NOVEMBER · 1951

PRICE 75 CENTS

electronics

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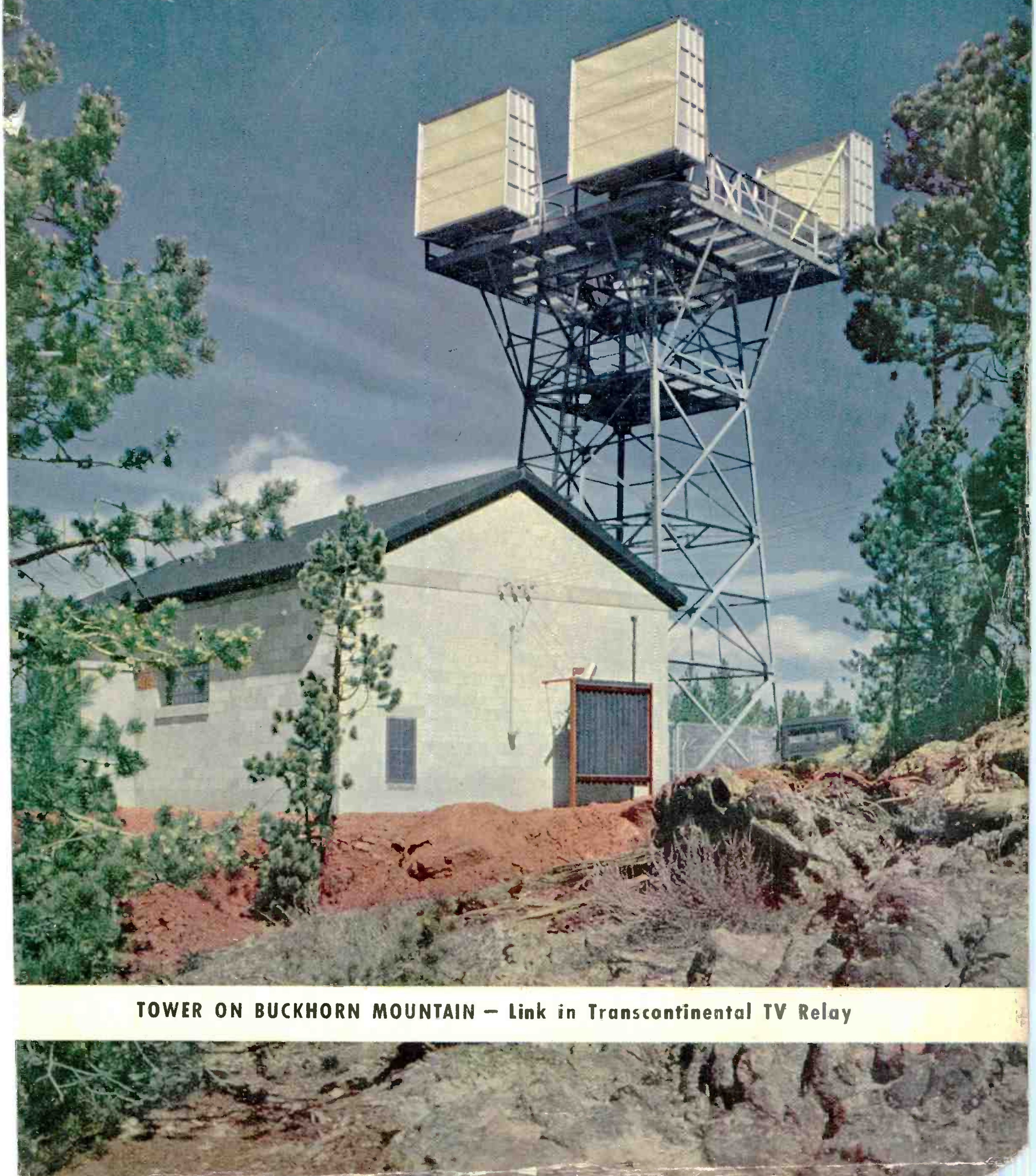
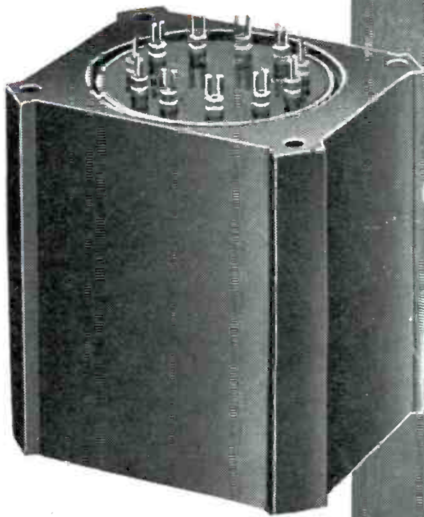


TOWER ON BUCKHORN MOUNTAIN — Link in Transcontinental TV Relay

Linear Standard Units...

THE ULTIMATE IN QUALITY...

UTC Linear Standard Audio Transformers represent the closest approach to the ideal component from the standpoint of uniform frequency response, low wave form distortion, high efficiency, thorough shielding and utmost dependability.

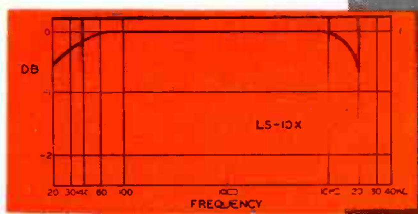


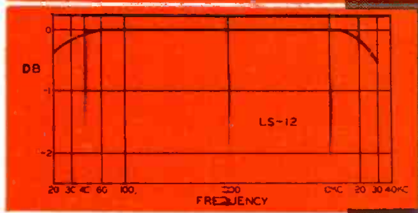
UTC Linear Standard Transformers feature . . .

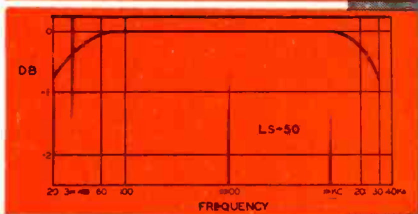
- **True Hum Balancing Coil Structure** . . . maximum neutralization of stray fields.
- **Balanced Variable Impedance Line** . . . permits highest fidelity on every tap of a universal unit . . . no line reflections or transverse coupling.
- **Reversible Mounting** . . . permits above chassis or sub-chassis wiring.
- **Alloy Shields** . . . maximum shielding from inductive pickup.
- **Hiperm-Alloy** . . . a stable, high permeability nickel-iron core material.
- **Semi-Toroidal Multiple Coil Structure** . . . minimum distributed capacity and leakage reactance.
- **Precision Winding** . . . accuracy of winding .1%, perfect balance of inductance and capacity; exact impedance reflection.
- **High Fidelity** . . . UTC Linear Standard Transformers are the only audio units with a guaranteed uniform response of ± 1 DB from 20-20,000 cycles.

TYPICAL LS LOW LEVEL TRANSFORMERS

Type No.	Application	Primary Impedance	Secondary Impedance	±1 db from	Max. Level	Relative hum-pickup reduction	Max. Unbalanced DC in prim'y	List Price
LS-10	Low impedance mike, pickup, or multiple line to grid	50, 125, 200, 250, 333, 500/600 ohms	60,000 ohms in two sections	20-20,000	+15 DB	—74 DB	5 MA	$25.00
LS-10X	As Above	As above	50,000 ohms	20-20,000	+14 DB	—92 DB	5 MA	35.00
LS-12	Low impedance mike, pickup, or multiple line to push pull grids	50, 125, 200, 250, 333, 500/600 ohms	120,000 ohms overall, in two sections	20-20,000	+15 DB	—74 DB	5 MA	28.00
LS-12X	As above	As above	80,000 ohms overall, in two sections	20-20,000	+14 DB	—92 DB	5 MA	35.00
LS-26	Bridging line to single or push pull grids	5,000 ohms	60,000 ohms in two sections	15-20,000	+20 DB	—74 DB	0 MA	30.00
LS-19	Single plate to push pull grids like 2A3, 6L6, 300A. Split secondary	15,000 ohms	95,000 ohms; 1.25:1 each side	20-20,000	+17 DB	—50 DB	0 MA	26.00
LS-21	Single plate to push pull grids. Split primary and secondary	15,000 ohms	135,000 ohms; turn ratio 3:1 overall	20-20,000	+14 DB	—74 DB	0 MA	26.00
LS-22	Push pull plates to push pull grids. Split primary and secondary	30,000 ohms plate to plate	80,000 ohms; turn ratio 1.6:1 overall	20-20,000	+26 DB	—50 DB	25 MA	32.00
LS-30	Mixing, low impedance mike, pickup, or multiple line to multiple line	50, 125, 200, 250, 333, 500/600 ohms	50, 125, 200, 250, 333, 500/600 ohms	20-20,000	+17 DB	—74 DB	5 MA	26.00
LS-30X	As above	As above	As above	20-20,000	+15 DB	—92 DB	3 MA	32.00
LS-27	Single plate to multiple line	15,000 ohms	50, 125, 200, 250, 333, 500/600 ohms	30-12,000 cycles	+20 DB	—74 DB	8 MA	26.00
LS-50	Single plate to multiple line	15,000 ohms	50, 125, 200, 250, 333, 500/600 ohms	20-20,000	+17 DB	—74 DB	0 MA	26.00
LS-51	Push pull low level plates to multiple line	30,000 ohms plate to plate	50, 125, 200, 250, 333, 500/600 ohms	20-20,000	+20 DB	—74 DB	1 MA	28.00
LS-141	Three sets of balanced windings for hybrid service, centertapped	500/600 ohms	500/600 ohms	30-12,000	+10 DB	—74 DB	0 MA	30.00

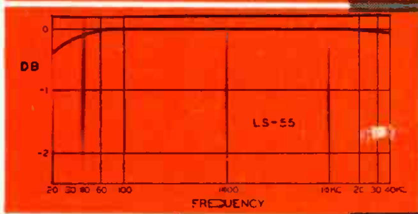






TYPICAL LS OUTPUT TRANSFORMERS

Type No.	Primary will match following typical tubes	Primary Impedance	Secondary Impedance	±1 db from	Max. Level	List Price
LS-52	Push pull 245, 250, 6V6, 42 or 2A5 A prime	8,000 ohms	500, 333, 250, 200, 125, 50, 30, 20, 15, 10, 7.5, 5, 2.5, 1.2	25-20,000	15 watts	$35.00
LS-55	Push pull 2A3's, 6A5G's, 300A's, 275A's, 6A3's, 6L6's	5,000 ohms plate to plate and 3,000 ohms plate to plate	500, 333, 250, 200, 125, 50, 30, 20, 15, 10, 7.5, 5, 2.5, 1.2	25-20,000	20 watts	35.00
LS-57	Same as above	5,000 ohms plate to plate and 3,000 ohms plate to plate	30, 20, 15, 10, 7.5, 5, 2.5, 1.2	25-20,000	20 watts	25.00
LS-58	Push pull parallel 2A3's, 6A5G's, 300A's, 6A3's	2,500 ohms plate to plate and 1,500 ohms plate to plate	500, 333, 250, 200, 125, 50, 30, 20, 15, 10, 7.5, 5, 2.5, 1.2	25-20,000	40 watts	50.00
LS-6L1	Push pull 6L6's self bias	9,000 ohms plate to plate	500, 333, 250, 200, 125, 50, 30, 20, 15, 10, 7.5, 5, 2.5, 1.2	25-20,000	30 watts	50.00



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electronics

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NOVEMBER • 1951

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Member ABC and ABP

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Increased demands on today's electrical manufacturing equipment call for maximum performance, extended parts life and reduced maintenance. When incoming line voltages fluctuate, manufacturing inefficiencies and rising costs are bound to occur. To maintain constant voltage to equipment regardless of variations in line voltage or load current, install a STABILINE Automatic Voltage Regulator type EM (ELECTRO MECHANICAL).

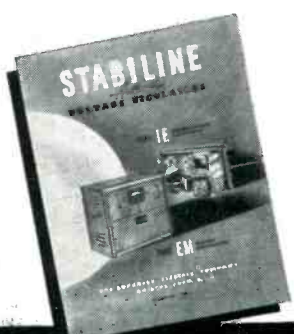
Simple and easy to install, a STABILINE type EM features high efficiency — zero waveform distortion — complete insensitivity to magnitude and power factor of load — adjustable output voltage and no critical adjustments.

	Nom. Output Voltage	Input Voltage Range	Output Voltage Range	Output Current (Amperes)	Output KVA	Type
Single Phase	115	95-135	110-120	17.5	2.0	EM4102
				52.0	6.0	EM4106
				130.0	15.0	EM4115
	230	195-255	220-240	32.5	7.5	EM4207
				120.0	27.5	EM4228
	460	400-520	420-460	15.0	6.6	EM4407
				40.0	17.6	EM4418
Three Phase	230	195-255	220-240	25.0	10.0	EM6210Y
				38.0	15.0	EM6215Y
				50.0	20.0	EM6220Y
				113.0	45.0	EM6245Y
				175.0	70.0	EM6270D
	460	400-520	420-460	16.0	12.5	EM6412Y
				22.0	17.5	EM6417Y
				33.0	25.0	EM6425Y
				66.0	50.0	EM6450Y
				100.0	75.0	EM6475Y
		420-500	420-460	131.0	100.0	EM64100Y

There's a STABILINE type EM to meet your need. Standard types are listed in the rating chart. For special requirements consult The Superior Electric Company, 411 Church St., Bristol, Conn.

STABILINE type IE (INSTANTANEOUS ELECTRONIC), a completely electronic unit with no moving parts, is available in ratings from 0.25 to 5.0 KVA.

Learn more about STABILINES type IE and EM. Write today for Bulletin S351 complete with application data, ratings, dimensions and circuit diagrams.



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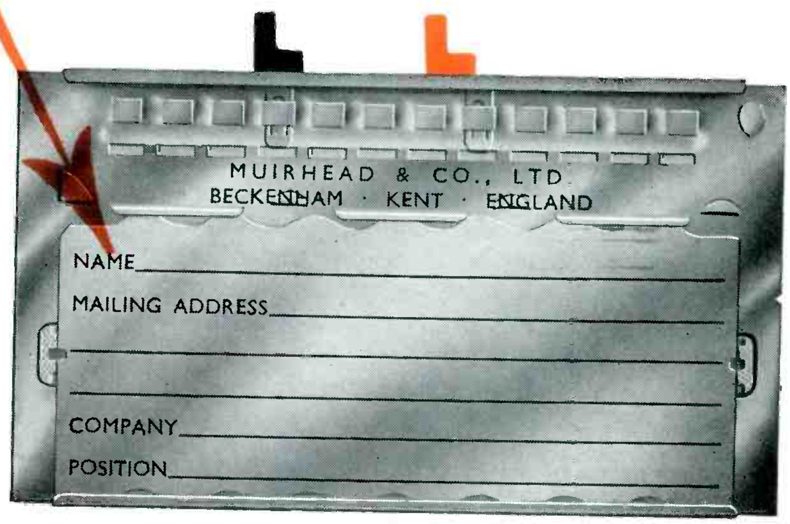

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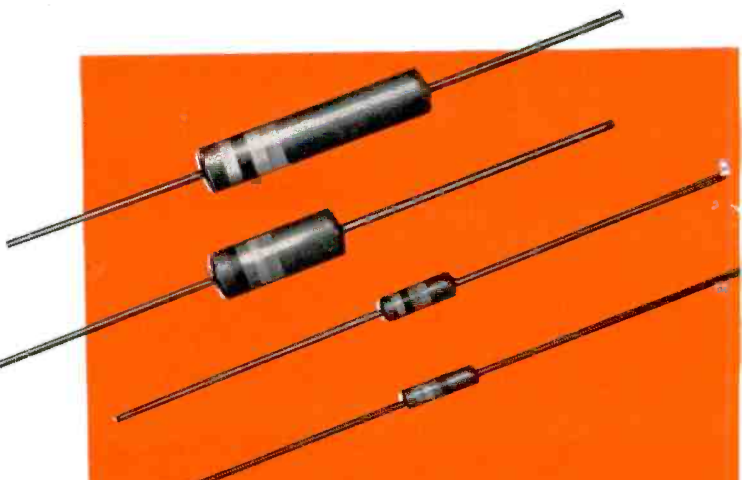
Typical products of quality control, IRC Advanced BT Resistors meet and surpass JAN-R-11 Specifications. In standard RTMA ranges, Advanced BT's are designed to operate with moderate temperature rise and provide efficient power dissipation. Reason is the combination of IRC's filament-type resistance elements with exclusive construction features. Resistance material is permanently cured and bonded to special glass. Leads extend into filament for rapid heat dissipation. Molded bakelite seals element against moisture and prevents grounding. Advanced BT's are available in ⅓, ½, 1 and 2 watt ratings. Send for full details in 12-page technical data Bulletin B-1.



Meet and beat JAN-R-11 Specifications.
⅓, ½, 1 and 2 watts—available in ±5%, ±10% and ±20% tolerance.
Low noise level and temperature coefficient.

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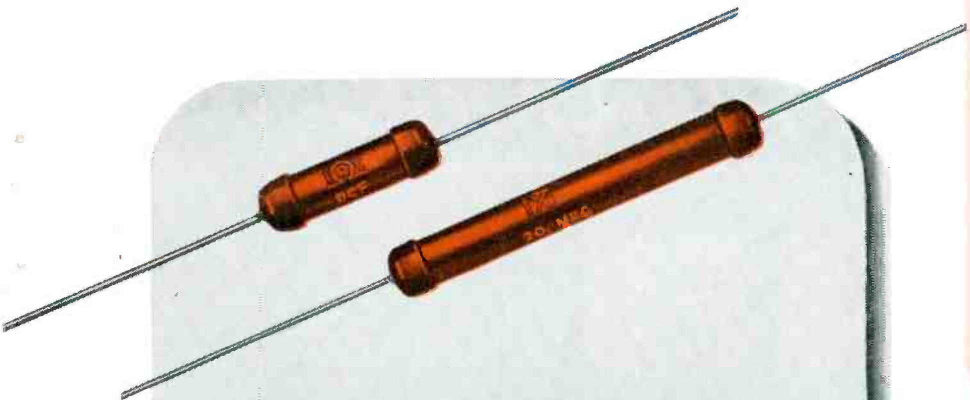
Quality control assures maximum uniformity in IRC's small 15/16" Type Q Controls. Construction features one-piece dual contactor of special alloy—simplified single-unit collector ring—molded voltage baffles—special brass element terminals that will not loosen when bent or soldered. Type Q Controls have unusual durability and efficiency—adapt to a great variety of small-space applications. Send coupon for full details in Catalog A-4.



Where accuracy and economy are desi-ed in high frequency applications and circuits requiring high stability and close tolerance, use IRC PRECISTORS. IRC makes 2 sizes of PRECISTORS *to customers' specifications,* rather than to standard RTMA values (subject, of course, to maximum and minimum values for each type). You'll find PRECISTORS excellent where carbon compositions are unsuitable or wire-wound precisions too expensive. Coupon brings full particulars in Catalog B-4.

Exacting tests and inspections control every step in the processing of IRC Power Wire Wound Resistors—assure balanced performance in every characteristic. In essential electrical and mechanical characteristics, these rugged wire wounds are ideal for heavy duty applications. Steatite forms are uniformly wound with high-grade alloy wire, and coated with special heat-dissipating cement. PWW's have been specified for over 14 years by leading industrial, commercial, broadcast, maritime and aircraft users. Catalog C-2 contains full information.

Your supplies of standard resistors for pilot runs, experimentation, or maintenance need never get out of control. When you need resistors in a rush, simply phone your local IRC Distributor. We keep his shelves filled with the most wanted types of standard resistors; he can give you prompt, 'round-the-corner delivery. If you don't know his name and address just ask us.

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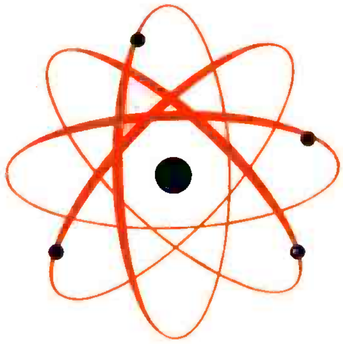

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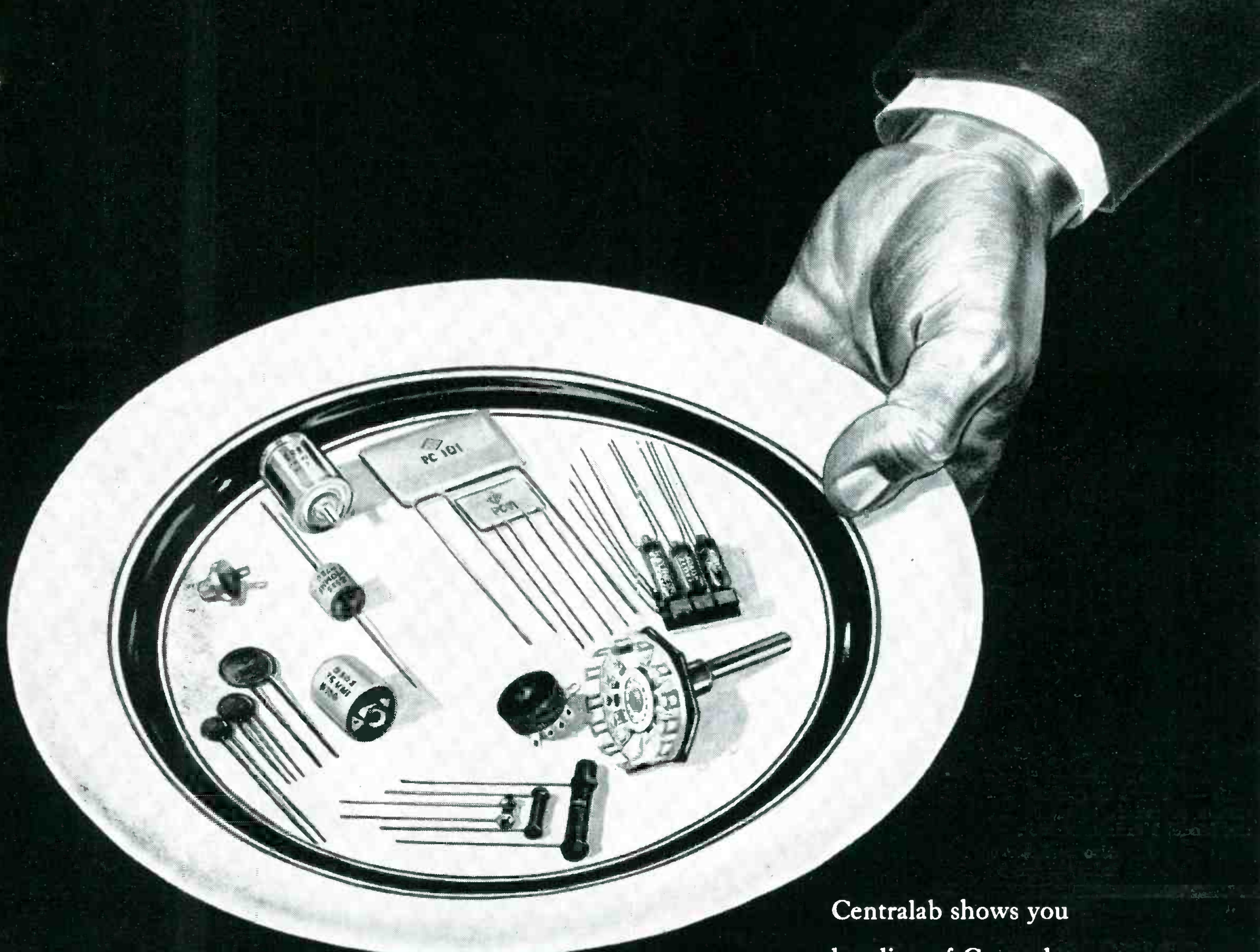

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in the *smallest* sizes and in the ratings
needed to help you MINIATURIZE nearly all
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For more information on how Centralab Printed Electronic Circuits can offer you big savings . . .

see next two pages

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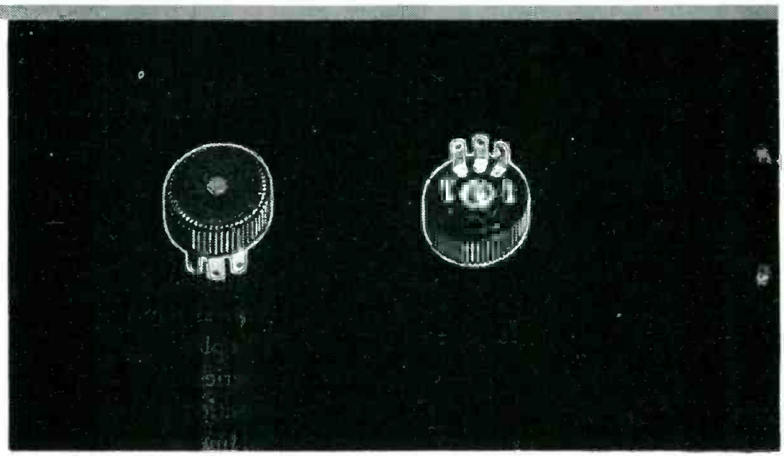
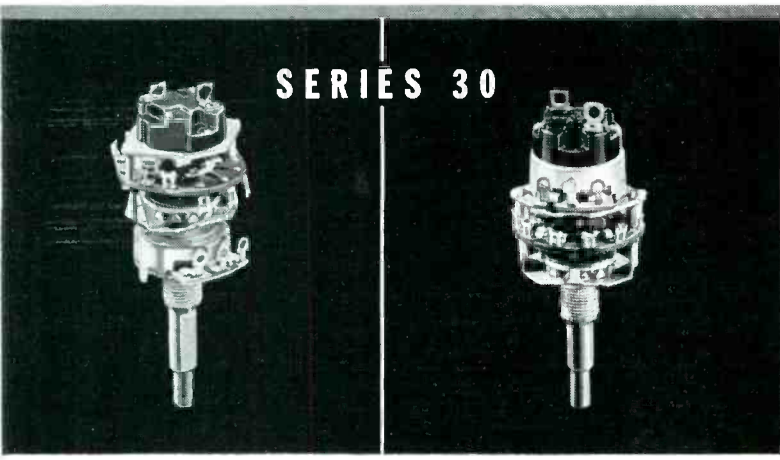
Whatever your need in modern miniature size controls, switches, ceramic capacitors or printed electronic circuits — you'll find Centralab your best source of supply . . . for standard components or special adaptations. For technical bulletins — check corresponding numbers in coupon below. For engineering assistance write factory direct — state your problem.



Model 1 variable resistor — a truly miniature unit . . . no bigger than a dime! Available in standard or new Hi-Torque types . . . either type with or without off-on switch. Also available with slot—front or rear—for screw-driver adjustment. New high torque units will hold settings under conditions of vibration or shock. Check No. 42-158 on coupon.

MINIATURE CONTROLS

You can rely on Centralab for the smallest in controls. The Model 1, illustrated here is literally the standard for the hearing aid industry — where small size and smooth, noiseless, reliable performance is of paramount importance. What's more, Model 1 controls now are being used widely for miniaturization of several types of military electronic equipment.



Combination Series 30 miniature switch unit with dual concentric shaft — permits independent operation of switch, off-on switch, and Model 2 variable resistor.

Same combination unit as shown at left, *except* that Model 2 variable resistor is mounted at rear of miniature switch. Position of resistor provides convenience of wiring.

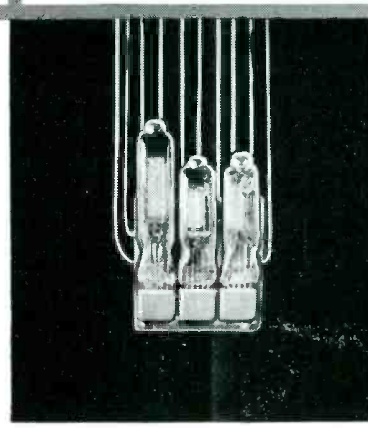
Also available with dual switches operated independently with dual concentric shafts.

MINIATURE CAPACITORS

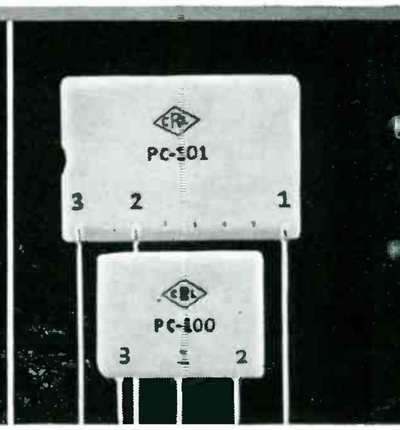
Centralab ceramic capacitors make possible tremendous savings in space; many of them are 1/7th the size of ordinary capacitors. This is particularly important where new design requirements call for less bulk. What's more, they provide a permanence never before achieved with old-fashioned paper or mica condensers. The ceramic body provides imperviousness to moisture, plus unmatched ability to withstand temperatures generally encountered in electrical apparatus. You can rely on Centralab ceramic capacitors for close tolerance, high accuracy, low power factors, and temperature compensating qualities as required.

PRINTED ELECTRONIC CIRCUITS

Printed Electronic Circuits are complete or partial circuits (including all integral circuit connections) consisting of pure metallic silver and resistance materials fired to CRL's famous Steatite or Ceramic-X and brought out to convenient, permanently anchored external leads. They provide miniature units of widely diversified circuits—from single resistor plates to complete speech amplifiers. No other modern electronic development offers such tremendous time and cost saving advantages in low-power applications. *Important to note:* All PEC's illustrated are developed for standard applications. Numerous other circuit complements can be furnished for volume requirements.



New Model 3 Ampec — a sub miniature 3 stage speech amplifier . . . dimensions: 1-1/32" x 15/16" x 11/32". Check coupon for Technical Bulletin 42-130.



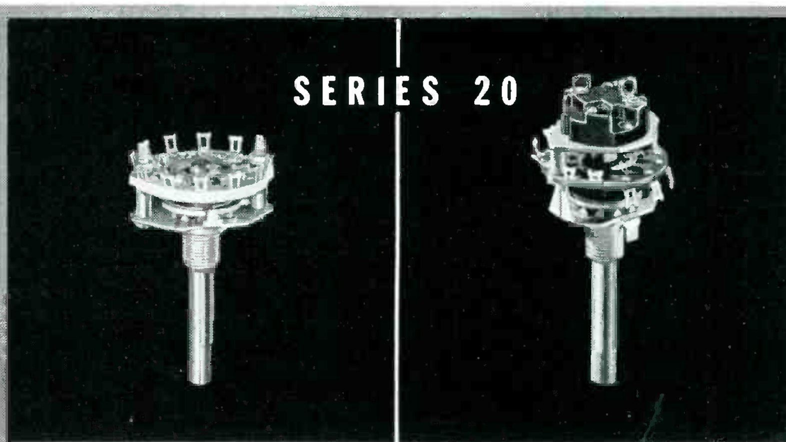
82% less soldered connections with Vertical Integrator . . . in assembly of TV vertical integrator networks . . . reduces 16 soldered connections to 3! Technical Bulletin 42-126.

SIZE-SPACE-WEIGHT- AND COST

MILITARY ELECTRONIC GEAR

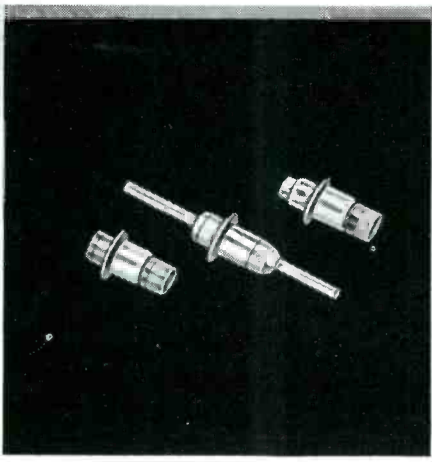
MINIATURE SWITCHES

Centralab's new miniature Series 20 and Series 30 switches have been specifically designed to meet the modern trend toward greatly reduced size for high-frequency, low-current applications. Extremely compact design and small size, plus availability of separate sections and index assemblies, provide an adaptability that is invaluable to design engineers and manufacturers. For complete information on the new Centralab Miniature Series 20 and Series 30 Switch line . . . multi-pole, multi-position, multi-section models or combinations with attached line switches and variable resistors, mail the coupon [illegible]ay. *Manufacturer's samples promptly.* Bulletins 4[illegible]63 and 42-164.



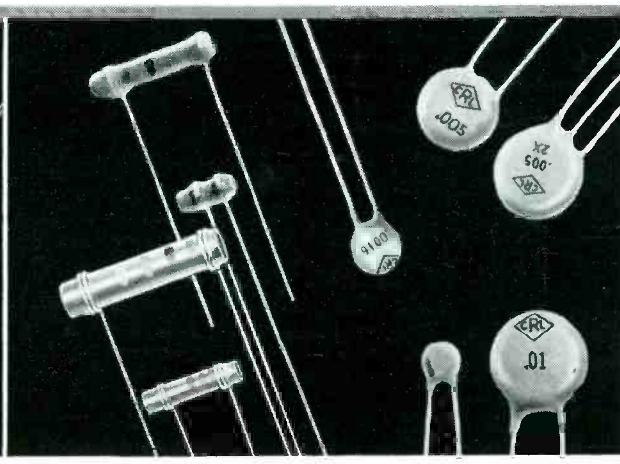
New Centralab Series 20 miniature switch, single steatite section. Available in 2 to 11 positions with stops, or 12 position continuous rotation—and with multiple sections.

Here's standard Series 20 miniature switch with standard shaft and phenolic section with off-on switch added. Also available with multiple sections.

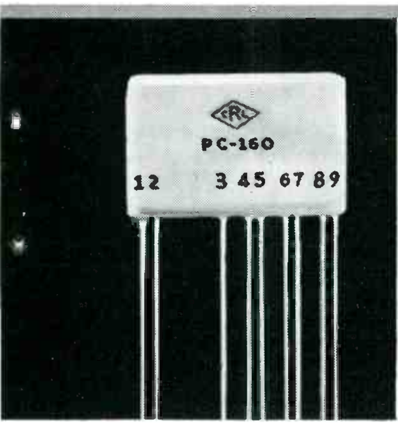


NEW Eyelet-Mounted Feed-through Ceramic Capacitors are exceptionally small. Capacities range from 25 to 3000 mmf., Voltage rating. 500 V. D. C. W. Check No. EP-15 in coupon.

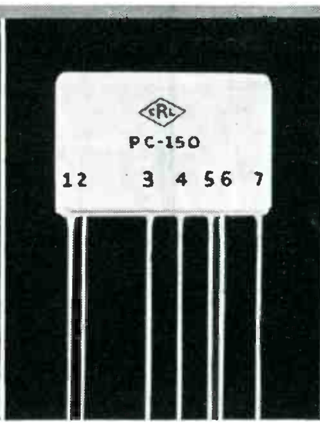
Centralab's Type 850 high voltage ceramic capacitors are especially designed for high voltage, high frequency circuits. Centralab's Type 950 high accuracy ceramic capacitors are especially developed for exacting electronic applications. Bulletins: 42-102 and 42-123.



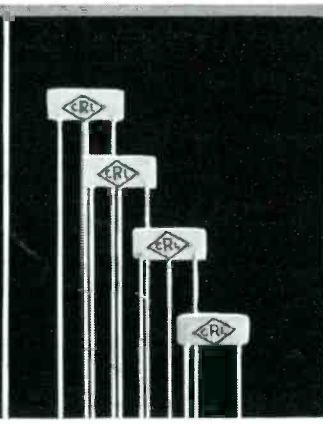
Ceramic Disc Hi-Kap Capacitors have very high capacity in extremely small size. Bulletin No. 42-4R. TC Tubulars (Temperature Compensating) — TCZ units show no capacity change over wide range of temperature; TCN's vary capacitance according to temperature. Bulletin No. 42-18. BC (By-pass Coupling) Tubulars . . . well suited to general circuit use. Bulletin No. 42-3.



50% less soldered connections with Centralab's new Pendet... 5 capacitors and 4 resistors in a single plate...couples diode-triode and pentode tubes in output stage of AC-DC sets. Technical Bulletin 42-149.



50% less soldered connections with Centralab's Audet . . . furnishes all values of all components generally found in the output stage of AC-DC radio receivers. Technical Bulletin 42-129.



Tiny plate capacitor, resistor, and resistor-capacitor units. Readily fit all types of miniature and portable electronic equipment. Technical Bulletin 42-24.

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Please send me the Technical Bulletins as checked below:

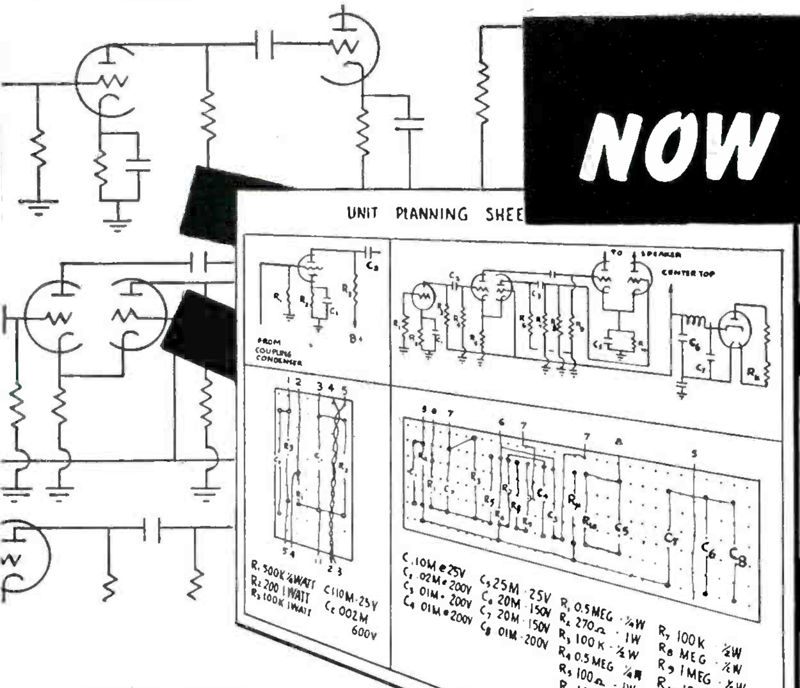
☐ 42-3	☐ 42-102	☐ 42-130	☐ 42-164
☐ 42-4R	☐ 42-123	☐ 42-149	☐ EP-15
☐ 42-18	☐ 42-126	☐ 42-158	
☐ 42-24	☐ 42-129	☐ 42-163	

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

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

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

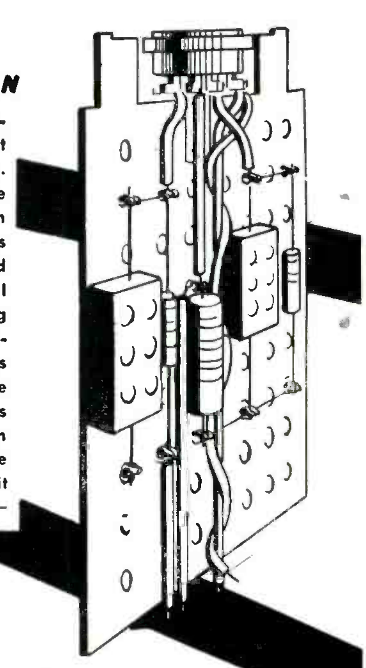
Title............



NOW YOU CAN MOVE

① ORGANIZE CIRCUITS QUICKLY FOR SYSTEMATIC LAYOUT AND CONSTRUCTION

Schematics of most all electronic equipment can be broken down into circuit Blocks of logically associated functions. These functional circuit blocks can be mounted readily either in the Alden "20" plug-in packages or Basic Chassis unit. The tube sockets and associated components quickly lay out on full scale Unit Planning Sheets for mounting on terminal cards. These special pre-punched, multi-hole terminal cards have wide flexibility to take an infinite variety of circuit variations. Both sides of card can be used to obtain maximum component density area. Using the Unit Planning Sheets, functional circuit units — components and housings — are all planned in one step.



FROM IDEA TO EQUIPMENT FAST!

If you are designing urgently needed electronic equipment that must be produced quickly, and in quantity — start with the Alden Basic Chassis — follow through with Alden Plug-in Units and other components.

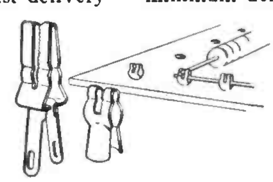
Make your original model with the Alden Basic Chassis rather than breadboard — automatically force isolation of circuits — ready accessibility, easy replacement — and natural functional sub-assemblies. Save vital engineering and planning time — machine and tool hours — critical material and manhours.

IT'S AS SIMPLE AS THIS!

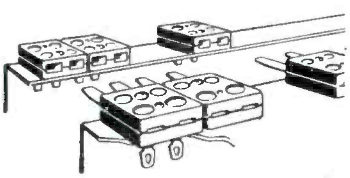

Basic Chassis Construction

The **Basic Chassis** frame is of strong "U" shape construction — designed for utmost accessibility in assembly and servicing — and for rapid manufacture and delivery to you from small to large volume.

Manufacturing technique allows most of chassis work to proceed as flat piece — Without stacking — it flows from one operator to next, similar to progressive die. Bending is last. Finish and plating is done by automatic conveyorized equipment. Means fast delivery — minimum delay.


Miniature Terminals — 650 Series

Terminal cards have been designed to accommodate tremendous number of circuit variations — to make neat tube and component sub-assemblies with a minimum of wiring and simplified assembly techniques. Special **Alden Miniature Terminals** are new and radical punch press configuration — ratchet slot holds various size component leads for soldering — no twisting of leads with pliers. Figure "eight" shape accommodates cross wiring and buss leads. Punch press parts — so take a minimum of solder, reduce solder time, eliminate danger of cold solder joints.


Back Connectors — 402 Min Series

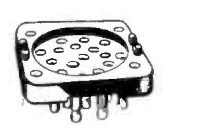
Alden Terminal Card System means minimum of inter-cabling — but even this cabling can be laid out easily and proceed as simple sub-assembly. Open sided chassis construction makes cable easy to wire to front panel, terminal cards and back connectors. The **Alden Back Connectors** are units that can be discretely positioned on the back of the chassis — isolating lines with incompatible voltages, currents, or frequencies. This design insures accessible solder terminals for soldering — avoids rat nests of congested conventional back connector wiring — Color coded, the Alden back connectors provide beautiful operational or service check points for all leads to and from chassis.


Target Screws

Hinged front panel design of chassis — allows rheostats, indicator lights, jacks, etc. to be mounted on panel as another easy-to-work sub-assembly. This panel attaches easily to chassis — is wired — swung up and fastened with **Alden Target Screws.** These screws have concave head with arced notch so power screw driver locates head quickly, no danger of it slipping out and marring panel surface — yet same screw can be unfastened with coin in order to hinge forward the front panel for servicing and check in the field.

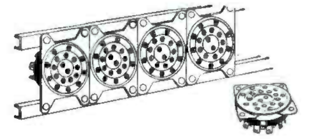
Assembled — Basic Chassis simplifies the operation of your equipment — Slashes service and maintenance time. Smooth, positive insertion and removal of the chassis is provided by the Alden **"Serve-A-Unit Lock."** A simple twist of the handle and the chassis backs off with finger tip ease. It also pilots the chassis back into place — securely locking it for operation with the same facility.

FOR YOUR SMALLER UNITS!


'20" Non-Interchangeable Base

Get the same ease of layout — speed of assembly — ready check or replacement — with the Alden "20" Plug-in Packages. The Alden Terminal Cards with completely interwired tube sockets and components are mounted on special **Alden "20" Non-Interchangeable Bases.** These bases have stubby, strong pins — no molded locating boss to break. Units can be made non-interchangeable to prevent mismating by selected variable pin layouts of less than 20 pins. Using the same Alden "20" base — coupled with simple brackets and housing — relays, stepping switches, and condensers can be made neat, accessible, replaceable units.

Only recently developed, Alden "20" Packages have already saved thousands of vital engineering and construction hours in large computer projects. They are natural for extensive, complicated electronic equipment.

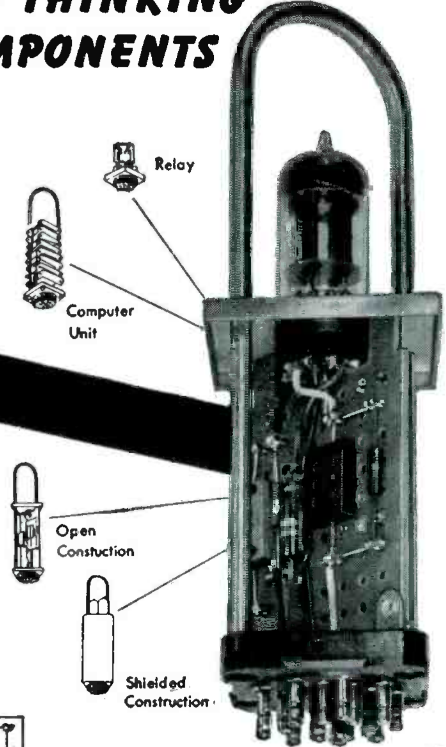

"20" Rack and Chassis Mounting Sockets

Whole Alden "20" Packaged circuit panels can be constructed by simply mounting "U" channels across racks! The **Alden "20" Rack Mounting Socket,** having 4 extended ears, quickly rivets side by side between the channels. Wiring to sockets feeds up from cables laid along "U" frame — leaving contacts accessible for soldering and checking. Where Alden "20" Packages are mounted on chassis, the space saving **Alden "20" Chassis Mounting Socket** has 4 mounting ears which rivet within the square area covered by the Alden "20" Base.

ALDEN PRODUCTS COMPANY

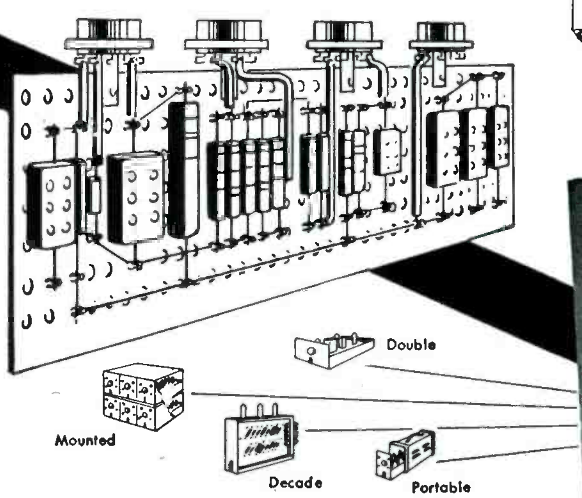
FROM IDEA TO EQUIPMENT FAST

FORCE STRAIGHT LINE THINKING WITH NEW ALDEN COMPONENTS FOR PLUG-IN UNIT CONSTRUCTION



② GET THE MOST NATURAL, EASY SUB-DIVISION OF LABOR IN MANUFACTURE

Solder terminals and sockets quickly rivet to Alden terminal card according to layout on Unit Planning Sheet. Components snap into the special Alden Miniature Terminals which hold them for soldering. — (No twisting or wrapping of leads necessary) — With all tube sockets and their associated components mounted on one card — the wiring and soldering of circuits is an open, easy-to-work sub-assembly operation.

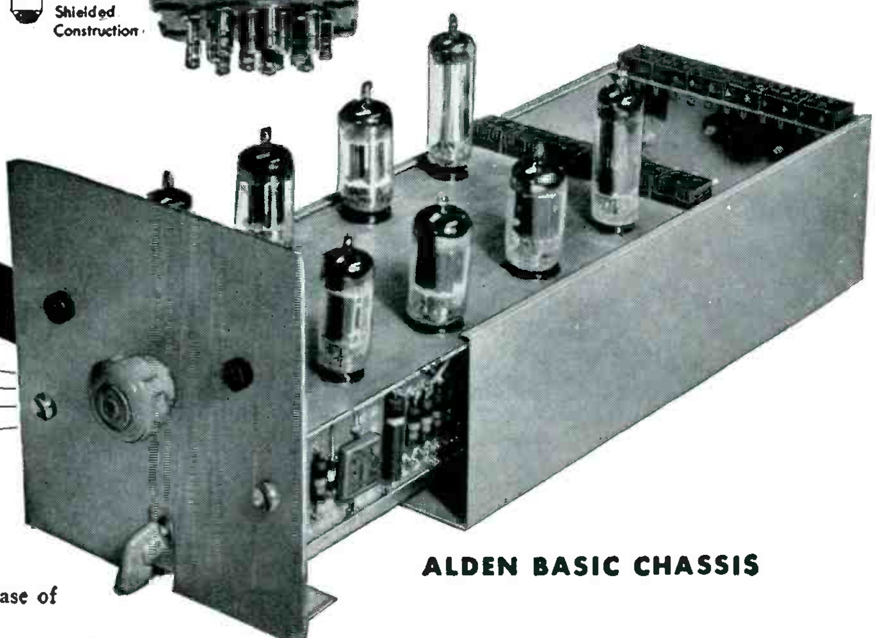


③ INSURE THE LOWEST OPERATING AND SERVICE COSTS IN FINAL EQUIPMENT

The ALDEN "20" PLUG-IN PACKAGE is completed simply by mounting the terminal card on the Alden "20" Non-Interchangeable base, dip soldering the leads and adding cover or housing and handle. . . . In operation, visual or instrument checks are easily made — if trouble occurs doubtful units are quickly isolated — these units easily unplug and a comprehensive inspection made. Spare units can be plugged in so equipment doesn't have to be inoperable while repairs are in process.

The ALDEN BASIC CHASSIS UNIT is rapidly completed by mounting terminal cards into the chassis — soldering unit cables and making connections to Alden Color Coded Back Connectors and detachable front panel. Completed unit is easily piloted in and out of rack with the Serve-A-Unit Lock. Open sided construction, aided by the neat direct front and back connections, gives instant accessibility for rapid circuit checks and service.

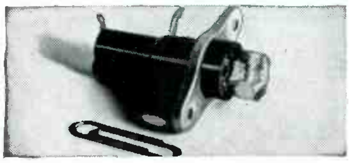
ALDEN "20" PLUG-IN PACKAGE



ALDEN BASIC CHASSIS

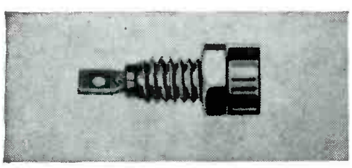
GET LOGICAL FOLLOW THROUGH WITH THESE COMPONENTS !

Use entire Alden Component line for maximum ease of service and replacement —



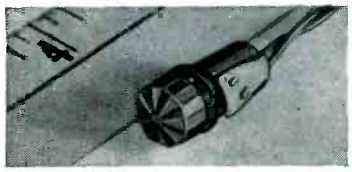
Indicating Fuseholder - 440-3FH

Immediately spot blown fuse — quickly replace it. Neon bulb glows when fuse blows — is molded as integral part of crystal clear lens. **Compact Indicator Fuseholder** rivets or eyelets easily to mounting panel — accessible solder tabs for fast soldering.



Miniature Test Point Jack — 110BCS

Here for the first time is a **Miniature Test Point Jack** that will fit in a .257" hole and has a breakdown voltage of 6,500 V. RMS to ground. Nothing else like it for bringing out test leads — has heat treated beryllium copper contact so will stand up under continuous use. Has run life tests of over 5,000 insertions.



Pan-i-Lite — 86L

Here's the indicator light you've probably been waiting for. The **Alden Pan-i-Lite** — really small — easy-to-service. Bulb is made integral part of lens. Replaces from the front of panel — no digging into equipment necessary. Takes the absolute minimum of space. Less than 1" overall, it can mount almost anywhere — simply punch ¼" hole. Tiny but powerful 6 V. bulb gives brilliant indication through the high-temperature — translucent lens. Use minimum of critical material.

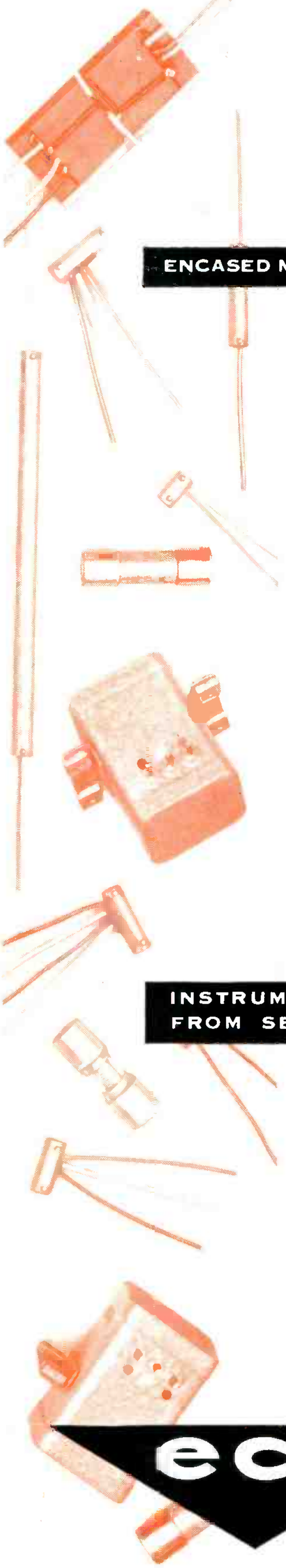
TO GET STARTED QUICKLY !

'phone our New Products Director for an appointment to visit our plant—Wire for a sample Basic Chassis at $40.00 or an Open and Closed Alden "20" Plug-in Package at $10.00 or write Dept. E for booklet: "Basic Chassis and Components for Plug-in Unit Construction".

117 North Main Street · Brockton · Massachusetts NA-ALD edi

EXPANDS FACILITIES UNIQUE LINES OF

New and improved designs already used in military and civilian applications



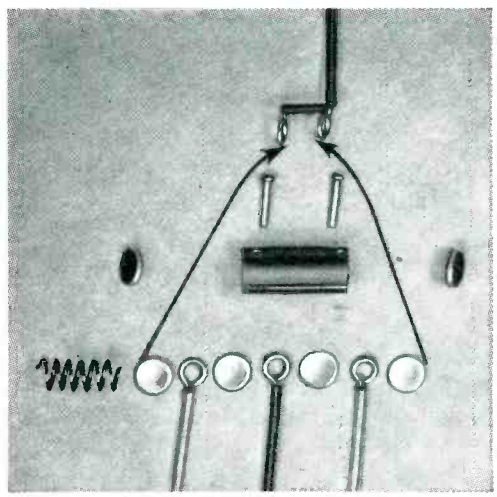
ENCASED MINISEL LINE USED IN GOVERNMENT SUBMINIATURIZATION PROGRAMS

Their long life, rugged construction, high operating temperature, matched plate characteristics, and extremely small size (for subminiaturization programs) make MINISEL rectifiers especially useful for military applications. The basic component of a single unit is a newly perfected, exceptional high quality ¼" round selenium rectifier cell, which is produced by a unique process. This cell has extremely long life, unusually stable characteristics and can be used at plate temperatures as high as 90°C.

The high quality of this line makes it possible to guarantee the life of all units for 2000 hours or 2 years, whichever comes first when used at rated current and voltage in ambients up to 40°C. At rated current and voltage in ambients up to 50°C., all units are guaranteed for 1000 hours or 1 year, whichever comes first.

Although made in four standard types of construction, MINISEL units can be produced in an infinite number of electrical configurations and mechanical designs. The MINISEL line is now being used in such applications as synchro overload transformers, relay spark suppressors and special control instruments.

NOTE 1. Typical MINISEL units.



NOTE 2. Exploded view of MINISEL type MS.

INSTRUMENT RECTIFIERS NOW MADE FROM SELENIUM CELLS

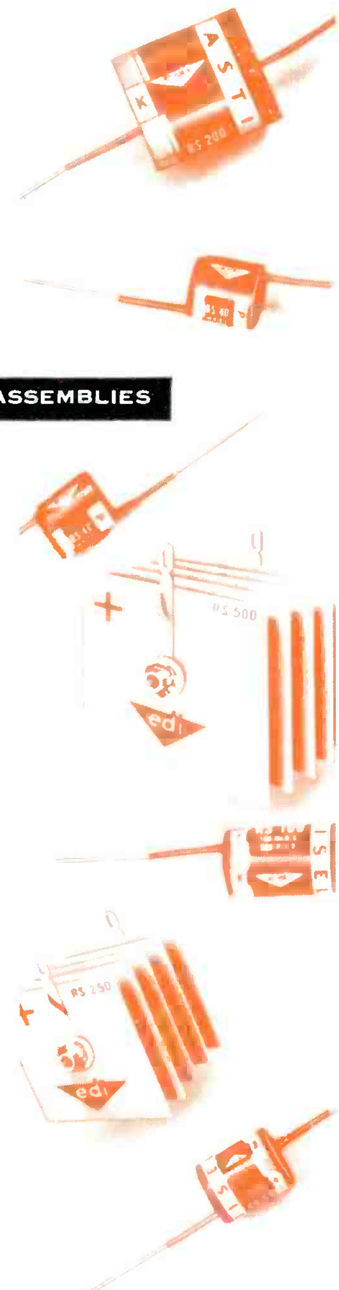
MINISEL rectifiers are also being manufactured in a complete line of instrument rectifiers. It is the first time that selenium rectifiers have been successfully adapted to this purpose. This has been made possible by the perfecting of a selenium rectifier cell which has even more stability and uniformity than that which is normally associated with copper oxide cells. These matched MINISEL rectifier cells are made from large pre-aged selenium rectifier sheets which are manufactured by a special process to insure uniformity and long life. All units in this line can be had with or without mounting screws.

edi

ELECTRONIC DEVICES, INC.

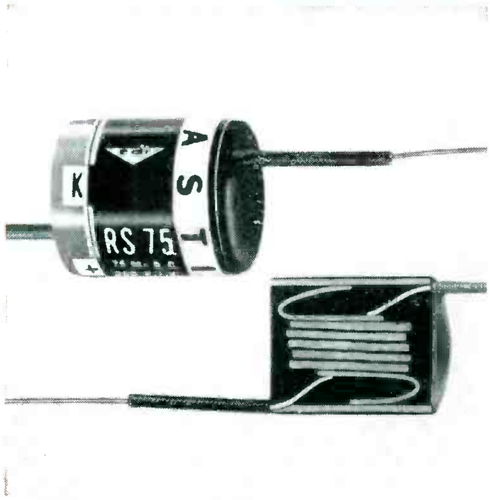
429—12TH STREET, BROOKLYN 15, N. Y.

TO MEET DEMAND FOR SELENIUM RECTIFIERS



In order to facilitate better deliveries of selenium rectifiers manufactured by its Precision Rectifier Division, EDI has inaugurated a large scale expansion program. A fully staffed plant, complete with the latest rectifier manufacturing and test equipment, has been set up. The new plant will produce all of Precision's selenium rectifiers in addition to new and improved designs, many of which have already been adapted for military applications.

NEW MOLDED-IN S.R.'S CUT PRODUCTION COSTS ON ELECTRONIC ASSEMBLIES



NOTE 3. Encased PLASTISEL unit and cutaway view

NOTE 4. Typical hermetically sealed cans used for MINISEL type MS-HM or any PLASTISEL rectifier.

The PLASTISEL line of miniature electronic selenium rectifiers was designed to eliminate the usual open stack rectifier problems encountered on electronic assembly lines. In all ratings through 200 M.A. PLASTISEL rectifiers are molded-in to plastic casings which give them the appearance of small condensers. (From 250-500 M.A. an improved type of open stack construction is used.)

These smaller, molded-in units are encased in spiral wound phenolic tubes filled with a high melting point synthetic wax of good thermal conductivity. In each tube strong spring brass clips firmly hold a stack of special high voltage, high temperature selenium rectifier plates in place. These plates have a special inorganic barrier layer that allows for operation at the higher temperatures encountered in the molded-in unit. This barrier layer has long life and can withstand higher temperatures than the organic barrier layer used in all other electronic selenium rectifiers.

PLASTISEL rectifiers can be used to replace any vacuum, gas filled, or dry disc diode rectifier. In multiple they can be used to replace multiple groups of these rectifiers in such circuits as center tap and bridge rectifiers. They can also be used for doubler, tripler and ladder circuits. All units are guaranteed for 1000 hours or 1 year, whichever comes first, when used under specified conditions.

FREE ENGINEERING SERVICE

Electronic Devices, Inc. maintains a complete rectifier engineering service which is available to you without any cost or obligation. Write or wire 429 12th St., Brooklyn 15, N. Y. or telephone SOuth 8-3530 for a prompt laboratory tested solution to your rectifier problems.

Send for complete product information hand book today!

ELECTRONIC DEVICES, INC. • 429-12th Street, Brooklyn 15, N. Y.

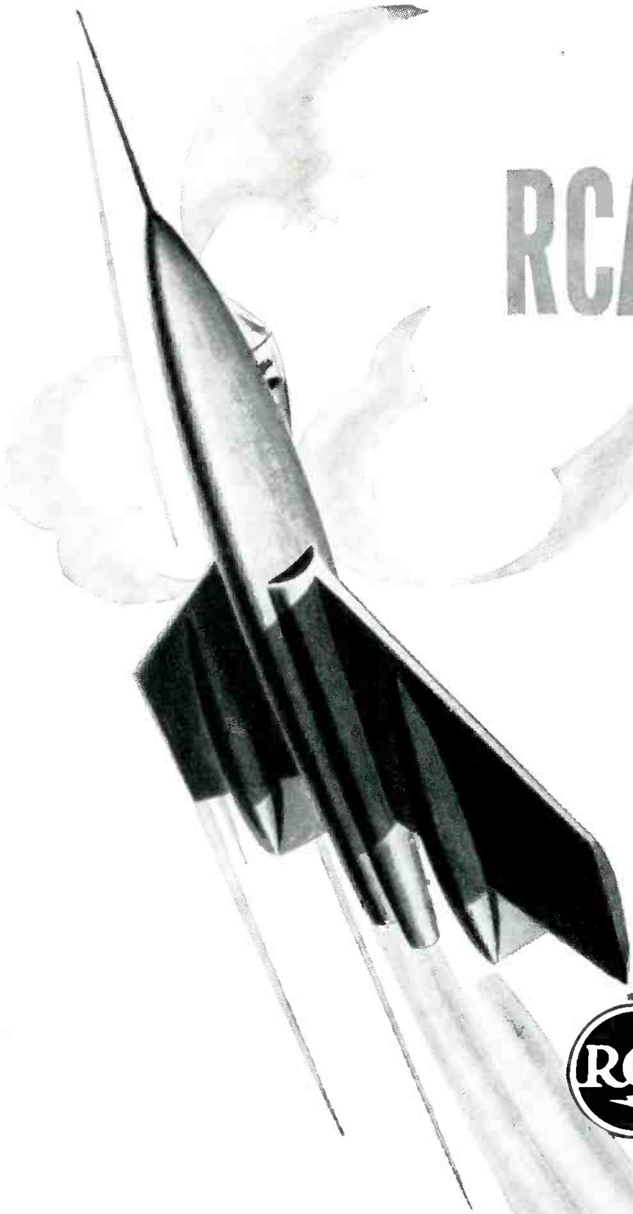
Gentlemen:

Please send me at no cost your hand book of EDI rectifier products.

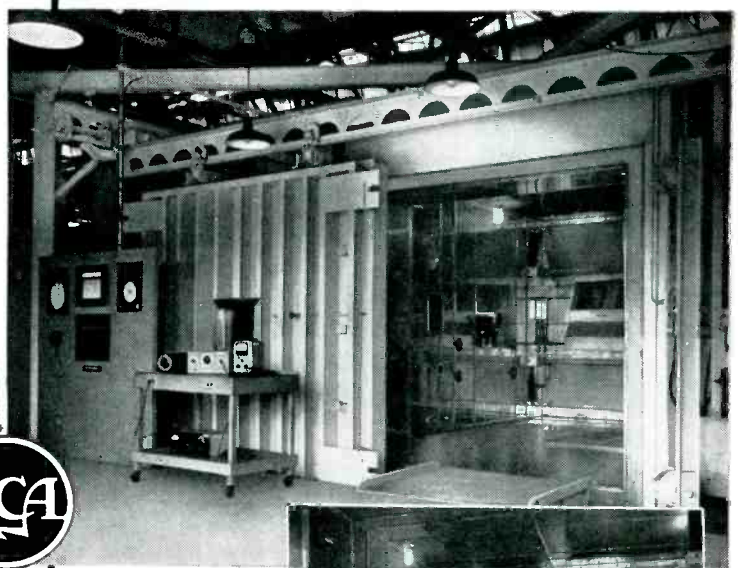
Name__________ Title__________

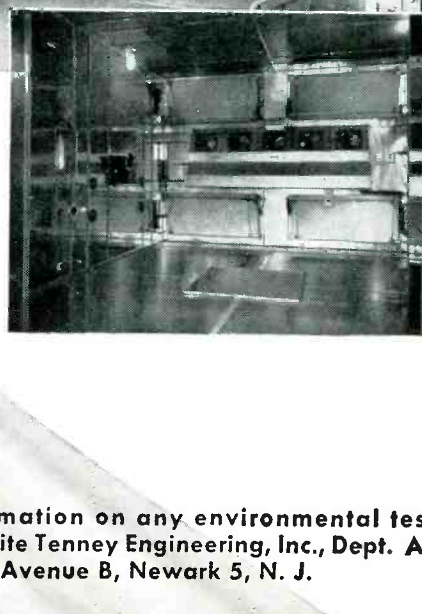
Company__________ Main Products__________

Address__________ State__________



RCA takes its ENVIRONMENTAL TEST PROBLEMS to Tenney





*RCA monogram reg. U. S. Pat. Office Radio Corp. of America

QUESTION

How is a jet fighter's transmitter affected by a screaming climb to the thin cold of 65,000 feet?

What is the useful life of a walkie-talkie in the steaming heat of the South Pacific jungle?

The answers to these and thousands of other questions will be worked out by RCA Engineers from test data obtained in an atmospheric test chamber designed and built by Tenney Engineering, Inc. This 50-ton chamber has been installed for the RCA Engineering Products Department, Camden, N. J., for environmental testing of both military and civilian electronic equipment.

Here, in one room can be simulated any and all conditions of temperature, humidity, and pressure found on earth or above it—to altitudes of 100,000 feet!

SPECIFICATIONS

Altitude:	70,000 feet rated 100,000 feet practical ceiling
Humidity:	10% to 95%
Temperature:	−85°F. to +185°F.
Dimensions:	18'w x 28'd x 14'h
Refrigeration requirements:	180 hp

For all types of testing—development, research, environment, specification, and production—a Tenney-engineered chamber will insure dependability and precisely controlled test data for your requirements.

For full information on any environmental test equipment, write Tenney Engineering, Inc., Dept. A, 26 Avenue B, Newark 5, N. J.

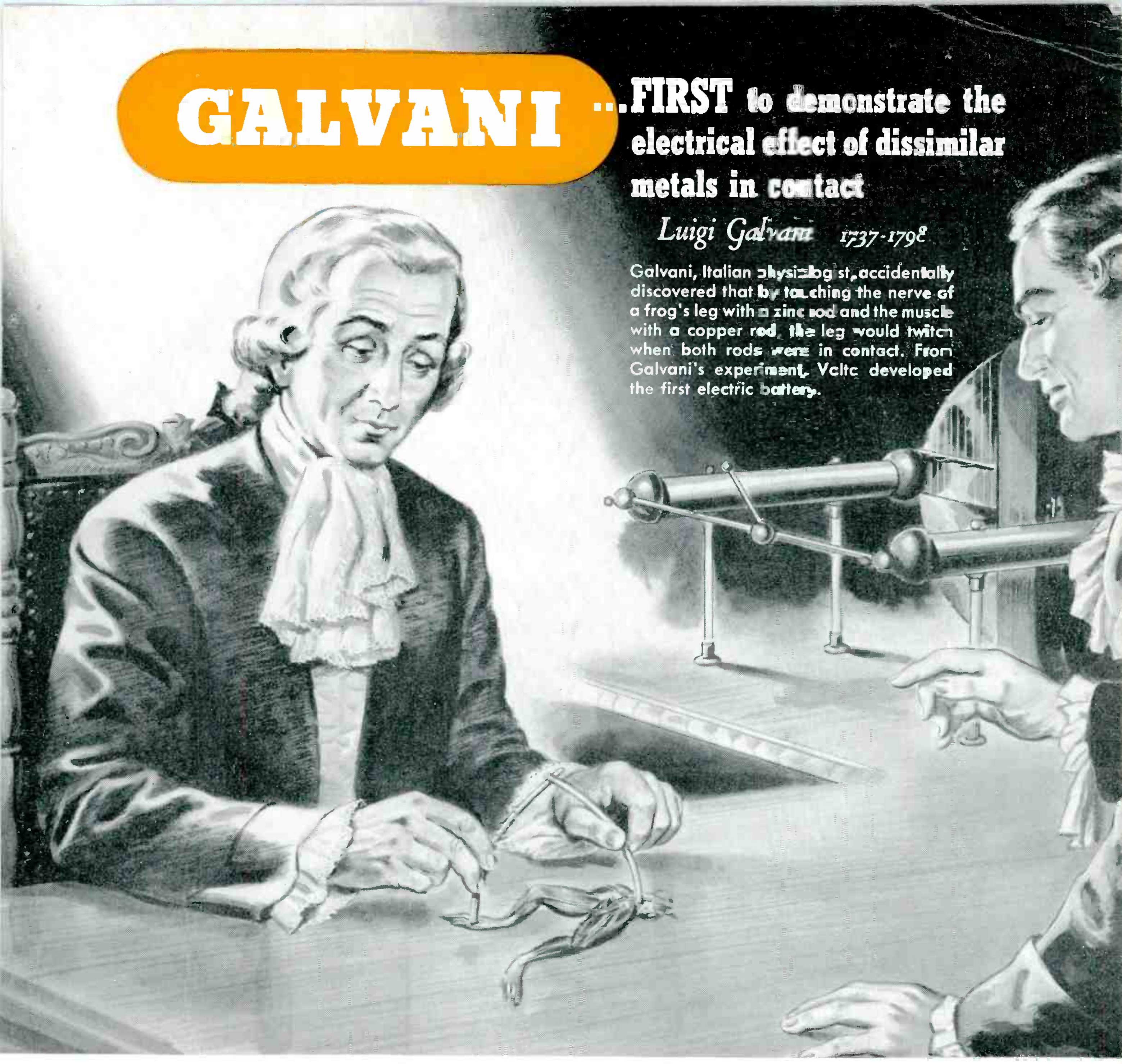
Tenney

Engineers and Manufacturers of Automatic Temperature, Humidity, and Pressure Control Equipment

GALVANI ...FIRST to demonstrate the electrical effect of dissimilar metals in contact

Luigi Galvani 1737-1798

Galvani, Italian physiologist, accidentally discovered that by touching the nerve of a frog's leg with a zinc rod and the muscle with a copper rod, the leg would twitch when both rods were in contact. From Galvani's experiment, Volta developed the first electric battery.



From an original drawing made for OHMITE.

OHMITE® ...FIRST in Tap Switches ...today

Be Right with

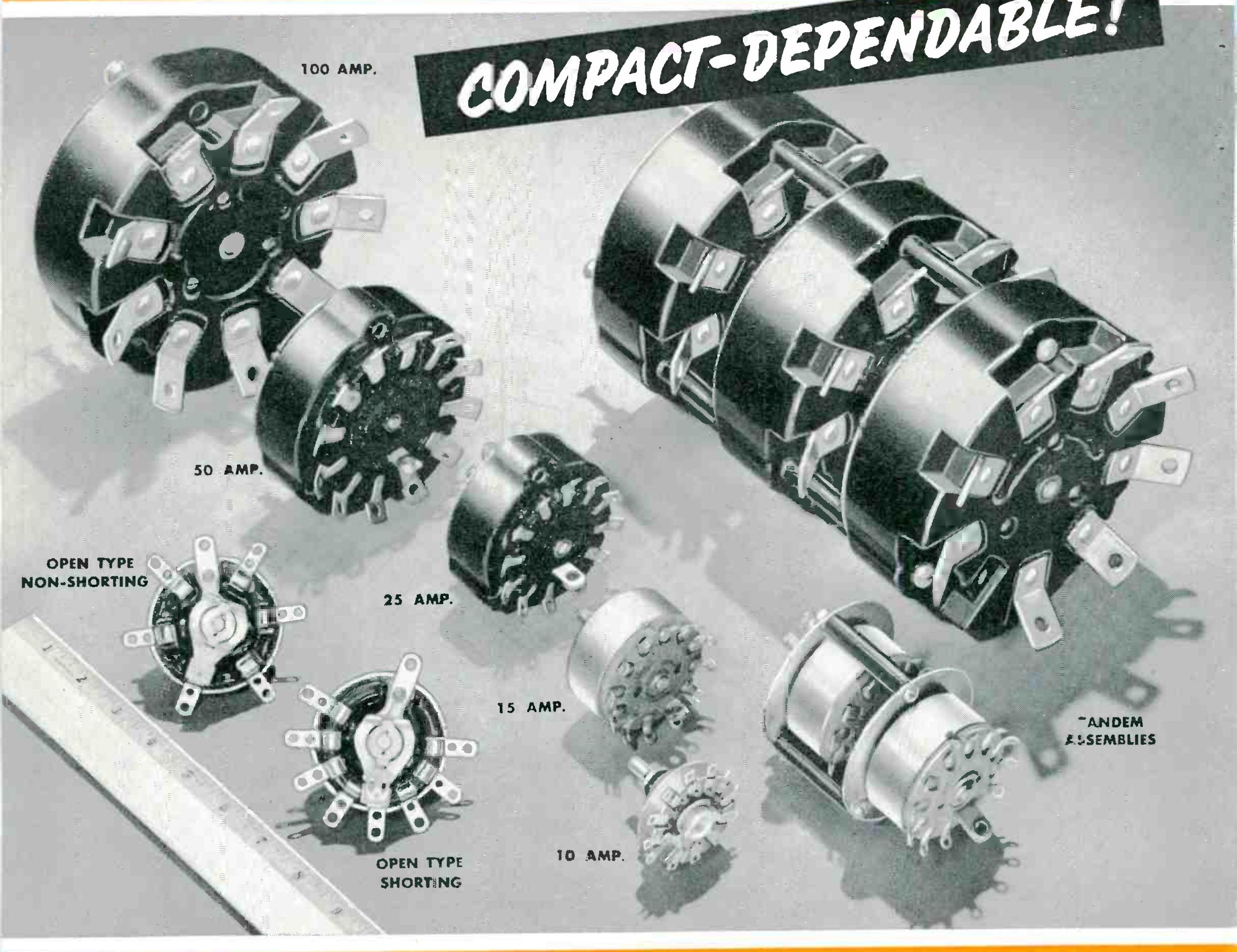
OHMITE

RHEOSTATS
RESISTORS
TAP SWITCHES

In high-current, ceramic power-type tap switches, OHMITE leads the field. More manufacturers have standardized on these rugged tap switches than any other make on the market. The primary reason for this industry-wide preference for Ohmite tap switches is their compactness, permanent ceramic construction, and proven ability to give years of unfailing, trouble-free service. Available in ratings from 10 to 100 amperes a.c.

OHMITE *Rotary* TAP SWITCHES

THE MOST COMPLETE LINE OF ITS TYPE ON THE MARKET



If you need a compact, high-current, all-ceramic, power-type, rotary tap switch, investigate the Ohmite line. Ohmite tap switches are particularly designed for a-c use. They are available in the single-pole, non-shorting type with up to 12 taps. The self-cleaning, silver-to-silver contacts require no maintenance. The rugged, one-piece ceramic body is unaffected by arcing. Ratings range from 10 to 100 amperes a.c. Two or three of these switches can be grouped in tandem to form multi-pole assemblies. Ohmite tap switches are also available in open-type models for both shorting and non-shorting applications.

Write on Company Letterhead for Catalog and Engineering Manual No. 40

OHMITE MANUFACTURING CO.
4318 Flournoy Street
Chicago 44, Ill.

Be Right with OHMITE
Reg. U. S. Pat. Off.

RHEOSTATS • RESISTORS • TAP SWITCHES

Noise Suppression?

Engineers think of FILTRON for RF Noise Suppression!

FILTRON might not be able to lick the problem shown above, but we can solve all of your problems of RF Interference Suppression on electronic 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	Dynamotors
Generators	Power Plants
Inverters	Actuators
Electronic Controls	Gasoline Engines

And other RF Interference producing equipment

filtered by FILTRON

LOCKHEED XF-90

Send for our LATEST CATALOG on your company letterhead

THE FILTRON CO., INC.
FLUSHING, LONG ISLAND, N. Y.
LARGEST EXCLUSIVE MANUFACTURERS OF RF INTERFERENCE FILTERS

BUSINESS IN MOTION

To our Colleagues in American Business . . .

For several years this space has been used to tell how Revere has collaborated with its customers, to mutual benefit. Now we want to talk about the way our customers can help us, again to mutual benefit. The subject is scrap. This is so important that a goodly number of Revere men, salesmen and others, have been assigned to urge customers to ship back to our mills the scrap generated from our mill products, such as sheet and strip, rod and bar, tube, plate, and so on. Probably few people realize it, but the copper and brass industry obtains about 30% of its metal requirements from scrap. In these days when copper is in such short supply, the importance of adequate supplies of scrap is greater than ever. We need scrap, our industry needs scrap, our country needs it promptly.

Scrap comes from many different sources, and in varying amounts. A company making screw-machine products may find that the finished parts weigh only about 50% as much as the original bar or rod. The turnings are valuable, and should be sold back to the mill. Firms who stamp parts out of strip have been materially helped in many cases by the Revere Technical Advisory Service, which delights in working out specifications as to dimensions in order to minimize the weight of trimmings; nevertheless, such manufacturing operations inevitably produce scrap. Revere needs it. Only by obtaining scrap can Revere, along with the other companies in the copper and brass business, do the utmost possible in filling orders. You see, scrap helps us help you.

In seeking copper and brass scrap we cannot appeal to the general public, nor, for that matter, to the small businesses, important though they are, which have only a few hundred pounds or so to dispose of at a time. Scrap in small amounts is taken by dealers, who perform a valuable service in collecting and sorting it, and making it available in large quantities to the mills. Revere, which ships large tonnages of mill products to important manufacturers, seeks from them in return the scrap that is generated, which runs into big figures of segregated or classified scrap, ready to be melted down and processed so that more tons of finished mill products can be provided.

So Revere, in your own interest, urges you to give some extra thought to the matter of scrap. The more you can help us in this respect, the more we can help you. When a Revere salesman calls and inquires about scrap, may we ask you to give him your cooperation? In fact, we would like to say that it would be in your own interest to give special thought at this time to all kinds of scrap. No matter what materials you buy, the chances are that some portions of them, whether trimmings or rejects, do not find their way into your finished products. Let's all see that everything that can be re-used or re-processed is turned back quickly into the appropriate channels and thus returned to our national sources of supply, for the protection of us all.

REVERE COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

Executive Offices:

230 Park Avenue, New York 17, N. Y.

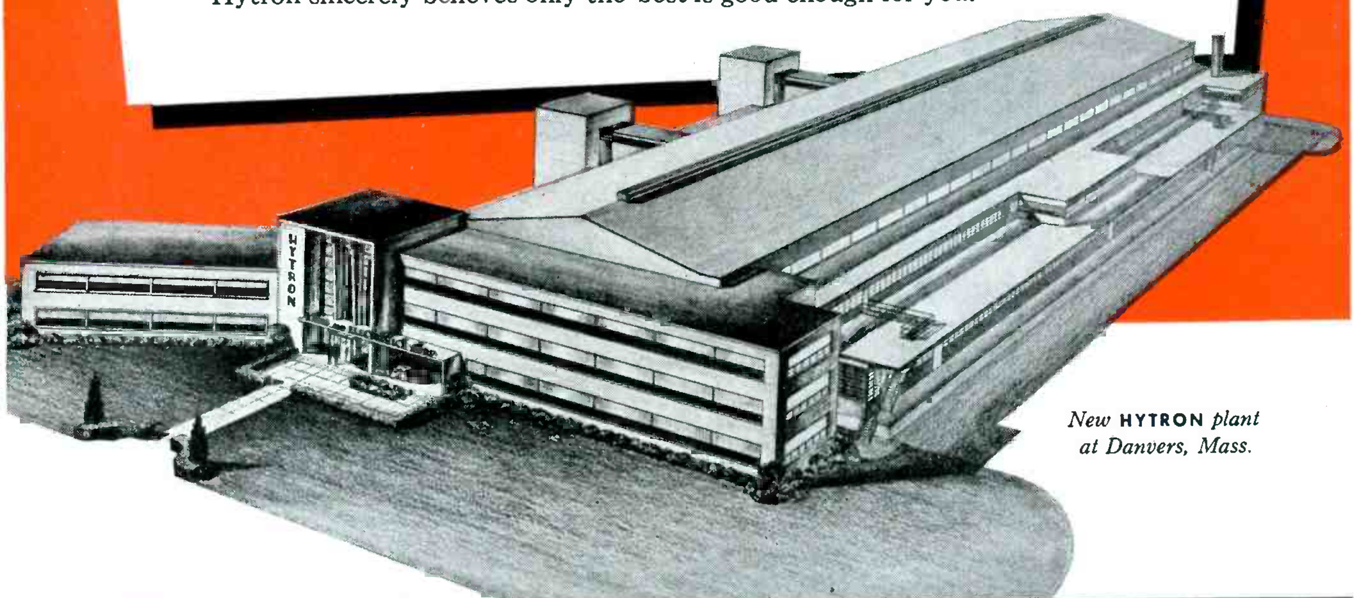
SEE "MEET THE PRESS" ON NBC TELEVISION EVERY SUNDAY

150th YEAR OF SERVICE TO AMERICA

You ARE HELPING TO BUILD THIS PLANT!

Your increasing demand for Hytron tubes is helping to build this fine, ultra-modern plant. Located at Danvers, Massachusetts, it will be the most modern receiving-tube plant that engineering know-how can build.

And this is more important to you. Its advanced equipment and skilled staff will — we promise — give you the best tubes your money can buy. Because Hytron sincerely believes only the best is good enough for you.



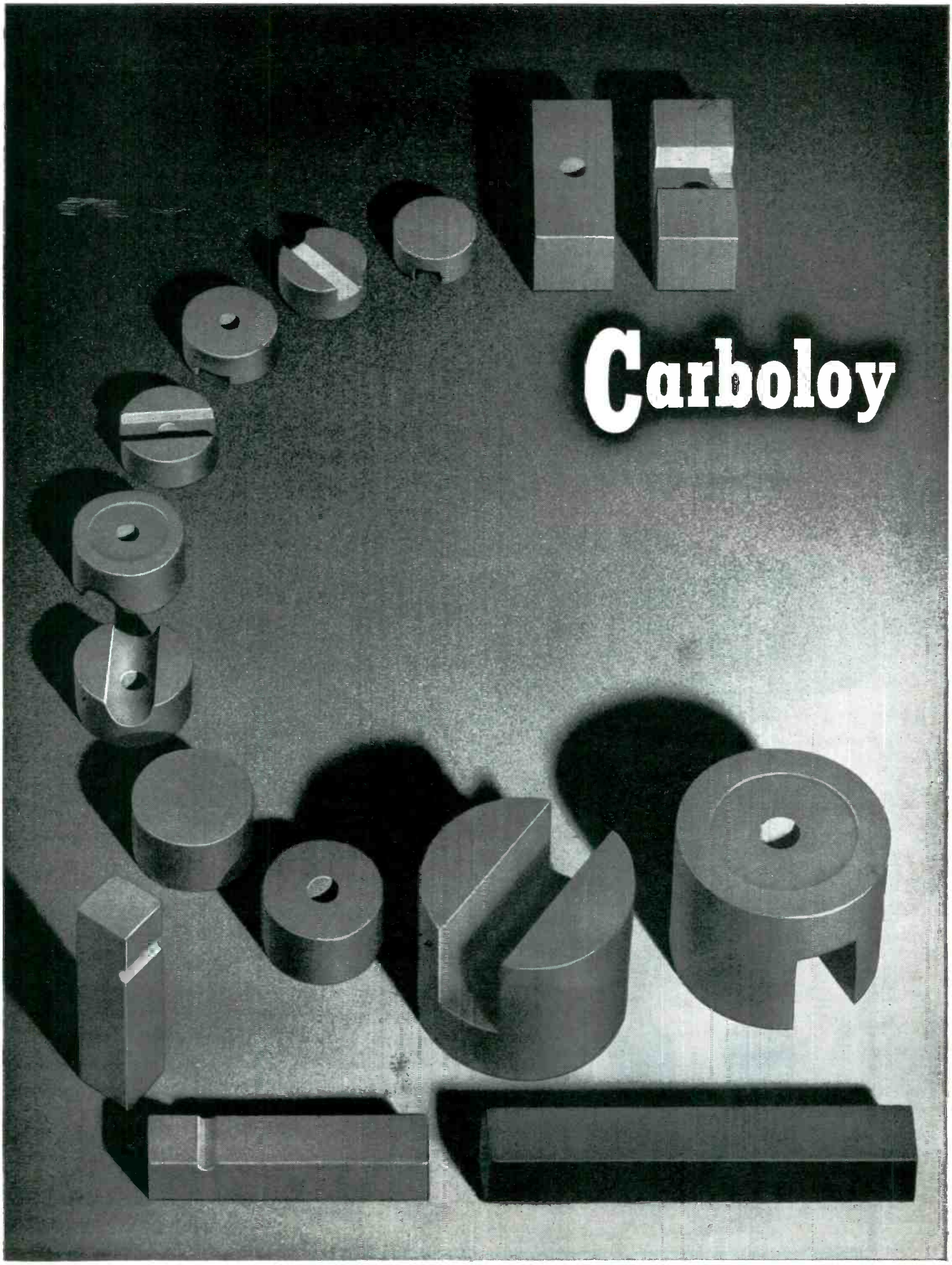
New **HYTRON** *plant at Danvers, Mass.*

NEW NAME ADDED

The famous red-white-and-blue Hytron carton has added a famous symbol: CBS. Yes, Hytron is proud to be a division of the Columbia Broadcasting System, Inc. — with greatly expanded opportunities to grow in service to you. Two respected names now guarantee you unsurpassed tube performance. CBS-Hytron is your sign of the very best in electronic tubes. Look for the attractive carton. Be sure to demand the best: CBS-Hytron.

MANUFACTURERS OF RECEIVING TUBES SINCE 1921
HYTRON
RADIO AND ELECTRONICS CO.
A DIVISION OF COLUMBIA BROADCASTING SYSTEM INC.

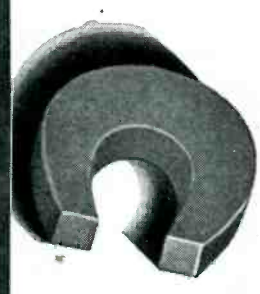
MAIN OFFICE: SALEM, MASSACHUSETTS


Carboloy

Designed Right

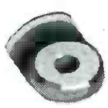
Built Right

Delivered Right on Time
and with
Energy-Potential Right



Alnico permanent magnets

Carboloy Alnico permanent magnets are job-designed to your exact needs by engineers who have years of application and research data at their fingertips from the laboratories where permanent magnets were first developed.



More, they are produced under precise and exacting quality controls that assure you external energy at a *guaranteed* minimum level consistent with today's methods of manufacture and advanced metallurgical techniques.

And, once your order is accepted, they are delivered right on time, as promised. Every one unvaryingly uniform . . . every one quality-built and guaranteed to meet or surpass the external energy minimum.

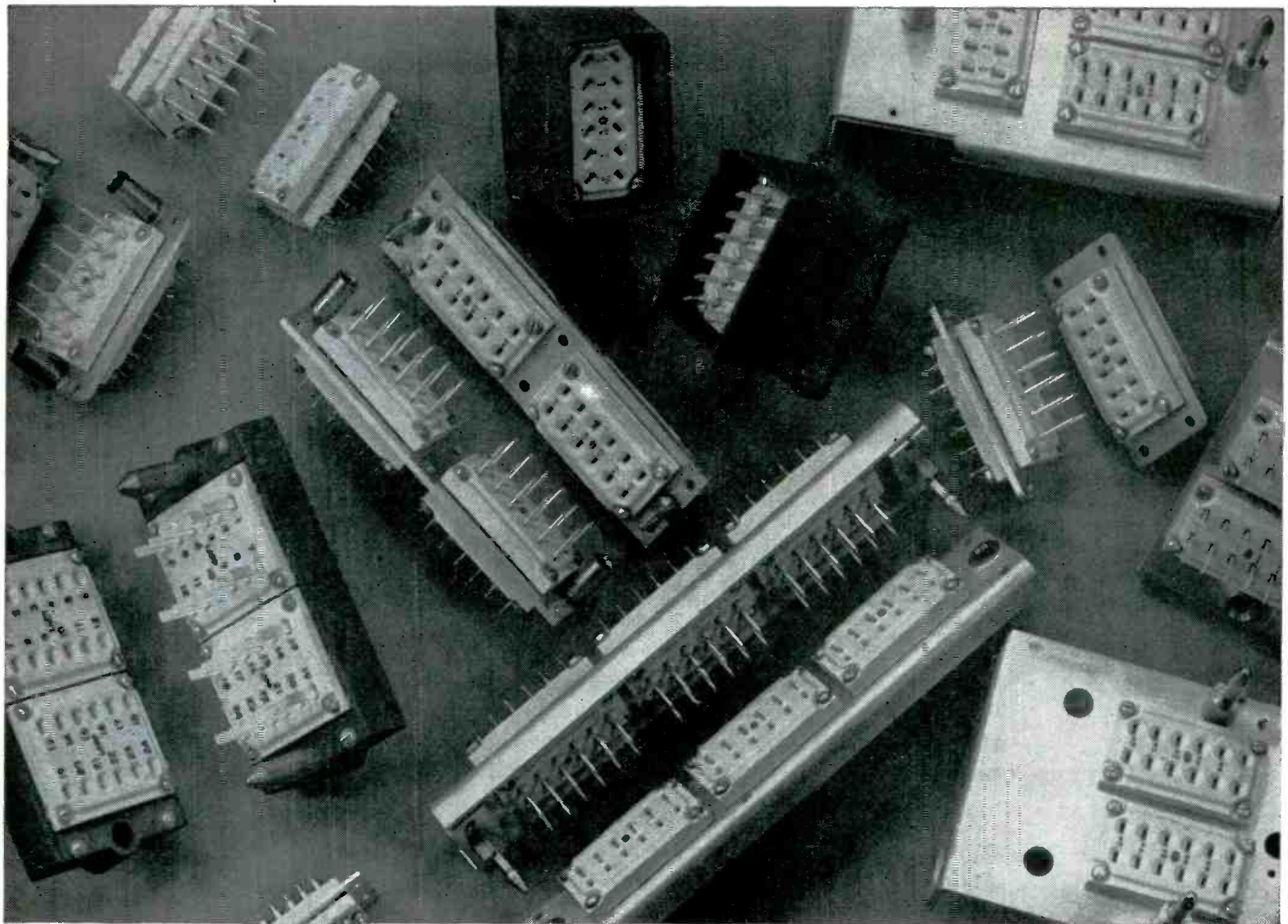
Do you need any type of permanent magnet . . . made to order, or from standard stock? For defense? To improve a generator, meter, motor or instrument? To speed up a production job with a magnetic holding or separating device? Or for a projected civilian product, perhaps?

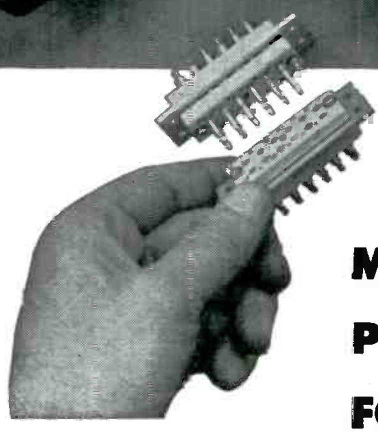
Then get in touch with our Carboloy engineers at once. They'll give you all the assists possible on your present and future magnet applications . . . all the expert help you need to make your products better, your savings greater, your profits higher. Send specifications or write for Standard Stock Bulletin PM-100. Write direct to:

Carboloy Department of General Electric Company
11139 East 8 Mile Road, Detroit 32, Michigan

"Carboloy" is the trade-mark for the products of Carboloy Department of General Electric Company.

CARBOLOY
ALNICO PERMANENT MAGNETS
FIRST IN MAN-MADE METALS FOR BETTER PRODUCTS



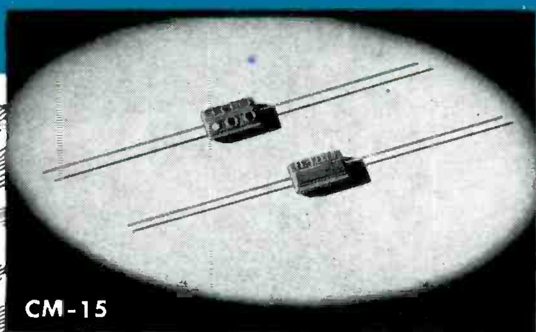


MULTIPLE-CONTACT PLUG-RECEPTACLE UNITS FOR SECTIONALIZING CIRCUITS

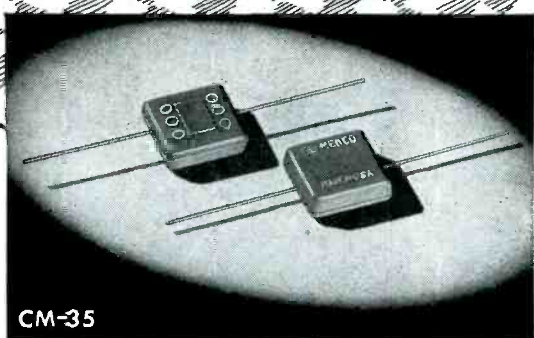
FOR panel-rack or other sectionalized circuits, Lapp offers a variety of plug-and-receptacle units, some of which are shown above. Any number of contacts can be provided (in multiples of twelve). Male and female contacts are full-floating for easy alignment and positive contact. Contacts are silver-plated, terminals tinned for soldering. Polarizing guide pins are provided where desired. Insulation is Steatite, the low-loss ceramic which is non-carbonizing even under leakage flashover resulting from contamination, moisture or humidity. Write for complete electrical and mechanical specifications of available units or engineering recommendations for an efficient component for your product. Radio Specialties Division, Lapp Insulator Co., Inc., LeRoy, N.Y.

Lapp

NO PLACE FOR AN *almost perfect* PARACHUTE



CM-15



CM-35

In military operations, complete success depends upon the unfailing performance of all parts of the war machine. Small as they are—hidden in the vitals of countless complicated devices—El-Menco Capacitors have won the highest praise for their absolute reliability.

For higher capacity values, which require extreme temperature and time stabilization, there are no substitutes for...

— EL-MENCO SILVERED MICA CAPACITORS —

El-Menco Capacitors are made in all capacities and voltages in accordance with military specifications.

From the smallest to the largest, each El Menco Capacitor is paramount in the performance field.

***Jobbers, Retailers, Distributors*—For information communicate direct with Arco Electronics, Inc., 103 Lafayette St., New York, N. Y.**

Write on your business letterhead for catalog and samples.

MOLDED MICA El-Menco MICA TRIMMER

CAPACITORS

Radio and Television Manufacturers, Domestic and Foreign, Communicate Direct With Factory—

THE ELECTRO MOTIVE MFG. CO., INC. WILLIMANTIC, CONNECTICUT

10-kw TV transmitter for VHF

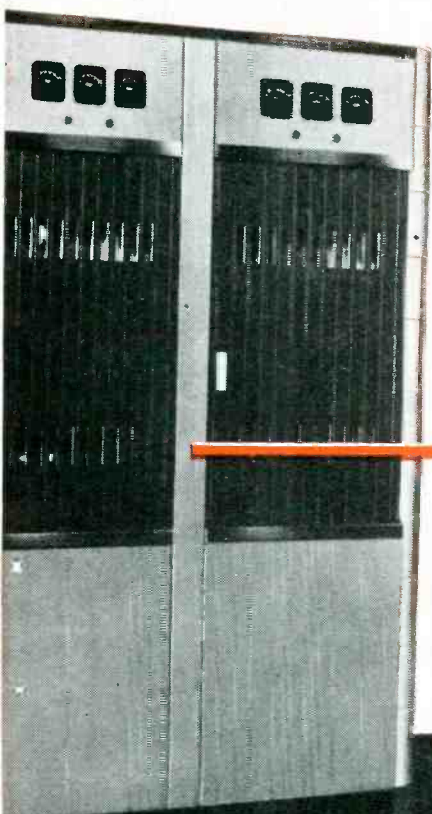
RCA high-gain antenna... at the lowest cost per kilowatt

• This remarkable new 10-kw TV transmitter, and an RCA high-gain antenna (type TF-12AM), will provide up to 100 kilowatts of effective radiated power. More than twice the power of any commercial TV transmitter operating today—and AT SUBSTANTIALLY LOWER COST PER RADIATED KILOWATT than other transmitter-antenna combinations!

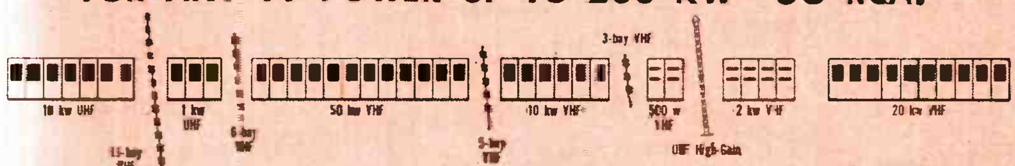
Using an improved type of air-cooled tetrode in the final power amplifier stages, this transmitter removes all former restrictions on interior cooling and floor-space requirements. No water supplies to bother about. No problem setting up the transmitter in tight quarters (it takes approximately half the floor area of previous 5-kilowatt models and weighs substantially less).

The new RCA 10-kw transmitter is available in two types. Type TT-10AL covers channels 2 to 6. Type TT-10AH covers channels 7 to 13.

For complete information on this new 10-kw... call in your RCA Broadcast Specialist. He can show you what you'll need to get "on the air"—with the power you want—at lowest possible cost. Phone him. Or write Dept. 46W, RCA Engineering Products, Camden, New Jersey.



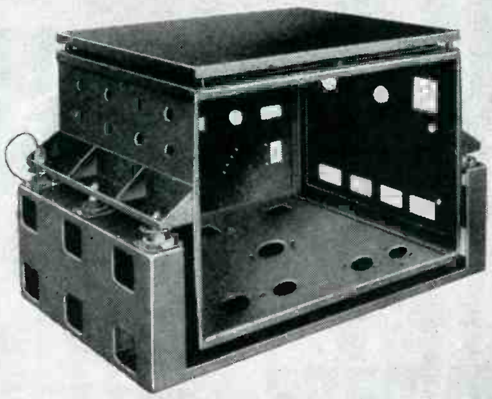
FOR ANY TV POWER UP TO 200 KW—GO RCA!

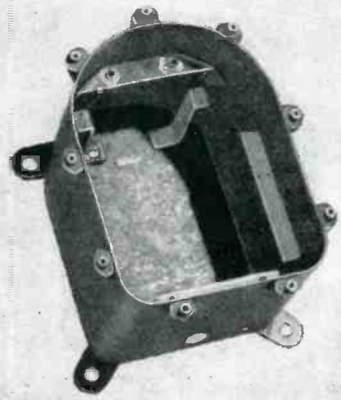


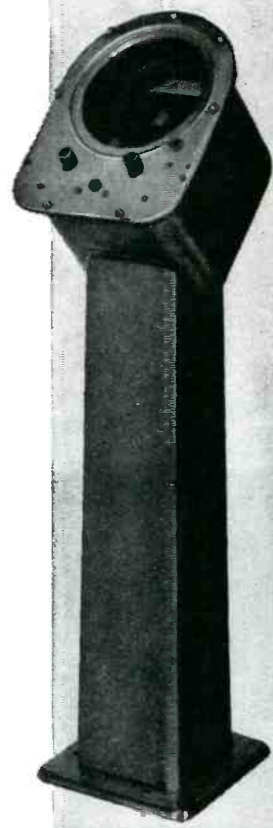
The Key to High Power and Low Cost

Improved RCA Air-Cooled tetrode—used in the aural and visual finals. Proved for long life, easy to handle.

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





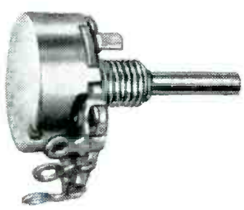
3 New Resistors

−55°C to +150°C

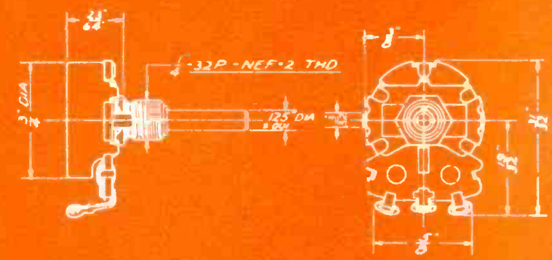
Complete aridity to saturation . . . An _unprecedented_ temperature and humidity range

FOR MILITARY APPLICATIONS

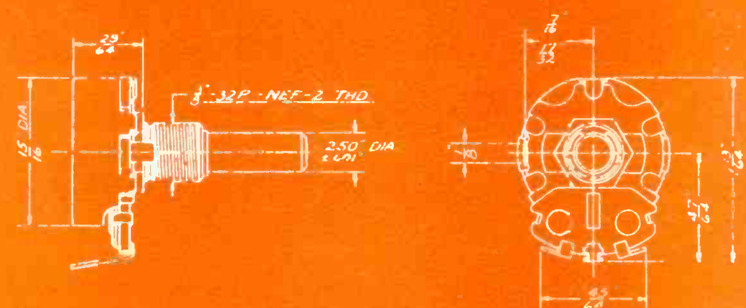
Highly recommended for use in jet and other planes, guided missiles, tanks, ships and submarines, portable or mobile equipment and all other military communications. Manufactured from specially developed materials, these absolutely unique variable resistors are now available in a _complete range of sizes_. (See chart at bottom of page.)

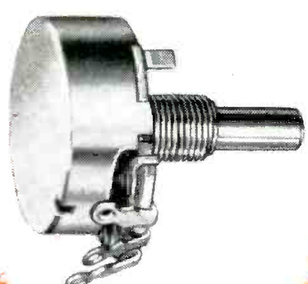


Type 65

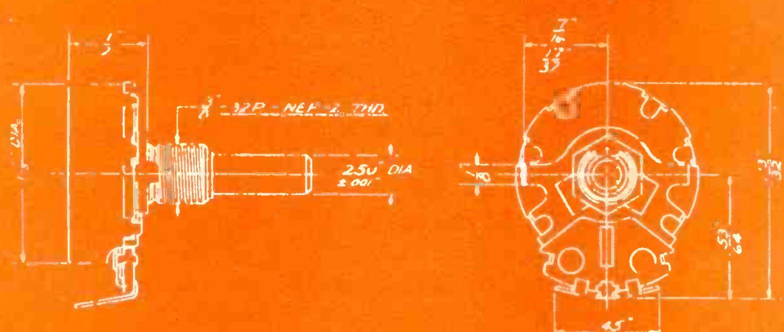


Type 90





Type 95



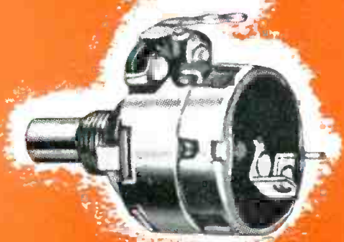
+150°C to −55°C

DIAMETER	TYPE 95 1⅛″	TYPE 90 15/16″	TYPE 65 (miniaturized) ¾″
Wattage and Voltage Rating	2 watts @ 70°C with 500 V max. across end terminals	1 watt @ 70°C with 500 V max. across end terminals	½ watt @ 70°C with 350 V max. across end terminals

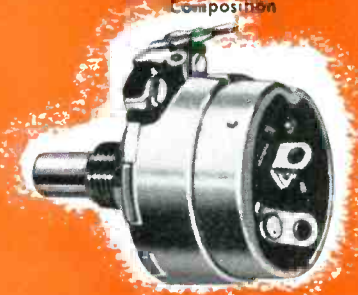
Specialists in Precision Mass Production of Variable Resistors

Meets Military Specifications

JAN-R-94, Type RV-3A
CTS Type 35, 1⅛" Diameter
Composition

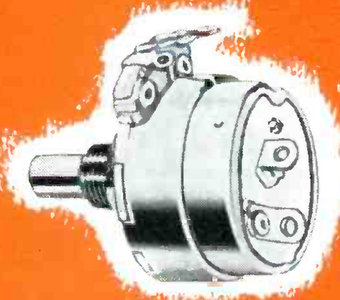


JAN-R-94, Type RV-2B
CTS Type GC 45 with Switch
Composition



JAN-R-94, Type RV-3B
CTS Type GC 35 with Switch
Composition

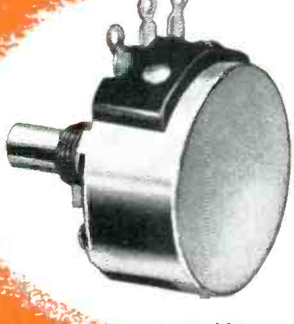
JAN-R-94, Type RV-2A
CTS Type 45, 15/16" Diameter
Composition



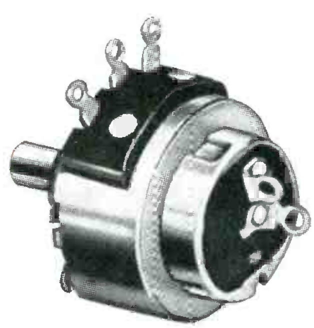
JAN Type RV-4B
CTS Type FGC 95 with Switch
Composition

JAN Type RV-4A
CTS Type 95, 1⅛" Diameter
Composition

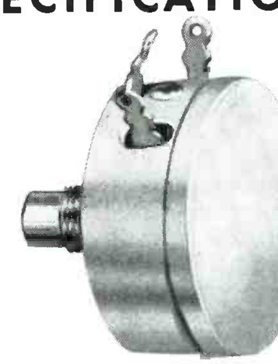
MEETS ALL JAN-R-19 SPECIFICATIONS



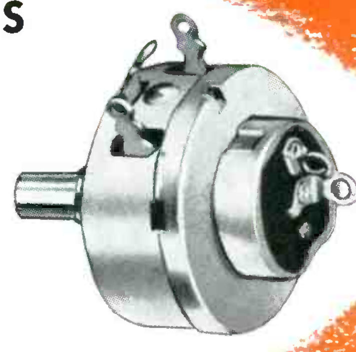
JAN Type RA 20A
2 Watt (CTS Type 252)



JAN Type RA 20B
2 Watt (CTS Type GC-252)



JAN Type RA 25A or 30A
3 or 4 Watt (CTS Type 25)



JAN Type RA 25B or [illegible]
3 or 4 Watt (CTS Type GC 25)

EXCEPTIONALLY GOOD DELIVERY CYCLE on military orders due to enormous mass production facilities . . . Please give complete details on your requirements when writing or phoning for further information.

FOUNDED 1896

CTS

CHICAGO TELEPHONE SUPPLY *Corporation*

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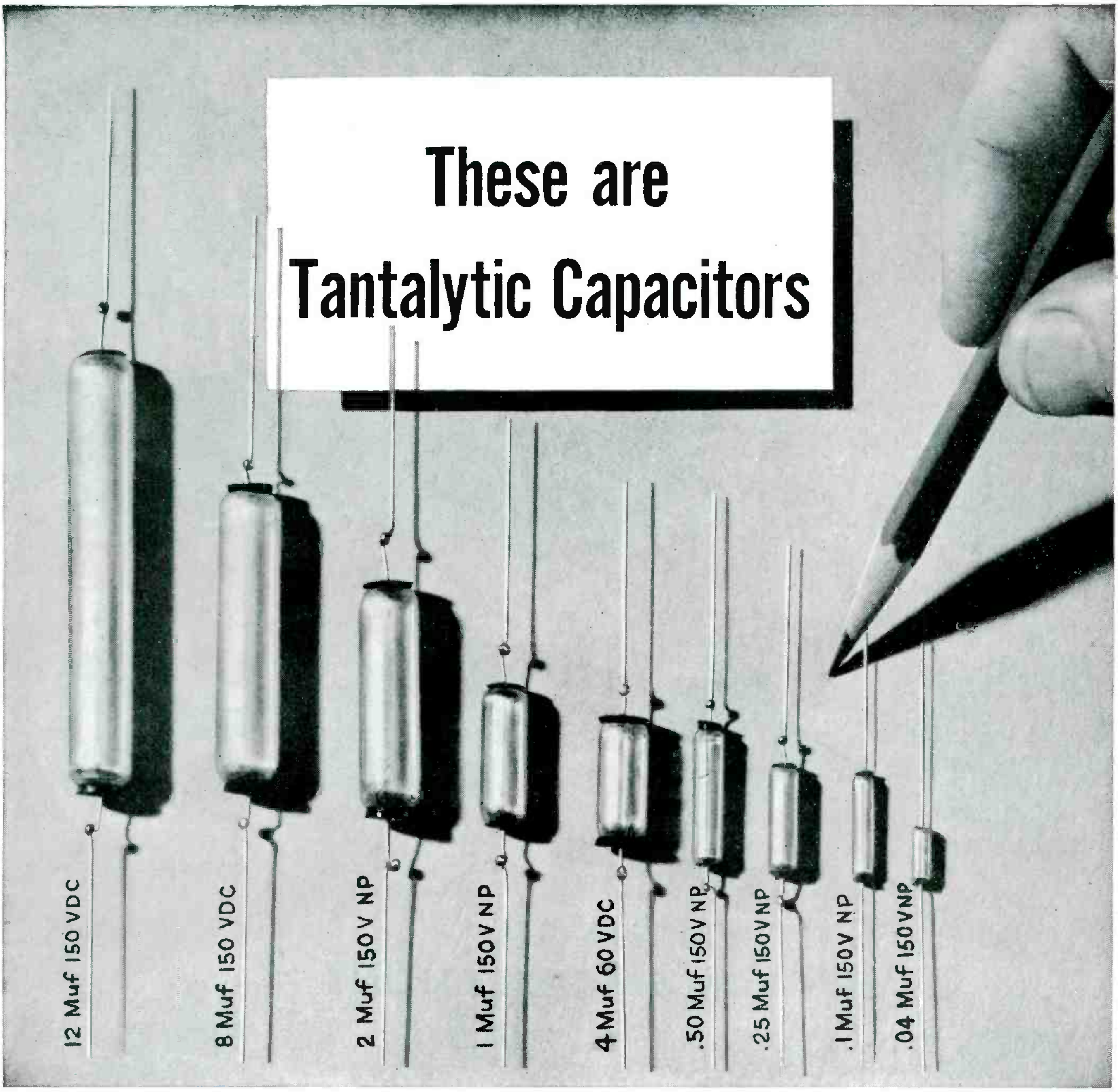


Here is one of the fastest moving developments in recent years—General Electric's new electrolytic-type capacitors. These Tantalytic capacitors with their small size and large capacitance per unit of volume have excellent low temperature characteristics, long operating life and in many cases can replace bulky hermetically-sealed paper capacitors. Ratings presently available for consideration range from .02 muf up to 12 muf at 150 volts dc. Units pictured are representative of these ratings.

Other features of G-E Tantalytic Capacitors include:

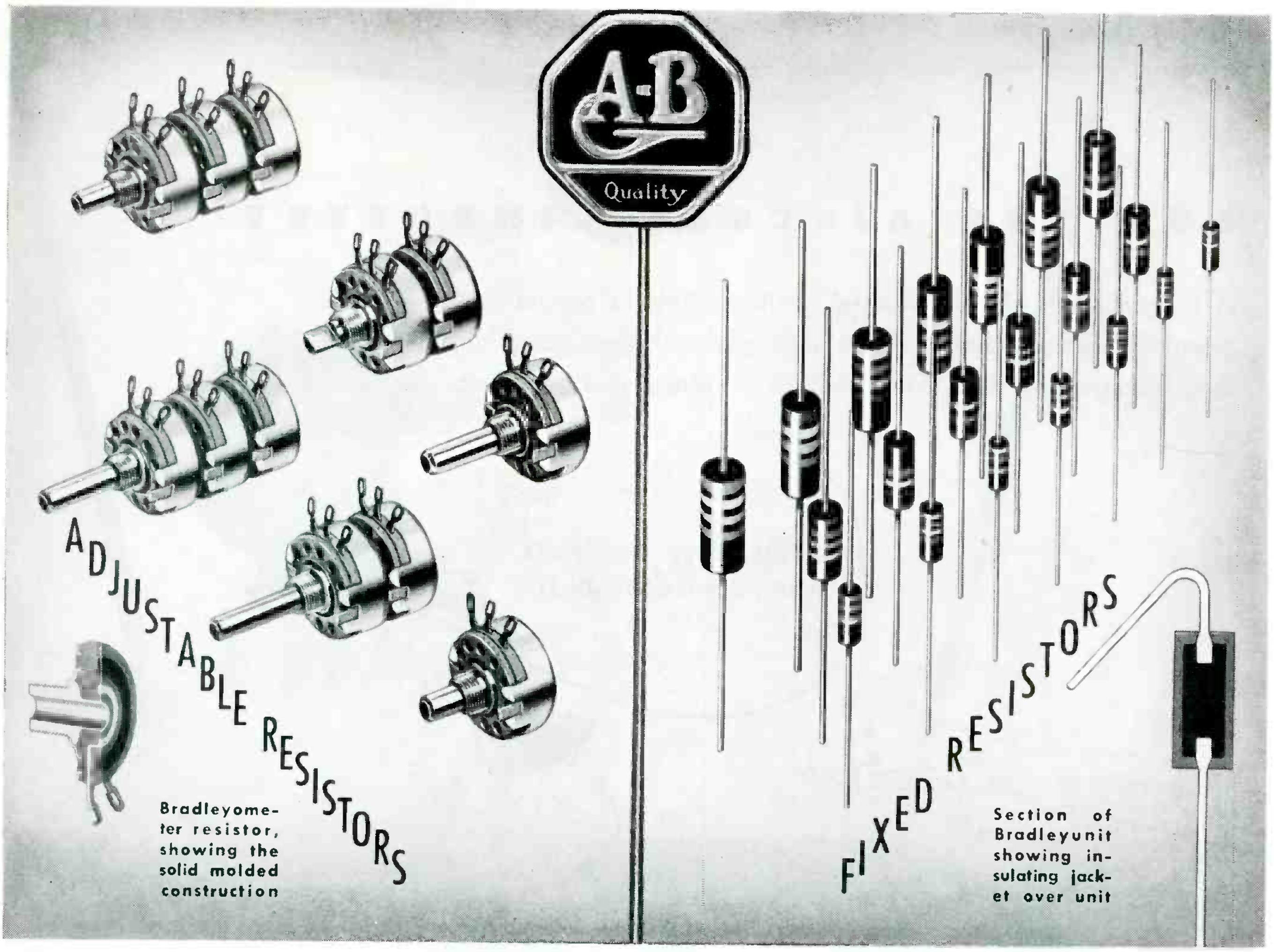
- Extremely long shelf life.
- An operating temperature range from −55°C to +85°C.
- Exceedingly low leakage currents.
- Ability to withstand severe physical shock.
- Completely sealed against contamination.

If you have large-volume applications where a price of 3 to 5 times that of hermetically-sealed paper capacitors is secondary to a combination of small size and superior performance—get in touch with us. Your letter, addressed to Capacitor Sales Division, General Electric Company, Hudson Falls, N. Y., or your nearest Apparatus Sales Office will receive prompt attention.

General Electric Company, Schenectady 5, N. Y.

GENERAL ELECTRIC

407-306



CONSISTENT PERFORMANCE UNDER ALL ATMOSPHERIC CONDITIONS

BRADLEYOMETERS—Available as rheostats or potentiometers with any type of resistance rotation curve up to 5 megohms. Rated at 2 watts.

Available in single, dual, or triple unit assemblies, with or without line switch.

Resistor element is molded as a single piece, with terminals, faceplate, and bushing molded together in one piece. Shaft and casing are made of stainless steel. Send for dimension sheet and performance curves, today.

BRADLEYUNITS—Available in ½-watt, 1-watt, and 2-watt ratings in standard R.T.M.A. values up to 22 megohms.

Rated at 70C ambient temperature . . . not 40C. Under continuous full load for 1000 hours, resistance change is less than 5 per cent. Require no wax impregnation to pass salt water immersion tests. Differentially tempered leads prevent sharp bends near resistor.

Packed in honeycomb cartons to prevent tangling of leads during assembly operations.

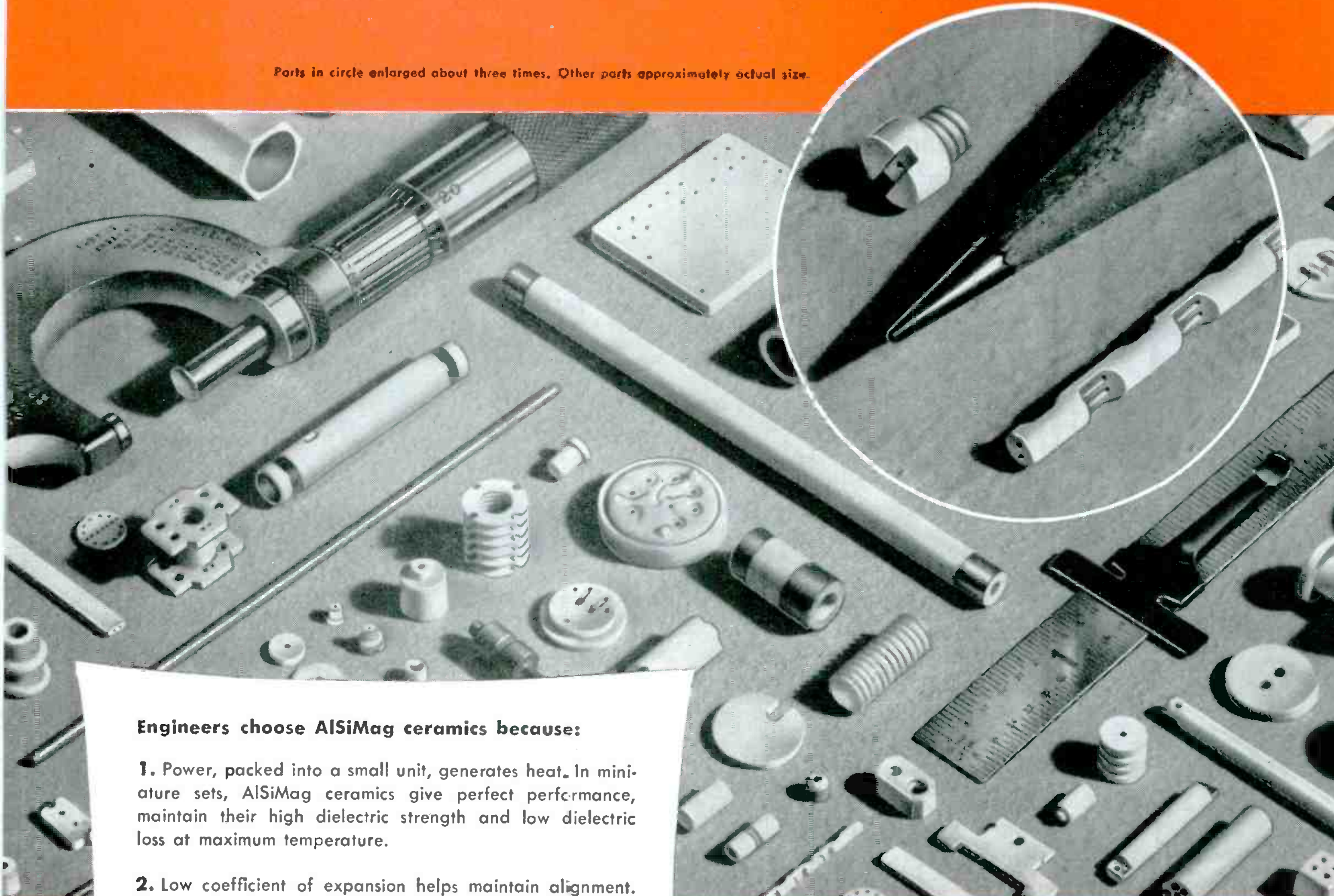
Allen-Bradley Co., 110 W. Greenfield Ave., Milwaukee 4, Wis.

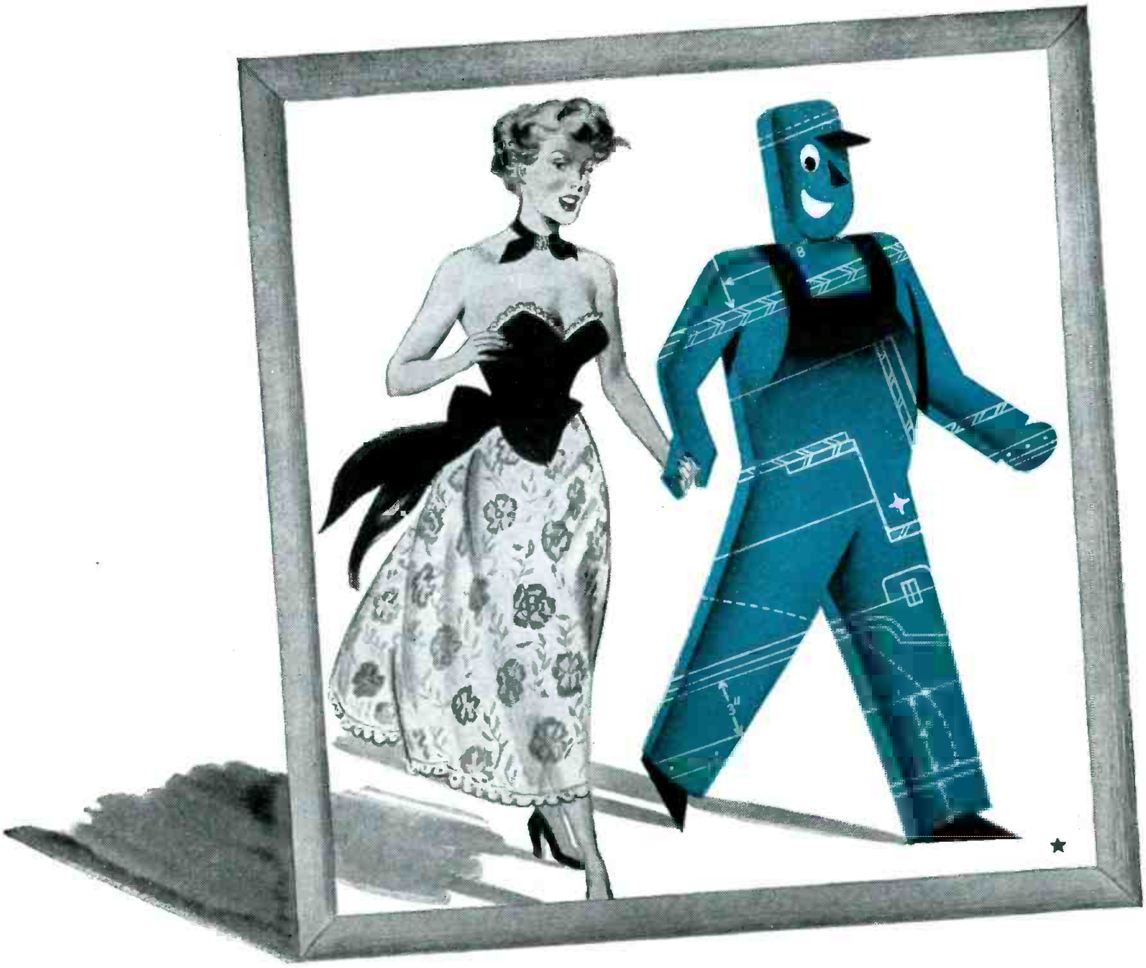
A-B Quality

ALLEN-BRADLEY

FIXED & ADJUSTABLE RADIO RESISTORS

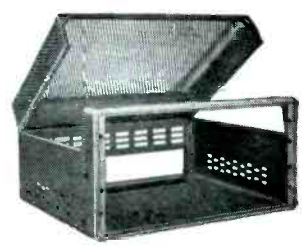
Sold exclusively to manufacturers QUALITY of radio and electronic equipment





THEY'RE BOTH IN THE KARP PICTURE

Beauty AND *Utility* IN ENCLOSURES



Hand in hand they go, briskly pacing each project in our streamlined plant . . . symbols of the handsome *styling* and *utility* that engineers demand in modern "packaging" of electrical and mechanical equipment.

Under our big roof there lives a proud tradition: industry holds the name Karp synonymous with sheet metal fabrication of the highest order . . . in every category from simple to intricate.

This reputation we prize highly as a challenge that draws out our best efforts for every customer we serve, large or small. May we prove to you, too, that superior craftsmanship really costs less in terms of value received? Write for data book.

ANY METAL ANY GAUGE ANY SIZE
ANY QUANTITY ANY FINISH

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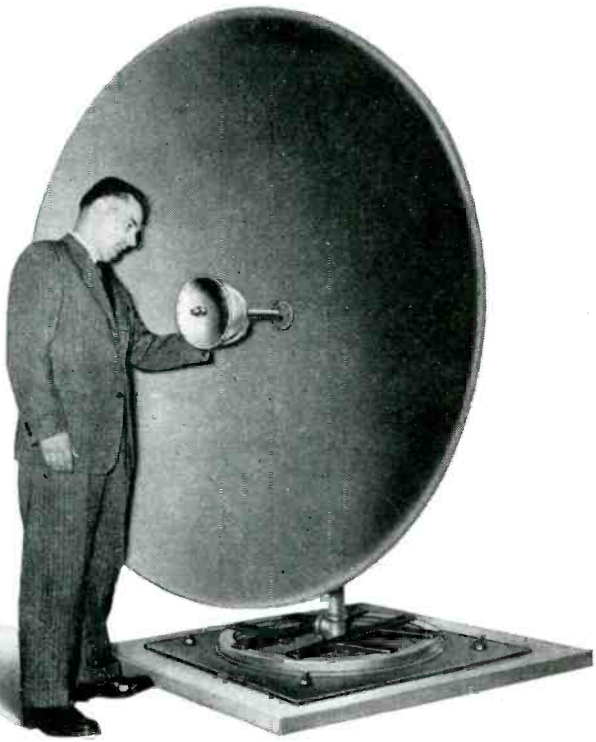
Specialists in Fabricating Sheet Metal for Industry

940 MCS

TOP PERFORMANCE



Parabolic Antennas for 940 mcs.

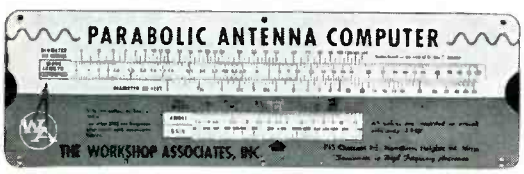
and every other Microwave Frequency

The Workshop was the first manufacturer to bring out a complete line of parabolic antennas for all microwave frequencies. Having specialized in this field for several years, we can supply equipment from our standard line to meet the majority of installations. However, for special requirements, we are equipped to design and supply reflectors in a wide range of sizes and focal lengths.

Model 940

Frequency Range	920 to 960 Mcs.			
Input Impedance	52 ohms nominal			
VSRW	1.20 to 1 over the band			
Power Rating	1 kw. continuous			
Polarization	Either vertical or horizontal available at time of installation.			
Reflector Size	4′	6′	8′	10′
Gain (db, approx., over isotropic radiator)	19	23	26	28
Half Power Angles (H plane)	17.75°	11.75°	8.6°	6.9°
(E plane)	19.75°	12.9°	9.6°	7.8°
Side Lobes	17 db down or better			
Pressurized	Feed can be pressurized to 10 lbs. p.s.i.			
Input Connection	Weatherproof type "N" fitting; special fittings are available for RG-8/U, RG-17/U or 7/8″ copper line. Specify when ordering.			
De-icing	Available for all models. Capacities range from 400 to 4000 watts.			

FREE SLIDE RULE



This pocket size slide rule quickly computes diameter, wavelength, angle and gain for parabolic antennas. Reverse side carries FCC frequency allocations conversion tables and other data. Write for your copy.

OTHER STANDARD MODELS

MODEL NO.	FREQUENCY (MCS.)	GAIN* (DB.)	HALF POWER ANGLE E Plane*	H Plane*
2000	1700–2300	27.0–34.5	10.28–3.65	9.2 –3.25
7000	5925–7425	36.0–43.0	3.24–1.36	2.86–1.21

*Gain and Half Power Angles are dependent on size and frequency of parabolas,— 4, 6, 8 or 10 foot diameter.

Write for Parabolic Antenna Catalog

The WORKSHOP ASSOCIATES

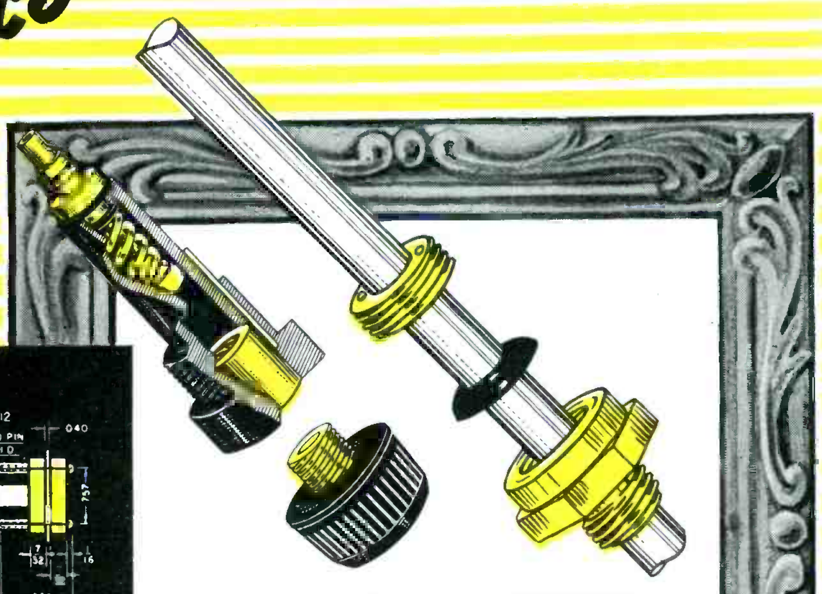
DIVISION OF THE GABRIEL COMPANY

Specialists in High-Frequency Antennas

135 Crescent Road, Needham Heights 94, Massachusetts

NEO-SIL CORPORATION

Master Pieces of Hermetic Sealing

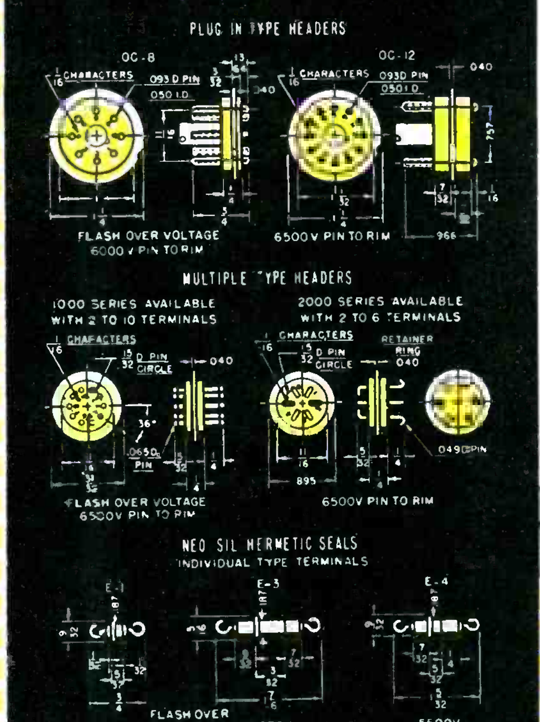


HERMETIC SEAL FUSE HOLDER

"Hermetically Sealed Fuse Holders are available for 3-AG and 4-AG fuses. These units are completely sealed from moisture with or without the cap or fuse inserted and are applicable for use on vacuum or gas filled units."

1/4" SHAFT WATERSEAL BUSHING

"Rotary Waterseal Panel Assemblies, with GRAF-SIL Packing Glands, have an excellent five year customer history on gas filled pressurized components. They are available for 1/4" shafts and for potentiometers and switch bushings."



TEST DATA

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

Volume Resistivity at 800 Volts d-c

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

Dielectric Constant and Dissipation Factor

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

Dielectric Strength at 60 cycles
Volts per mil — 370

Durometer Average — 80 ± 5

Temperature — Rated as a Class A material conservatively + 160° to —70° centigrade.

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

"NEO-SIL'S proven Hermetic sealing components are pressure checked at 25 psi—to meet military requirements and as applied to our units, NEO-SIL rubber will resist abusive temperature cycling, salt water, most acids and alkalies, and withstand high pressures and vacuums."

"In addition to the items illustrated above, NEO-SIL offers many other components, such as E Series terminals, Octal Type Plug In Headers, Multiple Pin Headers, Hermetically Sealed Cables, Hermetically Sealed Line Cords With Plugs For European use, Meter Gaskets, Panel Gaskets, Adapters (U. S. to Continental), Coil Forms, Crystal Contacts and other molded bakelite and NEO-SIL rubber units."

Your special problems are solicited.

NEO-SIL CORPORATION

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

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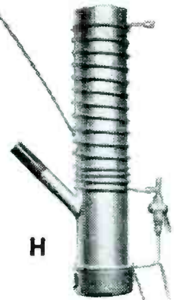

SOURCE!

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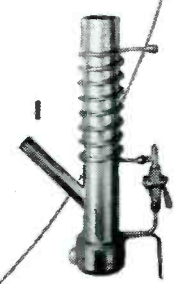

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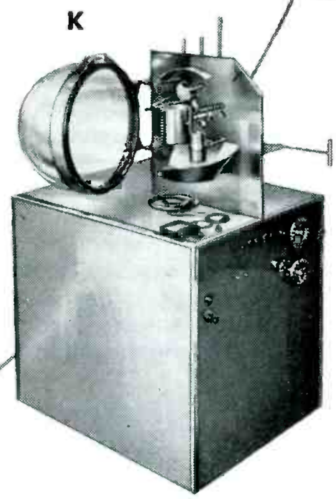

J

with a COMPLETE LINE *of* HIGH VACUUM EQUIPMENT *for the* ELECTRONIC INDUSTRY

You may be using one or two of our products without realizing that at this one source you have available such a full line of high vacuum equipment.

You will find a unique quality in most of these products. They were created to "ideal" specifications drawn up by *manufacturers* who, in many cases, never dreamed we could fulfill their exacting requirements. The products are meeting these requirements day after day on production lines.

Let us supply all your high vacuum equipment needs. You will gain the benefits of a single source of supply plus the high standards of performance designed into National Research products. Write us for further details. National Research Corporation, Memorial Drive, Cambridge, Mass.

(L) Narcoil Diffusion Pump Fluids. Three different oils fulfilling industrial and scientific workers' requirements.

● **Tube Dollies.** Special NRC manifolds, dollies, and vacuum systems designed and built for electronic industry to increase production and lower costs.

*Reg. U. S. Pat. Off.

