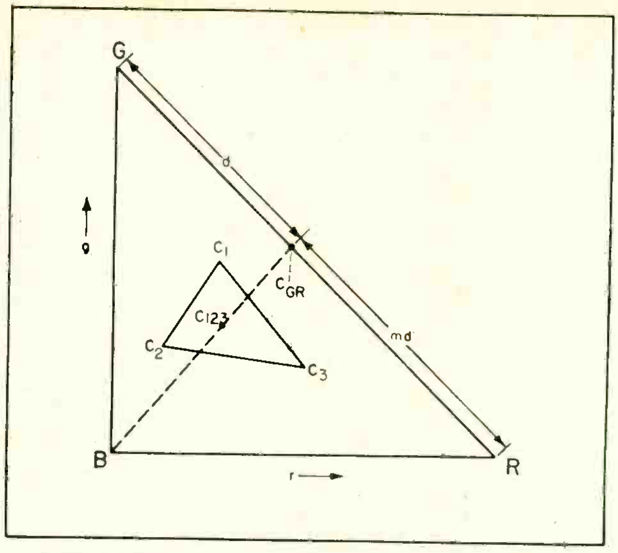


FIG. 11—Color mixture when three colors are combined. If the colors are present in equal amount, the mixture color falls on the center of gravity of the triangle. Dashed line represents finding mixture of primaries to match a given color

# COLOR FUNDAMENTALS

**In this second installment, the color mixture properties of the RGB chromaticity diagram and its transformation to the XYZ form are described. The spectral locus is identified, and the color gamut covered by three primaries is investigated. Specification by dominant wavelength is defined**

**By DONALD G. FINK**
*Editor,* ELECTRONICS

DERIVATION of the RGB chromaticity diagram in terms of colorimeter measurements was outlined in the previous installment. This diagram represents the hue and saturation of all colors that can be matched by combinations of the selected primary colors R, G, and B.

### Mixture Colors on the RGB Diagram

The RGB chromaticity diagram, in addition to providing an array of points whose coordinates represent the hue and saturation of every color capable of being matched by the selected primaries, constitutes a highly useful basis for computing the hue and saturation of mixture colors arising from the additive mixture of any number of other colors.

To show the method of combining colors, consider two colors, $c_1$ having coefficients $r_1$, $g_1$ and $c_2$ described by $r_2$ $g_2$ (Fig. 10). When these two colors are added, *in equal amount*, ($l_{c1} = l_{c2}$) and the resultant mixture color $c_{12}$ is matched against the selected primaries in a colorimeter, as described in Part I, it is found that the coefficients of the mixture color are

$$r_{12} = \frac{r_1 + r_2}{2} \quad (5)$$

and

$$g_{12} = \frac{g_1 + g_2}{2} \quad (6)$$

As shown in the diagram, the point representing the mixture color $c_{12}$ is located at the center of the line joining $c_1$ and $c_2$.

Similarly if colors $c_3$ and $c_4$ are mixed in unequal proportion, such that the flux $l_{c3}$ is $m$ times the flux $l_{c4}$, the mixture color $c_{m34}$ lies on the line joining $c_3$ and $c_4$, but the distance from $c_4$ to $c_{m34}$ will be $m$ times the distance from $c_3$ to $c_{m34}$ shown in Fig. 10.

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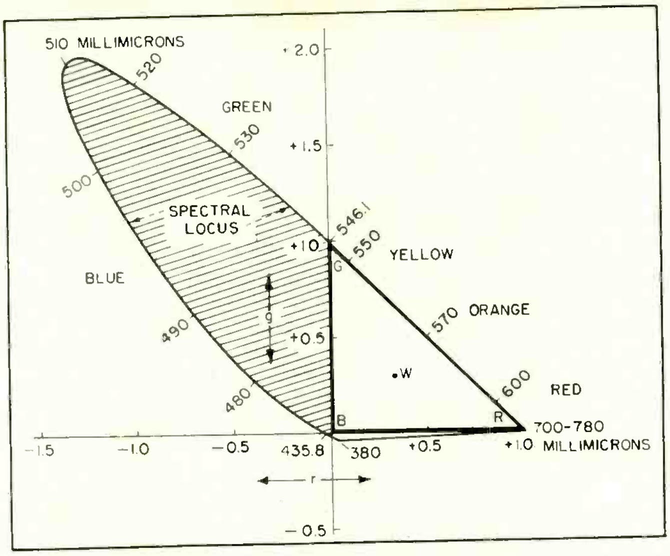


FIG. 12—The spectral locus, shown on the RGB diagram, represents the color coordinates of each color in the spectrum. Numbers on locus indicate corresponding wavelengths

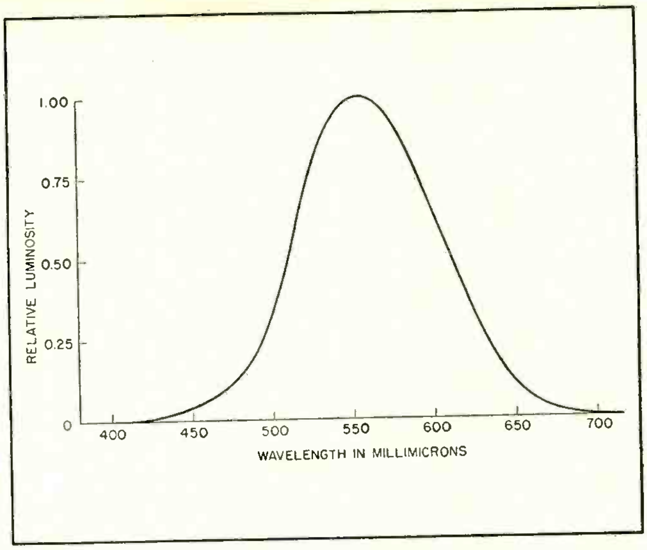


FIG. 13—Relative luminosity of the spectrum colors, as defined by the I.C.I. standard observer. This curve can be used to compute the relative luminosity of different primary colors

# for TV Engineers

**PART II of a series**

When three or more colors are combined, they may be taken in pairs, each pair in the manner of $c_1$ and $c_2$, above. The mixture color $c_{12}$ of this pair is then combined in the same manner with $c_3$ to find a third mixture color $c_{123}$, and so on until all the colors are combined. The same point is ultimately reached, regardless of the order in which the colors are combined.

Figure 11 shows a typical example involving three colors in a mixture. The mixture color $c_{123}$ lies at the center of gravity of the triangle formed by $c_1$, $c_2$ and $c_3$ when all are present in equal amount. When the component colors are present in unequal amount, the mixture-color point lies within the triangle, but the color point is displaced toward the predominant color point or points.

The process of combining primary colors to find the resultant mixture color can, of course, be reversed, so as to find a combination of primary colors which will match a given color. In this case, there is an infinite number of possibilities depending on the relative amounts of the primaries taken. A typical case is shown in Fig. 11. In this case, a line (shown dashed) connecting one primary and the color to be matched is extended until it strikes the opposite side of the triangle RGB. The point of intersection with this side represents a mixture color of the remaining two primaries. The inverse ratio of distances from the intersection point to the apexes gives the relative amount of each of these primaries required to complete the match.

### *The Spectral Locus on the RGB Diagram*

The RGB diagram described has been set up using the I.C.I. standard primaries*, which are spectral colors. Other spectral colors can be located on the diagram, and the line passing through all the spectral points is known as the *spectral locus*. Figure 12 shows this locus, with the wavelengths of the various spectral hues marked on it. It will be noted that the left-hand portion of the figure (shown shaded) lies outside the triangle RGB. This means that the corresponding spectral hues (the saturated blues and greens) cannot be matched by combining the three selected spectral primaries. Rather, these spectral colors can be formed only in desaturated form by combinations represented by points within the triangle RGB. This limitation of matching with primary colors is not a serious matter, because highly saturated green and blue colors represented at the left of the line BG seldom need to be reproduced with high accuracy.

The procedure for finding a point on the spectral locus is as follows: Consider the spectral light of wavelength 500 millimicrons.

To find the corresponding quantities $r$, $g$, $b$ in Eq. 1-3, Part I, we must perform two color matches, one between the primaries and the equal-energy standard white, and the other between the primaries and the 500-millimicron spectral hue, the amount of flux $l_w$ of the white light being equal to the flux $l_c$ of the spectral hue.

* A similar diagram can be based on any three primaries, spectral or otherwise, saturated or desaturated, provided only that each primary cannot be matched by a combination of the other two. If one can be matched by the others, the triangle degenerates into a straight line.

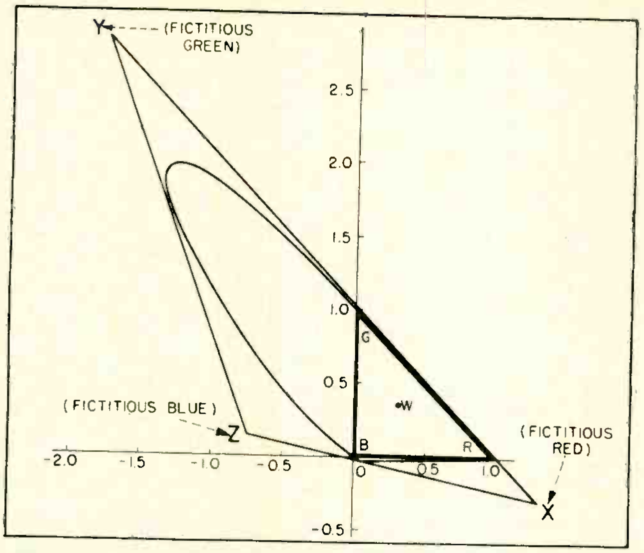


FIG. 14—To transform RGB diagram, triangle XYZ is circumscribed about spectral locus as closely as possible (compare with Fig. 12). Locations of points X, Y and Z are chosen to simplify calculations

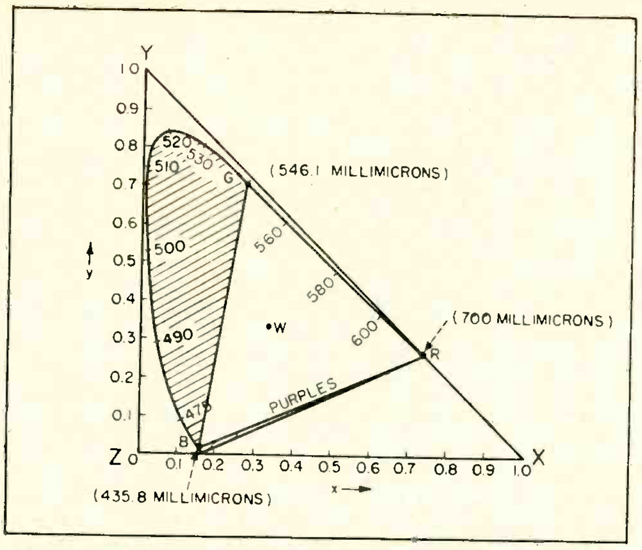


FIG. 15—By use of three linear equations, diagram in Fig. 14 is transformed to XYZ diagram, shown here, thereby eliminating negative values of quantity r. Triangle RGB assumes new shape, but retains color mixture properties of Fig. 10 and 11

The first step is to convert from the power units to light units, that is, to convert from watts to lumens. This conversion is performed with the aid of the "relative luminosity curve", shown in Fig. 13, which gives the response of the normal eye (that of the I.C.I. standard observer) to a given amount of energy of each wavelength in spectrum. The area under this curve is proportional to the number of lumens ($l_w$) produced by a given number of watts of the equal-energy standard white light.

From the same curve we can find the relative luminosities of the standard I.C.I. primaries; these are in the ratio red: green: blue = 1.0:4.6:0.06. Finally, from Fig. 8 (Part I), we can find the relative amounts of the standard primaries required to match the 500-millimicron spectral hue. These are in the ratio red: green: blue = −17:0.40:0.17. Taking the luminosities in corresponding pairs to form the ratios $l_{rc}/l_{rw}$, $l_{gc}/l_{gw}$, and $l_{bc}/l_{bw}$ in Eq. 1–3, we can find the values of $r$ and $g$ from these equations and thus plot the point for the 500-millimicron spectral hue. The negative amount of red light required in the match places the point to the left of the line $BG$, that is, $r$ has a negative value.

The RGB diagram, with the spectral locus, can be used as the basis of color specification, were it not for the fact that the saturated blues and greens lying between the spectral locus and the triangle involve negative values of the quantity $r$. If the negative sign is inadvertently omitted in the specification or computation of a color, the color point has the wrong position. To avoid such confusion, and to simplify color and luminosity computations, the RGB diagram is placed on a new set of coordinate axes, $x$, $y$ and $z$, such that no negative values appear.

### The XYZ Chromaticity Diagram

The transformation from the RGB form to the XYZ form of the chromaticity diagram is illustrated in Fig. 14. The triangle RGB is enclosed by a larger oblique triangle XYZ which fits the spectral locus as closely as possible. The size and position of XYZ are not chosen arbitrarily. The triangle is arranged to enclose all physically-realizable colors, and its shape is such as to simplify computations.

The diagram shown in Fig. 14 is transformed by three linear equations designed to produce, on the $x$-$y$ coordinates, an oblique projection of RGB, such that the triangle XYZ becomes a right isosceles triangle, with point X at $x = 1$, $y = 0$, point Y at $y = 1$, $x = 0$, and point Z at $y = x = 0$. The transformed diagram is shown in Fig. 15. The transformation is so arranged that point W, representing equal-energy white light, appears at the center of gravity of the figure XYZ. We note that there are no negative values in the XYZ diagram, that no value of $x$ or $y$ exceeds unity. The transformation is arranged, moreover, so that $x + y + z = 1$.

The XYZ diagram is the internationally accepted representation of chromaticity values. The hue and saturation exhibited by any light source or colored object, illuminated by a particular light source, can be specified by the quantities $x$ and $y$, which are known as the "trichromatic coefficients" of the specified color. These two coefficients, plus a statement of the brightness, give the complete specification of the color in physical terms.

The transformation from the RGB diagram to the XYZ diagram is a mathematical operation, without physical significance, designed to avoid negative values and to simplify certain calculations. Nevertheless, the XYZ diagram can be given a physical interpretation which serves to fix in mind certain of its properties. In this interpretation, the apex points X, Y and Z are thought of as representing the color coordinates of three *fictitious* primary colors, just as the points R, G, and B in Fig. 14 represent

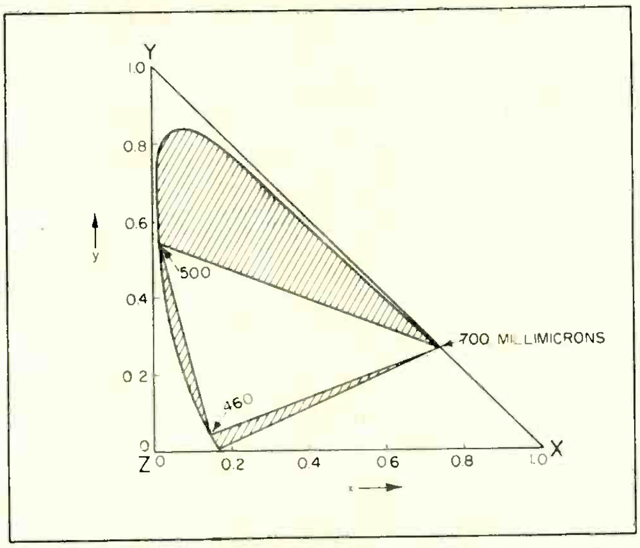


**FIG. 16—If another set of primaries is chosen (spectral colors of 460, 500 and 700 millimicrons as shown), saturated blues can be matched but oranges, yellows and greens, in upper shaded area, cannot be matched**

three actual primaries (the spectral colors of wavelengths 700, 546.1 and 435.8 millimicrons).

Following out this analogy, the X, Y and Z fictitious primaries are such that if they were physically realizable, and were used in a colorimeter to match the equal-energy white light and the unknown color, the amounts of these primaries needed to achieve the match in each case could be inserted in Eq. 1-3 and the quantities $x$, $y$ and $z$ computed directly from these equations.

On this basis, the equal-energy white point should fall, as it does, at the point $x = 0.333$, $y = 0.333$. The line YX represents the locus of all colors which can be matched by combining the X and Y fictitious primaries. None of these colors are real, since the spectral locus falls inside line YX.

We note that all the color-mixture properties of the RGB diagram are possessed by the XYZ diagram. The real colors are those enclosed by the spectral locus. Since this locus is not a closed figure, it is necessary to specify the limit of real colors in the open region. It might be expected that a straight line, joining the red and blue ends of the locus, would represent the limit of all the physically-producible colors in the purple region. Experiment verifies this.

The I.C.I. spectral primaries, located as shown on the spectral locus, form the triangle RGB. This triangle covers only about two thirds of the area enclosed by the spectral locus. Colors represented by points outside this triangle (in the shaded area, Fig. 15) cannot be matched by additive combinations of the standard spectral primaries. These include the saturated greens and blues previously mentioned.

If another set of primaries had been chosen, say spectral hues of wavelengths 700, 500 and 460 millimicrons (Fig. 16), many of the saturated blues could be very closely matched, but the triangle formed by these primaries would not enclose the important region of saturated oranges, yellows and reds. For purposes of color reproduction, it is more essential to reproduce saturated reds, oranges and yellows than saturated blues and greens, since the latter colors occur less often in nature. Accordingly the I.C.I. spectral primaries are a better choice. The filters and phosphors used in color television receivers are chosen to be as close approximations to these I.C.I. spectral primaries as is feasible.

Following further the analogy of X, Y and Z as fictitious primaries, we can specify these primaries by a set of color-mixture curves having the same significance as the mixture curves for the real primaries shown in Fig. 8, Part I. The corresponding curves for X, Y and Z are shown in Fig. 17. These curves completely describe the primaries, and correspond to the choice of the particular points X, Y and Z in Fig. 14. Since the shape of the triangle XYZ is subject only to the condition that it enclose the spectral locus rather closely, the corresponding color mixture curves (known as "distribution coefficients" and designated as $\bar{x}$, $\bar{y}$ and $\bar{z}$) can be chosen in a correspondingly arbitrary manner, to meet the purposes of the RGB-XYZ transformation.

We note that the curves in Fig. 17 are generally similar to those in Fig. 8, with the following exceptions: First, there are no negative values of $\bar{x}$, $\bar{y}$ or $\bar{z}$; on this account no negative values of $x$, $y$ or $z$ occur. Secondly, the area under each curve is chosen to be the same; thus equal amounts of the primaries X, Y and Z are required to match the equal-energy white, for which $x = y = z = 0.333$.

Finally, the shape and ordinate scale of the $\bar{y}$ curve are chosen to be identical to the relative luminosity curve, Fig. 13. Actually these two curves have quite different significance: $\bar{y}$ represents the amount of a green (fictitious) primary color required to match each spectral hue in combination with two other fictitious primaries, whereas the luminosity curve represents the relative luminous effect on the eye of each spectral hue. If these two curves are identical, however, a single computation serves to produce two results, namely the value of the tristimulus coefficient $Y$ (see Eq. 8) of a particular colored light, and the luminosity $L$ of that light.

Thus the three curves in Fig. 17, with the spectral radiation curve of a particular colored light source, serve to make available the complete description of the color in numerical terms, namely values of $x$ and $y$ which specify the hue and saturation, and the value $L$ which specifies the luminosity (brightness) of the color.

To illustrate the manner in which these computations are carried out, consider the color described by Fig. 18A. This is a spectroradiometric curve of a particular color, obtained by measuring (with a bolometer or other radiation-measuring device), the number of watts radiated by the source at each wavelength λ in the visible spectrum. This curve is plotted with its maximum ordinate as $W$ watts. To obtain the trichromatic coefficients of this color we proceed as follows: First we divide the $w(\lambda)$ curve by $W$, thus producing a maximum ordinate of unity. Next we multiply the $w(\lambda)/W$ curve by the $\bar{x}$ curve. The area under the product curve, designated as the "tristimulus coefficient" $X$, represents the ratio $l_{rc}/l_{rw}$ in Eq. 1–3, except that the color match between the color $w(\lambda)$ and the equal-energy white is now understood to be performed with the fictitious primaries X, Y and Z. Similarly, by taking the area under the product of the $w(\lambda)/W$ curve (maximum ordinate unity) with the $\bar{y}$ curve, we find the tristimulus coefficient $Y$ (having the significance $l_{gc}/l_{gw}$), and a similar process involving the $\bar{z}$ curve gives the tristimulus coefficient $Z$ (having the significance $l_{bc}/l_{bw}$).

Stated symbolically, the tristimulus coefficients are:

$$X = \frac{1}{W}\int_0^\infty w(\lambda)\,\bar{x}(\lambda)\,d\lambda \qquad (7)$$

$$Y = \frac{1}{W}\int_0^\infty w(\lambda)\,\bar{y}(\lambda)\,d\lambda \qquad (8)$$

$$Z = \frac{1}{W}\int_0^\infty w(\lambda)\,\bar{z}(\lambda)\,d\lambda \qquad (9)$$

By analogy with Eq. 1–3, the trichromatic coefficients $x$, $y$ and $z$ are then given by

$$x = \frac{X}{X+Y+Z} \qquad (10)$$

$$y = \frac{Y}{X+Y+Z} \qquad (11)$$

$$z = \frac{Z}{X+Y+Z} \qquad (12)$$

From these equations we note that $x + y + z = 1$, and that the maximum value of $x$, $y$ and $z$ is unity, as previously stated.

The luminosity of the color $w(\lambda)$ is given by Eq. 8, since the $\bar{y}$ curve is identical to the relative luminosity curve of the eye. Since the factor converting lumens to watts at the peak of the latter curve is 650 lumens per watt, the luminosity is expressed directly in lumens as

$$L = 650\ W\ Y \text{ lumens} \qquad (13)$$

The integrals in Eq. 7-9 are indicated as covering the whole wavelength range from zero to infinity. Actually, since the $\bar{x}$, $\bar{y}$ and $\bar{z}$ curves are zero outside the visible range from 380-780 millimicrons, the integration need not be carried outside these limits.

### Specification by Dominant Wavelength

The values of $x$ and $y$ specifying the hue and saturation of a particular color, while of great value in technical specification, have the disadvantage that they offer no direct clue to the spectral hue which most nearly describes the color represented. Thus a color described by the wavelength 550 millimicrons is more clearly recognizable than the same color described as $x = 0.3$, $y = 0.7$. To avoid this difficulty, an alternative specification of a color can be taken directly from the chromaticity diagram.

This specification is in terms of the *dominant wavelength* (or dominant hue), the *purity*, and the *luminosity* of the color. To find the dominant hue and purity of a color, we pass a line through the point $C$ representing the color and the point $W$ representing the equal-energy white light and extend this line until it intersects the spectral locus, as shown in Fig. 19. The wavelength corresponding to the point of intersection is defined as the dominant wavelength of the color, and the corresponding spectral hue is the dominant hue.

The purity $p$ is a measure of the saturation of the color, that is, of the distance from its point to the white point, and is given by

$$p = 1 - 0.333\left(\frac{1 - y_s/y_c}{0.333 - y_s}\right) \qquad (14)$$

where $y_c$ is the $y$-coordinate of the color and $y_s$ is the $y$-coordinate of the intersection with the spectral locus. The purity ranges from 0 to 1. For example, color point $C$ in Fig. 19 has a dominant wavelength of 560 millimicrons and a purity of 0.69.

From Eq. 14, colors near the

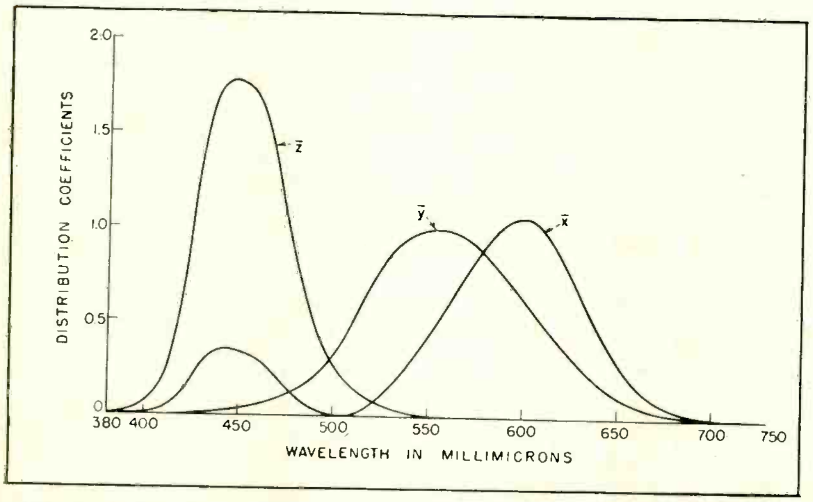


FIG. 17—Color mixture data ("distribution coefficients") for the fictitious primaries X, Y and Z. These have the same significance as the color mixture data for the real primaries R, G and B, shown in Fig. 8, Part I

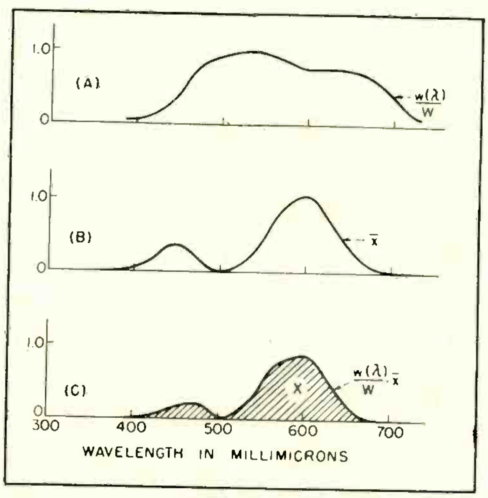


FIG. 18—Method of combining spectral radiation curve of light source with distribution coefficient to find tristimulus coefficient X

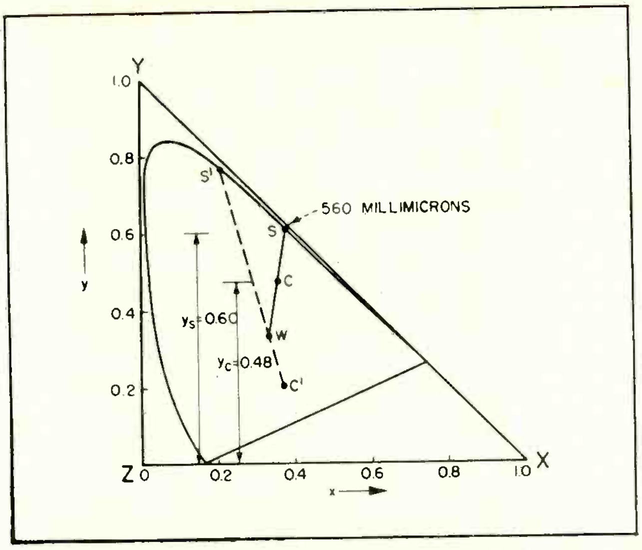


FIG. 19—Specification of color by dominant wavelength and purity. Line, passed through white point and color point to be specified, is extended to locus. Wavelength of intersection is dominant wavelength

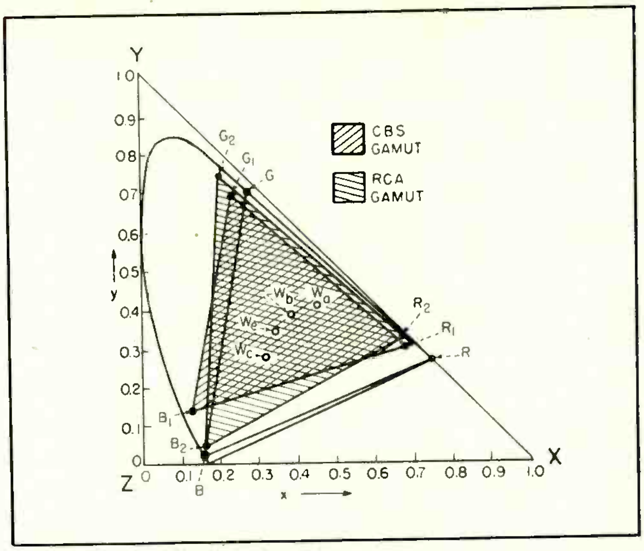


Fig. 21—Color gamuts of the CBS and RCA color television systems, as proposed to the FCC during the recent hearing, compared with the range covered by the standard spectral primaries

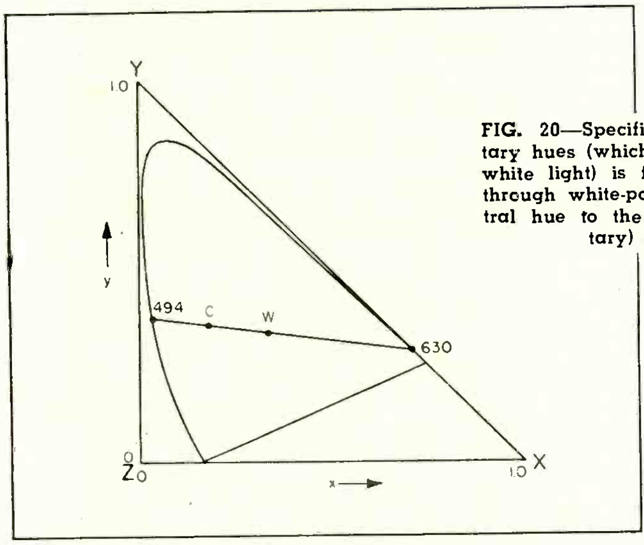


FIG. 20—Specification of complementary hues (which when mixed produce white light) is found by passing line through white-point W from one spectral hue to the opposite (complementary) spectral hue

spectral locus ($y_c$ nearly equal $y_s$) have a purity near one, whereas colors near the white point ($y_c$ near 0.333) have a purity near zero. The purity is, in other words, a direct measure of saturation.

This system of specification falls down when the color is one of the purples, that is, when its point falls below the white point in such a position that the extended line does not pass through the spectral locus, as point C′ in Fig. 19. In such cases the line is extended in the opposite direction, as shown, intersecting the spectal locus at a wavelength representative of the dominant hue *complementary* to that of the given color.

Complementary colors are not a very satisfactory specification, since the indication of subjective sensation is lost. The purity of such purple colors is computed by Eq. 14, taking $y_s$ as the $y$-coordinate of the complementary dominant hue. To distinguish the color so indicated from color having the same actual dominant hue and purity, the purity of purples is stated as a negative number.

The foregoing illustrates the ease with which complementary colors (colors which when mixed produce white light) can be identified on the chromaticity diagram. To find a complementary color to a given color $C$ (Fig. 20), we pass a line through $C$ and $W$, extending it so as to intersect both sides of the spectral locus (or through the locus above and the saturated purple line below). The dominant hues so indicated are said to be complementary to one another.

With the properties of the $x$-$y$ chromaticity diagram in mind, we are now in a position to locate certain colors on it and to show the boundary of the colors which can be covered by color-reproduction processes. In Fig 21, the I.C.I. spectral primaries are shown as $RGB$, and the equal-energy white as point $W_e$. Three other standardized whites are shown. Point $W_a$ represents the color of average artificial (incandescent) illumination, known as illuminant A. Actually this is the color of an incandescent lamp operated at a color temperature of 2,848° Kelvin. Illuminants B and C (points $W_b$ and $W_c$) are two forms of daylight, the first being representative of conditions met in the higher latitudes, the second of the middle and the lower latitudes. Also shown in Fig. 21 are the primary colors proposed for color television receivers. The points $R_1$, $G_1$, $B_1$ represent the receiver primaries standardized by FCC for the CBS field-sequential color system. Points $R_2$, $G_2$, $B_2$ mark the primary coordinates proposed to the FCC for the RCA dot-sequential system.

# Capacitive Slip Ring

**The problem of multiple temperature measurements on aircraft supercharger impellers at speeds greater than 20,000 rpm has been solved with thermistor elements capacitively connected to an r-f bridge. Under optimum conditions it is possible to determine temperatures within ±0.25 C**

THE DETERMINATION of temperatures at selected stations on a high-speed rotor, like that of an aircraft engine supercharger, has been a very difficult problem.

One system that has been used with some success employs thermocouples as electrothermal converters and d-c slip rings as transfer devices to the recording equipment. At speeds greater than 20,000 rpm, however, the brush pressure must be so great to secure a continuous contact that brush life may be only a few minutes. The slip ring often must be refurbished after 15 minutes of operation. Possible thermoelectric action at the slip ring must also be properly understood.

Somewhat better results have been obtained when thermistors replaced the thermocouples. A thermistor is a thermally sensitive but otherwise stable resistor that can have the same physical size as a thermocouple. Instead of measuring voltage one now measures electrical resistance which is a known function of temperature.

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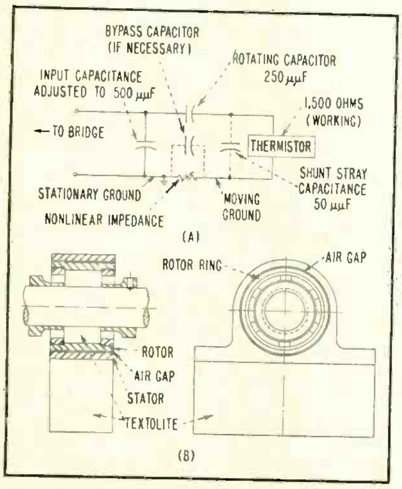


**FIG. 1—Thermistor and slip ring connections looking into bridge (A) and mechanical layout of the capacitive slip rings (B)**

Commercial thermistors in thermocouple size (about 6-mil spheres) can be purchased with resistance-temperature calibration possessing values ranging from about 2,000 ohms to $10^6$ ohms at 70 F. Thermistors possess a negative temperature coefficient of ten times that of platinum at ordinary room temperatures, but this decreases as the temperature increases. They have upper temperature limits where their stability is no longer satisfactory.

Much longer brush and d-c slip ring life has been obtained by employing thermistors having resistance of about 15,000 ohms at the operating temperature. Resistance can be measured with a Wheatstone bridge or ohmmeter. If one can measure the resistance of the thermistor within ± 1 percent, then uncertainties of thermistor temperatures may be no greater than ± 0.25 C. Variable contact resistance or contact potential at the slip ring plays a relatively unimportant role when a high resistance level is maintained. Caution must be exercised, however, for too high a resistance level may result in spurious electric pickup when certain types of electronic measuring instruments are employed. To avoid difficulties inherent in mechanical contacts a capacitor type contact can be used.

Of the two types of noncontact coupling available, capacitor coupling seems much simpler than magnetic coupling. Simplicity becomes paramount when one must have a coupling device for each measuring station. A simple and dependable selector switch capable of positive switching into specified measuring stations by small actuating forces at high speeds would be difficult and expensive to make.

High-frequency measuring techniques make it possible to use a capacitor ring. The thermistor lends itself to a-c as well as d-c excitation as there is no significant skin effect. A General Radio type 516-C r-f bridge may be used to measure the impedance transferred to the stationary reference frame although the newer type 916-A bridge is more advantageous.

A test rig was built simulating the geometry of an actual supercharger impeller. The elementary equivalent electric circuit of this rig is displayed in Fig. 1A. The requirements to be met in the circuit are that the reactance of the stray capacitance in shunt with the thermal resistor be about 10 times the value of that resistor (for a 1 percent unidirectional error at this point), that the rotating capacitor be as high in capacitance as possible and still quite independent of rotation or axial translation, and that the variable impedance between moving ground and stationary ground be reduced to a low value.

Figure 1B illustrates a cylindrical slip ring capacitor whose capacitance is not very sensitive to end play or to eccentricity of rotor member. The axial length of the capacitor is 1.5 inches, with a 4-mil average air gap. The rotor diameter is 1 inch. It is believed that improvement would result if the stator were split into two 135-degree arcs, each adjusted in position by set screws under rotating conditions to secure a minimum gap.

There is an unavoidable parallel

# for Instrumentation

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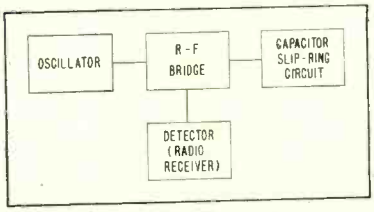


**Arrangement of the r-f bridge equipment for thermistor measurements via slip rings**

input capacitance at the points where the bridge is connected owing to the physical arrangement of parts. This inherent capacitance may have to be appropriately increased so as to reduce the equivalent resistance that the bridge can accept. In the present case the resistance must be no higher than 111 ohms. The newer type 916-A r-f bridge can accept 1,000 ohms at 1 mc. In the test rig, the input capacitance was maintained at 500 $\mu\mu$f. This value must be known and enters into the formula found in the instruction manual supplied by the manufacturer of the bridge. It is clear that the bridge does not directly read the thermistor resistance but the latter may be derived from the bridge dial settings by computation or, better still, by prearranged charts or nomographs including the thermistor calibration.

The shunt stray capacitance is minimized by sufficiently separating a No. 36 Formex wire from the ground plane by laying down some Bakelite insulating cement and then finally cementing the wire. The wire is staked to the capacitor ring at one end and fastened to the thermistor at the other. The free thermistor terminal is grounded. It is desirable to use a low value of thermistor resistance at the working temperature, for example, below 2,000 ohms so the shunt stray capacitive reactance has little effect.

The frequency is a compromise in an attempt to keep the shunt stray reactance high and the rotating-capacitor series reactance low. If there is sufficient instrument sensitivity, lower values of frequency can be used. The oscillator, preferably a crystal type, delivers one stabilized frequency at 100 mv.

If several rings are to be used, the return path is always through a common ground. If ball bearings are used to support the dummy impeller, a parasitic variable impedance is set up between moving and stationary grounds that inhibits a bridge balance. A satisfactory bypass is effected by placing a large stationary grounded shield close to the moving impeller. In an actual supercharger assembly, such a shield is inherent in the construction.

The 516-C radio-frequency bridge is operated at 500 kc with an associated oscillator. The detector is a suitable radio receiver used to secure an audible minimum in conjunction with a modulated oscillator. A 500-kc unmodulated oscillator is equally satisfactory since the rotating capacitor modulates the carrier so the audio note is an additional indication of frequency. Since a meter indication is superior in noisy areas to an audible note, a wave analyzer that filters stray frequencies may be added to the radio receiver to give a sensitive visual null. In an actual installation such formal equipment as a wave analyzer or commercial crystal oscillator could be replaced by simpler and less expensive electronic equipment.

When the test rig was run up to speeds of 20,000 rpm by an air turbine bridge sensitivities of one part in a thousand were observed over the whole speed range. This is the significant part of the test. Good correlation was observed between thermistor measurements and readings of a stationary standard thermometer arranged close to an axially located rotating thermistor.

A direct measurement of resistance in this case is inherently limited by the calibration error of the bridge and also by the residual parameters. Although the sensitivity of the instrument is about one part in a thousand, a precision greater than ± 3 percent in resistance probably cannot be expected even when balancing out the residual parameters, including residual resistance in the r-f paths.

If the bridge and circuit as a unit is first calibrated over the range (maintaining constant oscillator frequency) by substituting small calibrated resistors for the thermistors, or by making a controlled heat run under stationary conditions with thermistors as well as other temperature sensing elements of known characteristics in place, a ±1-percent measurement of resistance and a thermistor temperature within ± 0.25 C should be attainable. Such measurements are best made on an actual impeller assembly free from its enclosing case.

This work was a portion of a general project on instrumentation completed in December 1946 by the authors in collaboration with G. S. Timoshenko and L. E. Williams of the University of Connecticut. The project was sponsored by the Pratt and Whitney Division of the United Aircraft Corporation. R. E. Gorton and E. M. Moffatt of the Corporation served respectively as project coordinator and technical advisor.

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# PERMANENT-MAGNET

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WITH THE ELECTRON MICROSCOPE finding new uses in every field of science and in every industry, the need for a simpler and more reliable microscope has been growing rapidly. In order to fill this need, the permanent-magnet type was designed.

The instrument, Fig. 1, requires little technical skill to operate. As a natural consequence of the simplification of design and function, external appearance is both simple and functional.

At a third of the expense and complexity of larger electron microscopes, the permanent-magnet electron microscope solves ninety percent of the problems applicable to electron microscopy.

### Electrical System

The source of illumination in the microscope, Fig. 2, is a beam of high-energy electrons. The electrons are released, accelerated and aimed in the gun which is situated at the top of the microscope column. A fifty-kilovolt potential applied between the filament and the anode of the gun gives the electrons enough kinetic energy to pass through the specimens used in electron microscopy.

Fifty kilovolts potential is used because at lower voltages a considerable number of the electrons are stopped by the specimen, which consequently heats up, frequently to its own destruction. Excellent voltage stability is a necessary requirement of the high voltage because the focal length of a magnetic lens such as the one used in the microscope depends upon the energy of the electrons as well as upon the magnitude of the magnetic field. Image defect produced by fluctuating voltage is analogous to chromatic aberration in light optics. In order to achieve a resolution of 100 A with the permanent-magnet electron microscope it is necessary to stabilize the accelerating voltage to one part in ten thousand.

The gun on the microscope is energized by an external and remotely located high-voltage supply which is connected by means of a length of x-ray cable.

The high-voltage unit, Fig. 3, divides into two sections, a control unit, and a rectifier unit. The control unit is small enough to sit on a table beside the microscope column and provides electrical control at the point most convenient to the operator. The rectifier unit, Fig. 4, houses the high-voltage tripler and the filament oscillator and transformer. It may be placed on

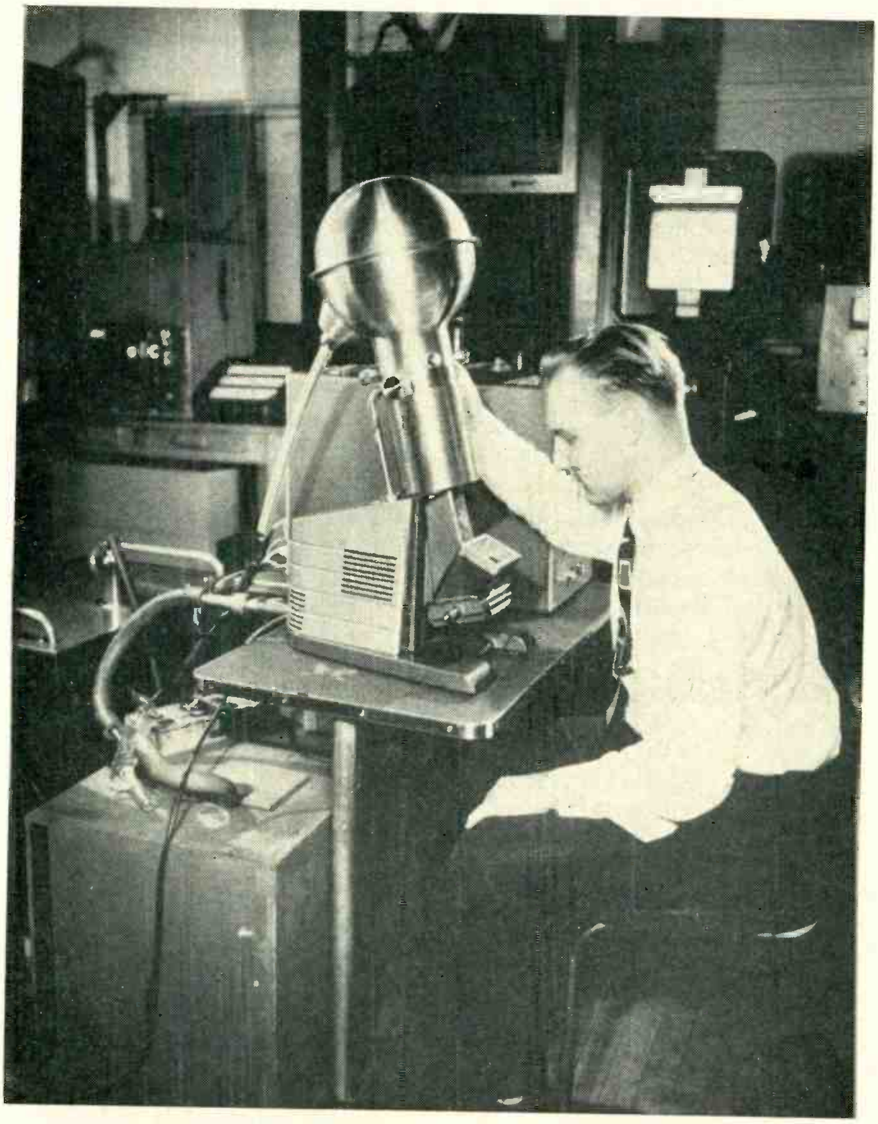


FIG. 1—Permanent-magnet electron microscope in use in a laboratory, control unit in the background on the table and power supply on the floor

# ELECTRON MICROSCOPE

**Use of Alnico 5 instead of conventional electromagnets to energize the lenses, and other design innovations, provide a handy, economical and comparatively trouble-free instrument suitable for 90 percent of all applications. Specimens are readily manipulated and photographic plates made without extensive pumping-down**

the floor or under a table.

Referring to Fig. 3, oscillators $V_1$ and $V_2$ produce an 80-kc r-f signal. This signal is applied across the series-resonant high-Q L-C circuit $L_1C_1$ producing a 17-kilovolt signal across $L_1$. On one part of the cycle $C_2$ is charged through rectifier $V_3$ then, during the next half cycle, the voltages across $C_2$ and $L_1$ are additive and charge capacitors $C_3$ and $C_4$, through rectifier $V_4$. The signal across $L_1$ also causes $C_5$ to charge through rectifier $V_5$. The voltage across $C_5$, $C_3$ and $C_4$ in series is thus triple that across $L_1$. The ripple in the output is filtered through a resonant filter to ground.

Stabilization of output voltages against line and load fluctuations is accomplished by d-c amplifier, $V_6$ and $V_7$, operating series regulators $V_8$ and $V_9$. Resistors $R_1$ and $R_2$ provide a bridge element between the d-c and high-voltage output and a reference voltage established by glow tubes. Tube $V_6$ calls for full power to the oscillators through the regulators until the negative high voltage produces a negative bias at the junction of $R_1$ and $R_2$, whereupon the d-c amplifier regulates the output voltage by reducing oscillator plate voltage.

Focus of the microscope is accomplished by changing the accelerating voltage, which changes the focal length of the lenses. Potentiometers $R_3$ (coarse) and $R_4$ (fine) vary the reference voltage, which causes the voltage-regulating system to readjust itself to a corresponding output voltage. The output is continuously variable from 45 to 50 kilovolts.

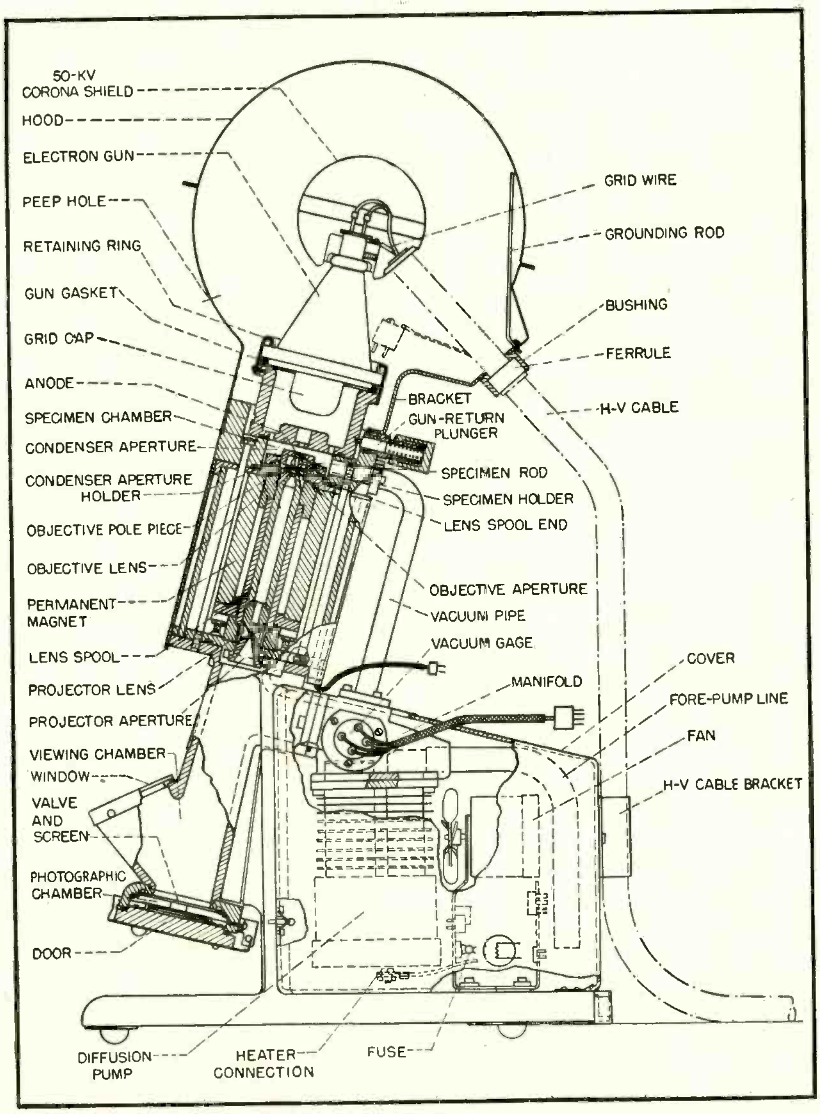



FIG. 2—Cross-sectional drawing of the microscope column, showing the location of component parts

### Gun Filament Transformer

In order to solve the problem of termination of the high-voltage cable at the rectifier in the minimum amount of space, the high-voltage bushing which connects the x-ray cable to the high-voltage output is also the filament transformer, as shown in Fig. 4. The voltage gradient from the high point of the rectifier unit to its wall is in the direction which the conductors in an output cable must occupy, while the gradient in the cable proper is radial to those wires and therefore perpendicular to the gradient toward the wall. To make the transition in fields without reaching a gradient above the corona point an annular corona ring is mounted axially with the outgoing cable and therefore parallel to the field from the wall.

Physical transition to the cable is made through a hard-rubber insulator with the surface cut in the usual manner to increase the leakage path. The inside diameter of the hard-rubber piece is large enough to take the rubber insulation of the x-ray cable. The cable extends into the bushing a distance of six inches to prevent breakdown along the interface of the two insulators.

Inside the bushing extra space is provided for a secondary coil, the means of energizing the filament. The outside surface of the bushing, from the point where it contacts the corona ring to its termination at the metal cable shield, is at ground potential by virtue of an Aquadag surface. This equipotential surface on the rubber prevents corona starting between the rubber and an otherwise necessary ground electrode. It has the additional function of shielding the high-impedance output from the r-f fields inside the cabinet. The primary of the filament transformer, actually the inductive element of a Colpitts oscillator, is wound on the outside of a laminated Bakelite core, which also serves as a support and alignment bushing for the hard-rubber cable connector. The cable assembly actually includes the hard-rubber connector. Connection to the high-voltage supply is effected by sliding the rubber connector into a hole on the top of the rectifier cabinet.

The filament transformer is energized by a 200-kc oscillator. The relatively high frequency is utilized to improve coupling in the transformer, which contains no iron.

A system of fail-safe circuit-completing interlocks prevents turn-on of high-voltage power unless all components are correctly in place and shielded. When protective hoods are removed grounding rods short out the high voltage before access to the voltage compartments is possible. The power supply is protected during such shorting episodes by its high internal resistance and by overload relays which cut off plate power. All cables carry a ground lead for protection against short-circuit shock.

### Vacuum System

The kinetic vacuum system is made up of two pumps in series, an oil-vapor or diffusion pump and a mechanical fore or rough pump.

In earlier instruments the vacuum pumps were cut off from the microscope column during specimen and plate changes. This necessitates complex valving and pumping systems to protect the diffusion-pump oil from decomposition by the oxygen in the air. Some instruments employed systems of air locks and auxiliary pumps. The permanent-magnet microscope has eliminated much of this valving and pumping complexity by first reducing to a minimum the air admitted with a specimen and plate, and second by utilizing recently developed chemically stable silicone diffusion-pump oil that does not readily decompose.

The total evacuated volume of the instrument is one liter. An oil diffusion pump mounted as shown in Fig. 2, can pump the system to operating vacuum ($5 \times 10^{-1}$ mm) in twenty-five minutes from a cold start. The oil diffusion pump, a thermal device, is air cooled by a small magnetically shielded fan situated with the pump under the rear cover of the instrument. The pumping system will recover from the admission of 0.06 cc of air with a specimen in six seconds, and from the admission of 80 cc of air with a photographic plate in a little over

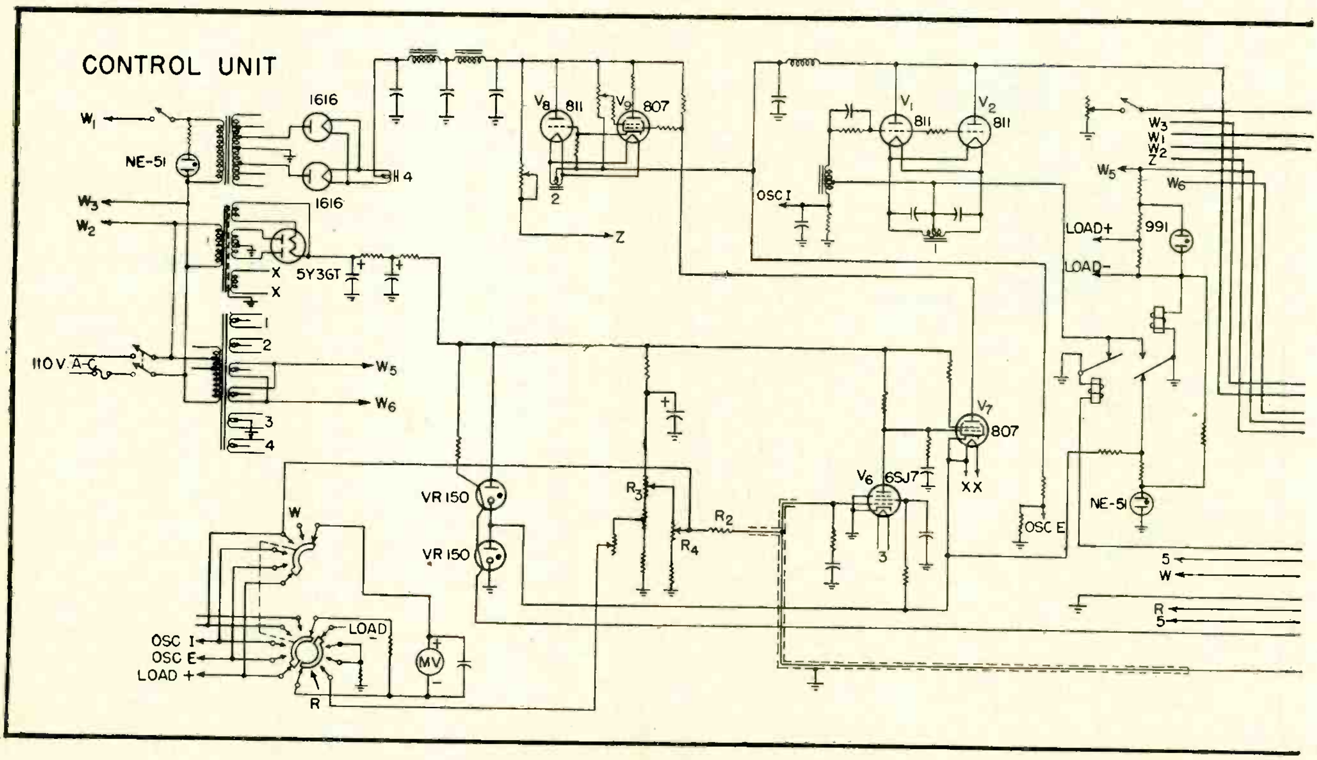



FIG. 3—Simplified schematic circuit diagram of the three-unit permanent-magnet electron microscope. Plugs

a minute. A thermocouple-type of vacuum indicator, attached to the microscope column, reads on the test meter of the high-voltage control unit.

### *Optical System*

The exterior appearance of the microscope column makes the position of the optical elements nearly self-evident. In reverse order to that in the ordinary light microscope, the source of illumination is at the top and the image is formed at the foot of the microscope.

The electron gun is situated under the spherical hood. The hood has been removed in Fig. 5 to show the gun and a grounding rod which shorts out the high-voltage power when the hood is removed. The high-voltage cable is held in place by a bracket at the rear of the gun so that movement of the cable can exert no strain on the gun. The heavy rubber-covered cable enters the spherical corona shell on the gun through a large hole. Inside the corona shell, connection is made to the gun terminals by thin flexible leads which permit the gun to be moved transversely on the instrument without binding in the cable.

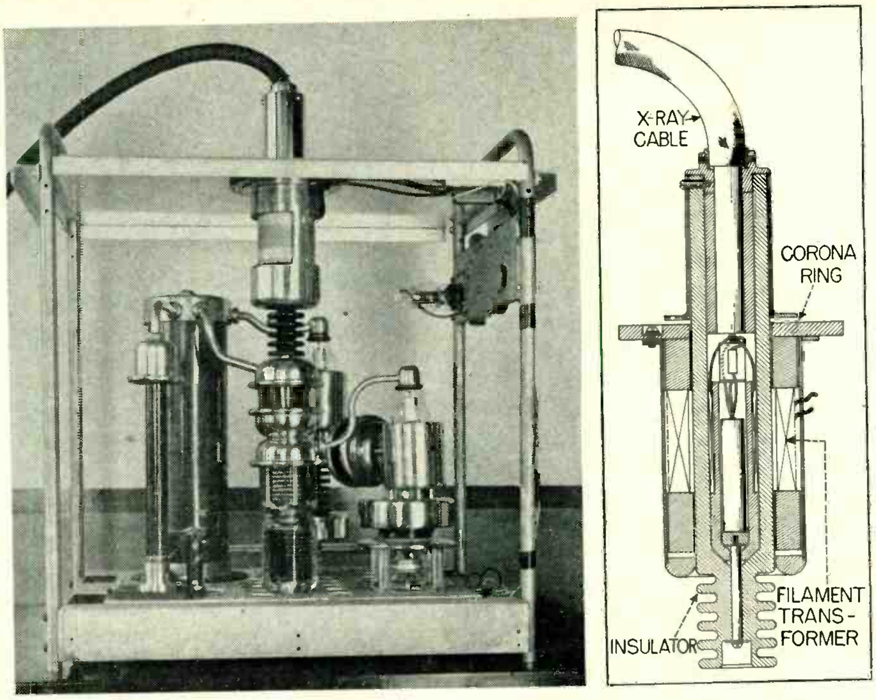



**FIG. 4**—High-voltage rectifier unit, with case removed, and cross-sectional drawing of the combined output connector and electron-gun filament transformer

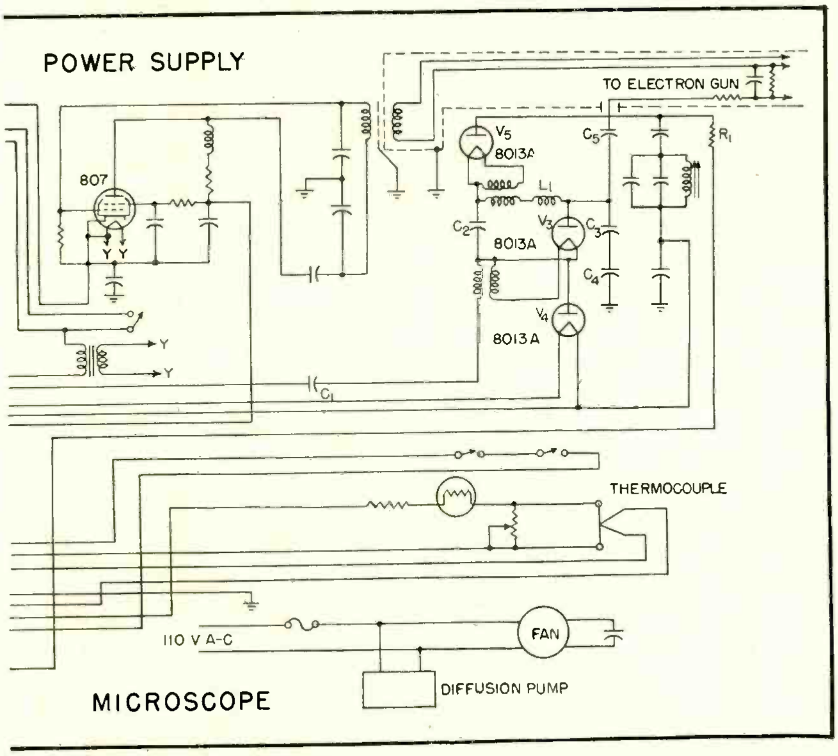
Two knobs directly below the gun position the gun transversely with respect to the axis of the optical system. By this means some element of the solid cone of illumination out of the gun which is parallel to the optical axis of the instrument may be found and centered over that optical axis.

The gun comprises both the cast-glass insulator and the cylindrically shaped metal element which supports the glass. This metal element is the anode, and is at ground potential. The adjustment screws press against the anode shell to cause the gun to move. The vacuum seal between the glass insulator and the anode is made by means of a neoprene gasket lubricated with stopcock grease. The transverse adjustment of the gun may be made while the beam is turned on since the neoprene gasket between the anode and the upper wall of the object provides a good sliding vacuum seal.

The electron beam leaving the gun is so wide and intense that it would destroy a delicate specimen unless restricted by a beam-limiting aperture, frequently called a condenser aperture by analogy to the light microscope. The hole in the thin platinum aperture disc has a diameter of 0.003 inch. Directly below this aperture is the specimen.

### *Permanent-Magnet Lens*

A magnetic lens focuses the electrons passing through the specimen and forms a real magnified image in front of a second magnetic lens which forms a further enlarged image on the viewing screen or photographic plate. The magnetic lens is actually a magnetic field




are omitted from the diagram; several are used where this illustration splits which is formed by a gap in a magnetic circuit. The field fringing out from such a gap, formed by iron pole pieces, interacts with the electron beam much as a glass light lens does.

The literature on the gaps or pole pieces used in magnetic lenses is extensive so the subject need not be discussed here. Of more interest because of its novelty and importance is the energization of the magnetic lenses by the permanent magnets from which the new electron microscope derives its name.

Permanent magnets are desirable because they eliminate coil windings, cables, power supplies, filters and multitube regulating circuits required with electromagnetic energization of lenses. The resultant advantages are lower cost and comparatively trouble-free service.

It is not generally possible to replace an electromagnetic element directly with a permanent magnet because the circuit is actually altered. In the case of the lens, simple replacement of windings by magnets to energize the lens gap produces stray fields which utterly destroy the microscope image. To use permanent magnets successfully, it is necessary to utilize the otherwise stray external flux to energize an additional gap. By positioning the second gap coaxially with the first gap, two lenses may be energized from a single magnetic source. Most important, the two lens gaps, and all the intervening space, are covered by a surface of sensibly constant magnetic potential, so that destructive stray fields are eliminated. Since two lenses are necessary for high magnification the double-gap magnetic circuit proves to be doubly beneficial.

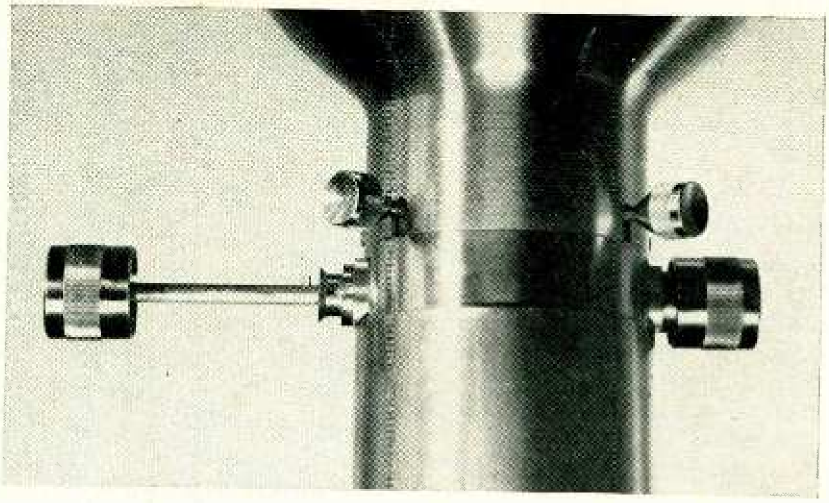


FIG. 6—Specimen-manipulation rod shown withdrawn

FIG. 5—Microscope column with protective hood removed

Alnico 5 is used as the magnet material in a high-demagnetization-coefficient circuit to give strong energization and great stability against demagnetization by removal of pole pieces. The upper or objective gap is energized to 1,300 gilberts and the projector to 900 gilberts.

The use of permanent magnets to energize lenses has the disadvantage of discarding the unique property of variable focal length of magnetic lenses. This property is frequently used to change the magnification of an electron microscope over wide ranges by merely turning a selector switch, or to focus an image by turning a knob.

Change of magnification is actually unimportant for any single type of problem. However, specific problems have certain magnifications which are most suitable. Tissue sections are best studied at low magnifications of about 1,500 x where fine structure may be related to gross structure most easily. Virus studies need high magnification of 6,000 x merely to be seen. In order to provide a wide range of magnifications in the permanent-magnet electron microscope, the pole pieces are changed to provide any one of three fixed direct magnifications of 1,500, 3,000 and 6,000 times. Photographic plates exposed at these magnifications may frequently be enlarged to show new detail at magnifications of 40,000 times.

Focus is obtained by varying the accelerating high voltage.

### Specimen Holder

The specimens used in electron microscopy are small. An object 0.0003 inch in extent will completely fill the field of view of the microscope at 6,000 x. Specimens are likewise very thin, less than $0.3 \times 10^{-3}$ mm, and need to be supported on wire screens. Small particles are deposited on equally thin plastic films, in turn supported by the wire screens. For ease of handling, standard ⅛-inch diameter 200-mesh metal screens are used for specimen support. To insert a specimen into the microscope, the screen is clamped in a small holder and inserted in a hole drilled transversely into a 5/16-inch rod which slides in and out of the microscope across the optical axis of the system.

Figure 6 shows a specimen holder partially inserted in the specimen control rod. When the specimen holder is in place, the rod is pushed into the microscope. The specimen slides through a neoprene vacuum-sealing gasket which surrounds the rod. The only air admitted to the interior in the process is that in the open volume of the specimen holder. The rod slides until its end abuts the plunger driven by the large

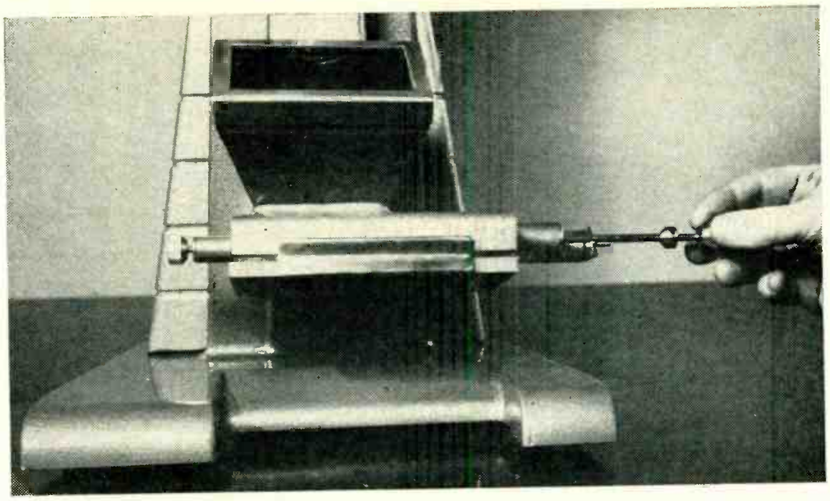


FIG. 7—Exposure of a photographic plate

right-hand knob on the upper part of the column. When this occurs, the specimen screen is over the axis of the microscope and the enlarged image of the specimen will be seen on the final screen.

Turning the right-hand knob drives the plunger in or out and the specimen follows with the rod which abuts the plunger. The specimen may be moved at right angles to this motion by rotating the rod by turning the large left-hand knob at the end of the rod. Since the specimen holder locates the specimen as far off the axis of the rod as possible, a rotation of the rod displaces all points on the specimen toward or away from the optical axis and also changes their distance from the objective lens. If the rotation is limited to three degrees from center, it is possible to scan three meshes in a direction perpendicular to the length of the rod and yet not move the specimen points out of range of focus of the lens.

This principle of using a single axis to produce both longitudinal and transverse movements as well as furnish a path for the introduction of specimens ranks along with the permanent-magnet lenses as a simplifying and economizing feature. Operationally, it has been found that the rod specimen stage has excellent stability in the face of heating from the gun, or from room vibration. The large control knobs permit ease of control and house additional mechanism. The left-hand knob contains a three-to-one friction planetary drive to increase the fineness of the transverse specimen adjustment.

### Final Image

The image is viewed through a front window wide enough for two people to make observations simultaneously. The phosphorescent material used to convert the electron image to a visible image is deposited on a surface perpendicular to the optical axis. Viewing the phosphor directly permits maximum brilliance in the image for a given beam intensity but requires oblique viewing. The fifteen-degree tilt in the microscope was applied to make comfortable viewing possible.

The photographic function of the electron microscope is essential to provide a permanent record, to provide an image which can be studied at length and measured accurately and to make use of the high resolution inherent in the electron image. It is practice to expose the photographic plate directly to the electron image which, like light, causes darkening in the developed negative. Direct exposure has the advantage of great photosensitivity, which permits photography of low-intensity images. Also, because of the fine-grain properties of the photographic plate, the detail in the image is all preserved on the plate. Photographic enlargements to ten times are frequently carried out. The drawback to direct exposure of the plate in earlier electron microscopes is the difficulty of inserting the plate.

In the permanent-magnet microscope, the functions of vacuum valving, fluorescent screen and photographic shutter are carried out by a simple mechanical system comprising a sliding plate and a push rod. A circular groove in the bottom of the viewing chamber holds a neoprene gasket against which the valve plate presses to seal off the chamber during the periods when the door of the photo chamber is open for the insertion or removal of the plate cassette. Following insertion of the cassette and closing of the photochamber door, a knob at the right of the photochamber is pulled ⅜-inch to a stop. This motion slides the valve plate off the gasket, breaking the vacuum seal, and permits the plate chamber to be pumped out. The upper surface of the sliding plate is dished to hold a fluorescent screen, while a pin from the lower surface of the plate engages a catch on the cassette. When the valve-shutter rod is pulled to its extreme right-hand position, Figure 7, the valve plate is pulled from in front of the photographic plate. At the same time the light-tight cover of the cassette slides aside and the plate is exposed. Sliding the rod all the way back closes the valve and cassette. A relief valve on the left of the photochamber is used to admit air to the photochamber, permitting the door to be opened.

The simplification of operation of the electron microscope has been brought to a point where people can operate it usefully and confidently after less than an hour's instruction. The expense has been reduced to a point where small economic units can afford to use it. The performance of the instrument is such as to make it applicable in ninety percent of all electron microscopic problems.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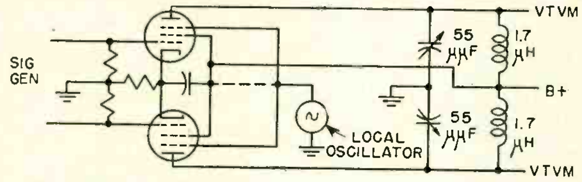
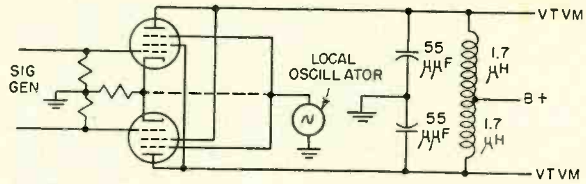



(A) CONVENTIONAL




(B) NEW

| $E_{osc}$ RMS VOLTS | I-F VALUE $f_1$ MC | $\Delta f_1$ MC | GAIN $A_1$ | $A_1 \Delta f_1$ |
|---|---|---|---|---|
| 2.5 | 16.1 | 0.126 | 14.0 | 1.76 |
| 5.0 | 16.1 | 0.192 | 15.0 | 2.88 |
| 7.5 | 16.1 | 0.238 | 13.0 | 3.10 |
| 10.0 | 16.1 | 0.232 | 13.5 | 3.13 |

| $E_{osc}$ RMS VOLTS | I-F VALUE $f_2$ MC | $\Delta f_2$ MC | GAIN $A_2$ | $A_2 \Delta f_2$ | $\frac{A_2 \Delta f_2}{A_1 \Delta f_1}$ |
|---|---|---|---|---|---|
| 2.5 | 16.1 | 0.128 | 26.5 | 3.39 | 1.93 |
| 5.0 | 16.1 | 0.190 | 28.0 | 5.32 | 1.85 |
| 7.5 | 16.1 | 0.226 | 26.5 | 6.00 | 1.93 |
| 10.0 | 16.1 | 0.241 | 25.5 | 6.15 | 1.96 |

FIG. 1—Comparison of conventional balanced push-pull pentode mixer with improved method that places tuned circuit between screen and plate of each tube. Values of components are not necessarily the most desirable for the frequency and bandwidth used

# GAIN-DOUBLING

**Theory and experimental results for a method of obtaining twice the normal conversion transconductance from pentode mixers. Signal is applied to an inner grid, and No. 3 grid is used in an outer space-current local oscillator. Practical converter circuits for narrow-band broadcast receivers and wide-band f-m receivers are given**

IN THE USUAL frequency mixer tube the conversion transconductance is approximately $g_m/\pi$, where $g_m$ is the maximum signal grid-to-plate transconductance during the excursion of an oscillator cycle. The possibility of obtaining a conversion transconductance equal to $2g_m/\pi$ was first pointed out by E. W. Herold[1]. In effect, his method involves changing the phase of the signal current 180 deg at the local oscillator frequency rate, using a beam-deflection tube or one having multihumped characteristics. The method to be described here achieves the same gain-doubling result more simply with a pentode mixer.

### Analysis

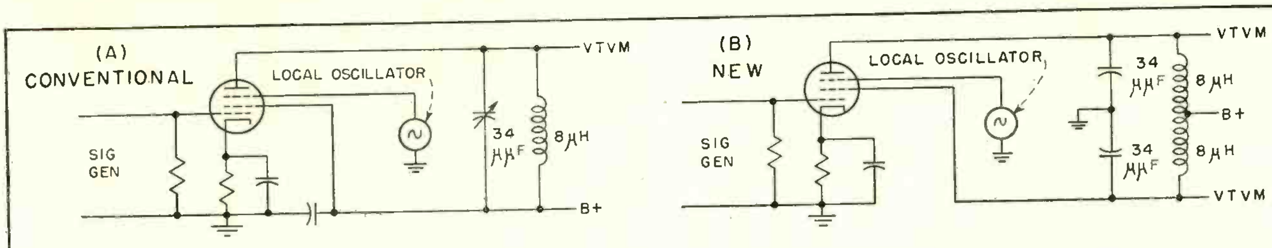
The conversion transconductance $g_c$ of a mixer tube, when considering a small signal modulating a relatively large local oscillator signal of radian frequency ω, is

$$g_c = \frac{1}{2\pi}\int_{-\pi}^{+\pi} g_m \cos \omega t \, d(\omega t) \qquad (1)$$

Solution of this equation does not give maximum conversion transconductance because the negative portion of the cycle subtracts from the positive portion. However, if the integral is observed from $\pi/2$ to $-\pi/2$ only, we obtain $g_m/\pi$ as the maximum positive limit for conversion transconductance with conventional mixing. These limits are achieved in a triode mixer by imposing sufficient oscillator voltage on the No. 1 grid to cut off the tube during the negative portion of the oscillator cycle. In conventional pentode mixing with the oscillator signal on an outer grid, the same limits are obtained by diverting the space current to an inner grid of the tube during the negative portion of the local oscillator cycle. The goal, however, is to double this transconductance value.

With conventional triode and pentode mixing, the i-f signal is obtained from a tube element that is cut off for half of the tube-operating period. If by some means the sign of the integral of Eq. 1 could be changed for this cut-off half of the oscillator cycle, then the conversion transconductance would be doubled.

Consider a pentode mixer in which the incoming carrier signal is applied to the No. 1 grid and the local oscillator to the suppressor (No. 3) grid. Since a pentode maintains essentially constant current in the screen-plate region, each increase in plate current due to oscillator modulation of the suppressor must be offset by an equal decrease in screen current. As a




| $E_{osc}$ RMS VOLTS | I-F VALUE $f_3$ MC | $\Delta f_3$ MC | GAIN $A_3$ | $A_3 \Delta f_3$ |
|---|---|---|---|---|
| 2.5 | 9.5 | 0.440 | 10.5 | 4.60 |
| 5.0 | 9.5 | 0.383 | 11.5 | 4.40 |
| 7.5 | 9.5 | 0.348 | 12.4 | 4.32 |
| 10.0 | 9.5 | 0.340 | 12.6 | 4.29 |

| $E_{osc}$ RMS VOLTS | I-F VALUE $f_4$ MC | $\Delta f_4$ MC | GAIN $A_4$ | $A_4 \Delta f_4$ | $\frac{A_4 \Delta f_4}{A_3 \Delta f_3}$ |
|---|---|---|---|---|---|
| 2.5 | 9.5 | 0.460 | 19.5 | 8.96 | 1.95 |
| 5.0 | 9.5 | 0.440 | 20.5 | 9.03 | 2.05 |
| 7.5 | 9.5 | 0.413 | 21.4 | 8.85 | 2.04 |
| 10.0 | 9.5 | 0.410 | 21.5 | 8.83 | 2.05 |

FIG. 2—Comparison of conventional single-tube pentode mixer circuit with improved method that eliminates screen bypass capacitor so tuned circuit is between screen and plate. Values of correspond ng inductances and capacitances should be equal as indicated

# Frequency Converters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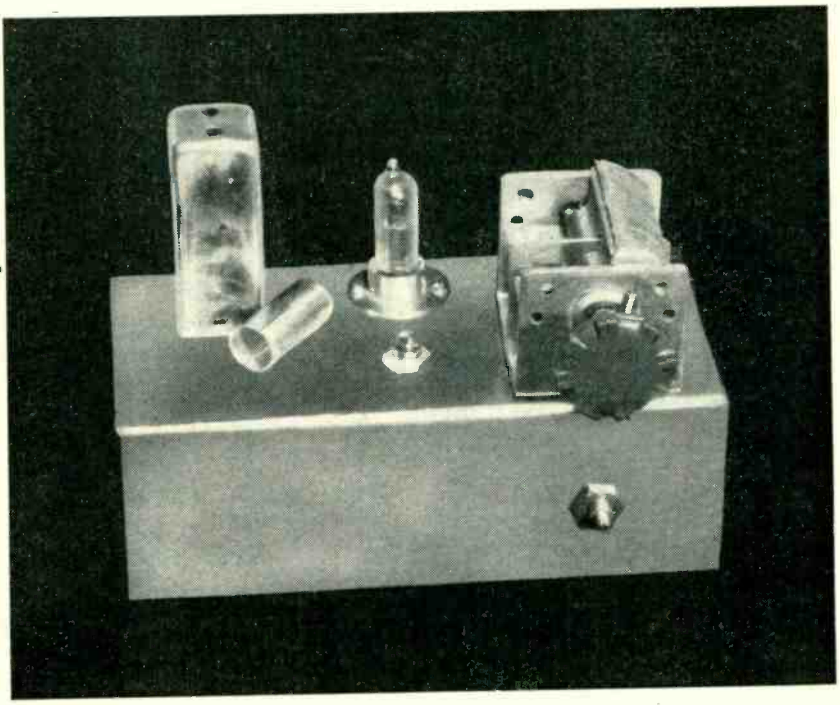


Subminiature pentode converter for broadcast band use, employing improved circuit of FIG. 5 to achieve more than twice the gain of a conventional 6BE6 circuit

result, the i-f components of plate and screen currents are 180 deg out of phase and can be added in a conventional push-pull manner to get twice the gain from the tube. Actually, the mere placing of a tuned circuit between the plate and screen changes the sign of the integral in Eq. 1 for half of each cycle to give the desired doubling of conversion transconductance.

### Verification

Experimental verification of gain doubling with this frequency-mixing process is given in Fig. 1 and 2. Performance of a conventional balanced type mixer is presented in Fig. 1A and results for the new circuit, using the same tubes under the same d-c operating conditions, are in Fig. 1B. The tubes were developmental types with many-turns-per-inch suppressor grids. The oscillator voltage is used as a variable.

Since the voltage gain is inversely proportional to $\Delta f$ and the two vary with oscillator voltage, the product of these two terms serves as a convenient means of comparison between the two systems. The last column of the tabulation in Fig. 1B indicates the ratio of $A_2 \Delta f_2$ for the new system to $A_1 \Delta f_1$ for the conventional system. These values center about a ratio of 2 to 1, which is predicted from the theory.

As a further check and comparison, the new frequency-conversion method was compared with the conventional method when using a single tube. Data for a conventional single-ended mixer circuit is given in Fig. 2A, and corresponding data for the new circuit in Fig. 2B. The ratios are again approximately 2 to 1.

The foregoing data were obtained with the suppressor grid operating at zero d-c bias rather than the grid-leak bias that is usually employed. Operating the grid

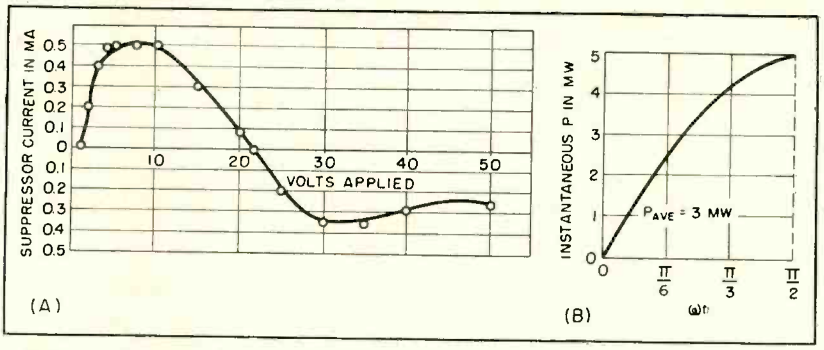



FIG. 4—Characteristic curves for No. 3 grid of typical experimental pentode

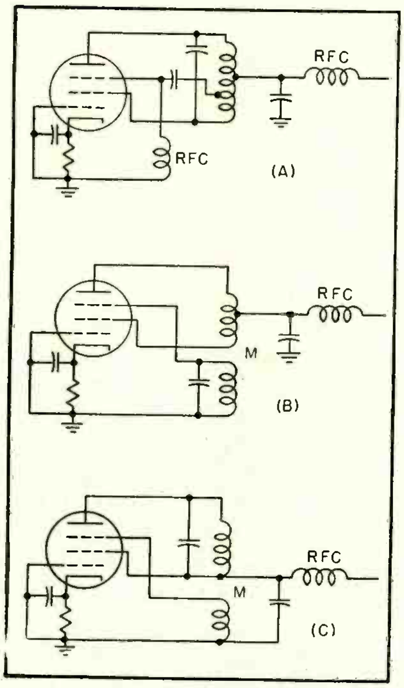



FIG. 3—Balanced and unbalanced oscillator circuits employing new gain-doubling technique

at zero bias results in a much greater peak $g_m$ and thereby increases conversion transconductance. If sufficient oscillator voltage is impressed, the plate current is swung into saturation and $g_c$ approaches the ideal value of approximately 32 percent of the peak $g_m$.

### Isolation

Another interesting aspect of the circuit is the isolation it offers to signals that tend to pass through the mixer tube at the intermediate frequency. Isolation exists, since any signal on the No. 1 grid produces modulation of the same phase on the screen and plate currents, and will cancel out in the push-pull i-f transformer. This action makes it somewhat difficult to align the i-f by the usual manner of placing the i-f signal on the signal grid of the mixer tube. In this case the signal can better be placed on the oscillator grid. The degree of isolation is determined by the degree of balance in the primary of the i-f transformer and by the transconductance from signal grid-to-plate relative to the transconductance of signal grid-to-screen.

In a pentode we are mainly concerned with shot-effect noise and partition noise. The former is due to time-varying emission from the cathode, and the latter is due to random distribution of cathode current to the positive electrodes in the tube.

### Noise Suppression

Assume an ideal pentode in which partition noise does not exist. Assume also that there is a push-pull connection between plate and screen, and that the screen and plate currents are precisely equal. The noise in the plate and screen would then be of equal magnitude and identical phase, disregarding transit-time effects. With a perfect output transformer, there would be no noise output from the tube, because of cancellation within this transformer.

Now, imagine another ideal pentode in which no shot-effect noise exists, but in which partition noise does exist. In this tube any noise variation that takes place in the plate circuit must be accompanied by an equal and opposite noise variation in the screen circuit, since space current is perfectly constant. Thus, if this push-pull connection has in some way doubled the effective transconductance, the equivalent noise resistance of the tube has not changed since the effective noise has also been doubled.

The pentode mixer circuit presented here is actually the combination of these two ideal cases. It therefore has somewhat smaller equivalent noise resistance in the circuit than does a conventional mixer, since the shot-effect noise has decreased while the affect of partition noise remains unchanged.

### Converter Tube

In conjunction with this work on the mixer circuit, a program was also carried out to combine this circuit into a converter tube that performs the functions of mixer and local oscillator. In this converter, the outer space current oscillations that exist between the outer elements of a multigrid tube are utilized. The resulting converter circuit gives four times the voltage gain with 30 percent less cathode current relative to the 6BE6 converter. The equivalent noise resistance of this converter was below 18,000 ohms, which is less than one-tenth that of the 6BE6.

The tube characteristics most desirable for the oscillator are those of a pentode whose No. 3 grid-to-plate transconductance is relatively high. This No. 3 grid is used as the control grid, and the plate or screen as the oscillator anode.

The oscillator may be either the balanced or unbalanced type. In the balanced oscillator, shown in Fig. 3A and 3B, the plate-screen coil is center-tapped to r-f ground. This oscillator is suited to a balanced-type circuit since the current variations, as caused by No. 3 grid modulation, are 180 deg out of phase in the plate and screen. The plate voltage holds the same phase relationship to the controlling grid voltage as it does in a conventional oscillator.

For unbalanced operation, either plate or screen may be grounded to r-f as in Fig. 3C. Since the screen-plate current is nearly constant, the oscillations are confined to the outer space of the tube.

The No. 3 grid characteristics for a typical experimental pentode are shown in Fig. 4A. The negative resistance characteristic encountered above 10 volts tends to enhance oscillations. To find the required grid-driving power, a sine wave can be impressed on the suppressor grid and a time plot of current obtained from the grid characteristics. The product of instantaneous voltage and grid current is shown in Fig. 4B. A peak swing of 10 volts is used because this value produces plate current cutoff and is in accordance with characteristics that follow. The average power may be obtained by integrating the instantaneous power curve. The resulting average power is three milliwatts, which is very low and normally will be less than the associated circuit losses.

### *Converter Design*

It is possible to calculate the tickler coil impedance required for a particular application. Suppose an oscillator is to be built at 20 mc in which a tickler coil is placed in the plate circuit to excite a tuned circuit connected to the No. 3 grid, and a total driving power of 15 milliwatts is required. The available exciting power is proportional to the external voltage drop, or in this case the reactive drop across the tickler coil. Then $P_{exciting} = I_{eff}^2 \omega L = 15 \times 10^{-3}$. The effective plate current for the development tubes used is approximately 4 ma. The required tickler coil impedance is then $\omega L = 15 \times 10^{-3}/(4 \times 10^{-3})^2 = 938$ ohms.