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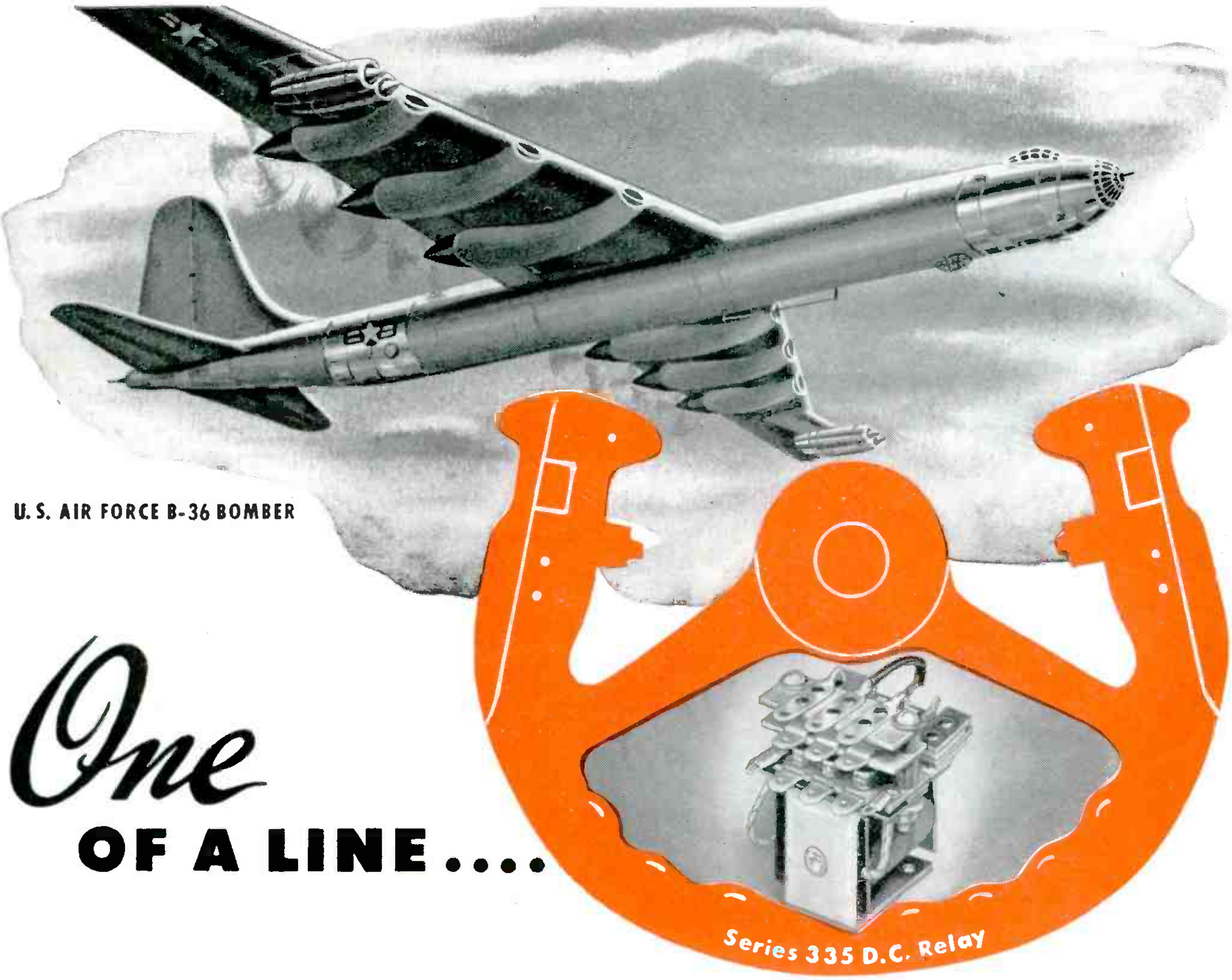


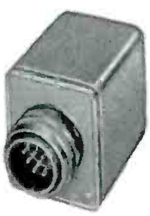
U. S. AIR FORCE B-36 BOMBER

One OF A LINE....

APPROVED BY THE AIR FORCE FOR *Dependable Control*

"GUARD-A-SEAL"

Guardian engineering developments of hermetically sealed aluminum containers, designed specifically for aircraft, include: The AN Connector — Screw Terminal—Lug Header — Octal Plug standard types, plus a variety built to government specifications.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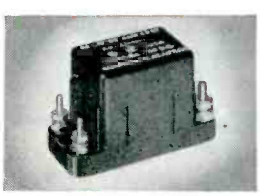
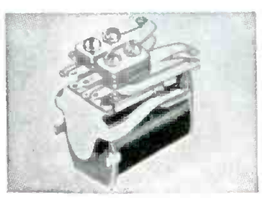
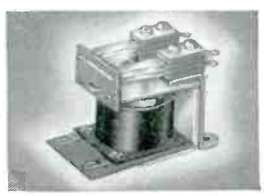
GUARDIAN RELAYS — Standard equipment in virtually all U.S. warplanes—exemplify the highest degree of *electronic precision* required by the U.S. Air Force, by government agencies and aircraft manufacturers. Guardian Relays and Solenoids—specified for timing, fusing and releasing bombs . . . firing guns . . . controlling radios . . . floodlights . . . landing gears . . . navigation aids . . . turrets . . . further establish Guardian's reputation for *electronic precision.* The Guardian Series 335 D. C. Relay, illustrated above, is but *one of a complete line* of Guardian Relays designed to permit more control in less space . . . more room for armament, power and personnel. Sensational Guardian developments include the famous "Guard-A-Seal" units specifically designed for aircraft and portable equipment, *sealed in aluminum.* They incorporate heavier frames, larger contacts, higher capacities, yet qualify under all AN weight requirements because the weight is in the relay—not the can!


AN-3320-1 D. C.


AN-3324-1 D. C.


Series 595 D.C.


Series 610 A.C.—615 D.C.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A COMPLETE LINE OF RELAYS SERVING AMERICAN INDUSTRY

Let's be HONEST with the American Public and ourselves about UHF

A message from Sarkes Tarzian, president of Sarkes Tarzian, Inc., the largest producer of switch-type tuners.

"You can fool some of the people all of the time and all the people some of the time, but you can't fool all the people all the time."
—ABRAHAM LINCOLN

● In the early days of commercial Television (1946-47) even the major manufacturers of receivers thought that a 7 to 9 channel tuner was sufficient to take care of reception in any area. They maintained the distributors and dealers could easily retune or change strips to suit their own needs.

We believed *then* that since 13 channels were available for Television, tuners should be designed and built to use the FULL RANGE of Television frequencies. We built only tuners then—as we are building now—to take care of *all* channels. It was only a matter of a year or two until all manufacturers were doing the same thing . . . providing FULL RANGE coverage.

Today, we have a similar problem facing the industry. The FCC has indicated that the frequency range from 470 megacycles to 890 megacycles (UHF) will be opened shortly for about *seventy* new Television Channels. These, of course, in addition to the twelve now available for VHF. This allocation will allow several thousand more Television stations to operate all over the United States.

Is the Television industry going to face this challenge honestly and courageously? Is it going to design and manufacture Television sets so that the AMERICAN PUBLIC—in the years to come—can get FULL RANGE Ultra High Frequency when it wants it?

Or, is the industry going to temporize . . . be opportunistic . . . and *insinuate* it has the answer to UHF through *single* channel strips? Wherein, each time the set owner adds a UHF channel strip in his tuner he loses the possible service of a VHF channel!

Is the industry going to live up to its responsibility and provide for FULL RANGE UHF? Or, is it going to try to avoid immediate engineering and manufacturing problems (which it must eventually face) by just providing LIMITED RANGE receivers now . . . letting the public, distributors and dealers "hold the bag" in the future?

We believe the logical—and honest—approach to the UHF problem is to design and produce VHF tuners now that easily—and at nominal cost—may have added to them at a later date FULL RANGE (70 Channel) coverage whenever the customer wants UHF service.

We have such a VHF Tuner available *now* to the industry. It's the Tarzian TT16. Cost of this tuner to the manufacturer is about the same as that for the regular VHF Tuners in general use now. However, by using the TT16 Tuner the manufacturer can honestly show his customer that the set *is designed* for FULL RANGE UHF Service. Cost-wise, the manufacturer is ahead, because the TT16—which includes this added feature—costs no more than regular VHF Tuners. We estimate that the additional cost to the set owner for FULL RANGE UHF Service will be less than the cost of adding 2 or 3 channel strips . . . piecemeal.

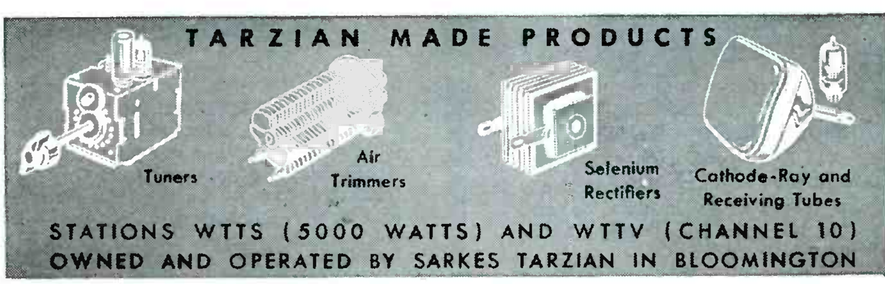
The manufacturer, by adopting this policy of producing sets which now—or later—can have incorporated FULL RANGE UHF Service, enjoys these advantages:

1—He has a distinct competitive advantage over other manufacturers who do not follow this plan and can offer only *partial* UHF.

2—He eliminates future problems and headaches for himself, his distributors, and the dealers by giving the buyer FULL RANGE Service once and for all.

3—He contributes his efforts towards placing UHF Television on a sound basis. By giving the buyer what he rightfully expects, he gains the confidence of his customer . . . adds prestige and value to his product, and his own name on that product.

So, let's be honest with the AMERICAN PUBLIC and OURSELVES about UHF, and provide for FULL RANGE UHF Service NOW.

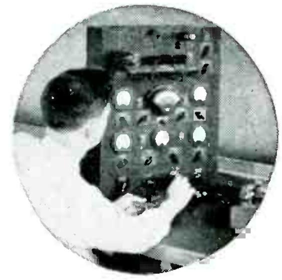


Sarkes Tarzian, Inc.
TUNER DIVISION
Bloomington, Indiana

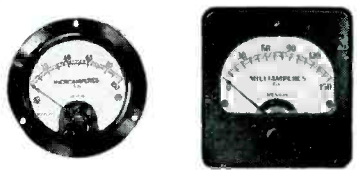
To do important measurement jobs

Better... Quicker!

Model 697 **VOLT-OHM-MILLIAMMETER**
One of a line of pocket-size meters, Model 697 combines a selection of a-c and d-c voltage, d-c current, and resistance ranges. Ideal for maintenance testing and many inspection requirements.



Model 686 **ELECTRONIC TUBE ANALYZER** tests tubes under exact operating potentials. Accurately determines true mutual conductance of all tubes, in accordance with manufacturers' rated operating conditions, or under desired operating conditions.



PANEL and SWITCHBOARD INSTRUMENTS—a complete line of instruments in all types, sizes and ranges required for switchboard and panel needs . . . including d-c, a-c power frequencies and radio frequency, rectifier types and D.B. meters.

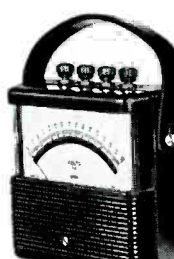
Model 622 **ULTRA-SENSITIVE INSTRUMENTS**—portable d-c and a-c thermo instruments for precision measurement of potentials and minute currents in electronics or laboratory research.

The same *dependability* evident in all WESTON standard instruments also is available in a broad line of *specialized* and *multi-purpose* instruments...all designed to do special and complex measurement jobs better, quicker, more economically. Whether for laboratory, shop or field requirements, first check instrument needs with WESTON. Consult the nearest representative, or write direct.

WESTON *Instruments*

WESTON Electrical Instrument Corporation
595 Frelinghuysen Avenue, Newark 5, New Jersey
Manufacturers of Weston and TAGliabue Instruments

SENSITIVE RELAYS—a line of sensitive relays including the Model 705 which provides positive control at levels as low as ½ microampere. Non-chattering magnetic contacts handle up to 10 watts at 120 volts.



Model 901 **PORTABLE TEST INSTRUMENTS** available in d-c, Model 901 —and a-c, Model 904, single and multiple ranges of wide coverage. Excellent scale readability and shielding. Accuracy within ½ of 1%.

Model 1411 **INDUCTRONIC D-C AMPLIFIER**—stable amplifier provides high degree of resolution even at fractional loads. Reaches steady full scale deflection in fraction of a second. Interchangeable plug-in range standards for either microamperes or millivolts.

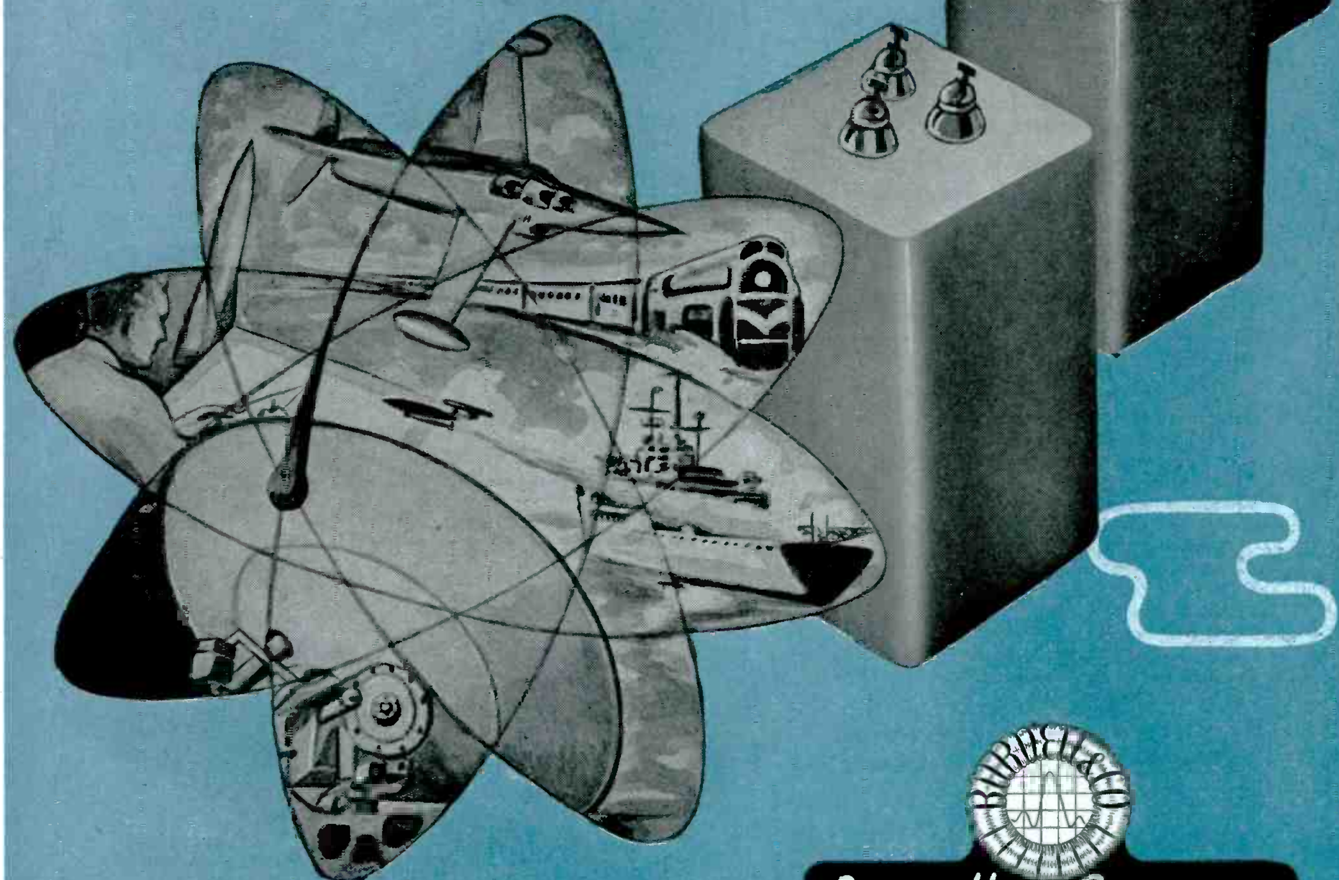
Burnell Filters

FOR MILITARY APPLICATIONS

With the increasing number of audio filter applications in electronic military equipment, the importance of stability and durability under extreme service conditions creates many more problems in the design and manufacture of these networks.

A filter, which is not really a component, but an assembly of many components (often quite intricate) is affected by the slightest weakness in any of these parts. As a consequence, it has been our greatest task to either develop or find sources of the highest quality for materials employed in the production of filters. This project has so far been very fruitful although it necessarily resulted in increased material cost, much of which has been offset by the introduction of new and more efficient production and design methods.

All of this adds up to another step forward for Burnell & Company in the production of high quality filter networks for the Nation's military electronic program.



EXCLUSIVE MANUFACTURERS OF COMMUNICATIONS NETWORK COMPONENTS

Burnell & Company
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CABLE ADDRESS "BURNELL"

improve your product with — MYCALEX

THE OUTSTANDING **LOW LOSS HIGH FREQUENCY INSULATION** FOR OVER A QUARTER OF A CENTURY

MYCALEX is a highly developed glass-bonded mica insulation backed by a quarter-century of continued research and successful performance. Both pioneer and leader in low-loss, high frequency insulation, MYCALEX offers designers and manufacturers an economical means of attaining new efficiencies, improved performance. The unique combination of characteristics that have made MYCALEX the choice of leading electronic manufacturers are typified in the table for MYCALEX grade 410 shown below. Complete data on all grades will be sent promptly on request.

MYCALEX is efficient, adaptable, mechanically and electrically superior to more costly insulating materials

- **PRECISION MOLDS TO EXTREMELY CLOSE TOLERANCE**
- **READILY MACHINEABLE TO CLOSE TOLERANCE**
- **CAN BE TAPPED THREADED, GROUND, SLOTTED**
- **ELECTRODES, METAL INSERTS CAN BE MOLDED-IN**
- **ADAPTABLE TO PRACTICALLY ANY SIZE OR SHAPE**

MYCALEX is available in many grades to exactly meet specific requirements

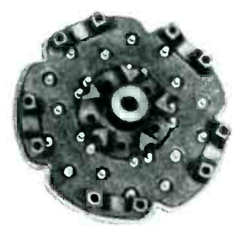
CHARACTERISTICS OF MYCALEX GRADE 410

Meets all the requirements for Grade L-4A, and is fully approved as Grade L-4B under Joint Army-Navy Specification JAN-1-10

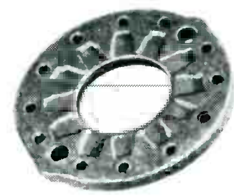
Power factor, 1 megacycle	0.0015
Dielectric constant, 1 megacycle	9.2
Loss factor, 1 megacycle	0.014
Dielectric strength, volts/mil	400
Volume resistivity, ohm-cm	1×10^{15}
Arc resistance, seconds	250
Impact strength, Izod, ft.-lb/in. of notch	0.7
Maximum safe operating temperature, °C	350
Maximum safe operating temperature, °F	650
Water absorption % in 24 hours	nil
Coefficient of linear expansion, °C	11×10^{-6}
Tensile strength, psi	6000

MYCALEX is specified by the leading manufacturers in almost every electronic category

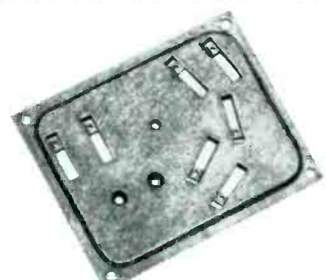

Mycalex 410 Tuning Coil Form


Mycalex 410 Tuning Switch Plate


Mycalex 410 Terminal Base and Cap Assembly for Fire Detection Equipment


Mycalex 410 Rotary Switch Stator


Mycalex 410 Solenoid Type Coil Form


Mycalex 410 Tuning Stator Plate

SINCE 1919 MYCALEX THE INSULATOR TRADE MARK REG US PAT OFF

MYCALEX CORPORATION OF AMERICA

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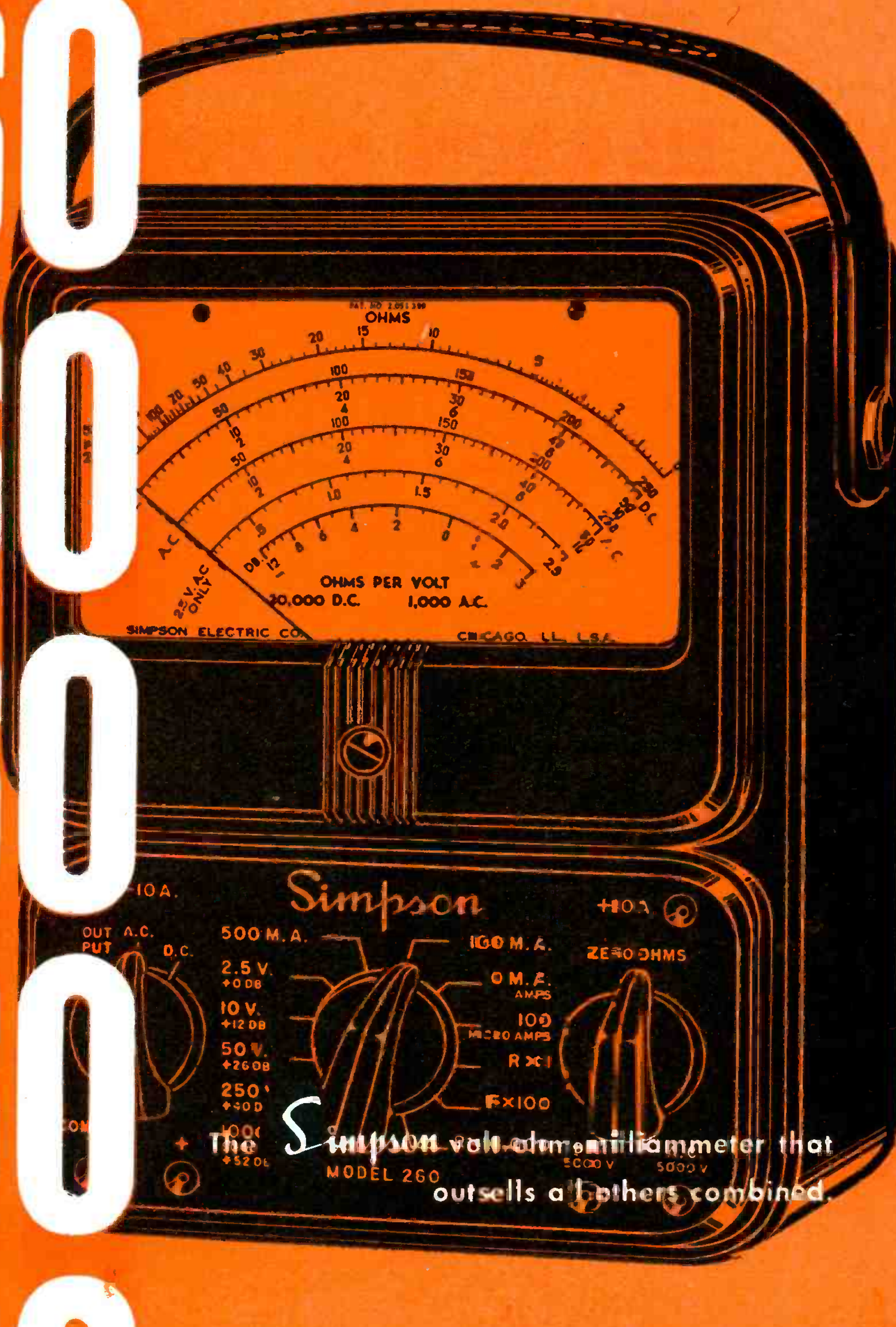

The Simpson volt-ohm-milliammeter that outsells all others combined.

REASON for CONFIDENCE

. . . in Peace or War

. . . that's what the trademarks and brand names of American producers establish. For never has a country accumulated such wealth of designing and engineering talent, such monumental means for producing both the necessities and luxuries of the day, or such massive potential for meeting the needs of tomorrow—however vast and varied they may be.

Accordingly, we take particular pride in *our* personal emblem. Representing a wide range of alloys for the electrical, electronic and heat-treating industries, it is the very symbol of quality and dependability to a host of manufacturers thruout the nation. We are well aware of our obligation to uphold its reputation—in peace or war.

So if your products demand electrical resistance material of outstanding uniformity, high stability, and long life . . . or if you require radio alloys for electronic uses . . . or high heat-resistant equipment . . . *consult with us.* Our fifty years' experience is at your disposal.

As recipient of the highest Armed Services Award in 1918, and of no less than five Army-Navy "E" Awards in World War II, it is logical that the resources of this firm should be engaged to an unprecedented extent in meeting the demands of the present emergency. However, we stand ready to make recommendations based upon your specific requirements, and shall be glad to serve you to the best of our ability.

One thing is sure: Your use of a D-H product will prove a source of confidence—confidence not only in Driver-Harris products per se, but, in a wider sense, confidence in the capacity of creative America to meet any situation, *come what may.*

Manufacturers of world-famous Nichrome and over 80 other alloys for the electrical, electronic, and heat-treating fields.*

SPECIAL PURPOSE ALLOYS SINCE 1899 — TRADE MARK REG. U. S. PAT. OFF.

Driver-Harris Company

HARRISON, NEW JERSEY

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

In Canada: The B. GREENING WIRE COMPANY, LTD., Hamilton, Ontario, Canada

SPECIAL PURPOSE ALLOYS SINCE 1899 — TRADE MARK REG. U. S. PAT. OFF.

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Will Defense Production Be Caught in the Squeeze?

When Congress revised and extended the Defense Production Act, it relaxed a squeeze on business profits.

President Truman asserted that this action by Congress cripples the government in its effort to prevent inflation which, as he puts it, could lead to "enrichment and profiteering for the few, economic hardship and misery for the many."

He asked Congress to rescind its action.

This editorial—the second on problems presented by "escalator"clauses—aims to throw some light on this conflict of opinion.

The Squeeze

The squeeze on profits was imposed in the name of price stabilization. The idea behind it was simple. The *selling prices* of industrial products were to be held under a tight lid. But many industrial costs are affected by "escalator" clauses of one kind or another which tend to boost production *costs*. Thus, with rising costs and fixed prices, profits would be squeezed and much of the cost of defense would thereby be shifted from those favored by escalator clauses to business concerns.

The mechanics of this squeeze on profits were complicated. But here, in brief, is how it was to work. The first step was to require manufacturers to set ceiling prices, effective May 28, for their products.

These ceiling or maximum prices were to allow for increases in manufacturers' costs that had occurred since Korea. *But they did not allow for all increases.* Manufacturers, for example, could not include increases in indirect costs—office or selling costs. Neither could they, in calculating their new prices, include increases in the costs of materials or direct labor that had come after March 15. This was the first phase of the squeeze on profits.

The second phase was prepared by **not** putting a ceiling on costs. The Wage Stabilization Board said it could not disturb the operation of "escalator" clauses by which wage rates are geared to the cost of living. Moreover, nothing could be done to curb the operation of the farmers' "escalator" clause, the farm parity arrangement. Under it, the federal government underwrites higher prices for farm products to match increases in the cost of things farmers buy. So this left wages and many materials costs free to rise against a ceiling imposed on the prices of what industry has to sell.

Relief—at a Loss

On two conditions only would the Office of Price Stabilization permit a company to raise its prices and escape this squeeze. One of these was that increased costs had more than wiped out its profits; in other words, that it was operating at a loss. The other condition was that the industry of which the company is a part was not, as a whole, making "excess profits." That is, the industry, as a whole, could not get price relief if its overall profits before taxes were greater than 85 percent of its average profits during the best three of the four years from 1946 through 1949. Many companies expected that their profits would be cut drastically before they could get through this narrow escape hatch.

When this squeeze on profits was set up, we were told that industry as a whole was reporting record profits. But, it was equally true that wage rates and farm prices also were at record high levels. And it was also true that, under the impact of rising taxes and the dislocations caused by the defense mobilization program, profits actually were on the way down.

Profits — Going Down

By the time Congress acted to relax the squeeze, corporate profits, after taxes, were running at a rate 20 percent lower than they had been six months before. And the clear prospect was that they would continue to decline.

So the issue put up to Congress was simply this. Should business firms stand so much of the brunt of the defense costs while "escalator" clauses continued to exempt organized workers and farmers from paying their share of those costs?

But this question actually is much broader than one of fairness or unfairness alone. One certain effect of such a squeeze on profits would be to undercut the capacity of private industry to install the new plants and equipment needed for our mobilization effort. Today — unlike World War II — private industry is financing almost all of our huge program to expand production. And about two-thirds of the money that has been plowed into the expansion and improvement of our industrial machine since World War II has come out of profits.

In view of all this, Congress decided last summer to relax the pressure on profits. This was done by the controversial Capehart Amendment to the Defense Production Act. This amendment has serious administrative weaknesses. But some measure with the same purpose is needed to maintain profits at a high enough level to finance the huge and continuing expansion of our industrial machine that is now underway.

Basic Issues

As soon as the amendment was enacted, the President asked Congress to revise the law again. The heart of his proposal was to restore to the Administration the powers it used last spring to arrange the squeeze on profits outlined here.

This controversy will continue. There can be no final answer to it as long as we have the economic controls made necessary by mobilization.

But if we look beneath the surface of this technically complicated controversy, we shall see clearly that the basic issues are:

1. Whether we really shall make an effort to distribute fairly the burdens of inflation caused by our defense mobilization —

2. Whether farmers and organized workers should be exempted from these sacrifices by escalator clauses — at the expense of the nation as a whole —

3. Whether profits should be squeezed still more — at the risk of putting a fatal squeeze on the effort of industry to build new plants and install new tools. These new facilities are essential to maintaining American living standards — and they are the heart of our ability to defend ourselves and the rest of the free world.

Americans face no more important economic issues at this time.

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NEW Sperry Signal Source

operates both low and high voltage klystrons

A new *Microline* instrument, Model 555 Klystron Signal Source, is an extremely well-regulated power supply. It features a continuously adjustable beam supply from 250 to 3600 volts. In addition, a reflector power supply is continuously variable from 0 to 1000 volts, and a control electrode supply is continuously variable from 0 to 300 volts. The versatility of this signal source permits operation of low voltage as well as high voltage klystrons.

Several types of modulation are provided with this instrument: sine wave at 60 cps, 0-300 volts peak to peak; saw tooth wave continuously variable from 600 to 1050 cps, 0-300 volts peak to peak with 15 microseconds decay time; and square wave continuously variable from 600 to 1050 cps, 0-300 volts peak to peak with 5 microseconds maximum rise and fall time. A modulation selector switch on the front panel permits external choice of type of modulation.

Write our Special Electronics Department for further information on Model 555 as well as other *Microline* instruments.

USABLE KLYSTRONS WITH MODEL 555 SIGNAL SOURCE

2K22	3K23	QK-277
2K25	3K27	QK-289
2K26	707B	QK-290
2K28	723A/B	QK-291
2K29	726A,B,C	QK-292
2K33	QK-140	QK-293
2K39	QK-141	QK-294
2K41	QK-142	QK-295
2K42	QK-143	QK-306
2K43	QK-159	6 BL6
2K44	QK-226	6 BM6
2K48	QK-227	SRX-16
2K56	QK-246	X-12
2K57	QK-269	X-13
		X-21

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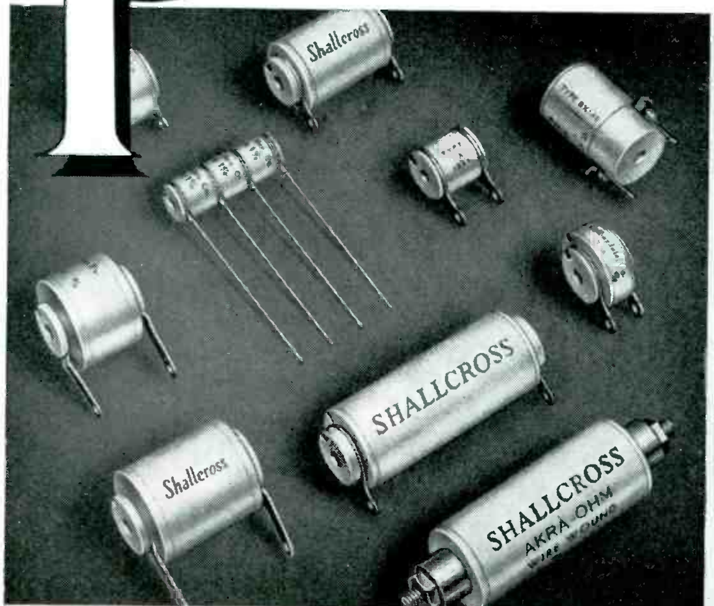

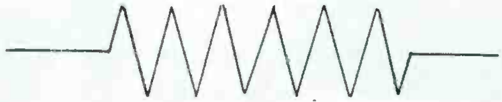

◀ CLOSE TOLERANCE RESISTORS

(JAN and standard types)

Wire-wound precision resistors have characteristics suitable for many exacting modern circuits. Shallcross Akra-Ohm resistors meet these requirements and are available in several types, shapes, and mounting styles. They are noted for high stability, low temperature coefficients, low noise levels, uniformity, long life, and extreme accuracy in matched pairs and sets. Ask for Bulletin R3.

PRECISE ELECTRICAL ▶ MEASURING INSTRUMENTS

- Resistance Standards
- Decade Potentiometers
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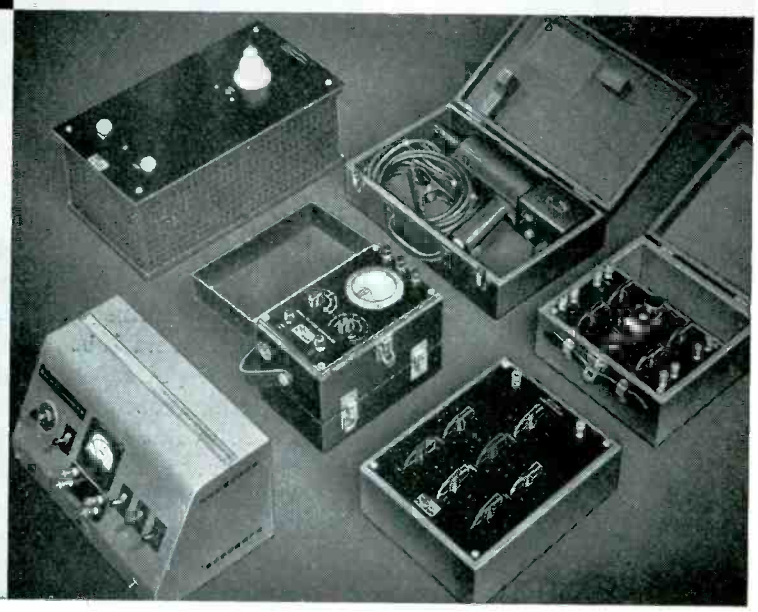
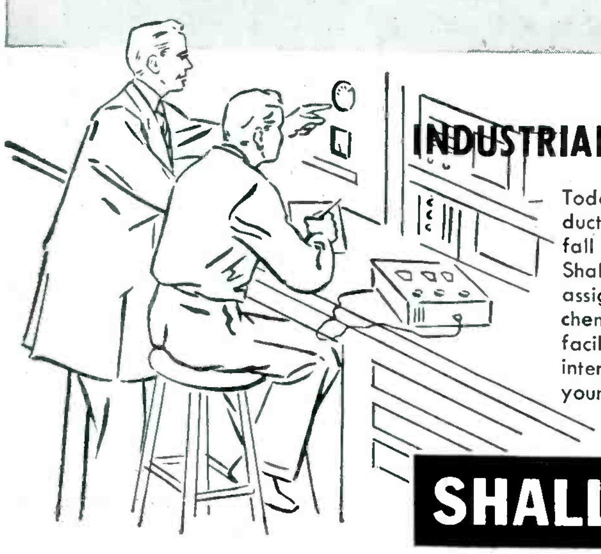
- Bridges, Wheatstone
- Bridges, Kelvin-Wheatstone
- Bridges, Limit
- Decibel Meters
- Tone Generators
- Telephone Test Equipment
- Low-Resistance Test Sets
- Insulation Test Sets
- Bridge Components

Write for Catalog No. 10.



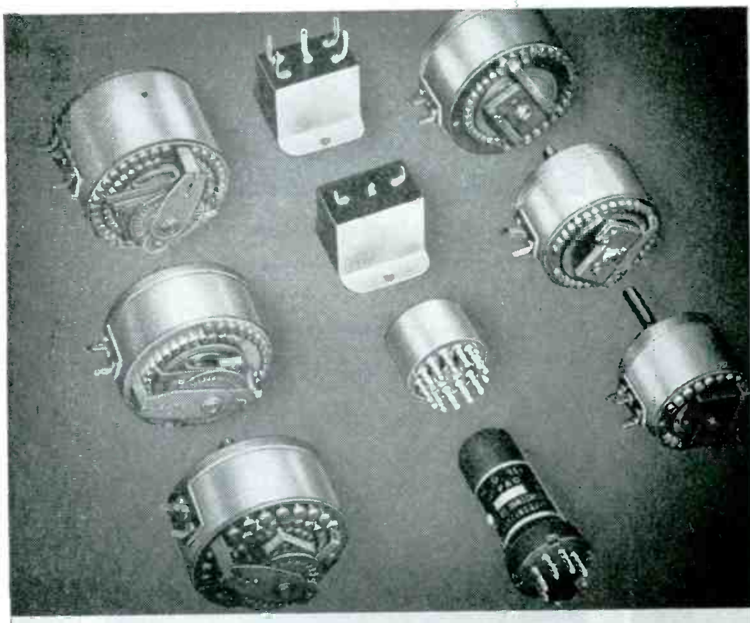


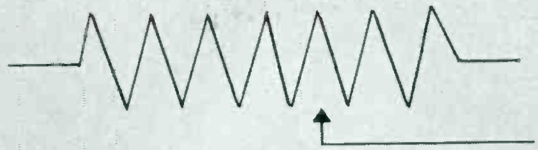
INDUSTRIAL RESEARCH AND DEVELOPMENT SERVICE

Today's complex circuits frequently require the design development, and production of highly specialized components, sub-assemblies, or instruments which fall outside the realm of standard engineering or production facilities. The Shallcross Research Department has been specifically formed to handle such assignments. Composed of electronic, electrical, instrument, mechanical, and chemical engineers of broad experience and backed with adequate modern facilities, this unique service group combines a highly technical as well as an intensely practical engineering-production viewpoint. We invite you to submit your requirements for review and recommendation.

SHALLCROSS MANUFACTURING

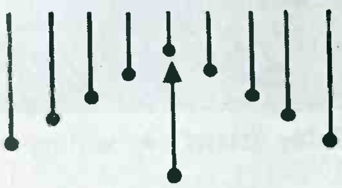
by SHALLCROSS





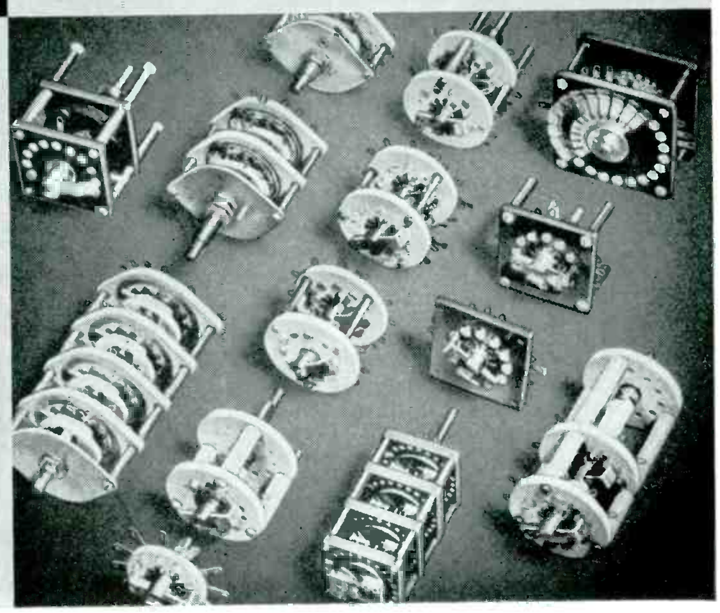
◀ HIGH QUALITY ATTENUATORS

Improved materials and production techniques for Shallcross Attenuators have resulted in a line that sets new higher standards of attenuation performance for practically every audio and communications use. Shallcross Audio Engineering Bulletin No. 4 will be sent on request.



CUSTOM-BUILT SELECTOR SWITCHES ▶

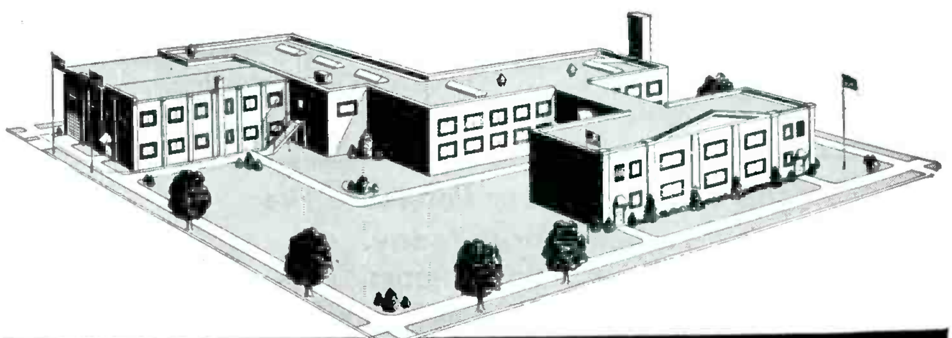
Shallcross builds single or multiple deck selector switches having up to 180 positions. Test units have given satisfactory performance at 250 volts 10 amperes and at 2500 volts 1 ampere A.C. Contact resistance ranges from a low of 0.0005 ohms to a maximum of 0.005 ohms depending upon the size and material of the contact surfaces. You are invited to outline your requirements on Shallcross Specification Sheet No. 6.



HIGH-VOLTAGE

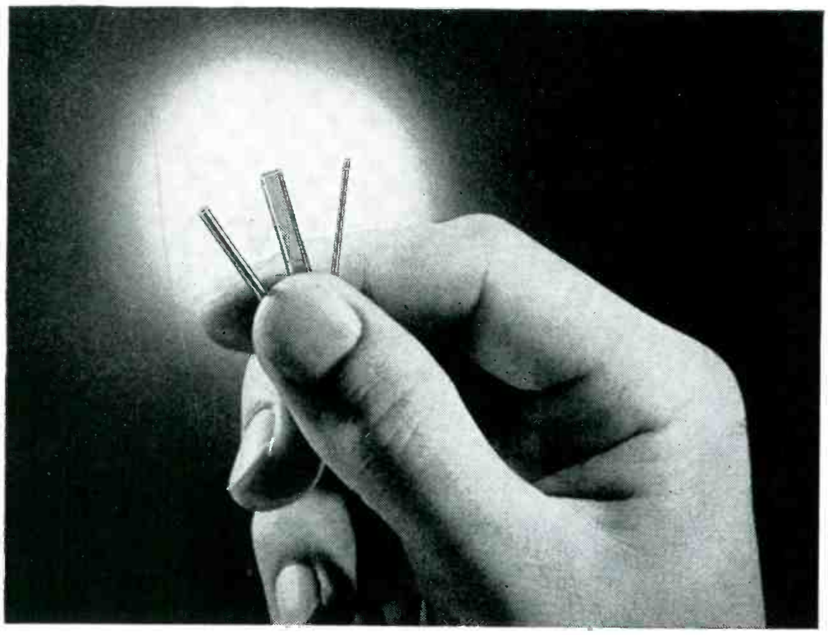
Test and Measuring Equipment

Shallcross high-voltage instruments and corona-protected resistors provide maximum accuracy, safety, and dependability in a broad range of applications, from nuclear physics to electrostatic generators, precipitrons, power supplies, transmitters, and many others. Write for Bulletin F.

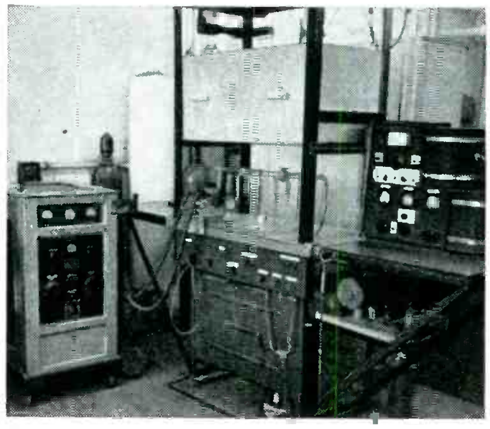


COMPANY • Collingdale, Pennsylvania

What Superior Electroneering Does for You



Life testing of standard diodes which compares various cathode alloys.



Trolley exhaust for sealing-off standard diodes.

Microscopic examination studying surface conditions of cathodes.

● Cathodes, three types of which are shown above, are one result of Superior engineering for the Electronics Industry—Electroneering. This is one of our big jobs. It is also one in which we take considerable pride and pleasure.

Among the usual run of our operations in this field: melt approval tests, raw material inspection, chemical analysis, testing of emission characteristics, physical characteristic tests, customer specification investigation and many others, we find time to dig well beneath the surface of the field.

For example, we continuously examine satisfactory products in an effort to improve their quality, shorten the required fabrication time, cut the costs to you, make it easier for you to assemble into finished parts or give you better service in any way.

Another example is our customer service which goes well beyond the limits of supplying good parts on schedule. We frequently work hand-in-hand with customers' engineers to solve their problems involving tubular parts. We are glad to consult with them at any time about the design or materials required for a new part or application. And, although we do a good bit of this, we'd like to do more. If you have a problem, why not let us help you find a solution with our combination of Electroneering and production know-how about cathodes and other parts for television, radio and other vacuum tubes. Write Superior Tube Company, Electronics Division, 2500 Germantown Ave., Norristown, Pennsylvania . . . no obligation of course.

This Belongs in Your Reference File
. . . Send for It Today.

NICKEL ALLOYS FOR OXIDE-COATED CATHODES: This reprint describes the manufacturing of the cathode sleeve from the refining of the base metal. Includes the action of the small percentage impurities upon the vapor pressure, sublimation rate of the nickel base; also future trends of cathode materials are evaluated.

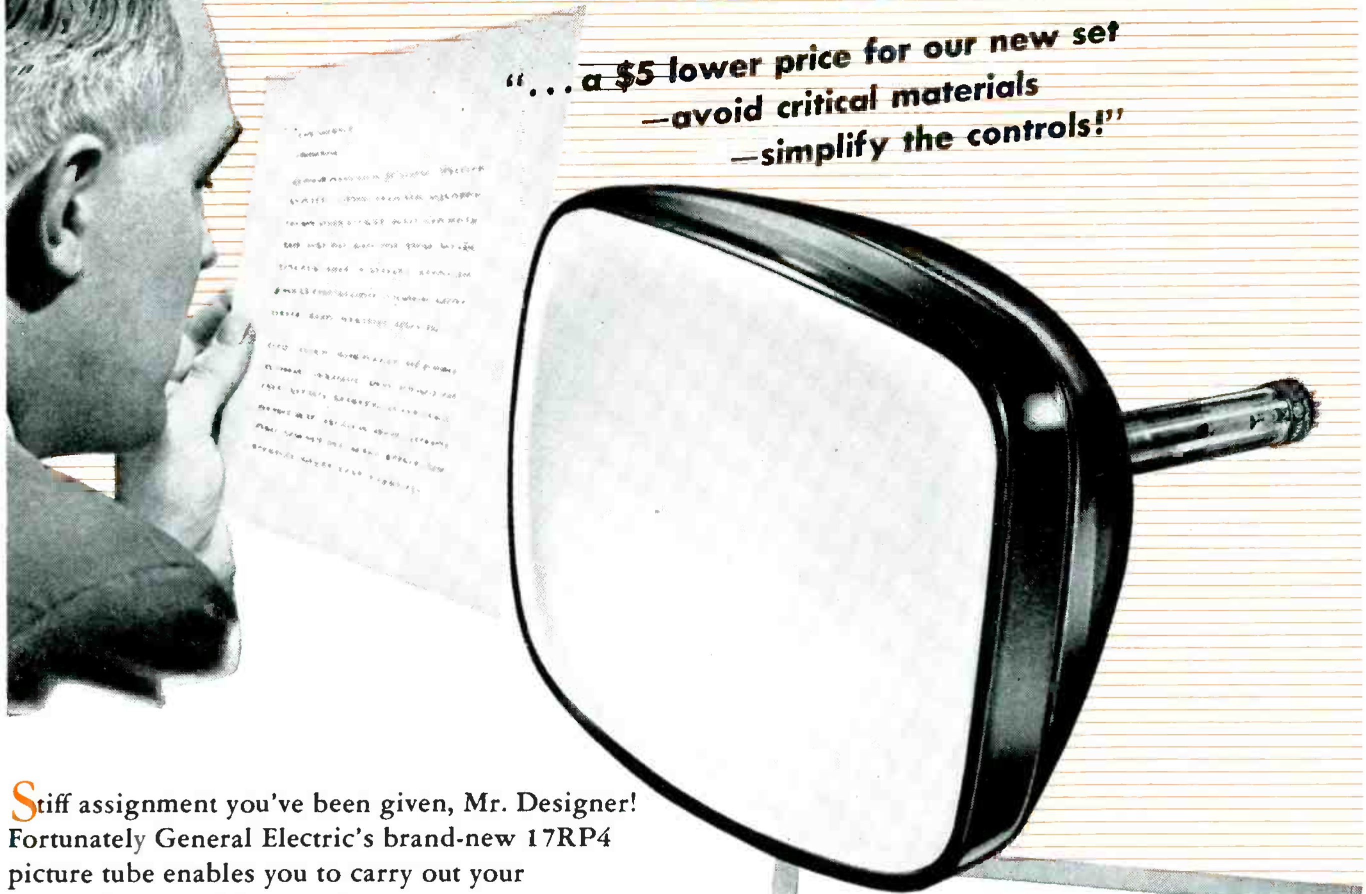
Superior
THE BI... E IN SMALL TUBING

All analyses .010" to ⅝" O.D.
Certain analyses (.035" max. wall) Up to 1¼" O.D.

SUPERIOR TUBE COMPANY • Electronic Products for export through Driver-Harris Company, Harrison, New Jersey • Harrison 6-4800

TV-DESIGNER'S COST PROBLEM

"... ~~a $5~~ lower price for our new set
—avoid critical materials
—simplify the controls!"



Stiff assignment you've been given, Mr. Designer! Fortunately General Electric's brand-new 17RP4 picture tube enables you to carry out your instructions word-for-word.

CHASSIS COSTS ARE TRIMMED because the 17RP4, electrostatic in design, requires no fixed magnet or focus coil with potentiometer. Convert either of these, plus labor, into retail pricing, and you have the desired mark-down in your new receiver.

CRITICAL MATERIALS SAVED! Needing neither fixed magnet nor focus coil, G.E.'s new 17RP4 eases your requirements for cobalt, nickel, and copper . . . thus helps assure steady TV production in your plant.

NO FOCUS CONTROL REQUIRED! The 17RP4 has zero focus voltage, which eliminates a receiver focusing knob or internal adjustment . . . meaning simpler TV operation and extra customer appeal for your set.

Picture performance is equal to other tubes *or better!* Exhaustive tests have proved this. Phone, wire, or write for descriptive Bulletin ETD-102, just off the press! *General Electric Company, Electronics Division, Section 7, Schenectady 5, New York.*

17RP4

Electrostatic picture tube with zero focus voltage.

RECOMMENDED OPERATING CONDITIONS

Anode No. 2, voltage	14,000 v
Anode No. 1, voltage for focus	0 v
Grid No. 2, voltage	300 v
Grid No. 1, voltage for spot cut-off	−33 to −77 v
Ion-trap field intensity (single-field), approximate	35 gausses

You can put your confidence in—

GENERAL ELECTRIC

181-K5

AGAIN

Oster

REG. U.S. PAT. OFF.

SERVOS
ACTUATORS

Has the Answers!

BLOWERS
GEAR REDUCERS
ELECTRO
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TO YOUR FRACTIONAL H. P. MOTOR PROBLEMS

Electric motors to meet exacting requirements have been a specialized business of OSTER for more than 25 years.

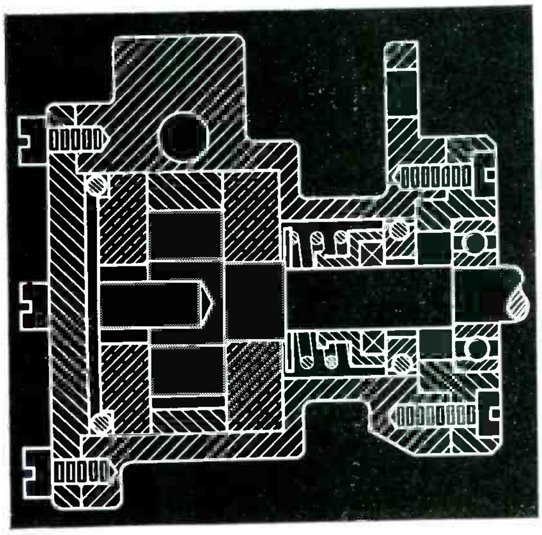
A highly qualified engineering and production personnel which helped to solve your fractional h.p. electric motor problems in the last war makes fully available to you once again an engineering and manufacturing skill known for service, quality and dependability. A staff of trained field engineers is at your disposal. Call on us!

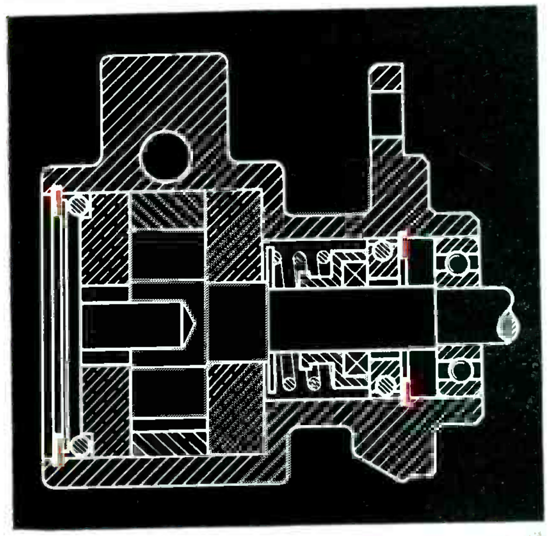
JOHN OSTER
MANUFACTURING COMPANY
AVIATION DIVISION
RACINE, WISCONSIN

TWO TRUARC RINGS IN NEW PRESSURE PUMP SAVE $1.48 PER UNIT

OLD WAY Requires 4 skilled-labor threading operations...4 heavy screws on a cover plate and an internal tapped thread, plus plug at rear. Assembly is slow and difficult...maintenance necessary.

NEW WAY Just 2 Truarc Rings, set into accurately predetermined grooves, bring new simplicity of design... speedy assembly. No skilled-labor required! No maintenance! Rings lock parts accurately for life of unit.





Using 2 Waldes Truarc Retaining Rings in their new Pump, saved the Procon Pump & Engineering Co., Detroit, $1.48 per unit! With Truarc Rings, assembly is speedy, simple. Skilled-labor threading operations ...stripped threads...maintenance are eliminated. Parts are firmly held together for life of unit!

Redesign with Truarc Rings and you, too, will cut costs. Wherever you use machined shoulders, bolts, snap rings, cotter pins, there's a Waldes Truarc Retaining Ring designed to do a better job of holding parts together.

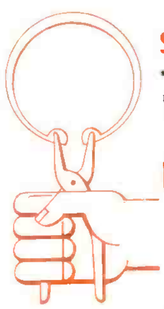
Truarc Rings are precision-engineered...quick and easy to assemble and disassemble. Always circular to give a never-failing grip. They can be used over and over again.

Find out what Truarc Rings can do for you. Send your blueprints to Waldes Truarc engineers for individual attention, without obligation. Waldes Truarc Retaining Rings are available for immediate delivery from stock, from leading ball bearing distributors throughout the country.

USE OF 2 WALDES TRUARC RINGS PERMITTED THESE BIG SAVINGS:

Eliminated 2 castings	$ .39
Eliminated 8 screws	.04
Eliminated machining of 2 castings	.56
Eliminated drilling and tapping housing	.40
Reduced assembly time by elimination of screws	.09
TOTAL SAVINGS	**$1.48**
Weight saved	14 ounces

For precision internal grooving and undercutting . . . **Waldes Grooving Tool.**



SEND FOR NEW BULLETINS ➡

WALDES

TRUARC

REG. U. S. PAT. OFF.

RETAINING RINGS

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

WALDES TRUARC RETAINING RINGS AND PLIERS ARE PROTECTED BY ONE OR MORE OF THE FOLLOWING U. S. PATENTS: 2,382,947; 2,382,948; 2,416,852; 2,420,921; 2,428,341; 2,439,785; 2,441,846; 2,455,165; 2,483,380; 2,483,383; 2,487,802; 2,487,803; 2,491,306; 2,509,081 AND OTHER PATENTS PENDING.

Waldes Kohinoor, Inc., 47-16 Austel Place, L. I. C. 1, N. Y.
Please send engineering specifications and data on Waldes Truarc Retaining Ring types checked below. E-113

- ☐ Bulletin #5 Self-locking ring types
- ☐ Bulletin #6 Ring types for taking up end-play
- ☐ Bulletin #7 Ring types for radial assembly
- ☐ Bulletin #8 Basic type rings
- ☐ Send me information about the Waldes Grooving Tool.

Name ______
Title ______
Company ______
Business Address ______
City ______ Zone ______ State ______ 5678

DOW CORNING SILICONES

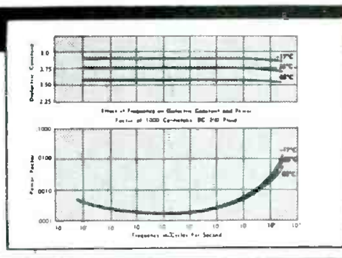
Heat-Stable, Moisture-Proof

SILICONE DIELECTRIC MATERIALS

are available in the following forms:

LIQUID DIELECTRICS

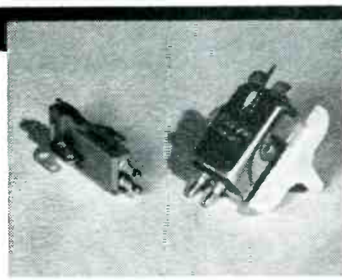
DOW CORNING 200 FLUIDS are a series of clear, inert liquids, notable for their thermal stability and for their remarkably flat viscosity-temperature slopes. Available in viscosities from 0.65 to 1,000,000 centistokes. Pour points range from −123° to −47°F. and flash points range from 30° to 600°F. Low dissipation factors at elevated temperatures or at high frequencies, inertness to moisture, oxidation resistance and heat stability make Dow Corning 200 Fluids unique among liquid dielectrics.



As indicated by these curves, neither frequency nor temperature changes have any pronounced effect on the power factors or dielectric constants of Dow Corning 200 Fluids. Power factor and dielectric constant of 1000 cs. fluid at −17°, 23°, and 83° C. are plotted against frequencies ranging from 10 to 10^{10} cycles per second.

DIELECTRIC COMPOUND

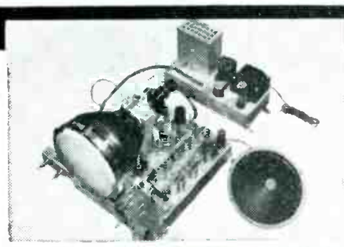
DOW CORNING 4 COMPOUND is a nonmelting water-repellent dielectric paste which retains its grease-like consistency at temperatures from −70° to 400°F. It is highly resistant to oxidation and to deterioration caused by corona discharge. Power factor is less than 0.003 at frequencies up to 10,000 megacycles; volume resistivity is more than 10^{12} ohm centimeters at temperatures up to 400°F.; dielectric strength is more than 500 volts per mil at a 10 mil gap. Dow Corning 4 meets all requirements of Specification AN-C-128a.



Dow Corning 4 packed in phonograph pick-up head cartridges increased crystal service life 20 times. The silicone compound prevents Rochelle Crystals from deteriorating due to absorbed moisture. It also acts as a viscous damping medium, thereby reducing excess vibration and enabling the head to handle a much higher frequency.

ELECTRICAL INSULATING VARNISHES

DOW CORNING 996 VARNISH dries tack-free in not more than 3 hours at 150°C. Dielectric strength measured with 2 inch electrodes on 2 mil films baked for 16 hours at 150°C. is 1000-2000 volts/mil, dry, and 500-1500 volts/mil, wet. Heat flexibility is more than 100 hours at 250°C. Cured films have good resistance to dilute acids, concentrated hydrochloric acid, and dilute or concentrated alkalies.

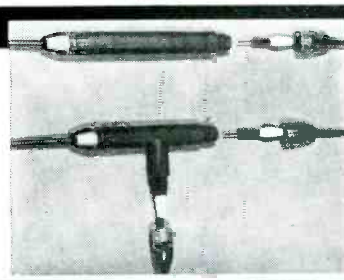


Flashover in high voltage television power supply coils can set ordinary organic varnish aflame. To eliminate this fire hazard, coils are impregnated with Dow Corning 996. Highly resistant to arcing, 996 provides positive protection against carbon tracking for the life of the entire set.

SILASTIC *, THE DOW CORNING SILICONE RUBBER

Silastic combines the remarkable heat stability and moisture resistance of resinous silicones with the physical properties of rubber, including resilience, shock and abrasion resistance, and resistance to both mechanical and electrical fatigue. Its dielectric properties show little change over a wide range of frequencies, even after aging at high temperatures. The surface resistivity of Silastic is high, and its thermal conductivity is about twice as great as that of either organic rubber or resinous insulating materials.

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



Completely eliminating taped connections on aircraft antennae, white Silastic seals reduce static and corona discharge by as much as 90%. They retain their resilience as well as their dielectric properties, excluding moisture and foreign matter after long exposure to the full range of ground and stratospheric temperatures.

SILICONE-GLASS LAMINATES

DOW CORNING THERMOSETTING RESINS are used to bond inorganic fabrics and finely divided particles such as powdered metals or mica. Typical ⅛" silicone-glass laminates have a flexural strength of 22,000 to 45,000 psi; water absorption after 24 hours of 0.25 %; dielectric strength with continuous filament cloth of 250 volts/mil or more; power factor of 0.002 at 1 mc; loss factor of 0.007 at 1 mc; wet insulation resistance of more than 10^{12} ohms; arc resistance of 300 seconds and a heat distortion value above 250°C.

For maximum dependability and long service life, silicone-glass terminal blocks and contactor bases are being used in late model automatic toasters. Tests prove that Dow Corning silicone resin bonded glass laminates are more rigid, more heat-stable, more resistant to moisture and easier to fabricate and assemble than conventional materials.

MAIL THIS COUPON TODAY!

DOW CORNING CORPORATION, DEPARTMENT BE-11, MIDLAND, MICHIGAN

Please send me full information on the subjects checked:

☐ Dow Corning 200 Fluids ☐ Dow Corning 4 Compound ☐ Dow Corning Electrical Insulating Varnishes ☐ Silastic ☐ Dow Corning Silicone-Glass Laminates ☐ Reference Guide to Dow Corning Silicones

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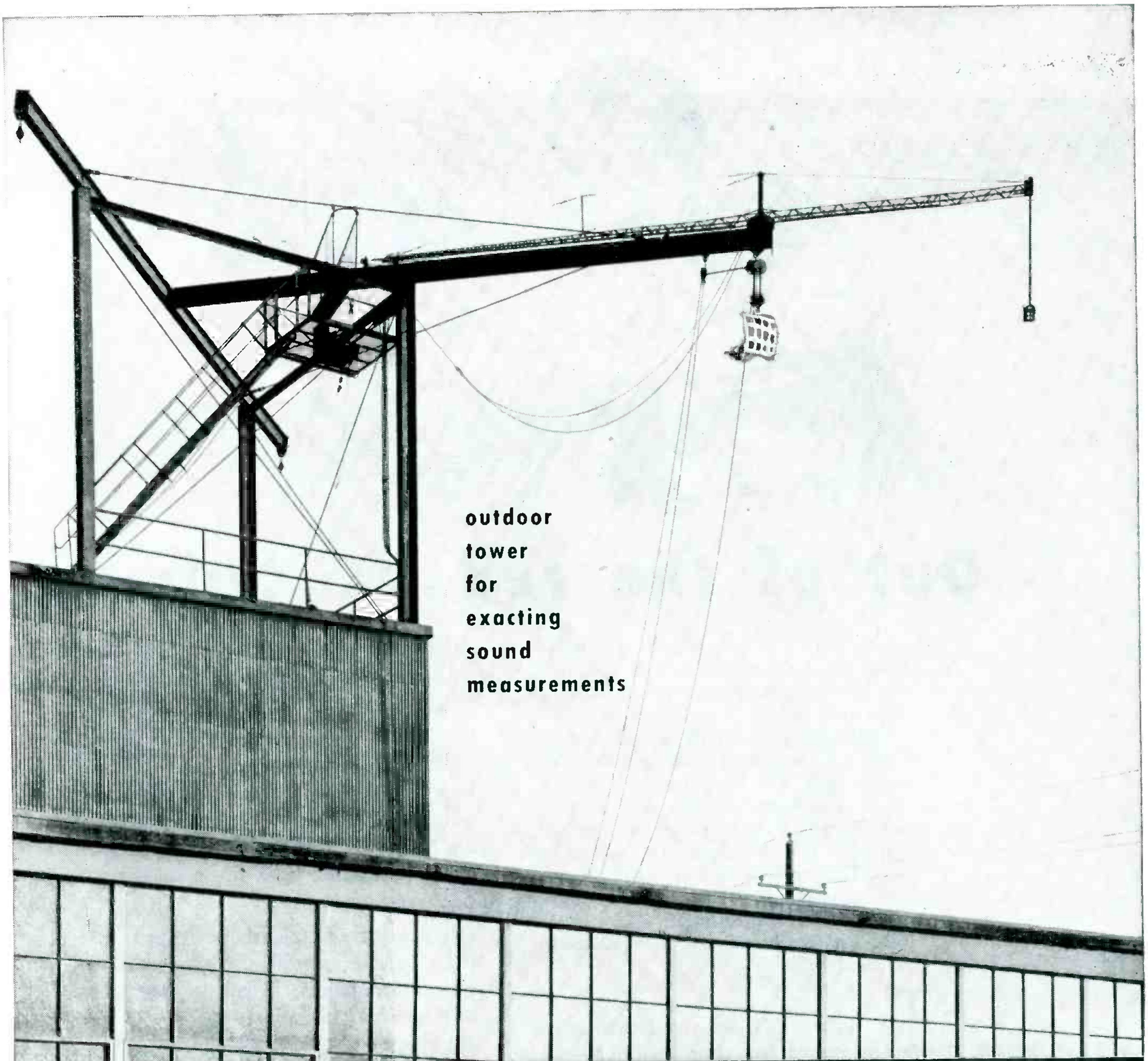
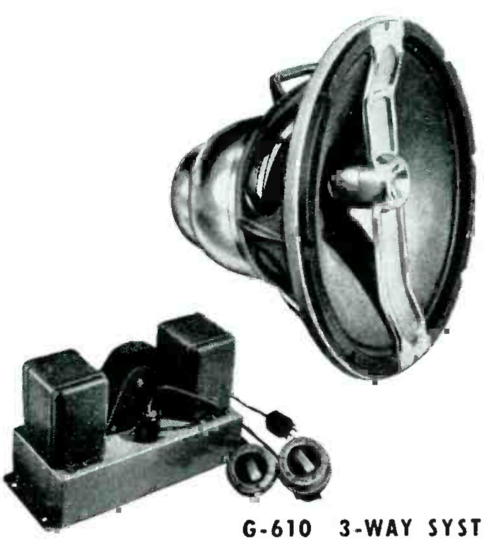
FIRST IN SILICONES

DOW CORNING CORPORATION

MIDLAND, MICHIGAN





G-610 3-WAY SYSTEM
World's Finest Loudspeaker

Jensen

. . . foremost

in advanced-design loudspeakers

Jensen's history is the history of the sound reproduction art itself. Dedicated to the purpose of making fine loudspeakers, Jensen engineering has led in the introduction of new basic developments, types and models . . . has been first most often throughout almost 25 years of progress in sound.

Typical of the engineering tools brought to bear on loudspeaker research, is Jensen's outdoor tower . . . high in the air, away from reflecting surfaces . . . used for precise measurements of acoustic performance.

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BURTON BROWNE ADVERTISING

Out of the red.....almost

Strike settled at long last — materials stock piled for uninterrupted production—orders pouring in with every mail. Blow that whistle — pull that switch — everything all set for full speed ahead. Then . . . the conveyor belt grinds to a stop — just like that, so does work. What had been a scene of bustling activity changes to a rest period. Profits geared to machine regularity, slow to a loss. The repair crew will find a motor breakdown due to failure of insulation on the coil leads. In order to save pennies, a motor manufacturer lost dollars in good will.

The right electrical insulation is the best insurance for your product — and your reputation. This is the reason more and more electrical equipment manufacturers are turning to BH "649" Fiberglas Sleeving and Tubing.

Available in three grades — A-1, B-1, and C-1, BH "649" is a tough, superior insulation remarkably abrasion resistant and permanently flexible. It will take unusual abuse without loss of its physical properties, or dielectric strength. In fact, often a less expensive grade can be used since there is little or no loss of dielectric strength in assembly or product use.

BH "649" is unaffected in heat tests of 425-450°F for 15 minutes, 302°F for 24 hours, 220-230°F for 1500 hours. Can be doubled back upon itself without cracking at −49°F.

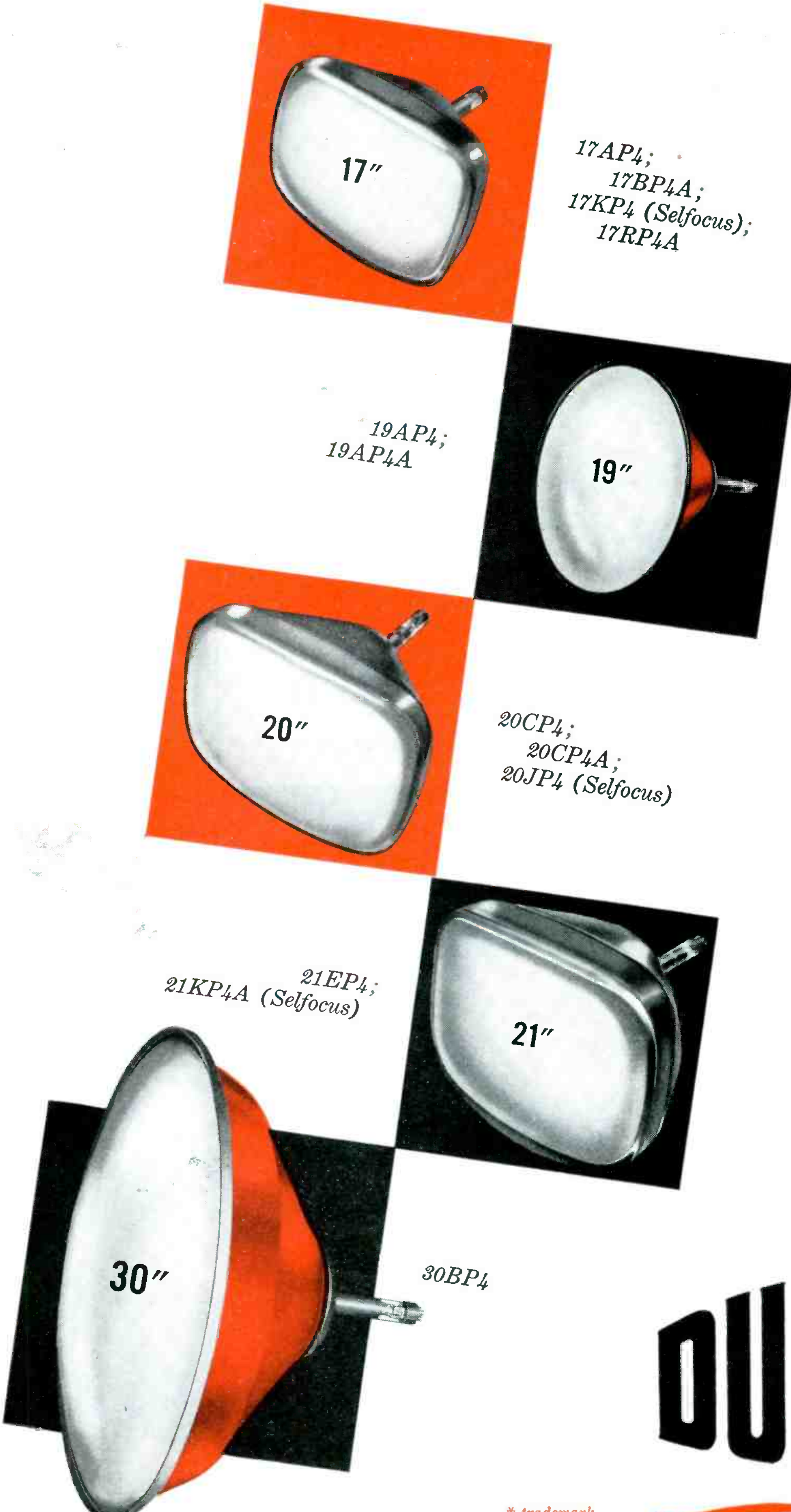
Crackproof, splitproof, peelproof, frayproof, it will not fog, corrode or support combustion, resists moisture, oil and ordinary chemicals.

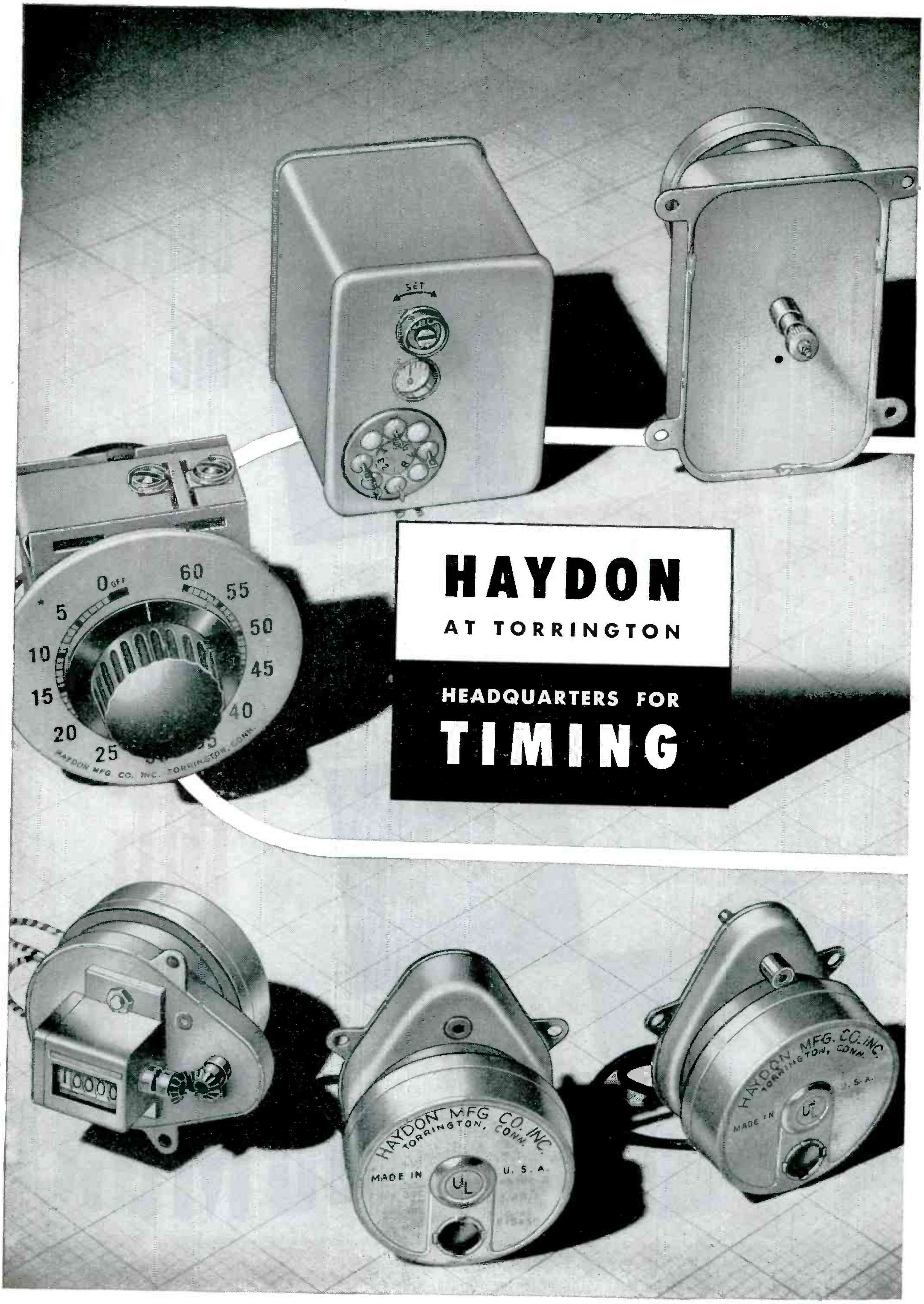
BH "649" is one of a family of electrical insulations, each designed to meet particular conditions in service. Give us a few facts about your requirements — product, temperatures, voltages — we will gladly furnish samples for testing purposes.

Address Dept. E-11
Bentley, Harris Manufacturing Co.
Conshohocken, Pa.

BH *Fiberglas SLEEVINGS**

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


17"
17AP4; 17BP4A; 17KP4 (Selfocus); 17RP4A
19"
19AP4; 19AP4A
20"
20CP4; 20CP4A; 20JP4 (Selfocus)
21"
21EP4; 21KP4A (Selfocus)
30"
30BP4


HAYDON
AT TORRINGTON
HEADQUARTERS FOR
TIMING
HAYDON MFG. CO. INC.
TORRINGTON, CONN.
MADE IN U. S. A.

TIMING MOTORS

HAYDON* timing motors offer many advantages. Slow rotor speed allows minimum of gearing for various output shaft speeds providing quiet operation and long life. Unusually small size. Motors totally enclosed. Controlled lubrication with separate rotor and gearing lubricating systems permits selection of best method and lubricants. Operates continuously in any position. Simple to mount securely. Interchangeable design in only 2 motor series with standard speed range from 60 rpm to one revolution in 7 days. Write for Motor Catalog.

400 CYCLE MOTORS and TIMERS

FOR MILITARY APPLICATIONS

HAYDON research and engineering staffs constantly seek to develop new and build better products. One example is the HAYDON 400 cycle timing motor. This is an hysteresis type synchronous timing motor, for use as a separate motor or in many different types of timers. HAYDON personnel and plant are equipped to build motors and timers using D.C., 60 cycle or 400 cycle for military or civilian applications. Write for Engineering Bulletin No. 2 for complete information on the 400 cycle motor.

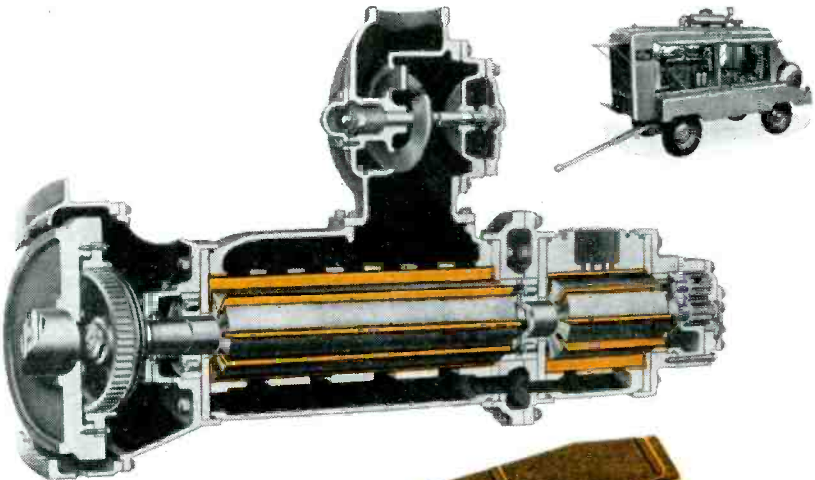
TIMING DEVICES

HAYDON specializes in the manufacture of timing components for standard applications and also in the design and mass production of custom-engineered timers for volume applications. The basic element of all HAYDON timers is our own rugged industrial motor described above. This means that HAYDON timing devices can be depended upon to give long, quiet operation. They are small and compact and offer designers unusual latitude in that they may be mounted and will operate without interruption in any position. Write for Device Catalog.

HAYDON Manufacturing Co., Inc.

SUBSIDIARY OF GENERAL TIME CORPORATION

2435 ELM STREET, TORRINGTON, CONNECTICUT



How to put on the squeeze

In the illustration above you see vanes used in the new Ingersoll-Rand Gyro-Flow portable air compressors. These vanes do an unusual job. They are made from an unusual material—Synthane laminated plastic.

The vanes are inserted in slots in a rotor which is mounted off-center in a cylinder. As the rotor spins, centrifugal action forces the Synthane vanes against the inside of the cylinder to form chambers between the vanes. Because of the eccentric mounting, these chambers constantly change in dimension. As they enlarge, air is drawn through intake ports in the cylinder walls. As they contract, the air is forced under pressure through discharge ports.

The result is a steady flow of compressed air without pulsation or vibration. Because of the complete simplicity of the machine, the compressor is lighter, more efficient, more economical to operate than conventional compressors.

It is apparent that the vanes are important components. They must be strong, light in weight, unaffected by the oils used to lubricate and form an air-tight seal between the vanes and the cylinder walls. They must be hard and dense to stand up under continuous operation yet not so hard as to score the walls of the cylinder.

Synthane has all of these properties and many more. In fact, it has so many useful mechanical, electrical and chemical characteristics that it cannot be adequately described in less than a complete catalog. If you have need for such material, a catalog containing a complete description of Synthane may be obtained by writing Synthane Corporation, 6 River Road, Oaks, Pennsylvania.

PLASTICS WHERE PLASTICS BELONG

SYNTHANE

S

Manufacturers of laminated plastics

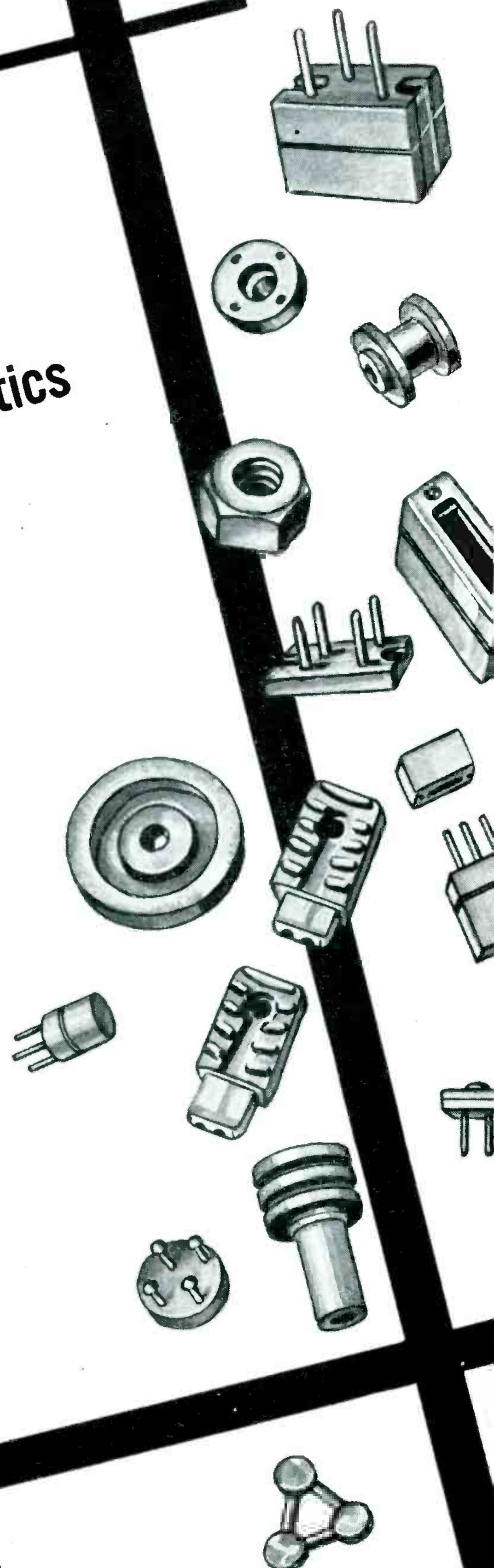
designers, product engineers . . .

a new moldable dielectric polymer that will maintain its exceptional insulating characteristics under high temperatures and ultra-high frequencies

AMP

POLYZOL

Trade-Mark



Write for Information Bulletin.

AMP

AMPLIFILM DIVISION

AIRCRAFT-MARINE PRODUCTS INC.

2100 Paxton Street, Harrisburg 10, Pa.

for PRECISION *Controls...*

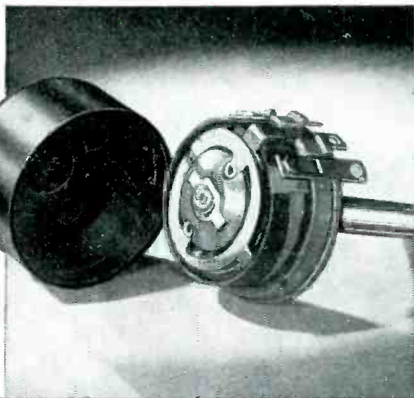
you can stand pat with CLAROSTAT

You know, of course, that Clarostat produces a major portion of those standard controls and resistors found in today's radios, TV sets and other commonplace electronic assemblies.

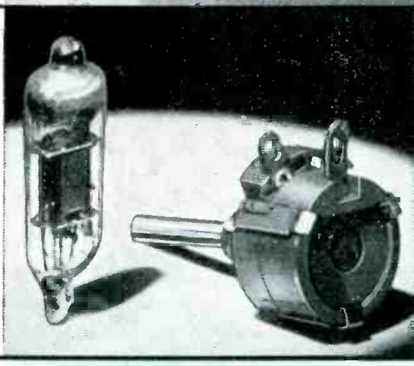
But did you know that Clarostat also builds *precision* controls and phasing controls to meet the most exacting requirements of *critical* electronic equipment?

Yes indeed, for years Clarostat has been supplying those superlative controls required in *precision* electronics. Herewith are three typical examples of Clarostat's *precision* craftsmanship.

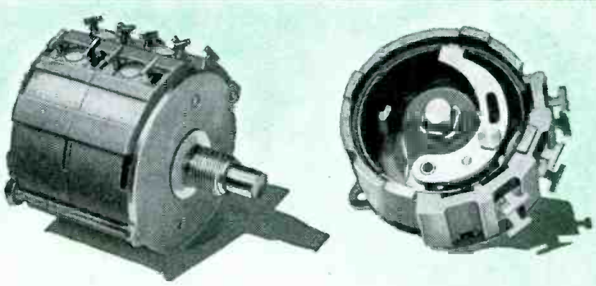
Regardless how difficult your control requirements may seem, *try Clarostat!* For here you will find the necessary experience background, engineering skill, production facilities and real pride of workmanship that can provide the answer to your *precision control* problem.



This precision potentiometer has a tapered winding held to plus/minus 1½% linearity as measured at 10 test points. Mechanical tolerances held to plus/minus 0.00025". Unit operates dependably over extreme ranges of temperature, humidity, altitude or barometric pressure, and severe vibration. Obviously built to a *quality* standard rather than to a price.



Shown alongside a miniature tube is this Clarostat Series 48 sub-miniature potentiometer. Only ⅝" dia. — no bigger than a dime! Carbon element up to 3 megs. linear; slightly higher in taper. 0.4 watt rating. Single, dual, triple units. Essential in ultra-compact electronic assemblies. Here's *precision* in diminution.

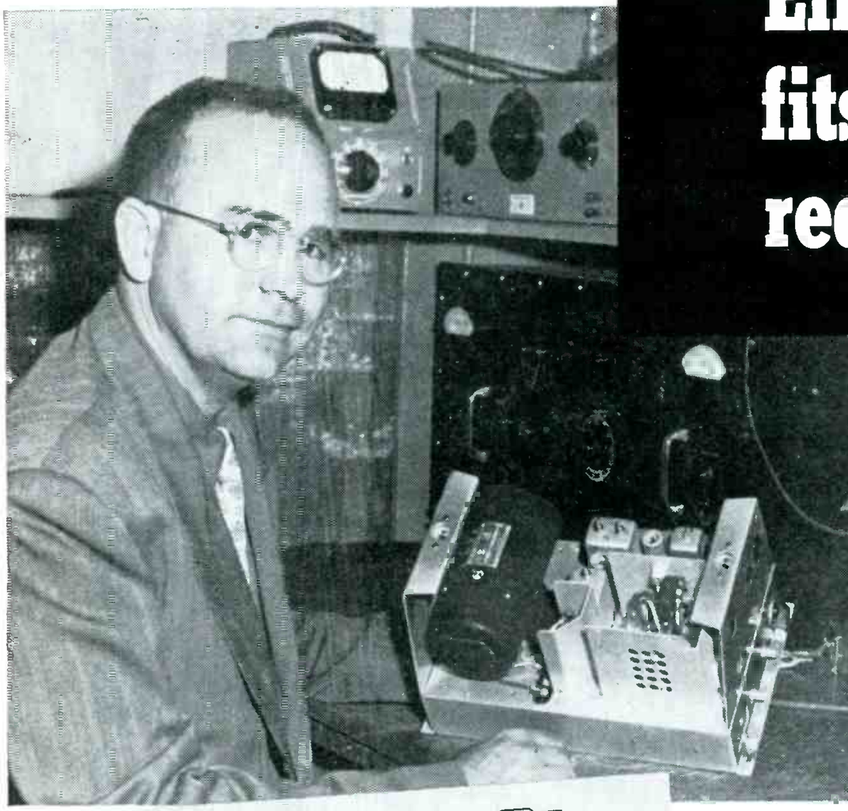


For *precision* multiple controls such as in electronic computing equipment, the Clarostat Series 42A potentiometer is *unique*. *Precision*-wound elements. Metal spraying for accurate start and finish points. Linear: 100 to 100,000 ohms. 3 watt rating. Also in tapered. No backlash or play. Tracking of all units positively assured. As many as 20 sections in a single tandem assembly. Standard overall resistance tolerance of plus/minus 5%. Outstanding mechanical *precision*. Definitely, the "impossible" made possible.

"the house of PRECISION controls" CLAROSTAT

CLAROSTAT MFG. CO., INC.
Dover, New Hampshire
In Canada:
Canadian Marconi Co., Ltd., Montreal, P. Q. and Branches

"Eimac 4-65A fits exacting requirements"



John M. Kaar, President of Kaar Engineering Co., prominent manufacturers of high quality radio-telephone equipment.

KAAR ENGINEERING CO.

PHONE DAVENPORT 3-0001
2995 MIDDLEFIELD ROAD
PALO ALTO, CALIFORNIA

July 13, 1951

Eitel-McCullough, Inc.
798 San Mateo Avenue
San Bruno, California

Gentlemen:

For some time now our FM-179X 50 Watt mobile transmitters have been in use, many of them in foreign countries under extremely trying operating conditions.

We believe you would be interested in knowing that the Eimac 4-65A was the only tube that could fit our exacting requirements in designing this equipment. The 4-65A combines ruggedness, dependability and high power output in an instant-heating tube that can stand up under the most difficult operating conditions. It made possible the design of a compact high-powered mobile transmitter with extremely low vehicle battery drain.

Cordially,

John M. Kaar

John M. Kaar

INSTANT HEATING

Eimac 4-65A tetrodes are the heart of the Kaar FM-179X mobile transmitter. As Mr. Kaar indicates, his engineers chose these tetrodes because they were known to be outstandingly dependable and because they exhibit highly desirable operating characteristics.

The 4-65A is excellent for power amplifier and modulator service in both fixed and mobile stations. They operate over a plate voltage range from 600 to 3000 volts with output powers ranging from 50 to 280 watts per tube. Upper operating frequency of the 4-65A under normal conditions is 220 Mc.

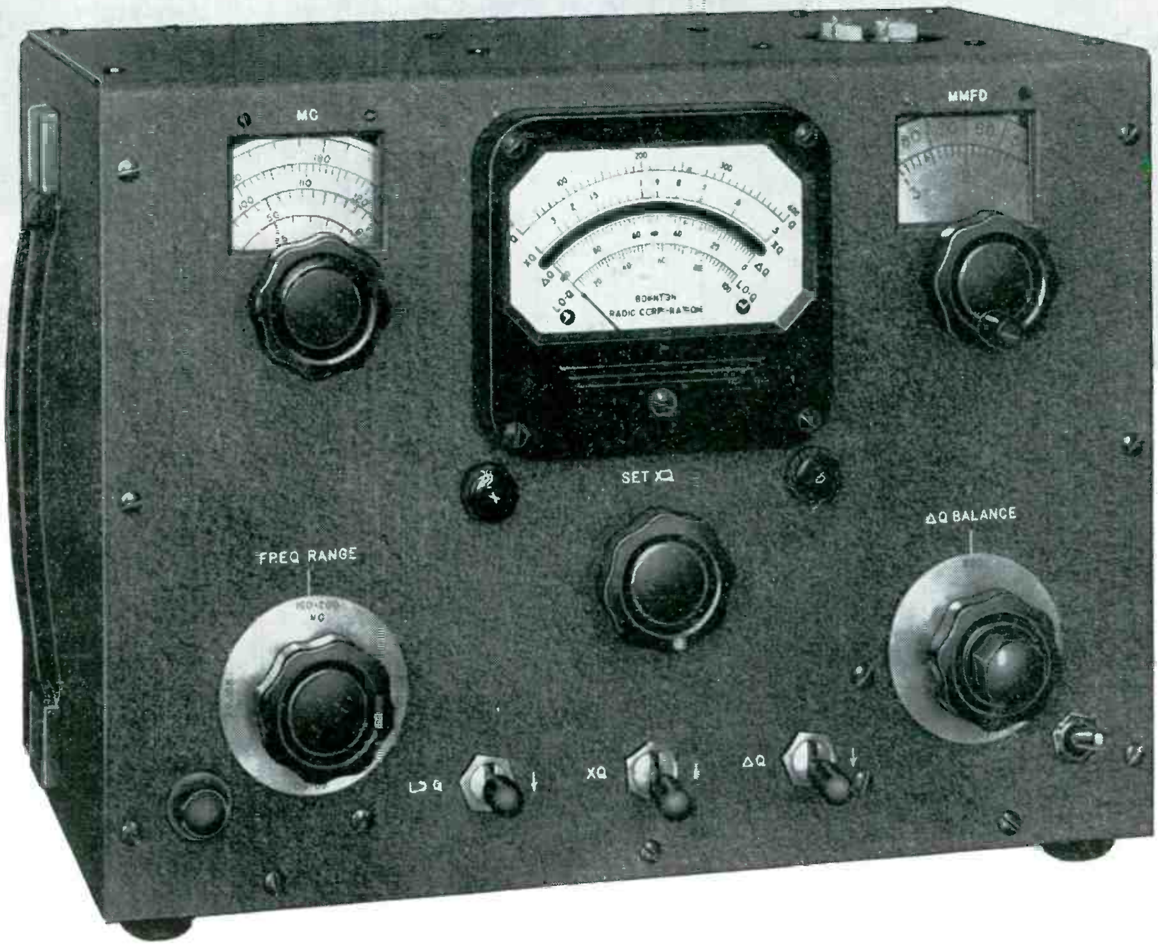
Put Eimac 4-65A tetrodes to work for you . . . take advantage of their proved performance and low cost. Complete data available upon request.

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

301

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

Announcing a significant



Here is the Q Meter you helped to develop

Over a period of seventeen years we have manufactured thousands of Q Meters and our customers have worked with us on application problems of a wide variety. Our own laboratories have amassed quantities of data on performance requirements. The result of our experience and research is a new VHF Q Meter capable of measuring an essential figure of merit of fundamental components to better overall accuracy than has been previously possible.

Engineers whose suggestions contributed to the design of the Type 190-A Q Meter will recognize immediately many of its new, important features. Construction of the instrument is simpler, more rugged. The resonant method of measuring Q, used in all Boonton Q Meters, has been retained because time and usage have proved it to be superior to all other methods.

Perhaps most noteworthy is the improvement in electrical performance. The VTVM, which measures the voltage at resonance, has a higher impedance over the entire frequency band—internal resistance of the resonating capacitor and associated circuit is extremely low—minimum capacitance and residual inductance of the Q measuring circuit are decreased. You will note that all of these improvements broaden the useful range of measurements for a given accuracy.

If you have immediate or possible applications for the 190-A Q Meter, write us for complete information. Boonton Radio Corp., Boonton, N. J.

new development in VHF measurements

The Q METER, Type 190-A

Frequency Range 20 mc. to 260 mc. **Q Indicating Range 5 to 1200**

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- Q indicating voltmeter: 50 to 400.
- Multiply Q scale: 0.5 to 3.0.
- A differential Q scale for accurately indicating the difference in Q between two test circuits.
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- Careful design to minimize instrument loading of circuit under test.
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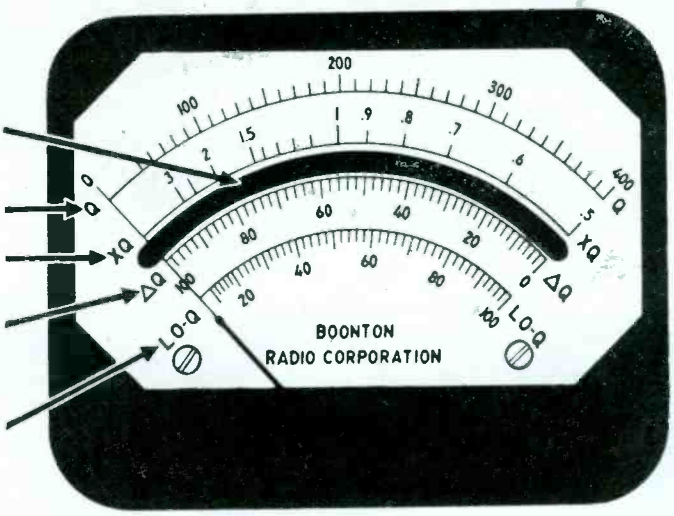

SPECIFICATIONS—TYPE 190-A

FREQUENCY RANGE: 20 mc. to 260 mc.

RANGE OF Q MEASUREMENT:

Q indicating voltmeter:	50	to	400
Low Q scale:	10	to	100
Multiply Q scale:	0.5	to	3.0
Differential Q scale:	0	to	100
Total Q indicating range:	5	to	1200

PERFORMANCE CHARACTERISTICS OF INTERNAL RESONATING CAPACITANCE: Range—7 mmfd. to 100 mmfd. (direct reading).

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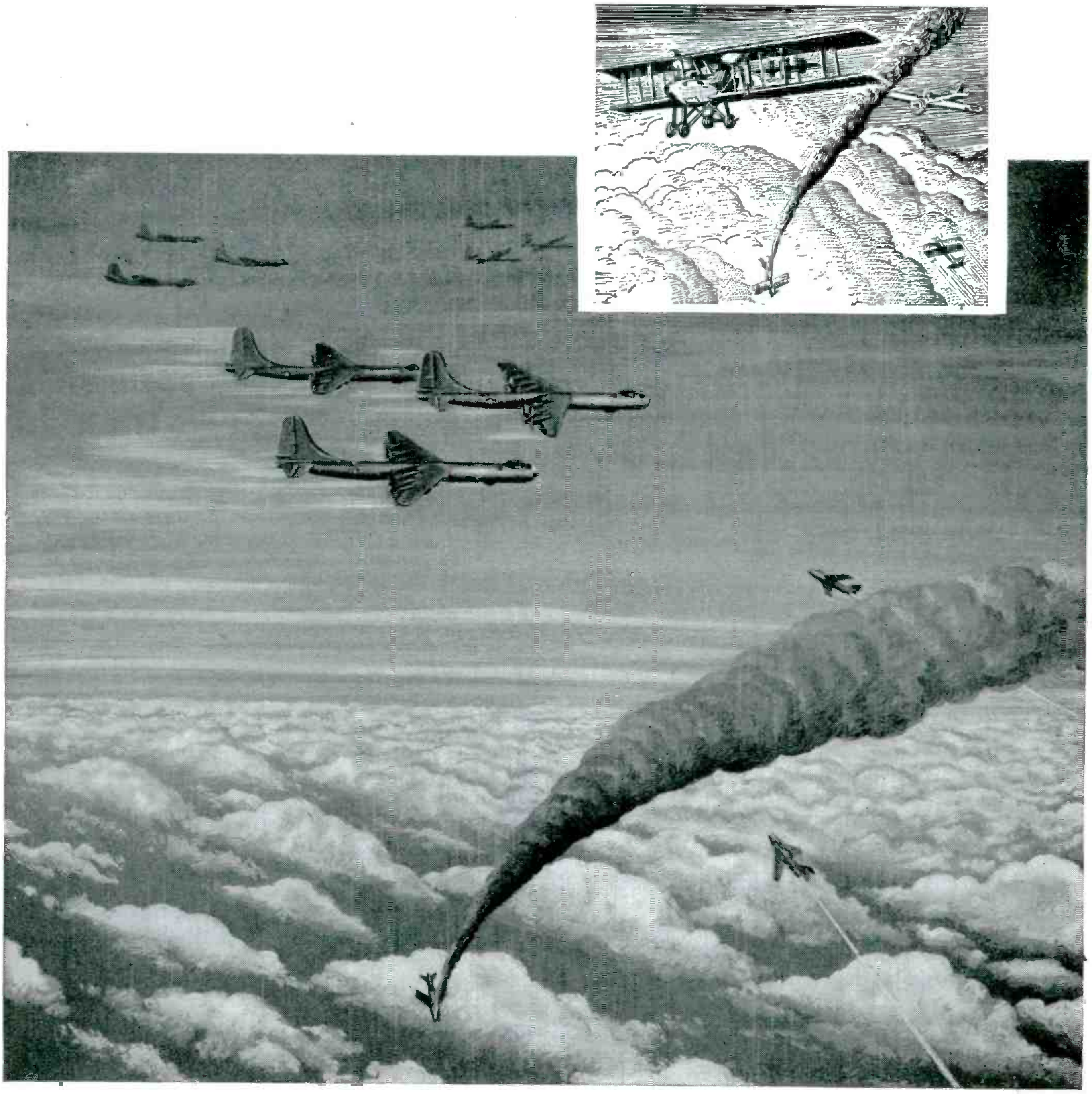

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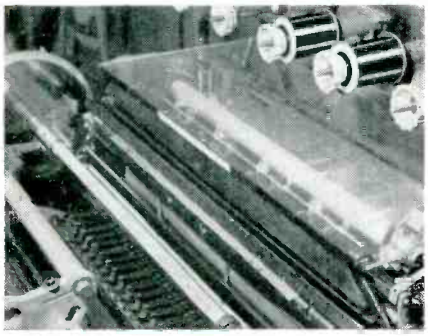
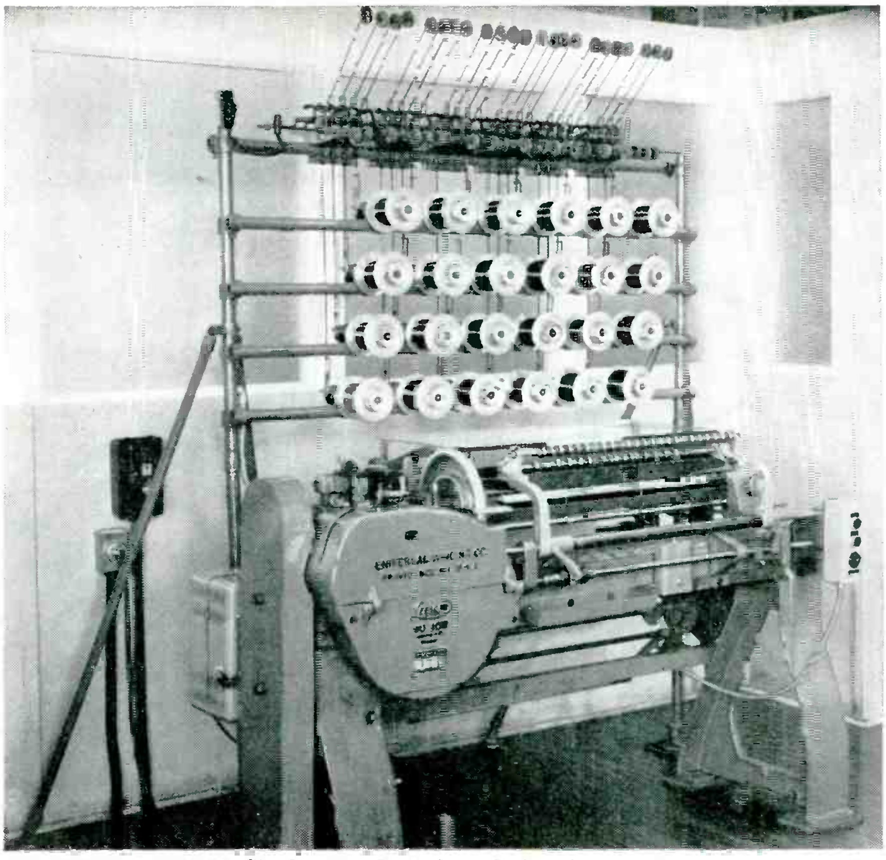
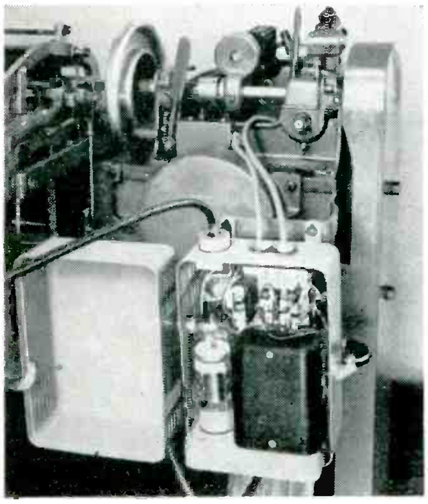


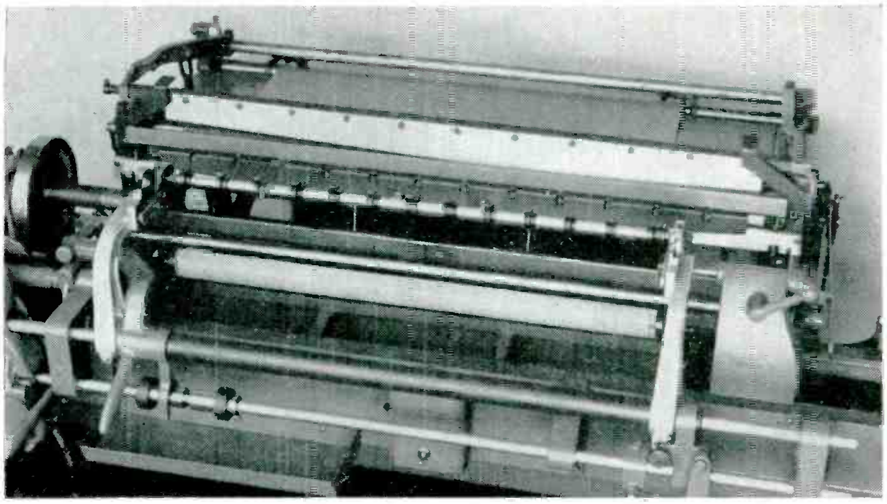
MAXIMUM COIL DENSITY An entirely new type of delivery shelf is used to insure coils of extreme accuracy and high density. It imparts a uniform backward pull to the paper as it is fed into the coil.



25 INSERTS A MINUTE Single or laminated insulating sheets, either paper or acetate, are fed into the Leesona No. 107 Coil Winder at rates as high as 25 per minute. Thus, on a coil containing 100 wire turns per layer, the machine can be run at speeds as high as 2500 rpm.



SLOW, CUSHIONED AUTOMATIC START Electronic speed-control automatically and smoothly accelerates the winding arbor to required speed and maintains it. No "jockeying" needed by operator. Wire breakage is minimized, tension is uniform.



EASY MANUAL OPERATIONS Photo shows coil arbor in position for quick transfer. Wire turn counter can be reset quickly. No cam transfers are required when changing wire layer length, wire spools are easily changed.

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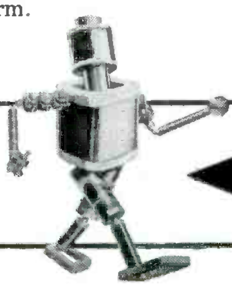

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For winding coils in quantity accurately . . . automatically use Universal Winding Machines

238.1.3

BUSINESS BRIEFS

By W. W. MacDONALD

Material Shortages were most troublesome in the field of electronics about a year ago. Then the situation eased because early controls designed to avoid dissipation of unknown stockpiles were loosened as it became apparent (1) that military apparatus still in process of design would take some time to produce, (2) that certain materials were in plentiful supply and (3) that consumer buying was declining.

Now we are facing a new period of shortage, and this time it is more real than imaginary, since critical materials are actually being used in quantity in the production of military gear. Washington people tell us that shortages will pinch harder and harder until well into 1952, and that sometime during that year relief will come as the peak of military production is passed.

That the pinch will become harder is a prediction with which we readily agree. As to when the peak of military production will be passed, bringing relief, we note that there are two variables, first, our own production capacity and, second, Stalin's timetable.

Californians, it was noted last month in this column, are making a strong bid for defense business. We have just returned from a three-week trip which took us into 47 plants in the San Francisco bay area and in Los Angeles county and offer the following observations:

For many years design and development work under way on the West Coast has been impressive. Now firms in that area are beginning to put the heat on *production* and all but two of the plants visited had just added materially to their physical facilities or were about to do so.

Still buying certain materials and component parts from other sections of the country at something of a premium, manufacturers now shooting at national rather than regional distribution and in a fair way toward achieving it are looking more intensively for new sources of supply. And are finding some closer at hand.

More highly specialized insofar as products are concerned, and in most instances still smaller than older firms making similar products farther east, California electronic equipment manufacturers are nevertheless handling sizeable contracts by cooperating with each other to an extent not often seen elsewhere. Collective action in the common interest appears to be both pleasant and profitable.

Speaking Of Cooperation, there was a great deal of it involved in the highly successful seventh annual Pacific Electronic Exhibit and Conference held in San Francisco's Civic Auditorium just one jump ahead of the Japanese Peace Conference.

West Coast buyers of some influence helped the Committee induce the largest number of midwest and eastern manufacturers so far to exhibit their wares. IRE tied in. And it seemed to our green eastern eyes that even the Bay Area and L. A. members of WCEMA eschewed the usual pleasantries regarding relative merits of the two areas with respect to climate, flora and fauna, traffic and civic virtue.

A Highlight among the various Pacific Electronic Conference papers, proving, if further proof is needed, that Californians are now definitely out of the longhair stage and quite aware of the commercial facts of life, is the following quote.

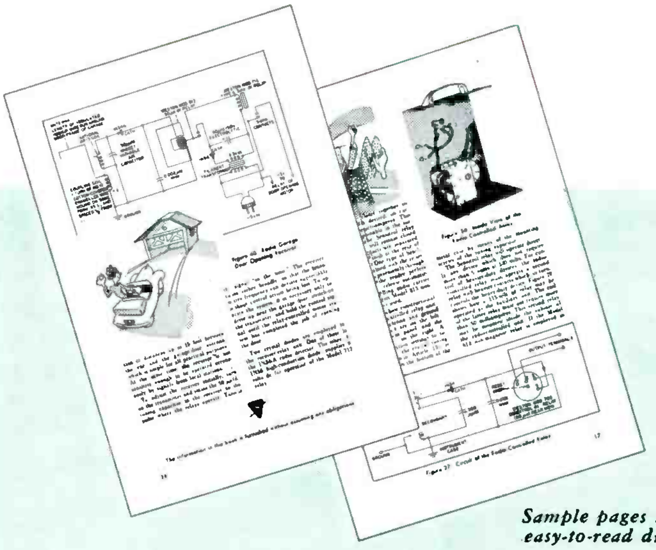
Said Russell Varian regarding development work: *"When you have money enough you don't have time enough, or vice versa."*

Mt. Wilson is Southern California's television highspot equivalent to New York's Empire State Building, so we went up there to browse around.

First thing we noticed was that

Put Electronics to work

IN YOUR HOME!



Sample pages showing easy-to-read diagrams.

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SYLVANIA ELECTRIC PRODUCTS INC. 1901-1951 — 50th ANNIVERSARY — FIVE DECADES OF PROGRESS

SYLVANIA ELECTRIC

ELECTRONIC DEVICES; RADIO TUBES; TELEVISION PICTURE TUBES; ELECTRONIC TEST EQUIPMENT; FLUORESCENT TUBES, FIXTURES, SIGN TUBING, WIRING DEVICES; LIGHT BULBS; PHOTOLAMPS; TELEVISION SETS one of the stations used a high-gain antenna that appeared to have been bent over a little by the wind. Investigation disclosed that the bend was deliberate, to pump stronger signals into a growing residential area of L. A. down near the base of the mountain. (Coincidentally, we note that tilting of uhf tv antennas to insure good local coverage has been suggested elsewhere in the public prints.)

Another station up on Wilson, the oldest one there in fact, secures excellent coverage near the base of the mountain by what might at first blush be considered default. The antenna is not new, and therefore does not have particularly high gain. So it doesn't pump signals over the heads of people down near the base of the mountain.

Station Operators on Mt. Wilson get what might be considered portal-to-portal pay, being paid from the time their car starts up the mountain until it is back down off again.

First station we entered early one morning had two very busy operators. They asked us to stick around a minute for a ragchew because, to put it in their words, "We're just getting the station on the air for the day . . . *we hope!*"

The old wheeze involving a grid-leak drip pan is no longer far fetched. In one of the stations visited a water-cooled final amplifier definitely could use such a gimmick.

GE's CD Conference at Syracuse (p 150) may have stimulated more people in civil defense work to practical action on communications matters than anything that has yet been done by official government agencies.

Two things quickly became apparent to us while circulating among men attending the conference; first, that most of them had never before had an opportunity to meet each other for a face-to-face discussion of common problems and, second, that few had previously seen any kind of emergency communications system in actual operation.

Also noted was the favor with which the story of Onondaga County's system was received as it became apparent that it was based primarily on a tieing together of existing communications facilities rather than upon a brand new network starting expensively and therefore unrealistically from scratch.

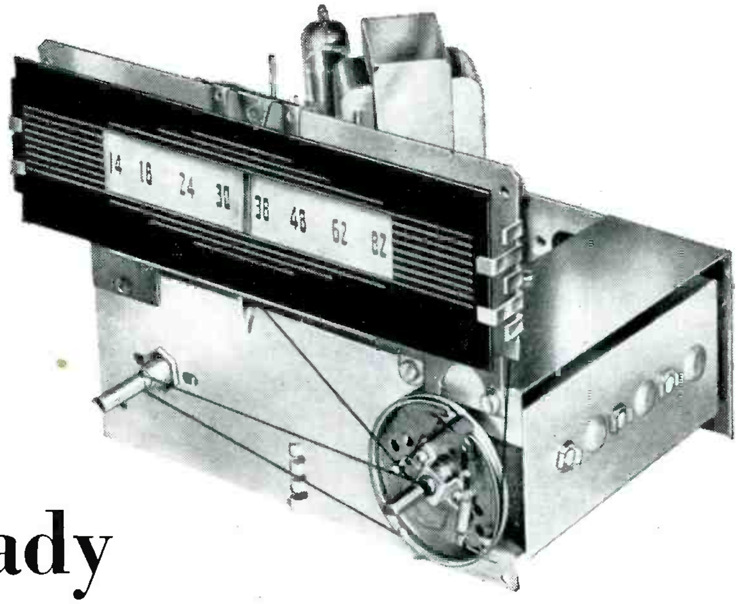
The major problem faced by all CD directors was picturesquely summed up by the county's Harvey S. Smith as follows: *"Lord, please continue your help and give me a communications system which will permit me, at very little cost, to talk back and forth with anybody in my organization. Communications, Lord, which will require little upkeep, easy technical operation, few telephones. And, above all, pleasant, intelligent and efficient people to staff my communications net."*

To which we can only add: *Amen.*

DX has a new meaning which will fascinate radiomen. You put the letters DX on orders calling for products, components or materials other than steel, copper or aluminum when delay in delivery would jeopardize top-urgency defense programs, says NPA.

Delicate Subject to be approached with the utmost finesse, yet nevertheless firmly approached because it appears to represent virgin editorial material, is the matter of *"Plant Pin-Ups."* We refer, of course, to the airbrushed or photographed lovelies pictured on calenders or torn from the pages of less staid magazines and found gracing the walls over desks, drafting boards and machines throughout our business.

Paid to explore the recesses of the subscriber mind with the objective of rendering a better editorial service, we have been conducting an unofficial and purely personal survey on the subject. So far, we must admit, our findings seem a far cry from the desired straight line between two points. Someone, it seems, has pitched us a curve.



UHF

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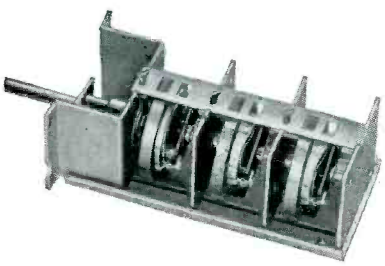
to equip any receiver for UHF channels



Mallory UHF Tuner

A new version of the continuously variable Mallory Inductuner®, consisting of three sections of variable inductance. Covers the range between 470 and 890 megacycles with approximately 2 micromicrofarads of shunt capacity and in 270° of shaft rotation. Selectivity is excellent over the entire band.

Available now for assembly in your converter or as an auxiliary UHF tuner in your receiver.

Now In Development
A combination VHF-UHF tuner.

The Mallory UHF converter has been designed to permit the tuning of *all* UHF channels by *any* TV receiver, with no sacrifice of VHF reception. Connection to the receiver involves only the power line and antenna leads—no internal adjustments are required. Check the characteristics listed below and in the panel at the left describing the basic tuner.

Physical dimensions 8⅛″ x 6¼″ x 5³⁄₁₆″

Built-in IF amplifier operating at the conversion frequency (channels 5 and 6) makes up for conversion and tuning losses

Temperature compensation and stabilization prevents frequency drift after initial warm-up

Low noise figure

High image and IF rejection ratios

The converter chassis is now available to set manufacturers for assembly with cabinets, dial plates and knobs of their design. Complete technical literature will be sent promptly on request.

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CROSS TALK

▶ **TRANSITION** . . . L. N. Ridenour, writing in the August issue of *Scientific American*, concludes "there is nothing wrong with electronics that the elimination of vacuum tubes would not fix!" This heretical statement focuses attention on the capabilities and limitations of vacuum tubes. Our science was founded on the ability of electron tubes to do jobs no other device could handle. Right after the war, well-read people everywhere got the idea that electron tubes could do anything. Now the pendulum hovers while we wait its reverse swing.

Electron tubes consume power (particularly heater power) inefficiently; they have limited and unpredictable life; they are fragile. So long as no really effective alternative presented itself, we put up with these shortcomings. Even when the transistor came along, in 1948, most electronic specialists were complacent. Sure, the transistor would do certain jobs: it was efficient, had long possibly indefinite, life. But it was noisy and fragile, expensive and difficult to apply. So the electron tube remained king of the roost, where it stands today.

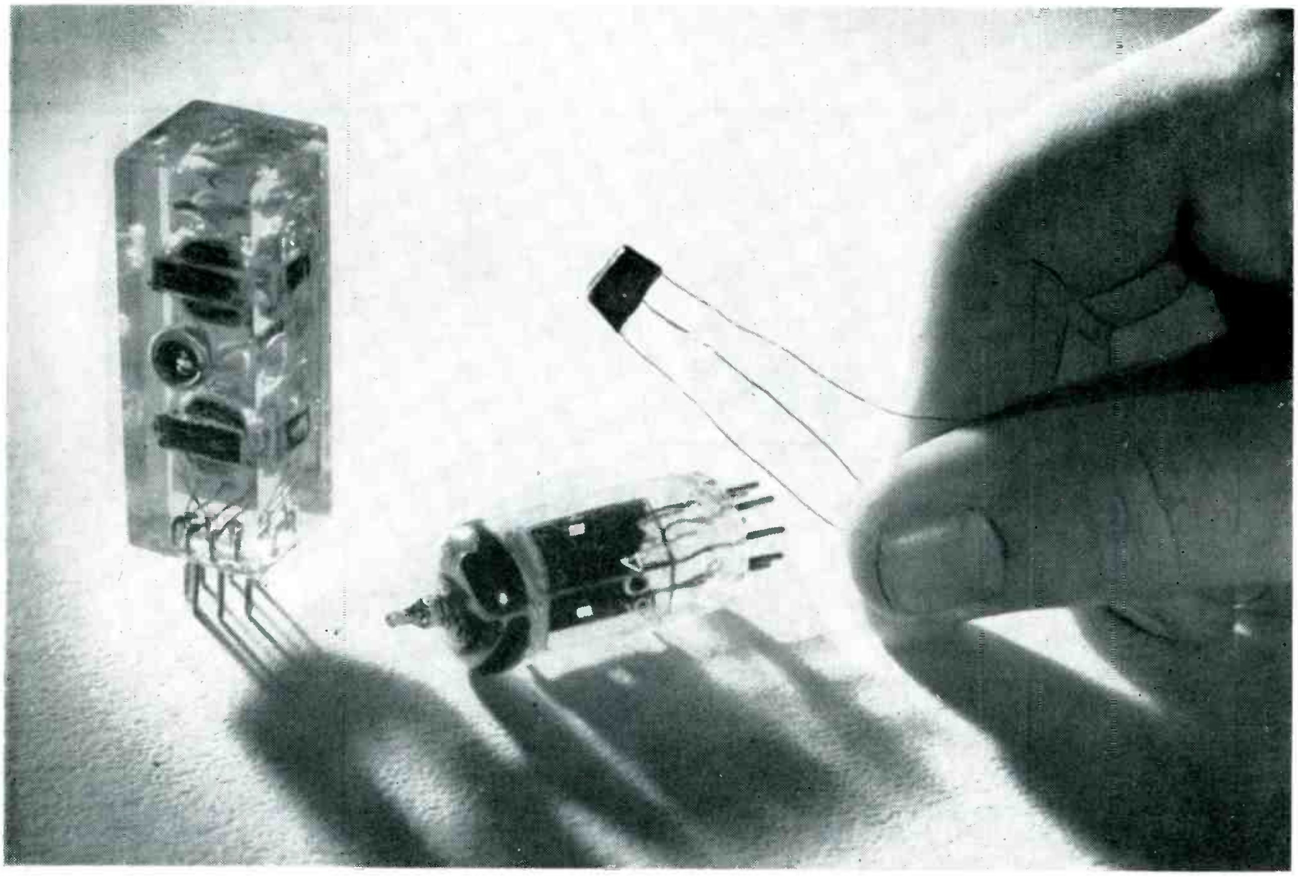
Now the next step has been taken. The junction transistor (p 82 this issue) is enormously more efficient than a vacuum tube, has indefinite life, is not noisy, is rugged as all outdoors, and easy to engineer into a circuit. It's still expensive but that's a detail subject to rapid correction. Every engineer in the know is pricking up his ears. The transistor can no longer be dismissed as a specialty item.

For the first time in half a century the electron tube has a real competitor, with sharp spurs and a disposition to take over. It promises to establish whole new areas of electronic engineering, from computers to telephone switching systems, and it will probably make real inroads in many existing applications, particularly military ones. We plan extensive additional coverage of transistor electronics in forthcoming issues.

▶ **ERROR** . . . We are happy to report that Haraden Pratt has not resigned as Secretary of the IRE, as mistakenly reported here last month. Since his IRE duties in no way conflict with his new job as Telecommunications Adviser to President Truman, Mr. Pratt is still on the job, where we hope he remains for many, many years. Our apologies for the error.

▶ **SCRAP** . . . As one of the industries facing drastic curtailment as a result of the steel shortage, electronics has more than the usual responsibility to get behind the scrap-collection drive. To maintain the present capacity production, steel makers are melting 3 million tons of scrap a month, fifty percent more than they used at the peak of World War II. Big scrap items are needed: obsolete machinery, waiting to be junked, and production left-overs. So take a look around your plant and its back yard. If you've got scrap, get it in to the scrap pile.

▶ **COLOR LINES** . . . We've just come from a look at the new single-gun tricolor picture tube developed by E. O. Lawrence, with findings as reported in the news pages of this issue (p 146). Great confusion seems to have been created by the initial press stories on this device. So here's a quickie: the screen consists of 1,200 vertical color-phosphor strips, arranged in groups of three. Behind it are 400 vertical wires which focus the electron beam on one or another of the strips. It's like the RCA tricolor tube in many respects, but being based on lines, rather than dots, it should be appreciably simpler to make. It will work on the CBS system readily, on the RCA-plus-industry system only if considerable power is available for color deflection. The results are at the moment not impressive in themselves, but improvement is to be expected. Full technical details next issue.



Developmental model of junction transistor illustrated (black object with three leads being held) as compared to a 6C4 miniature triode and an experimental model of a two-stage transistor amplifier imbedded in clear plastic. The amplifier has a power gain of 90 db in the audio range

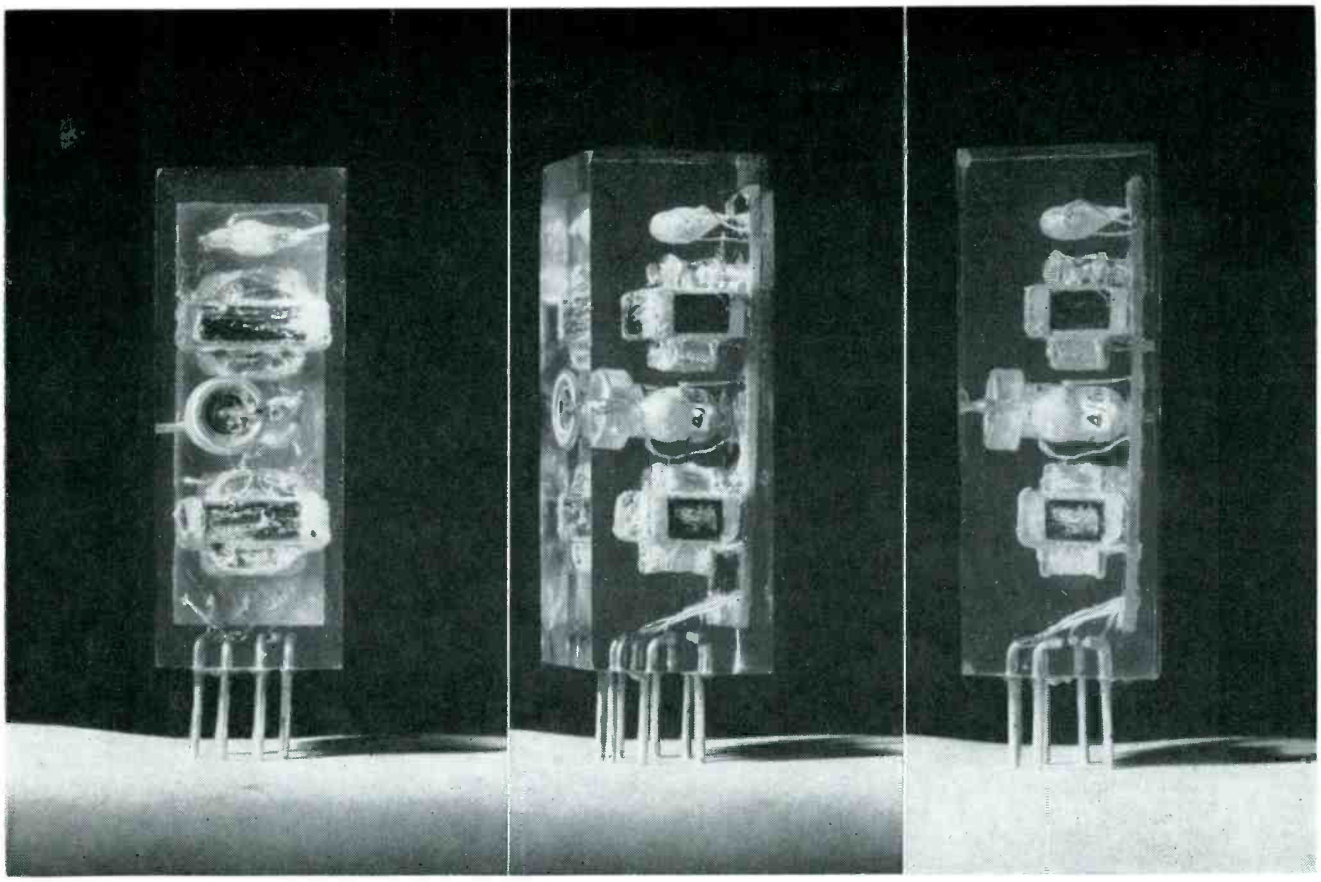
The JUNCTION TRANSISTOR

So IMPORTANT does the new *n-p-n* junction transistor appear for the future of all electronic development that the editors of ELECTRONICS have prepared this review from a recent *Bell System Technical Journal* paper[1] and other published sources, pending the release of more detailed information to appear in forthcoming issues.

Two years ago Shockley of the Bell Laboratories described[2,3] the theory of a junction transistor made of a single crystal of germanium, the germanium being so processed that the crystal is composed of three parts, as shown in the drawing of Fig. 1. The outer ends of the crystal are made of the so-called negative or *n*-type germanium, which contains a particular type of impurity (for example arsenic). These are joined by a thin section of positive or *p*-type germanium, containing a different impurity (for example gallium). The *p*-type has an excess of positive carriers ("electron holes") while the *n*-type has an excess of negative carriers (electrons).

Electrical connections are made to the three sections of the transistor as shown. The center section, called the base, corresponds to the grid of a vacuum tube; the end sections are the emitter and collector, corresponding respectively to the cathode and anode of a vacuum tube. When a signal current flows through the base and the emitter, a larger variation in current between collector and emitter results.

The static characteristics of Fig. 2, which resemble the plate family of a beam-tetrode vacuum tube, indicate the degree of amplification thereby produced. If the collector current I_c is held constant, very small changes in emitter voltage will cause enormous changes in collector voltage V_c. The amplifi-



Three views of the transistor amplifier shown in photograph on left page. Experimental model transistors are visible in the amplifier as white plastic-covered beads. Transformers and other components are also visible. Unit will operate continuously for months with one penlight cell as sole power source

New approach to transistor design eliminates catwhiskers in favor of junction between negative and positive forms of germanium. Major improvements over the point-contact transistor include lower noise, better stability, higher gain and higher power-handling capacity. Reliability and low power consumption permit new large-scale applications now beyond range of vacuum tubes

cation between them may be as much as 10,000 times (80 db) in voltage when the terminal impedances are such as to develop the maximum d-c gain.

In a-c amplifiers, the junction transistor can provide 40 to 50 db of power gain per stage. While gains of this order are theoretically possible in vacuum-tube amplifiers, they are seldom achieved in practice. Moreover, the high gain of the junction transistor amplifier is accompanied by unheard-of efficiency in the use of the applied voltages and currents, partly because no filament-heating power is required and also because about 95 percent of the theoretical maximum plate-circuit efficiency is achieved.

Advantages Over Point-Contact

When the transistor was first announced[4] in 1948, the device consisted of a block of uniform germanium on which two pointed catwhiskers made contact. This point-contact type immediately attracted wide attention as a device which had potentially long life and would amplify without filament-heating power, but it failed to immediately displace vacuum tubes (except in a few special applications) because of certain early problems that arose.

First and foremost among these was the high noise level, as high as 50 to 60 db above the theoretical limit. Second was the limit on the frequency of operation, to not more than a few megacycles. Third, and most important, this transistor was not reproducible nor reliable, at least in the early designs. Finally, its gain was not appreciably greater than that available from vacuum tubes, and its power-handling capacity was notably less than that of receiving-type power tubes. Consequently, the point-contact transistor is not a

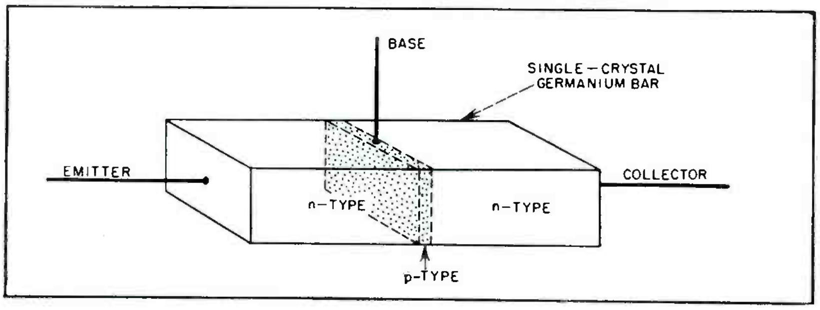


FIG. 1—Diagram of the junction transistor. A thin section of p-type germanium is formed as part of a single crystal, in intimate contact with two larger blocks of n-type material

competitor to vacuum tubes in the low-level input stages of radio receivers, where low noise is essential, nor in the output stages where high power or voltage is essential. On the other hand, current results with point-contact transistors show that they can now be made on developmental level with reproducibility of current vacuum tubes and reliability in excess of that obtainable with tubes. Such transistors are finding widespread usage in switching and computing circuits where negative resistance and high-frequency response are important.

The *n-p-n* junction transistor, it now appears, has removed all of these limitations except one (limited high-frequency response) and there is every right to hope that this remaining limitation can be overcome in time. As a result, when the problems of mass production are solved, it appears that the junction transistor may compete directly with receiver-type vacuum tubes in virtually all applications involving signal frequencies lower than a few megacycles and gain-bandwidth products of the order of 100 mc. The extremely high efficiency and absence of heating power fit it particularly for applications involving mass assemblies of amplifiers and trigger circuits, such as electronic computers. Its ruggedness, reliability and long life fit it for parts of the telephone system, notably local switching and subscriber circuits, where vacuum tubes have hitherto never been used.

Noise and Stability

A recently developed theory of noise in transistors, details of which have not yet been published, indicates that the noise inherent in a plane junction between *n* and *p* germanium should be substantially lower than that associated with a point contact. Measurements on the *n-p-n* junction transistor confirm this; in fact the units thus far produced have noise figures between 10 and 20 db above the thermal limit. This represents an enormous improvement, about 30 to 40 db, relative to the noise levels of the point-contact type. While still not the equal of the best vacuum tubes, operating at the same frequency range, the theory indicates that a reduction of noise figure to below 10 db can be achieved in the junction transistor as better techniques of design and manufacture are developed.

Circuit stability is another noteworthy characteristic of the new transistor. In the early point-contact form, negative impedances would develop in certain circuit connections. This is not always a disadvantage, especially in pulse-handling circuits for switching and computing applications. The junction transistor has positive impedances between all terminals, whether connected in the grounded-base, grounded-collector or grounded-emitter circuit. Resulting flexibility of circuit design permits conventional input and output circuits.

Excellent stability is achieved in another sense, the ability to withstand severe mechanical shock.

The junction transistor is inherently rugged. It consists of a single crystal of germanium, about ⅛-inch long, to which are fastened, mechanically and electrically, three leads. The assembly is then covered with a plastic shell. Although no figures on shock resistance have been published, it would appear likely that this assembly can stand at least as great a shock as any vacuum tube, including tubes designed for proximity fuzes. No measurable microphonism has been detected in any of the junction transistors yet built.

The power-handling ability of the

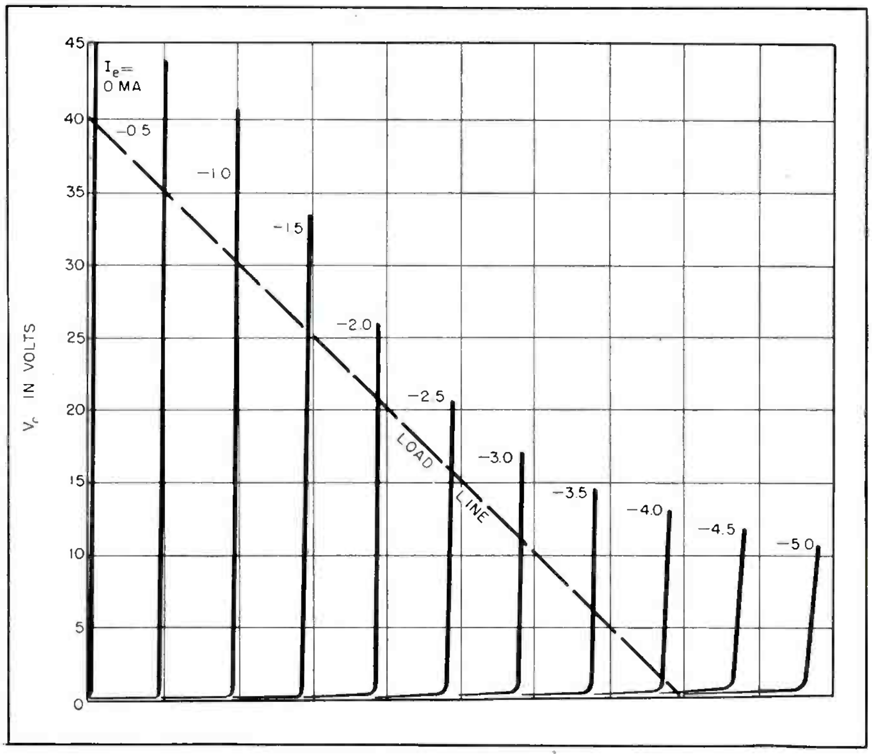


FIG. 2—Static collector voltage and current characteristics of the junction transistor. Note general similarity to the plate family of a beam tetrode

point-contact transistor is severely limited by heating at the contact itself, which must be of small area and high thermal resistance. In the *n-p-n* junction transistor, the currents pass over two interfaces between the *n* and *p* types of germanium, which may be of substantial area. As a result, power levels of at least 2 watts may be handled in units specially built for power service. Most of the transistors thus far built are of smaller size and operate at tens or hundreds of milliwatts maximum output power. But there appears to be no fundamental bar to handling power levels equal to that of any receiver power tube. As a result a broadcast-band receiver with normal sensitivity and power output can now be built completely without vacuum tubes.

Efficiency in the use of the power supply is far better than that of any vacuum tube ever built. The complete absence of filament-heating power is evident. This accounts for a saving of from several watts (in power output tubes) to about 50 milliwatts (in hearing-aid tubes). Over and above this, practically no power is lost in the collector circuit, corresponding to the plate circuit of a vacuum tube. In class-A operation, the theoretical maximum plate efficiency is 50 percent. Junction transistors operating class-A have efficiencies as high as 49 percent, and similar high performance is achieved in class-B and C operation.