These outer space current oscillations may readily be obtained from a pentode as used in Fig. 5 and 6, and the application of a signal to the No. 1 grid will result in a simplified converter. In each circuit, a tickler coil is placed in series with the i-f transformer primary to provide feedback to the No. 3 grid, which is tuned to the local oscillator frequency. In Fig. 5 the screen is grounded for r-f. Figure 6 represents a similar circuit in which the i-f is connected in push-pull between the screen and plate, and results in increased conversion transconductance.[1] The circuit of Fig. 5 is most useful in narrow-band applications, since the plate resistance in converter use is much larger than the effective plate-screen resistance. Conversely, Fig. 6 is more applicable to wide-band circuits.

The above circuits are operated with zero d-c bias on the suppressor grid. This type of operation is desirable since greater conversion transconductance will result owing to the larger peak plate current. A grid-leak bias on the grid of the oscillator is not necessary with the outer space current oscillator, as it would have little effect on the average current.

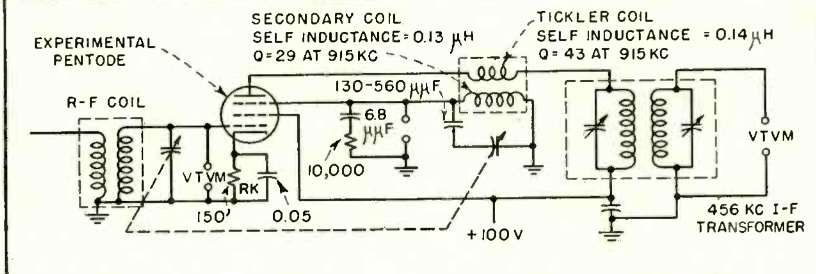
It is desirable that the peak swing be sufficient to produce plate-current saturation during the positive excursion of the local-oscillator cycle, and plate-current cutoff during most of its negative excursion, since these are the desired characteristics for maximum conversion transconductance.

### *Comparisons*

The most important characteristics of a converter-type tube are probably (1) conversion transconductance, (2) plate resistance, (3) noise, (4) isolation between signal and oscillator circuits, which is indicative of antenna radiation, (5) voltage gain as a function of wide-range tuning, and (6) automatic volume control, which indicates the cutoff characteristics of a particular tube and any undesirable detuning effects. These characteristics will be discussed in connection with a comparison of the new high-gain pentode converter circuit of Fig. 5 and a conventional 6BE6 frequency converter for the same narrow-band application (550 to 1,600 kc).

Before making comparative measurements, the oscillator voltage on the No. 3 grid was measured as a function of tuning. The oscillator voltage varied from 19 volts at 1,006 kc (the low end of the oscillator range) to 66 volts rms at the top frequency of 2,056 kc. This wide range of oscillator voltage is undesirable from the viewpoint of oscillator radiation, hence a series R-C circuit was used to load the oscillator. Values of 10,000 ohms and 6.8 $\mu\mu$f discriminate against the higher frequencies as desired to keep the range of oscillator voltage between 11 to 19 volts rms, which is within the practical limits of most converters.

Comparative sensitivity values are given in Fig. 5. With the experimental type pentode, the components were tuned for each individual measurement. The voltage gain was measured from the signal-generator terminals to the secondary of the i-f transformer. The i-f transformer used was designed as an output transformer, and consequently had closer coupling than that usually found in input i-f transformers. With the conven-




| NEW CIRCUIT (ABOVE) | | | |
|---|---|---|---|
| $f_{SIG}$ IN KC | GAIN | $I_K$ IN MA | $\Delta f$ IN KC |
| 550 | 580 | 7.3 | 10.6 |
| 1,000 | 780 | 7.3 | 12.0 |
| 1,550 | 680 | 7.4 | 12.0 |

| CONVENTIONAL 6BE6 CIRCUIT | | | |
|---|---|---|---|
| $f_{SIG}$ IN KC | GAIN | $I_K$ IN MA | $\Delta f$ IN KC |
| 550 | 140 | 11.0 | 11.8 |
| 1,000 | 320 | 10.5 | 11.8 |
| 1,550 | 300 | 10.5 | 12.1 |

FIG. 5—Narrow-band version of new converter circuit, suitable for broadcast band, and comparative performance data on conventional circuit

tional circuit, plate and screen voltages were 100 volts, and the signal grid was biased to −1.5 volts. The circuit was optimized for voltage gain.

The comparative data shows that greater than twice the voltage gain can be obtained with the pentode with 30 percent less cathode current. The increased voltage gain results from the increased conversion transconductance.

The conversion transconductance of the experimental pentode was approximately 1,200 μmhos. This conversion transconductance is easily determined for this type of operation by measuring the $g_m$ of the signal grid with +10 volts on the suppressor grid, and taking 30 percent of this $g_m$ value as the conversion transconductance. This is accurate to within a few percent.

The effective mixer plate resistance for the new type of operation is approximately three times the value measured for the tube as an amplifier. This value was 350,000 ohms for the development tubes used, as contrasted with 1 megohm for the 6BE6. The conversion transconductance of the 6BE6 is 475 μmhos.

### Oscillator Radiation

Radiation back to the antenna from a converter tube depends on the capacitance and space charge coupling between the oscillator grid and the signal grid. In the circuit of Fig. 5, oscillator currents are confined to the outer space of the tube so there is little or no space-charge coupling. The capacitance from the signal grid to oscillator grid of the tube under these conditions is approximately 0.10 μμf, while the corresponding capacitance for the 6BE6 is 0.15 μμf. The relative coupling values from the oscillator to the signal grid at signal frequencies of 550, 1,000 and 1,550 kc are 0.01, 0.07 and 0.13 respectively for the 6BE6 and 0.01, 0.05 and 0.21 for the pentode.

The space-charge coupling within the tube acts with a 180-deg phase shift relative to the direct capacitive coupling voltage. In most converters, these effects are controlled so that they are approximately equal on the broadcast band. This is the reason that the coupled voltage is slightly less with the type 6BE6 in spite of the fact that its capacitance and space-charge coupling are greater.

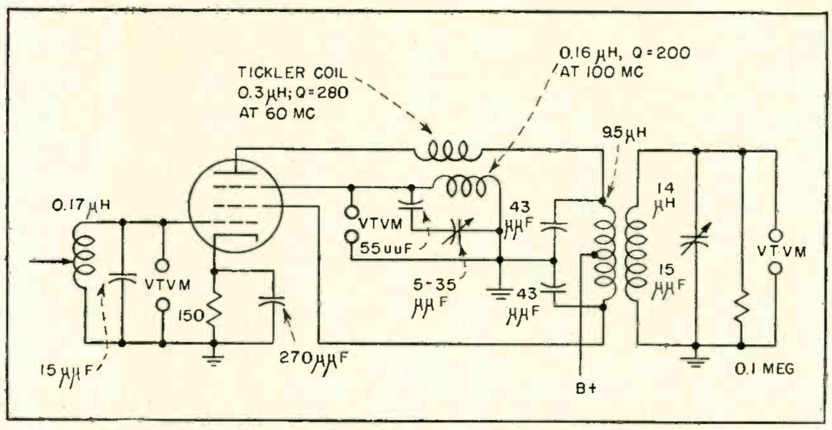



FIG. 6—Wide-band version of new converter circuit

### AVC Action

The action of an avc voltage on the signal grid of the experimental pentode changes the oscillator amplitude as well as the signal-grid $g_m$. This gives accentuated avc action, and may require a very remote cutoff characteristic for proper operation. Since extensive bias will ultimately result in a reduction of oscillator grid $g_m$ to the point where oscillations will cease, extended avc application (1,000 to 1 reduction of gain) is not possible in this new converter.

In conjunction with avc, it is important to consider the amount of frequency shift that results from its application. To obtain this relative measurement, the gain of the two systems was decreased by the same ratio, and the frequency shift of the oscillator section was measured. The results indicated that the frequency shift was comparable in the two systems, but in opposite directions; the frequency of the 6BE6 converter decreased with decreasing gain and the frequency of the new converter increased with decreasing gain.

### F-M Converter Circuit

Modifications needed in the new converter circuit to meet the requirements of the f-m band are given in Fig. 6. The relatively wide bandwidth permits the use of a push-pull i-f and derives increased gain. At 100 mc the voltage gain from the grid through a double-tuned i-f transformer is 27.5. (The calculated gain of the 6BE6 under similar conditions is one-fourth this value.) The center of the i-f band is 10.7 mc and the bandwidth at the half-power points is 350 kc. The frequency drift of this oscillator circuit was compared with that of a triode in a Hartley circuit and found to be nearly equal. The converter had less frequency shift as a function of filament voltage, but more as a function of supply voltage.

### Conclusions

Increased gain can be obtained by using a pentode tube as a converter, with the signal applied to an inner grid and the No. 3 grid used as an outer space current local oscillator. Four times the gain of the type 6BE6 may be obtained by using this less complicated tube, with 30 percent less cathode current. Simple tube construction, high conversion transconductance and low noise characterize this converter. The Sylvania type 5636 and SN1007B tubes are suitable for this application.

The author acknowledges the valuable assistance of B. F. Tyson and James Cooper who supplied measurements that confirmed the theory outlined here and John B. Grund of Sylvania's Emporium division, whose measurements in practical circuits contributed greatly to this project.

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# Low-Reflection PICTURE TUBES

Face plates is first etched, either chemically or by liquid-honing abrasive-blasting method, to produce light-diffusing characteristic. Plates thus etched are then treated with hydrofluoric acid to restore transmission loss introduced by first etch

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THE HIGH OPTICAL QUALITY inherent in metal cathode-ray tube face plates has turned out to be more of a drawback than a blessing.

When these tubes were first introduced, glass tube manufacturers took steps to equal their face-plate quality by chromium plating and polishing the molds, with the result that both types today are prone to specular reflections. These reflections of external light sources in a room are more noticeable because of the dark glass now almost universally used in face plates.

### Early Attempts

Attempts to reduce undesirable reflections by methods already employed in treating optical instruments have met with little success for various reasons. For example, one-quarter-wavelength thick films[1,2] are difficult to mass produce. Moreover, such films are quite fragile and give a characteristic purple tint since they are actually designed for a minimum reflection at only one wavelength, usually 5,550 A, which is the peak of the human eye sensitivity curve. Skeletonized layers, in which the constituents of the glass are etched out on the surface by hydrofluoric acid to leave only a film consisting largely of silica,[3] are also corrective for only one wavelength and have some residual reflected color.

For picture tubes one can resort to other solutions to reduce reflections, such as a polarizing filter combined with a quarter wave retardation layer in front of the tube face. These filters, in addition to the expense involved, absorb an appreciable portion of the useful light and the residual reflections are also tinted. Another possibility of reducing reflection involves scattering the light, and lacquer coatings have been tried to achieve this result.[4] However, these coatings are not durable and in most cases they

Television picture taken from 12-inch metal tube. Reflected image of fluorescent lights from untreated portion of face plate shows advantage of process

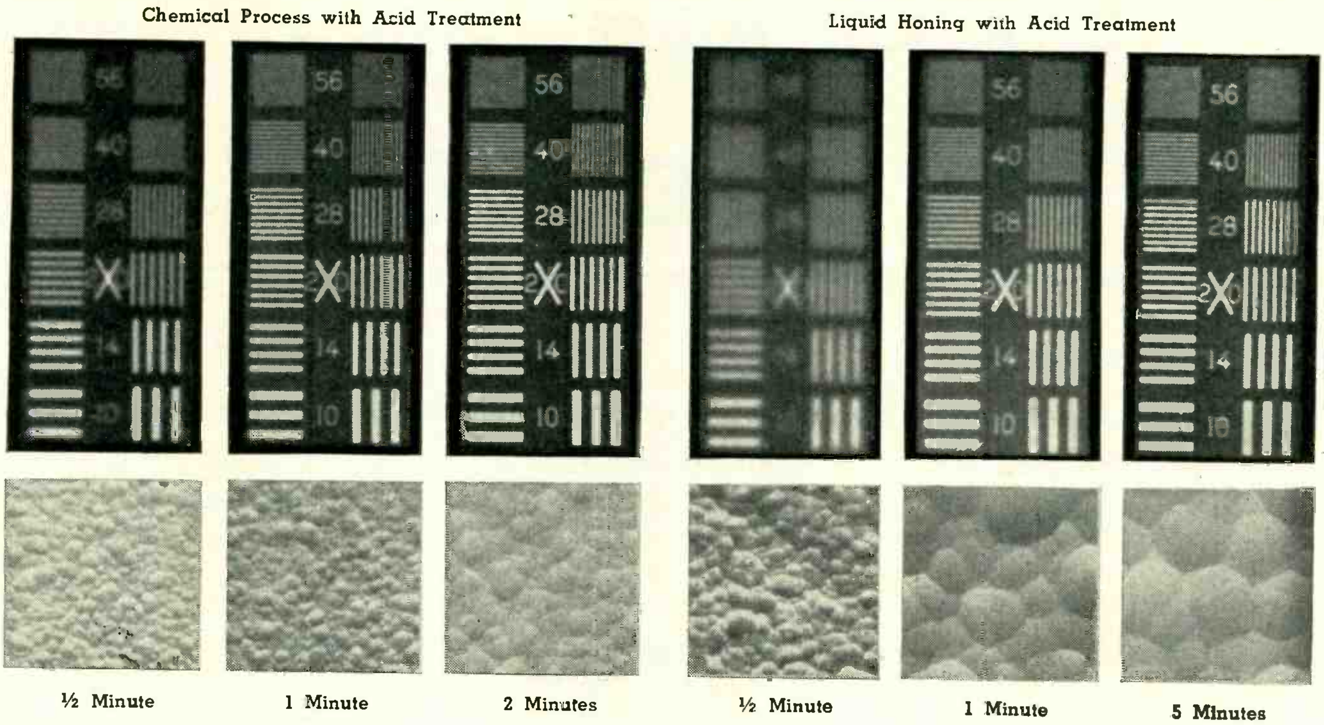


FIG. 1—Resolution test charts photographed through face plates having front surfaces treated by the two methods described and subsequently etched in hydrofluoric acid for periods of time indicated. Photomicrographs (approximately 125 microns square) below show processed surfaces

are too diffusive, thus impairing the quality of the transmitted image.

### New Method

The method described in this paper when adequately controlled has none of the aforementioned disadvantages. The surface of the plate is first etched either chemically or by a liquid abrasive-blasting method known as liquid honing. The latter is a process in which the plate is subjected to a high pressure spray of abrasive particles suspended in water. Either of these processes creates a surface having a light-diffusing property, which reduces the specular reflection but also tends to deteriorate the quality of the transmitted image. The etched plate is then subjected to a treatment in hydrofluoric acid, either by dipping or spraying, until the transmitting characteristics are restored to the extent required by test resolution patterns. The result of this processing is shown in the accompanying photograph, which shows a television image as seen through a face plate only one-half of which is treated in the described manner. The untreated half clearly illustrates how the reflected image of fluorescent light tubes, for example, can obliterate the transmitted picture information.

In Fig. 1 there are a series of resolution patterns as photographed through face plates which have been surface-etched by chemical means and liquid honing, respectively, and then subjected to hydrofluoric acid for varying lengths of time. From these photographs, it is apparent that control of the acid bath is necessary to preserve the image quality of the transmitted picture. In each case reading left to right, the first plate is considered to be unresolvable; the second is just resolvable, and the third is quite acceptable.

In order to investigate the surface structure of the treated face plates, photomicrographs of these same samples were taken and are shown. As the acid treatment is continued on any particular sample from a point of minimum reflection and maximum diffusion, the hill-like structures increase in diameter and become more flattened. The acid tends to dissolve the roughened edges and smooth out the surface to some extent. The surfaces etched by chemical means are much more uniform and give a greater number of and smaller hills for the same transmitting and reflecting qualities than those etched by the mechanical method. Tests made with a surface analyzer also indicate that the chemical etch provides a much more uniform surface.

### Reflection Characteristics

The reflection characteristics of these treated face plates have been studied quite extensively. Plates treated by the chemical etch method always exhibit a minimum reflection point before being subjected to acid, whereas in the case of liquid honing, the surface may be lightly etched, then brought to this minimum value by the acid treatment. This action of the acid can be seen in Fig. 2A, which is a plot of reflectivity as a function of acid treatment time. The reflection is specular before the minimum is reached and of a diffuse nature from that point on.

Measurements were made with a Weston photocell having a Viscor filter in a reflectometer built for this purpose. A collimated light beam is reflected from the surface under study at an angle of 35 degrees to the normal. A typical surface after being lightly liquid-honed has a reflection of 50 percent of that from the two sides of a conventional filter-glass face plate, or approximately 3.5 percent in terms of 100 percent from a perfect reflector.

It should be remembered that the combined reflection from the two surfaces of a clear glass face plate is approximately 9 percent. The filter-glass face plate now in general use has around 25 percent absorption, the reflection from the back surface is thus reduced to 2½ percent and the total from both surfaces to 7 percent.

Although still quite transparent, the liquid-honed surface has a misty appearance which produces a somewhat diffuse transmitted image quite objectionable for television applications. With subsequent acid treatment, however, the specular reflection decreases and the diffusion of transmitted light increases until the aforementioned minimum point of reflection is reached.

With further acid treatment the reflected light becomes almost entirely diffuse and the transmitted light becomes more specular. This behavior may be explained by the fact that the acid attacks the glass selectively wherever the surface has been broken and tends further to roughen the surface. After a period of time corresponding to the minimum on the curve, the acid becomes trapped and only the crests or high spots are attacked, thus producing a smoothing effect. This explanation is partially borne out by the fact that the negative slope of the curve is much steeper than the positive slope, indicating that the relative areas of roughened surface to smooth surface are much greater after the point of minimum reflection has been reached than before.

Limits on the residual reflection have been experimentally correlated with the resolution desired and the thickness of the plate. The resolution of a transmitted image in contact with the back surface of the treated plate is inversely proportional to the thickness. Furthermore, as the plate resolution increases, the reflection increases. In order to maintain high picture quality, these treated plates must resolve at least 2.2 lines per mm which corresponds to approximately 4.5 television lines per mm, or a definition of approximately 850 lines on a 12½-inch tube raster. It has been found that metal tube face plates which will give this resolution have a minimum reflection of 21 percent of the combined reflection from the two surfaces of an untreated filter-glass face plate which, as explained above, would correspond to approximately 1.5 percent of the total incident light. For all-glass tubes where the thickness across the face may vary from ¼ to ⅜ inch, a minimum reflection of 35 percent must be tolerated to achieve the desired resolution.

## *Additional Tests*

Several tests were made on completed television tubes having low-reflecting faces. It was found that there is no decrease in luminance from treated face plates as measured normal to the tube. There is, however, a slight falling off as the angle of observation is increased. This directional effect of various types of tube faces now in production is compared in **Fig. 2B.** It is evident that the plates treated by the liquid-honing process are slightly more directional than those treated by the chemical etch. This is due to the fact that the former gives a heavier etch, and more attenuation is to be expected as the light passes obliquely through it. Tests to determine whether or not any color shift is introduced by the etching process have proven that there is no effect either on the axis or at large angles of observation.

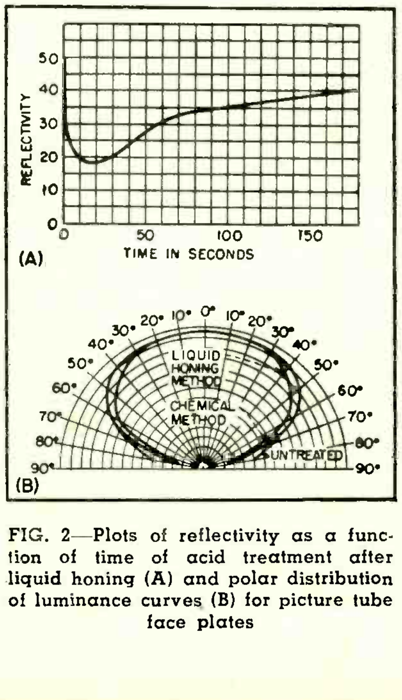


FIG. 2—Plots of reflectivity as a function of time of acid treatment after liquid honing (A) and polar distribution of luminance curves (B) for picture tube face plates

It is interesting to note that tubes with treated face plates appear to be mechanically stronger than those with untreated face plates, judging by pressure tests performed on both types of tubes. Similar experience has been reported in the manufacture of incandescent glass bulbs where acid treatment followed abrasion.[5]

Thus far treatment of the outer surface alone has been considered, the inner surface remaining specularly reflective. In order to reduce or mask the reflection from the inner surface to a negligible amount, the outer surface treatment must progress farther than desired. This reflection also can be eliminated by the low-reflection treatment of the inner surface. For a given reflectivity, the outer surface diffusion can therefore be made much less with a consequent improvement in the quality of the transmitted image. Of the two processes mentioned, the liquid-honing is more suitable for application to the finished tube, in which case only the outer surface is made diffuse. The chemical abrasive process can equally well be applied to the face plate before sealing it to the metal cone and, therefore, metal tubes can be easily fabricated with both surfaces treated, with the inherent improvement in resolution.

Tests show no loss of contrast for low-reflection treated tubes under normal viewing conditions. With intense external light, however, the residual light scattered back to the viewer has the effect of lowering the contrast ratio. But, multiple reflections within the glass are actually reduced by the combined abrasive etch and polishing treatment.

The authors are indebted to Joseph A. McCormick of the Dearborn Glass Company for his cooperation and persistent efforts in the successful development of the chemical etch process mentioned above.

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# ADJACENT-CHANNEL


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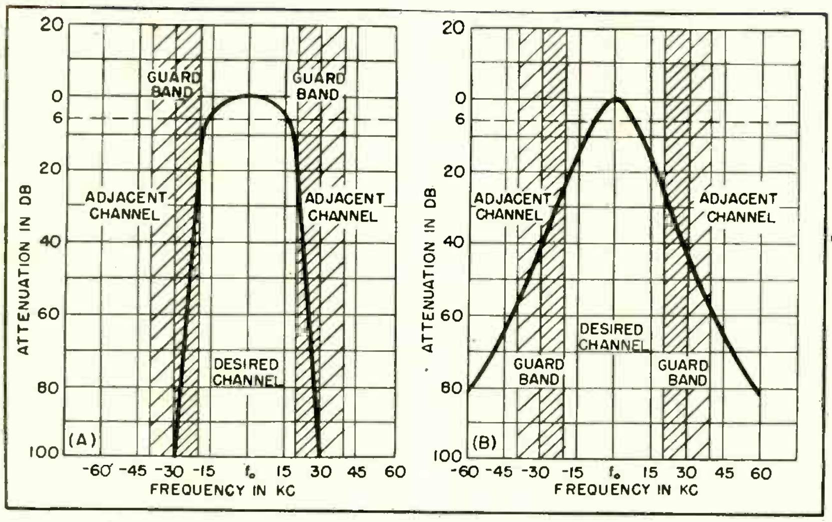



FIG. 1—Desirable selectivity curve is shown at *A*. The curve of a conventional Motorola receiver is shown at *B*

THE FREQUENCY SPECTRUM available for radio communications remains the same but the need for new channels is ever increasing as the number of applications and the number of users of electromagnetic waves increases. The problem of obtaining more useful channels is particularly acute in television and in mobile communication systems.

One solution to this problem would be to go to higher frequencies where more bandwidth is available. Some services such as radio relays and other point-to-point radio communication could be transferred to frequencies above 200 megacycles, but this is not necessarily the case with the mobile service. In this service the requirement of line-of-sight is not often fulfilled and so the ground wave must be relied upon. Such a wave is not propagated well even at frequencies as high as 200 megacycles and shadow effect becomes more and more pronounced as the frequency increases.

On the other hand, in thickly populated cities the waveguide effect of the streets may cause, at higher frequencies, considerable condensation of electromagnetic waves, usually accompanied by pronounced standing waves. In this special case, higher frequencies may be well suited for communication, but in general, mobile communication systems should operate in the region below 200 megacycles. For this reason, closer channel spacing and the ability to use adjacent channels are both very important in the mobile service.

The receiver design principles to be outlined were first applied to receivers for the mobile service, and for this reason an f-m receiver working in the 152 to 162-mc band has been chosen as an example, although the principles are by no means limited to this field and could be applied with equal benefit to any a-m, f-m or television receiver.

### Requirements

For successful adjacent-channel operation, a sufficient rejection of the unwanted signal should be achieved at the edge of the adjacent channel. The receiver should accept the band of frequencies required by the received signal and its modulation sidebands without appreciable attenuation. Therefore, a rather rapid transition from no attenuation to full attenuation has to occur. This transition has to occur within the so-called guardband which is an unused narrow band between channels in which no modulation exists. Figure 1A shows a desired practical shape of selectivity curve. The ideal square selectivity shape is not practical because it has two discontinuity points and infinitely steep sides. The performance of such a square curve would not be satisfactory because of nonlinear phase characteristics.

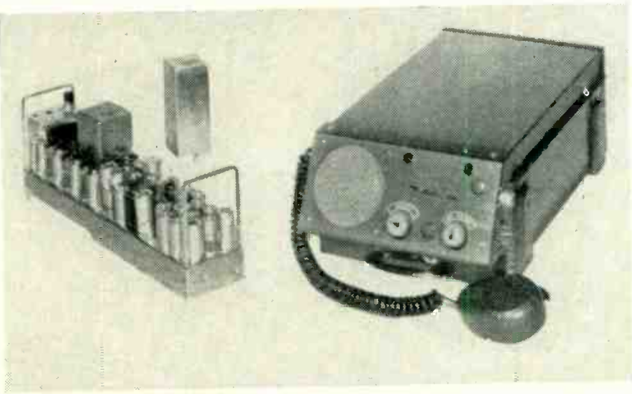
Figure 1B shows for comparison the average selectivity curve of an ordinary receiver obtained by using several tuned circuits. Usually the top of the curve is not wide enough and the sides of the curve are not steep. It takes the whole adjacent channel, not just the narrow guardband, before substantial attenuation is obtained. In addition, the shape of this curve depends greatly upon the tuning of the individual circuits and it will vary from day to day due to change in temperature.

The minimum receivable signal can be easily determined from the theoretical noise and the noise figure of the receiver. For example, for a 40-kc bandwidth f-m police receiver, the theoretical noise is equal to $KTB$ or $4 \times 10^{-21} \times 40 \times 10^3$ watts, or 158 db below a watt. Assuming the practical noise figure of a receiver to be 12 db, the noise level will be 146 db below one watt or 0.35 microvolt at the 50-ohm antenna input cable. A carrier giving 20-db quieting will, in this case, be of the order of 0.5 microvolt, which may be considered the weakest usable signal.

The strongest unwanted signal which can be rejected by the receiver depends greatly on the desensitization and intermodulation characteristics of the receiver. By desensitizing we mean the phenomenon occurring when a strong signal decreases the total gain of the receiver. This is generally caused by the grid voltage on one or more tubes swinging into the positive region and thus building up additional bias or loading the grid tuned circuit (or circuits) by grid current.

# REJECTION RECEIVER

**Desensitizing by strong local stations just outside desired-frequency guardbands, as well as intermodulation and spurious responses, is minimized by concentrating selective elements largely ahead of amplification. Hermetically sealed passive bandpass filter is heart of system**



Strip receiver chassis, one filter and complete mobile unit which incorporates some of the design techniques described

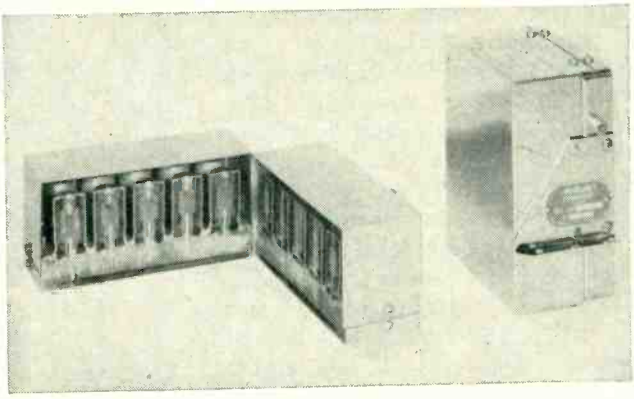


FIG. 3—Cutaway view of passive filter and a complete cased unit for a receiver

Situations frequently arise, particularly in mobile communication practice, where a police car, for example, has to receive messages from a remote station, or another police car, while it is operating in the close vicinity of the transmitter of a taxicab company, which may be on the adjacent channel. Under such conditions many receivers are completely desensitized or blocked by this high-level signal.

The amount of unwanted signal which can be tolerated depends greatly on the receiver construction. In an average receiver, the first r-f tube has a grid bias of the order of 0.7 volt, and this would be the peak voltage acceptable, the rms value being 0.5 volt. Assuming an input tuned circuit step-up ratio of 5 to 1, a 0.1-volt signal at the antenna input is all that can be tolerated. This means that the selectivity that can be expected in the receiver is 0.1 volt to 0.5 microvolt or 106 db. Practically, most receivers have a much lower limit, because they build up the gain before selectivity, which is obtained in the last i-f stages.

### Intermodulation

Another problem resulting from crowding of the spectrum is intermodulation. If there are two strong transmissions on frequencies $f \pm \Delta f$, and $f \pm 2\Delta f$, where $f$ is the receiver frequency and $\Delta f$ is the channel spacing (or some multiple thereof), then the second harmonic of the first transmission will be generated in the receiver because of nonlinearities in the amplifying tubes, usually the mixer stage and possibly the r-f stage. This second harmonic, whose frequency is $2f \pm 2\Delta f$, will beat with the $f \pm 2\Delta f$ transmission and create a beat note of frequency $f$. Once frequency $f$ has been created in a receiver, no amount of selectivity of the i-f circuits can prevent interference. This interference may be weak, so that it merely opens the squelch in the absence of a desired signal, causing annoyance, or it may be so strong as to completely block the receiver. If the signals on adjacent channels are properly spaced

FIG. 4—Stages of a mobile receiver employing the design discussed in the text →

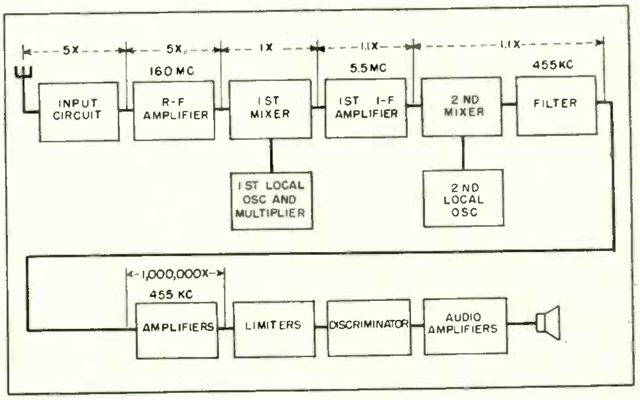
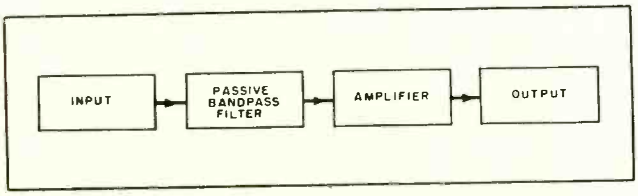



FIG. 2—Block diagram of new receiver using the passive bandpass filter



frequency-wise, a very small nonlinearity in receiving tubes is sufficient to create a pronounced interference, and consequently the intermodulation will exist with signals much weaker than necessary to desensitize the receiver.

The spurious responses of a receiver, such as image frequency, or frequencies obtained by beating with some multiple of the local oscillator crystal frequency (if crystal and multipliers are used), are not exactly connected with the adjacent-channel operation problem. It is nevertheless good practice to keep them down, since, with the present crowding of the spectrum, strong transmission at any frequency should be expected. If the selectivity of the receiver is such that it rejects a transmission on the adjacent channel 100 db stronger than the desired signal, then, consistently, all the spurious responses should be 100 db down.

### Band-Pass Filter

A design illustrated in the block diagram of Fig. 2 features:

*Separation of selectivity and amplification.*

*Placing all selectivity-determining elements in front of the amplifier stages.*

*Obtaining a suitable (approaching a square top) selectivity curve by using passive band-pass filter technique at a suitable low frequency.*

*Design of an input circuit, in front of this filter, consisting of one or more frequency converters with a minimum amount of amplification (consistent with good signal-to-noise ratio) and maximum spurious rejection.*

The passive band-pass filter is the heart of the receiver and can be built by using several coils and capacitors in constant-*K* and *M*-derived sections. The center frequency of the filter can vary from 50 kc to some 20 mc, depending on the particular application (a-m, narrow-band f-m, wide-band f-m or television). The filter can be made with sharp enough slopes to assure at least a 100-db rejection at the edge of an adjacent channel.

The top of the filter response curve could be made very flat but, to obtain desired phase characteristics, the corners of the curve should be reasonably rounded. Such a filter gives a stable and permanent performance since once the filter is factory adjusted and sealed there is no need or possibility of readjusting it in the field, and therefore the selectivity characteristics of the receiver remain constant. Should the need arise to change the width of the channel, or the selectivity characteristics, a simple exchange of the filter will permit this, since the filter is the only factor determining selectivity. Also, in television practice, the curve obtained by the filter can be of any desired shape, and as perfect a vestigial operation as may be required for good video reception can be had by properly designing the filter.

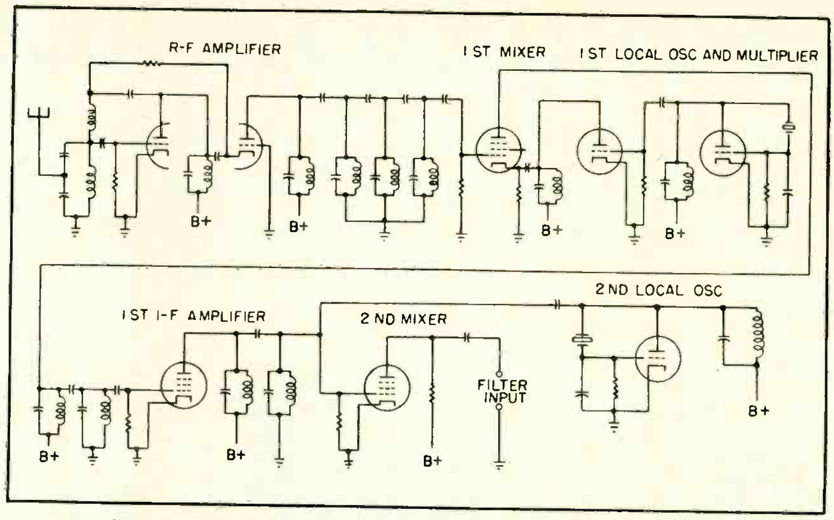



FIG. 5—Schematic of front-end for the receiver shown in Fig. 4

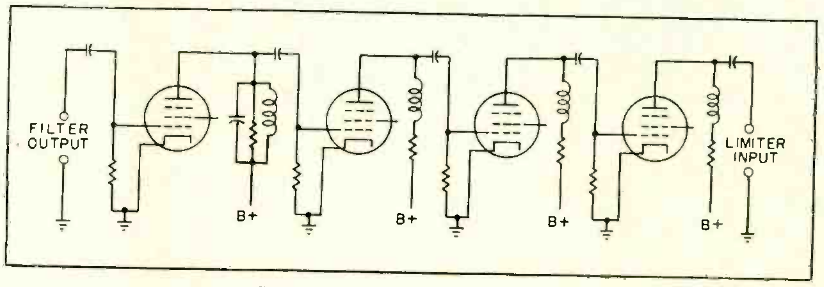



FIG. 6—Circuit of i-f amplifier

To illustrate how such a filter may be constructed, Fig. 3 shows a complete factory-sealed and adjusted filter used in a mobile communications receiver, and also a cut-away view. The coils of the filter are adjusted by iron slugs and then are sealed completely in compound, so that they will never change their characteristics. This particular filter is composed of fifteen coils arranged in more or less conventional constant-*K* and *M*-derived sections.

### Receiver Input

The head end starts with an antenna matching circuit followed by an r-f stage. The well-known cascode circuit can be used for maximum signal-to-noise ratio. The selectivity should be sufficient to reject the image frequency by about 100 db. Since the filter following the head end works on a relatively low center frequency, the image frequency is usually too close to the desired frequency. Therefore, in general, in f-m receivers two converters are used, one converting to a 5 to 10-mc first i-f, and the other to the filter frequency. In this way, sufficient image rejection can be obtained by using two or more loosely coupled tuned circuits in both r-f and first i-f stages.

The gain of every head-end stage should be held at a minimum consistent with good signal-to-noise ratio. If most of the noise is generated by the first tube and not by the antenna circuit, as often happens in vhf receivers, it means that the voltage gain between the first tube grid and the second tube grid should be approximately three, assuming that the same amount of noise is generated by both tubes. In this way the second tube will add only approximately five percent to the noise voltage of the first tube because the resultant noise is the square root of the sum of the squares of the voltages. This will practically not affect the signal to noise ratio.

From the second tube on, the gain should be unity since it is better to take some slight increase in noise voltage (roughly five percent per tube) than to amplify the signal and risk desensitizing and intermodulation. If one of the front-end tubes generates more noise than the first r-f tube, the gain in front of this tube has to be adjusted upwards accordingly. The low gain requirement permits use of several under-coupled circuits, thus converting extra gain encountered in the plate circuits into additional selectivity necessary for image and other spurious rejection. This also permits limiting the radiation of the local oscillator from the antenna since the under-coupled circuits will effectively prevent the local oscillator energy from penetrating into the antenna.

The design of the mixer stage requires particular attention. Low noise and minimum of distortion to signal and oscillator voltages are required since distortion produces the second harmonic which is essential for intermodulation.

An example of a mobile communication receiver is shown in the block diagram of Fig. 4. The schematic of the front end of this receiver is presented in Fig. 5.

The antenna circuit gives a voltage step-up of about 5. The r-f amplifier consists of a twin-triode cascode circuit with four under-coupled circuits as a plate load. The cascode circuit may be used as an r-f stage in place of a pentode but its advantages are less pronounced at lower frequencies and the complications connected with its use are not always warranted.

The first mixer uses cathode injection and is designed for a minimum of distortion. The first i-f consists of two pair of double-tuned undercoupled circuits, with the gain of the amplifier adjusted to just overcome the insertion loss of the tuned circuits. By using high-Q tuned circuits and high first-mixer gain, or possibly by using another sealed filter in place of tuned circuits, this amplifier tube can be omitted. The second mixer is conventional, to change the center frequency from 5.5 mc to the 455-kc filter frequency.

The construction of the amplifier which follows the filter is not critical. No selectivity is required, and therefore resistance-coupled stages can be used although, sometimes, single-tuned stages provide better gain and stability. The total gain required is rather high but since the frequency is low no special problems are encountered. A typical amplifier is shown in Fig. 6. This four-stage circuit operates at 455 kc with an overall gain of about 120 db.

The output portion of the receiver follows the amplifier and consists of any conventional detector, or limiter and discriminator, followed by an audio amplifier. Its design need not differ from usually used techniques, although in f-m receivers, because of the very low filter and amplifier frequency, special circuits such as a frequency counter or slave multivibrator could be used in place of the discriminator.

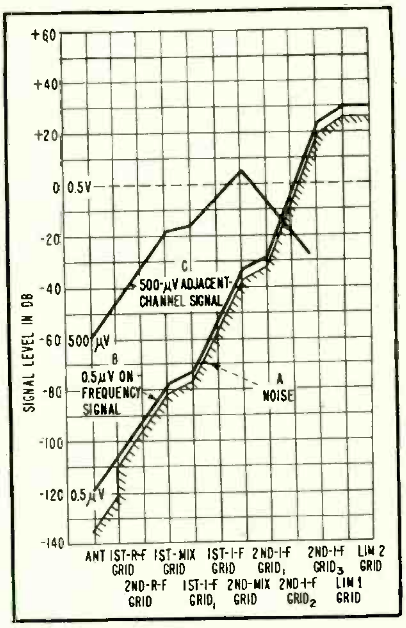



FIG. 7—Distribution of gain through conventional f-m receiver

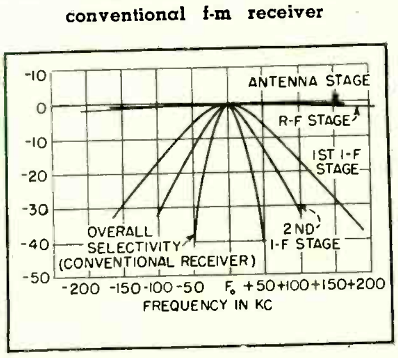



FIG. 8—Selectivity curves of a conventional receiver

### *Conventional Receiver Performance*

When the gain and the selectivity of each stage of a conventional receiver is known, curves similar to those shown in Fig. 7 can be drawn. The abscissas of this drawing show convenient points at which the signal can be measured, such as antenna input, r-f grids, mixer grid, and all grids of the following stages. The ordinates show the signal strength at various stages. The 0.5-volt signal was arbitrarily chosen as 0-db level, since this is the maximum signal which can be tolerated by most receiving-type tubes.

Curve *A* shows the receiver noise. It is about −110 db at the first r-f tube since noise equivalent to 1.75 microvolts on the grid was assumed to be generated by this tube. This noise is amplified by the successive stages and finally it has an amplitude sufficient to saturate the last limiter (10 volts or plus 26 db assumed). A weak 0.5-microvolt, or −120-db, desired signal (curve *B*) can likewise be traced through the receiver. Curve *B* will be essentially parallel to, and will lie above, noise curve *A*.

Assume a somewhat stronger signal of 500 microvolts, or −60 db, on the adjacent channel, curve *C*. Since the signal is off frequency, the gain of each stage for this signal will be less by the amount of selective rejection by that stage. Unfortunately, the first stages of the conventional receiver are never very selective.

Curves of Fig. 8 show the relative selectivity of an antenna stage, an r-f stage, a first i-f stage, a second i-f stage, and the total selectivity of one conventional receiver measured. Resonance of the antenna tuned circuit is generally very broad and the off-frequency signal will be amplified about the same amount as the on-frequency signal. Thus curve $C$ of Fig. 7 runs parallel to curves $B$ and $A$ between the antenna and the first r-f grid. The same is true for the r-f stages if the disturbing signal is close by in frequency, and so curve $C$ is practically parallel to curve $B$ up to the i-f stages.

Curve $C$ exceeds the zero-db level at the second mixer stage, and some serious desensitizing will occur at this stage. If the signal is on an adjacent channel, and is accompanied by another one on the next to the adjacent channel, a serious intermodulation will occur, probably at the second-mixer grid even if the signal should be weak enough not to cause desensitization. The intermodulation is very detrimental, and if stronger than the desired signal, will completely obscure it. The desensitization, if moderate, is not necessarily completely detrimental to reception as some additional gain is generally available, especially in f-m receivers and a-m receivers with agc. The most common result of moderate desensitization is deterioration in signal-to-noise ratio in f-m receivers and cross modulation in a-m receivers.

One more thing should be mentioned about receivers with distributed gain and selectivity, namely, the dependence of selectivity on the strength of the applied signal. If a receiver could receive a weak desired signal, say 0.5 microvolt, in the presence of an undesired off-frequency signal, say 60 db stronger, it may be unable to do so for desired signals of an order of 5 microvolts for two reasons. One reason is that the signal 60 db stronger than 5 microvolts may now completely desensitize the receiver to the point where one tube is biased off. The other reason in f-m receivers is that the last i-f stages, which contribute most to the selectivity, are now saturated and will not contribute to the selectivity of the receiver.

### New Design Performance

The noise and signal curves for our new receiver are shown in Fig. 9. The noise (curve $A$) is amplified only by the first r-f stage and is kept at this slightly higher level up to the filter. Amplification is necessary so that the noise contribution of other tubes may be insignificant. The desired signal (curve $B$) runs parallel to the noise curve. The big difference is shown in the off-frequency signal, curve $C$ (as compared to curve $C$, Fig. 7). This signal is only slightly amplified in the first r-f stage, then it is slightly weakened by the following stages because they are adjusted to unity gain (for the desired signal) and have some selectivity, and finally is completely rejected by the filter (100 db or more) and drops

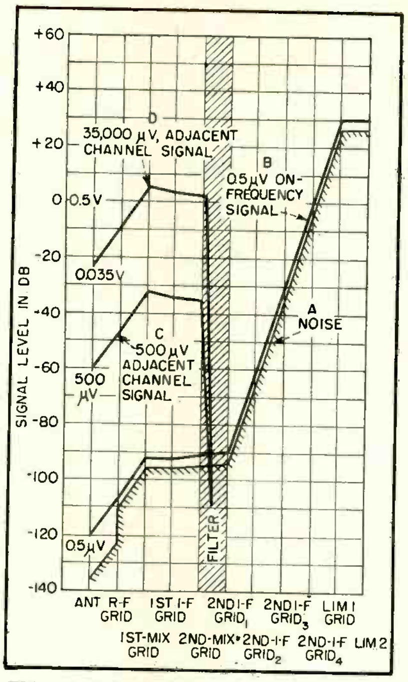


FIG. 9—Distribution of gain through new f-m receiver

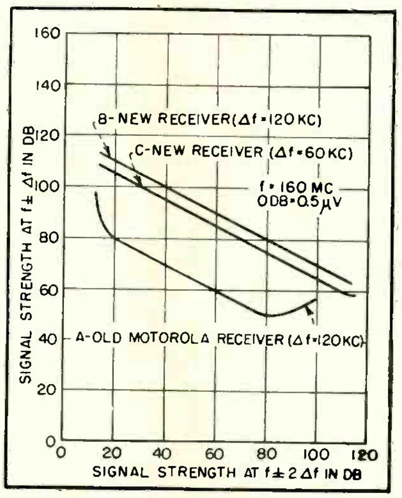


FIG. 10—Curves of intermodulation interference

below the noise level before being amplified. The unwanted signal is never permitted to desensitize the receiver, and hits the first mixer grid at a relatively low level so that intermodulation, which most often takes place there, is lower than in conventional receivers. Even a much stronger signal of 35,000 microvolts (curve $D$), which would be ordinarily completely detrimental, barely exceeds the desensitizing level at the mixer grid.

The intermodulation curves show marked improvement despite the fact that no special means of improving linearity and decreasing intermodulation were used. Intermodulation curves of the first new receivers are shown in Fig. 10. Curve $B$ is for signals 120 kc and 240 kc away at 160 mc. Curve $A$ shows the intermodulation of the old Motorola receiver for comparison. Curve $C$ is for the new receiver when the separation was decreased to 60 kc and 120 kc. This curve could not be duplicated on the old receiver because of insufficient selectivity.

For all curves, the coordinates are in decibels above an arbitrary zero level. This zero level was chosen as the power of a desired signal which is just sufficient to give 20-db quieting of the receiver. In this case it was 0.5 microvolt. The ordinates give the power level of the $f \pm \Delta f$ signal and the abscissas that of the $f \pm 2\Delta f$ signal. Each curve is the locus of points for which 20-db quieting, due to intermodulation, was obtained. The curve is linear over the greater portion of its length but curves at the ends where either of the two signals reaches a certain level. This effect is due to desensitization. The level of the $f \pm \Delta f$ signal has to be relatively stronger than that of the $f \pm 2\Delta f$ signal. This is to be expected since efficient generation of the second harmonic of the $f \pm \Delta f$ is necessary for intermodulation.

Gratitude is expressed to D. E. Noble, Vice-President and Director of Research of Motorola Inc., under whose direction the project was developed, and to James Clark, who made most of the laboratory measurements and constructed a successful laboratory model.

# Solenoid Motor Control

**Position of idler roll, raised or lowered by continuous strip of material moving toward wind-up roll, varies the direct current flowing through a saturable reactor in thyratron motor speed control circuit**

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VARIABLE speed is required when a wind-up roll as used for cloth, wire or strip metal is driven from its center shaft. For automatic control of this speed, a small solenoid may be used, with its accessory electronic unit, to furnish the speed signal to the motor-armature circuit of a Thy-Mo-Trol electronic drive.

In Fig. 1, the armature of a solenoid is moved when a dancer roll is raised or lowered by a continuous strip or web of material passing onto a wind-up roll driven by motor *M;* in this way the material is wound under constant tension. As the roll becomes larger, the motor speed must be decreased if material is received at nearly constant rate.

If the roll pulls the web faster than it is supplied, the web raises the dancer roll, withdrawing the solenoid armature; this movement increases the current in both triode sections of $V_3$ so that more voltage is produced across $R_1$. Part of this voltage is used as a speed signal for the electronic drive; it raises the grid voltage of $V_2$, increasing the voltage across $R_5$. This lowers the $V_1$ grid potential and decreases the direct current in the saturable reactor *SX*, increasing its impedance.

The a-c windings of *SX* are in a phase-shifting bridge with $R_6$, to vary the phase of the a-c voltage applied to the grid transformer $T_2$. As the direct current in *SX* decreases, thyratron tubes *A* and *B* are phased off (fired later in their half cycles of anode voltage) so that the motor armature receives less voltage. This reduces the motor speed so that the web holds the dancer roll and the solenoid armature at a new position; the whole circuit becomes a closed-cycle system that regulates the solenoid and the motor speed to match the increasing size of the roll.

Tube $V_3$ acts as a full-wave rectifier to produce a d-c voltage across $R_1$. Although $V_3$ is a high-vacuum tube, its grid circuits include a phase-shifting network comprising $R_4$ and the solenoid coil, connected across power transformer secondary $S_1$ so as to produce out-of-phase a-c voltage across $R_2$ and $R_3$.

The solenoid acts as a variable inductance. Withdrawing the armature decreases the solenoid inductance, letting more alternating current flow through its coil.

As the solenoid armature is withdrawn, the a-c voltage across $R_2$ becomes more nearly in phase with the anode voltage of the left-hand section of $V_3$; similarly, the a-c voltage across $R_3$ becomes more nearly in phase with the anode voltage of the right-hand triode section. This increases the plate currents of both triode sections, so that more electrons flow from the centertap of $S_2$ through $R_1$, producing a pulsing d-c voltage across $R_1$. This is filtered by capacitors (not shown) in the electronic drive to make terminal *A* of $R_1$ more positive.

As terminal *A* rises in voltage and increases the current of $V_2$, less current flows in $V_1$ and the d-c winding of *SX*, so that the thyratrons of the motor control system fire later and apply less voltage to the motor armature. The motor receives constant field current through other tubes not shown.

Top speed of the motor is set by the speed control potentiometer in the electronic drive. Even with no voltage across $R_1$, the grid voltage of $V_2$ cannot be lowered below the speed control slider potential.

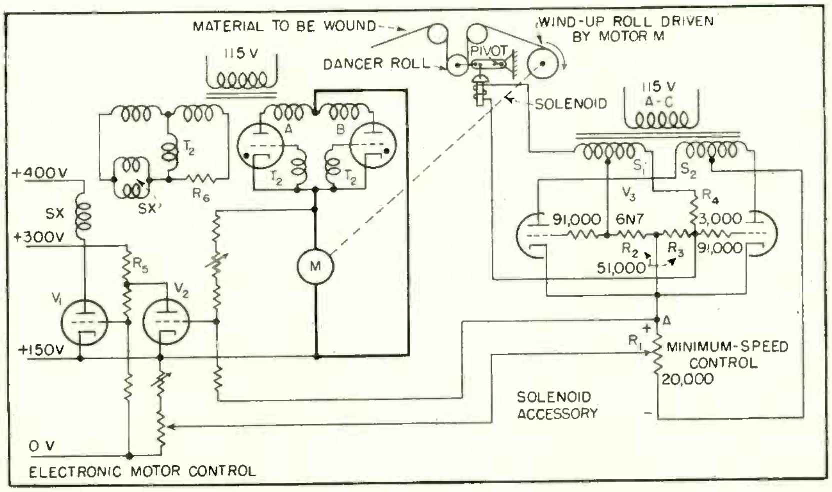


FIG. 1—Circuit of the electronic motor speed control and method of connecting solenoid attachment that is actuated by the dancer or idler roll

From a forthcoming book by the author to be published by McGraw-Hill Book Co., Inc., entitled "Electronic Motor and Welder Controls".

# TELEVISION PICTURE FIDELITY—

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WHAT IS MEANT by picture fidelity in standard home television?

The answer ought to be in the published standards on television, but a search of the IRE Standards, the RMA Standards and the ASA Standards shows only lists of factors that are said to affect picture fidelity. What it is, they don't say.

This lack of a published standard definition illustrates that picture fidelity involves something more than the simple physics of image formation, something more than the transmission system that connects the lens of the camera to the screen of the picture tube. That something more, that vital factor that standardizing committees can't agree on, is perception.

Perception opens the door to a better understanding of picture fidelity, by explaining how the television viewer, looking at his picture tube, sees what is before the lens of the distant camera.

In audio, fidelity is defined as the degree with which the output of a system accurately reproduces the essential characteristics of the input. Extending this to television, it might be said that fidelity is the degree with which the picture on the screen of the receiver accurately reproduces the essential characteristics of whatever is in the field of view of the camera.

It will simplify our thinking, to limit consideration of fidelity to cases of live pick-up under controlled conditions, ignoring for the moment such things as spot news and sporting events, and the use of motion picture film at either end of the system.

The list of factors that the standards say affect picture fidelity is comprehensive, and includes 14 items, most of them self-explanatory. The list follows:

(1) Number of scanning lines
(2) Number of frames and fields per second
(3) Percentage of time allotted to blanking
(4) Geometric distortion
(5) Aspect ratio
(6) Focus
(7) Interlace
(8) Highlight brightness
(9) Brightness range (contrast range)
(10) Black level (d-c insertion)
(11) Transfer characteristic (half-tone characteristic)
(12) Resolution (resolving power, definition)
(13) Electrical response (gain and phase vs. frequency, bandwidth, or transient response)
(14) Noise and interference

To use the list, a standard test chart, a flat card with geometrical figures and gray scales, is placed before the camera. Equipment which is well adjusted in all 14 items often turn out pictures of all degrees of fidelity.

The standard list covers the physics of image formation rather completely (except for the spectral response of the camera tube, which might be added as a 15th item). However, three things that are missing from the standard list are:

(1) Studio techniques (lighting, make-up, scenery)
(2) Home viewing situation (size, surroundings, lighting)
(3) Capacity of the individual observer to look at the picture and see what is not there

The key to picture fidelity is in these three missing factors. Imagine what would happen if the observer could see what really takes place on a picture tube—a flickering spot of light moving repeatedly over a flat screen, downwards at about 30 miles an hour, sidewards at about 3 miles a second. If he saw that, there would be no television.

**PERCEPTION**

The psychological factors which affect the excellence of a television image are here reviewed by one of television's outstanding engineers. Baldwin's classic study of the sharpness of television images, performed in 1939, freed the tv art from a servile attitude toward the equalization of vertical and horizontal resolution. In this brief paper he treats matters, not ordinarily considered by the engineers, which must be kept in mind to achieve maximum performance from a television system.

—The Editors

### *Perception Process*

As a reproduction, a television picture lacks four things:

(1) Continuity (flicker, line crawl, stroboscopic effects)
(2) Size (not life size)
(3) Color
(4) Depth (distance)

These four things are the essential characteristics of the input. They are not transmitted, as such. They are contributed by the observer out of his own experience, without conscious effort, without appreciable delay. This act of contributing is a part of the process of perception. We all perceive by the same process, yet individual perceptions of a given picture or object do not always agree, because our individual experiences and skills at learning and recognizing are seldom the same.

The observer does not see the flickering spot dashing over the screen of the picture tube but he sees familiar objects (people, rooms, tables, windows), and he sees these objects in motion. He sees them as good solid objects, rounded where they should be rounded, and arrayed at different distances from him. He sees distance as a separate thing in the picture, and size as a separate thing, and illumination as a separate thing. These are his habits of vision, the facts of visual perception.

The practical consequence is that high fidelity is not automatic in television. It requires the skill and

**Consideration of the various factors involved in the physics of image formation on a television picture tube, and discussion of inherent limitations and attributes of the overall system and its production techniques**

ingenuity of camera men, electricians, set designers, make-up men, sound men, and the whole production staff. At the receiver it requires favorable viewing conditions, not too much stray light, not too much image structure due to pairing or interference, not too much specular reflection from the tube face, and so on. In addition to these things that cannot be standardized, high fidelity requires a proper equipment line-up with respect to the 14 items in the list.

Consider some of the mechanical limitations of the present television system, and how these limitations interfere with picture fidelity. The most obvious limitation is that the system has, in effect, only one eye. This isn't as serious as it sounds, because binocular vision is by no means essential to the perception of depth and distance, as we shall see presently. However, when a two-eyed observer looks at a one-eye picture on a flat screen, he may receive conflicting cues to depth and distance, especially if his attention is drawn to the flat screen by line structure, or noise, or surface reflections. The next time you see a noisy picture, notice how little depth it has.

Another system limitation is in angular field of view. The natural field is about 160 degrees wide by 120 degrees high, without moving head or eyes. An image orthicon camera, with a 50-mm wide-angle lens, has a field 36 wide by 27 degrees high, and if the 135-mm medium-angle lens is used, the field is only 13.5 wide by 10 degrees high. The camera sees a great deal less than an observer in the studio. In particular, it never sees the main sources of illumination but puts them all outside the field, so that the shadows they cast may appear rather artificial and extreme.

Field of view is a limitation at the receiver, too. If you sit 4 feet away from a 10 or 12-inch receiver, the picture field is again only 13.5 wide by 10 degrees high, as compared to your natural field of about 160 by 120 degrees. Your eyes adapt to the room light, not to the picture, and because you don't adapt to the picture, brightness changes in it may tend to appear rather extreme.

A final system limitation is the lack of mobility of the camera lens, both in focus and in rotation. The camera focus does not follow your line of sight the way the focus of your own eyes does. A fuzzy background in television stays fuzzy no matter how hard you look at it, quite unlike what happens in direct vision. Then again, when the camera moves, the lens moves rigidly with it, quite unlike what happens to your eyes when you move around. At slow speeds you seem to move about with the camera, but let it move a little too rapidly and you find yourself stationary while the background goes whizzing by.

These three system limitations, the use of a single lens, the restricted fields of view, and the lack of mobility in the lens, all conspire to interfere with picture fidelity by introducing conflicting cues and artificial appearances.

There are some 10 cues to depth and distance; 8 of them are monocular cues, only 2 are binocular. You are so accustomed to these 2 binocular cues that you are usually completely unaware of them. The first is double images—objects in your line of sight and remote from your point of regard always appear double if you think about them. This cue never occurs in television. The second is different images in the two eyes, a completely unconscious effect. In television this is a conflicting cue, since by means of it you may be able to see that the picture is indeed flat.

The remaining 8 cues to depth all work fine with one eye, or with one camera lens.

(1) Overlap—near object overlaps far one. (*Life*, Jan. 16, 1950, for example.)
(2) Motion parallax — near object moves against you, far one moves with you. This cue results only from camera motion. There can be no motion parallax in the flat image on a picture tube.
(3) Size—nearer object is the larger. The Zoomar lens utilizes this cue to distance. A Zoomar shot is not as realistic as an actual dolly shot because there is no motion parallax with the Zoomar.
(4) Relative sizes of familiar objects.
(5) Places where objects rest on the floor—the nearer the object, the lower is its resting place.
(6) Brightness — nearer object is brighter.
(7) Highlights and shadows—reveal contours and fine texture. Highlights and shadows are often not seen as such, but as shape and illumination separately.
(8) Linear perspective. Man walking away actually subtends a smaller visual angle, but he is perceived as of constant size and increasing distance.

These 8 monocular cues to distance are all used by the studio technician to build fidelity into the television picture. Some, like overlap, require no skill at all. Others, like motion parallax and linear perspective, succeed in proportion to the experience and ingenuity of the studio crew. The use of highlights and shadows to create roundness and depth is an art.

The impression of distance is often enhanced by using short-focus lenses to exaggerate the perspective. An image orthicon picture, taken with a 50-mm lens, has correct perspective when viewed at only 2 times the picture height. One of the rewards of sitting further back is an increased illusion of depth in the picture.

A new definition of picture fidelity is proposed. In television, picture fidelity is the degree of perfection reached in creating the illusion of motion, the illusion of size, and the illusion of depth.

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# Static Magnetic Memory

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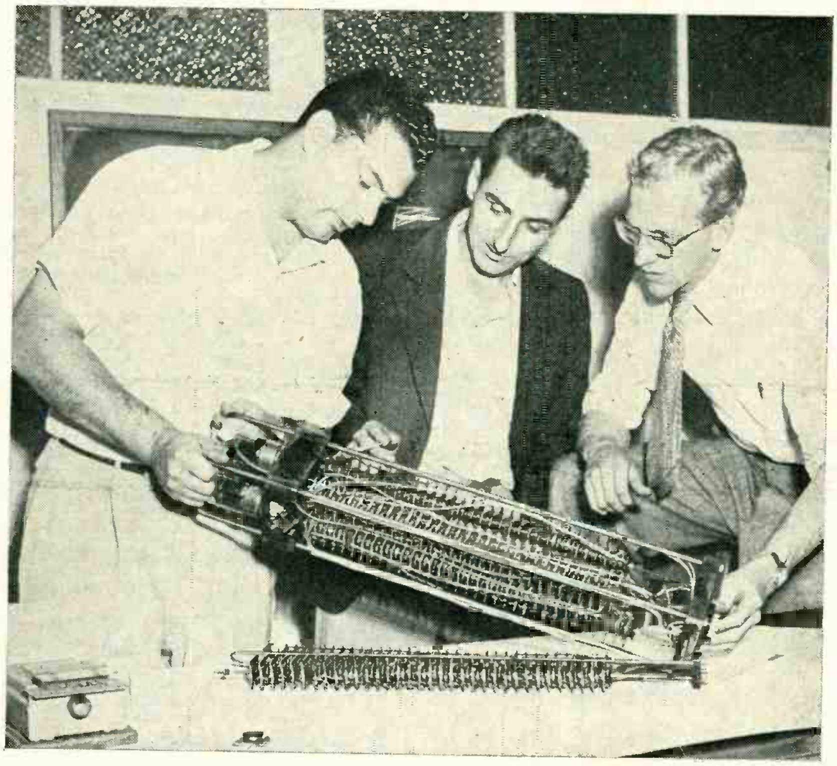
*Brockton, Mass.*



Prototype model of a 100-core static magnetic memory unit for use in the Mark IV computer at Harvard Computation Laboratory is composed of four vertically stacked banks of magnetic cores

LARGE-SCALE digital calculating machines have made many valuable contributions to fields in which the information handled is both extensive and complex. Typical applications have involved the solution of complex engineering and mathematical problems, such as the evaluation of Fourier series, the numerical solution of differential equations, and the solution of linear systems.

The machines used in this type of large-scale information handling are characterized by high cost; in many cases, they represent expenditures of one-quarter of one million dollars.

Progress made in this field has stimulated thinking concerning the possible application of less costly electronic computers to problems of information control and data-handling encountered in daily operation of business and industry. The high level of interest is indicated by the suggested application of computers to automatic continuous auditing, accounting and inventory systems, and automatic vending machines.

Less costly, less complex and practical machines for this type of business and industrial use certainly do not have to await ultimate perfection of ultrahigh-speed techniques. Operating speeds of the order of 30 kc, entirely practical at the present time, are sufficiently high to make machines of this type valuable. Furthermore, many of the necessary techniques and components for the design and manufacture of machines for medium-speed business use are either now available or becoming available.

### *Magnetic Material*

One of the newest components, called the Static Magnetic Memory, should permit substantial advances to be made in the improvement of computing machinery for business and industrial applications. The development of this device is an outgrowth of a discovery by German scientists during the last war of permanorm 5000Z, a material that has a rectangular hysteresis loop of low coercive force. A similar material known as Deltamax is now produced in this country by Allegheny Ludlum Steel Corp. Howard Aiken of the Harvard Computation Laboratory foresaw the possible use of such a material, because of its two stable-state characteristics, as a means of information storage in large scale digital computers. His basic idea has been implemented and carried out during the past two years by the work of Dr. An Wang and Dr. Way Dong Woo.

The device provides permanent information storage comparable to magnetic drum storage, but independent of mechanical mechanisms. A variable information handling rate is available ranging from zero to 30,000 pulses per second, with probable future increases in the present upper limit. Pulse storage is provided without

# for Low-Cost Computers

**Magnetic material having a rectangular hysteresis loop provides information storage independent of mechanisms, variable data-handling rate up to 30,000 pps and pulse storage without power. Aids in design of computing machines for business use**

Magnetic tape, magnetic drums, acoustic delay lines and other devices all accomplish a similar storage function. In this device, after information has been once stored, the cessation of power leaves the stored information unaffected. Furthermore, signal regeneration is unnecessary, for the device can continually store and circulate the pulses without attenuation. Fundamentally, the static magnetic memory differs from functionally similar devices in that it accomplishes pulse storage by electrical means without power being required.

The static magnetic memory operates essentially as a magnetic trigger pair, which requires no vacuum tubes to maintain position. The trigger-pair action depends on the state of the core material being represented by a point at either the top or bottom of the hysteresis loop, as in Fig. 1. This necessitates the use of a core material whose hysteresis characteristics approximate the ideal square loop, shown in Fig. 1.

### *Hysteresis Curve*

The hysteresis curve of Deltamax, Fig. 2, shows that this material is quite suitable for this application, due to the rectangularity of its loop. Because of the flat top and bottom of the loop, once the core is saturated in a given direction, further application of current pulses that tend to saturate the iron in the same direction will cause no further change in flux, and therefore will not produce any pulses in the output winding of the core. However, the first current pulse of an opposite polarity that occurs will cause an extremely large change in flux, thereby producing a pulse in the output winding. The presence or absence of a pulse is thus determined by the previous history of the iron core.

With several cores connected as in Fig. 3, the state of the preceding core can be transferred from that core to the next, provided suitable rectifiers are added to the basic circuit to prevent the backward flow of current. Rectifier 1 allows the current produced in the output winding of the first core to enter the input winding of the second core, and prevents any flux generated in the input winding of the second core from returning to the output winding of the first core.

Rectifier 2 allows all current provided by the output winding of the first core to enter the second core and provides a path for the current from input winding of the second core to be dissipated in the resistor instead of upsetting the first core. By alternately pulsing the advance windings of even and odd-numbered cores the state of any core relative to the hysteresis loop (Fig. 1) may be transferred to the succeeding core. Typical pulse patterns of this operation are shown in Fig. 4.

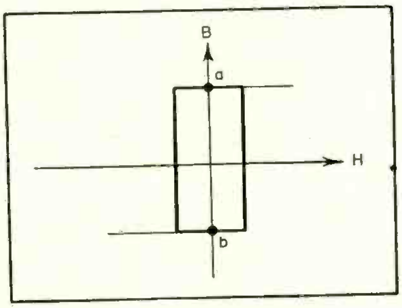



FIG. 1—Ideal hysteresis loop

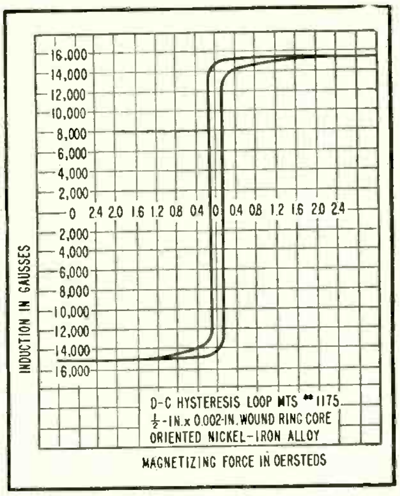
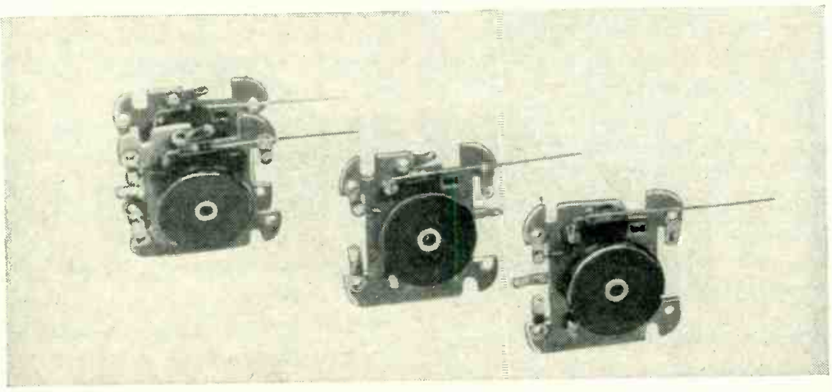



FIG. 2—Hysteresis loop of Deltamax core material



Single magnetic cores are shown in the center and at the right, at left is a pair of cores. The hollow rivets permit stacking employing complex vacuum-tube circuits, in a manner completely independent of the mechanical operation found in some of the other storage devices.

The static magnetic memory device has already proved useful as a means of storing information, as a means of transferring information

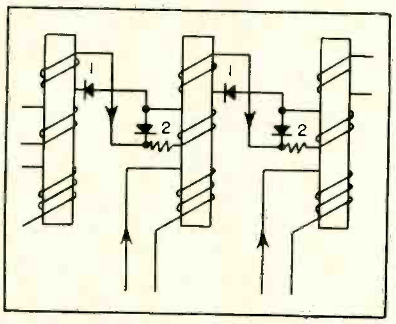


FIG. 3—Delay-line circuit of two cores per digit

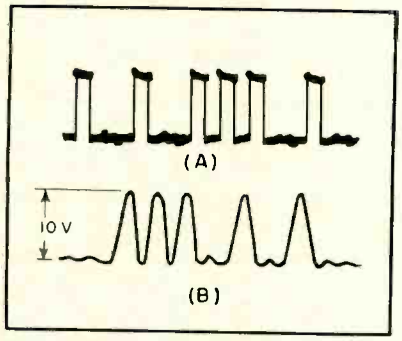



FIG. 4—Flux versus time curve in the two-core circuit. At (A), information 1010111010 is displayed at a rate of 2.5 kc. At (B), information 0011101010 is shown at 25 kc

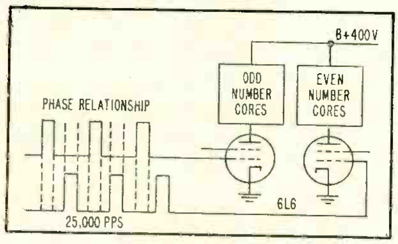



FIG. 5—Advance winding pulsing by means of tube plates. Evennumbered core advance windings are all in series

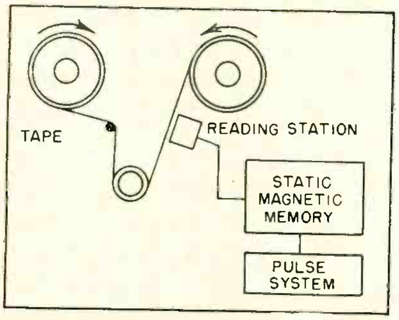



FIG. 6—Method of transferring high-speed pulses on magnetic tape to a slow-speed pulse system

between systems of different pulse rates, as a counter in which any configuration of pulses may be counted or circulated, and as a means of transferring information from serial form to parallel form, or vice versa.

### Storing Information

Whenever a time delay of any length is necessary between incoming pulse information and its later use, this device can continuously cycle or dormantly store the information pulses without attenuation until output is required. In its storage function it is particularly significant that the device requires no power to retain previously stored pulses.

Power interruptions or necessarily prolonged periods between input and output of pulsed commands or data thus do not impose limits on the storage function of the static magnetic memory for power is necessary only to pulse information in or out of the device.

One group is using these devices as a means of storing 16-digit decimal numbers. The number is determined by the presence or absence of a pulse. The static magnetic memory is involved in the relay circuit of a multiplier capable of obtaining a 46-digit product of two 23-digit factors. The equipment was constructed by the staff of the Computation Laboratory of Harvard University as an auxiliary to the IBM Automatic Sequence Controlled Calculator, usually known as the Mark I.

The single elements may also be assembled in such a manner that the two advancing windings are pulsed from the plates of tubes, thereby transferring the numbers in or out of a given register. A simplified schematic illustrating this arrangement is shown in Fig. 5. Any pentode type that will deliver 150 ma peak plate current will operate satisfactorily. At a lower repetition rate, however, more turns of wire may be added to each core and correspondingly smaller tubes may be used.

### Systems of Different Pulse Rates

A second broad group of applications of the static magnetic memory involve its use as a transfer medium between systems of different pulse input and output speeds. This means that the device operates essentially as a speed transformer. Pulse input speeds of the order of 25 kc in some cases might be of little value if output could not be effected at a much slower speed, as for example, to operate mechanical printing devices or telegraphic instruments. This function combined with its storing ability allows the coupling of medium-frequency pulsing systems to devices of much lower operating speeds and vice versa.

A system employing magnetic tape (Fig. 6) illustrates the value of a linking medium between systems of different pulse rates. While recording on the tape a pulse rate of 10 kc, for example, may be very desirable, yet output to typewriters, solenoids or relays is impractical at this speed. However, this process can be made entirely feasible by means of a rapid input pulsed into the static magnetic memory and pulsed out at the desired slower speed.

Conversely the same is true: a relatively slow input from punched cards or some mechanical source may be read out of the static magnetic memory at a higher speed appropriate to magnetic recording on tape. Wherever it is desirable to use a relatively high input speed to the device while a different output rate suitable for a mechanical operation is required later, (or the reverse of these conditions), this device can find many valuable applications.

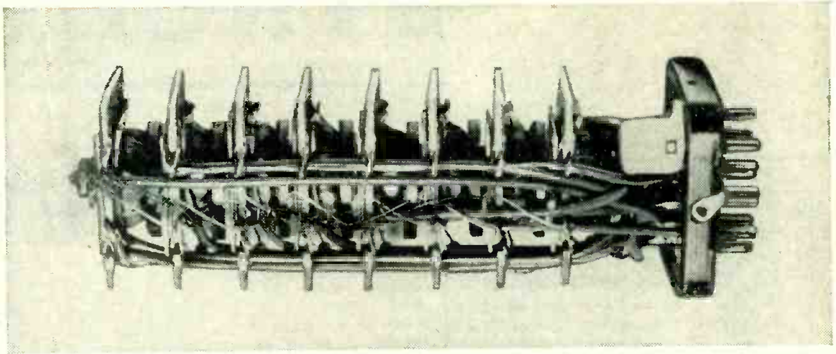
### Use as a Counter

The static magnetic memory provides a means of accurately recording pulses at rates up to 25,000 per second. In this application the device employs no complex vacuum-tube circuits, requires power only for circulation and none for storage of pulses, and imposes no restrictions because of inherent fragility. The unit may be applied to counting operations ranging from those using rapid electronic pulsing mechanisms to those of lower speed machine operations.

To be used in this manner the static magnetic memory uses as its input a single information pulse.

The number of advancing pulses that have been applied to the device is determined from the core location of the input pulse. For example, by using three units of 10 cores each and placing one pulse in each unit, the pulse in the first ring of 10 will operate a second ring of 10, which in turn can operate any other familiar counting device. An arrangement of this sort is shown in Fig. 7, in which an input of 25,000 pulses per second fed into a series of three units of 10 cores each operates a mechanical counting device at a rate up to 25 pulses per second.

Use of the static magnetic memory for counting purposes allows a peak counting rate of 25,000 pulses per second, in its present form. Any configuration may be cycled continuously by the device, and at this speed its value to decade counters, monitoring operations, and pulse control application in general is apparent.



Complete eight-core unit mounted on a 20-pin plug-in base

### *Changing Information*

An additional application of this device lies in its ability to change the form of input or output pulses. In certain instances, because of the particular circuit conditions involved, it is highly desirable for operation to be in either serial or parallel form. For example, large-scale digital computers utilize input information in both a serial and parallel manner. Furthermore, some means is necessary whereby the parallel output of a computer can be shifted to the serial form required if the information is to be recorded on magnetic tape. Hence the value of the device is its capability of changing input or output pulses from one form to the other.

By connecting gating circuits to every other core that makes every pulse obtainable through the unit (Fig. 8A) information may be introduced and transmitted in either a serial or parallel manner.

A gating circuit for this purpose is shown in Fig. 8B. Since each core can have an output of approximately 10 volts, satisfactory operation of the circuit is accomplished by using a type 6AS6 tube. By the addition of special windings to the cores of the device, the output voltage can easily be increased to a magnitude of 30 volts. This is sufficient voltage to bias and fire a typical 2D21 thyratron in a reasonably short time, and leads to relay operation such as that used in the Harvard multiplier previously mentioned.

### *Production*

A major problem in the manufacture of this device involved the development of special techniques and methods for handling, processing and controlling the expensive and fragile core material. For example, difficulty was encountered in maintaining proper curvature in Deltamax strips 0.001-inch thick, so that the essential hysteretic character of the material would remain unaltered. In addition, inherent fragility of the material necessitated painstaking handling. For these reasons an almost shadowless lighting bench was designed and built, at which specialized assemblers work in rotating short periods.

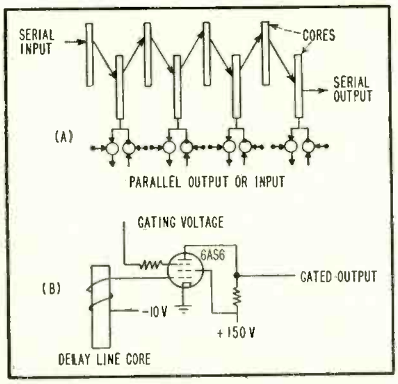



FIG. 8—Core connections for serial-parallel transformation, and delay-line output circuit for this purpose

Unit assembly is simplified and made rapid by the design of individual cores. A central tubular rivet in the individual unit allows them to be stacked about a central rod into lines of any feasible length, from a small 8-core unit up to 34 and 100 core banks. Adaptation to the particular circuit requirements thus has been anticipated, while ease of interconnection is provided by means of simple jumper connections between accessible solder terminals. The manufacturing design also incorporates the advantages of plug-in unit construction, by the addition of a 20-pin plug-in base.


The authors wish to acknowledge the valuable help and co-operation given by Howard Aiken, Director of the Harvard Computation Laboratory, Harvard University, Cambridge, Mass.

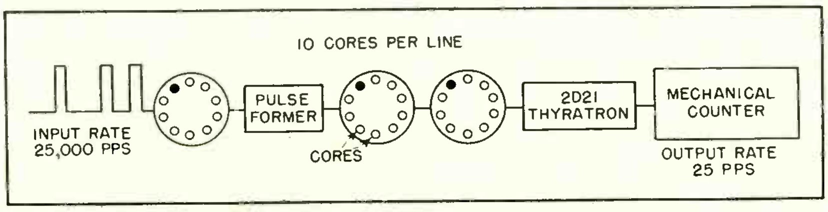




FIG. 7—Use of the magnetic memory device as a counter

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# SYNCHRO DATA

**By JEROME CORWIN and SAMUEL ADLER**

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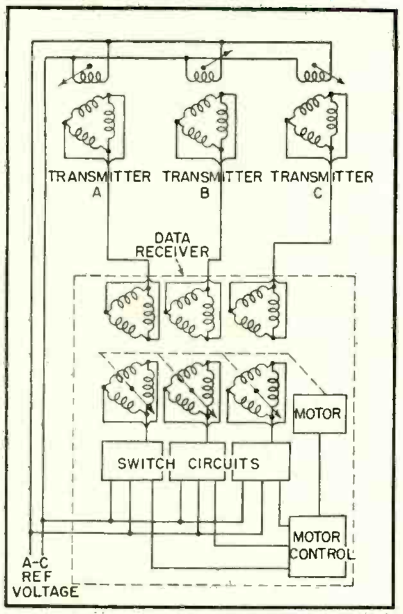


**FIG. 1—Typical sampling layout for three synchro transmitters**

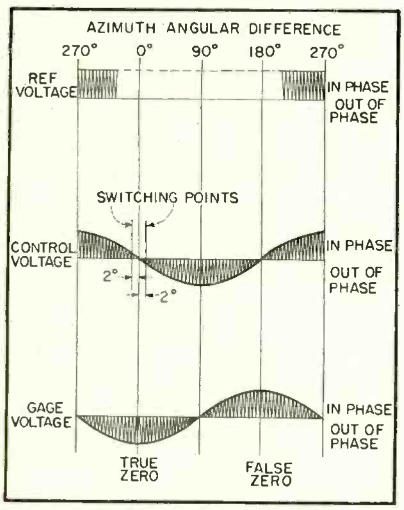


**FIG. 2—Ninety-degree displacement eliminates 180-degree ambiguity**

One serious limitation to the use of multi-synchro sampling systems for industry is the ambiguity introduced by the occurrence of null voltages at both zero and 180-degree displacements. The circuit described eliminates this 180-degree ambiguity factor, and enables a single receiving unit to sample the outputs of a number of synchro transmitters.

The receiving unit contains one synchro differential for each synchro transmitter. These synchro differentials are mechanically coupled to the shaft of a motor which rotates them from a fixed reference position in a predetermined direction and at a given speed. As each synchro differential comes within two degrees of the angular position of its corresponding synchro transmitter, to which it is coupled electrically, a single one-tube circuit operates a relay which causes the synchro data to be sampled at that point. The sampling process is repeated as each synchro differential reaches a position corresponding to its transmitter.

The circuit eliminates ambiguity by employing two synchro voltages whose amplitude envelopes are displaced 90 degrees. The amplitude of one of these voltages is used for switching when the angular difference is within two degrees of zero or 180 degrees (which is approximately equivalent to two volts in synchro voltage); the phase of the other voltage is used to differentiate between the zero and 180-degree positions by having its phase compared to that of a reference voltage. The reference voltage is the synchro excitation voltage.

Figure 1 illustrates the switching arrangements for sampling three synchro transmitters. The motor control can be any one of a number of devices which will start and stop the motor or cause the motor to slave the synchro transmitter if an additional synchro control transformer and a servoamplifier are available. The synchro transformer is coupled and indexed in the same manner as are the synchro differentials; however, only one transformer is required for each data receiver unit.

### *Synchro Voltages*

In order to explain how the two synchro voltages are obtained, the transfer of synchro voltage data from one synchro transmitter to the switching circuit is described. Synchro excitation is supplied to the transmitter whose output windings send data to the synchro differential. The output of the differential is connected to a Scott-T type resistor network[1] which supplies the two desired synchro voltages whose amplitude envelopes are displaced 90 degrees. It should be noted that these voltages are identical in amplitude and form, and that they reverse 180 electrical degrees in phase at each null-voltage point. If a special resolver synchro were available having a delta-wound stator and a dual-wound rotor with coils spaced 90 degrees apart, the Scott-T network would not be necessary.

The two synchro voltages have

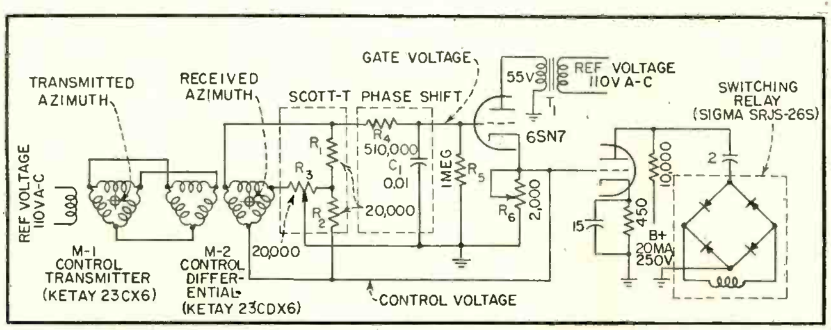


**FIG. 3—Switching circuit serves a number of synchro combinations**

# SWITCHING CIRCUIT

**One-tube circuit enables a single receiving unit to sample the outputs from a number of synchro transmitters automatically and without the ambiguity caused by the appearance of null voltages at both zero and 180-degree angular displacements**

been designated as the gate voltage and control voltage and Fig. 2 illustrates the angular relationship between phase and amplitude for a revolution of the synchro transmitter with respect to its synchro differential. The choice as to which voltage is gate and which is control is completely arbitrary. It can be seen from these curves that at one null-voltage position of the control voltage, the gate voltage has maximum amplitude and is 180 electrical degrees out of phase with the reference voltage; while the other null-voltage position occurs when the gate again has maximum amplitude but is in phase with the reference voltage. Although the phase relationship illustrated is true theoretically, actually there is electrical phase shift of the excitation voltage caused by the synchros and the Scott-T network. A simple phase-shift network compensates for the shift and gives the desired phase relationship.

### *Switching Circuit*

The switching circuit developed was designed around a single 6SN7 and a standard two-speed servo switching relay,[2] as shown in Fig. 3.

The first half of the tube is used to differentiate between the two null-voltage positions of the synchro transmitter. The gate voltage is fed to the grid, after the proper amount of electrical phase shift, and the reference voltage is fed to the plate through a 2-to-1 isolation transformer. When the gate voltage is in phase with the reference voltage the first half of the tube conducts, thus supplying bias to the grid of the second half of the tube by current flow through $R_8$. This grid bias is sufficient to keep the second half of the tube conducting over the major portion of the time during which the gate voltage is in phase with the reference voltage.

The control voltage is fed directly to the grid of the second half of the tube. Since only the amplitude of this voltage determines conduction, and since the gate voltage is available over a wide angle, no electrical phase shift is required on the control voltage. When the second half of the tube conducts, it energizes the relay which does the actual switching required for sampling. Switching occurs only when this relay is de-energized.

When the control voltage amplitude is less than two volts and the gate voltage is in phase with the reference voltage (this is equivalent to an angular difference of $180 \pm 2$ degrees), the cathode circuit of the first half of the tube supplies sufficient grid bias to keep the second half of the tube conducting. This is shown in Fig. 2 as false zero. The relay remains energized and no switching occurs.

The control voltage is again below two volts at an angular difference close to true-zero degrees. Here the gate voltage is 180 electrical degrees out of phase with the reference voltage, thus the first half of the tube cannot conduct and no bias is supplied to the second half of the tube. Since the control voltage is below two volts and no grid bias is available, the second half of the tube is cut off and the relay is de-energized. Switching occurs at this point which is the true zero.

### *Components*

The detail component design of the circuit is based on the use of the simplest types available in order to keep the size and number of components to a minimum while obtaining reliable operation. Component values and descriptions are indicated on the circuit diagram. Resistors $R_1$, $R_2$, and $R_3$ form the Scott-T resistor network for 90 degrees envelope shifting. Variable $R_3$ is adjusted for accurate 90-degree shift. Resistor $R_4$ and capacitor $C_1$ are used to make up for the electrical phase shift caused by the synchros and the Scott-T resistor network. A phase shift of approximately 45 degrees is required to bring the gate voltage in phase with the reference voltage.

Transformer $T_1$ is a standard 2-to-1 isolation transformer used to supply plate reference voltage to the first half of the 6SN7. Resistor $R_8$ sets the proper grid-bias voltage on the second half of the 6SN7 when the control voltage drops below two volts and the first half is conducting. The switching relay contains a full-wave dry disk rectifier and a d-c relay coil. A standard power supply capable of supplying 20 ma at 250 volts furnishes B+ voltages for each switching circuit.

Voltage and current measurements have indicated that all components are operated in their safe region. The switching circuit does not load the synchro data circuit, and the synchro wave shape has only a slight amount of distortion which will not affect the accuracy of the one-speed data used. The phase-shift network used to compensate for synchro electrical phase shift was satisfactory for the sampling method used; however, adjustment may be required if the transmission medium introduces a different amount of phase shift. The circuit is stable and not critical in adjustment or operation nor are any special components required.