By far the outstanding property of the *n-p-n* junction transistor is the unbelievably small level of power consumption required to achieve useful operation. Since the static and dynamic characteristics are the closest approach to the ideal yet achieved in any electronic amplifying device, the transistor amplifier requires only microwatts of power input to amplify signals to the level of microwatts.

One junction transistor, operating in an audio oscillator circuit, will oscillate stably with a power supply of 6 microamperes at 0.1 volt, or 0.6 microwatt. This is less than one millionth of the power required for the filament heater alone in a conventional receiver tube (6.3 volts at 0.15 amp), and is, in fact, less power than that developed by a flea jumping once every eight seconds. Ridenour[5] calls this not flea power, but "lazy flea power"!

In applications where less than a milliwatt of plate power suffices, the power consumption is so small that junction-transistor amplifiers can operate continuously for months or years on ordinary small dry batteries. Moreover, operation is quite feasible with a total applied voltage of from 1 to 2 volts, so single-cell batteries suffice.

OUTSTANDING PROPERTIES OF JUNCTION TRANSISTORS

- Noise figure is in range of 10 to 20 db at 1,000 cps
- Positive input and output impedance for all connections
- Power gain of 40 to 50 db per stage has been obtained
- Class A efficiency, as high as 49 percent of possible 50 percent
- Extremely small in size, as shown in illustration
- Relatively free from microphonic noise distortion
- Frequency response can be flat to at least one megacycle
- Power consumption is from one microwatt to several watts

Frequency Limitations

The important remaining limitation in the operation of the new transistor is frequency of operation and bandwidth. Since the junctions between *n* and *p* portions of the germanium crystal are of substantial area, the electrical capacitance across them is correspondingly large. Full gain is limited by collector capacitance in the present units to a few kilocycles, but by the use of appropriate impedance mismatching, the frequency response may be extended uniformly to at least one megacycle. At the moment, the useful upper limit, as determined by transit time dispersion, seems to be in the vicinity of 5 mc.

The frequency limit is imposed, in part, by the fact that the electrons and holes involved in the amplifying action must pass from the emitter to the collector by diffusion through the base layer. Thus the thicker the layer, the lower the frequency limit, the frequency varying inversely as the square of the layer thickness. By producing thin base layers, the frequency may be extended upward rapidly. Thus by a reduction in layer thickness by somewhat more than three times relative to that of present units, the frequency limit could be increased 10 times. The bandwidth limit imposed by the collector capacitance can also be extended by several conceivable modifications of design.

As in other amplifiers, the frequency limitation is most generally expressed as the gain-bandwidth product. Computations for a grounded-base stage indicate that the measured values of capacitance and resistance will produce a gain-bandwidth product of about 120 mc. The corresponding value for the same transistor in a grounded-emitter stage is 1,300 mc, and in a grounded-collector stage 15 mc. These figures indicate that appreciable gain can be had at values well above one mc.

From the standpoint of the design and application engineer, it should be emphasized that the junction transistor is in an early stage of development and that many problems remain to be solved in the production of the units, particularly in achieving uniform characteristics. But the basic principle of operation is now well established, in theory as well as practice, and it can be confidently expected that the new transistor will extend materially the range of application of electronic devices.—D.G.F. and R.K.J.

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Industrial METAL

By **CURTISS R. SCHAFER**

The Liquidometer Corp.
Long Island City, N. Y.

IDEAS WHICH are responsible for the design of metal detectors are based upon certain properties of metals. These properties are: relatively high density, electrical conductivity, magnetic permeability and radioactivity.

Detection of a material of high density may be accomplished through the use of either an x-ray source and fluorescent screen or an ultrasonic beam which will be reflected by a discontinuity in the homogeneity of the material under inspection.

Radioactive materials may be detected with a Geiger-Muller counter and this method is used in the location of uranium ore fields. It has also resulted in the design of United States Army Detector Set AN/PRS-2, which is used to detect American nonmetallic land mines by virtue of the gamma radiation from the marker pellets contained in these mines.

The industrial metal detectors under discussion are based upon either or both the magnetic permeability and the electrical conductivity of the particles to be located.

The introduction of one of these particles into an alternating magnetic field results in a distortion of the symmetry of that field. Therefore a coil system may be constructed which radiates an alternating electromagnetic field. This field may be called the primary field and should fill the entire space that is to be inspected. Any metallic particle within this field acquires a magnetic dipole moment as the result of eddy currents and magnetic polarization induced in the particle by the primary field. The induced magnetic dipole will in turn radiate a much weaker secondary field. The secondary field will induce a voltage in the coil used to radiate the primary field and in any other coil which may be placed within the secondary field.

Coil Considerations

The induced voltage may be measured as a change in the impedance of the exciting coil, as a change in the mutual impedance of two coupled coils in a mutual-inductance bridge or simply as a voltage induced in another coil in the field. When a mutual-inductance bridge is used, the coefficient of coupling k is the ratio to the geometric mean of the two self-inductances it connects:[1, 2]

$$k = \frac{M}{\sqrt{L_1 L_2}}$$

where M, L_1 and L_2 are all either in microhenrys, millihenrys or henrys.

The primary coils, connected to the oscillator or other generator, are usually connected series aiding. The secondary coils, connected through a matching transformer to the input of the amplifier, are connected series opposing. In this way, the effect of external electromagnetic fields may be balanced out. For metal detector use, the coils are so positioned that the net coefficient of coupling k is zero. The only effective transfer of energy from primary to secondary is through a metallic particle. The coefficient of coupling between a coaxial spherical coil and a resistanceless sphere has been calculated to be[3]

$$k = \frac{4}{3}\left(\frac{\sqrt{a\,b}}{d}\right)^3$$

where a = radius of the coil in cm, b = radius of the sphere in cm and d = distance between centers in cm. The maximum inductive coefficient between coils by means of a metallic particle is this term squared. Conversely, the maximum unbalance voltage induced in the secondary coil system is inversely proportional to the sixth power of the distance between coil and particle. The sensitivity of a metal detector falls off very rapidly as this distance is increased.

These phenomena have several interesting corollaries. A conductive particle in the field results in energy dissipation and therefore decreases the energy stored in the field. The self-inductance of the coil producing the field is reduced and its resistance increased and the voltage induced by the particle is out of phase with the voltage in the exciting coil. The conductive particle acts like a short-circuited secondary for the current flowing in it depends on its impedance and the coefficient of coupling with the exciting coil. The induced voltage is proportional to the square of the frequency and therefore a high frequency is desirable for the detection of particles which are electrically conductive. However, maximum sensitivity at high frequencies can

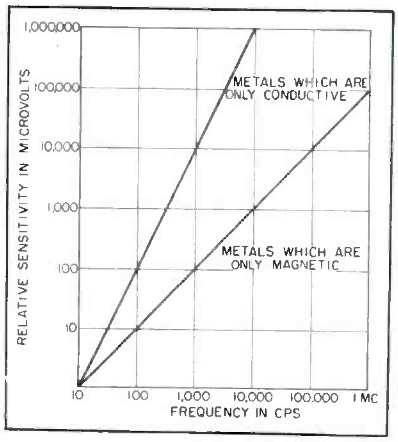


FIG. 1—Voltage induced in secondary coil as a function of frequency

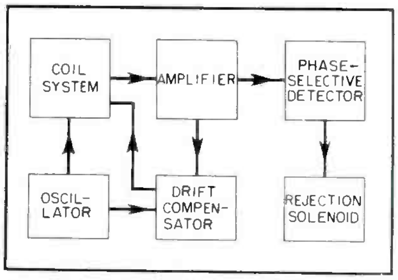
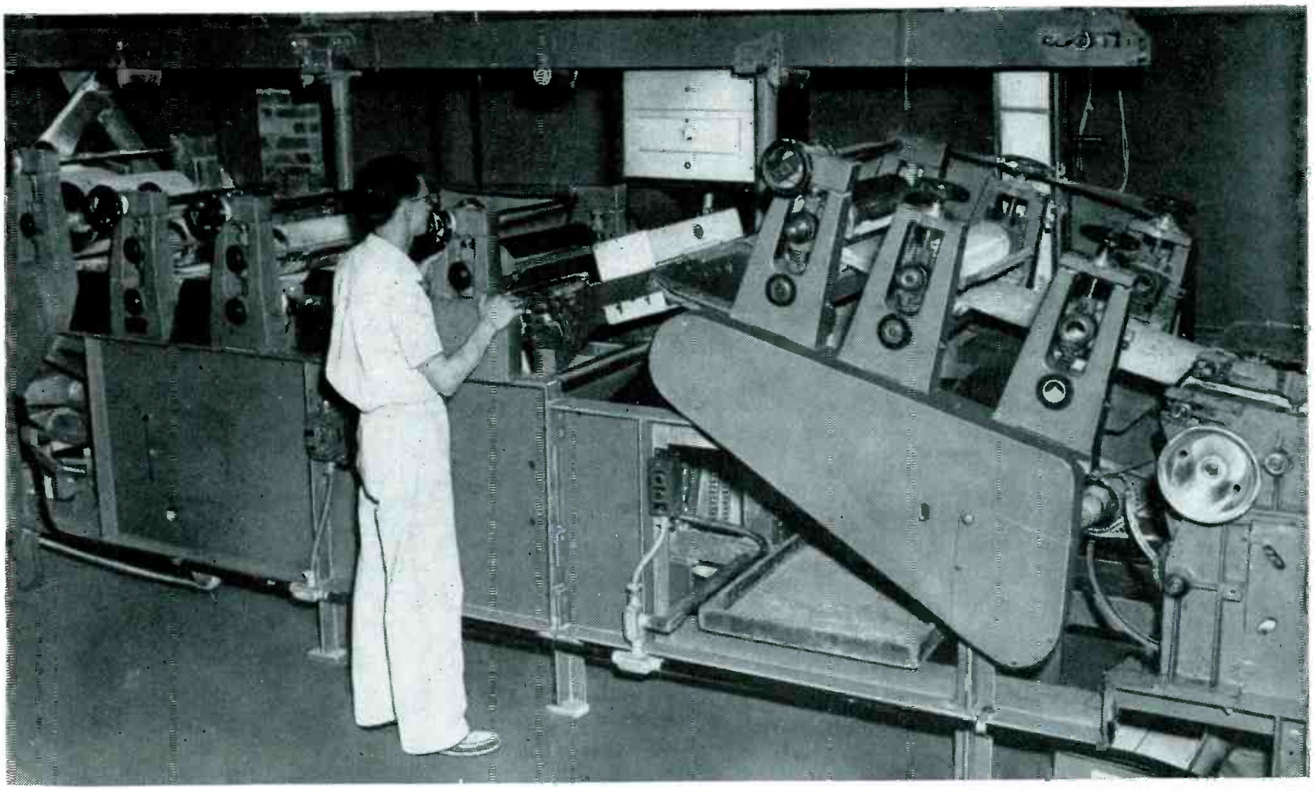


FIG. 2—Block diagram of an ideal metal detection system

DETECTOR DESIGN

How to design a metal detector for a specific application. Fundamental principles, basic equations and major design factors are discussed. A typical commercial industrial detector is described and schematic diagram presented



A commercial metal detector used for inspection of chewing gum. Inspecting coil is shown mounted on the machine in about the center of the picture with control box directly above it

be achieved only in the complete absence of moisture.

A ferromagnetic particle increases the energy in the field and increases the self-inductance of the exciting coil. The voltage induced in a mutually-coupled secondary coil is proportional to the frequency if the particle is purely magnetic, as shown in Fig. 1. However, in most cases the inductive effect due to magnetic permeability is opposed to some extent by eddy currents due to electrical conductivity. If any water is present in the space to be inspected, a low frequency is desirable for the detection of ferromagnetic particles.

Theoretical considerations in the calculation of the strength of the magnetic dipole moment may be found in the literature[3, 4, 5]. The important factors are the conductivity and permeability of the particle, the frequency of the current producing the exciting field and the depth of current penetration. Some of these factors are of course interrelated, such as frequency and depth of current penetration. If we assume the particle to be a sphere, the strength m of the induced dipole moment in maxwells per cm/4π is

$$m = \frac{3}{8\pi}\left(\frac{2\mu + 1 - W}{\mu - 1 + W}\right) V H_0 \text{ where}$$

$$W = \frac{(g + jg)^2 \tanh (g + jg)}{(g + jg) - \tanh (g + jg)}$$

$$g = \pi d \sqrt{\mu \sigma f} \times 10^{-9}$$

σ = conductivity of sphere in mhos, μ = relative permeability of sphere, f = frequency of exciting field in cps = $\omega/2\pi$, d = diameter of sphere in cm, V = volume of spherical particle in cubic cm and H_0 = magnetic field strength in gilberts per cm.

The voltage induced in a passive secondary coil which is subject to the flux of the dipole moment is

$$e = -j\omega \frac{3V}{8\pi}(X + jY)(H_p \cdot H_s) \times 10^{-8}$$

where e = induced voltage in volts, V = volume in cubic cm, H_p = mag-

Table I—Preferred Tube Types for Metal Detectors

Tube Classification	Oscillators	Plate Dissipation, Watts	Voltage Amplifiers	Amplification Factor	Power Amplifiers	Watts Output, One Tube	Rectifiers	Max Ma
Subminiature			Syl 5719	70	Syl 5902	1.0	Syl 5641	50
			Syl 5898	70	Syl 5639	1.0		
			Syl 1406A	70				
Miniature	GE 6005	12	E-P 5670	35	GE 6005	4.5	E-P 5993	70
			GE 5670	35	GE 5686	2.7	Ray 6X4W	70
			GE 5751	70			T-S 6X4W	70
			GE 5814	17				
			GE 5844	27				
			T-S 5687	17				
Glass Types	E-P 5992	10	RCA 5691	70	E-P 5992	4.5	E-P 5852	75
	T-S 5881	23	RCA 5692	20	T-S 5881	11.3	E-P 5838	75
			Ray 6SN7W	20				
			Ray 2C52	100				
Larger Glass Types	RCA 3C33	30	RayCK5694	35	RCA 3C33	15.0	5R4-GY	250
	WE 300B	40			WE 300B	17.5		

Syl (Sylvania), E-P (Eclipse-Pioneer), Ray (Raytheon), T-S (Tung-Sol), WE (Western Electric)

netic field intensity in lines per square cm caused by one amp flowing in the primary coil, H_s = magnetic field intensity in lines per square cm caused by one amp flowing in the secondary coil and $(X + jY)$ = complex variable which may be plotted as a function of g/μ for arbitrarily assigned values of μ.

If the exciting coil and the passive secondary coil form adjacent arms of a mutual-inductance bridge, the change of their mutual impedance in ohms resulting from the introduction of the metal sphere is

$$\Delta Z = j\omega \frac{3\,V}{8\,\pi} (X + jY) \mid H \mid^2 \times 10^{-8}$$

where $|H|$ is the magnitude of the exciting field in the vicinity of the sphere.

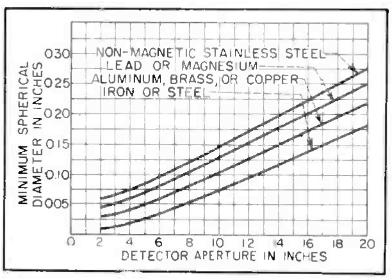
The voltage induced in each secondary coil by the adjacent primary coil must be nullified by the equivalent pair of coils in the opposite arms of the bridge. This voltage is

$$-e = A\,N \frac{dB}{dt} = A\,N \mu \frac{dH}{dt}$$

where e = emf in volts, A = area of cross-section of core in square cm, N = number of turns, B = flux density in gausses, H = magnetic field intensity in gilberts per cm, μ = relative permeability, d = diameter in cm and t = thickness in cm.

Variations of these equations appear in the literature[3] and enable the computation of the relative response obtained from spheroidal particles or from flat disks. The latter may be treated as degenerate spheroids with the minor axis zero.

All these expressions of the various relationships between a mutual inductance bridge and the metallic particle within its field represent only close approximations. Many variations of the equations would be required to accurately represent various distances between the four coils that make up the bridge, the distances between these coils and the particle, resistance versus permeability of the particle, the position of the particle with respect to the axes of the coils, and so forth. The equations should serve only as a guide to the designer, to enable him to judge the magnitude and direction of the various parameters



Maximum sensitivity obtainable from any present metal detector consistent with good stability

in a relative rather than absolute sense.

Similar equations are available in the literature for the design of metal detectors utilizing the change in self-impedance of a single coil, which usually forms part of an oscillatory circuit. However, the symmetrical mutual-inductance bridge circuit has two major advantages over the oscillator type of metal detector. First, the coil symmetry results in a balancing out of changes in the mutual impedance of the coils due to changes in their shape and position resulting from temperature and humidity changes. The balancing-out characteristic gives the highest sensitivity consistent with high stability. Second, the resistive and reactive components of the bridge unbalance current are easily separated and, as will be discussed later, this discrimination may be used to distinguish ferrous particles from nonferrous.

The change in mutual impedance between two coils in a bridge circuit is a measure of the change in total field energy and this fractional change is usually very small. The SCR-625 mine detector, for example, is responsive to a change in field energy of one part in a million, a gun detector built several years ago[6] was sensitive to changes of one part in twenty million and a recently described metal detector[4] is sensitive to changes in field energy of one part in ten million. The latter sensitivity represents the detection of a sphere whose diameter is one percent of the coil diameter.

Metal Detector Elements

With these principles as a basis, an industrial metal detector may be designed which is very nearly ideal, for it may incorporate all the best features of present and previous models. A block diagram is shown in Fig. 2, and the various circuits will be discussed in the order in which they appear there.

An amplitude-stabilized fixed-frequency oscillator feeds a coil system which is arranged in the form of a symmetrical mutual-inductance bridge. The unbalance voltage from this bridge is amplified and fed into a phase-selective detector. Either the reactive or the resistive component of the bridge current is made to actuate the warning or rejection device. Automatic drift compensation is provided so that manual corrections for drift are seldom required.

The oscillator design must satisfy three requirements: it must provide sufficient power output, frequency and amplitude stability must be reasonably good and the design must provide the correct frequency for the particle material and size that is to be detected.

Adequate power output is of paramount importance. In any practical coil system, only about one-quarter of the power put into the exciting coils is radiated in the form of an electro-magnetic field. As a practical design parameter, a

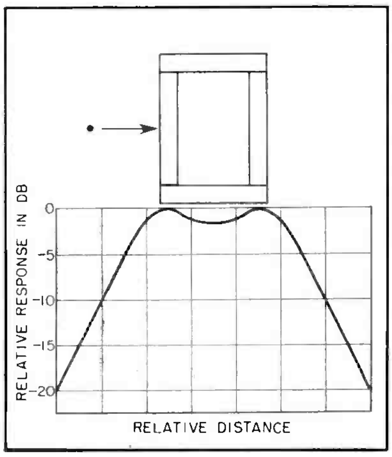


FIG. 3—Relative-amplitude response of quadrant coil system

minimum of 10 w is required for detectors with apertures ranging from 2 to 6 in.; 20 w for apertures up to one ft; 40 w up to 2½ ft; and about 100 w for apertures up to 5 ft. These figures are based upon the presumed ability of the system to detect spherical ferromagnetic particles whose diameter is one percent of the coil diameter or aperture spacing.

The power requirements may seem high, but it must be remembered that amplifier sensitivity is limited by the ambient electrical noise level, which is relatively high in most industrial locations. Therefore, the usable amplifier gain must be complemented by high power output from the oscillator. A well-designed gun detector made for a prison[6] used an input to the coil system of 1,200 watts. This was for a coil size of 6½ by 3 feet. In this case the frequency used was 60 cycles and the power was taken directly from the 115-volt line. For other low audio frequencies and large coil diameters, a 60-cycle synchronous motor may be used to drive an alternator and d-c field exciter of the required frequency and power output. The use of a motor-generator set is generally advisable if the required power is more than 100 watts and the frequency lies between 20 and 2,000 cycles.

Oscillator Design

For an output of 100 watts or less, an electron-tube oscillator may be designed around one or more of the tube types as shown in Table I. This oscillator should be one of two types, and R-C or Wien bridge feedback circuit over two stages plus a driver and power amplifier stage or a power oscillator of the Hartley, Colpitts, or Meacham type, amplitude and frequency stabilized.[7,8]

The second type has a much simpler circuit and fewer components. Frequency stability does not have to be exceptional unless the amplifier following the coil system uses high-Q tuned circuits, which are usually undesirable. Temperature and line-voltage changes should not shift the oscillator frequency by more than 5 percent, nor its amplitude by more than 2 percent. Inasmuch as the preferred amplifier characteristic is that of a band-pass filter, frequency shifts of 10 percent may be tolerated if a symmetrical coil system is used in the bridge. The lamp-stabilized oscillator and the Meacham circuit with auxiliary control, as described by Edson, are both excellent for this application.

Another practical source of bridge power consists of a full-wave rectifier, an isolated resonant circuit and power amplifier used to give a stable 120-cycle output.[9] Conversely, a system consisting of a regenerative frequency divider,[10] voltage amplifier, and power amplifier is very satisfactory if a 30 or even 15-cycle bridge supply is desired. These "oscillators" have the advantage of being frequency controlled simply and effectively by the 60-cycle power line. A voltage-regulating input transformer may be used to give good amplitude stability.

The best coil arrangement for the bridge is the symmetrical Felicci mutual-inductance balance and the variations of it that have appeared in the literature.[9] The two pairs of coils should be as nearly alike as possible in size, materials, impregnation, mounting and electrical characteristics. If these requirements are followed, the effects of temperature, frequency and oscillator amplitude are cancelled out and no spurious signals result from variations in these parameters.

Shielding of the secondary coils is sometimes necessary if maximum sensitivity is to be achieved, particularly at the higher frequencies. Care must be taken to insure that the shield material has a high electrical resistivity in order to keep eddy-current losses from reducing the sensitivity of the system. Aquadag or a thin foil of nonmagnetic stainless steel are good. A completely circular form of shielding should be avoided as it would act as a shorted turn. The Faraday screen principle is preferred wherever it can be used.

The relative-amplitude response of the quadrant coil system[9] is shown in Fig. 3 for a metallic

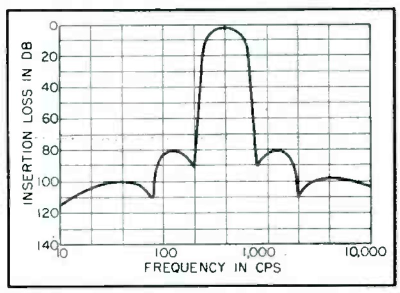


FIG. 4—Frequency response of band-pass filter

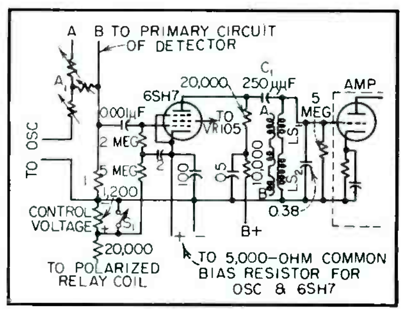


FIG. 5—Automatic drift compensation circuit

sphere passing through the coils from left to right. The separation between opposite coils should approximately equal the coil diameter. Few metal parts of any size should be used within a distance of the coils equal to twice their diameter and fastening screws should be of plastic or copper-nickel alloy. The latter material has the greatest depth of penetration and the least reflection of the electromagnetic field of any common metal with high tensile strength.

Impedance Considerations

The pair of coils energized by the oscillator are commonly known as the primary coils and those connected to the amplifier, the secondary coils. The output impedance of the oscillator should be matched to the impedance of the pair of primary coils, and the input impedance of the amplifier should be matched to the impedance of the pair of secondary coils. The impedances of either set of coils should be determined by the familiar equivalent-series-resistance bridge[10] or, for low frequencies, the approximate impedances may be derived from the following inductance formula which is accurate to within ± 10 percent:

$$L = \frac{0.8\,a^2 n^2}{6a + 9b + 10c}$$

where L = inductance in microhenrys, a = mean diameter of coil in cm, b = length of coil in cm, c = width of coil in cm and n = number of turns.

Charts are available which will enable the accuracy of the calculations, for low frequencies, to be increased to ± 1 percent.[1]

Design of the associated amplifier is best done with two separate sections, each with its own feedback loop, placed in series but separated by a band-pass filter with the characteristic shown in Fig. 4. The operating frequency selected for the system should be the center frequency of the filter.

The band-pass filter should be made of thermally stable L and C components, well protected from moisture. For the lower frequencies, say from 25 to 20,000 cycles, the filter may be designed along conventional lines with high-Q toroidal inductances. The basic design may be that of a composite of low and high-pass sections,[12] a narrow band-pass filter[13] or a plate-to-grid impedance-transforming band filter.[12] In the latter case, however, the rate of attenuation at the edges of the band will not be as great as with the other filters.

For a system operating at the higher frequencies, the filter may be designed as a regular r-f band-pass type of three or four sections.[14]

In any case, if the filter were included within the feedback loop, the resulting phase shifts would make the amplifier quite unstable.

The use of a band-pass filter in the amplifier is preferable to using tuned stages, for then any shift in oscillator frequency or thermal drift of the resonant-circuit elements results in a rapid decrease in sensitivity and possible instability. The insertion loss of a well-designed filter will be between 2 and 3 db. The insertion loss must be taken into account when determining the overall gain of the amplifier, which should be between 70 and 80 db for most industrial applications of metal detectors.

The amplifier should terminate in a phase-selective detector. Phase discrimination between the resistive and reactive components of the unbalance voltage from the bridge has several important advantages. No modern industrial metal detector or mine detector should be without this feature. The resistive component, due to the presence of water and metals which are not magnetic but conductive only, is almost 90 deg out of phase with the inductive component due to the presence of ferromagnetic materials. First, this relationship permits the detection of ferromagnetic particles in the presence of a great deal of water. Second, it permits the rejection device to be made responsive to either magnetic or nonmagnetic particles, or both. Third, it permits the use of automatic drift compensation.

Practical Types

Two examples of metal detectors with phase discrimination are to be found in the literature. In the first, a mine detector has been made most sensitive to the resistive component and least sensitive to the inductive components which result from changes of elevation above slightly magnetic ground or distortion of the coil assembly as it passes over rough ground.[15, 16] The sensitivity of the SCR-625 mine detector was limited by the magnetic susceptibility of the ground.

In the second case,[4] a metal detector has been made sensitive to

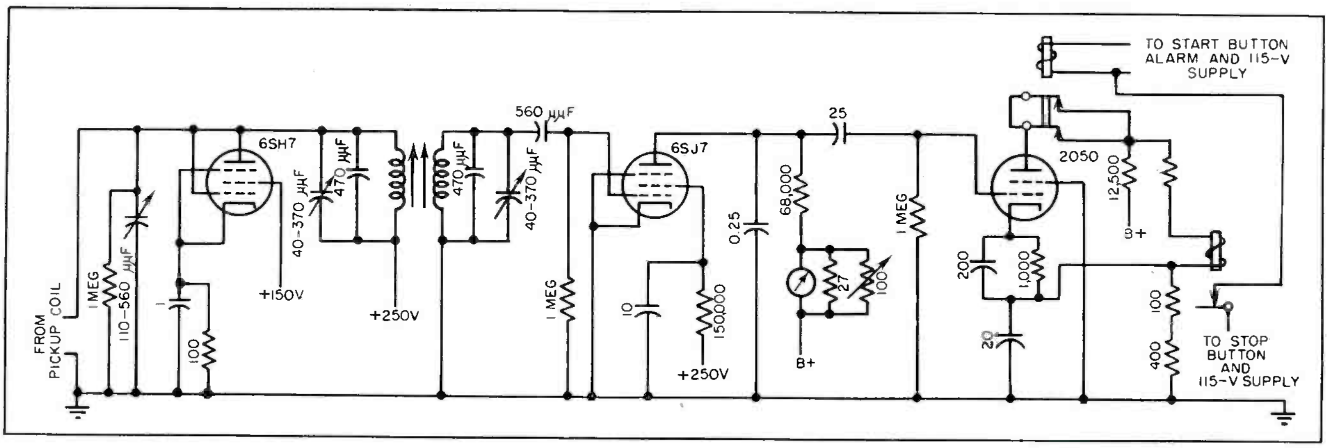


FIG. 6—Receiver section for one model RCA metal detector

the inductive component and insensitive to the resistive in order to reject signals caused by the presence of salt water.

Automatic Drift Compensation

Automatic drift compensation, sometimes known as automatic drift control, was first used in the AN/VRS-1 detector set for land mines.[15, 16] The balancing circuit incorporates a "variometer tube", and is shown in Fig. 5. A 6SH7 is connected as a resistance-coupled amplifier stage whose a-c output voltage may be controlled by variations of the d-c grid bias. The input voltage is obtained from the voltage drop across the 1-ohm resistor connected across the output of the oscillator, so that this input is always proportional to the output of the oscillator. The cathode of the 6SH7 is connected to a positive voltage of about six volts in the oscillator power supply, so the tube is normally biased to plate-current cutoff.

The a-c output voltage, which is a function of the control bias voltage obtained from the output of the main amplifier, is applied to the secondary coils of the bridge circuit through capacitor C_1. The reactance of C_1 is large in comparison to the antiresonant impedance of the tuned secondary coils, so the voltage across these coils is 90 deg out of phase with the voltage applied to the grid of the 6SH7. However, the voltage applied to the 6SH7 grid is in phase with the current in the primary coils of the bridge and the voltage across the secondary coils is in quadrature with the voltage produced by an unbalance in the mutual inductance of the bridge.

The effect of a small voltage is suppressed by a large voltage which differs from it by 90 deg and the voltage supplied by the 6SH7 minimizes the effect of drift in the mutual-inductance balance. The automatic balance circuit tries to maintain a constant unbalance voltage at the input to the main amplifier. The bridge circuits should be balanced while the automatic balance is made temporarily inoperative by closing switch S_1. Then, when S_1 is opened again, the only voltage appearing across the secondary coils will be that produced by the automatic balance tube.

When a reactive voltage appears across the secondary coils due to a temperature variation, for instance, which changes the relative positions of any two coils, its effect will be neutralized because the increase in voltage will be automatically offset by a decrease in the output voltage of the 6SH7. This compensation is effective only in the case of the reactive component of bridge unbalance, as it is applied here. The resistive component operates the relay and signals the location of a mine. Of course, either component may be used; the resistive component is cancelled out in another drift compensator described in the literature.[4]

The magnitude of this automatic compensation is not unlimited and, as the magnitude of the drift becomes greater, it will be necessary to rebalance the bridge manually. The value of automatic drift compensation is such that the bridge may have to be rebalanced manually only every few days, instead of the usual once or twice a day.

A Commercial Model

Schematic circuits of the RCA Electronic Metal Detector, models MD-0725-F4 and MD-1225-F4, are shown in Fig. 6 and 7. Physically, it is divided into two sections, one located above the inspection aperture, and the other below. The bottom unit contains the oscillator and its amplifier and the two primary bridge coils. The top unit has the amplifier and the single secondary bridge coil.

A biased thyratron is used to actuate the rejection relay, which in turn actuates the solenoid or motor reversing switch, as previously discussed.

An interesting variation of these models is the special model MD-0220-D2, in which the inspection head and the oscillator-detector unit are in separate cases and may be located in places convenient for each. Electrically, the unit is almost identical with the MD-0725 and MD-1225. The many advantages of a smaller inspection head are obvious.

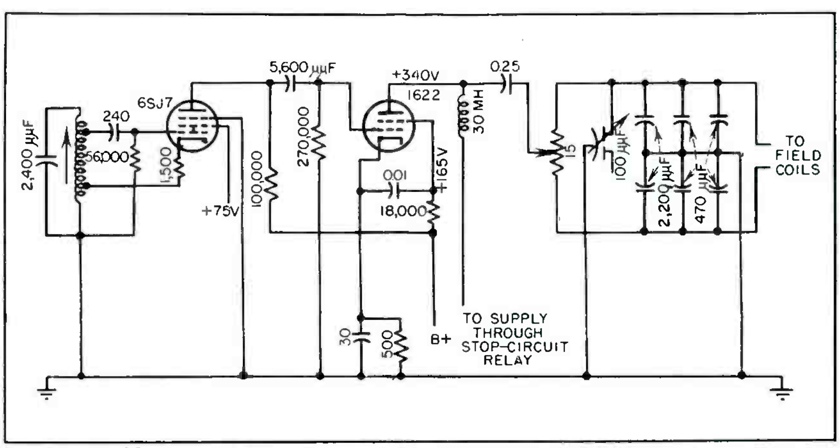


FIG. 7—Oscillator section of the RCA detector

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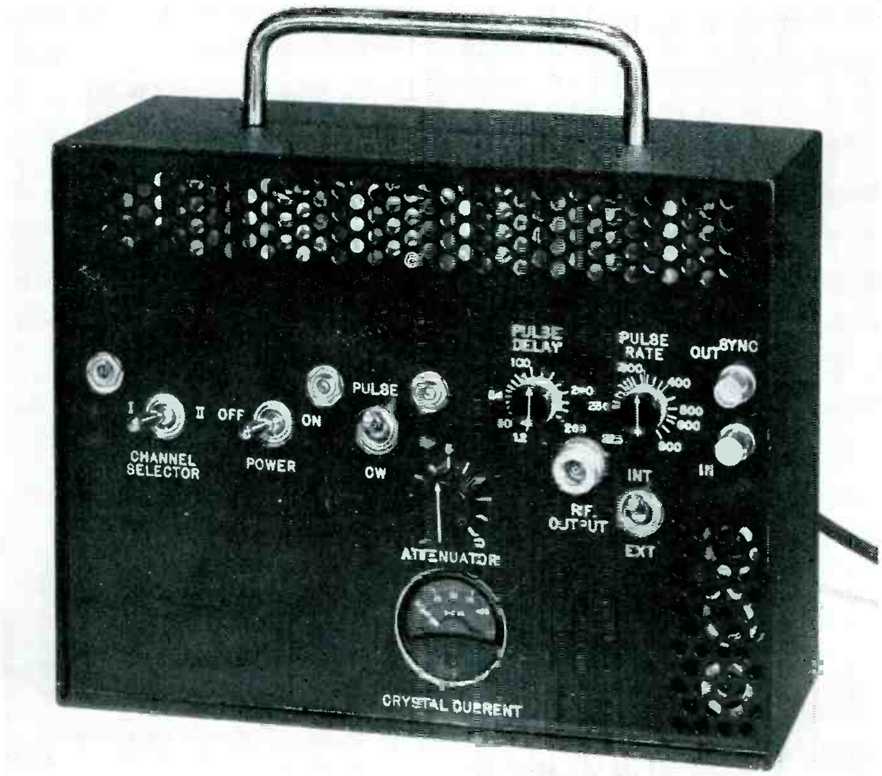
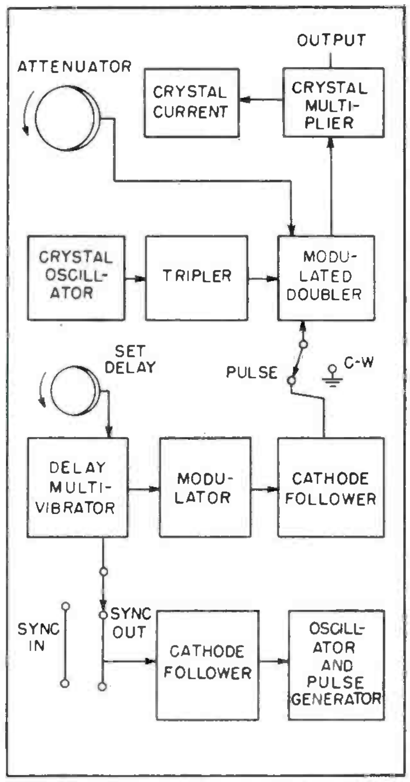


Fifteen-pound microwave signal generator. 10 by 5.75 by 4 inches in size



Block diagram of S-band generator

Microwave Generator

Portable 3,100-mc signal generator with pulsed or c-w output is useful for field testing of radar and beacon receivers. Substituting crystals in two channels gives up to 600-mc frequency range without changing other circuit components

By W. F. MARSHALL
Junior Research Engineer
Bendix Radio Division
Bendix Aviation
Baltimore, Md.

THE need often arises for a portable microwave signal source suitable for field testing of radar and beacon receivers. Among the prime requisites of such a generator are minimum size and weight and accurate frequency calibration.

Laboratory oscillators employing klystrons or lighthouse tubes require some kind of frequency-indicating device for accurate determination of output frequency. Since inclusion of such equipment in a portable set is not practical, it is desirable to use accurate crystal control of output frequency.

The signal generator to be described is an adaptation of the method of frequency generation employed by the Bureau of Standards and the MIT Radiation Laboratory[1] to a portable instrument suitable for field test work. The unit can be adapted for use with any system where microwave power requirements are modest, with little increase in over-all dimensions and no appreciable loss in portability.

The generator consists of a three-tube r-f section, a three-tube modulator section and a three-tube power supply. The r-f unit consists of a dual triode crystal oscillator operating near 50 mc, followed by two stages of frequency multiplication. The resulting signal is applied to a silicon crystal multiplier mounted in a standard S-band crystal mixer.

Output from the mixer provides an S-band signal of accurately known frequency. For receiver testing, which is the primary use of the present unit, a pulsed signal

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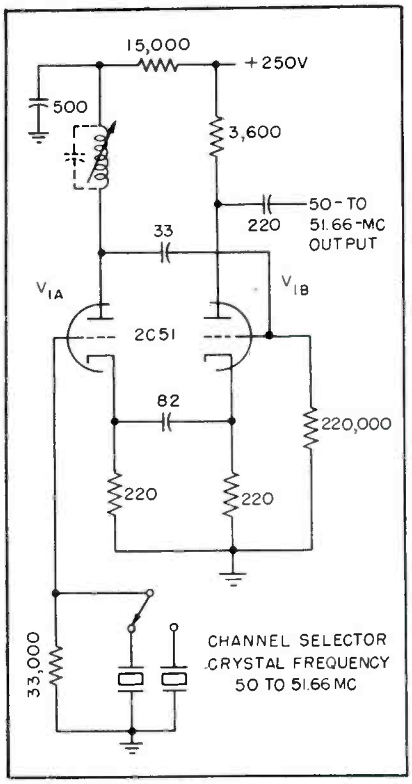


FIG. 1—Cathode-coupled oscillator

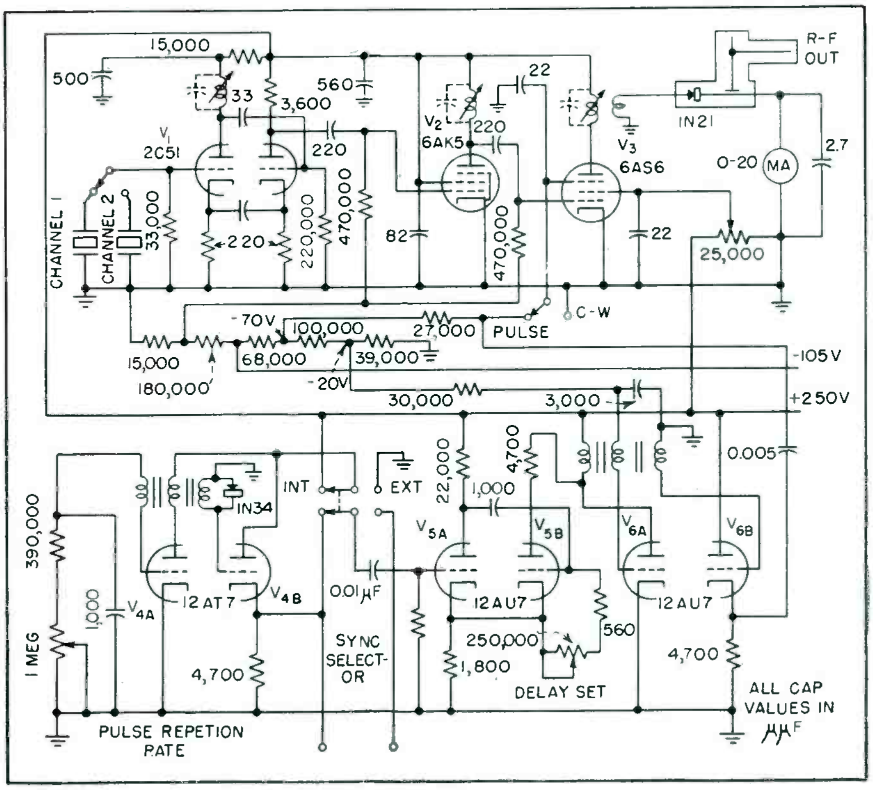


FIG. 2—Schematic diagram of S-band signal generator

with Crystal Control

is normally desired and provision is made for internal generation of a modulating pulse.

For convenience in oscilloscopic testing of receivers, a suitable sync source is provided with a variable delay between the output sync pulse and the modulator pulse. For maximum utility, provision is made for use of an external trigger for synchronization with other system components.

The cathode-coupled series-mode oscillator has been found ideally suited to operation of crystals at harmonics of their fundamental mode. This oscillator originally proposed by Butler[2] and further developed by Goldberg and Crosby[3] consists of a grounded-grid amplifier driving a cathode follower. Output of the cathode follower is in the proper phase to supply positive feedback to the grounded-grid stage. By using a quartz crystal as the cathode-coupling impedance, the feedback will be of the proper phase and maximum magnitude at the series-resonant frequency of the crystal. At all other frequencies the loop gain and phase-shift conditions will forbid oscillation.

Frequency Stability

This type oscillator is greatly immune to changes in tube characteristics, operating voltages and stray circuit impedances. Both the input and output impedances of the amplifier are low, less than 200 ohms, a criterion which analysis will show to enhance frequency stability. Operation of the crystal at its series or low-impedance mode will minimize the effect of variation in circuit constants.

A recent proposal by H. Cressman of Bendix Radio places the crystal in the grid circuit of the grounded-grid amplifier, thus achieving a grounded-grid condition only at the series resonant frequency of the crystal. At other frequencies the degeneration provided by the high-impedance grid circuit forbids oscillation. Cathode-coupled feedback is provided by a capacitor with the over-all operation essentially the same as previously described.

Some simplification in circuitry is provided by the Cressman oscillator in multiple-channel operation, in that one crystal terminal may be grounded and switching accomplished at the other terminal. Such an oscillator will run only at the fundamental and odd harmonics.

The oscillator employed by the author is essentially that of Cressman and is shown schematically in Fig. 1. A dual triode is employed as the oscillator. The plate tank of the grounded-grid stage is a slug-tuned, seven-turn coil on a 0.5-in. Bakelite form resonated by stray capacitance. The high L to C ratio plus the lossy iron core results in a broad-band plate impedance capable of providing adequate gain to sustain oscillation over the desired band of 50 to 51.666 mc. The broad-band amplification also increases the over-all stability of the oscillator since loop phase shift will only vary slowly with frequency.

Amplitude limiting is provided by grid-leak bias on the cathode-follower stage. The crystal circuit uses an ordinary toggle switch for channel selection. A 33,000-ohm resistor shunting the crystal provides a d-c return for the grid and is large enough to prevent oscillation in the absence of a crystal.

Output may be taken from the oscillator at several points, including the plate of V_{1A}, the cathode of V_{1B} or the plate of V_{1B}. In the last case the plate load may be a band-pass circuit tuned to a still higher harmonic of the crystal frequency, thus permitting the generation of crystal-controlled signals at frequencies upward of 200 mc in a single stage.

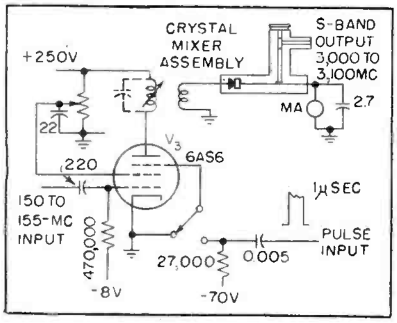


FIG. 3—Pulse-modulated r-f doubler and output stage

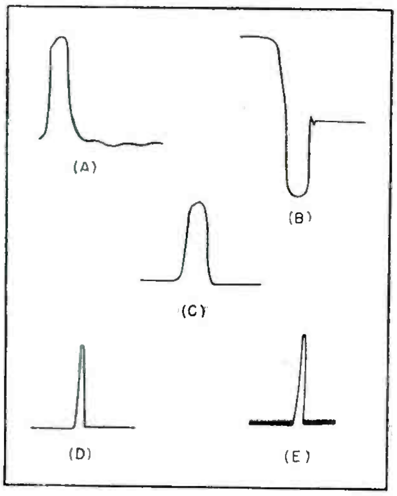


FIG. 4—Circuit waveforms: (A) sync pulse from pulse-repetition-frequency oscillator; (B) delay multivibrator output, showing firing of triggered blocking oscillator on trailing edge; (C) modulator output pulse; (D) generator output with strong signal input and agc; (E) generator output at low signal-to-noise ratio, with no agc

Resistor Load

Output necessarily falls off rapidly with increased multiplication and a resistor load provides output at the 50-mc level. The resistor is small enough to have a negligible effect on the output impedance of the cathode follower or upon the magnitude of the feedback voltage and large enough to provide some gain for driving the following stage.

Only discreet selected frequencies are available from such an oscillator but, in cases where operating frequencies are definitely specified, crystals may be selected accordingly. No limitation to two channels of operation is imposed. Turret selection of crystals for ten or more channels is entirely feasible. The range of frequency coverage is limited by the tuning range of the plate coils in the oscillator and multiplier stages. Coverage at S-band of 600 mc is practical with the present circuit.

The oscillator output is R-C coupled to a conventional tripler stage, a 6AK5 operated approximately class C, as shown in Fig. 2. The plate load of the tripler is a two-turn slug-tuned coil resonated by stray capacitance and sufficiently broad-band to cover the range of 150 to 155 mc without requiring retuning. Bias for this stage as well as the following stage is obtained from a bleeder across a regulated negative power supply.

Output of the tripler is R-C coupled to the grid of a doubler stage which serves as a modulated output amplifier, shown in Fig. 2 and 3. The output tube is a 6AS6 pentode, chosen for its sharp-cut-off suppressor-grid characteristics as well as its excellent uhf capabilities. For c-w operation the suppressor is returned to the cathode and the tube operates as a conventional doubler. For pulsed operation, the suppressor is returned through a resistor to a bias well below cut off.

A positive pulse supplied to the suppressor permits the tube to conduct for the duration of the pulse. The requirements imposed upon the modulating pulse are less severe than would be the case for plate modulation, particularly if sufficient pulse amplitude is available to drive the suppressor well above ground.

Control of the output signal strength is made possible by a potentiometer in the screen-grid circuit of the 6AS6. The drive supplied to the crystal is thus set by the level of the screen voltage, and smooth control of the output voltage at S-band is available over a range of at least 70 db with an ordinary wire-wound potentiometer.

Use of a wave-guide-below-cut-off attenuator in the output line was termed unnecessary since no means of measuring power input to the attenuator is provided. The plate circuit of the output stage is a single-turn slug-tuned self-resonant coil normally tuned to the center of the operating band of 300 to 310 mc. The output is loop-coupled to the crystal multiplier. The coupling loop and plate coil are wound concentrically on a 0.5-in. Bakelite form.

Crystal Multiplier

The final multiplication to S-band is accomplished by rectification of the 300 to 310-mc signal by a 1N21C silicon crystal mounted in a standard S-band coaxial mixer assembly. Input to the crystal is from the i-f output jack of the assembly. The S-band output is recovered from the jack normally used for local oscillator injection in a microwave superheterodyne receiver. The stub-supported oscillator injection line serves as a filter to remove low-frequency components from the output.

The variable oscillator injection probe provides a means of setting the maximum S-band output obtainable. Lesser outputs are obtained by controlling the screen voltage of the output stage. The remaining connection to the mixer assembly provides a d-c path for the crystal through a milliammeter to ground. Crystal current may be monitored in the c-w position to give a rough approximation of power output based on a previous calibration.

Modulator

The modulator section of the generator provides the necessary internal trigger, pulse delay and modulator pulse to drive the suppressor of the r-f output stage. Internal sync is provided by a conventional free-running blocking oscillator using one section of a 12AT7 dual triode, V_4, in conjunction with a pulse transformer.

Pulse repetition rate is variable from 200 to 800 pps by means of a potentiometer in the grid-return lead of the oscillator. Two windings of the pulse transformer are used for a 1-to-1 plate-to-grid feedback loop. A third winding is used to drive the second section of the 12AT7 as a cathode follower.

The cathode follower output is a positive pulse of approximately 100 volts amplitude and 0.75-μsec duration. The negative overshoot would terminate the period of the delay multivibrator prematurely and is accordingly clipped by a 1N34 diode, as in Fig. 4. The pulse is fed to a panel jack as a sync pulse for auxiliary equipment and also to the grid of a delay multivibrator, V_5. A second panel jack provides for use of an external input trigger where such operation is more desirable. A switch selects the trigger source and disables the internal pulse-rate oscillator when external sync is used.

The delay generator is a cathode-coupled one-shot multivibrator using a 12AU7 dual triode. The input section is biased off by the high cathode potential of the normally conducting output section. The arrival of a trigger pulse at the grid of V_{5A} generates a negative square wave in the plate circuit which cuts off V_{5B} for a period determined by a variable R-C combination in the grid circuit of that tube.

The width of the positive square wave at the plate of V_{5B} may be varied from approximately 1 to 300 μsec with the circuit constants shown. The plate load of V_{5B} is chosen as a compromise between fast rise time and adequate pulse amplitude. The particular multivibrator used was chosen because the output plate is not coupled to any other tube element. The timing process is unaffected by the load.

In addition to the normal load resistor, the plate circuit of V_{5B} contains the plate winding of the modulator blocking oscillator. The positive-output square wave is differentiated by the combination of the plate load resistor and the transformer inductance. The trailing edge of the square wave thus provides a sharp negative trigger in the plate circuit of V_{6A}, a 12AU7 connected as a biased oscillator. A 1-to-1 coupling to the grid of V_{6A} with appropriate phase reversal initiates a cycle of oscillation and produces a 1-μsec pulse of 100 volts amplitude, as in Fig. 4.

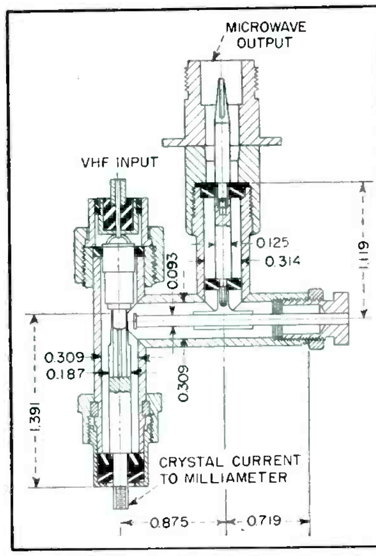
A fixed bias of −20 volts prevents a free-running condition in the modulator. The output pulse is coupled through an isolating cathode follower to the pulse—c-w selector switch for use in modulating the suppressor of V_3.

The blocking oscillator described will generate pulses with a maximum duration of about 3 μsec, limited by the low-frequency response of the pulse transformer. Variation of the pulse width by a panel control is impractical. However, the present unit was designed with a specific microwave system in mind for which a fixed pulse width is desirable.

Test Results

Tests have been conducted with the completed generator on an S-band receiver with very satisfactory results. The output signal necessarily contains a large number of frequencies, chiefly harmonics of the 300 to 310-mc output and a number of beat frequencies at intervals of 50 mc. Some type of preselection is desirable in order to utilize a specific output harmonic. For use with equipment not having preselection, an external transmission cavity tunable over the operating range of the signal generator may be required.

Output voltages of 12 mv into a 50-ohm receiver have been obtained with 15 ma of rectified crystal current referred to a c-w basis. To date no crystal failures have occurred despite the rather large peak currents being passed. Operation over a 100-mc S-band is possible by selection of the proper crystal. No retuning of the three band-pass plate loads is necessary.



Cross-section of crystal mixer assembly

A panel meter for monitoring crystal-multiplier current is provided and serves as a tuning indicator when the generator is operated in a c-w condition. Crystal current also provides a rough indication of the output power available.

Frequency checks indicate an accuracy of at least 0.002 percent in the S-band output. The pulse repetition rate, though not usually critical, has very acceptable stability. A change of ±10 volts in supply voltage produces a 1-pps change in the 800-pps rate. The delay between sync pulse and the modulator output pulse does not require any great stability. However, only ±1 μsec variation is produced by ±10 volts variation in plate supply.

The author wishes to express his appreciation for the assistance and advice of James F. Gordon in the development of this instrument and to C. C. Bath and G. W. Clevenger for suggestions as to circuit arrangements.

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(1) C. A. Montgomery, "Technique of Microwave Measurements", MIT Radiation Lab Series, McGraw-Hill Book Co., 1947.
(2) F. Butler, Cathode Coupled Oscillator, *Wireless Engineer*, p 521, Nov. 1944.
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Television Streaking Test Set

Adjustable square-wave generator makes possible a point-to-point test of television facilities and lines without tying up camera chain and other valuable equipment. Response of poorly adjusted facility shows up as smear or streak

By **ROBERT K. SEIGLE**
Development Engineer
National Broadcasting Co., Inc.
New York, N. Y.

THE operation of a television broadcasting system comprising more than the minimum of local studios, master control center, and adjoining transmitter requires interconnecting facilities of varying natures and complexities. Even the simplest of these interconnections, such as a passive coaxial cable, can, under adverse but not unusual circumstances, cause certain distortions in the television signal that it is transmitting. The more elaborate arrangements commonly encountered in remote studio and network operations include numerous amplifiers and clampers in the coaxial or radio-relay wide-band transmission system.

Television engineers are well aware that certain rather stringent criteria must be satisfied if faithful reproduction of video signals is to be accomplished. The wide range of variable-amplitude frequencies comprising the composite picture signal must be protected from frequency distortion, phase distortion, and introduction of transient distortions, among others. The degree to which a transmission medium satisfies these criteria is a good measure of its suitability to operation in television service.

Customary methods of testing systems for frequency and phase

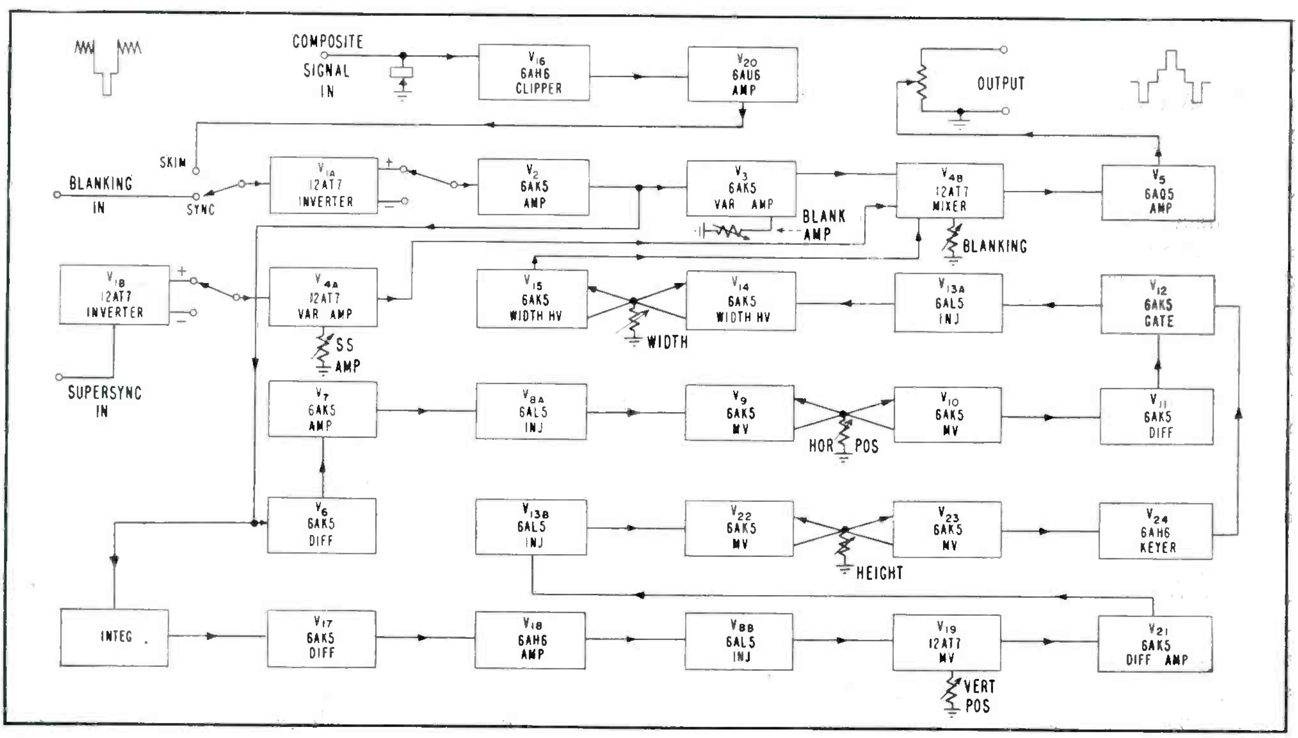
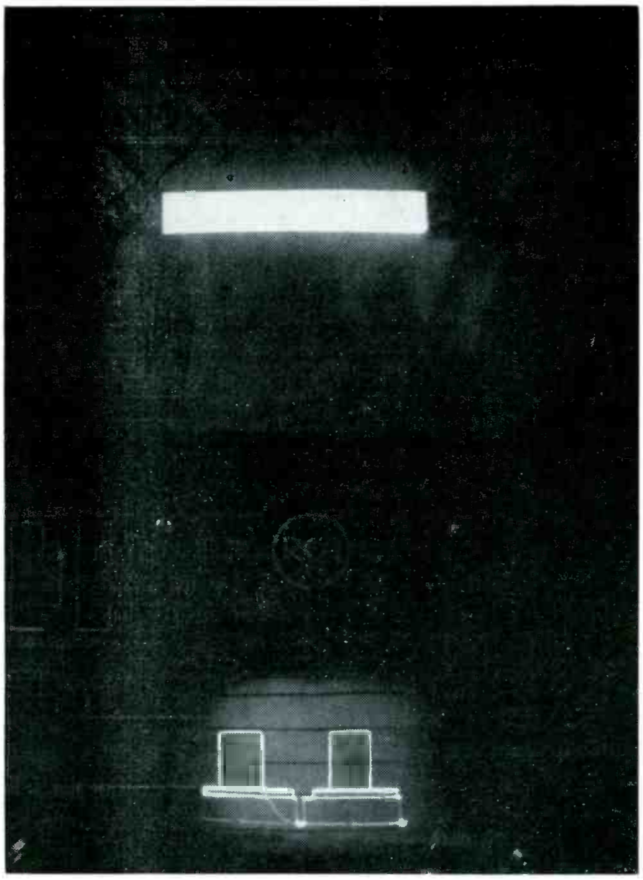
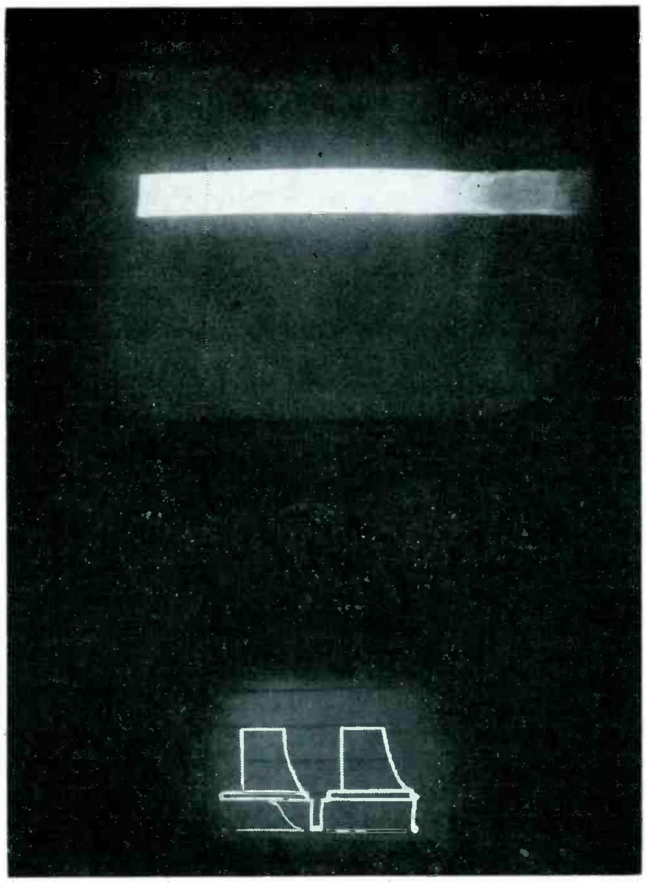


FIG. 1—Interconnection of various units in the streaking test set



When the tester is fed into a properly adjusted equipment, the pattern on the monitor scope is a perfect rectangle. Note the associated waveform scope



Improperly adjusted or faulty video facility will show a streaky or smeared pattern on the monitor as attested by poor waveform on lower scope

distortion and transient response are tedious, time-consuming and often require considerable equipment of laboratory caliber that must be skillfully used. The results of such orthodox testing usually are a set of plotted curves of the system characteristics. Analysis of these curves with eventual evaluation may give significant indication of the system's ability to carry faithfully a television signal. In the end, however, it is the actual critical viewing of a suitable picture or pictures that truly reveals the worth of the system. A purely objective analysis does not always conform with the behavior of the system under the acid test of video transmission.

Of the previously mentioned characteristics of a system, some of the most difficult to verify in objective measurements are low-frequency phase shift and transient response. In some instances the phase characteristic may affect picture quality to a greater degree than poor frequency response. The degradations resulting from these factors appear as streaking, smearing, shading, white- or black-following, or ringing, of varying degree and character. Transient, phase, and low-frequency response can be deemed satisfactory or unsatisfactory by noting whether black- or white-following, streaking or smearing, or large-area shading occur. The presence of improper terminations and ringing likewise are immediately discernible to the practiced observer.

Unfortunately, this desirable means of testing requires an iconoscope, monoscope, or other camera chain to originate the video signal. In general, this is not a satisfactory arrangement for prolonged and varied usage. The originating equipment is large, heavy and expensive. Round-robin checks originating and terminating at the same point cannot always be relied upon because of cancellation and balancing effects over outgoing and incoming circuits. It is usually much more illuminating to make point-to-point tests along any sizeable transmission circuit. This procedure makes highly impractical the use of camera-originated video signals.

The television streaking test set, for which the block diagram is shown in Fig. 1, was designed to provide a video-type signal for use in checking transmitter feed lines, r-f or coaxial video relay circuits, and in other locations where the overall transmission characteristics are to be observed. It gives a rapid indication of smearing, streaking, and transient response. It was constructed in the NBC laboratories and is based upon work previously done by J. J. Jansen and J. W. Rieke at Bell Telephone Laboratories. It is light in weight and may be rack mounted or installed in a modified airplane luggage type suitcase. A companion chassis contains an electronically regulated power supply that may be similarly rack mounted or carried in an identical suitcase.

Synchronized Square Wave

Essentially, the set delivers to the system under test a square-wave impulse properly synchronized with and accompanied by horizontal and vertical blanking and synchronizing information. The output of the system is then viewed on a suitable kinescope and oscilloscope monitor. The appearance of the test signal on a kinescope will be a white rectangle of variable dimensions and position on a dark background. A minimum of one input signal is required for operation. This minimum condition is met by: a complete positive composite signal; or positive or negative blanking; or positive or negative supersync. Any of these three inputs will result in a usable test signal, including blanking but without supersync. In order to furnish a complete composite waveform, either both blanking and supersync of either polarity or, alternatively, a positive composite signal and either polarity of supersync must be fed into the test set.

Referring to the block diagram (Fig. 1) and schematic (Fig. 2) it will be seen that there is a total of twenty-four miniature tubes in the streaking test set proper. Blanking and supersync incoming are fed to individual triode sections of V_1 where equal amplitude but opposite phase outputs may be taken from cathodes or plates by spdt switches. This arrangement makes possible the use of either polarity of input, because a positive pulse polarity must be maintained at the grids of V_2 and V_{4A}. Pentode-connected V_2 amplifies the blanking pulses and applies them to three points: to V_3 and its succeeding blanking-signal string; to V_6 and its succeeding line-signal string; and to an integrator circuit and its succeeding field-signal string.

Following out from V_3, whose grid bias (and consequently gain) is varied by means of the blanking amplitude potentiometer, the blanking pulses are mixed with supersync and video test signals in the plate circuits of V_4. The resulting composite is then amplified in the power stage V_5. The peak-to-peak output is adjusted by feeding the output into a load of approximately 0 to 75 ohms.

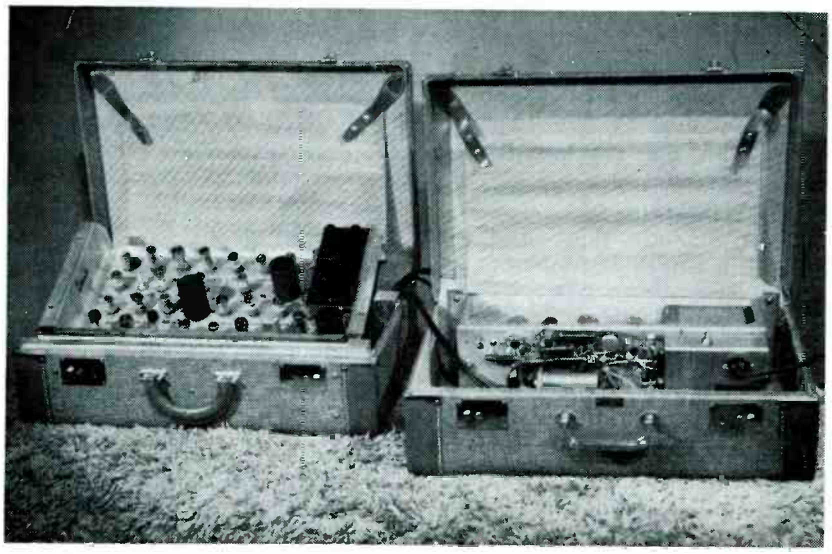
Meanwhile the amplified blanking pulses are feeding into V_6 and, through an integrator circuit, to V_{17}. The respective horizontal and vertical pulses are differentiated and amplified. The following three tubes in both the horizontal and vertical strings comprise a modified cathode-coupled monostable multivibrator. Four such multivibrators are employed in the test set. This circuit is desirable because it is capable of generating short rectangular pulses of adjustable width. The duration or width of the pulse is altered by adjustment of the grid voltage. Only a negative-trigger impulse of proper amplitude will actuate the circuit, and for each trigger, one rectangular pulse is generated. Now, in the succeeding stages, V_{11} and V_{12}, which in turn feed the second horizontal multivibrator group, the line pulses of variable width formed in the first horizontal multivibrator are differentiated and amplified. This processing produces two trigger impulses, one positive and one negative.

The positive impulse that is produced by the leading edge of the multivibrator pulse, which in turn is initiated by the leading edge of horizontal blanking, is seen to be fixed in time relation. The differentiated negative impulse, however, is not fixed in position, because it is formed from the trailing edge of the adjustable width horizontal pulse. Within limits, this negative trigger impulse can thus be made to appear anywhere in the time interval of one scanning line. This, then, is the horizontal position determining device. The negative trigger sets off the second horizontal or width multivibrator through the gate tube V_{12}. The duration of the pulses from this section is adjusted in a manner similar to that for the previous multivibrator. These pulses comprise the actual video portion of the test signal.

Vertical Blanking

The vertical blanking pulses are treated similarly in a pair of multivibrators that set vertical position and height. The amplified final vertical pulse is used as a keying voltage applied to the screen of the gate in the horizontal string. Thus it may be seen that the second horizontal multivibrator can be triggered only during time periods in each field when the keyer increases the voltage on the screen of V_{12}, the gate tube.

Returning now to the video test signal composed of a rectangular pulse of voltage occurring at a particular time in certain lines, it is seen that mixing of this pulse, blanking and supersync takes place in the plate circuit of V_{4B}. The resulting composite signal is amplified in V_5 for application to the system under test.



Complete rack-panel equipment in carrying case (left) with associated regulated power supply operating from 117-v outlet (at right)

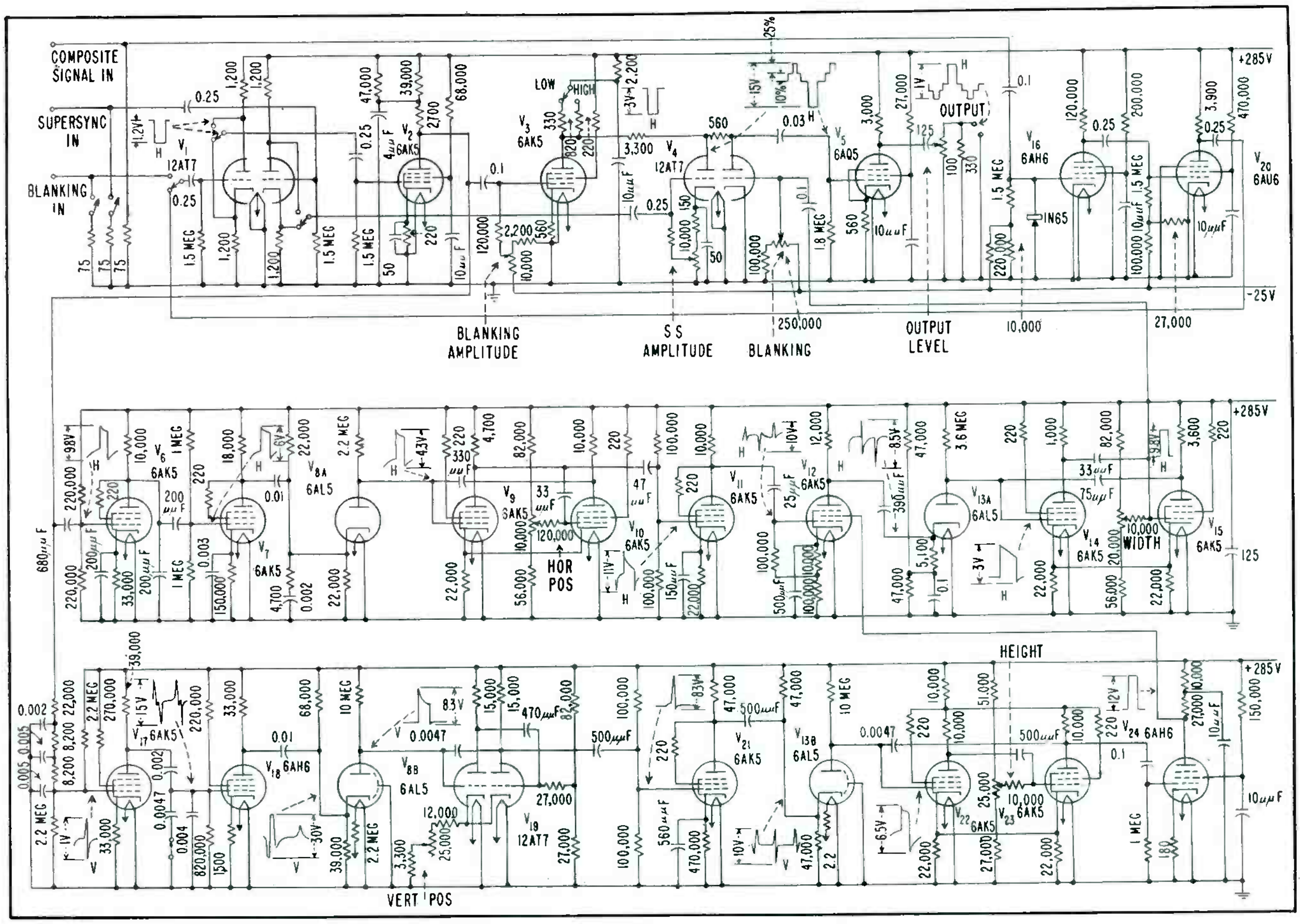


FIG. 2—Complete television facility tester. A conventional regulated power supply is employed

The streaking test set contains eight controls and four switches. These permit wide latitudes of adjustment in most of the components of the composite signal. The potentiometer labeled VERTICAL POSITION times the vertical position multivibrator to commence operation at practically any location of the field. The HEIGHT control determines the duration of operation for the height multivibrator, after it has been triggered on by the vertical position-determining pulse. The height of the white rectangle can be made nearly to fill the viewing raster. Of course, the size must be confined to active lines, and so if a large rectangle is desired, it must be decreased in height if its position on the raster is lowered or raised to the point where it might spill over into the vertical blanking portion. Two controls labeled HORIZONTAL POSITION and WIDTH perform similar functions in the string of horizontal multivibrators. A reasonably large latitude of width and left-right movement of the white bar permits checking at numerous fundamental frequencies.

A BLANKING or contrast control adjusts the amplitude of the bar signal by altering its excursion into the white direction. BLANKING AMPLITUDE and SUPERSYNC AMPLITUDE potentiometers affect the amplitude of their respective pulses as they appear on the output waveform. Something of a master or overall level adjustment is the OUTPUT LEVEL control that alters the total peak-to-peak voltage of the composite signal without affecting the percentage relationships of the individual components to each other.

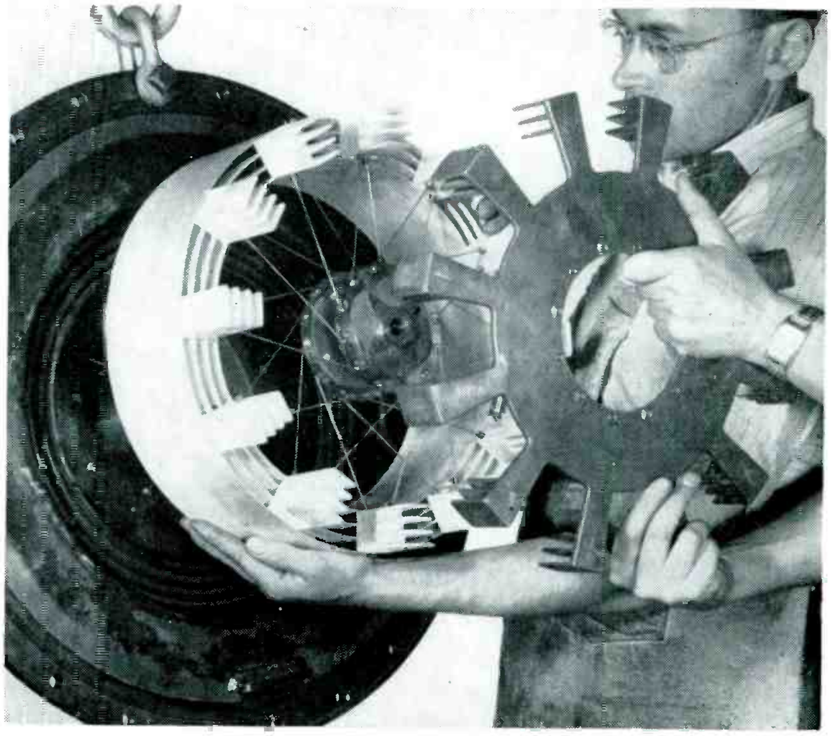
Two of the switches select plate or cathode outputs from inverting triode amplifiers fed by incoming blanking and supersync. This function is necessary to assure proper polarity of these pulses in the output as well as proper polarity of the trigger pulses formed from blanking. A third selector switch places the video clipper circuits in operation for use on an incoming composite signal when blanking and supersync are not separately available. In some instances it was found that a proportionately large amount of blanking level was required and so a toggle switch for altering the value of the blanking-amplifier plate load was installed.

Testing of a video transmission facility such as a coaxial cable or r-f link circuit requires use of a picture monitor known to have good frequency and transient response. In addition, a good waveform monitor may be used. The streaking test set is put into operation at the sending end of the circuit, preferably with blanking and supersync inputs. A local monitor is used to view the outgoing bar and to assist in desired positioning, height and width, as well as level setting. At the receiving end the artificial video signal composed of the bar is viewed and the amount of smearing, streaking, or transient condition ascertained. Variation of the height and width of the bar at the sending end serve to alter the fundamental of the video signal to permit exploration of system response over an extended range of frequencies.

Radio Frequency

How the acceleration of heavy particles up to a few hundred million electron volts is most economically produced in the f-m cyclotron. Design and construction of the oscillator and modulator, connected by transmission lines, is of interest to communications engineers building broad-band vhf circuits

THE PRINCIPLE of accelerating charged particles to high energies by constraining them to travel in circular orbits by means of a transverse magnetic field, and then applying to a gap in their path a relatively low voltage synchronous with the rotation of the particles, was suggested by E. O. Lawrence in 1930. Machines of this type have been used as high-energy accelerators since shortly thereafter, and are commonly called cyclotrons. Their basic elements are a magnet and a high-frequency generator. The magnetic field usually appears between two horizontal circular pole tips, and the accelerating gap is formed by two enclosed half-cylinders very much like a pill box cut in half. From the resulting shape, they are usually called dees. The ions to be accelerated are formed near the mechanical center of the system.



Variable capacitor to produce f-m. Note capacitance takeoff at left

From the simple equations of motion it may be shown that the angular frequency of the rotating particle is

$$\omega = eH/mc \text{ radians per sec} \quad (1)$$

where H is the magnetic field, in gauss; e is charge inesu; m is mass of the particle in grams; and c is the velocity of light.

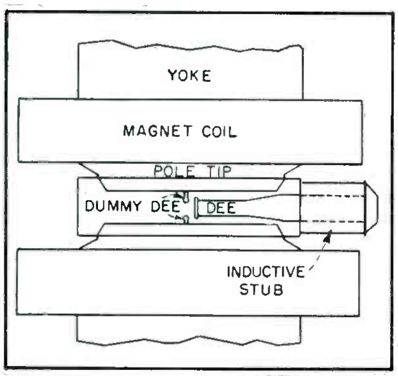


FIG. 1—Side view of the dee and cavity of the cyclotron

Thus if the mass is constant, there is a constant value of ω for a given value of H. This is the cyclotron resonance frequency.

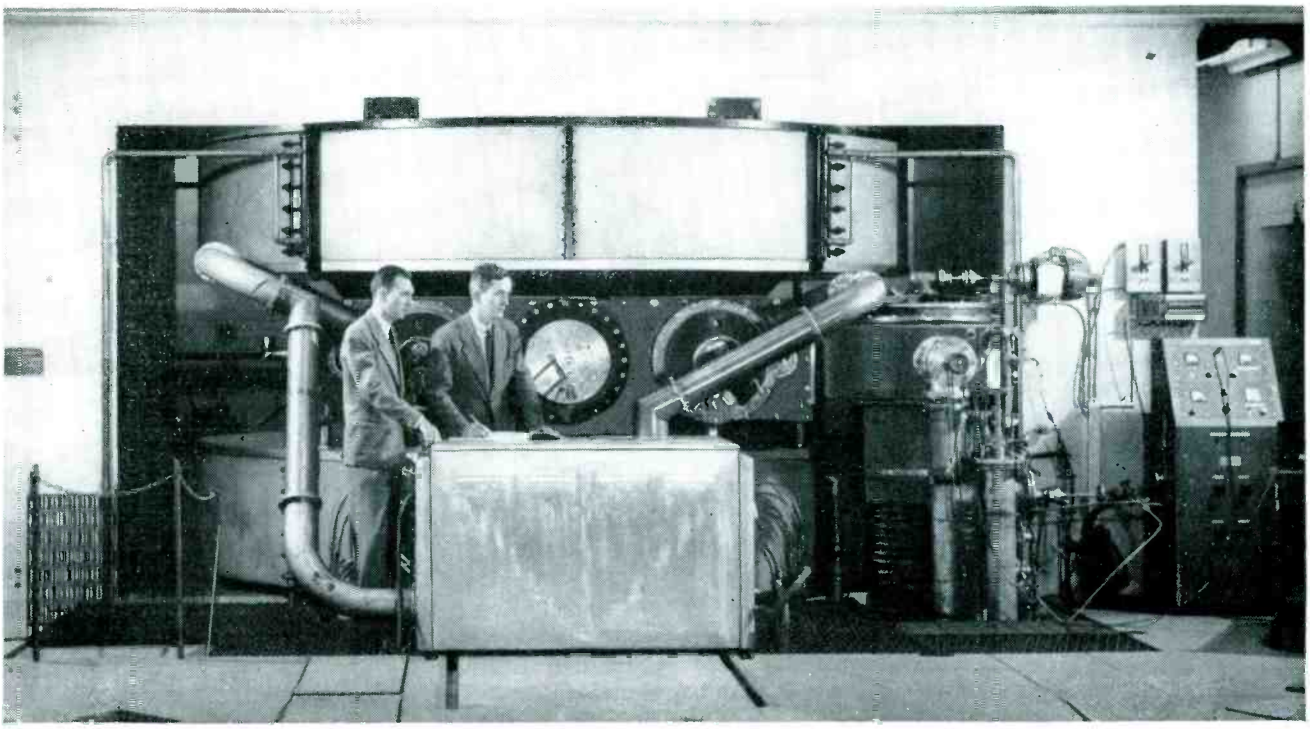
In fixed-frequency cyclotrons, the high-frequency generator problem is chiefly that of attaining high voltage across the dee gap (50 to 200 kv). Occasional slight departures from the cyclotron resonance frequency are tolerable so long as this high voltage is maintained. If operation free from parasitic or other undesirable modes is obtained and suitable measures are taken to permit gas discharges to occur without overloading the generator, the performance is considered satisfactory. Hence, the design of the radio frequency portion of the c-w cyclotron is a straightforward problem in radio engineering.

F-M Machines

The fixed-frequency machines are limited, however, to energy levels where relativistic changes in mass are negligible, since if m is a variable in Eq 1, the relationship between ω and H is dependent on the velocity of the particle. It is impossible to use a fixed compensating change in H with radius because the ion beam would be defocused. Thus to pass this limit it is necessary to vary the field and/or the frequency synchronously with the mass change. For heavy particles

for a Synchrocyclotron

By ALFRED J. POTÉ
Nuclear Laboratory
Harvard University
Cambridge, Mass.



Complete r-f setup with dee in place between magnet poles. Cathode line at right and plate at left

accelerated to a few hundred mev, it is more economical to keep the field constant and vary the frequency, the amount of frequency change depending mainly on the particle being accelerated and the final energy desired. Machines operating in this fashion are called synchrocyclotrons or f-m cyclotrons.

From Eq 1 may be derived the relation

$$f = 1.43H/E \quad (2)$$

where f is frequency in megacycles; H is field in gauss; and E is the total energy of the particle in mev including the rest energy.

In the Harvard machine, H at the center of the gap is 16,400 gauss. When accelerating protons (rest energy 938 mev) the initial generator frequency is 25 mc. If the final energy is 1,073 mev (assuming a kinetic energy of 135 mev is imparted to the particle), and H at the end of the orbit is 95 percent of the center field, then the final frequency is 20.75 mc. The field tapers slowly downward from the center so that the resulting configuration provides a vertical restoring force that tends to keep the particles focused in the central plane.

Theory indicates that the dee voltage may be as low as 1 kv in a synchrocyclotron, but for high average beam currents and possible c-w operation, the Harvard generator is designed to achieve dee voltages above 20 kv. It is also desirable to have the dee voltage rise as the frequency is decreased.

In addition to the above basic requirements, the design of the r-f generator is governed to a great extent by the mechanical design of the cyclotron. The desired r-f load is the ion beam, but the major portion of the actual load is the dee structure and its associated elements. Since extremely high gap voltages are not required, a single dee working against ground or a dummy dee can be used, thus allowing more free space for experimental gear.

The dee geometry shown in Fig. 1 is such as to make it a high-capacitance, low-impedance load. Since this is incompatible with the requirements of high voltage, the system is made resonant by adding inductance, thus achieving high impedance and high Q. In fixed frequency machines any difficulty that this high Q engenders is more than compensated by the large resonant step-ups obtainable, permitting extremely high dee voltages with reasonable driving voltages. In the f-m cyclotron, however, since it is this circuit that must be excited over a broad frequency range, the high Q poses a problem. Broad-banding would result in low dee voltage, large power requirements and circuit complexity, particularly since it appears in practice that the theoretical minimum dee voltage must be considerably exceeded for satisfactory operation. Accordingly, it was decided to tune the dee circuit directly, using a type 9C21 tube in a grounded-grid Hartley oscillator circuit.

The tuning may be done in several ways—mechanically by means of a variable capacitor, or electronically. The latter would be desirable, but for dee voltages in the order of 20 kv, 14,000 kva of reactive power is required at the peak of the modulation. It is relatively easy to design a variable capacitor with a dissipation factor of 0.0001, which would give a power loss for the above conditions of 1.4 kw. Unfortunately no electronic device is available with efficiency high enough to keep the losses within reason.

Mechanical Modulator

A variable capacitor presents difficult problems even though its use seems the best expedient. On one hand, the high voltages involved indicate that the capacitor should operate in a good vacuum, presenting such problems as rotating seals and bearings in vacuum. On the other, the currents are so high that if even a small fraction follows an alternative brush path to ground through bearings rather than flowing through the capacitance takeoff provided, breakdown of sealing and lubricating compounds may result, with consequent bearing and vacuum failure. In addition, the capacitor must be extremely efficient. It may be required to operate in a strong magnetic field, so the design must inhibit eddy current losses. Fortunately these problems, when recognized, can be solved without too much compromise.

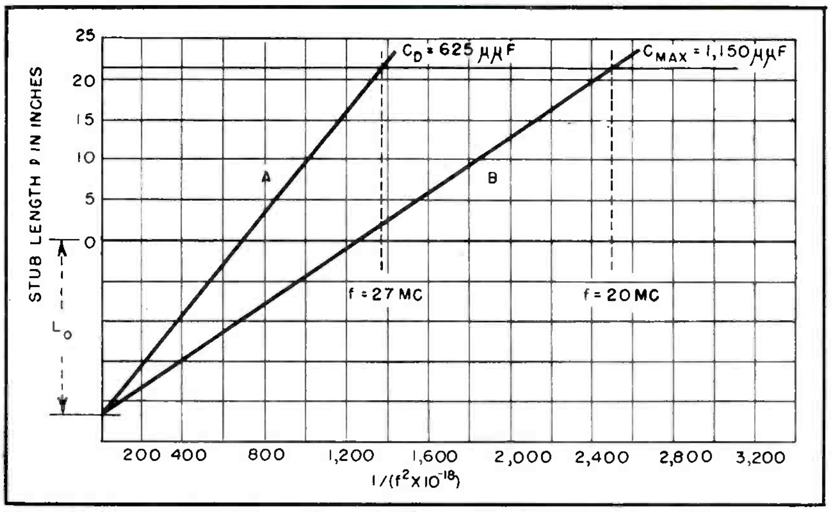


FIG. 3—Determination of L_0 and effective C_D is possible from curve *A*. Desired capacitance change is obtained by using curve *B* in addition

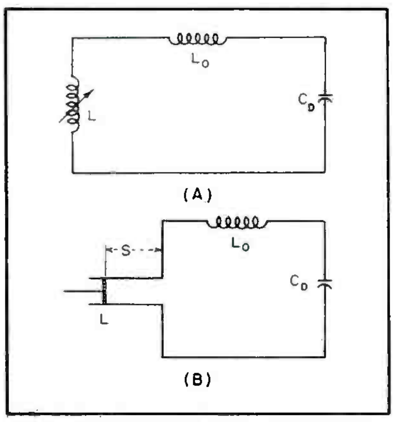


FIG. 2—Lumped circuit equivalent of dee (A), and variation using tuned stub (B)

As indicated, the dee capacitance across which it is desired to maintain a high r-f voltage may be made part of a high-impedance circuit by shunting inductance across it. The dee could also be extended as a uniform transmission line to become a quarter-wave resonator. At first glance it might appear that the latter course would result in higher dee voltage, since the voltage amplitude on a shorted line acting as an inductance for resonating the dee capacitance would rise only to a value equal to the sine of its electrical length, taking the voltage at the lip of the quarter-wave resonator as the normalizing value.

The important criterion, however, is the amount of power required to maintain a given voltage on the dee and this depends upon the losses in the system. A comparison between the losses of the extended section of a uniform line beyond the dee and the losses of alternative inductive elements, not neglecting the effects of constrained current paths, indicates the relative merits. This choice is also governed by the mechanical problems, which lent support to the use of two shorted coaxial stubs as the tuning elements. Electrically the use of two stubs permits the separation of the output and excitation circuits of the oscillator and also gives a longer stub length for a given surge impedance, this being desirable for a wide range of noncritical oscillator adjustments.

To keep losses low, the outer conductor diameter is made as large as the vacuum-tank dimensions permit and the inner conductor diameter is determined in the Harvard machine chiefly by mechanical considerations. The resulting stubs have a characteristic impedance of 30.6 ohms. While this value is not optimum, the large dimensions yield a Q of 11,000.

Scale-Model Oscillator

The dee may be considered a lumped capacitance, since it is only 0.1-wavelength long. If this assumption is made, the circuit may be represented as in Fig. 2A, where L_o is the internal and L the external inductance. For this system

$$1/f^2 = 4\pi^2 C_D (L_o + L). \quad (3)$$

As noted above, the dee design is

dictated almost entirely by the cyclotron requirements, and while a good approximation of its capacitance may be calculated, L_o is not so easily estimated. For this reason, and also because a critical study of the performance of the oscillator seemed desirable, a half-scale model of the dee and vacuum tank was built. Movable shorts were provided in the stubs so that the external inductance could be varied. The equivalent circuit for this structure is shown in Fig. 2B, where a single coaxial stub of variable length S represents the effect of the two stubs in parallel. For this circuit

$$1/f^2 = 4\pi^2 C_D \left(L_o + \frac{Z_o \beta S}{\omega} \right) \quad \text{where } S << \lambda \qquad (4)$$

It may be shown that a plot of S versus $1/f^2$ yields a straight line of slope

$$m = \frac{c}{4\pi^2 C_D Z_o}$$

where c is the velocity of light

Such plots were made for the half-scale model and later for the full-scale machine. These showed the expected correlation and permitted a determination of L_o and effective C_D, the latter from the slope and L_o from the $1/f^2$ intercept (see curve A of Fig. 3). The value of L_o may also be determined by extending the curve to intercept the S axis. The required change in capacitance for a desired frequency swing may then be determined graphically as shown in Fig. 3, curve B. For this construction a minimum capacitance (for the added variable capacitor) of 50 $\mu\mu$f is assumed by making the starting frequency about 4 percent higher than the upper design value of 26 mc or actually 27 mc. The ordinate yields the maximum stub length for this frequency, and the slope of the line through L_o and the point determined by the stub length and the lowest desired frequency gives the total capacitance required. The difference between the two capacitance values is the amount necessary for the modulation if the additional capacitance were placed at the dee.

For several reasons it is undesirable to put the variable capacitor at the dee lip. Chief among these is the problem presented by eddy currents induced in moving metal parts by the strong magnetic field in the region of the dee. While it is true that the capacitor could be made of nonconducting material except for thin conducting skins, this construction is fragile and costly.

Modulation Capacitor Design

The frequency modulation can be accomplished equally well by means of a variable capacitor connected to the dee through a section of transmission line. This scheme not only gets the capacitor into a region of weaker magnetic field, but also requires a lower maximum capacitance. It can be shown that

$$C_R = \cot(\alpha + \beta l) / \omega Z_o \qquad (5)$$

The values are $\alpha = \cot^{-1} C_e Z_o$; C_e = desired effective capacitance; C_R = required terminating capacitance; and l = length of line of impedance Z_o.

A plot of this relation is shown in Fig. 4 for the conditions: C_e = 500 $\mu\mu$f at 20 mc, C_e = 50 $\mu\mu$f at 26 mc; and Z_o = 70 ohms. For a length of 20 inches the ratio of C_e to C_R is approximately 2 to 1. This stub length is used and a capacitance of 254 $\mu\mu$f maximum achieves the desired frequency swing.

At the position of the rotating capacitor the magnetic field is 2,000 gauss, which is still high enough to give trouble from eddy currents. Further to relieve this difficulty, the capacitor is made of silver-plated Inconel, an alloy having a resistivity about 80 times that of copper. Its construction is illustrated.

Whether transmission lines or some other means of connecting the tube to the resonant dee circuit are used, the resulting feedback loop must have a wide-band, constant-phase characteristic. If the phase varies over the band, the dee circuit will have to detune sufficiently to satisfy the phase criterion for oscillation. When the required detuning is considerable, lower dee voltage and efficiency will result.

Dee-Oscillator Connection

Resonant transmission lines are admirably suited for use as wide-band constant-phase transformers with reasonably low losses. Some characteristics of these lines are indicated in Fig. 5.

An analytical expression for the effect of a termination different from the characteristic impedance at various line lengths may be readily obtained and in the general case where Z_R is complex, the phase shift is

$$\phi = \tan^{-1} - \frac{Z_o R_R \tan\beta l}{|Z_R|^2 + Z_o X_R \tan\beta l} + \eta\pi \qquad (6)$$

Two line sections of approxi-

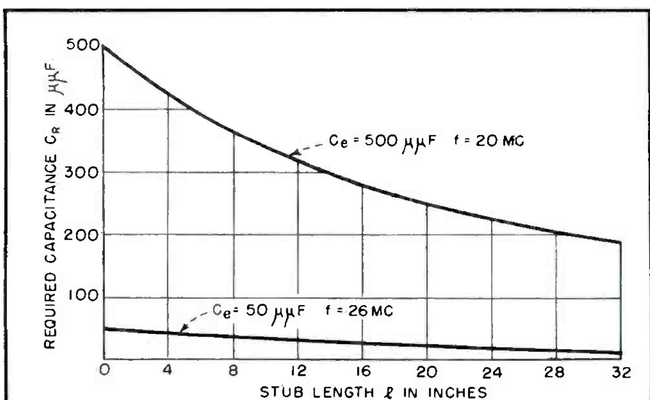


FIG. 4—Stub length versus required terminal capacitance for a representative cyclotron oscillator

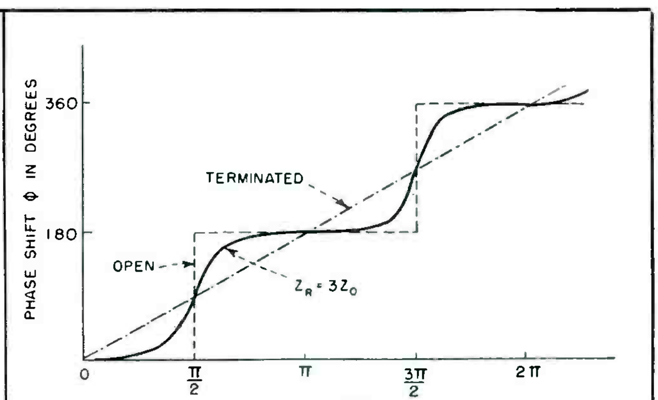


FIG. 5—Phase characteristics of a transmission line under various conditions of termination

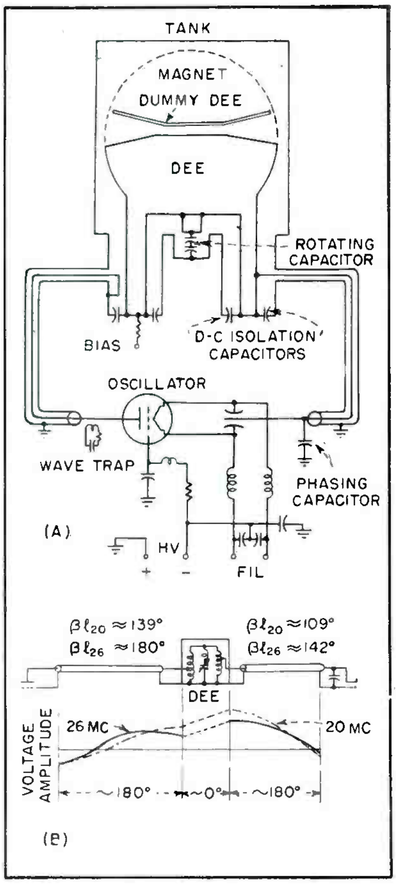


FIG. 6—Schematic circuit of the oscillator (A) showing connection to the dee, and qualitative phase and amplitude behavior of the circuit (B)

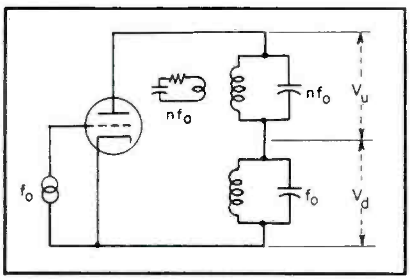


FIG. 7—Plate-line resonances owing to harmonic components

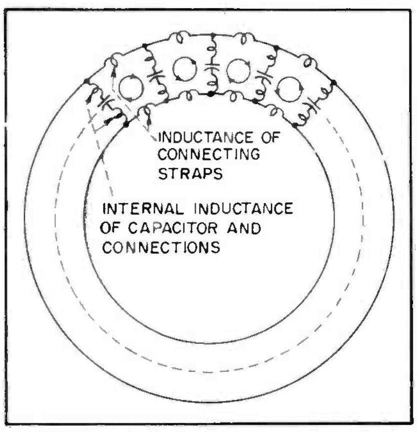


FIG. 8—Capacitor ring resonances

mately 180 degrees each are used. On the line connecting the plate of the tube to the resonant system, the real component of the terminating impedance reflected from the dee to become the plate load and the reactive component due to the tube capacitance are both of favorable magnitude to give good phase behavior with the 78-ohm line used. The cathode circuit, however, has a low equivalent resistance and so requires additional low reactive loading by means of a phasing capacitor to attain the desired characteristics.

The final circuit and its qualitative phase behavior are shown in Fig. 6. Since the phase is constant enough over a considerable range of line length, a length of plate line can be chosen that helps in achieving the desired amplitude variation with frequency, as shown in Fig. 6B where a given r-f plate voltage results in higher voltage delivered to the dee circuit at the lower frequency.

Arrangement of Components

The cabinet containing oscillator, filament transformer, and ancillary apparatus is built upon a wheeled dolly that allows removal of the dee. The r-f section of the cabinet is divided horizontally by a copper sheet that acts as a ground plane and isolates the output and excitation circuits. A flexible copper disk is connected to the ring grid seal and forms one terminal for sixteen 100-$\mu\mu$f vacuum capacitors, the other terminal being the ground plane. The reactance of these capacitors is sufficiently high to require an r-f choke for isolating the grid leak. Three sides of the cabinet and a vertical copper sheet together with the cabinet top and bottom complete the r-f enclosure illustrated.

The cathode line enters from the top and connects to the phasing capacitor and to a special isolating capacitor, which also serves as the cathode bypass. The plate line enters from the side, at the bottom of the cabinet.

Initial Adjustments

When the oscillator was first tested with no magnetic field and no vacuum the system oscillated well and with considerable power capacity at 26 mc. A temporary modulating capacitor was arranged on the capacitor stub and the behavior of the circuit over the desired frequency range was studied. Poor operation was obtained over the low-frequency portion of the range and various line lengths and values of phasing capacitor were tried with indifferent success. At this time the cathode-isolating capacitance consisted of four 1,000-$\mu\mu$f nickel-electrode vacuum capacitors, and the system showed unwarranted sensitivity to their number and position. They were removed from the circuit and the cathode bypass capacitor, which consisted of two commercial mica units, was made to perform the isolating function as well. There was immediate and gratifying improvement, apparently owing to decreased losses and better phase behavior.

Since it is inconvenient to connect the plate line to the dee system at a point where the impedance is higher than about 1,000 ohms, this impedance appears as a less-than-optimum plate load when transformed by the line, because of the foreshortening resulting from the plate-ground capacitance. The metal air manifold around the plate seal was replaced with one of plastic and improved operation resulted due to the effect of reduced circulating currents and higher plate loading.

With these changes, the circuit oscillated over the desired range, but the oscillations became intermittent at the ends of the range and at two places in between. The bursts of oscillation were at 120 cycles and synchronous with the line voltage. It developed that at the low d-c plate voltages used during the tests, magnetron-type cutoff of the space current was occurring from the magnetic field of the filament itself. Raising the plate voltage above a critical minimum removed this difficulty, since this minimum was well below the expected operating value.

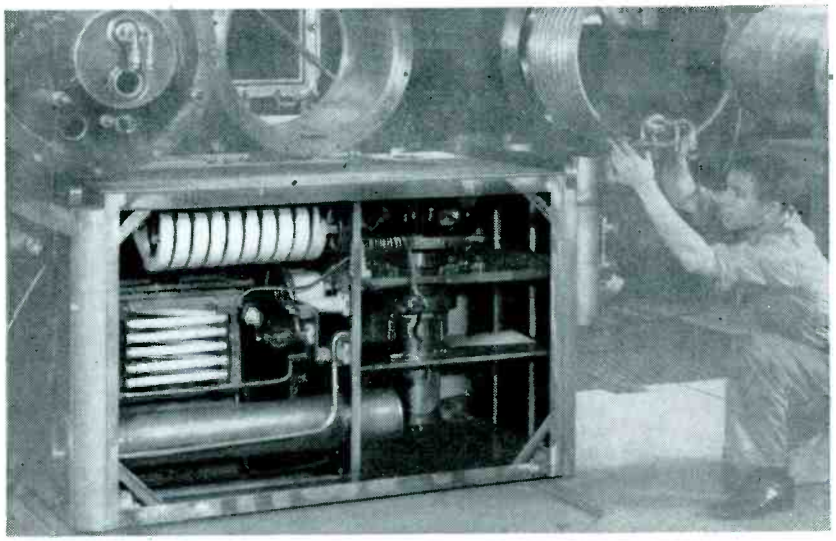
Plots of dee voltage versus frequency showed a droop at the ends of the range and two major dips. The latter occurred at about 22 mc and 23.6 mc and could be moved up or down the frequency scale with changing length of plate line. These dips are ascribed to the following effect: The tube is operated with a plate current pulse about 140 degrees long. The current then has a second-harmonic component whose amplitude is 69 percent of the fundamental and a third harmonic 31 percent of the fundamental.

The first of these can excite the fifth harmonic of the plate line, which occurs at about 47 mc, and the other can excite the seventh harmonic at about 66 mc. These frequencies cannot appear at the dee owing to the high Q of the system, but the effect is shown qualitatively in Fig. 7. Lossy wave traps tuned to 47 and 66 mc reduced the impedance appearing in the plate circuit at these frequencies and also reduced the dips to an acceptable value. The dips would be further reduced at high modulating frequencies by the high Q of the tuned circuit.

From the experience at other universities, it had been expected that trouble would occur when the oscillator was operated with the dee tank evacuated and the magnetic field present. As had been predicted, discharges in the tank prevented the dee voltage from rising beyond 100 volts or so. These discharges have been variously ascribed to resonant secondary-emitted electrons, Phillips ionization gage effects, and other mechanisms.

Berkeley workers had solved this problem by insulating the dee so that a d-c bias could be applied that would provide a sweeping field. The Harvard machine was built with this necessary contingency in mind, but first a grid of wires insulated from the r-f system and to which a d-c bias could be applied were tried. These wires were installed with some difficulty owing to the geometry of the dee and its stubs, but they did indeed reduce the discharges. Each wire, however, behaved like a continuously excited transmission line and, deriving its energy from the oscillator, acted like a high-voltage, low-impedance generator. This made the problem of isolating the r-f from the external biasing circuit an extremely difficult one.

Various resistor and choke networks were tried but no elegant or satisfactory solution appeared less difficult than proceeding with the insulation of the dee itself. To prevent discharge along the stubs as well as on the dee, special mica capacitors were designed and built to replace the shorts at the ends of the stubs as shown schematically in Fig. 6A. While this placed the capacitors at a low-voltage point of the system and hence made the isolation of the bias supply easier, the high current (1,000 amperes) made it imperative that the capacitors have low loss. Further, the capacitance had to be high enough to insure no substantial change in effective stub length, and to keep the change in effective length small with changing frequency.



Oscillator dolly with attached dee partially removed. Type 9C21 oscillator tube at right, grid leak, metering circuits and ceramic water coil at left

Capacitors in Vacuum

The capacitors were tested in air for breakdown at 3,000 volts d-c, but when they were installed in the vacuum system whose pressure was in the region of 10^{-5} mm of Hg, breakdown along the surface of the mica occurred at about 1,200 volts. Commercial fixed air-dielectric types were then tried in the vacuum system and could be operated at over 2,000 volts d-c. These units (sixteen of 750 $\mu\mu$f each per stub) were intended by the manufacturer to be fed at the end of the stack. With this connection the effective capacitance was 1,000 $\mu\mu$f per unit, indicating an effective inductance of approximately 0.016 microhenry. With these capacitors, the machine would not oscillate over the lower half of the range until the connections were made half-way down the stacks of plates. A hole then appeared in the dee voltage-versus-frequency curve, which was found to result from a resonance in the ring of capacitors. This was determined by measuring the impedance of the capacitor network as a function of frequency. The hole appeared where this impedance rose to 80 ohms from the normal value of less than half an ohm. Figure 8 shows a possible mode of resonance. An additional capacitor was connected in the ring and the nearest high impedance points occurred, fortuitously, just each side of the desired range.

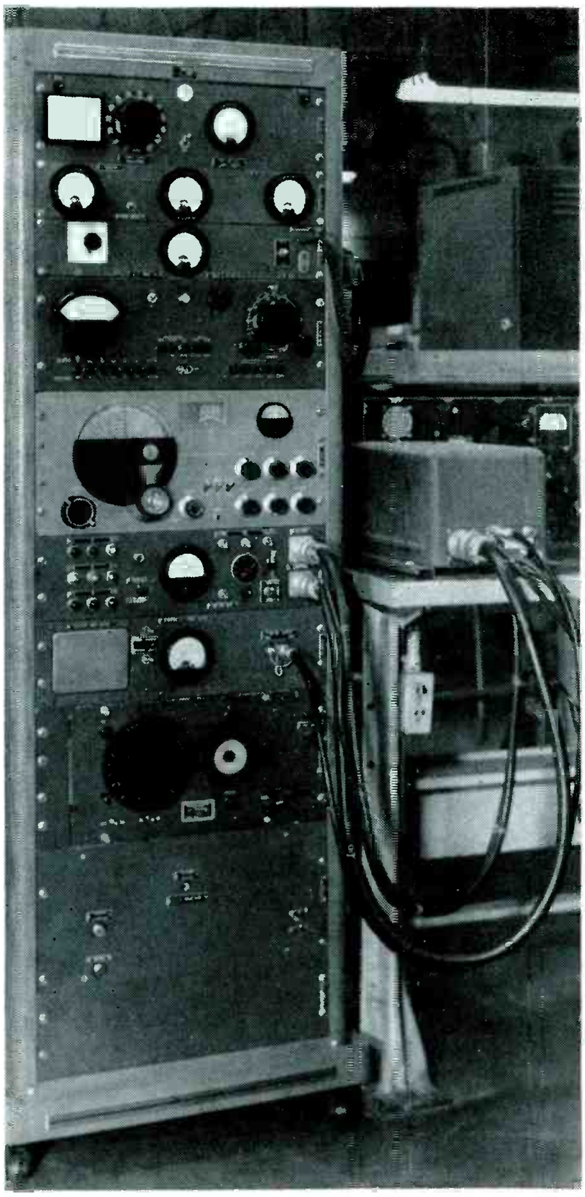
A new capacitor consisting of annular rings of 20-mil copper sheet and using the vacuum as a dielectric has reduced the losses further and eliminated the resonances.

No critical study of the oscillator performance other than that indicated has been made. The efficiency varies from 25 percent at 21 mc to 70 percent at 26 mc, a condition that can be improved by different plate-line impedance and length, or by using an electronic grid leak, which could be made to maintain optimal conditions over the range. Even with this low efficiency, however, an average dee voltage of 8,500 volts is obtained with a plate power input of 4.5 kw.

Mobile

By GEORGE J. KENT

Senior Engineer
Western Electric Co., Inc.
New York, N. Y.
and
Adjunct Professor of
Electrical Engineering
Polytechnic Inst. of Brooklyn,
Brooklyn, N. Y.



Top panel — adjustable autotransformer with a-c vm to give constant line voltage for all units

Three meters for test receiver

Phantom microphone panel and handset

Distortion and noise meter, with cps check dial at right

Receiver for highway range and tuner for converting urban range to 27.5 mc

Metering circuits for alignment of transmitters

R-f wattmeter, loudspeaker and switching circuits

Conventional 50 to 15,000-cps audio oscillator and audio amplifier

Heavy cast iron plate on floor of dolly truck improves stability of relay rack. Rubber pads on floor of truck protect tubes and preset controls from shock

Mobile transmitter being tested is on bench at right of relay rack containing testing set

IN THE initial stages of mobile telephone use and even now in some rare instances, the so-called talk test was considered the complete final test for servicing purposes. In this test the operator speaks into the regular microphone which modulates the transmitter under test. The modulated carrier is picked up by a nearby test receiver and converted into sound, and the intelligibility of the reproduced speech is checked by another operator.

The talk test must be considered inadequate from the standpoint of insuring maximum reliability along with low servicing cost. The satisfactory result of a simple talk test does not insure the proper behavior of the transmitter under a variety of operating conditions since it provides only a fragmentary picture of the transmitter's performance. For instance, it is impossible to establish quantitatively what the performance of the transmitter will be when its transmission is received at a small fraction of its original strength, or when the full dynamic range of speech is applied to the microphone. It is equally difficult to evaluate how the speech will sound after it reaches the telephone subscriber over the telephone lines.

General Test Procedure

To insure that a mobile transmitter will do what it is supposed to after being connected to the telephone system, the four shop tests described below are now made before installation of the equipment. The talk test has not been omitted but is the fifth and supplementary test. A testing set developed for the purpose permits making the five transmitter tests almost as quickly

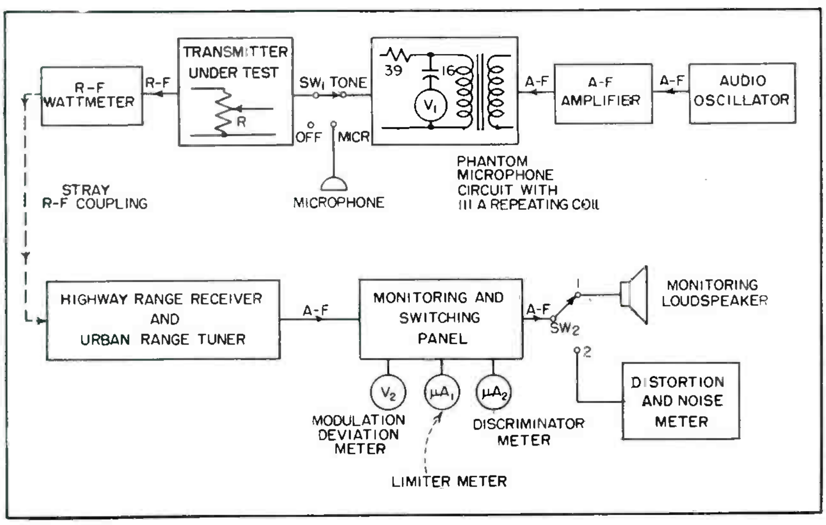


FIG. 1—Arrangement of major units in transmitter testing set

Transmitter Testing Set

Quickly and accurately checks performance of private or common-carrier p-m or f-m mobile telephone transmitters, such as those used in 30 to 44-mc highway and 152 to 175-mc urban service. Measures r-f power output, audio sensitivity, signal-to-noise ratio and harmonic distortion and gives speech intelligibility check in few minutes

as if only the talk test were made.

The transmitter testing set is primarily used for production-line testing of both new and serviced phase-modulated or frequency-modulated mobile or land transmitters operating on frequencies from 30 to 175 mc with outputs up to 80 watts. The tests are made with a single modulating frequency, usually 1,000 cps. With minor modifications, a-m transmitters operating from 540 kc to 110 mc and almost all types of higher-power f-m, p-m and a-m communications transmitters on the above frequency bands can also be tested. For outputs over 80 watts, however, power measurements must be made with a separate instrument. After a day or so of instruction a relatively inexperienced operator can perform the tests in a satisfactory manner. After a few days of experience he can completely check a transmitter in a few minutes.

The measurements are normally made on two main types of transmitters, the p-m highway type which operates between 30 and 44 mc and the p-m urban type which operates between 152 and 175 mc.

The arrangement of the major sections of the testing set is shown in Fig. 1. The unmodulated output of the transmitter is connected to a shielded load resistor located inside an r-f wattmeter, and the power is read directly in watts. The transmitter is modulated thereafter by a single frequency. The stray r-f coupling between the wattmeter and a very sensitive receiver is sufficient to obtain an audio output from the receiver for measurements of audio modulation sensitivity and modulation deviation. Next the same output is analyzed for distortion and signal-to-noise ratio in a suitable meter. Finally, speech is substituted for the single frequency modulating the transmitter. The receiver output is heard from a loudspeaker and evaluated for intelligibility. All of the measurements are made with the mobile transmitter operating on controlled battery supply voltages.

R-F Power Test

For the first test, the unmodulated r-f output of the transmitter is delivered through a coaxial line to an aperiodic resistive load in the r-f wattmeter. This load provides the correct standard terminating impedance (practically pure resistance) that remains constant over the range of 30 mc to 300 mc. External r-f radiation from the wattmeter complies with FCC rules yet provides the required r-f input to the receiver. The rectified voltage across the load is measured with a d-c voltmeter calibrated directly in watts. The tested transmitter must have an output power which is above a minimum value.

Audio Sensitivity and Noise Test

With SW_1 in Fig. 1 set to TONE and SW_2 at either position, the modulating circuits of the transmitter are connected through the phantom microphone circuit to the a-f amplifier and the output of the audio oscillator. The oscillator is usually set to 1,000 cps and its output, adjusted to a predetermined level indicated by voltmeter V_1, is injected into the transmitter. The transmitter audio gain control R is set for minimum sensitivity of the modulating circuits. This simulates the condition when an idealized customer speaks into the microphone at a standard sound level while the transmitter operates at its lowest permissible audio sensitivity. The r-f output of a transmitter which meets the requirements should now be adequately modulated.

The modulated carrier is picked up due to stray coupling by the test receiver or tuner tuned exactly to the same frequency as the transmitter. To insure that the stray coupling produces a sufficiently strong signal in the receiver, the limiter grid current in the receiver is checked with microammeter μA_1. Another microammeter, μA_2, serves as a discriminator output meter and is used in tuning the receiver to the frequency of the transmitter under test. An a-f voltmeter, V_2, is connected across the audio output of the receiver and is calibrated to read modulation deviation in kc. This tells directly whether the modulation deviation of the tested transmitter is within or outside the prescribed limits for a minimum setting of the transmitter modulation sensitivity control.

The receiver in the testing set is a commercial communications model in which frequency drift has been minimized and signal-to-noise ratio boosted to 41 db by preselection of tubes and use of a special alignment procedure. Elaborate multiple shielding, both static and magnetic, and a grounding system are used in the testing set to reduce external noise and hum pickup, so that the same high signal-to-noise ratio of 41 db is obtained for the complete testing set at 5.5-kc modulation deviation and a 1,000-cps modulating frequency.

With connections and adjustments the same as for the audio sensitivity test, the distortion and noise meter is connected by means of SW_2 to the output of the receiver. Control R is adjusted until voltmeter V_2 shows a predetermined modulation deviation, usually 5.5 kc. The distortion and noise meter measures first the receiver output in db. Next, modulation is removed by setting switch SW_1 to OFF and the receiver output in db is again measured. The ratio of these two voltages, expressed as a difference of two db readings, is the signal-to-noise ratio of the tested transmitter under specified conditions.

The distortion and noise meter used in the set is an aperiodic average-reading vacuum-tube voltmeter. Thus the measured ratio is the so-called unweighted ratio. The usual requirement is that the tested transmitter must have a signal-to-noise ratio of at least 35 db. The difference between this minimum and the safely assumed 41-db ratio of the testing set is 6 db. This difference causes an error of 1.2 db in the measurement of the transmitter's signal-to-noise ratio. Thus it is always possible to find whether this ratio is lower or higher than 35 db.

Noise weighting consists of assigning different relative values to noise components of different frequencies, depending on the disturbing effect they have on the average ear. The curve showing these relative values as a function of frequency is called the weighting characteristic. There exists sufficient correlation between the unweighted and weighted ratios for each weighting characteristic so that limits for unweighted ratios can be established when weighted measurements are required. Also, for the type of noises found in mobile telephone transmitters there exists a correlation between the indications of the average-reading meter used here and the rms noise meters often used for the same purpose.

The unweighted and average method of noise measurement contributes considerably to the simplicity of the set's construction and to the flexibility of measurements as well as to the reduction of both the initial and maintenance costs. It does not affect the accuracy of noise measurements.

During tests, the transmitters are usually supplied with somewhat less than 6 v or 12 v d-c from a full-wave rectifier with a floating battery. This type of power supply produces a 120-cps ripple voltage which tends in some cases to decrease the measured signal-to-noise ratio. Therefore, during this and the following distortion test, if the transmitter does not meet the requirements the rectifier is temporarily switched off and the transmitter is supplied with current from the battery only.

Harmonic Distortion Test

With the same setup as in the snr test, the required modulation deviation is obtained and the audio output voltage of the receiver is measured with the vtvm of the distortion meter. A continuously variable null network tuned to 1,000 cps is then inserted between the output terminals of the receiver and the vtvm of the distortion meter to eliminate the 1,000-cps fundamental frequency. The resulting measured audio output voltage now represents the average of all harmonic distortion products. The ratio of the last voltage to the first expressed in percent is the average harmonic distortion, and is directly indicated by the distortion meter. This reading is approximately the sum of the distortions produced by the audio oscillator, a-f amplifier, phantom microphone, tested transmitter and receiver, including the tuner for the urban range.

In the second measurement, the residual signal after elimination of fundamental frequency consists of both the harmonic distortion products and noise. Since the noise is usually 35 db or more below the audio output level when standard modulation is applied and since the permissible harmonic distortion of the transmitter is usually about 10 percent, the error caused by noise may be neglected. The residual signal may be considered as representing harmonic distortion of the complete testing setup.

Talk Test

With SW_1 set to MICR, SW_2 set to position 1 and modulation sensitivity control R set to a predetermined position, the operator talks in a normal voice before the microphone. Through the stray coupling, the tuner and/or the receiver pick up the signal and convert it into sound. Another operator judges the intelligibility of the speech from the loudspeaker and watches meter V_2 to see that the modulation deviation does not exceed the limit.

The range of modulating frequencies in the mobile telephone system is from 300 to 3,000 cps, hence a supplementary check with other modulating frequencies than 1,000 cps is useful in providing quick qualitative information on the transmitter's performance. If in the talk test a greater testing rate is desired, a magnetic wire recorder may be used instead of a microphone. A repeating record consisting of a few specially chosen sentences provides an adequate selection of modulating vowels and consonants which cover the range of modulating frequencies. This method speeds up the talk test and dispenses with the use of another man for this test.

Carrier Frequency Test

A separate crystal-controlled frequency monitor shows whether there is any deviation from the frequency which is assigned to the transmitter. In case of excessive deviation, the tester has to adjust the transmitter to the proper frequency. Actual experience shows that frequency adjustment does not appreciably affect the transmitter's performance as established during the five standard tests. Therefore, if needed, the frequency check may follow the talk test.

Maintenance Problems

The problem of the maintenance and calibration of transmitter testing sets to produce uniform results in more than a dozen different locations all over the country is naturally complex. In each location there are available either two high-precision f-m signal generators for two basic frequency ranges or only one such f-m highway range generator and another a-m type covering the urban range only.

A heterodyne spectrum analyzer of the Panalyzor type is used as in Fig. 2 for the calibration of the modulation deviation of the f-m signal generators. A typical transmitter, previously tested and meeting all requirements, is connected to the r-f wattmeter as usual and generates an unmodulated carrier of normal strength. A small antenna is connected through a switch to the receiver or to the tuner preceding the receiver. For urban range calibration the tuner is considered as included in the receiver block.

Both the receiver and the transmitter are tuned to exactly the same frequency *f*, as indicated by a zero reading on the discriminator meter. The limiter meter indicates the required minimum strength of the injected carrier. Now the f-m signal generator is substituted for the transmitter and is tuned to the frequency of the receiver. The generator output control is set to inject the same carrier voltage into the receiver as the transmitter produced. This generator's output is simultaneously connected to one input of the Panalyzor. Another signal generator, set to a frequency 500 kc higher or lower than *f*, is connected to the second input of the Panalyzor. When the first f-m generator is modulated, starting from zero deviation in the direction of higher deviations, different equidistant pips appear on the screen of the Panalyzor and show the spectrum distribution of the f-m or p-m modulated carrier.

In accordance with the theory of Bessel functions applied to f-m and p-m transmissions, a definite modulation index corresponds to each relative strength of a selected sideband or carrier with respect to the unmodulated carrier strength. When the modulation is gradually increased to give higher deviations, the pip which corresponds to the carrier starts decreasing and soon reaches a minimum, starts increasing until it reaches a maximum, and continues repeating this cycle of increasing and decreasing carrier pip height. To each minimum and maximum corresponds a definite modulation index, or for a fixed modulating frequency a definite modulation deviation. The values of modulation indexes may be found in the tables of Bessel function coefficients. The voltages indicated by V_2 are now calibrated against the modulation deviations or indexes indicated by the Panalyzor. Simultaneously the modulation deviation control knob or the deviation meter of the signal generator is calibrated.

Harmonic Distortion of Testing Set

Periodic measurements are made of the constant harmonic distortion produced by the testing set itself. The distortion produced by the audio oscillator, a-f amplifier and phantom microphone together can be measured directly by connecting the output of the phantom microphone to the distortion meter. The distortion produced by the receiver can be found by connecting the audio output from the first three units to the external modulation terminals of an f-m signal generator known to produce a very low harmonic distortion. The r-f output of this signal generator is connected through a suitable pad to the antenna terminals of the calibrated receiver or tuner.

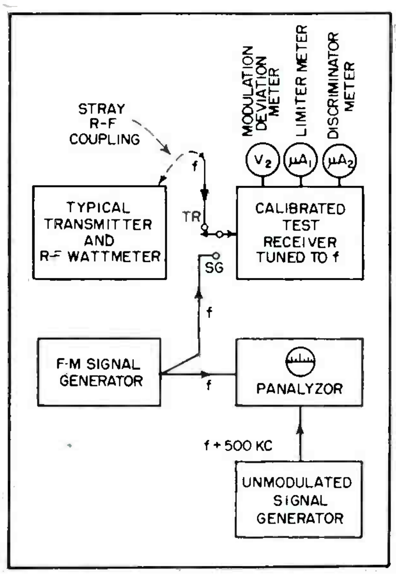


FIG. 2—Setup for calibration of modulation deviation of test receivers

The distortion meter connected in the usual manner to the receiver output now measures the total distortion of all connected apparatus. The distortion of the first three units is already known, while the distortion introduced by a precision signal generator may be neglected; therefore, the balance represents the harmonic distortion introduced by the receiver. Using this method, a constant value of harmonic distortion introduced by each transmitter testing set can be found. This constant value can be established separately, if necessary, for urban and highway ranges.

The testing set's own signal-to-noise ratio is checked against that of a mobile transmitter selected to have a snr of 39.8 db or more as measured by the testing set. This transmitter is considered as the maintenance standard and preserved in a careful manner.

Experience shows that the signal-to-noise ratio of the available transmitters cannot be higher than in the upper 40's. The ratio for the test equipment can be expected to be at least 0.4 db better than the test result (39.8 db), with the probability that it will be at least 1.2 db greater than the test result. If during one of the periodical maintenance checks it is found that the snr of the same transmitter has dropped below 39.8 db, then this condition indicates that the signal-to-noise ratio of the testing set has dropped below the permissible minimum. The trouble must be analyzed and the ratio brought again to the minimum level.

The signal-to-noise ratio of the transmitter maintenance standard can be cross-checked by using a precision f-m signal generator modulated from the testing set's audio oscillator through the amplifier and phantom microphone. The setup is the same as in Fig. 1 except that the signal generator is connected directly to the antenna terminal of the test receiver or tuner. To obtain the highest possible ratio for the generator, its circuits should be supplied from a B battery instead of from a rectified a-c power supply, and an A battery should be used for its tube filaments or heaters. To be suitable for cross-checking operations, the signal-to-noise ratio of the generator should be at least 47 db for 5.5 kc modulation deviation at 1,000 cps.

The author makes grateful acknowledgment to Brynjulf Berger for his advice and aid in the design and development stage of the project, to the members of his staff for their cooperation in some of the problems and, in particular, to Ernest Reuther for his assistance in the building and adjustment of the equipment.

Television Studio

By J. L. HATHAWAY and R. E. LAFFERTY

Assistant Manager Development Engineer
Engineering Development
National Broadcasting Company
New York, N. Y.

Superheterodyne receivers may be carried in pocket or worn around waist on a belt. Sound is piped from electromechanical transducer in set to ear by thin vinylite tube which also contains antenna

Standard commercial type batteries provide d-c power for receiving units at a cost of 2 cents an hour

INCREASED programming activity in television studios across the country has greatly crowded both facilities and personnel. Technical and production crews, performers, scenery sets, cameras, microphone booms, floor lights and turntables all compete for limited space. To add to the confusion, nearly everyone and every thing, with the exception of performers and scenery, requires a flexible cable connection into "the system". The result is a maze of ever-shifting rubber-covered cables.

For cue and direction from the producer in the control booth, several of the production staff must wear telephone head sets. A floor manager frequently finds it necessary to cover large areas which usually means changing his connecting cable from an outlet along one wall to one on the opposite side of the studio. This, at a crucial moment on a split-second timed show, requires rapid movement and is quite a gymnastic feat. There is also the ever present danger that the ear phones will be torn from his head as the cable trips up an unsuspecting actress, perhaps breaking the cable or producing an audible thump on the air.

To reduce the tangle, a project was initiated to eliminate the roving earphone cords not integral with camera or other cables. Without these, the production staff has complete freedom of movement for better direction and more accurately-timed cues. The present studio communications system has replaced wired roving telephone head sets in the NBC studios, and at the same time provides improved audio quality and wearing comfort over long periods of time.

Requirements

Miniaturization of equipment generally demands specialized components and techniques, including considerable model shop artistry. For small quantity manufacture these factors should be avoided, wherever possible, to keep the cost down and simplify the replacement problem. While compactness of the radio receiver is highly important in this type of service, numerous other factors rate higher priorities. For example, the most compact receiver consists of a crystal detector operating into an earpiece. This, however, necessitates a high-power transmitter for reliable coverage of a large studio. Such a transmitter is expensive and television equipment is highly vulnerable to r-f pickup. A compromise is indicated for practical transmitting and receiving equipment.

The item of utmost importance is reliability. The system must operate satisfactorily every time it is required, assuming reasonable maintenance, and receivers must function at all positions on the floor. Furthermore, maintenance must not require appreciable time or skill, since the system represents but a small portion of the total studio apparatus. Batteries must be long lived—not the smallest that could be made to operate such receivers. The hourly battery cost is important, since those required in a number of studios may account for 2,000 hours weekly operation, corresponding to about $2,000 annually at the rate of only 2 cents per hour.

Selectivity should permit simultaneous operation in adjacent studios without audible interference, on closely-spaced frequencies, and automatic gain control should substantially eliminate wave-interference level fluctuations. The receivers must be worn with comfort and should have only a single external control for power and volume—the latter necessitated by the large range of ambient sound within the tv studio on different types of programs. Signal-to-noise ratio must be excellent, implying high audio frequency de-emphasis in the receivers.

The radio transmitter should possess excellent automatic audio gain control to reduce variations of

Cueing Equipment

Several thousand hours of operating experience, engineering skill and model-shop artistry have led to development of an almost foolproof transmitter-receiver combination for relaying instructions from control booth to production staff on tv set

speech level, frequency stability to within ±0.01 percent, pre-emphasized high-frequency response to permit receiver noise reduction through compensation and reasonably low audio distortion at high modulation percentages. The transmitter, or at least its radiator, should be centrally located within the studio for best coverage at minimum power. It should be a completely self-contained unit, operating from a low-level, low-impedance audio circuit, such as the direct output of a high-quality ribbon or dynamic microphone. High audio frequencies should be pre-emphasized in order to compensate for de-emphasis within the receivers.

Operating Frequency

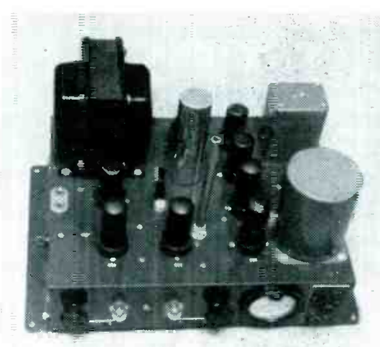
Operating frequency must permit satisfactory coverage with practical and available components. The state of the art ruled out uhf and indicated either hf or vhf, all factors considered. With the ever present likelihood of radiation beyond the studio confines, licensing was required. There are a number of allocation possibilities around 27 mc, including low-power industrial, diathermy and broadcast remote pickup frequencies. First experiments and later studio operations were conducted with FCC sanction within the 27-mc diathermy band. More recently, under expanded operation, in order to stagger frequencies in adjacent studios, remote broadcast pickup frequencies were authorized and are used, namely, 26.35 and 26.55 mc. These require Restricted Radio Telephone Licenses and the keeping of simple logs.

First exploratory investigations of the utility of an r-f studio instruction system were conducted using a rod antenna, a tuning coil and crystal detector all mounted on the band of a headset, together with a transmitter having less than 1-watt radiation. This combination lacked receiver agc as well as sensitivity but indicated good possibilities otherwise. Next the rod was eliminated in favor of a tuned pick-up coil, and an audio amplifier was added with a semblance of agc. Performance was greatly improved, with fading only in locations of severe wave interference. Actually, this cumbersome unit, with batteries carried in a pocket, was immediately commandeered into studio operations as a marked improvement over the wired system. Thus it was used until more refined receivers became available.

The first really successful model, completed in mid-1946, consisted of a single-stage r-f amplifier with avc, a voltage doubling detector, and a single-stage audio amplifier. Like present-day models, sound was generated within the receiver and conveyed to the user's ear through a thin-walled vinylite tube about 30 inches in length. This tube also contained the flexible antenna wire, meaning that only a single connection through the case was needed for both input and output. The wearer could carry the unit within a pocket or by means of a belt slung over the shoulder or strapped around the waist.

After minor improvements, a number of very similar units were constructed for use in two studios. These have been used an average of 6 hours daily during the past five years. Recently, when ten more tv studios and theaters were to be equipped with radio communication, it was decided to incorporate

Transmitter is hung from ceiling as near center of studio as possible. Forty-inch whip is electrically short for 27 mc but inefficiency can be tolerated because of reserve of power available



Top view of transmitter shows placement of components. High audio frequency pre-emphasis compensates for falling response of receiving units

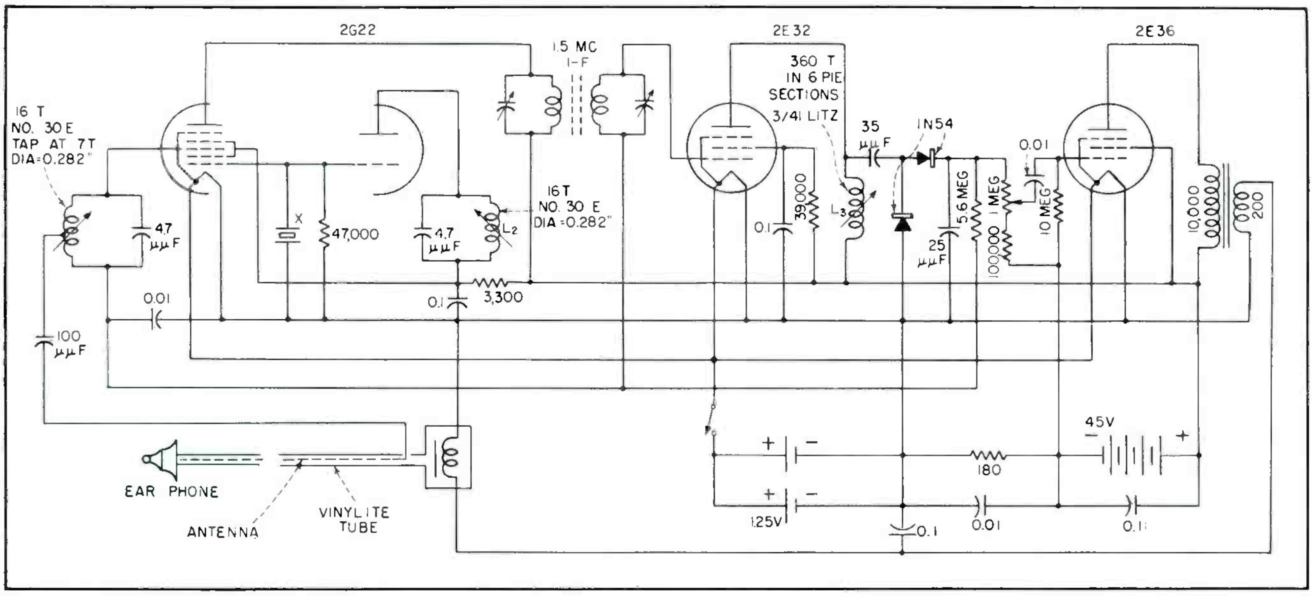


FIG. 1—Receiver uses crystal control to give single control (audio gain) operation with complete reliability

numerous improvements, including a change of circuit from trf to superheterodyne, in order to increase selectivity.

Development of the transmitters has gone through fewer stages than the receivers. Suitable transmitters are inherently rather straightforward since there is no special restriction on space. Hence, present units are similar to early models except where minor alterations have offered improved performance and reliability.

Present Receiver

Power supply maintenance and hourly cost are of sufficient importance to justify designing around a preferable battery after selection of tube types and establishment of power requirements. Obviously, the largest power source that can be accommodated should be used for reasons of economy. Small batteries cost as much or even more in many instances than those of several times greater capacity. The 455 type of 45-volt unit represents an excellent compromise between size and operating life and was selected for this application. With a B drain of around 2.5 ma, it affords 150 hours of operation down to a 34-volt end point. Companion A batteries should last either an equal number of hours or a submultiple thereof for greatest economy and minimum maintenance. At the same time they should be compatible in size and shape to avoid mechanical complications and loss of usable volume. Two paralleled type 1005E cells were selected after consideration of all factors, giving 75 hours of service on the normal starting drain of 115 ma. This combination with an intermediate change of A battery for each new B battery results in an operating cost of just under 2 cents per hour, at 1951 prices.

To meet selectivity and stability requirements a superheterodyne circuit is utilized with a crystal-controlled oscillator, as shown schematically in Fig. 1. The miniature quartz crystal is of harmonic type, connected from grid to ground in a triode-heptode converter circuit. The r-f signal voltage is stepped-up by the tuned input circuit, which also rejects spurious signal responses. Mixer output is fed through a band-pass filter and single i-f amplifier resonating at a nominal frequency of 1,580 kc. This i-f tuning may be altered sufficiently to permit reception over the range from approximately 26.0 to 26.8 mc, assuming a crystal frequency of 27.96 mc.

Two germanium rectifiers are employed for voltage doubling detection, providing 3 to 4 db greater gain than a conventional detector with the same type of germanium rectifier. Automatic volume control actuating voltage is derived from the detector and applied to both the r-f and i-f grid-return circuits. Following detection, a potentiometer permits manual control of audio grid excitation to the power amplifier. A power switch is integral with this potentiometer. Although a pilot light is not provided, since it would create excessive battery drain, the switch knob is machined so as to expose a brilliant yellow indicator except when in the off position.

Receiver Output

A miniature step-down transformer couples the power output stage to an electroacoustic transducer, in the form of a modified hearing aid ear piece. Sound is conducted from this, through a thin-walled vinylite tube of a little over 1/16-inch diameter bore, to a soft molded-rubber ear plug. The tube also contains a flexible antenna wire, which must be insulated from the housing and undue capacitance avoided. An insulated metal jack permits ready insertion and removal of this combined sound tube and antenna for maintenance purposes, and permits individual wearers to retain their own plugs for subsequent use—thus avoiding possible communication of ear infection.