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# IMPROVED VERTICAL

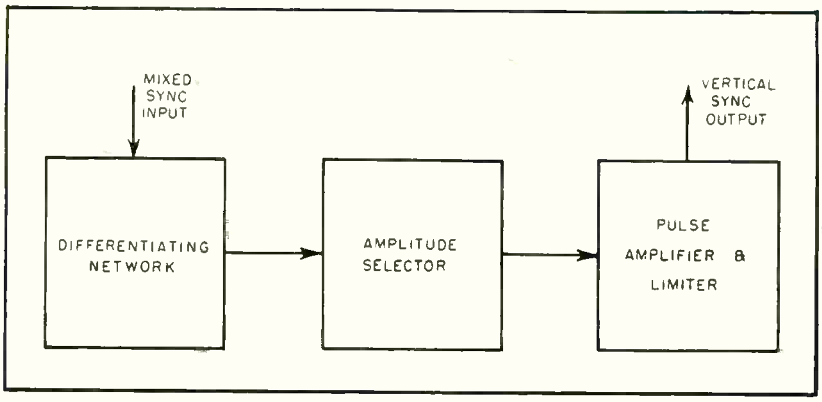


FIG. 1—Block diagram of system for producing steep-fronted pulses

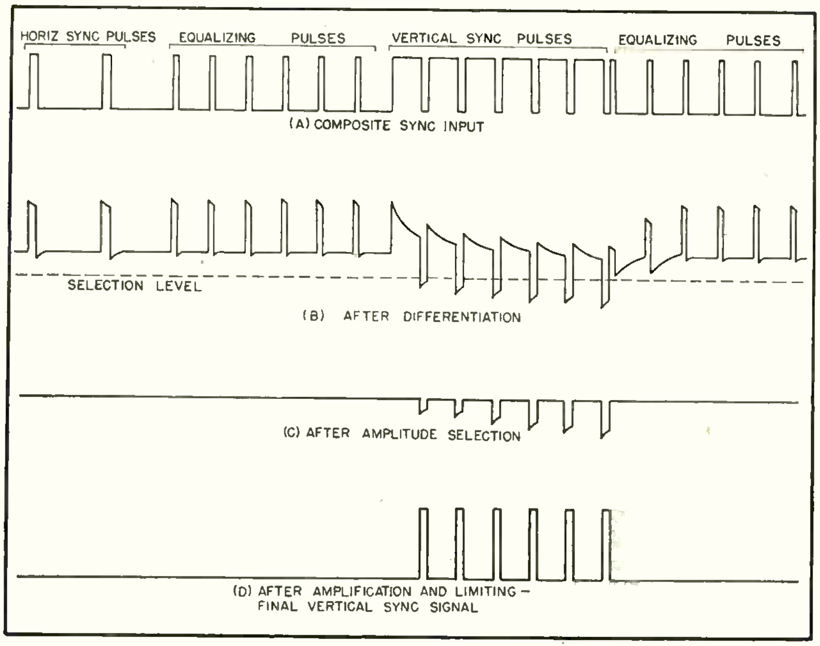


FIG. 2—Waveforms of composite sync input and changes produced by the system

**Table I—Operating Characteristics**

| | *Input Pulses* | *Output Pulses* |
|---|---|---|
| Amplitude | 40 v, peak | 55 v, peak |
| Polarity | positive | positive |
| Rise time | 0.8 μsec | 0.9 μsec |
| Decay time | 0.7 μsec | 1.1 μsec |
| Pulse width | 27 and 5 μsec | 4.8 μsec |
| Pulse flatness | —— | better than 2% |
| Keying frequency | 60 cps | —— |
| Repetition frequency | 31,500 pps | 31,500 pps |
| Number of pulses | —— | 6 |
| Threshold level | —— | 17.5 peak sync input |
| Interference components on pulse baseline | —— | 1.5 v, p-p, approx |


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THE RELATIVELY POOR performance of vertical sync circuits is indicated by the difficulty often encountered in obtaining accurate and stable interlace free of drift, line pairing and the necessity for frequent and critical adjustment of television receivers.

With a few exceptions, present vertical sync circuits are essentially unchanged from those used in receivers of prewar vintage. Many of the shortcomings of these systems come about as a result of the method used for segregation of the vertical sync pulses from the composite sync signal. Almost without exception, this is performed by resistance-capacitance integration or equivalent means.

Integration with a resistance-capacitance network having a time constant suitable for complete elimination of the horizontal pulses produces a slowly rising serrated wavefront which reaches its maximum amplitude in approximately 190 microseconds. Because, with sync pulses of this shape, the triggering point of the vertical deflection oscillator is not positively determined with respect to time, stable and carefully controlled operating conditions of the latter are required if accurate interlacing is to be maintained.

### *Improved Rise Time*

A material improvement in both vertical sync stability and interlace performance would result were the triggering pulses steep-fronted and of fairly large amplitude. Moreover, if a circuit responsive only to pulses of greater than a certain duration were placed between the sync clipper and the vertical deflection circuits, both horizontal pulses and short-duration noise pulses

# SYNCHRONIZING SYSTEM

**Positive interlace, freedom from line pairing and increased noise immunity without critical adjustments result from use of large-amplitude steep-fronted pulses for vertical synchronization. The pulses are derived from a simple circuit containing a germanium diode and a single triode**

occurring during the field scanning interval would be rejected and the noise immunity of the entire system improved.

The circuit to be described performs the functions of pulse segregation, amplification, limiting, and sharpening, to yield a series of large-amplitude, steep-fronted pulses in rigidly controlled phase relationship to the transmitted vertical sync signal.

### *Theory of Operation*

Figure 1 shows a block diagram of the improved sync system, while Fig. 2 indicates the significant waveforms drawn against a relative time scale.

Part A of Fig. 2 is a section of the standard sync signal at a time corresponding to the end of one interlaced field, and shows the last two horizontal sync pulses, twelve equalizing pulses and six vertical sync pulses. The approximate durations of these pulses are 5 $\mu$sec, 2.5 $\mu$sec and 27 $\mu$sec respectively.

The mixed line, equalizing, and field sync pulses are applied in positive polarity to a resistance-capacitance differentiating network having a carefully chosen time constant. The network passes with negligible attenuation the leading and trailing edges of all pulses. Charge storage in the capacitor during the pulse interval, however, introduces an appreciable droop in the flat top of each pulse, and causes the trailing edge to undershoot the pulse base line. It can be shown that the amplitude of the undershoot is a function of both the width of the applied pulse and the time constant of the network.

For a single-stage resistance-capacitance network, the amplitude of the undershoot may be expressed by:

$$E = V - \left[\frac{V}{\epsilon^{t/RC}}\right]$$

where $E$ = amplitude of pulse undershoot, $V$ = amplitude of applied pulse, $t$ = width of applied pulse in $\mu$sec, $RC$ = time constant of network in ohms-$\mu$f, and $\epsilon$ = 2.71828, the base of natural logarithms.

For a cascaded network containing $n$ identical stages,

$$E = V - \left[\frac{V}{(\epsilon^{t/RC})^{\frac{n(n+1)}{2}}}\right] \text{ to a close approximation}$$

The equations relate the amplitude of the pulse undershoot to that of the applied pulse, and are strictly valid only where the network is driven from a zero-impedance generator, and is terminated by an infinite impedance.

In a practical case, the source and terminating impedances may vary over wide limits. Use of a cascaded multistage network reduces the effect of variations in the former by making the output waveform less dependent upon the characteristics of the generator.

The composite sync signal is passed through a two-stage resistance-capacitance network, each stage of which, neglecting the terminating impedances, has a time constant equal to the width of one vertical sync pulse or 27 $\mu$sec.

The effective constants of the network are then such that the undershoot amplitudes become

$$E_o = (V - 0.136V) = 0.864V \text{ for the 27-}\mu\text{sec vertical pulses, and}$$

$$E_o = (V - 0.705V) = 0.295V \text{ for the 5-}\mu\text{sec horizontal pulses}$$

where $E_o$ is the amplitude of the undershoot developed across the final resistive element. For convenience in terminology, these undershoots may be called inverse pulses.

The ratio of amplitudes of the inverse vertical to inverse horizontal pulses is approximately 2.9 to 1. For equalizing pulses and noise pulses of duration shorter than 5 $\mu$sec, this amplitude ratio is increased.

### *Amplitude Selector*

The output of the resistance-capacitance network consists of positive-going high-frequency components of the applied sync signal, together with the inverse vertical, inverse equalizing, and inverse horizontal pulses in the opposite polarity. This waveform, shown in Figure 2B, is applied to the cathode of a biased diode amplitude selector.

The cathode of the amplitude selector diode is maintained at a fixed positive potential with respect to its anode, and is nonconductive both for positive-going input signals and for negative signals of small amplitude. The positive cathode bias is adjusted to be somewhat greater than the peak amplitude of the inverse horizontal pulses. The latter, together with the inverse equalizing pulses and

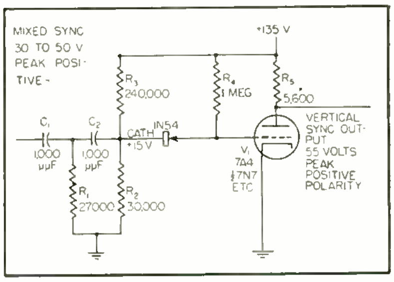


FIG. 3—Complete circuit contains a crystal diode and triode tube

any short-duration noise pulses, are therefore rejected by the diode.

During the vertical sync pulse interval, the higher amplitude inverse vertical pulses developed by the network drive the diode into conduction. As shown in Fig. 2C, a series of six steep-fronted negative pulses occurring in time coincidence with the trailing edges of the applied vertical sync pulses appear at the anode of the amplitude selector diode. These have durations approximately equal to the width of the serrations in the vertical sync block, 4.7 μsec, and a recurrence rate of 31,500 pps, twice the line scanning frequency.

### Pulse-Width Gate

From the above discussion, it is apparent that the combination of the R-C network and amplitude selector function as a pulse-width actuated gate, developing pulses at its output only when the input pulse duration exceeds a certain fixed value. Particularly effective pulse-width discrimination is obtained if the applied pulses are squared and amplitude stabilized, as is generally the case in a practical receiver application.

The negative-going inverse vertical pulses at the anode of the diode are applied to the input of a triode pulse amplifier, the operating conditions of which are such that pulse limiting and sharpening takes place. Because the grid is returned through a high resistance to the plate supply, it assumes a very slightly positive potential with respect to the grounded cathode. This assures conduction of the tube in the absence of signal.

With the grid slightly above ground, a very effective clamping action takes place at the input of the pulse amplifier. The grid is prevented from being driven more positive, thus assisting materially in rejecting any positive-going high-frequency sync pulse components which may leak through the amplitude selector. At the same time, the d-c axis of the pulse is restored and held rigidly near ground potential.

Since the peak amplitude of the inverse vertical pulses applied to the pulse amplifier is more than sufficient to drive the grid to cutoff, the final inverted output pulses at the plate are squared and sharply clipped at the same level. The tube therefore acts as a limiter in both positive and negative directions.

The pulse train of Fig. 2D becomes the final vertical synchronizing signal, the amplitude of which may be made as large as desired, and the rise time of which is limited only by the bandwidth of the preceding video amplifiers and sync auxiliaries of the receiver.

### Circuit Details

Figure 3 shows the complete schematic diagram of the system. Capacitors $C_1$ and $C_2$, together with resistors $R_1$, $R_2$ and $R_3$ comprise the two-stage differentiating network. The values of these components are such that each stage of the network has the required 27-μsec time constant. Resistors $R_2$ and $R_3$ also serve as a voltage divider across the B supply, and maintain the cathode of the amplitude selector diode at a suitable positive potential.

The amplitude selector is a type 1N54 germanium diode. This type is characterized by high forward conductance together with unusually high resistance in the reverse direction, that is, with the cathode positive. Materially improved operation of the circuit is obtained with a germanium diode in this position, since the extremely low interelectrode capacitance of 1-μμf greatly reduces feed-through of undesired high-frequency components existing at the output of the differentiator. In addition, the increased conductance afforded by the germanium diode provides a substantially higher pulse amplitude across the relatively low grid-cathode impedance of the pulse amplifier. This improves the limiting action of the latter at low signal levels.

The circuit constants have been selected for a supply voltage of +135 volts, and an input pulse peak amplitude of 40 volts. Inasmuch as resistors $R_2$ and $R_3$ provide a positive bias of 15 volts at the cathode of the amplitude selector diode, the circuit as a whole has a threshold of operation somewhat above this level of input sync pulse. Since upward of 30 volts are generally available at the output of the final sync amplifier, this threshold lies considerably below the video level at which a picture having satisfactory contrast is obtained.

Triode $V_1$ operates as a pulse limiter and sharpener, with a voltage gain of slightly over five times. The relatively low plate load resistance, 5,600 ohms, affords adequate amplifier response to pulses having rise times as short as one microsecond.

Although a substantial improvement in pulse rise time could have been effected by inductive peaking in the plate circuit, this was not considered sufficiently advantage-

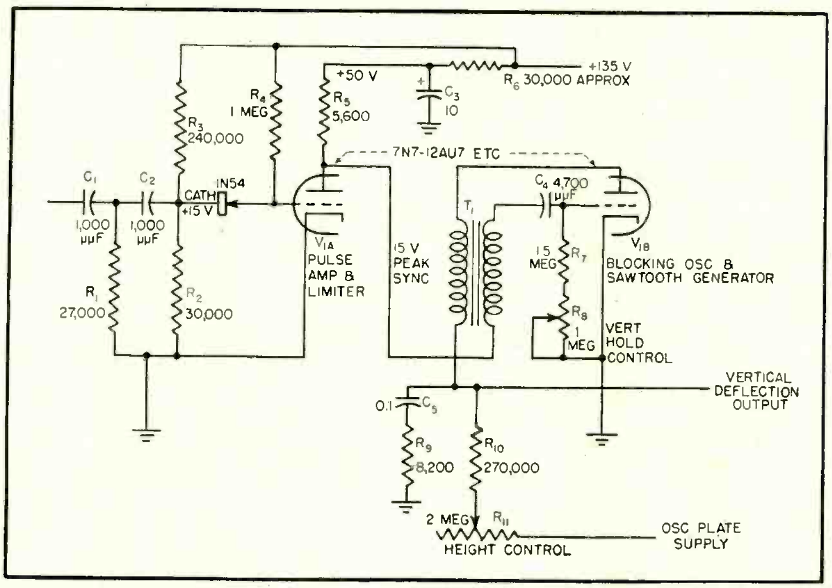


FIG. 4—Typical vertical blocking oscillator with addition of vertical sync pulse separator

ous to warrant the additional circuit complication.

### Connection to Oscillator

Figure 4 is the schematic diagram of a typical vertical deflection circuit of the blocking-oscillator type, together with the vertical pulse separator system described. The preferred method of connection between the two is shown. The secondary of the blocking oscillator transformer $T_1$ is effectively a part of the plate load of $V_1$, and acts to further shape the sync pulses as well as to retain their sharp leading edges.

Because the plate resistance of $V_1$ in parallel with its load resistance represents an effective impedance of only a few thousand ohms in series with the a-c grid return of the oscillator, including the pulse amplifier as a portion of the oscillator circuit in no way affects normal operation of the latter. Injection of sync in this manner offers the further advantage of extreme simplicity.

### Sync Amplitude

The peak amplitude of vertical sync pulse developed at the plate of $V_1$ depends upon the effective supply voltage at the junction of $R_5$ and $R_6$. Although a maximum of 55 volts of sync is available if $R_6$ were omitted, it may in some cases be found that more satisfactory operation of the blocking oscillator itself will be obtained with peak sync amplitudes of 10 or 15 volts.

The network consisting of $C_3$ and $R_6$ provides a means of adjusting the output pulse amplitude without affecting the pulse rise time; $R_6$ and $C_3$ also supply a measure of decoupling at the plate of the pulse amplifier. The time constant of this network should be long with respect to the field repetition period, and in general should be not less than 0.05 second.

With component values indicated in Fig. 4, the pulse amplifier operates at a quiescent plate voltage of 35 volts and a plate current of 2.9 ma. Under these conditions, the tube develops between 12 and 15 volts of sync pulse across the plate load, and requires but 4 volts of negative swing at the grid for complete limiting.

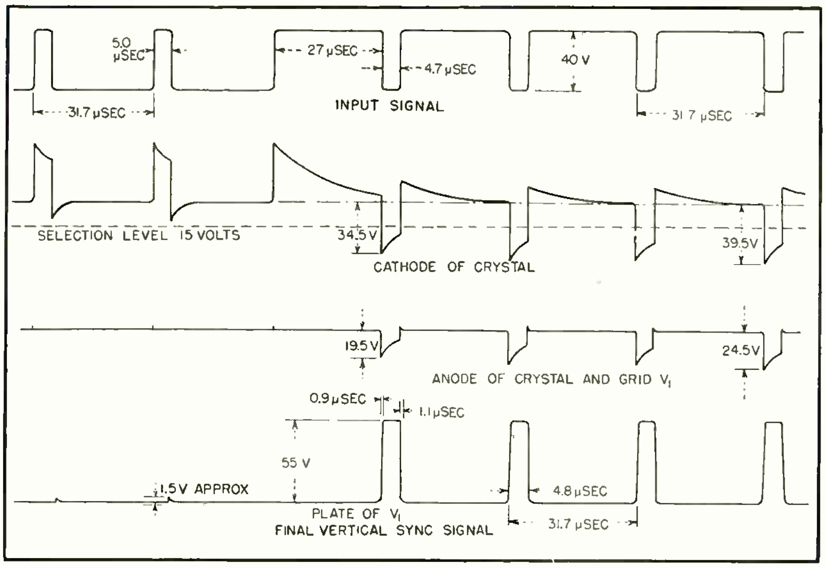


**FIG. 5—Waveforms produced at designated points in the circuit**

Pulse segregation with a system of this type has several additional advantages. Vertical synchronizing with pulses whose leading edges have a large time rate of change greatly minimizes interlace instability and eliminates the necessity for critical adjustment of the vertical oscillator frequency during and after warmup. The resulting accuracy of synchronizing is not nearly so dependent upon maintaining a constant amplitude of applied sync pulses as is that obtained with the usual R-C integrator system. This is because the shape of the final triggering pulse is completely independent of the input pulse amplitude over a very wide range. Rigid control of the latter is not so essential.

Integrator sync systems require that conditions before and after transmission of the broad-topped vertical sync pulses in the composite sync signal be identical for odd and even line fields. This necessitates the insertion of two groups of six equalizing pulses. Because the method of pulse segregation described does not depend upon integration, the equalizing pulses are unnecessary. This suggests that a degree of simplification could be effected in the composite sync signal.

An improvement in noise immunity in the vertical sync circuit may be realized, because short-duration noise pulses which occur during the field scanning interval will affect the circuit in exactly the same manner as normal horizontal sync pulses and will be rejected by the amplitude selector. Such noise rejection increases the vertical sync stability of the receiver under adverse noise conditions, and virtually eliminates frame splitting and picture roll.

### Operating Data

The major electrical operating characteristics of the circuit are shown in Table I. Figure 5 shows scale waveform tracings taken at significant points throughout the system. These were obtained directly from a Tektronix model 511-A wide-band oscilloscope. To permit more accurate measurements, resistor $R_6$ of Fig. 4 was temporarily shorted out, allowing maximum amplitude of output pulse to be developed.

All data are taken with a simulated sync signal consisting of keyed 27-$\mu$sec and 5-$\mu$sec pulse trains. The pulse repetition frequency and keying frequency are 31,500 pps and 60 cps respectively.

Measurements were made with a plate supply voltage of 135 volts and the total current was 10.7 ma with $R_6$ removed.

The author acknowledges with thanks the valuable assistance of M. C. Pease of Sylvania Electric Products Inc. in the preparation of this paper.


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# TUBES AT WORK

## Including INDUSTRIAL CONTROL

Edited by VIN ZELUFF



### Stereo Television for Remote Control

By H. R. Johnston C. A. Hermanson and H. L. Hull
*Remote Control Engineering Division*
*Argonne National Laboratory*
*Chicago, Illinois*

Manipulation of objects in three-dimensional space requires that depth perception be incorporated into any scheme used to view and control the means of manipulation. Ordinary two-dimensional television is not satisfactory for working with radioactive materials at a distance because the ability to judge depth is almost entirely lacking.

In the development of stereo television for the purpose a standard DuMont television pickup chain was employed. This equipment was modified so that two different lines of approach to the problem could be explored. One approach is the time-division method and the other the simultaneous method.

The time-division method used a mechanical rotating shutter and an optical system consisting of full and half-silvered mirrors. The left and right-eye images were sequentially projected onto the photo-cathode of the television camera tube. This system was abandoned because of image carryover and flicker.

In the simultaneous method finally adopted, the stereoscopic pair of images are transmitted simultaneously instead of sequentially. The two images are placed side by side in the same space normally occupied by a single image in standard two-dimensional television picture transmission.

Two variations of the simultaneous method have been tried. The first variation used a single lens and a beam splitter attachment at the camera. This scheme was dropped in favor of a two-lens arrangement illustrated herewith.

The twin-lens system was found to be superior to the beam splitter because the optical quality of the individual images was greatly improved and the image overlap in the center was reduced. Figure 1 shows a diagrammatic sketch of the twin lenses and mirrors that were used.

In the first version of the twin-lens system, two 105-mm lenses were mounted three inches between centers. The lenses were arranged so that they would be slightly rotated about a vertical axis and be converged on a nearby object.

At the receiving end of the system, the two images appear side by side on the face of a standard picture tube. The right-eye view is on the left side and the left-eye view on the right side as the observer views the face of the receiving tube. See Fig. 2. This transposition of

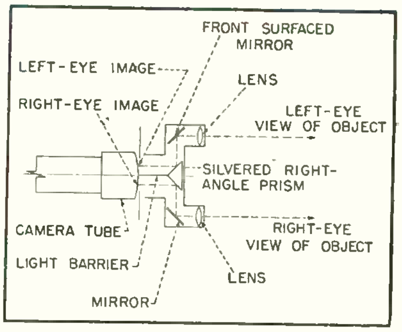



FIG. 1—Setup of the first version of the twin-lens system for the camera

Single-tube stereo-television viewer monitoring the pouring of a liquid by a mechanical master-slave manipulator

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

images is due to the geometry of the optics used.

Two polarizing filters whose axes of polarization are at right angles to each other are placed immediately in front of the images on the cathode-ray tube. An observer wears a pair of polarizing spectacles so oriented that the right eye is permitted to see only the right eye image and the left eye sees only the left eye image. In addition, a pair of 10-degree glass prisms are placed in front of the eyes to enable

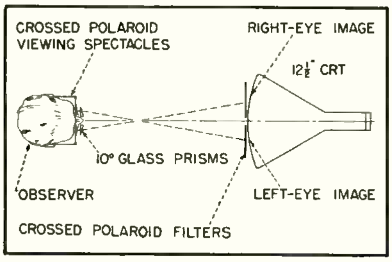



FIG. 2—Single-tube viewer for the first version of twin lens system

the observer to fuse the two pictures into a single three-dimensional image of the objects in front of the camera.

The use of glass prisms by the observer requires that his attention always be directed to the television screen since every other object in view appears double. Severe eye strain and mental discomfort result when the attention is directed to the hands in an attempt to operate switches or other devices.

A rotation of only 5 degrees of the observer's head about a horizontal axis perpendicular to the center of the viewing tube is sufficient to cause loss of stereo.

In the second twin-lens camera arrangement, the effective distance between viewpoints is variable from five to seven inches. The mirrors were made adjustable for both distance between viewpoint and for convergence.

Another method used to view the three-dimensional television pictures makes use of two television picture tubes. These tubes are arranged at right angles to each other and a semi-transparent mirror is placed at 45 degrees to both tubes. See Fig. 3. Crossed polarizing filters are placed in front of each picture tube and the observer wears crossed polarizing spectacles. Both images of the stereo pair appear on the tubes but by means of positioning controls and masks, the right-eye picture is placed in the center of one tube and the left-eye picture in the center of the other tube. The observer is enabled to see the three-dimensional image by observing one image by transmission through the semi-transparent mirror and the second image by reflection.

The twin-tube stereo-viewer is by far the more desirable because the observer is required to use only a pair of polarizing spectacles. The super-position of the two images is accomplished by the use of the half-silvered mirror and the positioning controls of the television viewers.

Since no prisms are used, the observer may look from the viewing screen to other objects in the room such as controls and switches without danger of severe eye strain as in the first method. Also this method permits considerable translation and rotation of the head of the observer before the stereo illusion is lost. Several persons may

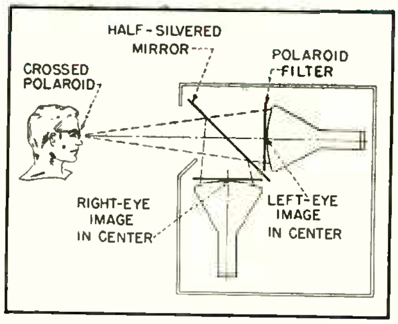



FIG. 3—Two-tube viewer has no prisms and provides best picture

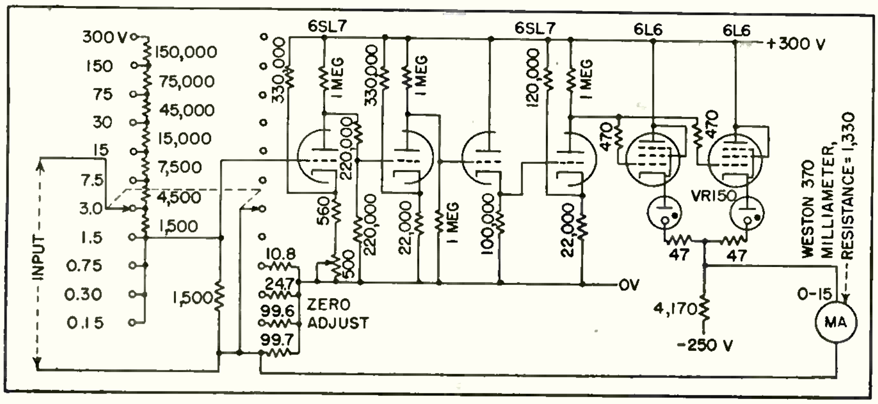
easily observe the stereo image at the same time.

A considerable amount of nonlinearity in the sweep circuits could be tolerated without serious impairment of the stereo-illusion. Slight differences in the sizes of the two images could be reconciled by the brain with some fatigue involved. In was found however, that appreciable vertical displacement of the images could not be tolerated.

Approximately 60 percent of the light of the image is lost in the first polarizing filters; 60 percent of the remaining light is then lost in the half-silvered mirror and another 10 percent of the light is lost in the polarizing spectacles. This results in a loss of approximately 85 percent of the total light available.

The picture tubes are $12\frac{1}{2}$ inches in diameter and have aluminum-backed screens. To obtain the required increased brilliance, an accelerating voltage of 12,000 volts is applied. A well-regulated high-voltage supply is essential in the twin-tube viewer so that the size of the image does not change when brightness and contrast controls are adjusted.

## Operation of Electrodynamometer Instruments Through Amplifiers




Circuit of direct-coupled power amplifier for operation of an electrodynamometer


By W. G. Hoover
*Associate Professor*
*Department of Electrical Engineering*
*Stanford University*
*Stanford, California*


Use of direct-coupled vacuum-tube amplifiers to drive electrodynamometer instruments is worth considering from the standpoint of sensitivity. Under proper conditions, amplifiers stabilized with large amounts of negative feedback can provide the required power with

(Continued on p 159)

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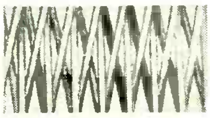
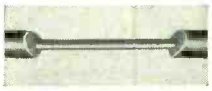


KOOLOHM interleaved winding—Resistors are available having negligible inductance, even at VHF.



Section of KOOLOHM wire with ceramic insulation removed to show contrast between bare and insulated wire. This flexible, heat-proof insulation is actually applied to the wire at a temperature of 1000°C.

# THE ELECTRON ART

Edited by JAMES D. FAHNESTOCK



## High-Definition Black-and-White Television System

A NEW high-definition system for black-and-white television has been suggested by R. B. Dome of the General Electric Company. Present monochrome receivers may receive high-definition transmissions with definition equal to that obtainable with present standards, but the addition of four tubes to the circuit will provide upward of 50 percent increase in horizontal detail. All precision equipment is located at the transmitter. The resultant picture is free from dot structure, since no sampling is employed.

The new system is based on the fact that the eye is not as susceptible to flicker in small areas as it is to flicker in large areas. The normal video band is divided into two approximately equal portions. The low-frequency portion is transmitted in regular 60-cps sequence, as in present-day monochrome transmissions, but the upper section of the video band is used only on *odd* fields for the transmission of picture detail normally transmitted by present transmitters on both odd and even fields. The superhigh video band of frequencies added by the new system is transposed in frequency to fit the upper section which can be radiated and is transmitted on *even* fields. This represents an increase in horizontal resolution from the present 350 lines to 525 lines.

The block diagram of Fig. 1 shows the transmitter for generating the required signal. The camera output passes through three filters which divide the 0 to 5.3-mc signal into three sections, 0 to 1.6, 1.0 to 3.8 and 3.44 to 5.3 mc. The low portion is continuously amplified. The middle-band amplifier is keyed on alternate fields and its output is connected in parallel with the output of the low-frequency amplifier. The high range, carrying the superfine detail, is fed to a suitable mixer-transposer to which is also fed a continuous wave of 15,750 cycles. The difference frequency of these signals is selected by a filter that passes 1.6 to 3.44 mc—the 1.6-mc comes from the 5.3-mc end,

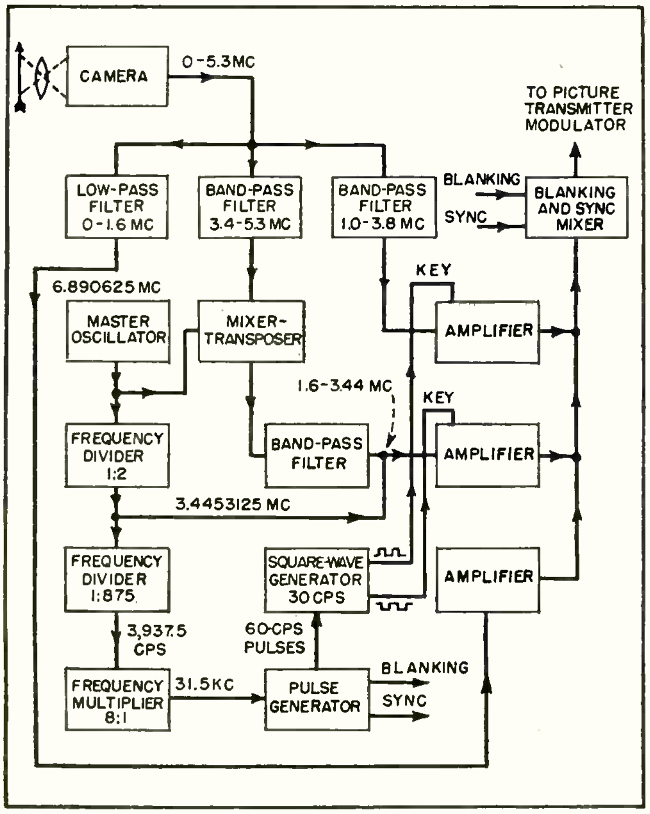



FIG. 1—Block diagram of circuits that are added to transmitter to utilize Dome system of high-definition black-and-white television

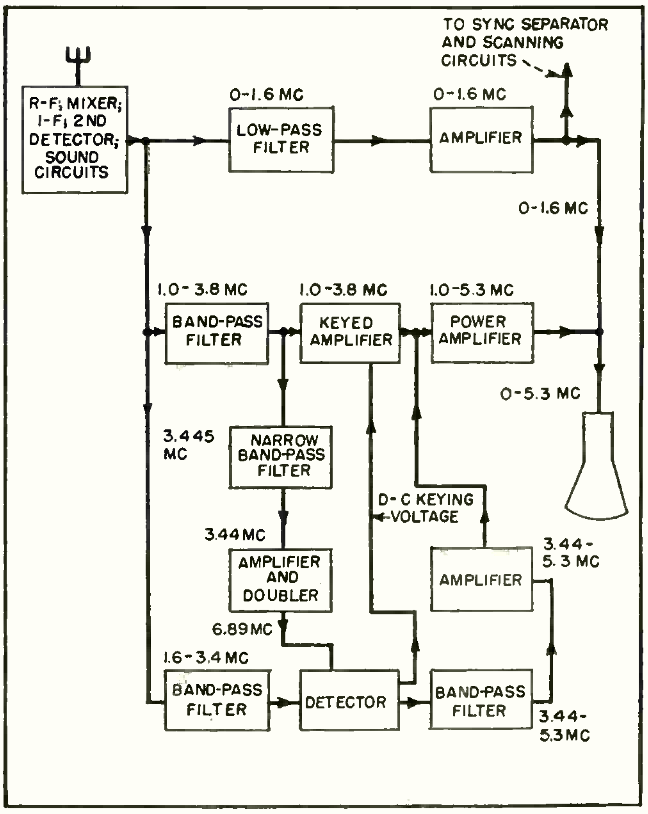



FIG. 2—Normal pictures are received by conventional receiver. Addition of four tubes increases horizontal detail by 50 percent

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**VERNIER DIAL:** 24:1 gear ratio with main frequency dial.
**FREQUENCY DEVIATION RANGES:** 0-24 kc., 0-80 kc., 0-240 kc.
**AMPLITUDE MODULATION:** Continuously variable 0-50%, calibrated at 30% and 50% points.
**MODULATING OSCILLATOR:** Eight internal modulating frequencies from 50 cycles to 15 kc. available for FM, AM.
**RF OUTPUT VOLTAGE:** 0.2 volt to 0.1 microvolt. Output impedance 26.5 ohms.
**FM DISTORTION:** Less than 2% at 75 kc. deviation.
**SPURIOUS RF OUTPUT:** All spurious RF voltages 30 db or more below fundamental.

If you have an FM or television instrument requirement, let us acquaint you with full particulars and technical data concerning the Type 202-B FM Signal Generator and Type 203-B Univerter.

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**R. F. INCREMENT DIAL:** ± 250 kc. in 10 kc. increments.
**R. F. OUTPUT:** 0.1 microvolt to 0.1 volt, ± 1 db. Also approximately 2 volts maximum (uncalibrated).
**OUTPUT IMPEDANCE:** Approximately 60 ohms at 0.1 volt jack, 470 ohms at 2 volt pin jack.

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DESIGNERS AND MANUFACTURERS OF THE Q METER · QX CHECKER FREQUENCY MODULATED SIGNAL GENERATOR · BEAT FREQUENCY GENERATOR AND OTHER DIRECT READING INSTRUMENTS while the 3.44 beat is derived from the 3.44 end beating with the 15,750 carrier. Thus inversion, as well as transposition of the superhighs has been accomplished.

At the output of the filter, a 3.4453125-mc wave is added for use at the receiver in retransposing. The 1.6 to 3.44-mc band is amplified by a third amplifier and combined by addition with the 0 to 1.6 and 1 to 3.8-mc bands. The 1.6 to 3.44-mc band is keyed on during alternate fields when the 1 to 3.8-mc amplifier is turned off. The combined signal is combined in a blanking and sync mixer to form a composite television signal which is then fed to the modulator of the conventional television transmitter.

The transmitted pulse generator chain includes a master oscillator at 6.890625 mc from which is derived the 3.4453125-mc signal and sync for a standard transmitter pulse generator. Transition keying is made during the vertical blanking period.

*Receiver Circuit*

The only receiver change appears in the video amplifier. A typical circuit block diagram is shown in Fig. 2. The video detector output is fed through three filters. The first passes the 0 to 1.6-mc band which is common to both odd and even fields. A second filter passes frequencies from 1 to 3.8 mc. These frequencies are keyed by an amplifier and combined with the low frequencies to feed the picture-tube gun.

A side circuit, connected at the output of the 1 to 3.8-mc filter, is tuned to the transposing frequency of 3.445 mc. This signal is amplified, doubled to 6.890625, and fed to a detector-modulator. The d-c output from this detector is fed to the keyed amplifier so that when 3.445 is present, the keyed amplifier is keyed off.

The third filter connected to the video detector passes 1.6 to 3.4 mc and this band is fed into the 6.89-mc detector-modulator. The output of this detector contains a difference band of 3.44 to 5.3 mc. This band is passed by a filter which rejects the 1.6 to 3.4-mc band and the 6.89-mc carrier and any traces of the 3.445-mc carrier which may have passed the other filters. The output of the 3.44 to 5.3-mc filter is amplified by a video amplifier and applied in parallel to the 1 to 3.8-mc amplifier output.

The extra functions may be accomplished by the addition of four tubes, a 6AS6, 12AX7, 12AU7 and 6SF7.

The high-definition signal can be transmitted over any 4-mc channel. When used with a 2.7-mc channel, no improvement is possible under the system described, but it is possible to add some terminal equipment to transmit an apparent 3.84-mc signal over a 2.7-mc channel through the use of the system.

Tests have proved the feasibility of subdividing the video-frequency spectrum in the manner herein described.

## Sb-Cs, Ag-$Cs_2O$-Cs Phototube Characteristics

SEVERAL MONTHS AGO, (August, 1950, p 132), there appeared in *Backtalk* a letter from a reader in Eastern Europe suggesting a design for a phototube containing a semitransparent Sb-Cs and a Ag-$Cs_2O$-Cs surface. Two engineers of the Rauland Corporation, S. Pakswer and W. O. Reed, undertook the investigation of the idea and built a model of the tube as suggested in the proposer's diagram which accompanied his letter. Their findings are presented in the curves and text which follows. We quote from their letter to the inventor whose name has been withheld at his own request.

"In the August issue of ELECTRONICS you published a letter concerning a phototube which contained a semitransparent Sb-Cs and a Ag-$Cs_2O$-Cs surface. We processed a tube constructed according to the drawing on page 132 (again reproduced in Fig. 1), and made measurements on it, some of which are presented in the enclosed graphs.

"In Fig. 2 are shown the current readings in the common anode lead and in the Ag-$Cs_2O$-Cs lead, the anode being held at + 300 volts

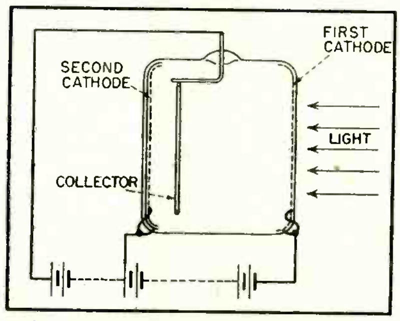



FIG. 1—Two-cathode phototube suggested by Eastern European reader in Backtalk letter

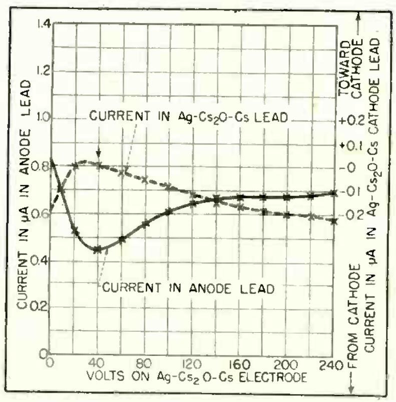
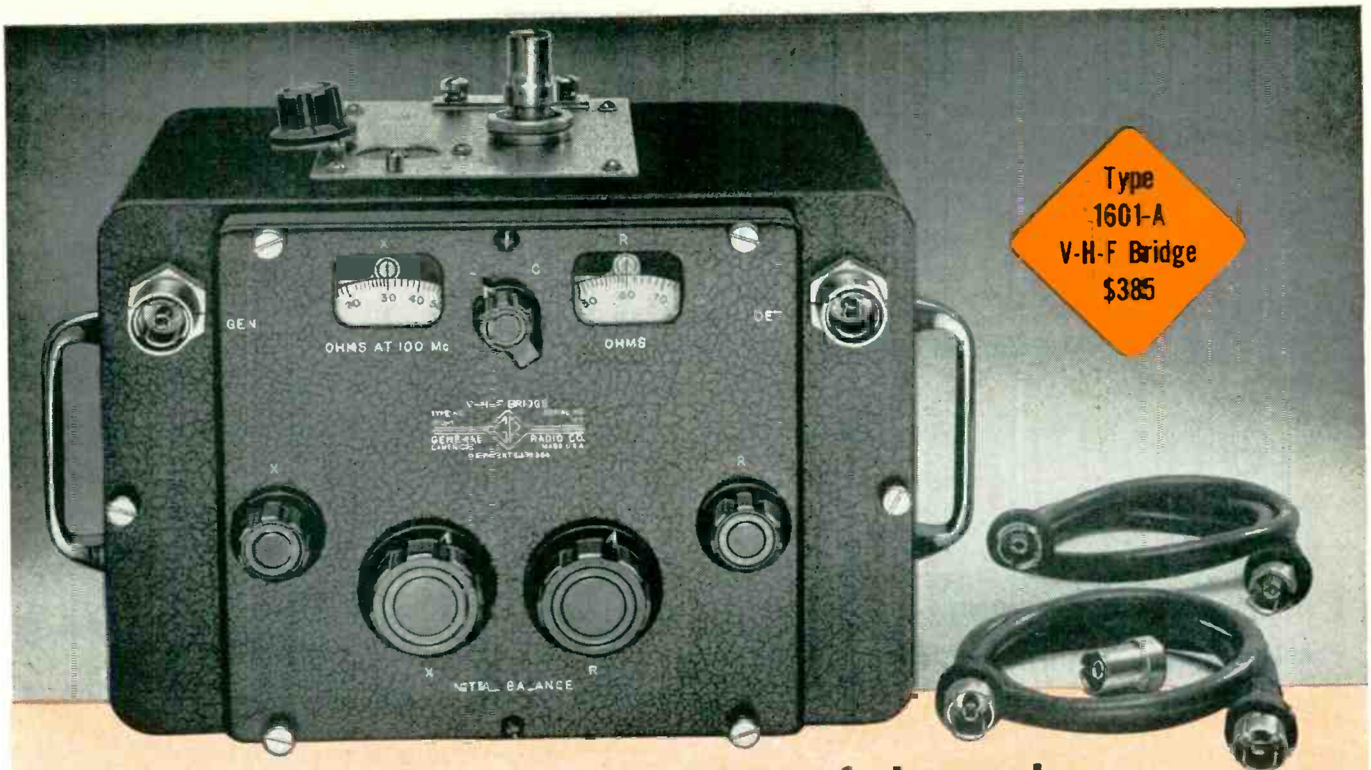



FIG. 2—Current readings in common anode lead and in Ag-$Cs_2O$-Cs lead of proposed combination phototube

and a variable positive potential being supplied to the second cathode. With both cathodes at the same potential the anode lead registers the combined photoemissive currents. Raising the potential at the second cathode, this cathode starts collecting some photoelectrons from the Sb-Cs surface; at still higher positive potentials the Ag-$Cs_2O$-Cs surface starts emitting secondary electrons and the current reverses itself. This consideration is substantiated by comparison of curves *B* and *C* in Fig. 3, which are drawn to the same scale (the other two curves being shown on other scales). Curve *B* had been taken with both cathodes at the same potential, curve *C* at a condition shown by the arrow in Fig. 2. It can be seen that the maximum in the blue green is less pronounced in curve *C*, corresponding to some loss of photoelectrons from the Sb-Cs surface.

"Curve *D* in Fig. 3 represents the response of the Sb-Cs surface alone

(Continued on page 190)



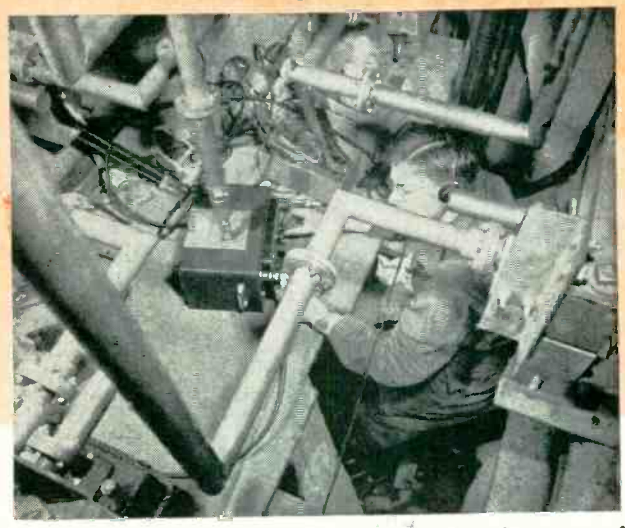

# for Bridge Measurements of Impedance

## BETWEEN 10 AND 165 Mc

**Direct-Reading Resistance Range 0 to 200 OHMS**—*independent of frequency except for small corrections.*

**Direct-Reading Reactance Range 0 to ±230 OHMS at 100 Mc**—*inversely proportional to frequency.*

**Coaxial Adapter Supplied for Measurements on Coaxial Systems**—*eliminates errors from connecting leads and from residual terminal capacitance. Standing-wave ratio of unknown coaxial system unaffected by terminal capacitance of bridge.*



The Type 1601-A V-F-H Bridge set up to measure the antenna of WCBS-TV on the Chrysler Building, New York City. The antenna consists of 16 radiating elements. Measurements of the impedance variation of an individual element over the operating frequency band as well as impedance measurements of the whole array were made easily and accurately.

THE new Type 1601-A V-H-F Bridge brings to the v-h-f frequencies a means for measurements of impedance of antennas, lines, networks and components, having the same accuracy and simplicity of measurement enjoyed by users of the popular G-R low-frequency Type 916-A R-F Bridge.

With this bridge the range of conventional bridge techniques is extended to 165 Mc. It is equally suited to measurements on coaxial-line systems as on lumped parameter circuits.

It is designed for direct-reading measurements of relatively low impedances, but measures high impedances indirectly and equally well.

For resistance measurements the accuracy is ±(2% + 1 Ω), subject to correction for inductance in the capacitor used to measure the resistance. A correction chart is supplied with the instrument. The ohmic portion of the accuracy statement varies between 0.1 and 1.0 ohm.

For reactance measurements the accuracy is ±(5% + 2 Ω). The ohmic uncertainty varies between 0.1 ohm at 100 Mc and 2 ohms.

This bridge is especially suited to measurements of resistors, capacitors, inductors, transmission-line networks and antennas.

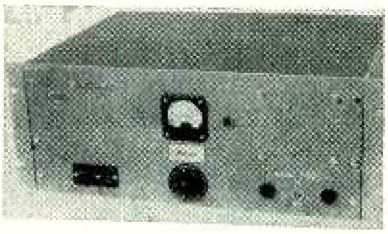
**GENERAL RADIO COMPANY** Cambridge 39, Massachusetts

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

# NEW PRODUCTS

Edited by WILLIAM P. O'BRIEN

**Industrial Lab Equipment Highlights New Devices . . . Wide Selection of Miniature and Weatherproof Components Will Aid Armed Forces Needs . . . Forty-Three Catalogs and Bulletins Are Offered for Engineers Mobilizing for Greater Production.**



### Multicoupler Amplifier

PLESSEY INTERNATIONAL LTD., Ilford, Essex, England. Type PV.14 antenna multicoupler wide-band amplifier permits the operation of up to 10 communication receivers within the 2 to 20-mc range from one common antenna system without loss of strength of individual signals or cross-modulation effects. It consists of an amplifier preceded by a high-pass filter attenuating incoming signals below 2 mc, which feeds ten cathode follower stages designed to work into 75-ohm unbalanced loads.

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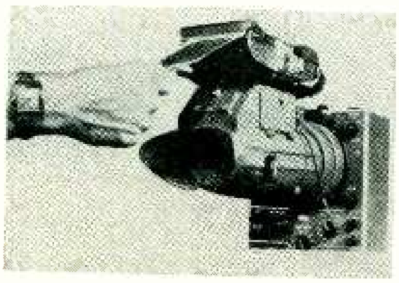

### Oscillograph-Record Camera

ALLEN B. DU MONT LABORATORIES, INC., 1000 Main Ave., Clifton, N. J. A new oscillograph-record camera provides, in one minute, a complete record of an oscillograph image. No darkroom facilities are required and waveform comparison is immediate. Designed specifically for application with any standard 5-in. c-r oscillograph, the camera employs the Polaroid-Land process for delivering a finished print at the termination of each completed exposure or set of exposures. Lens aperture is f:2.8. Size of print is 2¼ × 3¼ in.

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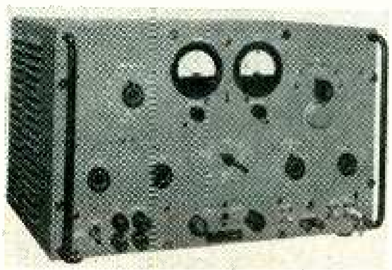

### Signal Generator

AIRCRAFT RADIO CORP., Boonton, N. J. Type H-14 signal generator was designed for complete testing of vhf airborne omnirange and localizer receivers in aircraft or on the bench. The unit has a frequency range of 108 to 118 mc. Its r-f output for ramp checks is 1 volt into a 52-ohm line and for bench checks, 0 to 10,000 μv. Also available is an a-f output for bench maintenance and trouble shooting. Price is $885.

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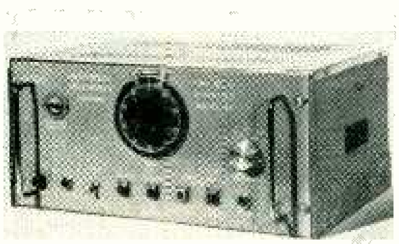

### Time Delay Generator

THE RUTHERFORD ELECTRONICS CO., 3724½ So. Robertson Blvd., Culver City, Calif. Model A2 time delay generator will produce variable time delays ranging from 0.4 μsec to 100,000 μsec. Five delay ranges are provided, giving a full scale reading of 10 μsec on the lowest range and progressing by decade steps to the highest range. The blocking oscillator output pulse is 0.5 μsec wide. The multivibrator output pulse width is designed to permit easy viewing on a synchroscope and is a function of the delay range in use.

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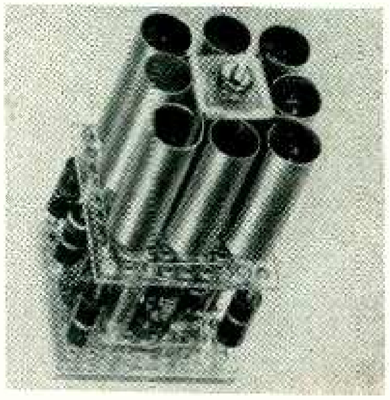

### Universal Chassis

AVION INSTRUMENT CORP., 121 E. 24th St., New York 10, N. Y., has designed a universal electronic chassis for use in servomechanisms, pulse and flip-flop circuits, analog computers and similar devices. Up to eight subminiature tubes can be mounted and wired. The complete assembly mounts in a metal case filled with a special potting compound which provides mechanical support for the components, ample heat dissipation and protection from tropical or arctic conditions. The chassis is designed to operate in temperatures ranging from −50 C to +80 C. It meets specification An-E-19 with respect to condition of altitude, humidity and vibration.

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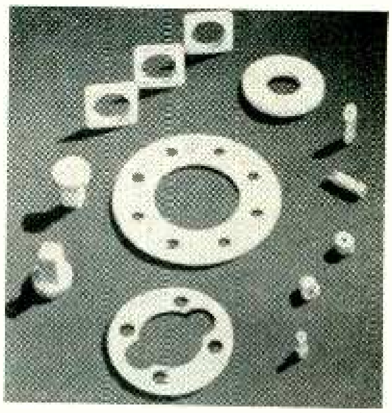
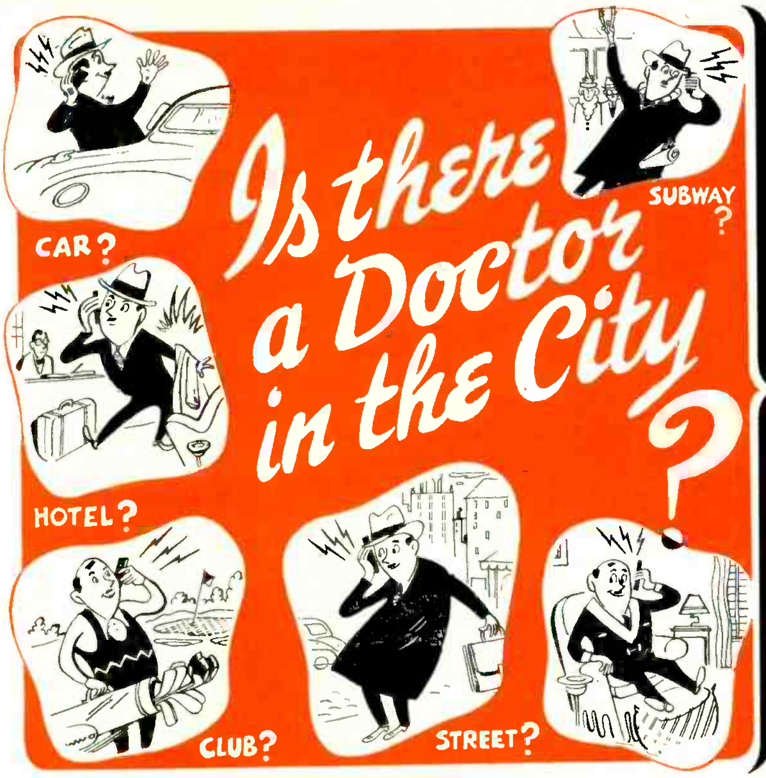


### Insulating Devices

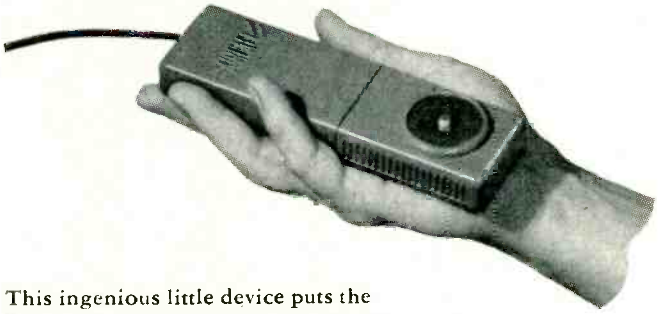
TEFLON PRODUCTS DIVISION, UNITED STATES GASKET CO., P.O. Box 93,




# TELANSERPHONE'S "AIRCALL" FINDS HIM QUICKLY, SURELY, DEPENDABLY THANKS TO THESE

## RAYTHEON

# SUBMINIATURE TUBES



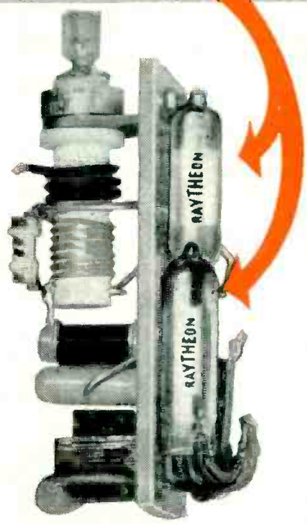
This ingenious little device puts the finger on the "doctor, lawyer or merchant chief" wherever he may be, indoors or out, within a twenty-five mile radius. He simply presses the button, holds the "Aircall" to his ear for a moment while it gives off broadcast call numbers, headed and terminated by call letters in a different voice. If his number comes up he simply calls the Telanserphone office from the nearest phone and is given the message. In this way he is never missing—never out of touch with his office, hospital, home or what not. Will electronic wonders never cease!

## Raytheon Subminiature Tubes

have exactly what it takes for applications such as this. They're rugged, long lasting, generally more dependable and efficient than their large tube counterparts.

Raytheon Subminiatures fit standard sockets or can be soldered or welded into the circuit.

Raytheon Subminiatures are standard the world over — *more in use than all other makes combined.*




**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 | | | |
| **FILAMENT TYPES** | | | | | | | | | | | | |
| 1AD4 | Shielded RF Pentode — high Gm | 0.300x0.400 | 1.5 | 1.25 | 100 | 2000 | | 45.0 | 3.0 | 45.0 | 0.8 | 0 |
| CK571AX | 10 ma. Filament electrometer tube, Ig = 2x10-13 amps. | 0.285x0.400 | 1.5 | 1.25 | 10 | 1.6† | | 10.5 | 0.20 | | | −3.0 |
| CK573AX | Triode, high frequency output | 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 | 37† | | 22.5 | 0.125 | 22.5 | 0.04 | −0.625 |
| CK5672 | Output Pentode | 0.285x0.385 | 1.5 | 1.25 | 50 | 625 | 60.0 | 67.5 | 2.75 | 67.5 | 1.1 | −6.25 |
| CK5676/CK556AX | Triode, UHF Oscillator for radio use | 0.300x0.400 | 1.5 | 1.25 | 120 | 1600 | | 135.0 | 4.0 | | | −5.0 |
| CK5677/CK568AX | Triode, UHF Oscillator for radio use | 0.300x0.400 | 1.5 | 1.25 | 60 | 650 | | 135.0 | 1.9 | | | −6.0 |
| CK5678/CK569AX | RF Pentode | 0.300x0.400 | 1.5 | 1.25 | 50 | 1100 | | 67.5 | 1.8 | 67.5 | 0.48 | 0 |
| CK5697/CK570AX | Electrometer Triode Max. grid current 5x10-13 amps. | 0.285x0.400 | 1.25 | 0.625 | 20 | 1.5† | | 12 | 0.22 | | | −3.0 |
| CK5785 | High voltage rectifier | 0.285x0.400 | 1.5 | 1.25 | 15 | | | | 0.1 | Inverse peak 3500 volts | | |
| **VOLTAGE REGULATORS** | | | | | | | | | | | | |
| CK5783 | Voltage reference tube — like 5651 | 0.400 | 1.63 | Operating voltage 85. 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.

## RAYTHEON

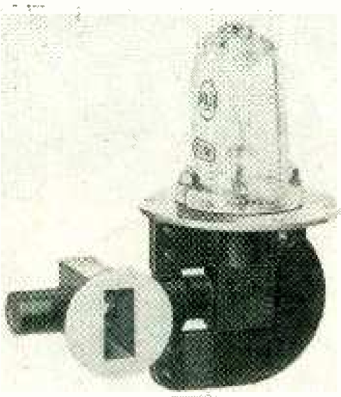
*Excellence in Electronics*

**RAYTHEON MANUFACTURING COMPANY**

**SPECIAL TUBE SECTION**
**Newton 58, Massachusetts**

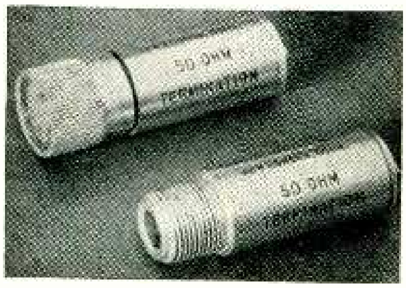
SUBMINIATURE TUBES
GERMANIUM DIODES and TRIODES
RADIATION COUNTER TUBES
RUGGED, LONG LIFE TUBES

Camden, N. J., is now fabricating all types of Teflon insulators (spacers for coax cables, inserts for coax connectors, beads, and so on) for high-voltage, high-temperature, high or ultrahigh-frequency service in tv transmitters, radio, radar and other electrical equipment. These tetrafluoroethylene resin insulators have a power factor less than 0.0005, and a dielectric constant of 2.0 over the frequency range measured to date. Teflon is serviceable throughout a temperature range of from below −90 F to +500 F.



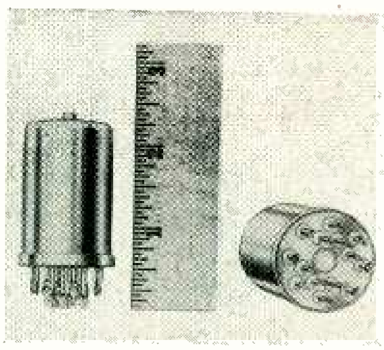
## Magnetron

Radio Corp. of America, Harrison, N. J. Model 2J50 magnetron is of the internal-resonant circuit type intended for pulsed oscillator service, such as radar, at a fixed frequency of 8,825 mc. It has a maximum peak power input rating of 260 kw. When operated with a peak anode voltage of 12,000 volts, the 2J50 is capable of giving a peak power output of 45 kw at a duty factor of 0.001.



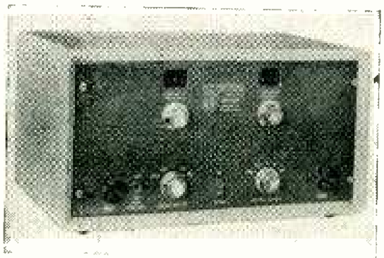

## Coax Line Terminations

New London Instrument Co., P.O. Box 189, New London, Conn. Illustrated above are 50-ohm terminations for coaxial transmission lines featuring low standing-wave ratios from d-c to over 3,000 mc. Fittings are type N, especially designed for minimum reflections. The units are useful for testing cables, slotted lines, r-f bridges, sweep generators and random noise sources. Price is $11.30.



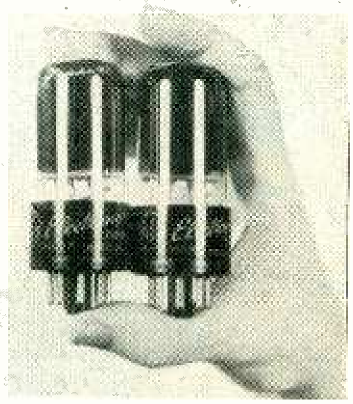
## Miniature Relay

The Hart Mfg. Co., Hartford, Conn., has developed a new aircraft type, hermetically sealed, miniature 4-pole double-throw relay. It is built to withstand shocks up to 50 G and to operate in temperatures ranging from −65 C to +200 C. Displacing only 1.5 cu. in. and weighing but 3.5 oz sealed with a dry, inert gas, pressure filled, the new relay has variable mounting arrangements. Contact ratings are 2 amperes, 28 volts, d-c; 2 amperes, 115 volts, a-c, 400 cycles. Overload rating is 12 amperes, 28 volts, 20 seconds.



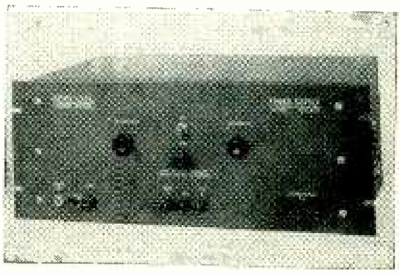
## ULF Rejection Filter

Krohn-Hite Instrument Co., 580 Massachusetts Ave., Cambridge, Mass., announces model 350-A variable ultra-low frequency rejection filter that provides either a rejection band in which the gain falls at a rate of 24 db per octave or a sharp single frequency null. High and low cutoff frequencies of the rejection band are independently and continuously adjustable over the frequency range from 0.02 to 2,000 cps. A sharp null may be obtained at any frequency between 0.1 and 500 cps. Gain is within 3 db of unity at one octave above or below the null frequency. The unit is especially useful for vibration studies and electromedical research, for geophysical and seismological instrumentation, and in conjunction with any 1-f phenomenon involving selective amplification.



## Beam-Power Amplifier Tube

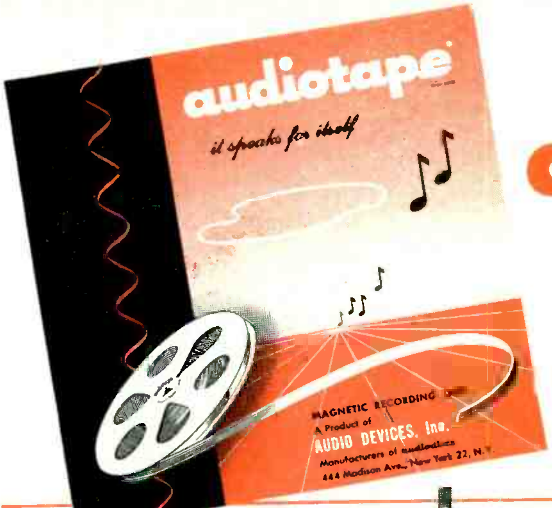
General Electric Co., Syracuse, N. Y. Type 6W6-GT beam-power amplifier tube is designed for use in the audio output stage of tv and radio receivers. Maximum ratings of the tube include: peak positive pulse plate voltage, 1,000 volts; peak negative pulse grid No. 1 voltage, 200 volts; plate dissipation, 10 watts. Heater voltage, a-c or d-c, is 6.3 volts; heater current, 1.2 amperes.



## Voltage-Regulated Power Supply

Kepco Laboratories, Inc., 149–14 41st Ave., Flushing, N. Y. Model 131 power supply features a high-

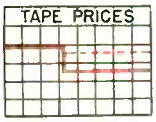
(Continued on p 212)




# Here's What These audio "Firsts" Have Done for You

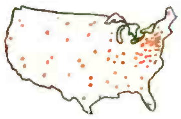
*. . . to lower the cost and improve the quality of magnetic recording tape*

### *First* with liberal discounts to professional users




—enabling radio stations, recording studios and educational institutions to save as much as 33⅓% on the cost of magnetic tape.

### *First* with attractive resale discounts



— and a nation-wide network of helpful, cooperative sound-equipment distributors in principal cities from coast to coast.

### *First* with red oxide tape on paper base

— offering recordists a high-quality tape designed to match the characteristics of the vast majority of recorders, at *lowest possible cost.*

### *First* with supercalendered kraft paper base

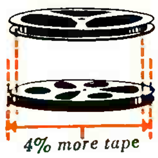
— providing maximum smoothness of texture and minimum noise, without the use of fillers which tend to come out or stiffen the paper.

### *First* with all-aluminum 7-inch reels

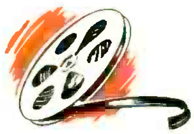
— mechanically strong, light in weight, and permanently free from warping or twisting even under adverse conditions.

### *First* to give extra footage on standard size reels

Audio's "full measure" of 1250 ft., 2500 ft., and 5000 ft. give *4% more tape* on every reel.



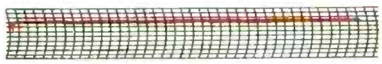

### *First* with black oxide tape on plastic base



— offering highest fidelity of recording and reproduction for machines designed to use a high coercive-force oxide.

### *First* to offer paper base tape in 2500 and 5000 foot rolls

— permitting maximum economy for professional applications where premium quality recordings are not required.



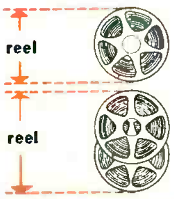
### *First* to produce a constant output tape

— made possible by Audio's specially designed coating machinery which controls coating thickness to within 5 *millionths* of an inch.

### *First* to guarantee output uniformity of

± ¼ db for 2500 ft. reel

± ½ db from reel to reel in 2500 ft. size



### *First* to produce a splice-free 2500 ft. roll

— to *guarantee* that the tape is all one piece, with absolutely no splices in the entire length.

### *First* to develop the safe-handling package for professional-size rolls

— permitting tape on hub to be transferred to or from turntable without danger of spilling — and simplifying the attachment of side flanges.

These "Firsts" are proof of the continuous research and development that keeps Audiotape foremost in the field. They are the result of more than a decade of experience — by the only company specializing solely in the manufacture of fine recording materials — both tape and discs.

That's why you can always look to Audio for the latest developments in the recording art. A trial order of Audiotape will speak for itself. Or send today for a free 300-foot sample.

**Trade Mark*

**AUDIO DEVICES, INC.**
**444 Madison Ave., New York 22, N. Y.**

Please send me a free 300-foot sample reel of ☐ plastic base or ☐ paper base Audiotape.

NAME.............................................

COMPANY.........................................

ADDRESS.........................................

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

# NEWS OF THE INDUSTRY

Edited by WILLIAM P. O'BRIEN

## Navy Needs Technicians

CURRENT military action in Korea has resulted in a large increase in over-all activity at the Naval Air Development Center (NADC), Johnsville, Pa. The NADC is now accepting applications for engineering and other technical positions from high-grade engineering, scientific, and mechanical personnel with education, training or experience in the fields of aeronautical, mechanical, electrical or electronics engineering, physics, mathematics, biology and clinical psychology. It is also seeking engineering draftsmen and laboratory mechanics who have considerable experience in aeronautical, electrical, electronic or mechanical drafting or shop work.

Under the management control of the Bureau of Aeronautics, the NADC performs development functions in the fields of aircraft electronics, pilotless aircraft, aviation armament and research and development in aviation medicine pertaining to the centrifuge.

Positions currently available, salaries offered and experience required are as follows:

*Electronics engineer, GS-13* ($7,600–$8,600). Development, operation and maintenance of analog computer.

*Physicist, GS-13* ($7,600–$8,600). Magnetic detection.

*Electronics engineer, GS-12* ($6,400–$7,400). Sonar development.

*Electrical engineer, GS-12* ($6,400–$7,400). Design and administrative experience as applied to aircraft systems.

*Physicist, GS-12* ($6,400–$7,400). Sonar development.

*Physicist (Electronics), GS-12* ($6,400–$7,400). Design experience in adopting electronic methods

## Latest Color TV Receiver

One of three experimental color TV receivers demonstrated by RCA in December is shown above. It contains 43 tubes, uses the latest tricolor picture tube containing about 600,000 phosphor dots for higher definition and has new red and blue phosphors for better brightness. Also demonstrated was a standard 16-inch black-and-white receiver converted for color by inserting a tri-color picture tube, a new deflection yoke and other circuits containing 13 additional tubes. Since the RCA system is compatible, the received color pictures were shown side by side with standard black and white receivers

## RTMA Board of Directors for 1950-1951

# PRODUCED FOR YOUR REQUIREMENTS
## *- by the top specialists in the ceramic field*

**HI-Q**

## CERAMIC PLATE CAPACITORS

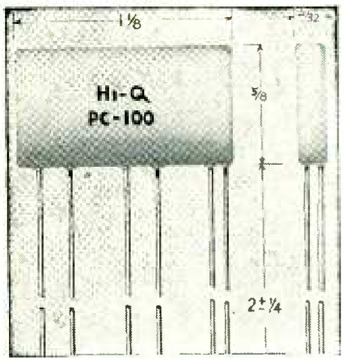
Essentially similar, except in shape, to **Hi-Q** Disk Capacitors except that in the multiple units they do NOT have to have a common ground as is the case with disks. These **Hi-Q** Plates can be produced in an unlimited range of capacities, the number on a plate being limited only by the K of the material and the physical size of the unit. They offer the greatest available capacity per unit volume of any type condenser on the market.

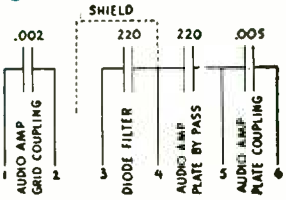
Guaranteed minimum values of capacity up to 33,000 mmf per sq. in. are available. This is based on the use of Body 41 ceramic having 3000 as a dielectric constant "K" and .020 in. thickness and the formula:

$$C\ (\text{mmf}) = \frac{.224\ K\ A\ (\text{Sq. in.})}{D\ \text{in.}}$$

If temperature compensating ceramics are used, the capacity will be considerably lower. Typical circuits are shown here, but almost any combination can be produced for your specific needs. Consult our engineers for complete details. Write for new **Hi-Q** datalog.

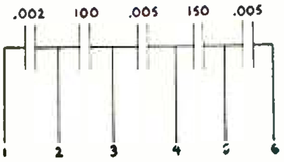
### PC-100



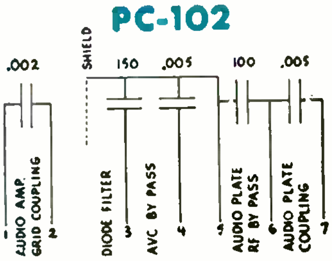

| | | | | |
|---|---|---|---|---|
| 1-2 | .002 | +75 −25 | % | mf |
| 3-4 | 220 | +50 −50 | % | mmf |
| 4-5 | 220 | +50 −50 | % | mmf |
| 5-6 | .005 | +75 −25 | % | mf |

### PC-101



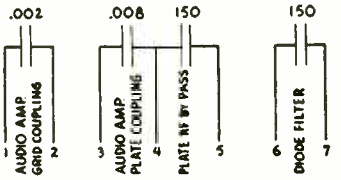

| | | | | |
|---|---|---|---|---|
| 1-2 | .002 | +75 −25 | % | mf |
| 2-3 | 100 | +50 −50 | % | mmf |
| 3-4 | .005 | +75 −25 | % | mf |
| 4-5 | 150 | +50 −50 | % | mmf |
| 5-6 | .005 | +75 −25 | % | mf |

### PC-102



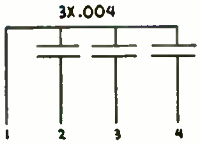

| | | | | |
|---|---|---|---|---|
| 1-2 | .002 | +75 −25 | % | mf |
| 3-5 | 150 | +100 −0 | % | mmf |
| 4-5 | .005 | +100 −0 | % | mf |
| 5-6 | 100 | +75 −25 | % | mmf |
| 6-7 | .005 | +75 −25 | % | mf |

### PC-103



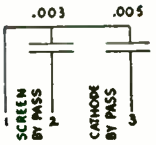

| | | | | |
|---|---|---|---|---|
| 1-2 | .002 | +75 −25 | % | mf |
| 3-4 | .008 | Min | % | mf |
| 4-5 | 150 | +50 −50 | % | mmf |
| 6-7 | 150 | +50 −50 | % | mmf |

### PC-104

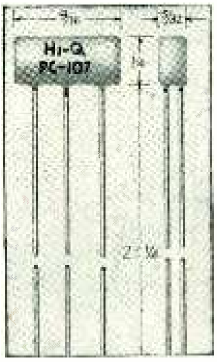



3X .004 Min mf

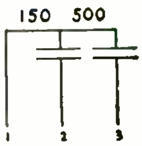
### PC-105




| | | | | |
|---|---|---|---|---|
| 1-2 | .003 | +75 −25 | % | mf |
| 1-3 | .005 | +75 −25 | % | mf |




### PC-107




| | | | | |
|---|---|---|---|---|
| 1-2 | 150 | +75 −25 | % | mmf |
| 1-3 | 500 | +75 −25 | % | mmf |

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*Physicist*, *GS*-11 ($5,400–$6,400). Sonar development; radar development; electronic option in test and evaluation of developmental airborne search and attack equipment.

*Electronics engineer*, *GS*-9 ($4,600–$5,350). Installation of radio telemetering gear in pilotless aircraft, design or selection of special components and establishment of data—reduction calibrations; countermeasures equipment; radar development; missile guidance control.

*Physicist*, *GS*-9 ($4,600–$5,350). Optics.

Inquiry regarding the above positions should be made by letter addressed to the Industrial Relations Officer, U. S. Naval Air Development Center, Johnsville, Pa., or by personal visit to the NADC.

### *MEETINGS*

JAN. 10-12: Second High Frequency Measurements Conference, sponsored by AIEE, IRE and NBS, Hotel Statler and Dept. of Interior Auditorium, Washington, D. C.

JAN. 22-26: AIEE Winter General Meeting, Hotel Statler, New York, N. Y.

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. 30-MAY 4: SMPTE Spring Convention, Hotel Statler, New York.

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.

## First TV in Canada

THE LATE John D. Woodlock, VE2HE, former assistant director of O'Sullivan College in Montreal, transmitted television signals recently from his home in Iberville, Quebec, Canada, using equipment designed by J. R. Popkin-Clurman, reported in August 1950 ELECTRONICS. Iberville is located about 28 miles north of the American border and 32 miles from the city of Montreal.

The transmitting equipment was on the air continuously from Sept. 1 to 5 using a carrier frequency of 53.51 mc (6-meter amateur band). Standard tv receivers modified by shifting the local oscillators down from channel 2 were used for field tests.

The transmitter radiated 25 watts peak and was fed into a VEE-DX type RD-13-A rotatable array mounted 90 feet high. Effective radiated power was estimated at 250 watts. Later, propagation tests were made with an erp of 5 kw.

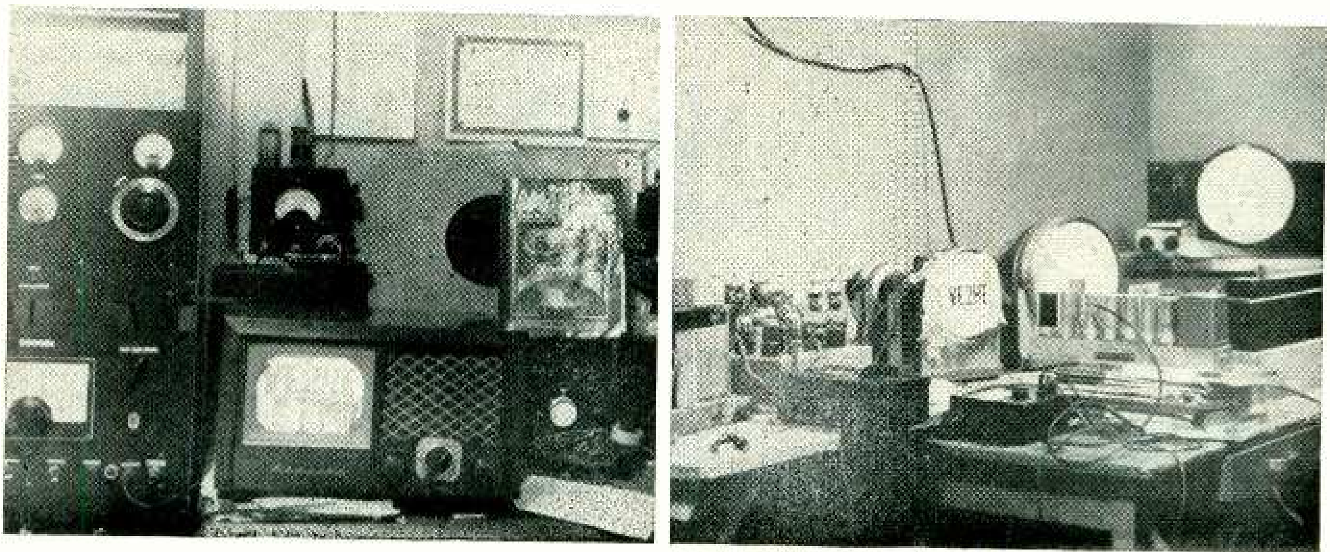
Strong signals were received at Lacolle, Quebec, by VE2AMO, 21 air miles distant and at several places in the city of Montreal. The blanking bars were received at Lavaltrie, Quebec, by VE2SV, approximately 51 miles distant, with a faint picture visible.

The effective resolution of the pictures up to eight miles was better than 325 lines.

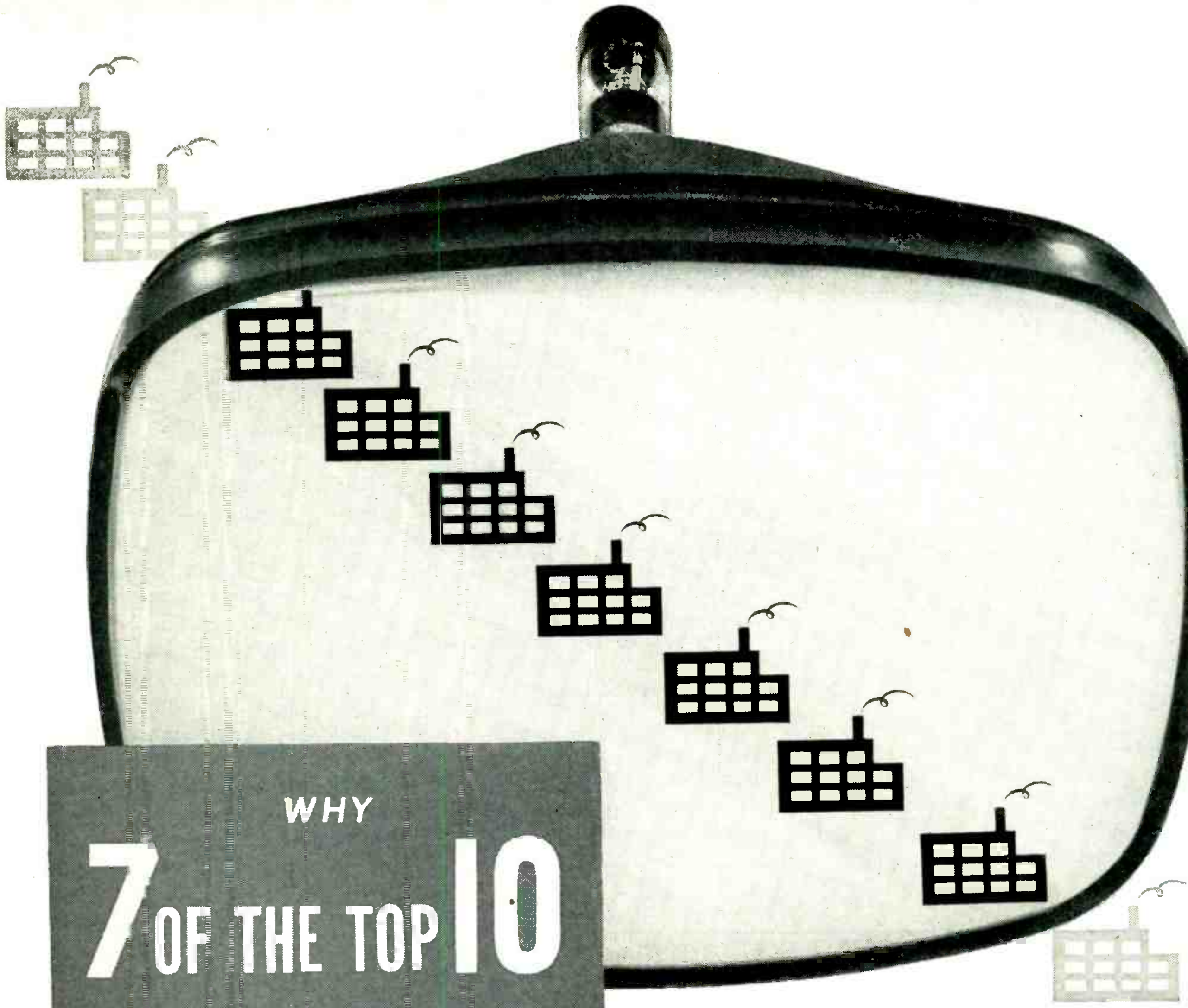
## Signal Corps News

THE SIGNAL CENTER at Fort Monmouth, N. J., has over 700 vacancies for civilians who can qualify

(Continued on p 246)



**Equipment used in recent amateur tv transmissions showing the r-f portion of the transmitter, monitoring set, and phototube and video amplifier chassis facing test transparency on face of the transmitting crt**



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# 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

## The Theory and Practice of Industrial Research

BY DAVID BENDEL HERTZ. *McGraw-Hill Engineering Management Series, McGraw-Hill Book Co., New York,* 1950, 354 *pages,* $5.50.

THIS BOOK deals with the "application of the methodologies of scientific disciplines in industry" and the necessity for efficient use of the limited reservoir of creative ability. It defines research as the "application of human intelligence in a systematic manner to a problem whose solution is not immediately available". The author recommends that a research director be given the prime responsibility to attempt to solve all the problems turned over to him. He recommends a tight organization, with specific problems planned in detail in advance and preliminary estimates on what is to be done.

It is unfortunate that the author did not use the word "development" instead of "research" because his suggestions would have been at least somewhat more applicable. However, no attempt to distinguish between basic or applied research or development is carried through the discussions. The policies which he recommends are not in accordance with those practiced in productive research organizations where creative work is done.—WALDO H. KLIEVER, *Director of Research, Minneapolis-Honeywell Regulator Co.*

**RELEASED THIS MONTH**

**Electrons and Holes in Semiconductors; William Shockley; Van Nostrand; $9.75.**

**Fundamentals of Acoustics; L. E. Kinsler and A. R. Frey; Wiley; $6.00.**

**Micro-Wave Measurements; H. M. Barlow and A. L. Cullen; Macmillan; $6.00.**

**Traveling Wave Tubes; J. R. Pierce; Van Nostrand; $4.50.**

**TV and Other Receiving Antennas; A. B. Bailey; Rider; $6.00.**

## Principles and Applications of Waveguide Transmissions

BY G. C. SOUTHWORTH, *Bell Telephone Laboratories. D. Van Nostrand Co., Inc., New York,* 1950, 689 *pages,* $9.50.

THE AUTHOR of this book is internationally known as one of the pioneers in waveguide work and one of the outstanding authorities in this field. A book written by him should be expected to be, and is in fact, outstanding in many respects.

As the title of this book states, both principles and applications of waveguide transmission are discussed. Most of the emphasis is placed on the applications and this book will be invaluable to all development engineers employing or developing microwave components. Seldom in the experience of this re-

(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**

## Video on Tape

DEAR SIRS:

I'M AFRAID I can't quite agree with John Boyers' conclusions (see *Backtalk,* and the Editorial page of ELECTRONICS, June, 1950) that anything so plebeian as a direct approach to the problem of recording video frequencies on magnetic tape is obviously impractical. To be sure, the application of new principles to the problem is most desirable and logical, but the cost of doing the job by the "brute-force" method is not as fantastic as it may seem.

The calculation presented by Mr. Boyers is the first one everyone makes, of course. However, the cost given ($1,275.00 for a fifteen-minute recording) is somewhat high since, in the quantities that any large user buys tape, the net price for the material would come to about $760.00. If the tape were used only 100 times (and re-use of the tape is one of the objectives in developing a new system), the cost per use would be only $7.60.

At the present time, television recordings are made on 16-mm and 35-mm film. The cost of a fifteen-minute print (neglecting entirely the negative costs) is about $15.00 and $50.00 respectively. These films are reproduced once in the city to which they are sent and then destroyed. So, even using an elementary approach to the recording problem, magnetic recording of television programs would result in a 2 to 1 saving over 16-mm costs and better than a 6 to 1 saving in 35-mm costs. When it is considered that well in excess of 200 hours (or 800 quarter-hours) of release points are used every week by each network, the potential savings are seen to be substantial. I don't think that the approach is as "obviously" impractical as Mr. Boyers concludes!

HOWARD A. CHINN
*Columbia Broadcasting System, Inc.*
*New York, N. Y.*

## It Is to Laugh

DEAR SIR:

YOUR *"Cross Talk"* column in the June 1950 issue under the heading, "Landlord" illustrates perfectly the comic aspect of what passes for engineering these days. The reference to Alpine, however, while quite

(Continued on p 262)

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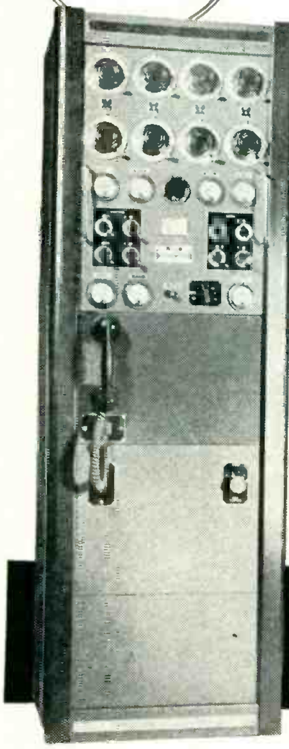

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Presents in compact form all currently available theoretical data and some experimental data on the properties of microwave transmission lines, microwave circuit elements (obstacles, windows, discontinuities, bends, junctions and couplings) and of some structures, such as cavities, which may be considered as composites of these.

**2. PROPAGATION OF SHORT RADIO WAVES**

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This volume treats the phenomena associated with the propagation of short radio waves between terminal points, whether they be the radar antenna serving a dual purpose or the antennas of a communications system. Emphasizes methods of planning experiments and of analyzing results.