The plug is applied to the end of the sound tube by simply slipping it over the retaining flange of a

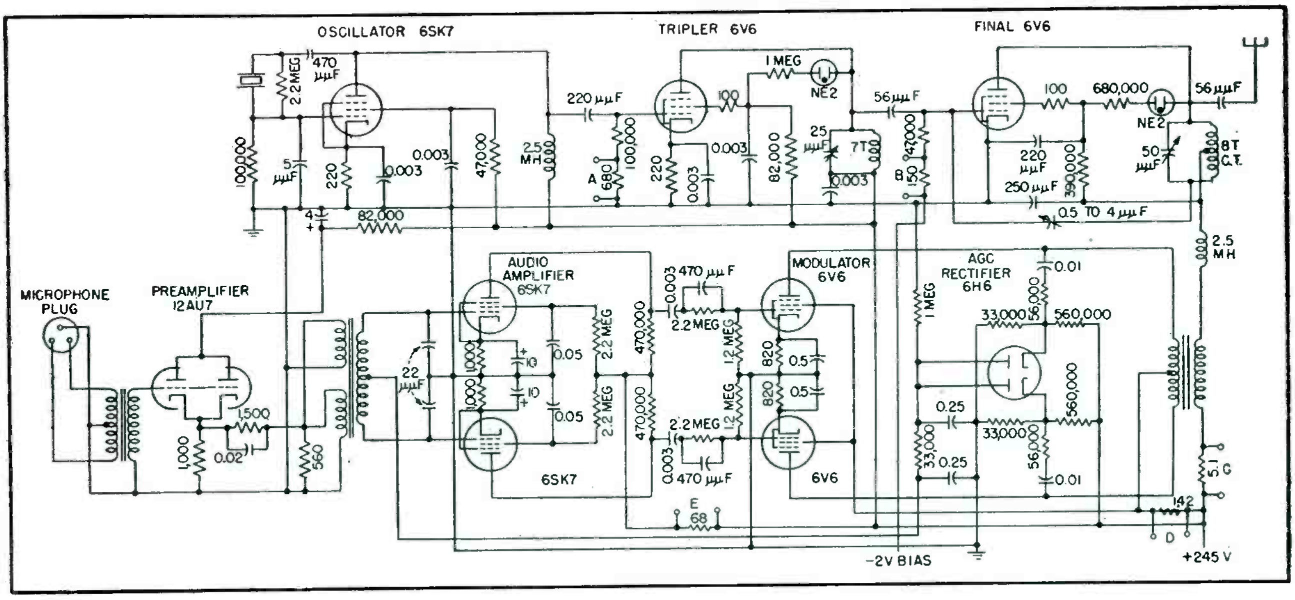


FIG. 2—Transmitter circuit is straightforward with exception of high audio frequency pre-emphasis and delayed agc circuit

metal fitting. Sound transmission through this length of small-diameter tubing results in appreciable attenuation, especially at the higher audio frequencies. However, high-frequency loss is not considered especially detrimental since this constitutes a ready means of de-emphasis to achieve noise reduction. The general loss of level is compensated by increasing audio output power.

The receiver measures 5½ by 3⅞ by 1$\frac{1}{16}$ inches thick with no protuberances excepting the sound tube jack, the control and the strap clips. It is fabricated of rigidized stainless steel and weighs 22 ounces complete with batteries. The hinged cover is retained in the closed position by means of a compact-case-type of clasp and, when opened, provides ready access to the battery section for replacement or removal of the entire receiver from its housing.

Sensitivity is sufficient to produce 0.1-volt audio across a 100-ohm load resistor with a 1-millivolt r-f signal applied through 10 μμf to the input. These input and output connections are employed for all test and alignment procedures. Maximum undistorted audio output power into the resistive load is approximately 3 milliwatts with a 1-volt A battery and 36-volt B.

Selectivity curves obtained with blocked avc show response to be down 6 db, 10 kc off resonance and 30 db, 50 kc off. Oscillator and i-f frequencies are almost completely independent of both voltage and temperature variations within the ranges encountered in operations.

Tube life has not been determined as no failures of the subminiatures have yet occurred after many thousand hours of operation.

Transmitter

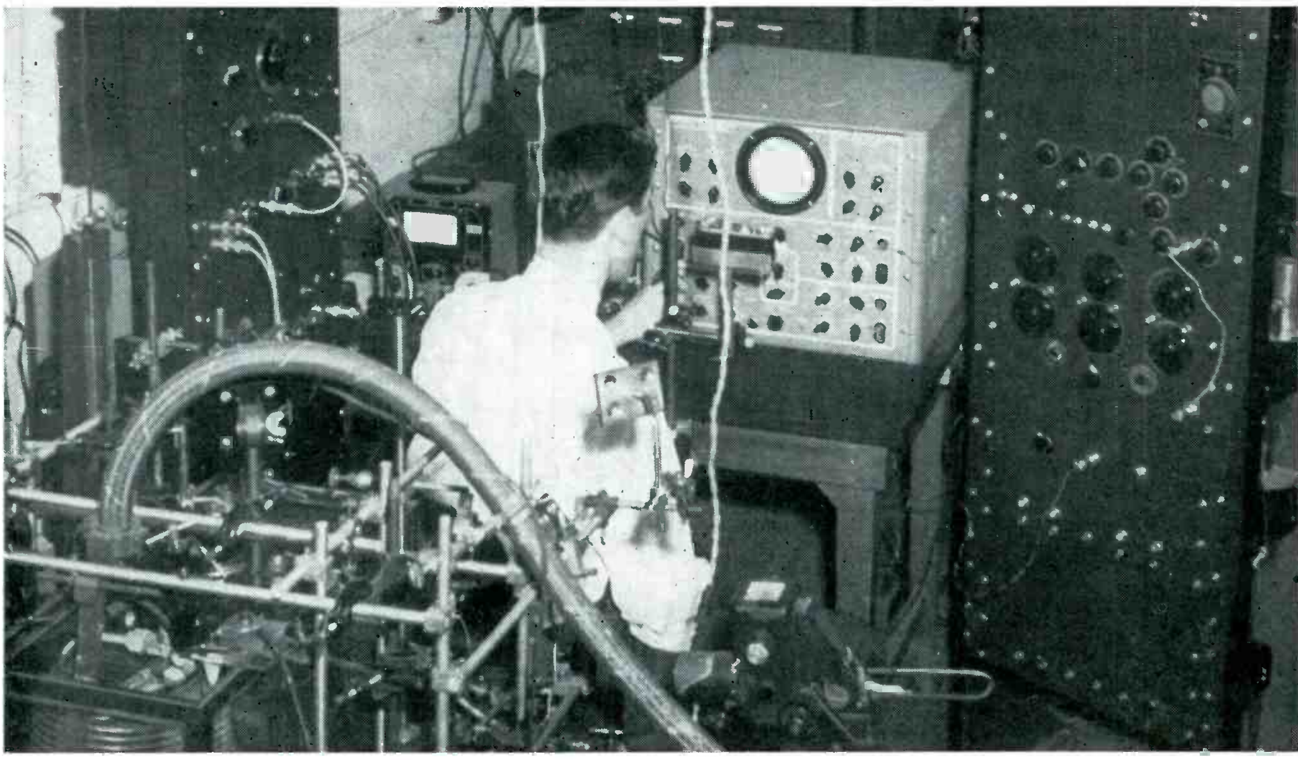
The radio transmitter should preferably be centrally located above stage, by hanging it from the ceiling, a catwalk or other permanent fixture. Even when so located, especially in a studio with low ceiling, movement of such objects as microphone booms and scenery sets would make impractical the use of a long antenna. A ¼-wave spike, for example, protruding 10 feet from the transmitter might frequently be damaged. Hence, a small fractional wavelength antenna, only 40 inches in length, is utilized despite the low resultant efficiency. Actually, since ordinary small tubes have been found to furnish adequate power for coverage of a studio, antenna radiation efficiency is of little consequence.

The transmitter schematic shown in Fig. 2 is largely self-evident. A Pierce crystal oscillator circuit excites a frequency tripler, whose output is amplified by a class-C output stage which is coupled to the antenna. The audio portion consists of a low-level amplifier, an automatically-controlled push-pull amplifier, and a push-pull modulator stage transformer-coupled to the class-C power amplifier. The automatic control utilizes full-wave rectification with delay bias. Gain reduction is not as rapid as for types designed for high-quality broadcast service, since momentary overloading at the start of high-level speech is of little importance. Excepting this, the control limits modulation to just under 100 percent on extremely loud speech into the cue microphone. Speech of 20 db lower acoustical level produces around 50-percent modulation. In order to compensate for the high-frequency de-emphasis in the receivers, with consequent noise reduction, high frequencies are pre-emphasized in the transmitter.

Power output in the form of radiation from the short studio antenna is around 0.5 watt.

Metering is provided for plate currents and also for grid current of the class-C amplifier, a facility especially useful in preliminary alignment as well as in periodic preventative maintenance. All tubes and components within the transmitter are operated at small fractions of their ratings for maximum reliability and minimum maintenance.

High-Current Dual-Pulse



Research laboratory at New York University, showing dual-pulse electronic stimulator in rack at right. Constant-temperature salt bath containing muscle being stimulated is barely showing at lower left. Rack back of it contains various amplifiers and oscillators used with dual-beam oscillograph in center for recording mechanical and electrical responses of the muscle

IN CONNECTION with a program of research on muscular contraction, currents ranging from a fraction of an ampere to as high as 6 amperes were required.

In the experimental procedure a physiologic structure such as muscle is immersed in an electrolyte bath containing two large (distributed, or so-called massive) silver-silver chloride electrodes symmetrically flanking the muscle, as shown in Fig. 1. An electric stimulating pulse must pass from electrode to electrode through the intervening electrolyte solution and on its way stimulate the muscle supported in the electrolyte. Measurement proves that the impedance of this massive electrode system is only 9.2 ohms.

By using 6AS7G power amplifiers, the required high output currents through such a low impedance were obtained directly from the 117-volt d-c power line. Construction of a special high-power d-c supply was thus obviated.

The new stimulator produces a unit cycle consisting of two rectangular pulses each of which is independently and smoothly variable in duration from 30 to 100,000 μsec, with amplitude variable from zero to maximum and with the same or opposite relative polarity. In addition, the two pulses are separable by an interval independently variable from 5 to 100,000 μsec. The rise time of each square wave from zero to 90 percent of peak amplitude is 15 μsec and the fall time is 10 μsec. Within the limits set, the stimulator, delivering correspondingly short pulses, has operated at repetition rates up to 2,000 per sec.

General Operation

The overall operation of the stimulator can be understood from the block diagram in Fig. 2. A positive trigger of about 30 volts triggers the first phantastron, whose interval determines the duration of the trapezoidal output pulse. The two shaping circuits which follow change this to a rectangular pulse, which the driver stage amplifies to about 250 volts for feeding to the power amplifier either directly or through the mixer.

The first phantastron output is also fed through a cathode follower to a differentiating circuit or peaker. The positive spike from the peaker, corresponding to the trailing edge of the first phantastron pulse, is used to initiate a blocking-oscillator pulse of the order of 1 μsec for triggering the interval-determining phantastron.

The output of the interval phantastron is fed through a cathode follower to a peaker whose output triggers a blocking oscillator. A sharp trigger voltage is obtained which marks the trailing edge of the interval phantastron and initiates the action of phantastron II, whose trapezoidal pulses are shaped and amplified for feeding to the power amplifier by way of the

Physiologic Stimulator

Sixteen paralleled 6AS7G dual-triodes operating directly from 117-volt d-c power line deliver pairs of 6-ampere pulses for Navy-sponsored basic research project involving stimulation of live muscles supported in electrolyte. Three phantastron time-delay stages provide complete control over pulse width and spacing

By **DAVID MOSTOFSKY**
Instructor in Physiology
College of Dentistry
New York University

and

ALEXANDER SANDOW
Associate Professor of Biology
Washington Square College of Arts and Science
New York University

mixer when pulses are of the same polarity, or directly to the power stage when pulses are of opposite polarity.

The power amplifier delivers maximum pulses of 6 amperes peak current through the 9-ohm output impedance when the pulses are of the same polarity, and about one-fourth of this when the pulses are of opposite polarity.

Circuit Analysis

The circuit of the stimulator is given in Fig. 3. The basic timing and pulse-forming action is performed by phantastron circuits[1]. The output of such a circuit is a negative trapezoidal pulse, smoothly variable over a wide range and with a rapid fall and rise time.

Diodes (all in a 6AT6) are connected to the first grids of the three phantastron circuits to permit operation at high repetition rates with the relatively wider pulses and intervals. The diodes permit a more rapid recovery of the grid voltage after the pulse. Switching in the extra capacitor in the phantastron circuit permits extending its pulse duration to 100,000 μsec.

The time of the phantastron pulse, in general, is determined by a voltage applied to the plate. Except for extremely narrow time intervals there is a linear relationship between this voltage and the pulse width. The control voltage is applied to the plate of phantastron V_1 through diode V_8 which isolates the plate from the control voltage during the phantastron cycle. The two 5,000-ohm potentiometers in the phantastron circuit are screwdriver adjustments which determine the minimum and maximum voltage obtained from the 20,000-ohm wire-wound potentiometer that serves as the phantastron pulse width control. The 500-ohm wire-wound potentiometer is a vernier control.

The trapezoidal output of phantastron I is taken from its cathode and fed to the grid of V_4 where grid-clipping action flattens the pulse. On the plate of this tube the pulse is a positive rectangular voltage with a negative overshoot. This pulse is coupled to the next stage through a large time constant network in order to pass the wide pulses. The 6H6 diode connecting the grid side of the coupling capacitor to ground is a clamper or d-c restorer.

Tube V_5 is biased to cutoff so only the positive part of the pulse is amplified; the negative overshoot is not obtained in the plate circuit of this tube.

From the plate of V_6 the pulse, now negative, is inverted and clipped by V_{10} and then passed through attenuator stage V_{11}. Attenuation is limited by the fixed 22,000-ohm resistor so that, at any setting of the potentiometer, the pulse finally

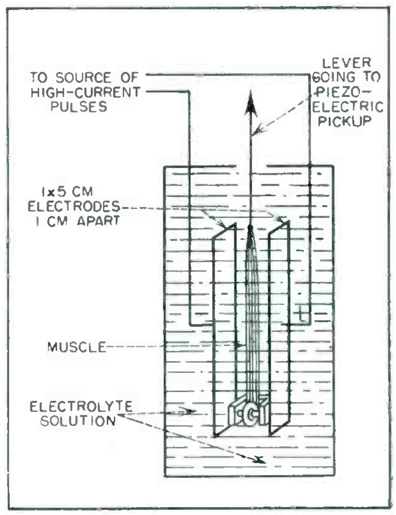
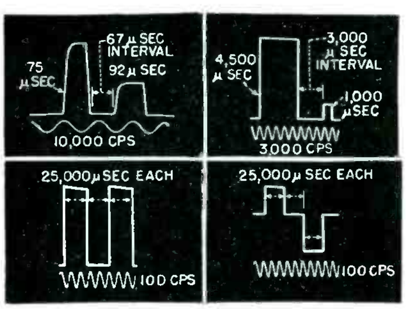


FIG. 1—Method of electrically stimulating a muscle with so-called massive electrodes connected to output of high-current electronic pulse generator. Muscle is clamped at its lower end, and upper end is connected through a lever to a piezoelectric pickup. Muscle (of frog) can live for many hours in the salt solution serving here as electrolyte



Examples of trains of pulses produced by stimulator, as recorded with dual-beam oscillograph to get timing wave passed on to the power amplifier is built up on a fixed pedestal which overcomes the large cutoff bias of the power tubes. Switch S permits feeding the pulse from V_{11} either directly to the power stage, or through mixer V_{12}, in which mixing with the corresponding second pulse is accomplished. The cathode of V_{12} is biased by its 80,000-ohm resistor connected to B+, in order to minimize interaction between the attenuation setting of either pulse with that of the other.

Pulse Interval Circuit

The interval-determining second phantastron V_{14} is triggered by a spike that corresponds to the trailing edge of the first phantastron. The pulse on the cathode of the first phantastron is connected to a trigger-forming circuit by way of cathode follower V_6, which isolates the phantastron from the circuits that follow. The following tube, V_7, differentiates the pulse. Thus on the secondary of the pulse transformer, in the plate circuit of V_7, there appears a narrow spike which triggers blocking oscillator V_9 after going through isolation stage V_8. The latter is normally cut off by the network in the cathode, and conducts only during the positive spike that is derived from the trailing edge of the first pulse. The sharp positive pulse which is obtained at the cathode of V_9 is directly coupled to the interval phantastron which it triggers.

The output of the interval phantastron is differentiated and a blocking oscillator pulse corresponding to the trailing edge is obtained through the circuits associated with V_{6A}, V_{7A}, V_{8A} and V_{9A}, which are the same as V_6, V_7, V_8 and V_9. The blocking oscillator spike triggers phantastron II which determines the second rectangular output pulse.

Second Rectangular Pulse

The output of phantastron II is shaped and attenuated in V_{4B}, V_{5B}, V_{10B}, and V_{11B}. After passing through switch S it is used in either of two ways. If two pulses of the same polarity are required, the output from V_{11B} goes through cathode follower V_{12} where it is mixed with the corresponding wave from V_{11}. When the pulses are to be of opposite polarity, the wave from V_{11B} is led directly to the power stage, each pulse being in its own channel. The reason for this switching will become apparent later in the discussion of the power amplifier stage.

Power Amplifier

Switches S_1 and S_2 change the power amplifier circuit to either of two forms, one for pulses of the same polarity and another for pulses of opposite polarity. For pulses of the same polarity all the tubes are in parallel, with appropriate isolating resistors in the plate and grid circuits, as in Fig. 4A. Use of 6AS7G tubes makes it possible to obtain relatively high currents with low plate voltage. Five, ten, fifteen or twenty tubes may be used independently since there are individual filament supplies and B+ switches. The circuit is arranged as a cathode follower and the load is connected directly between cathode and ground. Fixed 200-ohm and 9-ohm resistors are permanently incorporated as output loads of the power amplifier to permit tests without a working load. This is desirable because the massive electrodes are easily polarized when handling large currents. When output pulses are to be connected to the massive electrode stimulating system, output switch S_2 is set for the 200-ohm resistor and the massive electrode system is connected as a shunt across this resistor. Since the impedance of the massive electrode device is only about 9 ohms, the 200-ohm resistor gives no appreciable loading. For any load impedance used, the power tubes are heavily biased beyond cutoff, and thus no current flows through the load except when a pulse is applied to the power tube grids. The diode in the grid circuit clamps the grid bias to an adjustable value, usually set at —120 v.

For output pulses of opposite polarity, the circuit is switched to correspond to the simplified schematic of Fig. 4B. This resembles a push-pull arrangement with half the tubes receiving the first pulse from V_{11} and the other half receiving the second pulse from V_{11B}. When this setup is used under working conditions, each set of tubes is connected to its own 9-ohm cathode resistor and each side of the massive electrode load is connected to the one of the common cathode terminals. Under these conditions alternate pulses will be opposite in polarity at the output provided by the massive electrode load.

Of special interest are the results for the 9-ohm output for which the stimulator was designed. When sixteen 6AS7G output tubes are in parallel (32 triodes), the output for the maximum 250-v pulse applied to their grids is about 55 volts, thus giving us a pulse of about 6 amperes. Considerably greater voltages and currents may be obtained by adding still more tubes.

When the output stage is set for push-pull operation, the output is about one-fourth of that for paral-

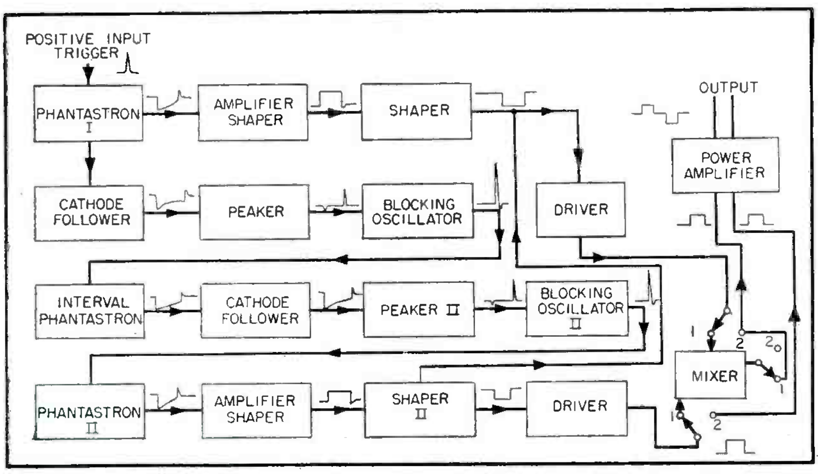


FIG. 2—Major stages of stimulator and waveforms of pulses at various points

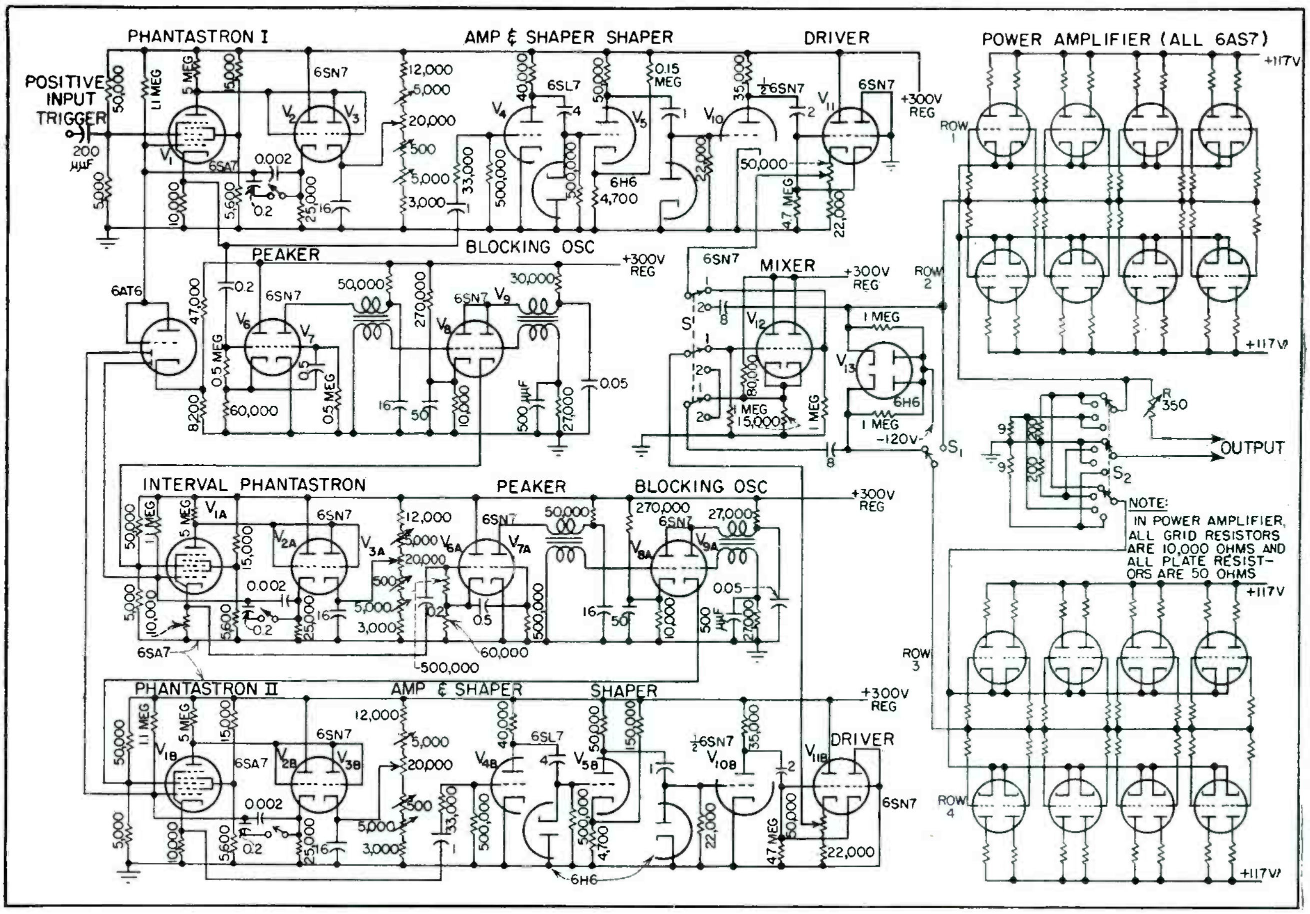


FIG. 3—Circuit of pulse generator and synchronizer. Power amplifier requires 117-volt d-c power line, and all other stages operate from a common 300-volt regulated power supply

lel operation, because when the tubes on one side of the push-pull arrangement are conducting, the tubes on the other side are inactive; the current delivered by the set of active tubes now subdivides between its cathode resistor and the parallel circuit including the load in series with the cathode resistor of the inactive tubes. Thus, the power dissipated across the actual load (the stimulating bath) becomes quite small. This available power is sufficient, however, for certain critical physiological experiments requiring alternate pulses of opposite polarity.

The d-c line used as a B+ supply for the power amplifier is not perfectly steady. Apart from the occasional relatively large fluctuations, there is a constant ripple of the order of one volt. This appears with essentially constant absolute value at the output, regardless of the magnitude of the desired pulses. When the pulses are small, and thus the ripple relatively large, this difficulty is circumvented by delivering

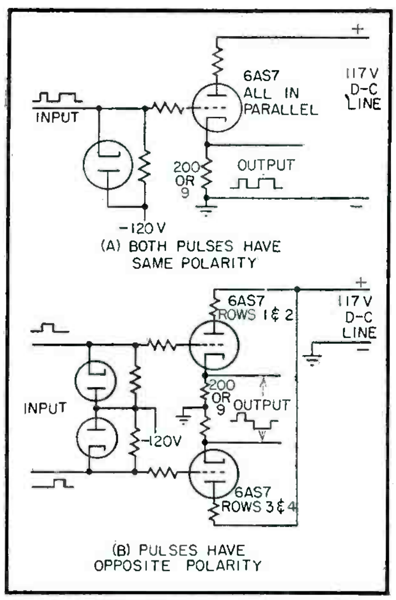


FIG. 4—Simplified circuit of power amplifier for the two settings of the polarity-changing switch

maximum or near maximum voltages to the input of the power stage and then attenuating by means of variable resistor R in series with the output load. In this way the ripple is always of the tolerable relative order of about 1 percent of the final pulse voltage, no matter how small this is.

The stimulator has been in almost daily use for many months. Throughout this time the generator has proved to be highly stable and dependable, and well suited to the special needs for which it was constructed. Although these needs are physiological, this type of high-current pulse generator may have other applications.

The work on this project was aided by a contract between the Office of Naval Research, Department of the Navy, and New York University (NR113-300). The authors express their indebtedness to Harvey Mandel, who did much of the wiring of this stimulator, and Arthur J. Kahn who aided in the testing.

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Cathode-Follower

Excellent square-wave response from 10 to 40,000 cycles is obtained from eight double triodes directly driving loudspeaker voice coils. Direct-coupled stage has power gain of 37 db. Up to 20 tubes can be used for auditoriums

By E. W. FLETCHER and **S. F. COOKE**

Cruft Laboratory
Harvard University
Cambridge, Mass.

Case Institute of Technology
Cleveland, Ohio

MANY AUDIO EXPERIMENTERS, including the authors, have felt that the power cathode follower was the ideal audio amplifier output coupling stage into a speaker system. Heretofore, either preliminary investigation or practical circuit design has led previous attempts to utilize the cathode-follower power stage into the compromise of coupling the speaker or speaker system with an output transformer.

Such an arrangement has gained some advantages, notably, good frequency response, excellent damping qualities and low distortion. The transformer has, with all its design problems, still been the limiting component of such an audio amplifier. Disadvantages, such as low efficiency and low power sensitivity inherent with this device might be ignored by those seeking true and distortionless reproduction. On the other hand, the lack of voltage amplification of the cathode follower imposes such severe requirements upon the preceding driver stage that the avoidance of distortion is very difficult, if not quite impossible.

The authors have felt strongly that if an arrangement could be developed to couple the cathode-follower stage directly to the voice coil of the speaker, or dividing network of a speaker system, many real advantages would accrue. Initial investigation of such a power cathode follower using the 2A3 class of triodes was not too encouraging; the ideal remained without practical implementation.

In 1946, the introduction of the twin-power triode type 6AS7G revived interest. Single-ended and balanced arrangements were tried using inductive and capacitive coupling, but finally a direct-coupled, push-pull balanced stage evolved. Figure 1 shows a schematic of a cathode-follower stage utilizing a total of eight twin-triodes of the 6AS7G type. Such a balanced stage retains all the inherent advantages of a push-pull amplifier and permits direct coupling to the low-impedance voice coils with no direct-current flow through these coils.

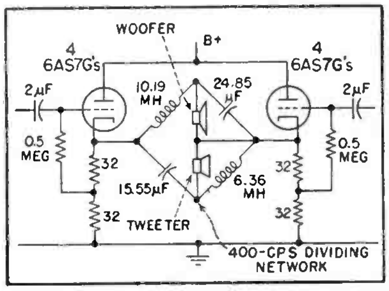


FIG. 1—Basic cathode-follower stage for direct coupling to low-impedance voice coils

Balanced Stage

An equivalent circuit of this balanced stage containing eight tubes is shown in Fig. 2. The cathode-follower stage is loaded by the 16-ohm audio load shunted by the cathode resistors, making an effective load of 14.22 ohms driven by a generator having an internal impedance of 23.67 ohms.

For a given number of twin triodes, increasing the cathode-resistor value will make the useful audio power into the speaker approach a limiting value of $I^2R_{vc}/2$, where I is the peak current and R_{vc} is the speaker resistance. Decreasing its value will lower the plate-supply voltage and increase the electrical damping on the speaker. Such a design eliminates the output transformer from the audio amplifier, enabling one to build a completely direct-coupled amplifier or an all-stage capacitance-resistance coupled audio amplifier.

The input impedance of a cathode follower is high; this is an obvious advantage. Manufacturers of the 6AS7G recommend that for cathode biasing a grid resistor of not greater than 1 megohm be used to limit ion collection on the grid, thus avoiding erratic operation. For eight paralleled triode sections, a 125,000-ohm grid resistor would be required.

The gas current in these tubes has been low enough to justify a 0.5-megohm resistor, which has proved satisfactory for this cathode-follower service. The high-impedance input into the follower stage allows the use of a simple voltage amplifier as a driver, while a 2-μf coupling capacitor gives adequately low frequency response.

In addition, the drive voltage is relatively small at each of the output cathodes. With five volts rms phased 180 degrees apart across a 16-ohm load the dissipation is 6.32 watts. Since eight triodes in parallel as a composite cathode follower have a voltage gain of 0.254, the necessary voltage at the grids is less than 20 volts rms. This is a moderate and easily fulfilled condition for a resistance-coupled am-

Loudspeaker Coupling

plifier. The power sensitivity is even greater than the power tubes and transformer combination when replaced by the power cathode follower. An input of 1.32 milliwatts at the cathode-follower grids corresponds to 6.32 watts in a 16-ohm load across the cathodes, a power gain of 37 db!

A square-wave test of the power cathode-follower output stage loaded with a 16-ohm noninductive resistor was so good that the problem of building an amplifier and preamplifier to match its performance became nonconventional audio practice. To avoid angular phasing within the audio range of 20 to 20,000 cps, one might make the empirical stipulation that the amplifier be capable of linear amplitude response from 2 to 200,000 cps.

Square Wave Test

If the amplitude drops 0.1 db at either end of the audio spectrum, a corresponding 10-degree phase shift is suffered while a 3-db drop corresponds to 45 degrees. A balance should be maintained in extending frequency response at both ends of the audio spectrum. That is, if an extension of upper response is made to 200,000 cps, then an extension of the lower response frequencies should be made to 2 cps. One rule of thumb has been to make the product of the upper and lower half-power frequencies equal to 400,000. Figure 3 shows a schematic of an amplifier that fulfills these conditions. It passes a square wave over the frequency range of 20 to 20,000 cps, which compares favorably with the response of the cathode-follower stage.

Power Supply

Perhaps the most difficult problem to be solved in the design of an amplifier incorporating this power cathode-follower stage is an adequate power supply whose cost, size and weight remain small. A supply voltage of 200 volts and 2,000 ma will supply sixteen triodes of an eight-tube cathode-follower stage at the manufacturer's recommended operating conditions. This requirement was easily accomplished by using 4 rectifiers, type 872/872A, in the bridge circuit shown in Fig. 4.

The output had a capacity of 2,500 ma, which allowed a 300-ma additional drain for the amplifier heaters. They are in series with a 300-ma field in the tweeter. The woofer field absorbed another 100

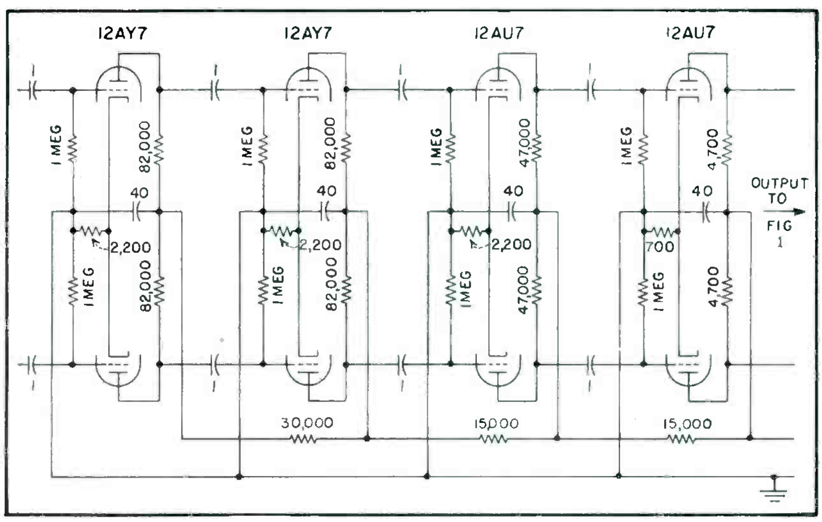


FIG. 3—Suggested resistance-coupled preamplifier with good square-wave response from 20 to 20,000 cps

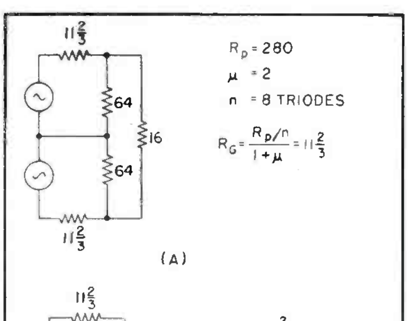


FIG. 2—Equivalent circuit for the eight-tube stage shown in Fig. 1

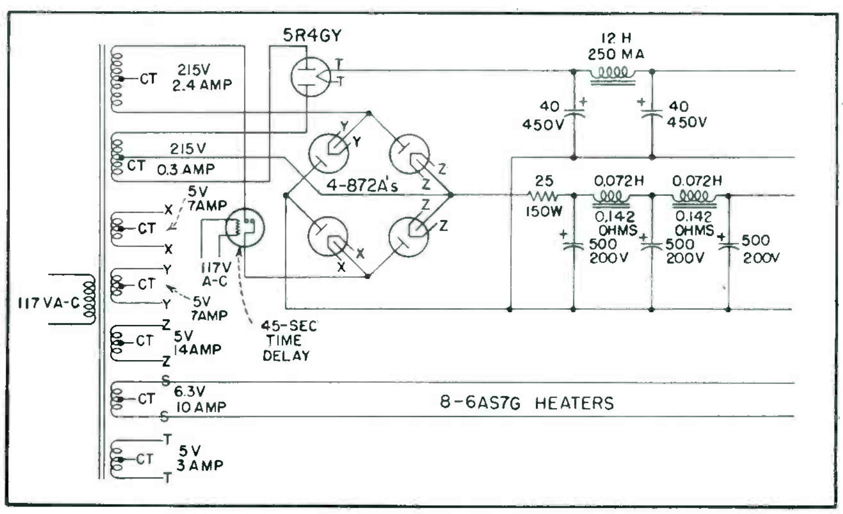


FIG. 4—Unique power supply used to operate the cathode-follower multitube output stage

ma while 50 ma supplied the voltage amplifier. This drain brought the total load on the supply to 2,450 ma.

Pi-section filters, consisting of 500-μf capacitors and 0.072 henry inductors, adequately reduced power hum in the speakers to an inaudible level, −10 mv of 120-cps ripple. The cost of this supply was held to a ridiculously small figure by utilizing parts available on the surplus market. The extraordinarily low frequency response of the follower makes the hum problem all the more difficult, but the hum level in the balanced output stage itself is down more than 90 db below the maximum output of 6.32 watts for eight tubes. Shot noise, although not objectionable, is more serious than hum. Careful attention to grounding techniques, and the use of an all d-c heater supply in the amplifier kept its hum level below that of the output stage. It might be pointed out that there is no hum pickup problem here such as that encountered with output transformers owing to winding linkage or magnetic coupling.

The maximum audio power output for the cathode-follower stage consisting of eight twin-triode 6AS7G tubes coupled to a speaker system of 16-ohm nominal impedance, where the limiting condition is class A operation, is $I^2R_{vc}/2 = 16/2 = 8$ watts, if the cathode resistor were infinite in value. For the 64-ohm cathode resistors actually used, the total power into these resistors and the 16-ohm speaker system is $I^2R_c/2 = (16 \times 128)/2(16 + 128) = 7.11$ watts of which only 6.32 watts divides to the audio load while the remaining 0.79 watt is dissipated in the 64-ohm cathode resistors.

In view of the fact that most good audio-amplifier designs claim output powers of 10 to 20 watts, and more recently values even as high as 30 to 50 watts, this value of 6.32 watts seems small. However, with this output cathode follower, the best speakers available are hard pressed even to approach the follower performance. This precludes the use of the output follower with any but the best types of speakers available. Relatively, such speakers are highly efficient.

Table I—Comparison of Multitube Cathode-Follower Stages

Number of 6AS7G Tubes in Stage	4	8	12	16	20
Plate Supply Current (ma)	1,000	2,000	3,000	4,000	4,600
Plate Supply Voltage (volts)	167	199	231	263	282
Push or Pull Composite Tube Characteristics					
Plate Current (amp)	0.50	1.00	1.50	2.00	2.30
Ions Conductance (μmhos)	28,000	56,000	84,000	112,000	140,000
Plate Resistance (ohms)	70	35	23.33	17.5	14
Cathode Resistance (ohms)	64	64	64	64	64
Bias Voltage (volts)	32	32	33	37	41
Follower Resistance (ohms)	23.67	11.67	7.78	5.83	4.67
Generator Resistance (ohms)	46	23.33	15.56	11.67	9.33
Load Resistance (ohms)	14.22	14.22	14.22	14.22	14.22
Damping Resistance (ohms)	34.33	19.72	13.87	10.69	8.69
Audio Power to Speaker (watts)	1.58	6.32	14.22	22.78	33.38
Audio Power to Cathode Resistors (watts)	0.20	0.79	1.78	2.85	4.17
Voltage across Load (volts)	5.0	10.0	15.0	19.0	23.0
Amplification	0.156	0.253	0.319	0.369	0.402
Power Gain (db)	36.5	37.0	37.2	37.5	37.5
Drive Voltage (Push or Pull) volts (rms)	16.0	19.7	23.5	25.7	28.7
Total Power Input (watts)	320	640	960	1,280	1,600
Overall Efficiency (percent)	0.5	1	1.5	1.78	2.09

A speaker system and dividing network of good efficiency in a room of 2,300 cubic feet volume, with sound intensity distinctly uncomfortable, had a measured average power into the dividing network of only 100 milliwatts. At a comfortable, more desirable level, the measured average power was less than 20 milliwatts!

Average power of 6.32 watts or 12.64 peak watts leaves a considerable factor of safety for the dynamic range required to reproduce a symphonic orchestra over this average power of 0.02 watt. In Symphony Hall, Boston, this may be greater than 90 db above background noise, but a-m and f-m broadcasting as well as record restrictions hold the range below 60 db above noise.

Simplified Amplifier

In the form presented, the cathode-follower power amplifier has low power efficiency as well as poor weight and space efficiency. There is reason to believe that a follower stage, utilizing only four twin triodes of the 6AS7G type, will do as well except for a reduction in average power to 1.59 watts. No deterioration in reproduction could be detected by a listening test in the original system with four tubes removed.

At an average power output of 20 milliwatts, a 22-db factor of safety for peaks still remains. If a four-tube system were acceptable (neighbor objection may be anticipated in a single-house residential section where house spacing is on approximately 100-ft centers, if the average level is maintained as high as 50 milliwatts) a supply of 1-ampere capacity would suffice.

A selenium rectifier of the full-wave bridge type could be used to advantage for space economy. One-ampere chokes of approximately 100 millihenrys in a double-pi filter will be more than adequate filtering if used with three 500-μf capacitors of the proper voltage rating. Proper isolation of the cathode-follower stage and speaker system might allow the rectifier to be supplied directly from the a-c line without power-line transformers.

Four amplifiers using eight tubes have been built and lived up to all expectations. Those who may have requirements for much more power output, such as an auditorium or theater, might consider a 20-tube system. Table I gives an interest-

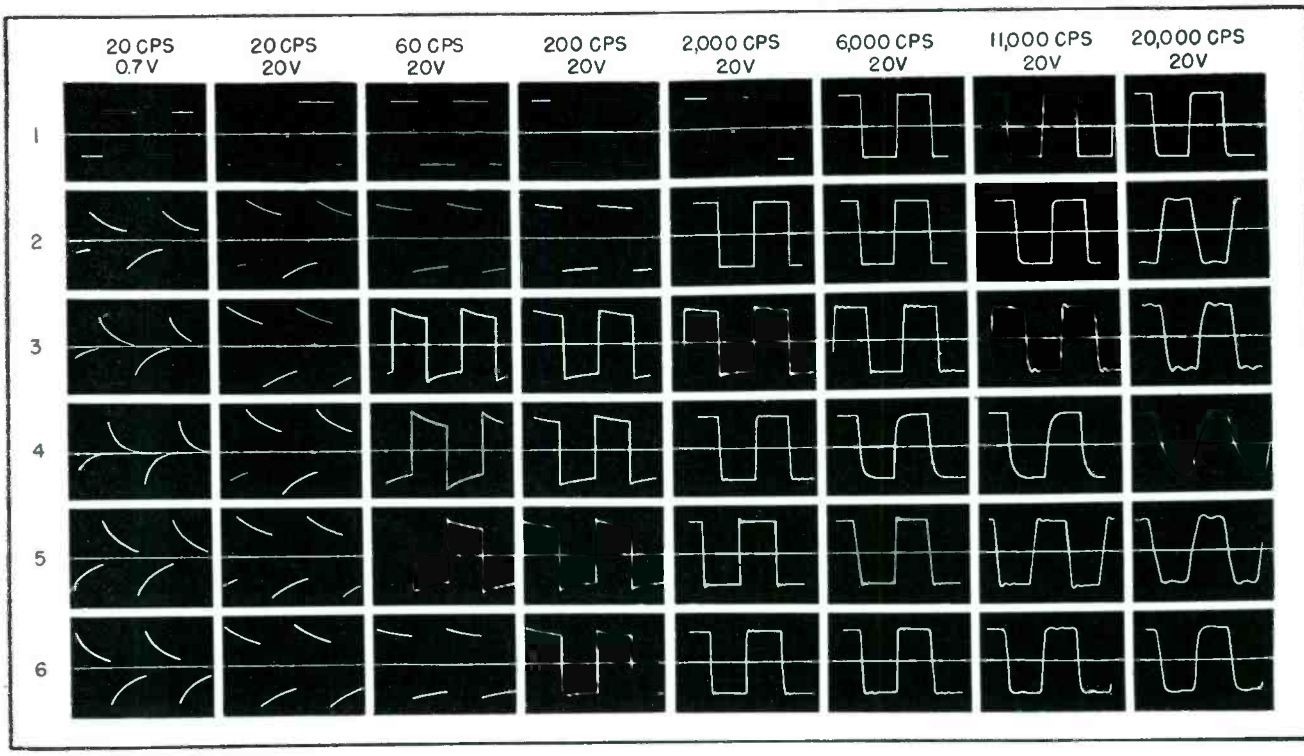


FIG. 5—Square-wave oscillograms obtained in comparison between follower output stage and various high-quality transformers. Top row shows the follower results. Transformer types are listed in the text

ing comparison of cathode-follower output stages, using 4, 8, 12, 16, and 20 tubes.

Highly efficient speakers, not acoustically matched throughout the whole of the audio spectrum, must be well damped electrically. Some advocates propose an effective impedance looking back into the amplifier of a fraction of an ohm, usually accomplished by heavy feedback. Another theory proposes that such electrical damping have a resistance of the order of value of the voice-coil impedance. Whatever may be the better for transformer coupling into an electrodynamic speaker system may be questionable, but no evidence of overshoot can be detected in a Klipsch speaker system driven by the 8-tube cathode-follower stage.

The 15-inch driver is damped properly by virtue of good acoustic matching into the horn. The damping resistance for this case is 19.5 ohms. It is well-known that the speaker impedance is highly variable and the resistive damping afforded by the follower is probably critical when using speakers that have proper acoustic loading. If electrical damping is desirable or necessary, a feedback link from the voice coil back into the amplifier could be used with no danger of instability or oscillations.

Square-wave tests of five of the best available audio transformers and the eight-tube cathode follower stage exhibited the striking results shown in Fig. 5. The conditions of testing were as follows: Square waves were fed from a balanced generator through resistors equivalent to the plate load of the power tubes driving the transformers. A noninductive resistance load of proper value (16 ohms) was used on the secondary. All transformers and cathode follower were tested under identical conditions. No compensation of any kind was used. Numbers at the left identify the following equipment: (1) cathode follower, 8-6AS7G tubes; (2) General Radio, Special; (3) UTC LS55; (4) Thordarson CHT, 15S91; (5) Partridge, English Williamson amplifier; (6) Peerless S-245-Q.

The first oscillogram in each set was taken with a 20-cps, 0.7-volt input square wave. The second at 20 cps and 20 volts shows the serious effect of the transformers' insufficient inductance. The remaining sets were taken at 60, 200, 600, 2,000. 6,000, 11,000, and 20,000 cps all with an input voltage of 20 volts.

The authors have used the cathode-follower stage driven by the amplifier in Fig. 3 to feed a good dividing network of less than 0.5- db insertion loss coupled to an 18-in. cone woofer and a metal-diaphragm multicellular tweeter. The reaction after several months of listening to this system might be likened to living with a great painting. At first you are convinced that it is good, but as more live program material is sampled you slowly realize that it is remarkable in its ability to handle extremes of frequency, dynamic range and transients.

In the cathode follower, no problem of leakage inductance nor shunt capacitance exists, therefore, better results at the high frequencies are obtained, especially in the reproduction of percussion instruments. Here steep wave fronts require a frequency response possibly as high as 100 or even 200 kilocycles. Response at the low-frequency end is much better than any transformer available, especially at low power settings. There is an apparent reduction in record scratch while at the same time the high-frequency response is better than with the best transformers.

FIG. 1—Interference from third video i-f harmonic on channel 5

FIG. 2—Eighth sound i-f harmonic on channel 7 produces a 50-kc beat

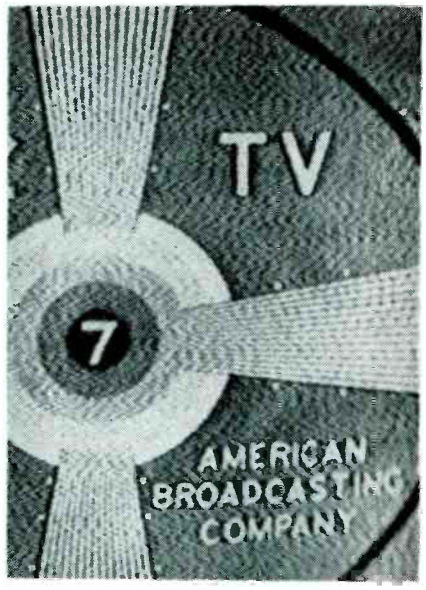


FIG. 3—Eighth sound i-f harmonic on channel 7, a 1.55-mc beat for 22.1 mc.

Internal Television

Minimum interference from harmonics of sound and video carrier intermediate frequencies is provided when 21.75 mc is used for the sound i-f. Harmonic-generating capabilities of the video detector are analyzed and optimum frequencies given for intercarrier and 41-mc operation

By BERNARD AMOS and **WILLIAM HEISER**
Head, Current Production Engineering — *Receiver Engineering Department*
Television Receiver Manufacturing Division
Allen B. DuMont Labs., Inc.
East Paterson, N. J.

ONE TYPE of television picture interference which has received little attention is that caused by harmonics of the video and sound carrier intermediate frequencies. A large majority of television receiver manufacturers still use the 21 to 26-mc band for the sound and video intermediate frequencies of their receivers and consideration should be given to the elimination of possible interference between the harmonics of these intermediate frequencies and the incoming television signal.

The harmonics of the video carrier intermediate frequency are generated almost entirely in the video detector stage. The harmonics of the sound carrier intermediate frequency are generated to some extent in the limiter stage, but mainly in the discriminator circuit. These harmonics may feed back into the antenna or tuner by many different paths.

Common filament and power leads are a potential source of trouble. It has also been observed that the video i-f harmonics will feed through the video amplifier and appear on a lead to the cathode-ray tube socket. Since this is usually near the antenna input connection, feedback may take place along this path. The use of a dual diode, such as the 6AL5, for the video detector and d-c restorer furnishes another path by which these harmonics may reach the leads to the crt socket and then the tuner input.

This problem has become increasingly more important as the sensitivity of receivers has been increased. Use of a single video amplifier, because of economic reasons, necessitates relatively high level video detection, with corres-

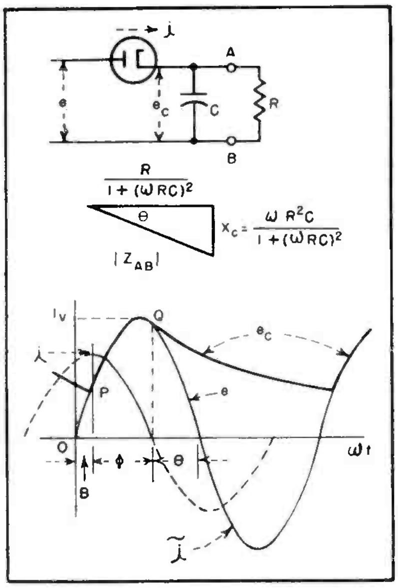


FIG. 4—Simplified video detector neglecting diode resistance

TABLE I

Harmonics of I-F Present on Channels 2—13 Video I-F = 26.4 Mc Sound I-F = 21.9 Mc

Channel	Video Carrier	Harmonic Falling in Channel	Harmonic in Mc	Beat Frequency
2	55.25 Mc			
3	61.25	3rd Sound I-F	65.7	4.45 Mc
4	67.25			
5	77.25	3rd Video I-F	79.2	1.95
6	83.25	4th Sound I-F	87.6	4.35
7	175.25	8th Sound I-F	175.2	0.05
8	181.25	7th Video I-F	184.8	3.55
9	187.25			
10	193.25	9th Sound I-F	197.1	3.85
11	199.25			
12	205.25			
13	211.25	8th Video I-F	211.2	0.05

Receiver Interference

pondingly larger magnitude of the video i-f harmonics. The built-in antenna has also served to emphasize the importance of this problem, since obviously a receiver with a self-contained antenna will be more susceptible to interference from these internal harmonics than one which has its antenna located some distance away. The wide-spread use of unshielded 300-ohm transmission line also increases the possibility of interference from this source.

Harmonics Involved

To illustrate this type of interference in more detail, consider a typical television receiver with a sound carrier i-f of 21.9 mc and a video carrier i-f of 26.4 mc. Table I lists the video carrier frequencies of the twelve television channels, the harmonic present on a particular channel, and the frequency of the beat resulting from the harmonic and the video carrier for the above intermediate frequencies.

The table shows that seven of the twelve television channels have an i-f harmonic existing within their bandwidth. The harmonics existing on channels 3 and 6 give beat frequencies much greater than the 3.5-mc bandwidth of usual video i-f amplifiers and therefore their effect will probably not be noticeable in the video output signal. Since at least part of the 3.85-mc beat on channel 10 will come through the video i-f pass band, we have five channels where harmonic interference may occur.

Figure 1 shows the 1.95-mc beat from the third harmonic of the video i-f interfering with the channel 5 signal. Notice that this interference pattern may be easily mistaken for local oscillator radiation.

Figure 2 shows the 50-kc beat between the eighth harmonic of the sound i-f and the channel 7 signal.

Figure 3 illustrates the interference of this same harmonic on channel 7 for a sound i-f of 22.1 mc, the resulting beat frequency being 1.55 mc. Note that this interference is quite similar to that obtained from an external f-m signal. The harmonics falling in channels 8, 10 and 13 are similar in nature.

In most television receivers, the video detection, because of the relatively large signal required to drive a single video amplifier and the high intermediate frequency which makes small amounts of capacitance important, may be essentially regarded as being peak linear detection. Figure 4 shows the simplified video detector with the diode resistance neglected and the output voltage waveform for an unmodulated input signal at 26.4 mc of one volt zero to peak.

Schade (*Proc. IRE*, Aug. 1943) has given a method for determining this waveform. Since at point *P* the discharging capacitor voltage equals the steady state voltage, no transient will occur. After solving for *B*, it is only necessary to make a Fourier analysis of the output waveform to determine the magnitude of the harmonics. Unfortunately, it has been found that these results do not check experimentally and that the diode resistance must be considered for representative video detector loads.

Detector Analysis

Figure 5 shows the simplified video detector with the diode resistance R_s considered. While this resistance will vary with the magnitude of the input signal, for our purposes it will be considered as the average slope of the diode characteristic over the input signal range. The steady-state a-c relations of the load circuit for a sine-wave input are shown at the left of Fig. 5. The alternating waveforms are shown on the right-hand side of the figure.

Note that the steady state current now leads the input voltage by a smaller angle, θ, than before. Since the steady-state capacitor voltage still leads the current by the same angle, θ′, as before, we now have the capacitor voltage leading the input voltage. At point *P* the transient capacitor voltage equals the input voltage and the diode starts conducting. However, since this voltage is different from the a-c steady-state capacitor voltage, a transient effect will take place. We will assume that this dies out by the end of the diode conduction time so that at point *Q*, the transient and steady-state capacitor voltages are equal.

Assume also a sine-wave variation for the capacitor voltage during the diode conduction period. The angle *B* may be found in the same manner as before except that θ now has a different value because of the diode resistance.

Figure 6 shows the output waveform alone with its two equations. A Fourier analysis of this waveform was made. Figure 6 gives the results of this analysis for the third and seventh video i-f harmonics generated in a typical video detector by a 3-volt peak input signal.

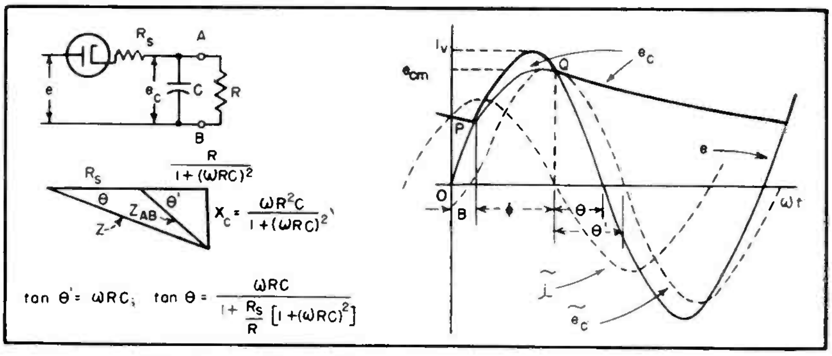
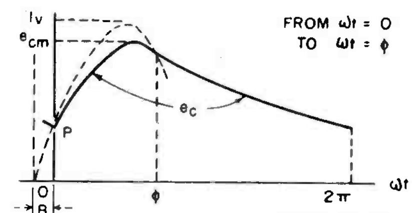


FIG. 5—Simplified video detector with diode resistance



FROM ωt = 0 TO ωt = φ

$$e_c = e_{cm} \sin k\omega(t + t') = \frac{\sin\theta}{\sin\theta'} \sin k\omega(t + t')$$

$$K = \pi - \theta' - \sin^{-1}\left[\frac{\sin\theta' \sin B}{\sin\theta}\right]$$

FROM ωt = φ TO ωt = 2π

$$t' = \frac{1}{\omega}\left[\frac{\pi - \theta'}{K} - \phi\right]$$

$$e_c = \sin\theta \, E^{\frac{-\omega t - \phi}{\omega RC}}$$

MAGNITUDES OF HARMONICS

WITH R = 4,300 AND INPUT e = 3 VOLTS ZERO TO PEAK
C = 11.5 μμF

R_s	D-C LEVEL	3RD HARMONIC RMS VOLTS	7TH HARMONIC RMS VOLTS
0	2.253V	107,000μV	14,100μV
250	2.01V	55,200μV	7,700μV
470	1.719V	28,400μV	4,280μV

FIG. 6—Output waveform and representative magnitudes of video i-f harmonics

The results are given for three values of diode resistance for purposes of comparison; the actual tube used, a 6AL5, was considered as having a resistance of 250 ohms. The results obtained for the 6AL5 checked experimentally. From the relatively large magnitude of these harmonics, it can be seen that only a small fraction need reach the tuner to interfere with a weak incoming signal. By increasing the time constant of the load so that the output voltage variation between cycles is reduced, the magnitude of the harmonics will

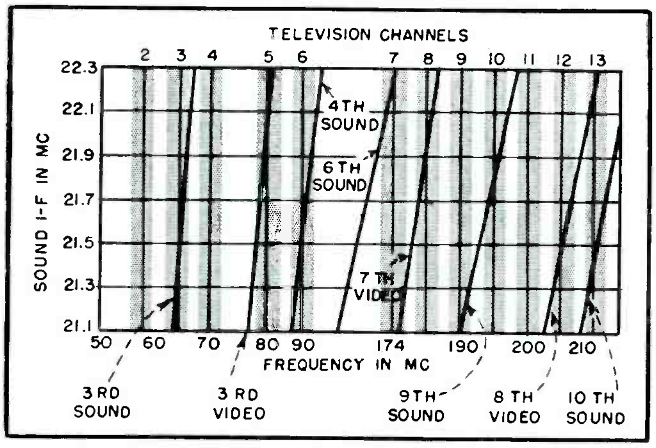


FIG. 7—Video and sound i-f harmonics as the sound i-f is varied

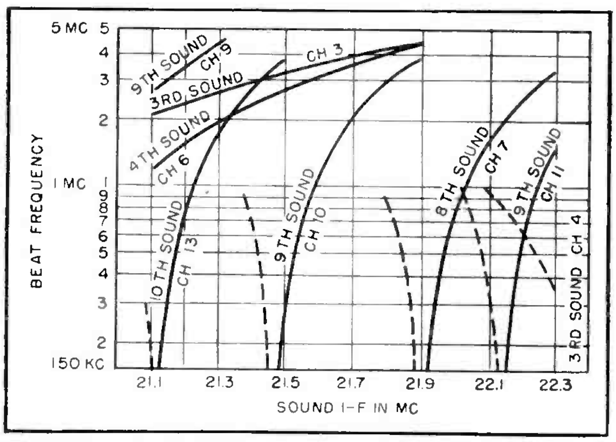


FIG. 8—Beat frequency versus sound i-f. Dotted lines in this and Fig. 9 and 10 indicate harmonic below video carrier

be decreased. However, then the load capacitor will be unable to follow high modulation frequencies near 3.5 mc, and distortion will occur.

Minimum Beats

One possible means of reducing the interference caused by these harmonics is to select intermediate frequencies in the 21 to 26-mc band for the sound and video i-f amplifiers that give the least number of objectionable beat signals. Figure 7 shows the location of the various harmonics falling in the twelve television channels as the sound carrier intermediate frequency is varied from 21.1 to 22.3 mc (video i-f varies from 25.6 to 26.8 mc).

Figure 8 shows the frequency of the various beats from the sound i-f harmonics as the intermediate frequency is varied. Figure 9 gives the beat frequencies from the harmonics of the video i-f signal as the video i-f is varied.

A study of these two figures will show that a sound-carrier intermediate frequency of 21.75 mc (video i-f = 26.25 mc) appears to give the most reduction in number of objectionable harmonics. With these intermediate frequencies the beat frequencies under 3.5 megacycles are:

(1) A 1.5-mc beat on channel 5 due to the 3rd video i-f harmonic.

(2) A 2.5-mc beat on channel 8 due to the 7th video i-f harmonic.

(3) A 2.5-mc beat on channel 10 due to the 9th sound i-f harmonic.

By moving the sound carrier i-f from 21.9 mc to 21.75 mc, the number of objectionable harmonics has been reduced from five to three.

The amplitude of these harmonics is such that interference may only be noticed under weak-signal conditions. The use of shielded cable for the antenna lead-in and careful chassis layout will minimize this interference. It may be necessary to use a series or parallel resonant trap to stop the 3rd video i-f harmonic from feeding back to the tuner under most signal conditions on channel 5. The other harmonics, being much smaller in amplitude, may usually be eliminated by proper lead dress and adequate bypassing. The use of two diodes of a triple diode-triode tube, such as a 6T8, for the sound discriminator, tends to aggravate the problems due to the sound i-f harmonics, because of the introduction of additional feedback paths to the tuner.

Intercarrier Sound

The use of intercarrier sound substantially reduces the chances of interference from any sound i-f harmonics since now these may only be generated in the video detector where the sound carrier is of relatively low amplitude. Therefore the only i-f harmonic interference is due to the video i-f harmonics as shown in Fig. 9.

By selecting a video intermediate frequency of 25.6 mc and using intercarrier sound, the possibility of harmonic interference is almost eliminated since the frequencies of the two offending harmonics lie almost outside the video i-f passband.

The use of intermediate frequencies in the vicinity of 41 mc makes the selection of the actual frequency much less critical than in the 22-mc region. Figure 10 shows the beat frequencies from both sound and video i-f harmonics that are possible for sound intermediate frequencies from 40.9 to 41.6 mc. Notice that only three harmonics fall into any of the twelve television channels. If intercarrier sound is specified, the only harmonic which must be suppressed for the above range of sound i-f is the 4th video i-f which falls on channel 8. Consequently, the exact selection of the sound i-f frequency, say at 41.25 mc, can be dictated by other considerations.

It is also possible, if the tuner image rejection ratio is not sufficiently large (as it may be on the high television channels) for i-f harmonics existing above the local oscillator frequency to cause interference in the picture. For example, consider a receiver tuned to channel 9, with a sound carrier i-f of 21.75 mc, the local oscillator frequency will be 213.5 mc. The eleventh harmonic of the sound i-f is 239.25 mc. The 25.75-mc beat between these two frequencies can possibly appear in the picture (as a 0.5-mc beat) if a feedback path exists. These harmonics, lying above the local oscillator frequency, will not usually cause trouble. However, the possibility of interference from this source should be recognized.

The authors wish to thank Carl Quirk for helpful assistance.

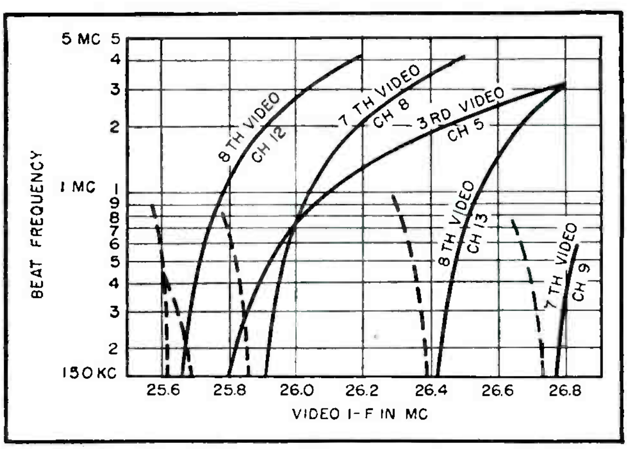


FIG. 9—Beat frequencies from harmonics of the video i-f signal plotted against change in the video i-f

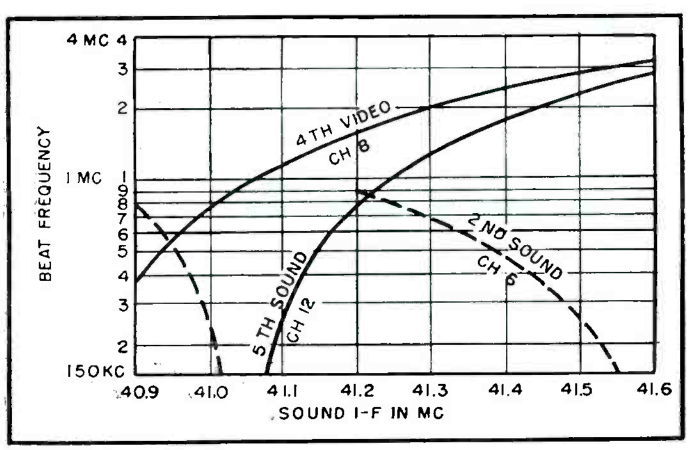


FIG. 10—Beat frequencies from both video and sound i-f harmonics using an i-f near 41 mc

EXTENDED Q-METER

Permit determination of a wide range of resistance and reactance in balanced or unbalanced circuits from 50 kc to 30 mc. Straight-edge charts are provided for approximate solutions. Transformer design and constructional details are given

ONE of the more versatile instruments found in most every radio laboratory is the Q-meter. It is capable of measuring a wide variety of circuit constants including r-f resistance and reactance. An important gap exists, however, between measurable values of low resistance (series connected) and high resistance (parallel connected). The latticed portions of Fig. 1 show the approximate range of low and high resistance that can normally be measured on the Q-meter.

In addition, the inherent unbalance of the Q-meter circuit prevents measurement of balanced circuits, such as transmission lines, filters and attenuators.

This paper proposes a means of extending the resistance and reactance range of the Q-meter with transformers. The primaries are connected to the Q-meter and the unknown impedances connected across the secondaries. The impedances are then transformed to values suitable to the Q-meter range. Impedance as used herein signifies resistance whose phase angle in radians is 10 or less, or reactance whose Q is 10 or more.

The transformers are usable at frequencies that give accurate Q measurements—from 50 kc to 30 mc. The shaded portion of Fig. 1 shows the range of resistance that can be measured with this method. Inductors as low as 1,000 μμh and capacitors as high as 1.0 μf can also be measured. All measurements can not, of course, be made with a single transformer. A frequency range of approximately 3.5 to 1 and resistance coverage of 15 to 1 is normal for average transformers. Investigations, however, are generally restricted in scope regarding frequency and impedance, and only a few transformers will normally be required.

Measurement Procedure

Select a transformer to operate at the required frequency and cover the range of impedance desired to be measured.

Connect the primary of this transformer to the inductor terminals of the Q-meter, Resonate the Q capacitor with the primary inductance leaving the secondary open-circuited.

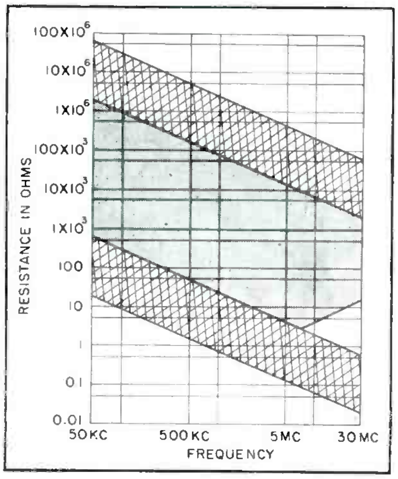


FIG. 1—Latticed portions show present range of measurable resistance with Q meter and shaded portion gives range using transformers

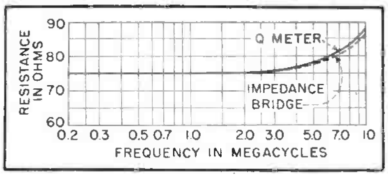


FIG. 2—Input resistance of an unterminated video attenuator at maximum attenuation, 62.5 db

Note values of C_1 and Q_1 as defined in Appendix I. Then short-circuit the secondary terminals with a short copper strip. Retune the Q circuit and read C_2 and Q_2 (Q_2 is not needed for most measurements). Remove the short-circuit and connect the unknown impedance in its place. Tune the Q meter once more and note C_3 and Q_3.

The nature of the unknown impedance may be determined by comparing C_3 and Q_3 with C_1 and Q_1. If C_3 equals C_1 but Q_3 is less than Q_1, the unknown is resistive. If C_3 differs from C_1, the unknown is reactive. It is capacitive if C_3 is less than C_1 and inductive when C_3 is greater than C_1.

For best results when making these measurements, it is recommended that the Q meter operate from a constant-voltage, power-line regulating transformer.

Resistance Measurement

If the impedance is resistive, its value can be calculated from the equation

$$R = \omega L_s Q_3 \frac{\left(1 - \frac{C_1}{C_2}\right)}{\left(1 - \frac{Q_3}{Q_1}\right)} \qquad (7)$$

where ωL_s is the reactance of the secondary winding and must be equal to or less than $R/10$.

It is always well to compare a new measuring technique with an established one. Figure 2 is the input resistance of a video attenuator measured from 200 kc to 10 mc with a GR model 916A r-f impedance bridge and a Q-meter. The curves show excellent agreement. It should be noted that the attenua-

MEASUREMENTS

By RAYMOND E. LAFFERTY

Engineering Development Group
National Broadcasting Co.
New York, N. Y.

tor is only recommended for use up to 5 mc.

Capacitive Reactance

If the unknown impedance is capacitive, its reactance equals:

$$X_c = \omega L_s \frac{C_1}{C_2}\left(\frac{C_2 - C_3}{C_1 - C_3}\right) \quad (11)$$

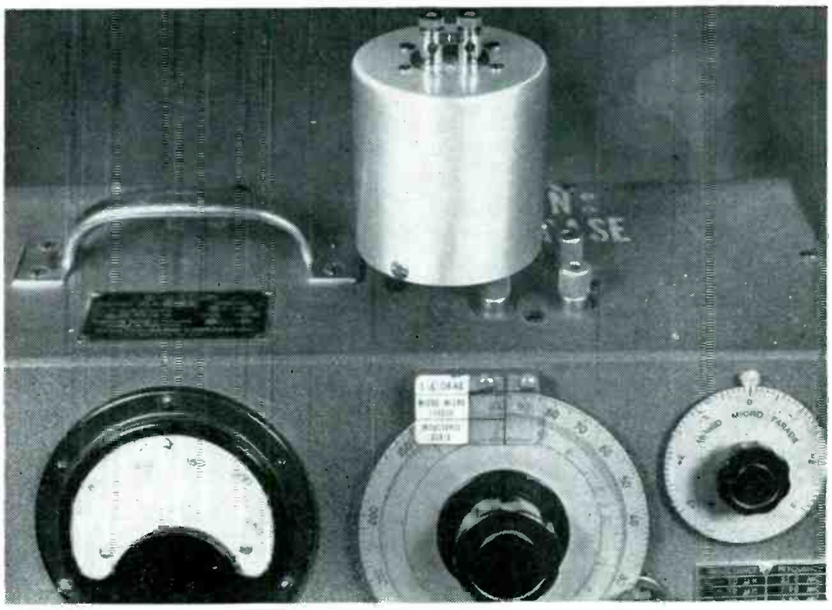
where ωL_s should be less than $X_c/5$ for normal capacitors. This relationship is discussed in more detail in Appendix I.

Inductive Reactance

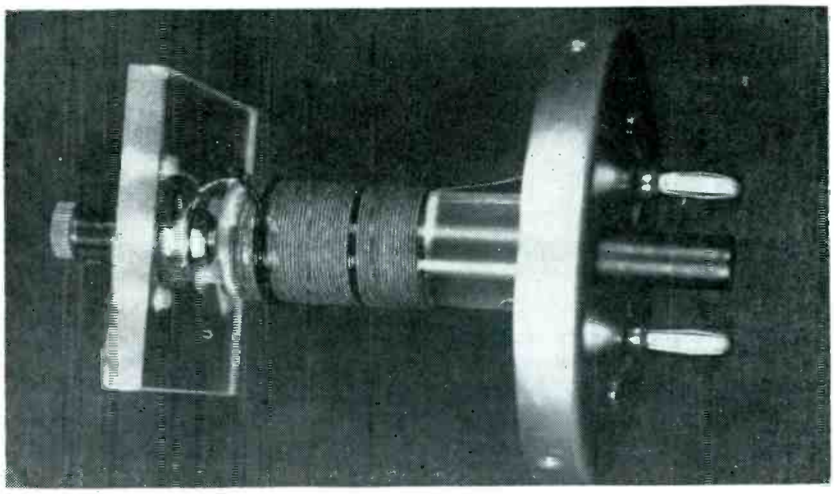
When the impedance connected to the secondary terminals is inductive, its reactance can be found from:

$$X_L = \omega L_s \frac{C_1}{C_2}\left(\frac{C_2 - C_3}{C_3 - C_1}\right) \quad (12)$$

There is no restriction to the size of L_s when measuring inductive reactance. For best results, however, L_s should be about equal to L. This condition is not possible when measuring very small inductors, but if L is greater than $L_s/20$, acceptable measurements can be made.



Two to seven-megacycle transformer plugged into the Q-meter inductor terminals



Transformer with shield removed has primary wound in two sections. This arrangement allows adjustment of inductance

Direct measurement for the true inductance of small coils on the Q meter demands the use of high frequencies. Should these frequencies approach the self-resonant frequency of the coil, a serious error results. For example, if the frequency used is one-half the self-resonant frequency, the measured inductance will be 33 percent higher than the true inductance. Using a transformer permits the measurement to be made at a frequency well below the self-resonant frequency, and hence, yields the true inductance.

A matter often overlooked when measuring inductors with cores, is the change of the effective permeability of the core material with frequency. Clearly, the frequency for which the coil is designed should be used in the measurement for significant results. In many cases this can be done directly on the Q-meter, but where the range of the Q capacitor restricts such measurement, the inductor can usually be measured at its operating frequency with a properly designed transformer.

When measuring inductors of 5,000 μμh and less, the inductance of the shorting strip should be taken into account. Grover[1] gives a formula for the inductance of straight conductors of rectangular form. If this inductance is small compared to L_s, the measured value can be corrected, to a first approximation, by subtracting the inductance of the strip from the measured value. Typical strips used by

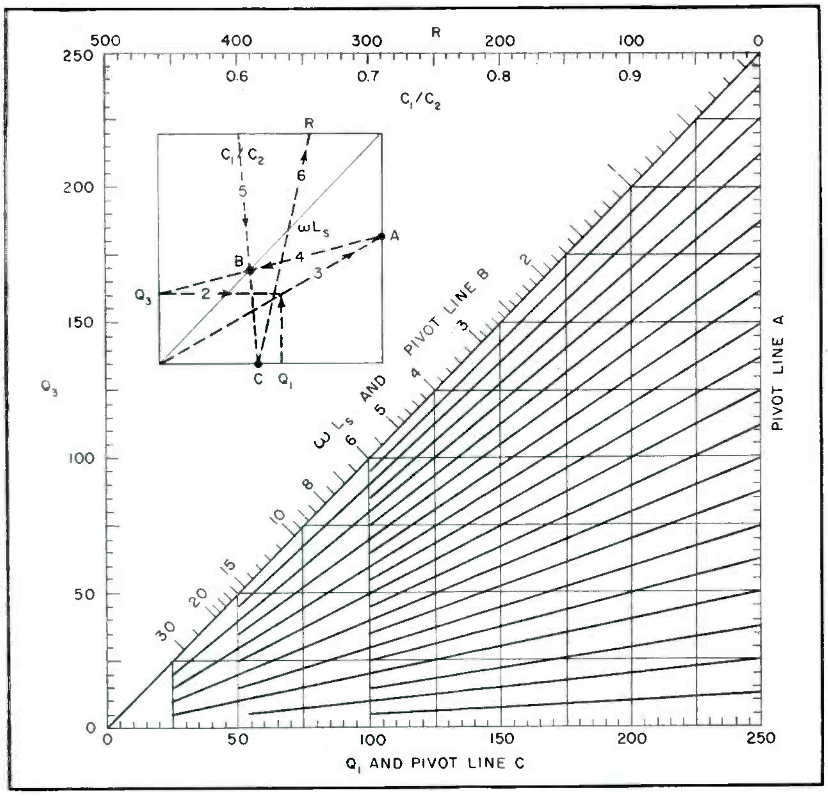


FIG. 3—Nomograph for resistance R in Eq. 10. If Q_1 equals 200 Q_3 equals 100, C_1/C_2 equals 0.75 and ωL_s equals 40 ohms, then R equals 2,000

the writer averaged 200 μμh to 500 μμh.

Alignment Charts

Although the equations presented for resistance and reactance are not complex, they require the use of a slide rule to evaluate. Alignment charts in Fig. 3 and 4 have therefore been constructed for the approximate solution of Eq. 7, 11 and 12. Two families of curves are suggested in Fig. 5 and 6 as the simplest means of determining resistance or reactance once the transformer constants are known and values of C and Q have been measured. The value Q_1 is included as a parameter of Fig. 5 since temperature and humidity may cause diurnal variations of this quantity.

Transformer Design and Construction

Primary Winding: The inductance of the transformer primary is designed to resonate over the desired frequency range with the variable Q capacitor. The operating Q of this winding should not exceed 250 to avoid changing the Q-circuit injection voltage. The initial Q, however, may be as high as practical. By shunting the primary, then, with a high resistance, the Q can be lowered to a value somewhat under 250. This lessens the mutation of Q with frequency and a substantially flat Q curve is obtained.

Inaccuracies in the measured values of C and Q result from the presence of distributed capacitance in this winding. Correction equations for these errors are presented later, but it is well, when designing the primary, to keep the distributed capacitance, and hence, the error, to a minimum.

Secondary Winding: The inductance of this winding will depend on the values of the unknown impedances. When measuring resistance, ωL_s must be equal to or less than 1/10 the smallest resistor and equal to or greater than 1/150 the largest resistor to be measured. To measure small coils and large capacitors, the secondary inductance should be small, yet preserve a high degree of coupling.

At low frequencies where universal windings are necessary for the primary, they should be wound in pies for high Q and low distributed capacitance. Satisfactory coupling may be realized by placing the secondary between the last two primary pies at the low-potential end.

Solenoid windings are best suited for medium and high-frequency operation. The secondary may be wound over the low end of the primary winding, as illustrated. The coil form can also be grooved for a turn or two of copper ribbon and the primary placed directly over the secondary.

Another type of transformer that lends itself to high-frequency applications can be constructed with a special triaxial cable consisting of a solid center-conductor, insulation, copper tubing, more insulation and an outside copper tube. The center-conductor forms the primary; the inside tubing acts as an electrostatic shield and the outside tubing is the secondary. Where low reactance is required for the secondary, only one turn of the outside tubing should be used. Even so, the coupling will be moderately high, k being 0.38 for a typical transformer designed by the author. Tubing of this type is manufactured by the Precision Tube Co.

The terminal leads of low-reactance secondary windings must be as short as possible to minimize the inductance.

Core Materials

Powdered iron and ferrite cores can be used at low and medium frequencies to increase the coefficient of coupling, reduce the number of turns and improve Q. Care should be taken to check L_s and the ratio C_1/C_2 over the entire frequency range of the transformer when these cores are used since the effective permeability may vary with frequency.

However, charts, similar to those in Fig. 5 and 6 can be drawn for transformers with any type core, such as air, ferrite or powdered iron.

Measuring L_s: One factor, that affects the percentage error of the measurements described in this paper, is the accuracy with which L_s is measured. Medium values or secondary inductance offer no great problem. When measuring small values of L_s, however, at the frequencies required by most instruments to measure low-inductance coils, the transformer primaries approach self-resonance and considerable error ensues.

Self-Calibration

One satisfactory method of measuring low secondary inductors involves standard fixed capacitors suitable for r-f operation, a grid-dip oscillator that will work at low radio frequencies and a means of accurately checking those frequencies. With short copper strips, connect a standard capacitor to the secondary terminals. Loosely couple the grid-dip oscillator to the secondary winding and carefully find the resonant frequency of L_s and the standard capacitor, C_{std}. The inductance, L_s, is then

$$L_s = \frac{1}{\omega^2 C_{std}}$$

The frequency of measurement should be at least 1/10 the self-resonant frequency of the primary winding.

There is an alternate method of self-calibration that can be used to determine L_s. High-frequency precision resistors such as the WE deposited carbon type 145A serve well as standards to measure the secondary inductance of these transformers. Connect one of these precision resistors, having a resistance approximately twenty times the estimated value of ωL_s, to the secondary terminals and follow a procedure as if to measure the standard resistor. After noting the Q-meter readings, transpose Eq. 7 and solve for ωL_s.

$$\omega L_s = \frac{R}{Q_3} \frac{\left(1 - \frac{Q_3}{Q_1}\right)}{\left(1 - \frac{C_1}{C_2}\right)} \quad (7a)$$

Likewise, a standard capacitor of suitable value can be connected to the secondary terminals and Eq. 11 transposed to solve for ωL_s

$$\omega L_s = \frac{C_2 (C_1 - C_3)}{\omega C_{std} C_1 (C_2 - C_3)} \quad (11a)$$

These measurements should be made with the Q capacitor near maximum, otherwise the distributed capacitance of the primary will produce an error in the calculated value of L_s. However, if corrections, given later, are applied, the measurement can be made with any value of Q capacitance.

If the proper transformer is calibrated first, it may be used to measure the secondaries of subsequent transformers.

If the Q meter has a constant percentage Q error and a standard capacitor is used to measure L_s, resistance measurements will be in error but reactance measurements will not suffer. If a resistance standard is used to determine L_s, a correction is introduced that compensates for the error in Q and other resistance measurements will be correct. Measured values of reactance, however, will be inaccurate.

It is important, therefore, that regardless of the method used to measure L_s, the Q meter read capacitance, Q and frequency correctly if the measurements described in this paper are to yield results of acceptable accuracy.

In general, resistance can be measured with an error of less than 3 percent and in no event should it be greater than 5 percent if precautions are observed in calibrating the transformer. Similarly, reactance measurements can usually be made with an error of less than 2 percent.

Miscellaneous: To measure small inductors and large capacitors, the degree of coupling between primary and secondary must be reasonably

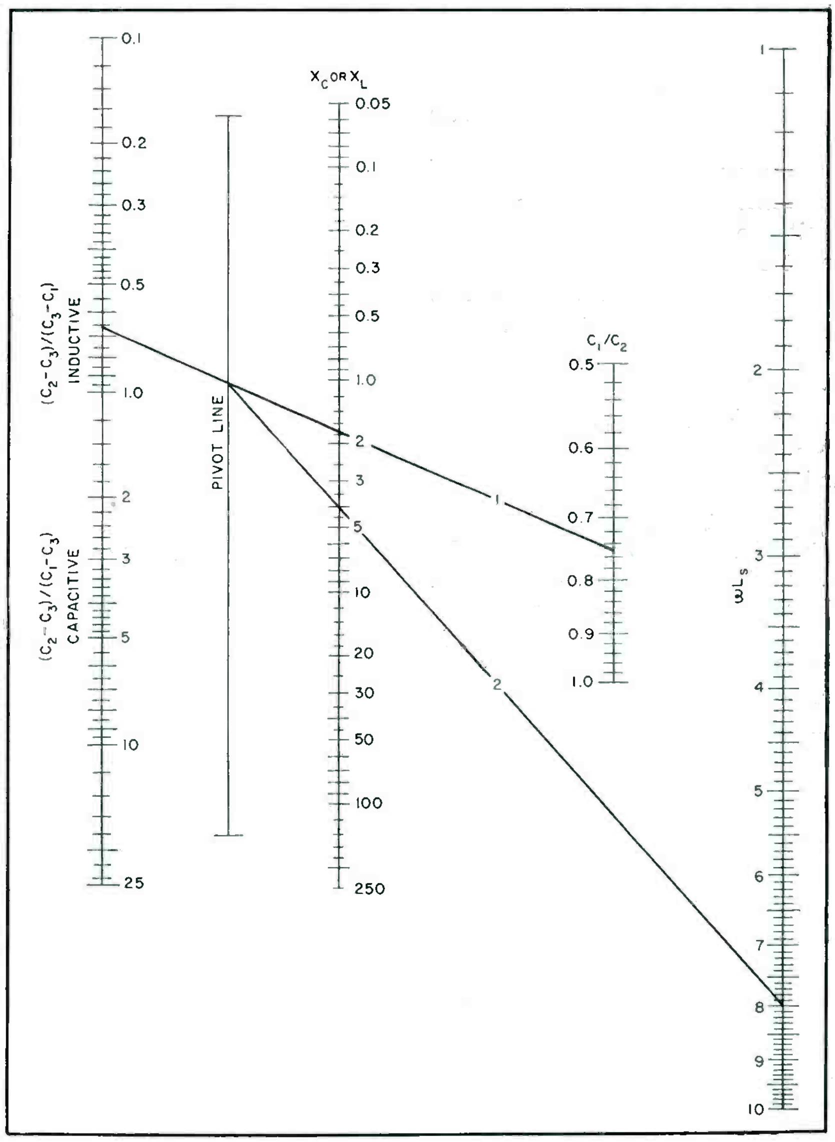


FIG. 4—Nomograph for reactance X in Eq. 17 and 18. If C_1 equals 150 $\mu\mu f$, C_2 equals 200 $\mu\mu f$, C_3 equals 180 $\mu\mu f$ and ωL_s equals 8 ohms, then X_L equals 4 ohms

high. Values of k of 0.5 to 0.7 are adequate for most purposes. For the measurement of resistance, the coupling need not be as great, but should be sufficient to make C_2 20 to 30 percent greater than C_1 (k of 0.4 to 0.5).

It is advisable to shield the transformers in copper or aluminum cans. Besides protecting the transformer from stray fields, it prevents coupling between transformers and inductors connected for measurement, a condition that would otherwise produce large errors.

Distributed Capacitance Errors

Transformer primaries are not immune to distributed capacitance and at the upper-frequency limits of the transformer this capacitance is normally sufficient to cause errors in the Q-meter readings of C and Q. When making measurements at frequencies where the Q-meter tuning capacitor is used near the maximum end of its range, the errors are usually negligible, but at higher frequencies, where the tuning capacitance is small, the error can account for appreciable inaccuracies in the measured values of R and X.

The true values of C and Q, in the presence of distributed capacitance, can be found with the following equations.

$$C = C_a + C_d \qquad (21)$$

and

$$Q = Q_a\left(\frac{C_a + C_d}{C_a}\right) \qquad (25)$$

where C and Q are the true values, C_a and Q_a the apparent values as measured on the Q meter and C_d is the distributed capacitance of the primary winding. The value of C_d can be measured on the Q meter following standard instructions furnished with the instrument.

Equations 21 and 25 are derived in Appendix II and were used in the construction of Fig. 5 and 6. An example of the correction required for a transformer with somewhat more than normal distributed capacitance, is shown in Fig. 7.

Appendix I

Nomenclature used:

- ω = 2 π times the frequency of measurement
- L_p = inductance of primary winding
- R_1 = series resistance of primary winding
- L_s = inductance of secondary winding
- R_s = series resistance of secondary winding
- Q_s = Q of secondary winding, $\omega L_s/R_s$
- M = mutual inductance between primary and secondary windings
- C_1 and Q_1 = C and Q of the primary circuit with the secondary open-circuited
- C_2 and Q_2 = C and Q of the primary circuit with the secondary short-circuited
- C_3 and Q_3 = C and Q of the primary circuit with the unknown impedance connected across the secondary
- R = unknown resistance
- X_C = unknown capacitive reactance
- Q_C = Q of unknown capacitor
- R_C = series resistance of unknown capacitor, X_C/Q_C
- X_L = unknown inductive reactance
- Q_L = Q of unknown inductor
- R_L = series resistance of unknown inductor, X_L/Q_L
- Q_{sec} = Q of secondary circuit with unknown reactance connected for measurement

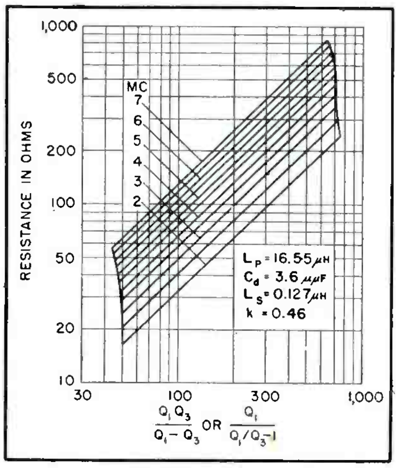


FIG. 5—Sample chart used to determine resistance of individual transformers

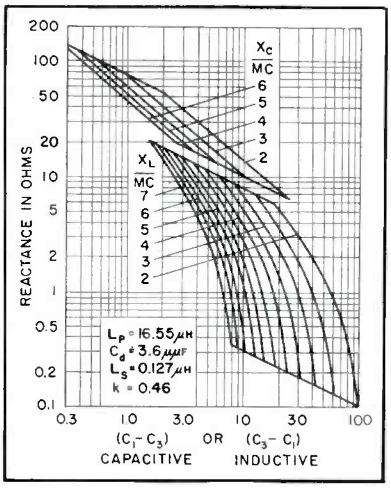


FIG. 6—Sample chart used to determine reactance of individual transformers

Derivations of the equations are based upon the transformer shown schematically in Fig. 8. It has been shown[2] when the secondary is short-circuited and its Q is greater than 10, the reactance reflected back into the primary equals

$$\text{Reflected reactance, secondary shorted} = \frac{\omega^2 M^2}{\omega L_s} \qquad (1)$$

To maintain resonance in the primary with this amount of reflected reactance, C_1 must be changed to C_2, from which

$$\omega^2 M^2 = L_s\left(\frac{1}{C_1} - \frac{1}{C_2}\right) \qquad (2)$$

Equation 2 is correct only if $Q_s \geqq 10$. The value of Q_s can be found from readings on the Q-meter. The resistance reflected into the primary with the secondary shorted, is

$$\text{Reflected resistance, secondary shorted} = \frac{\omega^2 M^2 R_s}{\omega^2 L_s^2} \qquad (3)$$

It can be shown that

$$Q_s = \frac{Q_1 Q_2 (C_2 - C_1)}{C_1 Q_1 - C_2 Q_2} \qquad (4)$$

If a resistor R equal to or greater than 10 ωL_s is connected to the secondary terminals, substantially no reactance will be reflected into the primary. A resistance component is reflected, however

$$\text{Reflected resistance} = \frac{\omega^2 M^2}{R} \qquad (5)$$

This reduces the primary Q from Q_1 to Q_3

$$Q_3 = \frac{\dfrac{1}{\omega C_1}}{\dfrac{1}{\omega C_1 Q_1} + \dfrac{\omega^2 M^2}{R}} \qquad (6)$$

Substituting Eq. 2 for $\omega^2 M^2$ and solving for R

$$R = \omega L_s Q_3 \frac{\left(1 - \dfrac{C_1}{C_2}\right)}{\left(1 - \dfrac{Q_3}{Q_1}\right)} \qquad (7)$$

This form is well suited for slide-rule calculation.

Now assume a reactance is connected to the secondary. To allow the equations for X_C and X_L to be simplified to a workable form, the circuit Q of the secondary must equal 10, or more. Thus, for capacitors

$$Q_{sec} = \frac{X_c - \omega L_s}{R_c + R_s} \geqq 10 \qquad (8)$$

and for inductors

$$Q_{sec} = \frac{X_L + \omega L_s}{R_L + R_s} \geq 10 \qquad (9)$$

When measuring capacitors, if X_C approaches ωL_s, it can be seen from Eq. 8, that the secondary circuit Q will approach zero. For exceptionally high-Q capacitors, where R_C is negligible compared to R_s, the lower limit for X_C is: $X_C = 2\omega L_s$. A safer value for normal large capacitors is: $X_C = 5\omega L_s$.

With a capacitor that satisfies Eq. 8 connected to the secondary, the reactance reflected back into the primary equals

$$\text{Reflected reactance} = \frac{\omega^2 M^2}{X_c - \omega L_s} \qquad (10)$$

This causes a change in the primary tuning from C_1 to C_3, and it follows that

$$X_c = \omega L_s \frac{C_1}{C_2} \left(\frac{C_2 - C_3}{C_1 - C_3} \right) \qquad (11)$$

For inductive reactance, it can similarly be shown that

$$X_L = \omega L_s \frac{C_1}{C_2} \left(\frac{C_2 - C_3}{C_3 - C_1} \right) \qquad (12)$$

The Q of the unknown reactance can be derived as follows

$$\text{Reflected resistance} = \frac{\omega^2 M^2 (R_c + R_s)}{(X_c - \omega L_s)^2} \qquad (13)$$

and

$$\text{Reflected reactance} = \frac{\omega^2 M^2}{X_c - \omega L_s} \qquad (14)$$

Using these equations and simple coupled-circuit theory, it can be shown that

$$Q_c = \frac{C_1 (C_2 - C_3)}{C_3\left(\frac{C_1}{Q_3} - \frac{C_3}{Q_1}\right)\left(\frac{C_2 - C_1}{C_1 - C_3}\right) - C_2\left(\frac{C_1}{Q_2} - \frac{C_2}{Q_1}\right)\left(\frac{C_1 - C_3}{C_2 - C_1}\right)} \qquad (15)$$

Similarly, by changing $(C_1 - C_3)$ to $(C_3 - C_1)$, we can write, for Q_L

$$Q_L = \frac{C_1 (C_2 - C_3)}{C_3\left(\frac{C_1}{Q_3} - \frac{C_3}{Q_1}\right)\left(\frac{C_2 - C_1}{C_3 - C_1}\right) - C_2\left(\frac{C_1}{Q_2} - \frac{C_2}{Q_1}\right)\left(\frac{C_3 - C_1}{C_2 - C_1}\right)} \qquad (16)$$

Due to the complexity of these equations, only a fair degree of accuracy can be expected with their use.

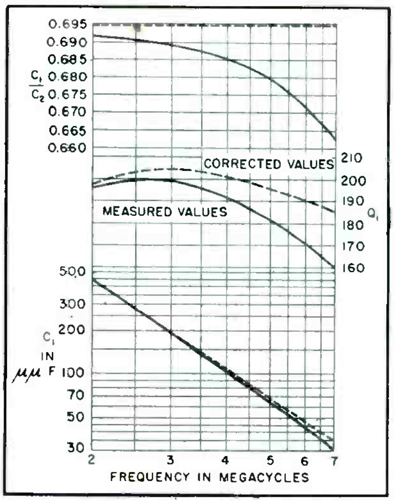


FIG. 7—Curves showing the extent of correction required for transformers with moderate distributed capacitance in the primary

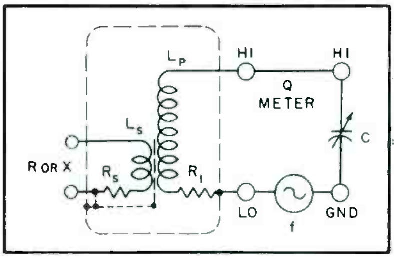


FIG. 8—Basic Q-meter circuit with a transformer connected to the inductor terminals. Electrostatic shield and dotted connections optional

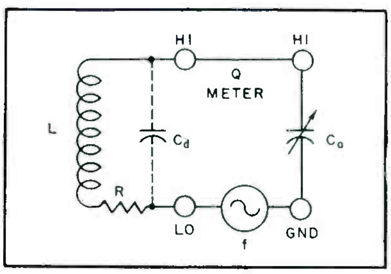


FIG. 9—Basic Q-meter circuit with the primary inductance of a transformer and its distributed capacitance connected to inductor terminals. Secondary not shown

Appendix II

Nomenclature used:

ω = 2 π times the frequency of measurement
L = true inductance of coil
R = series resistance of coil
L_a = apparent inductance of coil as measured on the Q-meter
R_a = apparent series resistance of coil
C_a = capacitance of Q-meter that resonates with L_a at ω radians
C = capacitance required to resonate with L at ω radians
C_d = distributed capacitance of primary winding
Q = true Q of coil, $\omega L/R$
Q_a = apparent Q of coil as measured on the Q meter, $\omega L_a/R_a$

By looking at the circuit in Fig. 9, equations that correct the errors in C and Q, owing to distributed capacitance can be derived as follows: The combination of L, R and C_d produce an apparent inductance L_a, resistance R_a and figure of merit Q_a. The parallel reactance of L and C_d, neglecting R since $Q > 10$, is

$$\omega L_a = \frac{\omega L}{1 - \omega^2 L C_d} \qquad (17)$$

from which

$$L_a = \frac{L}{1 - \omega^2 L C_d} \qquad (18)$$

By definition

$$L_a = \frac{1}{\omega^2 C_a} \qquad (19)$$

and

$$L = \frac{1}{\omega^2 C} \qquad (20)$$

Substituting, there results

$$C = C_a + C_d \qquad (21)$$

Q_a is defined as $\omega L_a/R_a$. R_a can be found by solving for the resistance component of Z_{La}.

$$Z_{La} = R_a + j\omega L_a = \frac{-j\frac{1}{\omega C_d}\left(R + j\omega L\right)}{R - j\left(\frac{1}{\quad} - \omega L\right)} \qquad (22)$$

from which, if $Q > 10$, R_a equals

$$R_a = \frac{R}{\left(1 - \frac{C_d}{C}\right)^2} \qquad (23)$$

Substituting Eq. 20 in Eq. 17 and dividing by Eq. 23, we have

$$Q = \frac{Q_a}{\left(1 - \frac{C_d}{C}\right)} \qquad \mathbf{(24)}$$

However, since C can not be determined on the Q-meter, and C_a can, if we substitute Eq. 21 for C in Eq. 24 we get, for the true Q of the coil

$$Q = Q_a\left(\frac{C_a + C_d}{C_a}\right) \qquad (25)$$

References

(1) Frederick W. Grover, "Inductance Calculations," D. Van Nostrand Co., New York, 1946, p 35.
(2) P. M. Honnell, Note on Measuring Coupling Coefficient, *Radio*, p 41, Feb. 1945.

Universal Equalizer Chart

Modification of familiar Smith chart consolidates on one time-saving plot all positive-value solutions to the two general equations for series, shunt and bridged-T audio equalizers

By D. A. ALSBERG

Bell Telephone Laboratories
Murray Hill, N. J.

THE single chart in Fig. 1 replaces as many as eleven conventional equalizer charts, yet gives all solutions containing positive resistances or conductances for the commonly used equalizer structures of Fig. 2. The chart is derived by applying to the two general forms of equalizer equations (Eq. 10 and 11 in Fig. 2) the bilinear transform

$$u + jv = (1 + \zeta)/(1 - \zeta) \quad (12)$$

where ζ is a complex number. This transforms the conventional rectangular grid of u and v to a set of orthogonal circles, all of which pass through the point $\zeta = +1$, and the circle $u = 0$ is identical with the unit circle in the ζ plane. This grid of orthogonal circles representing the u and v coordinates is identical to the grid of the familiar Smith chart.

(continued on page 134)

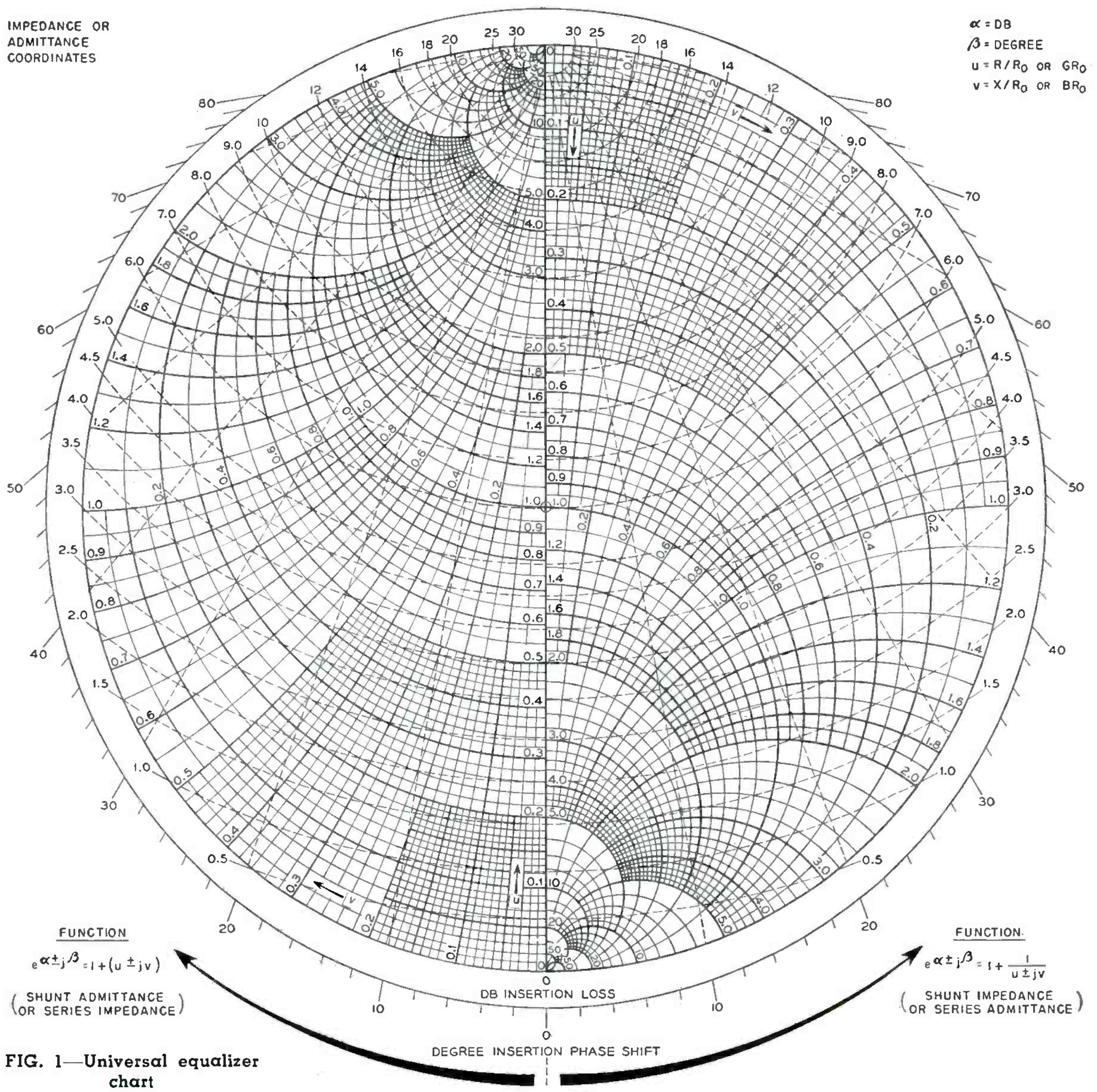
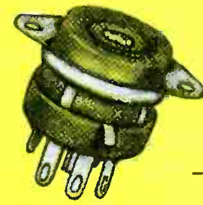


FIG. 1—Universal equalizer chart

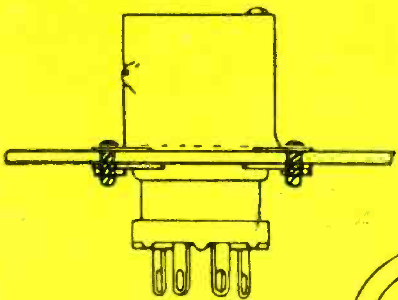
CINCH-ERIE "Plexicon" TUBE SOCKET

A Joint development of ERIE RESISTOR CORP., and CINCH MANUFACTURING CORP., now in universal use, commercial and military types; available also in Octal, Loktal and Noval type socket.

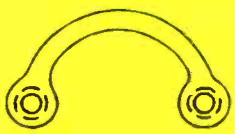


—Miniature, 7 Pin.

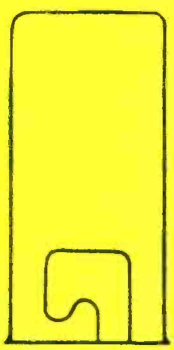
. . . PROVIDES SHORTEST ELECTRICAL PATH TO GROUND . . . SIMPLIFIES WIRING . . . REDUCES SPACE REQUIRED BY CIRCUIT COMPONENTS



Bayonet shield base when shielding of tube is necessary.



Mounting Strap



Three lengths of shield cans are available: height: 1 3/8, 1 3/4, and 2 1/4

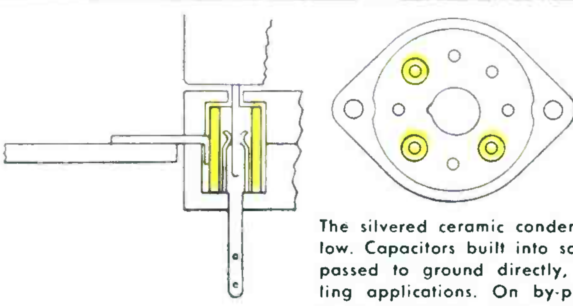
Erie Ceramic Condensers

— with built-in Ceramic Condensers, Plexicon Tube Sockets, no larger than standard receiver socket, provide the most effective method of by-passing . . . with condenser close to tube element providing shortest path to the ground.

. . . capacity up to 1,000 MMF — tube element may be coupled or by-passed as desired.

Reduces set assembly costs — saves space; permits moving other components closer to tube socket. Where space and weight makes compactness mandatory, as in Airborne equipment, the Plexicon socket is the solution.

CONSULT CINCH!



The silvered ceramic condensers are shown in yellow. Capacitors built into socket may be either by-passed to ground directly, or left open for coupling applications. On by-pass applications, ground strap contacting outer plate of capacitor is connected to metal chassis when tube socket is mounted.

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Cinch ELECTRONIC COMPONENTS

Cinch Components available at leading Jobbers — everywhere

 (continued from page 132)

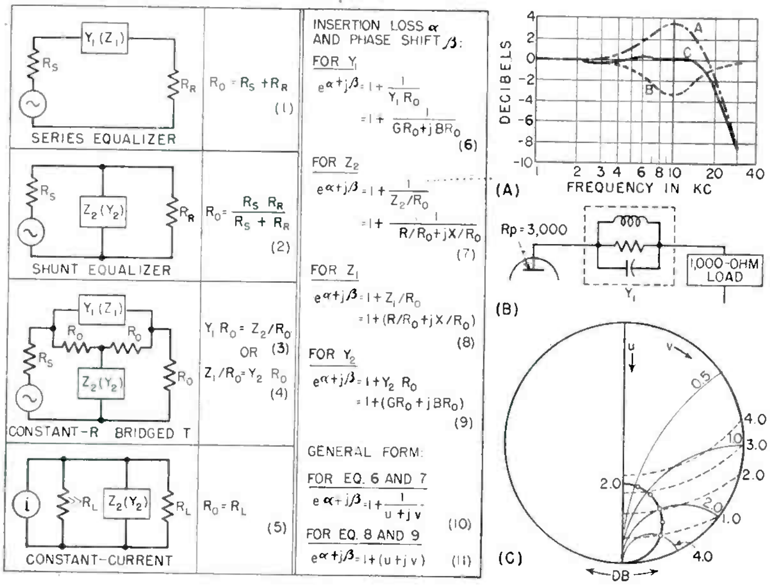


FIG. 2—Basic equalizer circuits, pertinent equations, and example

Solving Eq. 10 in the ζ plane, the lines of constant insertion loss become circles centered on the point $\zeta = -1$ and whose loci are defined by

$$\alpha\,(db) = -20 \log |(1 + \zeta)/2| \qquad (13)$$

The lines of constant phase shift are radii through the point $\zeta = -1$ whose angle from the real axis in the ζ plane is equal to the phase shift.

The solution of Eq. 11 in the ζ plane is essentially the same as Eq. 10 except that the center for the loss circles and phase shift radii is now the point $\zeta = +1$ and the loci of the loss circles are defined by

$$\alpha\,(db) = -20 \log |(1 - \zeta)/2| \qquad (14)$$

Applications

Series and shunt equalizer configurations are useful when it is unnecessary to maintain constant impedance, such as in electron tube interstages. When the network must have constant impedance, the bridged-T equalizer is used. The constant-current generator is a special case of the shunt equalizer and is particularly useful in electron tube stages which behave substantially like constant-current generators, such as pentodes. One specific use is to compute the effect of shunting parasitic capacitances on the gain and phase of an electron tube stage. In this case the parasitic shunt reactance would be considered Z_2.

While Eq. 1 to 9 have been written for a pure resistance R_o, R_o may be replaced in all these expressions by a complex impedance Z_o. Then the values u and v in the chart represent the real and imaginary components of the fraction Z/Z_o or the product YZ_o. The chart is also useful when measuring impedance using the insertion loss and phase principle.

Example of Use

Curve A in Fig. 2A represents an amplifier response curve. The objective is to flatten the response peak at 10 kc. A convenient place to perform the equalization is found in the plate circuit of a tube which has an internal plate resistance R_p = 3,000 ohms and works into a load of R_r = 1,000 ohms, as in Fig. 2B. The shape of curve A suggests use of a parallel-tuned circuit shunted by a resistance in the case of a series equalizer. With three independent elements in the equalizer, three independent parameters may be chosen. As first parameter we choose to tune the circuit to ω_o = 10 kc. As second parameter we choose to make the equalizer loss exactly 3.5 db at 10 kc, and as third parameter we decide to match exactly the excess gain of 1 db at ω_1 = 5 kc.

Proceeding with the computation on a normalized admittance basis, at resonance the susceptance of the equalizer must be zero. Entering the chart as shown in Fig. 2C on the zero-susceptance line, we find the 3.5-db loss circle intercept at the 2.0 conductance circle. Thus the equalizer must contain a normalized conductance of $GR_o = 2.0$.

At 5 kc the loss was set to 1 db. We now find the intercept between the 2.0 conductance circle and the 1.0-db loss circle at a susceptance of 4.0. From resonance at ω_o

$$\omega_o C R_o - \frac{1}{\omega_o L/R_o} = 0 \qquad (15)$$

From the solution of Eq. 10 at ω_1

$$\omega_1 C R_o - \frac{1}{\omega_1 L/R_o} = 4.0 \qquad (16)$$

then

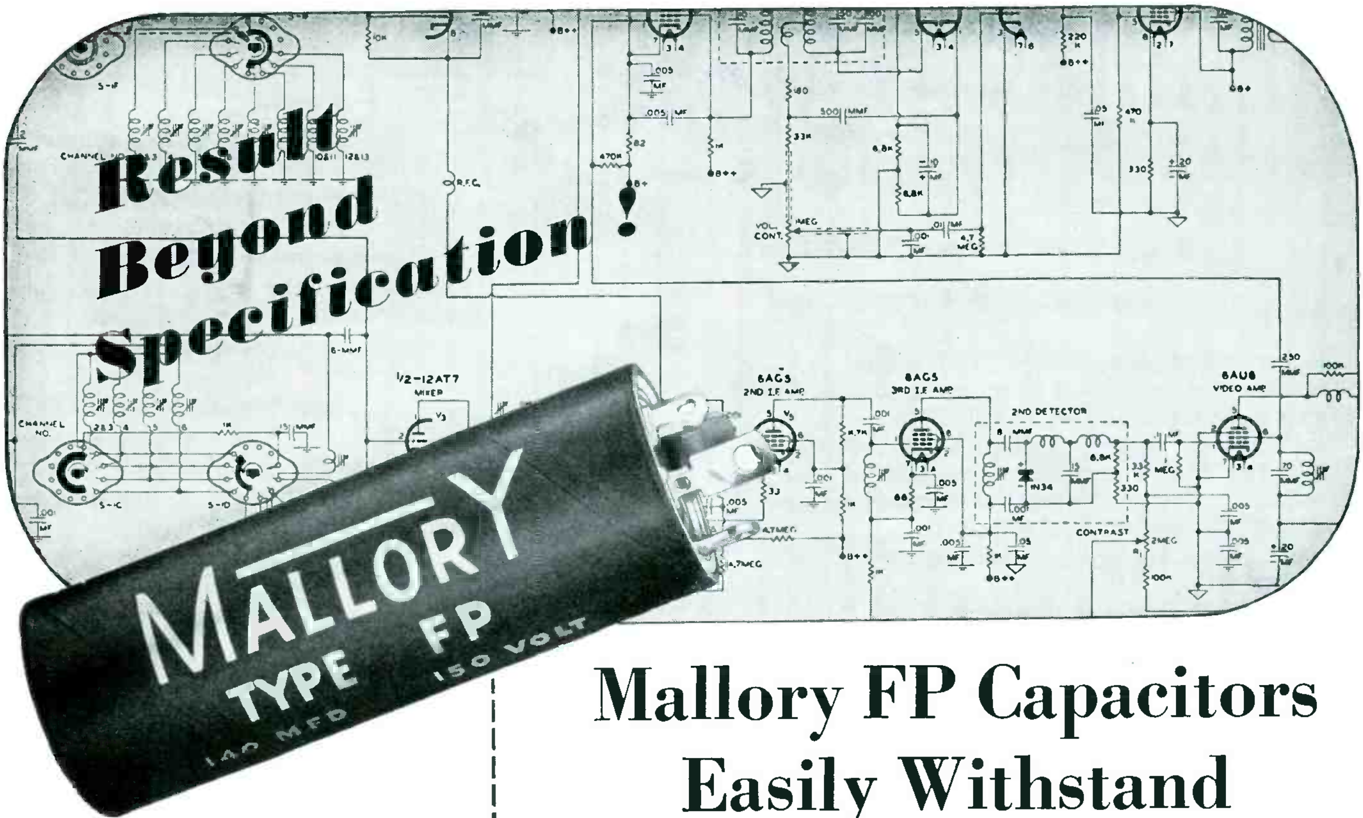
$$CR_o = \frac{4}{\left(\omega_1 - \dfrac{\omega_o^2}{\omega_1}\right)}$$

$$= 4.25 \times 10^{-5} \qquad (17)$$

$$L/R_o = 5.97 \times 10^{-6} \qquad (18)$$

From Eq. 17 and 18 the net normalized susceptance of the network at any frequency may be determined. To find the loss associated with each of these susceptance values the equalizer chart is entered on the 2.0 conductance circle and the intercept with the computed susceptance circle is located, at which point the loss value is read. The result is plotted in curve *B* on Fig. 2A, and the resulting net transmission characteristic is plotted as curve *C*.

Assuming curve *C* to be adequately flat, the actual element values of the equalizer are found: From Eq. 1, R_o is 4,000 ohms. Substituting this in $GR_o = 2.0$ gives 2,000 ohms for $1/G$. From Eq. 17, C is 0.0106 μf. From Eq. 18, L is 23.9 mh.



Mallory FP Capacitors Easily Withstand High Ripple Currents In TV Circuits

When you specify Mallory Capacitors for television receivers or other equipment where heat is a problem, you can be sure they will stand the test. Mallory FP Capacitors are designed to give long, trouble-free performance at 85°C. —naturally they give even longer service at normal temperatures. In addition, Mallory FP Capacitors are famous for their long shelf life. Write for your copy of the FP Capacitor Engineering Data Folder.

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Thorough testing demonstrated that standard Mallory FP Capacitors would stand up in the rugged service involved in the voltage doubling rectifier circuit. The jump from radio ripple currents of about .15 amperes to five or six times this current in TV service places a tremendous burden on capacitors. But Mallory FP Capacitors are giving long, uninterrupted performance . . . at temperatures approximating the boiling point of water.

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FP is the type designation of the Mallory developed electrolytic capacitor having the characteristic design pictured and famous throughout the industry for dependable performance.

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TUBES AT WORK

Including INDUSTRIAL CONTROL

Edited by RONALD K. JURGEN

Electronic Switch for Video Frequencies

By R. LEE PRICE
Research Department
Zenith Radio Corp.
Chicago, Ill.

AN ELECTRONIC SWITCH capable of handling the signal amplitudes and frequencies commonly found in tv receivers without distortion or need for corrective networks has been built utilizing controlled cathode followers.

In the circuit of Fig. 1, two 6BF5's are connected as cathode followers with the output signal appearing across a common cathode resistor. These two tubes are alternately switched by two 6BF5 control tubes which shunt the respective screens of the cathode follower stages.

A push-pull square-wave voltage is applied to the grids of the control tubes. On the positive half cycle of input square wave, the control tube plate impedance becomes low as compared with the 20,000 ohms from B+, and the cathode-follower screen voltage is thus reduced to a value below the minimum cathode voltage.

On the negative half cycle of input square wave, the control-tube plate current is cut off and normal screen voltage is re-established on the cathode follower. Thus it is seen that the cathode currents in the two cathode followers are alternately switched by the square wave.

Stabilization

To provide adequate stabilization of cathode-follower screen voltage for low frequencies without introducing time-constant difficulties during switching, OC3's are used to maintain constant screen voltage during the conducting period. The 0.01-μf capacitors across the gas tubes provide a bypass at higher frequencies where gas tubes are no longer effective.

Biasing the cathode-follower control grids positive with respect to ground allows the handling of signal voltages up to about 40 v rms without distortion. The variable resistance in the grid return of the first cathode follower operates to provide variable separation of d-c levels. The frequency response of this unit was found to be essentially uniform from 60 cps to above 4 mc.

In practice it was found desirable to keep the square wave switching rate low and to synchronize it to a submultiple of the scope sweep frequency so that the transient due to gas tube ionization would not interfere with the waveform of the signal being observed.

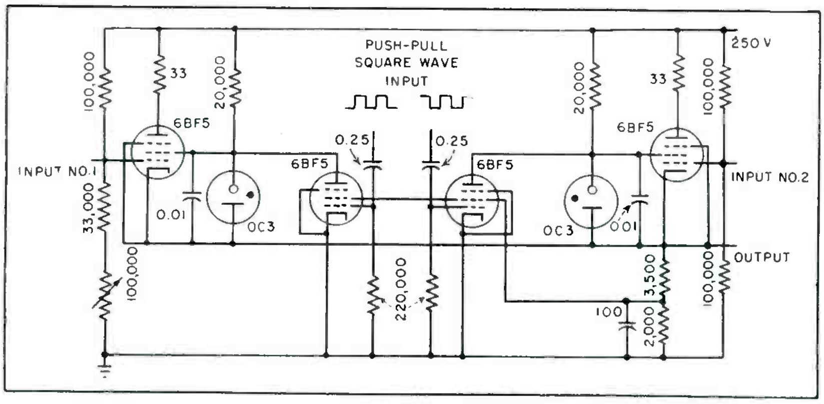

FIG. 1—Electronic switch for video frequencies

Photoelectric Dew-Point Hygrometer

By RONALD C. WALKER
Physicist and Engineer
Reading, England

THE INSTRUMENT to be described indicates dew point to a high degree of precision and is designed to act as a convenient means of measuring the water content of the atmosphere down to −85 C and enables the relative humidity to be found immediately by the aid of tables.

In the instrument, a small metal thimble is cooled by continuous conduction through a heavy copper rod which is immersed in liquid oxygen or is alternatively cooled by a small refrigerator. A small quantity of the air to be tested is blown through a jet across the top of the thimble and when the temperature falls to the dew point, a deposit of frost or moisture forms on its surface.

The surface of the thimble is brightly illuminated by a lamp and optical system and when the moisture forms, the light is scattered and detected by a photocell. The photoelectric current is amplified and used to control a heater winding on the thimble which tends to disperse the moisture by increasing the temperature. The system thus operates to maintain a temperature at which a steady deposit is just formed on the surface.

The measuring device comprising the thimble and associated optical

THE FRONT COVER

OPENING of the new transcontinental tv and telephone relay system by the American Telephone and Telegraph Company is a result of construction work started in 1947. The radio-relay system spans the country from East to West in 106 steps with a total of 107 stations. The various stations along the route are spaced from nine to fifty miles apart with the average spacing about 30 miles. Height of the antenna towers along the route, not including antennas, varies from 2½ ft on the Utah salt flats to 415 ft at Des Moines, Iowa. Stations are placed in a zigzag manner to prevent the signal from overshooting one station and being picked up by the following one.

The cover photograph shows the Buckhorn Mountain, Colorado installation, one of the last towers to be constructed. This tower is located 63 miles northwest of Denver at an elevation of 8,306 ft. It constitutes the second jump out of Denver. The accompanying photograph is of the Cisco Butte, California station which is located in a valley high in the Sierra-Nevada Mountains.

New developments incorporated in the system are a vacuum tube with outstanding performance at superhigh frequencies, an improved metal lens antenna and a unique system of filters.

equipment is built in a unit and the thimble is totally enclosed to avoid contamination of the air under test. The electrical equipment is made up in interconnected units with particular attention given to the circuit design, Fig. 1, to ensure stability of output.

Referring to Fig. 1, the photoelectric current is amplified in an electron multiplier and simple amplifier followed by a magnetic amplifier to supply the heater of the thimble. A standard photocell amplifier may be used to operate a recorder from the thimble.

At ordinary temperatures, the instrument will respond in about 0.5 sec depending mainly on the rate of air flow in the pipes and will record the dew point to about 0.25 C. The time of response increases and the accuracy decreases at lower water contents until a frost point of −80C is reached where the response time is about 10 to 20 sec and the accuracy 1 to 2 deg C.

The slow response at low temperatures is due to the very small amount of water vapor available and the lower accuracy is due to the difficulty of eliminating the effects of water given up, even by clean metal pipes, to the air under test.

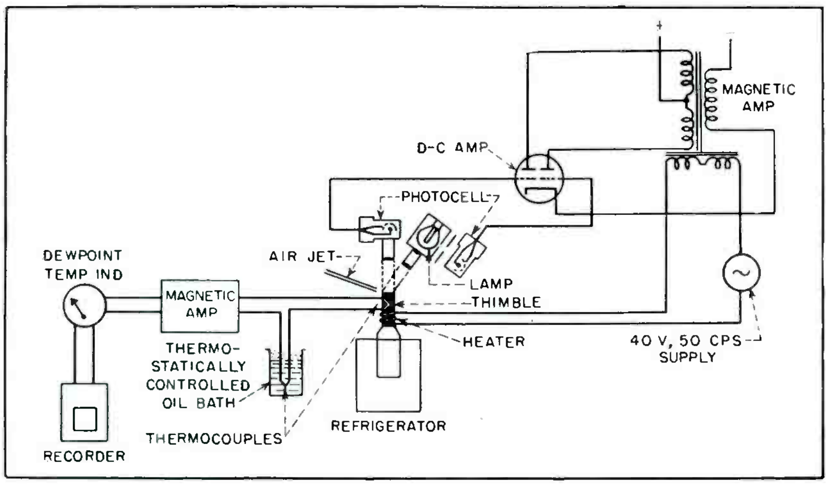

FIG. 1—Photoelectrically controlled dew-point hygrometer

Frequency Checking of Mobile Equipment

By M. H. DIEHL AND C. J. STATT
Commercial Equipment Division
General Electric Company
Syracuse, New York

ONE OF THE MOST ACCURATE means of frequency measurement for mobile transmitting equipment is the crystal-controlled multivibrator, detector and interpolation oscillator method. The major disadvantage here is that it is too slow and very susceptible to human error for large-scale testing. The system to be described here is a highly specialized application of this method.

A block diagram of the synchronized-pulse system is shown in Fig. 1. All frequencies shown and those used in the explanation are for equipment operating in the 30 to 50 mc band, but the same general principles apply to the other types of equipment. Since the channel spacing is 40 kc in this band, a multivibrator is needed with a repetition rate of 40 kc to generate the required harmonics. This would require that the 40-kc harmonics be used up through 50 mc. Harmonics can be generated this high (as in the receiver checker) but they have low amplitude and a large amount of amplification would be required before or after mixing. For this reason and for simplicity in circuit layout, it was decided to measure the frequency at the lower, oscillator level.

The total multiplication in the

(Continued on page 156)

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Joint Army and Navy component specifications were never meant to limit engineering progress—and, with Sprague, they most certainly haven't!

. . . Sprague subminiature capacitors have pioneered size and weight reductions plus high-temperature operation that would have been impossible with conventional capacitors. You'll not find these unique, hermetically-sealed capacitors listed in the current issue of Joint Army-Navy specification JAN-C-25. In every case, however, they have been fully approved for use. The reason is simple: In effect, Sprague subminiature capacitors are *super*-JAN types. They greatly exceed the already high minimum quality limits established by JAN specifications.

As the long-time leader in capacitor development, Sprague clearly recognizes that its engineering obligation extends far beyond conventional standards—*so markedly so that much of today's tremendous production of Sprague components for military use is based on types for which no JAN specifications yet exist!*

Thus, to equipment manufacturers faced with the problems of reducing size and weight or of paving the way to higher temperature operation, Sprague offers help along many lines—from the subminiature capacitors shown here to Vitamin Q☆ photo-flash capacitors to Ceroc☆ 250°C. ceramic-Teflon insulated magnet wire and many others.

...opening new horizons to critical equipment design

You can do miniaturization jobs with these capacitors that were hitherto impossible!

Conservatively rated in designs for either 85°C. or 125°C. operation and with voltage ratings from 100 to 1000 volts, Sprague subminiature hermetically-sealed paper capacitors are available in physical sizes materially smaller than JAN types. Rigid mounting is greatly simplified by a variety of new mounting designs—also pioneered by Sprague.

For complete information write for Bulletin 213B.

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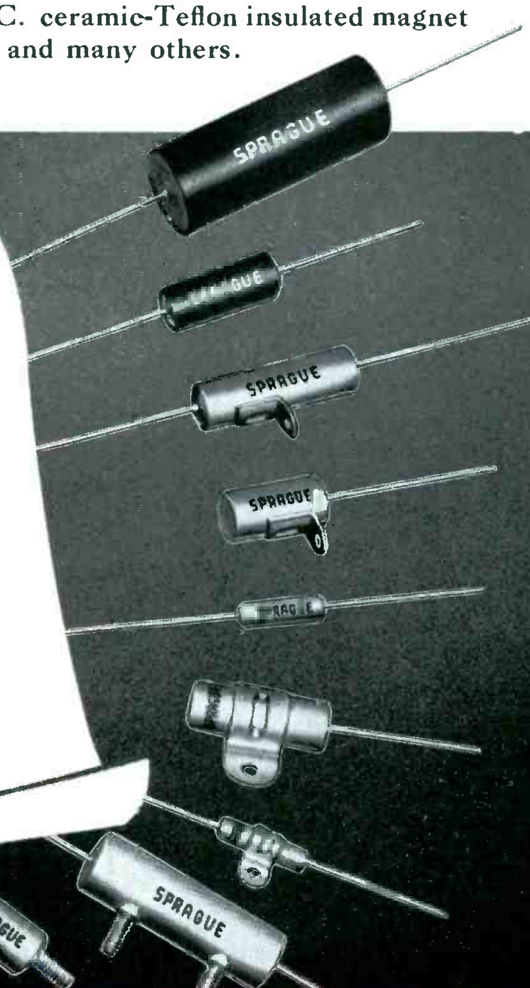

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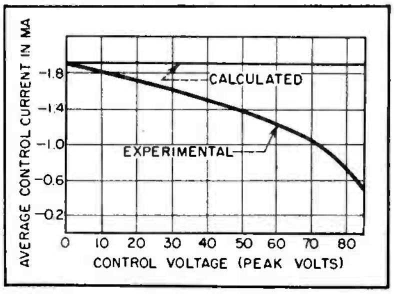

FIG. 3—Curves show theoretical and experimental input characteristics. Theoretical curve is for matched cores with vertical magnetization loops and ideal rectifiers

Parallel-Connected Magnetic Amplifier

THE RECENT DEVELOPMENT of a parallel-connected magnetic amplifier at the Naval Research Laboratory has resulted in a considerable improvement in magnetic-amplifier performance. The circuit is shown in Fig. 1.

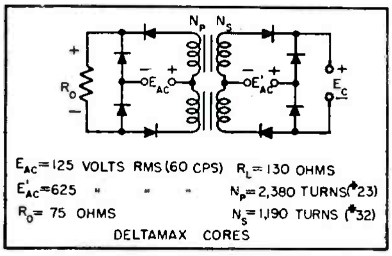

FIG. 1—Circuit diagram of parallel-connected magnetic amplifier

Among the advantages offered by the new arrangement are short response time, high gain, good linearity, wide output range, virtual independence of supply voltage, and good output power to weight ratio. Time-of-response measurements for the experimental amplifier show the output current reaches the steady-state condition one-half cycle after application or removal of control voltage.

The independency of output current with respect to line voltage, indicated by theoretical considerations, was also checked experimentally, as shown in Fig. 2. With the control voltage set at a constant value to give one-fourth maximum output current, the line voltage was reduced to 50 percent of nominal value with a resultant change in output average current of less than 10 percent.

If power absorbed in the control source is considered as the input power and that absorbed by the load impedance the output power, the gain of the amplifier may be examined. On this basis, it has been experimentally determined that gains of more than a thousand can be obtained at 60 cycles per second (with 100 percent response within a cycle) using materials now abundantly available commercially and without compensating for control current. With care in selection of core materials and rectifiers, gains of the order of 10,000 at 60 cycles per second are possible with appropriate circuitry. The response time will remain less than one cycle. This performance is compared with today's commercially available magnetic amplifiers which, with similar response characteristics, exhibit power gains in the range of 20 to 50. Operation at higher frequencies should give increasingly better performance.

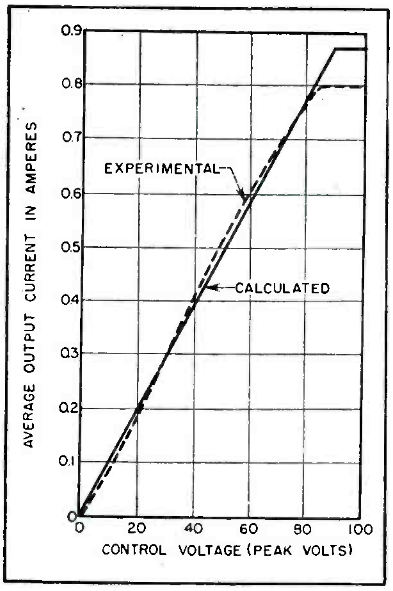

FIG. 2—A linear transfer characteristic is one feature of an NRL-designed experimental parallel magnetic amplifier which is also characterized by high gain and short response time

Voltage Sensitivity

This approach to the magnetic amplifier problem was based on the fact that the magnetic amplifier is a voltage-sensitive device and not, as generally believed, a current-sensitive device. Control voltage is the only truly independent variable. The theoretical and experimental input characteristics are illustrated in Fig. 3.

High gain with short response time was also secured in a series magnetic amplifier based on this consideration, but the transformers required would be quite large for any given output and the output characteristic far from linear.

Electronic Drinkometer

IN CERTAIN CIRCLES the rate of intake of certain liquids to the body is a topic of prime importance. One research group has applied electronics to the job of making an accurate record of the number of laps an animal's tongue makes in a given interval of time.

At The Johns Hopkins University an "electronic drinkometer" has been devised for this purpose. The principle is as follows: whenever the animal touches the fluid with

(Continued on p 224)

VOLTAGE REGULATED POWER SUPPLIES

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MODEL 815

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REGULATION BIAS SUPPLIES: 10 millivolts for line 105-125 volts.
½% for load at 150 volts.

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VOLTS	CURRENT	MODEL
100-325 0-150 Bias 6.3 AC.CT.*	0-150 Ma. 0-5 Ma. 10 Amp.	131
200-500 6.3 AC.CT.	0-200 Ma. 6 Amp.	245
0-300 0-150 Bias 6.3 AC.CT.	0-150 Ma. 0-5 Ma. 5 Amp.	315
0-500 6.3 AC.CT.	0-300 Ma. 10 Amp.	500R
#1 200-500 #2 200-500 #3 6.3 AC.CT. #4 6.3 AC.CT.	0-200 Ma. 0-200 Ma. 6 Amp. 6 Amp.	510
0-500 0-150 Bias 6.3 AC.CT.	0-200 Ma. 0-5 Ma. 10 Amp.	515
#1 0-500 #2 0-500 #3 6.3 AC.CT. #4 6.3 AC.CT.	0-200 Ma. 0-200 Ma. 10 Amp. 10 Amp.	600

VOLTS	CURRENT	MODEL
0-500 0-150 Bias 6.3 AC.CT.	0-300 Ma. 0-5 Ma. 10 Amp.	615
#1 0-600 #2 0-600 #3 6.3 AC.CT. #4 6.3 AC.CT.	0-200 Ma. 0-200 Ma. 10 Amp. 10 Amp.	800
0-600 0-150 Bias 6.3 AC.CT.	0-200 Ma. 0-5 Ma. 10 Amp.	815
0-1000-Ripple 10 mv. 6.3 AC.CT.	0-20 Ma. 10 Amp.	1020
0-1200-Ripple 10 mv. 6.3 AC.CT.	0-20 Ma. 10 Amp.	1220
200-1000-Ripple 20 mv.	0-500 Ma.	1250
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Specify your voltage and current requirements. Regulation available .5%, .1%, .01%.		SPECIAL SERIES

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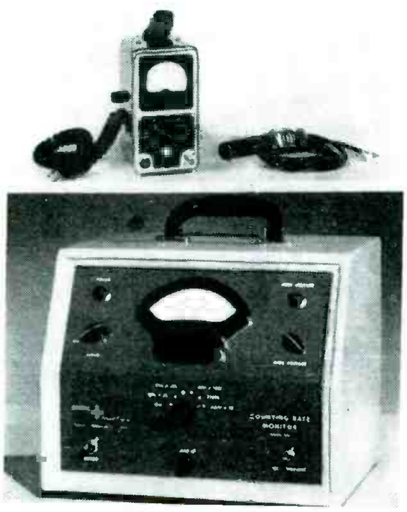
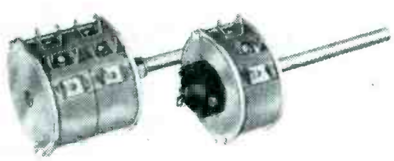


Count-Rate Meters

ATOMIC INSTRUMENT CO., 84 Massachusetts Ave., Cambridge 39, Mass., has available two new count-rate meters. Model 410 has an accuracy of 2 percent. In addition to the standard Geiger probe input the instrument is suitable for use with an alpha scintillation probe. Incorporation of a true Schmitt discriminator permits sine-wave, square-wave and pulse counting without affecting calibration. Model 409 meter is accurate to 5 percent and is ideally suited for applications that are considerably less exacting, such as general safety work, monitoring or search purposes.

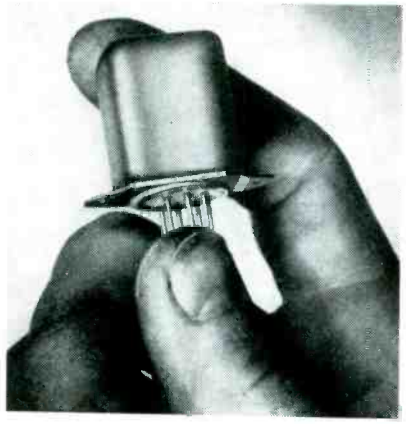


Precision Potentiometer

DEJUR-AMSCO CORP., 4501 Northern Blvd., Long Island City 1, N. Y. The new L-400 series was designed and engineered to meet the demand for small compact precision potentiometers for military airborne instrumentation and similar applications. Some of its features are: 3 watts fully enclosed, 5 to 125,000 ohms resistance range, 5-percent accuracy, 0.5 linearity 300-degree mechanical rotation and 290-degree electrical rotation. It can be ganged up to 10 units with varying resistance ranges and is available with an on-off switch that can be made to operate at any desired point of rotation.

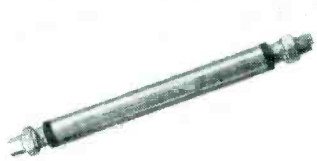
High-Vacuum Rectifier

GENERAL ELECTRIC CO., Schenectady, New York. Type GL-5973 high-vacuum rectifier tube for high-voltage, high-current service uses a thoriated-tungsten filament. It has a voltage drop of about 950 volts at 5 amperes peak current. Designed for use in radar both as a charging diode to supply d-c power to magnetrons and as a limiter to restrict surge currents, the tube may be used for such service at the high current rating of 10 amperes peak at 75,000 volts peak inverse. The tube is also expected to have application in high-voltage power supplies in cable-testing service for locating faults and in smoke precipitators for removing cinders from industrial chimneys. For such service the tube is rated at 1.25 amperes average at 40,000 volts or 1 ampere at higher voltages.



Antivibration Relays

NEOMATIC, INC., 11632 San Vicente Blvd., Los Angeles 49, Calif. The series 5000 line of subminiature, antivibration relays is now available in hermetically-sealed containers. Developed to meet the exacting space and performance requirements of military aircraft, rockets, guided missiles, radar, radio and telemetering devices, the sealed relays weigh less than 0.93 oz and occupy less than 0.860 cu in. of space. They are built to withstand 20 g vibration and more than 50 g acceleration in any direction without affecting contact position. Illustrated is model 5610, an spdt type with coils available in ratings from 3 to 72 volts d-c, and resistances ranging from 8 to 5,000 ohms.