**3. THEORY OF SERVOMECHANISMS**

**Vol. 25.** Edited by H. M. JAMES, Purdue Univ.; N. B. NICHOLS, Taylor Instrument Co.; and R. S. PHILLIPS, Univ. of Southern Calif. **375 pages, $5.00**

**4. PULSE GENERATORS**

**Vol. 5.** G. N. GLASOE, Rensselaer Polytechnic Institute; and J. V. LEVACQZ, Johns Hopkins Univ. **737 pages, $9.00**

**5. MICROWAVE RECEIVERS**

**Vol. 23.** Edited by S. N. VAN VOORHIS, Assoc. Professor of Physics, Univ. of Rochester. **611 pages, $8.50**

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**Vol. 11.** Edited by C. G. Montgomery, Associate Professor of Physics, Yale University. **937 pages, $10.00**

**7. VACUUM TUBE AMPLIFIERS**

**Vol. 18.** Edited by GEORGE E. VALLEY, JR., M. I. T.; and HENRY WALLMAN, M. I. T. **733 pages, $10.00**

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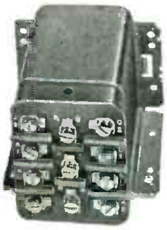
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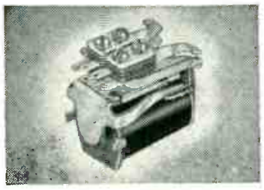
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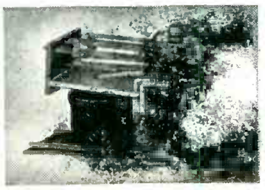
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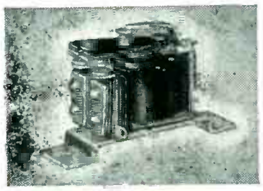
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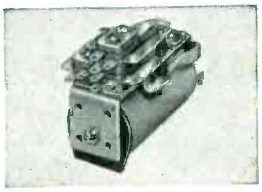
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A COMPLETE LINE OF RELAYS SERVING AMERICAN INDUSTRY viewer has such a coordinated picture been assembled of up-to-date developments in a particular field as this book does with regard to the work of the Bell Telephone Laboratories. In this respect this book could be compared to Volume 9 of the Radiation Laboratory Series. The fact that substantially more weight is given and space devoted to the work done within the Bell Telephone Laboratories than to the work of others was to be expected and detracts only very slightly from the value of the book.

*Introductory Theory*

After a very interesting historical introduction, basic concepts are given on networks, transmission lines, electromagnetic waves and waveguide theory. The discussion of these principles is given in the first seven chapters, which are necessary for an integrated presentation but will not be found as useful and satisfactory as the following ones. Some readers may object for instance to seeing critical coupling and maximally flat coupling confused in Section 2.5, or not completely agree with statements like the following: "according to one view of electricity the individual charges to which lines of force attach themselves are unable to flow through the conductor with the velocity of light. If this is true, lines of force snap along from one charge to the next in a rather mysterious fashion".

The eighth chapter deals with impedances in waveguides, junctions, irises, tuners and cavities.

The ninth chapter considers waveguide components in general, transformers and filters. Here the quality of the book and the wealth of material made available become outstanding. New information previously unpublished is given; the problem of branching filters is extensively dealt with together with that of more conventional filters, phase shifters, hybrid junctions, directional couplers, mode converters, rotary joints and attenuators.

The next chapter covers antennas, with a particularly excellent and complete treatment of horn antennas. Leaky waveguide antennas and dielectric antennas are dealt

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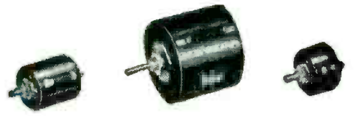

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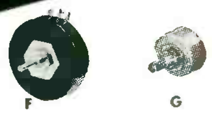

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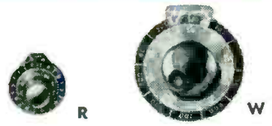

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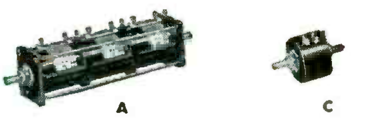
The versatility of the potentiometer designs illustrated above permit a wide variety of modifications and features, including double shaft extensions, ganged assemblies, the addition of a multiplicity of taps, variation of both electrical and mechanical rotation, special shafts and mounting bushings, 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 with in detail. Here again, material previously unpublished or available only through patent literature is supplied. Parabolic antennas and lens antennas are also dealt with, in somewhat less detail. In this chapter particular mention should be made of not only the section on horns but also that on corner reflectors, an important subject not usually covered in textbooks.

The eleventh chapter deals with tubes capable of operating at microwave wavelengths. The section on microwave amplifiers is particularly interesting. Information not previously available on circuits using the microwave Western Electric tube type 416A is also given. Descriptions of the multigap velocity variation tubes (which used to be known during the war as Samuel tubes) are given. Magnetron oscillators are also dealt with in reasonable detail; some basic information is given on traveling-wave tube amplifiers and TR and ATR tubes.

The twelfth chapter, on modulation and demodulation, contains, besides some other very useful information on converters, a summary of a theory on frequency conversion by crystals which is published here for the first time and which is attributed to A. B. Crawford.

In conclusion, this book contains a very complete summary of applications of waveguide components, suggests new ideas and points the way to future progress in the microwave field.—E. G. FUBINI, *Supervising Engineer, Airborne Instruments Laboratory, Mineola, N. Y.*

## Survey of Modern Electronics

BY PAUL G. ANDRES. *John Wiley & Sons, Inc., New York*, 1950, 522 *pages*, $5.75.

IN THE PREFACE to this book on electronics the author states that it is intended for use in a survey course in electronics for electrical engineering students who have not yet begun to specialize in power, communication or any other field. The emphasis throughout the book is very frankly on the description of electronic devices by words and pictures rather than by mathematics. The many applications of

# "It happened in the 3rd inning . . ."

It was the first day of the World Series. A big razor manufacturer had paid some $800,000 for the rights to televise the games. It was the third inning—and the Yankees and Phillies were tied 0 to 0. Millions of fans were glued to their sets when—pfft!—three million sets went black, and for twenty minutes there was no game insofar as television was concerned! What happened?...I don't know—that's for the sponsor and the broadcasting company to decide. But you can bet your bottom dollar that it was some little thing—like insulation at a vital point—that caused the breakdown!

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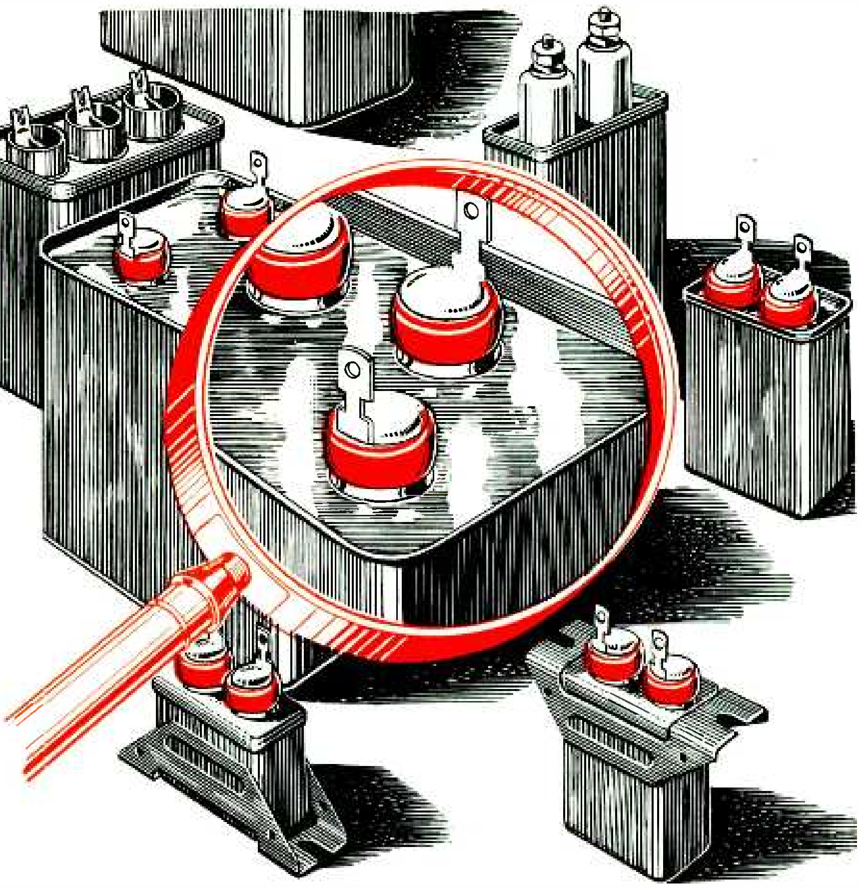

**SILICONE**—the amazing new synthetic that made headlines when General Electric brought it out—is back in the news again. For today, G-E small capacitors, up through 5000 volts, are hermetically sealed with G-E silicone rubber bushings or gaskets.

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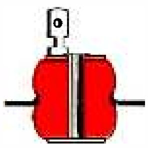
Silicone-rubber bushings, permanently elastic and formed to close tolerances, seal themselves by compression to the capacitor cover. They are used with capacitors 1500-v d-c, or 660-v a-c, and lower. Silicone rubber gaskets with plastic or porcelain stand-offs are used for higher voltages.



**GENERAL ELECTRIC**

407-172

electronics treated include a number which are not to be found in other texts of this general level—some interesting examples are the sections on Electrical Detearing and Precipitation, The Mass Spectrometer, Metal Detectors and The Electroencephalograph.

This broad treatment would certainly serve to arouse an interest in the field of electronics in the minds of electrical and other engineering students who have not begun to specialize. Although there is some gap between the elementary treatment of such subjects as the triode amplifier and the associated application example—an automatic pilot in this case—the excellent problems at the end of each chapter would serve to fill in if they were properly used.

Electrical engineering students are often plunged into the detailed study of the elements of electronic circuits in their junior or senior year without being provided with reasons for the importance of these elements. A survey course based on a book such as this would help to explain why the more detailed and more mathematical studies which follow are necessary.

A goodly number of references are given at the end of each chapter, and the index appears to be quite complete.—VINCENT C. RIDEOUT, *Assoc. Prof. of Electrical Engineering, Univ. of Wisc.*

## Father of Radio

*The Autobiography of Lee de Forest. Wilcox & Follett, Chicago,* 1950, 500 *pages,* $5.00.

ANY DISBELIEVERS of the idea that the way to succeed is to try, try again had better read this story of "old Doc" and become converted. For this is an incredible story of success and failure, one following the other, time after time throughout the first fifty years of a man's life and of the life of wireless and radio. Success in invention; failure in exploitation. It is the story of the unfinanced inventor, one gifted not only with technical ability but with great dreams; a story of the troubles such inventors have. All sorts of troubles; finances and the lack of them; unscrupulous associates; lawyers; stock salesmen; great companies with great funds;

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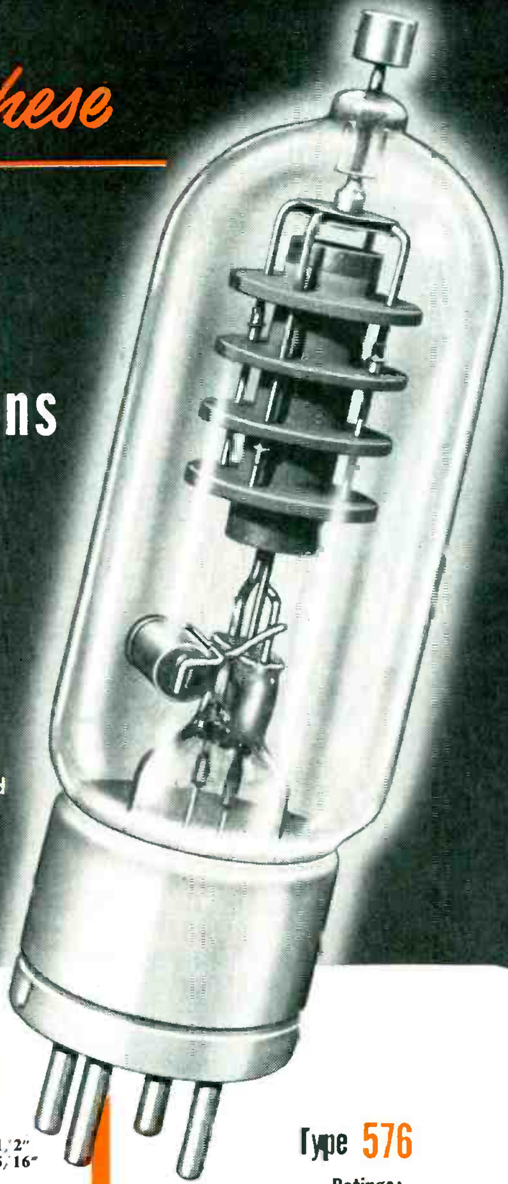

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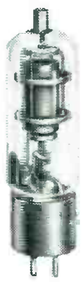

### Type 577

**Max. Dimen.:**

| | |
|---|---|
| Height | 7-3/8" |
| Diameter | 2-1/16" |

**Ratings:**

| | | |
|---|---|---|
| Ef | 5.0 | volts |
| If | 10.25 | amps. |
| epx | 25 | kv |
| Io | 300 | ma |
| ib | 1.50 | amps. |

### Type 578

**Max. Dimen.:**

| | |
|---|---|
| Height | 6-1/2" |
| Diameter | 2-5/16" |

**Ratings:**

| | | |
|---|---|---|
| Ef | 5.0 | volts |
| If | 6.0 | amps. |
| epx | 40 | kv |
| Io | 100 | ma |
| ib | 750 | ma |

### Type 576

**Max. Dimen.:**

| | |
|---|---|
| Height | 7-1/2" |
| Diameter | 2-5/16" |

**Ratings:**

| | | |
|---|---|---|
| Ef | 5.0 | volts |
| If | 14.0 | amps. |
| epx | 25 | kv |
| Io | 500 | ma |
| ib | 2.5 | amps. |

### Type 371-B

**Max. Dimen.:**

| | |
|---|---|
| Height | 8-3/4" |
| Diameter | 2-5/16" |

**Ratings:**

| | | |
|---|---|---|
| Ef | 5.0 | volts |
| If | 10.3 | amps. |
| epx | 25 | kv |
| Io | 300 | ma |
| ib | 1.5 | amps. |

### Type 3B24W

**Max. Dimen.:**

| | |
|---|---|
| Height | 4-1/2" |
| Diameter | 1-9/16" |

**Ratings:**

| | | |
|---|---|---|
| Ef | 5.0 | volts |
| If | 3.0 | amps. |
| epx | 20 | kv |
| Io | 60 | ma |
| ib | 300 | ma |

### Type 3B29

**Max. Dimen.:**

| | |
|---|---|
| Height | 4-3/8" |
| Diameter | 1-9/16" |

**Ratings:**

| | | |
|---|---|---|
| Ef | 2.5 | volts |
| If | 4.75 | amps. |
| epx | 16 | kv |
| Io | 65 | ma |
| ib | 250 | ma |

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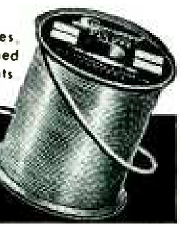

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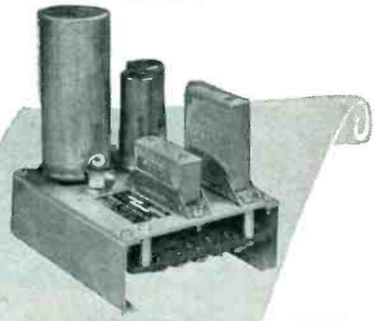

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marriage; troubles with those who did not believe.

In the first half-century of any art or science as big as electronics there is bound to be much that is exciting, tawdry, good, bad, sad, joyous. Of all these, Doc had his share. But he always had hope. There is scarcely any technical phase of electronics in which de Forest did not make an important mark; and of the major aspects of electronics as we now know it, he was way out a head of the procession. His efforts to establish and maintain wireless telegraph systems here and abroad, his first use of the electric knife in surgery, his broadcasting of voice and music before the present brood of crooners began drooling, his early work with sound-on-film, the story of the telephone repeater, of electronic musical instruments and of much more —all this is in Doc's book in his own words.

From the nontechnical standpoint, de Forest's love of music, of poetry and of the classics or his prowess as a mountain climber may be news to those who know so well his technical deeds; but there is no doubt about the value of these extra-curricular activities to him.

To the end the "father of radio" believes that better service could have been made of at least one part of his contributions—broadcasting —and there are millions of former avid listeners who will agree with him.

This is an interesting and often inspiring story.—K.H.

## High-Speed Computing Devices

BY THE STAFF OF ENGINEERING RESEARCH ASSOCIATES, INC., *including* C. B. TOMPKINS, J. H. WAKELIN AND W. W. STIFLER, JR. *McGraw-Hill Book Company, New York*, 1950, 451 *pages*, $6.50.

THIS BOOK is quite well written and should be of great interest to anyone concerned with computing machinery, particularly digital type computers. The material is presented in such a fashion that it could be successfully used as a first-course textbook for graduate students interested in digital computers. The basic fundamental concepts of machine computation are

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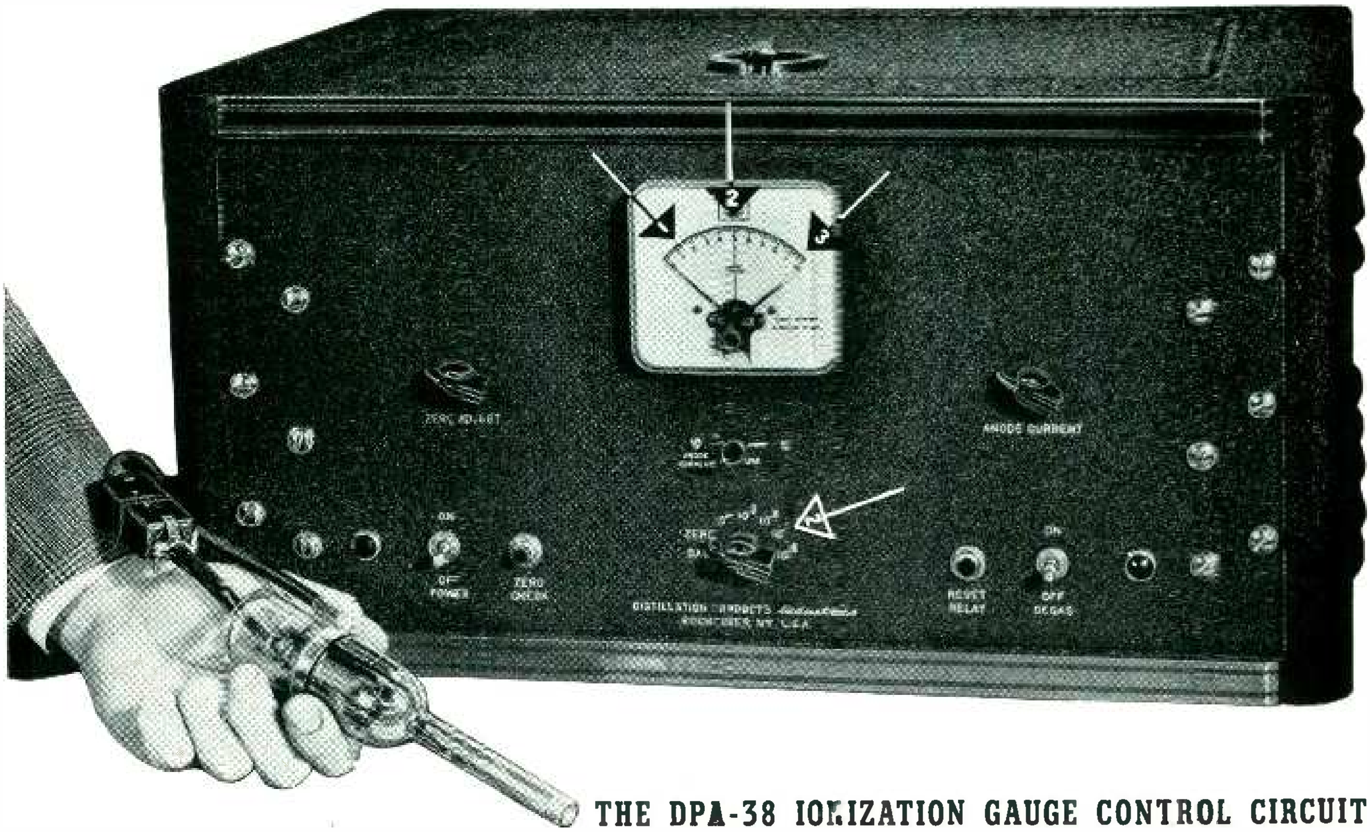


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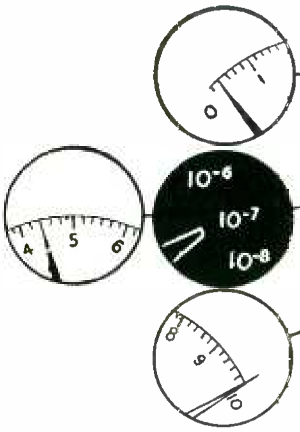


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Also . . . vitamins A and E . . . distilled monoglycerides . . . more than 3300 Eastman Organic Chemicals for science and industry quite clearly presented. The authors have done a particularly good job in breaking down a complex subject into simple terms such that one with only a reasonable technical background will have no difficulty in following the material.

It is somewhat disappointing, however, that the authors did not include more information on analog-type computers. The book consists of seventeen chapters and only one is devoted to analog computers. Furthermore, most of this chapter deals with analog computers in the most general terms only. Some details of the differential analyzer are given but less than one page is devoted to the large, modern general-purpose analog computer such as the Anacom at Westinghouse and Northwestern University and the California Institute of Technology. There is no discussion of modern analog techniques nor of the basic procedures used to derive analogies. The bibliography on analog computers is incomplete. A number of the classic analog papers presented during the past 10 years are not mentioned.

For those interested in digital type computers only, the book presents much valuable and interesting material.—D. L. WHITEHEAD, *Engineer in Charge, Analog Computing Laboratory, Westinghouse Electric Corp.*

### Industrial Instrumentation

BY DONALD P. ECKMAN. *John Wiley & Sons, Inc., New York,* 1950, 396 *pages,* $5.00.

AS AN introduction to the science of measurement for engineering undergraduates, this book reviews one by one the principles of various methods of measuring and sensing employed in industrial processing and manufacturing. Though emphasis is on the method rather than the mechanism, important practical details are stressed wherever possible.

Although electronic equipment is not specifically covered, practically all of the information in this book is essential for intelligent application of electronic controls in industry, since each control system must start with measurement of a variable. An appendix of tables,

dealing mostly with temperature measurement since this is the commonest type of instrumentation, adds to the reference value of the book for all engineers. Questions and problems after each chapter add to the value as a text both for colleges and for home study.—J. M.

## THUMBNAIL REVIEW

MAGNETIC RECORDING—1900-1949. Bibliography Series No. 1. John Crerar Library, 86 E. Randolph, Chicago, 60 pages mimeographed, $2.00. Compiled by Carmen Wilson, chief, Technology Department, to meet requests for material on magnetic recording. References have been supplemented by descriptive annotation or abstract wherever titles were not selfexplanatory. References to outstanding patents are included. Arranged chronologically and cross-indexed by authors and by subjects.

RCA RECEIVING TUBE MANUAL RC-16. RCA Tube Department, Harrison, N. J., 320 pages, $.50. New edition covers over 460 receiving and picture tubes, brought up to date by revisions and expansions. Technical data sections include new material on calculation of power output, load resistance and distortion, cathode-follower data, and high-voltage and safety considerations for kinescopes. Many new audio amplifier and receiver circuit designs have been added.

NOMOGRAMS OF COMPLEX HYPERBOLIC FUNCTIONS. By Jorgen Rybner, Professor at Royal Technical University of Denmark. Available from Scandinavian Book Service, 620 W. 158th St., New York (in English), 1947, 35 pages plus charts and diagrams, $4.80. Large, accurately printed nomograms give accuracy comparable to 5-place tables and a computing machine. The charts present the sinh and cosh functions as rectangular functions of a rectangular variable, and the tanh function as a polar function of a rectangular variable. Additional material in the text makes it in some respects a compendium of transmission line and filter theory.

TABLE FOR USE IN THE ADDITION OF COMPLEX NUMBERS. By Jorgen Rybner and K. Steenberg Sorensen. Available from Scandinavian Book Service, 620 W. 158th St., New York (in English), 1948, 95 pages, $4.00. Facilitates calculations with complex numbers by making possible their addition or subtraction in polar form.

TELEVISION SERVICING. By W. H. Buchsbaum. Prentice-Hall, Inc., New York, 1950, 340 pages, $5.35. Written to aid in training technicians in television. Part I covers receiver theory; Part II deals with installation and alignment; Part III serves as a troubleshooting guide.

STRUCTURAL PLASTICS. By H. C. Engel, C. B. Hemming and H. R. Merriman. McGraw-Hill Book Co., New York, 1950, 301 pages, $4.50. First seven chapters deal largely with properties of plastics, molding procedures, sandwich constructions and structural adhesives, but the last chapter—Radomes and Microwave Windows—is definitely of interest to electronic engineers. This analyzes the broad problem of providing antenna covers, also called radomes and microwave windows, that are as transparent as possible to the radio waves they are designed to pass. Four basic radome solutions are presented—the thin wall, thick wall, double thin wall and sandwich, and a design procedure is given.

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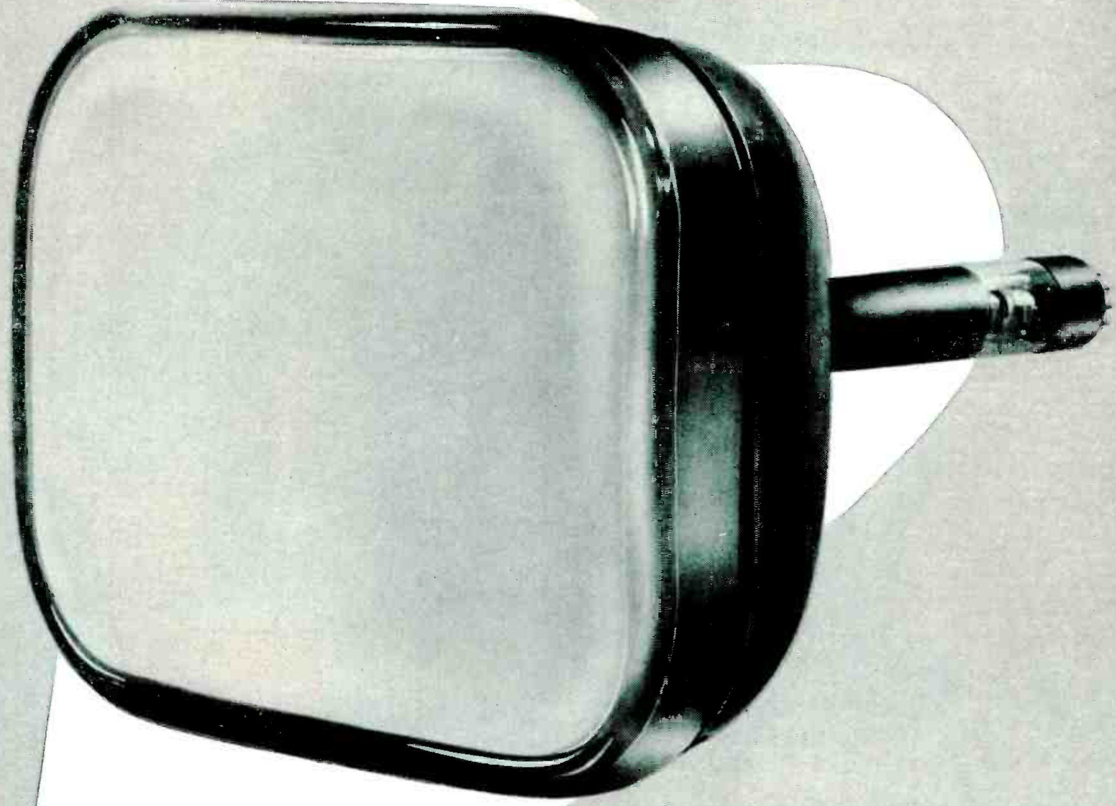

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## TUBES AT WORK

(continued from p 122)

sufficient sensitivity and accuracy.

An amplifier was constructed using the circuit shown. The amplifier is designed for operation of a Weston model 370 a-c and d-c milliammeter, an instrument of the electrodynamometer type with a stated accuracy of ¼ percent of full scale.

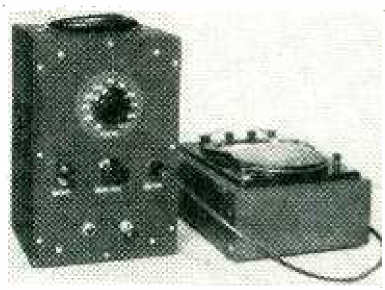
The amplifier is direct coupled throughout and makes operation possible on d-c as well as a-c. It maintains the combination useful as a transfer means between alternating and direct voltages.

The input voltage range of 1.5 to 300 v full scale is covered with a voltage divider made up of wire-wound precision resistors of 0.1 percent accuracy. The input resistance is 1,000 ohms per volt. For the ranges of 0.75 down to 0.15 volt full scale, reduced amounts of feedback are used with a fixed input resistance of 1,500 ohms.

The input voltage between grid and cathode of the first stage of amplification was measured as approximately 0.0039 v for full scale deflection of the milliammeter. For input voltage ranges of 1.5 to 300 v, the output of the voltage divider is 1.5 v. The feedback voltage is correspondingly about 1.496 v. The required feedback resistor is then $1.496/15 \times 10^{-3}$ or approximately 99.7 ohms. Accuracy of scale calibration thus depends mainly on the accuracy of adjustment of the feedback resistor. For a 0.15-v input, the feedback voltage is 38 times the net grid-cathode input voltage.

### *Advantages of D-C Coupling*

The use of d-c coupling in a high-gain amplifier brings with it problems of drift and zero adjustment but much higher values of negative feedback are allowable. Elimination of coupling capacitors or transformers between stages prevents phase shifts giving sufficient positive feedback at certain frequencies to cause oscillation. The use of a large amount of negative feedback reduces drift and sensitivity to power supply variations to nearly a negligible amount. Some drift has been noticed during warmup on the lowest voltage ranges (where the feedback is reduced) but is easily compensated



Amplifier and electrodynamometer-type milliammeter set up for operation

by the zero adjustment shown.

Regulated power supplies were found advantageous for stabilizing the low input voltage ranges and for maintaining high accuracy for either polarity of d-c input voltage. A high degree of regulation is not required, but an improvement over the natural power supply regulation (for d-c input voltages and corresponding plate current changes) and changes due to a-c line voltage variations is desirable.

A troublesome problem in the initial development of the amplifier was the effect of conductive grid current in the first stage. With low plate and grid bias voltages, a small but significant grid current may flow because of ionized gas in the tube or the initial velocity of electrons emitted from the cathode. This effect varies with electrode voltages, heater temperature, and the particular tube of a given type.

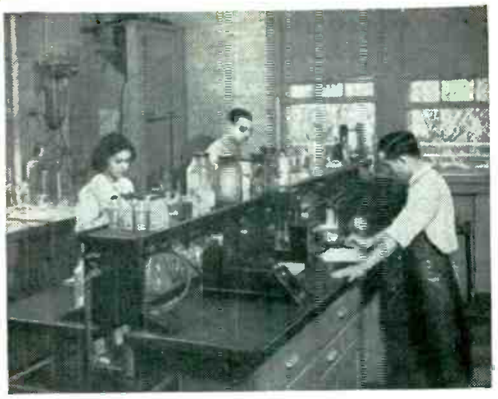
A current of 1 $\mu$a flowing through the 1,500-ohm grid to cathode voltage-divider resistance would cause an error in the input voltage of 0.1 percent. It is important to keep the plate potential of the first stage high enough to maintain the grid current at a low value, even at the expense of loss of gain in a voltage divider to supply the grid of the next stage.

The inherent gain of the amplifier is so great that it is difficult to adjust without feedback. However, by adjusting one or two stages independently, finding proper input and output d-c potentials, and then connecting all stages together along with the feedback loop, correct operation may be obtained.

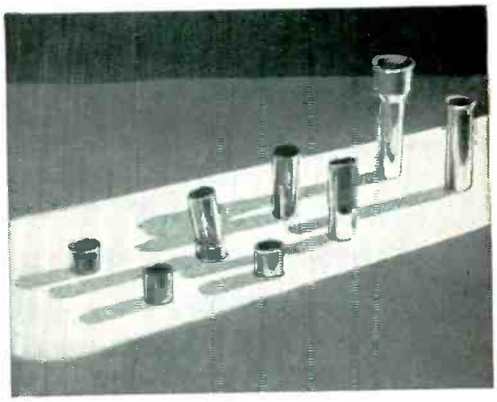
*Performance and Applications*

The combination described may be used also to measure current in

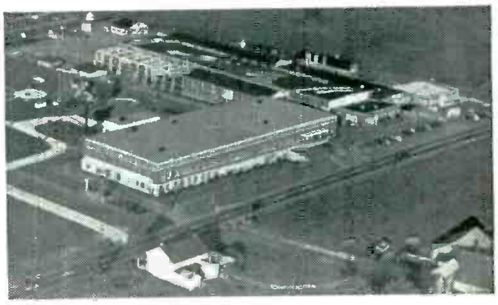
# Through this portal pass the nation's top stars



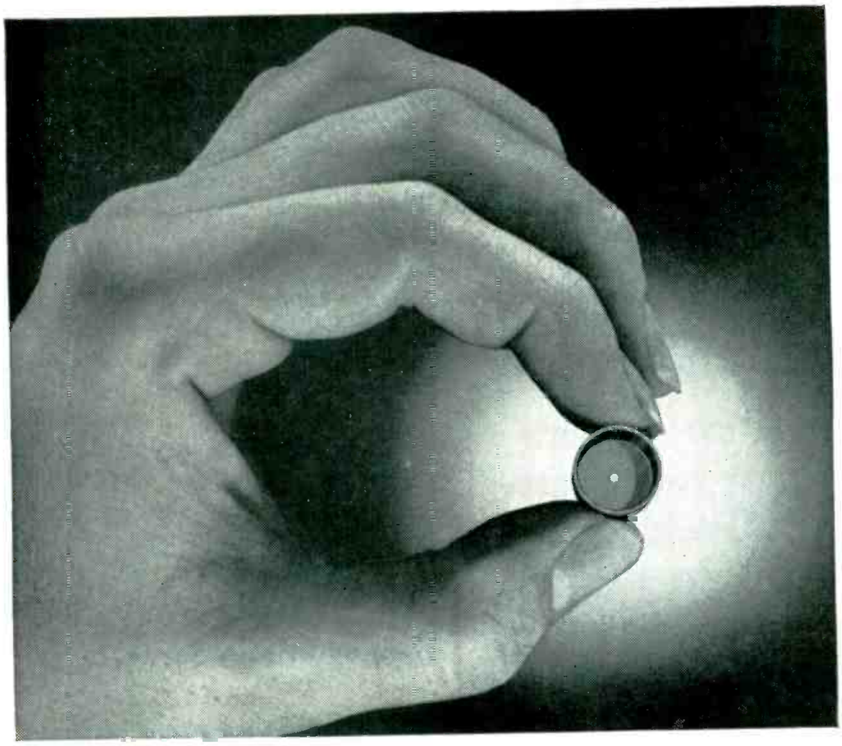
**All in a Day's Work**—Chemical Laboratory continually samples raw materials; checks and controls quality from suppliers.



**Sized and Shaped for TV**—Hundreds of tubular parts are produced b[illegible]erior from WELDRAWN Type [illegible] (18-12) stainless steel.



**Space and Time**—188,000 square feet—over 4 acres—for developing, producing, and testing small tubing . . . plenty of space . . . and people who take time to give you a good product and good service.



● You may not recognize the object pictured above. It is the first grid cylinder for a cathode ray tube gun structure, photographed from an unusual angle. The hole is only .040″ in diameter—and the grid itself is deep drawn in one piece to save unnecessary welding and assembly operations by TV tube manufacturers.

This is tubing technology in operation. It is an example of Superior's superiority in electronic research, production know-how and facilities, and metallurgy. It is one product of hundreds pioneered for the electronic industry by Superior.

You may already be one of our valued customers and friends—nearly all electronic manufacturers are. If small Seamless or †WELDRAWN tubing can help anywhere in your product Superior can help you. To find out how, write Superior Tube Company, 2500 Germantown Avenue, Norristown, Pennsylvania.

***Which Is The Better For Your Product . . .***

**SEAMLESS...?** The finest tubes that can be made. Standard production is .010″ to .121″ O.D. inclusive, with wall thicknesses of .0015″ to .005″. Cathodes with larger diameters and heavier walls will be produced to customer specification.

**Or LOCKSEAM*. . . ?** Produced directly from thin nickel alloy strip stock, .040″ to .100″ O.D. in standard length range of 11.5 mm to 42 mm. Round, rectangular or oval, cut to specified lengths, beaded or plain.

†REG. U. S. TRADEMARK—SUPERIOR TUBE COMPANY
*MFD. UNDER U. S. PATS. SUPERIOR TUBE COMPANY

**Superior**
THE BIG NAME IN SMALL TUBING
*All analyses .010″ to ⅝″ O.D.*
*Certain analyses (.035″ max. wall) Up to 1⅛″ O.D.*

*Electronic Products for export through Driver-Harris Company, Harrison, New Jersey • Harrison 6-4800* a shunt. The 0.15-v range is particularly useful in this case.

Another possible application is in the measurement of low values of power. Provided a non-inductive resistor is used for feedback, the large amount of feedback employed insures a very accurate phase relation between input voltage and output current. Amplifiers of this type might be used to drive potential, current, or both circuits of electrodynamometer voltmeters to measure accurately very small amounts of power.

Amplifiers of this type may be used to drive thermal instruments. The attendant advantages may be increased sensitivity and a much wider input current or voltage range than generally available in a single instrument.

Several particularly useful applications of this type of amplifier to the measurement of slowly varying or sub-power-frequency quantities have come to the author's attention. Since the amplifier is d-c coupled, it has no low frequency limit.

## Wien Bridge as Frequency-Shift Servo

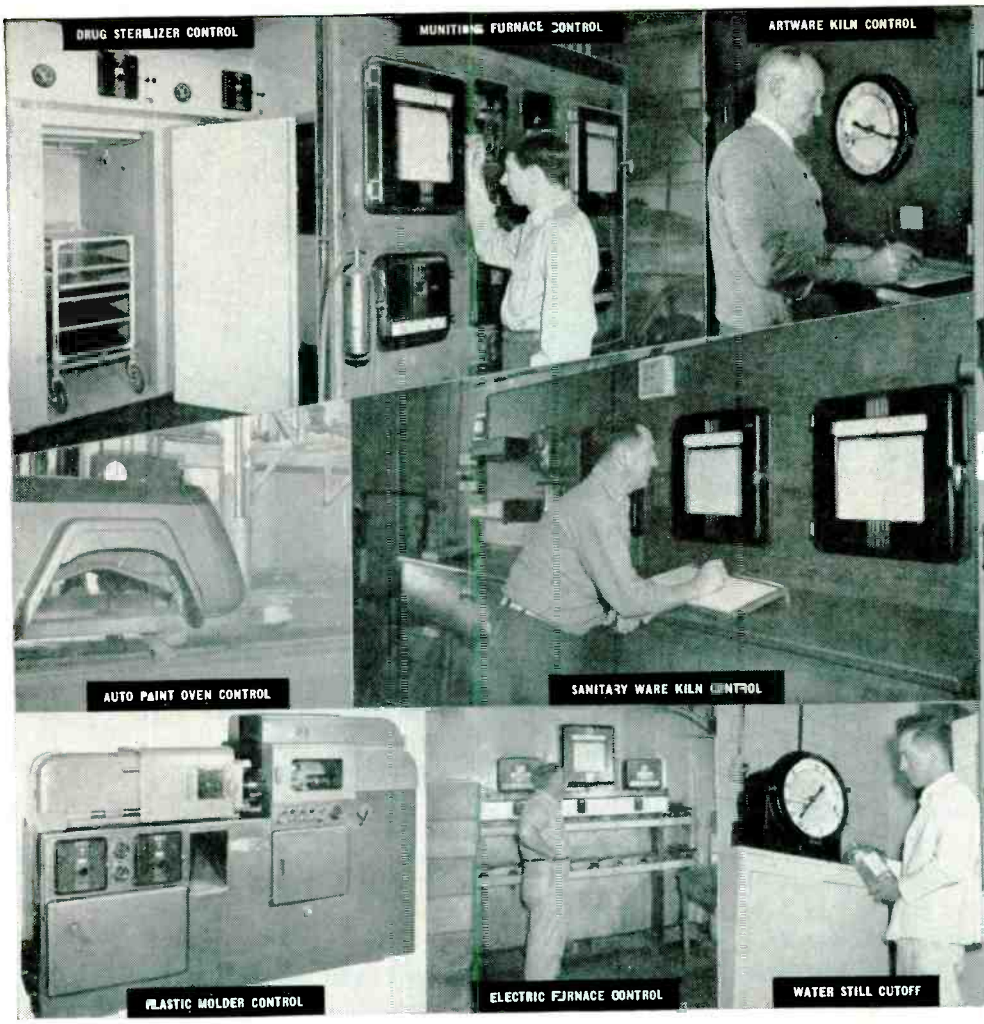

By Jack Yeiser

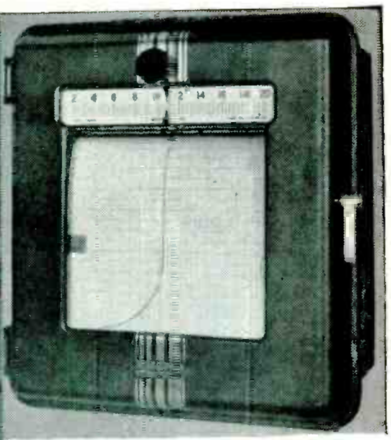
*Field Engineer*
*Philco Corporation*
*Philadelphia, Pa.*


Use of a Wien bridge as a frequency discriminator in servo applications makes it possible to employ a standard two-gang variable capacitor as the rebalance element. The low inertia of the capacitor as compared to moving-iron or slide-wire elements results in rapid response of the system.

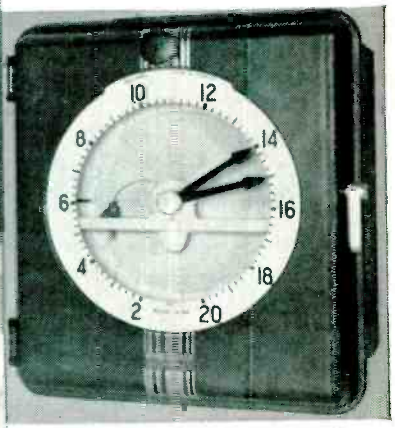
The instrument was constructed as a recording frequency meter for the purpose of recording telemetered information appearing as an audio tone with frequency varying between 45 and 150 cycles. Sensing is provided by taking advantage of the 180-degree phase shift which occurs as the bridge passes through a null.

A breadboard assembly was used with two standard 12-watt public-address amplifiers corrected for

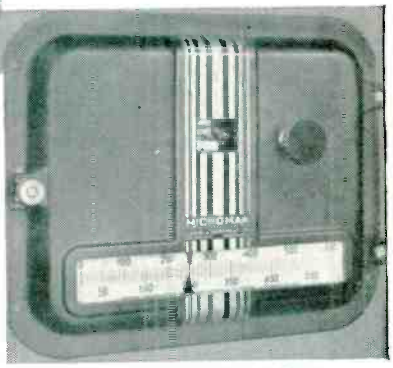


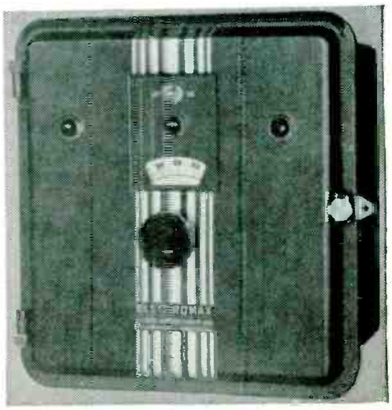
SPEEDOMAX (OR MICROMAX) STRIP-CHART ON-OFF CONTROLLER



SPEEDOMAX ROUND-CHART ON-OFF CONTROLLER



MICROMAX MODEL C ON-OFF CONTROLLER



ELECTROMAX ON-OFF CONTROLLER

# Dependable "ON-OFF" Controllers for Industry

THE kind of control instrument which industry calls on-off or 2-position is not only the oldest form of automatic regulator, but is one which many manufacturers still use instead of more advanced types, for simple requirements. Usually, the instrument merely closes the valve when temperature reaches the control point, and opens valve again when temperature falls below point. The question of whether such on-off action is best for the given case can of course be settled by using the instrument with the best, most useful features. Here are some which L&N On-Off Controllers offer:

1. Instruments may be Recording Controllers with either strip-chart or round-chart, or Controllers with no charts at all.
2. Instruments can operate at high or moderate speed; can be located regardless of machine vibration, building tremors or distance from process.
3. Controls are outstandingly dependable because they "balance" temperature against a standard. Intermediate bearings and springs cannot increase, decrease or otherwise influence accuracy or sensitivity.
4. Low maintenance assured by machine-like design and construction.
5. More than 1000 standard ranges. Specials are available, but seldom needed.

Tell us your problem and we will send further information. Write either to our nearest office or to 4979 Stenton Avenue, Philadelphia 44, Pa.

THESE instruments are fully automatic; need no standardizing; are ideal even for hard-to-get-at or difficult locations.

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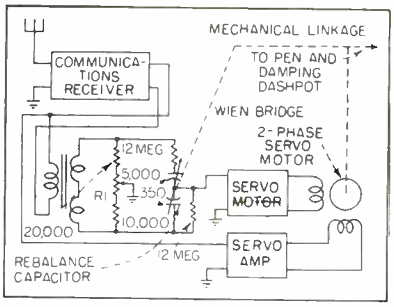
Jrl. Ad ND4-33(3)




**Breadboard assembly for Wien bridge used as a frequency discriminator in a servo system**

zero phase shift employed as servo amplifiers. The input grid resistor of the bridge amplifier is disconnected to prevent bridge unbalance. Transformer $T_1$ is a balanced shielded type with a one-to-one ratio and zero phase shift over the range of frequencies employed. Balance resistor $R_1$ is adjusted for best null.

Oil dashpot damping is used and overshoot is negligible for full pen deflection on a 3-inch strip chart with 5-cps excursions.

The Wien bridge follow-up circuit could also prove useful as the receiving servo in radio control systems. The accuracy and stability of the bridge make its use as an accurate frequency meter promising.

## TV Receiving Antenna Measurements

By Kendrick H. Lippitt
*Chief Engineer*
*Technical Appliance Corp.*
*Sherburne, N. Y.*

TECHNICAL information regarding antenna arrays is needlessly confused by the maze of conflicting performance figures published by some manufacturers.

Measurements made on television receiving antennas using the system of the Technical Appliance Corp. result in a gain figure which takes into consideration not only the true gain of the antenna but also the mismatch loss which occurs into a 300-ohm load.

In this system, the voltage developed across the terminals of a folded dipole terminated in a 300-ohm load is compared with the voltage developed across the terminals

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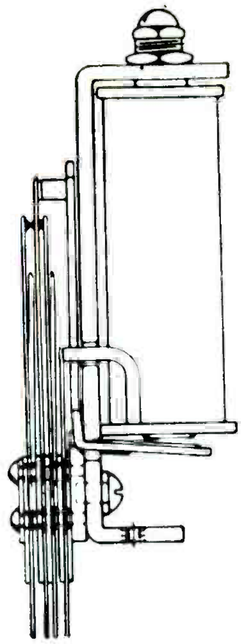

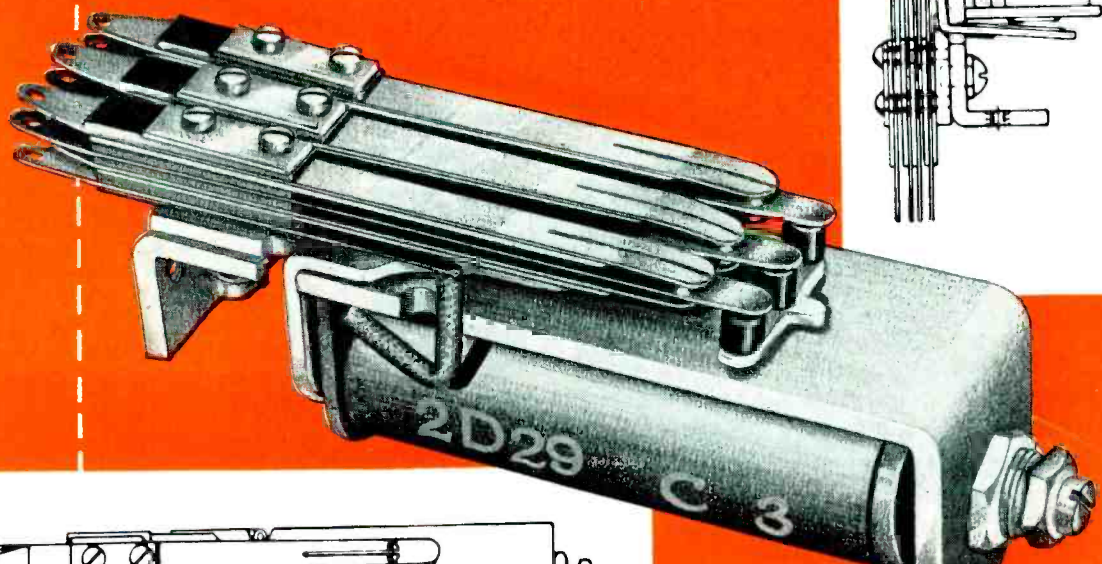


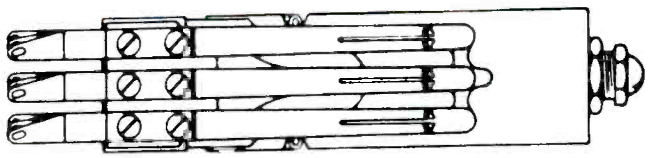

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BECAUSE their basic principle is so simple, it's easy to believe that anyone can make relays: But, where dependability, reliability and efficiency are specified, such belief leads to certain disappointment.

If you are designing circuits requiring absolute quality, with zero failure, you must have relays backed by years of experience and a very special know-how. North Relays have just such backing. We've been in the business since 1884, engineering and producing millions of relays, from multiples to midgets, from simple single-makes to intricate pileups with any combination of makes and breaks.

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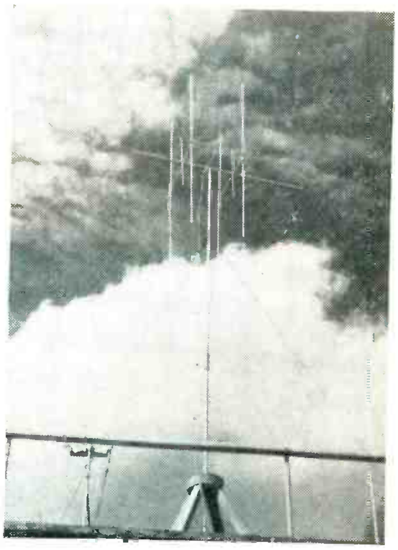
— *Originators of* **ALL RELAY** *Systems of Automatic Switching* —



All-channel type transmitting antenna in test position

of the antenna array being tested, also terminated in a 300-ohm load.

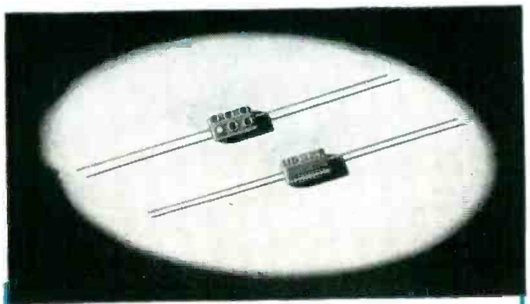
Thirty feet of standard 300-ohm twin-lead line connect the standard folded dipole and the array under test to the measuring voltmeter. A plug arrangement is used at the input to the voltmeter so that neither of the two transmission lines can be connected.

The voltmeter used is an RCA type 301B, a high-frequency field-intensity meter. It has a linear measuring system and is sufficiently stable for gain measurements. The input circuit of the meter was designed to have an impedance of 300 ohms by means of a General Radio bridge, type 916A, and a standing-wave line. For channels 7 to 13 special equipment was built with linear scales.

The zone in which the array is placed for measurement and the half-wave dipole used for reference are not subject to exactly the same signal intensity. Therefore, a television program can not be used to measure the gain of an antenna array because the 6-mc signal level changes as picture detail varies.

A signal generator with stable output connected to an all-channel-type transmitting antenna is the best source of signal for this type of measurement. It is tunable to any frequency within its range and sends out a signal with a narrow bandwidth. In this way the performance of the antenna over the 6-mc band or over a series of bands


# THIS GEM-SIZED UNIT DOES A GIGANTIC JOB



**CM-15 MINIATURE CAPACITOR**

- Actual Size 9/32" x 1/2" x 3/16"
- For Television, Radio and other Electronic Applications.
- 2 to 420 mmf. cap. at 500v DCw.
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- Temp. Co-efficient ± 50 parts per million per degree C for most capacity values.
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Each tiny El-Menco CM-15 capacitor performs at maximum efficiency regardless of climate or critical operating conditions. Before leaving the factory, it is tested for dielectric strength at *double* working voltage—for insulation resistance and capacity value. Every gem-sized El-Menco capacitor meets and beats the strictest Army-Navy standards. That's why *you* can always depend on this tiny condenser to give gigantic performance in your product.

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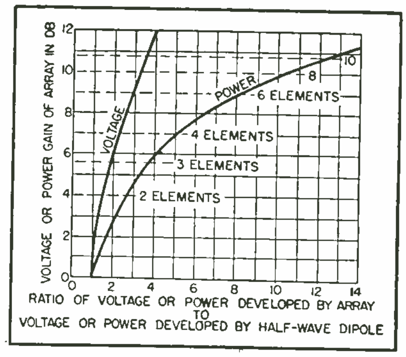



**Maximum gain obtainable from antenna arrays with various numbers of half-wave elements. For example, a four-element array is capable of producing a maximum power gain of 5 or a voltage gain of 2.3 which is 7-db gain over a half-wave dipole**

swung into the position previously occupied by the antenna array and the meter reading recorded.

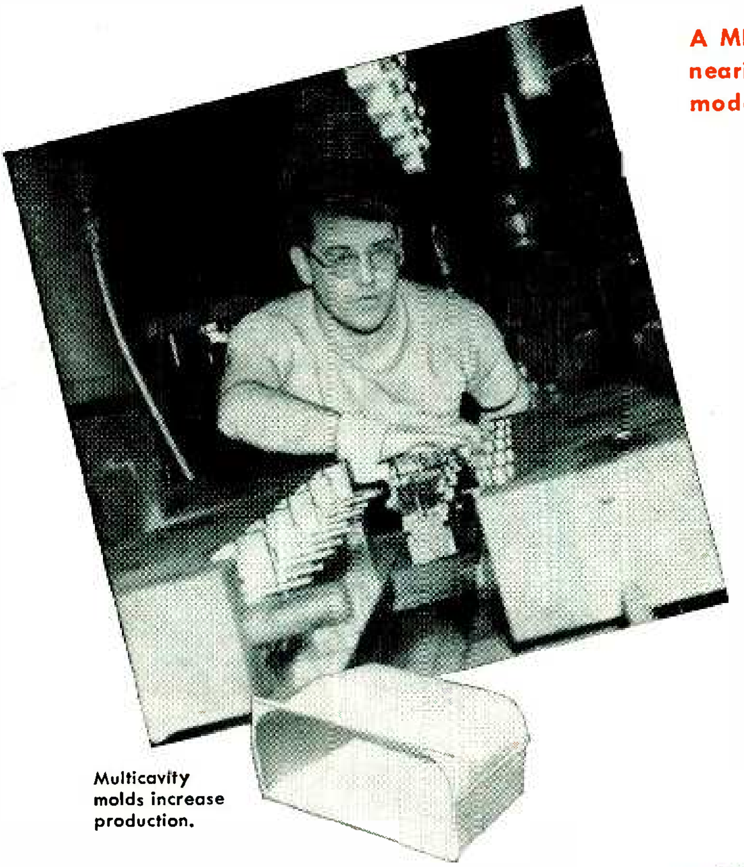
With single-channel type antennas, such as Yagi antennas, it is possible to estimate the maximum gain obtainable from any type array made up of half-wave elements. The chart shown gives the maximum gain available from antenna arrays with various numbers of half-wave elements.

For the same total transmitting power, the power in a single half-wave dipole antenna is twice that in each dipole of an antenna made up of two half-wave dipoles. If the power is cut in half the field produced by the antenna is reduced to 0.707 times its previous value. Therefore, if the voltage from the two half-wave dipoles adds up in phase, 1.4, a 3-db gain is obtained over a single dipole antenna.

In the chart the gain of two elements over one is given as four rather than three db. This improvement is produced by a change in the current distribution on the antenna elements. When elements are spaced close together, as in the conventional Yagi, the current distribution is not sinusoidal. For this same reason, top loading of transmitting antennas is justified where the current distribution is changed to increase the transmitted signal.

The justification for the remainder of the chart follows from the previous reasoning. When the power is divided into two similar antennas, the gain is increased

# TREMENDOUS PLASTICS MOLDING CAPACITY—*to serve your needs!*



Multicavity molds increase production.

**A MILLION-DOLLAR expansion program is now nearing completion at General Electric's modern plastics molding plant at Taunton, Mass.**

With expanded plant facilities to serve you in the Midwest and in the East, General Electric now provides a plastics molding service that offers you many important advantages.

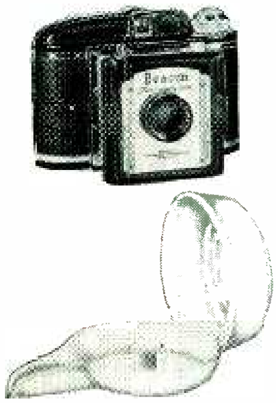
**Quick Delivery!** New automatic presses and equipment capable of handling the biggest jobs combine to give you *fast delivery*.

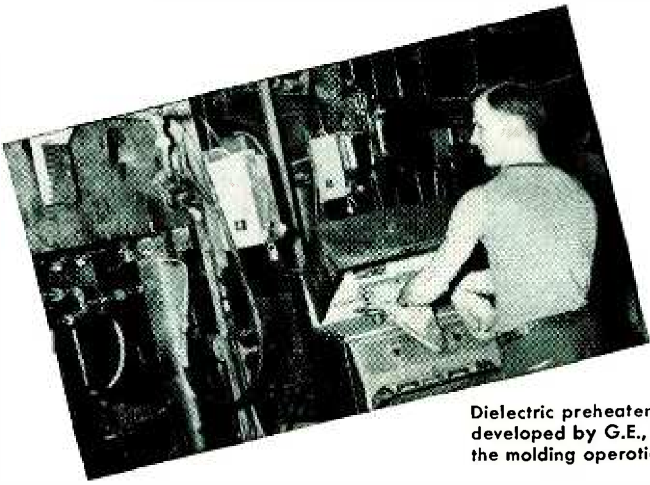
**Economical Production!** Modern plant layout and the latest equipment can cut costs on large-volume runs.

General Electric's 56 years of experience as one of the world's largest plastics molders means you get the benefit of sound and tested designing, engineering, and molding "know-how." You can depend on G.E. for a plastics service that may substantially reduce your costs or improve your product. Write us for further details.

Write on your company letterhead for the interesting booklet, **"Your Plastics Dollars Worth."** Address: Section Y4, General Electric Company, 1 Plastics Avenue, Pittsfield, Mass.

**ECONOMICAL BIG-VOLUME JOBS—like the refrigerator snack box, camera case, and juicer bowl pictured here—are the specialty of General Electric's molding service.**





Dielectric preheaters, developed by G.E., speed the molding operation.

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three db over one single antenna.

Over a period of two and one-half years more than 1,000 different antenna arrays have been measured using this technique, from single half-wave dipoles to arrays of sixteen elements. During this period the chart has been accurate and satisfactory.

## Radioactivity in Textile Production

A COTTON mill in Lancashire, England, is testing the use of radioactivity to measure the uniformity of slivers (pronounced slyvers in the cotton industry). Slivers are strands or slender rolls of cotton in an untwisted state produced by a carding machine and used to produce cotton yarns.

In the manufacture of yarns, the textile spinner has to pass the constituent threads through a series of doubling operations in order to even out any irregularities. This is a costly process and involves much work and handling of materials. If the uniformity of the sliver could be measured quickly and continuously in a uniform condition the doubling process could be eliminated.

The first step towards uniformity is an accurate means of measuring the sliver. This is difficult because sliver is of a loose and spongy nature which makes mechanical means impractical. By employing a beta-ray thickness gage, in which sliver is interposed between a radioactive isotope source and an ionization chamber, a means for obtaining an accurate measurement is available.

The sliver passing through the path of the rays absorbs some of them and the amount reaching the ionization chamber can be measured in terms of the sliver thickness. The ionization current developed is extremely small but can be amplified and used to operate an indicating instrument or recorder scaled in degrees of thickness or weight per unit length. If necessary, the current can be further amplified and used to operate a

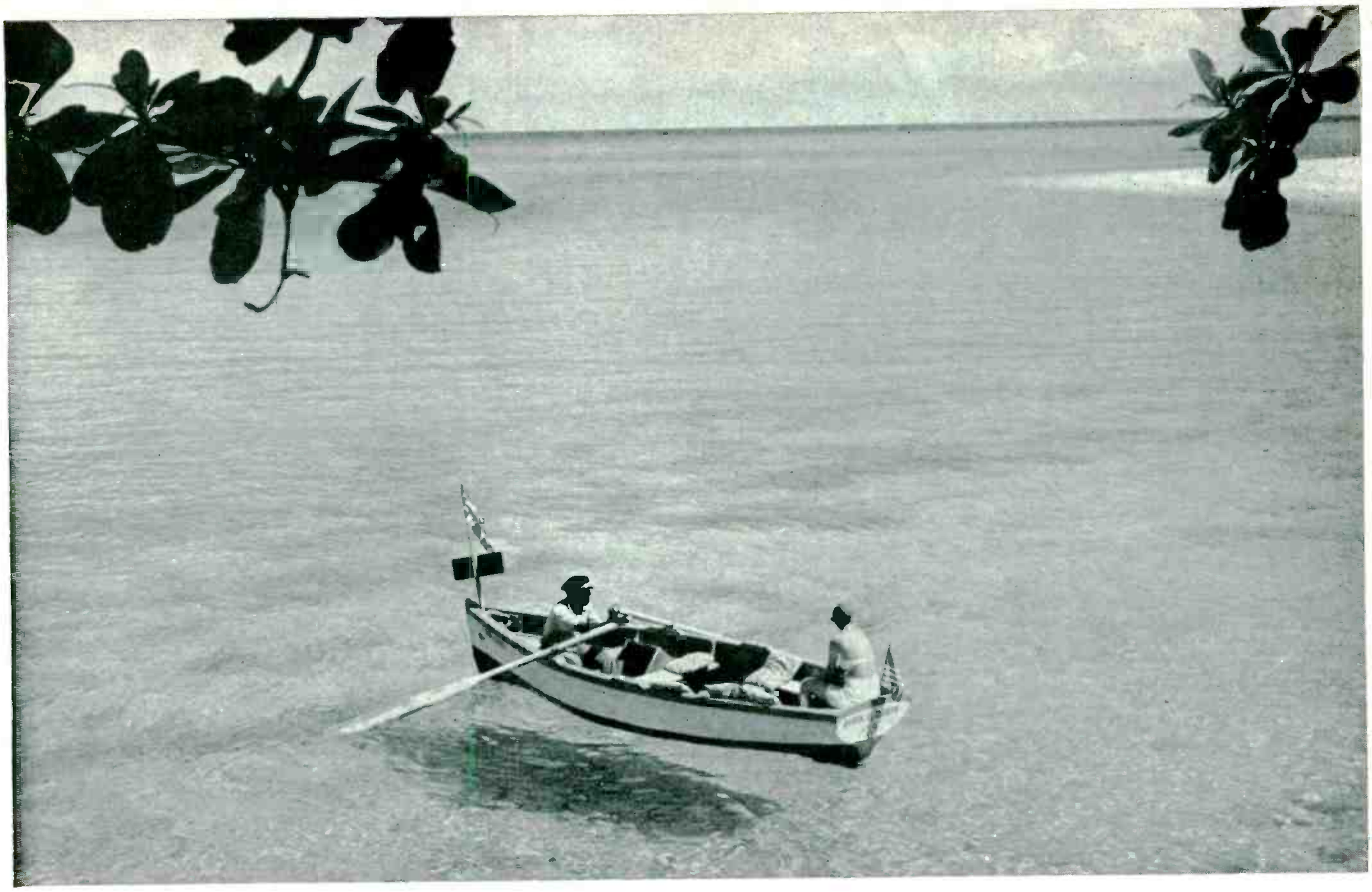

*Photo by Earl Leaf from Guillumette*

# out deep . . . *it's different*

Too bad all the ocean isn't this clear. There'd be no need for complicated under-water detection equipment, no need for constant research and development of depth-finding instruments and sonar equipment such as Edo engineers are working on now.

But as long as the ocean depths can hide their secrets, we'll need better and better eyes and ears with which to see and hear — electronically — what's below. Much is being pioneered along these lines at Edo.

Already Edo equipment, designed and manufactured for the U.S. Navy, makes possible new accuracy in under-water detection techniques.

WHO IS EDO?

Twenty five years of research, development and manufacturing experience are behind Edo's work in the electronic field. Founded in 1925, the company first built seaplane floats, later expanded to the design and manufacture of marine aircraft, and built various aircraft components in great quantity during the war. Now to this intimate knowledge of aviation, has been combined top engineering and manufacturing talent in the field of electronics for the design and production of various types of under-water detection equipment.

For a complete picture of Edo's first quarter of a century send for your copy of "Edo's 25th Anniversary" brochure by writing to the Edo Corporation, Dept. M-1, College Point, N.Y.

Edo

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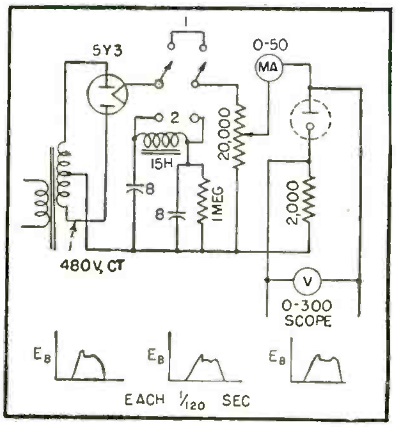
servo which will correct any deviation from the desired value.

The advantage of this new method of measuring sliver uniformity is that it enables accurate measurement to be made without physical contact with the material under examination.

## Precision VR Tube Tester

WHEN an unusually constant voltage is desired, careful selection of VR tubes is necessary as these tubes vary noticeably in their operating characteristics. A simple circuit for predetermining the reliability of VR tube performance is shown in the diagram.

Ideally, the voltage drop across the VR tube is constant throughout its rated current range; however, many tubes do not give a uniform



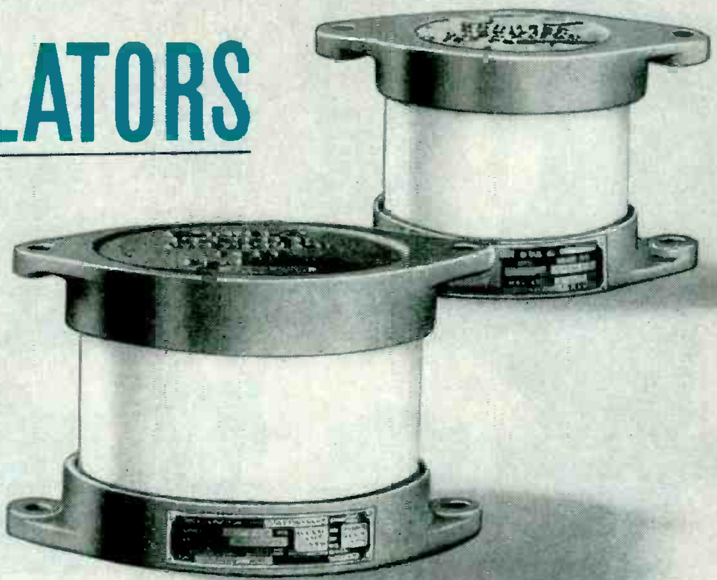

Circuit for testing VR tube over its operating current range

regulating characteristic. Small transients caused by line variations or other reasons result in changes in voltage drop across the tube with consequent changes in regulated output. These results are virtually independent of tube age, and new tubes are sometimes among the worst offenders.

Thus to test VR tubes properly, it is necessary to examine each tube over its entire operating current range, while employing a sensitive detecting device to indicate voltage variations.

The tube selector circuit has been developed by O. B. Rudolph and described in *Rev. Sci. Inst.*, May, 1950. By throwing the switch to position 2, a well-filtered d-c output they may look alike, *but:* there is only one C-D

# THE STANDARD IN THE FIELD OF HIGH POWER OSCILLATORS



**type 50 series**

## C-D HIGH POWER MICA TRANSMITTER CAPACITORS

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

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

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

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

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

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

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

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

Type 50 capacitors are available in all commercial capacity and voltage ratings. For complete description of these and Faradon type transmitter capacitors, write for catalog. CORNELL-DUBILIER ELECTRIC CORPORATION, Dept. K-11 South Plainfield, New Jersey. Other plants in New Bedford, Brookline and Worcester, Mass.; Providence, R. I.; Indianapolis, Ind., and subsidiary, The Radiart Corp., Cleveland, Ohio.

*C-D Best by Field Test!*

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will be obtained which can be used for preheating the tube undergoing test if desired and also for checking firing voltage which will be indicated on the voltmeter. With the switch in position 1, pulsating d-c voltage will be applied to the tube for precision checking of the overall voltage-current characteristic. The milliammeter indicates rms current and care should be exercised to prevent the peak value of the current from exceeding 40 ma.

Shown in the illustration are three of the various types of oscilloscope traces which have been obtained from different tubes. The trace at left is ideal and the only one acceptable for many applications.

## Television Electronic Pointer

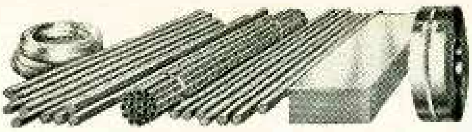
A METHOD for pointing out a person or item in a television picture by means of an electronic pointer has been developed by the General Electric Company.

The new device enables a narrator or commentator to insert a black or white pointer about thirty lines high and seven lines wide at any point in the tv picture.

The equipment consists of a rack-mounted chassis and a simple control unit, a device similar to the control stick of an airplane. A toggle switch selects either a black or white pointer.

The signal input is a noncom-

Operator shown positioning a white pointer by means of the control lever



BRIDGEPORT BRASS COMPANY

# COPPER ALLOY BULLETIN

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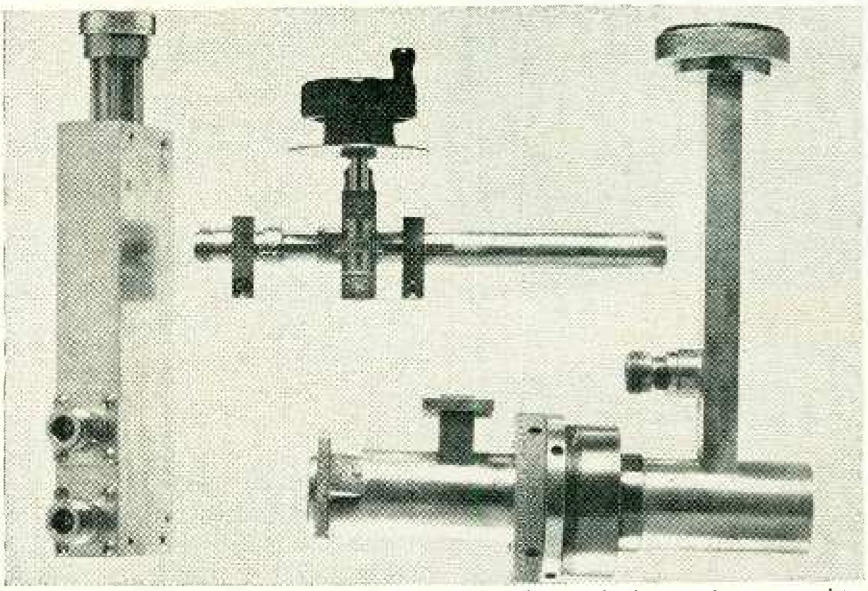


Various types of electronic components manufactured from brass: left, line stretcher; center, piston-type, cutoff attenuator; right, rotating joint. Diamond Manufacturing Co., Wakefield, Mass.

## Accuracy of Electronic Components Increased by Brass and Bronze

Copper-base alloys in rod, strip, sheet, wire and tube form are the backbone of the manufacture of electronic components such as crystal mixers, attenuators, rotating joints, line stretchers, antennas, R. F. coaxial connectors and numerous other items.

Accurate dimensions and highly polished surfaces are essential for microwave test equipment and plumbing components. Copper alloys can be both machined or drawn to these exacting demands.

### Plating Essential

All parts are either silver or gold plated for electrical conductivity and protection from corrosion. The majority of the copper alloys can be plated cleanly and with a minimum of work. They hold their plate for long periods of time without scaling.

All types of machining operations are necessary in producing this precision equipment. For example, the illustrated line stretcher is made up of a number of screw machine parts from free turning brass rod. The body is also rectangular rod of the same alloy. Drilling, tapping, milling, polishing, plating, silver soldering are involved in producing this component.

Any type of corrosion changes the electrical characteristics of these units. Brass and bronze are both resistant to atmospheric corrosion. Some of these units are used in the open, especially those linking up antennas and in radar and other communication equipment.

### Close Fits Needed

On sliding parts and mating surfaces used as bearings, the parts must be fitted closely enough to eliminate any play which would affect the characteristics of the unit. This is also true of mating threads.

Spring contact units are made from phosphor bronze, grade A, to reduce wear and fatigue dangers.

Since plating is essential for protection purposes, mating parts in tubular construction are sometimes plated with nickel and chrome to obtain a better bearing with the silver plated part through the difference in the coefficient of friction.

## Brass Smooths Action of Resistor

Smooth action, ability to withstand wear and corrosion in all types of weather conditions, are essential in variable resistance units used in television, radio and other electronic work.

Copper-base alloys answer these demands. Through the excellent machinability of free cutting brass rod, the threaded guide bushing can be held accurately to take the shaft with a minimum of play. At the same time the leaded brass makes a good bearing surface for smooth action.

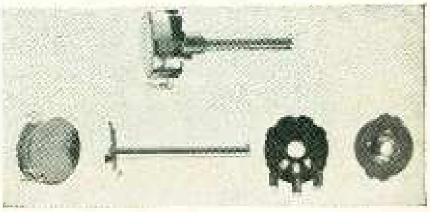
The bushing plate is leaded clock brass (62.25% copper, 2% lead and the remainder zinc). Clean blanking and piercing are possible with this alloy and in hard temper it has a tensile strength better than 70,000 psi.

Copper soldering terminal lugs are used both for conductivity and ease of tinning, and they are held into the body with hollow rivets made from cartridge brass, which has high ductility.

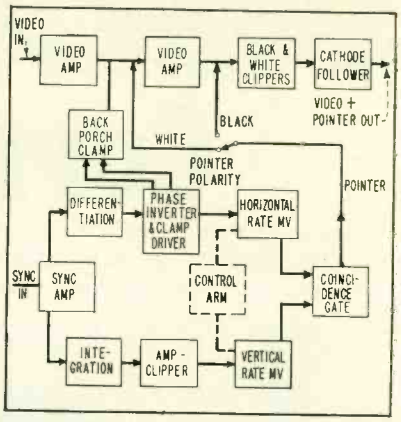
Both spring contact terminals, one which rides on the carbon impregnated resistance strip and the other against it, are made from phosphor bronze grade A (95% copper, 5% tin). This alloy has excellent spring characteristics and great resistance to fatigue from constant flexing.

A fixed pressure of the contact must be maintained on the resistance strip to insure a good electrical connection. Variations in this pressure would seriously affect the operation of the television, radio and similar electronic devices.

The shaft is also of free-cutting brass rod which simplifies the machining and the milling of the flat and tangs. (6154)



Variable resistor and component parts used in electronic work — Courtesy Clarostat Mfg. Co., Inc., Dover, N. H.




**Block diagram for the circuit enabling a black or white pointer to be inserted in the tv picture**

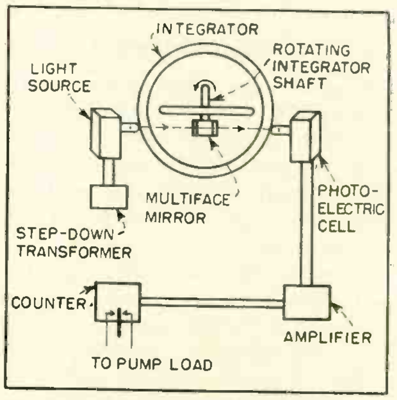
posite black-negative video, 0.5 to 2 volts peak to peak and 75 ohms. The separate sync signal is negative, 3 to 8 volts and of high impedance.

## Batch Integrator

A NEW batch-type integrator accurately establishes a predetermined quantity of fluid by making or breaking an electrical contact when the desired amount or batch has been integrated.

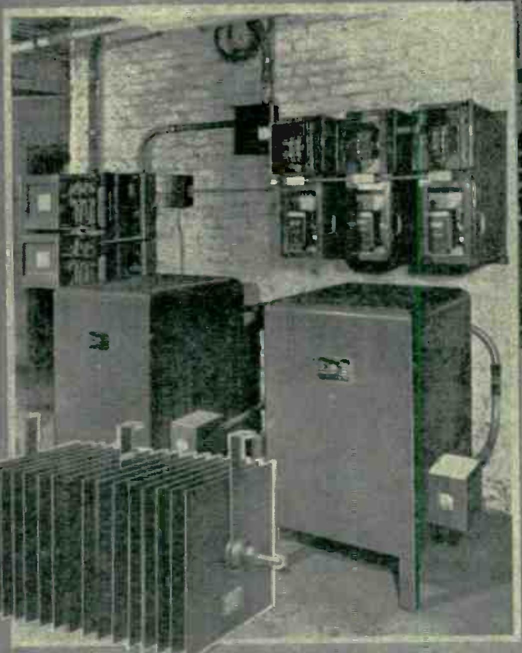
The control function is accomplished by using a photoelectric pickup unit that responds to reflections of a light beam from a multiface mirror mounted on the rotating integrator shaft and an electric predetermined reset counter. The counter may be set for any desired quantity or batch of fluid.

The electric counter is set for the desired quantity and the process started by depressing the momentary contact button which energizes the pump circuit or other apparatus




**Working drawing of the batch integrator control**

# HOW SELETRON RECTIFIERS GAVE CHICAGO A LIFT



WHEN THE POWER COMPANY changed over to alternating current in certain Chicago areas it meant that existing elevators operating on D.C. had to be converted fast, or the good people of the town would be "grounded."

Ther Electric & Machine Works of Chicago solved elevator rectification problems for considerably more than 100 famous buildings in the Windy City by designing complete power supply and regenerative braking equipment employing SELETRON rectifiers. The illustration shows a typical 3 bank unit with regenerative control, built for the Clinton Realty Co.

Of course, elevator operation is but one of many uses for SELETRON. These rugged, efficient selenium rectifiers are versatile — useful in hundreds of varying industrial applications for economical conversion of alternating current to D.C.

Your *own* rectification problems may easily be solved by SELETRON engineers. Write us now describing them — and request our new Bulletin No. ES-35

### PARTIAL LIST OF ELEVATOR INSTALLATIONS USING SELETRON RECTIFIERS IN THE CHICAGO AREA

| BUILDING | NO. OF RECTIFIERS | APPROX. NO. OF ELEVATORS |
|---|---|---|
| Drake Hotel Towers, 179 E. Lake Shore Dr. | 4 ea. 15 KW | 6 |
| Garden City Plating, 1750 N. Ashland Ave. | 2 ea. 10 KW | 2 |
| Jewish Charities, 241 S. Wells | 2 ea. 20 KW | 3 |
| 1336 North Dearborn Building | 3 ea. 27½ KW | 4 |
| 60 E. Scott Street Building | 2 ea. 14 KW | 2 |
| Bernstein Building, 14 S. Clinton | 2 ea. 10 KW | 2 |
| Bush Temple, 300 North Clark | 2 ea. 20 KW | 3 |
| Clinton Realty, 522 S. Clinton | 2 ea. 20 KW<br>1 ea. 14 KW<br>1 ea. 15 KW | 4 |
| Lansing Hotel, 1036 N. Dearborn | 2 ea. 20 KW | 2 |
| Plaza Hotel, 1553 N. Clark | 3 ea. 10 KW | 3 |
| Sears & Roebuck Co., 312 N. May | 3 ea. 25 KW | 2 |
| Covenant Club, 10 North Dearborn | 2 ea. 20 KW | 3 |
| Churchill Apts., 1264 North State | 2 ea. 17 KW | 2 |
| Western Elec. Bldg., 1706 S. Wabash | 2 ea. 10 KW | 2 |
| 70 East Cedar | 2 ea. 14 KW | 3 |
| Michael Reese Hospital | 4 ea. 50 KW | 10 |
| Steinway Drug Bldg. | 2 ea. 10 KW | 3 |
| Graphic Arts Bldg. | 4 ea. 25 KW | 6 |
| Walton Motors | 2 ea. 20 KW | 2 |
| Chicagoan Hotel | 2 ea. 27½ KW | 4 |
| 1220 North State Building | 2 ea. 40 KW | 4 |
| Canterbury Apts. | 3 ea. 14 KW | 3 |
| 241 Van Buren Street Building | 3 ea. 20 KW | 3 |
| Superior Elevator Co. | ea. 7 KW | 1 |
| 2[illegible] E. Walton Building | ea. 7 KW | 1 |
| Clinton Machine Co. | 3 ea. 10 KW | 2 |
| Western Electric Building | 2 ea. 20 KW<br>ea. 14 KW<br>ea. 10 KW | 6 |
| Gazzola Drug Company | ea. 10 KW | 1 |
| A. Rubloff Building | 3 ea. 14 KW | 4 |
| Goldenberg Furniture Company | ea. 10 KW | 1 |
| 210 E. Pearson Street Building | 3 ea. 20 KW | 4 |
| Illinois Electrotype | ea. 20 KW | 2 |
| Car Service Company | 4 ea. 20 KW | 4 |
| St. Clair Hotel | 4 ea. 25 KW | 5 |
| Eastgate Hotel | 4 ea. 25 KW | 4 |

**Seletron**

SELETRON DIVISION

**RADIO RECEPTOR COMPANY, INC.**

RR Since 1922 in Radio and Electronics RR

**Sales Dept: 251 West 19th St., New York 11, N.Y.**
**Factory: 84 North 9th St., Brooklyn 11, N.Y.**

that starts the flow of fluid.

An electric meter measures the flow and supplies a proportional current to the watt-hour type of continuous electric integrator. Speed of rotation of the integrator shaft is a direct measure of the rate of flow. Each revolution corresponds to a definite quantity of flow.

The counting is done by the photoelectric cell picking up the number of reflections of the light source from the rotating multiface mirror. As soon as the desired batch has been integrated the pump circuit is deenergized by the counter which then automatically resets itself. The process may then be repeated for the same batch or a new batch setting.

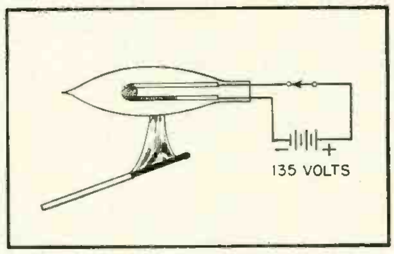
The electric counter will register up to 150 counts per minute. The maximum speed of the revolving integrator shaft, corresponding to maximum flow, is 25 rpm.

For a given calibration of the integrator, the range of batch control is varied by changing the number of faces (from one to six) of the revolving mirror. The instrument is manufactured by the Republic Flow Meters Co. of Chicago, Ill.

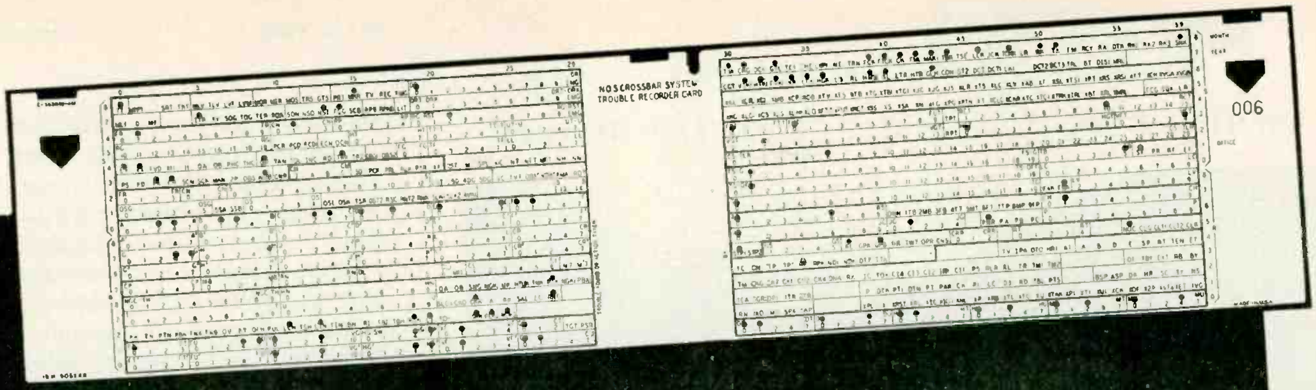
## Novel Application for Neon Diodes

By IRVING GOTTLIEB
*Electrical Engineer*
*Los Angeles, California*

A NEON BULB, connected as a relaxation oscillator, will function as a light-sensitive device, the response being a change in frequency when the illumination is changed. This phenomenon is ordinarily of no significance with respect to the




The luminous gas which uniformly surrounds the negative electrode before application of heat gradually collects as a brilliant ball of glowing gas in the end region of the electrodes






*Studying punched card record of dial system operation. Each card (top) can report 1080 items* usual applications of relaxation oscillators and escapes observation.

Interesting experiments can be conducted to detect frequency changes under various conditions of exposure to light. This little-known cause and effect relationship can be greatly enhanced by means of a "treatment", the result being a photoelectric transponder which behaves in an unusual and fascinating manner.

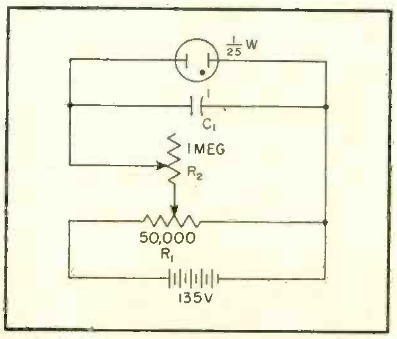
It will be shown that a neon bulb can be caused to flash during exposure to light but will be entirely inactive in darkness. In addition, the converse mode of operation can be demonstrated; the bulb can be caused to flash in the dark and be rendered inactive by illumination.

The foregoing experiments were performed with the small 1/25-watt butterfly-type bulb.

The sensitizing treatment consists of applying the flame of a match while the bulb is being energized by 135 volts. The bulb should be held in a horizontal position and the flame should be restricted as much as possible to the area of the glass immediately below the glowing electrode. A piece of window glass, a wire screen, or some other precautionary measure should be used to protect the eyes from possible explosion.

After a few seconds, the glowing gas will collect as a brilliant incandescent ball at the end of the electrodes. Just how long the heat should be continued to be applied after this occurs will have to be determined experimentally.

The circuit shown is that of a conventional relaxation oscillator. However, it is important to shield

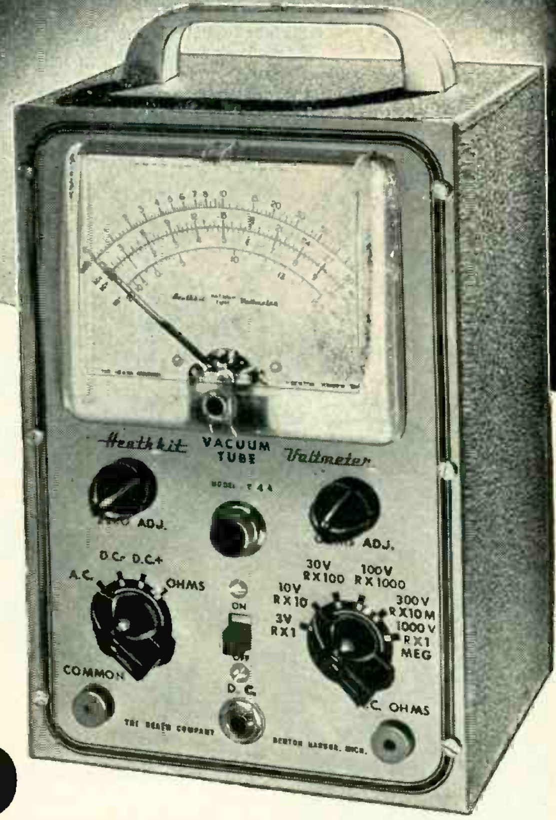



**Relaxation oscillator circuit for the photoelectric experiments**

# *New 1951* • • MODEL V-4A

# *Heathkit* VTVM KIT

## HAS EVERY EXPENSIVE *Feature*




- ★ Higher AC input impedance, (greater than 1 megohm at 1000 cycles).
- ★ New AC voltmeter flat within 1 db 20 cycles to 2 megacycles (600 ohm source).
- ★ New accessory probe (extra) extends DC range to 30,000 Volts.
- ★ New high quality Simpson 200 microampere meter.
- ★ New ½% voltage divider resistors (finest available).
- ★ 24 Complete ranges.
- ★ Low voltage range 3 Volts full scale (⅓ of scale per volt).
- ★ Crystal probe (extra) extends RF range to 250 megacycles.
- ★ Modern push-pull electronic voltmeter on both AC and DC.
- ★ Completely transformer operated isolated from line for safety.
- ★ Largest scale available on streamline 4½ inch meter.
- ★ Burn-out proof meter circuit.
- ★ Isolated probe for dynamic testing no circuit loading.
- ★ New simplified switches for easy assembly.

## *New* LOW PRICE $23.50

The new Heathkit Model V-4A VTVM Kit measures to 30,000 Volts DC and 250 megacycles with accessory probes — think of it, all in one electronic instrument more useful than ever before. The AC voltmeter is so flat and extended in its response it eliminates the need for separate expensive AC VTVM's. + or − db from 20 cycles to 2 megacycles. Meter has decibel ranges for direct reading. New zero center on meter scale for quick FM alignment.

There are six complete ranges for each function. Four functions give total of 24 ranges. The 3 Volt range allows 33⅓% of the scale for reading one volt as against only 20% of the scale on 5 Volt types.

The ranges decade for quick reading.

New ½% ceramic precision are the most accurate commercial resistors available — you find the same make and quality in the finest laboratory equipment selling for thousands of dollars. The entire voltage divider decade uses these ½% resistors.

New 200 microampere 4½" streamline meter with Simpson quality movement. Five times as sensitive as commonly used 1 MA meters.

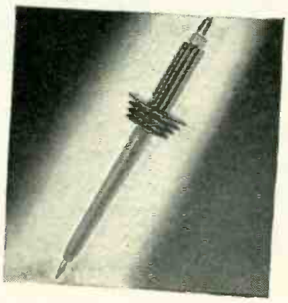
Shatterproof plastic meter face for maximum protection.

Both AC and DC voltmeter use push-pull electronic voltmeter circuit with *burn-out* proof meter circuit.

Electronic ohmmeter circuit measures resistance over the amazing range of 1/10 ohm to one billion ohms all with internal 3 Volt battery. Ohmmeter batteries mount on the chassis in snap-in mounting for easy replacement.

Voltage ranges are full scale 3 Volts, 10 Volts, 30 Volts, 100 Volts, 300 Volts, 1000 Volts. Complete decading coverage without gaps.

The DC probe is isolated for dynamic measurements. Negligible circuit loading. Gets the accurate reading without disturbing the operation of the instrument under test. Kit comes complete, cabinet, transformer, Simpson meter, test leads, complete assembly and instruction manual. Compare it with all others and you will buy a Heathkit. Model V-4A. Shipping Wt., 8 lbs. Note new low price, $23.50



### *New* 30,000 VOLT DC PROBE KIT

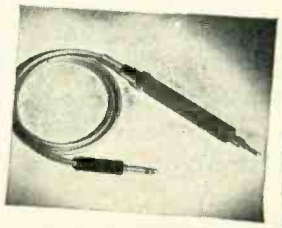
Beautiful new red and black plastic high voltage probe. Increases input resistance to 1100 megohms, reads 30,000 Volts on 300 Volt range. High input impedance for minimum loading of weak television voltages. Has large plastic insulator rings between handle and point for maximum safety. Comes complete with PL55 type plug.

No. 3366 High Voltage Probe Kit.
Shipping Wt., 2 pounds. **$5.50**

### *Heathkit* RF PROBE KIT

Crystal diode probe kit extends range to 250 megacycles = 10% comes complete with all parts, crystal, cable and PL55 type plug.

No. 309 RF Probe Kit.
Shipping Wt., 1 lb. **$5.50**



EXPORT AGENT
ROCKE INTERNATIONAL CORP.
13 E. 40th ST.
NEW YORK CITY (16)
CABLE: ARLAB-N.Y.

## *The* HEATH COMPANY

. . . BENTON HARBOR 14, MICHIGAN

the apparatus to prevent r-f pickup from broadcast stations. A surprisingly small amount of r-f pickup will serve to foul up the demonstration. Capacitor $C_1$ is a pyranol or other low-leakage type, conventional paper types are not suitable.

Clean the bulb with carbon tetrachloride and solder the wire leads to hook-up wire in such a manner to provide a minimum clearance between the bulb and other objects of four inches. For the initial testing, a 60-watt lamp should be located about five feet from the neon bulb. With the lamp off, the room should be completely dark.

*Initial Adjustments*

With the lamp turned on, adjust $R_1$ and $R_2$ until a flashing rate of approximately one flash per second is obtained. Next, find that setting of $R_1$ which barely allows the neon bulb to flash. If the flashing frequency is now greatly different from the suggested one-per-second rate, readjust $R_2$.

Turn off the sixty watt lamp. One of three things will happen; the neon bulb will cease flashing, it will flash at a noticeably greater frequency, or there will be no discernible effect.

If the flash rate increases, reverse the battery polarity and repeat the adjustment procedure. This will result in the first effect. Once the neon bulb has displayed photoelectric sensitivity by virtue of the first or second effects, a flashlight may be substituted for the lamp. By finer adjustment of the potentiometers, it should be possible to trigger the neon bulb from a distance of at least thirty feet with a flashlight beam.

If it is desired to extinguish the flashing by means of a light beam, then the second effect is the proper mode of operation. The threshold adjustment of $R_1$ should in this case be made in total darkness rather than under 60-watt lamp exposure.

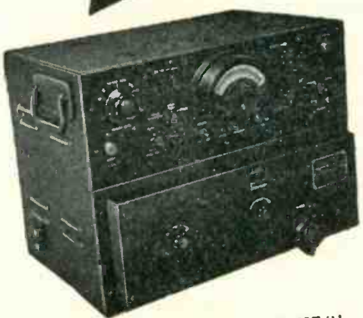
If no photoelectric effect is perceptible, try another neon bulb which was subjected to greater or less heat treatment. The writer, after considerable experimentation, has not been able to develop a better sensitizing method. The treatment

# STANDARD RI-FI* METERS

# 14kc *to* 1000mc!

DEVELOPED BY **STODDART**
FOR THE ARMED FORCES.

**AVAILABLE COMMERCIALLY.**



***VHF!***
**15 MC**
**to**
**400 MC**
**NMA - 5**

Commercial equivalent of TS-587/U. Sensitivity as two-terminal voltmeter, (95 ohms balanced) 2 microvolts 15-125 MC; 5 microvolts 88-400 MC. Field intensity measurements using calibrated dipole. Frequency range includes FM and TV Bands.

***VLF!***
**14 KC**
**to**
**250 KC**
**NM - 10A**

Commercial equivalent of AN/URM-6. **A new achievement in sensitivity!** Field intensity measurements, 1 microvolt-per-meter using rod; 10 microvolts-per-meter using shielded directive loop. As two-terminal voltmeter, 1 microvolt.

***HF!***
**150 KC**
**to**
**25 MC**
**NM - 20A**

Commercial equivalent of AN/PRM-1. Self-contained batteries. A.C. supply optional. Sensitivity as two-terminal voltmeter, 1 microvolt. Field intensity with ½ meter rod antenna, 2 microvolts-per-meter; rotatable loop supplied. Includes standard broadcast band, radio range, WWV, and communications frequencies.

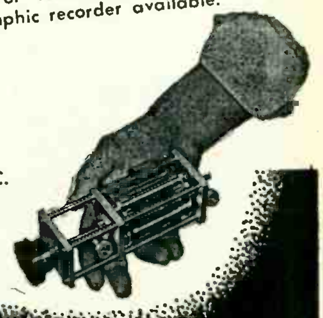
***UHF!***
**375 MC**
**to**
**1000 MC**
**NM - 50A**

Commercial equivalent of AN/URM-17. Sensitivity as two-terminal voltmeter, (50-ohm coaxial input) 10 microvolts. Field intensity measurements using calibrated dipole. Frequency range includes Citizens Band and UHF color TV Band.

Since 1944 **Stoddart RI-FI*** instruments have established the standard for superior quality and unexcelled performance. These instruments fully comply with test equipment requirements of such radio interference specifications as JAN-I-225, ASA C63.2, 16E4(SHIPS), AN-I-24a, AN-I-42, AN-I-27a, AN-I-40 and others. Many of these specifications were written or revised to the standards of performance demonstrated in Stoddart equipment.

The rugged and reliable instruments illustrated above serve equally well in field or laboratory. Individually calibrated for consistent results using internal standard of reference. Meter scales marked in microvolts and DB above one microvolt. Function selector enables measurement of sinusoidal or complex waveforms, giving average, peak or quasi-peak values. Accessories provide means for measuring either conducted or radiated r.f. voltages. Graphic recorder available.

***Radio Interference and Field Intensity.**



**Precision Attenuation for UHF!**

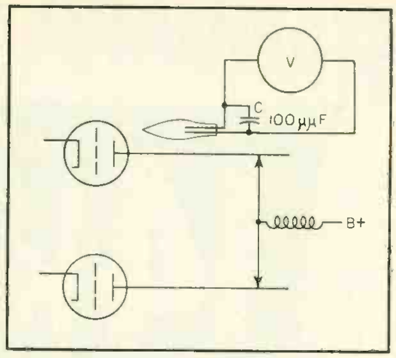
Less than 1.2 VSWR to 3000 MC.
Turret Attenuator:
0, 10, 20, 30, 40, 50 DB.
Accuracy ± .5 DB.

Patents applied for.

**STODDART AIRCRAFT RADIO CO.**

•

6644 SANTA MONICA BLVD., HOLLYWOOD 38, CALIF.
Hillside 9294




Circuit for using neon bulb as a d-c source when exposed to r-f radiation. Capacitor C is connected at the terminals of the bulb

evidently makes one electrode more photoemissive than the other.

Another interesting property of gaseous diodes involves the generation of a d-c emf when the gas is ionized by external radiation. A four-watt 150-mc self-excited oscillator is employed to supply the radiant energy. It is not necessary to treat the neon bulb for this demonstration. It is only essential that the center of the induced ionization is closer to one electrode than the other.

Readings as high as ten volts on a 5,000-ohm-per-volt meter are obtainable. The polarity of this emf is determined by the electrode which is closest to the mass of glowing gas. As with the photoelectric experiment, one electrode assumes the role of anode while its mate functions as the cathode.

The 2050 thyratron also works well in this capacity. It is unnecessary to heat the filament; the screen and cathode seem to be the best pair of electrodes to use.

A gaseous diode mounted near a tank or antenna circuit could be used as a power-indicating device and should be particularly well suited for certain microwave techniques. For such and similar applications, the gaseous diode will be found a more rugged device than a crystal which is susceptible to erratic changes and burnout from r-f currents often induced by stray pickup.

## Sine and Square Wave Generator Selective Amplifier

THE ARTICLE with the above title appeared in the December, 1950, issue of ELECTRONICS. Through an


# *type 44* STEPPING SWITCH

***Up to 6 Levels — 10-point plus home; yet it's Smaller Than Your Hand!*** Only 4½ inches long — and about half that wide — Automatic Electric's new stepping switch averages only 13½ ounces in weight. Yet it gives you *more* than other larger switches.

*It's speedy* . . . a typical three-level 10-point switch, at 48 volts D. C., self-interrupted, runs approximately *80* steps a second — impulse controlled, at 35 steps a second.

*It's smoother* . . . brush springs are in an "11th" position; wipers pass over them exactly as over bank contacts. No double load in any position — no "galloping."

*It assures long life* . . . smooth operation means longer life; in addition, all driving parts are especially armored against wear. In rigid laboratory tests, Type 44 Stepping Switches averaged *20,000,000* operating cycles (200 million steps!) and then required only minor readjustment.

*It's adaptable* . . . meets your specific needs with a wide range of coils (for any D. C. voltage up to 110), bank levels, bridging and non-bridging wipers, interrupter springs and off-normal springs.

The Type 44 Stepping Switch has *less* weight — takes *less* space — and gives you *more* of everything else! Get complete data NOW on this revolutionary new switch. Call, wire, or write AUTOMATIC ELECTRIC SALES CORPORATION, 1033 W. Van Buren St., Chicago 7, Ill. In Canada: Automatic Electric (Canada) Limited, Toronto.

**RELAYS SWITCHES**

**AUTOMATIC ELECTRIC**

**CHICAGO**

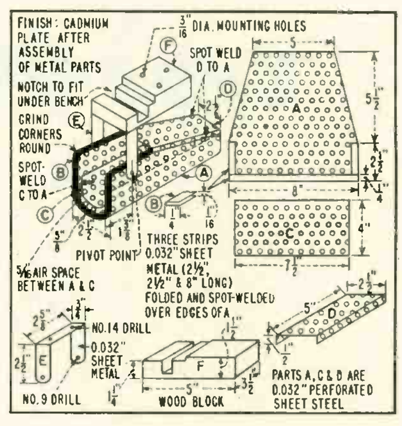
oversight credit was not given the author for his circuit design and analysis. The article should have carried a by-line crediting George Ellis Jones, Jr., Department of Chemical Engineering, The University of Pittsburgh, Pittsburgh, Pennsylvania.

## *SHOP SHORTCUTS*

VOLTMETERS and milliammeters cannot be used for measuring accurately the output of a pentode tube in a circuit because of the high value of the pentode plate resistor. If a 0-150-volt electrostatic voltmeter is placed across the plate resistor, it will not draw any current and, consequently, will not load the plate circuit.

*Fred Lichtgarn*
*Chicago, Ill.*

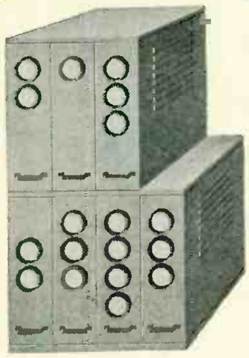
A SOLDERING-IRON holster, pivoted to assume a vertical position when empty, saves time on the production line. The holster is fastened to a block of wood and mounted above and near the back of the bench. When the iron is placed in the holster, the pivotal action allows it to adjust itself to an almost horizontal position with the tip of the iron pointed slightly upwards. With




the iron in this position, the heat rises up and away from the handle and the operator. A large fibre washer prevents the iron from sliding out the back of the holster. The line cord is kept out of the operator's way by being connected to an overhead outlet.

*Allen B. DuMont Laboratories, Inc.*
*Passaic, N. J.*

# no hand controls this "brain"



***Look for amazing things to come from the engineers who designed it***

**It's an Analogue Computer,** contract developed and manufactured by Arma Corporation for the Armed Forces. The human element enters not at all into its continuous solution of many complex equations simultaneously and the deadly accuracy with which it controls the fire of shells and other missiles. It translates original data into required results automatically . . . is the swiftest means of computing problems in which factors vary continuously.

**Symbolizing the engineering progress** crowded into the post-war years at Arma, the modern electrical analogue computer is composed of interchangeable Arma "Brain Blocks"*. Highly trained technical personnel is not required to service it.

**The Analogue Computer is an example** of the complex types of instrumentation Arma has developed and manufactured. Other amazing things developed by Arma engineers include many combinations of computer elements and servo mechanisms that advance the automation of industry. The only limits to automation recognized at Arma are situations defying reduction to finite mathematical formulae.

**Arma Corporation** has devoted more than 30 years to contract development and manufacture of unique things.

*** "Brain Block" components and the "Brain Block" technique of instrumentation were created by the people of Arma Corporation. The contributions thus made to the development of electrical brains for machines stagger the imagination.**

**ARMA CORPORATION**

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

**SUBSIDIARY OF AMERICAN BOSCH CORPORATION**

ARMA PRODUCTS RELEASED FOR PRIVATE INDUSTRY

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

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QUALITY ARMA INSTRUMENT PRECISION

THE ELECTRON ART
(continued from page 126)

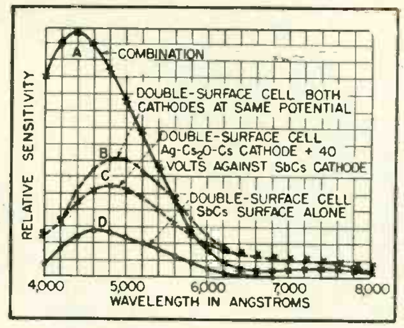



FIG. 3—Response of various types of phototubes including suggested combination unit

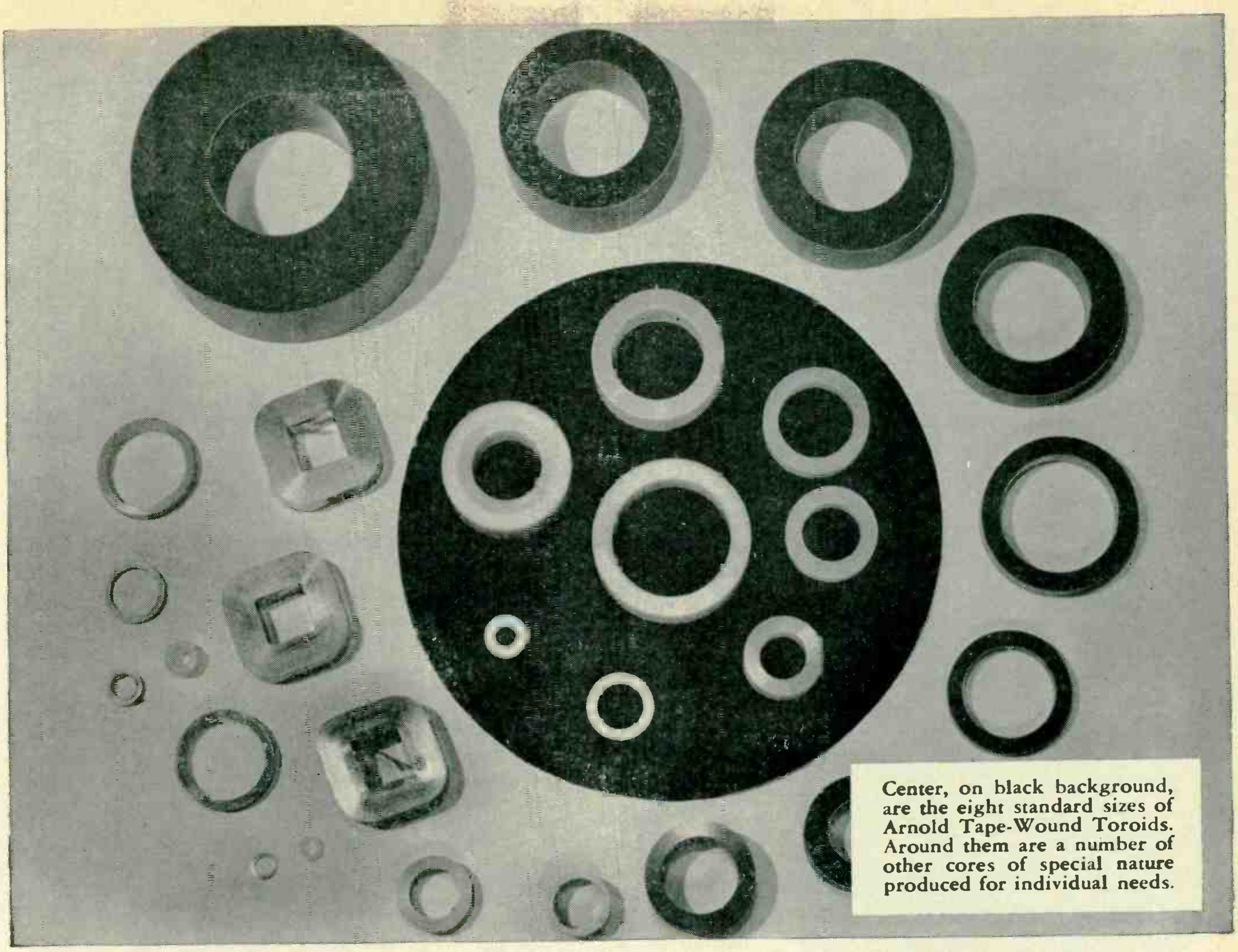
and curve *A* shows the combined response of two photoemissive tubes, one with a semitransparent Sb-Cs surface, the other with a Ag-$Cs_2O$-Cs surface placed one behind the other, the light shining on and through the Sb-Cs cathode. The use of a more transparent Sb-Cs surface would give a more uniform response throughout the spectrum.

"Although the double surface tube shows all the expected features, it does not seem practical as compared to the combination of two suitably-selected separate tubes. The conditions in a single tube are rather complicated and depend greatly on the geometry of the tube, the processing of the cathodes, and on the relative voltages applied to both cathodes and the anode. Two separate tubes could be processed more readily to maximum sensitivity of each surface and there would be no secondary emission to affect the Ag-$Cs_2O$-Cs surface."

## A Novel Pressure-Measuring Method

AN INTERESTING and unique method for measuring pressure electrically has been developed. The device used has two exceptionally inviting advantages. First, there are no intricate mechanical linkage systems, and second, the moving parts are all sealed in a chamber filled with an inert gas (argon).

Essentially, the device consists of an air-tight chamber filled with a gas whose expansion characteristics are known. One wall of the chamber is made up of a flexible diaphragm that will move inward when the pressure outside the



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.

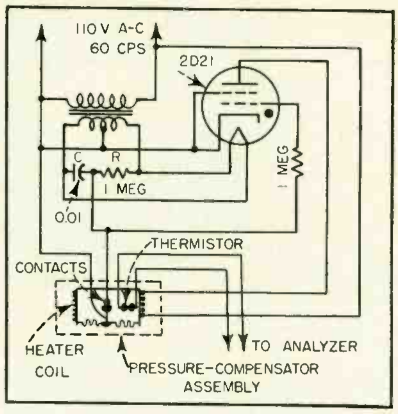
**Manufactured under licensing arrangements with Western Electric Company.*

W&D 3182

**THE ARNOLD ENGINEERING COMPANY**

SUBSIDIARY OF ALLEGHENY LUDLUM STEEL CORPORATION

General Office & Plant: Marengo, Illinois




Simple thyratron circuit for use with novel pressure-measuring unit

chamber exceeds the pressure of the gas within the chamber. A pair of electrical contacts are arranged so that a heater circuit is closed whenever the outside pressure presses the diaphragm inward. This heater circuit causes the gas in the chamber to expand, until it equals the pressure outside the chamber, at which time the heater contacts open. The temperature is thus held at some point where the pressure of the gas equals outside pressure.

A thermistor, also placed inside the chamber, along with the gas and heater contacts, can be used to measure the average temperature of the gas, and thus to determine the pressure of the gas by means of a calibration chart. The circuit of an instrument using this pressure-measuring device is shown in the illustration. According to Edward C. Blom, who describes this instrument in detail in *Instruments* (p 903, Sept. 1950), a model using this circuit has been in use over two years. The only maintenance required is the replacement of the thyratron once every six months or so.

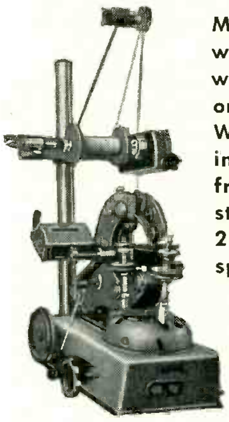
## Resistance-Coupled Amplifier Bandwidth

B. A. LIPPMANN
*Nucleonics Division*
*Naval Research Laboratory*
*Washington, D. C.*

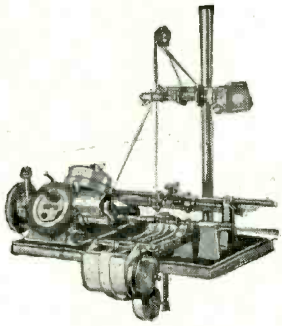
THE PRACTICE of examining the behavior of resistive amplifier coupling networks by an approximate method of analysis has apparently obscured the fact that the gain characteristic of this circuit is exactly equivalent to a single-tuned

# STEP UP COIL PRODUCTION *with* MICAFIL WINDERS

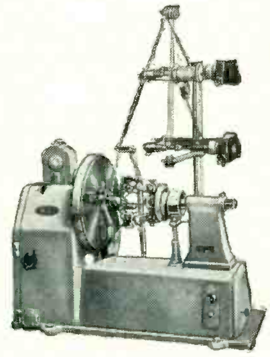
**Toroidal • Sector • Telephone Relay • Standard Relay • Loud Speaker • Choke • Field • Honeycomb • Transformer • and Many Other Types of Coils and Armatures Wound Accurately and Quickly**



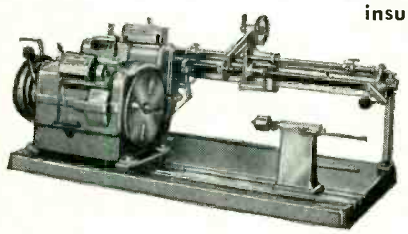
MODEL RW TOROIDAL WINDER with Coil Supports—automatically winds toroidal coils around 360° or sector coils up to 270°. Winds in either direction. Made in three sizes for single wire from 18 to 38 AWG, double or stranded wires from 2 x 18 to 2 x 26 AWG. Maximum winding speed 200 RPM.



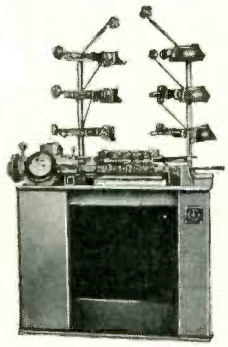
MODEL OOFA AUTOMATIC FINE-WIRE WINDER with removable semi or fully automatic paper interleaving attachment. Will wind wires from 24 to 44 AWG at certain speed ranges between 950 and 6000 RPM. Attachment available for winding two coils simultaneously. MODEL OOFA-T, similar to above, winds up to 12,000 RPM.



MODEL AWO-A SMALL ARMATURE WINDER—Fully automatic for mass production of small two-pole armatures with straight or skewed slots. Wire is guided by adjustable guide blade. Wire sizes (without insulation) from 23 to 44 SWG. Winding speed 700 RPM.



MODEL OGA AUTOMATIC WINDER with removable semi or fully automatic paper interleaving attachment. Adaptable for multiple coil winding with or without interleaving and for interweaving of cotton threads. Made for five speed ranges from 70 to 3000 RPM. Wire sizes from 8 to 44 AWG.



MODEL OOFA-PEM MULTIPLE FINE-WIRE WINDER with fully automatic paper interleaving device, for flanged or flangless coils. Winds up to 6 coils at a time with individual paper interleaving. MODEL OOFA-PEB winds up to 10 flangless coils with common paper interleaving. Wire sizes from 24 to 44 AWG. Winding speeds from 360 to 3000 RPM.

## THESE WINDERS HAVE MANY ADVANTAGEOUS OPERATING FEATURES:

Accurate and Stepless adjustments of feeds during operation.

Automatic reversing—without play—of wire guide at layer end.

Simple adjustment of wire pull, which will remain constant regardless of speed and reel diameter.

Five figure turn counter with zero set-back lever.

Automatic cut-off at pre-set number of turns, or by wire breakage or empty reel.

There's a MICAFIL for Every Winding Application.

*SEE* THESE MACHINES IN OPERATION AT COSA'S NEW YORK SHOW ROOM OR SEND FOR DESCRIPTIVE LITERATURE.

COSA NATIONAL REPRESENTATIVES

**COSA CORPORATION**
405 Lexington Ave., New York 17

circuit. In this article, the equivalence will be proved.

The standard uncompensated resistive coupling network takes the form shown in Fig. 1, where $C_1$ and $C_2$ include the tube and wiring capacitances, $R_1$ is the resultant of the load resistance and the plate resistance of the first tube taken as a parallel combination, and $C_m$ is the coupling capacitor. Ordinarily, $C_m >> C_1$ and $C_m >> C_2$. Where approximate formulas are given, we shall understand them to refer to this condition.

The conventional analysis proceeds by examining the limiting forms the circuit takes at low, medium and high frequencies. For example, at low frequencies $C_1$ and $C_2$ are considered negligible and the voltage gain $G$ is determined by considering the voltage divider formed by $C_m$ and $R_2$ in series. The grid voltage on the second tube is $R_2[R_2 + 1/j\omega C_m]^{-1}$ times the plate voltage on the first tube. Using $g$ for the transconductance of the first tube, its plate voltage is

$$\frac{-gR_1\left(R_2+\frac{1}{j\omega C_m}\right)}{R_1+R_2+\frac{1}{j\omega C_m}}$$

times the input voltage. The gain $G$ is therefore given by

$$G = \frac{-gR_1R_2}{R_1+R_2+1/j\omega C_m},$$

so that the low-frequency 3-db

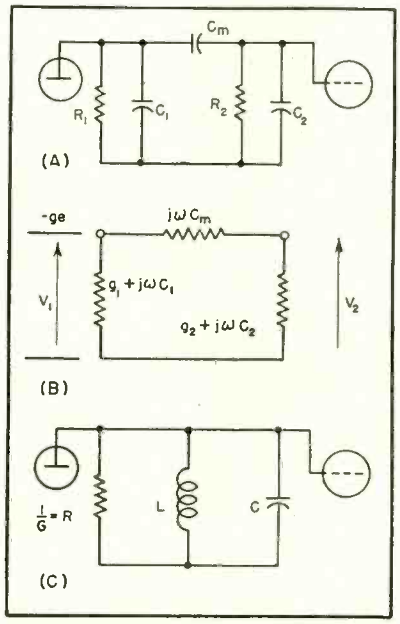



FIG. 1—Resistance-coupled circuit and equivalent

## DU MONT TYPE 280-A

High-voltage operation, high sensitivity, and a 10-megacycle bandwidth are provided in the Type 280-A along with the calibrated sweep delay, versatile time-base synchronization, and sweep durations continuously variable from one to 15000 microseconds. These and many other precision features make the Type 280-A important quantitative equipment in industrial applications where detailed study of high-speed phenomena contributes to the evaluation of the quality and design of products.

Supplementing the usual sweep-control circuits of the cathode-ray oscillograph, the Type 280-A also contains a specialized video synchronizer unit. Used in conjunction with the calibrated sweep delay, it will select and display any line or fraction of a line of the standard RTMA television signal.

### FEATURES

- Type 5XP- high sensitivity Cathode-ray Tube.
- 10-megacycle Video Amplifier.
- Pulse Response—0.01 µsec. rise time reproduced as a rise time of 0.04 µsec. or less.
- Video Synchronizer Unit—Field and line selector for a study of any portion of the composite television signal.
- Sweep Calibration — 10-, 1-, 0.2-microsecond intervals.
- Calibrated Sweep Delay Ranges—100 µsec., 1000 µsec.; Accuracy ±0.1% full scale.
- Internal Trigger Generator—120 to 2500 cps.; can be synchronized to external signals from 120 cps. to 50,000 cps. Sweep may be triggered externally.
- Output Trigger—0 or 25 µsec. delay with respect to calibrated delay; 50 volts positive; rise time, 0.5 microseconds or less.
- Output Test Pulse—variable to 20 volts positive; duration, 1 µsec.; rise time, less than 0.01 µsec.; 25-usec. delay with respect to the start of the calibrated delay.

# CALIBRATED SWEEP DELAY

**measures fractions of ONE MICROSECOND!**

**The precision sweep delays of the Du Mont Types 280-A and 256-D Cathode-ray Oscillographs provide for the accurate measurement of small time intervals.**

**provides DIRECT READINGS in Du Mont precision cathode-ray oscillographs**

## DU MONT TYPE 256-D

The Type 256-D is designed as a highly precise time-measuring device. Its versatility serves many of the general-purpose functions in laboratory work.

The calibrated sweep delay of the Type 256-D will measure time intervals up to 1000 microseconds with an accuracy of ±0.1% of the full-scale ranges of 100 µsec. or 1000 usec. With both delayed and undelayed sweeps, a movable marker in the Type 256-D will indicate that portion of the sweep which is expanded on the shorter delayed sweeps. Delayed sweeps are of 4-, 10-, and 25-microsecond durations. Undelayed sweeps are available in six ranges from 4 to 4500 microseconds.

Response of the video amplifier of the Type 256-D is within ±1 db at 20 cps; down no more than 3 db at 8 megacycles, no more than 6 db at 11 megacycles. Sensitivity is 0.7 peak-to-peak volt per inch. Pulse response is such that a rise time of 0.01 microsecond will be reproduced as a rise time of 0.04 microsecond or less.

Crystal-controlled timing markers are provided in the Type 256-D for calibration of the delay circuit sweeps. Both delayed and undelayed sweeps may be started by external trigger pulses of either polarity or by a built-in trigger generator which provides 1-microsecond pulses of either polarity, having a rise time of 0.3 microsecond and amplitude greater than 100 volts. Trigger repetition rates up to 2000 P.P.S. are usable.

*Please address all inquiries concerning these precision cathode-ray oscillographs to:*

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

point is

$$\omega_1 = 2\pi f_1 = 1/(R_1 + R_2)C_m.$$

At medium frequencies, all three capacitors are considered to have negligible reactances compared with $R_1$ and $R_2$ and the effective network is just $R_1$ and $R_2$ in parallel. In this frequency range, the gain is a maximum and has no frequency variation.

Finally, at high frequencies, $C_m$ is considered equivalent to a short circuit, so that the network reduces to the parallel combination of the other elements. This network has a falling characteristic with the 3-db point at

$$\omega_2 = 2\pi f_2 = (g_1 + g_2)/(C_1 + C_2)$$

where the conductances of $R_1$ and $R_2$ are $g_1$ and $g_2$ respectively.

We now show that a straightforward analysis of the network of Fig. 1A leads to the result that it is exactly equivalent to a shunt combination of $R$, $L$ and $C$.

Our problem is to compute $G = V_2/e$ for the admittance network of Fig. 1B. The result is

$$G = V_2/e = \frac{-jg\omega C_m}{[g_1 + j\omega(C_1 + C_m)][g_2 + j\omega(C_2 + C_m)] + \omega^2 C_m{}^2}$$

$$= \frac{-g}{\left[\frac{g_1C_2 + g_2C_1}{C_m} + g_1 + g_2\right] + j\omega\left(\frac{C_1C_2}{C_m} + C_1C_2\right) - \frac{jg_1g_2}{\omega C_m}}$$

We observe that if the coupling network were of the form shown in Fig. 1C, we would have

$$G = \frac{-g}{1/R + j\omega C - j/\omega L}$$

It follows that both networks will have exactly the same gain characteristic if we put

$$G = \frac{1}{R} = \frac{g_1C_2 + g_2C_1}{C_m} + g_1 + g_2$$

$$\cong g_1 + g_2$$

$$L = \frac{C_m}{g_1g_2}$$

$$C = \frac{C_1C_2}{C_m} + C_1 + C_2 \cong C_1 + C_2$$

The gain characteristic is therefore the same as that of a single-tuned circuit resonant at $f_o$ where

$$\omega_o = \frac{1}{\sqrt{LC}} \cong \sqrt{\frac{g_1g_2}{C_m(C_1 + C_2)}}$$

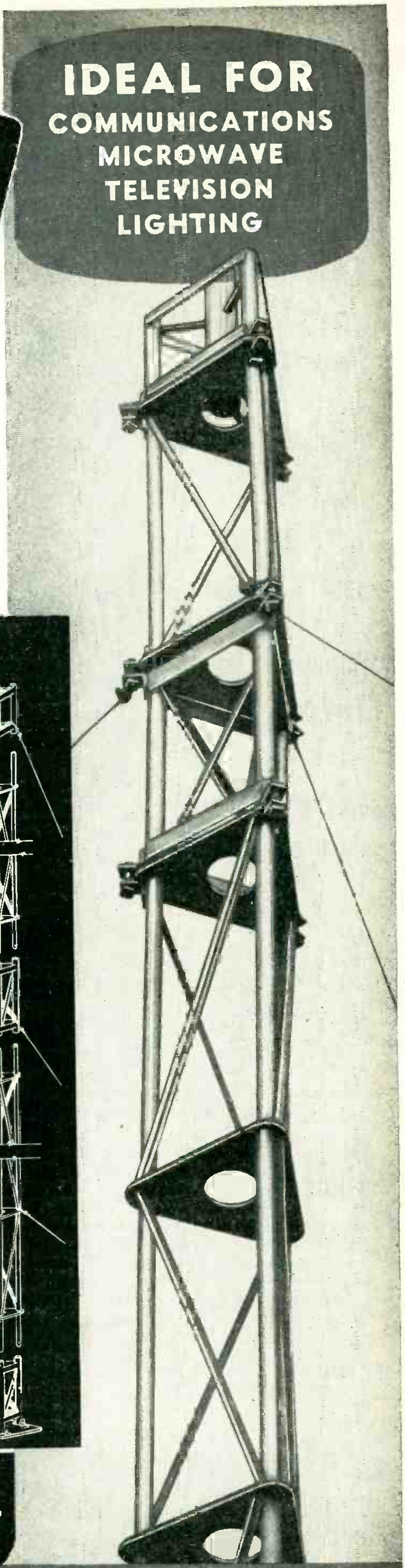
(continued on p 198)

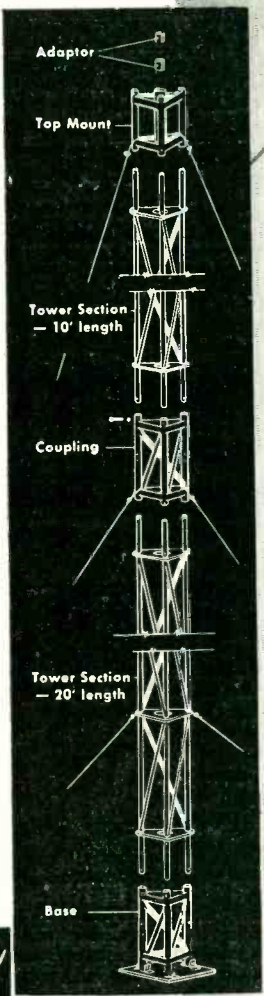
# THE TOWER OF STRENGTH

**Superior construction features give LOW COST Vee-D-X sectional towers the highest safety factor of any tower in its price class.**

If you have an elevated installation problem, absolute permanency of your installation is assured when you use a VEE-D-X sectional tower. Strength is a major factor. Don't take chances with structural failure. Be sure with VEE-D-X!

- *Rugged, all-welded construction diagonally laced with angle iron for maximum rigidity.*
- *Can be erected on ground or on flat or peaked roof.*
- *Patented plate spaced at two foot intervals prevents twisting and affords rigidity found in no other tower.*
- *Safe and easy to climb.*
- *Completely galvanized, light weight tubular steel . . . 20 ft. section 72 lbs.*



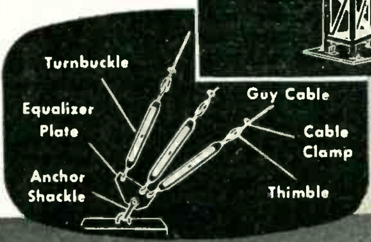




## *PRE-ASSEMBLED*
### *for fast, inexpensive installation*

VEE-D-X towers are designed for use at any height from 10 to 140 feet. They are self-supporting up to 20 feet and, where space is limited, *semi-guyed** type installations may be used at 30, 40, and 50 foot heights. Sketch at right shows the basic parts and necessary accessories for a complete installation. Three types of top mount are available. VEE-D-X towers may be ordered in separate units or as a complete package for a specific height. (Either guyed or semi-guyed.) Write the LaPointe-Plascomold Corporation of Unionville, Conn. for complete information.

*Semi-guyed towers employ one set of guy cables attached at a height of 10 ft. up the tower and anchored at a 6 ft. radius from the base.

# VEE-D-X




**BUILDERS OF THE WORLD'S MOST POWERFUL ANTENNAS**

The Q and bandwidth $\Delta f$ are

$$Q = \omega_o RC \cong \frac{1}{g_1 + g_2}\sqrt{\frac{g_1 g_2 (C_1 + C_2)}{C_m}}$$

$$\Delta\omega = \frac{\omega_o}{Q} \cong \frac{g_1 + g_2}{C_1 + C_2}$$

To find the 3-db points, we recall that $\Delta\omega = \omega_2 - \omega_1$ and $\omega_o^2 = \omega_1\omega_2$. Solving for $\omega_2$ and $\omega_1$

$$\omega_2 = (\Delta\omega/2) + \sqrt{(\Delta\omega/2)^2 + \omega_o^2}$$

$$\omega_1 = -(\Delta\omega/2) + \sqrt{(\Delta\omega/2)^2 + \omega_o^2}$$

For the two limiting cases,

$\Delta\omega/2\omega_o >> 1$ and $\Delta\omega/2\omega_o << 1$, we get

$$\left.\begin{aligned}\frac{\Delta\omega}{2\omega_o} << 1;\ \omega_1 &\cong \omega_o - \frac{\Delta\omega}{2}\\ \omega_2 &\cong \omega_o + \frac{\Delta\omega}{2}\end{aligned}\right\}\ \text{error} \cong \frac{\Delta\omega}{4\omega_o}$$

$$\frac{\Delta\omega}{2\omega_o} >> 1;\ \omega_1 \cong \frac{\omega_o^2}{\omega}\ \Big\}\ \text{error} \cong 3\left(\frac{\omega_o}{\Delta\omega}\right)^2$$

$$\omega_2 \cong \Delta\omega\ \Big\}\ \text{error} \cong \left(\frac{\omega_o}{\Delta\omega}\right)^2$$

so that finally,

$$\omega_1 = \sqrt{\frac{g_1 g_2}{C_m\left(C_1 + C_2 + \frac{C_1C_2}{C_m}\right)}}\left[\sqrt{\frac{C_m\left(g_1 + g_2 + \frac{g_1C_2 + g_2C_1}{C_m}\right)^2}{4g_1g_2\left(C_1 + C_2 + \frac{C_1C_2}{C_m}\right)}} + 1 - \frac{\sqrt{C_m}\left(g_1 + g_2 + \frac{g_1g_2 + g_2C_1}{C_m}\right)}{2\sqrt{g_1g_2\left(C_1 + C_2 + \frac{C_1C_2}{C_m}\right)}}\right]$$

$$\omega_2 = \sqrt{\frac{g_1 g_2}{C_m\left(C_1 + C_2 + \frac{C_1C_2}{C_m}\right)}}\left[\sqrt{\frac{C_m\left(g_1 + g_2 + \frac{g_1C_2 + g_2C_1}{C_m}\right)^2}{4g_1g_2\left(C_1 + C_2 + \frac{C_1C_2}{C_m}\right)}} + 1 + \frac{\sqrt{C_m}\left(g_1 + g_2 + \frac{g_1C_2 + g_2C_1}{C_m}\right)}{2\sqrt{g_1g_2\left(C_1 + C_2 + \frac{C_1C_2}{C_m}\right)}}\right]$$

Or, since $\frac{\Delta\omega}{2\omega_o} >> 1$ in the cases of interest to us,

$$\omega_1 \cong \frac{g_1 g_2}{(g_1 + g_2)C_m} = \frac{1}{(R_1 + R_2)C_m}$$

$$\omega_2 \cong \frac{g_1 + g_2}{C_1 + C_2}$$

These results justify the usual approximate analysis for the case $C_m >> \frac{C_1}{C_2}$

For the opposite extreme, $C_m << \frac{C_1}{C_2}$ we get

(Continued on p 200)

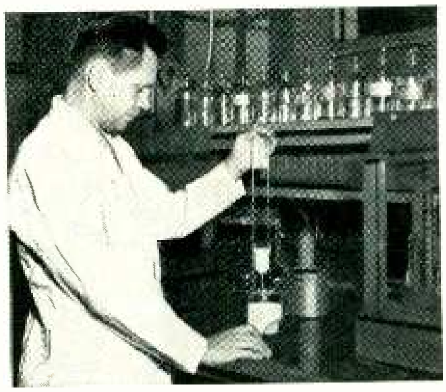
# G-E Instrument NEWS

## New Pacific Evenness Tester Uses Photoelectric Recorder

A new testing instrument developed by the Pacific Mills Worsted Division at Lawrence, Massachusetts, measures quickly and accurately the evenness and weight of textile strands. Known as the "Pacific Evenness Tester" and using a G-E photoelectric recorder, it largely eliminates the need for visual inspection of finished cloth, always a tedious and costly process.

The sensitivity of the system is indicated by the fact that a .002-inch deviation in strand thickness can represent full-scale deflection of the recorder.

The "Pacific Evenness Tester" is a tremendous step forward in the field of textile quality control. And it is one more proof of the versatility of the G-E photoelectric recorder. R. C. Wilkie (shown above), Manager of the Worsted Division's Engineering Research Department and designer of the new tester, says, "With its sustained accuracy, fast response, and high-sensitivity, the G-E photoelectric recorder is ideal for this application."



**In the laboratories of the E. Ferbert Schorndorfer Company, Cleveland, Ohio, specialists in paints for industrial products, the Zahn viscosimeter is used as one means for maintaining uniformity and quality of finished product.**

## G-E OSCILLOGRAPH AIDS IN STUDIES OF BEACH AND OCEAN FLOOR EROSION

The General Electric Type PM-10-C3 oscillograph is playing an important part in the extensive studies of beach and ocean floor erosion now being made at La Jolla, California, by the Scripps Institute of Oceanography, part of the Graduate School of the University of California, in co-operation with the Army Corps of Engineers. The purpose of the studies is to find ways to minimize the serious harbor damage often caused by the action of waves.

Using a unique double strain gage pick-up and special signal generators and amplifiers, all designed and built by Scripps personnel, the velocities of the waves are measured in two directions and the results recorded on photographic film by the Type PM-10-C3 oscillograph.

The oscillograph itself is located in the laboratory while the gage unit lies on the ocean floor more than half a mile away. Interconnecting cables relay the delicate signals.

Mr. James Snodgrass (shown at right), technical director, says "the wide frequency response and high sensitivity of the Type PM-10-C3 oscillograph, together with its adjustable resistances and high-speed camera control, make it particularly suitable for this application."

## Magnets Balanced Quickly With Indicating Fluxmeter

Wilfred O. White and Sons, Inc., of Boston, Massachusetts, manufacturers of the famous *Constellation* spherical compass and other navigational instruments and associated equipment, are now using a General Electric indicating fluxmeter for checking the flux-density balance of permanent magnets used in their complete range of compasses.

The raw magnets are inserted in holes in a testing panel connected to the fluxmeter and especially designed for this application. The fluxmeter gives an immediate and accurate indication of their comparative strength. If one magnet is too strong, it is inserted into the "demagnetizer," another hole in the panel. The process is repeated until the desired balance is obtained.

With this system, the flux densities of the magnets can be brought to within 10 percent of each other, a high degree of balance for magnets of this type.

SECTION A602-196
APPARATUS DEPARTMENT
GENERAL ELECTRIC CO.
SCHENECTADY, N. Y.

Please send me information on the following products:

- ☐ Type PM-10-C3 oscillograph
- ☐ Type CE photoelectric recorder
- ☐ Indicating fluxmeter
- ☐ Zahn viscosimeter

NAME ........................................
COMPANY ........................................
STREET ........................................
CITY .................. ZONE .......... STATE ..........

GENERAL ELECTRIC







$$G = \frac{1}{R} \cong \frac{g_1C_2 + g_2C_1}{C_m} \qquad \omega_o \cong \sqrt{\frac{g_1g_2}{C_1C_2}}$$

$$L = \frac{C_m}{g_1g_2} \qquad Q \cong \sqrt{\frac{g_1g_2C_1C_2}{g_1C_2 + g_2C_1}}$$

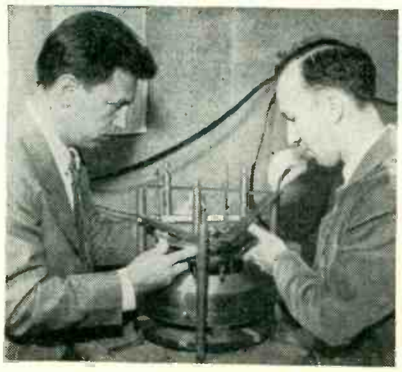
$$C \cong \frac{C_1C_2}{C_m} \qquad \Delta\omega \cong \frac{g_1C_2 + g_2C_1}{C_1C_2} = \frac{g_1}{C_1} + \frac{g_2}{C_2}$$

It is easily seen that the equivalent circuit is characterized by an inherently low Q. Indeed, since the original circuit of Fig. 1A is aperiodic, the equivalent circuit of Fig. 1C must have $Q<\frac{1}{2}$. In practice, Q is much smaller than $\frac{1}{2}$. For a 100-cps to $10^6$-cps bandwidth, for example, $Q \cong \sqrt{10^2/10^6} = 0.01$.

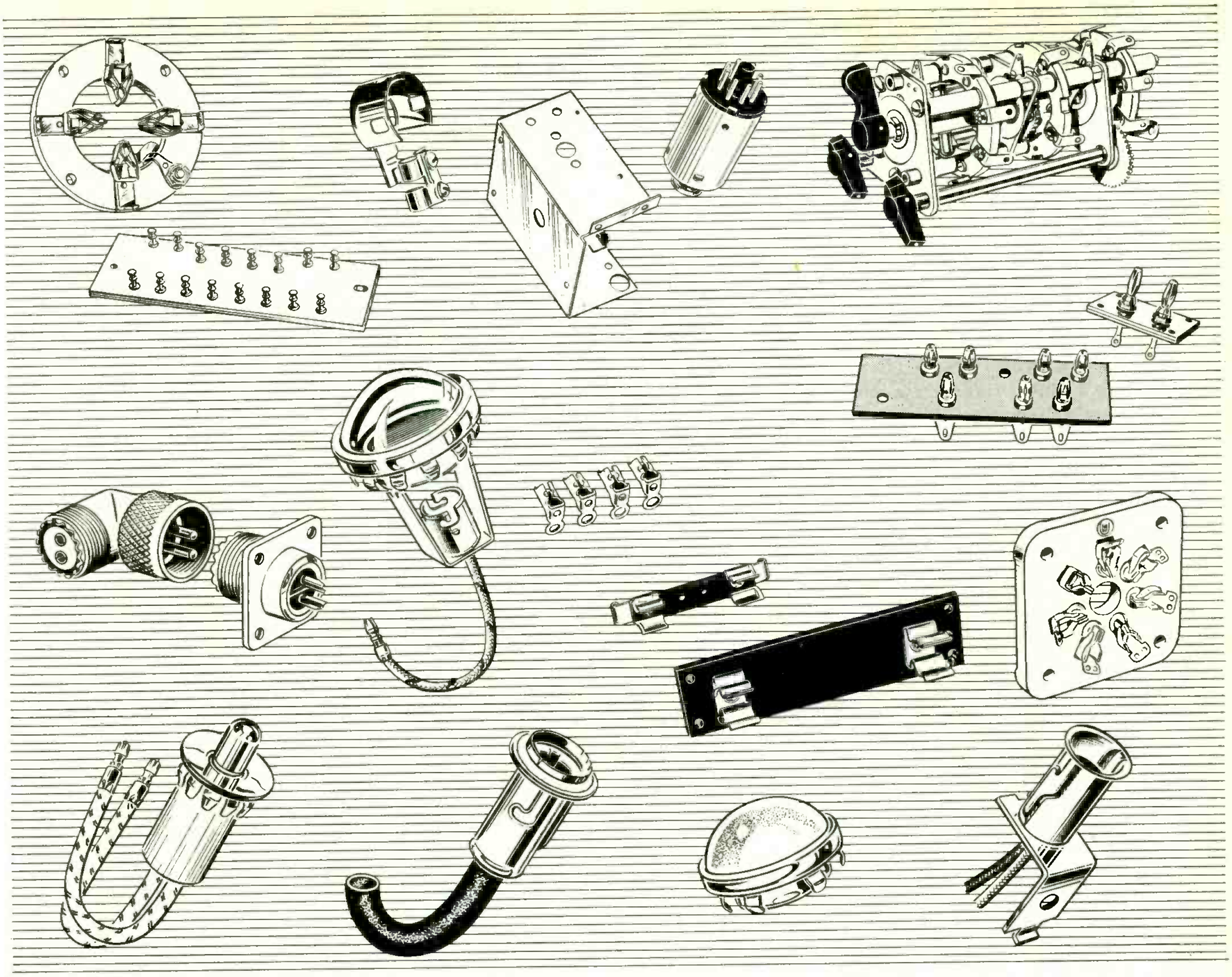
Since this analysis shows that the circuit is exactly equivalent in its gain characteristic to a single-tuned circuit, it suggests the feasibility of combining this circuit with others in cases where an extremely low Q is required. The point of view taken here also suggests that several of these circuits might be stagger-tuned to produce a wide-band video amplifier without additional compensation. However, since $Q<\frac{1}{2}$, this circuit could only be used as the center stage of an odd number of stagger-tuned circuits.

## New Accuracy in Speed-of-Light Measurements

THE SPEED OF LIGHT has been measured with an accuracy of 0.0002 percent by a special microwave system at Stanford University. The new figure of 186,280.0 miles per second is believed to be 10 to 20 times more accurate than the previously-accepted value of 186,272 which was drawn from



Accurate measurements of resonant frequency of microwave cavity permit determination of the speed of light with 0.0002-percent accuracy



# Do you remember?

Old hands in the electronics field will recognize some familiar items in the selection above. They are typical of the many components and assemblies we supplied for use by the Services from 1940-45. We also illustrate several new parts, representative of our current production.

With the present expansion of military procurement, we stand ready as before to supply the all-important components promptly . . . and in quantity. Just let us know your needs.

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*Newtonville 60, Mass.*

Division of United-Carr Fastener Corp.

***Specialists in***

**ELECTRICAL ASSEMBLIES, RADIO AND AUTOMOTIVE**

averages computed by many workers during the past 25 years.

The basis of the measuring system is a microwave cavity whose dimensions are known down to the millionth part of an inch. These accurate dimensions, and an accurate measurement of the resonant frequency of the cavity, allow calculation of the speed with which radio waves, and thus light waves, travel.

To allow the extremely accurate determination of cavity dimensions, contour maps of the covers of the cavity were made to allow mathematical calculation of any deviations that might occur. Spacer rods, which hold the cover in place, are measured with an accuracy that permits calculation of their dimension changes, down to the ten-thousandth of an inch, when compressed by the weight of the disc cover. The rods themselves had to be equal within a few millionths of an inch. The temperature of the room in which the measurements are made is held to within 0.01 degree C.

The development work on the new sytem took five years. The actual measurement process is relatively simple, once the equipment is set up. The photograph shows Edward Ginzton and Arthur W. Hornig positioning the equipment to measure the inside dimensions of the microwave cavity.

## Ratio and Product Control By Shield-Grid Thyratrons

BY CHARLES F. SPITZER
*Yale University*
*New Haven, Connecticut*

IN MANY instances of process control, it is desirable to actuate a relay or to trigger an indicating circuit whenever the ratio of two quantities deviates from a preset value. In other instances it may be desirable to maintain the product of two quantities constant and to obtain an indication if a certain limit has been exceeded. These results are readily obtained through the use of a shield-grid thyratron. The 2D21 thyratron has been chosen in the following investigation since its miniature design and relatively

# For Negative Resistance-Voltage Characteristics

# GLOBAR
TRADE MARK

# TYPE BNR RESISTORS

Responding instantly to voltage changes, GLOBAR type BNR Silicon Carbide Resistors provide increased resistance as a potential is decreased. Conversely, as a potential is applied, resistance decreases. These resistors are what is commonly referred to as voltage sensitive. They are used to dampen the effect of transient voltages and provide instant protection for electrical circuits.


Bulletin GR2 contains useful engineering data on GLOBAR BNR Ceramic Resistors. Copies will be supplied immediately upon request. Write Dept. V-11, The Carborundum Company, GLOBAR Division, Niagara Falls, N. Y.

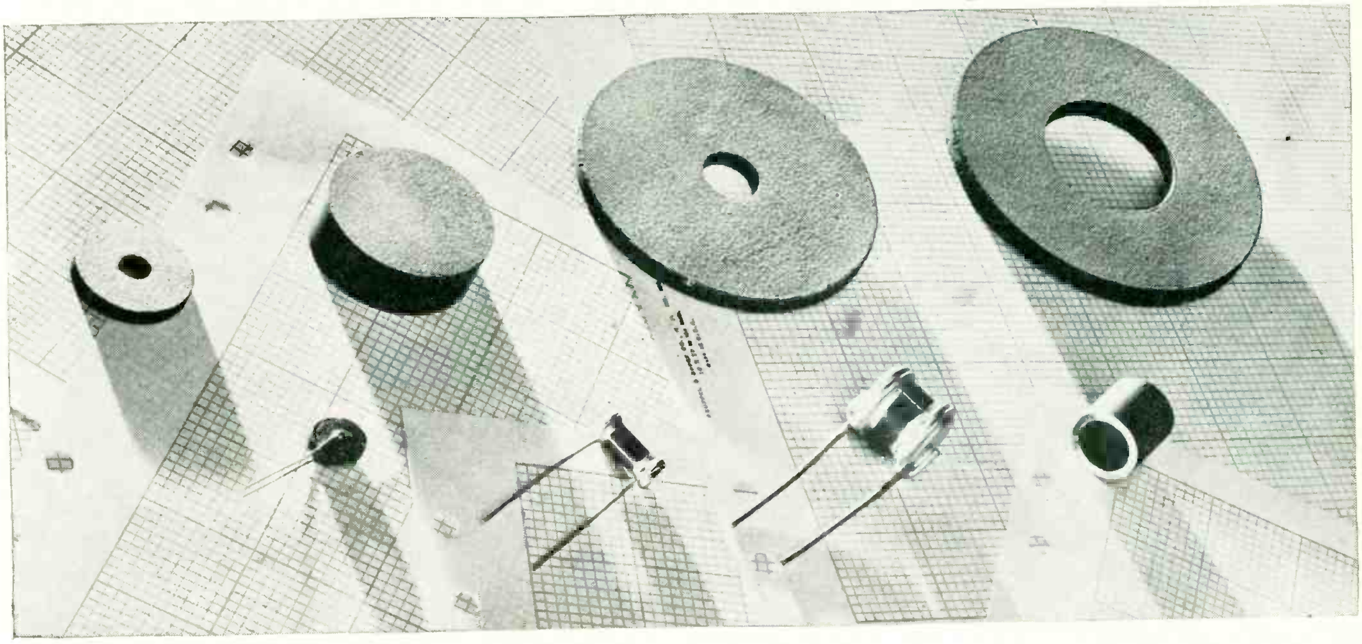
*Typical applications where these resistors operate successfully include:*

**1** Small motors to prevent arcing of governor contact points.

**2** Stabilizing rectifier circuits by limiting peak voltages.

**3** Voltage control circuits in electronic devices.

**4** Protection of solenoids in direct current circuits.



Resistors of this type are readily made to meet exact specifications. Working samples are available when necessary. To be sure of receiving resistors made to correct specifications, the following information should be furnished:

**a.** Type of apparatus in which resistors are to be used.
**b.** Method of mounting and space limitations.
**c.** Normal operating voltage and peak voltage if available.
**d.** Resistance and inductance of the circuit if available.
**e.** Ohmic resistance of the resistor and allowable plus or minus tolerance.
**f.** Maximum voltage applied continuously or intermittently.
**g.** Duration of load and elapse of time between applications.

*Furnishing these data will also avoid unnecessary delay and confusion.*

# GLOBAR Ceramic Resistors
## BY CARBORUNDUM
TRADE MARK

*"Carborundum" and "Globar" are registered trademarks which indicate manufacture by The Carborundum Company, Niagara, Falls, N. Y.*

large current carrying capacity (100 ma continuously) make it particularly suitable for compactly built control devices.

*Ratio Limiting*

The characteristic curves of the tube under consideration are shown in Fig. 1. In the region above each curve the tube conducts, and below each curve it remains cut off.

For a plate voltage of 300 volts, the characteristic consists of three nearly straight lines, marked *a*, *b* and *c*. Line *a* has a small slope ( $= -0.25$) while line *b* has a fairly steep slope ($= -7.65$). Line *c* merges into line *b*, and has a somewhat steeper slope than the latter.

If it is desirable to obtain an indication that the ratio $\Delta E_g/\Delta E_s$ has exceeded a certain value, a static operating point *P* may be chosen (by proper biasing). Then, if operation takes place along line *b*, that is if $\Delta E_g$ is positive and $\Delta E_s$ is negative, the tube will fire if the ratio $\Delta E_g/\Delta E_s$ has exceeded the value 7.65. Other ratios are readily available through the use of attenuators (or amplifiers) for the original signals from which $\Delta E_g$ and $\Delta E_s$ are obtained.

If less than optimum accuracy is permissible, the range of operation can be greatly extended by replacing lines *b* and *c* by a single line of average slope. This will allow $\Delta E_g$ to swing over more than 40 volts,

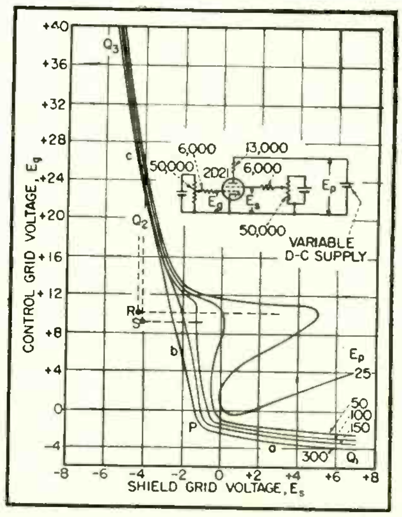



Fig. 1—Characteristics of a 2D21 thyratron, with d-c on the plate. For ratio control the static operating point is chosen at *P*, $Q_1$, $Q_2$ or $Q_3$, whichever the problem demands. For product control operating point is set at *R* or *S*

# NEW! FREQUENCY AND TIME MEASUREMENTS ACCURATELY . . . CONVENIENTLY

FREQUENCY RATIO MEASUREMENTS

DIRECT RPM READING TACHOMETER

SECONDARY FREQUENCY STANDARD

using $f = \frac{n}{t}$

ANY FACTOR MAY BE MEASURED FOR FIXED VALUE OF THE OTHER

FREQUENCY MEASUREMENTS

TIME INTERVAL MEASUREMENTS

TOTALIZING COUNTER

## The Universal 6-IN-ONE MEGACYCLE FREQUENCY-TIME COUNTER by Potter

Now, the Potter Instrument Company offers all-in-one equipment, the features heretofore available only in separate counting systems. Two complete counting channels, a 100 kc crystal oscillator time base and unique gating circuits are combined to provide the new FREQUENCY-TIME COUNTER.

| | |
|---|---|
| FREQUENCY MEASUREMENTS | 0 to 1 mc range by counting cycles per pre-selected time or by measuring time per pre-selected count. Accuracy 0.001 % minimum. |
| TIME INTERVAL MEASUREMENTS | 0 to 10 seconds ± 10 micro-seconds. |
| FREQUENCY RATIO MEASUREMENTS | Ratio of two external frequencies can be measured. |
| SECONDARY FREQUENCY STANDARD | 100 kc crystal oscillator with divided frequencies available at 10, 1 kc and 100, 10, 1 cps. |
| TOTALIZING COUNTER | Six decades, pulses 0 to 1 mc, sine wave 10 cps to 1 mc. |
| DIRECT RPM READING TACHOMETER | Through the use of an external 60 count per revolution photoelectric disc generator an accuracy of ± 1 rpm is obtained. |

## FEATURES

**WIDE FREQUENCY RANGE** — Pulses 0 to 1 megacycle — sine waves from 10 cps to 1 mc.

**EXTREMELY HIGH ACCURACY** — 0.001% from 0 to 1 megacycle.

**VERSATILITY** — Frequency measurements, time intervals, frequency ratios, high speed counting, rpm measurements, and a secondary frequency standard — all in one instrument.

**RAPID MEASUREMENT** — No adjustments or interpolations — only a few seconds for a complete measurement.

**DIRECT DECIMAL READING** — Frequency or time displayed on six Potter Counter Decades using the 1-2-4-8 large neon glow lamp decimal indication. Readable even under high ambient illumination.

**AUTOMATIC OR MANUAL RECYCLING** — The counter will retain the measurement until reset or will automatically recycle after displaying the measurement for a selected time.

**NO ADJUSTMENT** — Stable decade counter frequency dividers, rather than multivibrators are used to establish the precise time base.

**DEPENDABLE** — The exclusive four-lamp Potter decades provide a direct on-off indication of the counter stages without the complexity and unreliability of a readout matrix. An associated glow lamp for each tube in the counting and dividing circuits simplifies tube servicing.

**PERMANENT RECORD** — Other versions of the Frequency Time Counter can be supplied with high speed recording devices.

**POTTER INSTRUMENT COMPANY**
INCORPORATED
115 CUTTER MILL RD., GREAT NECK, NEW YORK

with a corresponding $\Delta E_s$ of nearly 5 volts.

If $Q_1$ is chosen as the static operating point and operation takes place along line *a*, that is, again, if $\Delta E_g$ is positive and $\Delta E_s$ is negative, the tube will fire if the ratio of $\Delta E_g/\Delta E_s$ exceeds the value 0.25. Again, other ratios are readily available through the use of attenuators (or amplifiers for the signals from which $\Delta E_g$ and $\Delta E_s$ are obtained. In general, point *P* and line-*b* operation are preferable if the ratio to be indicated is greater than unity, while $Q_1$ and line-*a* operation are better suitable for ratios of less than unity.

If it is desirable to obtain an indication that the ratio $\Delta E_g/\Delta E_s$ has *dropped* below a certain value, point *P* and line *a* operation may be chosen ($\Delta E_g$ negative and $\Delta E_s$ positive). The tube will then fire if $\Delta E_g/\Delta E_s$ drops below the value 0.25, with other ratios obtainable through attenuators or amplifiers.

If point $Q_2$ and line-*b* operation are chosen ($\Delta E_g$ negative and $\Delta E_s$ positive), the limiting ratio will be 7.65 and the tube fires if the signal ratio is less than this value with other ratios becoming available, as before, through attenuators or amplifiers. If less than optimum accuracy is permissible, lines *b* and *c* can again be merged and their slopes replaced by an average value. In this manner the operating range is greatly extended. For ratios below unity, operating point *P* should be used, while for ratios above unity operating point $Q_2$ is more suitable.

### *Ratio Limiting Applications*

One application of this circuit might be to indicate whether the percent distortion of an amplifier exceeds a certain value. Through the use of two such circuits, the ratio of two quantities can be kept within close limits; in this case one circuit operates when the ratio drops below the preset value, the other when the ratio exceeds it. Thus, liquid mixtures of two components may be accurately controlled by automatically adjusting the flow of each component liquid, for example.

It is particularly noteworthy that the response of the tube appears

# The RCA "TV Duo"...

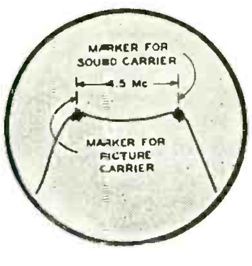

## ...the last word in *precision* and *versatility*

### RCA WR-59B Television Sweep Generator

**What it does**—Provides fast and accurate sweep alignment and trouble shooting of TV front ends . . . sound and picture if amplifiers . . . discriminators and ratio detectors . . . trap circuits . . . video amplifiers . . . and if amplifiers in FM sets.

**What it features**—Preset switch positions for TV channels 2 to 13 . . . continuous tuning from 300 kc to 50 Mc . . . flat output, within ±1.5 db even at maximum sweep width . . . fundamental oscillator output on all TV channels . . . filtered beat-frequency-fundamental output on if/vf range . . . zero-voltage reference line provided by return-trace blanking . . . dual piston attenuator with maximum attenuation ratio of 20,000 to 1 . . . continuously variable sweep width up to 10 Mc . . . output frequency-modulated at the fundamental frequency by a precision-type vibrating capacitor, for long life and good linearity . . . balanced rf output cable terminated in 300 ohms . . . fully shielded circuits and filtered power line . . . resistance-terminated if/vf output cable.

**For complete details** ask your RCA Test Equipment Distributor for Bulletin 2F753.




'Scope pattern of dual markers for rf picture and sound carriers, produced by the "TV Duo."

### RCA WR-39B Television Calibrator

**What it does**—Provides dual markers for rf picture and sound carriers . . . provides signals for peak alignment of stagger-tuned if amplifiers . . . develops vertical bar pattern for horizontal linearity adjustments . . . generates a crystal-controlled AM signal for alignment of inter-carrier sound if's . . . provides triple markers for sound discriminator adjustment . . . allows adjustment of local oscillators in TV front ends with crystal accuracy . . . checks reception on all 12 channels by means of video signal obtained from single channel of a TV set.

**What it features**—Variable-frequency oscillator operating on fundamentals over entire range . . . sound and picture carrier frequencies marked on expanded, easily-read scale . . . two crystal oscillator stages with 3 crystals supplied . . . wide-band modulator stage with range of 0 cps to 30 Mc . . . crystal standard supplying over 600 calibration check points at 0.25-Mc intervals . . . bar-pattern generator for linearity adjustments.

**For complete details** ask your RCA Test Equipment Distributor for Bulletin 2F751.

***Available from your RCA Test Equipment Distributor***

**RADIO CORPORATION of AMERICA**
**TEST EQUIPMENT** — **HARRISON, N. J.**

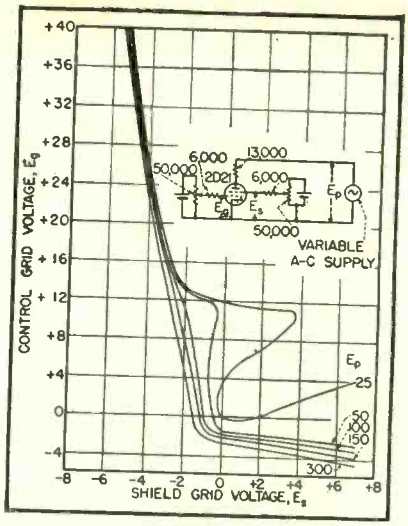



Fig. 2—Characteristics of a 2D21 thyratron, with a-c on the plate. These curves are very similar to those of Fig. 1, illustrating that either type of plate excitation is suitable for ratio or product control

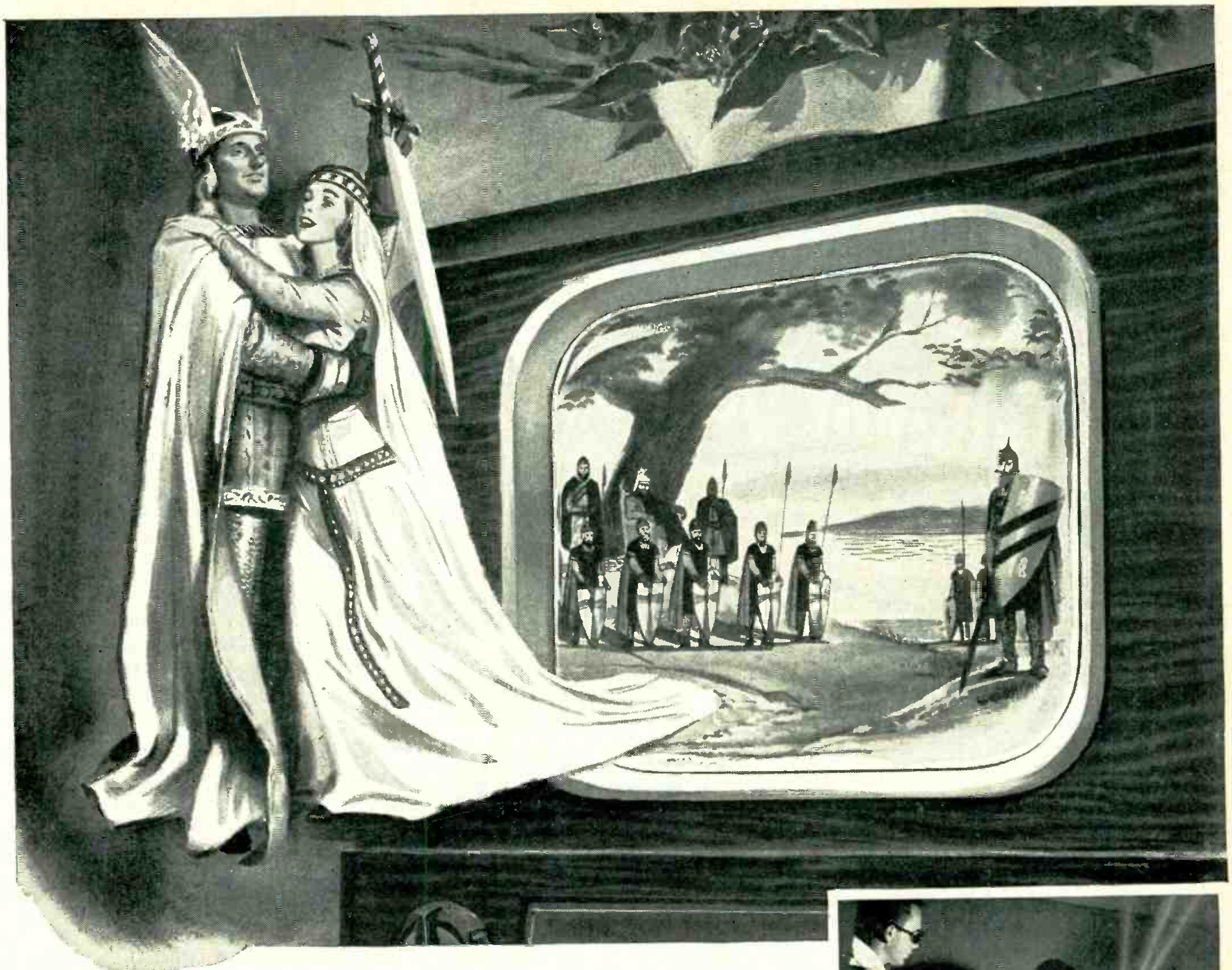
relatively independent of the plate voltage between 150 and 300 volts, (and probably above) as reference to Fig. 1 discloses. Thus, small variations in plate supply voltage have almost no effect on the slopes of lines *a*, *b* and *c*, or on the location of the operating point.

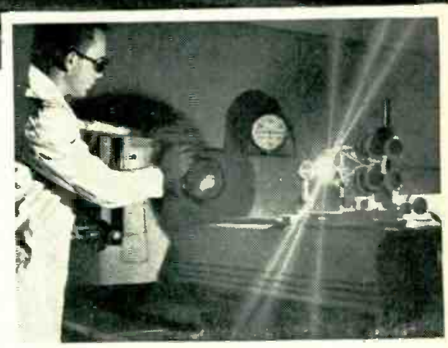
### *Product Limiting*

Again referring to Fig. 1, it is noted that the characteristic curve for a plate voltage of 25 volts has a very noticeable bend near the point ($E_g = 12, E_s = -2$). Over a certain range, this characteristic is very nearly hyperbolical with asymptotes intersecting at $R(E_s = -4.3, E_g = +10)$. The equation of this hyperbola is approximately $E_gE_s = 7$ between the points ($E_s = -3.2, E_g = +18$) and ($E_s = +3; E_g = +11$). An operating point is then chosen near $R$ such as to keep the tube extinguished if the product $E_gE_s$ is less than 7. If the characteristic curve for a plate voltage of 50 volts is chosen, a very similar result is observed.

The equation of the curve is again very nearly $E_gE_s = 7$, but over a smaller range. The points ($E_s = 3.3, E_g = +18$) and ($E_s = -1.0, E_g = +11.4$) limit hyperbolic operation. The asymptotes intersect at $S(E_s = -4.1, E_g = +9)$ and an operating point is chosen near this point.

It is clear that products other than $E_gE_s$ can again be readily





Quality is built-in, not "tested-in." Nevertheless, the guarantee of built-in quality is unlimited testing. Here is one of TUNG-SOL's numerous and exacting quality control tests—the chemicals used in the screen of the TUNG-SOL TV picture tube are analyzed in the spectograph to determine purity.

# This, we can't quite do!

But TUNG-SOL does make electron tubes that accurately synchronize the television receiver with the transmitter—cathode ray tubes that present a picture of unexcelled clarity.

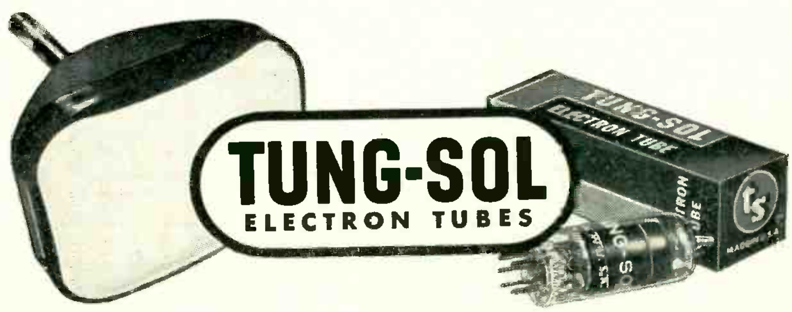
How well we do it, is indicated by the fact that TUNG-SOL tubes meet fully the performance requirements of every leading television set manufacturer.

There is no mystery to the source of TUNG-SOL quality. We just work hard at it. Raw materials are carefully inspected—thoroughly tested. Then, using the most modern statistical quality control methods, TUNG-SOL produces tubes to standards of uniformity and reliability that are unsurpassed in the electronic industry.

Finally, before any tubes can be shipped, they must be certified by TUNG-SOL'S Quality Control Department. This means a complete re-check of each day's output to make certain of a strict adherence to specifications. Every TUNG-SOL tube is made to back up the TUNG-SOL slogan—"Make the best that can be Made."

If you use electron tubes for radio, television, or special-purpose applications, we'd like to have the opportunity of demonstrating the many advantages of doing business with TUNG-SOL.

TUNG-SOL LAMP WORKS INC., Newark 4, N.J.
Sales Offices: Atlanta, Chicago, Dallas, Denver, Detroit, Los Angeles, Newark




FOR RADIO, TV AND SPECIAL PURPOSES

obtained by the use of amplifiers or attenuators preceding this product-limiting stage.

Since the control grid and shield grid lose control once the plate circuit of the thyratron conducts, it is necessary to reset the device by opening the plate circuit. It has been further observed that above a grid voltage of about 12 volts interruption of the plate circuit does not extinguish the tube. The reason is evidently that the control grid-cathode circuit is ionized and remains so unless it also is opened.

Figure 2 shows the characteristics of the 2D21 thyratron when the plate is supplied from a-c. Otherwise, the circuit is the same as that of Fig. 1. As will be noted, the curves are very similar to those of Fig. 1. Thus, when using the circuit for ratio limiting (and if the control grid voltage is kept below 12 volts), resetting takes place automatically. In this form the circuit lends itself exceptionally well to use in continuous control devices. If the control grid voltage exceeds 12 volts a hysteresis effect is observed which necessitates the opening of the control grid circuit to reestablish control. The reason is, as before, that the control-grid-cathode circuit remains ionized, otherwise.

The ability of a thyratron to fire when the $E_g/E_s$ ratio deviates from a preset ratio was used in a device designed to measure the ratio of voltages which were, in turn, determined by the high and low frequency content of a signal. In this arrangement it gave satisfactory service over an extensive period of use. It must be realized that tube replacement will require recalibration of the device, in general.

ERRATUM NOTICE:

IN the September *Electron Art* department, an error was made in crediting the development of the "Electrodynamic Ammeter for VHF". This was called to our attention by H. R. Meahl, of the General Electric Company. In accordance with his request, this notice is being published, calling attention to his letter which appears in this month's *Backtalk* department.

# DUMONT

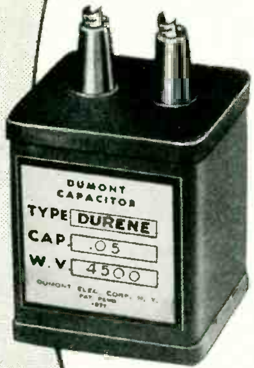
**TYPE S DURENE (PLASTIC FILM) CAPACITOR**


**TYPE S1**
IN TUBES

EXCELLENT POWER FACTOR .0005

CAP. FROM .00005 to 20 MFD

DUMONT "ZERO-LOSS" DURENE CAPACITORS




PLASTIC FILM IDEAL SUBSTITUTE FOR MICA OR CERAMIC CAPACITORS

**TYPE S2**
IN CANS

VOLTAGES FROM 500 to 20000 VOLTS

EXTREMELY HIGH "Q"
MOISTUREPROOF
STABLE
CAPACITY RANGE
LONG LIFE

Leakage Resistance ½ Million Megohms

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FOR DEPENDABILITY ALWAYS SPECIFY DUMONT

**DUMONT ELECTRIC CORP.**
MFR'S OF CAPACITORS FOR EVERY REQUIREMENT
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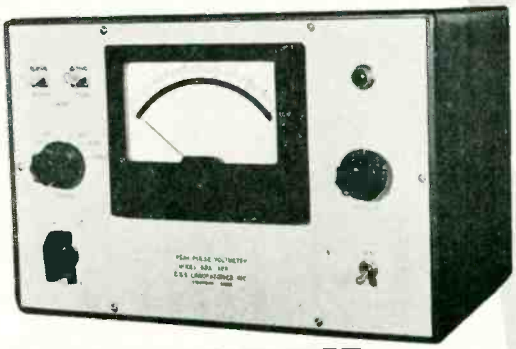
**automatic slideback peak pulse**



# VOLTMETER

Far more versatile than conventional types, the C.G.S. peak pulse voltmeter reads *rapidly* and *accurately* on pulse widths of .25 microseconds and at repetition rates of 10 pps. The instrument reads on either positive or negative pulses. Controls include an on-off, range selector and input polarity switch; zero set control. A switch which throws a D.C. restorer into the circuit provides accurate peak to peak measurements of sine and square waves.

**SPECIAL FEATURES—**

- Wide Voltage Range — 5 scales from 10 to 5000 volts full scale.
- Pulse Width 0.25 microseconds to 50 milliseconds.
- Accuracy ±3% of full scale.
- Input Impedance 200,000 ohms.

Write for Catalog Sheet Giving Full Information — Or Contact Us Concerning Your Own Individual Problems. Our Staff is at Your Service. Write Dept. A

**C. G. S. LABORATORIES, INC.**
LUDLOW STREET STAMFORD, CONNECTICUT

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# E-I HERMETIC SEALING COMPONENTS

***Announcing:* AN IMPORTANT ADDITION TO THE E-I FAMILY OF SEALED LEADS—**

## NEW R and RR SERIES TERMINALS

R-80W-PP
Current 16 amps.

RR-60W-HP
Current 10 amps.

RR-60W-PP
Current 10 amps.

R-90-TL
Current equal to copper lead +10 amps.

A completely new line of double barrel terminals that provide added protection against flashover without any appreciable increase in terminal size. The double barrel results in a longer leakage path on both ends of the terminal while the upper barrel increases the mechanical strength of the terminal and facilitates soldering. For information call or write today.

Write for These Descriptive Bulletins:

**849—Hermetically Sealed Terminals**
**850—Hermetically Sealed Headers**
**851—Gasket Type Bushings**

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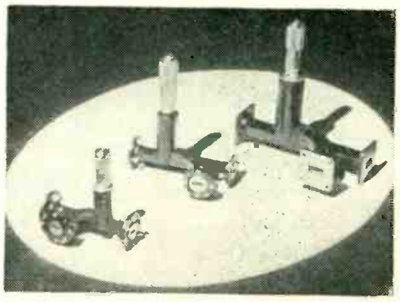
44 SUMMER AVENUE • NEWARK 4, N. J.

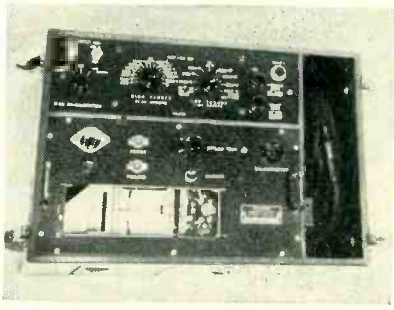
NEW PRODUCTS
(continued from page 130)

voltage supply that is continuously variable from 100 to 325 v and delivers from 0 to 150 ma, with a ripple of less than 5 mv; and a bias supply that is continuously variable from 0 to 150 v and delivers 5 ma. Its a-c output is 6.3 v, 10 amperes, center-tapped, unregulated.



## Cavity Frequency Meters

SPERRY GYROSCOPE CO., Great Neck, N. Y. The cavity frequency meters illustrated are low-Q broadband instruments designed for both transmission and absorption indications. They are extremely useful for general search-type frequency measurements in the laboratory and in the field; and may also be used for setting oscillators and signal sources to a predetermined frequency with an accuracy of 0.1 percent. Model 348 is designed for the 13,000 to 18,000-mc range; model 349—19,000 to 26,000 mc; and model 350—26,500 to 39,000 mc. Each model consists of a cylindrical cavity with one end joining the broad side of a standard section of waveguide. The cavity is tuned by means of a plunger which is driven by a micrometer head. Individual calibration curves are furnished with each instrument.



## Recording Instruments

MILLIVAC INSTRUMENT CORP., P.O. Box 3027, New Haven, Conn., has available a series of direct-reading recording instruments of unusual voltage and current sensitivity. The MR-61A has a sensitivity of $3 \times 10^{-12}$ amperes per mm of deflection; the MR-67A has 20 $\mu$v per mm and an input impedance of 6 megohms; and the MR-65A, a maximum sensitivity of 0.2 $\mu$v per mm with an input impedance of 1,000 ohms. Chart width is 5 centimeters. Standard paper speeds are 25 and 10 mm per second. Frequency range is d-c to 20 cycles for the 61A and 67A, and d-c to 10 cycles for the 65A, all within 3 db.