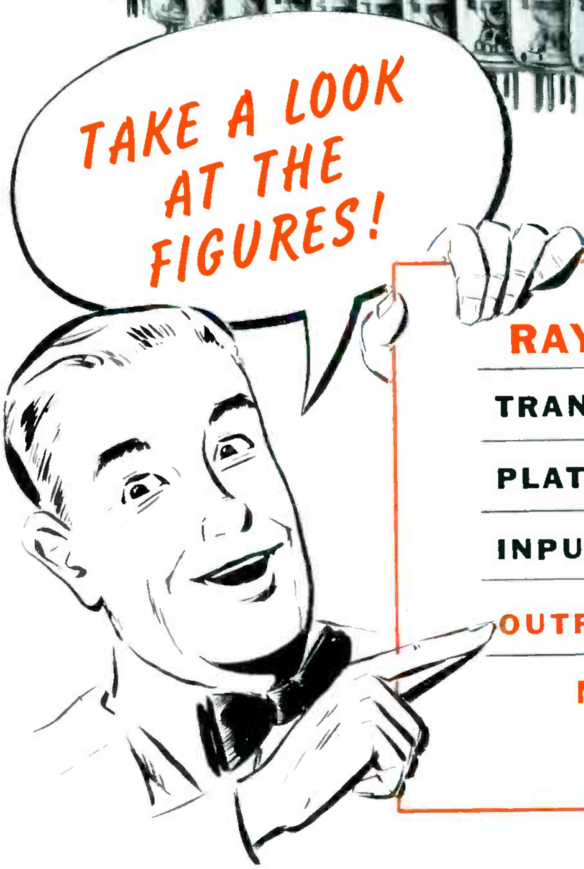


Power Line Filter

TOBE DEUTSCHMANN CORP., Norwood, Mass., has designed the type

Millions of RAYTHEON 6AH6 MINIATURE Television Amplifier Pentodes

ARE NOW ON THE JOB IN VIDEO AMPLIFIER SERVICE



RAYTHEON TYPE 6AH6 PENTODE

TRANSCONDUCTANCE	9000 umhos
PLATE DISSIPATION	3.2 watts
INPUT CAPACITY	10 uufds
OUTPUT CAPACITY	2 uufds

MAXIMUM CATHODE CURRENT
NOW 20 ma!

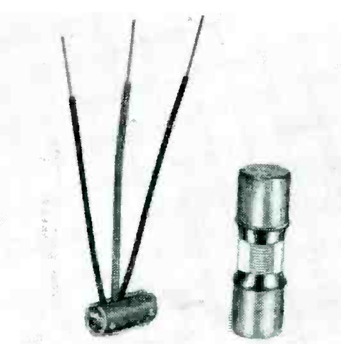
High transconductance and low capacities alone cannot make a good video amplifier tube for mass produced applications. Developed by Raytheon, the 6AH6 combines the above features with *freedom from microphonics, freedom from noise, freedom from short circuits, and freedom from negative grid currents.*

Use of the Raytheon 6AH6 throughout the industry is conclusive evidence that this combination of qualities has been successfully achieved.

RAYTHEON ®
Excellence in Electronics

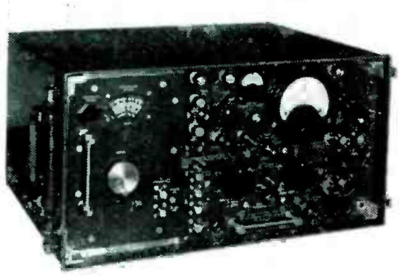
RAYTHEON MANUFACTURING COMPANY
Receiving Tube Division
Newton, Mass., Chicago, Ill., Atlanta, Ga., Los Angeles, Calif.
RADIO AND TELEVISION RECEIVING TUBES, PICTURE TUBES, SPECIAL PURPOSE TUBES, SUBMINIATURE TUBES, MICROWAVE TUBES

1457-1 power line filter that is capable of passing 100 amperes and having high attenuation in the vhf, uhf and radar frequencies. It extends only 10 3/16 in. overall length with a diameter of ⅞ in. The filter can be inserted in a 110, 200 or 440-volt a-c or d-c line for applications such as screen rooms, radar equipment, radio transmitters, diathermy equipment, x-ray machines, high-frequency television transmitters and similar high-frequency equipment.



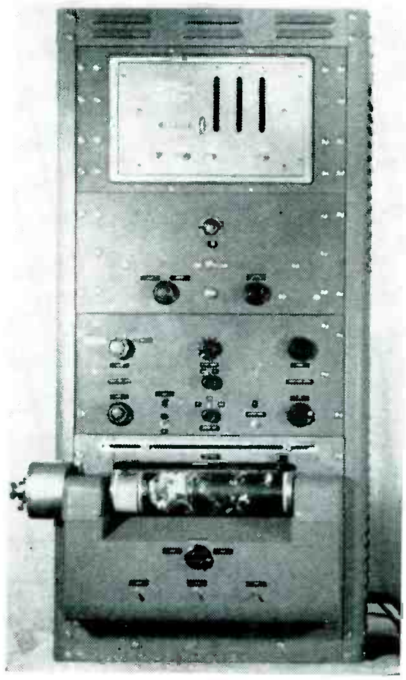
Tiny Selenium Rectifiers

ELECTRONIC DEVICES, INC., 429 12th St., Brooklyn 15, N. Y., has developed the Minisel line of subminiature selenium rectifiers with ratings up to 20 ma d-c output and 25,000 volt a-c input per single stack and featuring a variety of constructions for military and commercial applications. These rectifiers are constructed of matched ¼-in. diameter round selenium rectifier cells encased in Bakelite, glass or metal housings.



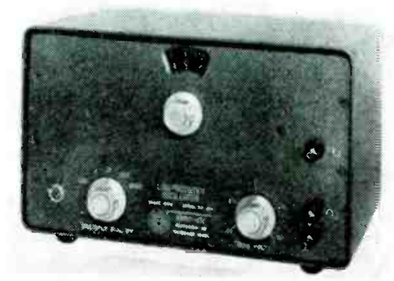
Noise & Field Intensity Meter

EMPIRE DEVICES, INC., 38-25 Bell Blvd., Bayside, New York. Model NF-105 noise and field intensity meter covers the frequency range from 20 to 400 mc. The range is covered by means of two readily replaceable plug-in heads housing the r-f and i-f circuits. The unit operates on 115 v, 50 to 400 cycles, or, by using an inverter, on 12 or 24-v batteries. Bandwidth of the instrument is 70 kc from 20 to 200 mc and 200 kc from 200 to 400 mc. The vswr is below 1.2 to 1. The meter is ideally suited for unmodulated and modulated carrier measurements as well as noise measurements; it uses 31 tubes, is constructed for field use in accordance with military specifications and is fully waterproofed.



Optical Density Analyzer

HOGAN LABORATORIES, INC., 155 Perry St., New York 14, N. Y. The type ODA-1 optical density analyzer illustrated was designed for the analysis of radioisotopic photographs in cancer diagnosis, but has many applications in other fields. Under the control of an operator it automatically and rapidly performs a quantitative geometric analysis of a photographic subject in terms of its reflected optical density. An electronic counter at the top of the cabinet counts the signals applied to it from the electronic analyzer unit. Its results are displayed as a number which is proportional to the area of original copy containing each of the ranges or selected portions of optical densities in question. The unit will provide numerical and graphical information as to the extent and position of information of varying optical densities in a subject photograph. The recording paper used is permanent, and provides high resolution and contrast.



Low-Frequency Oscillator

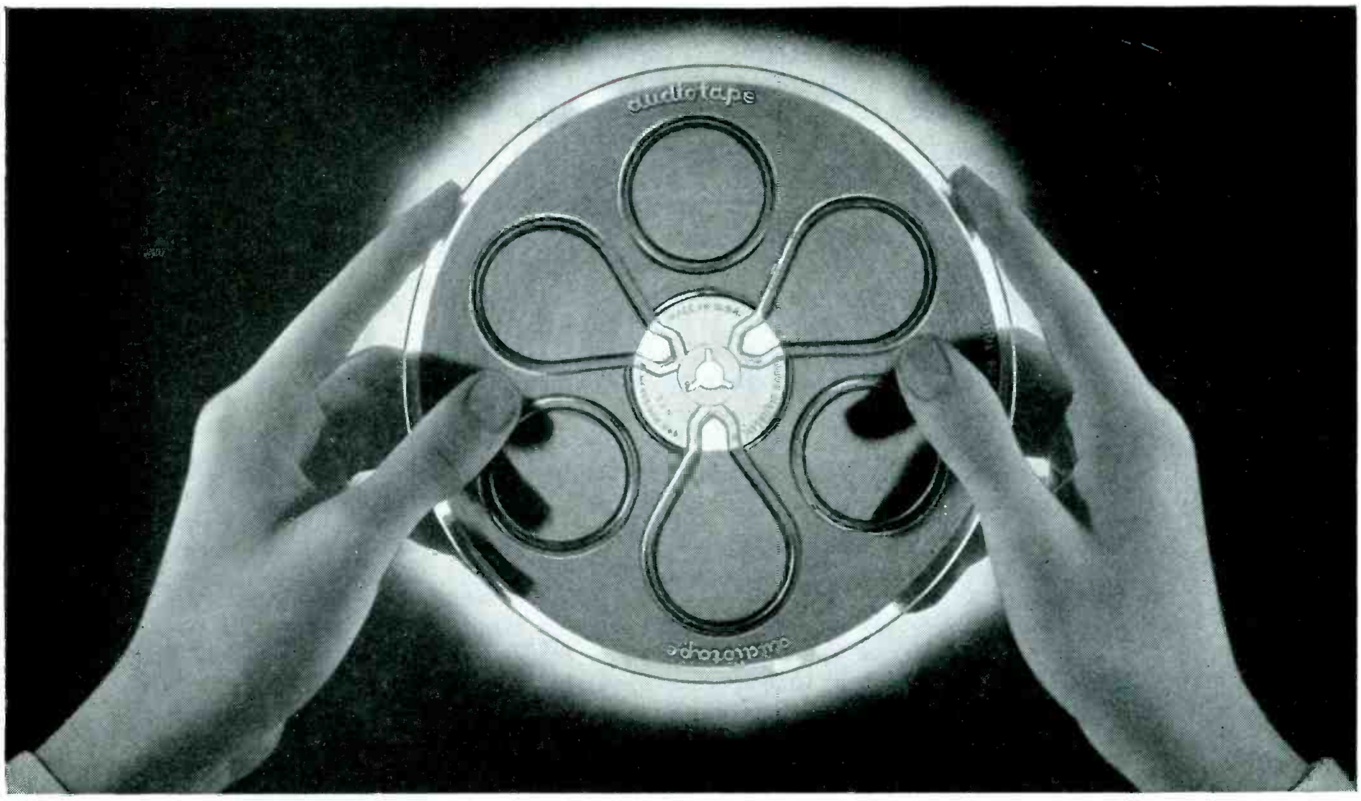
KROHN-HITE INSTRUMENT CO., 580 Massachusetts Ave., Cambridge, Mass., announces the model 420-A low-frequency oscillator. The unit simultaneously provides both sine and square wave voltages at any frequency between 0.35 and 52,000 cps. Special circuitry is employed to eliminate tuning and bandswitching transients. The 420-A is especially useful for servomechanisms, geophysical and seismological work and for vibration checks and medical research. It measures 12 × 7 × 8 in. and is priced at $290.

Potentiometer

G. M. GIANNINI & CO., INC., Pasadena 1, Calif. Type 85129 Syncromount potentiometer has long life

(continued on page 278)

You don't have to look, because THERE ARE NO SPLICES in audiotape*



... but this "transparency test" shows some other important things about Audiotape quality

When you hold a reel of plastic base Audiotape up to the light, notice its extremely uniform translucency—free from dark rings or fuzzy areas. You can see your fingers right through it, sharply outlined against the light. This is proof of the clean, straight line slitting that makes Audiotape track and wind absolutely flat. There are no rough or turned-over edges which would lift the tape away from the heads, causing loss of high-frequency response. Of course this test also proves that the tape is entirely free from splices. But with Audiotape you can be sure of that without looking. For all 1250 foot and 2500 foot reels of plastic base Audiotape are *guaranteed splice-free!*

You can *see* the output uniformity of Audiotape, too. For every 5-reel package includes an Esterline-Angus output chart, showing the measured output of the entire length of one of the reels in the package. And since all 5 reels are slit from the same roll after coating, the chart actually measures the uniformity of all the tape in the package. This gives positive visual proof of Audiotape's unequalled output uniformity.

NO OTHER TAPE OFFERS YOU ALL OF THESE EXTRA-VALUE FEATURES:

- **Splice-Free Reels.** All 1250 and 2500 foot reels of plastic base Audiotape are *guaranteed* to be free from splices.
- **Unequalled Uniformity.** Plastic base Audiotape is guaranteed not to exceed ±¼db within the reel and ±½db from reel to reel.
- **Output Curves** in every 5-reel package of plastic base Audiotape show actual measured output of the tape contained in the package.
- **Maximum Output with Minimum Distortion.** Oxide formulated to give high output at bias which results in low harmonic distortion.
- **Safe-Handling Package** for 2500 and 5000 foot reels permits loading onto turntable without danger of spilling tape from hub, simplifies attachment of reel flanges, and provides safe storage without flattening bottom of roll.

Trade Mark

AUDIO DEVICES, Inc.
444 Madison Avenue, New York 22, N. Y.
Export Dept.: 13 East 40th St., New York 16, N. Y., Cables "ARLAB"

NEWS OF THE INDUSTRY

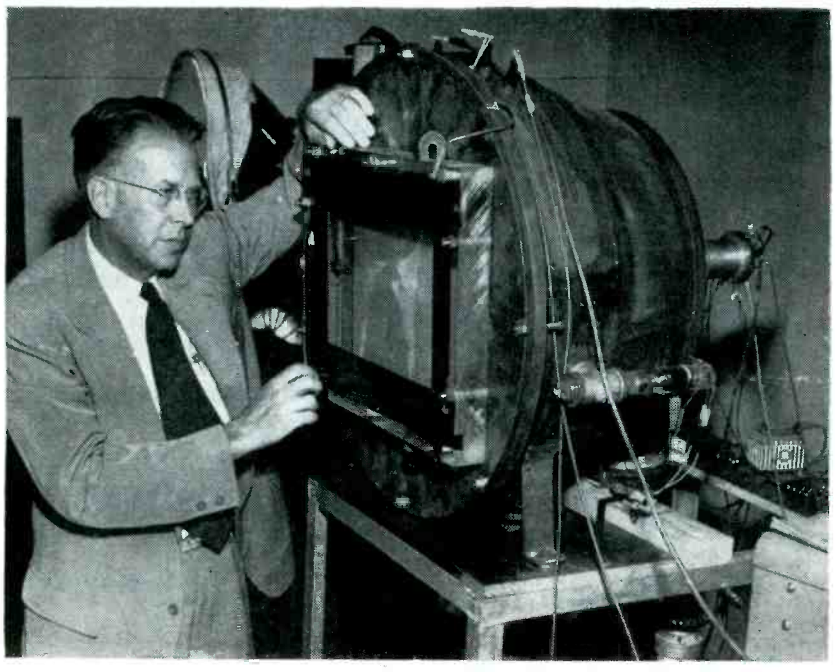
Edited by William P. O'BRIEN

New Lawrence Tricolor Tube Shown

A NEW version of the tricolor picture tube developed by Prof. E. O. Lawrence of the University of California was demonstrated to the press at the laboratories of Paramount Television Productions in New York on September 21. The cellular structure of the older Lawrence tube has been abandoned in favor of a linear arrangement of phosphor strips and wires. The viewing screen consists of 1,200 vertical strips of phosphor which fluoresce individually in the three primary colors. Reading across the screen, the color of the strips is RGBBGRRGB and so on, where the letters stand for red, green and blue. In the experimental model shown (see accompanying photo) the active width of the viewing screen is about 11 inches. In the demonstration, scanning was at 525 lines, 180 fields by the field-sequential method.

A single electron gun is used, operated at a second-anode potential of 3,000 volts. The beam is deflected horizontally, across the strips, in the usual manner over a maximum scanning angle of about 70 degrees. The beam passes through a grid of 400 vertical wires, placed parallel to, and 0.4 inch from, the phosphor screen. A post-deflection voltage of 9,000 volts is applied between the wire grid and the phosphor, so the electrons hit the phosphor strips after having been accelerated through a total voltage drop of 12,000 volts, but the line-scanning circuits need only deflect the beam at the 3,000-volt level. Consequently the scanning power requirement is moderate.

The wires in the grid are accurately aligned with the phosphor strips, so that three strips lie in front of the space between two adjacent wires. The spacing between the wires is 0.04 inch, and the space occupied by three strips is 0.0408 inch. Consequently the strips at the outer edges of the viewing screen are displaced outward from the associated wires, to accommodate the scanning angle. Precise register between strips and wires in these outer regions is accomplished by manual adjustment of the post-deflection voltage.



Professor E. O. Lawrence and the experimental model of his strip-and-wire type of tricolor picture tube, demonstrated last month to the press

The geometry of wires and wire-phosphor spacing is such that the post-deflection voltage causes a focusing action as the electrons pass from the wires to the phosphor screen, somewhat after the manner of electron focusing in a beam-tetrode tube. As a result, the beam is focused to a width of a few mils, less than the width of the individual phosphor strips. Consequently the lateral displacement of wires with respect to the strips need not be controlled more precisely than about half the width of a strip or about 5 mils.

Selection between color strips is accomplished by deflecting the beam as it passes between wires. If no color-deflection voltage is applied, the beam passes undeflected to the green strip at the center of each group. When the color-deflection voltage is applied in one polarity the beam moves to the left or right, depending on the polarity of the adjacent wires, hitting the red strips, while the reverse polarity of color deflection causes the blue strips to be excited.

The color deflection is arranged by connecting alternate wires on the grid to common terminals, the two sets of alternate wires serving as the two elements of the deflection system. A color deflection voltage of 400 volts, peak, is required to swing the beam from the green strip to the red strip or to the blue strip. The capacitance between the sets of grid wires is 1,000 μμf.

As applied to the CBS field-sequential system, the color deflection voltage is applied at the end of each field, fundamental period of the deflecting wave being 3/144 = 1/48th second. Allowing ten harmonics to secure a rapid shift from one color to the other, the maximum color deflection frequency is thus under 500 cps. At the fundamental frequency of 48 cps, the color-deflection voltage across 1,000 μμf produces a reactive current of less than a milliampere, at a wattless power of less than one voltampere. When the tube is applied to a compatible color system in accordance with the tentative NTSC standards, the color switching rate is that of

the color carrier or 3.89 mc. At this frequency the corresponding wattless power for deflection is several thousand voltamperes. It thus appears that the new tube would be difficult to use in a compatible system of this type, in which the color switching rate is well above 3 mc.

Those observing the demonstration noted that the vertical line structure was prominent, even at viewing distances well beyond five times the picture height. This may be due in part to the fact that two red strips and two blue strips are adjacent, as is required by the color deflection method, and in part to the fact that all the picture elements in one color are accurately aligned so the eye can discern the lines more readily than if the elements were more heterogeneously arranged, as in the RCA tricolor tube. The color values were not equal to those demonstrated by CBS and RCA, since the experimental nature of the tube had prevented baking out the binder in the phosphors. The Paramount officials announced plans to continue the development in a recently acquired plant in Stamford, Conn. Details of this and modified versions of the tube have been promised and will be published in an early issue.—D.G.F.

MEETINGS

OCT. 29-31: Radio Fall Meeting, sponsored by IRE and RTMA, King Edward Hotel, Toronto, Ontario, Canada.

NOV. 1-3: Third Annual Convention and Audio Fair Exhibition of the Audio Engineering Society, Hotel New Yorker, New York City.

NOV. 12-15: NEMA Convention, Haddon Hall, Atlantic City.

NOV. 16-17: Third Annual Technical Conference of the Kansas City Section of IRE, Hotel President, Kansas City, Mo.

NOV. 29-DEC. 1: First Conference of the Joint Electron Tube Engineering Council and its committees, Seaview Country Club, Absecon, N. J.

DEC. 10-12: Joint AIEE-IRE Computer Conference, Benjamin Franklin Hotel, Philadelphia, Pa.

JAN. 7-8: AIEE Conference on Electronic Instrumentation in Nucleonics and Medicine, Hotel Statler, New York, N. Y.

JAN. 21-25: AIEE Winter General Meeting, Hotel Statler, New York, N. Y.

MARCH 3-6: 1952 IRE National Convention, Waldorf-Astoria Hotel and Grand Central Palace, New York, N. Y.

JUNE 23-27: AIEE Summer General Meeting, Hotel Nicollet, Minneapolis, Minn.

Army Television as Training Aid

INTRICATE field exercises can now be televised by the Signal Corps and pictures transmitted to expert observers, to maneuver umpires or to classrooms. Designed by the Signal Corps Engineering Laboratories, Ft. Monmouth, N. J., in cooperation with RCA engineers, a television caravan was recently delivered to Ft. Monmouth, where personnel to operate it are being trained.

Built by RCA, the caravan consists of four special ten-ton six-wheel coaches, each 31 feet long. The first coach in the television fleet contains three complete tv field camera chains, a microwave transmitter for transmitting the video signals, and a 45-watt f-m transmitter for the sound signals.

The cameras are RCA standard field types, equipped with tripod dollies and electronic viewfinders. A multiconductor cable is attached to each camera and to a distribution box inside the coach. Each cable can be used in lengths up to about 1,000 feet.

Camera controls are suitcase-type units which are all shock-mounted to a convenient operating desk built into the rear of the coach. Suitcase-type power supplies of about the same size are shockmounted below the desk. Glass windows surround the operating position so that the operators can see the field of action and thus be aided in directing pickup activities.

Complete transmitting studio for the Signal Corps is equipped with a specially constructed operating desk for the portable monitoring, control and power supply units used with the field tv cameras

Monitoring and switching equipment associated with the cameras is in accordance with standard practice. Video signals from the three cameras are fed to a field-type video switching unit on the operating desk where any of the three cameras can be monitored and switched to the microwave transmitter. The camera controls provide preview monitoring, enabling the operator to decide which camera should be switched to the transmitter.

Facilities are provided for patching the microphones through amplifiers into either recorder or directly to the f-m audio transmitter, or for mixing microphone and recorder signals. A two-way radio system provides order wire facilities between all four vehicles on 163 mc. A second such system on 173 mc

These leading TV set makers use Sylvania Picture Tubes

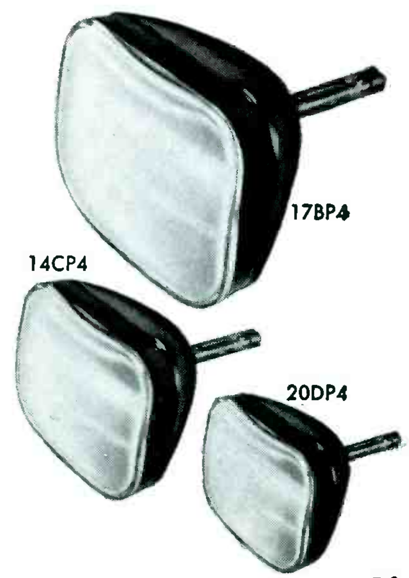
We're PROUD of this picture!

Today's sales picture shows that 75% of the leading television set manufacturers use Sylvania picture tubes.

This popularity is no accident. It's based on a sure foundation of outstanding performance. For, Sylvania picture tubes have won their prized position through years of research and quality production techniques developed during more than a quarter of a century of leadership in radio, electronics, and lighting.

Remember, too, when you choose Sylvania picture tubes, you choose products of nationally recognized excellence . . . products that carry prestige and sales appeal when listed among your sets' specifications.

Send today for new folder giving complete descriptions and ratings of all Sylvania TV Picture Tubes. Simply write a postal card to Sylvania Electric Products Inc., Dept. R-1111. Emporium, Penna. *Sylvania Representatives are also located in all foreign countries. Names on request.*



SYLVANIA ELECTRIC PRODUCTS INC. 1901-1951 50th ANNIVERSARY FIVE DECADES OF PROGRESS

SYLVANIA ELECTRIC

RADIO TUBES; TELEVISION PICTURE TUBES; ELECTRONIC PRODUCTS; ELECTRONIC TEST EQUIPMENT; FLUORESCENT TUBES, FIXTURES, SIGN TUBING, WIRING DEVICES; LIGHT BULBS; PHOTOLAMPS; TELEVISION SETS provides an additional order wire channel between the transmitter and receiver coaches.

The second mobile unit contains two 15-kva gas-driven generating units, each of which supply 120 or 208-volt, 3-phase, 4-wire, 60-cycle power. One generator is for standby use, or for supplying power to special lighting equipment for illuminating the scene to be televised. The truck batteries supply power to the radio communication system when the caravan is in motion and the generators are not in use.

The third coach in the caravan houses the f-m and microwave receiving equipment, ten 16-inch picture monitors, a 16-mm tv projector and film camera, slide projector and a large-screen television projector.

This equipment is interconnected so that picture and sound received by microwave can be switched to the ten monitors, or if desired, film can be used on the 16-mm tv projector and the picture and sound fed to the monitors or to the large screen projector, which can be set up in a nearby building or shelter. The monitors are 16-inch receivers modified to be used as viewers.

The fourth coach contains a 15-kva gas-engine generator of the same type used in the transmitting unit to supply a-c power for the receiving equipment.

The 7,000-mc equipment is identical to that supplied by RCA to broadcast stations for studio-to-transmitter link and relay purposes. The four-foot parabola provides a gain of 5,000 which, multiplied by the 100-mw output of the klystron oscillator mounted at the parabola, provides an equivalent power output of 500 watts. The control unit for the transmitter contains a video amplifier and modulator which frequency-modulates the klystron by varying the voltage on the repeller plate.

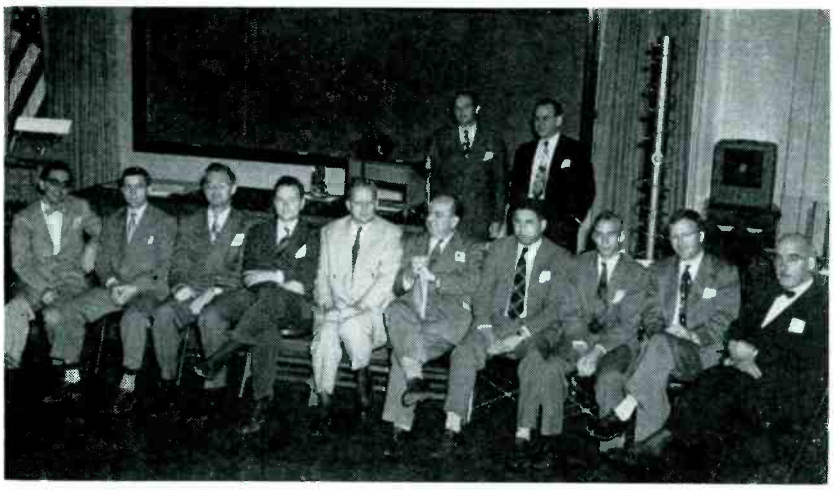
CD Conference Held

NEARLY 300 federal, state, county and city officials actively engaged in civil defense in all parts of the U. S. and Canada attended a CD communications conference at the General Electric Company's Electronics Park plant in Syracuse, N. Y., late last month.

Conference speakers covered the fundamental change in the strategic position of the U. S. caused by the atomic bomb, radioactive dusts, guided missiles and supersonic speeds, spotlighting the need for adequate communications.

Among the principal speakers were Lloyd J. Jolly, assistant administrator, Federal Civil Defense Administration; Col. William Talbot, director of the Warning and Communications Division, FCDA; Hanson W. Baldwin, military editor of the *N. Y. Times;* Harvey S. Smith, civil defense director of Onondaga County, N. Y.; W. R. G. Baker, vice-president of General Electric Co. and L. L. German, GE atomic scientist.

One of the day's highlights was the first public demonstration of a new emergency radio communications system (ELECTRONICS, p 88, July 1951) used by Onondaga County's civil defense authorities. Believed to be the first of its kind, the system provides communications in depth, utilizing existing facilities. Another highlight was the showing of a new 20-minute motion picture filmed by the *March of Time.* Titled "And A Voice Shall Be Heard," the movie stresses the vital role played by radio communications in everyday life, and the part it will play in the event of an enemy attack on the United States.



Speakers at the UHF symposium of the IRE Professional Group on Broadcast Transmission Systems, held on Monday, September 17, at the Franklin Institute in Philadelphia, are left to right (front row): Frederick W. Smith, NBC; L. O. Krause, General Electric; R. A. Soderman and F. D. Lewis, General Radio; W. B. Whalley, Sylvania Electric; George H. Brown, RCA Laboratories Division, RCA; William Sayer, Jr., Elliot Mehrbach and J. M. DeBell, Jr., DuMont; and Raymond Guy, NBC. In the rear appear the two moderators for the session, left to right: Dorman D. Israel and Stuart L. Bailey

UHF Symposium

THE IRE Professional Group on Broadcast Transmission Systems sponsored a day-long symposium on uhf techniques at the Franklin Institute, Philadelphia, Pa., September 17, 1951. Government (including the FCC Engineering Department), educational institutions and the industry were well represented among the more than 160 in attendance. Registration data showed visitors from twenty states and Canada.

Two past presidents of IRE spoke; Stuart Bailey was moderator of the morning session, and Ray Guy made a progress report on the Bridgeport uhf experiment during the afternoon.

The total of eight technical papers was followed by a roundtable discussion period and later a cocktail party. It is expected that the collected papers will be published in a proceedings of the group at a cost of about $2. Requests for copies should be addressed to: Institute of Radio Engineers, 1 E. 79th St., New York 21, N. Y.

Technical Program

"Some Experiments with 850-Mc Television Transmission in the Bridgeport, Connecticut, Area", by

(Continued on page 304)

NEW BOOKS

Electronic Motor and Welder Controls

BY GEORGE M. CHUTE. *McGraw-Hill Book Co., New York, 1951, 348 pages, $6.50.*

FOR every book, like this one, that will tell you exactly *how* an electronic device works, there are a dozen that relate the theory of *why* it ought to work. The truth is that there are a dozen who know the theory for everyone who really knows what every resistor, capacitor or whatnot does in a particular circuit. The author's earlier books have been intensely practical, for he is an application engineer; this one follows the same pattern. It is aimed at those who operate and maintain electronic equipment of the types described.

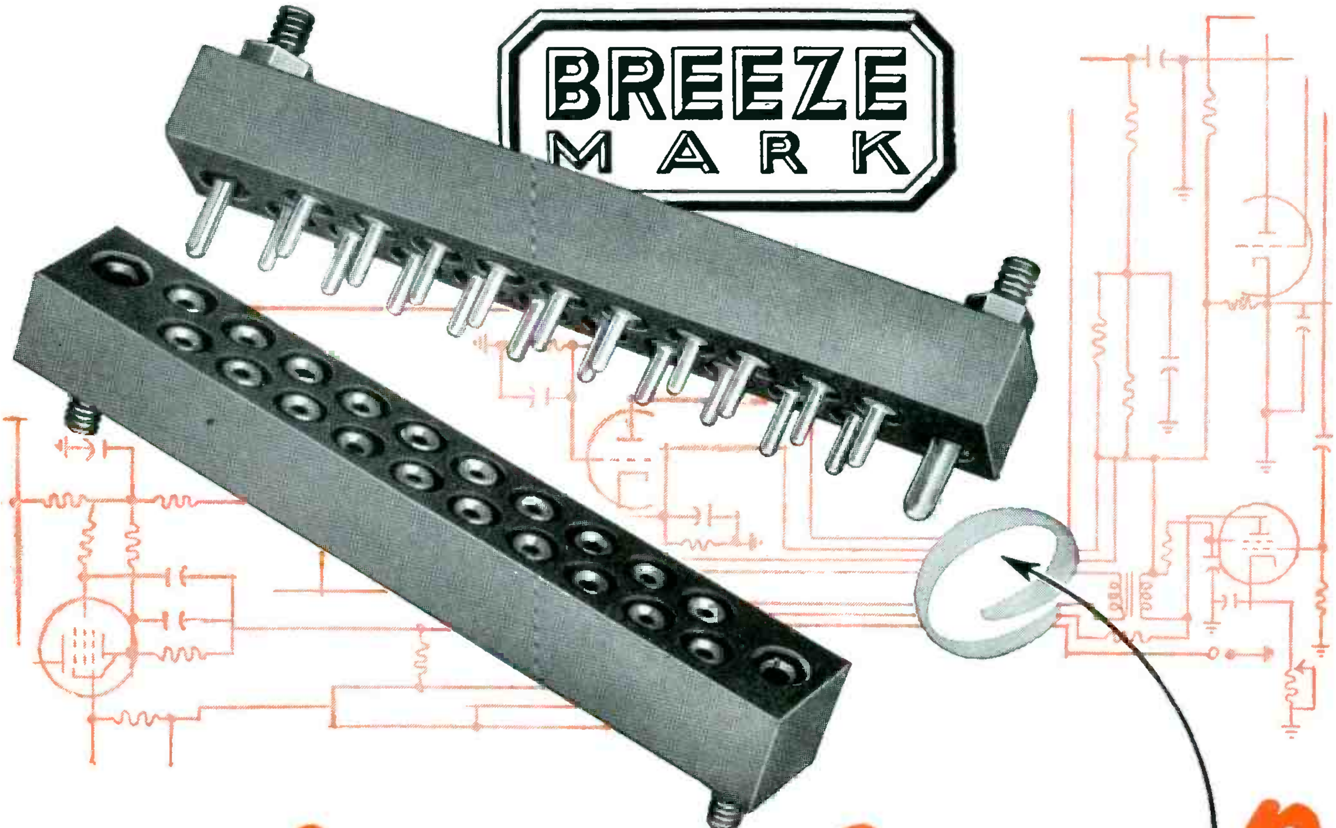
The first half of the book deals with welding controls of the most modern types, starting with the basic circuits and going through sequence weld timers, high-speed circuits in which tubes replace relays in earlier equipment, synchronous timing, slope control, temper welding, forge timing, seam welding, multiphase circuits and limited-power-supply systems.

The second half covers all types of motor controls, with a great deal of material on register control systems. The amplidyne, antihunt circuits, phototube curve tracers, applications to multicolor printing and paper-machine controls are covered.

The text is really a description of certain commercial apparatus and its complex circuits. While most of the equipment described is GE, Westinghouse, Weltronic, Taylor-Winfield and perhaps other manufacturers are represented.

The diagrams employ the power engineers' symbols and the text is in the lingo of the power man, so that somewhat more concentrated study is required of an electronics engineer if he wishes to understand thoroughly what is happening. The curious inversion of common practice in indicating the various components so that the several capacitors in the first welding timer described become 1*C*, 2*C*, 3*C* rather than *C*1, *C*2 and *C*3 is a bit disconcerting, as is the practice of indi-

(Continued on page 314)



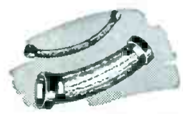
Connector Problem?

...We'll take it from HERE

Good ideas for electronic circuitry sometimes run afoul of connector problems. Maybe existing connector units won't hold air pressure gradients, won't stand the heat, aren't rugged enough for the job. Or maybe it's a question of altitude, or under-water application. But if you can sketch the circuit, we'll take it from there. We've engineered so many special connectors, solved so many "impossible" problems, that whatever the requirements are, we can usually provide the answer.


Lightweight actuators for any requirement.


Job engineered, welded-diaphragm bellows.


Flexible conduit and ignition assemblies.

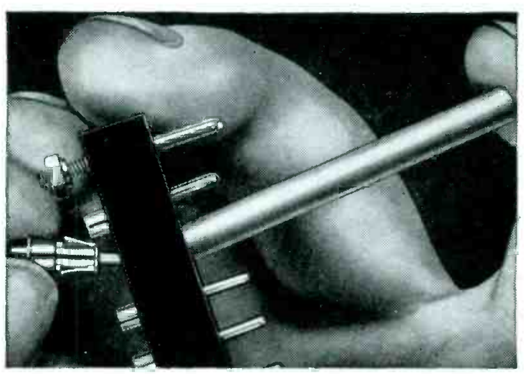

Aero-Seal vibration-proof hose clamps.

WRITE TODAY for specific information, or send us your sketches. We'll forward recommendations promptly.

BREEZE
Special CONNECTORS

BREEZE CORPORATIONS, INC.

41 South Sixth Street Newark, New Jersey


Removable pins in Breeze connectors speed soldering, save time, trouble. Pins snap back into block.

Backtalk

This department is operated as an open forum where our readers may discuss problems of the electronics industry or comment upon articles which ELECTRONICS has published.

High Frequency Measurements

DEAR SIRS:

THE FOLLOWING has reference to a review of my book, "High Frequency Measurements", second edition, in the September 1951 issue of ELECTRONICS, beginning on page 152.

To keep this reply short and to the point, quotations are given of the preface of the second edition, in order to bring out *pertinent* claims of the text and its purpose.

The *claims* are repeated literally and marked by capital letters so that they can be readily referred to, where Mr. M. T. Lebenbaum and his partner Mr. F. H. Rockett agree and differ.

The IRE list shows that Mr. Lebenbaum is associated with the Institute since 1942 and his partner since 1943. This means that the reviewers are probably engaged with electronics since about 1942. They have therefore the courage and boldness of opinion, as far as their highly specialized practical experience goes. The author has specialized in the radio profession, mostly experimenting on the laboratory bench, ever since graduation and written radio books on and off, in spare hours, when requested to do so. The author was always fortunate that publishers in the USA and abroad were *conservative* organizations who screen a manuscript by parties who have mature judgment and vision as to intrinsic values of a book and *economic* factors which play a part *in these days*, where no one knows the answers of tomorrow. The author can assure any reader that wise judgment was exercised before giving the go-ahead signal to

(Continued on page 326)

TUBES AT WORK

(continued from page 138)

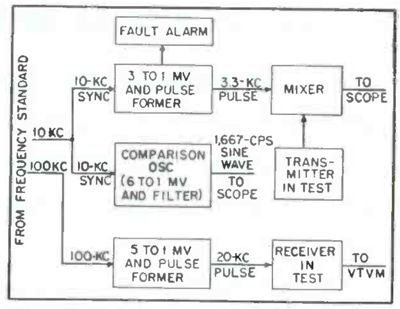


FIG. 1—Block diagram of synchronized-pulse system of frequency measurement

narrow-band (20-kc channels) transmitter is twelve so that the measurements can be made in the 2.4-to-4 mc range. The channel separation will also be divided by a factor of twelve which makes the separation equal to 3,333⅓ cycles at the oscillator frequency. The repetition rate of the reference multivibrator will be this frequency and the harmonics need only be usable through 4 mc.

Since 10 kc is a standard output of most primary or secondary frequency standards, it becomes a simple matter to generate the 3.3-kc pulse rate by a 3-to-1 multivibrator triggered by the frequency standard. The actual circuit consists of a sync buffer, the 3-to-1 multivibrator and a series of three tubes which shape the multivibrator wave into a narrow pulse of about 0.2 μsec width. The pulses are then carried over coaxial line to the various test positions.

A factor to be considered at this point is the width of the pulse. Examination of the equation of a rectangular wave shows that the harmonics are distributed along the frequency axis as shown in Fig. 2, where the length of the vertical lines represents the relative amplitude of the harmonics. As seen from this sketch they pass through null points at frequencies of $1/P$, $2/P$, $3/P$, etc., where P is the pulse width in seconds. Since the

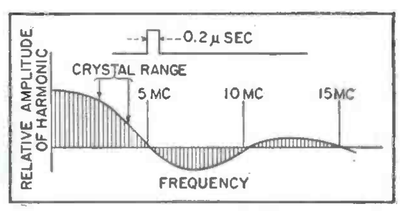
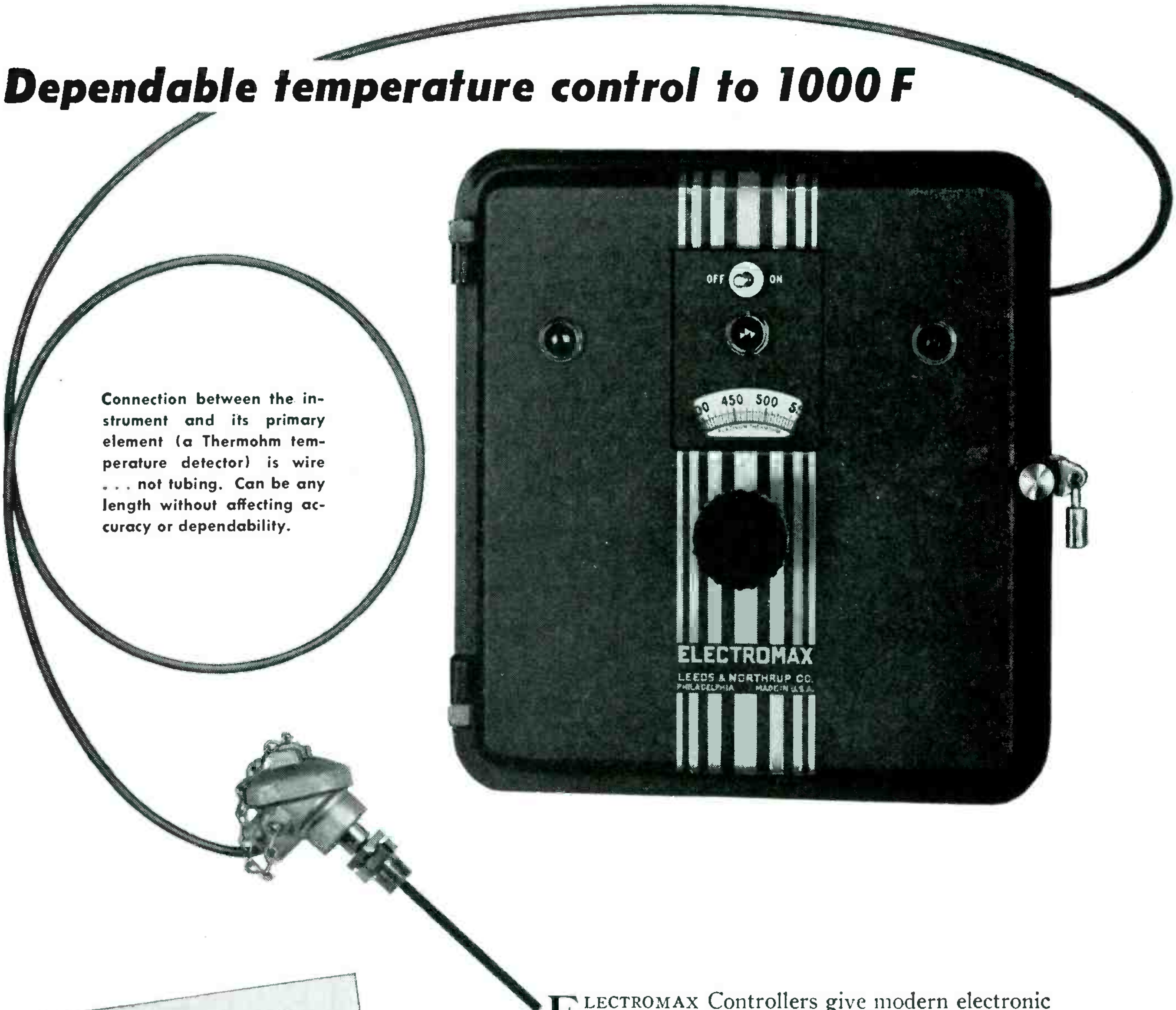
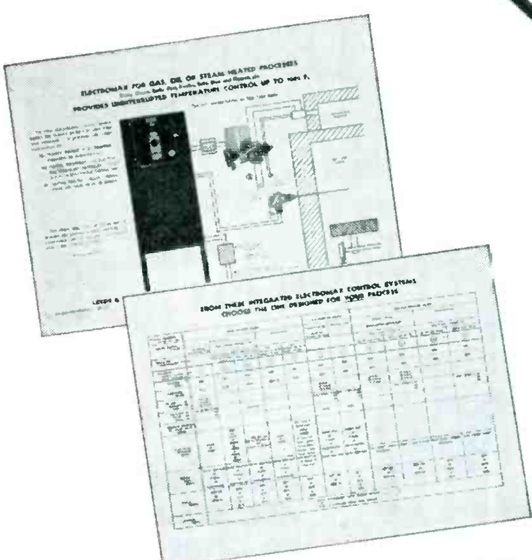


FIG. 2—Harmonic distribution of 0.2-microsecond pulse

Dependable temperature control to 1000 F



Connection between the instrument and its primary element (a Thermohm temperature detector) is wire . . . not tubing. Can be any length without affecting accuracy or dependability.



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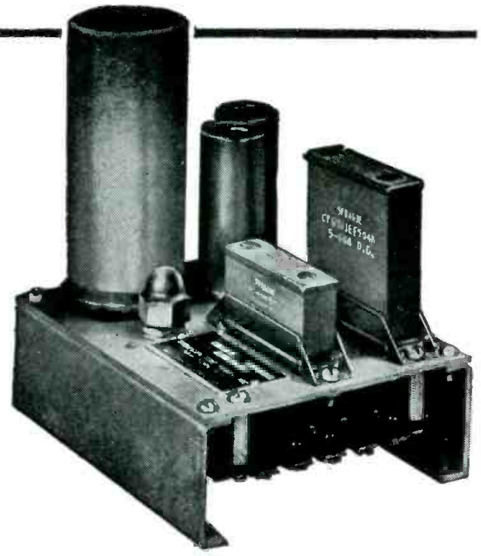

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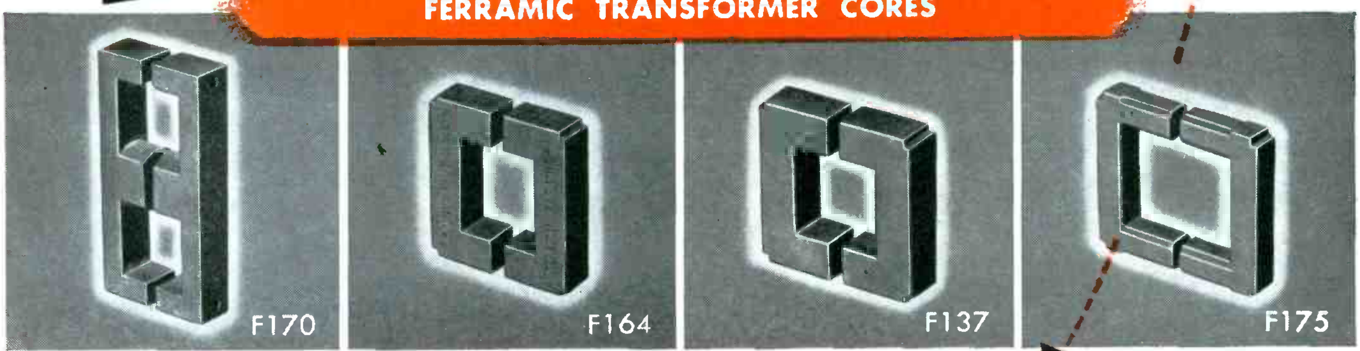

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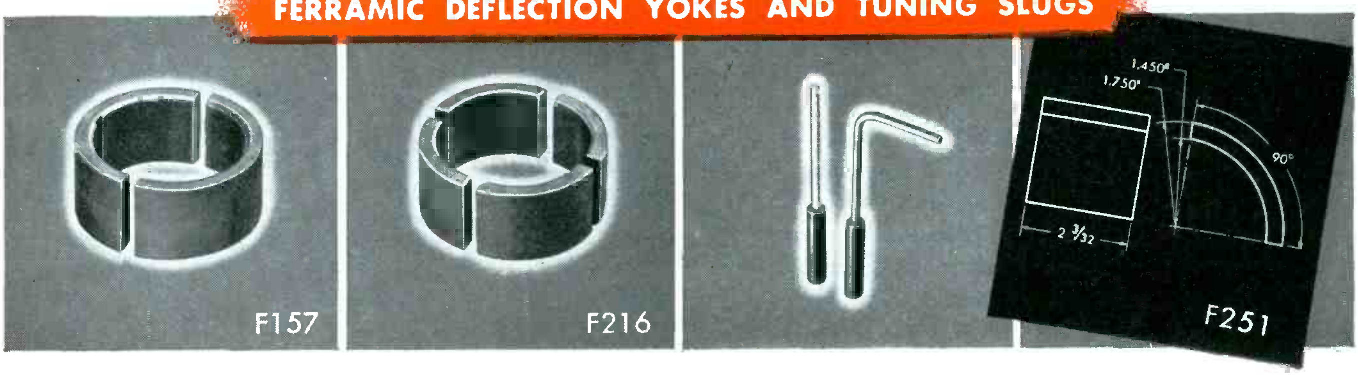

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maximum range of frequencies measured by this equipment is about four mc, a pulse width of 0.2 μsec. was chosen to place the first null at five mc. The amplitude of the harmonics then will not vary greatly over the 2.5-to-4 mc range.

The mixer unit which is included in each test setup, Fig. 3, is used to beat together the transmitter crystal frequency and the proper harmonics of the 3.3-kc pulse. It consists of four basic sections; a tunable r-f amplifier, a pulse-harmonic amplifier, a highly selective a-f amplifier and the mixer stage itself. The r-f amplifier tunes from 1.2 to 4.2 mc which covers the range of both narrow-band and wide-band crystal oscillators. It's primary purpose is to filter the signal from the oscillator so that only the fundamental reaches the mixer tube. The tuned amplifier is isolated from the mixer by a 6AQ5

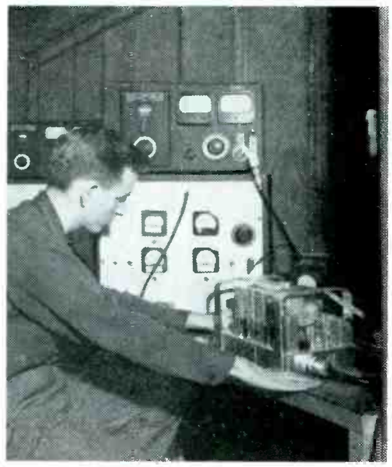
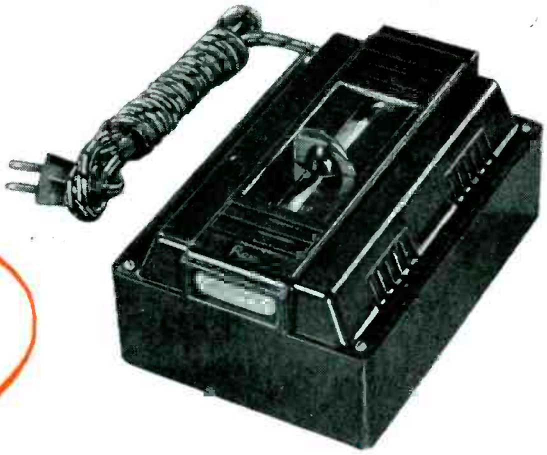


FIG. 3—Transmitter test setup

cathode-follower stage to prevent the oscillator injector grid of the 6BE6 mixer from loading the tuned amplifier. The harmonics of the 3.3-kc pulse are amplified by a broadly resonant amplifier which is fix-tuned to about four mc for narrow-band sets. As seen in Fig. 2, the harmonics of the pulse fall off in amplitude from 2.5 to 4 mc. However, the gain of the amplifier is increased over this range so that the harmonics reaching the mixer have about the same amplitude.

Whether by design or not, the channel frequencies fall exactly in the middle of two adjacent harmonics of 3.3 kc. For example, on the first channel used, 2,548,333 cycles



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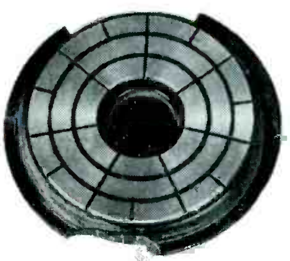

High stresses are set up by wide differences in expansion coefficients of brass inserts and phenolics, and by mold shrinkage. Yet not one of these distributor blocks and collector plates has ever cracked. Molder: Scintilla Magneto Div., Bendix Aviation Corp., Sidney, N. Y.

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BAKELITE "low-loss" phenolic BM-16981 is employed by Dietz Design & Mfg. Co. for their "Desco" plug-in assemblies, designed for easy stud mounting of coils, relays, filters, and crystals. The material provides excellent electrical insulating characteristics for high-frequency service, even under humid conditions.

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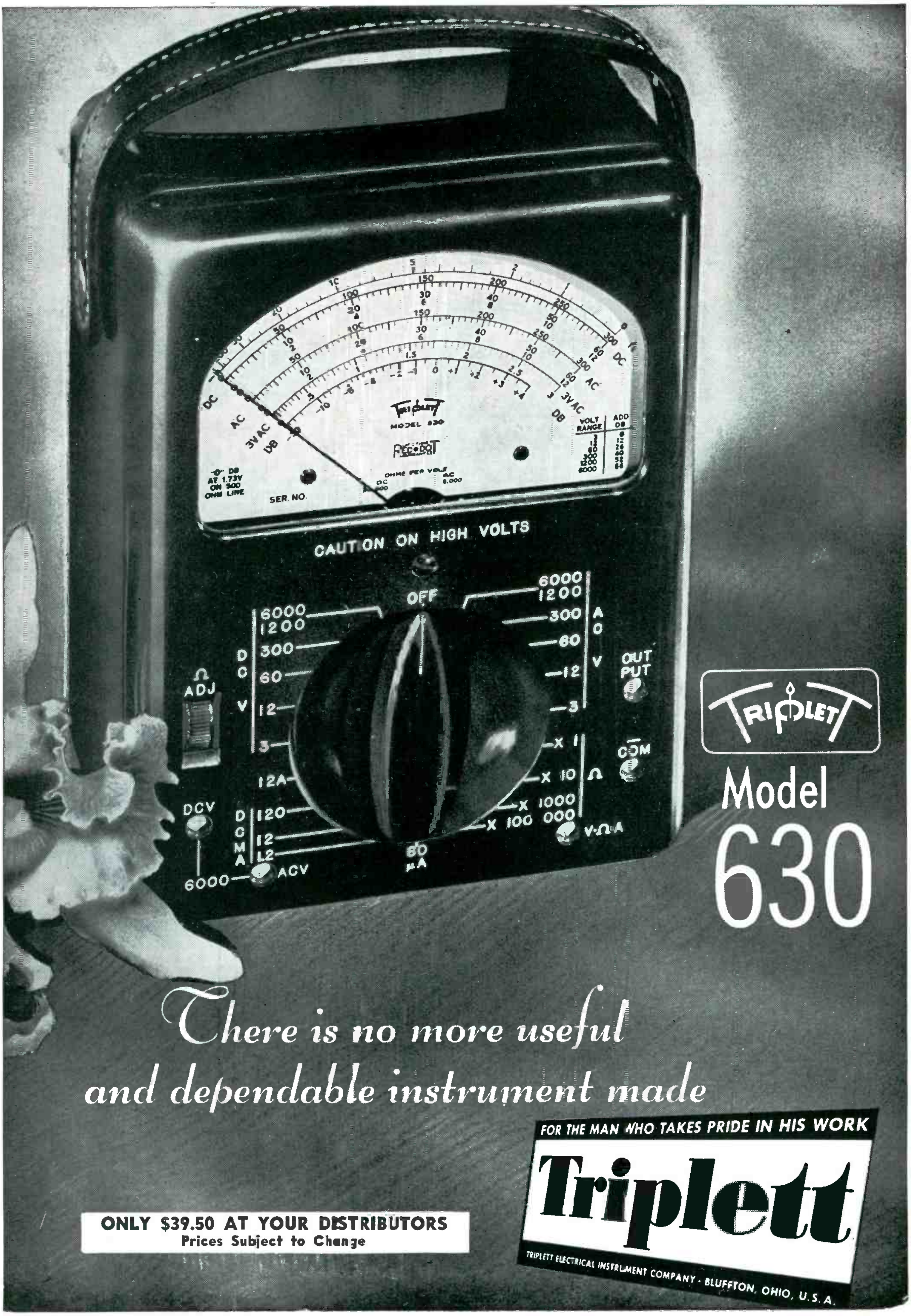
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is exactly midway between the 764th and 765th harmonics. Therefore two beats of the same frequency are produced and are each $1{,}667\frac{2}{3}$ cycles. In the mixing process many spurious responses are generated and it is necessary to include a selective amplifier following the mixer. The stage has the response curve as shown in Fig. 4 so that only the beats within about 40 cycles of 1,667 will be passed. After passing through this section the 1,667-cycle beat signal is fed via a cathode follower ($\frac{1}{2}$ 12AT7) to the vertical input of a scope.

If a known frequency of $1{,}666\frac{2}{3}$ cycles is applied to the horizontal input of the scope, a stationary circle or ellipse will appear when the transmitter crystal oscillator is set on channel. The $1{,}666\frac{2}{3}$ cycle signal is also derived from the frequency standard for high stability. This comparison signal is generated by a unit which supplies signals for both narrow and wide-band 30-to-50 mc equipment and two comparison signals for the 152-to-174 mc equipment. The unit takes a 10-kc trigger from the frequency standard and by a series of counting multivibrators produces $1{,}666\frac{2}{3}$ cycles for narrow-band 30-to-50 mc equipment; 833 cycles for wide band 30-to-50 mc equipment and 417 cycles and 1,250 cycles for 152-174 mc equipment. The rectangular waveforms from the multivibrators are filtered by a series of R-C sections so that a reasonably good sine wave is produced. This sine wave, which has

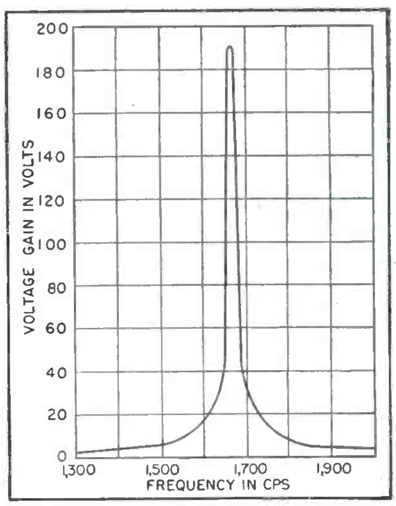

FIG. 4—Response of selective amplifier in mixer unit for narrow-band operation

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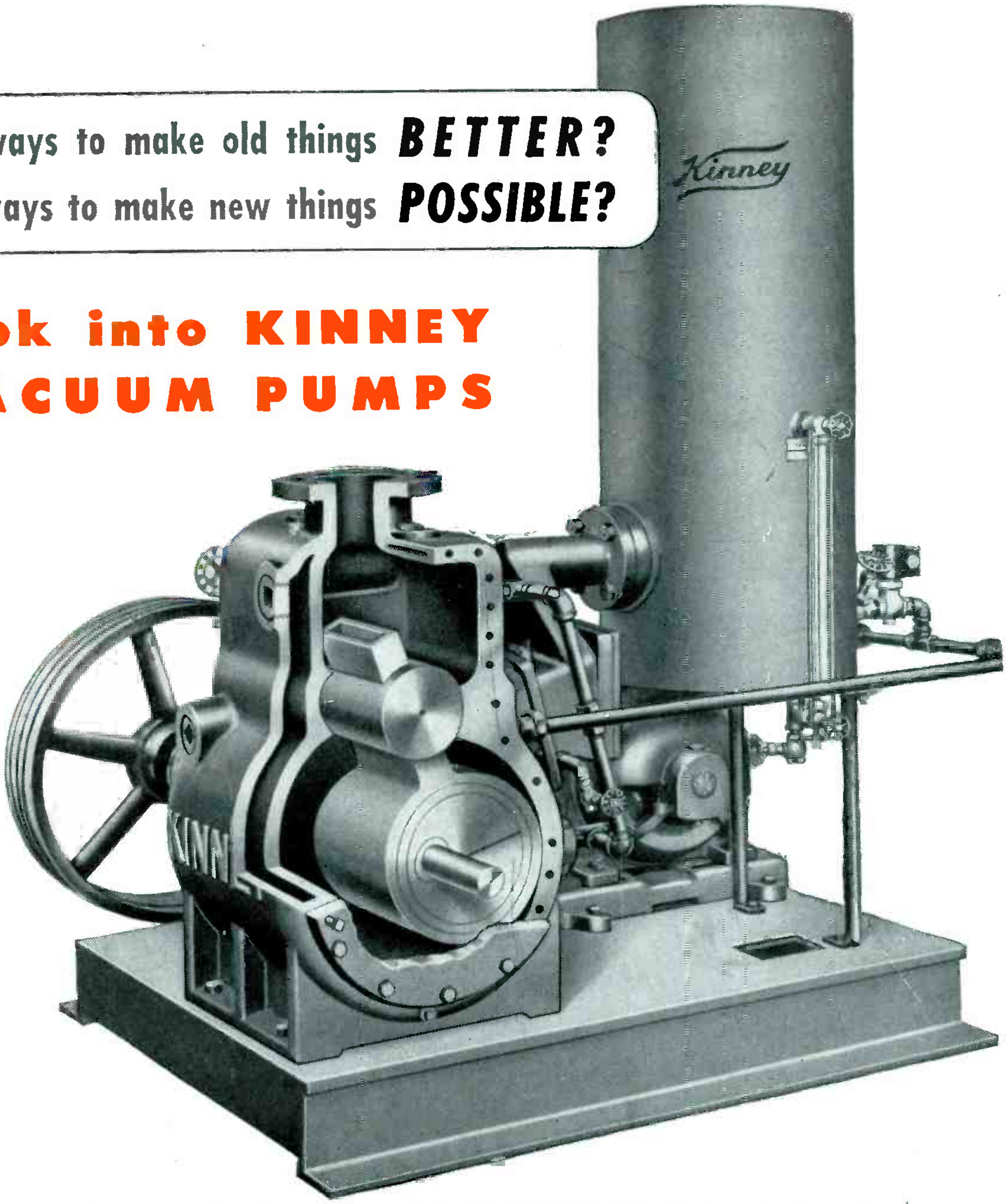

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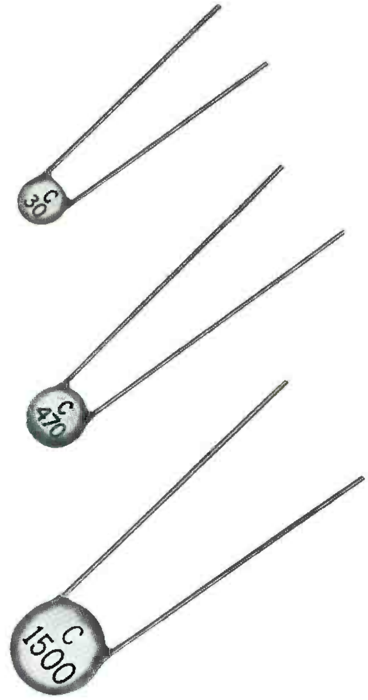

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cord set like this we
can save $50,000
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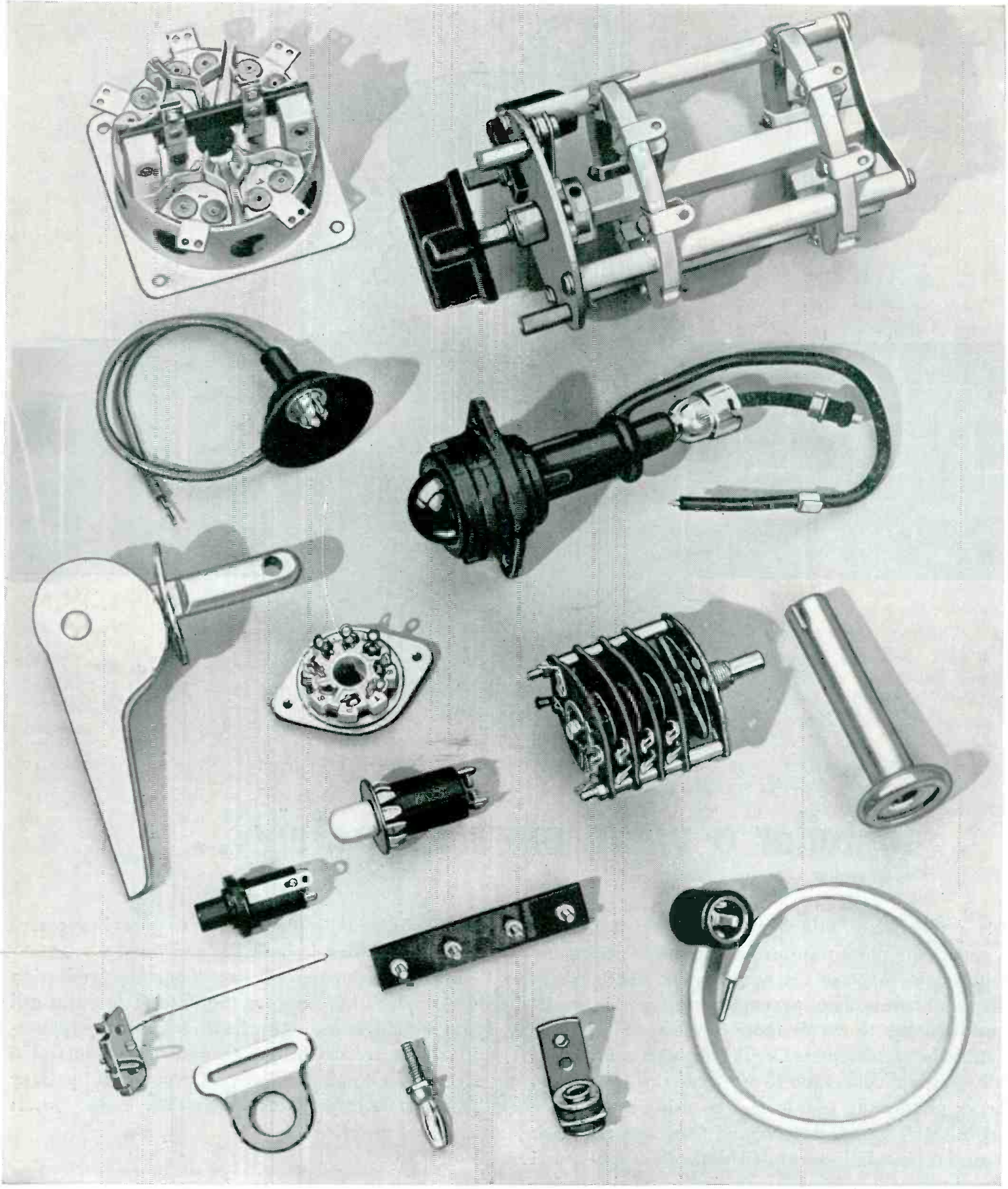

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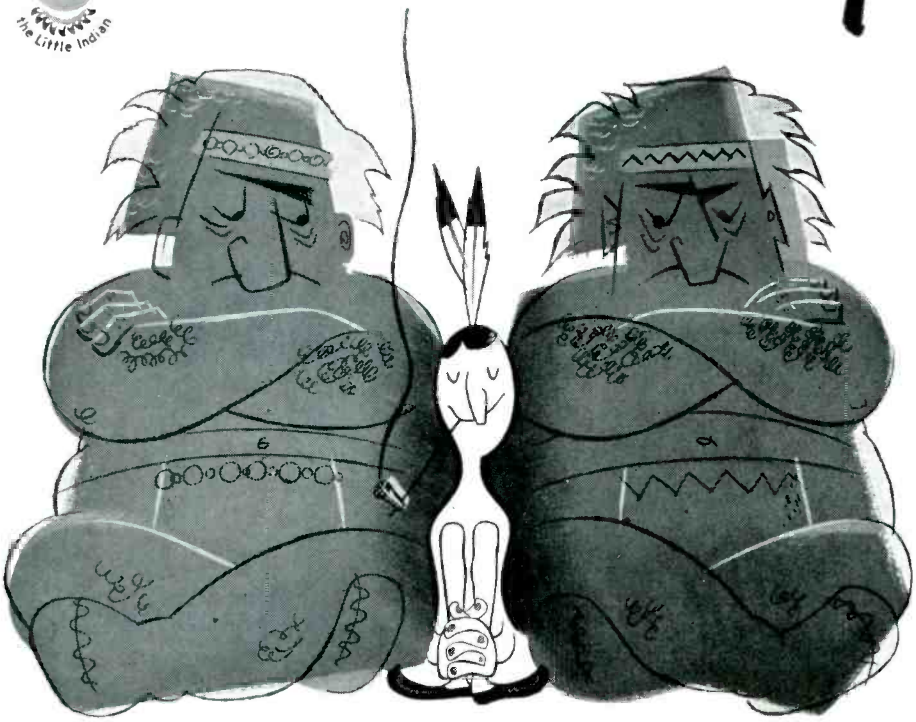

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IN CANADA: SANGAMO COMPANY LIMITED, LEASIDE, ONTARIO make the system unstable. This jitter can be most easily explained by referring to Fig. 6. The time between the first and third maximum is always the same since it is determined by the pulse from the frequency standard. However, the exact time when the second maximum occurs depends on the tuning of the multiplier tank. If the unit is slightly inductive or capacitive the phase of the maximum will change and cause every other pulse to be displaced from its true center position as indicated in Fig. 6. Even the slightest amount of phase shift in the multiplier tank causes severe amplitude modulation of the high-order harmonics of the pulse, so great that it cannot be removed by the limiters in the receiver.

The solution of this problem was to use a 100-kc standard as a sync source and divide down to 20 kc with a multivibrator. Here a sync pulse initiates every 20-kc output pulse and the jitter if any, is unnoticeable. The output of the 5-to-1 multivibrator is clipped and narrowed into a 0.1-μsec pulse of about 1 volt amplitude across a 50-ohm line. The pulse is fed to the various receiver test positions and directly into the antenna jack of the mobile or station receiver. Observing the receiver i-f frequency with a wide-band oscilloscope shows a good sine wave free of any jitter or modulation. If the set is correctly aligned, the discriminator output voltage will be zero. A null shifter is provided on the 20-kc pulse generator to vary the pulse width slightly and move the null points of the 20-kc harmonics. It was thought this might be necessary since null points of a 0.1-μsec pulse fall at 30, 40, and 50 mc in the usable range. However, practice has shown that the har-

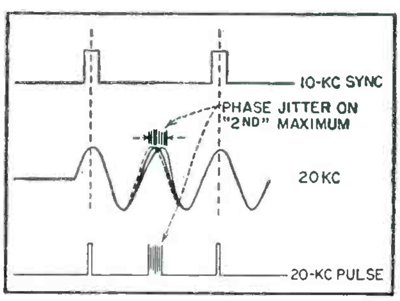
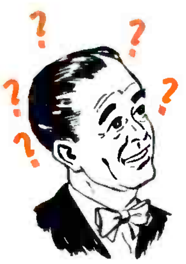


FIG. 6—Illustration of phase jitter in tuned frequency multiplier

Glass Code	Type	Principal Use	Viscosity Data: Strain Point °C	Viscosity Data: Annealing Point °C	Viscosity Data: Softening Point °C	Viscosity Data: Working Point °C	Thermal Expansion Coeff.—/° C	Density (Sp. Gr.)	Refractive Index Sod. D Line (.5893 Microns)	Log₁₀ of Volume Resistivity 250°C	Log₁₀ of Volume Resistivity 350°C	Dielectric Properties at 1 Mc and 20° C: Power Factor	Dielectric Const.	Loss Factor
0010	Potash Soda Lead	Lamp Tubing	397	428	626	970	91×10^{-7}	2.85	1.539	8.9	7.0	.16%	6.6	1.1%
0080	Soda Lime	Lamp Bulbs	478	510	696	1000	92×10^{-7}	2.47	1.512	6.4	5.1	.9	7.2	6.5
0120	Potash Soda Lead	Lamp Tubing	400	433	630	975	89×10^{-7}	3.05	1.560	10.1	8.0	.16	6.6	1.1
0280	Hard Lime	General	515	547	726	—	82×10^{-7}	2,50	1.517	—	—	—	—	—
1710	Hard Lime	Cooking Utensils	672	712	915	1200	42×10^{-7}	2.53	1.534	11.4	9.4	.37	6.3	2.3
1990	Potash Lead	Iron Sealing	334	359	496	—	127×10^{-7}	3.47			7.7	.04	8.3	.33
3320	Borosilicate	Tungsten Sealing	497	535	780	—	[illegible]				7.1	.32	5.0	1.6
6750	Opal	Lighting Ware	445	475								—	—	—
6810	Opal	Lighting Ware										—	—	—
7040	Borosilicate	Kova[illegible]									[illegible]	.18	4.8	.86
7050	Borosilicate	Series[illegible]										.33	4.9	1.6
7052	Borosilicate	Kovar[illegible]										.26	5.1	1.3
7070	Borosilicate	Low Loss[illegible]										.06	4.0	.24
7251	Borosilicate	Electrical										—	—	—
7720	Borosilicate	Electrical										.27	4.7	1.3
7740	Borosilicate	General										[illegible]	4.6	2.1
7750	Borosilicate	Series Sealin[illegible]								9.3	7.7	.20	4.6	.92
7760	Borosilicate	Electrical						2.23	1.473	9.4	7.7	.18	4.5	.79
7900	96% Silica	High Temp.				—	8×10^{-7}	2.18	1.458	9.7	8.1	.05	3.8	.19
7900	96% Silica (Multiform)	High Temp.	820	910	1500	—	8×10^{-7}	2.18	1.458	9.7	8.1	.05	3.8	.19
7910	96% Silica	Ultraviolet Transmission	820	910	1500	—	8×10^{-7}	2.18	1.458	11.2	9.2	.024	3.8	.091
7911	96% Silica	Ultraviolet Transmission	820	910	1500	—	8×10^{-7}	2.18	1.458	11.7	9.6	.019	3.8	.072
8830	Borosilicate	X-Ray	475	510	715	—	48×10^{-7}	2.25	—	7.8	6.3	—	—	—
8871	Lead Potash	Electrical Capacitors	357	384	527	—	103×10^{-7}	3.84	—	11.1	8.8	.05	8.4	.42
8160	Lead Potash	Dumet Sealing	399	433	627	—	91×10^{-7}	2.98	1.553	10.6	8.4	.09	7.1	.64
9010	Lead Free	Television	411	442	650	—	88×10^{-7}	2.59	1.506	8.9	7.0	.22	6.5	1.43
9700	————	Ultraviolet Transmission	517	558	804	1195	37×10^{-7}	2.26	1.478	8.0	6.5	—	—	—
9741	————	Ultraviolet Transmission	407	442	705	—	39×10^{-7}	2.16	—	9.4	7.6	—	—	—

HAVE YOU OVERLOOKED SOME OF THE PROPERTIES OF GLASS?



Glass has proved an important material for electronic equipment—in tube envelopes, special tubing, sealing beads, insulation and a host of other uses. In almost every application the special electrical and physical characteristics are vital to top notch performance—characteristics such as well controlled dielectric strength, proper loss and power factor, desired transparency and corrosion resistance.

Take a fresh look at your present and projected equipment. Glass may help improve performance or lower costs. Then bring your idea to Corning and let our engineers help choose a glass for you. We have hundreds of glasses with widely varying characteristics, the research and pilot plant facilities to develop your idea and a broad variety of production facilities to produce it. For a quick look at some properties of glasses by Corning write for Bulletin B-83 to Dept. E-11, Corning Glass Works, Corning, New York.

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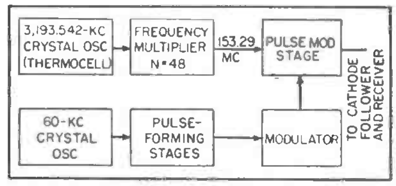

FIG. 7—Receiver checker for 148-to-174 mc band

monics are strong enough even at these null points.

The wide-band 30-to-50 mc and the 152-to-174 mc test equipment involve the same principles. The only differences are the comparison frequencies and the pulse repetition rate (2,500 cycles) for 152-to-174 mc equipment. Figure 5 illustrates how the 3.3-kc pulse repetition rate can also be used for wide-band units even though the channel separation at the crystal frequency is 1,666⅔ cycles.

The generation of the marker frequencies for the 152-to-174 mc band is done in a unit mounted in a master rack from which the harmonics are sent to the various test positions. Since this band is too high in frequency for the direct use of 60-kc harmonics and since these harmonics do not fall on the channel frequencies, an approach different from the 30-to-50 mc receiver setup is required.

A block diagram of the 152-to-174 receiver checker is shown in Fig. 7. A stable r-f carrier is generated with a thermocell crystal oscillator and multiplied up to a channel which is about in the middle of the 152-to-174 band. This carrier is modulated by a narrow 60-kc pulse such that the side bands (each 60 kc apart and falling directly on a channel) extend about 10 mc above and 10 mc below the carrier. Modulation is accomplished by inductively coupling the r-f carrier into the cathode of a 6AG7 which is held beyond cutoff by 20 volts of fixed grid bias. Positive pulses at 60 kc are applied to the grid and drive the tube into the conducting region so that a pulse of r-f appears across a low-Q tank in the plate circuit. Cathode followers (6J6's) are used to drive the 50-ohm lines which carry the signals to the test positions. The 60-kc repetition rate is also crystal controlled but need not

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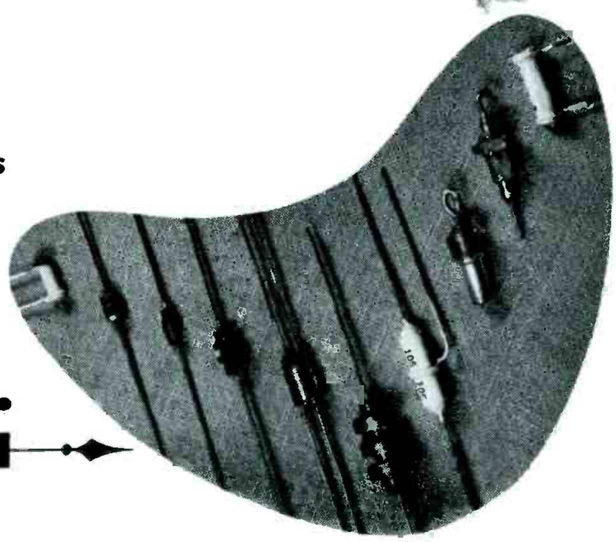

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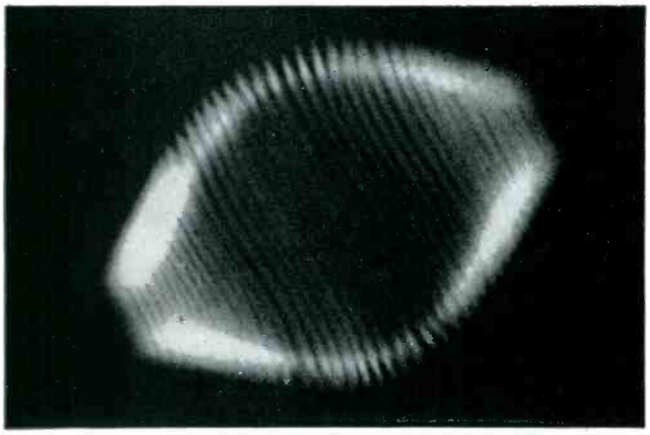
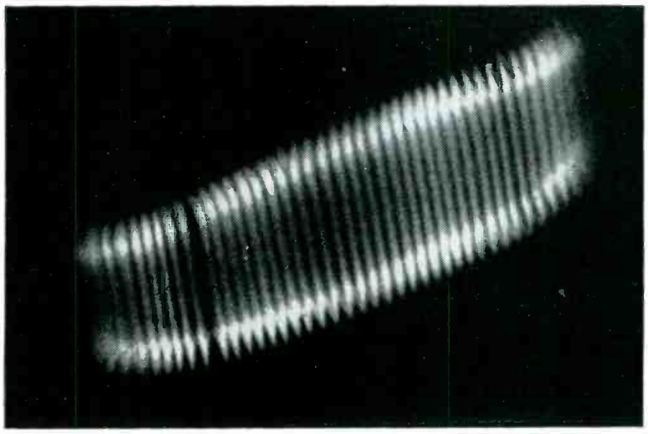
Why G-E dial lamps are seen

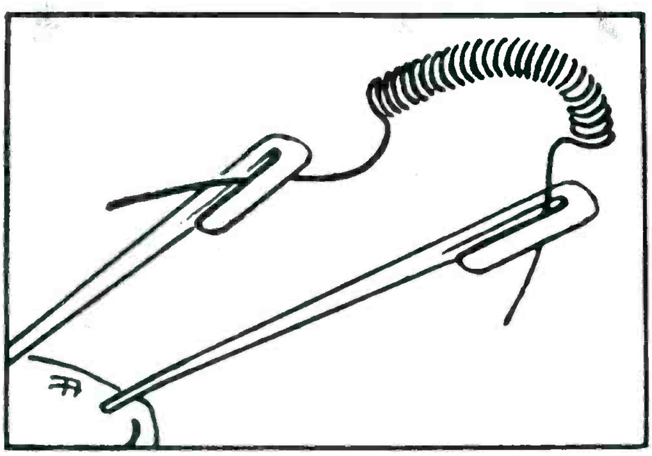


OLD FILAMENT. High notes often cause the filaments and lead-in wires of radio dial lamps to vibrate. In old-style lamps, they vibrate to frequencies different from those of the noise. This produces a whipping action (above) which eventually tears the filament apart.

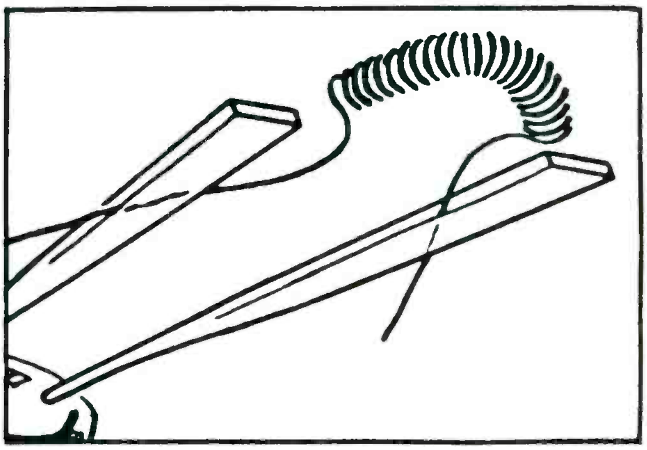


NEW FILAMENT. By redesigning the filament supports of G-E radio dial lamps, General Electric engineers matched the frequencies and greatly reduced the effects of vibration (above). As a result, G-E radio dial lamps give longer, more dependable service.

...but not heard

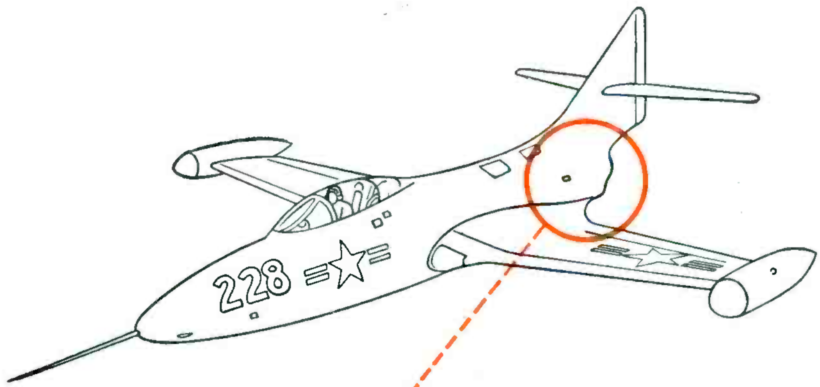


OLD-TYPE JOINT. Some types of dial lamps actually cause "static". Old-type clamp joints in the bulb (above) often permit changes in resistance or tiny arcs that cause the lamp to radiate bothersome interference.

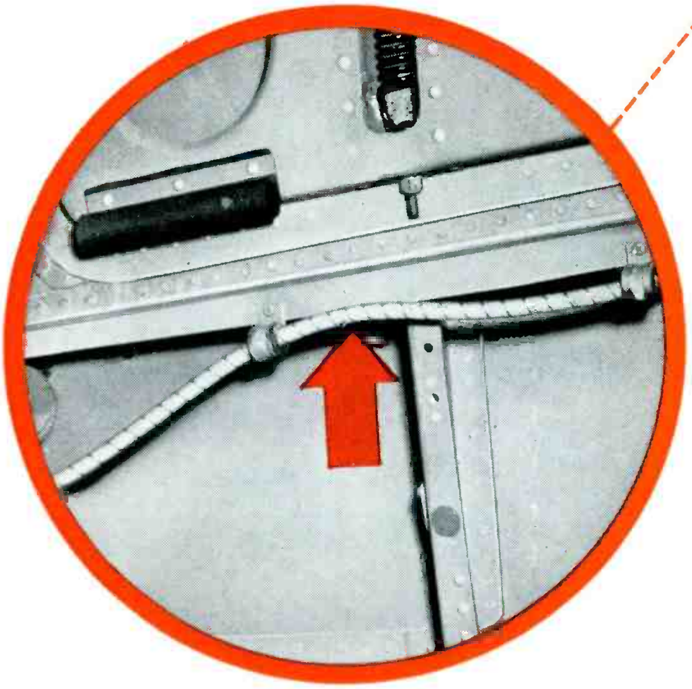


IMPROVED JOINT. To prevent dial lamps from being "noisy", General Electric developed a better joint—one with tungsten filament legs pressed firmly into the softer metal of the lead-in wire. It's another reason why G-E dial lamps insure customer satisfaction!

GENERAL ELECTRIC



UHF cable insulated with Du Pont "TEFLON"



SEGMENT of UHF transmission line to antenna, running through tail of Grumman "Panther." Conductor is covered with (1) 0.280" insulation of extruded "Teflon," (2) silvered wire shield, (3 wrapping of "Teflon" tape, and (4) an outer jacket of silicone-treated glass braid. RG87/U cable made by American Phenolic Corp., Chicago, for Grumman Aircraft Corp., Bethpage, L. I., N. Y.

withstands 250°C. next to jet engine ... remains intact, electrically efficient

A 50-ohm UHF transmission line that could be installed within *inches* of a jet combustion chamber . . . that was a need faced by engineers specifying communications equipment for the Grumman "Panther."

Insulation for this cable had to have a low dielectric constant, resist temperatures up to 250° C., remain tough but flexible, withstand long periods of continuous vibration. Du Pont "Teflon"* tetrafluoroethylene resin provides this unusual combination of properties.

"Teflon" has a dielectric constant of 2.0 and a loss factor of less than 0.0005 over the entire spectrum measured to date (60 cycles to 30,000 megacycles). These electrical properties combined with outstanding heat resistance, toughness, resiliency, and zero moisture-absorption make "Teflon" widely applicable wherever high frequencies, high voltages, and/or high temperatures are encountered.

Demand for "Teflon" currently exceeds supply. However we suggest you investigate its properties for future applications. "Teflon" can be extruded or molded . . . is also supplied by Du Pont as tape and in water dispersions. It may well help you, as it has helped Grumman, solve difficult electrical insulation problems. We'll gladly discuss the availability of experimental quantities for development work. For additional information on "Teflon" and other Du Pont plastics, write to:

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be a thermocell since this frequency does not contribute much to the over-all accuracy.

The intention of the test equipment described is for the fine adjustment of crystal-controlled oscillators whose frequency to the last several hundred parts per million are previously known, having been checked by the crystal manufacturer. It should be mentioned that the equipment cannot distinguish between channels.

The significant advantage of this equipment is that an inexperienced operator can set any mobile or station transmitter on the nose with an accuracy equal to that of the frequency standard itself, on any channel in the band—in less than a minute. The only maintenance required is a daily check of the frequency standard against WWV. The multivibrators have never

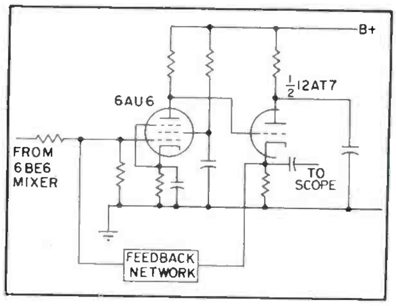

FIG. 8—Selective amplifier circuit

jumped out of sync in five months of operation. Should some component fail and the multivibrator run free, the instability is so great that a stopped pattern cannot be obtained on the scope. If the multivibrator should jump from a count of three to any other count, say two or five, an automatic fault detector rings a bell.

The fault detector consists of a selective amplifier, Fig. 8, tuned to 3.3 kc. The input signal is taken from the 3.3-kc multivibrator. As long as the frequency is 3.3 kc, a large voltage appears at the output of the amplifier which is rectified and biases positive one half of a 12AT7 and a relay in the plate circuit is held in. If the 3.3-kc changes to say 2,500 cycles, it cannot pass through the selective amplifier which removes the positive bias from the 12AT7 and the relay is

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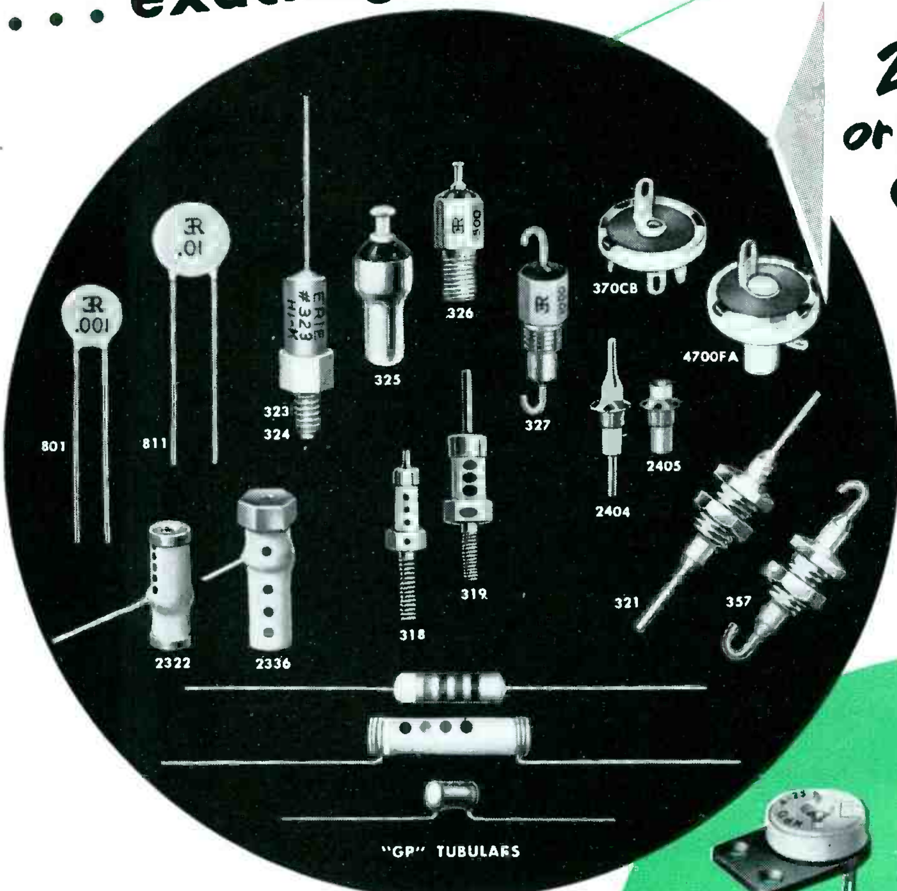

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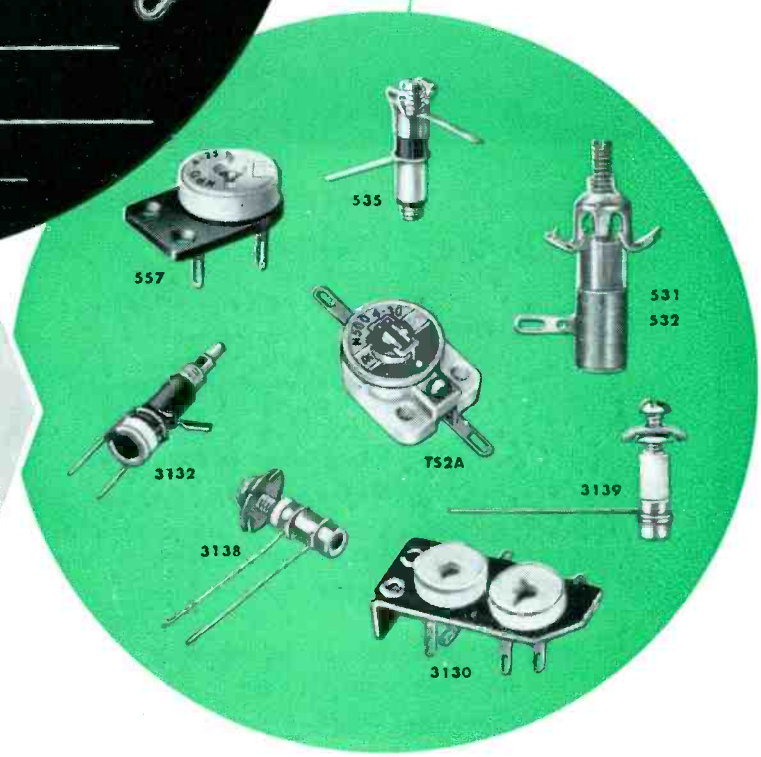

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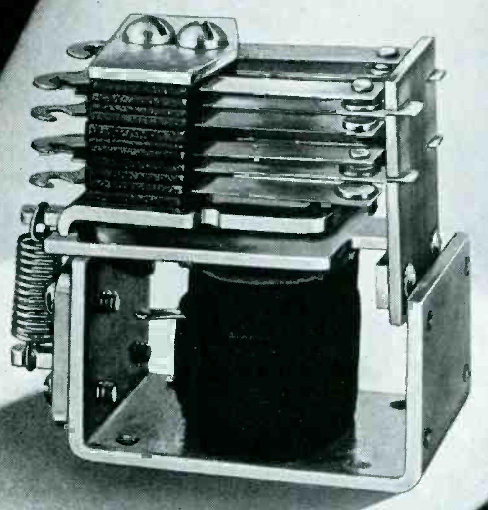

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CONTACTS: 10 amp. standard. 24 volts D.C., 115 volts A.C.
15 amp. contacts available.

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2 pole .7 watts
A.C.: 4 pole 5 volt amperes
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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 RISE: 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—$2\frac{1}{16}$", $1\frac{1}{8}$", $2\frac{1}{16}$"
Sealed Relay—$3\frac{1}{8}$", $1\frac{1}{2}$", $2\frac{5}{16}$"
Overall Mounting Flange—$3\frac{1}{8}$"
Center to Center Mounting Holes—$2\frac{11}{16}$"

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.

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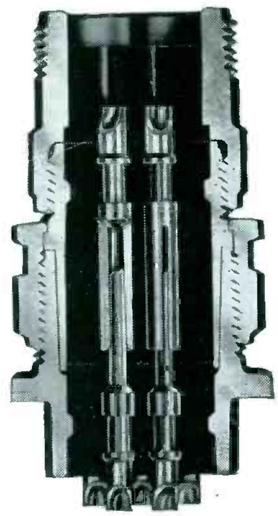

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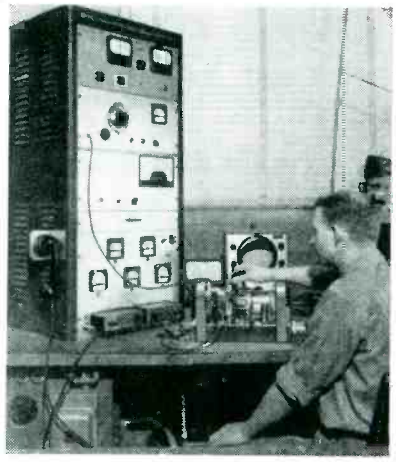


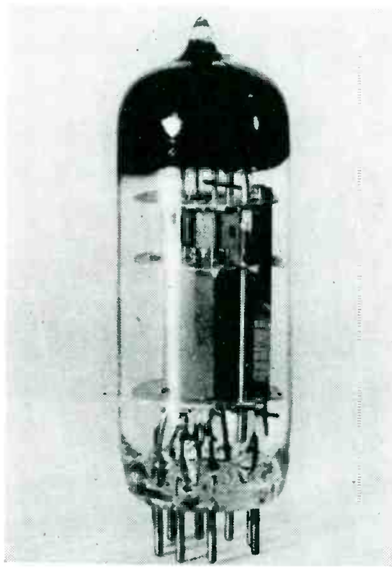
Receiver test setup

de-energized, closes it's contact and rings a bell.

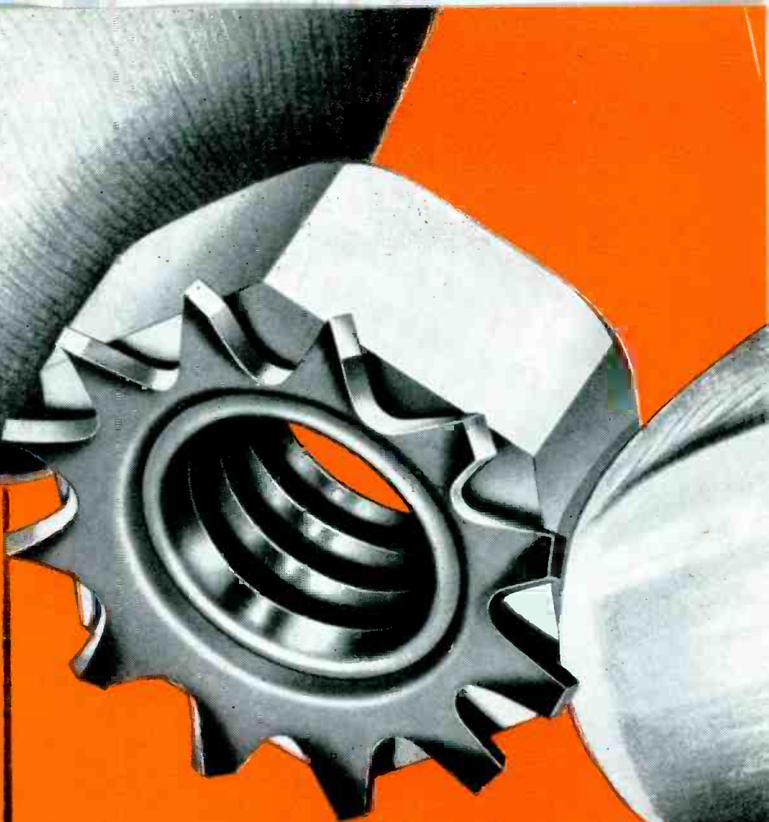
The use of this system for a signal source to align this type of equipment has brought laboratory precision of frequency setting to the production line and simultaneously has yielded a considerable labor saving.

Radiographic Examination of Tubes

IN CERTAIN phases of present-day tube manufacture electrode dimensions have to be made very small with resulting narrow tolerances. A slight eccentricity of the control grid with respect to the cathode in



Combined pentode and triode for tv reception, tube type ECL 80, is shown in x-ray silhouette in the accompanying photograph



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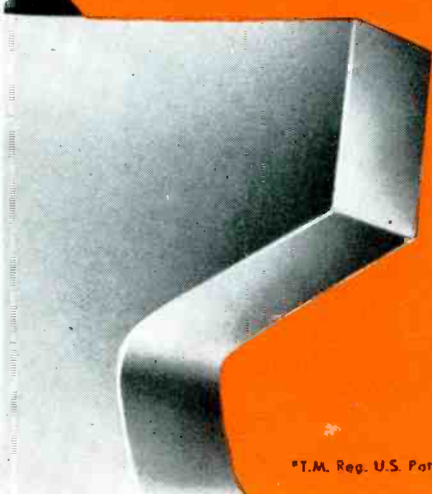

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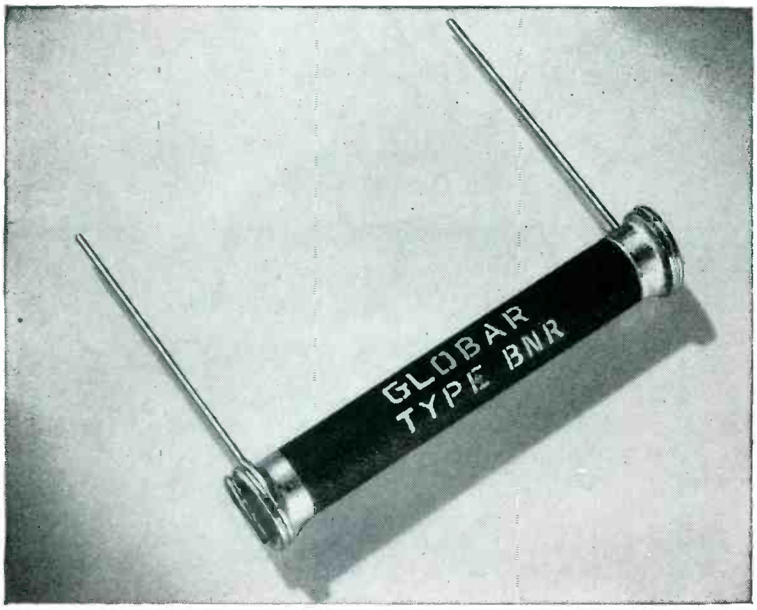

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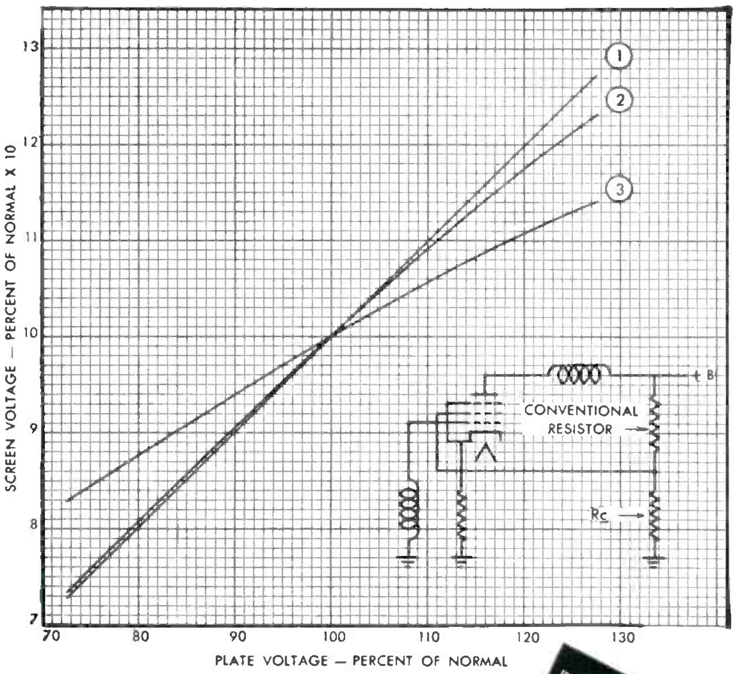
RESISTORS



Performance of Various Voltage Reducers for Pentode Screen Supply

1 Divider with conventional composition Resistor at R_c.

2 Plain series dropping Resistor (R_c omitted).

3 Divider with GLOBAR type BNR at R_c.

● Variation in supply voltage which impairs pentode amplifier performance is especially serious in cathode ray tube applications where the effect on sweep amplifier output is visible. This is where the voltage sensitive characteristics of GLOBAR type BNR resistors prove extremely valuable. Employed in a voltage divider as shown here, they help to stabilize gain of amplifiers against supply voltage variations. Often, they reduce screen voltage variations by as much as *one half*.

WRITE for a copy of Bulletin GR-2 which contains useful engineering data on GLOBAR type BNR resistors. Dept. E 87-69, GLOBAR Division, The Carborundum Company, Niagara Falls, New York.

GLOBAR Ceramic Resistors BY CARBORUNDUM

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87-69

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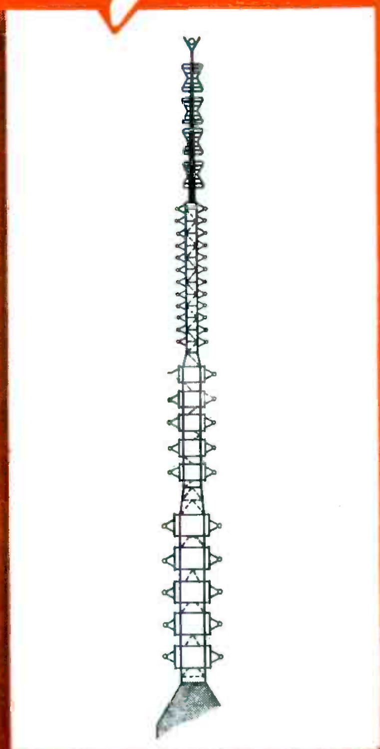

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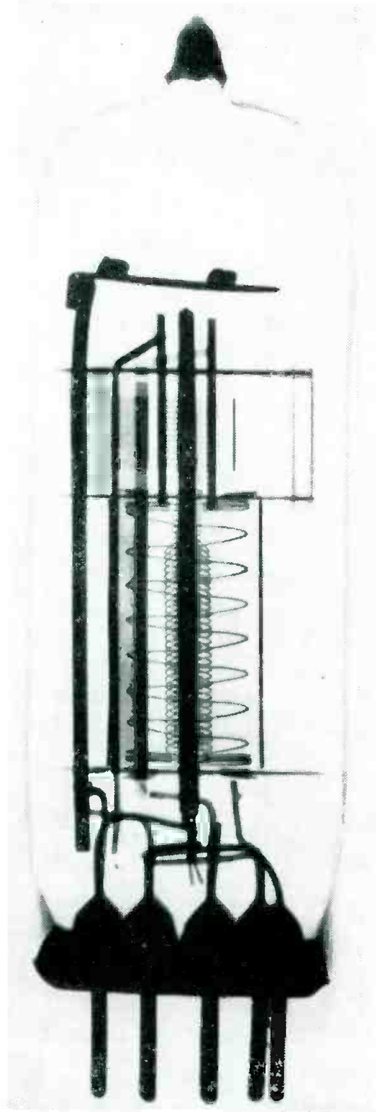


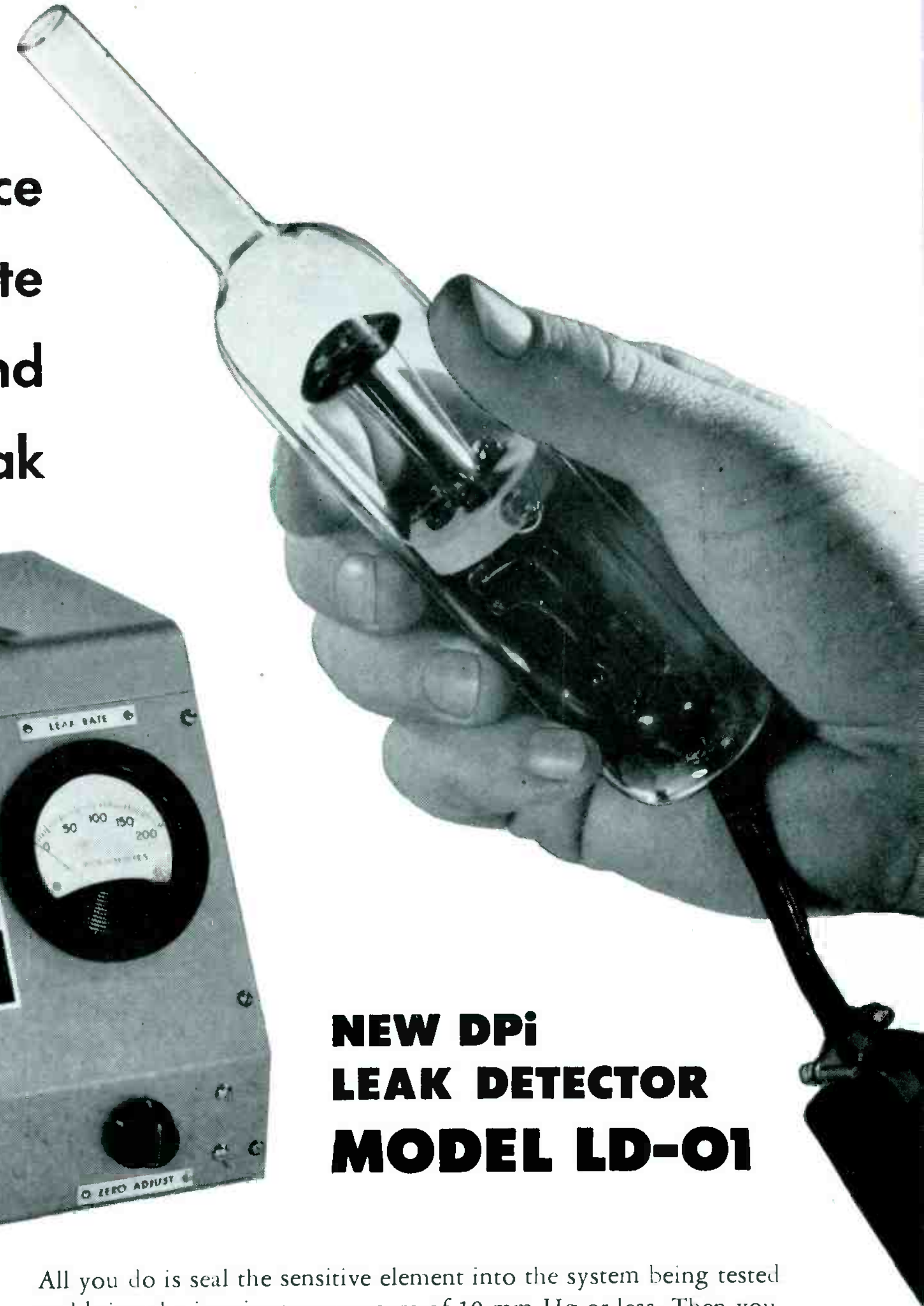
X-ray photograph of ECL 80. The screen grid, which does not reach right to the top, has been distorted in manufacture

a certain high-frequency pentode with coaxial cylindrical electrodes is enough to change the tube characteristics so that the tube no longer fulfills the required specifications.

An x-ray method of studying tube structures has been devised. To obtain good definition, an x-ray tube with the smallest possible focus has to be used. In this case, the focus was 0.3 by 0.3 mm. There are two ways of viewing the image; either with a fluorescent screen or by photographic recording. The photographic method is preferable since the sharpness of a fluorescent screen is not great enough.

The tube being examined, the x-ray tube and the film are screened off with an iron case lined with

here's a simple device to locate almost any kind of leak



NEW DPi LEAK DETECTOR MODEL LD-01

All you do is seal the sensitive element into the system being tested and bring the interior to a pressure of 10 mm Hg or less. Then you direct a small jet of harmless Freon Gas at suspected spots and watch the meter. It's as simple as that, and sensitivity is high enough even where one-millionth of atmospheric pressure is to be maintained.

It works like this: The sensitive element contains a heated platinum anode and a cold cathode with relatively low voltage between them. The tendency of hot platinum to emit positive ions is enormously stimulated by infinitesimal traces of halogens or their compounds. The circuit to accomplish all this uses only three standard radio tubes and operates from your 115-v a-c lighting circuit.

For full information write *Distillation Products Industries,* Vacuum Equipment Department, 727 Ridge Road West, Rochester 3, N. Y. (Division of Eastman Kodak Company).

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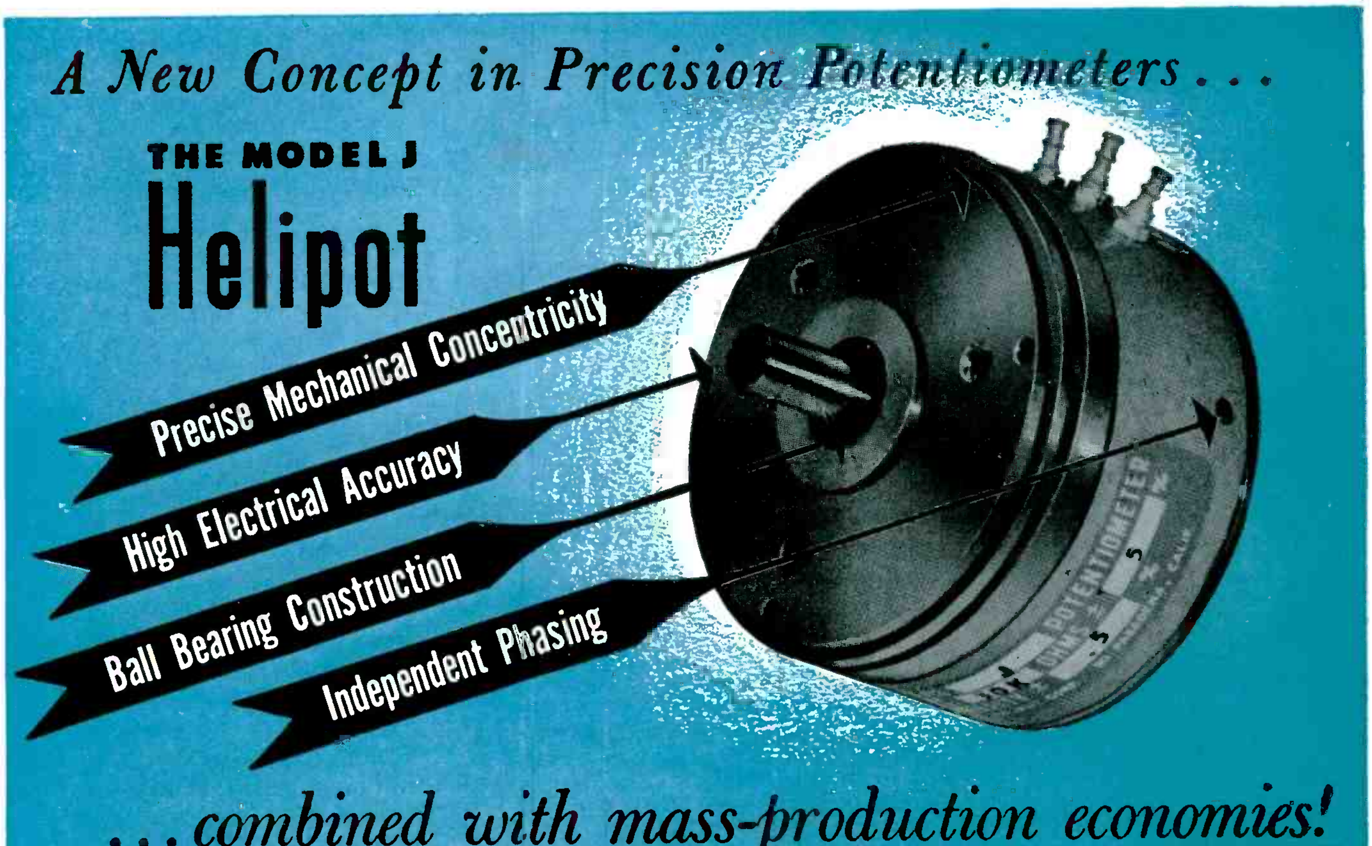


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Modern servo mechanisms and computer hook-ups require high mechanical precision to insure uniform accuracy when connected to servo motors through close-tolerance gears and couplings.

In the "Model J," close concentricity between mounting surface and shaft is assured by a unique mounting arrangement. The unit can be aligned on either of two wide-base flange registers and secured with three screws from the front of the panel . . . or it can be secured with adjustable clamps from the rear of the panel to permit angular phasing. Or if preferred, it can be equipped with the conventional single-hole bushing type of mounting.

In addition to accurate mounting alignment, exact rotational alignment is assured by the long-life, precision-type ball bearings upon which the shaft rotates. Precise initial alignment coupled with negligible wear mean high *sustained* accuracy.

High Electrical Accuracy

Helipot products have long been noted for their unusually high electrical accuracy and the "Model J" embodies the latest advancements of Helipot engineering in this field.

For example, tap connections are made by a new Helipot welding technique whereby the tap is connected to only ONE turn of the resistance winding. This unique process eliminates "shorted section" problems!

High linearity is also assured by Helipot's advanced production methods. Standard "Model J" linearity accuracies are guaranteed within ±0.5%. On special order, accuracies to ±0.15% (capacities of 5000 ohms and up) have been obtained.

Ball Bearing Construction

The shaft of each "Model J" is carefully mounted on precision-type ball bearings that not only assure sustained rotational accuracy, but also provide the constant low-torque operation so essential for servo and computer applications. Starting torque is only ¾ of an inch-ounce (±.25 in.-oz.)—running torque, of course, is even less.

Independent Phasing

When using the "Model J" in ganged multiple assemblies, each section can be independently phased electrically or mechanically—even after installation on the panel—by means of hidden internal clamps controlled from outside the housing. Phasing is simple, quick, accurate!

Mass-Production Economies

In addition to its many other unique features, Helipot engineers have developed unusual techniques that permit mass-production economies in manufacturing the "Model J". Actual price depends upon the number of taps required, special features, etc. . . . but with all its unique features, you will find the "Model J" very moderate in cost.*

Wide Choice of Designs

The "Model J" Helipot is available in a wide selection of standard resistance ranges—50, 100, 1,000, 5,000, 10,000, 20,000, 30,000 and 50,000 ohms . . . in single- or double-shaft designs . . . with choice of many special features to meet virtually any requirement within its operating field.

***Write for Bulletin 107 which gives complete data and price information on the versatile "Model J" Helipot!**

THE Helipot CORPORATION

South Pasadena 2, California

Field Offices: Boston, New York, Philadelphia, Rochester, Cleveland, Detroit, Chicago, St. Louis, Los Angeles and Fort Myers, Florida. Export Agents: Frotham Co., New York 18, New York.

lead. A fluorescent screen is located so that a silhouette of the tube being examined can be seen so as to set it in the right position before exposure of the film is made.

The tube is positioned by three knobs outside the case. The positioning knobs turn the tube in two directions at right angles to the x-ray beam and also move the tube vertically.

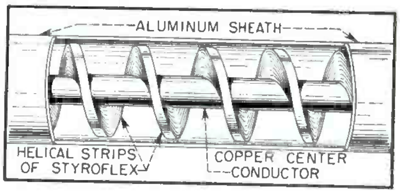
Exposure time varies from 1 to 2.5 minutes depending on whether the tube being examined has a lime-glass or lead-glass bulb. After the photograph is developed, it is measured up under an optical projector. Accuracy of measurement can be checked by photographing a gage together with the tube.

The material presented here was abstracted from an article entitled "Radiographic Examination of Electronic Valves" which appeared in the January 1951 issue of *Philips Technical Review*.

Improved High-Frequency Cable

A HIGH-FREQUENCY coaxial cable, new in design to the United States, has been in use in Germany and neighboring countries for about the last ten years. The cable, because of its unique construction, has many characteristics better than those obtained in any coaxial cable manufactured in this country at the present time.

The cable consists of either a solid-copper center conductor, or hollow copper tubing for higher frequencies, and an extruded aluminum outer sheath. The inner conductor is held at precise center by a continuous helix of Styroflex thread or tape. Styroflex is made from polystyrol that has been converted to a highly flexible material by a process known as all-directional mechanical pulling. Because of the helical construction, the



Section of cable cut out to show copper center conductor and helical windings

For *lasting* insulation strength, Sperry counts on HARVEL 912-C

For more than 10 years, Sperry Gyroscope Company has been insulating coils and other components with Harvel Internal Curing Varnishes, because of their excellent mechanical and electrical properties. Sperry . . . world famous for the quality and performance of its instruments . . . reports these specific advantages from the use of Harvel 912-C, electrical insulating varnish:

1. *High mechanical strength.* Conductors rigidly bonded into a compact mass. No soft, tacky varnish interiors to allow movement of conductors.
2. *High dielectric strength* . . . 2200 vpm. Electrical properties retained at high temperatures—unaffected by oil.
3. *Fast baking time.* 912-C cuts baking schedules as much as 50%—materially reduces production costs.

Sperry also turns to Irvington for Class "H" flexible insulations when space and weight are at a premium. Running safely at temperatures as high as 500°F, these insulations permit using smaller conductors, and thus open the way to lighter, more compact designs. It will pay *you* to investigate these Irvington products—mail coupon today for the full story.

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for insulation leadership
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INSULATING TUBING
CLASS "H" INSULATION

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Please send me technical literature on:
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Street..........
City.......... Zone.......... State..........

For Further Information, Consult pages 92–93 in the 1951–1952 Electronics Buyers' Guide


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WAR PLANES
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ALL COMPONENTS OF
THE FIRST MODEL
Buy YOUR TRANSFORMERS
ON A "PROVE-IT-FIRST" BASIS
It's a good feeling, when you order a quantity of GRAMER Transformers, to know that each unit is physically and electrically in keeping with your specifications. This is usually achieved by first arranging for a production sample GRAMER Transformer (hermetically sealed to MIL-T-27 Government specifications, or one of open type construction). Such procedure permits putting your GRAMER production sample to any test in your electrical equipment. Precision manufacturing assures physical and electrical correctness, uniformity for easy assembly and substantial savings on your quantity orders.
James M. Blacklidge
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HEAVY DUTY FILAMENT TRANSFORMER
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B/P
SPECIFICATIONS

amount of dielectric is the same at every point in the length of cable with no resulting discontinuity.

The complete cable is flexible enough so that large sizes may be shipped on drums whose diameters are 26 times the diameter of the cable. The cable can be supplied with outer diameters ranging from about [illegible] in. to 7 in. and is manufactured in one continuous piece to any desired length. No joints or butts are required in any particular installation as the cable can be ordered in the length required and is flexible enough to avoid the use of angle joints or other similar connections.

One of the most interesting properties of the new cable is that it does not have to be pressurized. In addition, according to recent laboratory tests in Germany and in the laboratories of interested companies in the United States, the cable has a standing wave ratio of better than 1.01, is much lighter in weight than conventional cables, has high longitudinal and sectional stability and is remarkably resistant to change of characteristics caused by weather effects or undersea installation.

In one installation in Germany, the cable is suspended from a 450-ft f-m tower, with no other anchorage than at the point of suspension. The maximum length of cable that can be suspended directly is approximately 8,000 ft.

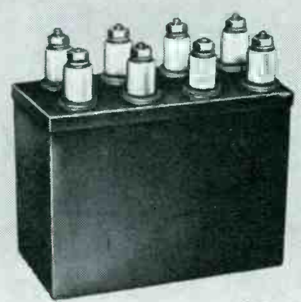
From the information available, it seems that the cable could be utilized to advantage in the United States at frequencies up to 3,000 mc. It is now manufactured by Felten and Guilleaume, Koln-Mulheim, Germany. The cable was demonstrated in the United States by National Varnished Products Corp. and Phelps-Dodge Copper Co.

Testing for Microwave Relay Tower Location

AN INTERESTING TECHNIQUE has been used by engineers for determining suitable microwave relay tower locations for communication between Eugene and the Crescent Lake district in Oregon. The installation is being made by Philco

a statement of fact • • •

AMP CAPITRON CAPACITORS and AMP Pulse Forming Networks, fabricated with AMPLIFILM, are smaller and lighter, at working voltages of 3 KV and higher, than any other products of equal electrical characteristics.



20 KV Pulse Forming Network redesigned using AMPLIFILM. Volume and weight reduction: 64%!

8,000 V, .5 micro-farad capacitor redesigned using AMPLIFILM Volume and weight reduction: 57%!

AMP CAPITRON

Trade-Mark

HIGH VOLTAGE CAPACITORS and PULSE FORMING NETWORKS

AMP CAPITRON High Voltage Capacitors and Pulse Forming Networks are particularly suitable for applications where miniaturization or maximum conservation of weight are paramount factors. Units can be installed adjacent to irregular or curved surfaces with terminal outlets placed to permit the most efficient and compact circuiting. They will operate effectively at both lower and higher temperatures than ordinary units which use paper, mica, or plastic dielectrics.

Write for complete information.

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If you have a fabricating or processing problem involving paper . . . if you require definite technical characteristics and, above all, *dependable uniformity*, it may be worthwhile for you and MOSINEE technicians to get together. MOSINEE is not interested so much in terms of volume production as in our ability to render helpful service to manufacturers in the field of electronics and in the electrical goods industry. Our "paperologists" are at your service for consultation.

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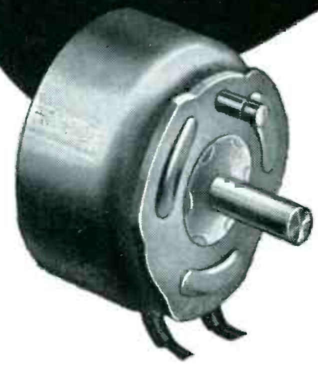
LEDEX ROTARY SOLENOID



SOLVES MANY REMOTE CONTROL PROBLEMS

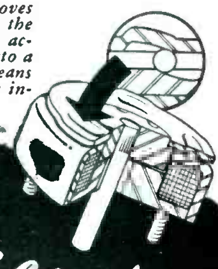
The many production applications of Ledex Rotary Solenoids vary from the dependable, snap-action tripping of airborne bomb releases to the actuation of rugged, hydraulic valves in heavy duty materials handling equipment.

Five Ledex Rotary Solenoid models are manufactured. Diameters range from 1⅛ to 3⅜ inches. Predetermined rotation up to 95° can be engineered to suit your product's requirements. Starting torques for 45° stroke range from ¼ pound-inches to 50 pound-inches.

We supply to quantity users and solicit the opportunity to be of assistance in engineering a Ledex Rotary Solenoid to meet your product's requirements.

MODEL NO.	2	5	6	7	8
Diameter	1⅛"	1⅞"	2¼"	2¾"	3⅜"
Torque lb./inches	¼	5	10	25	50
Weight lbs.	⅛	½	1	2¼	4¼

Magnetic action moves the armature along the solenoid axis. This action is converted into a rotary motion by means of ball bearings on inclined races.



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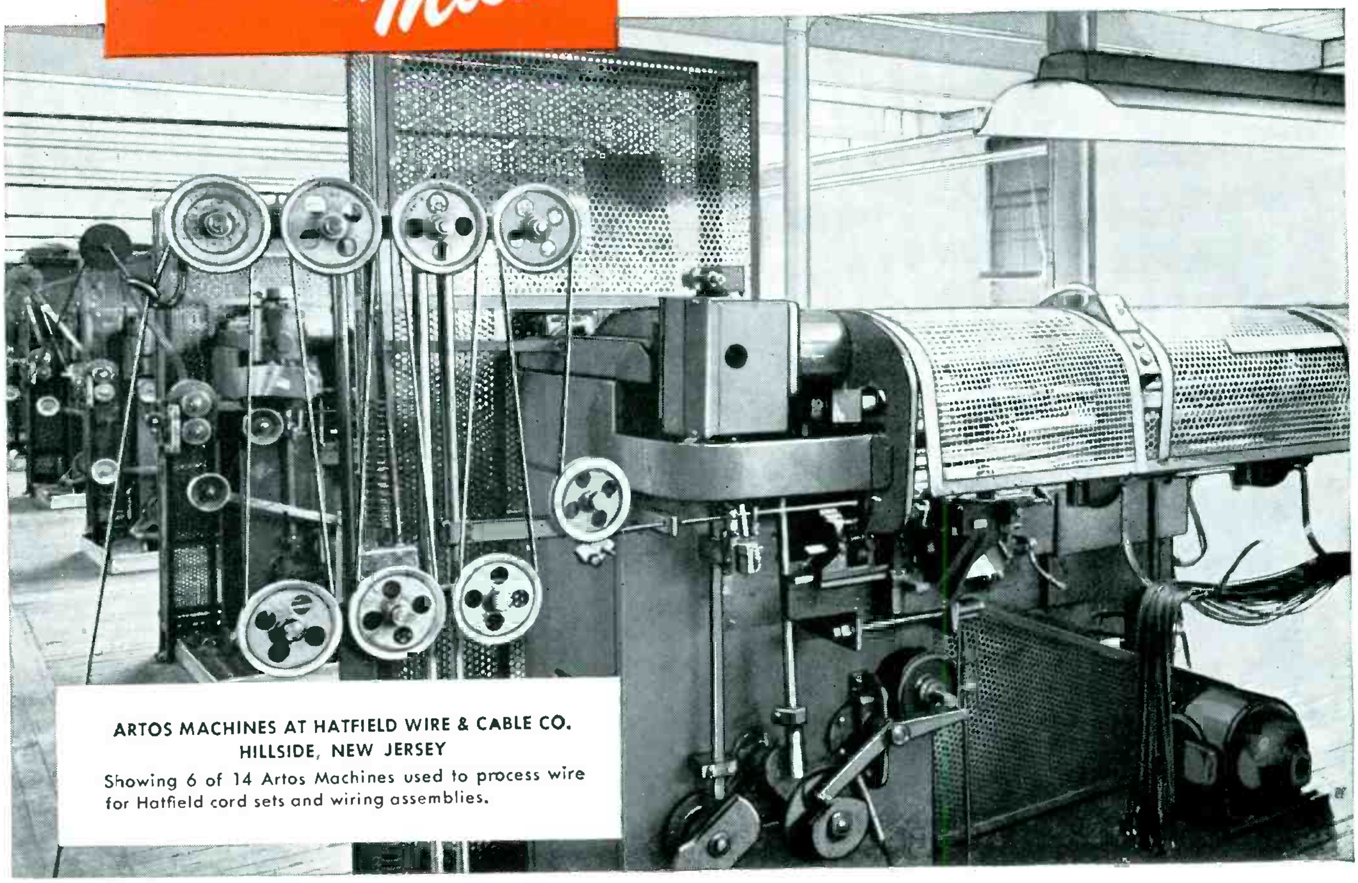
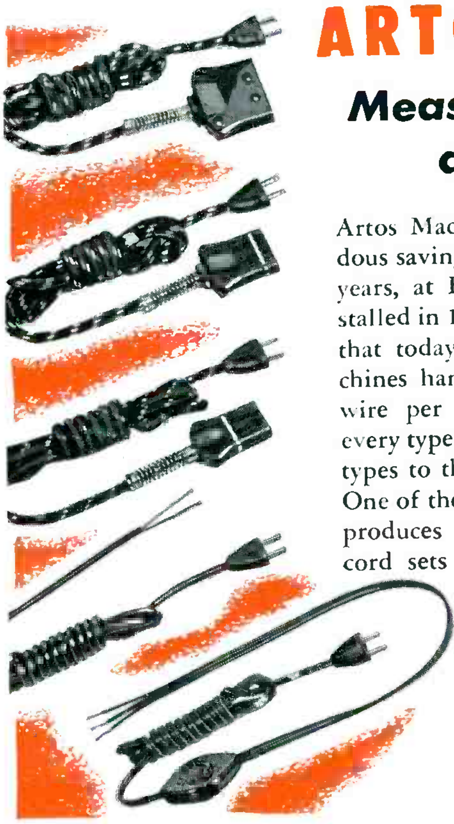


ARTOS MACHINES AT HATFIELD WIRE & CABLE CO.
HILLSIDE, NEW JERSEY
Showing 6 of 14 Artos Machines used to process wire for Hatfield cord sets and wiring assemblies.



ARTOS AUTOMATIC MACHINES

Measure, Cut, Strip over 200 Million Feet annually at Hatfield's great plant

Artos Machines have chalked up tremendous savings in time and labor through the years, at Hatfield. The first machine, installed in 1931 proved itself so conclusively that today they have fourteen Artos Machines handling over 200 million feet of wire per year. This includes practically every type of wire, from the POSJ and POT types to the heavy SJ and S types of wire. One of the leaders in the industry, Hatfield produces both special and custom built cord sets for the electrical appliance industry, including most of the larger radio and television companies. In addition, they manufacture special wiring harness assemblies, and custom-mold both rubber and thermo-plastic materials integrally to wire.

Choice of Artos Automatic Machines by such leaders in the electrical industry is effective proof of their amazing production-savings, cost-savings advantages. You'll probably find an ARTOS AUTOMATIC to match your wire cutting needs exactly. Write or wire for details.

ARTOS

ARTOS ENGINEERING CO.
2743 S. TWENTY-EIGHTH STREET, MILWAUKEE 46, WIS.

Photograph shows one man raising the kitoon in the mountain area as his partner keeps in touch with the Eugene area to determine when the kitoon is visible

for the Southern Pacific Railroad.

Engineers were confronted with the problem of determining just what locations for the three towers necessary would give line-of-sight communication. They solved the problem by employing a device known as a "kitoon". The 8-ft half-kite and half-balloon filled with hydrogen gas was sent aloft in the mountains south of Eugene. Other members of the party equipped with binoculars and field radio located at Eugene notified the mountain team when the kitoon became visible over the trees. By making appropriate markings on a cord attached to the kitoon, the proper elevation for the tower to give line-of-sight communication to Eugene was determined. The other two tower locations were determined similarly.

Unusual Photoelectric Applications

By JOHN H. JUPE
Middlesex, England

MANY INTERESTING applications of photoelectric cells have been developed in Great Britain in recent months. This article presents a brief description of a few novel applications.

Determining Color Content

A device recently developed in Britain is used to determine the color content of a sample in terms of a series of color components; red, *More* NEW UNIT INSTRUMENTS

Simple • Compact • Rugged

Interchangeable Laboratory-Type Equipment at Moderate Prices

SOME months ago General Radio announced the availability of its 'unit' line of inexpensive instruments designed for general laboratory use Each unit is complete in itself, with straightforward circuit, good accuracy, and with plug-in power supply which automatically furnishes proper filament and plate voltages

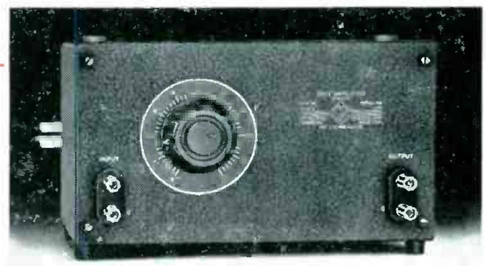
These units are electrically and mechanically interconnectable and can be combined to provide a number of essential power sources for both audio- and radio-frequency measurements. Units can be assembled to make inexpensive standard-signal generators, test oscillators, heterodyne detectors, voltage calibrators, power sources for slotted line measurements, null detectors, etc.

This line of unit instruments is inexpensive, flexible and versatile and comprises basic measuring equipment either for general laboratory use or for specialized measurements. Several new units are described in the following:

Type 1203-A Unit Power Supply This new unit supplies voltages of 6.3 for cathode heaters at 3 amperes maximum, and 50 ma at 300 volts dc, maximum. The no-load voltage is 410. Hum level is 250 mv at 300 volts and 50 ma d-c output. Connections to associated unit equipment are made through a standard multipoint connector mounted in the ends of the unit. A mating multipoint connector for connecting the supply to other equipment is furnished.
Price: $47.50

Type 1204-B Variable Power Supply This is a general-purpose variable-output power unit. It is equipped both with multipoint connectors for plugging into other unit instruments and with binding posts for connecting to other equipment. It furnishes cathode supply of 6.3 volts ac at 3 amperes maximum, and d-c plate supply continuously adjustable from zero to 300 volts with a maximum load of 100 ma. A panel meter shows the d-c output voltage and current. The hum level is 250 mv at 300 v, 100 ma d-c load. A mating multipoint connector is supplied.
Price: $85.00

Type 1206-A Unit Amplifier This unit amplifier uses two triode, RC-coupled, voltage-amplifier stages and an impedance-coupled output stage. It furnishes a maximum voltage gain of 45 db, continuously adjustable from zero with a maximum output of 3 watts into 7500 ohms, with distortion of less than 2% at frequencies above 100 cycles. The frequency response is essentially flat from 100 cycles to 100 kc.
Price: $85.00



Type 1209-A U-H-F Unit Oscillator This *new* unit oscillator has a continuous tuning range of 250 to 920 Mc. It uses a Butterfly Circuit with no moving contacts. Output coupling is a short coaxial line with a coupling loop and a G-R Type 874 Coaxial Connector. Coupling can be varied over a wide range. The calibration accuracy is ± 1%. The output power is 200 mw into 50 ohms at any frequency. Amplitude modulation of 30% can be provided from an external source of 40 volts. Input impedance is about 8000 ohms. **Price: $235.00**

Type 1214-A Unit Oscillator This new unit oscillator supplies frequencies of 400 and 1000 cycles, accurate to ± 2%. It is a convenient modulator for the Types 1208-A and 1209-A Unit Oscillators, and is widely used as a power source for bridge measurements. This oscillator contains its own power supply, unlike other G-R unit instruments. Maximum output power is over 200 mw. Output impedance is about 8000 ohms at maximum output. Open-circuit output voltage is about 80 volts. A toggle switch selects either the 400-cycle or 1000-cycle output. **Price: $60.00**

Type 1208-A V-H-F Oscillator This unit oscillator is similar to the Type 1209-A in construction and operation. The tuning circuit employs a sliding contact which makes possible a wider frequency range of 65 to 500 Mc. The frequency calibration is accurate to ± 2%. Into 50 ohms the output power is 100 mw at any frequency and 500 mw in the center of the range.
Price: $190.00

GENERAL RADIO Company

275 Massachusetts Avenue, Cambridge 39, Mass.

90 West Street NEW YORK 6 *920 S. Michigan Ave.* CHICAGO 5 *1000 N. Seward St.* LOS ANGELES 38

Other G-R Unit Instruments are under development and will be available in the future. Watch for them.

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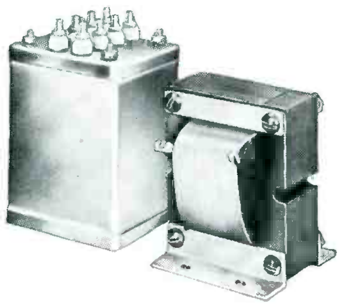
Raytheon Voltage Stabilizers, Transformers and other Magnetic Components are noted for reliability in the most exacting military service. As a leading manufacturer for 20 years, Raytheon has developed engineering and production facilities which enable it to produce highest quality components to meet the most rigid MIL requirements. Write for complete information.

VOLTAGE STABILIZERS

Precision built to provide maximum voltage stabilization with minimum variation in output voltage. An essential component for all electronic or electrical equipment requiring constant voltage for dependable, accurate operation. Available in catalog models from 15 to 2000 watts output capacity . . . or custom-engineered to suit special applications.



CUSTOM-BUILT TRANSFORMERS

Individually engineered to meet the most exacting military or commercial requirements. Typical units include: single or polyphase power transformers, pulse transformers, servo transformers, chokes, saturable magnetic components, etc. Cased or open types to meet MIL specifications as well as Underwriters' Laboratories and R. M. A. requirements.