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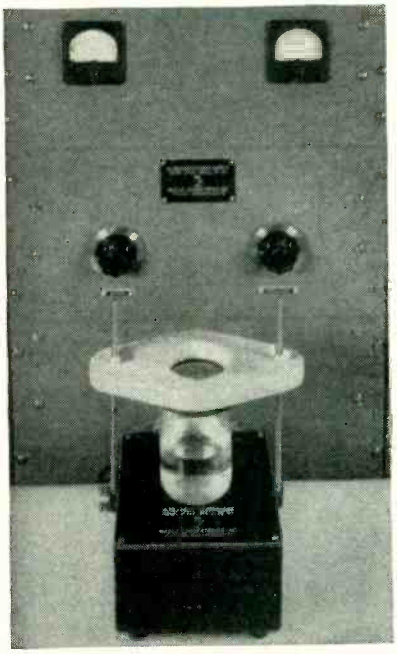
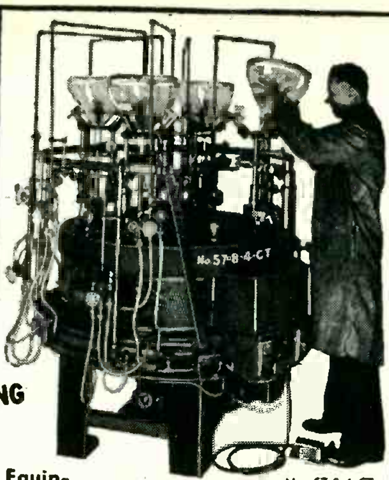


### Ultrasonic Generator

MASSA LABORATORIES, INC., 5 Fottler Rd., Hingham, Mass. Model GA-1010 ultrasonic equipment has been made available to meet the demands of industrial laboratories where the higher frequency quartz crystals were not found satisfactory. It includes a 1-kw magnetostriction transducer, operating at approximately 24 kc and having an exposed flat vibrating surface of 20 sq cm. The structure is oil filled and is provided with a water-cooled radiator to permit the continuous long-time operation of the apparatus without harmful temperature rise. The ultrasonic power supply equipment for operating the transducer is operated from 115-v, 60-cycle power mains. In addition to safety interlocks and relays, the

# EISLER
## Television Tube MACHINERY




No. 57-8-4 CT


No. 102-VID

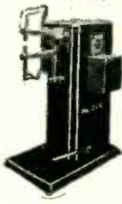
- ECONOMICAL
- MODERN DESIGN
- PRODUCTION ENHANCING

**EISLER'S Electronic Equipment is especially Designed and Built to your exact requirements.**
From 5" to huge 24" Television Tube

**EISLER specializes in GLASS WORKING MACHINERY for the manufacture of: Cathode Ray; Radio Tubes (Standard, Miniature, Sub Miniature); Fluorescent Lamps; Glass Ampoules; Vials; Incandescent Lamps.**

- *Consultation without any obligation on your part is cordially invited.*

No. 57-VID



RESISTANCE WELDERS
•
¼ to 300 KVA

EISLER TRANSFORMERS
STANDARD • SPECIAL
Air, Oil or Water Cooled
•
Sizes From ¼ to 500 KVA

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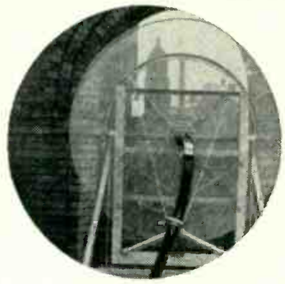
# Titeflex
## FLEXIBLE WAVEGUIDES
## *Save Money*
## IN VIDEO TRANSMISSION



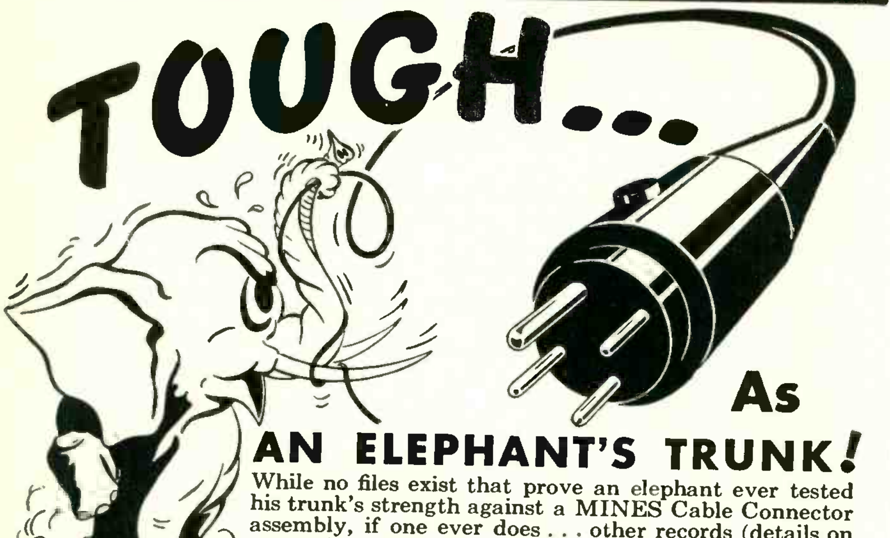
Titeflex Waveflex Waveguides used in television transmission. Assembled lengths of Waveflex over 30 feet long connect movable antenna with transmitter inside building. Antenna is directed at Empire State Bldg. faintly visible in background.

Titeflex Waveflex Waveguides give you all the advantages of rigid waveguides *plus* the additional feature of flexibility. Complicated bends and twists can be made with virtually no change in electrical properties . . . installation costs are lowered . . . design problems are simplified. Waveflex Waveguides are made in many standard types to Army-Navy specifications—or our engineers will develop special styles for you.

Write for
**COMPLETE WAVEFLEX CATALOG**

**TITEFLEX, INC.**
500 Frelinghuysen Ave., Newark 5, N. J.

# TOUGH...



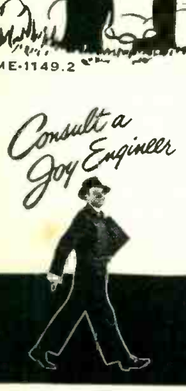

## As AN ELEPHANT'S TRUNK!

While no files exist that prove an elephant ever tested his trunk's strength against a MINES Cable Connector assembly, if one ever does . . . other records (details on request) prove, he'll be tackling a tough job.

Molded directly to cable as one-piece Neoprene units MINES electrical connectors are Jerk-proof, Shatter-proof and Wear-resistant—Special construction and resilient rubber mounting of pins and spring loaded sockets insure a long life of low contact resistance — and the famous MINES Water-Seal automatically protects connections from dirt, oil or water.

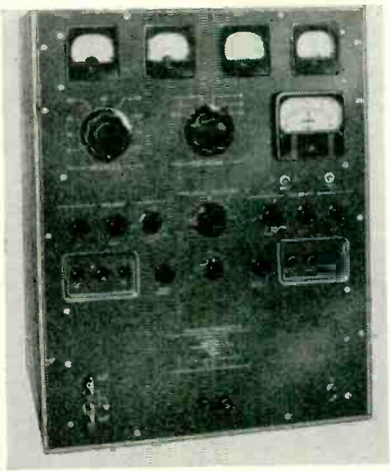
*A wide variety of sizes, shapes and pin combinations are available to meet the portable power requirements of TV, FM, AM or PA Circuits. No. 4A093 Male plug illus.*

*Consult a Joy Engineer*



MINES EQUIPMENT —MINES— *Division*
**JOY MANUFACTURING COMPANY**
HENRY W. OLIVER BLDG., PITTSBURGH 22, PENNA.

power supply includes dials for adjusting the frequency and output.

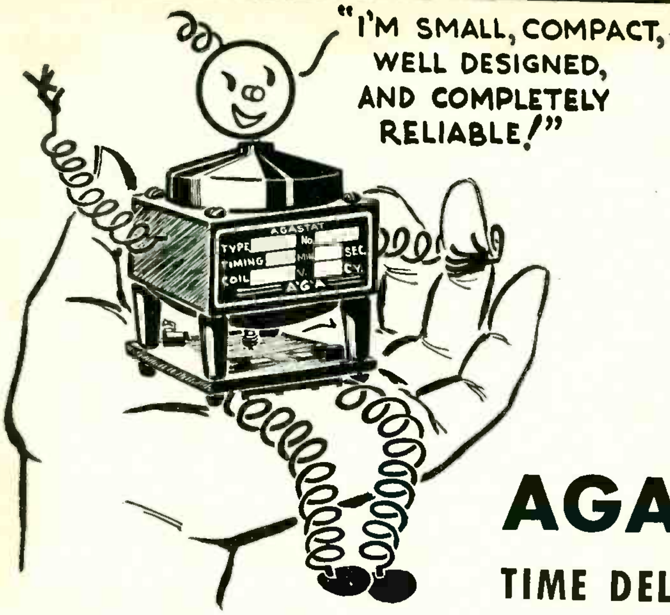


### Phase Meter

THE W. L. MAXSON CORP., 460 W. 34th St., New York 1, N. Y. Model P-1060 phase meter, originated as an aid to design of single-sideband transmitters by the U. S. Air Force, provides means for precise determination of phase relationships throughout the audio spectrum of 30 to 20,000 cps. The instrument is accurate to 0.1 degree. Its self-calibrating feature permits the operator quickly to check accuracy without recourse to complex calibrating apparatus and techniques. The power supply for the electron-tube circuits is integral with the instrument chassis. It is designed to operate from an unregulated 105 or 125-volt, 60-cycle circuit.

### Oscillograph Tube

RADIO CORP. OF AMERICA, Harrison, N. J. Model 7JP1 is a 7-in. c-r tube of the electrostatic focus and deflection type designed to provide excep-




# AGASTAT

## TIME DELAY RELAY

Solenoid actuated – pneumatically timed. For AC and DC service. A special diaphragm and cap encase the head, providing an enclosed, dustproof timing chamber in which the air used for timing is recirculated. Low cost with dependability.

A'G'A AIRPORT LIGHTING · A'G'A STIMSONITE REFLECTORS · A'G'A MARINE LIGHTING EQUIPMENT · A'G'A AGASTAT TIME DELAY RELAY

**AMERICAN GAS ACCUMULATOR COMPANY**
1027 NEWARK AVENUE · ELIZABETH 3, N. J.

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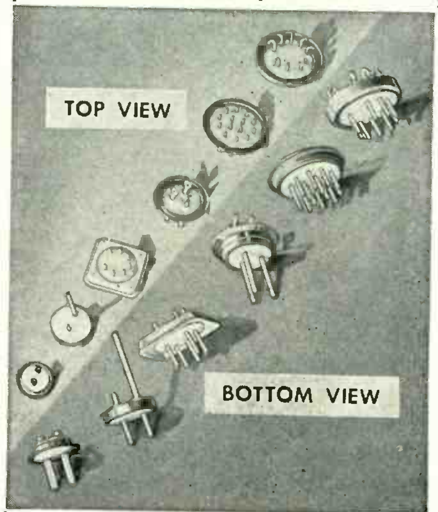
● JANUARY, 1950 ●




## Quality plus unlimited shapes

The only seals you can hot tin dip at 525°F. for easy assembly soldering, for a strain and fissure-free sealed part with resistance of over 10,000 megohms!

Hermetic headers withstand high vacuum, high pressure, temperature cycling, salt water immersion and spray etc., and are used extensively by America's leading industries and government agencies.

**TERMINALS AND HEADERS ARE AVAILABLE IN RMA COLOR CODE**

*Free!*


Write for your copy of the most complete catalog ever produced on hermetic seals.

**HERMETIC SEAL PRODUCTS COMPANY**
31-33 So. Sixth St., Newark 7, N.J.

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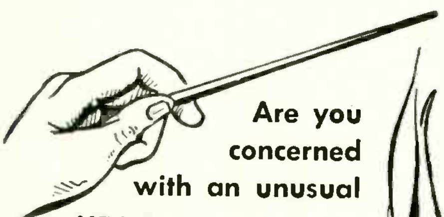
**HEAT RESISTANT WIRES FOR EVERY APPLICATION . . .**



**Are you concerned with an unusual HEATING PROBLEM?**

We make a specialty of insulated resistance wire. Perhaps we can help you. We can furnish either straight wire or flexible core wound elements. Our heat resisting insulations are supplied in glass, asbestos or combinations. Write or call us about your problem.

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- HEATING ELEMENT
- RESISTANCE LINE CORD
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- ASBESTOS LEAD & FIXTURE WIRE
- INSULATED RESISTANCE WIRE
- FIBERGLAS INSULATED WIRE
- WIRE TO ANY SPECIFICATIONS

*Send your electronic control, communications or appliance wiring specifications for a recommended solution by our engineers.*

FOR A TRIAL ORDER OR A CARLOAD *consult*

**THE LEWIS ENGINEERING CO.**
*Wire Division*
NAUGATUCK CONNECTICUT

tional brightness when operated with an anode-No. 2 voltage near the maximum of 6,000 v, and good brightness at anode-No. 2 voltages as low as 1,500 to 2,000 v. It uses an electron gun which has a grid No. 2 operated at anode-No. 2 potential so that the beam current and grid-No. 1 cutoff voltage will not be affected by focusing adjustment. The gun also has an anode No. 1 which takes negligible current.

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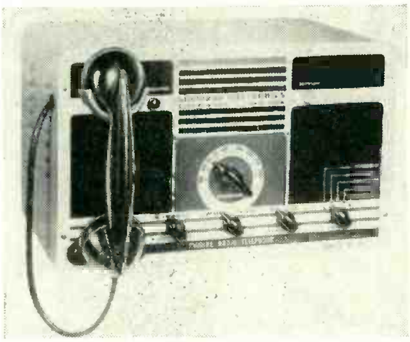


## Marine Radios

STANDARD ELECTRONICS CORP., 25 W. 43rd St., New York 18, N. Y., is producing four types of marine radios ranging in power from 12 to 80 watts and designed to cover pleasure and commercial craft requirements. The 12-watt unit for small boats includes a standard broadcast band that can pick up all radio broadcasts available from shore. Another model, 15 in. wide × 9 in. deep, operates at 35 watts and has 5 channels. The 50 and 80-watt units both have six transmitting and receiving channels. All operate on low battery drain and feature complete high-precision low-drift crystal control of each transmitting and receiving channel.

---

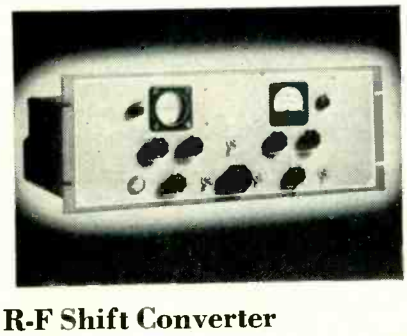
## Null Detector and VTVM

THE FREED TRANSFORMER CO., INC., 1718–36 Weirfield St., Brooklyn 27, N. Y. The No. 1210 null detector and vtvm has been designed for a-c

bridge measurements. It provides simultaneous measurement of the voltage across the unknown and the balance of the bridge. The vtvm has a sensitivity of 0.1, 1, 10 and 100 volts. Input impedance is 50 megohms shunted by 20 $\mu\mu$f. Frequency range is from 20 cycles to 20,000 cycles. Null detector gain is 94 db.

**Multiplier Photometer**

PHOTOVOLT CORP., 95 Madison Ave., New York 16, N. Y. Series 520 line-operated supersensitive electronic multiplier photometer is designed for the exact measurement of extremely low light values down to 1/10,000 microlumen. The model 520-A illustrated is intended primarily for density measurements. It has an indicating meter of logarithmic response. The top scale of the meter is calibrated in optical density and has approximately uniform divisions of 0.02 density. The bottom scale is a photometric scale that reads light intensities in arbitrary units from 0 to 100. Bulletin 360 gives a complete description and price list for the line.



**R-F Shift Converter**

NORTHERN RADIO CO., INC., 143 W. 22nd St., New York 11, N. Y. Type 107 model 2 radio-frequency shift

Another
PRECISION
PRODUCT

# FOLLOW THE PARADE TO THE *New* Burlington *Hermetically Sealed* INSTRUMENT

**JUST PLAIN RUGGED**
. . . yet an instrument of highest QUALITY
. . . PRECISION
. . . ACCURACY

The Burlington "Hermetically Sealed" *Instrument* was designed and is manufactured to conform to JAN specifications for sealed *instruments.*

- Steel case with heavy copper-cadmium plate and black finish.
- Excellent shielding due to case material and construction.
- Double strength clear glass.
- Black satin onodized aluminum bezel.
- Glass to metal seal under controlled humidity and temperature conditions.
- D'Arsonval permanent magnet type movement for DC applications.
- Designed to enhance panel appearance.
- Available in 1½" square, 2½" and 3½" round case types.
- Guaranteed for one year against workmanship and materials.


Best Buy Burlington

**BURLINGTON INSTRUMENT COMPANY**
DEPT. F-11, BURLINGTON, IOWA

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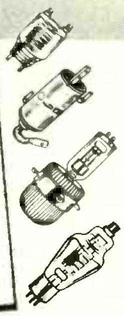
# ALLIED world's largest distributor of RCA ELECTRON TUBES FOR INDUSTRY

**All types in stock**
- Vacuum Power Tubes
- Thyratrons
- Vacuum & Gas Rect.
- Ignitrons
- Cold-Cathode Tubes
- Phototubes
- Oscillograph Tubes
- Camera Tubes
- Monoscopes
- Special Tubes



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ALLIED maintains *in stock for quick shipment* the world's largest inventory of RCA special-purpose electron tubes—*of all types.* We specialize in supplying the tube needs of industrial, broadcast, governmental and other users. Shipments are made *from stock* to any part of the nation within hours after we receive your order. Save time, effort and money—fill *all* your tube needs from a *single, dependable source.*

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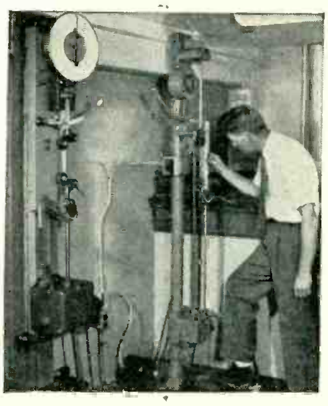
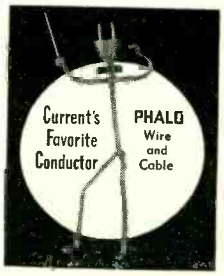
# PHALO OFFERS ASSURED QUALITY



All PHALO plastic insulated wire and cables, cord sets and other assemblies assure quality performance. The latest testing methods guarantee this fact.

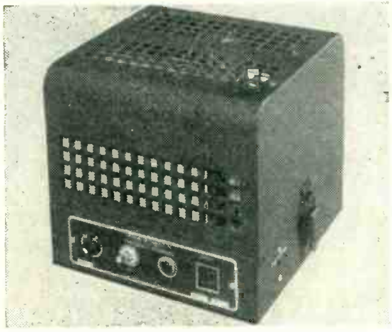



Look For The PHALO trademark
*Ask For The New PHALO catalog*

**PHALO**
*Plastics Corporation*

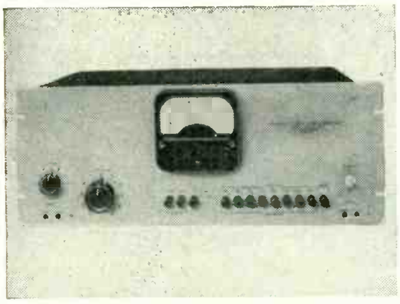
Corner of Commercial Street
Worcester, Mass.

converter is a dual-channel unit which converts mark and space tones into d-c pulses and drives teleprinters, tape and other recorders directly. Its integral 2-in. oscilloscope provides an outstanding tuning pattern for precise receiver adjustment during initial setup and while keying. It is capable of keying speeds up to 600 wpm. The unit also features 100 to 1,000-cps frequency shift. Mark frequency is set at 2,975 cps.



**Frequency Standard**

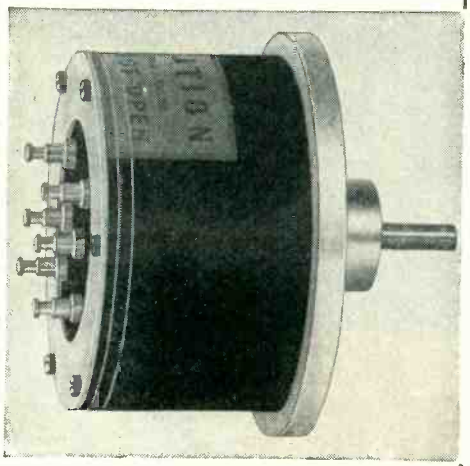
AMERICAN TIME PRODUCTS INC., New York City, N. Y. Type 2005 frequency standard is a compact source of accurate frequency at a commonly needed power level. It is useful in running small motors, timers and clocks; also in making frequency measurements, providing timing marks in oscillographs and high-speed cameras. Output frequency is 60 cycles, accurate to 1 part in 100,000 in a temperature range from 0 to 60 C. Output power is 10 watts at 115 volts approximate sine wave. Input is 115 volts, 50 to 400 cycles at 45 watts.



**Distortion and Noise Meter**

DAVEN CO., 191 Central Ave., Newark 4, N. J. Type 35-A distortion and noise meter provides a rapid accurate means of measur-

# PRECISION POTENTIOMETERS



A minor modification of the standard sinusoidal potentiometer type RL-11-C (as illustrated) permits operation up to 1800 RPM. After a test of 28 million cycles at 1800 RPM, one of these units showed negligible wear.

Various types of potentiometers custom wound to specifications are available. They feature extremely close limits in electrical characteristics and mechanical construction, low electrical noise, low torque, and long life.

All types will operate within specified limits of performance at temperatures —55° C. to +55° C., 95% relative humidity at altitudes up to 50,000 feet. Corrosion resistant materials are used throughout and all insulating parts are fungicided. Our potentiometers meet AN-E-19 specifications.

We invite your inquiries and specifications.

***Write for Bulletin F-68.***

**THE GAMEWELL COMPANY**

**Newton Upper Falls 64, Massachusetts**

TRADE MARK GAMEWELL REG. U.S. PAT. OFF.

# ACTUAL TESTS

***PROVE***

## JK H17 Crystals Are Truly Hermetically Sealed!

There's no room for doubt! Every JK H17 Crystal described as hermetically sealed is actually immersed in 95° C water as an actual test!

This, and many other rigorous tests, guards the quality of JK stabilized crystals all down the line.

JK makes a crystal to fit every industrial, broadcast, communication and amateur need.

Send today for your copy of the JAMES KNIGHTS Crystal catalog.

## JK Stabilized H17

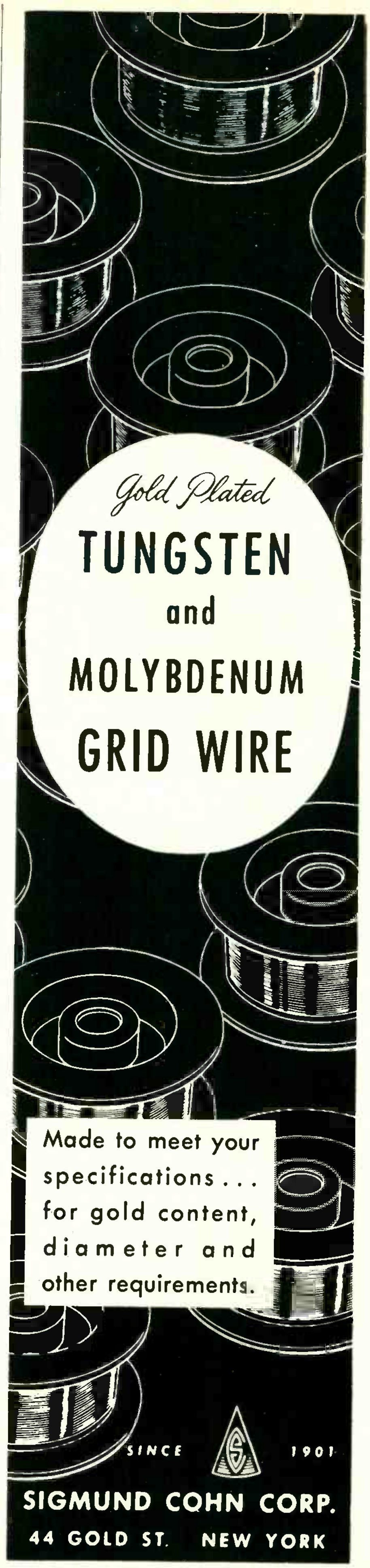
Frequency range 200 kc to 100 mc. The pin spacing is such that two units can be mounted in a loctal socket. A small extremely light weight hermetically sealed unit. Moisture and dustproof. Designed especially for use where space is at a premium. The crystal is plated and wire mounted. Pin diameter of the H17 is .050".

The H17L and the H17W are also available in the same frequency range. The H17L has a pin diameter of .093", and the H17W has wire leads.

CRYSTALS FOR THE CRITICAL JK

*The James Knights Company*

SANDWICH, ILLINOIS



ing distortion, noise and hum level in audio-frequency equipment. No balancing or time-consuming tuning is required to make measurements. A pushbutton balances the unit automatically. The fundamental circuit of the meter comprises a series of eight fixed band rejection filters covering the 50-cycle to 15-kc range, followed by a stable, high-quality, wide-range (50 cycles to 45 kc), high-gain amplifier. Two amplifier gain controls are provided—one a step type covering the range +40 to -60 in 10-db steps; the other a continuously variable control covering the ± 10-db range.

---

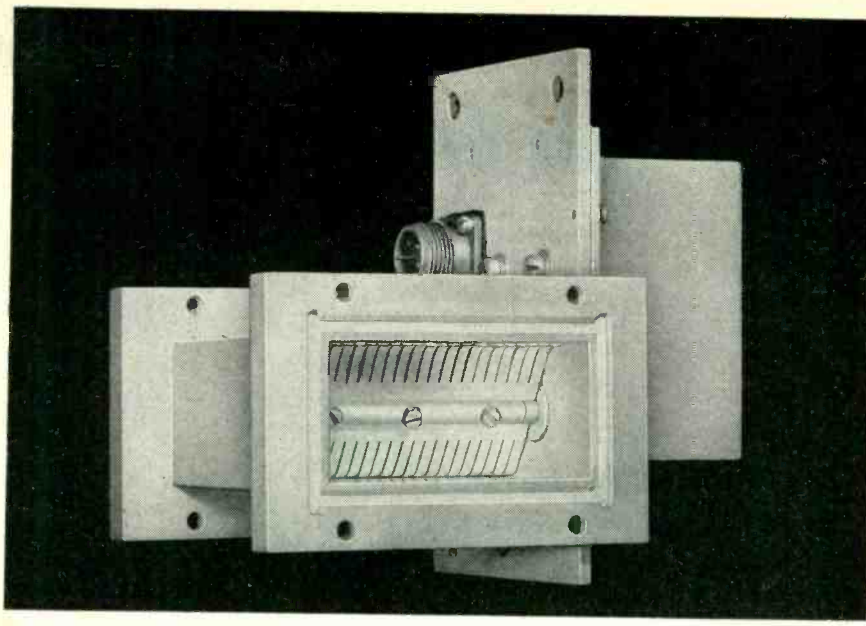
### Frequency Standard & Test Set

FREED TRANSFORMER CO., INC., 1718-36 Weirfield St., Brooklyn, N. Y., have introduced the model 1360 frequency standard and test set. It consists of a crystal-controlled oscillator, a modulator and a c-r oscilloscope for observation of Lissajous figures. Accuracy is better than 2 cycles or 0.1 percent, whichever is greater. Main advantages are the ease of adjustment procedure and the fact that any low-frequency oscillator can be used as an audio-frequency source for alignment of telemetering equipment. Catalogs and price lists are available.

---

### Tape Recording Head

SHURE BROTHERS, INC., 225 W. Huron St., Chicago, Ill. Model TR5 tape recording head combines the functions of record, playback and erase in a single unit with excellent frequency response and output level. A special feature is the use of a deep-drawn mu-metal shield for optimum hum reduction. Record and playback coil impedance is







1,650 ohms at 1,000 cps, while erase coil impedance is 1,000 ohms at 40 kc. Output level is 5 db above 1 mv at 1,000 cps at tape speed of 3.75 in. per second. Overall dimensions are 0.685 in. maximum height, 1.240 in. wide and 1.031 in. deep.

## Amplifier Kit

TRIAD TRANSFORMER MFG. CO., 2254 Sepulveda Blvd., Los Angeles 64, Calif., has introduced the HF-10 amplifier, produced especially for those who like to build their own sound reproducing systems. It features a frequency response within 1 db from 20 to 20,000 cycles. Distortion is less than 2 percent from 50 to 18,000 cycles at full 10 watts output; less than 1 percent from 20 to 20,000 cycles at 5 watts. Gain is 74 db from crystal microphone or radio receivers, 96 db through preamplifier. Complete specifications, circuit diagram and prices are shown in bulletin HF-10.

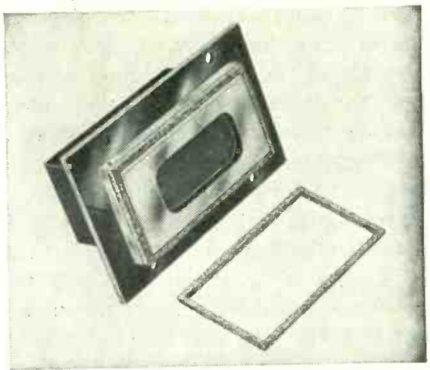
## Counting Rate Meter

RADIOACTIVE PRODUCTS, INC., Detroit 26, Mich., announces the model C-2, 3 counting rate meter for use with Geiger tubes. The instrument has application in monitor installations and also in the recording of x-ray diffraction patterns and other transient phenomena. Pulse inte-

**"We have found Metex Electronic Gaskets excellent for HF currents inexpensive to assemble."**
Sylvania Electric Products Inc.

Sylvania has been using Metex gaskets for over a year as conductive shields for their TR tubes used in radar and micro-wave ranging equipment.

To quote their experience: "We have found Metal Textile knitted wire gaskets excellent for conducting high frequency currents without boundary arcing. The gaskets are resilient, and yet do not deform too readily. Best of all, the material is inexpensive to assemble through soft soldering techniques."



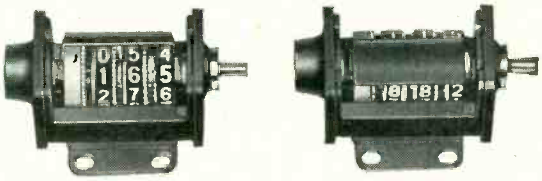
A Sylvania Electric TR tube showing Metex gasket loose and in position

The properties—electrical and physical—which make Metex Electronic Gaskets effective in this, and other demanding HF and UHF applications are due to their being made from *knitted* (not woven) wire mesh. The hinge-like action of the knitted mesh permits controlled resiliency of the finished gaskets. These can be die-formed to close dimensional tolerances, when required. There is practically no limit to the metal or alloy which can be used.

If the equipment you are manufacturing or designing requires a resilient conductive or shielding material, our engineers will welcome the opportunity of working with you. A letter, addressed to Mr. R. L. Hartwell, Executive Vice President and outlining your requirements, will receive immediate attention.

**METAL TEXTILE CORPORATION**
641 EAST FIRST AVE., ROSELLE, N. J.

# PRODUCTIMETER "SPECIALS"
## for Radar and Electronic Applications



Companion shutter counters used as dual direction indicators. One counter adds while the other subtracts. Shutter blanks out counter which is on negative side of 000.

"Y" 2-figure Rotary Counter used in navigating instruments.

High-speed, non-reset "Y" type counter for building into radar instruments.

Special Model "Y" with window at rear designed for use in radar equipment.

These are a few of the "specials" developed by Durant for Radar and Electronic applications. When one of the many standard Productimeters is not the exact answer to a problem, Durant engineers modify, combine, or develop entirely new counters to meet the particular requirements of the job.

Write for Bulletin

**DURANT MFG. COMPANY**
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112 Orange St., Providenes 3, R.I.
Representatives in Principal Cities

**PRODUCTIMETERS**
SINCE 1879
*Speedometers* OF INDUSTRY

# COSTS LESS *because it's best*

**A CHIEF ENGINEER SAYS:** . . . have been using the Fairchild Tape Recorder constantly . . . over 5000 hours now . . . practically no maintenance . . . get more work done in less time . . . optimum performance always . . . has operating features no other equipment has . . . my men work faster . . . without fatigue . . . has literally paid for itself . . . front office thinks I'm a magician!

**FROM THE FRONT OFFICE:** . . . tried to get along with cheaper tape recorders . . . looked good but didn't hold specs or stand up for long . . . Fairchild gives my customers better recordings . . . brings me more customers . . . can do shows now we couldn't with other recorders . . . brought in new sponsors . . . and my engineers' budget asks almost nothing for maintenance . . . how soon can we get delivery on another unit? . . . regret we didn't get the Fairchild Tape Recorder sooner!

**WE HAVE FAIRCHILD TAPE RECORDERS:** Columbia Records (N.Y.) • CBS-TV (N.Y. and Hollywood) • Reeves Sound Studios (N.Y.) • WJR (Detroit) • U. S. Signal Corps Photographic Center (L.I. City) • Italian Broadcasting System (Rome, Turin, Milan) • General Motors (Detroit).


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WHITESTONE, N. Y.

Send Bulletin TR-2 About
FAIRCHILD PROFESSIONAL TAPE RECORDERS

My Name ..................................
Company ..................................
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..................................

FR-120

grating circuit of the Geiger-tube power supply is adjustable to full-scale ranges from 100 to 50,000 counts per minute. Response time of the circuit is independently variable from 480 seconds to 0.1 sec. Better than 1-percent circuit linearity has been achieved and provisions for driving an external recording meter are provided.

---

### Dynamic Pressure-Measuring System

SIERRA ELECTRONIC CORP., San Carlos, Calif. Phase and amplitude errors arising from flexible-tube connection of pressure cells used in dynamic measurement are eliminated in the new flush-mounted cells by elimination of the tubing connections themselves. Cells mount directly in the surfaces upon which the measured pressures impinge. Having a natural frequency of approximately 2,400 cps, the cells exhibit a uniform frequency response between 0 and 250 cps. Units are listed with these sensitivities: 0 to ± 2.5 psi, 0 to ± 5 psi and 0 to ± 10 psi. Phase accuracy throughout is better than ± 0.2 deg. The equipment is particularly applicable to the measurement of instantaneous aerodynamic forces.

## Literature

**Deflection Amplifier.** Sylvania Electric Products, Inc., Emporium, Pa. Three loose-leaf perforated catalog sheets cover the type 6BL7GT duotriode deflection amplifier. Included are ratings, typical operating conditions, physical specifications, circuit applications and characteristics charts.

**Switch Listings.** Unimax Switch Division, The W. L. Maxson Corp., 460 W. 34th St., New York 1, N. Y. Makers and designers of equipment for the armed forces will find useful information about precision, snap-acting switches in the interchangeability guide recently issued. It is pictorially indexed with outline drawings of switches used in aircraft and other applications requiring precise control or

**NATIONAL**

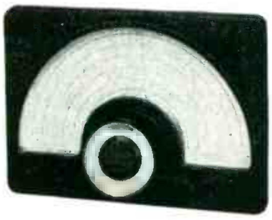
- **Proven**
- **Dependable**
- **Quality**

MCN

SCN

ACN

ICN



## POPULAR NATIONAL DIALS

ACN—the original design so popular with manufacturers, amateurs and experimenters who "build their own" and desire direct calibration, 5" H. x 7¼" W. $3.30 net. ICN—an illuminated version of the ACN, 5⅛" H. x 7¼" W. $6.00 net. SCN—same dial scales as ACN in reduced size, 4 7/16" H. x 6¼" W. $3.00 net. MCN—scaled down dial, ideal for mobile installations and small converters, 2¾" H. x 3⅞" W. $2.70 net.

**Export Div., Dept. E-151**

**National**

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**NATIONAL COMPANY, Inc.**
MALDEN, MASSACHUSETTS

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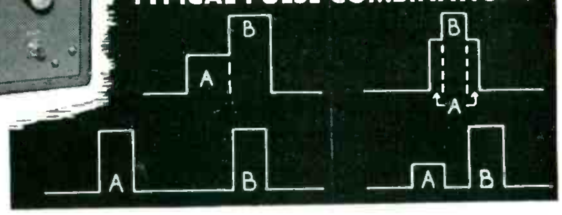
THE *Berkeley*
MODEL 902
# DOUBLE PULSE GENERATOR

**TYPICAL PULSE COMBINATIONS**




**BRIEF SPECIFICATIONS**

PULSE DURATION individually adjustable from 0.15 to 1.5 microseconds; RISE TIME is .05. DECAY TIME 0.10 microseconds. SPACING between pulses variable from —0.5 to +10 microseconds. REPETITION RATE adjustable in 3 ranges, 1 to 10, 10 to 100 and 100 to 1000 cycles; can be externally triggered. OUTPUT IMPEDANCE approximately 400 ohms, maximum output voltage,—200 v. CONTROL CALIBRATION ACCURACY ± 5% over entire range.

The Berkeley Double Pulse Generator produces two pulses individually controllable in width, amplitude and time relation to each other. Pulse amplitude is individually adjustable without cross effect from 0 to +50 v. and 0 to −200 v. A fine control, plus a 10 to 1 step attenuator permits varying the amplitude of both pulses after mixing.

TYPICAL APPLICATIONS...Resolution tests of high speed scaling circuits, response simulation of scintillation and proportional counters, evaluation of electronic gate and switch response, TV equipment testing, characteristic checks of wide band amplifiers, etc.

COMPLETE INFORMATION *is yours for the asking; please request Bulletin E-902.*

*Berkeley Scientific Corporation*
**2200 WRIGHT AVE. • RICHMOND, CALIF.**

---

**KENYON** *Fits Your Production To A* **"T"**

**KENYON** "T's"—high quality, uniform transformers, are your best bet for development, production and experimental work. For over 20 years, the KENYON "K" has been a sign of skillful engineering, progressive design and sound construction.

Now — reduce inventory problems, improve deliveries, maintain your quality — specify KENYON "T's," the finest transformer line for all high quality equipment applications.

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**KENYON** new modified edition tells the complete story about specific ratings on all transformers. Our standard line saves you time and expense.
Send for your copy of our latest catalog edition *now!*

**KENYON** TRANSFORMER CO., Inc.
840 BARRY STREET • NEW YORK 59, N. Y.

limit switching, lists AN numbers and gives the corresponding company type numbers.

**Radio In Petroleum Industry.** General Electric Co., Syracuse, N. Y., has available a new booklet covering broadly the use of two-way radio in the petroleum industry. It treats the general uses of two-way equipment, types of systems, licensing regulations, equipment capabilities, special installations, relaying, costs of installations and savings experienced by operators using two-way radio in their work.

**Regulated Power Supply.** Oregon Electronics, 206 S. W. Washington St., Portland 4, Oregon. Bulletin 53 covers the model D6 dual-output, heavy-duty, regulated power supply. The unit treated supplies d-c continuously variable from 0 to 600 v at 400 ma. Chief features and technical specifications are given.

**Lever Key.** Circuit Controls Co., 3201 Peoria St., Steger, Ill. A single-sheet bulletin describes the model 1 lever key intended to be used in medium-duty multiple-circuit switching. Illustrations, typical applications and general ordering information are included.

**Rotary Switches.** Electro Switch Corp., 167 King Ave., Weymouth 88, Mass. Rotary multiple tap and transfer switches that conform to Navy and Underwriters' Laboratories requirements are described in catalog 1950-JR. Sectional, cutaway and exploded views of typical switches show details of the design. Contact possibilities shown include single- and double-break as well as shorting and non-shorting action. Four-, eight- and sixteen-position switches are listed.

**Audio Equipment.** Sun Radio & Electronics Co., Inc., 122-124 Duane St., New York, N. Y., has ready for distribution the new edition of its 100-page audio equipment handbook. A large section is devoted to questions and answers most common to high-fidelity aspirants or owners. The balance of the handbook contains listings, prices and information on hundreds of components and subas-

semblies relative to high-fidelity music reproduction.

**Radio Hook-Up Wire.** Rome Cable Corp., 330 Ridge St., Rome, N. Y. Three data sheets describe the various standard types of radio hook-up wires now available. Those included are Underwriters' Laboratories approved thermoplastic types for 90 C and 80 C temperatures, rubber-insulated types for 75 C temperature and military approved types WL, SRIR, SRHV, SRI and SRIB. The insulation thicknesses and coverings as shown in the tables are required on approved types, or as noted.

**Relay Catalog.** Potter & Brumfield, 221 N. Main St., Princeton, Indiana. The 24-page catalog 109 contains new information on relays, shaded-pole motors and timers. Its comprehensive presentation facilitates ordering procedure, offers valuable assistance in development problems and in selecting the proper type relay to meet every requirement. Fully illustrated, the catalog contains pictures and schematic drawings of over 150 models, showing accurate over-all and mounting dimensions. Easy-to-read charts list complete coil and contact data on every relay.

**Insulation Tape.** Insulation Manufacturers Corp., 565 W. Washington Blvd., Chicago 6, Ill. Complete application and technical data on Silastic tape, Type R class H electrical insulation are given in bulletin 680. The type described, made by coating woven glass cloth with a partially vulcanized silicone rubber, is an extremely flexible insulation combining the heat stability qualities of the silicones, the resilience of rubber-like materials and the excellent physical and noninflammable properties of glass.

**Portable F-M Radiotelephone.** Doolittle Radio, Inc., 7421 S. Loomis Blvd., Chicago 36, Ill., has issued a 2-page bulletin on the Littlefone portable f-m radiotelephone that now provides increased power and range to facilitate 2-way communication in many fields of operation. The unit described

contains a 10-tube f-m transmitter and ultrasensitive 12-tube receiver that are both crystal-controlled. It is powered by self-contained lightweight storage batteries that may be recharged from 6-volt car battery or 115 volts a-c.

**Acrylic Extrusion Molding Powder.** Rohm & Haas Co., Washington Square, Philadelphia 5, Pa., has published a technical bulletin showing the recent modifications in Plexiglas VM acrylic molding powder that have made it as easily handled for extrusion as for injection molding. Physical properties of the powder described are unchanged but the improved formulation makes possible extrusions by standard techniques, with oven drying usually sufficient.

**Tube Data.** Sylvania Electric Products Inc., Emporium, Pa. Three recent technical data bulletins cover the type 5845 emission limited control diode, type 6CD6G beam power amplifier and type 6W6GT beam power amplifier respectively. Ratings, typical operating conditions, circuit applications, physical specifications and characteristics charts for each are given.

**Spectrum Analyzer.** Vectron, Inc., 235 High St., Waltham, Mass. A recent 2-page bulletin describes the spectrum analyzer, a superhet receiver with a 5-in. c-r oscilloscope output indicator. An illustration of the unit is included, and its chief uses and technical specifications are given.

**Miniature Test Equipment.** Oak Ridge Products, 239 E. 127 St., New York 35, N. Y., has literature available on its line of miniature test equipment. It includes mailing pieces, a reprint of an advertisement and a reprint of a technical article dealing with the model 103 signal generator; model 101 substitution tester and model 102 high-voltage meter. Chief features, technical data and prices are shown.

**Transmitter Kit.** E. F. Johnson Co., Waseca, Minn. Catalog 705 is a four-page treatment of the Viking I transmitter kit, a completely

designed and engineered transmitter furnished unassembled but complete in every detail including wiring harness and ample assembly instructions. A circuit diagram of bandswitching the 10 to 160-meter transmitter is included.

**Fast Pulse Amplifier.** Hewlett-Packard Co., 395 Page Mill Road, Palo Alto, Calif. Volume 1, No. 11 of the Journal is a well illustrated description of the model 460B fast pulse amplifier, which is designed for a maximum output level of 125 volts open circuit—high enough to give more than full deflection on the type 5XP- c-r tube or a 2-in. deflection on a type 5CP- tube. Prices for the unit and its various accessories are shown.

**F-M & TV Antenna.** Tricraft Products Co., 1535 N. Ashland Ave., Chicago 22, Ill. Technical information on the new P-38 unidirectional f-m and tv antenna is found in a single-page bulletin. Among the features of the unit described are peak reception on all channels, seven separate and distinct radiating elements, and a 23-degree beam which rejects ghosts, interference and noise.

**Cathode-Ray Tubes.** Sylvania Electric Products Inc., Emporium, Pa., has published a 12-page booklet tabulating characteristics of 194 c-r tubes for tv receivers, oscilloscope and radar applications. The tubes described include 103 designed for magnetic deflection and 91 electrostatic types with screen sizes ranging from 2 to 22 inches. Data supplied includes: heater current and voltage; nominal dimensions, basing, persistence and fluorescence of screen; maximum design center ratings; and typical operating conditions.

**TV Field Equipment.** Radio Corp. of America, Camden 2, N. J. Form 2J-6881 is a six-page illustrated folder giving information on the company's latest field tv equipment, including an improved friction head, a new tripod, new field desk, and a rotatable mount and remote control for microwave parabola.

**Radioactivity Measurement.** Landsverk Electrometer Co., Pip-

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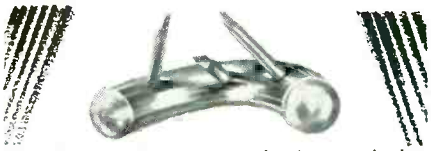

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| C 22 | 5.5 | 184 | 2.8 | 0.44 |
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pin Road, Cincinnati 31, Ohio. The model L-75 analysis unit, an instrument for radioactivity measurement, and its accessories are illustrated and described in bulletin A-2. Construction, operation, sensitivity and advantages, as well as other uses of the unit, are discussed.

**Testing Facilities & Services.** Inland Testing Laboratories, 2745 Janssen Ave., Chicago 14, Ill., announces a new 24-page, fully illustrated brochure covering the test facilities, equipment and their capabilities of an organization specializing in complete qualification testing of components and assemblies made under government contracts in accordance with military specifications.

**Pressuregraph and Supplementary Instruments.** Electro Products Laboratories, Inc., 4501 North Ravenswood Ave., Chicago 40, Ill. This bulletin gives features and specifications for the company's Pressuregraph, Syncro-Marker, and Dynamic Micrometer. Illustrations of the equipment are shown.

**Vibration Test Equipment.** The Calidyne Co., 751 Main St., Winchester, Mass. Bulletin No. 4401 describes the company's model 44 Shaker and its associated rotary power supply and console, models 45A and 45B. Included are installation details, a listing of outstanding features of the equipment, and guaranteed performance curves.

**Television Equipment.** Polarad Electronics Corp., 100 Metropolitan Ave., Brooklyn 11, N. Y., has issued a new catalog on television equipment for broadcast, manufacturer and laboratory use. It fully describes in 14 pages a line of television cameras, synchronizing generators, monitors, tv amplifiers and tv power supplies designed for broadcast operation.

**TV Antenna Gain Chart.** Technical Appliance Corp., Sherburne, N. Y. Engineering bulletin No. 64 contains actual measurements in db gain over half-wave dipoles for all popular antenna types. It is helpful to the serviceman in select-

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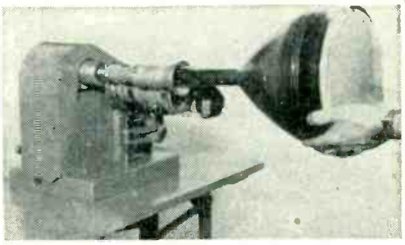
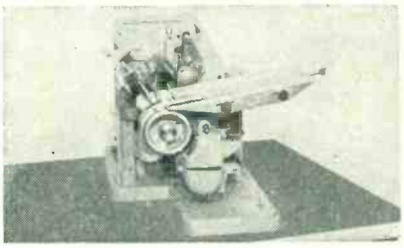


**The MARKEM 13A** — imprints the base of television and cathode ray tubes. It holds the tube completely immobile during the printing operation . . . uses sturdy rubber plates with quick-drying, heat-resistant inks.



**The MARKEM 20A** — marks radio tubes, miniatures, resistors, capacitors, and other cylindrical objects clearly, durably with Markem rubber plates and quick-drying, heat-resistant inks.

**Type changes can be made on either machine in seconds. Both make attractive, legible imprints and will not damage the most fragile surfaces. Write today, describing the components you are marking, and we'll send facts and costs about the machine best suited to your needs.**

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ing the antenna type for specific areas in relation to channels operating and signal strength.

**Quantitative Measuring Instrument.** Allen B. Du Mont Laboratories Inc., 1000 Main Ave., Clifton, N. J. Form 10014-WP is an 8-page bulletin treating of the type 303 quantitative 10-mc c-r oscillograph, an instrument which incorporates circuits for the accurate calibration of time as well as amplitude. Specifications, chief features, and circuits (amplifiers, sweep and sync, and calibrator) are included.

**F-M Communications Monitor.** Hewlett-Packard Co., 395 Page Mill Road, Palo Alto, Calif. Volume 1, No. 12 of the Journal deals with the model 337 monitor for f-m communications services. The instrument described directly measures and continuously indicates both the carrier frequency and modulation deviation of an f-m transmitter operating in the range from 30 to 175 mc. Circuits and technical specifications are included.

**Instrumentation Data.** Minneapolis-Honeywell Regulator Co., Brown Instruments Division, Wayne and Windrim Aves., Philadelphia 44, Pa. Instrumentation data sheet No. 9.1–3 describes in a 4-page folder methods for accurate and rapid measurement of useful power with a check on reactive power to prevent overloading of generators. The system under discussion provides a continuous record of the power output of individual generators, the station and the system total.

**Automatic Sample Counter.** Special Instruments Laboratory, Inc., 1003 Highland Ave., Knoxville, Tenn. A single-sheet bulletin discusses the model 101 Auto Analyzer, designed to solve the problems encountered in accumulating large quantities of data from radioactive samples. The radioisotope analytical instrument described costs $2,725.

**Magnetic Tape Recording.** Amplifier Corp. of America, Twin-Trax Division, 398 Broadway, New York

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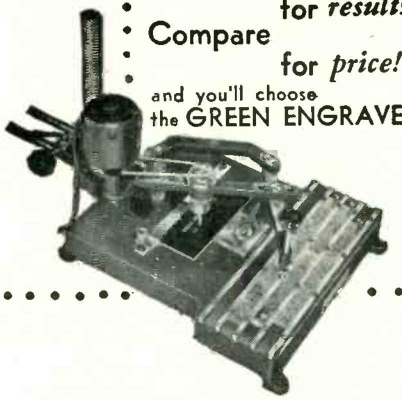
13, N. Y. A recent 128-page booklet and its 16-page supplement cover the elements of single and dual-track magnetic tape recording, as well as its applications. Among the 21 chapters are discussions of the recording process, playback process, erase process, unique magnetic tape phenomena and the inherent advantages of magnetic recording. Price of the profusely illustrated booklet is one dollar.

**Controls and Resistors.** Clarostat Mfg. Co., Inc., Dover, N. H. Catalog No. 50 offers a choice of resistors, controls and resistance devices. Cataloged resistors include cement-coated power resistors, flexible glass-insulated resistors, plug-in ballasts and voltage dividers, and automatic line-voltage regulators. Other items are tv beam benders, constant-impedance output attenuators, L-pads, T-pads and the handy power resistor decade box.

**Hum Eliminator.** Kalbfell Laboratories, Inc., 1076 Morena Blvd., San Diego 10, Calif. A recent mailing piece covers the model 503A bridged-T filter that is specially designed for use at the input terminals of a vtvm or c-r oscilloscope. The filter described attenuates hum at least 50 db. Special features, applications and prices are given.

**Rosin Core Solder.** Anchor Metal Co., 87 Walker St., New York 13, N. Y., has issued a bulletin on Shurflo rosin core solder, a new development in cored solders bringing together a superior rosin flux with virgin metals making a combination that is particularly adapted to all solder connections where corrosion is an important factor. Chief advantages and properties of solders are shown in the single-sheet bulletin.

**Pocket Reference Book.** Radio Corp. of America, Harrison, N. J., has completed the 1951 edition of its pocket reference book giving basic data on tubes, electronic components, test equipment, batteries and miniature lamps. A special feature in the new edition



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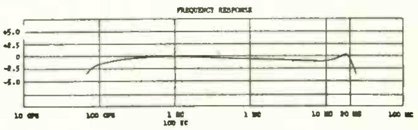
This unit is designed for use as an oscilloscope deflection amplifier for the measurement and viewing of pulses of extremely short duration and rise time, and contains the Video Amplifier Unit, Power Unit and a low Capacity Probe.



**Specifications**

Input Impedance: Probe—12 mmf + 470,000 ohms; Jack—30mmf + 470,000 ohms; Output Impedance 18mmf + 470,000 ohms each side push pull; Max. Input Volts 500 peak to peak with probe; Max. Output Volts 120 volts peak to peak (push pull): Power: 115 volts 50/60 cps AC Line: Size 19¼"x22"x14¾".

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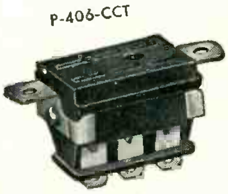

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is an authoritative article on tv trouble-shooting. Additional television information includes charts on tv channels and carrier frequencies, tv signal data, tv receiver alignment, test-pattern analysis and air-path distance of reflected signals. The section on electron tubes has also been completely revised.

**C-R Oscillograph.** Allen B. Du Mont Laboratories, Inc., 1000 Main Ave., Clifton, N. J., has available a two-page advertising reprint giving technical information on its type 303 quantitative 10-mc c-r oscillograph. The leaflet illustrates the instrument itself and includes a frequency response chart, an oscillogram, complete description of the unit and an outline of its chief advantages.

**Modulated Light Relay.** Electronic Control Corp., 1573 E. Forest Ave., Detroit 7, Mich., has devoted a 4-page folder to the modulated light relay, a photoelectric relay which is not affected by other sources of light; is not affected by smoke, fog, dust, or line-voltage variations; will operate over long distance, through furnaces or ovens, and on invisible light. An illustrated description, specifications, mechanical dimensions and ordering information are given.

**Aircraft Circuit Breakers.** Heinemann Electric Co., Trenton 2, N. J. The 8-page, 2-color bulletin No. 3300 describes fully magnetic, nonthermal aircraft circuit breakers, which will operate in a range of from −65 to 185 F, vibration proof for 10 G. The Aero-Magnette breakers discussed have definite instantaneous trip point independent of time-delay characteristics and are not affected by ambient temperature. Also included are ratings, time overload curves for a-c and d-c, suggested uses and diagrams giving specifications of available mountings, covers and handles.

**Selenium Rectifier.** Clark Electronic Laboratories, Palm Springs, Calif. A recent 4-page folder covers a selenium rectifier with ratings available from 5 to 500 kw at any voltage from 6 to 600 or

higher. The units described come complete in a steel cubicle containing rectifying plates, a dry-type transformer with class-B fireproof insulation, and control apparatus to fulfill the specifications desired.

**Infrared Pyrometer.** Hanson-Gorrill-Brian, Inc., One Continental Hill, Glen Cove, N. Y., has issued a single-sheet bulletin describing and illustrating its infrared pyrometer which measures temperatures of surfaces where physical contact methods and optical pyrometers are not usable. Accuracies of temperature measurements of the unit treated are within ±5 F. Chief advantages and prices are given.

**Subminiature Tubes.** Sylvania Electric Products, Inc., Emporium, Pa., has published data providing average characteristics of 30 commercially available subminiature electron tubes ranging from 0.200 in. to 0.383 in. diameter. Also provided in the characteristic chart are useful suggestions for mounting, shielding and application to obtain maximum life for tube types including those rated up to 5,000 hours. Two tables are also included for easy cross reference between experimental and RTMA type numbers and classification of types with respect to applications.

**Logarithmic Attenuator.** Kalbfell Laboratories, Inc., 1076 Morena Blvd., San Diego 10, Calif., has available a mailing piece dealing with the model 511B Logaten, a logarithmic attenuator with a dynamic range of 50 db. The unit described controls an ambient temperature range of 32 to 100 F. Technical data, chief uses and a price list are included.

**Power and Control Cable.** The Rome Cable Corp., Rome, N. Y., recently published a 60-page power and control cable catalog designed as a handy guide for easy selection and specification. It gives complete technical data, descriptions and recommended uses for the company's complete line. Considerable space is devoted to the subject of insulations and their applications and to approved shielding practices.

## NEWS OF THE INDUSTRY

(continued from page 134)

as instructors, technical writers, and professional engineers in the field of communications and electronics.

Although veterans are accorded preference, there are a sufficient number of openings to provide for the appointment of nonveterans who can qualify. Salaries range from $3,825 to $6,400 a year. Applicants for electronic engineering positions should have at least one year of professional experience in addition to an appropriate bachelor's degree or a master's degree for the salary of $3,825 a year. Additional experience may be qualifying for higher salaries up to $6,400.

Persons with 4 years or more of practical experience in the construction, maintenance or repair of radio or radar are especially needed for instructor positions. Men with teaching experience in addition to their technical background in these fields may be employed at salaries ranging from $3,825 to $4,600 a year. Openings are in microwave radio relay, radar, radio electronics, fixed station radio, central office techniques, teletype installation and maintenance, repeater and carrier, and dial central office techniques.

Technical writers with 3½ to 5½ years of experience in preparing reports, manuscripts or manuals dealing with electronics, radio, radar or communications may qualify for positions at salaries of $3,825 to $5,400 a year.

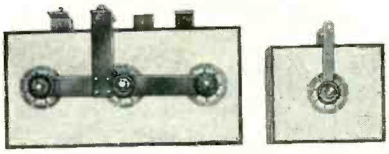
Applicants should complete Standard Form 57, which is available at any first or second class post office, and submit it to the Civilian Personnel Branch, Building T-530, Ft. Monmouth, N.J. For applicants who can report in person, interviews will be held between 8:00 a.m. and 3.00 p.m., Tuesday through Friday.

### IRE Elects Officers for 1951

ELECTION of Ivan S. Coggeshall, general traffic manager of Western Union Telegraph Company's overseas communications, as president of the Institute of Radio Engineers for 1951 was recently announced by the board of directors in New

# SYNTRON

## SELENIUM RECTIFIERS



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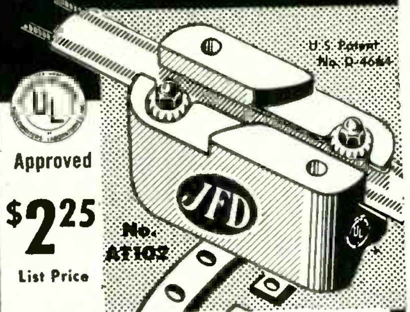


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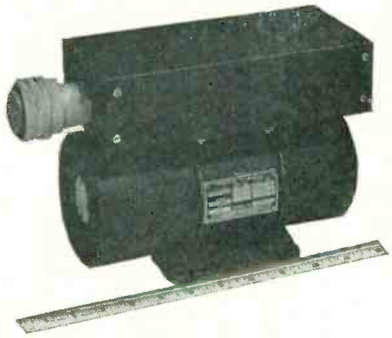

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Newly developed in the Carter research and engineering departments, this new rotary power supply is ideal for aircraft, geophysical, government and laboratory research, and other applications demanding a small, mobile source of up to 100 watts high frequency AC. Primarily designed for 24 - 29v. DC airborne equipment, but available at any input voltage 5.5v to 230v. Inductor principle eliminates slip rings and brushes. Electrically isolated input and output units. Separate DC plate output also available in addition to the h.f. AC.

WRITE for Bulletin #350. Contains complete illustrated information on the New Carter Inductor Alternator, mechanical and electrical specifications, performance chart, etc. Yours FREE for asking!

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I. S. Coggeshall

York. The new president has been active in the adoption of electronic methods and devices in the telegraph and submarine cable field. He will succeed Raymond F. Guy, manager of radio and allocation engineering of the National Broadcasting Company.

Jorgen C. F. Rybner of Copenhagen, professor of telecommunications at the Royal Technical University of Denmark and noted author of Danish and English textbooks on network theory, was elected vice-president. He will succeed Sir Robert Watson-Watt of London, an authority on military radar.

Directors elected by the Institute for 1951 are: William H. Doherty, director of electronic and television research for Bell Laboratories, Murray Hill, N. J.; George R. Town, associate director of the engineering experiment station at Iowa State College, Ames, Iowa; Harry F. Dart, office manager of the electronics engineering department of Westinghouse Electric Corp., Bloomfield, N. J.; Paul L. Hoover, head of the department of electrical engineering, Case Institute of Technology, Cleveland, Ohio; William M. Rust, Jr., head of geophysics research for Humble Oil and Refining Co., Houston, Texas; and Allan B. Oxley, chief engineer of RCA Victor Co., Montreal, Quebec.

In addition, the following directors will continue to serve on the Board during 1951: S. L. Bailey, R. F. Guy, W. L. Everitt, D. G. Fink, W. R. Hewlett, J. W. McRae,





H. J. Reich, F. Hamburger, Jr., J. D. Reid, and A. V. Eastman.

### Taxicab Radio Advances

INITIAL use of commercial radio communications equipment in the 450 to 460-mc band for the general mobile radio services was recently announced by Link Radio Corp., New York, N.Y. A pioneer move by two major taxicab companies in the uhf range was made officially in a request by the Yellow Cab Co. and the Cab Sales and Parts Corp., both of Chicago, Ill., to the FCC for what will eventually call for the installation of 3,666 mobile units and 16 base stations.

Under the mobile radio service rules established by the FCC in May 1949, the taxicab service was allocated 10 frequencies in the 450 to 460-mc band for developmental purposes, ranging from 452.05 to 452.95 mc. Commercial application was made permissible by the FCC in its directive of May 1949. The radio services which may use the 450 to 460-mc band are remote pickup broadcast; land transportation, which includes railroads, taxicabs and urban transit; public safety, which includes police, fire, forestry-conservation, highway maintenance and special emergency; industrial, which includes power radio, petroleum, forest products, motion picture, relay press and special industrial; and domestic public.

The system applied for in the construction permit request will use eight multiple main-station transmitters to cover the city in checkerboard fashion so that the traffic-handling capability of the radio circuits may be multiplied to enable dispatchers to control, via two-way radio, a large number of taxicabs in the Chicago area.

Each main station transmitter will have an output of 100 watts and each mobile transmitter will have an output of 10 watts.

### Radio Engineers Announce Awards

ROBERT B. DOME, electrical consultant for General Electric Co., Syra-

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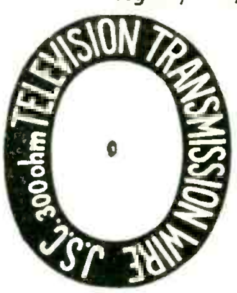


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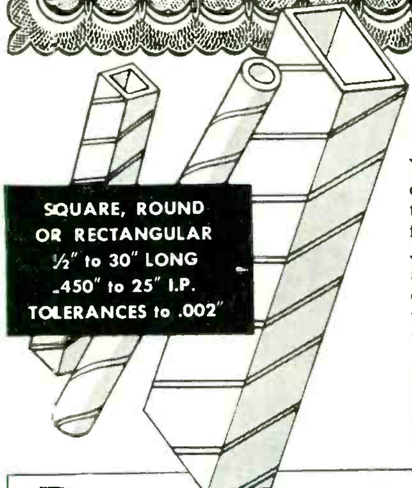


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cuse, N. Y., will be awarded the Morris Liebmann Memorial Prize for 1951 by the IRE for his contributions to the intercarrier sound system of television reception, wide-band phase-shift networks, and various simplifying innovations in f-m receiver circuits. The award will be presented at the Institute's annual banquet on March 21, 1951, at the Waldorf-Astoria Hotel in New York City.

Other 1951 awards which will be presented at that time are as follows:

Alan B. MacNee, assistant professor of electrical engineering at the University of Michigan, Ann Arbor, Mich., will receive the Browder J. Thompson Prize for his paper "An Electronic Differential Analyzer," which appeared in the November, 1949 issue of the *Proceedings of the IRE*. The award is given annually to the author under thirty years of age for that paper recently published by the Institute which constitutes the best combination of technical contribution to the field of radio and electronics and presentation of the subject.

The Harry Diamond Memorial Award, given only to persons in government service, will be bestowed on Marcel J. E. Golay, Signal Corps Engineering Laboratories, Fort Monmouth, N. J., for his contributions in the over-all Signal Corps research and development program, and particularly for his accomplishments leading toward a reduction in the infrared-radio gap.

Willis W. Harman, associate professor at the University of Florida, Gainesville, Fla., will receive the Editor's Award, established to stimulate the use of good English in technical writing, for his paper "Special Relativity and the Electron," which appeared in the November 1949 issue of the *Proceedings of the IRE*.

## IRE-RTMA Fall Meeting

THE TWENTY-SECOND annual Fall Meeting of members of the IRE and the RTMA Engineering Department was held Oct. 30-Nov. 1 at the Hotel Syracuse in Syracuse, New York, with a total registration of over 600.

At the general session on Monday

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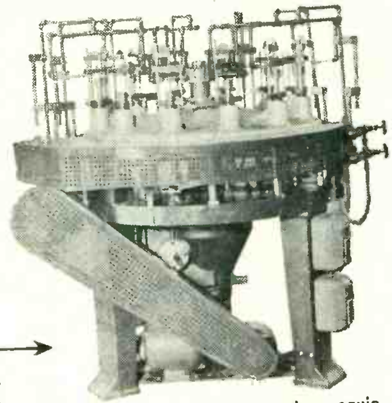

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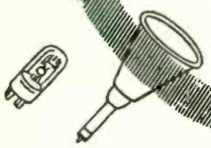

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For high power tubes Gates has designed several very attractive tube sockets.

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MID-JUNE

**BUYERS' GUIDE**

morning, papers presented included one on the use of the noise diode for determining amplifier sensitivity and another on wideband impedance matching between a resonant antenna and a line.

The Monday afternoon quality control session covered efficient use of data for quality control, the General Electric quality control indicator, the control of averages in radio tube manufacture, and the human aspect of engineering quality into a product.

At a joint session with the Technology Club of Syracuse on Monday evening, Dr. Allen B. Du Mont spoke on problems of the television industry, including the color tv controversy and the freeze on new tv station construction.

Both sessions on Tuesday were devoted to tv and much interest was shown in a paper titled, "An Analysis of Color Television," by A. V. Loughren of Hazeltine Electronics Corp. (Our cover last month showed four of the illustrations used in this presentation.) At the same session, two new tubes were described—the RCA low-noise double triode which is used as an r-f and i-f amplifier in tv receivers, and the GE miniature magnetron for use in the uhf tv band.

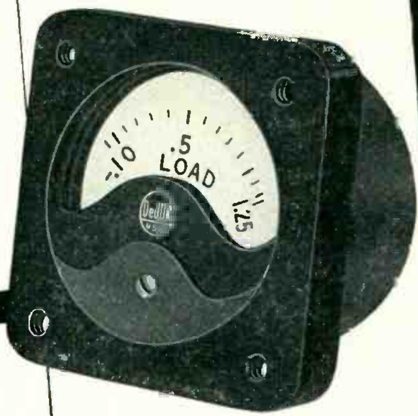
The RTMA award was presented posthumously to L. C. F. Horle at the Tuesday night banquet meeting. The late Mr. Horle was, until his recent retirement, RTMA's chief engineer.

The audio session on Wednesday morning consisted of papers on the mechanics of the phonograph pickup, a lightweight pickup and tone arm, sound pickup in high ambient noise, and the recently adopted RTMA standards for sound equipment.

It was announced that the Fall Meeting next year will be held in Toronto, Canada.

## *BUSINESS NEWS*

ELECTRONIC CONTRACTORS INC., Philadelphia, Pa., is a new firm formed by John C. Merman and four other television service contractors for the purpose of entering into defense and private manu-










facturing contracts that require electronics background and experience.

GENERAL ELECTRIC CO. will reopen a former radio tube plant in Utica, N. Y., and convert it for the manufacture of emergency radio communications equipment. The new plant is expected to be in full operation by June 1951, employing about 425 people.

ELECTRICAL REACTANCE CORP. recently dedicated its new 70,000-sq-ft plant in Olean, N. Y. The plant will be devoted to the manufacture of capacitors, resistors and choke coils.

RADIO RECEPTOR CO., INC., manufacturer of radio and electronic components and complete assemblies for industry and government, has purchased a 90,000-sq-ft factory in Brooklyn, N. Y., to house its expanding divisions.

SARKES TARZIAN, INC., has begun operation of its new 53,000-sq-ft plant in Batavia, Ill., to increase production of television picture tubes.

NATIONAL ELECTRONICS INC., Geneva, Ill., now has a new brick factory addition to its plant which increases total floor space by 80 percent and provides facilities for greater production of thyratrons, rectifiers and mercury pool tubes.

WESTERN ELECTRIC CO. has leased the Pomona Mills plant near Greensboro, N. C., to manufacture electronic equipment for the armed forces. Approximately 2,000 persons will be employed.

THE BARRY CORP., Cambridge, Mass., is erecting a new plant in Watertown, Mass., that will more than double its present floor space for production of shock mountings and vibration isolators.

NORTHWESTERN UNIVERSITY, Evanston, Ill., will build a 4½-million-volt electrostatic accelerator for nuclear research, to be used by staff members and graduate students doing research work, and in connection with special government projects. Cost of the project will be approxi-

The New STAVER
# MINI-SHIELD
TRADE MARK REG. AND PAT. PEND.


## The shield that fits all Miniature Tubes

A flexible shield that snugly fits all miniature tubes because it compensates for all variations in tube dimensions. Mini-Shields are made for both T5 1/2 and T6 1/2 bulb tubes. Send for catalog sheet.

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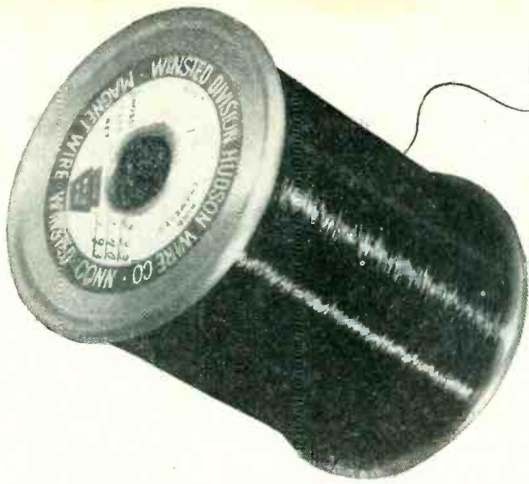


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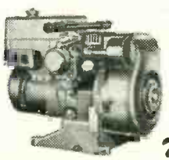

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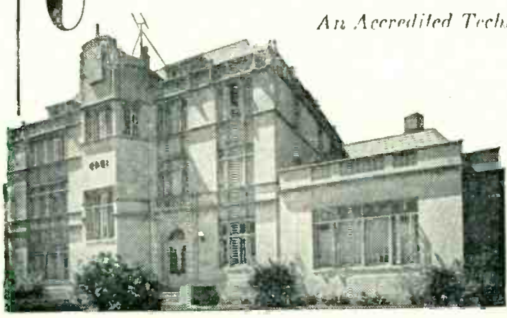

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mately $150,000 exclusive of the housing.

MINNEAPOLIS-HONEYWELL REGULATOR CO. recently launched a road show, called the Parade of Progress, which will cover more than 60 cities. Purpose of the traveling show is to demonstrate the latest electronic, electric and pneumatic control systems recently developed and now in production.

PEMCO CORP., Baltimore, Md., manufacturer of porcelain enamel finishes and ceramic chemicals, is expanding its plant by the addition of more than 30,000 sq ft of floor space to existing facilities.

AMERICAN ELECTRONEERING CORP., producers of aircraft instrument test equipment, power supply units and signal generators, have moved to new larger quarters at 5025 W. Jefferson Blvd., Los Angeles, Calif., to consolidate production facilities under one roof and make room for stepped up armed-service activities.

RADIO CRAFTSMEN, INC., Chicago, Ill., makers of custom-built tv and radio chassis and electronic equipment, have acquired 12,000 sq feet of space at 4401 North Ravenswood, Chicago, to be used in tv production.

### *PERSONNEL*

VINCENT SALMON of Stanford Research Institute has been elected chairman of the San Francisco Section, Audio Engineering Society. Other officers are: Harold Lindsay of Ampex Electric Corp., vice-chairman; Frank Haylock, secretary; Myron J. Stolaroff of Ampex, treasurer; and Walter T. Selsted, Jack Hawkins and Ross Snyder, executive board members.

L. E. RECORD has been promoted from supervisor of the engineering development and testing laboratories to division engineer of the cathode-ray tube division of General Electric Co., Syracuse, N. Y.

JOHN T. WILNER, engineering director of stations WBAL and WBAL-TV, has been elected vice-president in charge of engineering

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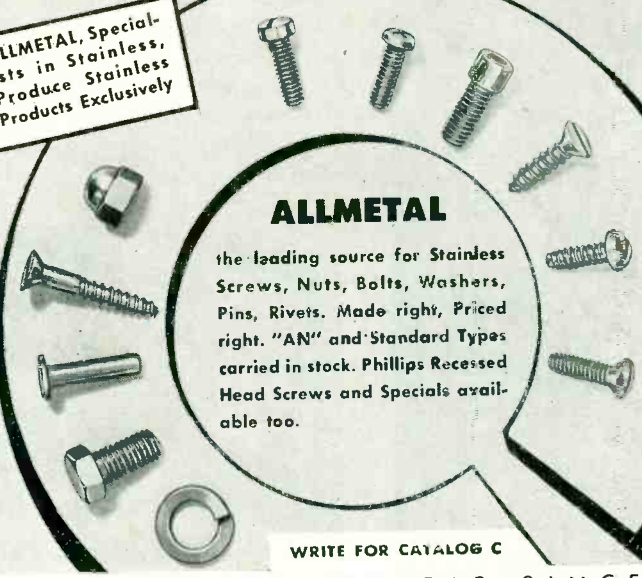

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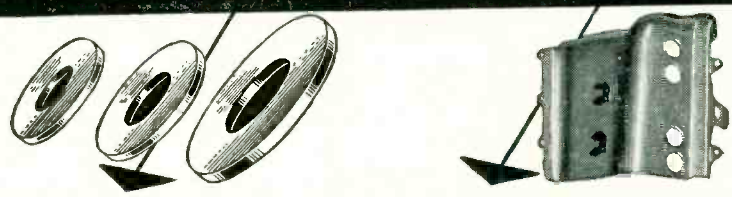

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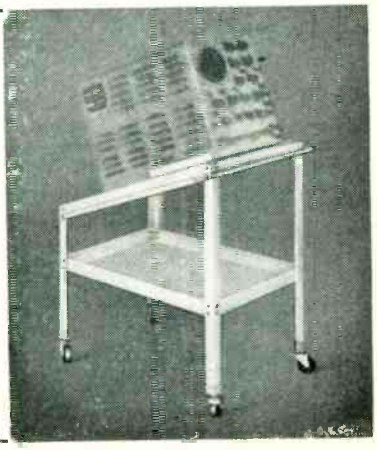


of Hearst Radio, Inc., He was formerly engineer-in-charge of CBS television development.

CHARLES D. PERRINE, JR., formerly manager of the electronics department of Fairchild Engine and Airplane Corp.'s guided missiles division, has joined the electronics and guidance section in Consolidated Vultee's San Diego Division engineering department.

C. D. Perrine, Jr.

M. A. Acheson

M. A. ACHESON, formerly chief engineer of the radio tube division of Sylvania Electric Products Inc., Emporium, Pa., has been transferred to the staff of E. Finley Carter, vice-president in charge of engineering at Sylvania's New York office.

HARRY STOCKMAN, former consulting engineer to industrial firms in the Boston area, has been appointed director of research of the Tobe Deutschmann Corp., Norwood, Mass.

G. F. CALLAHAN, formerly division engineer of the cathode-ray tube division of General Electric Co., Syracuse, N. Y., has been appointed staff assistant to K. C. DeWalt, manager of the division.

LEIGH W. HAEFLE, with Air Reduction Co., New York, N. Y., since 1938, was recently appointed assistant chief engineer of the company's general engineering department.

DAVID S. RAU, formerly assistant to the vice-president in charge of engineering, is now assistant vice-president and chief engineer of RCA Communications, Inc.

JOHN F. BYRNE, formerly vice-president and chief engineer of Airborne Instruments Laboratory, Inc., Mineola, N. Y., has been appointed associate director of research in the division of communications and electronics of Motorola, Inc., Chicago, Ill.

EDWIN LOCKWOOD, formerly senior research engineer for Electro-Mechanical Research, Inc., Ridgefield, Conn., has been appointed chief engineer of Price Electric Corp., Frederick, Maryland, manufacturers of electronic relays.

E. Lockwood

L. C. Smith

LESTER C. SMITH, formerly instructor in electrical communications at MIT, has been appointed chief engineer of Spencer-Kennedy Laboratories, Inc., Cambridge, Mass.

CHARLES N. KIMBALL, formerly technical director of Bendix Research Laboratories, Detroit, Mich., has been elected president of Midwest Research Institute, Kansas City, Mo.

CARL E. SCHOLZ, formerly vice-president and chief engineer in charge of Mackay Radio and Telegraph Company's engineering and plant department, was recently appointed vice-president and chief engineer of All America Cables and Radio, Inc., and The Commercial Cable Co.

ROBERT H. WEINMANN, formerly assistant vice-president of Geovision, Inc., New York City, and chief electronic engineer for the Rieber Research Laboratory of the same city, has been appointed chief engineer of Danco Instruments, Inc., Huntington Station, L. I., N. Y.

JAMES L. LAWSON, former head of the nuclear investigations division, has been named manager of the newly formed Electron Physics Divisions of the General Electric Research Laboratory, Schenectady, N. Y.

in point, omits the best part of the story.

It is true, as you observe, that the Alpine tower was designed for the operation of a series of transmissions simultaneously from antennas appropriately arrayed between the arms. The attempt, however, to start such pioneering work at Alpine by Paul Godley with the installation of a second transmitter was promptly vetoed by the then engineering czar of the FCC, Mr. Andrew J. Ring.

Time passes. Mr. Ring leaves the Commission. He enters private practice. In due course, Mr. Ring advocates an arrangement among Washington f-m licensees and prospective licensees to locate all stations in two groups, the stations to be arranged as to frequencies and location to give maximum coverage and minimum interference to the people of Washington.

The world moves on. Now, twelve years after the disapproval of what was attempted at Alpine, the erection of at least a half dozen antennas atop the Empire State Building in New York City enters the realm of FCC standards of good engineering practice. The French have a word for it—"It is to laugh."

EDWIN H. ARMSTRONG
*Columbia University*
*New York, N. Y.*

## Due Credit

DEAR SIRS:

YOUR article "Electrodynamic Ammeter for VHF" in ELECTRONICS (*Electron Art, Sept. 1950*) does not credit the development of the electrodynamic ammeter to those responsible for it.

In 1934, Professor H. M. Turner suggested to Dr. P. C. Michel, a graduate student at Yale University, that he examine the field of current measurement at high frequencies and try to make a contribution to the art in his doctorate thesis. Dr. Michel perceived that the attempt to operate a conventional pointer caused the poor performance of the electrodynamic ammeters previously developed and, by allowing the short-circuited ring to oscillate, invented an absolute standard of current at high frequencies. When Dr. Michel came

to the General Engineering and Consulting Laboratory of the General Electric Co. at Schenectady, he was assigned to a group vitally concerned with such standards. The group continued the development of the electrodynamic ammeter, extending its frequency range up to 350 megacycles.

This new current standard provided new knowledge of the true frequency characteristics of thermocouple ammeters and led to the invention of an improved thermocouple, U. S. Patent 2,199,247—T. A. Rich, H. R. Meahl and P. C. Michel—1939, which was used in the General Electric Low-Impedance Thermocouple Ammeter.

One early application of these new thermocouple ammeters was the solving of a problem for the National Bureau of Standards which had resulted from attempts to measure r-f output of electrotherapy machines. When these were tested by measuring output current with then commercially available thermocouple ammeters, efficiencies greater than 100 percent were indicated.

The writer was asked by the Bureau if General Electric would supply a satisfactory ammeter and took several developmental samples of the ammeter to Washington, which solved the immediate problem. While there, the writer suggested that the Bureau might want an electrodynamic current standard. Later, a quotation was requested on an electrodynamic current standard and on a set of the Low-Impedance Thermocouple Ammeters. The Bureau purchased a set of these new thermocouple ammeters but at the time, showed no further interest in the accompanying quotation on an electrodynamic current standard.

Some time later, the Bureau asked for further information and Dr. Michel loaned them a copy of his unpublished thesis.

The only published data we have since seen on work on the Electrodynamic Ammeter at the Bureau of Standards is CRPL Preprint 50–15 by Max Solow. There is no attempt in that preprint to attribute full credit for this development to the Bureau; in fact, proper references are included, even the unpublished thesis.

H. R. MEAHL
*General Engineering and Consulting Laboratory*
*General Electric Co.*
*Schenectady, N. Y.*

## Maxson, Not Maxon

DEAR SIRS:

IN the October, 1950 edition of ELECTRONICS an article was written by Jack Kritz entitled "Precision Phase Meter for Audio Frequencies." In the by-line for this article the name of the company was misspelled. It would be appreciated if, in the next edition, you would print a correction notice calling attention to the proper spelling of the company name.

THE W. L. MAXSON CORPORATION
*Contracts Department*
*Engineering Division*

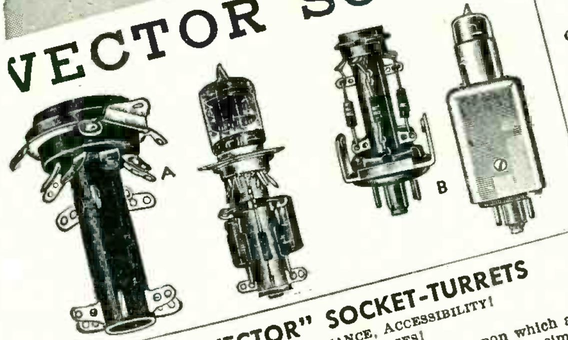
## Electronics Quiz

THIS MONTH'S puzzle problem was submitted by Walther Richter, Consulting Electrical Engineer, Allis-Chalmers Manufacturing Company, Milwaukee, Wisconsin.

**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 seized 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.**

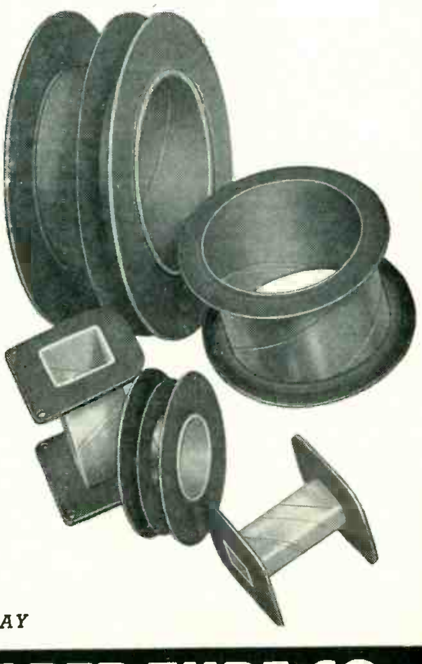
**Assuming that fuses were available in any desired rating, and would blow at exactly this rating, would the**









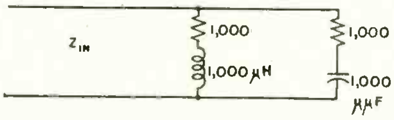
**choice of one ampere in the center, or presumably one-half ampere in series with each plate be correct?**

The answer to this problem will appear in next month's *Backtalk* along with a new problem. Readers are encouraged to submit puzzle problems. A payment of five dollars will be paid for each acceptable entry (with solution).

*Last Month's Solution*

Last month's problem was:

**What is the input impedance and the frequency for which the following circuit**




**has unity power factor (anti-resonance)?**

*Solution.* The input impedance $Z_{IN}$ is 1,000 ohms, and the anti-resonant frequency is indeterminate—that is, the circuit is resonant for all frequencies. The susceptance of the $L$ branch is

$$\frac{\omega 10^{-3}}{10^6 + \omega^2 10^{-6}}$$

The susceptance of the $C$ branch is

$$\frac{\dfrac{1}{\omega 10^{-9}}}{10^6 + \dfrac{1}{\omega^2 10^{-18}}}$$

For unity power factor these two equations are equal

$$\frac{\omega 10^{-3}}{10^6 + \omega^2 10^{-6}} = \frac{\dfrac{1}{\omega 10^{-9}}}{10^6 + \dfrac{1}{\omega^2 10^{-18}}}$$

$$\omega 10^3 + \frac{10^{15}}{\omega} = \frac{10^{15}}{\omega} + \omega 10^3$$

which is an identity satisfied for all values of ω.

The input impedance $Z_{IN}$ is equal to the reciprocal of the sum of the conductances

$$\frac{1}{Z_{IN}} = \frac{10^3}{10^6 + \omega^2 10^{-6}} + \frac{10^3}{10^6 + \dfrac{1}{\omega^2 10^{-18}}}$$

$$= 10^{-3}\left[\frac{1}{1 + \omega^{-2} 10^{-12}} + \frac{\omega^2 10^{-12}}{\omega^2 10^{-12} + 1}\right] = 10^{-3}$$

Thus $Z_{IN} = 1{,}000$ ohms.

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**BENDIX RADIO DIVISION**

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**Laboratories for Research and Development**

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Send resume of education and experience, salary requirements and photograph to:

*Personnel Department*

**THE FRANKLIN INSTITUTE**

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P-8023, Electronics
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P-8256, Electronics
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P-7849, Electronics
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Glass Technologists
Established Company in Midwest

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**For Overseas Assignments**

*Technical Qualifications:*

1. At least 3 years' practical experience in installation and maintenance.
2. Navy veterans ETM 1/c or higher.
3. Army veterans TECH/SGT or higher.

*Personal Qualifications:*

1. Age, over 22—must pass physical examination.
2. Ability to assume responsibility.
3. Must stand thorough character investigation.
4. Willing to go overseas for 1 year.

Base pay, bonus, living allowance, vacation add up to $7,000.00 per year. Permanent connection with company possible.

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Men qualified in RADAR, COMMUNICATIONS or SONAR give complete history. Interview will be arranged for successful applicants.

# NATIONAL UNION RESEARCH DIVISION

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Junior Electrical Engineers are desired for training as tube or circuit design engineers.

Men qualified by virtue of education or experience to handle problems in the field of tube or circuit design are invited to send their resumes to:

*Divisional Personnel Manager*

**NATIONAL UNION RESEARCH DIVISION**
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Mechanical engineer with five to seven years of product design experience preferably in the electronics industry.

These are permanent positions with a progressive organization offering stimulating work, congenial associates, pleasant surroundings and advanced personnel policies.

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W-6863, Electronics
330 W. 42nd St., New York 18, N. Y.

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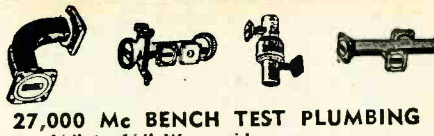

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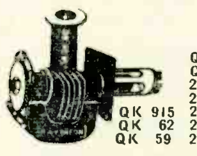
| Gauss | Pole Diam. | Spacing | Price |
|---|---|---|---|
| 4850 | ¾ in. | ⅝ in. | $12.50 |
| 5200 | 11/32 in. | ¾ in. | $17.50 |
| 1300 | 1⅝ in. | 1 5/16 in. | $12.50 |
| 1800 | 1⅝ in. | 1½ in. | $14.50 |

Electromagnets for magnetrons..........$24.50 ea.

GE Magnets type M7765115, GI Distance Between pole faces variable. 2 1/16" (1900 Gauss) to 1½" (2200 Gauss) Pole Dia. 1 ⅝" New Part of SCR 584 ........................................$34.50

## MAGNETRONS



| | | | |
|---|---|---|---|
| QK 61 | 2J32 | 2J61 | 720CY |
| QK 60 | 2J37 | 2J62 | 725-A |
| 2J21 | 2J38 | 3J31 | 730-A |
| 2J22 | 2J39 | 5J30 | 728 |
| QK 915 2J26 | 2J40 | 714AY | 706 |
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Klystrons 723A, 707B, 417A, 2K41

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D-170396 (bead) ...$ .95
D-167613 (button)..$ .95
D-164699 for MTG in "X" Band Guide $2.50
D-167018 (tube)....$ .95

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D-171528 ..........$ .95
D-168442 ..........$3.00
D-165593 ..........$1.25
D-98336 ...........$2.00
D-161871A .........$2.85
D-171121 ..........$ .95
D-98836 ...........$1.50
D-162356 (308A) .....
D-163357 ..........$2.00
D-99946 ...........$2.90

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TVN-9HU POWER SUPPLY, MIT Rad. Lab.
TVN-8SE KLYSTRON POWER SUPPLY. MIT. Rad. Lab.
CS60ABW WATT METER — Wavemeter, 3 CM.
APR5 RECEIVER—1000 to 6000 mcs.
AN/CPN-8—10 centimeter 40 kw-output RF package. Includes magnetron oscillator, complete modulator, complete receiver, complete signal and power analyzer with 5" scope. 115V AC input.
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TS12 3CM Slotted Line
TS13 3CM Signal Generator
TS33 3CM Frequency Meter
TS35 3CM Signal Generator
TS56 3CM Power Meter
TS45/APM3 3CM Signal Generator
TS62 3CM Echo Box
TS108 Dummy Load
I-185A Oscillator
I-158 Range Calibrator
I-233—Range Calibrator
RC 438 Freq. Meter
RF Preamp.
G.R. Capacity Brdg #216
G.R. Uni Galvo Shunt #229
G.R. 1000 Aud. Osc. #213
TS 226A/AP Pwr. Mtr. 0-1000W.
Sig Gen #804 8-330 MC
BC 221 Freq. Meter
TS 10A/AP
TS 69/AP Freq. Meter
I-114 Test Set
I-126
Field Int. Meter 43A
Sig. Gen. Mod. 78B
Megometer 0-5 Meg Ω
TS 1-49 Bridge
I-166 Volt Ohmmeter
Sig Gen 9.5-500 MC
CY 81/AP
TS 59/APN1
CW 60/ABM
Freq Meter BC 438

## 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.
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## THE MUST OF THE MONTH

Complete 3 CM Radar System equipment 40 KW peak transmitter, pulse modulator, receiver, using 723AB. power supply operating from 115V 800 Cycle, antenna system. Complete radar set neatly packaged in less than 16 cubic feet, all tubes, in used but excellent condition—$350.00. This price for laboratories, schools, and experimental purposes only.

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Used ..............................$45.00
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AS125/APR Cone type receiving antenna. 1080 to 3208 megacycles. New ...............................$4.50
140-600 MC. CONE type antenna. complete with 25' sectional steel mast, guys, cables, carrying case, etc. New ..............................$49.50
ASD 3 cm. antenna, used, ex. cond. $49.50
YAGI ANTENNA AS-46A. APG-4. 5 elements ..................$14.50 ea.
Dish for Parabola 30"..........$4.85
AN 122 ..........................$22.50
RC 224 ..........................$99.50
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DAK Directional Finder Loops
Adcock Arrays
SA-1 Radar
200 MC. Bed Spring
LP21-A Airborne Dir. Find. Loop, w/ Selsyn & Loop Housing
APS 4 Ant.
AN 128A 200 MC. Array
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## 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
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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 Rifiar 2.75 Amp....$64.50
W.E. #D169271 Hi Volt Input pulse Transformer .....................$27.50
G.E. K2450A. Will receive 13KV. 4 micro-second pulse on pri. secondary delivers 14KV. Peak power out 100KW G.E. ......................$34.50
G.E. #K2748A. Pulse Input, line to magnetron ......................$36.00
#9262 Utah Pulse or Blocking Oscillator XFMR Freq. limits 790-810 cy-3 winding turns ratio 1:1:1 Dimensions 1 13/16 x 1⅞" 19/32 $1.50
Pulse 131-AWP L-421435..........$6.00
Pulse 134-BW-2F L-440895........$2.25
RAY—WX4298F ....................$39.50
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APS-31 3 CM Airborne
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MARK 10 10 CM Ship Gunlaying
SA 200 MC Ship Air Search
SC 200 MC Ship Air Search
SD 200 MC Submarine
SE 10 CM Surface Search
SF 10 CM Surface Search
SG 10 CM Surface Search
SJ 10 CM Submarine
SK 200 MC Air Search
SL 10 CM Surface Search
SN 10 CM Portable
SO (All Series) 10 CM Surface Search
SQ 10 CM Portable
SW 200 MC Portable
SCR 51B 400 MC Altimeter
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## 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
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Directional coupler CU-103/APS32 ..................................$49.50
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"K" Band Directional Coupler CU104 /APS-34 20 DB.............$49.50 ea.
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## 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
Variable Stub Tuner............$90.00
Wvgd. to Type "N" Adapter...$18.50
Wavemeter Tee. DB352.........$32.50
Magic Tee ........................$80.00
Directional Coupler, two hole 25DB coupling, type "N" output....$25.00
Precision Crystal Mount. Equipped with tuning slugs and tunable termination ..........................$125.00
Tunable Termination. Precision adjust ..............................$70.00
Low Power Load..................$35.00

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Flap Attenuator ..................$48.00
Variable Stub Tuner and Low Power Termination ......................$48.00
Wavemeter Tee ....................$48.00
Adapters: Choke to choke......$18.00
Cover to cover......$14.00
Choke to cover......$16.00
Waveguide to Type "N" Adapter ..................................$45.00
Directional Coupler. Two hole type, type "N" output ...............$48.00
Klystron Mount. Equipped with tunable termination and micrometer adjust. Klystron antenna tuning $110.00
Crystal Mount. Equipped with tunable termination and micrometer adjust crystal tuning.............$125.00
Tunable Termination. Precision adjust ..............................$90.00

## 3000 Mc BENCH TEST PLUMBING

### TEST EQUIPMENT

10 CM Wavemeter WE type B435490 Transmission type. Type N Fittings. Veeder Root Micrometer dial., Gold Plated W/Calib. Chart P/o Freq. Meter X66404A. New ........$99.50
AS14A/AP-10 CM Pick up Dipole with "N" Cables..................$4.50
LHTR. LIGHTHOUSE ASSEMBLY. Part of RT39 APG 5 & APG 15. Receiver and Trans Cavities w/assoc. Tr. Cavity and Type N CPLG. To Revr. Uses 2C40, 2C43, 1B27, Tunable APX 2400-2700 MCS. Silver Plated..$49.50
Beacon Lighthouse cavity 10 cm with miniature 28 volt DC FM motor. Mfg. Bernard Rice ..................$47.50 ea.
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

### ⅞" RIGID COAX

10 CM FEEDBACK DIPOLE ANTENNA, in lucite ball, for use with parabola ⅞" Rigid Coax Input $8.00
721A TR cavities, heavy silver plated ...........................$2.00 ea.
Magnetron Coupling with TR Loop ..................................$7.50
Sperry Rotating Joint, pressurized ..................................$22.50
5 Ft. Lengths Stub Supported, gold-plated, per length ...............$7.50
Short Right Angle Bends (for above) ..................................$2.50

## 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 fitter 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

### 1¼" x ⅝" WAVEGUIDE

Tunable Termination. Precision adjust ..............................$65.00
Low Power Termination.........$25.00
Magic Tee ........................$45.00
Oscillator Mount, for four 723AB klystron ........................$38.50
90 Degree Elbows. E or H plane ..................................$12.50
Waveguide Lengths. Cut to size and supplied with 1 choke, 1 cover, per length ....................$2.00 per ft.
Wavemeter. Absorption type. Precision micrometer adjust. Very high "Q" ..............................$150.00
BI-DI-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

## SCR 454 22 FT TRAILER RADAR TRACKING & 10 CM SEARCH WRITE OR PHONE

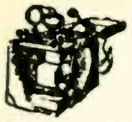
All merch. guar. Mail orders promptly filled. All prices, F.O.B. N.Y.C. Send M.O. or Chk. Only shipping chgs. sent C.O.D. Rated concerns send P.O.

MIN. ORDER $3.00

# COMMUNICATIONS EQUIPMENT CO.

MIN. ORDER $3.00

131 Liberty St., New York, N. Y. Dept. E-1 — P. J. PLISHNER — Phone: MAin 4-8373



**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) $9.49

**ARC 5 MODULATOR**

MD7/ARC5 w/ dynamotor complete w / Tubes 1-12J5. 2-1625, 1-UR50. Good cond.
Price .....$8.95

## 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 | .30 |
| 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 |

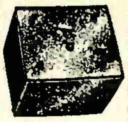
**Ceramic Case Mic**

| | |
|---|---|
| 120MMF 10KVW | $19.00 |
| 30MMF 10KVW | 19.00 |
| .08 MFD 1500 | 10.00 |
| .045 MFD 2000 | 12.00 |
| .0001 20KVW | 24.00 |
| .0051 15KVW | 21.00 |
| .001 25K | 35.00 |

**COLLINS ART-13 FREQ. MULT. UNIT**

2-18 Mc for two 1625 Tubes. Comp. Assy less Tubes & Coils w/ ckt dia
Price.. **$8.95**

1619—1619—1619
Octal Base Pentog Aversatile High Perveance
Tube. New **35¢**
5 for ... **1.50**



400 MA 12 HY Choke 90 ohms Herm. sealed.
Special ...$3.75

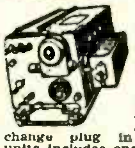
**Choke Swinging**

9/60Hv .400/.05 Amp 10000V ins. Mfg. Super Elect. .....$7.95

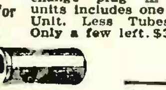
# TUBES

Write or Phone Your Needs

MS49 and MS50 Fishpole Antenna, 74" long. Both for 49¢



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.



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 |

| | |
|---|---|
| 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 | 110-125 |
| 75-84 | 110-125 |
| 88-106 | 110-1 50 |
| 107-129 | 110-165 |
| 130-157 | 110-1.75 |
| 130-150 | 70-150 |
| 130-180 | 110-185 |
| 158-191 | 110-185 |
| 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 |

Trimmer Cond. Variable

| | |
|---|---|
| 15 MMF | 21¢ ea. |
| 5 MMF | |
| 20 MMF | |
| 40 MMF | |
| 50 MMF | |
| 60 MMF | |

## There Are No Shortages of Equipment at C.E.C.

Our warehouses are full of surplus radio, radar, electronic equipment, for your needs, as a manufacturer, jobber, amateur, experimenter, engineer, everything at surplus prices. We own what we sell, phone or write us your needs and let us quote.

*Mr. Chas. Rosen*
*Digby 9-4124*

6V Input Dynamator
Output 150V/ 75MA or 12V Input. 500V/ 50 MA Out.
$3.49

FEED THRU
2¼" L x 1¾" W Type XSI 10c ea. 10 For 50c

**ANTENNA MAST**

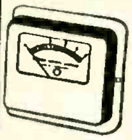
Are you in a dead spot? If you can't get a good T.V. Picture here is a sig. Corp. Ant. mast 30' high of rugged plywood construction to solve your problem. It telescopes into 3 ten feet. sec. for easy stowage. Easy to Mm Comp. with stakes & rods. Each.... **$19.95**

MS49 and MS50 Fish Pole Antenna, 74" long. Both for 49¢

866 Filament Xfmr 2x2.5v 6 Amp 8000 V Test Size. Approx 3½" SQ. Easy to Mount.
Price ..$2.95

**Thermostatic Switches**

SPST NO closes at 85°. .69¢ ea
SPST NO opens at 85°. .69¢ ea.
5 amp. contacts



METERS
0.5MA SQ 2" Metal Case or 0-10 volt movement readrite meter ....98c

BC433 Mod or unmod CW Reception 200-1750KC in 3 bands 14 or 24V & 115V AC ADF Radio Compass As Is. Less Tubes Poor Condition $10.49

ID6 APN4 Scope 5" Loran. Full of Resis. Micas Basic Assay for Scope. N.G. As Is. Less Tubes. $9.95

GP7 Aircraft XMTTR Fair Condition. As Is. Less T. U. ........$19.95

LP21 LM Radio Compass Loop. Excellent Condition. $10.95

Crystals for BC 684 Complete set of 120 Xtals From 27-38.9 MC $95.00

Xtals Low & High Freq. in Ft. 241 Holders Mfg. by W. E. ½" Pin Spacing. Marked in army Mc Harmonic freq. almost all freq's. $.69 ea.

## DS FILTER CONDENSERS

| | | |
|---|---|---|
| 40-20 | 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.

I 82A 5" 360° Compass Ind. & Selsyn Receiver New ...$4.95

BC 306A Ant. Tuning unit for BC 375 Excellent Cond.
$1.50 ea.

**Voltage Stabilizer VR3**

95-130V 2.4A66CY 1ϕ Cut. 115V 120 Watt 100% Mfg. Raytheon w/ert Bx Box. Sockets & cable used but good.

**Voltage Regulator BA623**

95-130V 1.76A 60CY 1ϕ CU 115V 150 Watt 100%. Slightly used, excellent.

BC 604 DM Transmitter FM 20-28 MC 11 & 15 Mtr. Can be operated on 10 Mtr. 10 Channel push button control w/ tubes meter. Less xtals. Good used Sold as it $15.95
Set of 80 xtal $25.00

Motor Driven Yagi Switch 24V 1800 RPM. Price English Type.....$3.95

**BC434 Control Box**

Remote Control for 433 Radio Compass contains 0-5MA Meter. Dial Control ..............$3.95

Magnesyn Instrument Field Tester AAF 43G23330 Spec. 40772 To test individual mag. Ind. & Xmttrs. for isolating Faults in magnesyn systems Brand new ..........$25.95

**PE 157 VIBROPACK FOR BC 745**

Runs on 2V DC. Obtained from small Willard Rechargeable battery contained in case which is charged from 6 Vac or DC. Also contains 5" PM Speaker & Jacks for Mike Hdsets. Used, excellent ...............$9.95

Photo Material Ethyl Phthalate (East Kod) Apprx. 1 Qt Bottle $3.95
Oetonit Surface Cleaning Solution Photomat lithomat Apx. 1 Qt.... $3.95
Transparento #146 For Transparentizing Drawings & Tracing Apx. 1 Qt. ...$3.95

FT234A274N Single Xmtr Rack. New........$1.69

**AMPLIFIER**

AM-32/PRSI less batt w/carry case for Mine Detector AN/PRSI.
Price ea. .........$7.95

Horsie Talkie BC745 Xmtr Revr 3-6Mc w/ITU Less Pwr Supply..$11.95

**Carbon Pile Voltage Regulator**

- ★ Contract #NOAS-858 Bendix Aviation. MFRS Drawing 111144 w/mnt & pot.
- ★ Type A .105-115 amps 35°-45° C. Ser. 28YK 809-JL. Reg. Volt. 80 Volts. Leland Electric

Mark I. Resis. In enclosed base. Bendix Aviation.

- ★ A-M Ref. #5U/1304 w/rect. & resis. in base. Type E 80V AC.
- ★ Type C. Coil amps .80 at 25C. Output volts 19. Ser. 3711-702. Spec. VR 9000-2C. Output amps 5.7. Input volt 22-30 w/resis. Leland Electric.

These regulators are in brand new condition, priced at $2.75 each.

Model 542 Supreme Sensitivity, 5,000 Ohms/v 3" square meter, Reads: D.C. volts, 6-150-300-1,5000: 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—SC56J 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.

**BATHTUB CAPACITORS**

| Mfd | Volt | Type | Price Ea. | 10 For |
|---|---|---|---|---|
| .5 | 600 | 2ST | $.25 | $2.40 |
| .5 | 400 | 2BT | .23 | 2.20 |
| .5 | 600 | 2TT | .25 | 2.40 |
| 3x.1 | 600 | 3TT | .45 | 4.35 |
| 3x.1 | 600 | 3ST | .45 | 4.35 |
| 2x.1 | 400 | 3ST | .26 | 2.50 |
| 2x.1 | 600 | 3ST | .28 | 2.65 |
| 2x.1 | 600 | 3BT | .28 | 2.65 |
| 2x.1 | 400 | 2TT | .26 | 2.50 |
| 2x.1 | 200 | 2ST | .23 | 2.20 |
| 2x.1 | 600 | 2BT | .26 | 2.50 |
| 2x.1 | 600 | 3TT | .26 | 2.50 |
| .1-.1- | 400 | 3ST | .28 | 2.65 |

Discriminator coil in Can Double Slug Tuned 465 KC ..................79¢ ea
IF Coil Q5'R High Selectivity slug tuned 100KC L 71798 ................69¢
MO Coil Plugin 1800—2250KC ..................59¢
1480—1840KC ..........59¢
4-5.5 MC; 5.2, .7 MC $1.10
P/o 32RA Buffer Coil Dual
P/o 32RA Mod Xfmr Screen Mod. for Pair of 807's PP-P Push or Parallel. Sidetone Wndg. ........95¢

**VERNIER 3 GANG**

Precision Assy used for single dial Control up to 75 watt. 2 single spaced 250Mmfd Sect's & Heavy Double Spaced Sect's. 50:1 Ratio Spring loaded Ceramic ins. 4 Metal Dial ....... **$3.25**

## AUDIO TRANSFORMERS

| ITEM | | |
|---|---|---|
| AT666 | Input 6 ohms: 250K ohms | .79¢ |
| AT SUB | Multimatch Subouncer 200 ohms 15K ohms C. T.: 100K ohms/20K ohms | .69¢ |
| AT070 | Input to Grid 250 ohms: 60K ohms Hi Fi | 1.19 |
| AT566 | Input to Grid, 50/200 ohms 50K ohms | .95 |
| AT227 | Output to line, 7500K 500 ohm CT 200-5kcy | 1.45 |
| AT353 | Output PP 6L6 to 300/20/12/16 ohms 25 Watt | 2.95 |
| AT871 | UNIV. Output. Hi Fi. Pri 20K ohms Sec 15/7.5/5/3.75/1.25/500 ohms | 2.79 |
| AT554 | Interstage, 10K ohms: 250K ohms 15db Level | 1.95 |
| AT765 | Input 600 ohms to 50K ohms | .79 |
| AT707 | Interstage ouncer 10K ohms: 125k/125K ohms | .79 |
| AT750 | Input Pri: 15/15 ohm Sec: 180K ohm | .59 |
| AT449 | Driver 5k ohm to 4K ohm PP6L6 to PP805 Class B | 3.89 |
| AT21 | Dual XFRMR 300 ohms: 300 ohms and 600 ohms: 250K ohms | 1.35 |

0-30V DC Meter Westing. Type AX Aircraft type.
Price .....$2.49

**CONDENSER TUNING UNITS FOR BC 191**

Write up in CCT QST for Conv to vhf freq meter

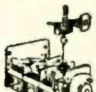
| | | | | |
|---|---|---|---|---|
| TU | 5— | 1500 to | 3000 | KC |
| TU | 6— | 3000 to | 4500 | KC |
| TU | 7— | 4500 to | 6200 | KC |
| TU | 8— | 6200 to | 7700 | KC |
| TU | 9— | 7700 to | 10000 | KC |
| TU | 26— | 200 to | 500 | KC |

Price **$2.49 ea.**

**CERAMIC TRIMMER**

Stack of 6 Ceramic Trimmers 110-460 Mmf. Can be used singly or ganged ...................... **69¢**

**VFO CAPACITOR**



High Grade Unit. Consists of 3 Gang Capacitor 20 mmf per sect. Ceramic ins. Low drift w/Worm Gear (reduction) 120:1 w/ext Shaft and Veeder 4 digit Counter ........$3.95

**TYPE 18 TELEPHONE RELAYS**

| | Price |
|---|---|
| D171258 4850 ohms DPDT SPST (NO) | $.98 |
| H77312-1 5220 ohms SPST (NO) | .98 |
| G189 33 ohms coil 6VDC DPST (NO) | .98 |
| H77312 H7D984-3 6000 ohms SPST (NO) | .98 |
| CP Claire 14127-C12443 6500 ohms coil DPST (NO) SPST (NC) | .98 |
| Control Cox SC5853A 6000 ohms coil SPDT SPST (NO) | .98 |
| CP Claire A6941 100 ohms coil 115V 60 cy SPST (NO) SPOT POBC 3038 | .98 |
| W.E. D169614 5800 coil 110V 3 PST (NO) | .85 |
| A10195 No Controls 390 ohms | .30 |
| H70448-6 No Controls 90 ohms | .30 |
| A70255-2 No Controls 400 ohms | .30 |
| H70448-2 No Controls 400-400 2 coils | .35 |
| MFPAUG-45 DPST 6300 ohms 110V 1 AMP | 2.20 |
| AQA (277589) SPST & SPDT 1000 ohms PO Sw Bd BD628 | 1.10 |
| ZH7712613 DPST (NO) SPST (NC) 1300 ohms | 1.00 |
| GR206 DPST (NO) 500 ohms | 1.00 |
| UR1066 3PDT WE V Type 600 ohms | 1.00 |
| D161968-29 DPST WE V Type 463 ohms | 1.00 |
| 7140AE DPST WE V Type | 1.00 |
| 41U156 3PST (NO) 2500 ohms | 1.25 |
| GR207 (452-1085) 490 ohms 3PST (NO) SPST (NC) | 1.39 |
| GR206 (452-1084) 490 ohms DPST (NO) | 1.39 |
| Allen Bradley Type ED2 6V DPST (NO) in metal box | 3.45 |
| D161974-101 125 ohms SPDT WE V Type | 1.00 |
| D161968-1131 1700 ohms 3 PDT (NC) WE V Type | 1.10 |
| XD19459 725 ohms 3PDT (NC) SPDT (NO) WE V Type | 1.10 |
| XD18316 725 ohms 3PDT (NC) WE V Type | 1.10 |
| XD-11974 in metal box SPDT WE V Type | 1.45 |
| UR1115 in metal box 400 ohms SPDT (NO) WEV Type | 1.10 |
| (UA10025) (XD 19391) in metal box 300 ohms SPDT WEV Type | 1.10 |
| 293677 in metal box DPDT (NO) WEV Type | 1.35 |
| (4C8827-2007) (D161968-2007) 95 ohms SPST (NO) DPDT for Sw Bd ED80C | 1.35 |
| Signal relay 161-A Western Union Plug in type in metal box plug DPST (NO) 4PDT 190 ohms | 4.95 |

**TYPE 18**

| | |
|---|---|
| 694391 190 ohms SPST (NO) | 1.20 |
| D169316 1375 ohms SPDT SPST (NO) | 1.20 |
| D169615 5800 ohms DPST (NC) SPDT | 1.20 |
| D151318 SPST (NC) w/micro chuck moves in & out | 2.95 |
| D169614 5100 ohms TPST (NO) | 1.20 |
| D163482 4850 ohms SPDT | 1.20 |
| D169314 1300 ohms DPDT | 1.25 |

## AMPHENOL "AN" CONNECTORS

LARGE VARIETY AVAILABLE AT GREAT SAVINGS

*Send your specs and let us quote*

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-1 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.**

**Type 1600** Haydon Timing Motor—110 V., 60 cycle, 3.2 w., 4 r.p.m., with brake **Price $4.00 each net.**

**Type 1600** Haydon Timing Motor—110 V., 60 cycle, 2.2 w., 1/240 r.p.m. **Price $3.00 each net.**

**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.**

**CK5 Pioneer,** 2 phase, 400 cycle. **Price $20.00 ea. 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.**

**Kollsman Type 776-01** 400 cycle 2 phase drag-up 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.**

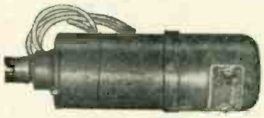
**Norden** Type M7 Vertical Gyro. 26 V., D.C. **Price $19.00 each net.**

**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. FD6-16,** Diehl, 27 V., 10,000 r.p.m. **Price $6.50 each net.**

**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**

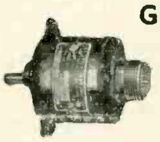
**706343** Delco 27.5 V. 10,000 R.P.M. Shaft 0.5 in. long. **Price $7.50 ea. net.**

**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 $17.50 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 $40.00 each net.**

**149F, Holtzer Cabot.** Input 28 V. at 36 amps. Output 26 V. at 250 V.A., 400 cycle and 115 V. at 500 V.A., 400 cycle. **Price $40.00 each net.**

**12117, Pioneer.** Input 12 V.D.C. Output 26 V., 400 cycle, 6 V.A. **Price $22.50 each net.**

**12117-2 Pioneer.** Input 24 V.D.C. Output 26 V. 400 cycle, 6 V.A. **Price $20.00 each net.**

**12116-2-A Pioneer.** Input 24 volts D.C., 5 amps. Output 115 volts 400 cycle single phase 45 watts. **Price $100.00 each net.**

**5D21NJ3A General Electric.** Input 24 V.D.C. Output 115 V., 400 cycle at 485 V.A. **Price $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.**

**Weston Model 545.** Type 82PE Indicator. Calibrated 0 to 3000 RPM. 2¾" size. Has built-in rectifier, 270° meter movement. **Price $15.00 each net.**

**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.**

## 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.**

**AY201-2-A.** **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**

**37 EAST BAYVIEW AVE., GREAT NECK, N. Y.**
**Telephone GReat Neck 4-1147**

*Write for Catalog NE100*

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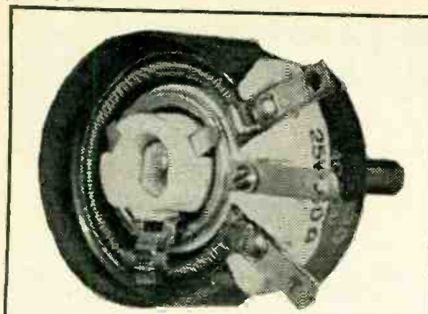


D-245

# KING of the WIRE WOUND POTENTIOMETERS

***Immediate Delivery—Perfect Boxed Material***
***Leading Manufacturer—Excellent Selection***
***Your Satisfaction Positively Guaranteed***

## WIREWOUND POTENTIOMETERS

| Ohm | Watt | Bushing | Shaft | Cat. No. | Stock No. | Quan. | List Price |
|---|---|---|---|---|---|---|---|
| 2 | 25 | 5/8S | 1/8SD | O—H | 8A-1 | 523 | $5.20 |
| 3-3 (Dual) | 25 | 1/2 | 1/2 | I | 8A-2 | 1339 | 5.20 |
| 15 | 25 | 3/8 | 1" | C | 8A-3 | 175 | 5.20 |
| 15 | 25 | 3/8 | 1 1/8 | D—245 | 8A-4 | 213 | 5.20 |
| 15 | 25 | 1/2 | 1 1/4 | I | 8A-5 | 10 | 5.20 |
| 20 | 25 | 1/2 | 1/2F | D—245 | 8A-6 | 377 | 5.20 |
| 25 | 25 | 1/2 | 1/2F | C | 8A-7 | 31 | 5.20 |
| 25 | 25 | 3/8 | 1" | D—245 | 8A-8 | 512 | 5.20 |
| 25 | 25 | 1/2 | 3/8S | I | 8A-9 | 7 | 5.20 |
| 30 | 25 | 3/8 | 1" | C | 8A-10 | 101 | 5.20 |
| 50 | 25 | 3/8 | 1 1/8 | D—245 | 8A-11 | 5569 | 5.20 |
| 50 | 25 | 5/8 | 1/8SD | O—H | 8A-12 | 1051 | 5.20 |
| 75 | 25 | 1/2 | 7/16 | O—H | P-54 | 79 | 5.20 |
| 100 | 25 | 3/8 | 1" | D—245 | 8A-13 | 148 | 5.20 |
| 100 | 25 | 1/2 | 1/2 | H | 8A-14 | 52 | 5.20 |
| 225 | 50 | 3/8 | 11/16 | D—241 | 8A-15 | 132 | 5.85 |
| 350 | 25 | 3/8 | 1 1/8 | O—H | 8A-16 | 892 | 5.20 |
| 350RHO | 25 | 3/8 | 1 1/8 | H | 8A-17 | 369 | 5.20 |
| 500 | 25 | 3/8 | 11/16 | D—245 | 8A-18 | 419 | 5.20 |
| 800 | 50 | 3/8 | 7/16F | O—J | 8A-19 | 76 | 6.18 |
| 1K | 25 | 1/2 | 1/2 | O—H | 8A-20 | 148 | 5.85 |
| 3K | 25 | 3/8 | 1 3/16 | D—245 | 8A-21 | 256 | 6.18 |
| 5K | 25 | 1/2 | 1/8SD | I | 8A-24 | 31 | 6.18 |
| 5K | 25 | 3/8 | 7/8FS | D—245 | 8A-25 | 7660 | 6.18 |
| 5K | 50 | 3/8 | 7/16 | O—J | P-67 | 7 | 6.50 |
| 20K | 25 | 1/2 | 1/8SD | D—245 | 8A-26 | 6901 | 7.00 |

| Ohm | Watt | Bushing | Shaft | Type | Body Dia. | Stock No. | Quan. | List Price |
|---|---|---|---|---|---|---|---|---|
| 6 | 4 | 3/8 | 7/16 | CTS | 1 9/16 | P-68 | 77 | $2.25 |
| 10 | 2 | 3/8 | 1 5/8 | — | 1 5/16 | P-64 | 112 | 1.75 |
| 10 | 2 | 3/8 | 2" | C | 1 1/8 | P-1 | 48 | 1.75 |
| 20 | 2 | 1/2 | 1/8SD | CTS | 1 1/4 | 4A-57 | 26 | 2.25 |
| 20 | 4 | 3/8 | 3/8FD | M | 1 5/8 | P-3 | 78 | 2.25 |
| 30 | 4 | 3/8 | 1/4SD | CTS | 1 9/16 | P-4 | 8 | 2.25 |
| 50 | 2 | 3/8 | 7/8F | CTS | 1 1/4 | P-69 | 80 | 2.25 |
| 50 | 4 | 3/8 | 1 1/16 | CTS | 1 9/16 | P-70 | 10 | 2.25 |
| 50 | 4 | 3/8 | 5/16F | CTS | 1 9/16 | P-71 | 21 | 2.25 |
| 50 | 4 | 3/8 | 3/8SD | M | 1 1/16 | P-5 | 226 | 2.25 |
| 75 | 2 | 3/8 | 5/8 | CTS | 1 1/4 | P-20 | 8 | 2.25 |
| 100 | 2 | 5/8 | 3/8F | — | 1 5/16 | P-32 | 270 | 2.00 |
| 100 | 4 | 3/8 | 5/16 | CTS | 1 9/16 | P-6 | 352 | 2.25 |
| 100 | 4 | 3/8 | 1/2 | C | 1 1/8 | 4A-58 | 31 | 2.00 |
| 200 | 2 | 3/8 | 7/8 | CTS | 1 1/4 | P-22 | 38 | 2.25 |
| 255 | 2 | 1/2 | 1/8SD | CTS | 1 1/4 | P-83 | 100 | 2.25 |
| 300 | 2 | 3/8 | 3/8 | CTS | 1 1/4 | P-73 | 12 | 2.25 |
| 300 | 4 | 3/8 | 3/8 | M | 1 5/8 | P-7 | 31 | 2.25 |
| 350 | 2 | 3/8 | 1 1/8 | — | 1 1/4 | P-63 | 38 | 1.75 |
| 350 | 2 | 3/8 | 1/2 | CTS | 1 1/4 | P-23 | 56 | 2.25 |
| 500 | 2 | 3/8 | 1/2 | CTS | 1 1/4 | P-24 | 100 | 2.25 |
| 1K | 4 | 3/8 | 3/8 | CTS | 1 9/16 | P-10 | 90 | 2.25 |
| 1K | 2 | 3/8 | 3/8SD | CTS | 1 1/4 | P-25 | 7 | 2.25 |
| 2K | 2 | 1/2 | 5/8F | CTS | 1 1/4 | P-26 | 70 | 2.25 |
| 2K | 4 | 3/8 | 1/8SD | CTS | 1 9/16 | P-81 | 44 | 2.25 |
| 3K | 4 | 3/8 | 1/2 | C | 1 5/8 | 8A-38 | 16 | 2.25 |
| 3K | 4 | 3/8 | 1/2 | CTS | 1 9/16 | P-82 | 100 | 2.25 |
| 4K | 4 | 3/8 | 1/2SD | CTS | 1 9/16 | P-13 | 37 | 2.25 |
| 5K | 2 | 3/8 | 7/16SD | CTS | 1 1/4 | P-28 | 244 | 2.25 |
| 5K | 4 | 1/2 | 1 7/8 | T | 1 5/8 | 8A-40 | 190 | 2.25 |
| 5K | 4 | 1/2 | 1/2SD | T | 1 5/8 | 8A-39 | 2344 | 2.25 |
| 7.5K | 4 | 7/16 | 3/8SD | CTS | 1 9/16 | P-17 | 31 | 2.25 |
| 10K | 2 | 3/8 | 1/2SD | CTS | 1 1/4 | P-75 | 219 | 2.25 |
| 10K | 2 | 3/8 | 1 15/16 | CTS | 1 1/4 | P-29 | 266 | 2.25 |
| 10K | 2 | 3/8 | 1/4SD | — | 1 5/16 | P-59 | 10 | 1.75 |
| 10K | 2 | 3/8 | 3/8F | — | 1 1/4 | P-57 | 29 | 1.75 |
| 10K | 4 | 1/2 | 5/8 | T | 1 5/8 | 8A-42 | 880 | 2.25 |
| 10K | 4 | 3/8 | 3/8 | CTS | 1 9/16 | P-16 | 27 | 2.25 |
| 10K | 4 | 3/8 | 1/2 | CTS | 1 9/16 | P-76 | 31 | 2.25 |
| 15K | 4 | 3/8 | 1/2SD | CTS | 1 9/16 | P-17 | 146 | 2.25 |
| 20K | 4 | 5/8 | 2 3/4 | CTS | 1 9/16 | P-77 | 20 | 2.25 |
| 25K | 6 | 3/8 | 1 3/16 | CTS | 1 15/16 | P-78 | 8 | 2.25 |
| 40K | 4 | 3/8 | 3/8SD | M | 1 5/8 | P-51 | 66 | 2.25 |

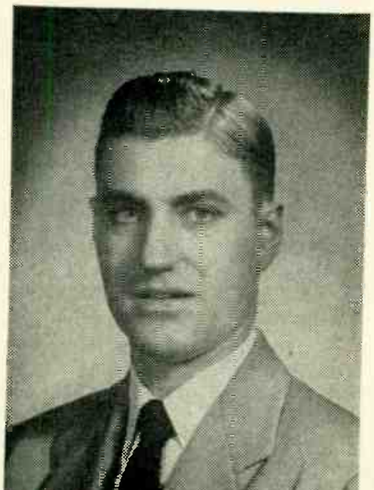
## PRECISION POTENTIOMETERS

| Ohm | Watt | Cat. No. | Stock No. | Quan. | List Price |
|---|---|---|---|---|---|
| 10 | 6 | D—292 | 8A-27 | 23 | $6.00 |
| 12 | 6 | 301AS | 8A-28 | 14 | 6.00 |
| 5K | 6 | M—314A | P-66 | 76 | 8.50 |
| 10K | 6 | D—260D | 8A-30 | 2 | 17.50 |
| 10K | 12 | D—271 | 8A-31 | 2 | 15.00 |
| 10K | 12 | 371A | 8A-32 | 70 | 15.00 |
| 20K | 6 | D5083-G2 | 8A-33 | 101 | 6.00 |
| 20K | 6 | D—260 | 8A-34 | 757 | 8.50 |
| 20K | 6 | M—314A | P-65 | 65 | 8.50 |
| 100K | 25 | 433A | 8A-35 | 14 | 32.50 |
| 100K | 25 | D—501 | 8A-36 | 2 | 32.50 |

**WIRE WOUND POTENTIOMETER—DISCOUNT SCHEDULE**

**1 to 49. .*80% off list price***
**50 to 199. .*80 & 10% off list***
**200 and up. .*80 & 10 & 10% off list***

***Different items may NOT be mixed for discount. Quantity discount allowed only to quantity shown. NEDA members write.***



## COMPOSITION POTENTIOMETERS

| Ohm | Taper | Bushing | Shaft | Type | Stock No. | Quan | Net Price |
|---|---|---|---|---|---|---|---|
| 75 | Lin. | 3/8 | 3/8 | J | P-34 | 65 | $1.00 |
| 200 | Lin. | 1/4 | 9/32 | J | P-62 | 59 | .75 |
| 1K | Lin. | 1/2S | 1/2 | J | P-61 | 6 | 1.50 |
| 1K | Lin. | 3/8 | 3/8SD | — | P-36 | 75 | .35 |
| 1.5K | Lin. | 3/8 | 1/8SD | J | P-60 | 80 | .75 |
| 2K | Lin. | 1/2S | 1/8 | J | P-38 | 90 | .65 |
| 5K | Lin. | 5/16 | 1/2 | J | P-39 | 46 | .75 |
| 10K | Lin. | 3/8 | 3/8 | J | P-40 | 22 | .75 |
| 10K | Lin. | 1/2S | 3/16SD | J | 4A-61 | 45 | .75 |
| 10K | Lin. | 3/8 | 1/2 | J | P-58 | 26 | 1.00 |
| 50K | Lin. | 3/8 | 3/8 | CTS | P-41 | 8 | .70 |
| 75K | Lin. | 3/8 | 3/8F | CTS | P-46 | 28 | .40 |
| 10-75K | Lin. | 3/8 | 3/8 | J | P-43 | 35 | .70 |
| 100K | Lin. | 3/8 | 7/16 | J | 4A-60 | 48 | 1.00 |
| 100K | Lin. | 3/8 | 2 1/4S | J | P-56 | 117 | 1.25 |
| 300K | Lin. | 1/2 | 1/8SD | J | P-35 | 115 | .75 |
| 25-400K | Lin. | 1/4 | 5/16 | J | P-42 | 79 | .70 |
| 500K | Tap. | 3/8 | 3/8 | CTS | P-44 | 15 | .40 |
| 1Meg. | Tap. | 3/8 | 7/8 | — | P-50 | 153 | .19 |
| 1Meg. | Lin. | 1/4 | 3/8 | — | P-45 | 55 | .70 |
| 2Meg. | Lin. | 3/8 | 3/8F | CTS | P-55 | 45 | .40 |
| 2Meg. | Lin. | 3/8 | 1 9/16 | CTS | P-48 | 79 | .40 |
| 2Meg. | Lin. | 1/2 | 7/16F | J | P-49 | 208 | 1.00 |
| 10Meg. | Lin. | 3/8 | 2 1/2 | J | P-49 | 27 | .49 |

**Write for our Unique Flyers. Complete Stocks of AN Connectors, Turret Sockets, Turret Lugs, Mounting Boards, Tube Sockets, Glass to Metal Seals, Stand-off Insulators, Etc.**

***Widely Known for Fair Dealing and Good Service.***

# HAROLD H. POWELL

**632 Arch Street  Philadelphia 6, Pa.  MArket 7-5650**

# AN CONNECTORS

## FAST SERVICE - LOW COST

| Insert | Shell & Price 3100 | 3102 | 3106 | 3108 | 3101 |
|---|---|---|---|---|---|
| 8S-1S | $.64 | $.48 | $.64 | $1.02 | $.65 |
| 8S-1P | .62 | .48 | .64 | 1.03 | .64 |
| 10S-2S | .59 | .43 | .56 | .99 | |
| 10S-2P | .57 | .43 | .60 | 1.00 | |
| 10SL-3S | | | .79 | 1.03 | |
| 10SL-3P | .69 | .57 | | | .71 |
| 10SL-4S | | | .61 | 1.10 | |
| 10SL-4P | .64 | .48 | | | .65 |
| 12S-3S | .65 | .48 | .77 | 1.10 | .69 |
| 12S-3P | .89 | .50 | .79 | 1.15 | .68 |
| 12S-4S | .55 | .41 | .64 | 1.09 | .62 |
| 12S-4P | .56 | .41 | .64 | 1.10 | .62 |
| 12-5S | .64 | .56 | .79 | 1.20 | .77 |
| 12-5P | .61 | .50 | .77 | 1.13 | .69 |
| 14S-1S | .71 | .53 | .95 | 1.27 | .81 |
| 14S-1P | .71 | .53 | .96 | 1.27 | .81 |
| 14S-2S | .75 | .57 | .96 | 1.30 | .79 |
| 14S-2P | .83 | .65 | .95 | 1.40 | .87 |
| 14-3S | .81 | .57 | .87 | 1.66 | .83 |
| 14-3P | .83 | .57 | 1.02 | 1.58 | .85 |
| 14S-4S | .68 | .57 | .91 | 1.26 | .68 |
| 14S-4P | .56 | .43 | .77 | 1.13 | .59 |
| 14S-5S | .85 | .63 | .98 | 1.49 | .93 |
| 14S-5P | .85 | .64 | 1.14 | 1.49 | .95 |
| 14S-6S | 1.03 | .86 | 1.23 | 1.68 | .98 |
| 14S-6P | 1.05 | .84 | 1.19 | 1.65 | 1.04 |
| 14S-7S | .89 | .65 | 1.10 | 1.50 | .89 |
| 14S-7P | .79 | .57 | .90 | 1.26 | .78 |
| 14S-9S | .83 | .60 | .95 | 1.43 | .83 |
| 14S-9P | .93 | .57 | .88 | 1.34 | .77 |
| 16S-1S | 1.05 | .89 | 1.29 | 1.54 | 1.15 |
| 16S-1P | 1.16 | .75 | 1.29 | 1.76 | 1.15 |
| 16-2S | .91 | .67 | 1.09 | 1.43 | .93 |
| 16-2P | .83 | .59 | .99 | 1.43 | .85 |
| 16S-3S | .73 | .50 | .89 | 1.36 | .77 |
| 16S-3P | .73 | .50 | .89 | 1.36 | .77 |
| 16S-4S | .77 | .56 | .93 | 1.17 | .81 |
| 16S-4P | .77 | .55 | .93 | 1.42 | .81 |
| 16S-5S | .87 | .69 | 1.10 | 1.43 | .95 |
| 16S-5P | .87 | .63 | 1.06 | 1.50 | .90 |
| 16S-6S | .85 | .61 | 1.06 | 1.57 | .95 |
| 16S-6P | .85 | .61 | 1.01 | 1.49 | .87 |
| 16-7S | 1.07 | .83 | 1.04 | 1.66 | 1.09 |
| 16-7P | .95 | .93 | 1.12 | 1.56 | 1.01 |
| 16S-8S | .95 | .83 | 1.23 | 1.46 | 1.09 |
| 16S-8P | 1.05 | .77 | 1.15 | 1.49 | .99 |
| 16-9S | 1.09 | .85 | 1.30 | 1.72 | 1.15 |
| 16-9P | 1.03 | .81 | 1.20 | 1.62 | 1.07 |
| 16-10S | 1.05 | .85 | 1.25 | 1.63 | 1.11 |
| 16-10P | .91 | .69 | 1.09 | 1.54 | .95 |
| 16-11S | .95 | .73 | .99 | 1.57 | 1.01 |
| 16-11P | .91 | .64 | 1.09 | 1.52 | .95 |
| 16-12S | 1.05 | .81 | 1.23 | 1.65 | 1.09 |
| 16-12P | .95 | .71 | 1.11 | 1.54 | .98 |
| 18-1S | 1.46 | 1.15 | 1.57 | 2.07 | 1.52 |
| 18-1P | 1.60 | 1.25 | 1.79 | 2.29 | 1.66 |
| 18-2S | .90 | .85 | 1.45 | 1.82 | 1.19 |
| 18-2P | .90 | .83 | 1.45 | 1.82 | 1.19 |
| 18-3S | 1.11 | .65 | 1.46 | 1.78 | 1.01 |
| 18-3P | 1.09 | .59 | 1.19 | 1.70 | .99 |
| 18-4S | 1.15 | .73 | 1.25 | 1.58 | 1.17 |
| 18-4P | 1.23 | .80 | 1.26 | 1.82 | 1.18 |
| 18-5S | 1.11 | .73 | 1.26 | 1.78 | 1.10 |
| 18-5P | 1.19 | .67 | 1.16 | 1.77 | 1.07 |
| 18-6S | 1.15 | .73 | 1.32 | 1.76 | 1.17 |
| 18-6P | 1.10 | .69 | 1.16 | 1.70 | 1.13 |
| 18-7S | 1.34 | .81 | 1.44 | 1.85 | 1.25 |
| 18-7P | 1.15 | .83 | 1.17 | 1.82 | 1.07 |
| 18-8S | 1.48 | 1.18 | 1.60 | 2.00 | 1.60 |
| 18-8P | 1.44 | 1.05 | 1.48 | 1.97 | 1.46 |
| 18-9S | 1.60 | 1.37 | 1.95 | 1.76 | 1.43 |
| 18-9P | 1.64 | 1.18 | 1.74 | 2.39 | 1.68 |
| 18-10S | 1.60 | .95 | 1.93 | 2.10 | 1.48 |
| 18-10P | 1.43 | .87 | 1.37 | 1.90 | 1.30 |
| 18-11S | 1.44 | .98 | 1.74 | 2.17 | 1.34 |
| 18-11P | 1.28 | .93 | 1.57 | 1.97 | 1.18 |
| 18-12S | 1 25 | 1.00 | 1.34 | 1.86 | 1.30 |
| 18-12P | 1.44 | .89 | 1.34 | 2.00 | 1.27 |
| 18-13S | 1.85 | 1.36 | 2.27 | 2.47 | 1.76 |
| 18-13P | 1.38 | .89 | 1.58 | 1.93 | 1.27 |
| 18-14S | 1.54 | 1.01 | 1.64 | 2.04 | 1.44 |
| 18-14P | 1.35 | .93 | 1.44 | 2.00 | 1.26 |
| 18-16S | 1.23 | .69 | 1.30 | 1.30 | 1.06 |
| 18-16P | 1.15 | .67 | 1.24 | 1.70 | 1.04 |
| 18-20S | 1.19 | .83 | 1.28 | 1.80 | 1.25 |
| 18-20P | 1.32 | .85 | 1.50 | 2.00 | 1.12 |
| 18-22S | 1.41 | .83 | 1.48 | 1.87 | 1.27 |
| 18-22P | 1.05 | .65 | 1.52 | 1.70 | 1.09 |
| 18-29S | 1.44 | .87 | 1.76 | 1.92 | 1.30 |
| 18-29P | 1.52 | .95 | 1.84 | 2.00 | 1.38 |
| 18-30S | 1.19 | .85 | 1.28 | 1.80 | 1.12 |
| 18-30P | 1.32 | .85 | 1.50 | 2.00 | 1.25 |
| 18-31S | 1.19 | .85 | 1.28 | 1.80 | 1.12 |
| 18-31P | 1.32 | .85 | 1.50 | 2.00 | 1.25 |
| 20-1S | 1.77 | 1.44 | 1.90 | 1.94 | 1.88 |
| 20-1P | 2.28 | 1.54 | 2.37 | 2.39 | 2.53 |
| 20-2S | 1.30 | .77 | 1.61 | 1.70 | 1.35 |
| 20-2P | 1.24 | .73 | 1.38 | 1.68 | 1.32 |
| 20-3S | 1.48 | .90 | 1.70 | 1.88 | 1.50 |
| 20-3P | 1.36 | .69 | 1.52 | 1.94 | 1.43 |
| 20-4S | 1.35 | .83 | 1.50 | 1.97 | 1.35 |
| 20-4P | 1.30 | .77 | 1.49 | 1.94 | 1.28 |
| 20-5S | 1.23 | .67 | 1.38 | 1.78 | 1.28 |
| 20-5P | 1.15 | .57 | 1.42 | 1.68 | 1.17 |
| 20-6S | 1.30 | .83 | 1.43 | 1.76 | 1.26 |
| 20-6P | 1.30 | .73 | 1.44 | 1.68 | 1.33 |
| 20-7S | 1.41 | 1.15 | 1.52 | 2.04 | 1.66 |
| 20-7P | 1.73 | 1.30 | 1.85 | 2.24 | 1.88 |
| 20-8S | 1.76 | 1.20 | 2.13 | 2.13 | 1.77 |
| 20-8P | 1.68 | 1.12 | 1.95 | 2.04 | 1.71 |
| 20-9S | 1.71 | 1.16 | 1.91 | 2.10 | 1.76 |
| 20-9P | 1.66 | 1.10 | 1.85 | 2.04 | 1.68 |

| Insert | Shell & Pric 3100 | 3102 | 3106 | 3108 | 3101 |
|---|---|---|---|---|---|
| 20-11S | 1.60 | 1.05 | 1.60 | 1.83 | 1.76 |
| 20-11P | 1.60 | 1.00 | 1.67 | 1.83 | 1.68 |
| 20-12S | 1.42 | .87 | 1.77 | 1.80 | 1.44 |
| 20-12P | 1.35 | .81 | 1.52 | 1.74 | 1.38 |
| 20-14S | 1.76 | 1.25 | 2.23 | 2.16 | 1.77 |
| 20-14P | 1.56 | 1.17 | 1.66 | 2.12 | 1.77 |
| 20-15S | 1.82 | 1.28 | 2.08 | 2.21 | 1.88 |
| 20-15P | 1.58 | 1.04 | 1.96 | 1.97 | 1.64 |
| 20-16S | 1.82 | 1.32 | 1.96 | 2.25 | 1.92 |
| 20-16P | 1.77 | 1.24 | 1.95 | 2.17 | 1.80 |
| 20-17S | 1.77 | 1.24 | 2.24 | 2.17 | 1.82 |
| 20-17P | 1.68 | 1.13 | 1.84 | 2.07 | 1.72 |
| 20-18S | 1.93 | 1.37 | 2.33 | 2.33 | 1.97 |
| 20-18P | 1.70 | 1.12 | 2.17 | 2.09 | 1.72 |
| 20-19S | 1.68 | 1.12 | 2.16 | 2.07 | 1.70 |
| 20-19P | 1.56 | 1.08 | 1.68 | 2.01 | 1.66 |
| 20-20S | 1.70 | 1.12 | 1.76 | 2.10 | 1.72 |
| 20-20P | 1.52 | .96 | 1.76 | 1.91 | 1.56 |
| 20-21S | 1.84 | 1.30 | 1.97 | 2.25 | 1.90 |
| 20-21P | 1.77 | 1.25 | 2.17 | 2.17 | 1.77 |
| 20-22S | 1.77 | 1.25 | 2.18 | 2.18 | 1.82 |
| 20-22P | 1.70 | 1.15 | 1.82 | 2.10 | 1.74 |
| 20-23S | 1.48 | .93 | 1.85 | 1.88 | 1.52 |
| 20-23P | 1.35 | .81 | 1.52 | 1.74 | 1.38 |
| 20-24S | 1.57 | 1.03 | 1.68 | 1.88 | 1.60 |
| 20-24P | 1.48 | .93 | 1.64 | 1.87 | 1.52 |
| 20-26S | 1.38 | .99 | 2.02 | 1.93 | 1.56 |
| 20-26P | 1.38 | .89 | 1.52 | 1.82 | 1.48 |
| 20-27S | 1.79 | 1.44 | 1.90 | 2.37 | 2.02 |
| 20-27P | [illegible] | 1.84 | 2.37 | 2.77 | 2.42 |
| 20-28S | [illegible] | 1.44 | 1.90 | 2.24 | 2.02 |
| 20-28P | 2.25 | 1.78 | 2.37 | 2.67 | 2.38 |
| 20-29S | 3.40 | 3.40 | 4.50 | 5.62 | 4.50 |
| 20-29P | 3.40 | 3.40 | 4.50 | 5.62 | 4.50 |
| 22-1S | 1.41 | .81 | 1.70 | 2.02 | 1.48 |
| 22-1P | 1.36 | .75 | 1.60 | 1.92 | 1.37 |
| 22-2S | 1.72 | 1.15 | 2.10 | 2.25 | 1.74 |
| 22-2P | 1.58 | 1.02 | 1.76 | 2.13 | 1.60 |
| 22-3S | 1.49 | .92 | 1 92 | 2.01 | 1.50 |
| 22-3P | 1.34 | .79 | 1.58 | 1.90 | 1.34 |
| 22-4S | 1.60 | 1.00 | 1.82 | 2.36 | 1.64 |
| 22-4P | 1.48 | .95 | 1.64 | 2.02 | 1.56 |
| 22-5S | 1.56 | 1.03 | 1.66 | 2.13 | 1.58 |
| 22-5P | 1.48 | 1.48 | 1.56 | 2.04 | 1.48 |
| 22-6S | 1.52 | .95 | 2.02 | 2.08 | 1.53 |
| 22-6P | 1.43 | .85 | 1.72 | 1.43 | 1.43 |
| 22-7S | 1.54 | .99 | 1.90 | 2.10 | 1.54 |
| 22-7P | 1.36 | .81 | 1.60 | 1.92 | 1.36 |
| 22-8S | 1.49 | 1.00 | 1.66 | 2.19 | 1.56 |
| 22-8P | 1.18 | .50 | 1.36 | 1.77 | 1.25 |
| 22-9S | 1.48 | .90 | 1.97 | 2.02 | 1 50 |
| 22-9P | 1.28 | .76 | 1.60 | 1.66 | 1.30 |
| 22-10S | 1.23 | .87 | 1.42 | 1.94 | 1.35 |
| 22-10P | 1.35 | .81 | 1.56 | 1.92 | 1.37 |
| 22-11S | 1.38 | .85 | 1.64 | 1.93 | 1.43 |
| 22-11P | 1.16 | .78 | 1.30 | 1.80 | 1.51 |
| 22-12S | 1.68 | 1.10 | 1.92 | 2.22 | 1.72 |
| 22-12P | 1.54 | .99 | 1.84 | 2.10 | 1.57 |
| 22-13S | 1.72 | 1.15 | 2.14 | 2.25 | 1.72 |
| 22-13P | 1.44 | 1.03 | 1.62 | 2.11 | 1.60 |
| 22-14S | 2.09 | 1.85 | 2.21 | 2.72 | 2.40 |
| 22-14P | 2.35 | 1.77 | 2.82 | 2.89 | 2.35 |
| 22-15S | 2.08 | 1.50 | 2.55 | 2.61 | 2.10 |
| 22-15P | 1.58 | 1.07 | 1.74 | 2.16 | 1.64 |
| 22-16S | 1.97 | 1.40 | 2.44 | 2.53 | 2.00 |
| 22-16P | 1.74 | 1.20 | 2.24 | 2.30 | 1.76 |
| 22-17S | 1.65 | 1.32 | 1.85 | 2.35 | 1.70 |
| 22-17P | 1.77 | 1.23 | 2.04 | 2.33 | 1.80 |
| 22-18S | 1.64 | 1.15 | 1.82 | 2.25 | 1.74 |
| 22-18P | 1.57 | 1.00 | 2.04 | 2.11 | 1.56 |
| 22-19S | 1.80 | 1.60 | 1.96 | 2.47 | 2.10 |
| 22-19P | 1.96 | 1.38 | 2.44 | 2.50 | 1.97 |
| 20-20S | 1.54 | 1.23 | 1.70 | 2.20 | 1.77 |
| 22-20P | 1.64 | 1.07 | 1.82 | 2.08 | 1.66 |
| 22-21S | 1.82 | 1.42 | 2.01 | 2.53 | 1.92 |
| 22-21P | 1.64 | 1.09 | 1.82 | 2.20 | 1.67 |
| 22-22S | 1.74 | 1.17 | 2.10 | 2.28 | 1.76 |
| 22-22P | 1.68 | 1.10 | 1.91 | 2.20 | 1.68 |
| 22-23S | 2.00 | 1.44 | 2.47 | 2.35 | 2.02 |
| 22-23P | 1.76 | 1.20 | 2.14 | 2.32 | 1.76 |
| 22-24S | 1.66 | 1.08 | 1.68 | 2.18 | 1.66 |
| 22-24P | 1.46 | .89 | 1.55 | 2.00 | 1.48 |
| 22-25S | 1.[illegible] | 1.09 | 2.10 | 2.20 | 1.68 |
| 22-25P | 1.52 | .95 | 1.76 | 2.08 | 1.52 |
| 22-26S | 1.80 | 1.25 | 1.92 | 2.35 | 1.80 |
| 22-26P | 1.68 | 1.12 | 1.90 | 2.22 | 1.70 |
| 22-27S | 1.96 | 1.47 | 2.13 | 2.57 | 2.03 |
| 22-27P | 1.72 | 1.32 | 1.90 | 2.37 | 1.94 |
| 22-28S | 1.82 | 1.26 | 2.31 | 2.37 | 1.82 |
| 22-28P | 1.52 | .95 | 2.00 | 2.08 | 1.54 |
| 22-29S | 1.92 | 1.36 | 2.16 | 2.45 | 1.94 |
| 22-29P | 1.80 | 1.25 | 2.18 | 2.32 | 1.80 |
| 22-33S | 1.57 | 1.24 | 1.76 | 2.30 | 1.68 |
| 22-33P | 1.68 | 1.13 | 2.05 | 2.22 | 1.70 |
| 22-34S | 1.66 | 1.09 | 1.95 | 2.20 | 1.68 |
| 22-34P | 1.52 | 1.00 | 1.72 | 2.12 | 1.58 |
| 22-36S | 1.65 | 1.70 | 1.95 | 2.20 | 1.68 |
| 22-36P | 1.52 | 1.00 | 1.72 | 2.12 | 1.58 |
| 24-1S | 1.77 | 1.06 | 2.12 | 2.24 | 1.74 |
| 24-1P | 1.49 | 2.03 | 1.82 | 2.20 | 1.60 |
| 24-2S | 1.95 | 1.21 | 2.25 | 2.40 | 1.92 |
| 24-2P | 1.63 | 1.03 | 1.80 | 2.20 | 1.72 |
| 24-3S | 1.72 | 1.20 | 2.01 | 2.36 | 1.87 |
| 24-3P | 1.52 | 1.24 | 1.80 | 2.21 | 1.52 |
| 24-4S | 1.85 | 1.23 | 2.25 | 2.39 | 1.92 |
| 24-4P | 1.62 | 1.03 | 1.93 | 2.20 | 1.70 |
| 24-5S | 1.87 | 1.76 | 2.16 | 2.63 | 2.15 |
| 24-5P | 2.08 | 1.56 | 2.05 | 2.75 | 2.25 |
| 24-7S | 2.20 | 1.88 | 2.47 | 2.95 | 2.55 |
| 24-7P | 2.12 | 1.50 | 2.42 | 2.88 | 2.41 |
| 24-9S | 1.98 | 1.60 | 2.31 | 2.76 | 2.10 |
| 24-9P | 1.54 | .99 | 1.85 | 2.16 | 1.64 |

| Insert | Shell & Price 3100 | 3102 | 3106 | 3108 | 3101 |
|---|---|---|---|---|---|
| 24-10S | 2.22 | 1.50 | 2.54 | 2.74 | 2.19 |
| 24-10P | 2.18 | 1.46 | 2.50 | 2.63 | 2.16 |
| 24-11S | 2.42 | 1.70 | 2.75 | 2.87 | 2.37 |
| 24-11P | 1.95 | 1.43 | 2.27 | 2.60 | 2.12 |
| 24-12S | 2.02 | 1.90 | 2.31 | 2.80 | 2.34 |
| 24-12P | 1.85 | 1.23 | 2.16 | 2.39 | 1.92 |
| 24-14S | 2.00 | 1.28 | 2.33 | 2.45 | 2.00 |
| 24-14P | 1.60 | 1.09 | 1.92 | 2.25 | 1.70 |
| 24-15S | 2.31 | 1.55 | 2.63 | 2.77 | 2.25 |
| 24-15P | 1.87 | 1.76 | 2.16 | 2.67 | 2.17 |
| 24-16S | 2.11 | 1.38 | 1.87 | 2.37 | 2.07 |
| 24-16P | 1.68 | 1.12 | 1.68 | 2.02 | 1.82 |
| 24-17S | 2.03 | 1.23 | 2.27 | 2.75 | 2.25 |
| 24-17P | 1.52 | 1.00 | 1.83 | 2.17 | 1.62 |
| 24-19S | 2.24 | 1.52 | 2.20 | 2.69 | 2.20 |
| 24-19P | 1.82 | 1.32 | 2.13 | 2.51 | 2.02 |
| 24-20S | 2.25 | 1.52 | 2.38 | 2.59 | 2.26 |
| 24-20P | 2.45 | 1.77 | 2.65 | 2.82 | 2.43 |
| 24-21S | 1.93 | 1.46 | 2.27 | 2.30 | 1.86 |
| 24-21P | 1.84 | 1.25 | 2.02 | 2.55 | 1.82 |
| 24-28S | 2.92 | 2.25 | 3.23 | 3.30 | 2.90 |
| 24-28P | 3.72 | 3.03 | 3.80 | 4.08 | 3.67 |
| 28-2S | 2.24 | 1.63 | 2.47 | 3.06 | 2.57 |
| 28-2P | 2.10 | 1.42 | 2.36 | 2.82 | 2.33 |
| 28-3S | 2.22 | 1.36 | 2.63 | 2.79 | 2.30 |
| 28-3P | 1.74 | 1.01 | 2.16 | 2.41 | 1.85 |
| 28-4S | 2.03 | 1.42 | 2.35 | 2.70 | 2.04 |
| 28-4P | 1.74 | 1.17 | 2.13 | 2.50 | 2.10 |
| 28-5S | 2.36 | 1.44 | 2.73 | 2.86 | 2.36 |
| 28-5P | 1.95 | 1.16 | 2.35 | 2.62 | 2.05 |
| 28-6S | 2.41 | 1.50 | 2.79 | 2.95 | 2.41 |
| 28-6P | 1.90 | 1.23 | 2.17 | 2.63 | 2.02 |
| 28-7S | 2.13 | 1.20 | 2.47 | 2.62 | 2.13 |
| 28-7P | 1.70 | 1.03 | 2.10 | 2.49 | 1.80 |
| 28-8S | 1.80 | 1.60 | 3.04 | 3.04 | 2.39 |
| 28-8P | 2.05 | 1.46 | 2.89 | 2.89 | 2.43 |
| 28-9S | 2.53 | 2.17 | 2.89 | 3.47 | 2.90 |
| 28-9P | 2.16 | 1.48 | 2.50 | 2.89 | 2.54 |
| 28-10S | 2.59 | 1.68 | 2.97 | 3.10 | 2.59 |
| 28-10P | 2.39 | 1.52 | 2.79 | 2.95 | 2.43 |
| 28-11S | 2.97 | 2.33 | 2.70 | 3.75 | 3.25 |
| 28-11P | 2.80 | 2.88 | 2.81 | 3.40 | 2.89 |
| 28-12S | 2.63 | 2.38 | 2.98 | 3.53 | 3.00 |
| 28-12P | 1.84 | 2.19 | 3.02 | 3.62 | 3.10 |
| 28-15S | 3.42 | 2.86 | 4.08 | 4.30 | 3.50 |
| 28-15P | 3.70 | 2.80 | 3.82 | 4.24 | 3.71 |
| 28-16S | 2.30 | 2.05 | 2.68 | 3.21 | 2.64 |
| 28-16P | 2.75 | 2.50 | 3.10 | 3.23 | 2.75 |
| 28-17S | 2.03 | 1.77 | 2.39 | 2.97 | 2.35 |
| 28-17P | 2.18 | 1.56 | 2.47 | 2.47 | 2.46 |
| 28-18S | 2.45 | 1.82 | 2.83 | 3.25 | 2.55 |
| 28-18P | 2.24 | 1.48 | 2.62 | 2.89 | 2.35 |
| 28-19S | 2.14 | 1.54 | 2.45 | 2.83 | 2.45 |
| 28-19P | 1.85 | 1.24 | 2.24 | 2.65 | 2.16 |
| 28-20S | 2.52 | 1.99 | 2.84 | 3.20 | 2.90 |
| 28-20P | 2.20 | 1.60 | 2.50 | 3.03 | 2.53 |
| 28-22S | 2.73 | 1.80 | 3.06 | 3.22 | 2.73 |
| 28-22P | 2.55 | 1.50 | 2.79 | 2.90 | 2.39 |
| 32-1S | 2.65 | 1.76 | 3.10 | 3.35 | 2.74 |
| 32-1P | 2.34 | 1.56 | 2.73 | 3.11 | 2.53 |
| 32-6S | 4.30 | 3.38 | 4.70 | 4.96 | 4.32 |
| 32-6P | 3.75 | 2.82 | 3.74 | 4.39 | 3.79 |
| 32-7S | 4.25 | 3.32 | 4.73 | 4.93 | 4.28 |
| 32-7P | 3.90 | 2.88 | 3.78 | 4.58 | 3.94 |
| 32-8S | 3.89 | 2.98 | 4.30 | 4.60 | 3.96 |
| 32-8P | 3.60 | 2.37 | 4.05 | 4.26 | 3.65 |
| 32-9S | 3.36 | 2.65 | 3.75 | 4.20 | 3.45 |
| 32-9P | 2.98 | 2.04 | 3.40 | 3.63 | 3.03 |
| 32-10S | 3.12 | 2.29 | 3.48 | 3.87 | 3.25 |
| 32-10P | 2.49 | 1.74 | 2.84 | 3.23 | 2.69 |
| 32-16S | 4.30 | 3.40 | 4.70 | 5.00 | 4.35 |
| 32-16P | 3.77 | 2.84 | 4.24 | 4.40 | 3.83 |
| 32-20S | 3.98 | 3.40 | 4.60 | 4.60 | 4.35 |
| 32-20P | 3.25 | 2.84 | 3.85 | 4.44 | 3.75 |
| 36-1S | 3.54 | 2.80 | 3.65 | 4.38 | 3.72 |
| 36-1P | 3.28 | 2.15 | 3.45 | 4.03 | 3.32 |
| 36-7S | 5.16 | 4.33 | 4.95 | 5.90 | 4.02 |
| 36-7P | 4.13 | 3.45 | 5.43 | 5.43 | 4.78 |
| 36-9S | 5.04 | 4.20 | 5.60 | 5.80 | 5.10 |
| 36-9P | 3.80 | 3.39 | 4.85 | 5.00 | 4.40 |
| 36-10S | 3.80 | 3.39 | 4.85 | 5.00 | 4.40 |
| 36-10P | 3.80 | 3.39 | 4.85 | 5.00 | 4.40 |
| 36-11S | 3.80 | 3.39 | 4.85 | 5.00 | 4.40 |
| 36-11P | 3.80 | 3.39 | 4.85 | 5.00 | 4.40 |
| 36-15S | 3.55 | 3.20 | 3.95 | 4.43 | 4.16 |
| 36-15P | 4.04 | 3.06 | 4.48 | 4.78 | 4.10 |
| 36-19S | 3.40 | 4.00 | 3.90 | 4.43 | 4.80 |
| 36-19P | 3.40 | 4.00 | 3.90 | 4.43 | 4.80 |
| 40-1S | 4.90 | 3.63 | 5.45 | 5.18 | 5.00 |
| 40-1P | 4.33 | 2.63 | 4.45 | 4.60 | 4.40 |
| 44-1S | 5.90 | 4.35 | 6.06 | 6.50 | 6.60 |
| 44-1P | 6.00 | 3.64 | 6.01 | 5.50 | 6.10 |
| 44-4S | 7.50 | 5.25 | 7.20 | 7.45 | 7.32 |
| 44-4P | 6.55 | 4.20 | 6.10 | 7.10 | 6.63 |
| 48-3S | 6.40 | 4.20 | 6.10 | 7.10 | 6.63 |
| 48-3P | 6.40 | 4.20 | 6.10 | 7.10 | 6.63 |

| SHELL | PRICE | SHELL | PRICE |
|---|---|---|---|
| 3057-3......... | $.26 | 3057-12......... | .33 |
| 3057-4......... | .26 | 3057-16......... | .33 |
| 3057-6......... | .26 | 3057-20......... | .65 |
| 3057-8......... | .31 | 3057-24......... | .69 |
| 3057-10......... | .31 | | |

# 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 |
| 30 | 75 | 175 | 430 | 910 | .0027 | .008 |
| 35 | 82 | 180 | 470 | MFD | .003 | .0082 |
| 39 | 85 | 200 | 500 | .001 | .0033 | .01 |
| 40 | 90 | 220 | 510 | .0011 | .0047 | |
| | | 240 | 560 | .0012 | .005 | |

Price Schedule
8.2 MMF to .0011 MFD. .......... 5¢
.0012 MFD to .002 MFD. .......... 7¢
.0023 MFD to .0082 MFD. .......... 12¢
.01 MFD. .......... 18¢

### SILVER MICAS

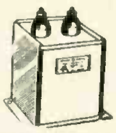
| MMF | MMF | MMF | MMF | MMF | MMF | MFD |
|---|---|---|---|---|---|---|
| 10 | 51 | 120 | 270 | 470 | 815 | .00282 |
| 18 | 60 | 125 | 325 | 488 | 820 | .002826 |
| 22 | 62 | 130 | 330 | 500 | 875 | .003 |
| 23 | 66 | 150 | 360 | 510 | MFD | .0033 |
| 24 | 68 | 180 | 370 | 525 | .001 | .0039 |
| 30 | 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 | 446 | | .0028 | .0082 |

Price Schedule
10MMF to .001MFD. .......... 10¢
.001625MFD to .0024MFD .......... 20¢
.00282MFD tc .0082 MFD. .......... 50¢

### OIL FILLED

| MFD | V. D. C. | Price | MFD | V. D. C. | Price |
|---|---|---|---|---|---|
| .25 | 20,000 | $15.75 | 8 | 1,000 | $1.35 |
| .03 | 16,000 | 1.95 | 4 | 1,000 | 1.15 |
| { .375@ | 16,000 and | | 3 | 1,000 | .80 |
| { .75 @ | 8,000 | 5.95 | 2 | 1,000 | .65 |
| .1 | 7,500 | 1.55 | 1 | 800 | .39 |
| .1-.1 | 7,000 | 1.55 | 10 | 600 | 1.35 |
| .01 | 6,000 | .95 | 8 | 600 | 1.15 |
| .03-.03 | 6,000 | 1.25 | 4 | 600 | .79 |
| .02-.02 | 7,000 | 1.25 | 2 | 600 | .39 |
| 1 | 6,000 | 5.25 | | | |
| 2 | 5,000 | 3.95 | | | |
| 2 | 4,000 | 2.50 | | | |
| 2 | 3,000 | 2.15 | | | |
| .25 | 3,000 | 1.10 | | | |
| .2 | 750 AC | .49 | | | |
| 8 | 2,000 | 3.95 | | | |
| 4 | 2,000 | 3.65 | | | |
| 2 | 2,500 | 1.95 | | | |
| 1 | 2,000 | .95 | | | |

2 mfd
4,000
V.D.C.
G.E.
SPECIAL
$2.50



### JONES BARRIER STRIPS

| Type | Price | Type | Price | Type | Price |
|---|---|---|---|---|---|
| 2-140Y | $0.10 | 5-141¾W | .30 | 3-142 | .17 |
| 3-140¾W | .15 | 5-141Y | .30 | 3-142Y | .23 |
| 5-140 | .17 | 7-141 | .29 | 5-142 | .26 |
| 6-140 | .20 | 7-141¾W | .41 | 5-142¾W | .37 |
| 9-140¾W | .40 | 8-141¾W | .47 | 10-142¾W | .71 |
| 10-140¾W | .44 | 9-141¾W | .52 | 11-142Y | .78 |
| 2-141 | .10 | 9-141Y | .52 | 2-150 | .31 |
| 3-141¾W | .19 | 10-141Y | .58 | 2-150¾W | .38 |
| 3-141W | .19 | 13-141¾W | .74 | 3-150 | .44 |
| 4-141W | .25 | 17-141Y | .96 | 4-150 | .57 |
| 4-141¾W | .25 | | | | |
| 5-141 | .22 | | | | |

### METERS

Brand New—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 DRUM (From BC-221)

0-50 in 180°. Black with silver marks. .......... 85¢

### VERNIER DIAL (From BC-221)

2 ⅝" Dia. 0-100 in 360°. Black with silver marks. Has thumblock .......... 85¢

### 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

## WIRE WOUND PRECISION RESISTORS 1% OR BETTER

### ¼ WATT—25c

| | | | | |
|---|---|---|---|---|
| 6.68Ω | 12.32Ω | 16.37Ω | 125Ω | 414.3Ω |
| 10.48 | 13.02 | 62.54 | 147.5 | 705 |
| 10.84 | 13.52 | 79.81 | 220.4 | 2193 |
| 11.25 | 13.89 | 105.8 | 301.8 | 59,148 |
| 11.74 | 14.98 | 123.8 | 366.6 | 100,000 |

### ½ WATT—25c

| | | | | | |
|---|---|---|---|---|---|
| .250Ω | 1.53Ω | 75Ω | 260Ω | 4,000Ω | 8,500Ω |
| .334 | 2.04 | 90 | 270 | 4,451 | 14,825 |
| .444 | 11.1 | 97.8 | 298.3 | 5,000 | 15,000 |
| .502 | 13.15 | 100 | 400 | 5,900 | 15,750 |
| .557 | 18.75 | 125 | 723.1 | 6,500 | 17,000 |
| .627 | 46 | 180 | 2,500 | 7,000 | 30,000 |
| .76 | 52 | 210 | 2,850 | 7,500 | 37,000 |
| 1.01 | 55.1 | 235 | 3,427 | 8,000 | 79,012 |
| | | | | | 100,000 |

### 1 WATT—30c

| | | | | |
|---|---|---|---|---|
| 1.01Ω | 5.21Ω | 270Ω | 9,000Ω | 55,000Ω |
| 2.58 | 10.1 | 3,300 | 18,000 | 65,000 |
| 3.39 | 10.9 | 7,000 | | |

### 1 WATT—40c

| | | | |
|---|---|---|---|
| 100,000Ω | 128,000Ω | 320,000Ω | 600,000Ω |
| 120,000 | 130,000 | 522,000 | 700,000 |

1 Megohm—1 Watt 1%—65c; 5%—40c

Orders for 100 precision resistors—10% Discount


### 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. } $5.95

### PULSE TRANSFORMERS

X 124 T2. UTAH, marked 9262, 9340, small gray case. Ratio 1:1:1; hypersil core .......... $2.75
D161310, 50 Kc to 4 Mc. 1¾" dia. x 1⅞" high. 120 to 2350 ohms .......... $1.50
352-7178—Spec. 10, 111 Chicago Trans. equivalent to 9262 (above) .......... $1.50
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: Biflar: one microsecond pulse width .......... $28.50

### PRECISION CONTROLS

| 6 WATT | | | | 4 WATT | | | |
|---|---|---|---|---|---|---|---|
| 20,000Ω | Muter | 314A | $1.70 | 500Ω | Centralab | 48-501 | $1.00 |
| 6,000 | De jur | 260 | 1.70 | 200Ω | GR | 301 | 1.25 |
| 6,000 | Muter | 314A | 1.70 | 20 | De jur | 292 | 1.00 |
| 5,000 | Muter | 314A | 2.50 | 12 | GR | 301 | 1.10 |
| 2,000 | De jur | 260 | 1.70 | 12 | De jur | 292 | 1.00 |
| 12 WATT | | | | 2 | GR | 301 | 1.25 |
| 10,000Ω | De jur | 271T | $2.00 | | | | |
| 10,000 | Muter | 471A | 2.00 | | | | |
| 5,000 | De jur | 271T | 2.00 | | | | |

### PRECISION CAPACITOR—W.E.

D-161270. 1 mfd @ 200 VDC; —40° to +65°C. .......... $8.50

### SELENIUM RECTIFIERS

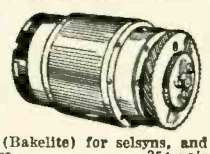
Full Wave—200 ma., 115 V. .......... $1.57
Half Wave—100 ma., 115 V. .......... .72

### 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

### SELSYNS

115 V., 60 Cyc.
#C78248
3⅜" dia. x 5⅜" long
$8.95 pair



### DIFFERENTIAL

115 V., 60 Cyc.
#C78249
3⅜" dia. x 5⅜" long
$2.95 ea.

Mounting Brackets — (Bakelite) for selsyns, and differentials shown above .......... 35¢ pair

Used between two #C78248's as dampener. Can be converted to 3600 RPM Motor in 10 minutes. Conversion sheet supplied. (Converted) .......... $3.50

Get On Our Mailing List!

Minimum Orders $3...... All orders f.o.b. PHILA, PA.

# RELIANCE MERCHANDIZING CO.

Arch St. Cor. Croskey Phila. 3, Pa. Telephone RIttenhouse 6-4927

## COAXIAL CABLES

GUARANTEED!! NEW!!

| | Ohms | Price per 1,000 ft | | Ohms | Price per 1,000 ft |
|---|---|---|---|---|---|
| RG-5/U | 53.5 | $70 | RG-29/U* | 53.5 | $50 |
| RG-6/U | 76 | 150 | RG-34/U | 71 | 175 |
| RG-7/U* | 97.5 | 65 | RG-35/U | 71 | 450 |
| RG-9/U* | 51 | 135 | RG-37/U | 55 | 40 |
| RG-10/U | 52 | 125 | RG-39/U | 72.5 | 180 |
| RG-13/U* | 74 | 125 | RG-41/U | 67.5 | 550 |
| RG-15/U | 76 | 160 | RG-54/U | 58 | 65 |
| RG-18/U | 52 | 450 | RG-54/AU | 54 | 75 |
| RG-21/U | 53 | 100 | RG-55/U | 53.5 | 65 |
| RG-22/U* | 95 | 110 | RG-57/U* | 95 | 100 |
| RG-24/U | 125 | 240 | RG-58/U* | 53.5 | 55 |
| RG-25/U | 48 | 575 | RG-74/U | 52 | 250 |
| RG-26/U | 48 | 75 | RG-77/U* | 48 | 100 |
| RG-27/U | 48 | 290 | RG-78/U | 48 | 80 |
| RG-28/U | | 160 | | | |

*No minimum order—others 250' minimum
Add 25% for orders less than 1,000 feet

## COAXIAL CABLE CONNECTORS

| Angle Adapter | Plug | Socket | Hood |
|---|---|---|---|
| 15¢ | 40¢ | 35¢ | 9¢ |
| M-359 | PL-259A | SO-239 | 83-1H |
| 83-1AP | 83-1SPN | 83-1R | |

Adapter for PL-259 A for use on small coax. 12¢ each .......... $10.00 per 100

| | | | | | |
|---|---|---|---|---|---|
| 83-1AC | $0.42 | UG-19/U | .73 | UG-85/U | .88 |
| 83-1F | 1.12 | 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 |
| 83-1T | 1.12 | UG-24/U | .67 | UG-167/U | 2.00 |
| 83-22AP | 1.10 | UG-25/U | .60 | UG-171/U | 1.33 |
| 83-22F | 1.48 | 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 | | |

### 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 | 30 MMF |
|---|---|
| 5.6 | 35 |
| 10 | 39 |
| 12 | 45 |
| 15 | 62 |
| 20 | 82 |
| 22 | 150 |
| | 200 |

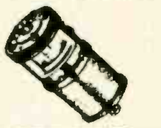
$6.50 per hundred

### 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 |

$5.50 per hundred

### 2J1G1 SELSYNS



BRAND NEW
400 Cycle
Can be used on 60 cycle
$1.85

### 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)...25¢

### 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 | 20 | 2.50 |
| 1 | 2.00 | 5 | 2.00 | 25 | 2.50 |
| | | | | 30 | 2.50 |

Fuse Holder—for 4AG Fuse. (Littlefuse or Buss)...18¢

### 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¢ |
| GB34X 1/4" wide | 3/16" | 11/32" | 25¢ |

### 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

### HAYDON TIMING MOTOR

4 R.P.M., 115 V., 60 Cycle .......... $1.79

### DELAY NETWORK—ALL 1400Ω

T 113—Approx. 1.2 micro sec. delay .......... 85¢
T 114—Approx. 2.2 micro. sec. delay .......... 85¢
T 115—Similar to T 114 with tap brought out .......... 85¢

### CHOKES

30 Hy., 8 ma. .......... $1.29
6 Hy., 8 ma. .......... .78

# R·H·S SPECIALS OF THE MONTH

| | |
|---|---|
| 1000 KC crystal BT cut | $3.95 |
| 3" scope shield | 1.29 |
| 2 speed dial drive for ¼" shaft ratios 5:1 1 to 1 | .39 |
| ATC 100 mmfd air trimmer screwdriver shaft | .29 |
| Sigma Sens. Relay 8000 ohms | 1.98 |
| Centralab 850 S 50MMF 5KV BUTTON COND. | .39 |
| 500 watt 12.5 ohm power rheostat | 3.49 |
| 50 mmfd 5 KV vacuum condenser | $1.49 |
| 6v, 12v vibrators any type | .98 |
| Rotary switch Mycalex. 2 deck SP3T | .39 |
| 1 mfd 5000v oil condenser | 2.98 |
| 2 mfd 3000v oil condenser | 3.25 |
| 3 mfd 4000v oil condenser | 3.95 |
| 24 mfd 1500v DC 3KV flash. Excellent for speed lamp | 3.95 |

# TUBES!! BRAND NEW! STANDARD BRANDS! NO SECONDS! COMPARE! TUBES!!

| | |
|---|---|
| OA3/VR75 | $1.29 |
| OB3/VR90 | 1.29 |
| OC3/VR105 | 1.49 |
| OD3/VR150 | 1.29 |
| 1B22 | 3.45 |
| 1B23 | 12.50 |
| 1B24 | 6.95 |
| 1B26 | 3.95 |
| 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 |
| 4AP10 | 4.95 |
| 4B22/EL5B | 9.95 |
| 4B24/EL3C | 7.95 |
| 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 |
| 45 Special | .39 |
| 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 |
| GL592 | 14.95 |
| HF125 | 14.95 |
| HF300 | 19.95 |
| HY114B | .79 |
| HY115 | .79 |
| HY615 | .29 |
| KC4 | 37.50 |
| KU610 | 6.95 |
| ML101 | 69.50 |
| REL21 | 3.25 |
| RK20 | 9.95 |
| RK25 | 4.49 |
| RK33 | .69 |
| RK34 | .89 |
| RK48A | 4.49 |
| RK59 | 1.49 |
| RK60/1641 | .98 |
| RK65 | 24.50 |
| RK72 | .59 |
| RK73 | .59 |
| RX21A | 2.95 |
| RX120 | 8.95 |
| V70D | 6.95 |
| 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

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.

5Z4, 6A3, 6A4LA, 6A6, 6A7, 6A8, 6AB7, 6AC5GT, 6AC7, 6AD7G, 6AE6G, 6AF6G, 6AG5, 6AG7, 6AH6, 6AJ5, 6AK5, 6AK6, 6AL5, 6AQ5, 6AQ6, 6AR5, 6AT6, 6AU6, 6AV6, 6B4G, 6B6G, 6B7, 6B8G, 6BA6, 6BE6, 6BF6, 6BG6G, 6BH6, 6BJ6, 6C4, 6C5, 6C6, 6C8G, 6D6, 6D8G, 6E5, 6F5, 6F6, 6F6GT, 6F7, 6F8G, 6G6G, 6H6, 6H6GT, 6J5, 6J5GT, 6J6, 6J7, 6J7GT, 6K5GT, 6K6GT, 6K7, 6K8, 6L5G, 6L6, 6L6G, 6L6GA, 6L7, 6L7G, 6N7, 6Q7, 6R7, 6S7G, 6S8GT, 6SA7, 6SC7, 6SD7GT, 6SF5, 6SF5GT, 6SF7, 6SG7, 6SH7, 6SJ7, 6SK7, 6SL7GT

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.

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 QUOTE 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 |
| 40K4 | 24.0 Amps. | 32.50 |
| 40K5 | 30.0 Amps. | 34.95 |
| 40J4 | 36.0 Amps. | 39.50 |
| 0-120v AC | Current | 0-100v DC |
| 40D1A | .6 Amps. | $ 7.85 |
| 40E1A | 1.2 Amps. | 10.76 |
| 40F1A | 3.2 Amps. | 16.65 |
| 40K1A | 6.0 Amps. | 24.75 |
| 40J1A | 9.0 Amps. | 32.95 |

## CENTER TAPPED RECTIFIERS
### Single Phase Full Wave Bridge

| 10-0-10v AC | Current | 0-8v DC |
|---|---|---|
| 10D1 | 1.2 Amps. | $ 1.89 |
| 10E1 | 2.4 Amps. | 2.25 |
| 10F1 | 6.4 Amps. | 3.87 |
| 10K1 | 12.0 Amps. | 4.95 |
| 10J1 | 18.0 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: 340-0340v @ 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 CT @ 3.6A; 6.3v @ 2A: 6.3v @ 1A | 4.85 |
| 700-0-700v @ 300 MA | 6.49 |
| 500-0-500v @ 175 MA | 4.55 |
| 430-0-430v @ 340 MA: 6.3v CT @ 6.3A: 5v @ 6A | 4.85 |
| 425-0-425v @ 75 MA: 6.3v @ 1.5A: 5v @ 3A | 3.65 |
| 415-0-415v @ 60 MA: 5v CT @ 2A: 115/230 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 |
| Step Up/Down 110/220, 220/440 600 watt | 14.95 |

## 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. Out | 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 | 10 HY @ 250 MA | $3.15 |
| .05 HY @ 15A | 7.95 | 10/20 HY @ 85 MA | 1.49 |
| .065 HY @ 2.5A | 2.49 | 13 HY @ 130 MA | 1.55 |
| .1 HY @ 15A | 6.95 | 13 HY @ 250 MA | 2.95 |
| 2 HY @ 175 MA | 1.49 | 14/3.5 HY @ 40/400 MA | 6.95 |
| 3 HY @ 50 MA | .39 | 15 HY @ 25 MA | .59 |
| 5 HY @ 1A | 13.95 | 15 HY @ 70 MA | 1.15 |
| 5 HY @ 70 MA/.2 HY 350 MA Dual | 2.39 | 26.5 HY 125 MA | 1.98 |
| 10 HY @ 700 MA | 11.95 | 200 HY @ 10 MA | 2.95 |
| 10 HY @ 55 MA | .89 | 325 HY @ 2 MA | 2.95 |
| 10 HY @ 100 MA | 1.49 | 600 HY @ 1 MA | 2.95 |

PHONE DIGBY 9-0347

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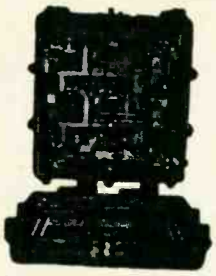
## BROWN TELEPLOTTER RECEIVER

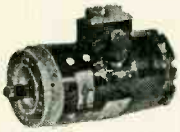


**Model 791X1R**

**115 volt 60 cycles**

Contains a pen driven by two balancing motors which writes on rear of a translucent chart. Pen arm position is in terms of two coordinates supplied balancing motors thru two amplifiers. Originally intended for recording plotted or written data from central plotting board. Writes at one half scale on 18 in. chart. Discriminator input circuit designed to operate unit as function of two varying R.F. frequencies varying about mean of approx. 430 KC. Further data on request. (Shipping weight 435 lbs.)

**Price $375.00**



**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 7.2 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**—⅛ 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

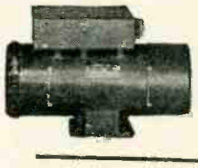
**Eastern Air Devices-J-72B**—115 v. 400 cy. 1/50 hp. Cont. duty. 4700 rpm.
**E. A. D. J-49B**—115 v. 400 cy. 1/250 hp.
**E. A. D. J-33**—115 v. 3φ 400 cy. Int. duty.
**Diehl FBF-24-1**—115 v. 400 cy. 1/100 hp.
**Synchron-600**—110 v. 60cy. 1 rpm.
**Haydon 36228**—115 v. 60 cy. 1 rpm.

## MAGNESYNS

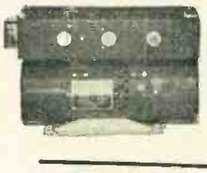
**Pioneer Type CL-3**, 6 power.
**Pioneer 1006-1E-B1 Indicator.** AN-5730-2.

## INVERTERS

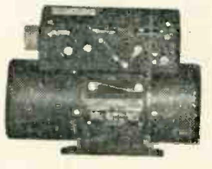
**Wincharger PU-7/AP** Input 28 VDC at 160 amps. Output 115 v. 400 cy. 1 φ at 2500 VA. Voltage and frequency regulated. Cont. duty. Stock #SA-164. Price $89.50 each.