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Raytheon Products include Mariners Pathfinder* radar; Fathometers*; radio and television receivers; tubes; microwave communications; electrostatic air cleaners; Weldpower* welders; voltage stabilizers; Recticharger* battery chargers; Rectifilter* battery eliminators; Rectiringers*; transformers; Microtherm* diathermy; fractional hp motors, and other electronic equipment.*®

Magnetic Components Division, Dept. 6460-A

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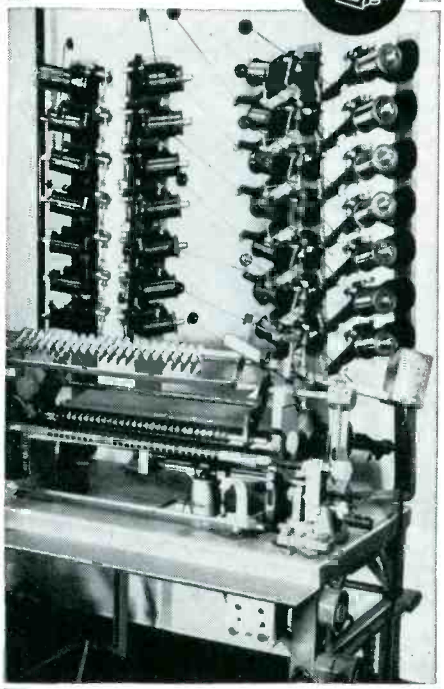
Waltham 54, Massachusetts

WIND more COILS faster

WITH YOUR PRESENT COIL-WINDING MACHINE!



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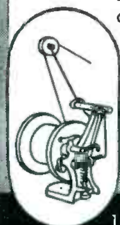
PAMARCO

Wire DeReeling Tensions for PERFECT COILS

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



PAPER MACHINERY & RESEARCH, INC.

1014 OAK STREET
ROSELLE, NEW JERSEY

blue and yellow. The equipment consists basically of a light source to illuminate the sample by transmission or reflection, a set of color filters corresponding to the chosen primary colors and a photo cell.

The color filters are mounted on a disk which is rotated at 1,500 to 3,000 rpm so that the output from the photoelectric cell varies cyclically with the filters breaking the beam of light.

A commutator is arranged to rotate synchronously with the disk and is used to connect the photoelectric cell in turn to one of a group of three amplifiers. Outputs from the amplifiers are presented on three meters and give an indication of the corresponding color content of the sample.

To enable the three amplifier systems to be adjusted for gain, a standard sample of accepted color content is used to produce standard indications on the meters.

Waveform Analyzer

A new instrument has been developed for analyzing complex waveforms although originally intended for analyzing the sea's tidal swell.

A strip chart of the waves to be analyzed is wrapped around a flywheel and is illuminated by a lamp and scanned by a photoelectric cell. Output from the cell is amplified and fed to a vibration galvanometer (or similar resonant system) set to respond to a fixed frequency of the order of 100 cycles.

At any instant, the output from the cell has a basic frequency that is determined by the speed of rotation of the wheel. Because of the complex waveform recorded on the chart, many harmonics are also present with frequencies integral with that of the wheel.

At first the wheel is rotated at a speed of about 240 rpm and is then allowed to run slowly to a standstill under the influence of friction and windage. All the wave periods which exist in the recorded waveform will become apparent in succession as the speed of the wheel falls to the rate at which the various wave periods pass resonance.

Liquid Glass Control

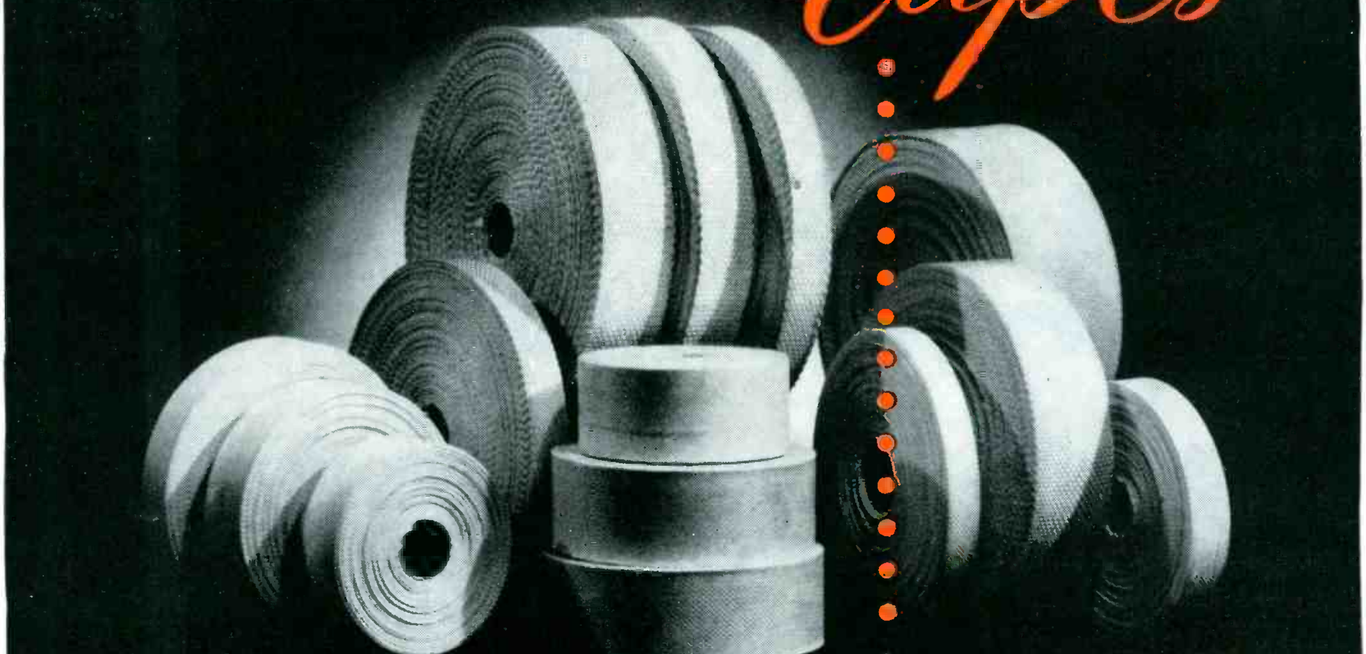
With some automatic machines used for the manufacture of glass-

MITCHELL-RAND

Electrical Insulation Headquarters

features . . .

MIRAGLAS* *tapes*



* woven of FIBERGLAS

. . . to provide the ultimate in electrical insulation

MIRAGLAS *tapes have* **HIGH TENSILE STRENGTH**

MIRAGLAS *tapes have* **GREAT DIMENSIONAL STABILITY**

MIRAGLAS *tapes resist* **EXCESSIVE HEAT · MOISTURE · OVERLOAD · ACID · DIRT**

MIRAGLAS TAPES are available in a wide variety of widths, thicknesses and styles, for practically every electrical insulation requirement where high dimensional stability and tensile strength are desired. Continuous filament MIRAGLAS TAPES are supplied in thicknesses ranging from .003″ to .015″ and in widths from ⅜″ to 1½″. Medium weave tapes, for machine taping, range in thicknesses from .005″ to .015″ while tight weave tapes for manual taping, range in thicknesses from .003″ to .007″ only. Staple fiber tapes in thicknesses from .010″ to .025″ and widths from ½ to 1½ are also available for applications where space is not a primary consideration or where a more resilient wrapper cushion is wanted.

Write for a copy of the MIRAGLAS TAPE BULLETIN
. . . also for a FREE TEST SAMPLE

MITCHELL-RAND · mr · Electrical Insulation Headquarters · SINCE 1889

MITCHELL-RAND INSULATION CO., INC.

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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 · INSULATING VARNISHES OF ALL TYPES · EXTRUDED PLASTIC TUBING

Standing
Room
Only

Sold **R**ight **O**ut

We're sorry, but we think it's only fair to tell possible new customers our Standing Room Only sign must be changed to Sold Right Out!

The design and production facilities of our microwave department are now taken over by the increasing requirements of our present customers. Because of our responsibility to them, this situation may continue quite a while.

We are sorry to say this because we enjoy making new friends. But we feel that we should tell those who might be interested in our engineering and manufacturing facilities, that for some time we may not be able to serve them.

Any change in the situation will be announced in this publication.

L. H. TERPENING COMPANY
DESIGN • RESEARCH • PRODUCTION
Microwave Transmission Lines and Associated Components
16 West 61st St. • New York 23, N. Y. • Circle 6-4760

TRADE MARK

NEW ONE-PACKAGE CONTROL SYSTEM

for
DIFFERENTIAL TRANSFORMERS
or
STRAIN GAGES
at the Flip of a Switch

DYNA-MYKE

The Dyna-Myke Model 129-B is a precision, high speed, dynamic micrometer using linear differential transformers as the sensing element. It measures and provides for recording such phenomena as force, torque, strain, vibration, acceleration, temperature, pressure, thickness, surface finish, etc., with a linear frequency response of DC to 1000 cps. Direct displacements are measured in five ranges from ±.1 inch to ±10 micro inches. On standard magnetic recorders a sensitivity of 1 micro inch per millimeter is available. A toggle switch converts the Dyna-Myke to a high frequency, high sensitivity strain gage indicator. The output is used to drive any type of magnetic, null balance or galvanometer recorder—or the DC or modulated carrier may be viewed on an Oscilloscope. Selsyn motors may be driven for remote indication or control. Request Technical Bulletin 129-B for full details.

DYNA-METER

The Dyna-Meter Model 144, when used with the Dyna-Myke, indicates by neon lights the peak amplitude of transients as fast as 1 millisecond. This indication may be instantaneous or a memory feature may be used to maintain the reading until reset. Built-in power relays provide on-or-off control to any plus or minus limits established by the Dyna-Myke. The combination of the Dyna-Myke and the Dyna-Meter offers many applications to industrial processes resulting in the elimination of scrap *at the source*. Uses in connection with machine tool operations are particularly impressive. Request Dyna-Meter Technical Bulletin 144.

Custom Builders of Electronic Instruments Since 1943

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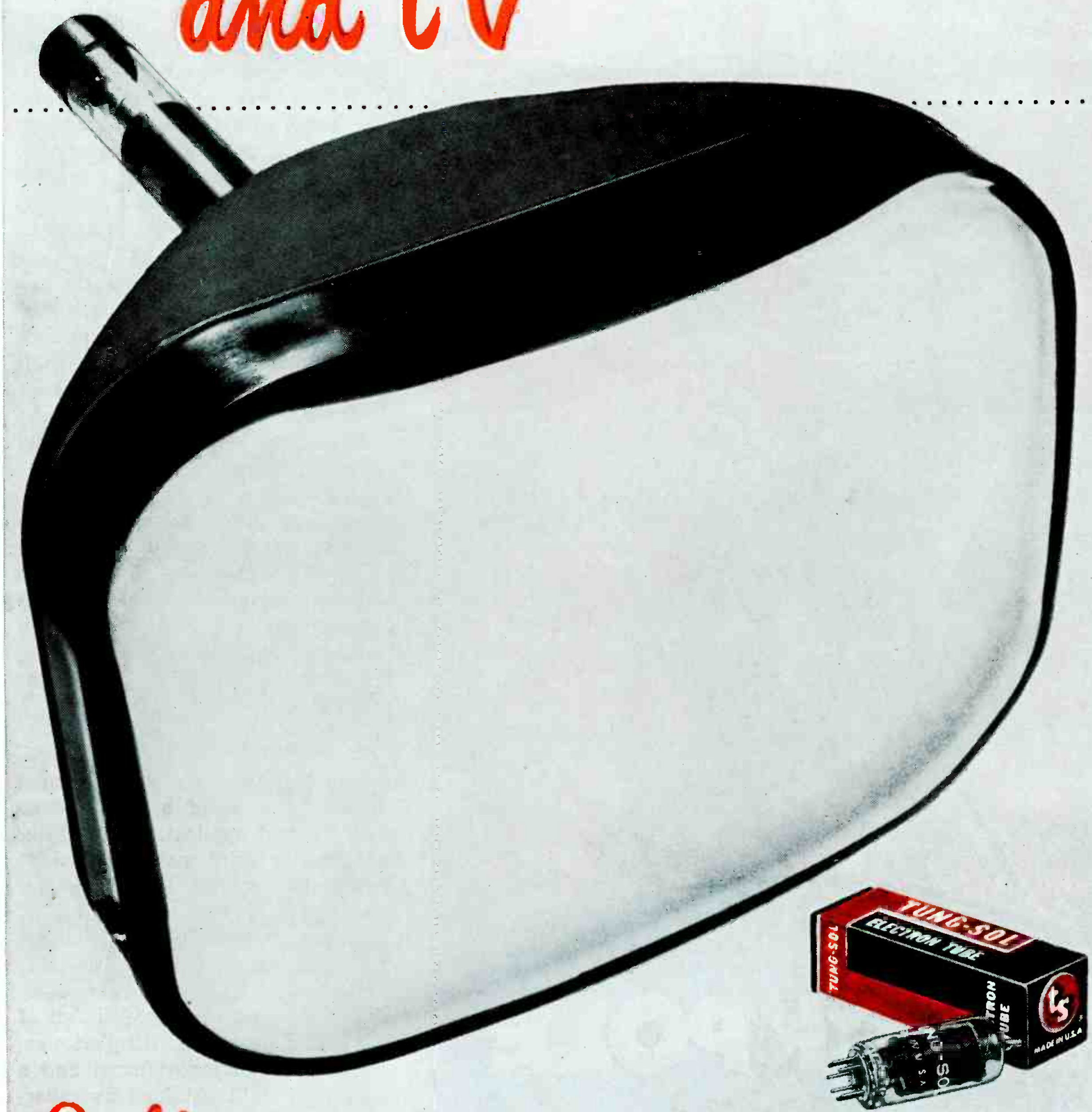
INDUSTRIAL ELECTRONICS, INCORPORATED
8062 Wheeler St., Detroit 10, Mich.

It's Tung-Sol for radio and tv



Quality -that keeps pace with the growth of the electronic industry

-that meets fully the performance requirements of all radio and tv set manufacturers

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TUNG-SOL

RADIO, TV TUBES, DIAL LAMPS

TUNG-SOL ELECTRIC INC., Newark 4, N. J. — Sales Offices: Atlanta • Chicago • Dallas • Denver • Detroit • Los Angeles • Newark

ware, it is important that the level of the glass in the melting tank should be held constant within close limits. A new method of achieving this is based on the projection of a beam of ultraviolet light onto the molten glass. The reflected light is detected by means of a photoelectric cell fitted with a filter to exclude all light except ultraviolet.

As the level of the glass drops, the angle of the reflected beam is altered and the resultant change in photoelectric current is amplified and used to control a mechanism which allows fresh materials to be run into the melting tank.

Operation of the device is not affected by light other than ultraviolet reflected from the glass because molten glass does not emit any appreciable amount of ultraviolet light and the filter excludes visible light which would influence the photoelectric cell.

An alternative to using the reflected beam is to water-cool a special metal brick built into the wall of the melting tank and so cause a dark spot. In this case, the photoelectric cell is focused on the reflection of the dark spot on the glass when the latter is at the desired level.

Chemical Process Control

Photoelectric cells have been used in many forms of bridge circuits but a recent application introduces a principle which makes the bridge self-balancing. The instrument has been devised for the control of chemical processes involving color, turbidity and so forth and is especially applicable to flowing liquids.

The essential principle is that of a Wheatstone bridge with photoelectric cells in adjacent arms and a source of light obtained by reflection from a mirror galvanometer. The width of the beam is adjusted so that it is just wide enough to cover both photocells, mounted side by side.

In front of one cell is placed a transparent vessel through which the liquid to be tested is allowed to flow. The second cell is not covered but is arranged so that when the galvanometer deflection changes, the beam of light falls onto a smaller area of the sensitive surface

WV-77A
JUNIOR VOLTOHMYST

- ✓ Sturdy 200-microampere meter movement
- ✓ Meter electronically protected against burn-out
- ✓ Metal case shields instrument from rf fields
- ✓ Carbon-film 1% multiplier resistors for lasting accuracy
- ✓ Response flat from 30 cps to 3 Mc on 3-, 12-, and 60-volt ranges
- ✓ DC input resistance, 11 megohms on all dc ranges
- ✓ Pointer can be zero-centered for TV and FM discriminator alignment
- ✓ Equipped with dc-polarity reversing switch
- ✓ Negative-feedback bridge circuit for greater stability
- ✓ More convenient . . . with new-type slip-on probe
- ✓ Polarity of ohms probe is positive . . . for checking electrolytics
- ✓ Durable, "full-view" 4½" plastic meter case

WV-97A
SENIOR VOLTOHMYST

Has all the features of the WV-77A and, in addition, the following features . . .

- ✓ Peak-to-peak direct measurement of complex waves from 0.2 volt to 2000 volts
- ✓ Has 7 non-skip ranges for resistance and voltage measurements
- ✓ All full-scale voltage points increase in a uniform "3-to-1" ratio
- ✓ Response flat from 30 cps to 3 Mc on 1.5-, 5-, 15-, 50-, 150-, and 500-volt ranges
- ✓ Covers wider ac and dc voltage ranges
- ✓ Especially useful as TV signal tracer
- ✓ Has etched aluminum panel
- ✓ Wider overlap of scales—more accurate readings
- ✓ Reads rms and peak-to-peak values of sine waves simultaneously up to 1500 volts rms and 4200 volts peak-to-peak

The dc ranges of both the WV-77A and WV-97A can be extended to 50,000 volts with accessory WG-289 High-Voltage Probe and WG-206 Multiplier Resistor. Accessory WG-264 Crystal-Diode Probe extends the frequency range of both instruments to 250 Mc.

YOUR CHOICE of 2 great RCA VoltOhmysts*

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Unquestionably the greatest value in all-electronic, ac-operated, vacuum-tube volt-ohmmeters . . . the WV-77A is factory-built and factory-calibrated against the finest laboratory standards. Comes complete with tubes, battery, probes, cables and instruction booklet . . . ready to use.

Equipped with five ranges each; for dc voltage, ac voltage, and resistance. It measures dc from 0.05 to 1200 volts; ac from 0.1 to 1200 volts rms; and resistance from 0.2 to 1 billion ohms. Superior in every respect to the famous 195-A.

*Reg. U. S. Pat. Off.

WV-97A—Especially useful for Television Servicing

The WV-97A combines in one instrument an unusual array of features of interest to every service technician.

The new Senior VoltOhmyst measures dc voltages from 0.1 volt to 1500 volts in high-impedance circuits, even with ac present. It reads the rms values of sine waves and the peak-to-peak values of complex waves or recurrent pulses, even in the presence of dc. Its electronic ohmmeter has seven ranges to measure resistances from 0.2 to one billion ohms.

An outstanding feature is its usefulness as a television signal tracer . . . made possible by its high-input resistance, wide frequency range, and direct reading of peak-to-peak voltages.

Ask your RCA Test Equipment Distributor for complete technical data folders, or write RCA, Commercial Engineering, Section 42KX, Harrison, New Jersey.

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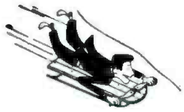
Resistance to Wear

Outlasting hardened steel and cemented carbides 2 to 5,000 times.

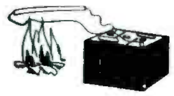


Resistance to Friction

Affording very low friction surfaces due to hardness and surface continuity.

Resistance to Heat Distortion

Retention of form at temperatures up to 1,000°C.



Retention of Insulating Properties

Excellent dielectric properties over a wide range of temperatures.

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The experience that LINDE engineers have in applying sapphire to industrial processes may be of help to you. Call or write the LINDE office nearest you. Get your copy of the booklet, "LINDE Synthetic Crystals For Industry." Ask for Form 7560.

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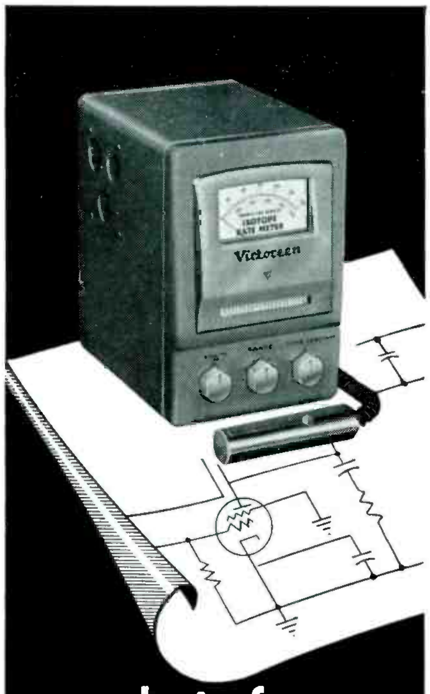

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Quality Workmanship

THE ISOTOPE RATEMETER

A New Laboratory Counting Ratemeter

The Model 524—Isotope Ratemeter is a laboratory-quality, counter-type ratemeter for detecting and monitoring alpha, beta, and gamma radiation. It has been designed for the exacting requirements of medical or laboratory personnel for use in chemical or isotope research laboratories. This instrument is applicable to civilian defense and numerous industrial requirements.

A wide selection of counting rates is provided: 0-300, 0-1000, 0-3000, 0-10,000, 0-30,000, and 0-100,000 counts per minute. Aural as well as visual presentation is featured. A three-position meter time-constant switch allows the operator to select the most desirable speed of response. The probe assembly uses standard co-axial base counter tubes and is connected to the case by means of a four-foot flexible cable. The instrument operates from a 115 volt AC supply. The rugged 10 x 7 x 8″ case is finished in gray baked enamel.

For more complete information on the Isotope Ratemeter, write for Bulletin (Form 3002-B).

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"We have found that the Heinemann Circuit Breakers are the best protection for our equipment of all Circuit Breakers which we have examined and used. Their action is always instant and positive and their performance is uniform."

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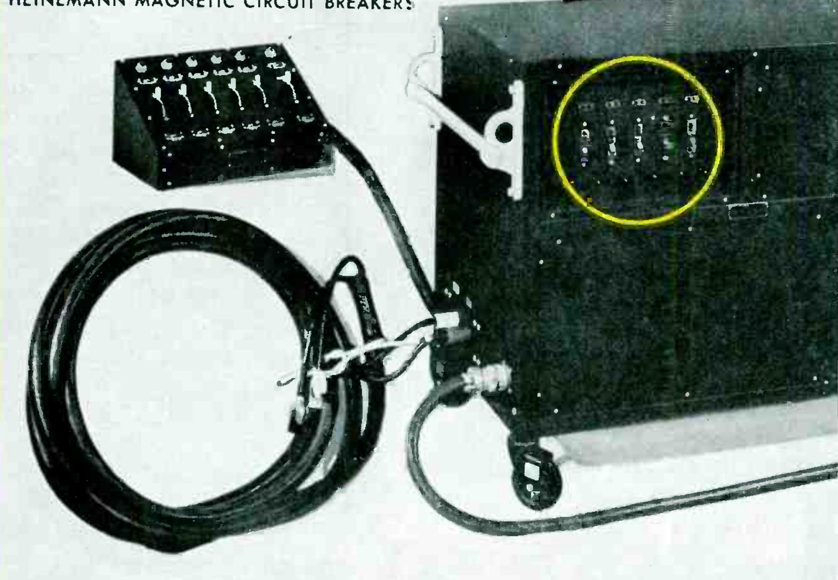
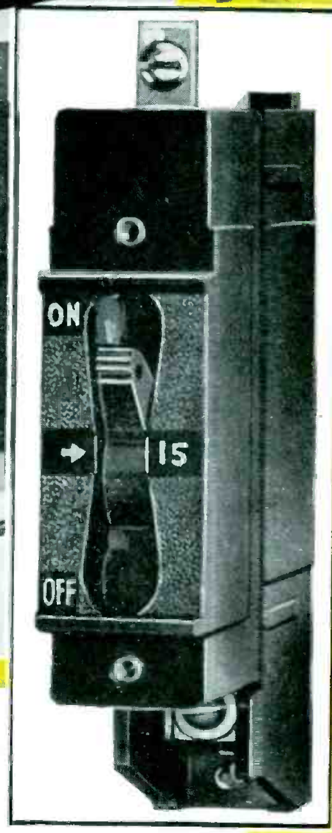




The above statement is typical of those made by users of HEINEMANN *Magnetic* CIRCUIT BREAKERS. These breakers cut off the current INSTANTLY on short circuit or dangerous overload but, where desired, are equipped with a magnetic-hydraulic Time Delay which permits passage of minor overload for a predetermined length of time.

They are FULLY MAGNETIC — they always carry full load, regardless of surrounding temperature conditions. They are NON-THERMAL — action depends on the electrical current itself, nothing else. Breakers can be designed to meet your individual requirements. Write for information. Send for Catalog.

EST. HECO 1888

HEINEMANN ELECTRIC COMPANY

97 PLUM STREET TRENTON, NEW JERSEY

of the cell. This area is illuminated in proportion to the deflection of the galvanometer.

The out-of-balance current from the cells is amplified and used to operate a recorder, as well as the galvanometer. This arrangement makes the bridge self-balancing.

Glossmeter

The measurement of gloss or shine on a painted or varnished surface is not a particularly easy quantity to evaluate and an instrument to do this has been designed by the Paint Research Station in Britain.

A parallel beam of light from a small lamp is directed onto the test specimen at an angle of 45 deg and the reflected light is picked up by a pair of photoelectric cells. One cell is arranged to receive the specularly reflected light and the other cell the light that is diffused normally to the surface. The two cells are connected in opposition, to a galvanometer, with an attenuator in the circuit of the one which receives the specular illumination. There is also a galvanometer sensitivity control.

To use the instrument, it is placed on a mat surface and the attenuator is adjusted to give a zero indication. A standard of reflectance (actually black glass) is then substituted for the mat surface and the galvanometer sensitivity control is adjusted for full-scale deflection. The instrument is then ready for readings to be taken on test samples.

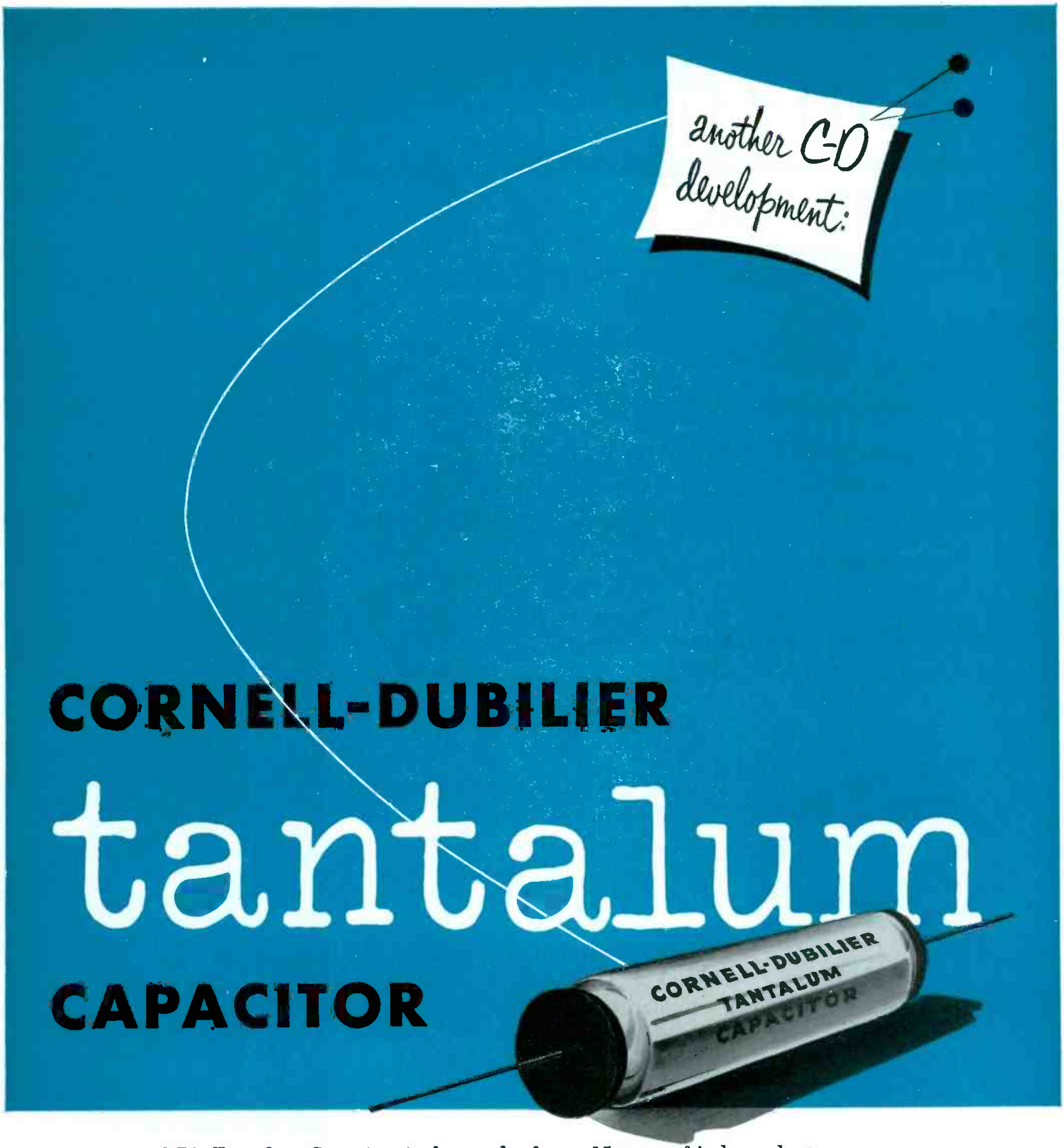
The optical system contains a plate of heat-absorbing glass and means are provided for the introduction of color filters into the light beam if desired.

Weight Checker

A new machine has been developed for checking of filled cartons leaving a weighing mechanism and uses a combination of a radioactive source and a photoelectric cell.

The radioactive source emits beta rays of sufficient power to be able to pass through an empty carton and so operate an alarm. The source is not of sufficient power to pass through a full carton. Thus, it is possible to find out whether each carton has been correctly filled.

There are two conditions which



C-D's Tantalum Capacitor is the result of over 15 years of independent research by Cornell-Dubilier engineers. Tests prove that C-D's Tantalum Capacitor has longer shelf life, lower leakage, even at +85°C and good frequency characteristics. For full details write for Engineering Bulletin No. 519, Dept. K-111, Cornell-Dubilier Electric Corporation, South Plainfield, New Jersey.

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CAPACITORS

CORNELL-DUBILIER CAPACITORS 1910-1951

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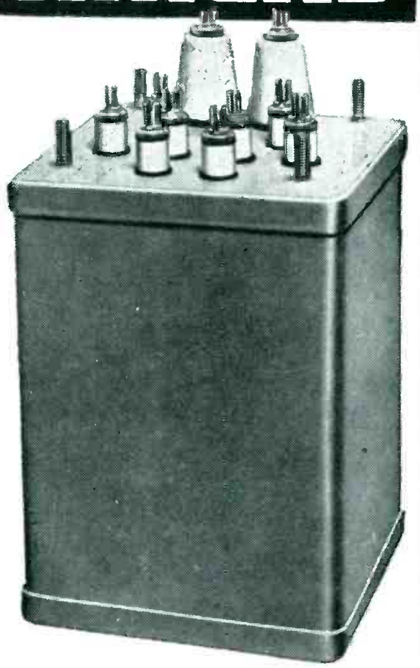
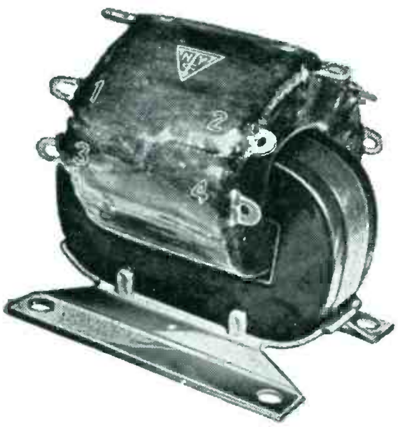
FULL RANGE OF MIL-T-27 TRANSFORMERS

HERMETICALLY SEALED UNITS



NYT hermetically sealed transformers are available in all standard sizes to meet MIL-T-27 specifications, and especially designed constructions for a wide variety of military as well as civilian applications. Designed and built to meet the most exacting specifications. Production facilities for quantity production of all sizes.



the HORNET

HORNET transformers, pioneered by NYT, are of open type construction, utilizing Class H insulating materials. Approximately one-fourth the size and weight of comparable Class A units. Filament and plate supply transformers and chokes. Units can be designed for ambients up to 190 deg. C., altitudes up to 60,000 feet; power ratings from 2VA to 5KVA.

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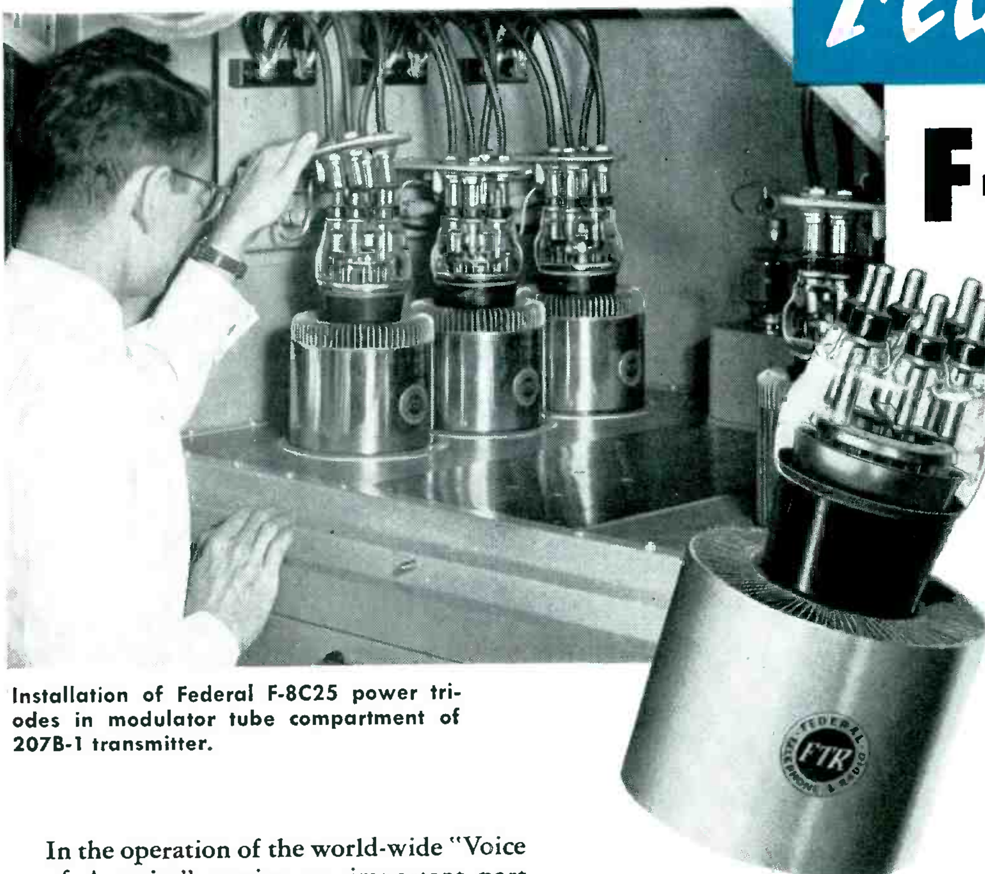
FOR THEIR 35 KW H-F TRANSMITTERS

Used in the "Voice of America" Service of the U. S. Department of State—

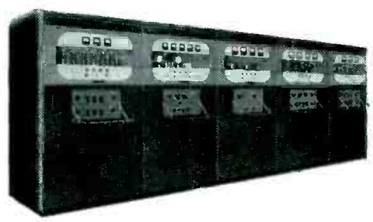
Federal's

F-8C25

POWER TRIODE



Installation of Federal F-8C25 power triodes in modulator tube compartment of 207B-1 transmitter.



207B-1 35 KW high frequency broadcast transmitter manufactured by Collins Radio Co.

In the operation of the world-wide "Voice of America" service, an important part will be played by the 207B-1, a 35 kilowatt high frequency broadcast transmitter manufactured by Collins Radio Company, of Cedar Rapids, Iowa.

In the view on the right are shown the five similar side-by-side units of the 207B-1, bolted together to form the full AM equipment.

When the time came to select a modulator tube for the 207B-1 the choice of Collins was the Federal F-8C25—a forced air-cooled triode rated at 5 kilowatts anode dissipation. The F-8C25 has a thoriated tungsten filamentary cathode, requiring lower power and providing longer service life.

Federal Telephone and Radio Corporation takes pride in having worked with Collins Radio Company to assure the ruggedness, efficiency and stability required by one of history's most important applications of radio broadcasting.

"Federal Always Has Made Better Tubes"

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AN IT&T ASSOCIATE

give false indications: spaces between cartons on the conveyor and the complete absence of a carton. To overcome this difficulty, a light beam is projected across the conveyor track and the photoelectric cell on the opposite side is interlocked with the beta-ray equipment so that the latter can only make its check when a carton (empty or full) is blocking the light beam.

Small Tubes Made by Electrodeposition

SMALL METAL tubes with diameters between 0.1 mm and 1 mm are often used in electronic instruments. Indirectly heated cathodes for electron tubes are one example.

The usual manufacturing procedure is to draw down larger tubes or to use electrodeposition on a mandrel. The first method is generally used for such alloy tubes as stainless steel but it is difficult to obtain very small diameters. The electrodeposition method may be used for pure metals. In this case, it is difficult to pull out the mandrel without destroying the tube when deposition on waxed or oxidized threads is used.

A innovation in the electrodeposition method is to use a Nylon fiber as a mandrel. Drawn Nylon fibers are obtainable in exact dimensions and have a high strength and very smooth surfaces.

Procedure

The first step taken in making tubes by the new method is to silver the Nylon fiber by the Brashar or rochelle salt method as used for glass.[1] If the Nylon fibers are dipped in a solution of one gram of $SnCl_2$ in 1 liter of distilled water and then rinsed in two baths of distilled water, a better adhesion between the Nylon fiber and silver coating is obtained. The silvered fiber is then plated to the necessary wall thickness with the desired metal. The electric circuit must be closed before the fiber is immersed in the electroplating bath in order not to destroy the thin silver coating.

The mandrel may be removed from the tube by holding one end of the tube with a pair of tweezers and

An Isotronic* First

±0.01% AC Regulation!

That's the degree of accuracy attained by Sorensen's new Model 1001 AC Line Voltage Regulator!

Heretofore, the closest regulation in commercially available regulators has been ±0.1%, regardless of manufacturer or circuit approach. Now, Sorensen's continuing study and design refinements have produced a super-accurate regulator — the Model 1001 — as a *standard* catalog item.

GENERAL SPECIFICATIONS

Load range	0 — 1000 VA
Input voltage range	95 — 130 VAC, 1ϕ, 55 — 65~
Load P. F. range	0.7 lagging to 0.95 leading
Output voltage	115 VAC, 1ϕ (adjustable from 110-120 volts)
Distortion	3% max.
Time constant	0.1 seconds
Regulation accuracy	±0.01%

The accuracy is *guaranteed* at room temperature, for a resistive load, an input variation of ±10%, and over a two-to-one load change. For *all* other conditions within the specifications, the Model 1001 has a proportionate amount of accommodation.

* Isotronics is a trade marked word pertaining to the electronic regulation and control of voltage, current, power, or frequency.

model 1001

WRITE FOR FULL INFORMATION

Note these extra features

- Combination twist-lock and double-T receptacle, or, output terminals to eliminate contact resistance.
- Three-function output switch for
  1. Normal regulator functioning.
  2. Operation with integral semi-fixed resistance in place of potentiometer.
  3. Direct load connection with the control diode for regulation of voltages other than 115 volts.
- Only FOUR vacuum tubes and NO relays are used.
- All tube filament voltages are regulated for long dependable life.

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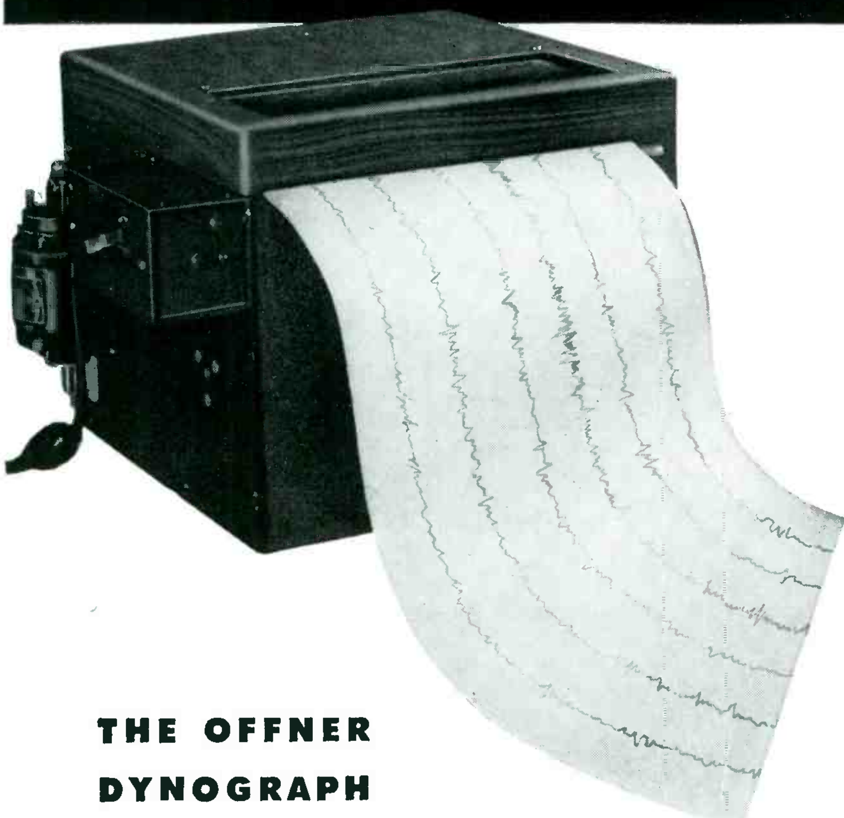

THE OFFNER DYNOGRAPH

Here's a direct writing, high speed oscillograph with microvolt d-c sensitivity—made completely drift-free through an exclusive chopper type amplifier. Now you can obtain a precise record of transient variables—some formerly recorded only by photographic means—at about 100 times the speed of other recorders with comparable sensitivity.

Remember—only the Offner Dynograph gives you all of these features:

Pen Deflection Linearity at 1% with pen response of 1/120th second.

Sensitivity of 150 microvolts d-c per centimeter of pen deflection.

No extra equipment needed with reluctance type pick-ups.

True differential input obtained through special transformer coupling.

Yes, if your need is for accurate, high speed, simultaneous recording of transients in the operation of various equipment —investigate the Offner Dynograph—write today for Bulletin L-311—see the complete specifications and construction details of the Dynograph.

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Bring your spring problems to us and be assured of unusual assistance and guaranteed satisfaction — for Lewis is geared to design and manufacture springs, coils and wireforms quickly, economically and dependably. Lewis offers:

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drawing on the free end of the fiber. The fiber will then free itself from the inside surface of the tube because it will contract without breaking. By short dipping in dilute nitric acid, the thin silver coating inside the tube can be removed if necessary.

This material was abstracted from an article by R. J. E. Gezelius entitled "Making Small Metal Tubes by Electrodeposition on Nylon Fibers" which appeared in *The Review of Scientific Instruments* for October 1950, page 886.

REFERENCE

(1) "Handbook of Chemistry and Physics," 30th Edition, p 2,537.

Universal Holding Jig

A TWENTY-POUND ball-and-socket universal holding jig consisting of a small vise mounted on a steel ball floating in a socket mounting base is being used in the production of midget and subminiature relays and holds promise for wide application in similar production work.

Universal holding jig in use on a subminiature relay production line

The vise in the jig opens and shuts by means of an eccentric cam. The steel ball is heavy enough to retain its position while permitting easy rotation of the relay to any convenient working position. The jig was developed by Potter and Brumfield of Princeton, Ind., for use on their own production and assembly lines.

SMALL PARTS

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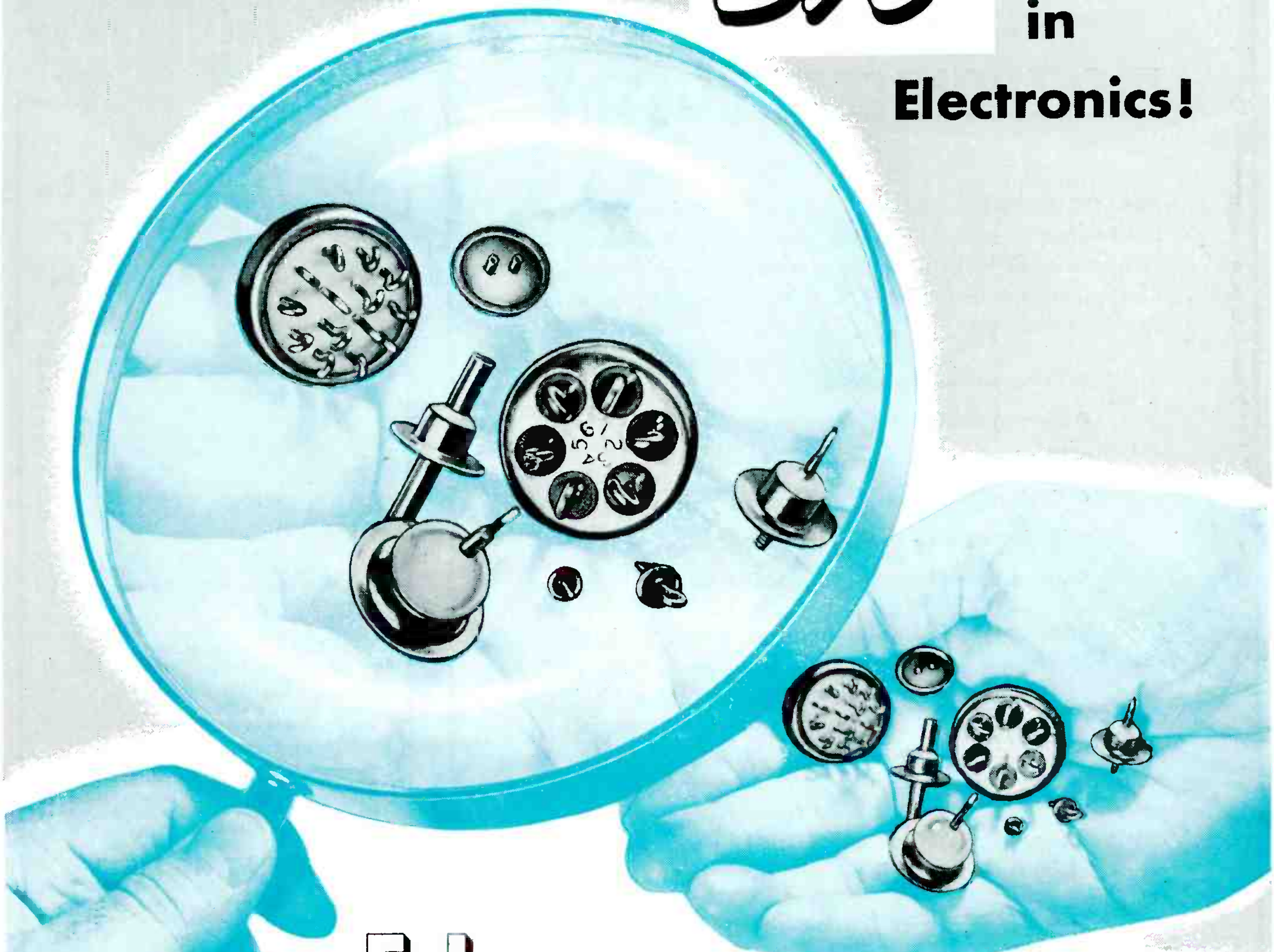

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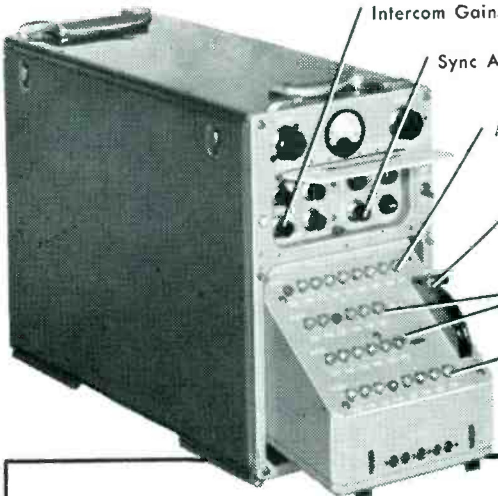

GPL VIDEO SWITCHER

- Studio switching flexibility anywhere
- Panel and active buttons internally illuminated
- Portable, self-contained — Panel enclosed for transit
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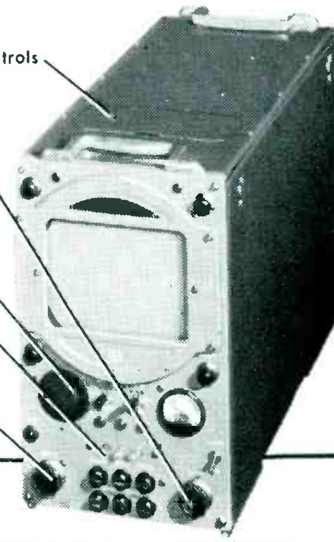
- Sound interlock switching for remotes and 2 cameras
- Two open panel positions, 90° and 120°
- Switch panel removable, operable to 5 feet
- Twin fading levers for fades, dissolves
- Two "effects" buses
- Styled to match all GPL TV equipment



GPL MASTER MONITOR

- Selection of 3 pre-set inputs
- 8½" Monitoring tube
- 3" Oscilloscope, also providing test facilities
- Meter readings of line voltage and power supply outputs
- Fast sweep for observing vertical sync block
- Quick-reference calibration voltage button
- Automatic sync of oscilloscope and kinescope sweeps at half-line or half-field frequency
- Regulated pulse high voltage supply isolated from sweep circuits
- High impedance bridging input
- Compact, portable
- Ready accessibility of all controls, tubes, circuits

For the new station, for the expanding station, GPL's champion team of Video Switcher and Master Monitor affords a new high in quality, in field flexibility, in rehearsal and programming control. Both units are packaged for easy portability, with self-contained power supplies. Either can be integrated into your present installation, can accommodate your particular operating conditions.

The Switcher and Monitor team is another example of GPL's unique achievement in the production of *high quality, high utility* equipment for TV stations — another reason why GPL *is* THE INDUSTRY'S LEADING LINE — IN QUALITY, IN DESIGN.

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TV Camera Chains • TV Film Chains
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Theatre TV Equipment

THE ELECTRON ART

(continued from p 140)

his tongue, he completes a circuit that activates the pens of a recording device. The subject is not disturbed by the passage of the minute current through his body.

The instrument has revealed several items of interest. A healthy rat will drink at the rate of six or seven laps a second, regardless of how long he has been deprived of water, or how long he has been drinking. (Humans could, perhaps, benefit from this lesson.) Also, it was found that out of a 24-hour day, rats spend only about 20 minutes quenching their thirst. Despite the foregoing revelations, the University's psychologists claim that the drinkometer has demonstrated several marked similarities between the drinking habits of animals and humans. Both have automatic mechanisms which provide thirst sensations when the body is in need of water. These mechanisms are often complicated, in the case of humans, by emotion and learning. In further experiments, Hill and Stellar, who devised the drinkometer, hope to find out what happens to the thirst mechanism of a perspiring football player who dashes off the field, gulps down a pint of ice water, and then collapses in a dead faint.

Measuring Distributed Capacitance of Coils

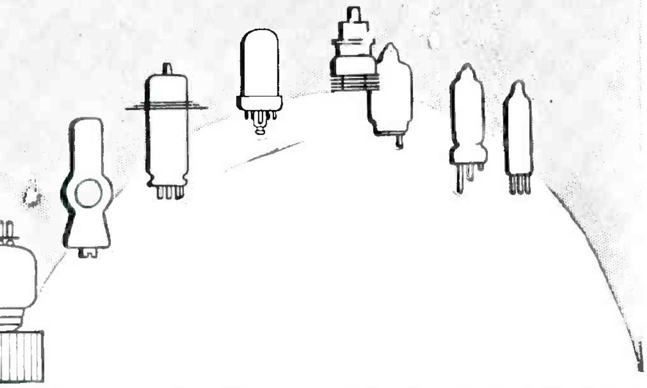
By John A. Connor*

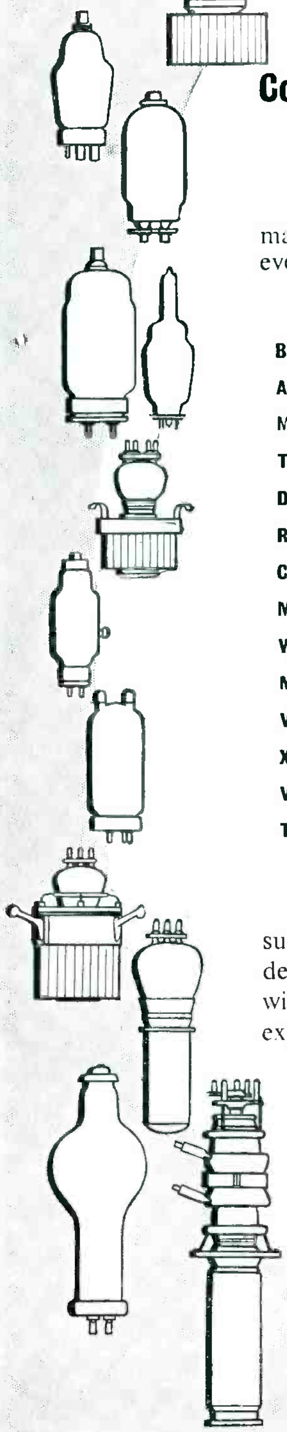
Leeds & Northrup Company
Philadelphia, Penn.

Probably one of the most obvious and direct methods of measuring coil inductance is by means of a resonant circuit. An instrument which has become accepted as one of the most flexible resonant-circuit devices is the Q-meter. When a coil is being investigated with this instrument, it is placed in series with a calibrated air-capacitor which in turn is shunted with a vacuum-tube voltmeter (see Fig. 1). At a generator frequency f which corresponds to a condition of resonance

$$\omega^2 = \frac{1}{LC} \quad (1)$$

* The work described here was done while the author was in the employ of the Naval Research Laboratory at Washington, D. C.





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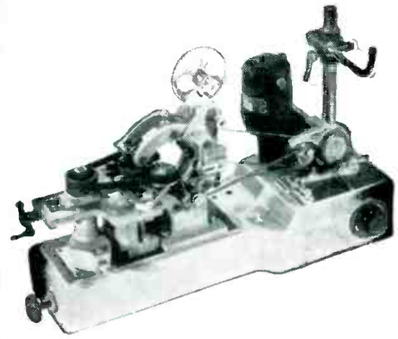

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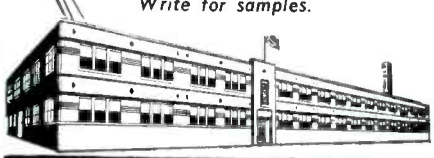

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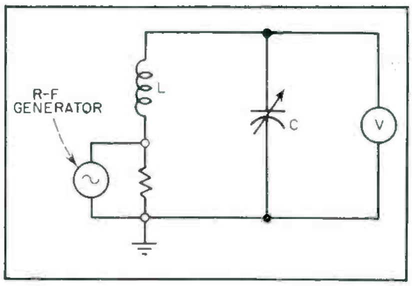


FIG. 1—Basic circuit of Q-meter method for measuring inductance

where $\omega = 2\pi f$ and L is the unknown inductance in series with the known capacitance C. If the equivalent capacitance C can be assured by means of some auxiliary calibration, the inductance L can be calculated from the known values of f and C. In this process, the value of L obtained is the equivalent series inductance as seen by the Q-meter circuit and includes lead inductances and the effects of the distributed shunt capacitance of the coil under test.

Distributed Capacitance

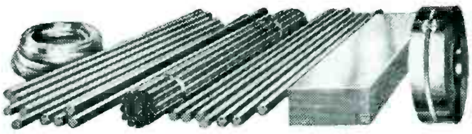
The equivalent series inductance of a coil is a circuit parameter which describes a simplification of the existing conditions. Figure 2A is an approximate equivalent circuit of a coil with distributed capacitance C_o within the coil and some distributed capacitance C_p due to external connecting leads. Since this is an intermediate simplification of the true nature of the distributed capacitance into equivalent lumped circuit constants, one more simplifying step can be taken to arrive at the equivalent of Fig. 2B. Thus, the unknown coil can be viewed as a coil with a true inductance L_t shunted by an equivalent distributed capacitance C_d. However, the resonant measuring circuit only identified the magnitude of the equivalent series inductance L_e of Fig. 2C. The relation between L_t, C_d, and L_e is immediately seen from equating the impedance of the networks of Fig. 2B and 2C. Thus

$$j\,\omega L_e = \frac{j\,\omega L_t\left(-j\,\frac{1}{\omega C_d}\right)}{j\,\omega L_t - j\,\frac{1}{\omega C_d}} \qquad (2)$$

or

$$L_e = \frac{L_t}{1 - \omega^2 L_t C_d} \qquad (3)$$

From this relation it is seen that



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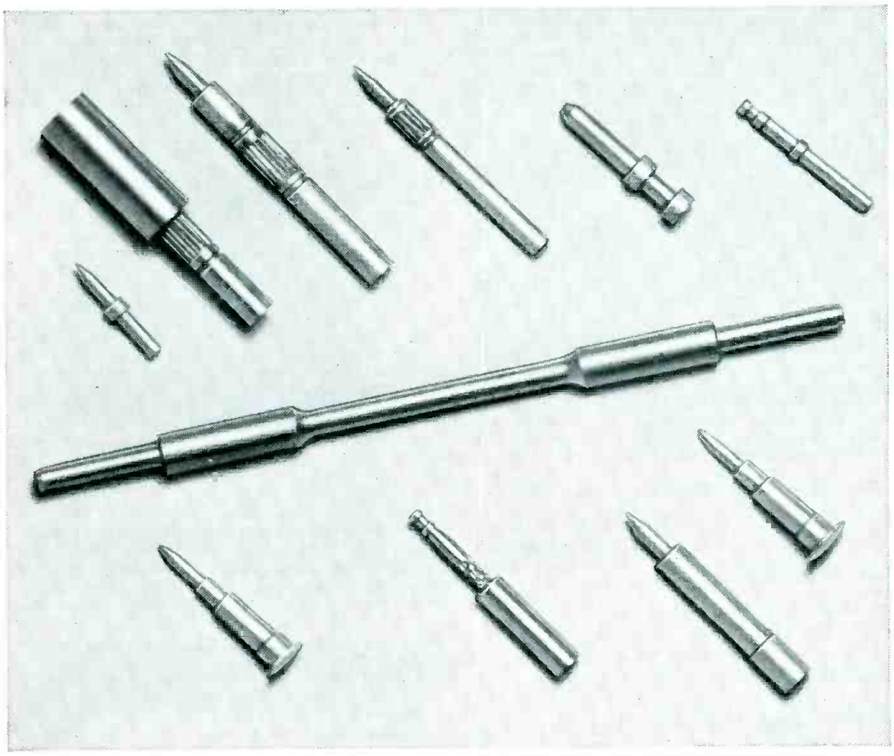


Examples of small parts produced accurately and economically on Swiss screw machines. Tapers on some parts generated on cutoff end to eliminate secondary machining operations. Courtesy Newtown Mfg. Co., Newtown, Conn. *(samples enlarged 35%)*

Taper Generated to Eliminate Secondary Machining Operation

Parts such as firing pins for fuses or electronic terminals with tapered points on one end, as well as operations on the opposite end, are often completed in the primary operation on Swiss screw machines. This is accomplished by generating the point on the cutoff end. Previously, this part was completed in a secondary operation.

In generating a taper, a single-point tool is used. The stock feed cam and the tool feed cam are synchronized to produce the required angle. Since the pressure of the single-point tool is almost negligible when compared to a broad-forming tool, distortion of the part is thereby reduced to a minimum, if not completely eliminated, and smoother finishes are obtained.

Unleaded Brass Used

The part in the lower right corner is a good example of such work. It is made from high brass rod (65% copper, 35% zinc) drawn to a spring temper. Without lead this alloy is generally not used in screw machines as the chip is long and stringy. However, the alloy and temper was used to obtain higher tensile strength and greater wearing qualities.

The overall length is .900 in. with one diameter .135 x 3/16 long, another .120 x ½ and the tapered diameter .065 x 7/32. A .090 drilled hole is put in the .135 diameter.

Drill Edges Rounded Over

The cutting edges of the drill were rounded over to produce a negative rake, thus causing the chip to come out in a long, unbroken curl. In this way clogging by chips was eliminated and drill breakage reduced.

In rounding over the cutting edge of the small spiral drills, it was found that a diamond wheel produced a finer finish which decreased the friction and also produced a cleaner hole. Care must be taken to prevent burring of the cutting edge.

Carbide tools were used on all the parts and only standard twist drills were used rather than the flat gun drill.

The cutting compound used was a heavy sulfur-base oil. The work discolored but tarnish was removed by dipping.

The difficulty of centering accurately prior to drilling was overcome by using a fixed cutting tool from the overhead post. By accurately turning the center, the possibility of the drill walking and breaking was considerably reduced.

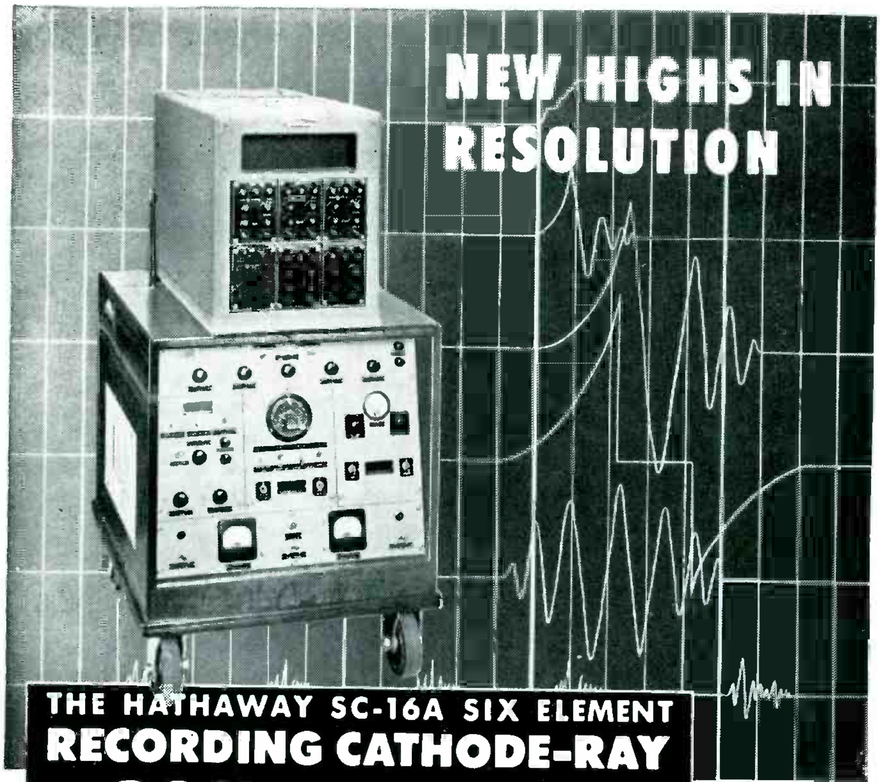
A spindle speed of 10,000 rpm was used with a feed of about 0.0009. For a better finish the feed can be reduced to around 0.0005.

Double Feed-Out Utilized

The length of the part in the center of the illustration theoretically was too great for the machine which matches the diameter of 5/32. However, by feeding twice without cutting off and supporting the work from the turret, it was possible to turn the three diameters, then cut off.

In cutting either leaded or unleaded copper-base alloys, no top rake was used and the clearance angles were between 5 and 10 degrees. High finishes were obtained by slightly breaking the edge of the cutting tools.

For information on the cutting characteristics of various alloys and information on machining them, write on company letterhead for Bridgeport Brass "Technical Handbook." If additional help is needed, contact our Laboratory. (7281)



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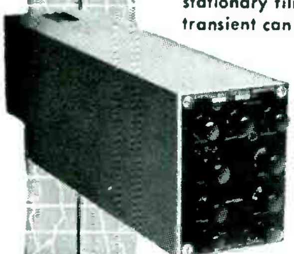

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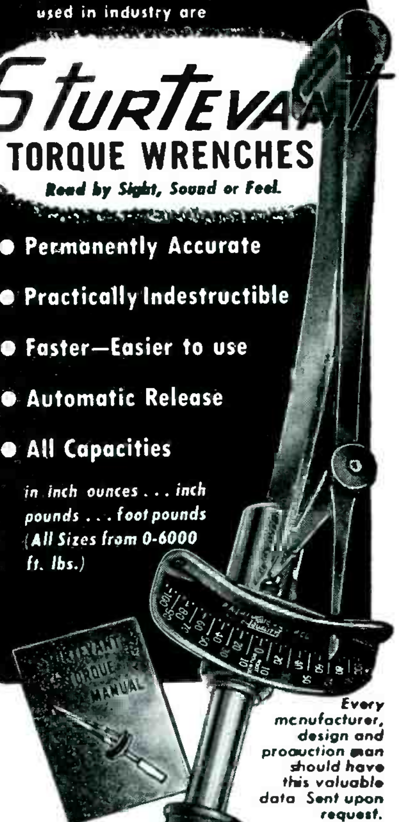

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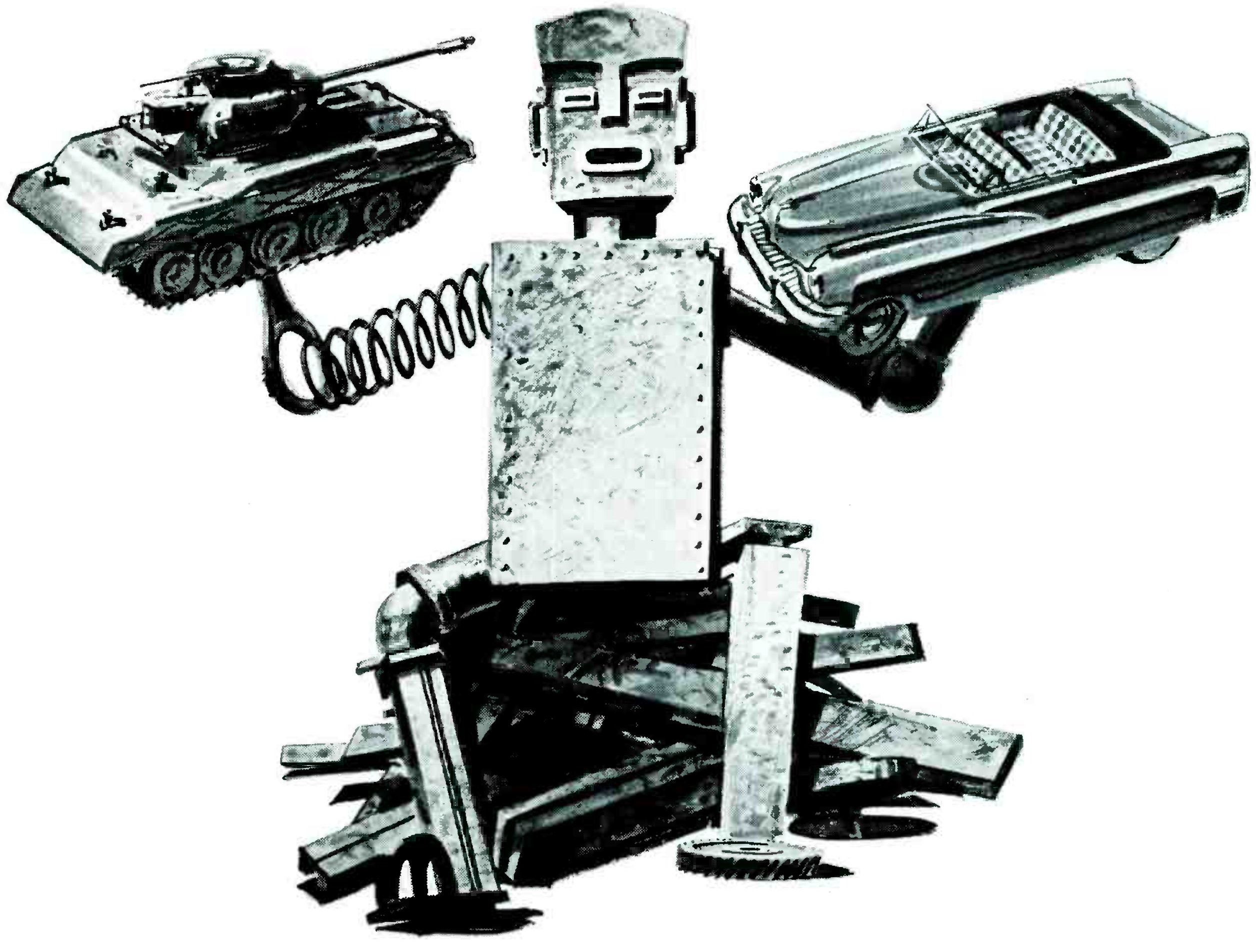

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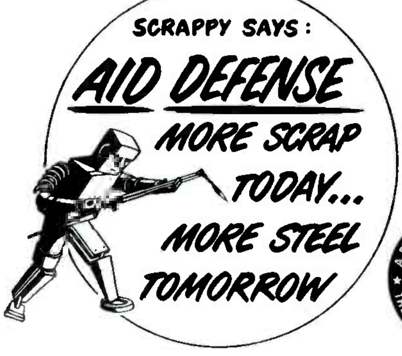

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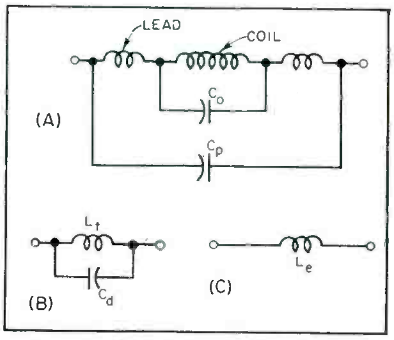

FIG. 2—Simplifying equivalents used in calculation of distributed capacitance

the distributed capacitance C_d is an intrinsic characteristic of the coil which may have considerable significance. Once the values of L_t and C_d are known, self-antiresonance of the coil can be predicted; the true coil inductance can be employed in the determination of the properties of magnetic materials used in the coil construction; and the efficacy of a coil design can be appraised in terms of the relative magnitudes of L_e and L_t.

Measurement of Coil Capacitance

The distributed capacitance C_d of Fig. 2B is an intrinsic part of the same structure which provides the inductance L_t, and cannot be measured directly. If the equivalent circuit of Fig. 2B is substituted for the inductor L of Fig. 1, it is seen that C_d will essentially shunt the resonating (standard) capacitance C. Thus, at resonance

$$\omega^2 = \frac{1}{L_t (C + C_d)} \qquad (4)$$

In this expression, only ω and C are known quantities, leaving the two unknown values L_t and C_d. Both of these unknowns can be determined by providing two independent conditions of resonance at frequencies corresponding to ω_1 and ω_2 with resonating capacitance values of C_1 and C_2. Thus, if L_t can be assumed to be constant over the frequency range involved,

$$\frac{1}{\omega_1^2 (C_d + C_1)} = \frac{1}{\omega_2^2 (C_d + C_2)} \qquad (5)$$

from which

$$C_d = \frac{C_2 - \left(\frac{\omega_1}{\omega}\right)^2 C_1}{\left(\frac{\omega_1}{\omega_2}\right)^2 - 1} \qquad (6)$$

For the sake of simplicity, a frequency ratio of 2 to 1 is often se-

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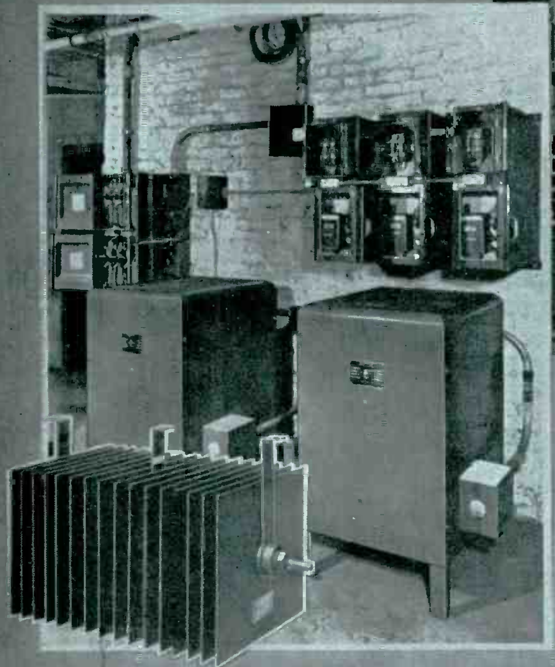

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Chicagoan Hotel	3 ea. 27½ KW	4
1320 North State Building	2 ea. 40 KW	4
Canterbury Apts.	3 ea. 14 KW	3
241 Van Buren Street Building	2 ea. 20 KW	3
Superior Elevator Co.	[illegible] ea. 7 KW	1
142 E. Walton Building	[illegible] ea. 7 KW	1
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Western Electric Building	2 ea. 20 KW 1 ea. 14 KW 1 ea. 10 KW	5
Gozzola Drug Company	1 ea. 10 KW	1
A. Rubloff Building	3 ea. 14 KW	4
Goldenberg Furniture Company	1 ea. 10 KW	1
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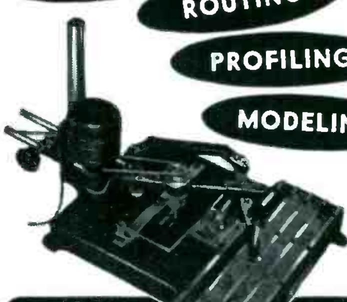

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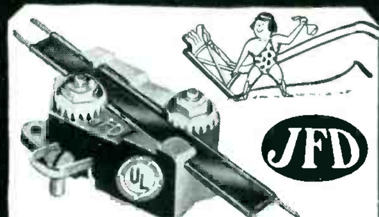

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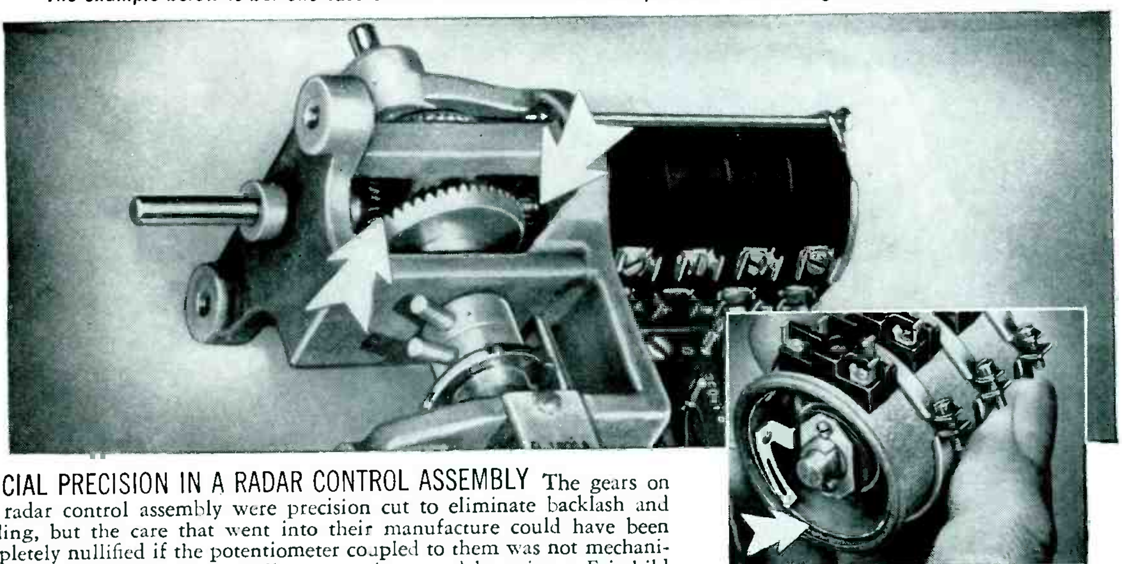
The example below is but one case of how this extra mechanical precision assures highest electrical accuracy.



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Like all Fairchild potentiometers, this one has a shaft that is centerless ground from stainless steel to a tolerance of +.0000, −.0005 inch. Its radial shaft play is held to .0015 inch F.I.R. or better and concentricity of shaft to pilot bushing is .0025 inch F.I.R. or better, depending on type. Shaft to mounting-plate squareness is held to .001 inch per inch.

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lected for the two resonant conditions. In such a case, ω_1/ω_2 of Eq. 6 will equal 2 and

$$C_d = \frac{C_2 - 4\,C_1}{3} \tag{7}$$

which represents a convenient equation for the measurement of the distributed capacitance of coils. The measurement process is simply one of establishing resonance at any frequency and recording the capacitance as C_2. Doubling the frequency, the new resonant capacitance is recorded as C_1 and Eq. 7 is applied to find C_d. For some distributed-capacitance measurements, the selection of frequencies with a nominal 2 to 1 ratio is adequately precise. In such cases the use of the distributed capacitance curves of Fig. 3 will be found quite useful. It is

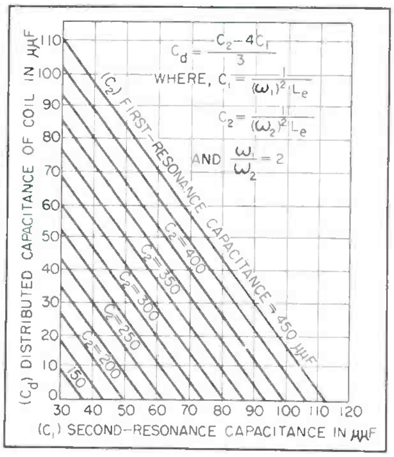
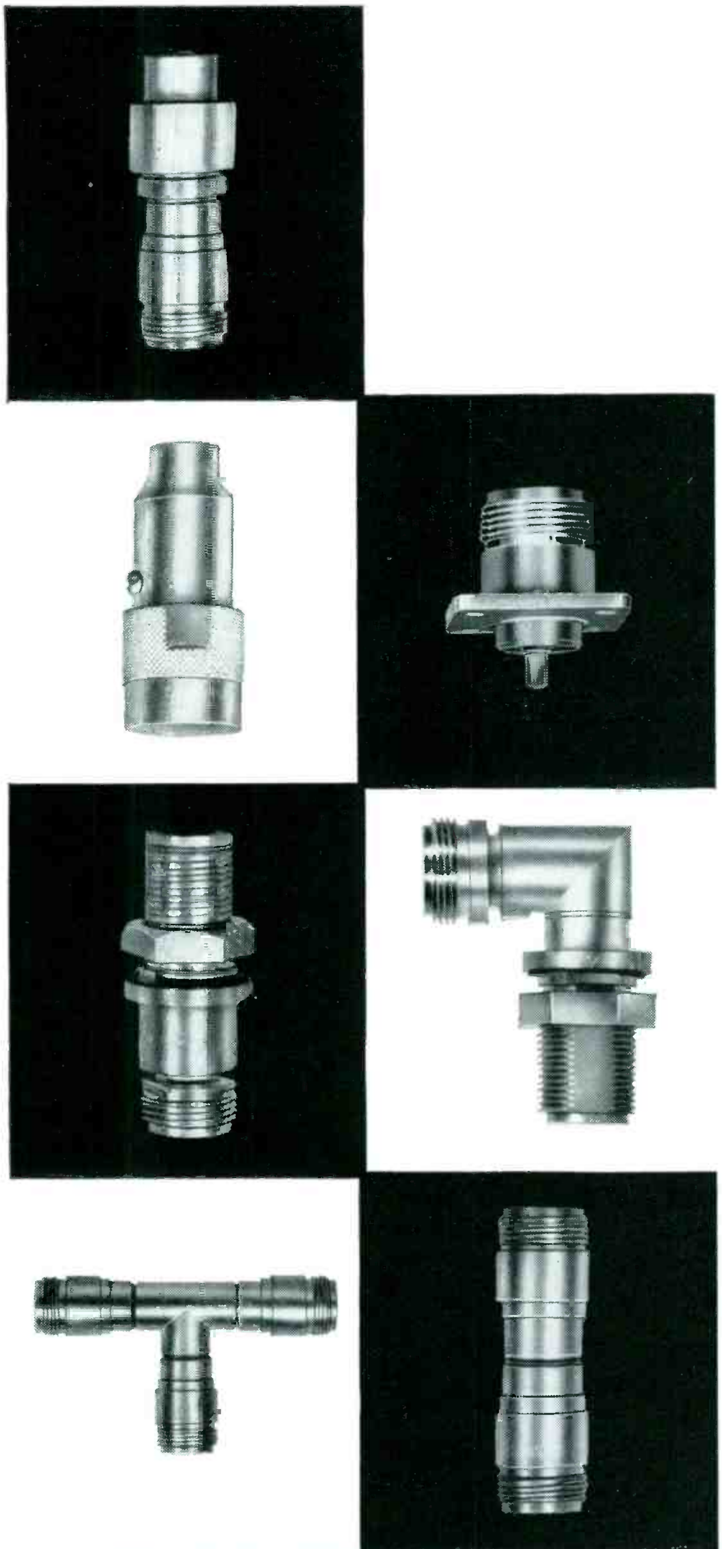


FIG. 3—Distributed capacitance curves

the purpose of this paper to show how more precise measurements of C_d can be made by means of establishing a nearly exact frequency ratio of 2 to 1.

A More Precise Method

A method of obtaining two resonant conditions at a frequency ratio of 2 to 1 can be devised by using the fact that even a good r-f oscillator usually generates some second-harmonic signal. If a Q-meter is resonated at a frequency f it may be re-resonated at a frequency of $2f$ if some auxiliary circuit is provided to remember twice the initial frequency. This can be accomplished by means of the arrangement shown in Fig. 4. The receiver is tuned to the second harmonic of the Q-meter oscillator without the use of a bfo signal. The auxiliary oscillator is



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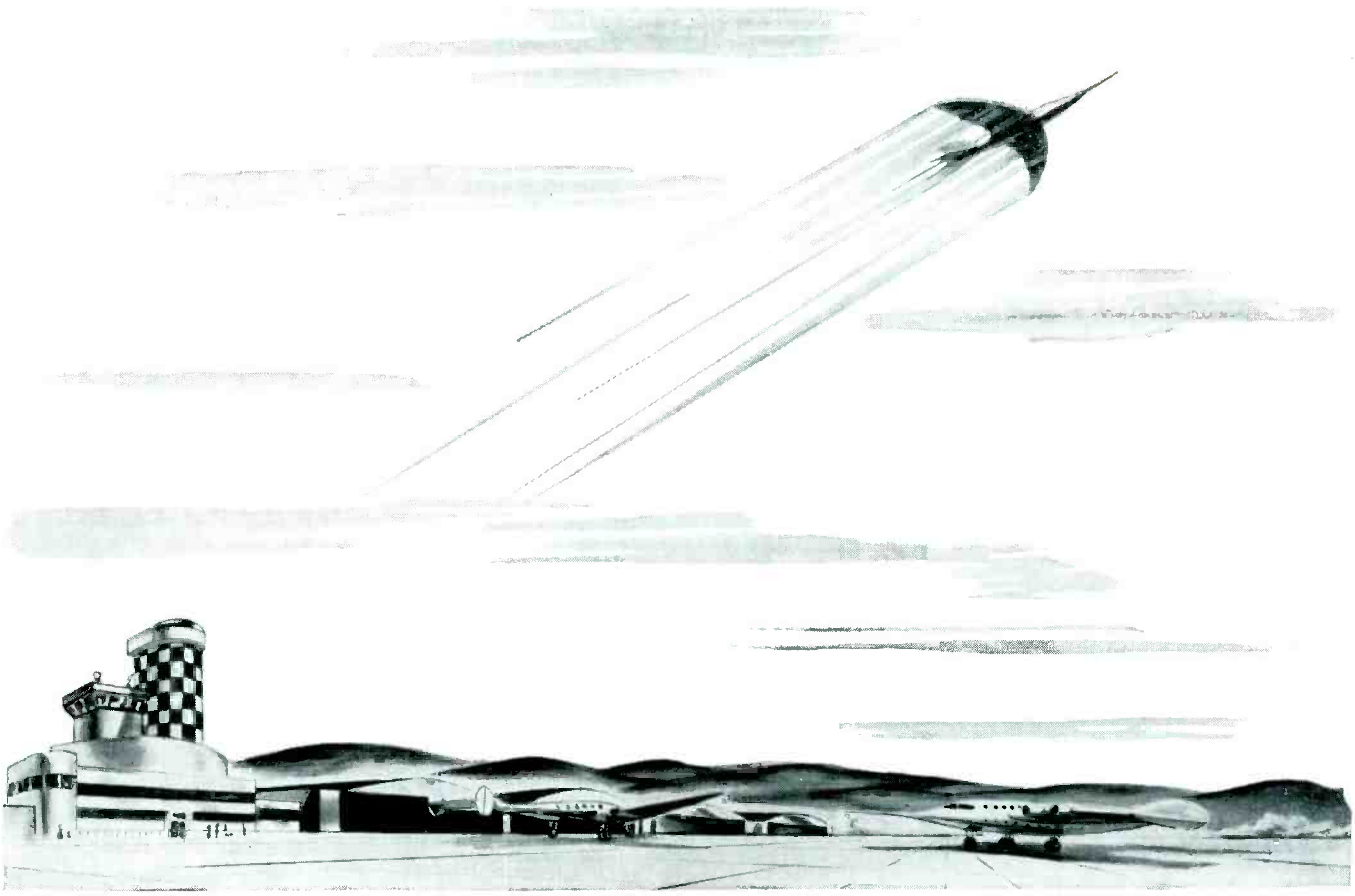

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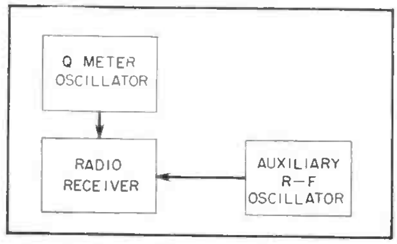


FIG. 4—Block diagram of precise system for determining distributed capacitance of a coil

then also tuned to this frequency and zero-beat with it. The auxiliary oscillator then acts to remember the exact second-harmonic of the initial Q-meter frequency and the second resonance of the Q-meter provides a highly precise ω_1/ω_2 ratio of 2 to 1.

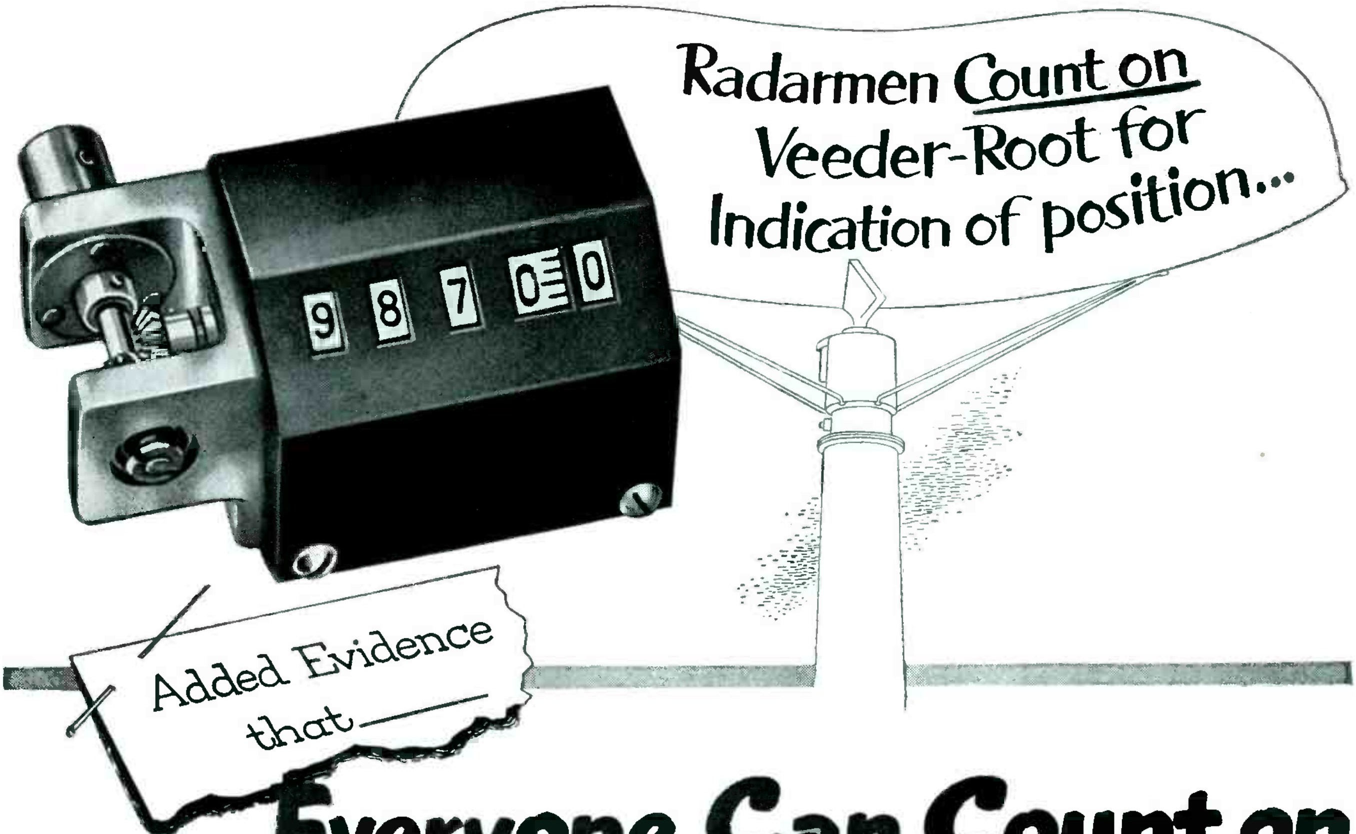
The success of this refined technique of measuring coil distributed capacitance can be best illustrated by means of the data given in Table I. These data show the comparable consistency of a measured value of C_d in the two cases where (1) the Q-meter frequency ratio of 2 to 1 was set by means of its own dial, and (2) the harmonic method was used to set a frequency ratio of 2 to 1.

Absolute Values

The absolute values of capacitance C_1 and C_2 given in Table I were all derived from a precise external calibration for both the normal and harmonic methods. In the normal method, an oscillator calibration was made against an outside standard to a degree as precise as the dial calibration markings would warrant. It is seen from Table I that the data dispersion for the harmonic method is bracketed by a

Table I—Comparison of Normal and Harmonic Methods for Measuring the Distributed Capacitance of Coils

Freq. (kc)		Normal Method ($\mu\mu$f)			Harmonic Method ($\mu\mu$f)		
f_1	f_2	C_1	C_2	C_d	C_1	C_2	C_d
150	75	36.2	169	7.9	37.0	174	10.6
140	70	41.4	194	9.3	43.7	201	10.6
130	65	49.3	226	9.7	52.5	235	10.3
120	60	60.5	265	7.6	63.2	278	10.0
110	55	71.8	315	0.1	76.5	332	10.6
100	50	89.6	389	10.0	93.8	400	10.3



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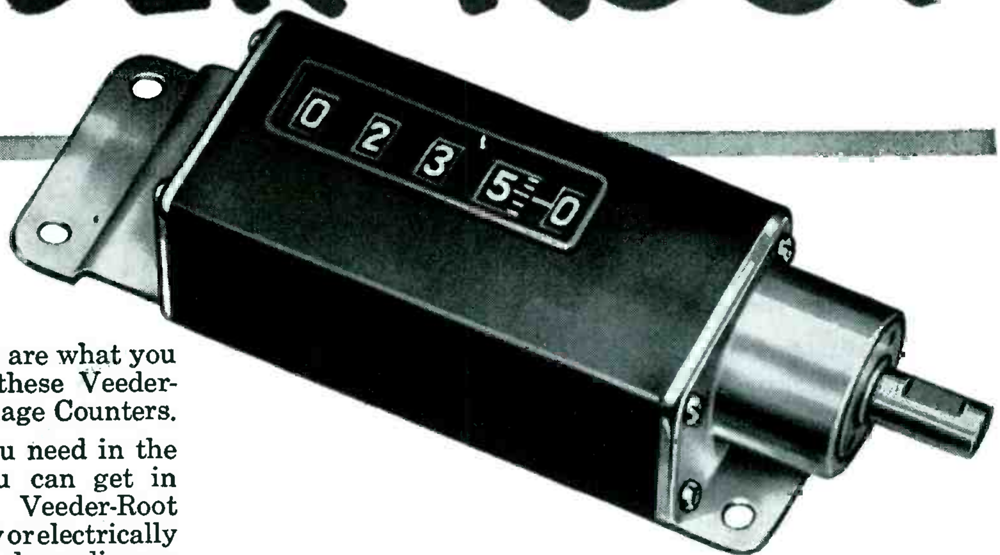

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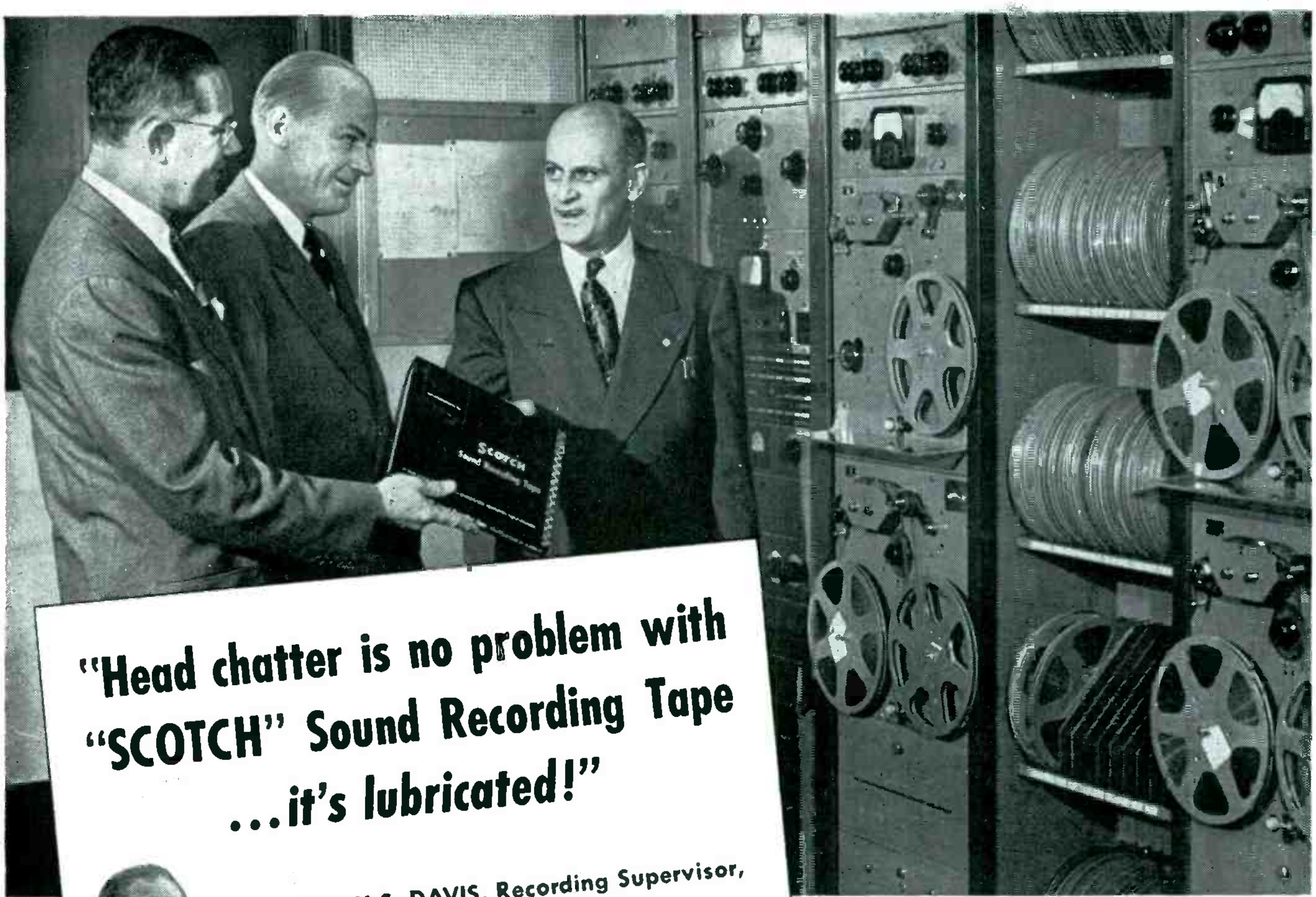

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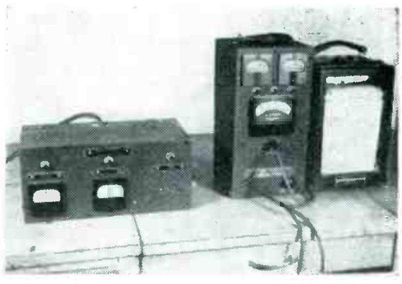
value of C_d of 10.3 $\pm$0.3 $\mu\mu$f, while the normal method gives 8.8 $\pm$ 1.2 $\mu\mu$f. This corresponds to measurement consistencies of about 3 percent against 13 percent, a worthwhile improvement in the measurement result. This refinement in the Q-meter technique of measuring the distributed capacitance of coils is one which is readily adapted to r-f measurement laboratory procedures and is capable of providing more reliable coil data for use in inductor investigations and development.

Spark Outage Recorder For High-Voltage Systems

By Murray Bevis
Vice President
Special Instruments Laboratory
Knoxville, Tennessee
and
J. D. Trimmer
Physics Department
University of Tennessee
Knoxville, Tennessee

Measurement of the outage time resulting from sparks in d-c high-voltage systems is most conveniently accomplished by counting the number of sparks and multiplying by an average figure of outage time per spark. However, where there is uncertainty about the reliability of such an average outage time figure per spark, direct measurement of outage by instrument recording has proved preferable.

Figures 1 and 2 show the wiring diagrams of a recording, and of an integrating, outage measuring instrument. The outage recorder gives a record of percentage outage time covering the immediately preceding interval of time. The outage integrator totalizes the outage time on a counter. A photograph below shows the two instruments set up and ready for operation as ex-



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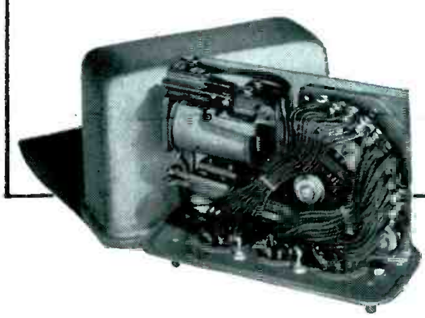

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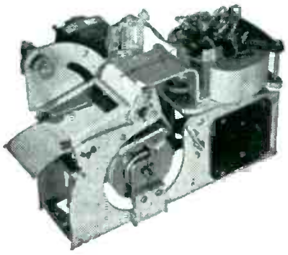
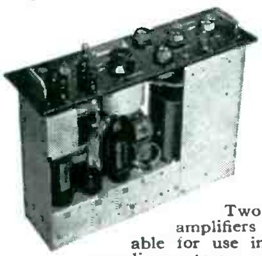
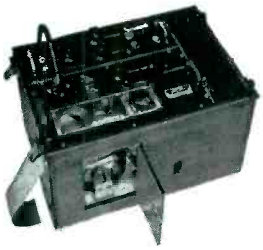


In all Sanborn recorders, tracings are produced by a heated writing stylus in contact with heat sensitive, plastic-coated paper. The paper is pulled over a sharp edge in the paper drive mechanism, and the stylus wipes along this edge as it swings; thus producing records in true rectangular coordinates. The writing arm is driven by a D'Arsonval moving coil galvanometer with extremely high torque movement (200,000 dyne cm/cm deflection). Standard paper speed for the Model 51-600 recorder assembly, shown above, is 25 mm/sec. Slower speeds are available. Paper width 6 cm with 5 cm recording area. The assembly shown above is used in Models 128 and 141 (described above right) and provides the basic principles and methods on which recorders for the 2- and 4-channel systems are designed.



Two types of amplifiers are available for use in Sanborn recording systems — a DC General Purpose Amplifier, and a Strain Gage amplifier (shown above). The amplifiers used in the 2- and 4-channel systems are generally identical with those in the 1-channel system, which are available, as are also all the recorders, for separate application.

1 CHANNEL RECORDING SYSTEMS



Model 128 comprises a DC General Purpose Amplifier in combination with the Recorder Assembly shown below left, to which is added panel, transformer, and controls. Both instruments are contained in a single hardwood carrying case. The complete system is a vacuum tube recording voltmeter capable of reproducing in rectangular coordinates any electrical phenomena from the order of a few millivolts to more than 200 volts. When a Strain Gage Amplifier is specified, the system becomes Model 141. Amplifiers are readily interchangeable. When a built-in timer is included for either, the Model numbers become 128T or 141T.

2 CHANNEL RECORDING SYSTEMS

The two channels of **Model 60** operate independently of each other, but record simultaneously. Ten paper speeds are standard equipment, in pairs of: 5 and 0.5, 10 and 1, 25 and 2.5, 50 and 5, 100 and 10 mm/sec. Ready interchangeability of amplifiers (DC and Strain Gage) and preamplifiers (DC and AC) makes possible the availability of a variety of input circuits. Timing and coding are built-in features. Each channel has a 5 cm recording width.

4 CHANNEL RECORDING SYSTEMS

Model 67 provides for the direct, simultaneous registration of up to four phenomena on one record, using the same principles and methods as the two systems described above. In addition, there is a selection of eight paper speeds: 50, 25, 10, 5, 2.5, 1.0, 0.5, and 0.25 mm/sec., and provision for the use of 4-, 2-, or 1-channel recording Permapaper. As in Model 60, above, amplifiers and preamplifiers are readily interchangeable.

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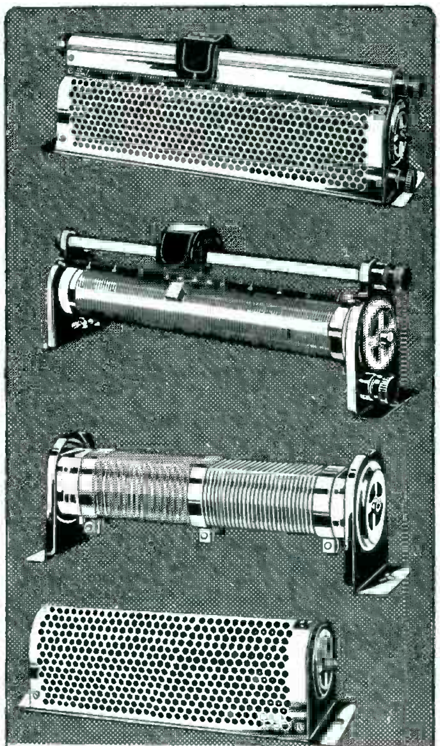

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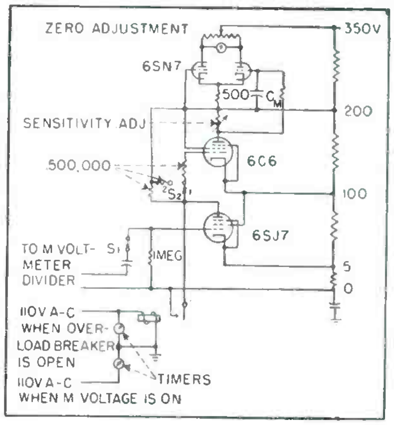

FIG. 1—Simplified diagram of spark outage recorder

plained in the following text.

Referring again to Fig. 1 and 2, it may be seen that both instruments function in terms of the charge on a capacitor, designated C_M in both diagrams. In both cases, moreover, C_M is given a certain charge through a 6C6 pentode each time a spark occurs. In the integrator this charge accumulates until sufficient voltage is built up to fire the VR-105, which in turn triggers the 2050 and registers on the counter. In the recorder C_M is shunted by a resistor, so that its voltage at any instant is an average value reflecting the number of sparks in the immediately preceding interval of time. Changes in this voltage cause an unbalance in the 6SN7 circuit and consequent deflection of the recording milliammeter. The 6C6 is completely cut off except when a spark occurs, at which time the 6SJ7 is driven from its normally conducting state to cutoff and beyond, causing the 6C6 grid to be driven positive. Thus the 6SJ7 and the 6C6 function as gross switching devices, so that their detailed d-c characteristics can have only small, second-order effects.

In addition to the means of charging the capacitor C_M, the means of indicating the amount of its charge must be considered in relation to stability and accuracy. In the recorder the balanced 6SN7 circuit is of course subject to some d-c drift, but tests have shown this to be over a period of weeks of smaller magnitude than would correspond to ½-percent outage. In the integrator the crucial quantity is the

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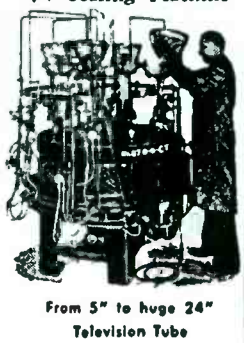

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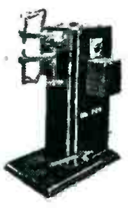

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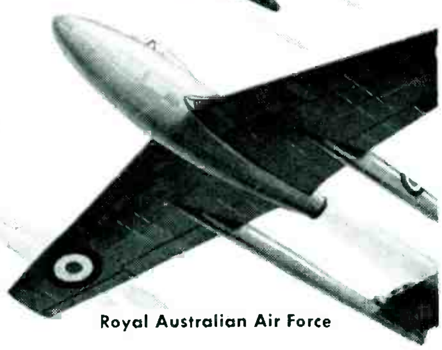

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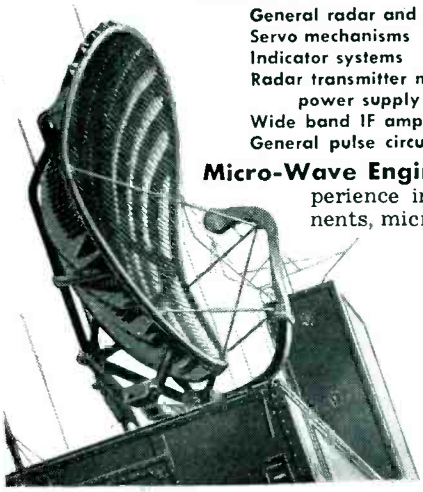

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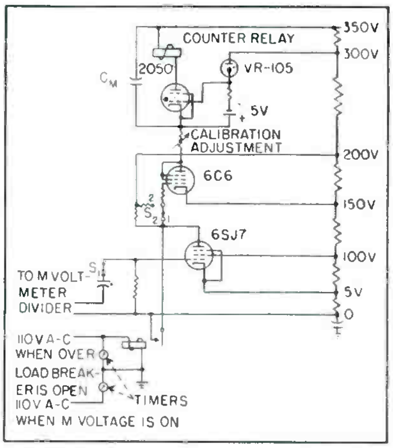

FIG. 2—Spark outage integrator instrument for recording outage time resulting from sparks in d-c high voltage sytems

breakdown voltage of the VR-105. It was because of its stability (within about 1 percent) in this quantity that the VR-105 was chosen, since the VR-150 would have fitted more conveniently into the circuits. Investigation showed that the VR-150 could be improved from its 20 percent variation to about 1 percent by intensely illuminating it with ultraviolet light. The inherent superiority of the 105 is due to the provision of a radioactive ionizing agent inside the tube structure.

For calibration purposes the switches S_1 and S_2 are used to establish conditions corresponding to zero and to 100 percent outage. In the running condition S_1 is closed and S_2 is in position 1. Opening switch S_1 gives the condition of zero outage; in this condition the recorder may be balanced for zero meter reading by means of the potentiometer between the plates of the 6SN7. Throwing S_2 to position 2 gives the condition 100 percent outage; in this position the integrator may be calibrated by adjusting the plate resistor of the 6C6 so as to give, for example, 100 counts per hour. The recording meter scale may also be calibrated in this condition of 100 percent outage provided a calibration is wanted in which 100 percent corresponds to full-scale, or less, deflection. For other calibrations a signal of known percentage outage must be applied to the instrument. A large-amplitude sine wave is a convenient source of 50 percent outage, and combination of such a wave with

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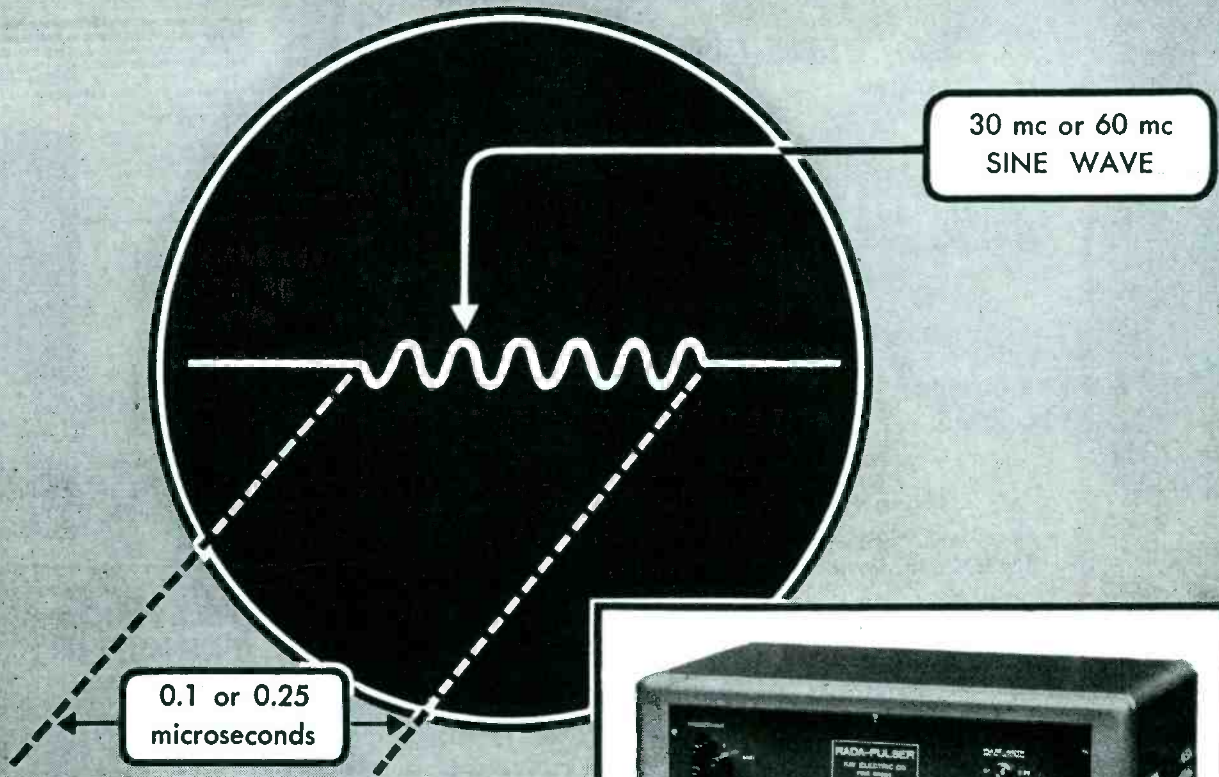

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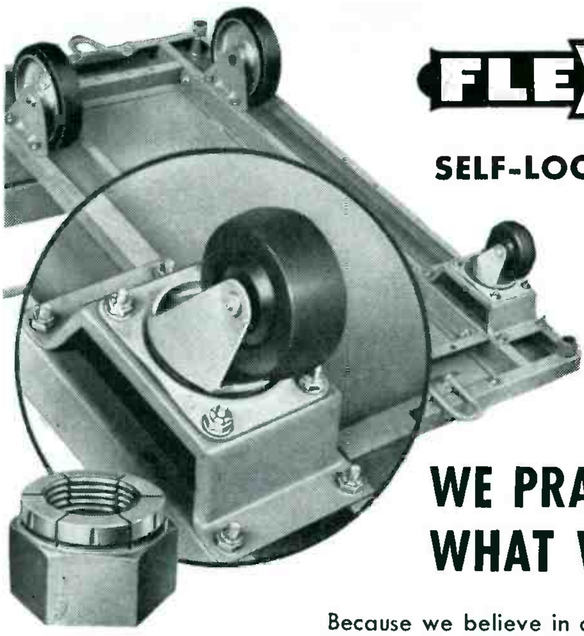

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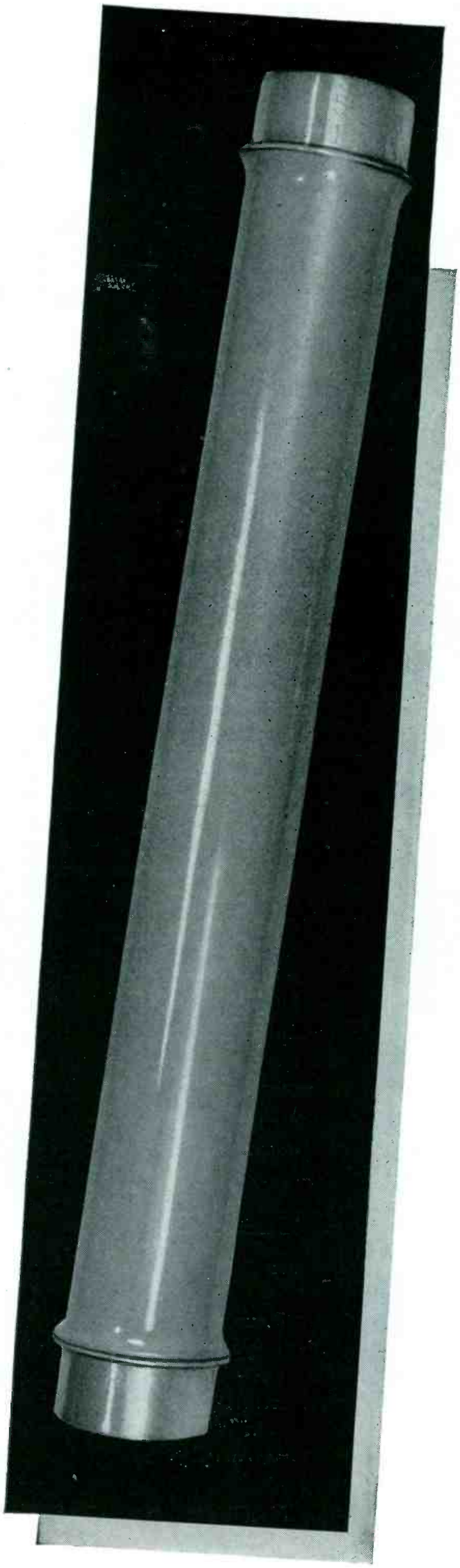

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Close-Differential Thyratron Relay

By Jordan J. Baruch
Acoustics Laboratory
Massachusetts Institute of Technology
Cambridge, Mass.

If a thyratron is operated with an alternating voltage applied to the plate it may, in many cases, be used as a switch. When the grid voltage is above the critical firing point the tube will conduct; when the grid voltage is below the critical firing point, the tube will not conduct.

In many applications, however, the critical firing point must be defined to a high degree of accuracy before the sharpness of operation of the switch can be specified. Consider, for example, a switch which must operate on a change of voltage from 1.000 volt to 1.001 volts and must become inoperative when the applied voltage is again reduced to one volt. Such a switch has a differential of 0.1 percent.

Thyratrons in general, have been considered unsatisfactory for such applications because of the fact that their critical firing voltage has a statistical variation, produced in some cases, by noise in the associated circuitry and in other cases by noise inherent within the tube itself.

Internal Noise

In the present discussion, we will confine ourselves to a consideration of the effects of the internal noise in the tube and the consideration of a means for reducing the effect of this noise on the uncertainty of the critical firing potential.

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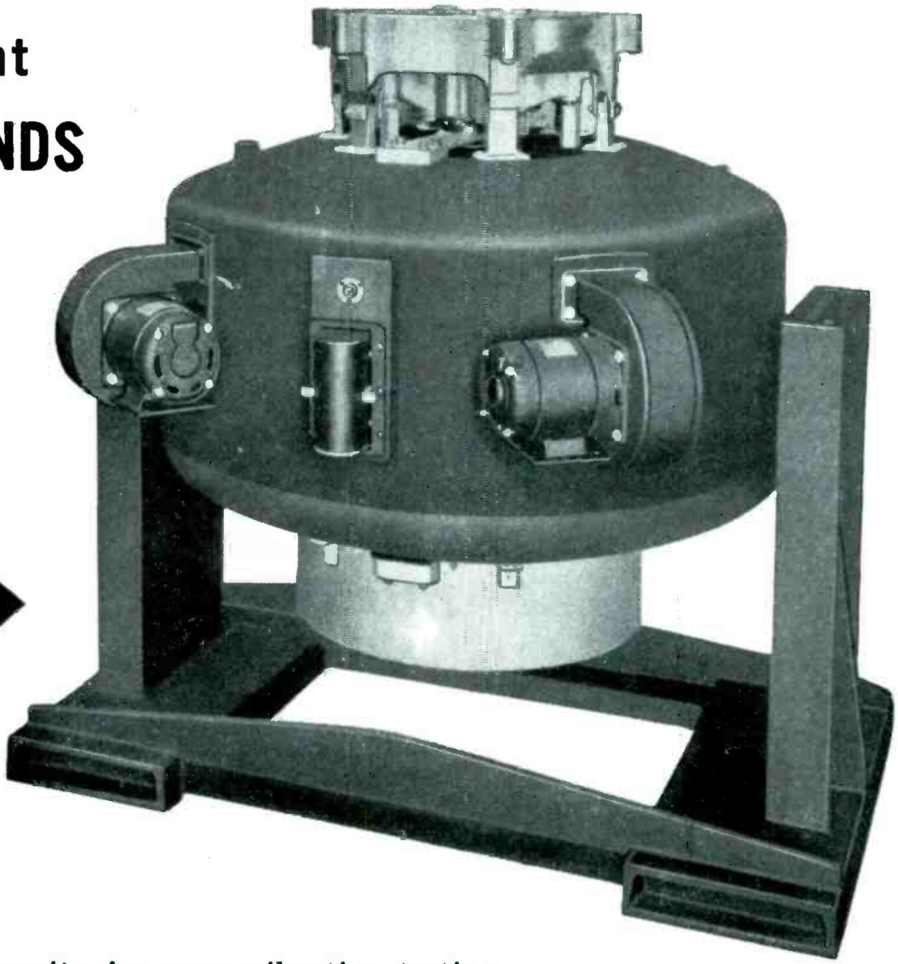

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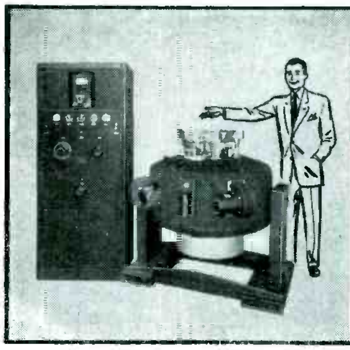

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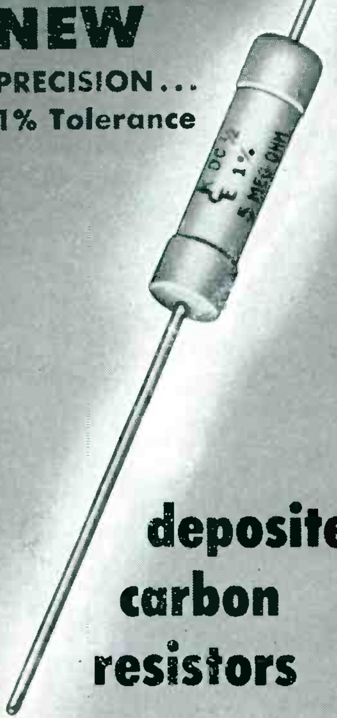

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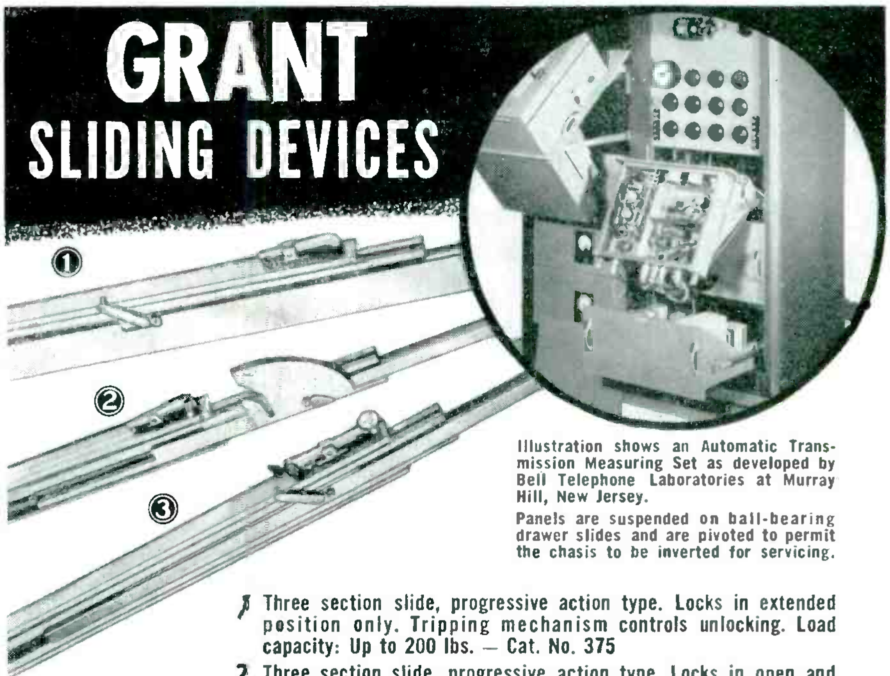

Illustration shows an Automatic Transmission Measuring Set as developed by Bell Telephone Laboratories at Murray Hill, New Jersey.

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and investigate the average plate current i_m which flows as a function of grid voltage E_g the curve which results is that shown in Fig. 1 for one voltage and load resistance. It is evident that there is a considerable curvature to this characteristic requiring a change in grid voltage of 15 millivolts to change the tube from the state where it is reliably nonconducting to the state where it is reliably conducting. The curved portion of the characteristic results from the fact that on some half cycles of the square wave the tube conducts, and on some half cycles, it does not. The conducting and nonconducting half cycles can be determined from an oscillogram to be quite random and are interpretable in terms of a noise internal to the tube. This noise manifests itself by an equivalent grid voltage noise signal. This noise may be due to clumping of gas atoms, statistical variations in secondry emission, random velocities of the ions and electrons and the diffussion process at the cathode surface.

Noise Analysis

If we state that the tube required N electrons to be accelerated past the grid and attain a velocity of v after passing the grid, then we can define a thermal velocity U normal to the grid such that there are N electrons whose thermal velocity exceeds U. If because of statistical variation U is a function of time represented by

$$U = U_o + U_n$$

where U_n is the previously mentioned noise or random fluctuation,

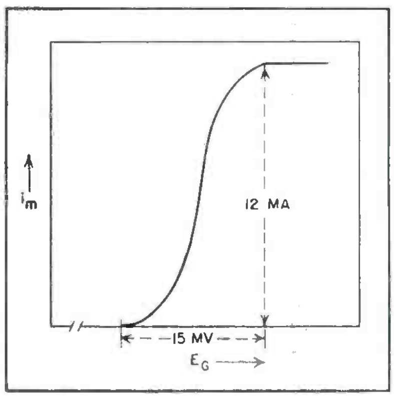

FIG. 1—Average plate current vs grid voltage curve for 2D21 in neighborhood of firing point

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PROPERTY	UNIT	K-21	K-30	K-50	K-75	K-85	K-130	K-280	K-500	K-1200	K-2500	K-3500	K-4000
Dielectric Constant—													
1 MC	—	21	30–35	50–55	70–75	85–90	—	—	—	—	—	—	—
1 KC.	—	—	—	—	—	—	135	275	550	1200 ± 10%	2500 ± 10%	3500 ± 10%	4000 ± 10%
Power Factor —													
1 MC	%	<.04	<.04	<.04	<.04	<.04	—	—	—	—	—	—	—
1 KC.	%	—	—	—	—	—	<.2	<.5	<1	<1	<1	<2	<2
Capacitance — Temp. Relationship	—	N. P. O.	Linear	Linear	Linear	Linear	Non-Linear	Practically Linear	Non-Linear	Non-Linear	Non-Linear	Non-Linear	Non-Linear
If Linear	Parts/Million	0	—225	—350	—700	—750	—	+750	—	—	—	—	—
If Non-Linear —	Hht/°C.												
Temp. of Max. K.° C.	°C.	—	—	—	—	—	18	—	> 85	> 85	85	50	40
% of K at 40° C.	%	—	—	—	—	—	—	—	—	—	70	50	40
% of K at 85° C.	%	—	—	—	—	—	90	—	147	101	135	76	55

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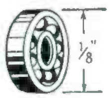
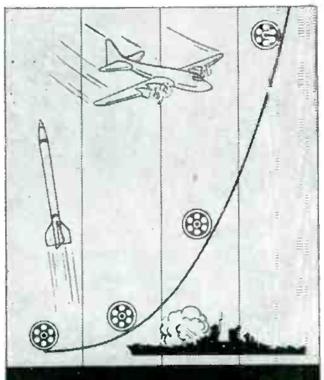


sales have increased 1700% in 3 years



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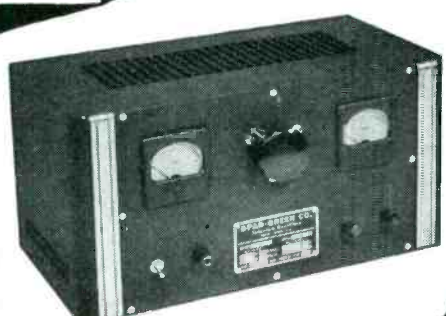

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then we can show that the firing point of the tube E will be given by $E = E_0 + E_n$ for E_n is the equivalent noise voltage at the grid represented by the noise fluctuation in thermal velocity of the electron.

Assume that for no fluctuation of U ($U = U_0$) a grid voltage of E_0 will just cause the tube to fire. This phenomenon indicates that the voltage E_0 is just sufficient to allow those electrons whose normal component of velocity is equal to or greater than U_0 to pass the grid. Now assume that the tube is again extinguished. If U has been reduced by some small value, and E is again made equal to E_0, the tube will not fire. The tube remains extinguished since the field generated by the grid voltage still allows only those electrons with a velocity greater than U_0 to pass the grid. Since U has been reduced below U_0, however, the number of electrons passing the grid will be smaller than N, and will hence be insufficient to cause conduction.

If a square wave is applied to the plate of the tube and if U is given by $U_0 + U_n$, then for a given grid voltage E, the tube will have a random firing characteristic. Firing will occur only during those positive half cycles when U_n is positive, and will fail to fire when U_n is negative. Actually, there are many other statistical noise sources in the tube other than the random space-charge velocities. Clumping of gas atoms, statistical variations in secondary emission, random velocities of the ions, and the diffusion process at the cathode surface all act as noise sources to cause a fluctuation in the firing voltage. Examination of these various conditions will lead to the conclusion, however, that they may be represented by an equivalent fluctuation in U.

The existence of this equivalent fluctuation is born out by a further observation of the thyratron firing behavior. If a square wave is applied to the plate, conduction is not always initiated at, or near the leading edge. For $E = E_0$ the conduction may start almost any place in the positive half cycle. If the square wave undergoes quasi-differentiation before being applied to the plate so that the top of the wave

drops off exponentially by 15 volts, then the conduction will be found to take place only in the first half of the positive half cycle. This corresponds to a fluctuation of the plate voltage at which conduction takes place of 7.5 volts. Since we are using a control ratio of 500, this 7.5-volt plate fluctuation corresponds to a 15-millivolt grid fluctuation. If the grid potential is now raised by 15 millivolts, this random firing ceases. Similarly, if the quasi-differentiation is left out and the grid is raised 15 millivolts, the conduction becomes constant.

Statistical Feedback

If an attempt is now made to apply regenerative feedback to sharpen the operation of the switch and to increase its accuracy, it can be seen that the feedback coefficient must perforce represent a statistical quantity. While the principle of statistical feedback may seem somewhat unusual, the problem can be greatly simplified by the process of smoothing or time integration. Consider the effect of an R-C circuit placed in the plate curcuit in such a manner that the output quantity measured i_m is no longer the instantaneous value of the plate current, but is given by

$$i_m = \frac{\alpha}{4} \int_0^{4/\alpha} i_p \, e^{-\alpha t} \, dt.$$

If our integration time, which is here taken as four time constants, is long compared to the random variation time of U then the plate current-grid voltage curve will have the form shown in Fig. 1. Thus at low values of E, $U_0 + U_n$ will seldom exceed the value necessary for firing and the time average of the plate current will be small. Similarly, at values of E above E_0, the time average will be greater than $i_{max}/2$ since U will be above the required value more than 50 percent of the time. The introduction of quasi-integration thus transforms the statistical fluctuation into a curved transfer characteristic which does not fluctuate sensibly with time.

It is evident that if the integral is accepted as the output, the feedback problem is greatly simplified. It now becomes necessary only to

GE Instrument NEWS

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"100% inspection for the first time and rejects cut to ½ of 1% are only two of the benefits we have been able to obtain through the use of our G-E gauss meters," reports All Star Products Company, Defiance, Ohio.

All Star Products, manufacturer of variable condensers and radio and television components, finds the General Electric gauss meter an essential item in test and inspection areas. The meter has enabled All Star to cut inspection costs by ⅓ and permitted a 20% material saving. With the simple-to-operate G-E gauss meter, readings are obtained in only 4 seconds. Because of this, All Star is able to do all of its testing along the production line.

Small and compact, the G-E gauss meter is easy-to-read, portable, and extremely rugged. This is why All Star supplies its field servicemen with gauss meters for inspecting television focus units.

For use with both d-c permanent magnets and electromagnets, the gauss meter can measure flux densities in extremely small magnet gaps—such as those of blocked relays, breakers, generators, and motors. It gives direct readings of unidirectional fluxes in gausses and can be supplied in a variety of ranges from 100 to 5000 gausses.

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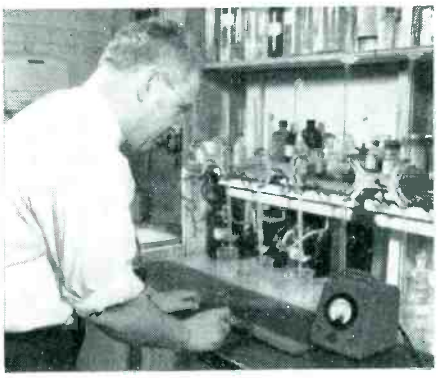

Briggs Manufacturing Company, of Detroit, Michigan, builder of automobile bodies and Beautyware plumbing fixtures, reports, "We've found the G-E thickness gage so easy and simple to use that we've been able to reduce our operators' training time to ½ hour." At its Eight Mile Road Plant, where chromium and stainless-steel automotive accessories are manufactured, Briggs uses the G-E gage because it can be used by unskilled help after this short indoctrination course. This simplicity of operation is an important feature since a number of different persons must use the gage each day.

To protect the stainless-steel strips that go around car windows from damage during production, it is necessary to spray each part with a plastic film. Precise thickness limits for this plastic film have been set up and laboratory checks are made periodically on cold-rolled-steel test parts to assure that correct coating thickness is maintained.

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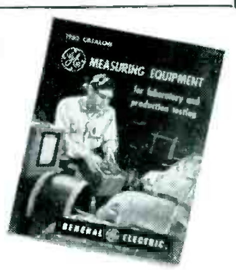

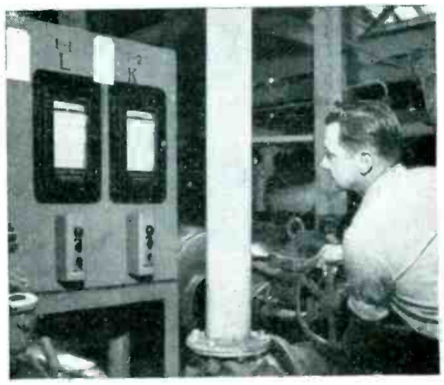

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"Our General Electric CD-27 recording ammeters take the guesswork out of regulating the load on each of our refiners. We could not operate without them," reports Mr. G. F. Durand, Vice-president of Port Huron Sulphite and Paper Co. This Port Huron, Michigan company is an old and well-established maker of fine quality papers.

Port Huron's refiners are used to produce dense, hard, high quality light weight papers. The refiners are hooked up in series and the paper stock being processed flows from one to the other. The quality of the paper produced depends upon uniformly holding the prescribed load at which each refiner is run. By using the G-E recording ammeters to record the load on each refiner motor, Port Huron finds that periodical inspection and minor adjustment is all that is necessary to maintain correct and uniform paper stock treatment.

Recorder Measures 11 Quantities

Besides recording amperes, the G-E Type CD recorder can also measure volts, single- and polyphase watts, power factor, frequency, and vars. Models also can be supplied for measurement of d-c millivolts, milliamperes, and microamperes. Most ratings have an accuracy of plus or minus 1 per cent of full scale.

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apply a positive grid voltage proportional to the integral of the plate current in order to obtain the regenerative feed back desired. Be cause of the difficulties inherent in obtaining this feedback from the plate to the grid, some other method must be used.

R-C Circuit

It is known that the conducting thyratron draws a grid current which is approximately instantaneously proportional to the plate current. This effect arises from the fact that the grid current is approximated by the intercept cross-section of the grid times the ion density in the plasma. Thus, the time integral of the grid current can also be used to apply the regenerative feedback. Because of certain circuit considerations, it was inadvisable to introduce an R-C circuit into the screen grid circuit of the tube. For this reason, the circuit of Fig. 2 was used. The control grid of the tube is used as a biasing element to set the value of E_0 at the screen. The control-grid circuit is composed of the biasing potentiometer and the parallel R-C combination. This R-C combination provides a regenerative feedback proportional to the integral of the plate current. The time-constant of the R-C circuit plus the dissipation rate of the ion sheath sets the integrating time, and the impedance level of the circuit sets the proportionality constant. Thus if R-C and the dissipation rate are selected for the desired integration time, R/C can be adjusted to yield the proper feedback coefficient. A satisfactory time constant was chosen and the impedance level was adjusted experimentally until an optimum value was found. The adjustment procedure consisted in varying R/C until the smallest hys-

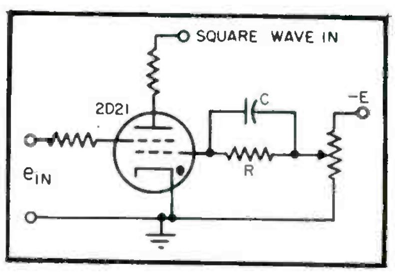

FIG. 2—Thyratron circuit with R-C compensation network

NEW! High-Frequency Design Data

21 Pages of Test Results on Armco Electrical Steel 1 to 7 Mils Thick

This brand-new Armco manual tells the story of Armco Thin Electrical Steels designed for frequencies of 400 to 200,000 cycles per second.

These hair-thin electrical steels are made in three types: TRAN-COR T, 5 and 7 mils thick, with good permeability in all directions; TRAN-COR T-O, 1, 2 and 4 mils thick, an oriented type with best permeability in the rolling direction; and TRAN-COR T-O-S, 4 mils thick only, a super-oriented steel designed particularly for 400-cycle applications at inductions above 16 kilogausses.

Armco's new booklet gives the designer representative test results to work with. No longer is skin effect a matter of guesswork. The curves show the allowance to be made for it.

Advantages vs. Costs

Included are curves for preliminary thickness selection, when either core loss or excitation is a limiting feature of design, to illustrate the possible operating induction for a given frequency. Thereafter, electrical characteristics of each thickness and type may be determined from its individual curve. By balancing electrical advantages against material cost, the particular thickness that is economically sound for the application may be chosen readily.

Armco Thin Electrical Steels have exceptionally high permeabilities, correspondingly low hysteresis losses, high lamination factors and minimum interlamination energy losses. Properties are fully developed at the mill. No high-temperature heat treatment is required to develop magnetic properties.

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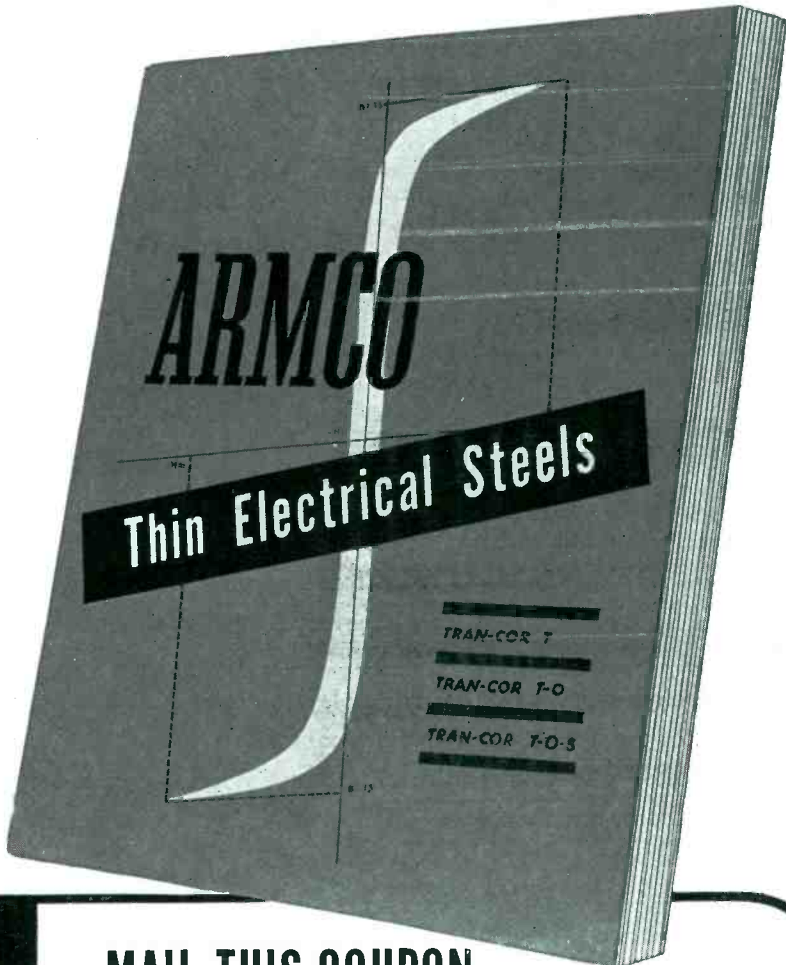

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teretic differential had been obtained. It was found that an R/C of 10^{12} resulted in a differential of less than 0.5 millivolts. This corresponded to an input differential of 5×10^{-3} percent, and was exceedingly satisfactory.

The large hysteretic differentials found by Wittenberg were probably caused in part by his use of an R-C grid circuit. The system was capable of producing a large coefficient of integral feedback and this would lead to a large drag-loop, or hysteretic differential.

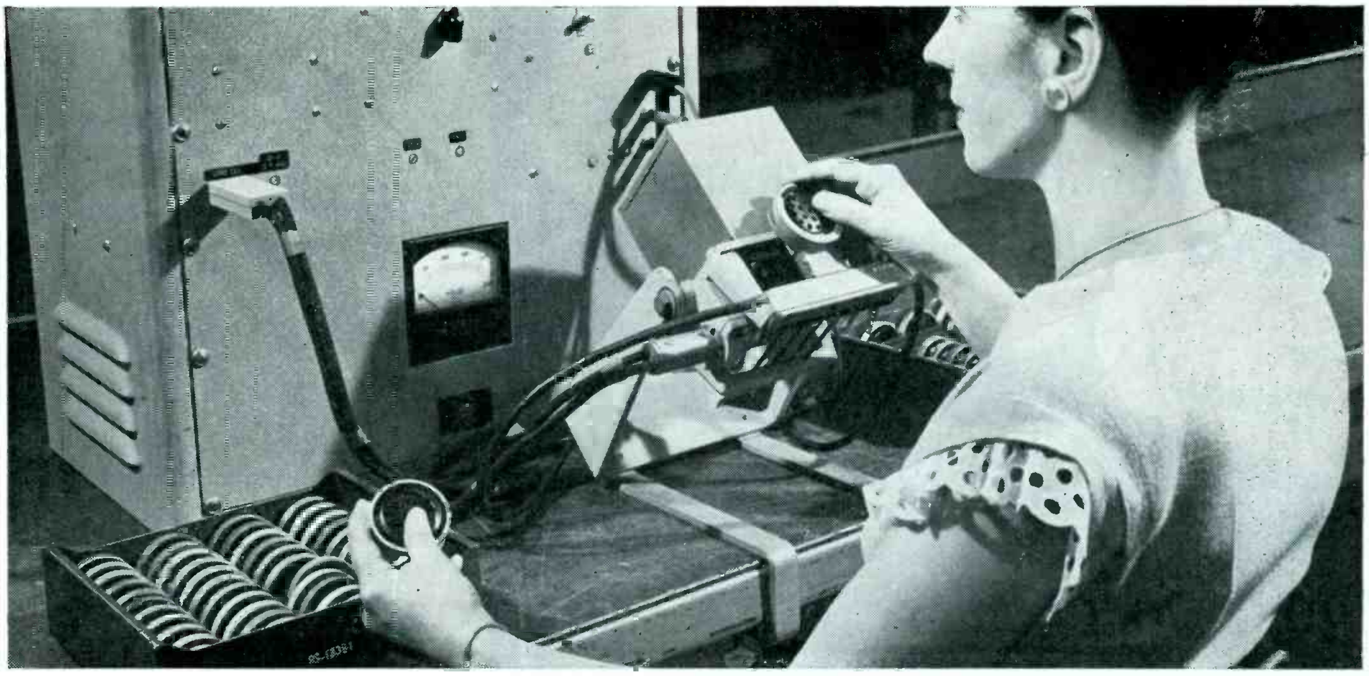
It is felt that the foregoing analysis and method of treatment is capable of making thyratrons behave as highly sensitive relays. Their use for instrumentation is strongly indicated by their close-differential property when the correct amount of feedback is used. Thus a 0.005-percent differential would make it possible to control a temperature of 100 C to within approximately 0.005 deg if no center clipping of the signal were used. The ease with which the differential may be varied also strongly suggests their use in relay controlled servomechanisms since Kochenberger has shown that adjustment of this factor can be used as a stabilizing means, for relay servos.

REFERENCES

(1) H. H. Wittenberg. Frequency Performance of Thyratrons, *AIEE Trans.* **65**, p 843, 1946.
(2) E. E. Staff, M.I.T., "Applied Electronics," John Wiley and Sons, New York, 1943.
(3) R. J. Kochenburger, A Frequency-Response Method For Analyzing and Synthesizing Contactor Servomechanisms.

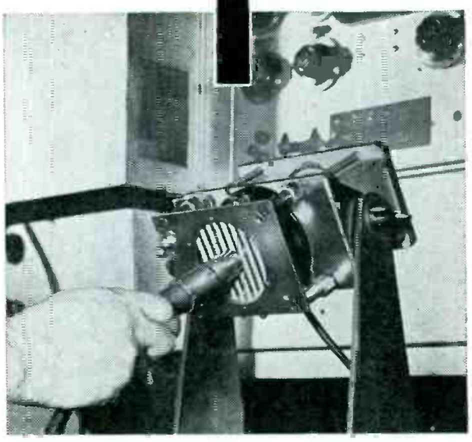
Magnetic Attenuator

THE INEXPENSIVE type of microwave attenuator for coaxial transmission lines shown in Fig. 1 utilizes a magnetic field to obtain instantaneous changes in attenuation. The new device, known as a magnetic attenuator, depends on the interaction between the electromagnetic field within a transmission line, which contains microwave energy-dissipating material, and an external magnetic field applied perpendicularly to the axis of the line. As a result of this interaction, the loss characteristics of the dissipative material are substantially al-



This Western Electric employee mounts a transmitter in the test fixture which is swung down to face an artificial mouth at 45-degree angle, just as transmitters are held in use. More than a million transmitters are tested each year.

This mouth speaks to millions



At Bell Laboratories a scientist employs a condenser microphone to check the sound level from another type of artificial mouth, used in transmitter research.

To serve the changing needs of telephone subscribers millions of telephone sets have to be moved each year. Before being put back into service most of them are returned to the Western Electric Company's Distributing Houses where they receive a thorough checkup.

Western Electric engineers needed a rapid method of testing transmitters over a range of frequencies. At Bell Telephone Laboratories, scientists had just the thing—a technique they had devised for fundamental research on transmitters. In co-operation with these scientists, Western Electric engineers developed the practical tester in the illustration.

The transmitter is removed from the handset and put in front of an artificial mouth which emits a tone that swings several times per second over a band of frequencies. A signal lamp tells whether the transmitter is good. Each test takes 5 seconds.

This new tester illustrates how Bell Laboratories research and Western Electric manufacturing skill team up to maintain your telephone service high in quality yet low in cost.

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• EXPLORING AND INVENTING, DEVISING AND PERFECTING, FOR CONTINUED IMPROVEMENTS AND ECONOMIES IN TELEPHONE SERVICE tered. The magnetic attenuator requires no movable components, mechanical controls, or slotted sections in coaxial transmission line and may be operated either manually or automatically from an approximate or remote position.

The electromagnet requires a d-c power source of 0 to 250 volts with a maximum of 30 milliamperes current to produce a magnetic field of 1,500 gausses in the air gap.

An experimental model which uses polyiron as the dissipative element was operated at frequencies from 1,000 to 3,000 mc. Variations in the losses of the polyiron were produced which were large enough to reduce the attenuation 60 percent, change the power by a ratio greater than 60 to 1, with a voltage-standing-wave ratio always less than 1.5.

More recently, a study was made of an attenuator that employs a slug of Ferramic B ½-inch long and ⅜-inch in diameter as the dissipative medium. The dependence of the losses in the material on frequency was remarkably demonstrated by this experiment. At 2,200 mc the attenuation was reduced from 17 db to less than ½ db, and less than 45 milliamperes of current was required to maintain the magnetic field. At a frequency of 2,600 mc, changes in attenuation greater than 20 db were obtained with the same electromagnet currents. To avoid

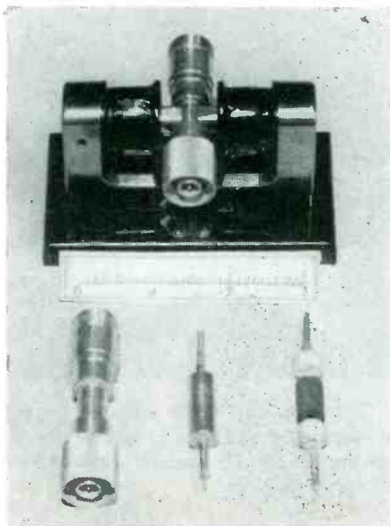

FIG. 1—The magnetic attenuator, a new, inexpensive type of microwave attenuator that requires no movable components, mechanical controls, or slotted sections in the waveguide or coaxial transmission line

PROBLEM:

How to Simplify and Speed Up Contact Brazing of Multiple Leads from a Screen

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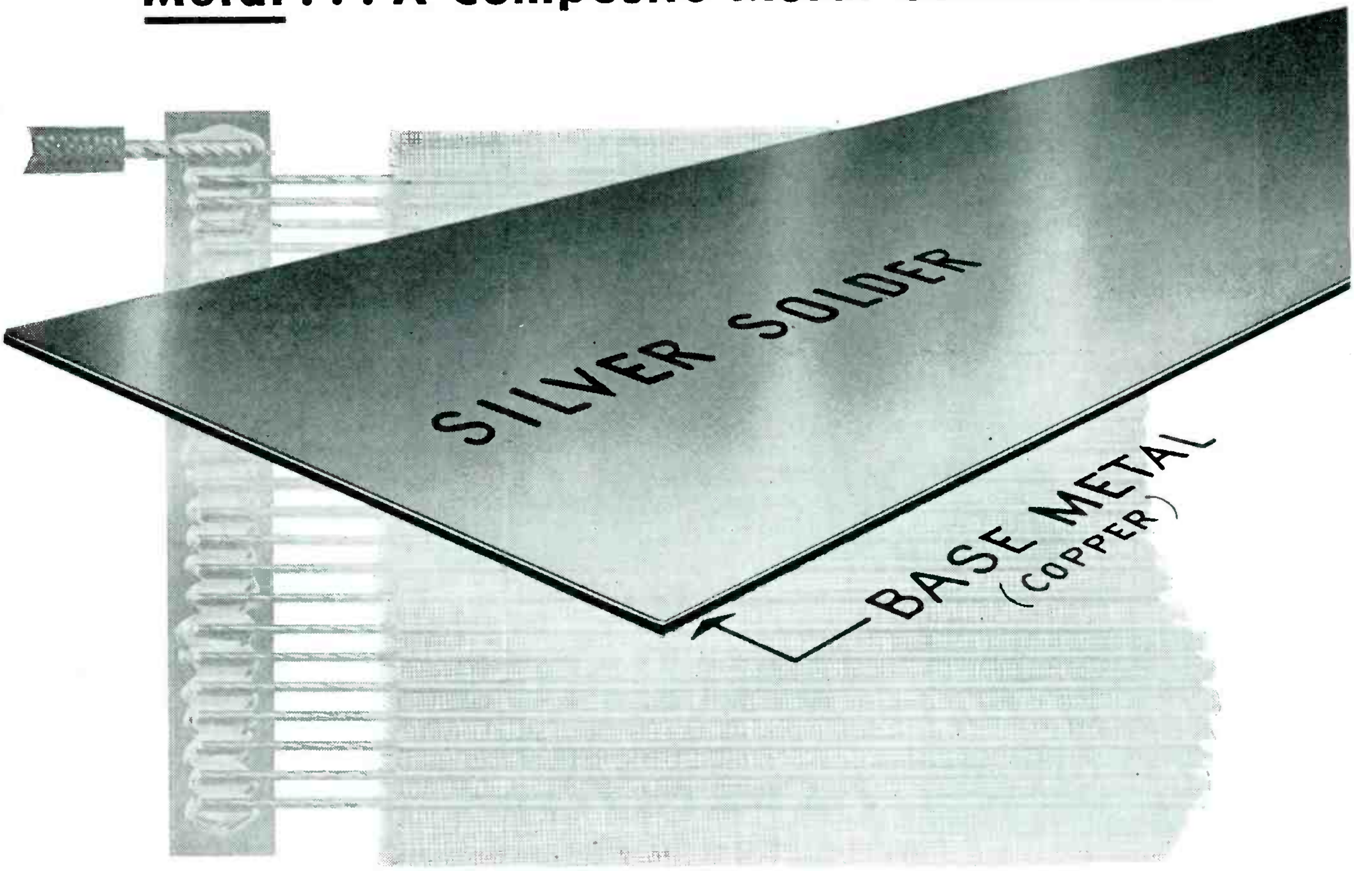

Recently a manufacturer had the problem of soldering leads from a screen to a copper strip. The old method required cleaning and positioning separate pieces of solder on each spot and then heat. This method was time consuming and costly.

General Plate Engineers solved the problem with "Solder-Flushed Copper Strip." Now the operation involves laying the leads on the strip and heating each wire. The result—a strong soldered joint at considerable savings in time.

General Plate "Solder-Flushed" metals make contact brazing quicker and easier. They eliminate handling of separate pieces of solder foil, provide a better, stronger joint. They can be supplied with solder to base or precious metal, copper layer for copper brazing or low silver content solder clad to base metal.

No matter what your metal problem, it will pay you to consult with General Plate. Their vast experience in cladding precious to base metals, or base to base metals can overcome your problems...often reduce costs.

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Division of Metals & Controls Corporation

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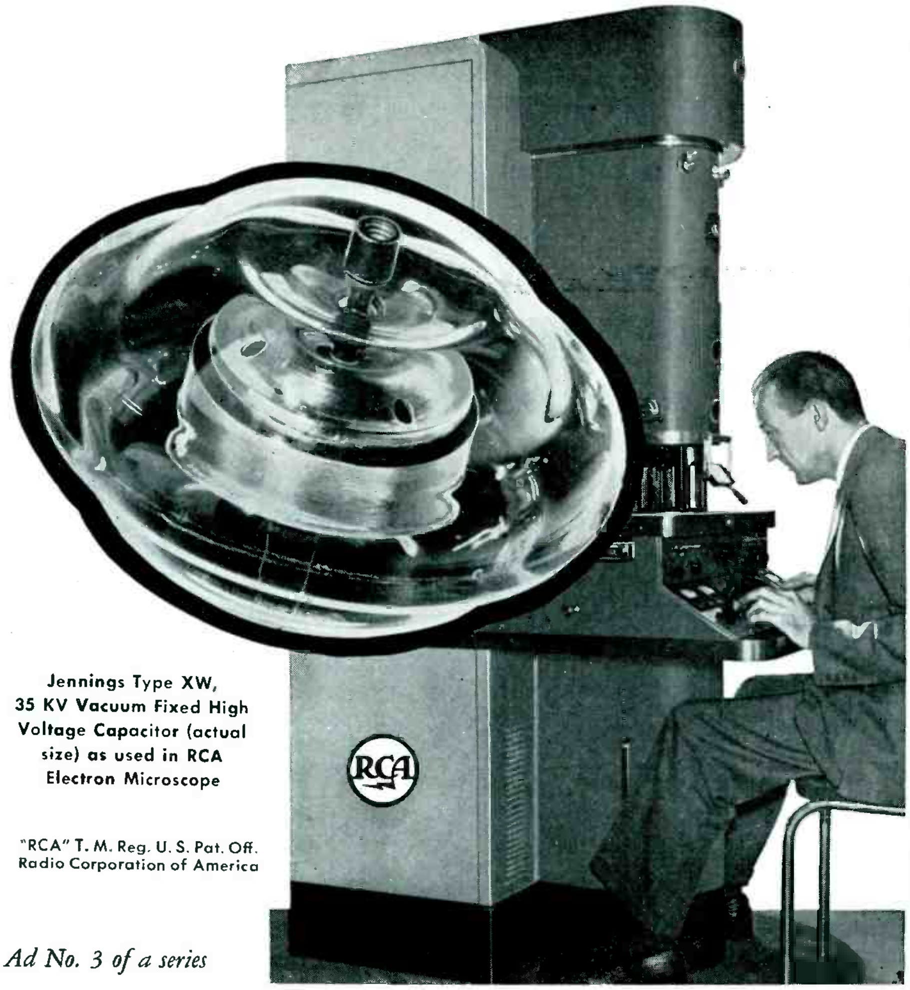
saturation in the iron core of the small, low-current electromagnet, a larger unit was used to obtain greater changes in attenuation. At several frequencies, attenuation changes in excess of 95 percent have been obtained without difficulty.

Ferro Resonance

While operating at a frequency of 3,200 mc, a striking example of ferromagnetic resonance was exhibited. As the electromagnet current was increased, the attenuation decreased from its initial value of 24 db to about 18 db, then peaked to about 25 db, and finally decreased to approximately 1 db. The peak occurred at a current of approximately 0.6 ampere. When operating at 3,700 mc, a similar phenomenon occurred. The initial attenuation of 26 db was reduced to about 16 db before peaking to 37 db; finally it dropped to about 1 db as the current continued to increase. The resonance effect appeared when the electromagnet current was approximately 0.8 ampere.

When the magnetic field is rotated 360 degrees about the axis of some of these coaxial attenuators, a position may exist where the field has its maximum effect. For instance, when a magnetic field of constant intensity was rotated about the axis of the above coaxial attenuator operated at 3,700 mc, changes in attenuation of 17 db were obtained. However, this does not exist for all materials.

Many applications of this magnetic phenomenon are immediately evident. An audio source can be used to vary the electromagnet current which produces a changing field in the attenuator and consequently amplitude-modulates the r-f signal. The resultant modulation envelope includes the predominant second and higher harmonic frequencies of the audio frequency field. However, these harmonics can be readily eliminated by employing a d-c bias about which the a-c field oscillates. The use of the NBS magnetic attenuator in this fashion permits amplitude modulation of uhf and microwave oscillator outputs without the frequency modulation effects which occur



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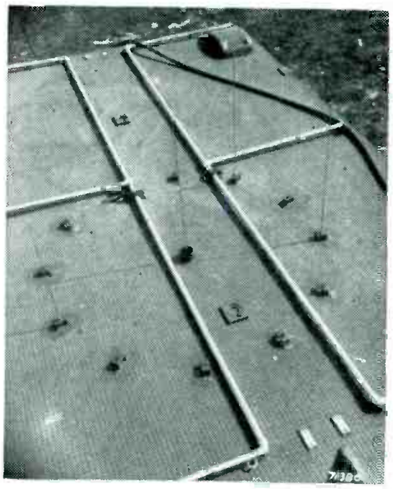
when the oscillator is modulated.

The NBS Magnetic Attenuator is equally adaptable as an output stabilizer for microwave oscillators. The unit can be part of a degenerative feedback circuit in which the magnitude of the field produced by the electromagnet is controlled by a small amount of r-f power taken from the coaxial transmission line. Another magnetic unit may also be utilized in such a feedback network. The rectified control voltage coupled from the transmission line may be applied to a magnetic amplifier which controls the field directly.

Plug-In Beam

A DIRECTIONAL radiation pattern can be obtained when required by inserting two parasitic whip elements in special connectors provided on the roof of a vehicle so that they operate as directors in conjunction with the whip radiator.



On the reinforced roof of the transmitter coach, a choice of mounts is provided for proper parasitic whips for the f-m audio transmitting system of Signal Corps mobile television caravan

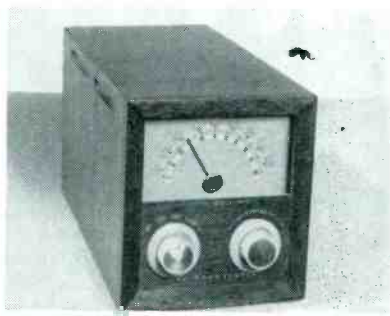
The radiator is permanently located in the center of a circle formed by closely-spaced connectors for the whip director elements. By placing these elements in front of the radiator, radiation is concentrated in the one direction; however one director can be placed in front of the radiator and one behind it for bidirectional radiation.

This idea is incorporated in a mobile television setup built by RCA for the Signal Corps tv educational program.

NEW PRODUCTS

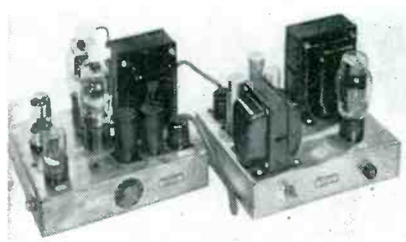
(continued from p 144)

and features a low torque shaft mounted in ball bearings. This shaft with runout and concentricity within 0.001 in. of the syncro type mount enables the potentiometer to be driven directly in a precision computer gear train. Its 1⅛-in. diameter makes it ideal for applications in guided missiles and aircraft installations where space is at a premium. It can be furnished with linear or functional output. Total resistance can be as high as 100,000 ohms, and torque less than 0.2 in. oz.



UHF TV Translator

GENERAL ELECTRIC Co., Syracuse, N. Y. The uhf 101 translator illustrated is designed to operate with all types and makes of tv receivers. However, one vhf and one uhf antenna must be connected to the translator for operating purposes. Dimensions of the unit are 7½ in. high, 6⅞ in. wide and 13⅜ in. deep. The translator uses a 6AF4 and 12AT7 i-f amplifier tubes; two selenium rectifiers, and one 1N72 high-frequency crystal detector. Power consumption is 20 watts at 115 volts, 60 cycles, a-c only.



Amplifier Components

STANDARD TRANSFORMER CORP., 3580 Elston Ave., Chicago 18, Ill., recently announced components for the Williamson amplifier, designed

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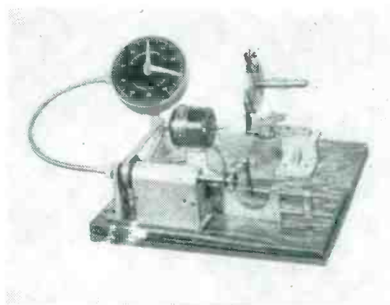
to make high-fidelity audio available at low cost. The components include a high-fidelity output transformer, A-8054; power transformer PC8412 and filter choke C-1411. Tests show zero-db change in frequency response at the 8-watt level remaining unchanged at the low level of 0.5 watt. Intermodulation distortion measures only 3 percent at 8 watts output. Total harmonic distortion at 1,000 cycles is extremely low and may be considered non-existent below the 10-watt power level.

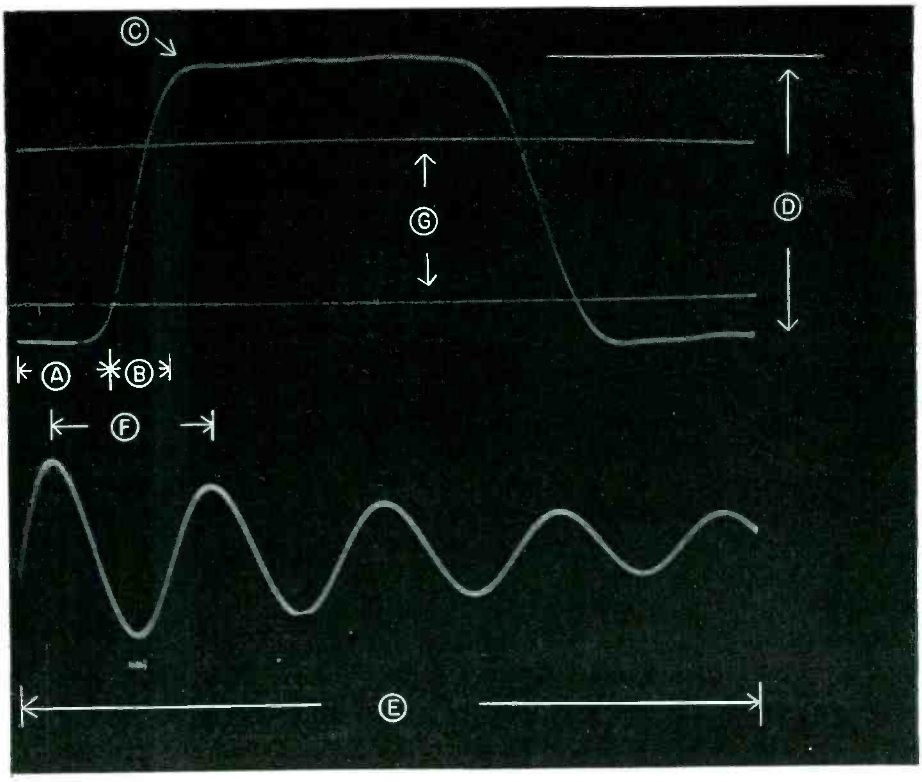


Miniature Coil Winder

GEO. STEVENS MFG. CO., INC., Pulaski Road at Peterson, Chicago 30, Ill., has introduced the model 39 coil winder for winding tiny, fine wire, random-wound bobbin coils up to $\frac{3}{4}$ in. wide and up to $1\frac{1}{2}$-in. diameter for the miniature field. Transmission of motor vibration to winding head is reduced to a minimum by a specially designed flat fabric belt. Weighing only 26 lb and measuring 24 in. long $\times$ 12 in. wide $\times$ 8 in. high, it is easily portable. Winding speeds up to 5,000 rpm are achieved by 1/25-hp variable speed, series-wound, a-c/d-c motor and foot-operated speed control of 115-v operation. For 230-v operation, a step-down transformer is available.

Shielded Leads

UNITED TECHNICAL LABORATORIES, Morristown, N. J., has announced



a SINGLE OSCILLOGRAM demonstrates...

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

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

...IN THE NEW DU MONT TYPE 303

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

B. EXCELLENT TRANSIENT RESPONSE—wholly essential to the proper study of high-speed phenomena—is depicted by the rise time which is reproduced without appreciable degradation. A rise time of 0.01 microsecond, or greater, will be reproduced as a rise time not exceeding 0.033 microsecond.

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

D. UNDISTORTED DEFLECTION provided by the Y-axis amplifier is 2 inches for unidirectional pulses. An equivalent undistorted deflection of 4 inches is available for symmetrical signals and may be positioned over the useful area of the cathode-ray tube. Even at the highest attenuation ratios, the Y-axis input is not frequency sensitive, as shown by the illustrated pulse which has been attenuated 4000 times. The direct-coupled X-axis amplifier of the Type 303 will provide over 5" of undistorted deflection.

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

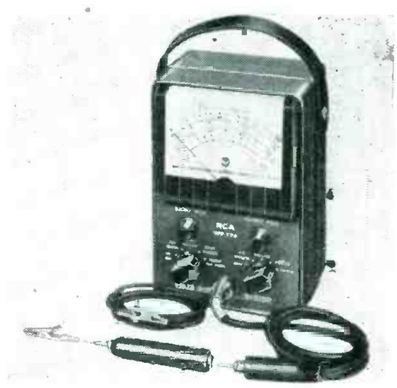
F. TIME CALIBRATION in the Type 303 is accomplished by substituting a damped sinewave for the signal. Double exposure by photographic recording of calibrating sinewave and signal provides a permanent quantitative analysis of the signal. In addition to the 10-megacycle signal shown above, calibrating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

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

price $820.00 FOR COMPLETE DETAILS WRITE for bulletin TYPE 303

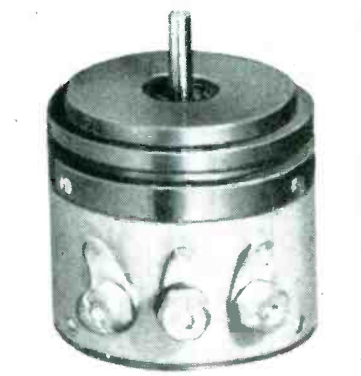
ALLEN B. DU MONT LABORATORIES, INC. Instrument Division 1000 Main Avenue, Clifton, N. J.

the type S Klipzon shielded leads with proportioned air and polyethylene dielectric for unusually low capacitance and losses, even at uhf, and without sacrifice of durability and flexibility required for laboratory and electronic service work. Complete shielding eliminates stray pickups, feedback and other undesirable coupling effects. They are supplied in three-foot lengths with an approximate outside diameter of 9/32 in., and have a maximum capacitance of only 25 $\mu\mu$f.



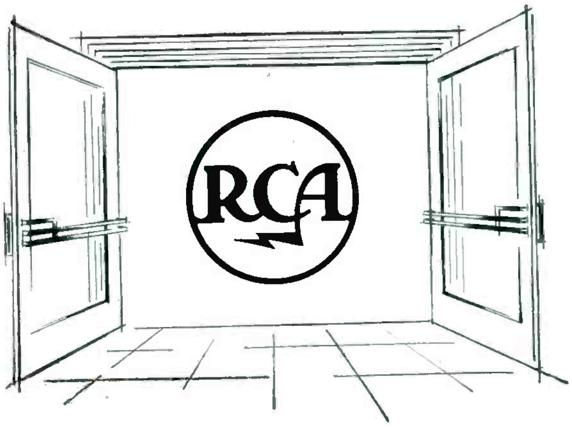
Test-Bench Unit

RADIO CORP. OF AMERICA, Camden, N. J., has added to its test equipment line the Junior Volt Ohmyst meter that measures a-c volts, d-c volts and resistance in five different ranges. The meter features a high-impedance diode tube as a signal rectifier, an electronic bridge circuit, a 200-μa movement and carbon-film multiplier resistors. Suggested user price is $47.50.



Miniature Potentiometer

HELIPOT CORP., 916 Meridian Ave., South Pasadena, Calif., has



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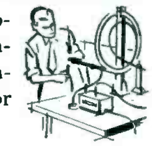
The opportunities are in research, development, design and application, also in technical sales—on commercial projects as well as the nation's defense program.

These are not temporary positions. Many of RCA's activities today are designed to satisfy the nation's military needs. RCA, however, has always been (even in peacetime years) an "arsenal" from which the military forces have been equipped with the finest radio-electronic apparatus. RCA also is working on many commercial long-range projects. They call for expanding electronic research and development in a diversified line of products.

These openings offer life-long career opportunities. Unlike "feast or famine" businesses, RCA has forged ahead regardless of wars or depression.

At RCA, you enjoy professional status, recognition for accomplishments . . . unexcelled research facilities for creative work . . . opportunities for advancement in position and income . . . pleasant surroundings in which to work. You and your families participate in Company-paid hospitalization, accident and life insurance. Modern retirement program. Good suburban or country residential and recreational conditions. Opportunities for graduate study.



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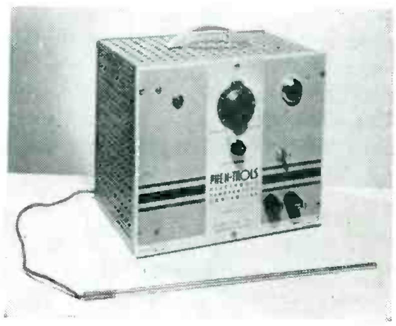
in production a new miniature potentiometer of ultra-low torque design. It measures $\frac{7}{8}$ in. in diameter, exclusive of the terminals, and 25/32 in. overall back-of-panel length; and weighs 0.56 ounce net. Average starting torque is 0.005 ounce-inches at room temperature. It is available in resistances from 1,000 to 100,000 ohms in single section and ganged assemblies with single or double shaft extensions. Called the Tiny-torque potentiometer, it has active electrical rotation of 355 deg and continuous mechanical rotation without stops. Power rating is 0.5 watt.

Digital-Computer Tube

GENERAL ELECTRIC CO., Schenectady, N. Y., has announced a new tube designed for use in moderately high-speed digital computers. The tube, a twin triode designated as GL-5844, is expected to be widely used in flip-flop service in binary-system calculators. It operates at cutoff and zero-bias. The tube requires only 300-ma heater current. Of particular interest to the circuit designer is the fact that the cutoff voltage between triodes balances within a one-volt limit. A special cathode design prevents failure of function after periods of nonconduction while biased to cutoff.



Temperature Controller

PHEN-TROLS INC., 15 Franklin Place, Rutherford, N. J. A rugged highly sensitive electronic temperature controller is now available for use in laboratories and industry with heated molds, immersion heaters, liquid baths, ovens, furnaces, laboratory heating jackets and similar devices where close control of

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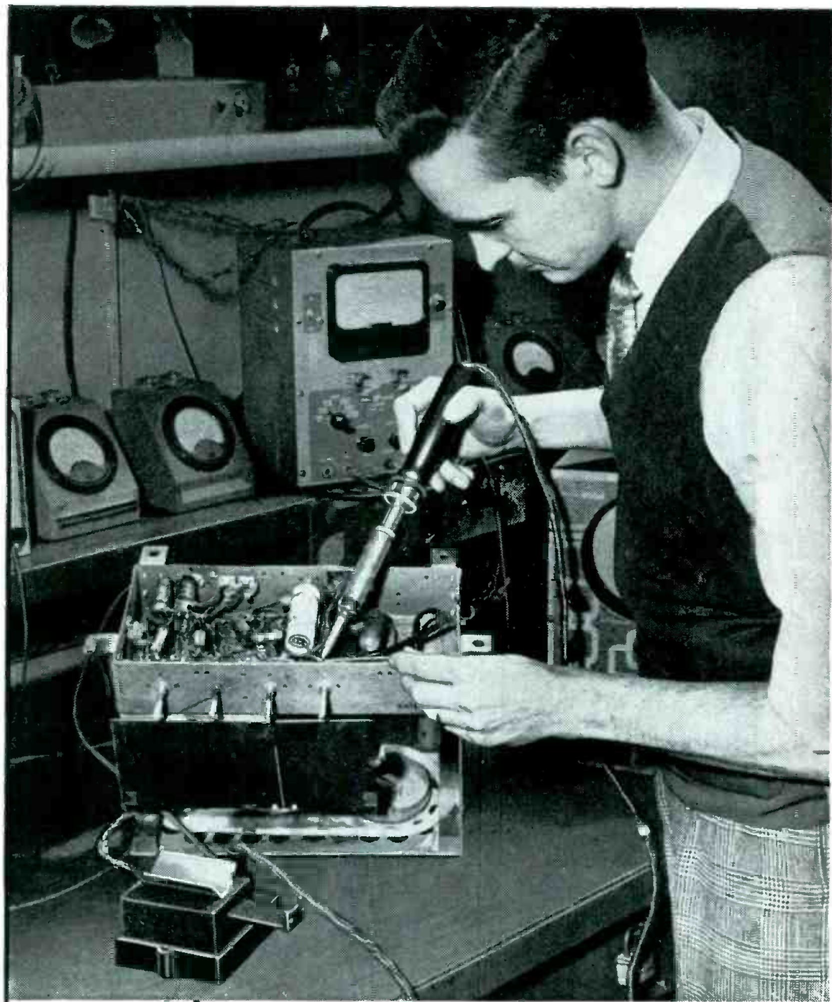
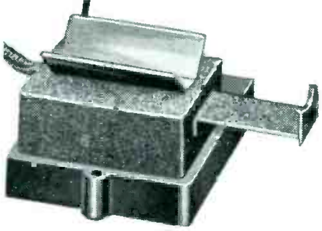
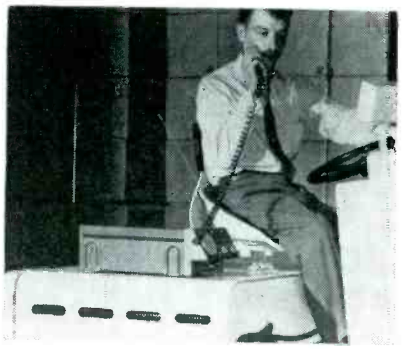




critical temperatures over long periods is desired. It is of a direct dial setting type and will maintain preselected temperature within 0.50-C sensitivity from any setting within its range. Designed to operate from standard outlet of 115-volt 60-cycle current fused to carry necessary load, it will handle loads up to 3,000-watt capacity. It is equipped with twin plug-in receptacles for hook up of devices or to solenoid or other temperature controls.

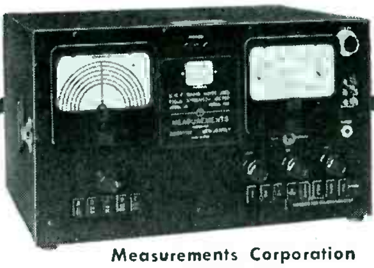
Snap-Action Switch

MU-SWITCH DIVISION, ACRO MFG. Co., Canton, Mass., has introduced a compact, precision snap-action switch especially suited for use in controlling direct current. It is designed for spdt circuits and is rated at 10 amperes, 125 volts d-c, and 5 amperes, 230 volts d-c. The design incorporates an Alnico magnet that blows out the arc to prevent burning as soon as contacts open or close. Overall dimensions are 1 15/16 in. long by 21/32 in. high by 11/16 in. deep.



Industrial Two-Way Radio

MOTOROLA, INC., 4545 W. Augusta Blvd., Chicago 51, Ill., has announced a new low-power 2-way radio that utilizes the Uni-Channel



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MODEL 58

UHF RADIO NOISE & FIELD STRENGTH METER

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15 Mc. to 150 Mc.

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SENSITIVITY RANGE: 1 to 100,000 microvolts. Direct reading dial.

POWER SUPPLY: Built-in supply, 117 volts AC, 6 volts DC.

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Measurements Corporation
MODEL 79-B

PULSE GENERATOR

REPETITION RATE: 60 to 100,000 pulses per second.

PULSE WIDTH: Continuously variable from 0.5 to 40 microseconds.

RISE TIME: Approx. 0.25 microseconds.

OUTPUT VOLTAGE: 150 volts (peak) positive.

POWER SUPPLY: 117 volts, 50/60 cycles.

MEASUREMENTS CORPORATION
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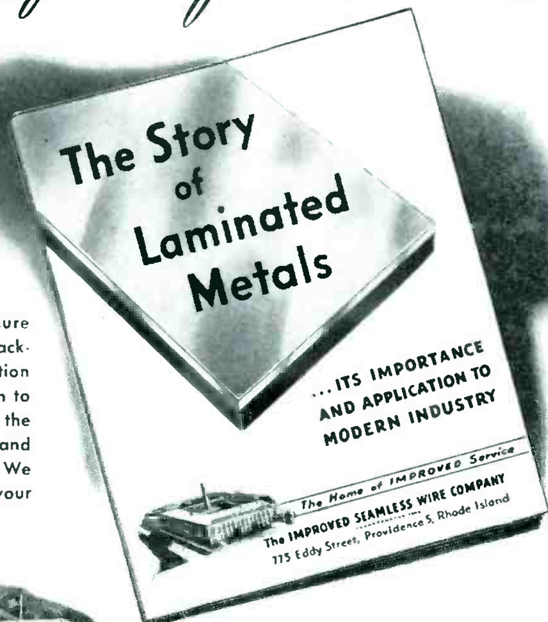

This new IMPROVED brochure presents an interesting background of the lamination process and its application to industry, particularly in the field of electrical parts and equipment manufacture. We invite you to send for your copy.

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Three deservedly popular members of the extensive JOHNSON line are described below and illustrated at right. Each is 1" diameter, for S6 candelabra screw bulb. Glass jewel 1" diameter in polished chrome holder, colors red, green, amber, blue, opal, clear. UNDERWRITERS APPROVED.

147-1000 Porcelain insulation, solder terminals, faceted jewel in snap-in holder. (-1001 is identical except smooth jewel).

147-1032 Molded phenolic insulation, screw terminals, faceted jewel in snap-in holder. (-1033 is identical except for smooth jewel).

147-1200 Porcelain insulation, solder terminals, faceted jewel in screw-in holder. (-1201 is identical except smooth jewel).

Many other types are readily available and described in the JOHNSON Catalog, free on request. For production quantities, JOHNSON offers a complete engineering and design service. Your inquiries are invited.

147-1000

147-1032

147-1200

JOHNSON
E. F. JOHNSON CO., WASECA, MINNESOTA

Sensicon receiver for industrial radio installations. The unit meets FCC regulations that allow a maximum power input of 3 watts to the final amplifier for those industries where all 2-way radio communications are carried on within a single plant area. Models are available for operation from either 6-volt d-c, 12-volt d-c or 117-volt a-c primary power source. They may be installed on a plant or industrial vehicle or used as a base station.

Klystron Power Supply

HEWLETT-PACKARD Co., 395 Page Mill Road, Palo Alto, Calif. Type 715A klystron power supply is a versatile unit designed for test-bench operation of all types of low-power klystron oscillators. The instrument provides a beam voltage continuously variable from 250 to 400 v at 50 ma maximum. Reflector voltage is variable from 10 to 900 v at 5 μa. The unit also provides for square wave modulation at 1,000 cps, or may be modulated from an external source. It gives a filament supply of 6.3 volts at 1.5 amperes. Price is $300.

Transmitting and Power Tube

AMPEREX ELECTRONICS CORP., 25 Washington St., Brooklyn 1, N. Y. Type AX-9906R/6078 high-power air-cooled transmitting and power tube has a plate dissipation of 45 kw and a weight of only 66 lb. It employs new, high-efficiency radiator fins and a unique air-flow chamber. High velocity air is diverted in the assembly into a number of parallel paths, thus mini-

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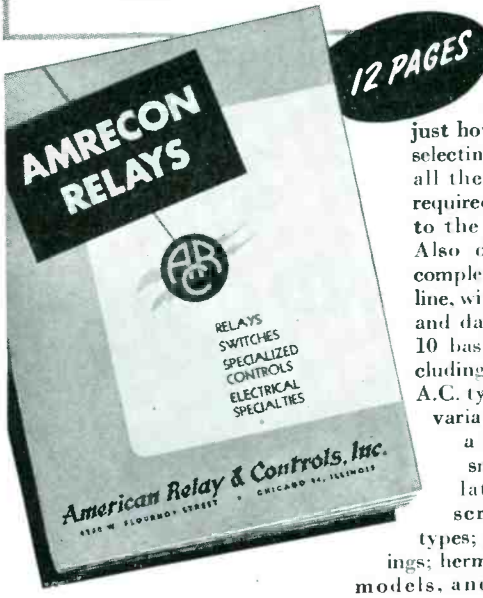
RELAY CATALOG



This useful catalog shows just how to go about selecting a relay, with all the information required to fit the unit to the application! Also describes the complete AMRECON line, with illustrations and data on each of 10 basic models (including both D.C. and A.C. types) and their variations. Includes a discussion of snap-action and latching relays; screw terminal types; plug-in mountings; hermetically sealed models, and other data.

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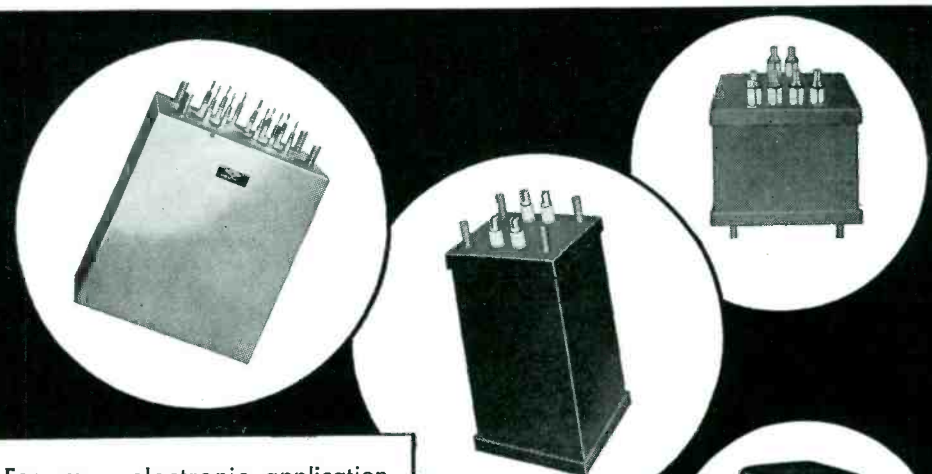

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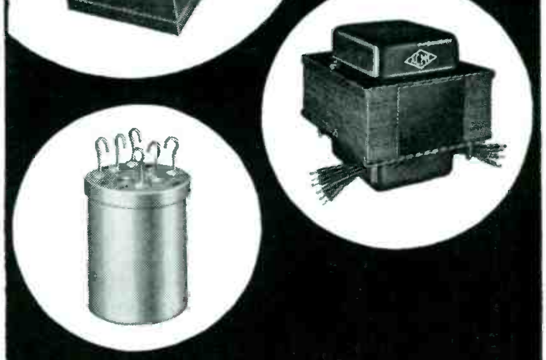
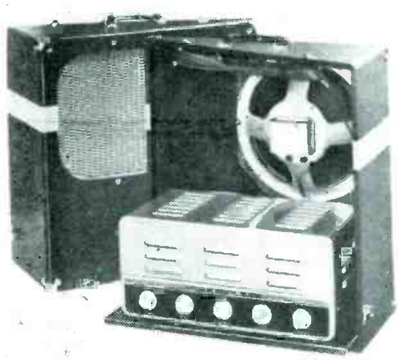


Acme Electric
TRANSFORMERS

mizing the total pressure. The triode produces an output of 108 kw at 15 mc and is intended for operation up to a maximum frequency of 30 mc. Maximum plate voltage is 13,500 v and maximum plate current is 12 amperes.



Portable P-A System

NEWCOMB AUDIO PRODUCTS CO., 6824 Lexington Ave., Hollywood 58, Calif. Model H-1512R portable p-a system features two 12-in. speakers in a split case with 17-watt amplifier providing inputs for 2 microphones and 1 phonograph. It has a frequency response of from 20 to 20,000 cycles and power output of 17 watts. A similar model is available with a 25-watt amplifier and inputs for 3 mikes and a phonograph pickup. Either model can be provided with remote control for all mikes from any distance up to 2,000 ft.

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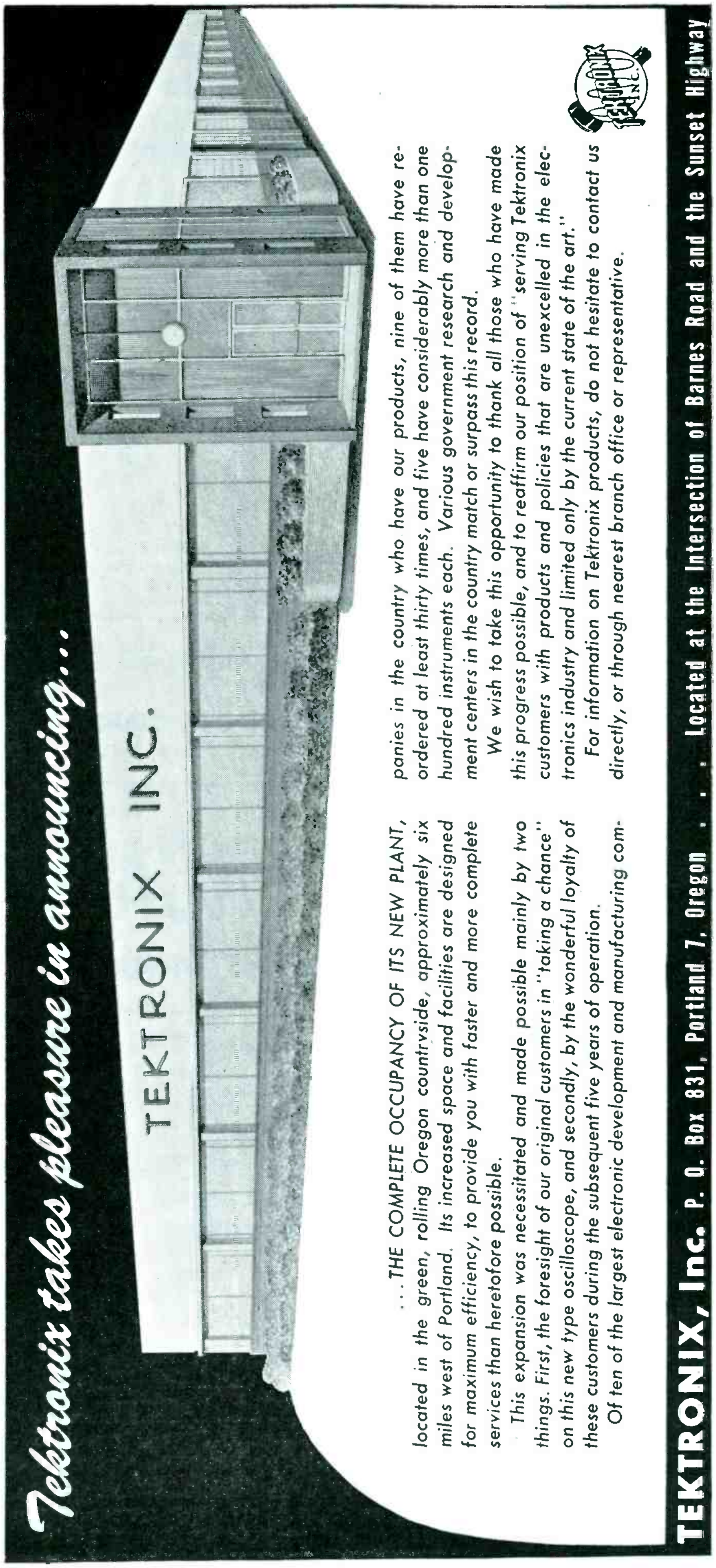
ATLAS AIRCRAFT PRODUCTS CORP., 1 E. 53rd St., New York 22, N. Y. The type FB-1615 motor has been designed for 60, 400 or variable frequency operation, for single or polyphase power input. Induction or synchronous types are available. They may be obtained in ratings from 1/1,000th to 1/50th h-p fo



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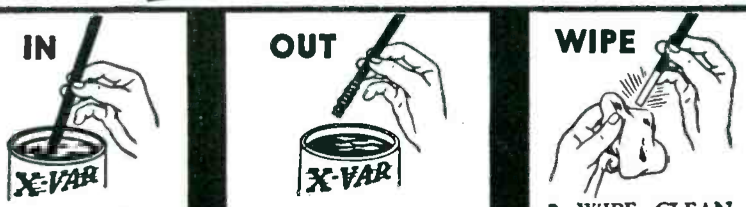

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Literature

Broad-band Klystrons. Sylvania Electric Products Inc., 1740 Broadway, New York 19, N. Y. A recent 18-page booklet covers a line of reflex klystrons, which are broad-band microwave oscillator tubes for both c-w and pulse operation. Technical description, illustrations, specifications and application notes are included.

Microwave Instrumentation. The Calnevar Co., Microwave Div., 1732 W. Washington Blvd., Los Angeles 7, Calif., has available a bulletin describing the company's ability to service requirements of manufacturers, research laboratories and engineering groups active in the radar and microwave field. The system components and laboratory instruments discussed include a precision standing-wave detector, a precision calibrated attenuator, rotating joints, a flap attenuator and matched magic tees.

Battery Brochures. Yardney Electric Corp., 105-107 Chambers St., New York 7, N. Y. Technical brochure No. 1 covers a line of rechargeable storage batteries that are up to $\frac{1}{5}$ the size and $\frac{1}{6}$ the weight of average storage batteries. Applications and physical and electrical characteristics are given. Technical Brochure No. 2 includes characteristic curves and terminal arrangements for these Silvercel batteries.

Decimal Scalers. Berkeley Scientific Corp., Richmond, Calif., has available a 6-page folder giving an illustrated description complete

with specifications of the model 100 basic scaler and model 110 utility scaler. The units described are direct-reading and portable. Accessories and auxiliary equipment, along with their prices, are included.

Nickel Alloys. The International Nickel Co., Inc., 67 Wall St., New York 5, N. Y. A recent 28-page booklet deals with a wide line of nickel alloys for electronic uses. Composition, general characteristics, typical uses and availability of each type are given.

Electrical Measuring Instruments. Westinghouse Electric Corp., Box 2099, Pittsburgh 30, Pa. Information on how to select electrical measuring instruments is provided in the 30-page booklet B-4696. Complete lines of portable, switchboard, panel, recording and socket instruments are described and illustrated, and functions of each are explained. Descriptions of instrument auxiliaries are included.

Decade Resistor. Rochester Electronics Co., Inc., P.O. Box 227, Penfield, N. Y., has issued a single-page bulletin illustrating and describing the model 2B decade resistor. Range, values per decade, accuracy, maximum ratings and price are given.

Capacitor Bulletin. Centralab Division of Globe-Union, Inc., 900 E. Keefe Ave., Milwaukee 1, Wisc. Technical bulletin No. 42-123, on the type 950 series high-accuracy capacitors, covers complete technical data, dimensions and suggested applications. The capacitors described are shielded, sealed hermetically and intended primarily for close tolerance oscillator circuits, primary and secondary frequency standards, frequency meters and similar precision resonant applications.

Mica Capacitors. Cornell-Dubilier Electric Corp., South Plainfield, N. J., recently released its new 60-page mica and Faradon capacitor catalog No. 420-421. Following the detailed type-by-type index will be found five pages of informative technical data on the selection, use and method of specifying mica ca-

pacitors. The catalog is profusely illustrated and detailed dimensional drawings are included for the user's convenience. References and cross-indexing are added to simplify replacement or design problems.

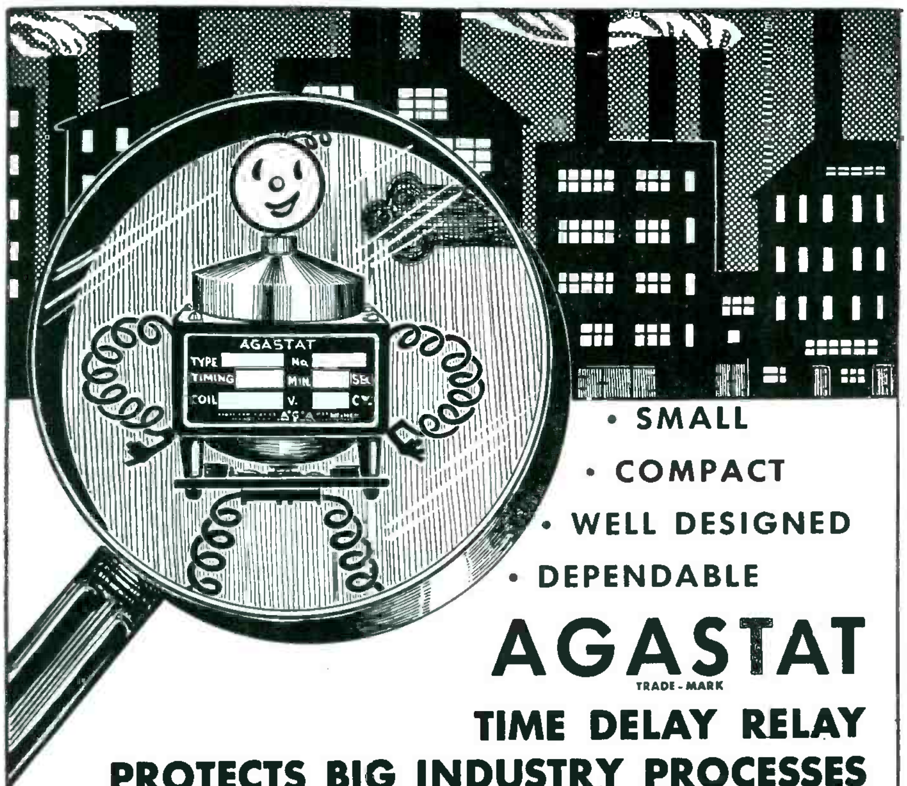
Carrier Telephone System. Lenkurt Electric Co., County Road, San Carlos, Calif. Form 32E-P folder covers a new carrier system capable of superimposing up to four high-quality voice channels and four dial- or ringdown-signaling channels on an open-wire line. The system described operates in the carrier frequency range from 3.3 to 35 kc, as shown in detail in the frequency-allocation chart included. Other data covers application, physical description, terminals, repeaters, signaling facilities, accessories and operating performance characteristics.

VHF Pack Sets. Link Radio Corp., 125 W. 17th St., New York 11, N. Y., has issued bulletins on the type 3035 and 3036 portable, fixed and aviation pack sets. The units described are designed for two-way radiotelephone communication in the 30 to 50 and 152 to 174-mc vhf bands respectively. Illustrations, principal characteristics and specifications are included.

Pressure Measurement. Electro Products Laboratories, Inc., 4501 North Ravenswood Ave., Chicago 40, Ill., recently published a bulletin on the new model 3700C linear stabilized Pressuregraph that offers measurement and recording of static and dynamic pressures in air, gases, water and viscous liquids. Illustrations, chief features and a list of applications of the unit are given.

Wire Identification. Thermo Electric Co., Inc., Fair Lawn, N. J., recently compiled a chart of calibration symbols and color codes for insulated thermocouple and extension wires. On the reverse side of the identification chart is printed a table of the electrical resistances of thermocouple wires. Copies may be obtained on request.

Frequency Recorder. Brown Instruments Division, Minneapolis-



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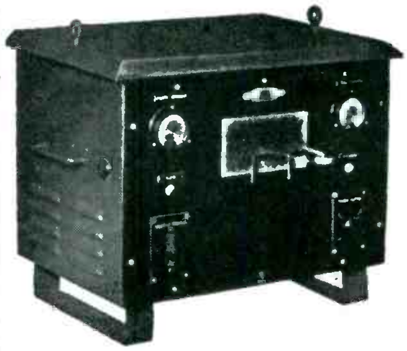

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107 Monroe St., Garfield, N. J.

Honeywell Regulator Co., Wayne and Windrim Aves., Philadelphia 44, Pa. A two-page data sheet describes the Electronik frequency recorder designed for measuring and recording the frequency of electrical power production. Complete engineering specifications and operating characteristics, including circuit diagrams and illustrations of the instruments, are described in Instrumentation Data Sheet No. 9.1-8.

Varnished Insulation & Insulating Varnishes. Irvington Varnish & Insulator Co., Irvington, N. J., has available a 52-page spiral-bound booklet covering the company's facilities and its wide variety of products. Some of those included are cambric for cable construction, splicing tapes, Silastic tape, class-H Silicone coated asbestos and tubings. Technical data and purchasing information are given. Twenty pages are devoted to insulating varnishes.

Sensitive Relays. Sigma Instruments, Inc., 170 Pearl St., South Braintree, Mass. Catalog 51-3 gives a 16-page illustrated description of a line of sensitive relays. A classification chart and list of definitions are included, as well as chief features and applications of each type of relay.

Fractional H-P Gearing. Gear Specialties Inc., 2635 West Medill Ave., Chicago 47, Ill. The new 6-page 2-color folder features 15 halftone illustrations presenting a few of the many different types of fractional h-p gearing made by the company. Also included are two useful standards charts. The folder will interest those using fractional h-p gearing from 12 to 96 d-p on a mass-production basis.

Metallic Oxide Cores. Stackpole Carbon Co., St. Marys, Pa., has published a new 12-page engineering bulletin profusely illustrated with graphs demonstrating the behavior characteristics of each of its three grades of metallic oxide Ceramag cores under varying conditions of permeability, flux density, temperature and other magnetic properties. The cores described

have found widespread use in tv flyback transformers, deflection yokes, image-width controls and other applications where high permeability for relatively low flux densities and medium frequencies is required.

Components Catalog. Herman H. Smith, Inc., 436 Eighteenth St., Brooklyn 15, N. Y. An 18-page indexed catalog covers a wide line of electronic components and television accessories. Over 125 items with technical descriptions and prices are listed.

Wire and Cable Information. Columbia Wire and Supply Co., 2850 W. Irving Park Road, Chicago 18, Ill., has released a new brochure describing the facilities and products of the firm. Beautifully illustated, it shows the planning and layout facilities, rubber capping, attaching of terminals, automatic braiding and shielding, multicutting, automatic cutting and stripping, coiling and winding, multiconductor twisting, heavy cable stripping, press assemblies and the like.

Tandem-Type Connectors. Cannon Electric Co., 3209 Humboldt St., Los Angeles 31, Calif. Bulletin RCS-1 illustrates and describes the CS tandem-type connector developed primarily for electric analog computers and also adaptable on a-c network analyzers. Dimensional diagrams, cutaway views, a typical circuit and the method of engagement are shown.

Radial Beam Tube Data. National Union Radio Corp., 350 Scotland Road, Orange, N. J., has issued two data sheets on types 5729 and 5730 30-anode radial beam tubes that are designed for high-speed electronic switching or commutation. Both of the tubes described employ electrostatic focusing supplied from a 6-phase a-c supply. Physical specifications, typical operating conditions and applications for each are given.

Geiger-Counter and C-R Tubes. 20th Century Electronics Ltd., Dunbar Works, Dunbar St., West Norwood, London, S.E. 27, England, has available an illustrated brochure on its Geiger counter tubes and precision cathode-ray tubes. Details and photographs are given of the new range of halogen-quenched low-voltage tubes and also the improved version of the company's double-gun c-r tube.

Copper Weights of Wires & Cables. Rome Cable Corp., Rome, N. Y., has published a bulletin containing information on copper weights of electrical wires and cables. It is designed to be of assistance to those who must report their requirements and past usage of wire and cable in terms of copper poundage. Covering a wide range of products, the pounds of copper per 1,000 feet are conveniently listed for most common sizes and types.

Iron Core Magnet. Arthur D. Little, Inc., Memorial Drive at Kendall Square, Cambridge 42, Mass., has available a reprint that reviews the development of an improved iron core magnet for general laboratory use. The paper presents design considerations and operating characteristics (with curves) for a research electromagnet having a wide range of application. The electromagnet described is compact and versatile, and has a field strength of over 40,000 gauss being obtained with only 20-kw power input.

Machine-Cast Bar Solders. Federated Metals Division, American smelting and Refining Co., 120 Broadway, New York 5, N. Y. A recent folder illustrates and describes the method of making Castomatic solders, which are machine-cast rather than hand-cast bar solders. Chief features of the solders are outlined.

Film Leader. Society of Motion Picture and Television Engineers, 40 W. 40th St., New York 18, N. Y., has available a reprint of a recent status report dealing with a new-type leader for motion picture prints. Use of the leaders described will eliminate blind switching of telecast films and will permit synchronous threading of all 16-mm projectors. It will not upset established theater practice because the new design which makes several provisions for tv use is based upon the familiar Academy leader.

NEWS OF THE INDUSTRY

(continued from page 150)

George H. Brown of RCA Laboratories Division. Recently, an 850-mc television transmitter has been installed at the site of the experimental 530.25-mc transmitter (see ELECTRONICS, April 1950, p 70). The new transmitting antenna is directional with a broad pattern in the direction of Bridgeport and a very narrow vertical pattern. Comparisons between field intensity measurements on the two bands have been made, but not yet completely evaluated. In addition, studies have been made of the effect of tilting the antenna downward 1.3 degrees. This orientation results in an average increase in signal of 10 db throughout Bridgeport to distances of five miles from the transmitter. At greater distances, the signal is decreased. With an effective radiated power of 40 kw, a median field intensity of at least 10,000 microvolts per meter is obtained to a distance of five miles. The tropospheric field at 100 miles is reduced approximately 12 db with the down-tilted beam.

"Du Mont 700-Mc UHF Installation", by William Sayer, Jr. and Elliott Mehrbach of Allen B. Du Mont Labs. Mr. Sayer described the current installation of an experimental transmitter in which the final stage employs six parallel 2C39 type tubes (an article about the transmitter design has been accepted for publication in ELECTRONICS). Propagation studies with the new equipment will have the advantage of a site in New York City from which characteristics of vhf television signals are already known.

"Impedance and Frequency Measurements at UHF", by R. A. Soderman and F. D. Lewis of General Radio Co. Mr. Soderman indicated a number of techniques necessary for the accurate and reproducible measurement of impedance at frequencies in excess of 1,000 mc (see also *Radio-Electronic Engineering*, July 1951, p 3). Measurements can be made using the slotted line that shows impedance by indicating the magnitude and position of the standing-wave set up on a standard line terminated in the unknown. However, newer equipment based on the bridge is also available com-

mercially. A uhf admittance meter, related to a hybrid junction, but balanced like a bridge, was described in some detail. Mr. Lewis summed up methods of frequency measurement at uhf, and showed a few of the design features to be incorporated into new heterodyne equipment for use at uhf.

"Side Fire Helix UHF Television Transmitting Antenna", by L. O. Krause of General Electric Co. Power gain of 20 is obtained in a four-section antenna using a radiation-attenuated, traveling-wave helical current. (See also ELECTRONICS, August 1951, p 107.) The helical conductor is supported by a coaxial metal mast through which the feed line is carried. Vertical aperture is about twenty wavelengths, each turn of the helix being two wavelengths in circumference. The helix side-fires, producing a beam of narrow angle in the vertical plane, horizontally polarized and of uniform azimuth pattern.

"A Fundamental Approach to UHF Television Receivers", by W. B. Whalley of Sylvania Electric Products. Because receiver design for uhf tv has not yet been frozen into production types, the speaker was able to set up three different tuner categories for discussion of their relative characteristics. He divided the possible types into continuously tuned, selector-switched and band-spread or semicontinuous. An important aspect of the uhf tuner is that it can often take the form of a converter, heterodyning a uhf signal into an unused channel of a vhf receiver or one employing similar circuitry.

"Transmission Line Problems in the UHF Television Band", by J. M. De Bell, Jr., of Allen B. Du Mont Labs. Mr. De Bell followed up the Du Mont uhf New York City installation story with further details of antenna feed. During the course of the installation, various types of coaxial cable and waveguide were considered. Of high interest was his description of the rat-race or hybrid ring used in place of the more conventional vestigial sideband filter.

"Progress Report on the RCA-NBC UHF Project at Bridgeport, Conn.", by Raymond Guy of National Broadcasting Co. Starting with a slide that showed Felix, the

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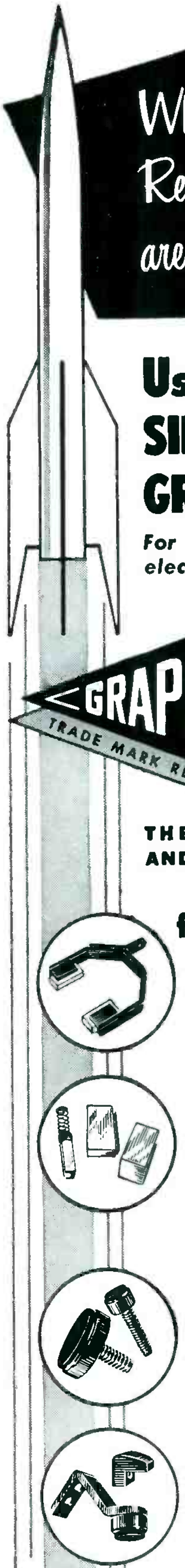

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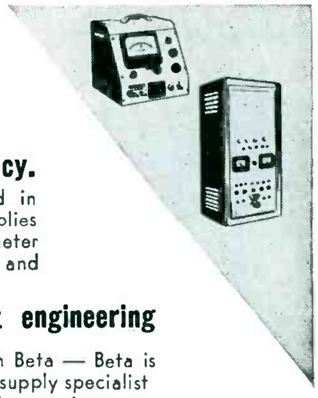

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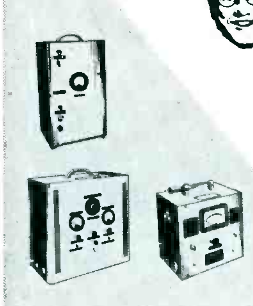

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Our field engineers coast-to-coast are ready to discuss your problems. Write, wire or phone Today first NBC television model, being televised for experimental broadcasts on 1,200 kc, Mr. Guy briefly traced engineering trends culminating in the 850-mc station in Bridgeport.

"An Electronic Radio Field Strength Analyzer for Use in Television Station Field Surveys", by Frederick W. Smith of National Broadcasting Co. Despite the forbidding title, Mr. Smith's serious paper proved to be the humorous highlight of the symposium. The evaluation of tape recordings presently required by FCC in proof of performance of broadcast stations takes many man hours and is subject to error. Automatic recorders that analyze signal intensity as a function of time (see ELECTRONICS, January 1951, p 75) are not suitable directly for field surveys along radial paths. The device described is connected into the speedometer drive cable in such a way that fields are recorded at each of several predetermined levels. The in-line presentation of counters can be manually or photographically recorded at any time.

Stuart L. Bailey of Jansky and Bailey was moderator of the morning meeting and Dorman Israel of Emerson Radio presided at the afternoon session. Arrangements were headed by L. Winner of Bryan Davis Pub. Co., with W. H. Doherty of Bell Labs. as vice-chairman and S. Helt of Allen B. Du Mont Labs. as program chairman.

AES Convention Program

THE Third Annual Convention and Audio Fair Exhibition of the Audio Engineering Society will be held Nov. 1–3 at the Hotel New Yorker, New York City. Tentative program of technical papers to be presented is as follows:

Problems of Ultra-Speed Recording Techniques, by C. J. LeBel of Audio Instrument Co.

Magnetic Recording Equipment for Motion Picture Production, by B. Denny & W. L. Thayer of Paramount Pictures, Inc.

Modern Recording Installation That Emphasizes Tape, by W. O. Summerlin of Audio-Video Recording Co., Inc.

An Artificial Reverberation Generator, by L. S. Goodfriend of Audio Facilities Corp.

Magnetic Tape Recording for Instrumentation and Data Storage, by K. B. Boothe of Audio & Video Products Corp.

Loudspeaker Enclosures, by D. J. Plach & P. B. Williams of Jensen Mfg. Co.

Multiple-Speaker Systems, by H. F. Olson of RCA Laboratories, Inc.

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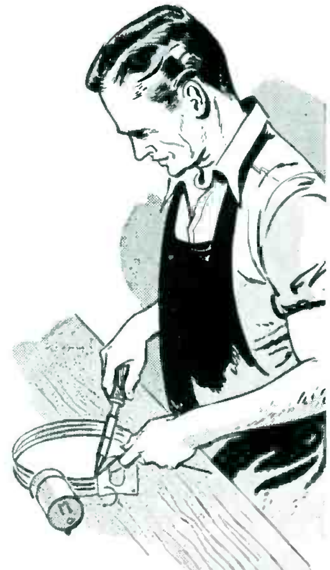

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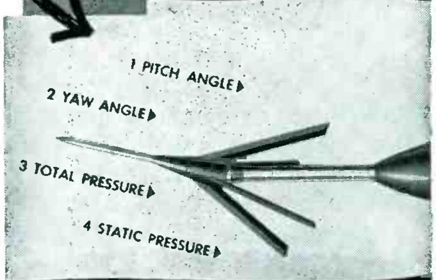

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NEWS OF THE INDUSTRY (continued)

and Loudspeaker Cabinets, by J. Markell of New Horizons Furniture, Inc.
New Amplifier Design, by H. I. Keroes of Acro Products Co., Philadelphia, Pa.
Industrial Sound Systems, by H. S. Morris of Altec Lansing Corp.
Transistors in Audio Use, by a member of the staff of Bell Telephone Laboratories.
Magnetic Amplifiers for Audio Applications, by a member of the staff of Bu Ships, U. S. Navy.

BUSINESS NEWS

ELECTRONIC DEVICES, INC., Brooklyn, N. Y., has purchased Precision Rectifier Corp. which will be operated as the Precision Rectifier Division of Electronic Devices. This division will produce long-life selenium rectifiers for all civilian and military applications, with a minimum guarantee of 1,000 hours.

WESTINGHOUSE ELECTRIC CORP. is completing its 400,000-sq ft Television-Radio Division plant near New Brunswick, N. J. The new plant will be used temporarily for electronic defense production.

ACRO PRODUCTS CO., transformer manufacturers, recently moved to the newly acquired Acro Building, 369 Shurs Lane, Roxborough, Philadelphia 28, Pa.

AVIATION ENGINEERING CORP., manufacturers of electronically operated aircraft fuel gaging systems, has doubled its floor area by the addition of a new building to its present plant in Woodside, N. Y.

THE NORTH AMERICAN PHILIPS CO., INC., recently purchased the capital stock of The A. W. Haydon Co., Waterbury, Conn., manufacturers of timing motors and electric controls for aircraft and electronic devices.

SIERRA ELECTRIC AND MFG. CO., Los Angeles, Calif., recently purchased the McDonald Mfg. Co. to expand its line of wiring devices and engage in the design, development and manufacture of electronic equipment and systems.

PERSONNEL

HOWARD ROWLAND, chief electrical engineer for the past five years, is now chief research engineer of The Workshop Associates, Division of The Gabriel Co., Needham Heights, Mass. In his new capacity he will direct a selected group of engineers

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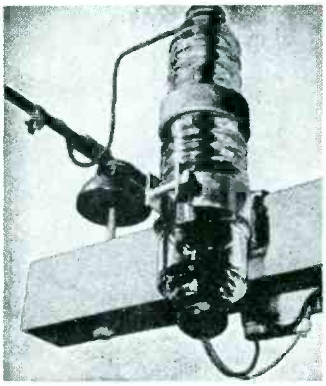
The All-Weather Resistors

ARE USED IN HIGH VOLTAGE "HIPOT" COUPLERS

S.S.White resistors are connected in series to permit a current flow to ground, when the "Hipot" Coupler is used to measure or to synchronize voltage of high voltage lines.

Canadian Line Materials, Ltd.—maker of "Hipot" Couplers and other transmission, distribution and lighting equipment says—"We have always found S.S.White resistors of the highest quality". This checks with the experience of the many other producers of electrical and electronic equipment who use S.S.White resistors.



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It gives details of S.S.White Resistors including construction, characteristics, dimensions, etc. Copy with price list on request.

S.S.WHITE RESISTORS are of particular interest to all who need resistors with *low noise level* and *good stability* in all climates.

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10 to 10,000,000 Megohms

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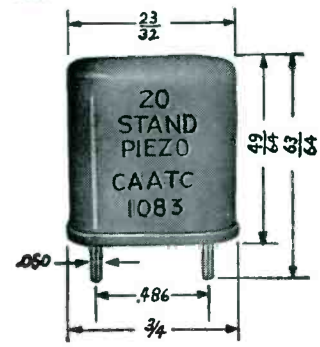

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In addition to lowering power requirements and weight, it increases compactness, durability and dependability. Type 20 meets all Government specifications, too.

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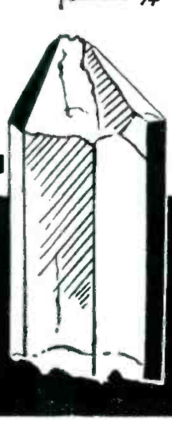

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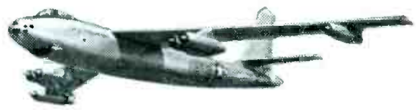

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Openings are available at both Seattle and Wichita. Your choice of location – Pacific Northwest or the Midwest. You'll enjoy good salaries that grow with you, and Boeing provides a moving and travel expense allowance.

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in the investigation of new products and advanced research into antenna problems.

CHARLES B. JOLLIFFE has been elected to the newly created position of vice-president and technical director of Radio Corp. of America. E. W. Engstrom will replace him as vice-president in charge of RCA Laboratories Division.

WILLIAM M. NAVE, superintendent of metal tube production at GE's Owensboro plant since 1950, has been appointed works manager for the General Electric Company's new electronic tube plant under construction near Anniston, Ala. He will direct more than 2,000 workers in the production of miniature receiving tubes at the new $6,000,000 plant.

JAMES M. VALENTINE, formerly television engineering manager of the American Broadcasting Company's Central Division, has been appointed an assistant division head in charge of television field engineering at Federal Telecommunication Laboratories, Inc., Nutley, N. J., research and development associate of the IT&T Corp.

J. M. Valentine

A. M. Pichitino

ALBERT M. PICHITINO, formerly chief, Electronics Section, Laboratories for Research & Development of Franklin Institute, was recently named chief engineer of E. F. Johnson Co., Waseca, Minn.

BERNARD HECHT, recently with RCA Victor, and previously with the International Resistance Co., has joined Starrett Television Corp., New York, N. Y., as general manager to direct and coordinate all phases of management of that concern with special emphasis on quality control for government operations.

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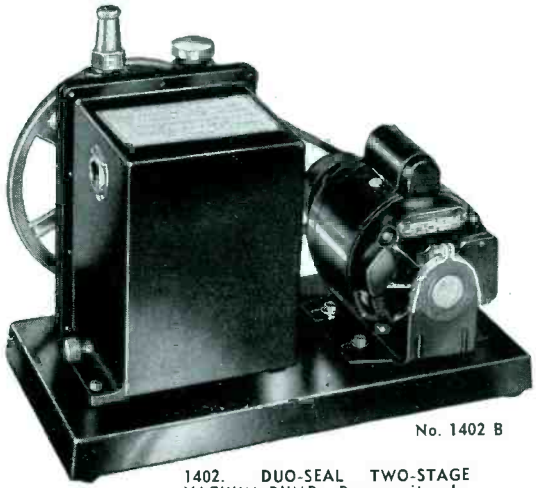

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5 cubic feet per minute
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GUARANTEED VACUUM

0.0001 mm Hg or 0.1 microns

QUIET OPERATION

VISIBLE OIL LEVEL

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Overall dimension for pump and motor 15½" high and 11" wide x 19⅝" long

This new two-stage Duo-Seal pump is constructed with the same care and precision as its fore-runners in the Duo-Seal line. The extremely quiet operation, so much appreciated in the other models, is also characteristic of this unit.

A positive oil seal prevents the oil from backing into the exhaust line. Oil may be changed in a few minutes due to the conveniently located oil drain.

1402. DUO-SEAL TWO-STAGE VACUUM PUMP. Pump unit only, not mounted on a base, but with a 10 inch grooved pulley, a supply of oil, and directions for use. Each $190.00

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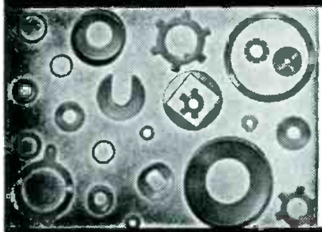

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Quality Products Since 1931
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NEW BOOKS

(Continued from page 152)

cating a relay by a zig-zag and a *CR*2 without any indication of what the contacts do. Thus in this first diagram there is no way to tell what relay *CR* does except by inference that it handles the welding current and that Tube 1 (not 1Tube) turns the weld on and Tube 2 (not 2Tube) turns the thing off.

These comments are not meant as criticisms, but only to warn the electronic-trained engineer that he cannot pick up this book and find out without effort exactly how welding timers and motor controllers work. He will have to adjust himself mentally a bit here and there to get into the swing of things. The operator and maintenance man, for example, would know that relay *CR* handles the welding current. He would not need to be told so by the author.—K.H.

Ultrasonics

P. VIGOUREUX, *Royal Naval Scientific Service. John Wiley & Sons, New York, 1951, 163 pages, $4.00.*

WRITTEN as a resume of the advances in the techniques and applications of superaudible vibrations since Bergmann published his work on ultrasonics, this small volume constitutes a concise introduction to the subject and a guide to the literature of the past decade.

The material in the six chapters of the book can be grouped into three classifications: theory, instrumentation, and effects. Chapter III, Propagation, presents the wave equations and phenomena associated with ultrasonic propagation. Other theoretical considerations are introduced throughout the book as the subject warrants. Chapter II, Generation, and Chapter IV, Observation, describe the laboratory instruments used in ultrasonic experiments. Chapters V and VI, Gasses and Liquids respectively, describe the phenomena observed when ultrasonic waves pass through fluids. The physical properties of fluids can be determined from such observations.

As the author points out in the introductory chapter, the book has been written to bridge the gap since Bergmann's now-standard work was published and the present time. During the intervening decade the

interest in ultrasonics has greatly expanded; techniques have been improved and new knowledge gained. This book presents these advances against a scientific background; an extensive bibliography complements this treatment. Although the spectacular industrial and military applications may take our attention, the fundamentals presented in this book deserve our consideration. — F. H. ROCKETT, *Airborne Instruments Laboratory, Mineola, New York.*

Waveguide Handbook

Edited by N. MARCUVITZ. *Radiation Laboratory Series, McGraw-Hill Book Co.*, 1951, $7.50.

MICROWAVE engineers who have been waiting for this volume for the past six years will not be disappointed. Before the publication of this first handbook, design of many waveguide components could often be classified as either semi-empirical or belonging to the realm of higher mathematics. Waveguide techniques are now brought within the range of the average engineer who is not familiar with boundary problems.

This handbook represents a gigantic step in the direction of supplying essential information to the designers in a large number of important cases. No one should, of course, expect to find all problems of importance already solved nor all the data always presented in a form easy to assimilate. The state of the art is such that three chapters and about 40 percent of the text need to be devoted to basic theoretical concepts. It is very probable therefore that this handbook will be followed by more handbooks which will put more emphasis on the practical and design side of the problem. It can be stated without doubt, however, that the information made available in this volume covers almost all the conventional microwave circuits and a good percentage of the unconventional ones.

Unfortunately the number of problems which present themselves in the study of waveguide circuitry is very large. Consider for instance the titles and the organization of

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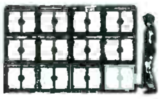

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- Costs less than 5¢ per hour to operate
- Plugs into any 110 V outlet—no special wiring required
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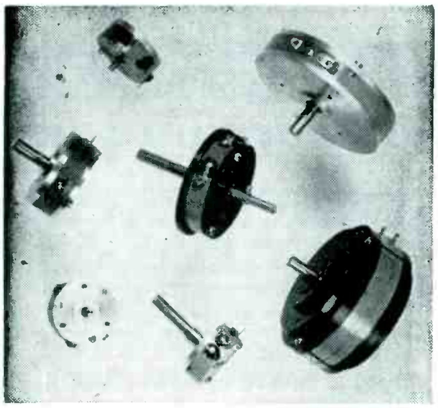

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Wedding ring type . . . five sizes charted below. Gamewell Potentiometers are precision instruments in every respect. They feature close limits in electrical characteristics and mechanical construction, low electrical noise, low torque, and long life. All types operate at —55°C. to +55°C., 95% relative humidity at altitudes up to 50,000 ft. Non-linear windings are available.

CONDENSED SPECIFICATIONS	RL-272	RL-270	RL-271	RL-275	RL-277
Diameter (in.)	5	3	2	1⅝	1¼
Rating (watts)	12	6	3	2	1.5
Torque, max. (oz. in.)	1	1	1	½	½
Weight (oz.)	15	6	3	2	1
Mounting: 3 holes ⅛" deep	#8-32	#8-32	#8-32	#6-32	#4-40
Mounting circle diam. (in.)	3.250	1.750	1.250	1.000	1.000
Max. resistance (ohms) ± 10%	500,000	275,000	160,000	105,000	64,000
Min. resistance (ohms) ± 10%	460	250	150	105	80
Max. useful angle (deg.)	358±½	356±½	354±½	352±½	350±½
Max. resolution (%)	0.05	0.08	0.15	0.2	0.25
Min. resolution (%)	0.01	0.015	0.025	0.04	0.05
Linearity (%)	±0.10	±0.10	±0.15	±0.25	±0.30

Standard Shaft: single end, ¾" extension; specify if otherwise.
Double ended shaft special; specify diameter and length.
Multiple sections can be ganged; add ⅜" to the overall length for each additional section.
Terminals will be positioned on the circumference as required for taps and winding angle.
Expected life of all types over 1,000,000 cycles.

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THE GAMEWELL COMPANY
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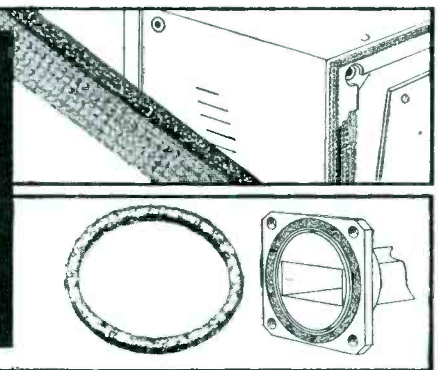

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the last five chapters of the book:

The fourth chapter deals with two-terminal structures, namely those which have only an input waveguide and either terminate into a reactive load or into space. This chapter is divided into two subchapters comprising lines terminating in guides beyond cutoff and lines radiating into space. The last subchapter for instance considers 14 different cases. The next chapter, No. 5, considers four-terminal structures namely those which have one input guide and an output guide. Thirty-five different cases are considered classified as follows: 8 cases of structures with zero thickness like windows, disks and apertures; 9 cases of structures with finite thickness like windows, posts, spherical dents and resonant rings; 6 cases of gratings and arrays in free space; finally 19 cases of asymmetric structures covering the coupling of two guides, of rectangular, coaxial and circular shapes. Corners, bends and aperture couplings are also considered. In the sixth chapter six-terminal structures are considered of which T and Y are typical examples. Bifurcation of coaxial lines is also considered. In the seventh chapter eight-terminal structures are considered which include both hybrid junctions and aperture-coupled pairs of guides. In the last chapter composite structures are examined including guides with dielectric slabs and cylinders, with ridges and resistive strips and finally with "non-radiating" slits. The case of thick windows already discussed on the fifth chapter is considered again and a particular E-plane T with slit coupling is mentioned.

The information given in the handbook for all these cases includes the equivalent circuit parameters with the corresponding formulas and in some cases with diagrams. Information is also supplied in most cases as to the expected accuracy of the formulas given.

From this summary it should appear clear that the scope of the volume is very wide and that the space devoted to each group of problems is roughly proportional to their practical importance.

Three chapters devoted to basic

theoretical concepts precede the five chapters which form the real handbook part of the volume. In these chapters a concise and coherent description is given of the problems involed in waveguide circuits. In the first chapter fields in waveguides are discussed with emphasis on the relationship between ordinary transmission line theory and propagation of each mode. Particular attention should be paid to Section 1.7 of the first chapter and to the diagrams attached to it because they enable the application to non-uniform radial waveguides of techniques similar to those employed in ordinary transmission line problems. These formulas and curves are very important because parts of many microwave devices can be treated as sections of radial or spherical, and therefore non-unform, waveguides. The second chapter gives a description of the most important modes in rectangular circular, coaxial, eliptical, radial and spherical waveguides.

The third chapter is perhaps the most important for a clear understanding of the equivalent circuit representation of discontinuities and should be read with care by any reader interested in applying the data found in the handbook portion. This statement however does not apply to section 3.5 which outlines the procedures employed in computing the equivalent diagrams given in the last five chapters. The nature of the theoretical procedures is such that, in the brief space of twenty-eight pages, it is impossible to completely explain to a reader not familiar with these theories the details of the methods of calculation. In this section, however, the expert reader will for the first time find a coherent and unified, although too concise, description of the variational, integral-equation, equivalent static, transform methods.

Since it is to be expected that many of the engineers employing this handbook will not have either the time or the patience or the cultural background necessary to read all of the theoretical preliminaries included in the first three chapters, a concise set of instructions for the use of formulas should have been given at the beginning of the handbook chapters. Some practical ex-

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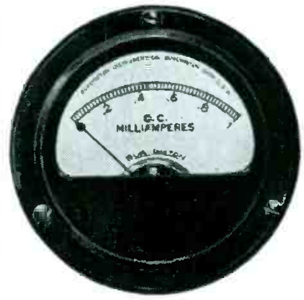

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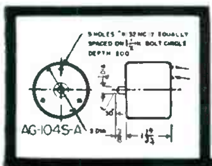

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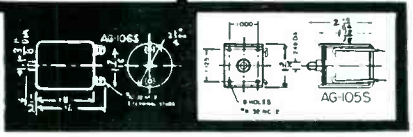

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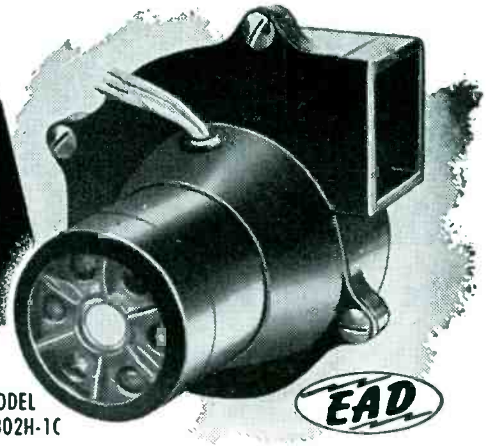

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amples would have contributed to the popularity of the volume. For instance in the handbook section use is made in some cases of the fact that the characteristic impedance of a guide cannot be defined in a unique way and doubts are left in the minds of the readers as to the proper way of applying some of the formulas given.

It is unfortunate that the author chose to limit to a minimum the papers and reports to which he referred. A total of 16 references are given in the whole volume and five of these are to unpublished papers by the author or his students. It is also somewhat unfortunate that obstacles of large thickness be dealt with in two completely different sections of the volume.

These are minor blemishes in an otherwise excellent book which should, and certainly will become a standard reference in the hands of the steadily increasing number of microwave engineers.—E. G. FUBINI

Airborne Instruments Laboratory, Mineola, N. Y.

THUMBNAIL REVIEWS

MINING, PROCESSING, AND USES OF INDIAN MICA. By Chand Mull Rajgarhia. McGraw-Hill Book Co., New York, 1951, 388 pages, $8.00. Geology, methods of prospecting, mining, processing and marketing. Includes step-by-step operations in processing various grades of mica, charts giving world-wide status of mica industry, methods of using micanite, short mica and ground mica for insulators, methods of conserving mica, and diseases associated with mica mining.

ALTERNATING-CURRENT ARMATURE WINDINGS. Charles S. Siskind, Asst. Prof. of E. E., Purdue Univ. McGraw-Hill Book Co., New York, 1951, 236 pages, $5.00. Companion volume to author's "Direct-current Armature Windings," giving planned simplification of principles and present-day practices for single-phase and polyphase a-c machinery in suitable form for classroom use in electrical courses at trade, vocational and engineering schools.

BASIC RADIO COURSE. John T. Frye. Gernsback Library Book No. 44. Radcraft Publications, New York, 1951, 175 pages, $2.25. Nonmathematical presentation of principles of radio receiver circuits and components.

A ROMANCE IN RESEARCH. By Alexander McQueen. The Instruments Pub. Co., Pittsburgh, 1951, 429 pages, $6.00. Biography of Charles F. Burgess, instructor and professor at the University of Wisconsin for many years before entering the dry battery business and forming Burgess Battery Co. and Burgess Laboratories. References include titles of 94 technical papers written by Burgess and 58 patents issued to him on dry cells, metal-coating processes, sound-absorbing materials and various electrical devices. Highlighted by frequent excerpts from his notebooks, such as: *"Wish that X could have better sense of proportion between important and unimportant matters."* Another is: *"Invention consists in combining two or more known facts, or ideas, into a new combination to produce useful results."* In an address accepting the Army-Navy E Award for his com-

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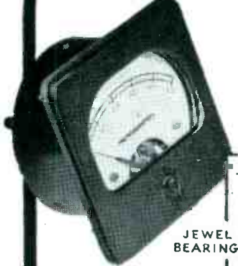

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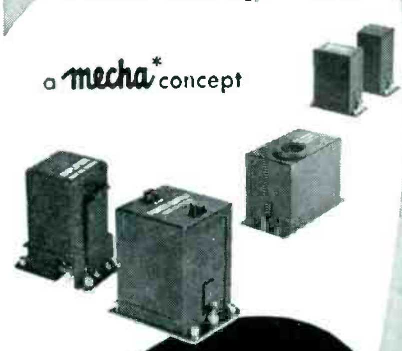

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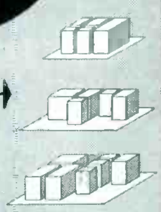

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pany in June 1944, a year before his death, he said: *"When the time finally comes that I shall attempt to crash the Pearly Gates, and St. Peter asks for an account of my doings on the earth, I shall answer—'My most important work was the making of electric batteries, spending over fifty years at it.'"*

PRINCIPLES OF ELECTRICAL ENGINEERING. William H. Timbie, Professor Emeritus of E. E. and Industrial Practice. MIT, and Vannevar Bush, president of Carnegie Institution of Washington, assisted by George B. Hoadley. Prof. of E. E., N. Carolina State College. John Wiley & Sons, 1951, Fourth Edition, 626 pages. $6.50. Undergraduate college text in electrical engineering for 29 years, revised here to bring text up to date and meet new demands. General plan of book remains unchanged though most of text has been rewritten. The last two of the fifteen chapters, totaling over 70 pages, deal with electronics and electromagnetic waves, setting a foundation for further study in this field.

REVIEW OF CURRENT RESEARCH AND DIRECTORY OF MEMBER INSTITUTIONS. Published by Engineering College Research Council of ASEE, and available from Office of Technical Services, U. S. Department of Commerce, Washington, D. C., 244 pages paper-covered, $2.25. Lists complete titles of more than 5,200 now-active engineering research projects, involving annual expenditures of over $50.5 million by over 11,500 faculty, graduate students and research engineers. Also listed for each school are names of responsible research administrative officers, number of research personnel, annual expenditures and other pertinent data and information.

TABLES OF THE BESSEL FUNCTIONS OF THE FIRST KIND OF ORDERS SEVENTY-NINE THROUGH ONE HUNDRED THIRTY-FIVE. By the staff of The Computation Laboratory. Harvard University Press, Cambridge, Mass., 1951, 614 pages, $8.00. Last in a series of 12 volumes in a series devoted to tabulation of $J_n(x)$ for all integral n from 0 through 100 for values of the interval x from 0 through 100. All values are to ten decimal places, while some (for the first four of these functions) are to eighteen places. The project operated as an activity of the U. S. Navy, Bureau of Ships.

TELEVISION TUBE LOCATION GUIDE. Howard W. Sams & Co., Indianapolis, 1951, 220 pages, $2.00. Second volume, showing position and function of each tube in hundreds of recent television receiver models to speed trouble diagnosis and tube replacement.

MAINTENANCE AND SERVICING OF ELECTRICAL INSTRUMENTS. By James Spencer. The Instruments Publishing Co., Inc., Pittsburgh, Pa., 256 pages, $3.00. How-to information on a-c and d-c voltmeters and ammeters, wattmeters, power factor and reactive factor meters, frequency meters, instrument transformers and synchroscopes. Included are sections on design and materials, pivots, calibration, and general service information.

ASTM STANDARDS ON METALLIC ELECTRICAL CONDUCTORS. American Society for Testing Materials, 1916 Race St., Philadelphia, First Edition, 1951, 232 pages, $2.50. Convenient compilation of 43 ASTM standard and tentative specifications and methods of test. Materials covered include copper, copper alloy and copper-covered steel wire; stranded conductors; aluminum wire; galvanized guy wire, copper bars. General tests include resistivity of electrical conductors; tension testing; hardness testing.

RADIOACTIVITY APPLIED TO CHEMISTRY. Edited by A. C. Wahl and N. A. Bonner. John Wiley & Sons, New York, 1951, 604 pages, $7.50. Compilation of result of intensive search of literature on subject. Part I comprises ten chapters presenting contributions of radioactivity to various branches of chemistry. Part II contains 18 extensive tables arranged according to subject, to serve as a summary of and key to the literature concerning these applications that was available by Jan. 1950.

BACKTALK

(continued from page 154)

the printer, as far as a careful survey is concerned. The second edition has found the expected market and there seems many who found the edition useful in their work.

It is true, however, there are no two readers who agree in all phases on a book, especially those who have never written books themselves, except perhaps a few articles and reports on a highly specialized subject. For writing a book we need a seasoned mind, a party with experience and idealism, and *before all* a party who can stand up to criticism *in its strongest form.* It takes also a party who takes all of the responsibility, *after a book is out* of any complaints and shortcomings.

As mentioned in HFM, close to the end, "The author welcomes any corrections and suggestions for improvements."

Claims

The claims for the second edition are:

(A) page v, "In the second edition, methods are described which cover the entire useful radio-frequency band of present-day applications. This required a complete revision of the text."

(B) page v, "Several chapters were completely rewritten. . . ."

(C) page vi, "the chapter on Modulation Measurements has been completely rewritten. . . ."

(D) page v, "Several chapters were completely rewritten, for example the chapter on Line and Antenna Determinations. . . ."

(E) page vi, "The second edition aims to give again *reliable* procedures of measurements and to present the principles underlying a particular determination. Many *alternate* methods are presented. *It is up to the judgment of the experimenter to select the most suitable procedure* and to adapt it to his particular needs. In radio-frequency work, it requires, besides a reliable method, also a certain amount of experimental skill. *Such skill must be acquired.* For this reason every method presented is discussed thoroughly. Often numerical examples are added in order to bring out the order of magnitude, as well *as the feel of operation.* In order to present formulas in a simple way, the

mks system of units was used in the second edition."

(F) page vi, "The last chapter again contains miscellaneous methods, which may be classified as belonging to one or two of the preceding chapters. . . . It is therefore a good policy to look for a particular method in the last chapter or in the index and the table of contents. . . ."

(G) pages vi and vii, "When the first edition of HFM was prepared, it did not seem advisable to recommend bridge methods, except at audio frequencies. . . . However, in the meantime the art and the measuring technique of modified and well-shielded bridges have greatly changed. For this reason the radio frequency and even vhf and uhf bridges are described in the new edition. . . . For further details the reader is referred to articles and pamphlets of the General Radio Company, Cambridge, Mass., the Ballantine Laboratories, Inc., Boonton, N. J., the Hewlett Packard Company, Palo Alto, Calif., and other firms in the United States and abroad, today manufacturing many useful measuring apparatus which are stand-bys in electronic laboratories."

(H) page vii, "if it had not been for the limited space for such a book . . ."

(I) page vii, "This book is a reference book for radio and electronic laboratories. It is also well adapted for a one-year course for students of senior and first-year graduate standing."

(J) page 626, "With respect to Microline instruments, such as the coaxial frequency meters operating at 650 to 10,500 Mc/sec . . ."

Author's Reply

As far as the author's reply to mentioned review is concerned, the following statements are submitted:

(1) The review as well as the author of HFM *agree* that many things concerning HFM have *radically* changed since the days the first edition was written. This applies in particular to high-frequency devices, built recently, and the order of frequency used. The author does not quite agree with the review that *basic* principles in modern applications are radically

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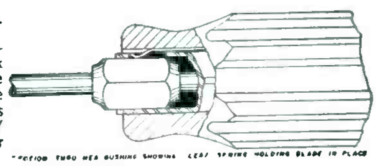

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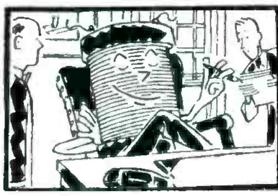

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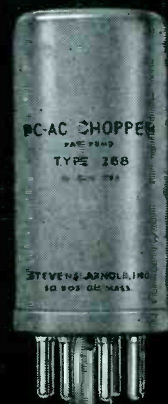

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different. *I mean basic principles*, to be specific. It is true that the order of magnitude may require *modifications* when we go to higher and higher frequencies. But such modifications may in many cases actually simplify certain techniques. As an example we are able to use at vh and uhf's, lines of suitable length as capacitance and inductance, respectively, which can be readily adjusted to a desired value. We may also use coaxial lines with the inherent feature of self-shielding. Even though shielding takes often, in apparatus, an ingenious design, but as is shown among bridges in the second edition and the final chapter we have now reliable apparatus using bridge networks which was never done before.

(2) Whether we deal with old-time Hartley oscillators, which for mere convenience, for school laboratories, are described with interchangeable coils to cover a wider frequency range *should not matter*. Many smaller laboratories can, with such retained descriptions, build their own resources, *which is besides a good practice for students. We still use* kilocycles per second in the standard broadcast range and many other applications. HFM belongs *today* to a very large range of frequencies, and molecular motions and motions of particles still smaller are surely not so important in a HFM book that they should remove *basic* electron tube oscillators of the simplest type. The *Physical Review* and other similar publications give descriptions of special sources, which apply to such motions, if a particular college experiment or some special scientific experiment calls for such determinations. Such publications have besides the advantage of bringing the *latest* in the art of measurement, while a book like HFM can just not keep up with the *electronic rush* of today and has to run at least several years before its investment becomes justified. Besides a writer likes to find out at first how reliable certain methods are before using them in a text.

Klystrons and Magnetrons

(3) *The reason* why klystrons and magnetrons are not described in detail and only referred to, is because the author needed the pages

for other information and the book is already expensive as it is, at least the two reviewers mentioned "even the dollar value", strange as it may seem, *in these days*. The klystron and magnetron descriptions could be omitted, *because* we have MIT and Harvard series of books today with authentic descriptions. They are the outcome of highly specialized contributors on World War II research, and very well edited. No author could do as well *by himself*. We have also books today on microwave techniques which are likewise at all libraries, where Government work and defense work is going on. It may perhaps interest the reviewers that even radio-parts supply stores carry MIT series and uhf technique books, which describe magnetrons and other special oscillators. Any libraries, where defense work is going on, have besides special classified reports on up-to-date uhf tubes of any kind and special descriptions by the Sperry Gyroscope Company and other special tube companies. They bring the latest, which would *outdate* many things in a HFM book even while it is being printed. It takes close to two years and often more before a technical book like HFM is finished, in a reliable publishing company, *just because it is even screened*, while it is on the press. The reviewers should realize this.

Another reason why HFM does not describe special modern tubes and sources is because the author has received complete information during World War II, and as a consultant later on, in classified reports at several defense plants. Therefore, no such information can be used in a publication without a special release. This was not necessary, however, since mentioned series did this and the later special reports are at all defense plants who are engaged in a particular project. *The reviewers ought to know this.* Moreover, the descriptions which the klystron manufacturers give with such tubes as well as firms who build magnetrons are better and more up-to-date than the author of HFM could do and is allowed to do. We, who worked on and off in this field, realize that klystron as well as magnetron oscillators, normally do not cover frequency ranges which are

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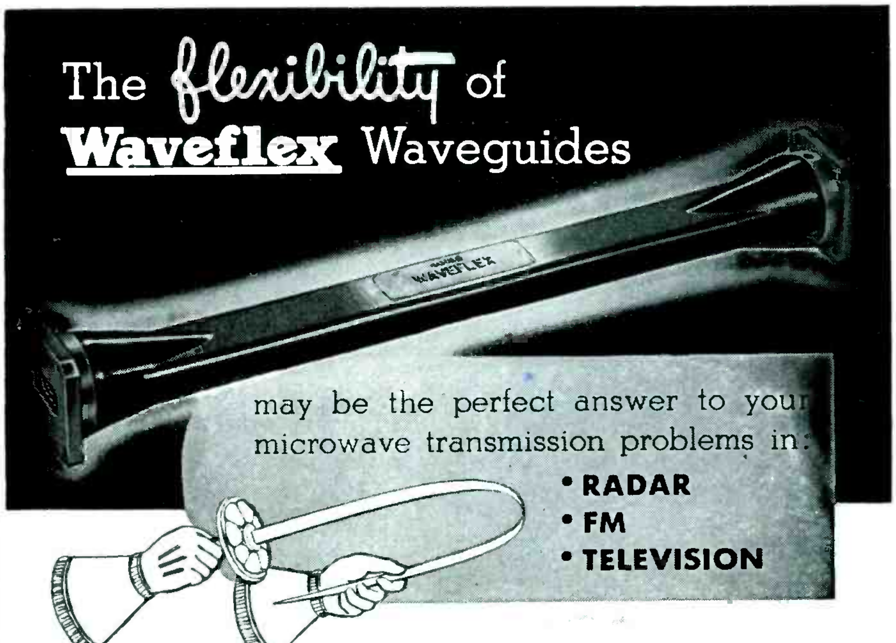

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large. This is open information now, thus in World War II we had L-band magnetrons giving wavelengths of 50 to 25 cm, S-band magnetrons of about 10-cm wavelength and X-band magnetrons operating near 3-cm wavelengths. Many experiments may require other wavelengths and corresponding frequencies and many texts which are on the market today show the frequency spectra of such devices, so that HFM would add little, except pages, if only a fraction of such material were included.

Sweep Circuits

(4) The same thing as in (3) can be said about vertical and horizontal sweeps, and if just the word Megasweep is used at a place, it should be sufficient for the average electronic worker. After all, a worker in a defense plant or a laboratory should once in a while improve the art and contribute something *himself* and not just copy what is in a book. The best that a scientific book can do is to bring well-established information with *basic* principles, so that a worker in a field can make improvements, and if possible show us something that was never done before. That is what the old-time radio workers did, and made what we have today.

(5) With respect to the reviewers remarks on a footnote on page 92 *as far back* as 1894, and a retained Fig. 49 on the same page of a Lenard window, there may be justification of it, since with modern fast scans we can do better and without a troublesome photographic procedure. However, this was in the first edition and required little space, and descriptions of Megasweeps *which are available* in mentioned series and more recent publications, the book would have been still more expensive.

Obsolete Tubes

(6) With respect to table XIV on page 413, the author does *not* agree with the reviewers. They mentioned in their comments that mentioned tubes are no longer listed in tube books. *So right they are.* That is the very reason why this table was *retained.* Among tube voltmeters, and many *basic* networks which are retained in the second edition, I have

often referred to such types of tubes, the characteristics of which, admitted by the reviewers, are no longer listed in modern tube manuals (some still are except under another substitute type of same properties). *That is the very reason why today* this list is needed more than ever, so that a reader of today has an idea what characteristic a tube in the network should have to give the described performance. All that an intelligent reader will do then is to find a similar tube by means of table XIV on page 413, and if possible a more suitable modern tube with still better circuit performance. This table was in the first edition to help foreign readers to pick tubes as they can buy and meet the described performance. Therefore, in the *second edition* it is needed for foreign readers and today for USA readers also. *It is needed.* There was no need at all to revise the pages on such mentioned networks, since they are *basic* at least as far as customary electron tube performance is concerned. It is true, we have today commercial tube voltmeters which are self-contained. Some of these meters are referred to in the second edition. But for school laboratories and smaller laboratories who prefer to build their own equipment such descriptions are *basic* and *instructive.* That is the reason why the author retained such material which occupies quite a number of pages. It is admitted.

(7) There is also criticism of the review on the section of signal to noise and especially with respect to giving also an alternate method besides the Friis procedure. I refer the reviewers to (E) of the preface. This reference says that *alternate methods are presented.* It says also *that it is up to the judgment of the experimenter to select the most suitable procedure.* Well the review selected the Friis method, but there are other readers and they may like and prefer the other method, *why not.* It is shown in the second edition that each method has its features.

Second Edition Changes

(8) With respect to the reviewers' question: "Is the book a complete revision?" I am referring to the preface letters B, C, D, F, and

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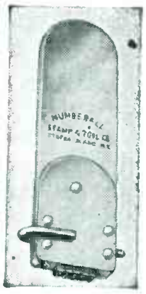

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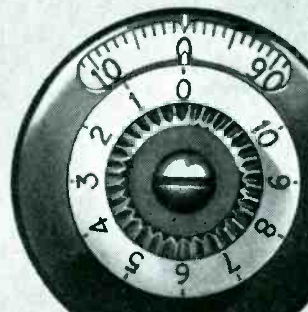

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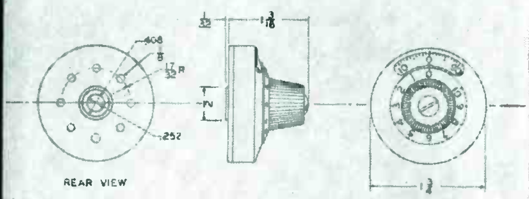

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suggest the reviewers to get a first edition and compare word by word against the second edition. As a matter of fact the change from classical cgs and Gauss units to mks units required many changes throughout the text. The author typed the first draft himself and ought to know. Seeing first edition figures is no proof that no changes are made in the printed text on the same page.

(9) The author *appreciates* calling attention to a typographical error. Fortunately, pages 588 and 598 deal with *entirely* different subjects, page 588 being a retained table on curve plots with a common general equation, and page 598 dealing with signal-to-noise ratio. Thanks.

Value to Students

(10) With respect to the reviewers' heading, "Will the Book Help Students?" The reviewers are probably more familiar with this, assuming that it is not so very long ago since they attended school. The author has only experience in graduate work at the University of California, Berkeley, Calif. and two years teaching at a university many years ago. The author mentioned already that many circuits which are *basic* are retained in the second edition. For many years, according to the author's opinion, there were no courses given in HFM, except at schools like Harvard, Stanford and perhaps at Columbia. I may not be correct on this. It was *always* the author's impression that HFM courses should be taught, because we can learn more in a laboratory, *by doing things*, than in a classroom, unless a laboratory course goes with it. The reason for this is perhaps, because the Physics department never thought radio measurements are scientific enough and the Electrical Engineering department thought more of power engineering courses. That means, at best, except at the schools mentioned, one of the two departments took over the *burden* of giving a Laboratory course in HFM and usually with an instructor who had other major interests. I may be wrong in this. I feel, however that radio, or electronics, if you wish, should become a *separate* depart-

ment, and great results could be obtained. Then a course in HFM could be taught by an *experienced* instructor and the HFM book will have value, since an experienced instructor could fill in details from mentioned MIT and other books and give a splendid picture of HFM.

(11) With respect to the reviewers' heading, "Responsibility of the Author"; *no comment*, except what is submitted in the backtalk.

(12) With respect to the "Responsibility of the Publisher", it seems quite amazing to the author, like it was when the "responsibility of a consulting editor" was challenged, *this was fortunately deleted by* ELECTRONICS.

(13) With respect to the responsibility of the reviewers I just wonder what the reviewers mean by it?

(14) There are only a few words which I would like to add, maybe somewhat off the record and I can not do it with such nice words as the reviewers:

(15) I think we have reached a period of grave social adjustment *everywhere in the world*. The USA is the world where I make my bread and butter, and if I can do something to help people here it must in some ways also register in the long run outside of USA. When I was a college student I thought I could write a short poem for a student multicopy magazine. It read in that language as follows:

Verse machen kann ich nicht
Dafuer fehlt mir die Muse
Kannst Du es besser als ich
Bitte mach Du se.

These verses mean freely translated and applied to the HFM review: Why do you not write a HFM book which is perfect?

Respectfully submitted,

AUGUST HUND
Santa Monica California

Automatic Matching

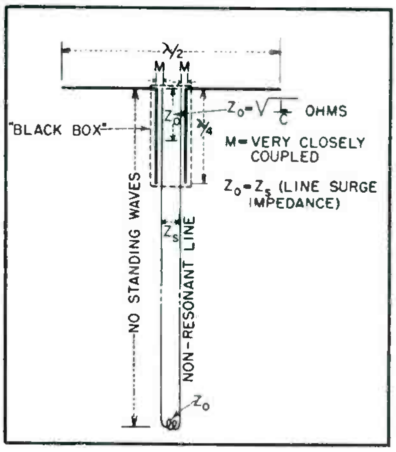
DEAR SIRS:

YOUR readers may be interested in my "blackbox" method of automatically matching *any* impedance transmission line to *any* antenna load.

The method is shown in the drawing. I am not sure how it works but I believe the theory is

like this: Since $Z_o = \sqrt{L/C}$ ohms and $Z_o = Z_s$, a line can be terminated in L and C values that equal Z_o, a real quantity. If the line has the same Z_s through the $\lambda/4$ stub it will automatically seek out Z_o. The antenna $\lambda/4$ stub will also seek out Z_o and an impedance match will result, even though the antenna impedance is changed by adding reflectors or directors, by folding or lengthening (harmonic operation). Any change in L and C values reflected or coupled in to either stub will automatically satisfy the equation for Z_o.

Another explanation may be that the line looks into an impedance



transformation—the $\lambda/4$ section becoming a matching transformer ($Z = \sqrt{Z_1 Z_2}$) and realizing Z in the equation by summation since the impedance rises and falls in opposite directions in the two stubs.

Since the "black box" automatically seeks out Z_o, the antenna can be operated on its even or odd harmonics. Tests proved this.

To obtain maximum energy transfer the coupling between the two stubs was as close as the insulation would allow—the antenna $\lambda/4$ stub was taped to the outside edges of a transmitting-type twin-lead. All measurements were made at 200 mc—lengths that were convenient for laboratory bench work. The data given here is that which was measured and observed.

I would be interested in any theoretical explanation the reader can give. The automatic match has interesting possibilities and applications. Further research and confirmation of the work done so far

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Thermal Shunt

DEAR SIRS:

I NOTED with some interest your abstract of E. N. Shaw's report entitled "The Overheating of Miniature Resistors During Soldering", which appeared in the *Tubes At Work* department of the July 1951 issue of ELECTRONICS.

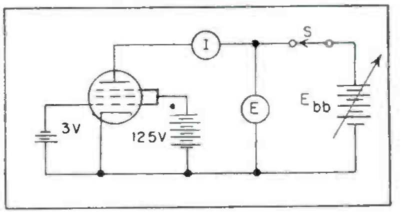
The same device, with a further improvement consisting of two semicircular recesses in the jaws, which provide a heat contact with lower resistance, was invented by me in November 1943, and was reported in the January 1944 issue of *Radio* magazine (now *Audio Engineering*.

R. G. MIDDLETON
Woodside, N. Y.

Electronics Quiz

THIS MONTH'S brain teaser was submitted by John C. Schuder, Instructor in Electrical Engineering, Purdue University, West Lafayette, Indiana. For submitting the problem, Schuder will receive our check for five dollars, as will all other contributors whose problems are used in this department.

The circuit shown below is often used in obtaining data for plotting a plate characteristic of a tube. During one such experiment the switch *S*



was opened when E_{bb} was 60 volts. The reading of voltmeter *E*, an ordinary 250-volt full-scale, 1,000-ohm-per-volt meter, increased to 75 volts instead of dropping to near zero. How can this be explained?

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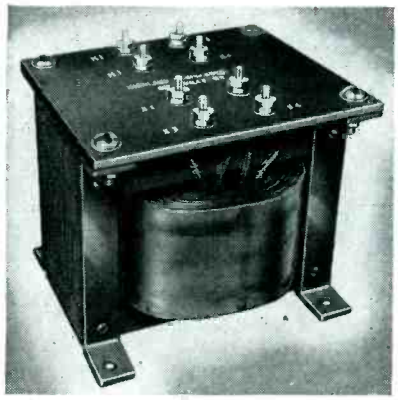

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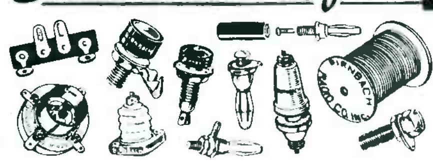

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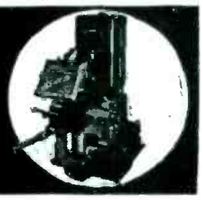

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McGraw-Hill Book Co., 330 W. 42nd St., N.Y.C. 18
Send me RADIO ENGINEERING LIBRARY for 10 days' examination on approval. In 10 days I will send $4.50, plus few cents for delivery, and $6.00 monthly until $34.50 is paid, or return books postpaid. (We pay delivery if first payment accompanies this coupon; same return privilege.)

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Name ....
Address ....
City .... *Zone* ..... *State* .....
Company ....
Position L-11
(This offer applies to U.S. only)

PROFESSIONAL SERVICES

SEARCHLIGHT SECTION

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(Senior)

Experienced in Design and Development Work in the fields of:

- GYROSCOPICS
- ANALOG COMPUTERS
- FIRE CONTROL SYSTEMS
- SERVO MECHANISMS
- INSTRUMENT DESIGN
- CONTROL CIRCUITS

or *Experienced in:*

- TECHNICAL WRITING

Applicants should have BS or MS degree with a minimum of 3 to 5 years' Experience.

Successful Applicants will be Offered Good Starting Salaries. Permanent Positions with Opportunity for Advancement and Professional Growth.

Reply by sending complete resume to

TECHNICAL PERSONNEL OFFICE

ARMA CORP.

254 36th St., Bklyn. 32, N. Y.

ELECTRONIC ENGINEERS

SENIOR ENGINEERS or PHYSICISTS

Degree and experience in Radar, Pulse Circuits, Digital or Analogue Computers, or Servomechanisms

JUNIOR ENGINEERS and recent graduate in EE or Physics.

ELECTRONIC ENGINEERING COMPANY OF CALIFORNIA

180 S. Alvarado St. Los Angeles 4, Calif.

ELECTRONIC ENGINEERS

SENIOR

ELECTRONIC ENGINEERS

Opportunities with Tracerlab, Inc. are available for Electronic Engineers qualified by design experience on DC and wide band amplifiers, low power pulse circuitry, computers, telemetering or allied fields.

Tracerlab, Inc. manufactures instruments of all types for the fast growing field of radioactivity. Tracerlab, as one of the foremost leaders in this field, has much to offer its employees concerning security and opportunity for advancement.

Easy access to New England's beautiful lake, mountain and shore recreational areas, educational facilities and fine business opportunities help to create an atmosphere which makes living in Boston and environs attractive.

Men who have had complete responsibility for design of complex electronic instruments in a manufacturing organization with supervision of Junior Engineers and Technicians are invited to write, giving a detailed outline of training and experience. Correspondence will be confidential. Selected applicants will be asked to come to Boston at our expense for an interview.

Industrial Relations Department

TRACERLAB, INC.

130 High Street Boston 10, Mass.

OPPORTUNITY

FOR TOP EXECUTIVE RESPONSIBILITY, EXPERIENCE, AND REWARDS FOR A CAPABLE, AMBITIOUS YOUNG MECHANICAL OR ELECTRICAL ENGINEER

As Assistant to the President of a nationally-known smaller firm in the electronics field. Starting salary $10,000 plus opportunities for bonus and stock participation. Unusual opportunity for broad experience in a million dollar manufacturing firm in all phases of production and management, plus a chance for key executive rating within five years.

QUALIFICATIONS: Graduate mechanical, electrical, or industrial engineer. Age 30 to 45. Must have background of production experience in electro-mechanical or electronic field for at least ten years. Clean record, outstanding intelligence, management ability. Candidate selected must stand investigation and general tests.

All replies treated in strict confidence, and personal interviews arranged in New York, Chicago, or certain other centers.

P-2141, Electronics
520 N. Michigan Ave., Chicago 1, Ill.

ELECTRONICS ENGINEER—SENIOR

Sound theoretical background and 5 to 10 years experience desirable. Will be required to design and construct Special Instruments and Apparatus needed for research in resistors, capacitors, & fundamental properties of conductors. Permanent position electric components manufacturer located in Eastern U. S.

ADDRESS D-19, P. O. BOX 3414
PHILA. 22, PA.

REPLIES (Box No.): Address to office nearest you
NEW YORK: 330 W. 42nd St. (18)
CHICAGO: 520 N. Michigan Ave. (11)
SAN FRANCISCO: 68 Post St. (4)

POSITIONS VACANT

DIELECTRIC HEATING Engineer with design and application experience for going department in established diversified company in New England. Salary. Write Box P-2123, Electronics.

ELECTRONIC ENGINEER, $5400 per annum. Responsible for maintenance and overhaul engineering of guided missile electronic equipment, including preparation of technical manuals for guidance of all aircraft overhaul activities throughout the Naval service. Applicants may write or contact in person the Employment Office. Room 0015-A, Main Navy Building, Washington, D. C.

INSTRUMENT ENGINEER—to be responsible for operation, installation, and maintenance of static and dynamic measuring and recording equipment including oscilloscopes, electro-mechanical oscillographs, strain gages, variable reluctance bridges using strain gages, inductance and capacitance type pickups for purpose of measuring high and low frequency vibrations and transient signals of displacement, velocity, acceleration, pressure, strain, temperature, etc. Considerable ingenuity required to develop experimental setups for aeronautical, structural, ordnance, and industrial programs. Position offers unlimited opportunities depending on initiative and ability of individual. Salary to be commensurate with training and experience. Write C. D. Pengelley, Southwest Research Institute, P. O. Box 2296, San Antonio, Texas.

THE TECHNION (Institute of Technology, Haifa, Israel) proposes to appoint two full Professorships and two associate Professorships to the faculty of Electrical Engineering. Applicants must have specialized professional and academic qualifications in Telecommunications and Power Engineering. Be willing to integrate themselves in to the life of the country and, in due course, teach in Hebrew. Applications with full details should be sent, for transmission to Haifa, to: The American Technion Society, 154 Nassau Street, New York 38, N. Y.

SELLING OPPORTUNITY OFFERED

ESTABLISHED MOLDER located Central New York and specializing in Compression, Transfer and Plunger Molding desires additional representation on commission basis for expanded Custom Division. Individual representatives desired for following territories: Metropolitan New York; New England; Middle Atlantic States; and Ohio. Reply stating experience, lines carried etc. to President, General Products Corp., Union Springs, New York.

EMPLOYMENT SERVICE

SALARIED PERSONNEL, $3,000-$25,000. This confidential service established 1920, is geared to needs of high grade men who seek a change of connection under conditions assuring, if employed, full protection to present position. Send name and address only for details. Personal consultation invited. Jira Thayer Jennings, Dept. L, 241 Orange St., New Haven, Conn.

POSITIONS WANTED

ELECTRICAL ENGINEER, 39, BSEE 1934, MSEE 1938, married, 14 years experience in elec. measurements in audio and ultrasonic ranges. Now head of a section of 10 in a large Gov't. lab., responsible for most electrical instrument design, construction, procurement and testing in one division of over 100 people. Desires responsible position related to background. Salary at least $8500, dependent upon location. PW-2099, Electronics.

GRADUATE EE, 10 years experience. Circuit design, field engr. & some results in development. Seek position of Chief engr. for small concern or group leader for large organization. PW-1935, Electronics.

PATENTS

Consult: Z. H. Polachek, Reg. Pat. Attorney, 1234 Broadway, New York 1, N. Y.

BENDIX RADIO DIVISION

Bendix
AVIATION CORPORATION

TV RECEIVER DESIGN ENGINEERS —Progressive TV Design Section has excellent opportunity for highly experienced men with proven ability. Desirable openings also available for promising young engineers. We will be pleased to discuss salaries at all levels.

ELECTRONICS ENGINEERS — At all salary and experience levels.

RESEARCH ON: Antennae, Servomechanisms, Microwave ccts. and other phases of communications and navigation equipment.

PRODUCTION DESIGN OF: Military and commercial communications and navigation equipment.

FIELD ENGINEERS — Supervise installation and maintenance of radio and radar equipment. Factory training will be given. Base salaries from $4200 to $6900 per year. 25% bonus for time spent overseas. Traveling and living expenses paid by Bendix. Insurance plan.

TEST AND INSPECTION ENGINEERS — Practical knowledge of radio, radar, or TV manufacturing processes. Good knowledge of radio fundamentals essential. Base salaries from $3900 to $5880.

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LABORATORY TECHNICIANS — Require knowledge of radio fundamentals and skill in use of measuring instruments and laboratory equipment. Previous industrial experience essential. Salaries from $262 to $321 per month.

BASE SALARIES FOR ALL POSITIONS LISTED ABOVE ARE SUPPLEMENTED BY UP TO 30% FOR REGULARLY SCHEDULED 48-HOUR WEEK.

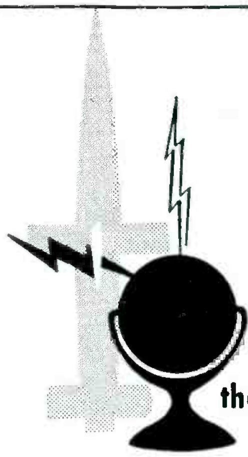
Housing is no problem in Baltimore.

Excellent group insurance and family hospitalization plan.

Attractive retirement plan for professional personnel.

Write for application:

Engineering Personnel Supervisor
Department E
BENDIX RADIO DIVISION of
Bendix Aviation Corporation
Baltimore 4, Maryland
TOwson 2200



ENGINEERS

Special opportunities for YOU in

SAN DIEGO

that sunshiny, smog-free city on the coast of CALIFORNIA

Convair (Consolidated Vultee Aircraft Corporation) is now accepting applications for these following positions in its modern, progressive Engineering Department.

Microwave Engineers
Servomechanism Engineers
Electronics System Engineers
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Unusual opportunities for those experienced in the design and analysis of Radar and Missile Guidance Systems.

WORKING FACTS: You get two holidays a week at Convair — overtime accomplished in 5-day week. Attractive salary ranges. An "engineers" engineering department . . . with stimulating, competent associates . . . and interesting, challenging, essential, long-range projects of a wide variety including — commercial aircraft, military aircraft, missiles, engineering research and electronic development. Excellent patent royalty arrangements. Top-notch retirement plan — better than-average life and health insurance. Complete progress-salary review for each person twice yearly. Opportunity for continuing engineering education.

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If you qualify, you will receive generous travel allowances. ***SEND COUPON*** for free booklets and complete information.

THANK YOU
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Convair, 3302 Pacific Hiway, San Diego, California
Please send me ***FREE*** booklets describing the Convair Opportunity for me and my Convair Application Form.

My name __________

Occupation __________

Address __________

City __________ State __________

EXPERIENCED electronic and mechanical engineers

Organization established in 1942. Electronic research, development, and production must expand to meet long-term, pre-Korea commitments. Openings in all branches of electronics, including

RECEIVERS TRANSMITTERS
ANTENNAS RADARS
RELATED EQUIPMENT

Positions available for men with at least 5 yrs experience

Write or telephone Howard J. Gresens at

Airborne Instruments Laboratory
INCORPORATED
160 Old Country Road, Mineola Long Island, N. Y.
Garden City 3-0600

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Electronic Engineers

Needed Immediately for
Long Range Research Program

Admiral Corporation, one of America's largest electronic and appliance manufacturers, needs electronic engineers for long range research program covering both consumer as well as governmental projects. Project and senior project engineers with minimum of two to five years' experience needed immediately. Top pay with excellent opportunities for advancement. Send resume of experience and education to Engineering Personnel Manager . . .

ADMIRAL CORPORATION
Dept. E, Chicago 47.

Engineers . . .
Physicists . . . .
Chemists . . . . . .
Metallurgists . . . .

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Tremendous material resources . . . the stimulation of highly creative work . . . long-range security and professional recognition . . . these are but a few of the assets General Electric offers you in unusual positions now available in:

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If you have a Bachelor's or Advanced Degree in Electrical or Mechanical Engineering, Physics, Metallurgy or Physical Chemistry and experience in the Electronics Industry, you can expand your training and experience to the fullest in openings in connection with:

.. MILITARY RADIO & RADAR
.. MOBILE COMMUNICATION
.. MULTIPLEX MICROWAVE COMMUNICATIONS
.. ELECTRONIC COMPONENTS
.. TELEVISION, TUBES and ANTENNAS.

Please send resume to:
TECHNICAL PERSONNEL
ELECTRONICS PARK

GENERAL ELECTRIC
Syracuse, New York

POSITIONS OPEN

Location
KANSAS CITY, MO.

Electronic & Mechanical Engineers

ELECTRONIC ENGINEERS: Must have considerable development experience in radio transmitting and receiving equipment. Ability to fill position of Senior Project Engineer a requisite.

MECHANICAL ENGINEER: Must have development experience in mechanical design of electronic or similar precise equipment. Practical and theoretical knowledge of materials, finishes, sheet metal, and machine shop design are basic requirements. Position is one of considerable responsibility.

SALARY: Open.

These positions are permanent.

Write stating educational and professional history direct to:

Jay V. Wilcox, *President*
WILCOX ELECTRIC COMPANY, INC.
1400 Chestnut St., Kansas City 1, Mo.
Dependable communications since 1931

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needs outstanding

RESEARCH PHYSICISTS
SR. ELECTRONIC ENGINEERS
SR. MECHANICAL ENGINEERS
ENGINEERING PHYSICISTS
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MICROWAVE ENGINEERS
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FIELD ENGINEERS
ELECTRONIC TECHNICIANS

with advanced academic training and several years' experience

for

RESEARCH AND DEVELOPMENT

in Radar, Servos, Computers, Receivers, Solid State Physics, Image Converters, Pulse and Timing Techniques, Special Purpose Tubes, Networks and Systems Design, Light and Electron Optics, Storage-Type Tubes, Photo-Electric Pickup Tubes, and Related Test Equipment.

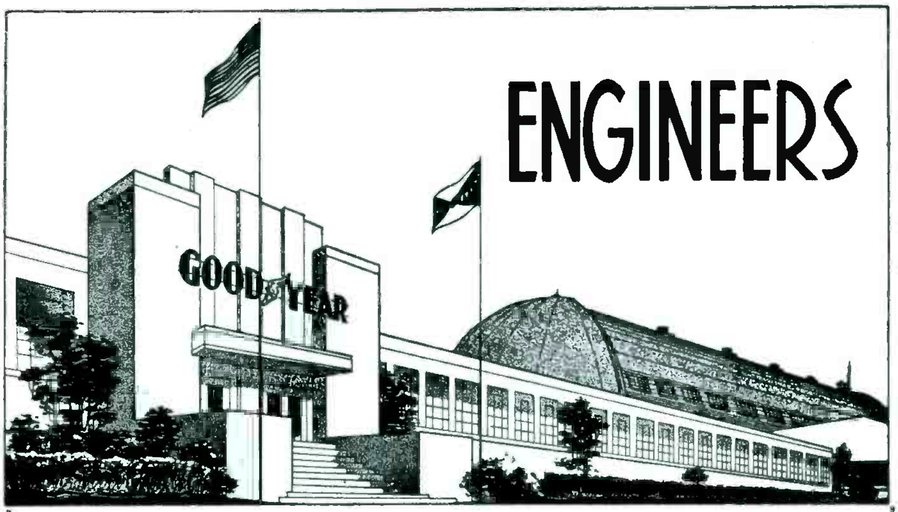
Our Long Range Programs and Steady Growth Assure Permanent Employment at Excellent Salaries for Competent and Qualified Personnel.

Interested Persons are Invited to Submit Detailed Resumes of Experience and Education with Salary Requirements and Availability Date to:

The Employment Department

CAPEHART-FARNSWORTH CORPORATION

FORT WAYNE, INDIANA



ENGINEERS

ENGINEERING WITH A FUTURE

RESEARCH • DEVELOPMENT • DESIGN

The continued and steady growth of established research and development projects has opened a number of unusual opportunities for outstanding and experienced men.

ENGINEERS • SCIENTISTS • PHYSICISTS

Positions are available in our organization for qualified personnel in the following fields:

- Circuit Analysis
- Microwaves
- Analog Computers
- Servomechanisms
- Dynamics
- Aerodynamics
- Applied Mathematics
- Physics
- Flight Test
- Design

Openings exist at several levels, and inquiries from recent graduates are also invited. Salaries are based on education, ability, and experience. Liberal salary, vacation, insurance, and retirement plans are yours if you qualify.

If you are interested in a secure future in these experimental fields, write and give full details to Mr. C. G. Jones, Salary Personnel Department.

GOODYEAR AIRCRAFT

GOODYEAR Aircraft CORPORATION

Akron 15, Ohio

ELECTRONIC and MECHANICAL

ENGINEERS
DRAFTSMEN

Sparton one of the oldest manufacturers of electronic equipment has openings for project, senior, and junior electronic engineers for a long range program covering both consumer and governmental projects. Senior engineer needed immediately, top pay with opportunities for advancement. Send resume of experience and education to personnel manager.

Sparton Radio and TV Division
The Sparks Withington Company
JACKSON, MICH.

WANTED

Engineers and Physicists with educational background in mechanical, electrical, or electronic engineering, physics or engineering physics for research and advanced development in plant and laboratory instrumentation, geophysics, physical measurements and industrial electronics. Prefer men with five to fifteen years' experience in experimental research, design and development of instruments, intricate mechanisms, electronic apparatus, optical equipment, servomechanisms and allied fields. Positions are of immediate and permanent importance to our operations. Southwestern location in medium-sized community; excellent employee benefits. Please give age, experience, and other qualifications in reply.

Personnel Director,
Research and Development Dept.
PHILLIPS PETROLEUM COMPANY
Bartlesville, Oklahoma

ENGINEERS

CREATIVE ENGINEERS

Inventive individuals with experience in small and intermediate mechanisms capable of devising mechanical solutions to specific problems, designing and supervising the construction of models.

DEVELOPMENT ENGIN'RS

with major training and applied experience in Pulse circuits, Digital Computors, Counting circuits or Radar.

DESIGN ENGINEERS

M. E. or E. E. min. of 5 yrs. design experience plus 5 yrs. of design engineering experience on Gun Fire Control mechanisms or automatic machines.

DESIGN ENGINEERS E. E.

With heavy background in experimental work and inventive ability. Must be able to run a project to successful completion with the aid of designers and draftsmen. Minimum 10 years exp. in Electro-Mechanical work in the above field.

OPTICAL ENGINEERS

Must know optical theory and optical production methods, preferably Fire Control Optics and Design experience on Optical Instruments.

TEST ENGINEERS . . . E. E. OR M. E.

with broad experience in Electro-Mechanical instrument field such as gunfire controls, gyroscopic devices, computors, servos or synchro circuits, etc.

CONTROL
Instrument Co., Inc.
67 35TH ST. BROOKLYN
SUBSIDIARY OF
Burroughs Add'g Mach. Co.

WANTED

MANUFACTURER'S REPRESENTATIVES

Many Territories Open

Prominent New York electronic manufacturer wants representatives now contacting manufacturers and laboratories to sell 5" wide-band high-gain oscilloscope in the $400 class.

Please write full details of lines now handled, area covered and other pertinent facts.

RW 2135 ELECTRONICS
330 W. 42nd St., New York 36, N. Y.

WANTED

SALES REPRESENTATION

Reputable established high grade test instrument manufacturer wants sales representation in all sections of country. Prefer offices now handling high grade non-conflicting lines. Must be technically informed.

RW-2010, Electronics
330 W. 42 St., New York 18, N. Y.

Wanted

ENGINEERS AND SCIENTISTS

Unusual opportunities for outstanding and experienced men.

These top positions involve preliminary and production design in advanced military aircraft and special weapons, including guided missiles.

Immediate positions include:

Electronic project engineers
Electronic instrumentation engineers
Radar engineers
Flight test engineers
Stress engineers
Aero- and thermodynamicists
Servo-mechanists
Power plant installation designers
Structural designers
Electro-mechanical designers
Electrical installation designers

Excellent location in Southern California. Generous allowance for travel expenses.

Write today for complete information on these essential, long-term positions. Please include resume of your experience & training. Address inquiry to Director of Engineering,

NORTHROP AIRCRAFT, INC.
1009 E. Broadway
Hawthorne (Los Angeles County) California

ELECTRONIC and ELECTRICAL ENGINEERS

One electronics instrumentation engineer with degree in EE or Physics, preferably some graduate study, and 5 years minimum experience, for permanent position in charge of electronics lab. associated with our aero. engineering laboratories. Also some openings for electrical engineers with less experience. Sal. commensurate with experience. Liberal employee benefits. Housing not a pressing problem. Submit details of educ. and experience to

UNIVERSITY OF MINNESOTA
Department of Aeronautical Engineering Laboratory
Rosemount, Minnesota

WANTED REPRESENTATION

California manufacturer of pulse type test equipment wants national representation.

We require a company or man now contacting users of precision test equipment. Our products have wide spread application in research and development work.

This will be a straight commission arrangement. Please write stating territory now covered, lines presently carried, number of salesmen in organization, and number and location of offices.

RW-1954, Electronics
68 Post St., San Francisco 4, Calif.

AC SPARK PLUG DIVISION of GENERAL MOTORS CORPORATION

PRECISION INSTRUMENT PLANT

Positions now available for highest caliber personnel in the field of airborne automatic electro-mechanical control equipment.

MECHANICAL DESIGN ENGINEERS
ELECTRONIC ENGINEERS
SERVO ENGINEERS
JUNIOR ENGINEERS

New and expanding division of an established firm with 20 years of successful experience in the instrument field. Work involved deals with the manufacture and development of highly complex equipment of the most advanced type.

Write or Apply

AC Spark Plug Division
GENERAL MOTORS CORPORATION
1925 E. Kenilworth Place
Milwaukee 2, Wisconsin

ELECTRONICS ENGINEERS
ENGINEERING PHYSICISTS

Several engineers required for development of electronic circuitry, electro-mechanical devices, analog and digital computing equipment.