**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.

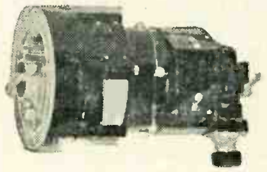


**PE-218E Inverters** Russel Electric and Leland. Input 28 VDC at 92 amp. Output 115 v. 400 cycles at 1500 VA. PF 0.9. Stock #SA-112A. Price $49.50 each.



**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-R 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 661824. 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**

## 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.

## U. S. NAVY 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

## 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

## 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

**50KVA STEPDOWN.** Standard Trans Corp. trans type MD. Pri: 450V111A. Sec: 117V427A. Navy type. Ambient temp. 50 Deg. C. ..............$125.00

**FILAMENT.** Raytheon Hypersil Core, Pri: 115V. Sec: 6.3V22A/6.3V2.4A/6.3V2.25A/6.3VO.6A Ins. for 1700V ....................................$5.95

**Plate.** Thordarson #T46889. 1650 VA. Pri: 105-120V. 60 cy. I 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

## PULSE TRANSFORMERS

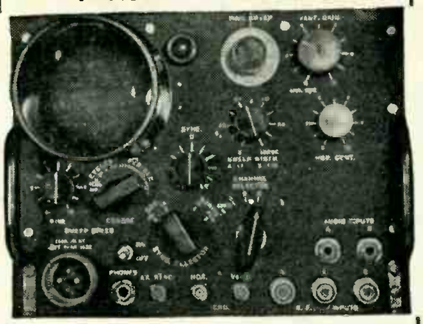
**PULSE.** WECO KS-9563. Supplies voltage peaks of 3500V from 807 tube. Tested at 2000 Pulses/sec and 5000V peak. Wdg. 1-2=18 ohms. Wdg. 1-3=72 ohms. L of Wdg. 1-3= .073-.082H at 100 cps..........$5.50
**PULSE.** WECO KS-161310, 50 KC. to 4MC. 1¾" Dia. x 1⅞" high. 120 to 2350 ohms. New.....$3.95

## HIGH VOLTAGE CAPACITORS

| | |
|---|---|
| .25 MFD., 20KV | $17.75 |
| .25 MFD., 15KV | 15.75 |
| .5 MFD., 25KV | $26.50 |
| 1 MFD., 15KV | $18.50 |
| 1 MFD., 7.5KV | $ 7.95 |

All brand new. Made by prominent manufacturers.

## MODEL AN/APA-10 PANORAMIC ADAPTER



**Provides 4 Types of Presentations:**
**(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.

### SUMMARY OF CHARACTERISTICS:

**SENSITIVITY:** "A" channel, 400 microvolts or less per ¼" beam deflection. "B" channel, 400 microvolts or less per ¼" beam deflection. "C" channel, 1 volt or less per ¼" beam deflection.

**RESOLUTION:** 12 kilocycles at 3 db down from peak, sweep control at maximum, using CW signal.

**PRESENTATION:** Panoramic ("A" & "B" channels); Oscillographic, "C" channel.

**SWEEP WIDTH:** Channel A, ± 50kc (100 kc overall) Channel B, ± 500 kc (1 Mc overall) Channel C, ± 1 Mc (2 Mc overall)

**CATHODE RAY SWEEP:** Oscillatory or non-oscillatory (Servo) Variable Sawtooth Generator, 35 to 40,000 cycles per second.

**AUDIO OUTPUT:** 50 milliwatts into 600 or 8000 ohm load.

**VERTICAL AMPLIFIER:** Single stage, ± 2db from 30 cycles to 100 kc or higher. Amplifier out position permits direct connection to one vertical plate through coupling capacitor.

**HORIZONTAL AMPLIFIER:** Single stage, ± 2db from 30 cycles to 100 kc. No provision for direct connection to deflection plates.

**CATHODE RAY TUBE VOLTAGE:** Cathode to accelerating anode; 1200V DC for 115V A.C. input.

**SENSITIVITY OF CATHODE RAY OSCILLOSCOPE:** Maximum through Amplifier. Horizontal: 10 volts peak to peak per inch. Vertical: 1.5 volts peak to peak per inch.

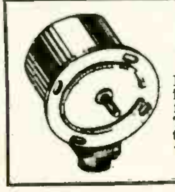
**DIRECT TO VERTICAL PLATE:** 150 volts peak to peak per inch.

**NOISE:** No disturbance in excess of 25,000 microvolts between 200kc to 200Mc generated by equipment.
**Overall Dimensions:** 19-9/16" x 10¼" x 7⅝"
**Weight:** 40 lbs.

**Power Requirements:** 115V. A.C. 60 cycles, 1 phase.

With 21 tubes including 3" scope tube, for operation on 115 V. 60 cycle source. **PRICE........$245.00**

AN/APA-10 80 Page Tech Manual...........**$2.75**



## 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**

## 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**

*PLEASE NOTE OUR NEW ADDRESS* ↓

## 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**

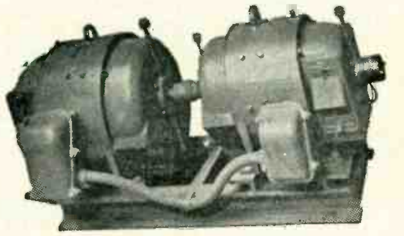
## RAYTHEON VOLTAGE REGULATOR

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**

## Synchro Differential Generator

Ford Inst. Co. Type 5SDG. Brand New.......$22.50

## MOTOR GENERATORS DYNAMOTORS, INVERTERS, ETC.



**2.5 KVA MG SET.** Diehl Elec. Co. 120V DC to 120V AC, 60 cy. 1 Ph. Complete with Magnetic Controller, 2 Field Rheos and Full Set of Spare Parts including Spare Armatures for Generator and Motor. Full specs. 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

**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

**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

**INVERTER**—G. E. Model 5D-21NJ3A. Input: 24V. DC, Output: 115V. 400 cy, 485 Va. New.....$24.50

**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

**DYNAMOTOR**—Type PE94C. For use with SCR522 Transmitter-Receiver. Brand new in export cases. $9.50

Radar Antennas in stock. Types SO-1, SO-3, SO-13. Brand New.

All prices indicated are F O B Bronxville, New York. Shipments will be made via Railway Express unless other instructions issued.

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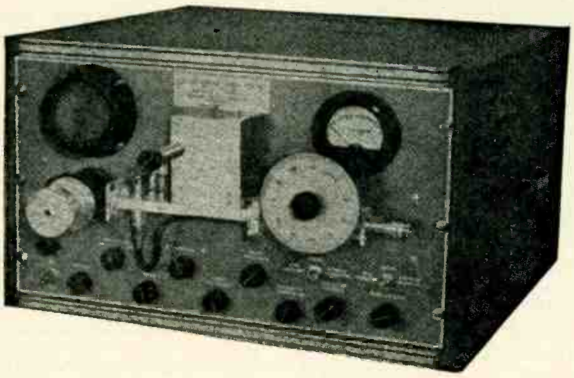
PHONE: BRONXVILLE 2-0044

All merchandise guaranteed. Immediate delivery, subject to prior sale.

*All Prices Subject to Change Without Notice*

# TEST EQUIPMENT



X Band Spectrum Analyzer 8500-9600 Mc., calibrated linear below cut-off attenuator, calibrated frequency meter, tuned mixer, 4 i.f. stages, 3 video stages overall gain 125 db., regulated power supply.

S Band Spectrum Analyzer 2700-3900 Mc., similar to above.

X Band Test Load low power low power $20.00

X Band Below Cut-Off Wave Guide Attenuator, with calibrated dial, type N input connector, output connects to ½" x 1" wave guide..........$55.00

X Band Test Load, low power....$15.00

TS-62 X Band Echo Box with r.f. cable and pick-up antenna.

TS-33 X Band Frequency Meter, 8500-9600 Mcs. Crystal detector and 50 micro-amp. meter. Indicates Resonance. Connection for scope available.

TS-45A-APM-3 Signal Generator, 8700-9500 mc., 110 V. 60-800 cps.

TS-35/AP X Band Signal Generator, pulsed, calibrated power meter, frequency meter, 8700-9500 mc.

30 MC I.F. STRIP, VIDEO, and AUDIO AMPLIFIER AND 110 Volt 60-2600 cps POWER SUPPLY, Bandwidth 10 mc, new, part of SPR-2 Receiver.

AMPLIFIER STRIP AM-SSA/SPR-2 contains I. F. amplifier, detector, video amplifier, pulse stretcher and audio amplifier and Rectifier Power Unit PP-155A/SPR-2 bandwidth 10 mc, center frequency 30 mc, sensitivity 50 microvolts for 10 milliwatts output. Power supply 80/115 V ac, 60-2600 cps 1.3 amps. ................$65.00 less tubes

X Band Test Load, 50 watts, average power ½" x 1" waveguide. Sand load TS 108..................$35.00

HI POWER X BAND TEST LOAD, dissipates 280 watts of average power for ⅝" x 1¼" waveguide, VSWR less than 1.15 between 7 and 10 KMC $150.00

S Band Signal Generator Cavity With Cut-Off Attenuator, 2300-2950 mc., 2C40 tube, with modulator chassis $30.00

High Pass Filter F-29/SPR-2, cuts off at 1000 mc. and below; used for receivers above 1000 mc...............$12.00

UPN-1 S Band Beacon Receiver-Transmitter ........................$75.00

S Band Test Load TPS-55P/BT, 50 ohms $12.00

High Pass Filter F-29/SPR-2, cuts off at 1000 mc and below; used for receivers above 1000 mc...............$12.00

TS-125 CALIBRATED S BAND POWER METER with attenuator.

TS-155 S BAND SIGNAL GENERATOR and Power Meter.

S Band Mixer, tunable by means of slider, type N connector for the R. F. and local oscillator input, U.H.F. connector for the I.F. output, variable oscillator injection .......................$30.00

TS-110 S Band Echo Box 2400-2700 mc, portable ....................$110.00

HI POWER S BAND TEST LOAD, dissipates 1000 watts of average power, for 1½" x 3" waveguide. Range 2500 to 3700 MC.

X Band Thermistor Mounts, VSWR less than 1.4 8500-9600 MC Fixed triple tuned, ½"x1" waveguide......$40.00
Fixed triple tuned ⅝"x1¼" waveguide .......................$50.00

Frequency Meter, 8500-9600, variable, absorption type for either ½"x1" or ⅝" x1¼" waveguide, with calibration, ± 4 MC, precision ground thread.$150.00

X Band Crystal Mount, ½"x1" waveguide ........................$25.00

X Band Attenuator, double van type, VSWR less than 1.4, 8500-9600 MC 0-30db, calibrated for 1¼"x⅝" waveguide .......................$80.00
½"x1" to ⅝"x1¼" adapter, UG80/U $5.00

TS-203/AP CALIBRATED SELSYN..$10.00

GENERAL RADIO PRECISION WAVEMETER TYPE 724A, range 16 kc to 50 mc. 0.25% accuracy, V.T.V.M. resonance indicator, complete with accessories and carrying case NEW....$175.00

HEWLETT-PACKARD-AUDIO SIGNAL GENERATOR 205A............$230.00

RADIO RECEIVER BC-967T2, 18-160 mc, 3 bands FM/AM, 110 V, 60 cps. $200.00

RADIO RECEIVER BC-969-B, 15-150 kc. $150.00

RADAR RECEIVER BC-1068A, 150-210 mc., individual tuning for r.f. stages, bandwidth 4 mc., 115 v. 60 cy.......$30.00

MEASUREMENTS 78E, 50-75 mc, calibrated output.................$100.00

ESTERLINE Angus recording Milliameter 60 cycles, AC................$150.00

FERRIS MODEL, 10B SIGNAL GENERATOR, 85 kc to 25 mc, calibrated output, good working order...........$100.00

TS-184 Echo Box and Attenuator for APS-13.

TS-226 Peak Power Meter for APS-13.

TS-89 Voltage Divider for measuring high video pulses, ratios 1:10 and 1:100 transmission flat within 2 db 150 c.p.s. to 5 mc., with cable for attaching to syndroscope.

Waveguide Below Cut-off Attenuator L 101-A U.H.F. Connectors at each end calibration 30-100 db...........$10.00

FIXED ATTENUATOR PADS, 20 db+0-2 db DC-1200 mc, 50 ohms, VSWR 1.3 or less, 2 watts average power....$30.00

WAVEGUIDE BELOW CUT-OFF ATTENUATOR same as above except input is matched in range of 2200-3300 mc. VSWR less than 1.2............$54.00

PULSE TRANSFORMER 132-AWP...$8.00

PULSE TRANSFORMER GE 69G, 828 G-1 $6.00

HYPERSIL CORE CHOKE, 1 Henry, Westinghouse L-422031 or L 422-32....$3.00

PULSE FORMING NETWORK, 20 kv., .92 micro-second, 50 ohms, 800 p.p.s. $40.00

PULSE INPUT TRANSFORMER, permalloy core, 50 to 4000 kc., WE-D161310, impedance ratio 120 to 2350 ohms..$3.00

TRANSFORMERS, 115 volts, 60 cps primaries:

1. 6250, 3250 and 200 volts, tapped primary voltage doubler, 12.5 kv. ins. ........................$14.00
2. 6250 volts 80 ma. G.E. voltage doubler, 12.5 kv. ins...........$12.00
3. 2 secondaries at 500 volts 5 amps each, at 210 pounds.........$50.00

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

SQ RADAR, used but in good working order, complete with antenna, control unit .........................$650.00

SN RADAR, used, good working order, complete ....................$550.00

UG-27/U TYPE N RIGHT ANGLE ADAPTERS 10 for $5.00; 1000 for $250.00

U.H.F. RIGHT ANGLE ADAPTER 10 for $2.50; 1000 for $125.00

# ELECTRO IMPULSE
## LABORATORY

P. O. Box 250 Eatontown 3-0007 Red Bank, N. J.

# ARROW → "The Home of Values!"

## BC 906—Frequency Meter

Range **150-225 MC** with modifications possible for lower frequencies of TV, etc. Contains 0-500 DC microammeter and uses Battery pack of 1.5 V and 45 VDC.
Like New—Less Batteries ...... **$10.95**

## 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**

**IS-185 Weston Voltmeter** Model 433—0 to 150 VAC 25 to 2400 cycles. New ........................ **$24.95**

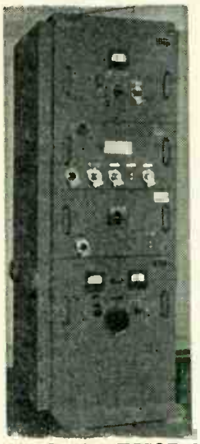
## TUBE SPECIALS!

| | |
|---|---|
| 211 | $ .39 |
| 307A | 5.50 |
| 703A | 1.89 |
| 723A/B | 12.95 |
| 724B | 1.89 |
| 803 | 2.89 |
| 805 | 3.29 |
| 807 | 1.89 |
| 813 | 6.95 |
| 832 | 2.95 |
| 832A | 7.95 |
| 837 | 1.19 |
| 841 | .49 |
| 860 | 4.95 |
| 864 | .24 |

## DYNAMOTORS

| | |
|---|---|
| DM 32A | PE 73 |
| DY2/ARR2 | PE 94 |
| DA 1A | PE 86 |
| DM 34 | DM 28 |
| DM 35 | DM 33 |
| DM 36 | PE 206 |
| DM 37 | PE 101 |
| DM 40 | DM 53A |
| DY 12 | PE 218 |
| DY 17 | MG 149 |
| BD 77 | |

Many other types are also in stock. Your inquiry is invited. Prices upon request.



# RADIO EQUIPMENT

## RC 100 B

**This equipment made by General Electric, was designed for ground use as an identification of friendly aircraft.**

**CABINET CH-118** is of the Standard 19 inch rack type structural steel frame with runner angles for each of the units. A full length access door with safety interlocks forms the rear of the cabinet. .$34.95

**TRANSMITTER BC-769** is designed to transmit RF pulsed signals at 470 megacycles with the use of the two type 15E Tubes operating in push-pull with resonant grid, plate and filament lines — Less tubes $19.95

**KEYING UNIT BC-770** furnishes the pulse of the Transmitter— Less tubes $14.95

**RECEIVER BC-768** was used to detect the 493.5 megacycle reply pulses from the interrogated station and to sufficiently amplify these signals for oscilloscope observation.................Less tubes $19.95

**RECTIFIER RA-52** produces the high voltage. An 0-15 kilowatt DC Meter is connected across the output of the filter to measure the voltage fed to transmitter BC-769, while an 0-20 milliammeter is connected to ground return to measure the average current drawn— With tubes $74.50

**AIR COMPRESSOR M-349** together with 12 feet of ¼ inch soft copper tubing and necessary hardware is used to fill and maintain transmission lines with dry air under pressure. Operation is direct from 110 V AC 60 cycles ..................................$42.50

**OVEN M-348** is furnished for removal of moisture from the dehydrating cylinders of the compressor. It too operates from 110 V AC 60 cycles...........................$29.50

**FREQUENCY METER** BC-771 is used for frequency checking and for tuning operations on Radio Transmitter BC-769 and Radio Receiver BC-768. It is a separate unit mechanically and has its own power supply, which requires a 110 to 120 Volt, 50 to 60 cycle source ..................................$49.50

**TECHNICAL MANUAL TM11-1113B** covering entire equipment ......................$5.00

**COMPLETE UNITS are available at amazing low price . . . WRITE TODAY!**

## BC-604 TRANSMITTER FM 20-28 MC

11 and 15 meters. Can be operated on 10 meters—10 channel push button crystal. With all tubes and meter but less dynamotor. Excellent Condition

**$19.95**

Crystals — Set of 80

**$19.95**

## BC 603

Receiver—Good. Used.

**$24.95**

Complete **SCR-508** Installation available—price and information upon request.

# MISCELLANEOUS SPECIALS!

| | Used | New |
|---|---|---|
| **ASB 7** Indicator Scope | $12.95 | —— |
| **MN 26 C** | 17.50 | $24.95 |
| **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 |
| **BC 461** Veeder Root Counter | —— | .59 |
| **BC 442** Less Condenser | 1.49 | 1.95 |
| **APS 13** UHF Antenna, Pair | —— | .98 |
| **FL 8** Filter | —— | 2.95 |
| **I-97** Bias Meter | 3.95 | 4.95 |
| **RM 29** Remote Telephone Control | 7.95 | 9.95 |
| **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

Tuning Units for **BC 375** — Presently most numbers are available in excellent condition with case at.....................$2.95 ea.

One Tube Interphone Amplifier—Small compact aluminum case fully enclosed. 2¼" x 3¾" x 5¾". **Less Tube**...............79¢

**96Q1** Complete Autotune assembly with motor and frame as used in **ARC-1 Transmitter.** New .................................$35.00

**BC 709** Battery operated lightweight interphone amplifier. Complete with tube and shock mount, but less battery....New $3.95

**SCR 183** Complete..............New $49.50

**220 MA Circuit Breaker**...........New .59

Collins VFO Dial—5 calibrated ham bands from 3.2 Mc to 32 Mc; complete with pointer, gears, logging dial and flywheel. Scale 6" on 8" plate. New........each .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

Indicator ..................................$2.45

**A-81-2** Transmitter selsyn for 182 indicator ..................................$2.45

(Both I82F & Trans. Selsyn for $7.00)

**MC 385A**—Headset Adapter..........New 49¢

**Information and Prices on Request**

**RTA 1B** Transceiver
**TA 2J24** Transmitter and **MP 10G** Power Pack
**SCR 2?9** Compass Installation
**R 5/ARN 7** Compass Installation
**MN 26** Compass Installation
**ASB7** Complete Radar Installation

**ID6/APN4** Scope unit complete with 5CP1 cathode ray tube and shield and all parts except smaller tubes and crystal. Used ..............................$9.95 ea.

## BC 620

Receiver-Transmitter—2 crystal channels—20 to 27.8 MC FM—13 tubes. Metered, Plate and Filament ...............Used $9.95

**PE-97** or **PE 117** or **PE 120** Power Supply for above 6-12 volt vibrator type.
Used less tubes, vib. & con.........$2.95
Used, complete ........................$6.95

**FT 250** Mount for both BC 620 and PE 97 New ......................................$1.50

## BC 223

Brand new **Transmitter** with all three tuning units, two tuning unit cases, spare tube carrying case, shock mount and brace; but less tubes at new low price of **$29.95**

**Set of 5 tubes**................................$3.95

**Tuning units** are available separately at Ea. $2.50

**PE 125**—12-volt Vibrator Pack...New $12.95 Used 8.95

## SURPRISE PACKAGE

20 lbs. Ass't radio parts. A $25.00 value for only........ **$1.95**

## TEST EQUIPMENT

| | | |
|---|---|---|
| **EV-10** | Precision Vacuum Tube Test Set ..............used | $28.00 |
| **No. 772** | Weston Multi Tester.....used | 40.00 |
| **No. 492** | Radio City Products. Volt-Ohm Meter ..............used | 25.00 |
| **No. 471** | Radio City Products Output Meter ..............used | 10.00 |
| **No. 803** | Radio City Products Tube Tester & Set Tester......used | 35.00 |
| **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 | 75.00 |
| **BC-1287** | Oscilloscope.............used | 75.00 |
| **BC-221** | Frequency Meter....Like New | 90.00 |
| | Others as Low as.................. | 49.50 |

**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 |

## COMMAND (SCR 274 N) EQUIPMENT

| | Used | New |
|---|---|---|
| BC-453 | $12.95 | —— |
| BC-454 | 5.95 | —— |
| BC-455 | 7.95 | $9.95 |
| BC-456 | —— | 2.95 |
| BC-457 | 5.95 | —— |
| BC-458 | 5.95 | 8.95 |
| BC-696 | 14.95 | 24.95 |
| BC-450—3 Receiver Remote Control | .89 | 1.95 |
| BC-442 | | 2.95 |
| 3 Receiver Rack | 1.95 | —— |
| 2 Transmitter Rack | 1.50 | —— |

Complete Command set as removed from aircraft—3 receivers—2 transmitters—Relay unit — control boxes — mounting racks — plugs — modulator and dynamotors—crated Set **$34.50**

## R C—150 RADIO EQUIPMENT

**BC 1161 A** Receiver is a 14 tube superhet all ready for 110 V 60 cycle operation. Frequency coverage is from 157 to 187 MC, but may be trimmed to cover the two meter ham band. The IF transformers are stagger tuned to provide a 4 MC band pass, but they may be retuned to a sharp center frequency of 11MC with no wiring changes. All RF and IF tuning is done by observing a magic eye indicator tube from the front panel. **Brand New—Complete $34.95**

**BC 1160 A** Transmitter also covers a frequency of from 157 to 187 MC and is also ready for 110 V 60 cycle operation using a transtat for regulated control and a meter for indication. Output is pulsed, reaching a peak of one kilowatt. Tube complement as follows: 1-6SN7; 1-9002; 1-9006; 1-6J5; 1-807; 1-2X2; 2-826; 2-5V4G. **Brand New—Complete $34.95**

**BC 1162 A** Interconnector and wavemeter units. These are contained in one housing but may be separated without interfering with the separate circuit wiring. Primary purpose is to control operation of transmitter and receiver units for correlation with radar screen, and to provide means of measuring their frequencies by means of cavity resonator. **New, complete except tubes. $14.95**

All shipments FOB warehouse. 20% Deposit required on all orders. Minimum order accepted—$5.00. Illinois residents, please add regular sales tax to your remittance.

**ARROW SALES, Inc.**
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1712-14 S. Michigan Ave., Chicago 16, Ill.
PHONE: HArrison 7-9374

# Switches

## FINEST QUALITY

***Immediate Delivery from Our Huge Stock... All New and Unconditionally Guaranteed!***

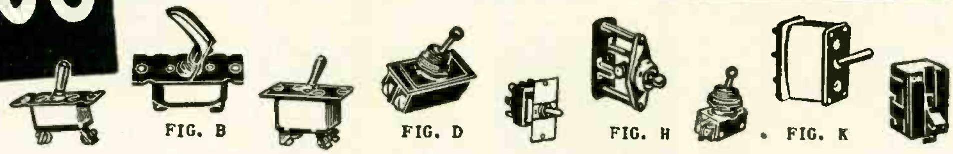


FIG. A FIG. B FIG. C FIG. D FIG. G FIG. H FIG. F FIG. K FIG. L

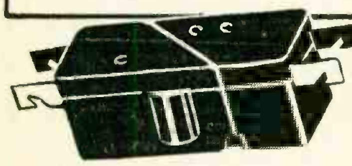
**WIDE SELECTION OF ELECTRONIC COMPONENTS AT**

**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

## TOGGLE SWITCHES

| STOCK NUMBER | FIG. | CONTACT ARRANGEMENT | MANUFACTURER & NUMBER | PRICE EACH |
|---|---|---|---|---|
| PH-500 | A | SPDT. | B1B. | $0.35 |
| PH-503 | A | SPDT Center Off Mom Each Side. | B11. | .32 |
| PH-505A | A | SPDT Momentary. | B21. | .30 |
| PH-505 | A | SPST. | AN-3022-2B. | .30 |
| PH-506 | A | SPDT Center Off. | AN-3022-1. | .35 |
| PH-507 | A | SPDT Center Off Mom Each Side. | AN-3022-7B. | .32 |
| PH-513 | A | SPDT Center Off. | Cutler Hammer AN-3022-1B. | .38 |
| PH-514 | A | SPST. | Cutler Hammer B-5A. | .35 |
| PH-516 | A | SPST. | B5. | .35 |
| LT-104 | A | SPDT One Side Momentary. | Cutler Hammer 8905K568. | .35 |
| 309-168 | A | SPST. | 168553. | .30 |
| 309-178 | A | SPDT Momentary. | AN-3022-11B. | .35 |
| 309-181 | A | SPST Momentary. | Cutler Hammer 8211K6. | .35 |
| 305-172 | A Spcl. | SPST Momentary. | Cutler Hammer 8905K531. | .35 |
| 305-182 | A Spcl. | SPST Momentary. | Cutler Hammer 8905K630. | .45 |
| 370-14 | A | SPDT Center Off 1 Side Mom. | Cutler Hammer B-7A. | .30 |
| 370-4 | A | SPDT Center Off. | Cutler Hammer B-9A. | .35 |
| 370-25 | A | SPST Momentary. | Cutler Hammer B-6B. | .25 |
| 309-169 | B | SPST Momentary. | Cutler Hammer B-19 | .35 |
| PH-509 | C | DPST. | AN-3023-2B. | .45 |
| PH-510 | C | DPDT Momentary. | Cutler Hammer 8715K2. | .50 |
| PH-511 | C | DPDT Momentary. | Cutler Hammer 8715K3. | .50 |
| PH-512 | C | DPST Center Off. | Cutler Hammer 8720K1. | .55 |
| 303-65 | C | DPST. | Cutler Hammer AN-3023-2. | .45 |
| 309-163 | C | DPDT Center Off Momentary. | Cutler Hammer C-11. | .55 |
| 309-162 | C | DPST. | Cutler Hammer C-1. | .45 |
| 309-164 | C | DPST Momentary. | Cutler Hammer 8711K3. | .40 |
| 305-87 | D | 1 Side DPST Mom, 1 Side SPST. | AH & H | .95 |
| LT-100 | F | SPST. | Cutler Hammer. | .22 |
| LT-101 | F | SPST Momentary. | AH & H. W/Leads. | .20 |
| 301-51 | G | 4PDT Momentary. | Cutler Hammer 8905K12. | .75 |
| 305-140 | H | DT No Make Each Side. | Open Frame. | .25 |
| 309-161 | K | SPST. | Cutler Hammer 8781K3. | 1.95 |
| 309-170 | K | SPST. | Cutler Hammer 8905K656. | 2.25 |
| 301-41 | L | DPST. | AH & H | .75 |
| 305-76 | L | DPST. | AH & H—Open Frame. | .75 |
| 319-50 | L | SPST. | Allied Elec. Mfg. Corp. | .28 |
| 305-170 | Spcl. | SPST. | Cutler Hammer Type B13. | .40 |



## SWITCHETTES

| STOCK NUMBER | MANUFACTURER'S TYPE NUMBER | CONTACTS | TERMINAL LOCATION | UNIT PRICE |
|---|---|---|---|---|
| 303-20 | CR1070C103-A3 | N.C. | Side | $0.47 |
| 301-29 | CR1070C103-B3 | N.O. | End | .47 |
| 303-34 | CR1070C103-C3 | 1-N.O. 1-N.C. | End | .47 |
| 303-18 | CR1070C103-F3 | 1-N.O. 1-N.C. | Side | .47 |
| 303-19 | CR1070C103-E3 | N.O. | Side | .47 |
| 303-43 | CR1070C123-B3 | N.O. | End | .47 |
| 303-23 | CR1070C123-C3 | 1-N.O. 1-N.C. | End | .47 |
| 305-83 | CR1070C123-J2 | SPDT | End | .47 |
| 303-22 | CR1070C123-J4 | SPDT | End | .47 |
| 303-17 | CR1070C124-M4 | SPDT | Side | .47 |
| 303-16 | CR1070C128-C3 | 1-N.O. 1-N.C. | End | .47 |

## LEAF SPRING SWITCHES

| STOCK NUMBER | CONTACT ARRANGEMENT | SPEC. INFORMATION | BACK OF PANEL DIM. | PRICE EACH |
|---|---|---|---|---|
| 303-96 | HPDT One Side. | . . . . . . . . | 3 1/4x1 3/4x3/4 | $1.65 |
| 311-58 | 1A Momentary & 1A. | W/Escutcheon Plate | 3 1/4x3/4x3/4 | 1.35 |
| 309-167 | 2C One Side. | . . . . . . . . | 3x9/16x1 1/16 | 1.25 |
| 305-183 | 3A Momentary & 3A Momentary. | . . . . . . . . | 3 1/8x1 1/8x3/4 | 1.50 |
| 319-43 | DPDT Center Off. | Mossman. | 3 7/8x2x1 3/8 | .85 |
| 319-42 | 4PDT Center Off Mom One Side. | Mossman. | 3 7/8x2x1 3/8 | .95 |
| 309-159 | 3B. | Mossman. | 3 7/8x2x1 1/4 | .85 |
| 309-158 | 2D. | Mossman. | 3 7/8x2 1/4x1 3/8 | .85 |
| 309-165 | 1A. | Mossman. | 3 7/8x1 5/16x1 1/4 | .75 |
| 311-96 | 4PDT. | Bakelite Actuator. | 3 7/16x1 3/8x7/8 | .85 |
| 305-164 | 3A. | . . . . . . . . | 3 1/8x1 1/16x1 1/16 | 1.25 |
| 319-43A | DPDT Center Off Mom Each Side. | Mossman. | 3 7/8x1 3/8x2 | .95 |
| 305-165 | 3A & 3A. | Switchboard Type. | 4 3/4x1 1/2x3/4 | .95 |

**Many Other Types in Stock. Send Us Your Requirements.**
**Order From Your Parts Jobber or Directly From Wells.**

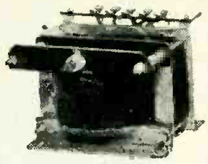
***WRITE FOR NEW WELLS CATALOG***

**World's Largest Display of Radio and Electronic Components. 9000 Square Feet of Display All on One Floor.**

**WELLS SALES, INC.**

**320 N. LA SALLE ST. DEPT. SL, CHICAGO 10, ILL.**

## RCA HI-VOLTAGE TRANSFORMER



Pri—115/230V. 60Cy
Sec—6000V—80 MA
**$11.80**
*Insulated for Voltage Doubler Use*

## COAXIAL CONNECTORS

| | | | | | |
|---|---|---|---|---|---|
| 83-1AC | .42 | UG-12/U | .63 | UG-86/U | 1.22 |
| 83-1AP | .15 | UG-21/U | .67 | UG-87/U.. | .79 |
| 83-1F | 1.12 | 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 | 1.20 | MX-195/U | .41 |
| 83-1T | 1.12 | UG-34/U | 12.80 | UG-197/U | 1.33 |
| 85-22AP | 1.10 | UG-36/U | 12.80 | UG-206/U | .63 |
| 83-22F | 1.48 | 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 | .85 |

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.
$11.50 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—Our Price—$8.22 ea.
**$7.50 EACH—Lots of 10**

## 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....$2.75
UTAH 9278 .... 2.75
G. E. 68G-627.... 4.75
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....$9.95
Philco 352-7150—50 ohm line to magnetron. 115 KW peak power ....$9.95

## 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 E4-16-67P, 7.5 KV, "E" Circuit 4 sections, 16 microsec. 60 PPS, 67 ohms imped....$8.25
15—E4-1.5-600-50P, 15 KV "E" Circuit 1.5 microsec. 600 PPS, 50 ohms imped. 4 sections..$12.00
15—E6-5-180-50P, 15 KV, "E" Circuit 5 microsec. 180 PPS, 50 ohms imped. 6 sections....$25.00

## 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.... 30.00
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-15 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.... 4.11
58-62 Cycles (115 V.) 3½" R.—JBT.... 6.45
10 amp, RF 3½" R.—Simpson.... 4.95

## MAGNETRONS

| | | | | | |
|---|---|---|---|---|---|
| 2J21A | $8.95 | 2J38 | 12.70 | 700C | 16.50 |
| 2J22 | 8.95 | 2J41 | 132.50 | 700D | 16.90 |
| 2J26 | 7.80 | 2J48 | 14.95 | 706AY | 45.00 |
| 2J27 | 13.70 | 2J49 | 39.50 | 706BY | 45.00 |
| 2J31 | 9.60 | 2J61 | 36.20 | 706CY | 17.95 |
| 2J32 | 14.45 | 4J50 | 197.00 | 706FY | 45.00 |
| 2J33 | 19.90 | 4J52 | 197.00 | 706GY | 45.00 |
| 2J34 | 19.90 | 5J23 | 14.20 | 714AY | 6.95 |
| 2J36 | 85.00 | 5J29 | 14.20 | 725A | 8.95 |
| 2J37 | 13.70 | 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 | 11.95 |
| 2K28 | 23.50 | 417A | 10.65 | 726A | 14.50 |
| 2K29 | 29.95 | 707A | 6.95 | 726B | 29.50 |

## TYPE "J" POTENTIOMETERS
75¢ each

| Resis. | Shaft | Resis. | Shaft | Resis. | Shaft |
|---|---|---|---|---|---|
| 100 | SS" | 10K | SS | 100K | 5/16" |
| 200 | SS" | 15K | ½" | 100K | ⅜" |
| 500 | ½" | 15K | SS | 100K | 7/16" |
| 650 | ½" | 20K | SS | 100K | SS" |
| 5000 | ⅜" | 25K | 1½" | 150K | ½" |
| 6500 | SS" | 25 | SS | 200K | SS |
| 10K | ⅜" | 30K | 1⅛" | 250K | SS |
| 10K | ½" | 50K | SS | 1 MEG | SS |

Dual "JJ" Potentiometers....$1.30 each
50-50 Ω SS 100-100 Ω SS 250-250 Ω SS
Triple "JJJ" Potentiometers—⅜" shaft....$1.67
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....$3.95
- REL W-1158 Frequency Meter 160-220 MC..$32.95
- CWI-60AAG Range Calibrator for ASB, ASE, ASV and ASVC Radars....$39.95
- CRV-14AAS Phantom Antenna for Transmitters up to 400 MC....$11.75
- TS-146/AP X-Band Test Set. Price on request.
- TS-184/AP ....Price on request.
- CPR-60AAJ and CPR-60AAK—IFF Test Sets, (pair) $16.95

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....pair $2.95
Caps for connecting to above....pair 1.00
G. E. 2J1F1 Generators....ea. 2.85
C-78248 Transmitters—110V 60 cy....pair 8.95
C-78411 Transmitters—50V 50 cy....pair 8.25
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.... | $2.64 | 0.6 Amps.... | $3.00 |
| 2.4.... | 3.07 | 1.2.... | 3.44 |
| 6.4.... | 4.09 | 3.2.... | 5.15 |
| 13.0.... | 7.67 | 6.0.... | 9.32 |
| 17.5.... | 8.69 | 9.0.... | 10.05 |
| 26.... | 15.33 | 12.... | 18.64 |
| 39.... | 23.00 | 18.... | 20.12 |
| 52.... | 30.67 | 24.... | 35.96 |
| 65.... | 38.33 | 36.... | 41.24 |

## 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

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- Type 12073-1A Torque Amplifier, Input 115 V 400 cy. Complete with Tubes....$14.95
- Magnetic Amplifier Assy. Saturable Reactor Type to supply one phase of 400 cycle Servo Motor ...$5.95

## OIL FILLED CONDENSERS

| MFD | VDC | Price | MFD | VDC | Price |
|---|---|---|---|---|---|
| 2 | 600 | $ .45 | 2 | 2000 | $2.70 |
| 4 | 600 | .95 | 4 | 2000 | 3.95 |
| 4 | 600 (R'd1) | .05 | .1 | 2500 | .49 |
| 4 | 600 R'd) | 1.05 | 1-1 | 2500 | 3.85 |
| 8 | 600 (R'd) | 1.39 | 32 | 2500 | 12.80 |
| 10 | 600 | 1.95 | 1 | 5000 | 4.88 |
| 10 | 600 (R'd) | 1.52 | .01-.03 | 6000 | 1.65 |
| 8-8 | 600 | 1.49 | .1 | 7000 | 1.79 |
| 1 | 1000 | .62 | 2 | 12500 | 23.95 |
| 2 | 1000 | .89 | .045 | 16K | 4.70 |
| 3.5-.5 | 1000 | 1.39 | .05 | 16K | 4.95 |
| 1 | 1500 | .89 | .075 | 16K | 8.95 |
| 4 | 1500 | 2.95 | 50 | 220VAC | 3.95 |
| .1-.5 | 2000 | .87 | 60 | 330VAC | 5.75 |
| .5 | 2000 | .95 | 7 | 660VAC | 3.35 |
| 1 | 2000 | 1.50 | | | |

## 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 | .04½ Ea. | $3.00 per 100 |
| .05 | 200 | .04½ | 3.00 |
| .1 | 200 | .04½ | 3.00 |
| .25 | 200 | .06 | 4.00 |
| .1 | 400 | .09 | 6.00 |
| .005 | 600 | .04½ | 3.00 |
| .01 | 600 | .07 | 4.75 |
| .05 | 600 | .08 | 5.50 |

CRYSTAL DIODES—

| | | | | | |
|---|---|---|---|---|---|
| 1N21 | .79 | 1N23 | 1.19 | 1N45 | .94 |
| 1N21A | 1.19 | 1N23A | 1.55 | 1N52 | 1.05 |
| 1N21B | 2.75 | 1N27 | 1.09 | 1N63 | 1.39 |
| 1N22 | .89 | 1N34 | .79 | | |

PHASE SHIFT CAPACITOR—Type D—150734—4 stator single rotor....$2.69

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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 |

### Full Wave Center Tap

Input: 10-0-10 VAC — Output: 0-8 VDC

| Type No. | Current | Price |
|---|---|---|
| C1-10 | 10.0 Amp. | $6.95 |
| C1-20 | 20.0 Amp. | 10.95 |
| C1-30 | 30.0 Amp. | 14.95 |
| C1-40 | 40.0 Amp. | 17.95 |
| C1-50 | 50.0 Amp. | 20.95 |

## THREE PHASE

### Full Wave Bridge

Input: 0-234 VAC — 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 |
| 3B13-15 | 15.0 Amp. | 120.00 |

### RECTIFIER MOUNTING BRACKETS

For Types B1 through B6, and Type C1 $.35 per set
For Types 3B .......................1.05 per set

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Attractive, rugged, and reasonably priced. Moving vane solenoid type with accuracy within 5%. Square case.

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| GPA1210 | 0–12 VDC | 10 Amps. | 75.00 |
| GPA2810 | 0–28 VDC | 10 Amps. | 85.00 |

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| | | | |
|---|---|---|---|
| CF-1 | 1000 MFD | 15 VDC | $ .98 |
| CF-20 | 2500 MFD | 15 VDC | 1.95 |
| CF-6 | 4000 MFD | 30 VDC | 3.25 |
| CF-19 | 500 MFD | 50 VDC | 1.95 |
| CF-16 | 2000 MFD | 50 VDC | 3.25 |
| CF-21 | 1200 MFD | 90 VDC | 3.25 |
| CF-2 | 200 MFD | 150 VDC | 1.69 |
| CF-10 | 500 MFD | 200 VDC | 3.25 |

Mounting clamps for above capacitors......15c ea.

### RECTIFIER TRANSFORMERS

All Primaries 115 VAC 50 60 Cycles

| Type No. | Volts | Amps | Shpg. wt. | Price |
|---|---|---|---|---|
| XF15-12 | 15 | 12 | 7 lbs. | $ 3.95 |
| TXF36-2 | 36 | 2 | 6 lbs. | 4.95 |
| TXF36-5 | 36 | 5 | 8 lbs. | 6.50 |
| TXF36-10 | 36 | 10 | 12 lbs. | 9.95 |
| TXF36-15 | 36 | 15 | 20 lbs. | 11.95 |
| TXF36-20 | 36 | 20 | 25 lbs. | 17.95 |
| XFC18-14 | 18 VCT | 14 | 10 lbs. | 6.95 |

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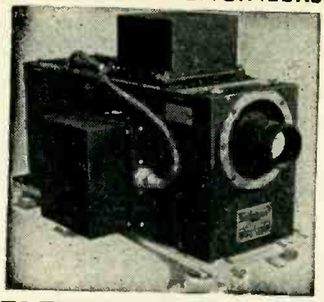

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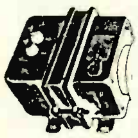

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| TS-35/APCY94 | I-95-A |
| TS-36/AP | I-100 |
| TS-41/CRN-I | I-104A |
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A proportional mutual conductance tester which is ideally suited for production, research and similar testing where versatility and a Gm test is essential.

The Weston 788 unit is composed of 3 separate & removable components:

SOCKET and PLUG PANEL consisting of 9 standard sockets: 4 pin, 5 pin, 6 pin, combination large & small 7 pin, 8 pin loktal, 8 pin octal, miniature, acorn and a socket for testing Western Electric 215A peanut tubes. All pins are wired and numbered with leads terminating at a numbered plug board. Additional sockets, plugs, etc. can be added and connected to the standard pin wiring as required.

TUBE TESTING SECTION consisting of a multirange A.C. Heater, Voltage meter, and Element Voltmeter and a Percentage Mutual Conductance Indicating meter. Completely wired with appropriate automatic switches separate controlled heater voltage transformer, electrode transformer, controls, short indicator, etc. and a numbered plug board section with patch cards to connect to the tube socket panel. Operates on 115 volt 60 cycle.

## U. S. NAVY MODEL OQ

### WESTON MODEL 788

ROLL TYPE TUBE CHART showing tube, data, values, etc. with sufficient room to add information on new tubes or special data on research projects, etc.

This unit is particularly suited to special applications as THE THREE COMPONENTS ARE COMPLETELY INDEPENDENT OF EACH OTHER thus enabling the test section to be readily adaptable & interchangeable to operate with any or all tube bases and socket combinations desired.

Complete in oak carrying case, with manual showing theory, design diagrams, operating instructions, tube data, tube base connections & parts list. Dimensions approx. 13"W 24"L 8"H, weight approx. 35 lbs.

THESE UNITS ARE USED—GUARANTEED

ONLY $89.50

They are in excellent condition and appearance. They have all been thoroughly inspected, tested & refinished & are fully guaranteed to be in perfect operating condition and to give complete satisfaction. They are, of course, subject to your inspection & approval & may be returned for full credit if returned to us prepaid within 10 days of receipt.

## U S N C V 49598 ADAPTER KIT

for OD and OQ Test Sets

This adapter Kit consists of 4 special adapters and clip lead to enable the model OD and OQ Transconductance Tube Testers to accommodate radar tubes type 316A, 703A, 707A & B, 713A, 446 and similar tubes. Complete in portable oak chest (approx. 7" 4" 3") with instruction sheet and test data. Weston Model 9999.

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An internal combustion type heater which will give 15,000 B.T.U. of heat per hour. Ideally suited for use with equipment, farms, boats, bungalows, cabins, trailers, work sheds, darkrooms, mobile equipment, transmitter stations, etc., and any place where a quick heat is required in volume.

Very economical in operation—tank holds one gallon of gasoline which is sufficient for 6 hours operation. Uses any grade gasoline.

This unit is designed primarily for aircraft installation, 24-28 volts D.C. but it can be readily adapted for a 115 or 230 volt 60 cycle power supply by use of a transformer and rectifier. Simple circuit diagram for adaption to 115 or 230 volts 60 cycle use supplied with each unit. Can be used on 32 volt farm or boat systems as is without the installation of additional transformers, etc. Power consumption approximately 75 to 100 watts.

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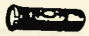

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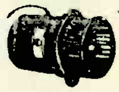

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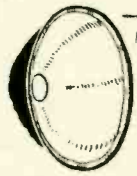

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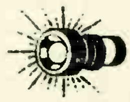

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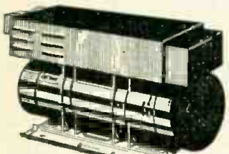
# SURPLUS EQUIPMENT

## 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.

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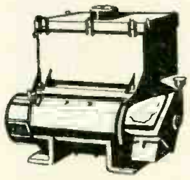
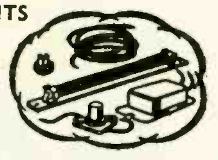


## BLACK LIGHT KITS

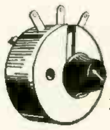
**Ultra-Violet Fluorescence**



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

## POWER RHEOSTATS

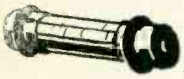


Standard Brands 5 ohms, 100 watt, 4.48 amps

BRAND NEW .. **$1.95 ea.**

Specially Priced ...$20.00/dozen

## RESISTORS, Precision; Glass Covered, Hermetically Sealed



12 Megohms, 10 watt ........ **$2.50 ea.**

2000 Ohms, 35 watt; wire-wound; Grade 1, Class, Style D. Removed from new equipment **$1.00 ea.**

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Approximately 90 ft. roll; ¾" x .020"; Tests approx. 14,000 Volts.

**75c per roll**
**$7.50 per doz.**

## CAMBRIC VARNISHED TAPE

¾" x 36 yards..........................

**$6.00 per doz.**

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Cut to your order Min. 50 ft........ **3½¢ ft.**
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Free Floating Cone Type-Magnetic-Loud Speaker. Removed from rooms of a large N. Y. Hotel. Original cost $32.00.......................$1.85
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4 pole 35 ampere 115v. AC relay.......... **$4.90**

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½" glass tube........................3 for **$2.50**

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Used for illuminating meters, compass, dials, airplane instruments, etc. Soldering iron removes lamp from base to use in models, doll houses, miniature trains, Xmas trees, etc.

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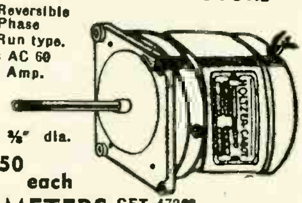

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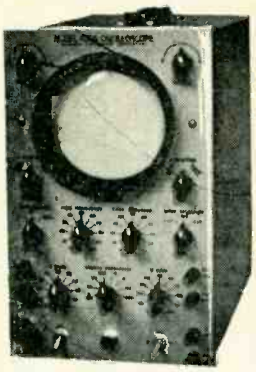

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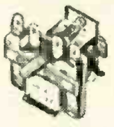

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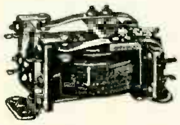

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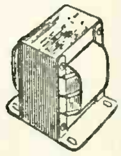

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| 7.8 | 299 | 1056 | 2195 | 8250 | 29500 | 205000 |
| 7.9 | 300 | 1059 | 2200 | 8500 | 29990 | 210000 |
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| 10.38 | 311.5 | 1100 | 2300 | 8770 | 31000 | 220000 |
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**F. ALEXANDER**
115 W. 23d St. New York 11, N. Y.

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## FM Carrier Current Communication Equipment

**BRAND NEW G.E. STOCK
FREQ. RANGE 70 KC TO 200 KC
MOBILE and FIXED STATION UNITS**

Mobile Receivers 5.7-volt input.....$50.00 ea.
Mobile Transmitters 5.7-volt input power output 25 watts..................$100.00 ea.
Fixed Sta. Receivers 110V/60/1 ...$125.00 ea.
Fixed Sta. Transmitters 110V 50 Watts Out $175.00 ea.
Fixed Sta. Console Controls with 5" Speaker (can be used for any type installation) $20.00 ea.
W. E. F-3 Handsets W/Retrax Cord..$8.00 ea.
Eicor Dynamotors 5.7-v at 22 amp input—450v @ .150 amp output...............$15.00
Eicor Dynamotors 5.7-v at 25 amp input—600-v @ .150 amp output..........$18.00
Antenna base w/coupler ............$20.00
Control Heads ......................$12.00

Above Material All Brand New. Delivery from Stock. Subject to Prior Sale.
*Subject to Prior Sale*

**AIRCRAFT RADIO INDUSTRIES, INC.**
274 Madison Ave., New York City
780 State St., New Haven, Conn.

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*Have available for quick sale:*

**Compound (Pitch) Melting Tank**
25 gal. capacity, electric operated
Glassine Paper: .001, .015, .002 & .0007 thickness. In rolls, 2500 lbs. total.

**Electronic Transformer Co., Inc.**
207 West 25th St. New York 1, New York

# "TAB" THAT'S A BUY

# TUBES

**TESTED—GUARANTEED**

Prices Subject to Change
*Critical Type—Write for Price

| | |
|---|---|
| OA2 | 1.69 |
| OA3/VR75 | 1.28 |
| OA4G | 1.33 |
| OB2 | 1.88 |
| OB3/VR90 | 1.29 |
| OC3/VR105 | 1.03 |
| OD3/VR150 | .85 |
| OY4 | 2.53 |
| OZ4 | .86 |
| C1A | 4.90 |
| O1A | .68 |
| 1A3 | 1.10 |
| 1A4P | .98 |
| 1A5GT | .85 |
| 1A6 | 1.78 |
| 1A7GT | 1.06 |
| 1AE4 | 1.80 |
| 1B3/8016* | 2.65 |
| 1B4P | .98 |
| 1B5/25S | .98 |
| 1B7GT | .98 |
| 1B21/471A | 2.85 |
| 1B22 | 3.49 |
| 1B23 | 8.25 |
| 1B24 | 4.39 |
| 1B26 | 3.69 |
| 1B27 | 23.83 |
| 1B29 | .98 |
| 1B32/532A | 1.71 |
| 1B36 | 10.00 |
| 1B37 | 18.00 |
| 1B38 | 34.00 |
| 1B40 | 4.95 |
| 1B41 | 49.95 |
| 1B42 | 7.50 |
| 1B46 | 3.69 |
| 1B53 | 49.95 |
| 1B54 | 79.95 |
| 1B56 | 40.95 |
| 1B59 | 12.95 |
| 1B60 | 64.95 |
| 1C5GT | 1.09 |
| 1C6 | .89 |
| 1C7G | .98 |
| 1D5GP | .98 |
| 1D7G | .98 |
| 1D8GT | .98 |
| 1E5GP | .98 |
| 1E7G | .98 |
| 1F4 | .79 |
| 1F5G | .98 |
| 1F6 | .98 |
| 1F7G | .98 |
| 1G4GT | .98 |
| 1G5G | .98 |
| 1G6GT | 1.19 |
| 1H4G | .98 |
| 1H5G | .87 |
| 1H6G | .98 |
| 1J5G | 1.20 |
| 1J6G | .98 |
| 1L4 | .98 |
| 1LA4 | 1.33 |
| 1LA6 | 1.33 |
| 1LB4 | 1.33 |
| 1LC5 | 1.33 |
| 1LC6 | 1.33 |
| 1LD5 | .98 |
| 1LE3 | 1.33 |
| 1LG5 | 1.41 |
| 1LH4 | 1.33 |
| 1LN5 | .98 |
| 1N5GT | .98 |
| 1N6G | .98 |
| 1P5GT | .98 |
| 1P24 | 2.39 |
| 1Q5GT | .98 |
| 1Q26 | 69.00 |
| 1R4/1294 | .98 |
| 1R5 | 1.06 |
| 1S4 | 1.20 |
| 1S5 | .95 |
| 1S21/S1A | 3.95 |
| 1T4 | 1.05 |
| 1T5GT | 1.33 |
| 1U4/5910 | .98 |
| 1U5 | .95 |
| 1V | .98 |
| 1V2 | .70 |
| 1X2* | 2.65 |
| 1Z2* | 3.98 |

| | |
|---|---|
| 2A3 | 1.29 |
| 2A4G | 1.20 |
| 2A5 | .89 |
| 2A6 | .89 |
| 2A7 | .89 |
| 2B4 | 2.98 |
| 2B7 | .98 |
| 2B22/GL559 | 1.38 |
| 2C21/1642 | .36 |
| 2C22/7193 | .89 |
| 2C26 | .25 |
| 2C34/RK34 | .30 |
| 2C39 | 23.98 |
| 2C40 | 2.70 |
| 2C43 | 28.50 |
| 2C43/464A | 16.95 |
| 2C44 | 1.20 |
| 2C50 | 3.69 |
| 2C51 | 5.69 |
| 2C52 | 3.06 |
| 2D21 | 1.15 |
| 2E5 | 1.16 |
| 2E22 | 1.12 |
| 2E24 | 4.50 |
| 2E25/HY65 | 4.20 |
| 2E26 | 3.38 |
| 2E30 | 2.25 |
| 2J21 | 10.69 |
| 2J21A | 10.69 |
| 2J22 | 9.45 |
| 2J26 | 6.98 |
| 2J27 | 13.90 |
| 2J30 | 39.50 |
| 2J31 | 8.90 |
| 2J32 | 12.80 |
| 2J33 | 18.45 |
| 2J34 | 19.39 |
| 2J36 | 95.00 |
| 2J37 | 12.80 |
| 2J38 | 9.95 |
| 2J39 | 19.90 |
| 2J40 | 24.50 |
| 2J48 | 15.70 |
| 2J49 | 39.45 |
| 2J50 | 27.50 |
| 2J55 | 89.25 |
| 2J56 | 249.50 |
| 2J62 | 49.45 |
| 2K25 | 24.95 |
| 2K28/mtd | 36.98 |
| 2K29 | 29.95 |
| 2K39 | 89.50 |
| 2V3G | 1.29 |
| 2W3GT | .98 |
| 2X2 | .89 |
| 2X2A | 1.49 |
| 3A4 | .69 |
| 3A5 | 1.25 |
| 3A8GT | 1.90 |
| 3B4 | 2.69 |
| 3B5 | .98 |
| 3B7/1291 | 2.45 |
| 3B22 | 2.45 |
| 3B24 | 3.98 |
| 3B25 | 4.60 |
| 3B27 | 1.95 |
| 3B28 | 7.85 |
| 3C6 XXB | 1.60 |
| 3C23 | 5.85 |
| 3C31/C1B | 3.45 |
| 3C45 | 12.65 |
| 3D6/1299 | .69 |
| 3D21A | 1.98 |
| 3E29 | 12.85 |
| 3LF4 | 1.33 |
| 3Q4 | .98 |
| 3Q5GT | 1.15 |
| 3S4 | .99 |
| 3V4 | .99 |
| 4B27 | 4.98 |
| 4C33 | 59.00 |
| 4C35 | 34.90 |
| 4C36 | 15.98 |
| 4D32 | 12.95 |
| 4E27/257 | 12.45 |
| 4J31 | 95.00 |
| 4J42/700 | 19.00 |
| 4J47 | 260.00 |
| 4J52 | 250.00 |
| 4T4/2 | 5.95 |

| | |
|---|---|
| 5C22 | 59.95 |
| 5C30/C5B | 9.95 |
| 5D21 | 24.30 |
| 5J23 | 13.45 |
| 5J29 | 12.40 |
| 5J32 | 99.00 |
| 5R4GY | 1.50 |
| 5T4* | 1.72 |
| 5U4G* | 1.65 |
| 5V4G* | 2.40 |
| 5W4 | .83 |
| 5X4G | .90 |
| 5Y3GT* | 1.25 |
| 5Y4G | .75 |
| 5Z3 | .98 |
| 5Z4 | 1.18 |
| C6A | 7.45 |
| 6A3 | 1.39 |
| 6A4 | 1.60 |
| 6A6 | 1.33 |
| 6A7 | 1.05 |
| 6A8GT | 1.05 |
| 6AB4* | 2.00 |
| 6AB5/6N5 | 1.33 |
| 6AB7/1853 | 1.42 |
| 6AC5GT | 1.29 |
| 6AC7* | 2.90 |
| 6AC7W* | 3.60 |
| 6AD7 | 1.60 |
| 6AE5 | .99 |
| 6AE6G | .79 |
| 6AF5G | .89 |
| 6AF6G | 1.33 |
| 6AG5* | 2.65 |
| 6AG7* | 2.88 |
| 6AH5G | 1.49 |
| 6AH6* | 3.90 |
| 6AJ5 | 1.49 |
| 6AK5* | 3.90 |
| 6AK6* | 2.40 |
| 6AL5* | 2.00 |
| 6AL5W* | 2.90 |
| 6AL7GT* | 2.65 |
| 6AN5* | 6.00 |
| 6AQ5* | 2.00 |
| 6AQ6 | .89 |
| 6AQ7GT | 1.23 |
| 6AR5* | 1.65 |
| 6AR6 | 1.98 |
| 6AS5* | 2.00 |
| 6AS6 | 1.89 |
| 6AS7G* | 6.75 |
| 6AT6* | 1.50 |
| 6AU5GT* | 2.65 |
| 6AU6* | 2.00 |
| 6AV5GT* | 2.65 |
| 6AV6* | 1.50 |
| 6AW6* | 2.65 |
| 6AX5GT* | 1.35 |
| 6B4G | 1.54 |
| 6B6G | .98 |
| 6B7 | 1.39 |
| 6B8G | 1.39 |
| 6BA4 | 1.49 |
| 6BA5 | 1.98 |
| 6BA6* | 1.80 |
| 6BA7* | 1.20 |
| 6BC5* | 2.00 |
| 6BD6* | 2.00 |
| 6BE6* | 1.80 |
| 6BF6* | 1.49 |
| 6BG6G* | 2.25 |
| 6BH6* | 2.00 |
| 6BJ6* | 2.00 |
| 6BQ6GT* | 3.20 |
| 6C4* | 1.65 |
| 6C5GT | .83 |
| 6C6 | .89 |
| 6C7 | 1.26 |
| 6C8G | .98 |
| 6C21 | 24.95 |
| 6CB6* | 2.00 |
| 6CD6G* | 6.00 |
| 6D6 | .89 |
| 6D7G | .89 |
| 6D8 | .98 |
| 6E5 | 1.10 |
| 6E6 | 1.30 |
| 6E7 | 1.39 |
| 6F5 | .83 |
| 6F6* | 1.04 |

| | |
|---|---|
| 6F6GT* | .85 |
| 6F7 | 1.39 |
| 6F8G* | 1.49 |
| 6G6G | .98 |
| 6H6* | 1.15 |
| 6CJ | 4.40 |
| 6J4* | 6.98 |
| 6J5GT* | 1.50 |
| 6J6* | 2.90 |
| 6J7* | 1.80 |
| 6J8G | 1.39 |
| 6K5GT | 1.16 |
| 6K6GT* | 1.65 |
| 6K7 | .75 |
| 6K8 | 1.07 |
| 6L5G | .98 |
| 6L6* | 2.26 |
| 6L6G* | 1.98 |
| 6L6GA* | 1.98 |
| 6L7 | .98 |
| 6N4 | 2.39 |
| 6N6G | 1.95 |
| 6N7GT | 1.26 |
| 6P5GT* | 1.26 |
| 6Q7 | .89 |
| 6R7 | .98 |
| 6R8 | 1.39 |
| 6S4* | 1.80 |
| 6S7 | 1.29 |
| 6S8GT | 2.65 |
| 6SA7GT* | 2.00 |
| 6SB7Y* | 1.20 |
| 6SC7 | 1.39 |
| 6SD7GT | 1.29 |
| 6SF5 | .93 |
| 6SF7 | .98 |
| 6SG7* | 2.00 |
| 6SH7GT* | 2.20 |
| 6SJ7* | 1.65 |
| 6SK7GT* | 1.80 |
| 6SL7GT* | 1.25 |
| 6SN7GT* | 2.20 |
| 6SN7WGT* | 2.90 |
| 6SQ7GT* | 1.50 |
| 6SR7* | 1.80 |
| 6SS7 | .90 |
| 6ST7 | 1.33 |
| 6SU7GTY | 3.37 |
| 6SV7 | 1.45 |
| 6SZ7 | 1.05 |
| 6T7G | 1.29 |
| 6T8* | 2.90 |
| 6U4GT* | 1.25 |
| 6U5/6G5* | 1.05 |
| 6U6GT* | 1.05 |
| 6U7G | .90 |
| 6V6* | 2.25 |
| 6V6GT* | 2.00 |
| 6V6GTY* | 2.45 |
| 6V7G | 1.18 |
| 6W4GT* | 1.80 |
| 6W4WGT* | 2.50 |
| 6W5GT | .98 |
| 6W6* | 2.00 |
| 6W7G | 1.33 |
| 6X4* | 1.50 |
| 6X5GT* | 1.85 |
| 6Y5 | 1.85 |
| 6Y6G* | 1.25 |
| 6Y7G | .98 |
| 6Z5/12Z5 | 1.18 |
| 6Z7G | .98 |
| 6ZY5G | .98 |
| 7A4 XXL* | .98 |
| 7A5* | 1.10 |
| 7A6* | [illegible] |
| 7A7* | 1.62 |
| 7A8 | .90 |
| 7AD7* | 2.39 |
| 7AF7* | .95 |
| 7AG7* | 1.15 |
| 7AH7* | 1.16 |
| 7B4* | 1.80 |
| 7B5* | 1.80 |
| 7B6* | 1.80 |
| 7B7 | .90 |
| 7B8 | .90 |
| 7C4/1203A | .89 |
| 7C5* | .89 |
| 7C6* | 1.62 |
| 7C7 | .95 |

| | |
|---|---|
| 7C23 | 72.00 |
| 7E5/1201 | 1.25 |
| 7E6 | 1.10 |
| 7E7 | 1.10 |
| 7F7* | 1.05 |
| 7F8* | 2.65 |
| 7G7/1232 | 1.33 |
| 7H7* | 2.00 |
| 7J7 | 1.33 |
| 7K7 | 1.33 |
| 7L7 | 1.33 |
| 7N7* | 2.65 |
| 7Q7* | .95 |
| 7R7* | 1.16 |
| 7S7 | 1.33 |
| 7T7 | 1.03 |
| 7V7 | 1.33 |
| 7W7* | 2.65 |
| 7X7/XXFM | 1.33 |
| 7Y4* | .90 |
| 7Z4* | .95 |
| 10Y | .29 |
| 12A | .89 |
| 12A5 | 1.39 |
| 12A6* | .98 |
| 12A7 | 1.49 |
| 12A8GT | 1.00 |
| 12AH7GT | 1.33 |
| 12AL5* | 2.00 |
| 12AT6* | 1.50 |
| 12AT7* | 2.90 |
| 12AU6* | 2.00 |
| 12AU7* | 2.40 |
| 12AV6* | 1.50 |
| 12AV7* | 3.20 |
| 12AW6* | 2.65 |
| 12AX7* | 2.40 |
| 12BA6* | 1.80 |
| 12BA7* | 2.40 |
| 12BD6* | 2.00 |
| 12BE6* | 1.80 |
| 12BF6 | .85 |
| 12BH7* | 2.40 |
| 12C8 | 1.39 |
| 12F5 | .90 |
| 12H6* | 1.80 |
| 12J5GT* | .75 |
| 12J7GT | 1.00 |
| 12K7GT | .98 |
| 12K8 | 1.07 |
| 12Q7GT | .90 |
| 12S8GT | .98 |
| 12SA7GT* | 1.05 |
| 12SC7 | 1.39 |
| 12SF5GT | .79 |
| 12SF7GT | .79 |
| 12SG7 | .89 |
| 12SH7 | 1.10 |
| 12SJ7GT | .89 |
| 12SK7 | 1.80 |
| 12SL7GT | 1.07 |
| 12SN7GT* | 2.20 |
| 12SQ7GT* | 1.50 |
| 12SR7 | .98 |
| 12X3 | .90 |
| 12Z3 | .98 |
| 14A4 | 1.29 |
| 14A7/12B7 | 1.08 |
| 14AF7/XXD | 1.18 |
| 14B6 | 1.08 |
| 14B8 | 1.10 |
| 14C5 | 1.29 |
| 14C7 | 1.20 |
| 14E6 | 1.10 |
| 14E7 | 1.33 |
| 14F7 | 1.10 |
| 14F8* | 1.33 |
| 14H7* | 1.20 |
| 14J7 | 1.33 |
| 14N7 | 1.33 |
| 14Q7 | 1.10 |
| 14R7 | 1.29 |
| 14S7 | 1.33 |
| 14W7 | 1.33 |
| 14X7 | 1.33 |
| 14Y4 | 1.20 |
| 15 | .98 |
| 15E | 1.17 |
| FG17 | 3.98 |

| | |
|---|---|
| RK18 | .98 |
| 18 | .98 |
| 19 | .69 |
| 19BG6G* | 6.00 |
| 19J6* | 3.20 |
| 19T8* | 2.90 |
| 20 | 1.17 |
| RK20A | 9.90 |
| RX21 | 2.50 |
| PJ22/CE1C | 1.49 |
| 22 | .99 |
| 24 | .89 |
| HY24 | 1.39 |
| 24A | 1.10 |
| 24G/3C24 | .69 |
| 25A6 | 1.20 |
| 25A7 | 3.27 |
| 25AC5GT | 1.95 |
| 25B5 | 1.39 |
| 25B6 | 2.49 |
| 25BQ6GT* | 3.20 |
| 25C6 | 1.18 |
| 25L6GT | .87 |
| 25N6 | 1.69 |
| 25W4GT* | 2.00 |
| 25Y5 | 1.45 |
| 25Z5 | .87 |
| 25Z6GT* | 1.50 |
| 26 | .79 |
| 27 | .75 |
| FG27A | 8.70 |
| RK28A | 3.85 |
| 28D7 | 1.39 |
| 30* | .89 |
| HY31Z | 2.75 |
| 31 | .59 |
| 32 | .59 |
| FG32 | 5.98 |
| 32L7GT | 1.69 |
| FG33 | 8.90 |
| 33 | .69 |
| 34 | 1.60 |
| 35/51 | 1.00 |
| 35A5 | .95 |
| 35B5* | 2.00 |
| 35C5* | 2.00 |
| 35D5* | 2.00 |
| 35L6GT* | 1.65 |
| 35W4* | 1.25 |
| 35X4 | .90 |
| 35Z3 | .90 |
| 35Z4GT | .75 |
| 35Z5GT* | 1.50 |
| REL36/6J4 | .50 |
| 36 | .69 |
| 37 | .69 |
| 38 | .69 |
| 39/44 | .69 |
| CRC40 | .54 |
| 41 | .79 |
| 42 | .79 |
| 43 | .85 |
| 45S/VT52 | .22 |
| 45Z3 | .89 |
| 45Z5 | .90 |
| 46 | .99 |
| 47 | .89 |
| RK48A | 14.85 |
| 48 | 3.90 |
| 49 | .89 |
| 50 | 1.95 |
| EF50 | .69 |
| 50A5 | 1.35 |
| 50B5* | 1.80 |
| 50C5 | 1.03 |
| 50C6* | 1.49 |
| 50L6GT* | 1.65 |
| 50X6 | 1.10 |
| 50Y6GT | .90 |
| 50Y7GT | .99 |
| 52 | .99 |
| 53 | 1.33 |
| 55 | 1.06 |
| 56 | .85 |
| 57 | .89 |
| 58 | .89 |
| 59 | 1.78 |
| RK65 | 24.95 |
| HY69 | 2.75 |
| 70A7 | 1.59 |
| 70L7GT | 1.39 |
| 71 | 1.00 |
| 72 | .95 |
| CRP72 | 1.37 |
| 73 | 1.67 |
| NR74 | .29 |
| 75 | .83 |
| 76 | .83 |
| 77 | .83 |
| 78 | .83 |

| | |
|---|---|
| 79 | .89 |
| 80 | 1.19 |
| 81 | 1.95 |
| FG81A | 3.75 |
| 82 | 1.29 |
| 82V | 1.39 |
| 83 | 1.29 |
| 83V | 1.39 |
| 84/6Z4 | .95 |
| 85 | 1.10 |
| 89 | .79 |
| VR92 | .25 |
| 100TH | 8.89 |
| FG104 | 17.45 |
| FG105 | 8.89 |
| VU111 | .45 |
| HY114B | .79 |
| HY115/145 | .75 |
| 117L7* | 1.95 |
| 117N7GT | 1.95 |
| 117P7GT | 1.95 |
| 117Z3 | .79 |
| 117Z4GT | 1.45 |
| 117Z6GT | 1.20 |
| 117Z7GT | 1.49 |
| F127A | 15.89 |
| CV148 | 4.98 |
| 150T | 14.50 |
| 155 | .98 |
| FG166 | 49.00 |
| 182B | 1.20 |
| FG190 | 12.80 |
| 205B/VT2 | 1.69 |
| CE206 | 3.15 |
| 211/VT4C | .45 |
| RX215 | 9.95 |
| WE215A | .15 |
| 227A | 2.65 |
| 231 | 1.20 |
| 249C | 1.95 |
| 250TH | 18.75 |
| 250TL | 18.75 |
| 282B | 8.49 |
| 304TH | 10.98 |
| 304TL | 10.98 |
| 307A/RK75 | 6.45 |
| 310A | 6.98 |
| 316A | .89 |
| 327A | 2.50 |
| 350A | 2.79 |
| 350B | 2.25 |
| 355A | 14.15 |
| 371B | .98 |
| 380A | .79 |
| 388A | 1.69 |
| 393A | 3.75 |
| 394A | 3.98 |
| X400 | 14.98 |
| WL414 | 63.95 |
| 417A | 9.49 |
| GL434 | 2.69 |
| 446A/2C40 | 1.19 |
| 446B | 1.75 |
| 450TH | 39.95 |
| 450TL | 44.25 |
| GL451 | .89 |
| 460/HF200 | 15.95 |
| WL468 | 6.89 |
| RH507 | 9.98 |
| 527 | 12.98 |
| GL530 | 49.69 |
| WL531 | 13.75 |
| WL532A | 3.89 |
| GL534/1S21 | 3.89 |
| 544 | 4.98 |
| GL546 | 1.69 |
| 550P1 | 19.95 |
| 575A/975 | 12.65 |
| 601B | .19 |
| HY615 | .18 |
| WL619 | 18.90 |
| WL632A | 8.98 |
| 701A | 2.90 |
| 702A/702B | 2.65 |
| 703A | 3.98 |
| 704A | 1.05 |
| 705A/8021 | .65 |
| 707A | 13.50 |
| 707B | 24.98 |
| 710A/8011 | .79 |
| 713A | 1.00 |
| 715A | 6.98 |
| 715B | 7.98 |
| 715C | 22.98 |
| 716A | 2.75 |
| 717A | .61 |
| 720CY | 45.00 |
| 721A | 2.19 |

| | |
|---|---|
| 722A/287A | 2.75 |
| 723A | 6.95 |
| 723A/B | 14.98 |
| 724A/B | 2.89 |
| 725A | 6.39 |
| 726A | 7.98 |
| 726C | 39.98 |
| 730A | 9.89 |
| 801A | .29 |
| 802 | 4.39 |
| 803 | 3.00 |
| 804 | 8.45 |
| 805 | 3.59 |
| 807 | 2.39 |
| 808 | 1.35 |
| 809 | 2.45 |
| 810 | 11.96 |
| 811 | 2.89 |
| 812 | 2.80 |
| 813 | 11.75 |
| 815 | 1.37 |
| 826 | .39 |
| SD828 | .98 |
| 829 | 7.20 |
| 829B | 12.50 |
| 832 | 7.98 |
| 832A | 10.64 |
| 833A | 33.98 |
| 836 | 1.98 |
| 837 | 1.39 |
| 838 | 2.35 |
| 842 | 2.75 |
| 843 | .39 |
| 845 | 5.95 |
| 851 | 29.98 |
| 860 | 5.70 |
| 861 | 10.89 |
| 864 | .29 |
| 865 | 1.39 |
| 866A | 1.10 |
| 869 | 25.98 |
| 872A | 1.29 |
| GE872A | 2.98 |
| 874 | .35 |
| 876 | 1.95 |
| 884/6Q5G | 1.45 |
| 885 | 1.39 |
| 893 | 395.00 |
| 920 | 2.70 |
| 922 | .98 |
| 923 | 1.75 |
| 927/CE25 | 1.00 |
| 929 | 1.33 |
| 930 | .87 |
| 931A | 4.98 |
| 954 | .25 |
| 955 | .49 |
| 956 | .39 |
| 957 | .39 |
| 958 | .39 |
| SD968 | .98 |
| 991 | .25 |
| FM1000 | 1.50 |
| 1000T | .85 |
| CK1005 | .49 |
| CK1006 | .64 |
| CK1007 | .89 |
| CK1089 | 3.98 |
| CK1090 | 2.69 |
| R1100 | 5.00 |
| R1130B | 12.00 |
| HY1231Z | 5.39 |
| HY1269 | 5.39 |
| 1273 | 1.15 |
| 1609 | 5.98 |
| 1613/6F6X | 1.06 |
| 1614 | 1.75 |
| 1616 | .75 |
| 1619 | .29 |
| 1620 | 4.95 |
| 1622 | 1.75 |
| 1624 | 1.05 |
| 1625 | .49 |
| 1626 | .49 |
| 1629 | .39 |
| 1631 | .80 |
| 1632 | .77 |
| 1633 | .75 |
| 1634 | 1.39 |
| 1635 | 1.49 |
| 1641/RK60 | .75 |
| 2050 | 1.80 |
| 2051 | .89 |
| R4340 | 36.00 |
| 5514 | 4.85 |
| 5516 | 6.70 |
| 5517/CK1013 | 1.89 |
| 5618 | 3.29 |
| 5656 | 9.98 |

| | |
|---|---|
| 5670 | 5.98 |
| 5686 | 4.23 |
| 5687 | |
| 5812 | 2.99 |
| UX6653 | .69 |
| 8012 | 1.25 |
| 8013 | 3.75 |
| 8020 | 1.25 |
| 9001 | 1.98 |
| 9002 | 1.65 |
| 9003 | 1.98 |
| 9004 | .79 |
| 9005/RC4B | 1.95 |
| 9006 | .27 |
| **Sub-Miniature** | |
| 2E31 | 1.39 |
| 2E32 | 1.19 |
| 2E36 | 1.49 |
| 2E42 | 1.39 |
| 2E43 | 1.39 |
| CK501AX | 1.26 |
| CK505AX | 1.79 |
| CK506AX | 1.79 |
| CK509AX | 1.26 |
| CK512AX | 1.79 |
| CK522AX | 1.79 |
| CK525AX | 1.79 |
| CK526AX | 1.98 |
| CK529AX | 1.98 |
| CK531DX | .98 |
| CX532DX | .98 |
| CK533AX | 1.39 |
| CK534AX | .89 |
| CK536AX | .89 |
| CK538DX | .89 |
| CK539DX | .98 |
| CK542DX | .98 |
| CK543DX | .98 |
| JRP5676 | 1.49 |
| CK5678 | 2.48 |
| CK5702 | 5.98 |
| CK5703 | 1.25 |
| JRP5704 | 1.25 |
| CK5744 | 2.98 |
| CK5784 | 5.98 |
| 5829 | 5.98 |
| 5875 | 5.98 |
| **C'Ray Tubes** | |
| 2AP1 | 4.85 |
| 2AP5 | 7.98 |
| 3AP1 | 4.69 |
| 3BP1 | 2.49 |
| 3BP1A | 14.98 |
| 3CP1-S1 | 2.20 |
| 3DP1 | 3.00 |
| 3DP1-S2 | 4.65 |
| 3EP1 | 2.45 |
| 3FP7 | 1.60 |
| 3FP7A | 14.98 |
| 3GP1 | 4.89 |
| 3HP7 | 2.85 |
| 3HP14 | 14.98 |
| 3JP1 | 15.00 |
| 3JP12 | 19.95 |
| 4AP10 | 4.39 |
| 5AP1 | 3.59 |
| 5BP1 | 2.25 |
| 5BP4 | 4.50 |
| 5CP1 | 1.75 |
| 5CP7 | 3.39 |
| 5FP7 | 1.26 |
| 5FP14 | 18.98 |
| 5GP1 | 5.25 |
| 5HP1 | 4.95 |
| 5HP4 | 9.75 |
| 5JP2 | 9.45 |
| 5LP1 | 11.89 |
| 5MP1 | 4.75 |
| 5NP1 | 3.98 |
| 7BP1 | 4.95 |
| 7BP7 | 4.65 |
| 7CP1 | 12.95 |
| 7JP4 | 16.49 |
| 9GP7 | 14.89 |
| 9JP1 | 6.45 |
| 9LP7 | 10.98 |
| 10BP4 | 19.49 |
| 10FP4 | 24.50 |
| 12DP7 | 12.45 |
| 12GP1 | 49.98 |
| 12JP4 | 27.00 |
| 12KP4 | 47.00 |
| 12LP4 | 24.35 |
| 905 | 2.45 |
| 910/3AP1 | 4.63 |
| 912 | 89.98 |
| 914A | 45.00 |
| **Tungar Bulbs** | |
| 20X672 | 2.95 |

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|---|---|
| 189048GE | 3.49 |
| 859483 | 3.98 |
| **Ballast** | |
| 1P1 | .49 |
| PM3 | .98 |
| PM4 | .98 |
| 4A1 | 1.29 |
| PM5 | .98 |
| 6-11 | .49 |
| PM6 | .98 |
| PM7 | .98 |
| PM8 | .98 |
| 9-3 | .49 |
| 10-4B | .49 |
| 13-4 | .49 |
| 20-4 | .49 |
| K49A | .36 |
| K55B | .36 |
| M55B | .36 |
| L62A | .49 |
| K80B | .36 |
| WL121A | 2.61 |
| C376 | 2.98 |
| ZB583 | 3.98 |
| 876 | .29 |
| **Mazda Pilots** | |
| 44, Box 10 | .50 |
| 49, Box 10 | .60 |
| 55, Box 10 | .50 |
| 64, Ea. | .07 |
| S6/T4/3W | .18 |
| 100W/20V | .25 |
| 291, Box 10 | .36 |
| 311/28V | .15 |
| 313/28V | .15 |
| 323/3V | .25 |
| **Sylvania** | |
| S6/6W/120V | .15 |
| **Wstghs** | |
| C7/7W/120W | .09 |
| **MedScrew Base** | |
| 15W/125V | .08 |
| 25W/125V | .08 |
| **Neon Bulbs** | |
| NE16/991 | .25 |
| NE20 | .10 |
| NE32 | .35 |
| NE45/¼W | .27 |
| NE51/NE20 | .10 |
| **TelSlideLamps** | |
| 6/12/24/48/55V, Ea. | .18 |
| **Xtal DiodesJan** | |
| 1N21 | .49 |
| 1N21A | 2.00 |
| 1N21B | 2.60 |
| 1N22 | 2.00 |
| 1N23 | .49 |
| 1N23A | 2.80 |
| 1N23B | 3.75 |
| 1N26 | 5.20 |
| 1N27 | 3.50 |
| 1N29 | 3.50 |
| 1N32 | 18.00 |
| 1N34 | .75 |
| 1N35 | 1.95 |
| 1N46 | .89 |
| 1N48 | .70 |
| 1N51 | .70 |
| 1N52 | .95 |
| 1N63 | .98 |
| **Thermistors** | |
| D167019 Vol Limiter | 2.95 |
| D168391 Thermal Comp | $1. |
| D170396 HF Pwr Meas. | .90 |
| 1C Bulb Time Delay | .90 |
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| CW20259/USN 38C | 2.95 |
| WEco 41A | 1.50 |
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| 200Kc | 3.98 |
| 1000Kc | 4.49 |
| 4700Kc | .98 |
| 5000Kc | 3.98 |
| **HtrOvenXtals** | |
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Tubes Gtd Exc Open Fil & B'kage Via R'Exp Only. Min Tube Order $5.00

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| MFD. | KV | AMPS | MC | Each |
|---|---|---|---|---|
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| .09 | 1.5 | 40 | 1 | 11.95 |
| .02 | 3 | 22 | 1 | 12.98 |
| .02 | 3 | 60 | 1 | 23.50 |
| .0006 | 5 | 7 | 1 | 4.98 |
| .005 | 5 | 20 | 3 | 6.49 |
| .01 | 5 | 20 | 1 | 6.98 |
| .0001 | 6 | 3 | 3 | 3.98 |
| .00015 | 6 | 4 | 3 | 4.29 |
| .0002 | 6 | 5 | 3 | 4.49 |
| .00025 | 6 | 6 | 3 | 4.69 |
| .0004 | 6 | 6 | 3 | 4.98 |
| .0006 | 6 | 8 | 3 | 5.49 |
| .00075 | 6 | 8.5 | 3 | 5.69 |
| .003 | 8 | 20 | 3 | 7.29 |
| .0001 | 10 | 6 | 3 | 4.98 |
| .00035 | 10 | 8 | 3 | 5.29 |
| .0004 | 10 | 8.5 | 3 | 5.69 |
| .005 | 10 | 30 | 1 | 21.95 |
| .0015 | 10 | 14.5 | 3 | 7.49 |
| .02 | 10 | 60 | 1 | 29.95 |
| .00005 | 20 | 4.5 | 3 | 4.98 |
| .00009 | 20 | 6 | 3 | 5.69 |
| .0002 | 20 | 8 | 3 | 6.49 |
| .000375 | 20 | 12 | 3 | 8.49 |
| .0004 | 20 | 12 | 3 | 8.98 |
| .006 | 20 | 35 | 1 | 34.95 |
| .0005 | 25 | 13 | 3 | 27.50 |

25000VDC CNDSR. .012 MFD C-D Type BT14, 15" long, NEW............ $4.98

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3000v/10ma, Csd H8Vinsul.......... 4.50
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380 Watts GEN ELEC Inpt 115-220V/60 cyc; Outpt 115V/380 Watts.....$39.95
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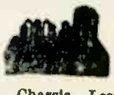

## "WILLIAMSON" 10W HI-FI KIT

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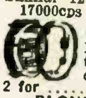

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2 for ....................................$9.49

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40 CFM 28vacdc .....................$4.98
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## Hi-Volt Oil Capacitors

| Mfd | Each | Mfd | Each |
|---|---|---|---|
| 3000 wvdc | | 7500 wvdc | |
| .1 | 2.19 | .03 | 2.29 |
| .5 | 2.69 | .05 | 2.69 |
| 2 | 4.29 | .1 | 4.29 |
| 3 | 5.95 | 1 | 13.98 |
| 4000 wvdc | | 10000 wvdc | |
| 2 | 7.98 | .03 | 2.69 |
| 5000 wvdc | | 12500 wvdc | |
| .2 | 3.29 | .65 | 14.98 |
| 2 | 9.98 | 15000 wvdc | |
| 4 | 17.98 | .0016 | 8.98 |
| 7000 wvdc | | 25000 wvdc | |
| .002 | $1.2 | .00025 | 6.49 |
| .0075 | 1.69 | 1 | 195.00 |
| .1 | 3.89 | | |

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ADVERTISERS INDEX



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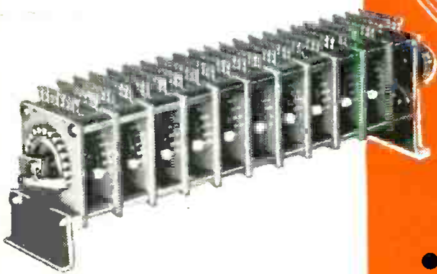
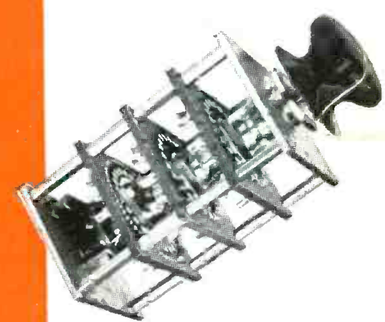
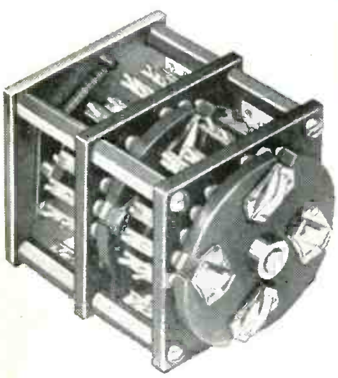
# Quick Switches



are a

# DAVEN SPECIALTY





And the "specialty of the house" is double-barreled . . . first, choose from hundreds of standard units to satisfy your needs—for quick switch delivery . . . second, Daven can effect quick 'switches' or changes from standard units to special switches, by using components at hand. Standard parts can be adapted for *your* switch. That too makes for speed, dependability, economy. Write for more detailed data.

## Here's Why Daven Switches Excel

- Low and uniform contact resistance.
- Minimum thermal noise.
- High resistance to leakage.
- Trouble-free operation and long life.
- Roller-type positive detent action.
- Depth of unit not increased by addition of detent.

Standard Daven Switches may be the answer to many of your problems. Therefore, check this list below for many of the popular types that are readily available.

| Type | Operation | Maximum No. of Positions (per pole) | Maximum Poles per Deck | Deck |
|---|---|---|---|---|
| G1A | Make before break | 24 | 1 | 1 3/8" |
| C1A | Make before break | 31 | 1 | 1 3/4" |
| C2B | Break before make | 15 | 1 | 1 3/4" |
| D1A | Make before break | 47 | 1 | 2 1/4" |
| D7A | Make before break | 14 | 4 | 2 1/4" |
| D8B | Break before make | 7 | 4 | 2 1/4" |
| D9A | Make before break | 9 | 5 | 2 1/4" |
| E3A | Make before break | 47 | 2 | 2 3/4" |
| E8B | Make before break | 12 | 4 | 2 3/4" |
| E11A | Make before break | 15 | 6 | 2 3/4" |
| F1A | Make before break | 60 | 1 | 3" |

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# . . . the RCA-17CP4 metal shell rectangular kinescope

As pioneers in the development of the kinescope, RCA leads again with a new and advanced type of metal-shell *rectangular* kinescope . . . destined to become the industry's leading large-picture tube. The new RCA-17CP4 has a picture area of 14⅝" x 11", and offers designers the following notable advantages . . .

Use of the metal shell not only makes practical a construction which weighs less than a similar all-glass tube, but also makes practical the use of a higher-quality face plate than is commonly used on all-glass tubes.

The rectangular shape, which allows reproduction of the transmitted picture without waste of screen area, permits use of a cabinet having about 20 per cent less height than is required for a round-face tube having the same picture width. In addition, the chassis need not be depressed or cut out under the face of the tube and controls can be located as desired beneath the tube.

The 17CP4 with its design-center maximum anode-voltage rating of 16 kilovolts, provides pictures having high brightness and good uniformity of focus over the whole picture area. It has a high-efficiency, white fluorescent screen on a relatively flat, high-quality faceplate made of frosted Filterglass to prevent reflection of bright objects in the room and to provide increased picture contrast.

Employing magnetic focus and magnetic deflection, the 17CP4 features an improved design of funnel-to-neck section which facilitates centering of the yoke on the neck and, in combination with better centering of the beam inside the neck, contributes to the good uniformity of focus over the entire picture area. The diagonal deflection angle is 70° and the horizontal deflection angle is 66°.

Other features incorporated in the 17CP4 are short overall length and an ion-trap gun which requires only a single-field, external magnet.

**RCA Application Engineers** are ready to co-operate with you in applying the 17CP4 and associated components to your specific designs. For further information write RCA, Commercial Engineering, Section 42AR, Harrison, N. J.

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