Positions offer security in a laboratory located in desirable residential area. Apply in writing and furnish information as to education and experience.

JET PROPULSION LABORATORY
California Institute of Tech.
4800 Oak Grove Drive
Pasadena 3, Calif.

A CHALLENGE
to Outstanding
ENGINEERS PHYSICISTS DESIGNERS

POSITIONS with SCOPE and IMAGINATION NOW OPEN

Minimum Requirements for ENGINEERS and PHYSICISTS

Four years experience in advanced research and development on Radar Systems, Computers, Wave Guide and Antennas, Fire Control, Moving Target Indication, Servomechanisms, Pulse Techniques, Gyroscopic Equipment and Related Fields.

Minimum Requirements for DESIGN ENGINEERS

Background-experience in design of Light Machinery, Radar Systems, Computers, Moving Target Indicators, Servomechanisms, Gyroscopic Equipment and related fields.

Please send resume and salary requirements to:

The W. L. MAXSON CORPORATION
460 W. 34th St., NEW YORK 1, N. Y.

WANTED

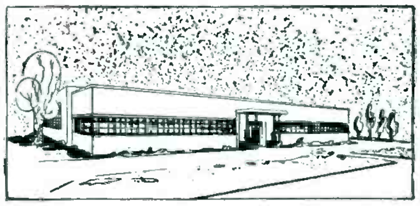
CAPACITOR ENGINEER

to go to South America to take full charge of the manufacture of Electrolytic, Paper and Mica Capacitors.

This is a permanent position with good salary, in a brand new plant, with modern equipment and in a wonderful climate.

Address Inquiries to
PERSONNEL DIRECTOR

CORNELL-DUBILIER ELECTRIC CORP.
333 Hamilton Blvd. So. Plainfield, N. J.



Only Top Performers Qualify

OUR CHALLENGE
to outstanding

- **ENGINEERS**
- **PHYSICISTS**
- **DESIGNERS**

Positions with *SCOPE* and *IMAGINATION* now *OPEN*

Pulse Circuits - Computers
Nuclear Instruments - Miniaturization

If you have at least four years experience in advanced research and development relating to the above-mentioned fields plus the necessary degree, please send resume and salary requirements to:

THE BERKELEY SCIENTIFIC CORP.
2200 Wright Avenue
RICHMOND, CALIFORNIA

SARKES TARZIAN, INC.
Tuner Division Bloomington, Indiana

Requires experienced engineers for TUNER DEVELOPMENT and TUNER FACTORY ENGINEERING.

Address inquiries to J. SONNEBORN
SARKES TARZIAN, INC.
Bloomington, Indiana

PHYSICISTS, MATHEMATICIANS ELECTRONIC ENGINEERS

Looking for opportunity? We have a new laboratory in Natick, Massachusetts, devoted to development and design of high frequency antennas. Television, mobile communications, radar, aircraft, and many other fields need more and better antennas. Your ability, complemented by ideal conditions in our laboratory, will assure your future.

You have
....New facilities, specifically designed for your work
....New England living, close to America's vacationland, and work in a small New England community near to Boston
....The security of permanent expansion

If you have
....Experience with microwave and servomechanisms
....A degree in physics, mathematics, or electronics
....Development experience in electronics, particularly antennas

WRITE TODAY TO: *Personnel Manager*

THE WORKSHOP ASSOCIATES
Division of The Gabriel Company *Specialists in High Frequency Antennas*
135 Crescent Road Needham Heights, Massachusetts

Wanted:
FACTORY MANAGER

ARE YOU THE RIGHT MAN for This HIGH PAYING POSITION

Who: A good man familiar with the manufacture and assembly of electronic parts. This man should preferably have an engineering background. Experience in running a 300-500 man plant is essential because he must be capable of taking complete charge of plant production as factory manager. He must be organizationally minded and capable of getting the most out of people in the modern manner through leadership.

What: There is an excellent opportunity for a capable and ambitious man to take over factory management in a medium-sized but growing manufacturing company in the electrical industry.

When: The position is available immediately, but the manufacturer is fully aware of the time necessary to transfer from one job to another, or from one area to another, so they will work out plans mutually beneficial to both parties.

Where: The location of the plant is in a medium-sized city in Connecticut . . . excellent suburbs for pleasant living. Good shipping receiving facilities.

Why: The business is expanding rapidly and the executive vice president is handling the job at the present time but other responsibilities have been placed on his desk so he needs to be relieved of the factory manager's job. Peacetime markets are unlimited.

This position is a good paying job for the right man. Salary will be arranged and will be commensurate with experience and ability . . . please submit complete resume outlining qualifications to

P-1972, Electronics
330 W. 42 St., New York 18, N. Y.

METERS

3MA DC 2½" R—Simpson black scale.......... $3.35
500 Microamps, DC—2½" round—Sun.......... 4.30
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50 amp. AC 3½" R.—General Electric.......... 4.11
3 amp. RF 3½" R.—Weston.......... 6.00

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2J27	2J40	5J23	714AY
2J31	2J41	5J29	718AY
2J32	2J48	700B	718BY
2J33	2J49	700C	720B/C/DY
2J34	2J56	700D	725A
2J36	2J61	706AY	730A

KLYSTRONS

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2K28	2K55	723A	5611
2K29			

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G.E. Cat. 8248886G-1 and 9001934G-1 17.246.400 ohms 35KV 70:1 ratio wire wound shielded oil-filled 40"H x 12"D.......................$77.50

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KOLLSMAN Type 937-0240—85/68V 100 cy 5 watts 2650 RPM—new.......................$12.95
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OIL FILLED CONDENSERS

MFD	VDC		Price	MFD	VDC	Price
2	600		$ .69	1	2000	1.95
4	600		1.65	1-1	2500	3.85
4	600	R'd	1.65	32	2500	15.80
6	600		1.85	3X.2	4000	2.95
8	600	R'd	1.85	1	5000	4.88
10	600	R'd	1.95	.01-.03	6000	1.65
8-8	600		1.95	.1	7000	1.79
1	1000		.62	.045	16KV	4.70
2	1000		.89	.05	16KV	4.95
4	1000		1.85	.075	16KV	8.95
8	1000		3.25	.25	20KV	18.95
4	1500		2.95	7	660VAC	4.25
.1-.5	2000		87	8	660VAC	4.50

HIGH VOLTAGE TRANSFORMERS

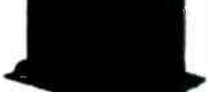
G.E.—Pri. 115V 60 cy Sec. 6250V 80 MA—12.5 KV Ins.......................$18.50
G.E.—Pri. 115V 60 cy. Sec. 6250/3850/2600V 56 MA 12.5 KV Ins.......................$18.50
Raytheon—Pri. 115V 60 cy. Sec. 8500/6450V CT 43 MA Hermetically sealed.......................$22.50

CRYSTAL DIODES

1N21	$1.19	1N23	$1.49	1N34	$ .79
1N21A	1.69	1N23A	3.25	1N38	1.66
1N21B	4.00	1N23B	5.25	1N45	.94
1N22	1.09	1N27	1.79	1N52	1.05

ANTENNAS

AT-38A/APT (70 to 400MC).......................$13.70
AT-49/APR-4 (300 to 3300MC)....................... 13.70
DZ-2 Loop antenna with pedestal....................... 22.50
AN-74B (125 to 150MC)....................... 3.25
AN-65A (P/O SCR-521)....................... 1.50
AN-66A (P/O SCR-521)....................... 1.75
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



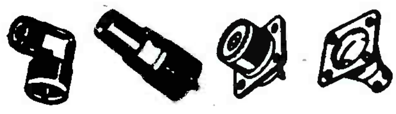
WESTINGHOUSE HYPERSIL TRANSFORMER

PRI-115V. 60CY ¾ KVA
SEC #1 - 240V - 1.56A
SEC #2 - 240V - 1.56A
WT. 30 LBS.

$14.50 EACH

Terms 20% cash with order, balance C. O. D. unless rated. All prices net F.O.B. our warehouse, Phila., Penna., subject to change without notice.

COAXIAL CONNECTORS



83-1AC	$ .42	83-1R	$ .40	83-22AP	$1.40
83-1AP	.30	83-1RTY	.65	83-22R	.68
83-1F	1.30	83-1SP	.50	83-22SP	1.15
83-1H	.10	83-1SPN	.60	83-168	.15
83-1J	.80	83-1T	1.30	83-185	.15

FULL LINE OF JAN APPROVED COAXIAL CONNECTORS IN STOCK

UHF N BN BNC

UG-7	UG-23	UG-37	UG-102	UG-175	UG-254
UG-12	UG-24	UG-57	UG-103	UG-176	UG-255
UG-18	UG-27	UG-58	UG-104	UG-185	UG-260
UG-19	UG-27A	UG-85	UG-106	MX-195	UG-264
UG-21	UG-29	UG-86	UG-108	UG-197	UG-274
UG-21B	UG-30	UG-87	UG-109	UG-201	UG-275
UG-22	UG-34	UG-88	UG-146	UG-206	UG-276
UG-22B		UG-98	UG-166	UG-236	UG-290
			UG-167	UG-245	UG-291
			UG-171		UG-306

M-358	MC-277	PL-259A	PL-325
M-359	MC-320	PL-274	SO-239
M-359A	PL-258	PL-284	SO-264
M-360	PL-259	PL-293	TM-201

93-C	49120	D-163950	ES-685696-5
93-M	49121A	D-166132	ES-689172-1

TYPE "J" POTENTIOMETERS

Resis.	Shaft	Resis.	Shaft	Resis.	Shaft
60	SS	5K	1/4"	50K	3/8"
60	9/16"	5K	3/8"	50K	1/2"
100	SS	5K	1/2"	100K	SS
200	SS	10K	SS	150K	1/2"
250	1 8"	10K	3/8"	200K	3/8"
500	SS	10K	1/2"	250K	SS
500	5/16"	15K	SS	250K	3/4"
500	1/2"	15K	1/2"	250K	3/8"
500	5/8"	20K	SS	500K	SS
650	1/2"	25K	SS	500K	1/4"
1K	SS	25K	1/4"	500K	7/16"
2K	3/8"	30K	1 1/8"	1 Meg	SS
2500	SS	40K	SS	2.5 Meg	SS
4K	SS	50K	SS	5 Meg	SS
5K	SS	50K	1/4"		

DUAL "JJ" POTENTIOMETERS

50	SS	500	SS	1 Meg	SS
100	SS	1K	SS	2.5 Meg	SS
250	SS	2500	SS	5 Meg	SS
330	SS	10K	SS	1K/25K	3/8"

TRIPLE JJJ POTENTIOMETERS

100K/100K/100K—3/8" 20K/150K/15K—3/4"

SOUND POWERED TELEPHONES

U. S. NAVY TYPE M HEAD AND CHEST SETS
U.S.I. A-260 W.E. D-173013
A.E. GL832BAO
ANY TYPE—$14.88 EACH
TS-10 Type Handsets.......................$8.92 ea.

F. W. BRIDGE SELENIUM RECTIFIERS

AC Volts Input — 18 DC Volts Out — 14.5		AC Volts Input — 40 DC Volts Out — 34	
1.3 Amps	$3.85	0.6 Amps	$4.60
2.4 Amps	4.95	1.2	5.95
6.(Amps	7.75	3.2	8.95
13.0	12.75	6.0	15.50
17.5	15.75	9.0	17.50
26	22.75	12	26.95
39	35.50	18	32.50
52	38.50	25	42.50
70	49.50	36	55.50

130 VAC ½ WAVE STACKS

75MA	$ .88	150MA	$1.30	250MA	$1.75
100MA	1.10	200MA	1.57	400MA	2.60

GENERATORS

• Eclipse-Pioneer type 716-3A (Navy Model NEA-3A) Output—AC 115V 10.4A 800 to 1400cy. 1 ϕ; DC 30 Volts 60 Amps. Brand New.......................$38.50
• Eclipse-Pioneer type 1235-1A. Output—30 Volts DC 15 Amps. Brand New—Original Packing...$15.50

3 PHASE INVERTERS

Voltage and Frequency Regulated
Eclipse Pioneer Type 12121A

DC Input—24 Volts 18 Amps
AC Output—115 Volts 1.25 Amps 3 Phase
250 VA 0.7 P.F. 400 Cycles
12,000 RPM 65°C Temp. Rise
Brand New.......................$225.00

TEST EQUIPMENT

• 1-222A Signal Generator.......................* $79.50
• 1-72K Signal Generator....................... $48.50
• Vibrotest Mod. 218 Megger.......................* $45.00
• C-D Quietone Filter Type IF-16 110/220V 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
• LM-20 Frequency Meter.......................* $49.50
• Gen. Radio 757-P1 Power Supply.......................* $27.00
• TS-6/AP Frequency Meter.......................* $42.00
• 1-130A Signal Generator.......................* $85.00
• A.W. Barber Labs. VM-25 VTVM.......................* $86.00
• TS-10A/APN Delay Line Test Set....................... $45.00
• TS-19/APQ-5 Calibrator....................... $75.00
• 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
• 3 CM. Pickup Horn Antenna....................... $9.95
• 1-138A Signal Generator—10 cm.......................*$185.00

All items New Except Where noted * (Exc. Used Condition)

MISCELLANEOUS EQUIPMENT

Amperex 1B98 Gamma Counter.......................$ 9.87
Powerstat 1226—115/230V Input—0-270V out @ 9 amp....................... 37.00
EIMAC 35 TG Ionization Gauge....................... 5.95
ATR Inverters 6VDC to 110 VAC 60 cy 75W... 22.95
ID-6/APN-4 Indicator....................... 29.50
R-7/APS-2 Receiver....................... 49.50
R-78/APS-15 Receiver....................... 49.50
FL-8 1020 cycle filter....................... 1.75
RM-29 remote control unit....................... 8.95
RM-14 remote control unit....................... 8.95
RTA-1B 12/24 V dynamotor....................... 40.00
BC-1206-CM2 Receiver....................... 12.95
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
T-9/APQ-2 less tubes....................... 16.50
RCA AVR-15 Beacon Recvr....................... 15.50
TBY Trans-Recvr....................... 29.95
Pioneer Type 800-1B Inverters—28VDC to 120V 800 cy 7 amp AC (used)....................... 22.65
G.E. Inverter—28VDC to 120 VAC 800 cy 750VA 1 ϕ....................... 39.50
Navy SD-3 Radar complete.......................1200.00
Navy DP-14 Direction Finder complete....................... 385.00

PULSE TRANSFORMERS

UTAH 9262 9278 9280	UTAH 9318 9340 9350
G.E. 68G-627	Westinghouse 232-AW2
G.E. 68G828	Westinghouse 232-BW-2
G.E. 68G929G1	AN/APN-4 Block Osc.
G.E. 80G13	Philco 352-7149
G.E. K-2469A	Philco 352-7150
G.E. K-2744B	Philco 352-7071
AN/APN-9 (901756-501)	Philco 352-7178
AN/APN-9 (901756-502)	Raytheon UX-7380
AN/APN-9 (352-7250)	W.E. D-161310
AN/APN-9 (352-7251)	W.E. D-163247
Westinghouse PH-1	W.E. D-163325
Westinghouse 132-AW	W.E. D-164661
Westinghouse 139DW2F	W.E. KS-9563

AN/APA-23 RECORDER

Sweeps any receiver through its tuning range and permanently records frequency and time of received signals on paper chart. Power input—(motor) 27V DC 1.5A, and (recorder) 80/115V AC 60-2600 cy 135W.

Originally designed to record pulse or sine-wave modulated signals received by AN-APR-1, AN/APR-2, AN-APR-4, AN/APR-5, BC-348, S-27, SX-28.
BRAND NEW.......................$147.50

SPRAGUE PULSE NETWORKS

7.5 E3-1-200-67P. 7.5 KV. "E" Circuit 1 Microsec. 200 PPS, 67 ohms Imped. 3 sections.......$4.30
7.5 E3-3-200-67P, 7.5 KV, "E" Circuit 3 microsec. 200 PPS. 67 ohms Imped. 3 sections.......$6.75
7.5 E4-16-60-67P. 7.5 KV. "E" Circuit 4 sections. 16 microsec. 60 PPS. 67 ohms Imped.......$8.25
15 E4-91-400-50P. 15KV. "E" circuit .91 microsec. 400 PPS, 50 ohms imped. 4 sections.......$12.00
15-A-1-400-50P. 15KV. "A" Circuit, 1 microsec. 400 PPS. 50 ohms imped.......$37.50
15 E7-2-200-50P. 15KV "E" Circuit, 2 microsec. 200 PPS, 50 ohms imped.. 7 sections.......$42.00

THYRATRONS & IGNITRONS

OA4G	FG-41	FG-271	722A
C1A	FG-57	393A	873
1C21	FG-67	394A	884
2A4G	FG-81A	GL-415	885
2B4	91	KU-610	1665
2D21	FG-95	KU-623	1904
3C23	FG-105	KU-628	2050
3C31	FG-166	KU-634	2051
4C35	FG-172	WL-652	5550
C5B	FG-178	WL-672	5551
5C22	RX233A	WL-677	5552
C6J	FG-235A	WL-681	5557
FG-17			5560
FG-33			

LECTRONIC RESEARCH LABORATORIES

715-19 ARCH ST. PHILA. 6, PA.
Telephones - MARKET 7-6771-2-3

GUARANTEED BRAND NEW

LECTRONIC RESEARCH

STANDARD BRANDS ONLY

TUBE SPECIALS

Receiving Tubes	
OOA	$1.50
O1A	.67
OZ4	.74
1A3	.99
1A5GT	.72
1A6	.99
1A7GT	1.10
1AB5	.96
1B3GT	.99
1B4P	1.17
1C5GT	.99
1C6	.69
1C7G	.69
1D5GP	.69
1D7G	.69
1D8GT	1.17
1E5GP	1.17
1F4	.69
1F5G	.69
1G4GT	.69
1G5G	.69
1G6GT	.69
1H4G	.89
1H5GT	.74
1H6G	.99
1H6GT	1.10
1J6G	.99
1J6GT	1.10
1L4	.74
1LA4	1.10
1LA6	1.10
1LB4	1.10
1LC5	.99
1LC6	1.10
1LD5	1.10
1LE3	1.10
1LH4	1.10
1LN5	.91
1N5GT	.93
1N6G	.97
1P5GT	.99
1Q5GT	.99
1R4	.69
1R5	.89
1S4	.93
1S5	.93
1T4	.93
1T5GT	.99
1U4	.93
1U5	.81
1V	.88
1X2	1.20
2A3	1.28
2A5	.79
2A7	.89
2B7	.79
2E5	.94
2X2	.89
2X2A	1.85
3A4	.65
3A5	1.89
3A8GT	2.25
3B7	.69
3C6	1.15
3D6	.69
3LF4	1.10
3Q4	.93
3Q5GT	1.10
3S4	.93
3V4	.93
5AZ4	.69
5T4	1.92
5U4G	.69
5V4G	1.20
5W4	.82
5X4G	.87
5Y3GT	.59
5Y4G	.75
5Z3	.87
5Z4	1.20
6A3	1.29
6A4	1.35
6A6	1.17
6A7	1.05
6AB7	1.39
6AC5GT	1.35
6AC7	1.45
6AC7W	3.25
6AD6G	.98
6AD7G	1.39
6AE6G	.89
6AF6G	1.19
6AG5	1.19
6AG7	1.59
6AH6	1.56
6AJ5	2.50
6AK5	1.85
6AK5W	3.05
6AK6	.99
6AL5	.69
6AL5W	2.90
6AQ5	.89
6AQ6	.79
6AR5	.79
6AS6	3.65
6AS7G	4.53
6AT6	.63
6AU6	.69
6AV6	.63
6B4G	1.60
6B5	1.20
6B7	1.19
6B8	.99
6B8G	.85
6BA6	.72
6BA7	.96
6BC5	.88
6BE6	.72
6BG6G	1.92
6BH6	.99
6BQ6GT	1.26
6C4	.65
6C5	.75
6CB6	.89
6C6	.88
6C8G	1.35
6CD6G	2.40
6D6	.88
6D8G	.99
6E5	1.10
6F5GT	.83
6F6	.99
6F6G	.99
6F7	1.05
6F8G	1.60
6G6G	1.06
6H6	.83
6H6GT	.83
6J5	.75
6J5G	.64
6J5GT	.64
6J6	1.19
6J7	.99
6J7GT	.79
6J8G	1.28
6K5GT	.99
6K6GT	.69
6K7	.88
6K7G	.88
6K8	1.22
6K8GT	.96
6L5G	1.06
6L6	2.13
6L6G	1.99
6L6GA	1.75
6L7	1.08
6L7G	.95
6N7	1.44
6N7GT	1.20
6P5GT	.96
6Q7	.99
6Q7G	.89
6R7	.99
6S7	1.06
6S7G	.99
6SA7	.99
6SA7GT	.89
6SB7Y	1.05
6SC7	1.20
6SC7GT	1.05
6SD7GT	1.10
6SF5	.83
6SF5GT	.80
6SF7	.69
6SG7	.91
6SH7	.99
6SH7GT	.99
6SJ7	.89
6SJ7GT	.89
6SK7	.89
6SK7GT	.89
6SL7GT	1.05
6SN7GT	.79
6SN7WGT	2.30
6SQ7	.75
6SQ7GT	.75
6SR7	.81
6SS7	.99
6ST7	1.25
6T7G	1.09
6T8	1.28
6U5	1.19
6U7G	.88
6V6	1.60
6V6G	.89
6V6GT	.79
6W4GT	.72
6W6GT	.99
6X4	.59
6X5GT	.59
6Y6G	1.19
6ZY5G	.89
7A5	1.08
7A6	.89
7A7	.89
7A8	.89
7AD7	1.44
7AH7	1.08
7B4	.89
7B5	.89
7B6	.89
7B7	.89
7B8	.89
7C4	.69
7C5	.89
7E5	1.20
7E6	.79
7E7	1.06
7F7	1.09
7F8	1.59
7G7	1.32
7H7	.99
7J7	1.32
7K7	1.32
7L7	1.32
7N7	1.09
7Q7	.99
7S7	1.32
7V7	1.32
7W7	1.32
7Y4	.89
7Z4	.89
10	.45
12A	.79
12A6	.89
12A6GT	.79
12A7	1.16
12A8GT	.89
12AH7GT	1.32
12AT6	.59
12AT7	1.15
12AU6	.79
12AU7	.95
12AV6	.63
12AX7	1.08
12BA6	.72
12BA7	.95
12BE6	.70
12C8	.89
12F5GT	.79
12H6	.69
12J5GT	.69
12K8	.99
12Q7GT	.89
12SA7	.89
12SA7GT	.89
12SF5	.79
12SF5GT	.79
12SF7	.79
12SG7	.99
12SH7	.89
12SJ7	.89
12SJ7GT	.89
12SK7	.81
12SL7GT	1.03
12SN7GT	.99
12SQ7GT	.79
12SR7GT	.89
12X3	1.19
12Z3	.89
14A4	1.32
14A7	1.09
14B6	1.09
14B8	1.09
14C5	1.29
14C7	1.15
14E7	1.29
14F7	1.09
14H7	1.15
14J7	1.29
14N7	1.29
14Q7	1.09
14R7	1.29
14W7	1.29
14X7	1.29
19	.89
19T8	1.16
22	1.16
24A	.79
25A6	1.16
25L6GT	.89
26	.79
27	.69
28D7	1.35
30	.72
30 Spec	.48
31	.62
32	.99
32L7GT	1.29
33	.99
34	.99
35/51	.79
35A5	.89
35B5	.99
35W4	.55
35Y4	.89
35Z4GT	.69
35Z5GT	.59
36	.69
37	.69
38	.69
39/44	.59
41	.99
42	.89
43	.89
45	.89
45Z5GT	.79
46	.99
47	.99
48	1.60
50	1.41
50A5	1.09
50B5	.88
50C5	.88
50L6GT	.79
50Y6GT	.92
53	.95
55	.99
L55B	.32
56	.69
57	.89
58	.89
59	1.24
70L7GT	1.52
71A	.79
75	.89
76	.69
77	.69
78	.79
79	.89
80	.65
81	1.41
82	1.19
83	1.59
83V	1.45
84/6Z4	.79
85	.79
89Y	.55
117L7GT	1.89
117P7GT	1.89
117Z3	.74
117Z6GT	.97
Cathode Ray Tubes	
2AP1	$9.75
2AP5	9.75
3AP1	10.25
3AP4	10.25
3BP1	7.95
3CP1	2.25
3DP1	4.85
3DP1A	6.75
3EP1	4.95
3FP7	2.95
3GP1	4.95
3HP7	4.91
4AP10	4.75
5AP1	3.75
5AP4	4.75
5BP1	5.75
5BP4	5.75
5CP1	4.95
5CP7	5.50
5FP7	2.85
5HP1	5.75
5HP4	5.75
5JP1	26.50
5JP2	26.50
5JP4	26.50
5LP1	19.75
5LP5	19.75
5MP1	10.65
7BP1	8.75
7BP7	7.95
7BP12	14.95
7BP14	14.95
7CP1	14.95
9GP7	12.85
9LP7	9.95
10BP4	18.50
10FP4	24.50
12DP7	16.50
12GP7	16.50
12HP7	16.50
902P1	9.95
905	4.45
Photo Cells	
1P24	$1.27
918	1.65
919	1.95
923	1.35
927	1.85
931A	6.95
1645	1.95
Thyratrons & Ignitrons	
OA4G	$1.32
EL-C1A	4.75
2A4G	1.25
2B4	2.10
2D21	1.80
3C23	9.95
3C31/EL-C1B	3.95
3C45	17.50
4C35	28.75
EL-C5B	9.95
5C22	53.45
C6J	6.95
FG-17/5557	5.25
FG-33	17.50
FG-41	122.50
FG-67	14.80
FG-81A	4.95
91	7.85
FG-95/5560	25.00
FG-104/5561	24.60
FG-105	19.50
FG-166	95.00
FG-172	39.50
FG-178	14.50
RX-233A	3.95
FG-235A/5552	94.50
FG-271/5551	62.50
393A	6.75
394A	4.77
GL-415/5550	39.50
KU-610	12.50
KU-623	39.50
KU-628	22.25
KU-634	39.50
WL-652/5551	62.50
WL-672	22.00
WL-677	39.50
WL-681/5550	39.50
722A	3.75
873/973	12.15
884	1.85
885	1.90
1665	1.80
1904	13.95
2050	1.80
2051	1.15
Transmitting & Special Purpose Tubes	
OA2	$1.69
OA3	1.51
OB2	1.88
OB3	1.29
OC3	1.20
OD3	1.15
1B21A	2.85
1B22	3.25
1B23	9.95
1B24 (West)	12.95
1B24 (Sylv)	18.95
1B26	3.75
1B27	19.50
1B29	2.90
1B32	3.95
1B35	12.50
1B42	9.80
1H20	.88
2B22	2.20
2C21	.75
2C22	.75
2C26	.49
2C26A	.49
2C34	.49
2C39	22.00
2C40	8.95
2C42	26.50
2C43	22.50
2C44	1.50
2C46	29.50
2C51	5.75
2E22	1.85
2E24	4.10
2J21A	9.95
2J22	9.95
2J26	26.50
2J27	24.50
2J31	39.50
2J32	42.50
2J33	39.50
2J34	39.50
2J36	85.00
2J37	13.70
2J38	17.50
2J39	49.50
2J41	175.00
2J48	27.50
2J49	39.50
2J55	87.50
2J56	150.00
2J61	45.20
2K23	37.50
2K25	33.50
2K26	135.00
2K28	34.50
2K29	26.00
2K33	295.00
2K45	145.00
2K54	135.00
2K55	135.00
2X2A	1.85
3B22/EL-1C	2.95
3B23	4.75
3B24	5.25
3B24W	7.95
3B25	4.50
3B26	3.75
3B27	3.95
3C24	1.85
3D21A	1.98
3E29	14.50
4-125A	29.50
4A1	1.18
4B22/EL-5B	8.95
4B24	5.75
4B25/EL-6CF	8.95
4E27	17.25
4J36	150.00
4J38	120.00
4J50	375.00
4J52	400.00
5D21	26.50
5J23	24.50
5J29	18.50
6AR6	3.35
6C21	29.50
6C24	52.50
6J4	6.95
7-7-11	1.19
10T1	.88
10Y	.45
15E	2.35
15R	.95
REL-21	2.25
24G	1.85
RK-25	3.82
FG-32/5558	6.75
RK-34	.49
35T	4.95
35TG	4.95
REL-36	.78
RK-47	4.92
EF-50	.79
VT-52 (Brit)	.36
53A	5.60
RK-59	2.44
RK-60	1.95
RK-63	22.50
72	1.32
73	1.32
VR-75/OA3	1.51
75T	5.80
VR-78	.64
VR-90/OB3	1.29
VR-98 (BR)	29.90
C100E	2.30
100R	2.90
100TH	10.25
WE-101D	1.65
WE-101F	3.62
VR-105/OC3	1.20
WE-113A	1.32
WE-117A	.95
WE-124A	3.80
VT-127A	3.60
VR-150/OD3	1.15
FG-190	12.15
203A	7.40
203B	6.33
204A	49.50
WE205	1.85
CE-206	3.15
211	.75
212E	42.50
WE-215A	.24
221A	1.95
227A/5C27	4.60
WE-231D	2.25
232CH	240.00
WE-244A	5.20
WE-245A	2.35
WE-249B	3.50
WE-249C	3.50
WE-252A	5.65
WE-254A	5.90
WE-257A	3.77
WE-271A	6.75
WE-275A	6.95
WE-283A	4.25
WE-285A	5.57
WE-286A	7.90
WE-294A	5.75
WE-301A	5.95
304TH	15.00
304TL	15.00
307A	5.50
WE-309A	6.45
WE-310A	7.50
WE-313C	4.15
316A	.89
327A	4.25
WE-331A	9.75
WE343A	185.00
350B	4.95
354C	19.50
WE-356B	5.45
361A	4.75
371A	.95
371B	.95
388A	2.95
417A	16.95
434A	4.55
446	1.95
446A	1.95
446B	2.25
450TH	42.50
450TL	42.50
471A/1B21A	2.75
SS-501	12.50
503AX	1.65
506AX	1.47
507AX	1.47
527	12.25
530	17.20
531	8.25
532A	3.95
559	2.20
561	3.50
HY615	.49
WL670A	8.70
700B	24.50
700C	24.50
700D	24.50
702A	2.95
702B	4.25
703A	6.95
704A	.95
705A	2.75
706AY	45.00
706BY	45.00
706CY	45.00
706FY	45.00
706GY	45.00
707A	9.95
707B	22.50
708A	4.85
709A	4.87
710A	1.70
713A	1.45
714AY	6.95
715A	6.75
715B	12.75
715C	26.50
717A	1.47
WE-719A	26.50
721A	4.90
723A	9.95
723A/B	16.95
724A	3.22
724B	3.22
725A	8.95
726A	8.50
726B	29.50
730A	25.00
731A	2.45
WL-787	9.80
788Y	1.40
800	1.88
801A	.48
803	3.87
804	8.95
805	4.50
806	24.50
807	1.70
808	2.65
809	2.40
810	10.95
811	3.60
813	9.50
814	3.95
815	2.75
816	1.45
826	1.45
828	13.48
829	9.95
829A	14.50
829B	14.50
830B	3.95
832	7.95
832A	9.95
836	3.50
837	1.58
838	3.25
841	.49
843	.59
845	5.75
849	29.50
851	45.00
852	22.60
860	4.95
861	24.50
864	.39
865	1.28
866A	1.48
869B	29.50
872A	2.95
874	1.45
876	1.60
878	1.85
954	.39
955	.49
956	.49
957	.49
958A	.69
959	.69
991	.40
CK-1005	.79
CK-1006	2.50
1201	1.20
1203	.69
1291	.69
1294	.69
1299	.69
1602	2.25
1613	.95
1616	1.07
1619	.39
1622	2.30
1624	1.95
1625	.45
1626	.39
1629	.39
1630	.95
1631	1.38
1636	3.10
1638	.70
1641	1.95
1642	.75
1644	1.17
1960	.70
UX-6653	.65
7193	.75
8011	.87
8012	2.60
8013	2.75
8013A	4.90
8014A	29.50
8020	1.39
8025	6.95
9001	1.75
9002	1.50
9003	1.75
9004	.55
9005	1.95
9006	.35
189048	3.79
189049	3.79
199698	2.69

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Manufacturer & No.	Volts	Contacts*	Ohms	Catalog No.	Each
Clare SK5032†	6VDC	DPDT	32	R581	$3.95

A.C. RELAYS

Manufacturer & No.	Volts	Contacts*	Ohms	Catalog No.	Each
Clare B19553†	24VDC	2C, 1A	——	R582	$3.49
Guardian 200	110VAC	2C, 2A	550	R583	1.95
Allied BO6A115	110VAC	DPDT‡	445	R429	3.49
Leach 1154	50VAC	2A‡	——	R431	2.49
Guardian 200	24VAC	1A‡	——	R274	.98
Guardian 200	24VAC	1A, 1C‡	——	R273	1.10
	12VAC	2A	——	R275	.98
Clare Type C†	110VAC	2A, 1B	——	R161	3.25
Automatic F Type RA	110VAC	4PDT	——	R159	4.49
Automatic F Type RA	110VAC	DPDT	——	R160	3.49
Allen Bradley RC3301	110VAC	Solenoid	——	R585	2.98
ABT C1070	110VAC	Coin Release	——	R362	.69
Amperite 24N02† (Delay)	24VAC	1A	——	R316	.98

Time Delay 2 Sec., can be used on 110V with 1250 ohms.

D.C. SENSITIVE PLATE RELAYS

Manufacturer & No.	Volts	Contacts*	Ohms	Catalog No.	Each
Sigma 4F	1 ma	SPDT	8000	R425	3.95
RBM 23025	6 ma	SPDT	8000	R428	1.50
G. E. CR2791B105C36	9 ma	SPDT‡	10000	R584	1.50
W. E. (Whelock) KS9665	9 ma	1A, 1B, 1C	2000	R426	4.95
Kurman Midget	12 ma	SPDT	1500	R427	.98
W. E. D170788	8ma	SPDT	4850	R92	2.50
Allied BOYX40	12 ma	DPDT‡	3940	R587	2.95
Clare Type J (K102)	6 ma	SPDT	3500	R30	3.50
Dumont	5 ma	1A‡	5000	R230	.98
Automatic 5035A7	8 ma	1A	1300	R103	1.25
Cooke Type C	4 ma	1A	6500	R596	3.50
Clare B11613 (K101)	2 ma	SPDT	6500	R588	4.95
Clare A8053†	8 ma	3A	6500	R408	3.95
Potter-Brumfield	9 ma	SPDT‡	2500	R364	1.25
Allied 80346 (Differential)	2.5 ma	SPDT	8000	R418	4.95

Dual Differential, two 8000 ohm coils for P.P. or balanced circuits. All contacts normally open.

D.C. SOLENOIDS (For More Complete Listing See Oct. Electronics)

Manufacturer & No.	Volts	Contacts*	Ohms	Catalog No.	Each
Magnecon 305381-2 (Amp 200)	36V	1A	14/140	R589	2.95
Magnecon 305381-3 (Amp 200)	72V	1A	60/600	R590	3.25
Magnecon 305381-4 (Amp 200)	120V	1A	200/2000	R591	3.50

Note: Relays # R589,-90,-91, are 200 amp solenoids. Holding current automatically cut by 90%.

Manufacturer & No.	Volts	Contacts*	Ohms	Catalog No.	Each
Cutler-Hammer 6041H50A	12V	2A	14	R592	2.95

3PDT D.C. RELAYS

Manufacturer & No.	Volts	Contacts*	Ohms	Catalog No.	Each
G. M. 12566	6-12V	3PDT‡	45	R593	1.95
G. M. 12889-2	24V	3PDT‡	800	R594	2.95
G. M. 12792-1	18-24V	3PDT‡	100	R240	1.75
G. M. 12885-1	24V	1A, 1B, 2C‡	300	R595	3.25
Leach 2069	24V	3PDT‡	130	R241	1.50
Allied B09D28	6V	3PDT‡	14	R225	2.25
G. E. CR2791B106J3	24V	3PDT	160	R273	1.25
G. E. CR2791B100J4	4-6V	3PDT	12	R361	1.25
G. E. CR2791B100J42	8-12V	3PDT	60	R163	1.25
Cooke 55531	12-24V	2A, 2C	150	R405	1.25

* A=Normally Open; B=Normally Closed; C=Double Throw.
† Octal Type Plug Base.
‡ Heavy Duty 10 Amp Contacts.

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40 W #T106, 2.49; 250 W, #T107, 4.75; 350 W, #T112, 5.75

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Contacts	Mfgr & No.	Description	Amps	Each
SPST	Carling	Small Toggle	3A, 110V	$.15
SPST	A, H&H	Toggle	3A, 250V	.29
SPST	C-H B5A	Aircraft	35A, 24V	.29
SPDT	C-H B9A	Aircraft	35A, 24V	.29
SPDT	A, H&H	Toggle	3A, 125V	.29
DPST	A, H&H	Toggle	3A, 125V	.39
1 B*	A, H&H	Momentary	5A, 125V	.23
1 B*	T&M Co.	Push	3A, 125V	.29
1 A*	Square D	Push	15A, 24V	.49

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#33 MECHANISM ONLY 24V, 200 ohm, R597	$1.50
#76-2945 MECHANISM & RATCHET & 3" lg shaft 6V, ½ ohm, R598	$3.50
#76-3576 MECHANISM & RATCHET & 4" lg shaft 6V, ½ ohm, R599	$3.75

LEDEX D. C. Impulse operated mechanisms rotate in 30° steps. Ratchet mechanism has ¼" shaft with flats for standard switch wafers.

CLARE A27523 Stepping Relay

3 Deck, 10 Position & Off, Electrical Reset, 24VDC, 45 ohm Impulse Coil; 6VDC, 62 ohm, Reset Coil, R600 17.50

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1N21A "	2.25
1N21B "	4.25
1N22 "	1.35
1N23 "	2.25
1N23A "	3.25
1N23B "	6.95
1N26 "	5.95
1N27 "	1.69
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2C44	1.49
2C46	7.50
2C51	6.95
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	99.50
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	29.50
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2K29	24.50
2K33	310.00
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3B22/EIC	2.95
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3B24	5.95
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3B28	8.95
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3FP7	3.95
3GP1	4.75
3HP7	3.95
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4-125A	26.95
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4B32	9.95
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4E27 257B	17.95
5AP1	3.69
5AP4	3.69
5BP1	5.95
5BP4	5.95
5CP1	4.95
5CP7	12.95
5C22	55.00
5D21	24.50
5FP7	3.25
5GP1	4.95
5JP1	24.45
5JP2	24.45
5JP4	24.45
5J23	12.95
5J29	12.95
5J30	49.50
5J32	99.50
5LP1	15.95
5NP1	5.95
6AS6	3.69
6C21	24.50
6F4	5.95
6J4	6.95
7BP7	8.95
7DP4	17.95
9GP7	14.95
9JP1	14.95
9LP1	19.95
9LP7	14.95
10BP4	22.50
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	2.90
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53A	5.95
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121A	2.98
203A	8.95
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211	.69
212E	49.50
215A	.19
217C	8.95

227A/5C27	$5.95
249C	3.95
250R	12.95
250TH	22.50
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	4.95
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	4.95
450TH	47.50
450TL	47.50
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	2.95
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
713	1.45
714AY	6.95
715A	7.95
715B	9.75
715C	29.95
717A	1.69
721A	2.59
722A	2.95
723A	14.95
723A/B	22.50
724B	3.89
725A	7.95
726A	6.95
726B	29.50
726C	49.50
730A	30.50
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	7.25
809	2.45
810	9.95
811	3.25
812	2.95

812H	$6.90
813	8.95
814	3.95
815	2.95
816	1.30
826	.98
828	12.75
829	12.95
829B	14.95
830B	3.95
832	12.95
832A	12.95
833A	41.50
836A	3.95
837	1.69
838	2.95
841	.45
843	.39
845	4.95
849	39.50
851	69.50
852	29.95
860	6.95
861	29.50
864	.39
865	1.45
866A	1.39
866JR	1.29
869B	49.50
872A	2.95
874	1.49
876	.59
878	2.25
884	1.85
885	1.49
902	11.95
905	3.59
908	12.95
918	1.69
919	2.79
922	.98
923	1.05
927	1.59
930	1.20
931A	4.95
954	.39
955	.45
956	.45
957	.45
958	.45
959	.69
991/NE16	.39
1603	5.25
1613	1.25
1614	2.25
1616	.98
1619	.35
1622	3.25
1624	1.98
1625	.45
1626	.45
1629	.35
1630	.98
1631	1.29
1632	.79
1633	.75
1634	.75
1636	3.25
1638	.65
1641	2.25
1644	.98
1654	2.39
1665	1.45
1851	1.89
1960	.79
1961	4.99
2050	1.90
2051	1.45
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	2.25
9003	2.25
9004	.75
9005	2.95
9006	.49
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	3.25
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
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FG434A	4.95
FG451	.89
FG502A	1.85
FG562	97.50
FG592	14.95
HF125	14.95
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HY114B	.79
HY115	.79
HY615	.29
KC4	37.50
KU610	6.95
ML101	69.50
REL21	3.95
RK20	9.95
RK25	4.49
RK33	.69
RK34	.89
RK48A	4.49
RK59	1.49
RK60/1641	2.25
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

OA2	$1.55
OA4G	1.20
OB2	1.65
OZ4	.75
O1A	.73
1A3	.73
1A4P	1.30
1A5GT	.78
1A6	.85
1A7GT	.95
1AB5	.80
1B3/8016	1.25
1B4	1.15
1B5/25S	.95
1B7GT	1.25
1C5GT	.85
1C6	.73
1C7G	.73
1D5GP	.73
1D7G	.73
1D8GT	.73
1E5GT	.73
1E7G	1.19
1F4	.73
1F5G	.73
1G4	.73
1G6GT	.73
1H4G	.89
1H5GT	.75
1H6GT	1.05
1J6	.98
1L4	.73
1LA4	.89
1LA6	1.15
1LB4	1.06
1LC5	.89
1LC6	.98
1LD5	.98
1LE3	.85
1LG5	.85
1LH4	.89
1LN5	.95
1N5GT	.89
1P5GT	.79
1Q5GT	.73
1R4	.73
1R5	.95
1S4	.73
1S5	.85
1T4	.85
1T5GT	.73
1U4	.89
1V	.72
1X2	1.18
2A3	.95
2A4G	1.25
2A5	.73
2A6	.73
2A7	.75
2B7	.75
2V3G	.79
2X2	.65
2X2A	1.60
3A4	.65
3A5	.90
3B7/1291	.59
3D6/1299	.59
3LF4	.95
3Q4	.79
3Q5GT	.85
3S4	.85
3V4	.90
5R4GY	3.75
5T4	1.95
5U4G	.73
5V4G	1.12
5W4	.81
5X4G	.89
5Y3GT	.63
5Y4G	.73
5Z3	.89

5Z4	$0.89
6A3	1.25
6A4LA	1.35
6A6	.92
6A7	.99
6A8	1.05
6AB7	1.05
6AC5GT	1.20
6AC7	1.15
6AD7GT	1.35
6AE6G	.89
6AF6G	.95
6AG5	.89
6AG7	1.55
6AH6	1.40
6AJ5	1.15
6AK5	1.50
6AK6	1.10
6AL5	.82
6AQ5	.92
6AQ6	.87
6AR5	.79
6AT6	.73
6AU5	1.25
6AU6	.93
6AV6	.72
6B6G	.99
6B7	.98
6B8G	.85
6BA6	.85
6BC5	.98
6BE6	.85
6BF6	.79
6BG6G	1.18
6BH6	.97
6BJ6	.97
6BQ6	1.35
6C4	.79
6C5	.79
6C6	.79
6C8G	.98
6CB6	.98
6D6	.85
6D8	.89
6F5	.79
6F6	.95
6F7	.89
6F8G	.95
6G6G	1.15
6H6	.95
6H6GT	.79
6J5	.75
6J5GT	.69
6J6	1.20
6J7	.82
6K5GT	.89
6K6GT	.79
6K7	.73
6K8	.73
6L5G	.87
6L6	3.00
6L6G	1.75
6L6GA	1.75
6L7	.98
6L7G	.95
6N7	.89
6Q7	.95
6R7	.85
6S7G	.98
6S8GT	1.05
6SA7	.85
6SC7	1.30
6SD7GT	.98
6SF5	.89
6SF5GT	.89
6SF7	.98
6SG7	.98
6SH7	.73
6SJ7	.89
6SK7	.89
6SL7GT	.98

6SN7GT	$0.98
6SQ7	.75
6SR7GT	.85
6SS7	.95
6ST7	1.10
6SU7GTY	2.15
6SV7	1.25
6T7G	1.20
6T8	1.18
6U5G	.95
6U6GT	.98
6U7G	.59
6V6	1.55
6V6GT	.89
6W4	.85
6W7G	1.05
6X4	.73
6X5GT	.75
6Y6G	.98
6Y7G	1.25
6ZY5G	.89
7A4/XXI	.79
7A5	.89
7A6	.85
7A7	.85
7A8	.89
7AG7	1.05
7B4	.85
7B5	.85
7B6	.85
7B7	.85
7C4	.79
7C5	.85
7C6	.85
7C7	.85
7E5	.75
7E6	.59
7E7	.89
7F7	.85
7H7	.85
7K7	1.20
7L7	.98
7N7	.98
7Q7	.83
7R7	.95
7S7	.98
7V7	.95
7W7	1.05
7X7	1.10
7Y4	.75
7Z4	.85
12A	.65
12A6	.73
12A7	1.05
12A8GT	.79
12AH7GT	1.27
12AL5	.93
12AT6	.73
12AT7	1.25
12AU6	.95
12AU7	1.15
12AV6	.73
12BA6	.85
12BE6	.87
12C8	.79
12F5GT	.79
12H6	.82
12J5GT	.55
12J7GT	.82
12K7GT	.79
12K8	.89
12Q7	.69
12SA7GT	.93
12SC7	.99
12SF5	.89
12SF7	.89
12SG7	.79
12SH7	.73
12SJ7	.79
12SK7	.98

12SL7	$1.05
12SN7	.98
12SQ7	.85
12SR7	.85
12Z3	.85
14A4	.98
14A7	.95
14B6	.95
14F7	.95
14F8	.95
14H7	.95
14J7	.95
14N7	.95
14Q7	.95
14R7	.95
19	.69
24A	.75
25L6GT	.85
25Z5	.79
25Z6GT	1.05
26	.50
27	.49
28D7	1.35
30	.45
31	.85
32	.95
32L7GT	.89
33	.93
34	.89
35/51	.83
35A5	.89
35B5	.89
35C5	.98
35L6GT	.85
35W4	.69
35Y4	.75
35Z3	.85
35Z4	.73
35Z5	.69
36	.79
37	.79
38	.60
39/44	.40
41	.75
42	.75
43	.75
45	.89
45Z3	.89
45Z5	.80
46	.82
47	.89
48	.98
49	.95
50A5	.95
50B5	.95
50C5	.95
50L6GT	.85
50Y6	.85
53	.98
56	.65
57	.80
58	.85
59	.95
70L7	.95
71A	.75
75	1.25
76	.55
77	.60
78	.79
80	.73
82	.89
83	1.15
83V	1.15
84/6Z4	.85
85	.89
89Y	.45
117L7/M7	1.35
117N7	1.35
117P7	1.35
117Z3	.89
117Z6	.90

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This is a Pack Portable Ground Search Radar for the detection of aircraft up to 100 miles. Range & Azimuth Data is displayed on a 7" P.P. 1 & a 5" scope. This set was called the G. I's Radar because of its ruggedness, dependability & ease of servicing. complete tech data is as follows: Power Output 150KW, P.R.R. 200 PPS, pulse width 2 microsec, beamwidth 3° horiz, 13° vert, power input 1100w, 115v 400 cyc & 27v DC. weight 1500 lbs. excellent condition.

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TS278/AP AN/APS13 Test Set.	
BC-221 Frequency Meter.	
1E-19 Test Set for SCR522.	
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TYPE 1600, 2.2 W., 1/60 RPM. PRICE $3.00 EA.

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CK2, PIONEER, 2 φ, 400 Cy. PRICE $14.00 EA.

CK2, PIONEER, 2 φ, 400 Cy., with 40:1 reduction gear. PRICE $15.50 EA.

10047-2-A, PIONEER, 2 φ, 400 Cy., with 40:1 reduction gear. PRICE $10.00 EA.

MINNEAPOLIS HONEYWELL Type B, Part No. G303AY, 115 V., 400 Cy., 2 φ, built-in reduction gear, 50 lbs. in torque. PRICE $10.00 EA.

MINNEAPOLIS HONEYWELL Amplifier Type G403, 115 V., 400 Cy., Used with above motor. PRICE $10.00 EA. WITH TUBES

REMOTE INDICATING COMPASSES 26 V., 400 CY.

PIONEER TYPE AN5730-2 Indicator and AN5730-3 Transmitter. PRICE $40.00 PER SET

KOLLSMAN TYPE 680K-03 Indicator and 679-01 Transmitter. PRICE $15.00 PER SET

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BARBER-COLMAN CONTROL MOTOR, Type AYLC 5091, 27 V., 0.7 Amps., 1 RPM. Contains 2 adj. limit switches. 500 in. lbs. torque. PRICE $6.50 EA.

WHITE RODGERS ELECTRIC CO., Type 6905 No. 3 ,12 V., 1.3 Amps., 1½ RPM, torque 75 in. lbs. PRICE $10.50 EA.

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GENERAL ELECTRIC TYPE 6RC146. Input 230 V., 60 Cy., 3 φ, adjustable input taps. Output 130 Amps., at 28 V. D.C. Continuous duty. Size 46" high, 28" wide and 17.5" deep. PRICE $225.00 EA.

INVERTERS

WINCHARGER CORP. PU-16/AP, MG750. Input 24 V. D.C., 60 Amps. Output 115 V., 400 Cy., 1 φ, 6.5 Amps. PRICE $100.00 EA.

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PIONEER TYPE 12117. Input 24 V. D.C., Output 26 V., 400 Cy. at 6 V.A. PRICE $30.00 EA.

PIONEER TYPE 12116-2-A. Input 24 V. D.C., at 5 Amps. Output 115 V., 400 Cy., 1 φ at 45 watts. PRICE $100.00 EA.

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LELAND PE 218. Input 24 V. D.C. at 90 Amps. Output 115 V., 400 Cy., 1 φ at 1.5 K.V.A. PRICE $47.50 EA.

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TYPE AY5, 26 V., 400 Cy. PRICE $8.50 EA.

TYPE AY14G, 26 V., 400 Cy. PRICE $15.00 EA.

TYPE AY14D, 26 V., 400 Cy. PRICE $15.00 EA.

TYPE AY54D, 26 V., 400 Cy. PRICE $10.00 EA.

TYPE AY131D Precision Autosyn. PRICE $35.00 EA.

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TYPE 6007-39. Dual Dial graduated 0 to 360°, 26 V., 400 Cy. PRICE $50.00 EA.

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LELAND ELECTRIC CO. TYPE B, Carbon Pile type. Input 21 to 30 V. D.C. Regulated output 18.25 at 5 Amps. PRICE $6.50 EA.

WESTERN ELECTRIC TRANSTAT VOLTAGE REGULATOR Spec. No. V-122855, Load K.V.A. 0.5. Input 115 V., 400 Cy. Output adjustable from 92 to 115 V. PRICE $10.50 EA.

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EASTERN AIR DEVICES J36A, .02 V. D.C. per RPM. Max. speed 5000 RPM. PRICE $17.50 EA.

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5G GENERATOR, 115 V., 60 Cy. PRICE $50.00 EA.

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DELCO TYPE 5069370, 27 V., 10,000 RPM. PRICE $15.00 EA.

DELCO TYPE 5072400, 27 V., 10,000 RPM. PRICE $10.00 EA.

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DELCO TYPE 5068571 Motor and Blower Assembly, P.M. Motor, 27 V., 10,000 RPM. PRICE $15.00 EA.

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SPERRY A5 DIRECTIONAL GYRO, Part No. 656029, 115 V., 400 Cy., 3 φ. PRICE $25.00 EA.

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TYPE C1 AUTO-PILOT FORMATION STICK, Part No. G1080A3. PRICE $15.00 EA.

PIONEER GYRO FLUX GATE AMPLIFIER Type 12076-1-A, 115 V., 400 Cy. PRICE $40.00 EA.

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W. E. S-1283228. For 2 phase 240 cycle operation. 55 volts.

Stock #SA-317. **Price $9.75 each.**

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Types B-9-1 & B-9-2 27.5 V DC & 12 V DC. 5600 rpm. Built-in noise filter. Large qty. PRICES ON REQUEST

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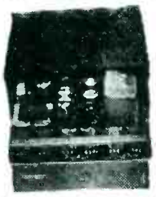

Three channel servo amplifier for use in C-1 Autopilot. 7 tubes. Stock #SA-172.

PRICES ON REQUEST

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.**

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Sampsel 27 V DC PM motor. Type S—151273. One in./oz. torque at 7000 rpm. 1½" x 1½" x 2¾" Lg. Stock #SA-283. **Price $12.75 each. Quantity available.**

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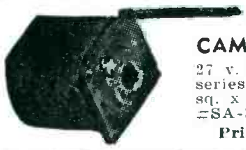

27 v. D-C Split field series. Approx. 2½" sq. x 2½" lg. Stock #SA-315.

Price $6.75 each.

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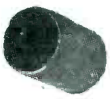


AC Motor Special Eastern Air Devices J-33 115 V. 400 cy. 3 phase synchronous. 8000 RPM. Stock #SA-59.

Price $19.50 each

DC SERVO MOTORS

Elinco B-64 DC Servo Unit — armature voltage, 80 v d-c max. 27.5 v. field 1/165 hp 3100 rpm. Field current 200 ma. Armature current 200 ma. at normal torque.

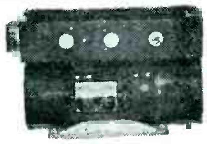
Stock #SA-211. **Price $16.50 each.**

John Oster A-21E-12R — Split field series reversible motor. W.E. KS-5996-LO-4. 28 v. d-c at 0.4 amps. 2 watts output. 1½" diam. x 2½" lg. Ideal for relay or thyratron servos. Stock #SA-282. **Price $8.75 each.**

INVERTERS

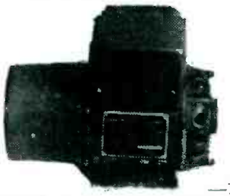
Wincharger PU-7/AP Input 28 VDC at 160 amps. Output 115 v. 400 cy. 1 ϕ at 2500 VA. Voltage and frequency regulated. Cont. duty. Stock #SA-164. **Price $99.50 each.**

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 (3 ϕ) Input 28 VDC at 14 amps. Output 115 v. 400 cy. 3 ϕ at 100 VA. Voltage and frequency regulated. Made 1949. Stock #SA-304. **Price $89.50 each.**



400 Cycles Three Phase

Holtzer Cabot MG-153—Input 28 volts DC at 52 amps. Output three phase 115 volts 400 cycles at 750 va. 0.90 P.F. Also second output of 26 volts 400 cycles at 250 V.A. Voltage and frequency regulated.

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115 v. 400 cy. 17 c.f.m. Includes capacitor. Stock #SA-144. **Price $14.50 ea.**

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A-5 AUTOPILOT GYROS
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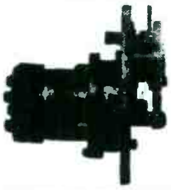
AC-SERVO MOTORS



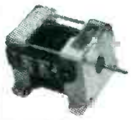
Pioneer Type CK-2. 26 v. 400 cycles fixed phase, var. phase 49 v. max. 1.05 in/oz. Stall torque. Rotor moment of inertia 7 gm/cm. With 40: 1 gear reduction. Large Qty.

Prices on Request

PIONEER CK-17

400 cycle 2 phase, 26 v. fixed phase. 45 v. max. variable phase. Built in gear reduction. Output shaft speed approx. 4 rpm. Stock #SA-287. **Price $16.50 each.**

FORD SERVO MOTOR



115 volt 60 cycle two phase low inertia motor. 15 watts output. BuOrd. 207927. Stock #SA-291. **Price $49.50 each.**

Pioneer Servo Motor

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D-C Selsyn type tilt indicator. G.E. 8DJ29AAK. 24 volt. Stock #SA-296. **Price $3.75 each.**

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C1A	4.95	2J61	75.00	5LP1	18.95	371B	1.95	730A	28.95	931A	6.95
C1B	6.95	2J62	75.00	5LP1A	19.50	385A	4.95	801A	1.00	954	.35
1B21A	2.75	2K25	47.50	6C21	29.50	388A	2.95	802	4.25	955	.55
1B22	3.95	2K28	37.50	C6A	3.95	393A	8.95	803	5.95	956	.69
1B23	9.95	2K29	27.50	C6J	9.95	394A	8.95	804	13.50	957	.29
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1B32	4.10	3B24	5.50	15E	2.95	446A	1.95	808	3.50	991	.45
1B38	33.00	EL3C	5.95	15R	.95	450TH	45.00	809	2.45	E1148	.29
1B42	19.95	3C24	1.95	NE16	.45	450TL	45.00	810	11.00	1280	1.95
1B56	49.95	3C31	5.95	FG17	6.95	464A	9.95	811	3.15	1611	1.95
1B60	69.95	3C45	13.95	RX21	3.95	471A	2.75	813	8.95	1613	1.38
1N21	1.35	3DP1A	10.95	35T	4.95	527	15.00	814	3.95	1616	2.95
1N21A	1.75	3E29	15.50	45 Special	.35	WL530	22.50	815	3.50	1619	.89
1N21B	4.25	SN4	5.50	RK39	2.95	WL531	12.50	816	1.45	1620	5.95
1N22	1.75	4A1	1.75	VT52	.35	700A/D	25.00	829	9.95	1622	2.75
1N23	2.00	4B26	10.95	RK72	1.95	701A	7.50	829A	11.95	1624	2.00
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1N27	5.00	4E27	17.50	FG105	19.00	706AY	48.50	832	6.95	2050	1.85
1N48	1.00	4J25	199.00	F123A	8.95	706CY	48.50	832A	9.95	2051	1.80
1S21	6.95	4J26	199.00	203A	8.95	707A	17.95	833A	49.95	8012	4.25
2B22	4.95	4J27	199.00	211	.75	707B	27.00	834	7.95	8013	2.95
2B26	3.75	4J30	395.00	217C	18.00	714AY	7.95	836	4.95	8013A	5.95
2C34	.35	4J31	99.00	242C	10.00	715A	7.95	837	2.95	8014A	29.95
2C40	20.00	4J32	99.00	249C	4.95	715B	15.00	838	6.95	8020	3.50
2C43	27.00	4J33	99.00	250TL	19.95	715C	25.00	845	5.59	8025	6.95
2C44	.90	4J37	99.00	274B	3.00	717A	1.75	849	52.50	9001	1.75
2D21	1.75	4J38	89.00	304TH	15.00	718AY/EY	48.50	851	80.50	9002	1.50
2E22	3.75	4J39	99.00	304TL	14.50	719A	29.50	860	4.95	9003	1.75
2E30	2.75	4J41	99.00	307A	4.95	721A	3.95	861	39.50	9004	1.75
2J26	27.75	4J52	350.00	310A	7.95	722A	3.95	866A	1.79	9005	1.90
2J27	29.95	C5B	2.95	311A	7.95	723A/B	14.95	869B	37.50	9006	.35
2J31	29.95	5BP1	6.95	312A	3.95	724A	4.95	872A	3.95		
2J32	69.95	5BP4	6.95	323A	25.00	724B	6.95	878	1.95		
2J36	105.00	5CP1	6.95	327A	3.95						

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TS 35 X Band Pulsed Signal Generator
TS 36 X Band Power Meter
TS 45 Band Signal Generator
TS 146 X Band Signal Generator
TS 62, TS 102, TS 168
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TS 125, TS 155, TS 127
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TS 226

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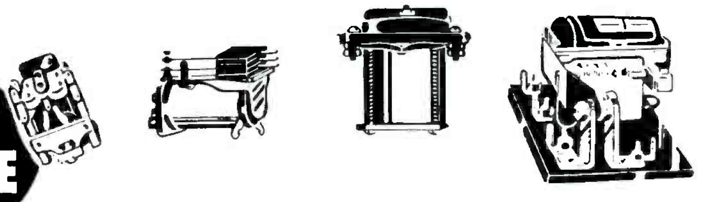

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The following list represents only a portion of our relay stock. Write or wire us for information on types not shown.

STANDARD DC TELEPHONE RELAYS

Stock No.	D.C. Voltage	Ohmage	Contacts	Unit Price
R-806	115*	900	1A	$2.05
R-161	6	10	2B & 1A	1.10
R-100	24	600	2A & 1C	2.45
R-518	85/125	6500	1C	3.60
R-633	180/350	10,000	1C & 5 Amps.	2.90
			Oct. Skt.	2.45
R-667	6	.75	1B/10 Amps. 1A/3 Amps.	1.45
R-632	6	12	5A & 1C	1.25
R-154	6/12	200	1A	1.50
R-517	12	250	2A	1.50
R-116	85	3000	1B	3.05
R-631	100/125	3300	2A	1.90
R-545	110/250	7000	1C	2.45
R-124	300	12,000	1A	1.55
R-160	6	12	3C & 3A	1.30
R-591	6	40	1B & 1C	1.35
R-155	12	100	4A & 4B	1.45
R-520	200/300	14,000	2C	3.45
R-159	6	50	2A	1.35
R-158	6	50	4A	1.35
R-576	12	200	2A	1.55
R-153	12	200	1C & 1A	1.55

SHORT TELEPHONE RELAYS

Stock No.	D.C. Voltage	Ohmage	Contacts	Unit Price
R-635	12	100	1C & 1A	$1.35
R-648	12	170	1E	1.35
R-826	12	150	2C, 1B	1.55
R-770	24	150	1A/10 Amps.	1.45
R-771	24	200	1A/10 Amps.	1.45
R-603	18/24	400	2A	1.55
R-575	24	500	2C	2.40
R-764	48	1000	2C & 2A	2.00
R-563	60/120	7500	1A	1.70
R-801	115*	——	None	1.45
R-213	5/8*	——	2A	3.10
R-589	12	125	2A	1.30
R-113	12	150	4A	1.55
R-689	12/24	255	1C	1.55
R-799	24	500	None	1.00
R-115	24	500	1C	1.70
R-110	24/32	3500	1C	1.70
R-121	150	5000	2A & 1C	2.05
R-634	150/250	6000	1A & 1B	2.45
R-800	12	150	2C & 1A	1.55
R-537	12/24	150	2C & 1B	2.00
R-750	24	400	1A	1.60

CONTACTORS

Stock No.	D.C. Voltage	Ohmage	Contacts	Unit Price
R-188	24	200	1A/75 Amps.	$3.70
R-183	24	60	1A/50 Amps.	3.45
R-187	24	100	1A/50 Amps.	3.70
R-554	24	85	2A/100 Amps.	5.90
R-788	100*	——	3B & 2A	5.45
R-682	115*	35	5A/10 Amps.	6.10
R-767	24*	20	2A/10 Amps.	4.95
R-180	12	25	1A/50 Amps.	4.05
R-657	24	50	4A/100 Amps.	6.95
R-265	24	60	1A/100 Amps.	3.45
R-535	24	70	1A/100 Amps.	4.80
R-556	24	70	1A/100 Amps.	4.80
R-557	24	100	1A/50 Amps.	3.85
R-178	24	100	1A/100 Amps.	4.80
R-727	10	20	1A/20 Amps.	2.00
R-608	24	125	1A/200 Amps.	2.80
R-184	28	50	1A/100 Amps.	4.90
R-719	24	10	1A/200 Amps.	4.95
R-182	28	80	1A/25 Amps.	2.40
R-244	75*	265	1A/20 Amps.	2.20
R-659	12	7.2	2A/20 Amps.	1.70
R-552	24	70	4A/50 Amps.	5.35
R-185	24	100	1A/50 Amps.	3.45
R-186	24	132	1A/50 Amps.	4.35
R-817	24	150	1A/50 Amps.	3.45
R-534	14	45	1A/30 Amps.	2.05
R-223	28	150	1A/40 Amps./48 VDC.	1.70
R-680	6	3	1A/50 Amps.	3.90
R-677	6	3.5	1A/50 Amps.	3.90
R-532	6	15	1A/50 Amps.	3.90
R-676	12	16	1A/50 Amps. 1AUX/25A	3.90

ROTARY RELAYS

Stock No.	D.C. Voltage	Ohmage	Contacts	Unit Price
R-709	6/8	1	12 Pos. 3 Wafer	$3.90
R-197	9/16	70	2C	2.05
R-713	9/14	125	1C & 1A	2.05
R-616	28	7	5B & 1A	2.40
R-712	24	200	2B	2.05
R-711	24	200	2C & 1B	2.05
R-573	28	200	1C & 1B	2.05
R-766	24	230	12 Pos. 8 Deck	4.90
R-809	28	7	1B & 12 Pos.W/ 7" Shaft for Wafers.	2.45

DIFFERENTIAL RELAYS

Stock No.	D.C. Voltage	Ohmage	Contacts	Unit Price
R-208	120	2000	2C/3 Amps.	$2.45
R-209	220/250	8000	1C/3 Amps.	3.10

SEALED RELAYS

Stock No.	D.C. Voltage	Ohmage	Contacts	Unit Price
R-658	6	35	2C/Octal Plug	$3.45
R-125	24	300	2C/Octal Plug	3.45
R-261	12/24	1900	1C/5 Pin Plug	3.75
R-673	48/150	7500	1C/5 Amps.	2.80

VOLTAGE REGULATORS

Stock No.	D.C. Voltage	Ohmage	Contacts	Unit Price
R-745	6	2	1A/10 Amps.	$1.05
R-780	24	350	1C/6 Amps.	1.05
R-509	6/12	35	1B/2 Amps.	1.05

SPECIAL RELAYS

Stock No.	D.C. Voltage	Ohmage	Contacts	Unit Price
R-503	12/32	100	3A, 2C	$13.50
R-749	600	——	Max. 28 Amps.	7.45
R-804	550*	——	1B/38 Amps.	4.35
R-250	115*	——	Adj. Cir. Bk.-.04-.16A	17.50
R-579	220*	——	1B	8.70
R-294	27.5	200	1B	5.35
R-686	115*	——	2C	6.10
R-246	115*	——	1B	11.20
R-246A	115*	——	1A	11.20
R-611	24*	——	1A/30 Amps.	5.35
R-283	12	125	1C/10 Amps.	4.35
R-614	18/24	60	1A/15 Amps.	4.35
R-245	12	25	4" Micalex Lever	3.20
R-527	6/12	50/50	In Series	1.20
R-544	12/24	60/60	1C	2.05
R-255	——	——	1A	3.50
R-669	75*	400 Cy.	1B, 1A	1.20

KEYING RELAYS

Stock No.	D.C. Voltage	Ohmage	Contacts	Unit Price
R-714	9/14	65	2C/5 Amps.	$1.55
R-850	12	450	1A/1.5 Amps.	1.50
R-721	18/21	290	2C/5 Amps.	1.55
R-694	24	300	1A/5 Amps.	1.50
R-935	28	1000	1C/1.5 Amps	1.65
R-949	2.4*	60 Cy.	1A/5 Amps.	1.95
R-704	2/6	.25	2B/5 Amps.	1.35
R-173	2/6	2	1A	3.00
R-280	6/8	77	1A Dble. Brk.	2.45
R-647	6/12	15	1B/20 Amps.	1.45
R-273	20	160	2A/15A Dble. Brk.	3.55
R-169	24	200	1A	2.45
R-570	24	230	1B Dble. Brk.	2.70
R-960	24	230	3C/15 Amps.	2.95
R-529	24/48	1020	2C	3.10
R-715	24	——	2C Ceramic	3.70
R-584	6	20	1A Dble. Brk.	1.30
R-192	12	44	3C/10 Amps.	1.70
R-204	12	66	2A	1.45
R-224	12	85	1A	1.45
R-221	18/24	5000	1A	2.00
R-205	24	260	2C	1.55
R-891	24	475	1C/5 Amps.	1.45
R-536	27	230	2C	1.55
R-858	27.5	250	1A Dble. Brk.	1.45
R-833	6.5	1300	2C	3.05
R-220	75	5000	1C	1.50
R-828	6/8	42	1A	1.50
R-627	115*	——	1B Dble. Brk.	3.10
R-734	24	150	3C/10 Amps.	1.30
R-598	28	185	2C	1.30
R-622	20/30	200	3A & 2C/10 Amps.	1.45
R-274	24*	——	2A	1.55
R-855	110* 60Cy	160	1A Dble. Brk/15A	3.25
R-277	12	30	2C-D Break Cera	2.20

MIDGET RELAYS

Stock No.	D.C. Voltage	Ohmage	Contacts	Unit Price
R-572	24	256	1C	$1.25
R-857	24	260	1 Make Before Make	1.75
R-912	4/5	20	3A-1C Ceramic	2.50
R-291	6	5	1A	1.25
R-921	6.7	18	1A Dbl.Brk.@10 Amp.	1.45
R-738	12	60	3A	1.20
R-922	12	75	1A Dbl.Brk.@10 Amp.	1.45
R-144	12	228	1A	1.45
R-145	18/24	250	2A Ceramic	1.45
R-298	21	300	1A	1.25
R-296	21	300	1A	1.25
R-586	21	300	1A & 1C	1.25
R-137	24	300	1C	1.45
R-142	24	400	2C	1.50
R-785	24	200	2C/10 Amps.	2.00
R-607	24*	——	1A	1.20
R-606	24*	——	1A & 1B	1.20
R-605	24*	——	3A	1.20
R-728	6	30	1A	1.25
R-149	6/8	45	1B	1.50
R-732	12	120	1A	1.45
R-281	12	126	2A	1.25
R-818	18/24	300	1B	1.30
R-135	24	250	1B	1.45
R-133	24	300	None	.75
R-138	24	300	4A	1.45
R-132	24	300	2C	1.50
R-731	24	300	2C	1.55
R-292	24	350	1C	1.25
R-626	24	400	1A/5 Amps.	1.55
R-786	60	1300	2C	2.00
R-588	90/125	6500	4C	2.70
R-755	24	300	1A	1.45
R-150	6	30	1A	1.50
R-893	14	150	1A, 1C	2.50
R-895	14	150	2A, 1B, 1C	2.50

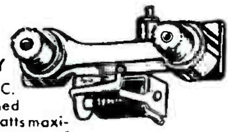
SPECIAL RELAYS—Cont'd

Stock No.	D.C. Voltage	Ohmage	Contacts	Unit Price
R-660	6	——	¾" Stroke	$1.20
R-651	24	100	Solenoid Valve	3.10
R-295	12	275	Annunciator Drop	2.70
R-230	5/8	2	2A, 1C	2.70
R-813	12	12	Wafer	5.35
R-275	12	750	1A, 1B, 1C	3.45
R-716	24	70	2A/5 Amps.	1.80
R-620	6/12	35	2C, 1A	1.30
R-629	9/14	40	1C/10 Amps.	1.55
R-720	24	50	2C Ceramic	1.70
R-500	12	10/10	2C/6 Amps.	3.55
R-816	12	10/15	2C/6 Amps.	3.55
R-524	24**			1.20
R-566	115*	Coil Only		1.00
R-710	——	150	Coil Only	.75

*AC. **AC/DC.

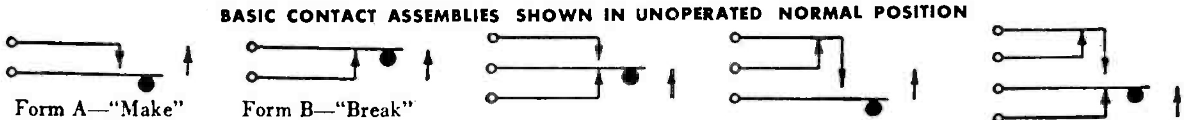
SPECIAL!

CO-AXIAL RELAY



D153766 SPDT, 6 VDC. 19 Ohm coil. Designed to accommodate 75 watts maximum. Perfect for all types of antenna switching. Designed for using standard 83-1SP coaxial fittings. Part of RAX-1 equipment. No. R-846—**$6.95** Ea.

BASIC CONTACT ASSEMBLIES SHOWN IN UNOPERATED NORMAL POSITION



Form A—"Make" (Single Throw, Normally Open)

Form B—"Break" (Single-Throw, Normally Closed)

Form C—"Break-Make" (Double-Throw)

Form D—"Make-Before-Break"

Form E—"Break-Make-Before-Break"

MANUFACTURERS AND DISTRIBUTORS:
WRITE FOR THE
NEW WELLS CATALOG

Telephone
SEeley 8-4143

WELLS SALES, INC.

833 W. CHICAGO AVE. DEPT. SL, CHICAGO 22, ILL.

Reliance Specials

TIMING MOTOR

8 RPM 115V 60 cyc
E. Ingraham Co.

$1.95

GEAR ASSORTMENT

100 small assorted gears. Most are stainless steel or brass. Experimenters dream!.................Only $6.50

VERNIER DIAL or DRUM (From BC-221)

DIAL—2⅝" dia. 0-100 in 360°. Black with silver marks. Has thumblock. DRUM—0 50 in 180°. Black with silver marks ....either 85c

SOUND POWER HANDSET

Brand New!
Includes 6 ft. cord. No batteries or external power source used. $17.60 pr.

Sound Powered Chest Set RCA—With 24 Ft. Cord
$24.95 per pair

Variac—General Radio 100W removed from equipment **$10.00**

400 CYCLE INVERTERS

Leeland Electric Co.
#10800 In: 20-28 V.D.C., 92 A. 8000 R.P.M. Out: 115V. 400 Cyc. 1 phase, 1500 V.A. 90 PF..............$24.95

3AG FUSES

AMP	Per 100	AMP	Per 100	AMP	Per 100
⅛	$4.00	1	$3.00	6	$3.00
½	4.00	1½	3.00	10	3.00
¾	4.00	5	3.00		

DELAY NETWORK—ALL 1400Ω

T 113—Approx. 1.2 micro sec. delay............
T 114—Approx. 2.2 micro sec. delay............
T 115 Similar to T 114 with tap brought out....
95¢ each

BEARINGS

Mfg. No.	ID	OD	Thickness	Price
MRC5028-1	5 1/2	6 1/2"	1"	$3.50
MRC7026-1	5 5/64	6 15/64	9/16	3.50
Timken 37625	4 5/16	6 1/4	29/32	4.25
MRC-7021-200	4 1/8	5 9/32	23/64	2.95
Norma A 545	2 1/16	2 5/8	1/4"	1.00
MRC 106 M2	1 17/64	2 7/16	25/64	1.75
MRC 106 M1	1 13/64	2 7/16	25/64	1.60
Federal LS 11	1 1/8	2 1/2	5/8	1.75
Norma S 11 R	1 1/8	2 1/8	3/8	1.25
Fafnir B 541	1 1/16	1 1/2	9/32	.55
Hoover 7203	5/8	1 9/16	7/16	.90
Norma 203 S	5/8	1 9/16	7/16	.90
SCHATZ	3/4	1 3/4	9/16	1.00
N5 5202-C13M	1/2	1 3/8	1 3/8	1.00
ND 3200	25/64	1 5/32	11/32	.55
Norma S 3R	3/8	7/8	7/32	.45
MRC 39 R1	11/32	1 1/32	5/16	.45
ND CW 8008	5/16	5/16	13/32	.45
MRC 38 R3	5/16	55/64	9/32	.45
Fafnir 33K5	3/16	1/2	5/32	.35

NEEDLE BEARINGS

TORRINGTON B108 ½" wide ⅝" 13/16" 30¢

Brand New METERS—Guaranteed

0-1 Amp. R.F. 2½"..$3.29 | 0-80 Amp. D.C. 2½"..$2.25
0-10 ma. D.C. 3½"... 3.95

SELENIUM RECTIFIERS

Full Wave 200 MA 115V.............................$1.79
Half Wave 100 MA 115V.............................91

SPAGHETTI SLEEVING—assortment—99 feet.....$1.00

TYPE "J" POTENTIOMETERS

60	SD	1000	SD*	5000	SD*	30K	SD*
100	SD	1500	SD	5000	3/8"	50K	SD*
150	SD	2000	SD	10K	3/8"	70K	SD
200	SD	2000	1/2"	10K	SD*	80K	SD
300	SD	2000	SD*	15K	1/4"	100K	3/8
300	3/8	2500	1/2"	15K	SD*	200K	SD*
400	3/8	2500	SD	25K	3/8"	250K	SD
500	3/8	3000	3/8	25K	SD*	1 Meg	SD
1000	7/8	4000	3/8				

* Split locking bushin' $1.50 each

JONES BARRIER STRIPS

Type	Price	Type	Price	Type	Price
2-140Y	$0.13	4-141W	$0.30	9-141Y	$0.64
3-140¾W	.19	5-141	.26	10-141	.50
6-140	.25	5-141¾W	.37	17-141Y	1.17
10-140¾W	.53	7-141	.36	3-142	.21
3-141¾W	.24	7-141¾W	.49	8-142	.69
3-141W	.24	8-141¾W	.58	2-150	.39
		9-141	.64	3-150	.54

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

AN CONNECTORS

IMMEDIATE SERVICE
PHONE! WIRE! WRITE! YOUR NEEDS

NEW COAXIAL CABLES

	Ohms	Price per 1,000 Ft.		Ohms	Price per 1,000 Ft.
RG-7/U*	97.5	$85	RG-39/U	72.5	$180
RG-10/U	52	245	RG-41/U	67.5	295
RG-12/U	200	45	RG-55/U	53.5	85
RG-13/U	74	225	RG-57/U*	95	125
RG-22/U*	95	150	RG-58/U*	53.5	65
RG-23/U		175	RG-59/U*	73	70
RG-25/U	48	425	RG-77/U*	48	100
RG-29/U*	53.5	50			

Add 25% for orders less than 1,000 feet.
*No minimum order—others 250' minimum.

COAXIAL CABLE CONNECTORS

15¢	$1.30	30¢	80¢	40¢	10¢
UG 175/U	83-1F	ANGLE	83-1J	83-1R	HOOD

83-1AC	$0.42	83-2R	$1.30	UG 57/U	$2.30
83-1AP	.30	83-21SP	2.10	UG 58/U	.63
83-1F	1.30	83-22AP	1.10	UG 60/U	2.40
83-1H	.10	83-22R	.68	UG 85/U	1.75
83-1J	.80	83-22SP	1.15	UG 87/U	1.60
83-1R	.40	UG 13/U	1.75	UG 88/U	1.60
83-1SP	.50	UG 21/U	1.20	UG 167/U	2.05
83-1SPN	.60	UG 21B/U	1.45	UG 175/U	.15
83-168	.15	UG 22/U	1.30	UG 176/U	.15
83-185	.15	UG 24/U	1.30	UG 206/U	1.60
83-2AP	2.00	UG 25/U	1.25	UG 260/U	1.60
83-2H	.25	UG 27/U	1.30	UG 281/U	.77
83-2J	1.65	UG 27A/U	2.95	UG 290/U	1.60
		UG 30/U	2.50	UG 499/U	1.25

DIFFERENTIAL

115 V., 60 Cyc. #C78249 **$3.95 ea.**
3⅜" dia. x 5⅜" long

Used between two #C78248's as dampener. Can be converted to 3600 RPM Motor in 10 minutes. Conversion sheet supplied. (Converted)..........$4.50
Mounting Brackets — Bakelite for selsyns, and differentials shown above.................35¢ pair

2J1G1 SELSYNS $3.50

BRAND NEW 400 CYCLE
Can be used on 60 cycle

POSTAGE STAMP MICAS

mmf	mmf	mmf	mmf	mmf	mmf	mfd	mfd	mfd
4	22	47	82	180	470	800	.001625	.004
5	23	50	90	220	500	820	.002	.0044
7	24	51	100	240	510	910	.0022	.005
7.5	25	56	110	250	560	.001	.0026	.0056
8	26	60	120	270	580	.0011	.0027	.006
8.2	30	62	125	300	600	.0012	.003	.0062
10	33	68	130	350	620	.0013	.0033	.0065
15	39	70	150	370	650	.00136	.0035	.0068
18	40	75	160	390	680	.0015	.0036	.0082
20	43	80	175	400	750	.0016	.0039	.01

Price Schedule

8.2 mmf to .410 mmf...............................5¢
.0011 mfd to .001625 mfd...............................8¢
.002 mfd to .0082 mfd...............................15¢
.01 mfd...............................28¢

SILVER MICAS

mmf	mmf	mmf	mmf	mmf	mmf	mfd	mfd	mfd
10	40	82	155	325	470	800	.0026	.005
18	47	100	170	350	488	875	.0027	.0051
20	50	110	180	360	500	900	.00282	.0056
22	51	115	208	370	510	.0011	.002826	.006
23	60	120	225	390	525	.0015	.003	.0068
24	62	125	240	400	560	.0016	.0033	.0082
27	66	130	250	410	570	.001625	.0039	
30	68	135	270	430	680	.0022	.004	
39	75	150	275	466	700	.0023	.0047	

Price Schedule

10 mmf to .001 mfd...............................10c
.001625 mfd to .0024 mfd...............................20c
.00282 mfd to .0082 mfd...............................50¢

FILAMENT TRANSFORMER

Pri., 115V., 60 Cyc.—Sec. } 6 V. @ 35 A. or 12 V. @ 18 A. or 24 V. @ 9 A. **$6.50**

PULSE TRANSFORMERS

UTAH—9262 9278 9340
WESTERN ELECTRIC—D166173 D161310
KS8696, KS9365, KS9565, KS9800, KS9862, KS13161
GENERAL ELECTRIC—K2731, 80-G-5
JEFFERSON ELECTRIC—C-12-A-1318
CROSLEY—W-226262-4
DINION COIL—TR1048, TR1049
also 352-7250-2A; 352-7251-2A; T-1-229621-60

PRECISION RESISTORS—¼ WATT—30¢

2	10.48	12.32	14.98	62.54	125	414.3
2.5	10.84	13.02	15.8	79.81	147.5	705
3.5	11	13.52	16.37	105.8	220.4	2,193
5	11.25	13.89	32	123.8	301.8	3,500
6.68	11.74				366.6	59,148

PRECISION RESISTORS—½ WATT—35¢

.2	13.15	71	298.3	3,427	14,825	37,000
.25	13.3	75	389	3,500	15,000	39,000
.334	13.52	80	397	3,995	15,750	40,000
.444	15	87	400	4,000	15,755	41,700
.502	18.75	90	607	4,101	15,810	43,766
.557	20	97.8	705	4,285	16,000	45,000
.627	21.5	123.8	723.1	4,300	16,700	47,000
.76	25	125	855	4,451	17,000	50,000
1	30	147.5	900	4,750	19,860	56,000
1.01	34.75	148.7	970	5,000	20,000	59,000
1.02	40	150	1,100	5,714	20,150	59,905
2	44.73	178	1,150	5,900	21,300	68,000
2.04	45	179.5	1,264	6,000	22,500	70,000
3.07	46	180	1,375	6,500	23,300	75,000
3.25	49	210	1,400	7,000	25,000	79,012
3.7	52	220	1,490	7,300	26,667	80,000
3.87	55.1	230	1,500	8,000	30,000	90,000
5.24	60	235	1,573	8,500	31,500	92,000
5.26	61	240	2,230	8,800	32,700	100,000
5.89	65	250	2,250	8,909	32,888	120,000
7.6	66	260	2,500	9,000	33,000	140,000
8	66.6	270	2,850	10,000	33,300	180,000
10.58	69	286	3,330	12,000	35,888	
11.1	70	290	3,400	13,333	36,000	

PRECISION RESISTORS—1 WATT—45¢

.1	2.5	18	80	1,000	5,400	35,000
.11	2.55	25	112.8	1,500	7,000	37,000
.147	2.58	27.4	206	1,800	7,800	40,000
.2	2.6	28	215	1,900	8,000	45,000
.31	2.66	30	250	2,200	8,250	50,000
.4	3.1	35	270	2,215	9,000	55,000
.861	3.39	38	300	2,250	10,000	56,000
1.01	4.29	43.6	312	2,413	12,000	60,000
1.106	4.3	45.5	321.7	2,500	12,420	65,000
1.17	5.21	49.75	400	3,300	12,500	68,000
1.21	10.5	54.25	420	3,800	15,000	70,000
1.25	12.8	60	425	5,000	18,000	80,000
2	15	71	565	5,221	20,000	84,000
						95,000

PRECISION RESISTORS—1 WATT—60¢

100,000	200,000	320,000	400,000	645,000
105,000	220,000	340,000	413,000	650,000
120,000	250,000	348,000	520,000	700,000
132,000	260,000	350,000	522,000	750,000
145,000	270,000	375,000	550,000	876,457
149,000	296,000	376,000	560,000	
166,100	300,000	390,000	590,000	
175,000	310,000	399,000	600,000	

1 MEGOHM 1 WATT 1%—$1.50; 5%—60¢

PRECISION RESISTORS—2 WATT—75¢

4,385 5,000 6,000 10,000 23,000

UNIVERSAL JOINTS

3/16" hole x ⅜ O.D. 1-⅛" long— steel or aluminum **50¢**
1/4" hole x 1/2 O.D. 1-⅛" long— aluminum only **75¢**

OIL FILLED

MFD	V.D.C.	Price	MFD	V.D.C.	Price
.125	35,000	$35.95	.3	2,000	$1.75
.125	27,000	28.95	.1-.1	2,000	1.65
.1	25,000	25.95	.02	2,000	.79
.25	20,000	19.95	2	1,500	1.79
.15-.15	8,000	2.75	1	1,500	1.50
.02	8,000	1.89	6	1,000	2.25
.1	7,500	1.95	3	1,000	1.59
.05	7,500	1.75	2	1,000	.90
.03	7,500	1.69	1.02	1,000	.65
.1-.1	7,000	1.98	1	1,000	.65
.1	7,000	1.85	7	800	1.98
.02-.03	7,000	1.40	1	800	.55
1	6,000	5.95	8-8	600	1.59
.1	6,000	2.75	8	600	2.05
.03-.03	6,000	1.35	7	600	1.75
.01-.03	6,000	1.35	4	600	1.63
2	5,000	5.95	4 x 3	600	1.95
.25	5,000	2.95	2	600	.69
2	4,000	4.95	2 x 2	600	1.40
.3 x .2	4,000	2.50	1	600	.49
.1	4,000	2.25	8	500	1.55
.06	4,000	1.45	4	500	.98
.1	3,500	1.95	4	200	.39
.25	3,000	2.25			
8	2,000	4.95			
6	2,000	4.65			
4	2,000	4.25			
3	2,000	3.75			
2	2,000	2.95			
.5-.1	2,000	1.95			
.5	2,000	1.95			

2 mfd 4,000 V.D.C. G.E. $4.95

OIL FILLED A.C. CONDENSORS

MFD	V.A.C.	Price
.2	750	$.69
8	660	4.95
6	660	4.95
5	660	4.50
4	660	4.25
2	660	3.25
1	660	2.35
28	440	6.95
15	440	4.95
6	440	3.50
5-3	440	3.95
4.4	375	2.15

MFD	V.A.C.	Price
30	330	$6.50
25	330	5.95
20	330	5.50
15	330	4.50
10	330	3.95
6	330	2.95
4	330	1.95
3	330	1.25
2.5	330	.98
2	330	.65
10	220	2.95

IN34 Crystal Diode...............................79¢
Neon Glow Lamp NE 16...25¢ ea. $20 per 100. $175 per M.
300 Twin Lead...............02½ per ft. $18.95 per M
Dynamotor DM 33A...............................$3.75 ea.
Chokes: 30 Hy. 8MA @ ....$1.29; 6 Hy. 8MA @....78¢
Minimum Orders $3........All orders f.o.b. PHILA, PA.

RELIANCE MERCHANDIZING CO.

Arch St. Cor. Croskey Phila. 3, Pa. Telephone RIttenhouse 6-4927

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 Tuning units TN-16 (38-95 MC) TN-17 (76-300 MC) TN-18 (300-1000 MC), TN-19 (950-2200 MC).
R111A/APR-5A Receivers. 1000 to 6000 MC.

MODEL AN/APA-10 PANORAMIC ADAPTER

Designed for use with receiving equipment AN/ARR-7, AN/ARR-5, AN/APR-4, SCR-587 or any receiver with I.F. of 455 kc. 5.2mc. or 30 mc. With 21 tubes including 3" scope tube. Converted for operation on 115 V. 60 cycle source.
PRICE $245.00
AN/APA-10 80 Page Tech Manual..........$2.75

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. Less batteries. Write for descriptive circular.... $69.50

SWEEP GENERATOR CAPACITOR

High speed ball bearings. Split stator silver plated coaxial type 5/10 mmfd. Brand new........$2.50

BC-348 RECEIVER PARTS
for Models C, E, H, K, L, M, P, R.

Dial Mechanism assemblies. 1st, 2nd, 3rd, 4th I.F. transformers. C. W. osc. and xtal filter trans. with xtals. All R.F. coils. Front panels. Shock mounts. Large quantity misc. hardware sub assemblies, etc. Write your requirements.

MISCELLANEOUS EQUIPMENT

TS-127/U Lavoie Freq. Meter—375 to 725 MC.
TS-47 APR Test Set—40 to 500 MC.
213-A DuMont C. R. Modulation Monitor.
BC1203 APN-4 Test Set.
6255A H.P. Interpolation Osc.
TS-487/U Peak to Peak VTVM.

G. E. SERVO AMPLIFIER

Type 2CV1C1 Aircraft Amplidyne control amplifier, 115 volts—400 cycles. Dual channel. Employes 2-6SN7GT and 4-6V6GT tubes. Supplied less tubes. New $22.50

LINEAR SAWTOOTH POTENTIOMETER
W.E KS-15138

Has continuous resistance winding to which 24 volts D.C. is fed to two fixed taps 180° apart. Two rotating brushes 180° apart take off linear sawtooth wave voltage at output. Brand New....$5.50

8,000-VOLT TRANSFORMERS

Primary: 115 V., 60 cycles.
Secondary: 8000 V., C.T., 800 V.A.

Brand new in sealed cans.... $27.50

CRYSTAL DIODE

Sylvania 1N21B. Individually boxed and packed in leaded foil. Brand new....................$4.25

SYNCHRO DIFFERENTIAL GENERATOR

Ford Inst. Co. Type 5SDG. Brand New....$22.50
Electrolux Torque Motor..................$16.50

MOTOR GENERATORS

2.5 KVA Diehl Elec. Co. 120V D.C. to 120V A.C. 60 cy. 1Ph., .4PF. Complete with Magnetic Controller, 2 Field Rheos and Full Set of Spare Parts including Spare Armatures for Generator and Motor. Full spec. on request. New........$285.00
2 KVA O'Keefe and Merritt. 115V DC to 120V AC, 50 cy. Idles at 3 Ph. syncs motor on 208V, 50 cy. New. Export crated..................$165.00
1.25 KVA Allis-Chalmers. 230 DC to 120 AC, 60 cy, 1 Ph. Fully enclosed. Splashproof, Ball Bearings, centrifugal starter. New, complete with kit of Spare parts $175.00
M.G. 164, Holtzer-Cabot Motor: 440V, 3Ph, 60 cy., .90A, 1/3HP, 1750 RPM. Generator: 70V, 3Ph, 146 Cy., .140KVA. Exciter: 115DC, 1A. New...$67.50
Type CG-21302. 440V AC, 60 cy, 3Ph, 1500 VA to 875 DC and 300V DC. New...............$69.50

INVERTERS

Onan MG-215H. Navy type PU/13. Input 115/230. 60 cy, 1 Ph. Output 115, 480 c. 1 Ph. 1200W and 26V DC at 4 amps. New...................$295.00
G.E. Model 5D-21NJ3A. Input: 24V, DC, Output: 115V, 400 cy., 485 Va. New...............$29.50
Leland Elec. Co. Model PE206A. Input: 28V. DC. 38 Amps. Output, 80V., 800 cy, 485 VA. New $22.50
G.E. J8169172. Input: 28V. DC, Output: 115, 400 cycles at 1.5 KVA.........................$32.50

DYNAMOTORS

Navy-Type CAJO-211444, 105/130V DC to 13V DC at 40A or 26V DC at 20A. Radio Filtered. Complete with Line Switch. New..............$89.50
Eicor. 64V DC to 110V AC, 60 cy. 1 Ph. 2.04 Amps. New $24.50
Eicor. 32V DC to 110V AC, 60 cy, 1 Ph, 0.43 Amps. New $22.50
Type PE94C. For use with SCR522 Transmitter-Receiver. Brand new in export cases........$15.00
Carter 6V DC to 400V DC at 375 mils. New..$39.50

AMPLIDYNES

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 $34.50
Edison type 5AM31NJ18A. Input: 27 volts, 44 Amps., 8300 RPM. Output: 60V DC at 8.8 amps. 530 Watts. New..........................$22.50

SMALL D.C. MOTORS

G.E. Model 5BA50LJ2A. Armature 27V D.C. at 8.3A. Field 60V DC at 2.3A. RPM 4000. H.P. 0.5. New $27.50
Electrolux Corp. of Canada. P/O vent fan assembly for SCR-602-T6. 1/35HP, 28.5V, 2.15 amps., 2200 RPM. Price.......................$16.50
Oster type E-7-5, 27.5V, 1/20HP, 3650 RPM. Shunt wound. Price......................$15.00
Dumore Co. Type EBLG, 24V DC, 40-1 gear ratio, for use with type B-4 Intervalometer. Price $17.50

RADAR ANTENNAS

Type SO-1 (10CM.) Complete assembly with reflector, waveguide nozzle, drive motor and synchros, etc. New in original cases..............$279.50
Type SO-3 (3 CM.) Surface Search type complete with reflector, drive motor, synchro, etc., but less plumbing. New in original cases..........$189.50
Type SO-13 (10CM.) Complete assembly with 24" dish with feedback dipole. Complete with synchros, drive motor, gearing, etc. New in original cases $149.50
Also in stock—spare reflectors, nozzles, probes, right angle bends for SO-1 antennas.

400 CYCLE TRANSFORMERS

AUTO. 400 cy. G.E. Cat No. 80G184. KVA .945S—520P. Volts 460/345/230/115. New. $4.95
FILAMENT. 400/2600 cy. Input: 0/75/80/85/105/115/125V. Output: 5V3A/5V3A/5V3A/5V3A 5V6A/5V6A/6.3V6A/6.35A. New $2.95
THYRATHRON POWER. 400/1600 cy. Raytheon UX-8876, 400/1600 cy. Pri: 115, Sec: 50-0-50V at 1.5A, 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
Plate. Thordarson #T46889. 1650 VA. Pri: 105-120V. 500 cy. 1 PH. Sec: 5600V. Center tapped. 1.5KV insulation. Brand new.............$49.50
PLATE & FIL. WECO KS9555, 400 cy. Pri: 115V. Sec #1: 930-0-930. Sec #2: Three 6.3V windings $3.95
FILAMENT. 400/2400 cps. WECO KS9553. Pri: 115V. Sec: 8.2V1.25A/6.35V1.5A Elecstat shdld. Wt. 0.5 lbs. New.........................$1.95
PLATE & FIL. 400/2600 cy. Pri: 0/80/115V. Sec: #1=1200VDC at 1.5MA. Sec. #2=400VDC at 130MA. Fil. Secs: 6.4V4.3A/6.35VO.8A (ins. 1500V)/5V2A/5V2A $4.95
RETARD. 400 cy. WECO KS9598. 4 Henry 100MA. $1.75

60 CYCLE TRANSFORMERS

FILAMENT. Raytheon Hypersil Core. Pri: 115V. Sec: 6.3V22A/6.3V2.4A/6.3V2.25A/6.3VO.6A Ins for 1700V $5.95
High Rectance 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 $69.50
High Voltage Trans. Westinghouse Pri: 115, 60 cy. Sec: 15,000 C.T., 60 MA. Good for Hi-Pot test set up. C. T. ungrounded....................$29.50

PULSE TRANSFORMERS

PULSE. WECO KS-9563. Supplies voltage peaks of 3500 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 =.082H at 100 cps.....$5.00
PULSE. WECO KS-161310, 50 KC to 4MC. 1¾" Dia. x 1⅞" high, 120 to 2350 ohms. New....$1.95

RAYTHEON VOLTAGE REGULATOR

Adj. input taps 95-130V., 60 cy. 1 Ph. Output: 115V., 60 Watts, ½ of 1% Reg. Wt. 20 lbs. 6⅜" H x 8¼" L x 4⅝" W. Overload protected. Sturdily constructed. Tropicalized. Special..........$14.75

HIGH VOLTAGE CAPACITORS

.25 MFD., 20KV	$26.50
.25 MFD., 15KV	22.50
.5 MFD., 25KV	34.50
1 MFD., 15KV	34.50
1 MFD., 7.5KV	12.50

SOUND POWERED 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 $10.00
U. S. Instrument Co. No. A-260. Complete with 20' cable and plug. Brand new............$13.50
W. E. type TS-10M Handset. New..........$16.50

PARABOLOIDS

Spun Magnesium dishes 17½" dia. 4" deep. Mounting brackets for elevation and azimuth control on rear. 1½ x 1⅝" opening in center for dipole. Brand new, per pair............................$8.75

WESTERN ELECTRIC CRYSTAL UNITS

Type CR-1A/AR. Available in quantity—following frequencies—fundamentals.
5910—6450—6370—6470—6510—6610—6670—6690—6940—7270—7350—7380—7390—7480—7580—9720—Kilocycles.

$1.25 each

All prices indicated are F O B Bronxville, New York. Shipments will be made via Railway Express unless other instructions issued.

ELECTRONICRAFT
INC.
27 MILBURN ST. BRONXVILLE 8, N. Y.
PHONE: BRONXVILLE 2-0044

All merchandise guaranteed. Immediate delivery, subject to prior sale.

All Prices Subject to Change Without Notice

PULSE EQUIPMENT

MIT. MOD. 3 HARD TUBE PULSER: Output Pulse Power 144 KW (12 KV at 12 Amp). Duty Ratio: .001 max. Pulse duration: 5, 1.0, 2.0 microsec. Input voltage: 115 v 400 to 2400 cps. Uses: 1-715B, 4-829-B, 3-'72's, 1-'73. New......$110.00

APQ-13 PULSE MODULATOR. Pulse Width .5 to 1.1 Micro Sec. Rep. rate 624 to 1348 Pps. Pk. pwr. out 35 KW. Energy 0.018 Joules..........$49.00

TPS-3 PULSE MODULATOR. Pk. power 50 amp. 24 KW (1200 KW pk): pulse rate 200 PPS. 1.5 microsec. pulse line impedance 50 ohms. Circuit—series charging version of DC Resonance type. Uses two 705-A's as rectifiers. 115 v. 400 cycle input. New with all tubes..............$49.50

APS-10 MODULATOR DECK. Complete, less tubes $75.00

PULSE NETWORKS

15A—1-400-50: 15 KV, "A" CKT. 1 microsec 400 PPS. 50 ohms imp..........$42.50

G.E. #6E3-5-2000-501P2T, 6KV "E" circuit, 3 sections .5 microsecond, 2000 PPS, 50 ohms impedance..........$6.50

G.E. #3E (3-84-810) (8-2.24-405) 50P4T: 3KV "E" CKT Dual Unit: Unit 1, 3 sections, 84 Microsec. 810 PPS, 50 ohms imp.: Unit 2, 8 Sections, 2.24 microsec. 405 PPS, 50 ohms imp..........$6.50

7.5E3-1-200-67P. 7.5 KV, "E" Circuit, 1 microsec. 200 PPS, 67 ohms impedance, 3 sections....$7.50

7.5E4-16-60.67P, 7.5 KV, "E" circuit, 4 sections 16 microsec. 60 PPS, 67 ohms impedance......$15.00

7.5E33-200-6FT, 7.5 KV, "E" Circuit, 3 microsec 200 PPS, 67 ohms imp. 3 sections..........$12.50

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 1/microsec. @ 600 PPS..........$39.50

W.E. #166173 Hi-Volt input transformer, W.E. impedance ratio 50 ohms to 900 ohms. Freq. range: 10 kc to 2 mc, 2 sections parallel connected, potted in oil..........$36.00

W.E.-KS 9800 Input transformer, Winding ratio between terminals 3-5 and 1-2 is 1.1:1, and between terminals 6-7 and 1-2 is 2:1. Frequency range: 380-520 c.p.s. Permalloy core..........$6.00

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

Ray. UX 7896—Pulse Output Pri. 5v, sec. 41v..$7.50

Ray UX 8442—Pulse Inversion:—40v + 40v....$7.50

RAY UX 7350—PRF 1 MC .05 microsec......$5.00

UTAH NUMBERS

9332 9340 9278

DELAY LINES

D-168184: .5 microsec. up to 2000 PPS, 1800 ohm term..........$4.00

D-170499: .25/.50/.75. microsec. 8 KV. 50 ohms imp..........$16.50

D-165997: 1¼ microsec..........$7.50

VARISTORS

D-167176	$ .95
D-172155	$2.25
D-172307	$1.70
D-168687	$ .95
D-171812	$ .95
D-171528	$ .95
D-162356(308A)	$1.50

THERMISTORS

D-166288	$1.50
D-167332 (tube)	$1.50
D-170396 (bead)	$1.50
D-167613 (button)	$1.53
D-164699 for MTG "X" band Guide	$2.50

PRECISION RESISTORS

1.01	128	2230	30000
3	150	4300	33000
5	200	5000	35000
5.05	250	7500	40000
10.1	300	8500	50000
18	430	10000	55000
43.5	468	12000	57000
50	800	17000	75000
75	920	17300	We ship
82	1000	20000	type in
120	1100	25000	stock
125	1450		

Above Ea....30¢ Ten For..........$2.50

100000	150000	200000
120000	170000	220000

Above Ea....40¢ Ten For..........$3.50

1,000,000 ohms..........Each 75¢

OIL CONDENSER

Mfd.	Volt.	Price
5	50	$0.45
650	80	1.95
15	220 AC	2.20
1	500	.40
0.5	750 AC	1.59
0.5	1000	.69
2x0.5	1000	.70
1	1000	.75
1.5	1000	.85
2	1000	.90
4	1000	1.75
3x.01	1200	1.35
1	1500	1.30
1.5	1500	1.40
2	1500	1.45
2x0.1	2000	1.10
0.15	4000	1.20
2x0.1	4800	1.20
0.1	6000	2.39
1.5	6000	17.50
2x0.1	7000	1.75
.015	16000	3.95
.0016	15000	5.95
.25	20000	
1	25000	
.5	25000	
1	7500	

MANY OTHERS

SELSYN TESTER

Magnesyn Instrument Field Tester AAF 43G-23330 Spec. 40772 To test individual mag. Ind. & Xmitters, for isolating Faults in magnesyn systems. Brand new. $125.00

COAX CABLE

RG 8/U, 52 ohm

RG 9/U, 52 ohms

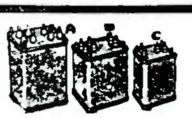
RG 57/U, Twin Cond. 95 ohms

RG 23/U, twin coax. 125 ohm imp. armored

RG 28/U, 50 ohm imp. pulse cable Corona min. starting voltage 17 KV.

RG 35/U, 70 ohm imp. armored

Many other Cables & Wire in stock. Write



TRANSFORMERS

These XFRMRS are Army Spec. All Underrated.

PRIMARIES 115V, 60 CYCLE

FILAMENT TRANSFORMERS

Stock #	Rating	Price
FT 104	6V/5A	$4.78
FT 924	5.25V/21A, 2x7.75V/6.5A, 2x26V/2.5A	17.95
FT 824	16V/1A, 7.2V/7A, 6.4V/10A, 6.4V/2A, 2x26V/2.5A	12.95
FT 357	9VCT/45A	14.75
FT-781	866 Trans. 2 x 2.5/5A	2.25
FTG-31	2.5V/2.5, 7V/7A (Tape @ 2.5V/2.5A), 16 lbs.	9.95
FT-674	8.1V/1.5A	1.10
FT-157	4V 16A, 2.5V/1.75A	2.95
FT-101	6V/.25A	.79

PLATE TRANSFORMERS

Item	Rating	Each
PT-976	Auto: 120VCT/10 MA	$0.69
PT-31A	2 x 300V/5 MA	.79
PT-033	4150V/400 MA 11½ x 9¼ W x 9" D 70 lbs.	49.95
PT-75-2	3780/3446/3112VCT/77 MA	10.95
PT-28-1	4600VCT/.077	12.95
PT-403	Auto: 70V/1A	2.29
PT-160	1120VCT 770 MA, 590VCT/82 MA, 25 lbs.	24.95
PT-170	Auto: 156/146/137/128—.71A	3.29
PT-31A	2 x 300V/5 MA	.79
PT-976	120VCT/10MA	.79
PT-12A	280VCT/1.2A	2.95
PT 919	1200—0—1200 200 MA	8.95

SPECIAL FIL. TRANSFORMERS

Item	Pri.	Output	Price
STF-946	210/220/230	25V 4A 3½" H x 2¼" x 2¼" D	$1.29
STF-443	220/440	11VCT 125A 6½" L x 6¾" x 8" 15 lbs.	15.95
STF-638	230	5V 9A 5½" H x 4½" x 3¾"	1.25
STF-054	115 230	2 x 5V/7.57" H x 7" x 5" D	4.25
STF-682	220	30-25-20V/1 MA	.69
STF-968	230	2.5V/6.5A	1.10
STF-405	230/115	5V 12/9A	2.95
STF-370	220/440	3 x 2.5V/57, 2.5V/15A, 5½ x 5 x 4½	5.25
STF-619	110/220	2.5V/500A, 7 x 5¾ x 5	19.95
STF-11A	220	2 x 40V/.05/2 x 5V/6A, 12.6/1A	2.95
STF-631	230	2 x 5V 27A 2 x 5V/9A, 103 4H x 5 x 7 30 lbs.	24.95
STF-96B	230	2.5V/6.5A	1.95
STF-608	220	24V/600, 5V/2A, 2 x 6.3V/1A	2.25
STF-45A	43/78/90 115/180/230	2 x 2.5 6.5. 6.3V/4 ? Few	3.25
STF-306	100/120 200/240	5VCT 10 amp 10000 VCT	3.95

SPECIAL PLATE TRANSFORMERS

Item	Pri.	Output	Price
STP-945	210/20/30	1100VCT/300 5¼ x 4 x 3½	$5.95
STP-444	230/460	230 105/115/125/ 15 lbs. 5¾ x 6 x 4½	14.95
STP-613	230V	2 x 230/.05	1.29
STP-823	137V	222VCT/300 MA	2.95

400 CYCLE TRANSFORMERS

Stock #	Ratings	Price
901699-501	2.77V @ 4.25A	$3.45
901698-501	900V/75 MA, 100V/.04A	4.29
UX8855C	900VCT/.067A, 5V/3A	3.79
RA6405-1	800VCT/65MA, 5VCT/3A	3.69
T-48852	700VCT/80 MA, 5V/3A, 6.3V/1.75A	4.25
352-7098	2500V/6MA, 300VCT, 135 MA	5.95
KS 9336	1100V/50MA, TAPPED 625V 2.5V/5A	3.95
M-7474319	6.3V/2.7A, 6.3V/.66A, 6.3VCT/21A	4.25
KS 8984	27V/4.3A, 6.3V/2.9A, 1.25V/.02A	2.95
52C080	526VCT/50MA, 6.3VCT/2A, 5VCT/2A	3.75
32332	400VCT/35MA, 6.4V/2.5A, 6.4V/.15A	3.85
68G631	1150-0-1150V	2.75
80G198	6VCT, .00006 KVA	1.75
D-167254	6.4V/8A, 6.4V 1A	2.79
302433-A	6.3V/9.1A, 6.3VCT/6.5A, 2.5V/3.5A, 2.5V/3.5A	4.85
KS 9445	592VCT/118MA, 6.3V/8.1A, 5V/2A	5.39
KS 9685	6.4V/7.5A, 6.4V/3.8A, 6.4V/2.5A ALL CT	4.79
70G30G1	600 VCT/36 MA	2.65

FILTER CHOKES

Stock #	Description	Price
CH 776	1.28 H/130 MA/75 ohms	$2.25
CH 344	1.5 H/145 MA/1200V Test	2.35
CH 905	.257 H/2 ADC/DCR — 2.24 ohms	4.79
CH 854	1 HY/80 MA	1.29
CH 43A	10 HY/15 MA—850 ohms DCR	1.75
CH 999	15 HY/15 MA—400 ohms DCR	1.95
CH 511	6 H/80 MA—310 ohms DCR	2.45
CH3-501	2x.5H/400 MA	2.79

AUDIO TRANSFORMERS

AT070 Mike-or-Line (250 ohms) to grid (250,000 ohms C.T.)..........1.29

AT765 Mike-or-Line (600 ohms) to grid (50,000 ohms C.T.)..........89

AUDIO TRANSFORMERS—Cont.

AT449 Hi-FI Driver (5000 ohms) to P.P. output grids (4,000 ohms) 100-10,000 CY. 10 W. 6V6 to PP 805's..........2.39

AT666 Intercom Input: Spkr (-4-8 ohms) to grid (250,000 ohms)..........69

AT415 Plate (18,000 ohms C.T.) to line (125 ohms) 175 w.—500-600 CY..........1.95

AT858 Plate (10,000 ohms C.T.) to line V.C. (500/125/30 ohms) HI-FI—50 W..........6.95

DYNAMOTORS

Type	Input Volts	Input Amps.	Output Volts	Output Amps.	Radio Set
PE86	28	1.25	250	.060	RC 36
DM416	14	6.2	330	.170	RU 19
DM33A	28	7	540	.250	BC 456
DM 42	14	46	515	.110	SCR 506
			1030	.050	
			2/8		
PE101C	13/26	12.6	400	.135	SCR 515
		6.3	800	.020	
BD AR 93	28	3.25	375	.150	
23350	27	1.75	285	.075	APN-1
ZA0515	12/24	4/2	500	.050	
B-19 pack	12	9.4	275	.110	MARK II
			500	.050	
D-104	12		225	.100	
			440	.200	
DA-3A	28	10	300	.060	SCR 522
			150	.010	
			14.5	.5	
5053	28	1.4	250	.060	APN-1
PE73CM	28	19	1000	.350	BC 375
CW21AAX	13	12.6	400	.135	
	26	6.3	800	.020	
			9	1.12	
PE94	28	10	300	.200	SCR 522
			150	.101	
			14.5	.5	

INVERTERS

PE 218-E: Input: 25 28 vdc. 92 amp. Output: 115 v. 350-500 cy 1500 volt-amperes. Dim: 17"x6½"x10". New..........$49.50

PE-218-H: Same as above except size: 16½"x6"x10". New..........$49.50

PE-206: Input: 28 vdc. 38 amps. Output: 80 v 800 cy. 500 volt-amps. Dim: 13"x5½"x10½". New.

MICROWAVE TUBES

MAGNETRONS

Tube	Frq. Range	Pk. Pwr. Output
2J27	2965-2992 mc.	275 KW
2J31	2820-2860 mc.	265 KW
2J21-A	9345-9405 mc.	50 KW
2J22	3267-3333 mc.	265 KW
2J26	2992-3019 mc.	275 KW
2J32	2780-2820 mc.	285 KW
2J38 Pkg.	3249-3263 mc.	5 KW
2J39 Pkg.	3267-3333 mc.	87 KW
2J49	9000-9160 mc.	58 KW
2J61	3000-3100 mc.	35 KW
2J62	2914-3010 mc.	35 KW
3J31	24,000 mc.	50 KW
5J30		
718DY	2720-2890 mc	250 KW
720BY	2800 mc.	1000 KW
725-A	9345-9405 mc.	50 KW
730-A	9345-9405 mc.	50 KW

700 A, B, C, D

706 AY, BY, DY, EY, FY, GY

KLYSTRONS

723A 723A/B—2K25—726A 707

"CW" MAGNETRONS

QK 62 3150-3375 mc.

QK 59 2675-2900 mc.

QK 61 2975-3200 mc.

QK 60 2800-3025 mc.

CR—TR—PULSE TUBES

705A	721	3EP1
3DP1	3FP7	5J30
3GP1	5CP1	15R

MANY OTHER TYPES AVAILABLE. SEND YOUR REQUIREMENTS.

TEST SETS

TS 102/AP
TS 62/AP
TS 36/AP
TS 12 UNIT 2
Q. METER
TS 69/AP
TS 33/AP
CW60-ABM
LU-1
LU-3
TS 159
TS 226
TS 250/APN
TS 89
I-203-A
TS 11/AP
BC 438
CS60-ABW
I-158
I-222
I-185
TS 268/U

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UP TO 18 VAC IN—UP TO 14 VDC OUT

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12A	9.00
24A	18.00

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12A	18.00
24A	36.00

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24v-1.5A..........1.95

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10 CM RESEARCH EQUIPMENT

Coaxial Wavemeter, W.E. Transmission Type, using type "N" fittings. Calibrated between 3400-4500 MC $99.50
LHTR. LIGHTHOUSE ASSEMBLY Part of RT39 APG 5 & APG 15 Receiver and Trans Cavities w/assoc Tr. Cavity and Type N CPLG. To Recvr. Uses 2C40, 2C43, 1B27. Tunable APX 2400-2700 MCS. Silver Plated $49.50
BEACON LIGHTHOUSE cavity 10 cm. Mfg. Bernard Rice .... $47.50 ea.
MAGNETRON TO WAVEGUIDE Coupler with 721 Duplexer Cavity, gold plated $45.00
SIGNAL GENERATOR using 417A klystron, 2700-3300 mc. Output approx. 50 mw. 115 vac power supply. With tubes, new $425.00
REGULATED POWER SUPPLY for GL, 446 type lighthouse tubes (2C40, etc.) 115 vac, 60 cycles. Panel Mounting. Less tubes $32.50
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RT-39/APG-5 10 cm. lighthouse RF head c/o Xmtr.-Recvr-TR cavity compl. recvr & 30 MC IF strip using 6AK5 (2C40, 2C43, 1B27 lineup) w/Tubes.
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TS 268 CRYSTAL CHECKER $35.00
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RIGHT ANGLE BEND, with flexible coax output pick-up look $8.00
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FLEX COAX SECT. Approx. 30 ft $16.50

1.25 CM RESEARCH EQUIPMENT

Complete 24,000 MC RF Head, including 2K33 Klystron, 3J31 Magnetron and Magnet, all plumbing, and associated circuitry, in standard A-N Pressurized housing. New, $1100.00.
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
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TR-ATR-Section. Choke to cover $4.00
Flexible Section 1" choke to choke $5.00
"S" Curve Choke to cover $4.50
Adapter, round to square cover $5.00
Feedback to Parabola Horn with pressurized window ... $27.50
90° Twist $10.00
"K" Band Directional Coupler .... $49.50 ea.

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QCU Magneto striction head RCA type CR 278225—New $95.00
Stainless Steel streamlining housings for above $18.50
QBG Driver Amplifier, New $200.00
QCU Magneto striction head, coil plate assembly, new .. $14.50
QCQ-2/QCS Magneto striction head coil plate assembly .. $14.50
QCG2 Sonar complete set—Write for details.
QC-RCA magneto striction head assy. consists of coil, plate, nickel diaphragm plate, milled steel body unassembled **$65.00**
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QBF Sonar mfg. WE complete console consists of 10-40 kc rec. driver osc. ind. & control unit, and driver amplifier 22-28 kc. Write.
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3cm Research Equipment 1" x ½" WAVEGUIDE

1" x ½" **Waveguide** in 5' lengths, UG39 flange to UG40 cover, silver plated .... $7.50 per length
Rotating Joint supplied either with or without deck mounting.
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TS-268 Crystal Checker $35.00
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Pressure Gauge Section 15 lb. gauge and press nipple $10.00
Pressure Gauge, 15 lbs $2.50
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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, type "N" take off 20 DB calibrated $17.50
2K25/723 AB Receiver local oscillator Klystron Mount, complete with crystal mount. Iris coupling and choke coupling to TR $22.50
TR-ATR Duplexer section for above $8.50
CU 105/APS 31 Directional Coupler 25 DB $25.00
723AB Mixer—Beacon dual Osc. Mut. w/xtal holder $12.00
Waveguide Section 12" long choke to cover 45 deg. twist & 2½" radius, 90 deg. bend $4.50
Twist 90 deg. 5" choke to cover w/press nipple $6.50
Waveguide Sections 2½ ft. long silver plated with choke flange $5.75
3 cm. mitred elbow "E" plane unplated $12.00
UG 39 flanges 85c
UG 40 chokes $1.00
90 degree elbows #E or H plane 2½" radius $12.50
90 degree twist 6" long—UG39 to UG 40 .... $8.00
45 degrees twist $8.00
40KW X Band radar, complete as described and illustrated in July, 1951, Electronics.—APS-4 under belly assembly, less tubes $375.00

1¼" x ⅝" WAVEGUIDE

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Low Power Termination $25.00
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Trailer, consisting of a complete low frequency radio range installation, including portable tower, gasoline generator, communications equipment. This unit is standard and approved. Write for details and price.

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APS-4, Airborne, 3 CM, Compl.
APS-15, Airborne, 3 CM, Major Units, New
SD-4, Submarine, 200 MC, Compl., New
SE, Shipboard, 10 CM, Compl., New
SF-1, Shipboard, 10 CM, Compl., New
SJ-1, Submarine, 10 CM, Compl., Used
SL-1, Shipboard, 10 CM, Compl., Used
SN, Portable, 10 CM, Compl., Used
SQ, Portable, 10 CM, Compl., Used
SO-1, Shipboard, 10 CM, Compl., Used
SO-7, Portable, 10 CM, Assault
SO-8, Shipboard, 10 CM, Compl., Used
Mark 4, Gunlaying, 800 MC, Less Ant., Used
Mark 10, Gunlaying, 10 CM, Compl., New
CPN-3, Beacon, CM, Major Units, Used
CPN-8, Beacon, 10 CM, Compl., New Less Ant., New
SCR-533, IFF/AIR, 500 MC, New
Airborne Radar Altimeter, 500 MC, Compl., New
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TS 56-A/AP EQUIPMENT

Frequency Range and Characteristic Impedance—The Model TS-56A/AP Slotted Line is designed for operation over a frequency range of 360 to 675 megacycles. The slotted line has a characteristic impedance of 51 ohms.

Indicator—The indicator consists of a detector and meter which when mounted on the slotted line indicates the voltage along the line.

Slotted Line—The slotted line has been designed to have a 51 ohm characteristic impedance by making the ratio of the inside diameter of the outer tube to the diameter of the inner rod equal to 2.342 with air as a dielectric. However, the ratio has been increased at the sections containing polystyrene spacers in order to compensate for the change in dielectric.

Since the length of the slot is 41.9 centimeters, no wave of wavelength greater than two times 41.9 centimeters can be used on the slotted line. This wavelength corresponds to a frequency of 358 megacycles. The slotted line has no upper frequency limit. However, the frequency limits of the complete unit are set by tuning range of the indicator box.

Indicator—The indicator is divided into two separable units; the meter box and the resonator box. The meter box contains the meter, battery and all wiring. The resonator box contains the 957 tube, the probe and the tuning condenser in the resonant chamber.

The frequency limit as set by the resonant cavity of the indicator box 340-690 megacycles.

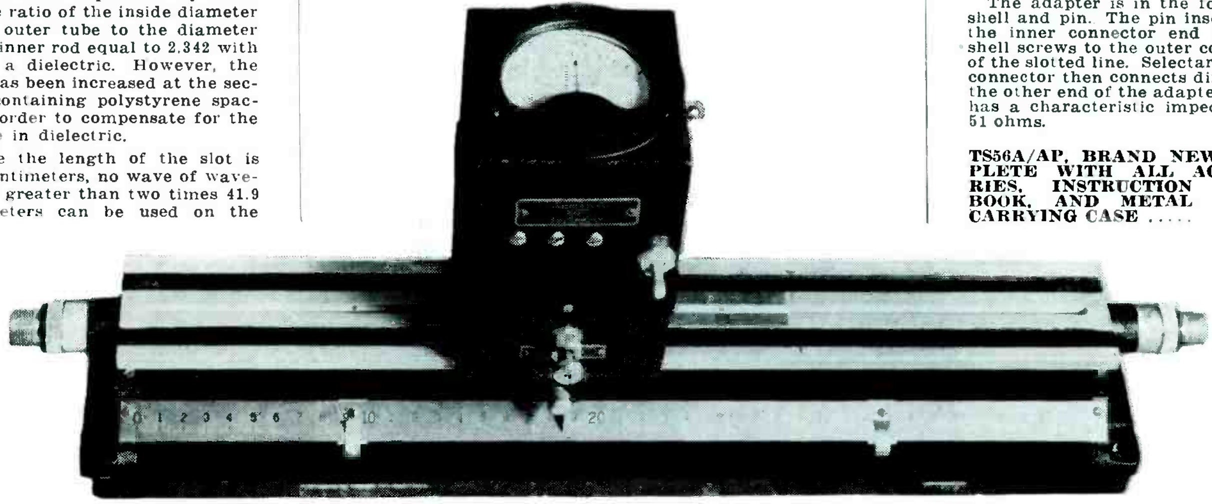
Cable—The cable supplied is the RG-8/U co-axial cable terminated by two Amphenol 93-M connectors. The nominal characteristic impedance of the cable is 52 ohms. The dielectric is stabilized polyethylene and the normal overall diameter is 0.405 inches.

The Amphenol 93-M connectors are provided with a special insert which is in the form of a shell that makes contact with the braid and the 93-M connector. The insert maintains the cable in on position and also provides electrical continuity between the slotted line and the cable.

Adapters—Two "Amphenol to Selectar" adapters are provided for use with an Amphenol 93-F connector (on end of slotted line) and a Selectar C-49195 connector. To connect a cable with a Selectar C-49195 connector to the end of the slotted line, the adapter must be used.

The adapter is in the form of a shell and pin. The pin inserts into the inner connector end and the shell screws to the outer conductor of the slotted line. Selectar C-49195 connector then connects directly to the other end of the adapter, which has a characteristic impedance of 51 ohms.

TS56A/AP, BRAND NEW, COMPLETE WITH ALL ACCESSORIES, INSTRUCTION BOOK, AND METAL CARRYING CASE $325



RC 145 IFF GROUND STATION EQUIPMENT

RC 145 includes:
Receiver and Transmitter BC 1267A;
Power Unit RA 105A;
and Indicator Panel 1-221A.

The 8 tube transmitter delivers 1 KW peak power between 157-187 mc. using PP 2C26 tubes, an 829 modulator, and several pulse forming and clipping tubes. There is plenty of room to install crystal oscillator, multipliers and modulators. The lecher line **plate circuit** and antenna coupler are adjustable from the front panel. Both receiver and transmitter can be matched independently to the antenna in use by adjustments on the front panel. The dials are not calibrated in frequency.

The receiver is a **13 tube superhet**, as follows: RF stage—6AK5; RF stage 6AK5; Mixer—6AK5; H. F. Osc.—6C4; Five IF Stages—6AG5; Second Det.—6H6; Tuning Eye—6E5; Video Amp.—6AG5; Cathode Follower—6AG5.

The I.F. frequency is 11 mc. and is stagger tuned to bandwidth of 4 mc. Power is supplied to the receiver from the main power supply. There is a jack for audio output from the second detector. Receiver dials are not calibrated in frequency Tuning range 157-187 mc.

The indicator panel has controls for turning on and off a beam antenna rotating motor and various tubes and circuits to indicate the position of the antenna. Includes 1 **selsyn motor.** (8 tubes)

The power required is approx. 450 watts **at 117 volts 60 cycles.** The power supply is fused on the front panel, and circuit breakers are used in the HV and Fil. primaries. (7 tubes). The relay rack measures 39 5/16" high, 26⅜" wide and 20½" deep. There is a blower mounted in the top of this rack. In all, there are 36 tubes supplied with the equipment. The weight of the entire equipment is approximately 400 lbs.

These units are brand new.
Price $390 ea.

Wavemeter for above	$75.00
Dipole Array for above	$85.00

MICROWAVE ANTENNA EQUIPMENT

3 CM ANTENNA WITH DISH 14". Cutler Feed horizontal and vertical scan with 28 V DC drive motor and drive mechanism. Complete. New as shown $125.00

Relay System Parabolic reflectors approx. range 2000 to 6000 Mc. Dimensions 4½' x 3'. New $75.00

Dipole for above $12.00

TDY "Jam" Radar rotating antenna, 10 cm. 30 deg. beam, 115 V AC drive. New $150.00

10 CM Horn, Rectangular-to square-to circular RF assembly ending in horn. radiating circularly polarized beam. Waveguide input. Complete with flange $50.00

Parabolic Peel. Radiation pattern approx. 25 deg. in horizontal, 33 deg. in vertical planes $35.00

Cone Antenna, AS 125 APR. 1000-3200 mc. Stub supported with type "N" connector (as shown) $4.50

S.F. Radar Antenna. 10 cm. approx. 30" dish comp. with Selsyn and 150V drive motor $185.00
With motor driven turntable echo box $70.00

SA Radar, 200 MC bedspring array. Complete with drive mechanism, etc., like new $850.00

ASD 3 CM sector scan antenna. Complete with cutler feed dipole, 15" parabola, drive motor, position indicating selsyns, rotary joint $37.50

Bellini-Tossi Direction Finder Cross Loop Assy's for Navy Dav. Radar. New and complete $275.00

AS14A.AP. 10 CM pick up dipole assy, complete w/length of coax and "N" connectors $3.50

AS46A/APG-4 Yagi Antenna, 5 element array $22.50

30" Parabolic Reflector Spun Aluminum dish $4.85

140-600mc Directional Antenna

140-310mc cone and 300-600 mc cone, each consisting of 2 end fed half wave conical sections with enclosed matching stub for reactance changes with changing frequency.

New: complete with mast, guys, cables, carrying chest $49.50

AN MPG-1 Antenna. Rotary feed type high speed scanner antenna assembly, including horn parabolic reflector. Less internal mechanisms. 10 deg. sector scan. Approx. 12'L X 4'W x 3'H. Unused $250.00
Gov't Cost—$4500.00

DBM ANTENNA. Dual back-to-back parabolas with dipoles. Freq. coverage 1,000-4500 mc. No drive mechanism $65.00

AN/APS-6-(AIA)

RT 17/APS-6 . . . A 3 C.M. package designed for aircraft interception . . . night fighter radar work for use with a conical scan antenna, pictured and described below. Package consists of 725A magnetron and magnet, 1B24 duplexer, 724 ATR, 723 A/B local oscillator and beacon oscillator, complete transmitter-receiver, RF plumbing, IF strip using 6AK5's and 6AL5's. Miniature tubes used throughout, enclosed blower, pressurized housing. A complete 3 CM RF package of the latest design, using miniaturized components.

Less receiving type tubes $425.

AN/APS-6 SPIRAL SCAN ANTENNA

The AN/APS-6 (AIA) system imposes unusual requirements on the scanner. This radar is used for airborne detection of aircraft under blind conditions, and therefore requires a search over a solid angle in the forward direction. The beamwidth is about 5°.

The scan is spiral, and one turn of the spiral is described in 1/20 sec, which causes the plane of polarization to gyrate at this speed. The beam is made to spiral outward from 0° (straight ahead) to 60° and back again in 2 sec. by the nodding of the antenna in relation to the yoke which forms the forward end of the horizontal main shaft. By throwing a switch the operator can halt the nodding of the antenna, which then executes a conical scan to permit accurate homing. A single motor, rated at 600 watts mechanical output, provides power for the nod and spin motions. The data take-offs are a 2-phase sine-wave generator for the spin angle and a potentiometer for the nod angle, both being mounted on the main gear case to obviate the need of slip rings. The gear case is unusual in airborne practice in that it is oil-filled **$375**

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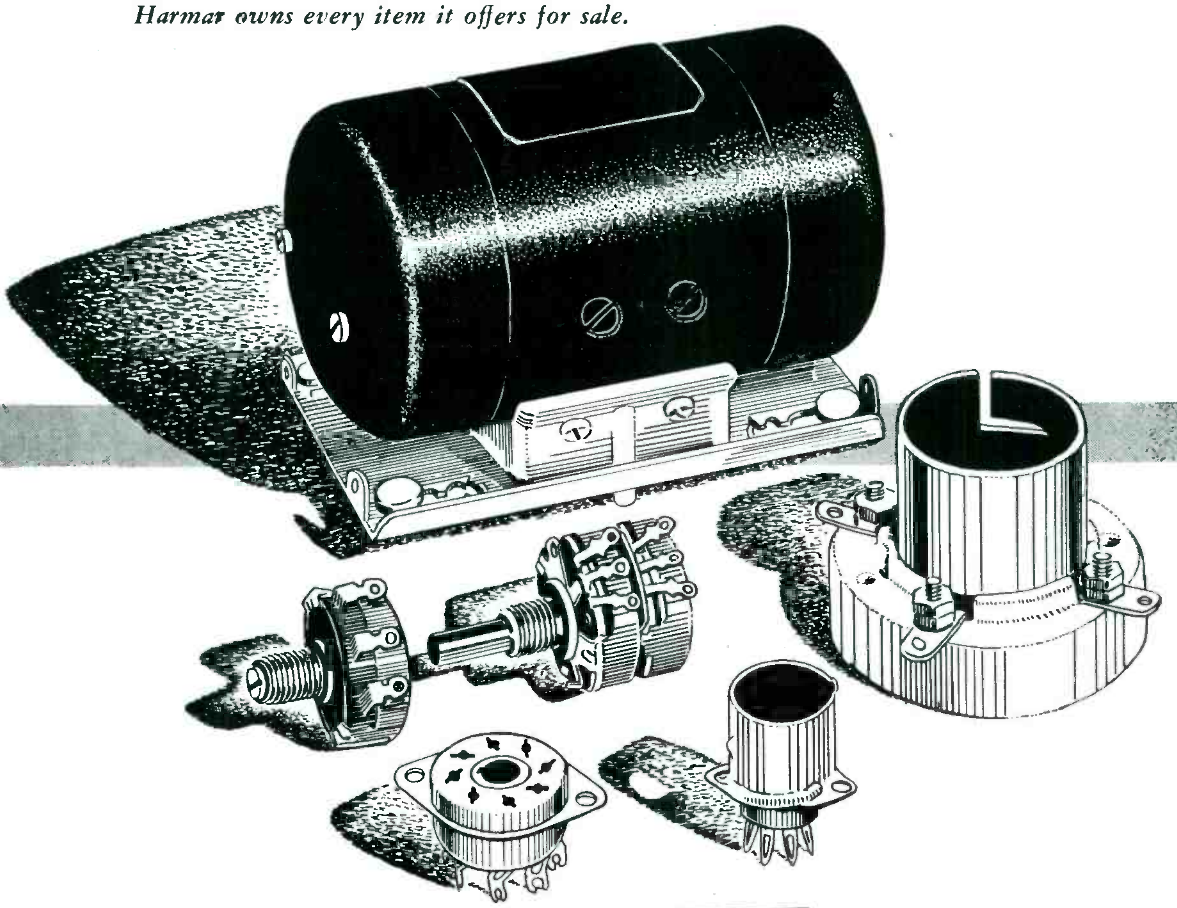

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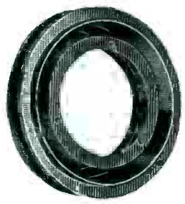
METER SHOCK MOUNTS



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Standard Brand. MFR. Name on Request

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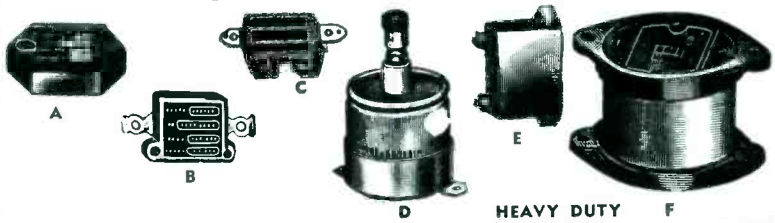


Stock No.	Cap.	Test Volts	Fig.	Type No.	Price Each
5493A*	.01	1000	B	1445	35¢
5494A	.02	1000	B	1445	30¢
5495A	.006	1200	A	A 2	35¢
5496A	.0001	1500	C	BE 15	20¢
5497A	.0005	1500	C	BE 15	20¢
5498A	.004	2500	B	4	40¢
5499A	.001	5000	A	F	40¢
5600A	.0036	5000	A	A2	60¢

* Supplied with Meter Bracket

HEAVY DUTY

Stock No.	Cap.	Test Volts	Fig.	Type No.	Price Each
5601A	.15	1000V	E	XS	90¢
5602A	.00007	2500V	E	3	90¢
5603A	.00005	3000V	E	15L	1.00
5604A	.0001	5000V	E	F2L	1.00
5605A	.0008	5000V	E	F2L	1.00
5606A	.000025	10,000	D	PL-341	1.95
5607A**	.00015	10,000	F	PL-315	7.95

** D.C. Working Voltage

STANDARD BRAND. MFR. NAME ON REQUEST. OTHER TYPES AND SIZES AVAILABLE

SOLENOID CONTACTORS

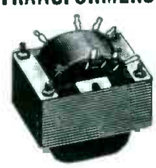
200 AMP. S.P.S.T. Normally Open Contacts

Stock No.	Mfg. & No.	Voltage	Resistance	Price Each
4201 A	Leach 7220.32	32VDC	234 OHMS	$4.00
4202 A	Leach 7220.24	24VDC	132 OHMS	5.00
4203 A	Leach 7220.3.24	24VDC	132 OHMS	4.00
4204 A	Guardian 3 3804-B78	24VDC	132 OHMS	4.00

50 Amp. S.P.S.T. Normally Open Contacts

5358 A Allen Bradley X101147 D.P.S.T. N.O. D.B. 24 VDC 60 OHMS $1.95
5482 A Leach 7064-12C S.P.S.T. N.O. D.B. 12 VDC 40 OHMS $1.95

6.3 VOLT FILAMENT TRANSFORMERS



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6.3 Volts @ 4.9 Amps.
6.3 Volts @ 4.5 Amps.
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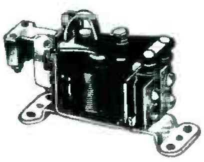
Price Each **$2.65**

Horizontal Half Shell Mounting. 2¼" x 2 13/16" Mounting Centers. 2 13/16" x 3⅜" Core Size. 2½" above Chassis. Solder Lug Terminals—All Terminals Marked.

MISCELLANEOUS RELAYS



Stock No.	Manufacturer and Mfg. No.	Contacts	Voltage	Coil Resistance	Price
563A	Automatic Electric R-25	S.P.S.T. Handle 2 Amp	12 VDC	75 OHMS	$.95 ea.
4210A	Guardian TC-195 2 Poles N.O.; 2 Poles N.C.—Slow Acting-Copper Slugged—1.5 AMP Contacts	4 P.D.T.	10 VDC	6 OHMS	1.75 ea.
4213A	C P. Clare A20545	S.P.S.T. N.C. 4 insulated leads with solder lugs	12 VDC	45 OHMS	.95 ea.
5484A	G M. Type 27 Cat. #12957-1	3 P.D.T.	28 VDC	150 OHMS	1.50 ea.
5488A	Leach 1024	D.P.S.T. N.O.	12 VDC	95 OHMS	1.50 ea.
5489A	Guardian 35935 & Automatic Electric R-30	5 P.D.T.	20–30 VDC	100 OHMS	1.50 ea.
5490A	Ward Leonard 13L21	Magnetic Relay	48 VDC	600 OHMS	2.50 ea.
5491A	Guardian G38273	D.P.S.T.	28 VDC	125 OHMS	1.50 ea.
5259A	G.E. K—275849	S.P.S.T. D.B. N.O.	12 VDC	70 OHMS	.75 ea.
102248A	Automatic Electric R-45 operates continuous duty on 6 VDC	S.P.D.T. & S P.S T.	24 VAC intermittent	25 OHMS	.60 ea.

Terms: Open Account to rated or acceptable referenced accounts. Others Pre-payment or 25% deposit with order, balance C.O.D. Prices F.O.B. Chicago and subject to change without notice. Merchandise subject prior sale.

BIRTCHER TUBE CLAMPS

Type 926-A16

Stock No. 56 28A 25¢ ea.

HIGH FREQUENCY RESISTOR

IRC Type MPO-7
50,000 ohm 30 watt

Stock No. 5625A $2.95 ea.

LARGE STOCKS OF FERRULE RESISTORS AVAILABLE. Write for list or specify your requirements. We also have mounting clips.

WRITE FOR SPECIAL LISTING OF SIGNAL CORPS AND NAVY TRANSFORMERS, CHOKES AND SPECIAL ITEMS. THIS INCLUDES WESTERN ELECTRIC, GENERAL ELECTRIC AND OTHER WELL KNOWN MANUFACTURERS' PART NUMBERS. COMPLETE INFORMATION AS TO SPECIFICATIONS AND CHARACTERISTICS.

Radio Surplus Corp.

732 South Sherman Street
Chicago 5, Illinois
Phone: HArrison 7-5923

New GOVERNMENT SURPLUS *Units*

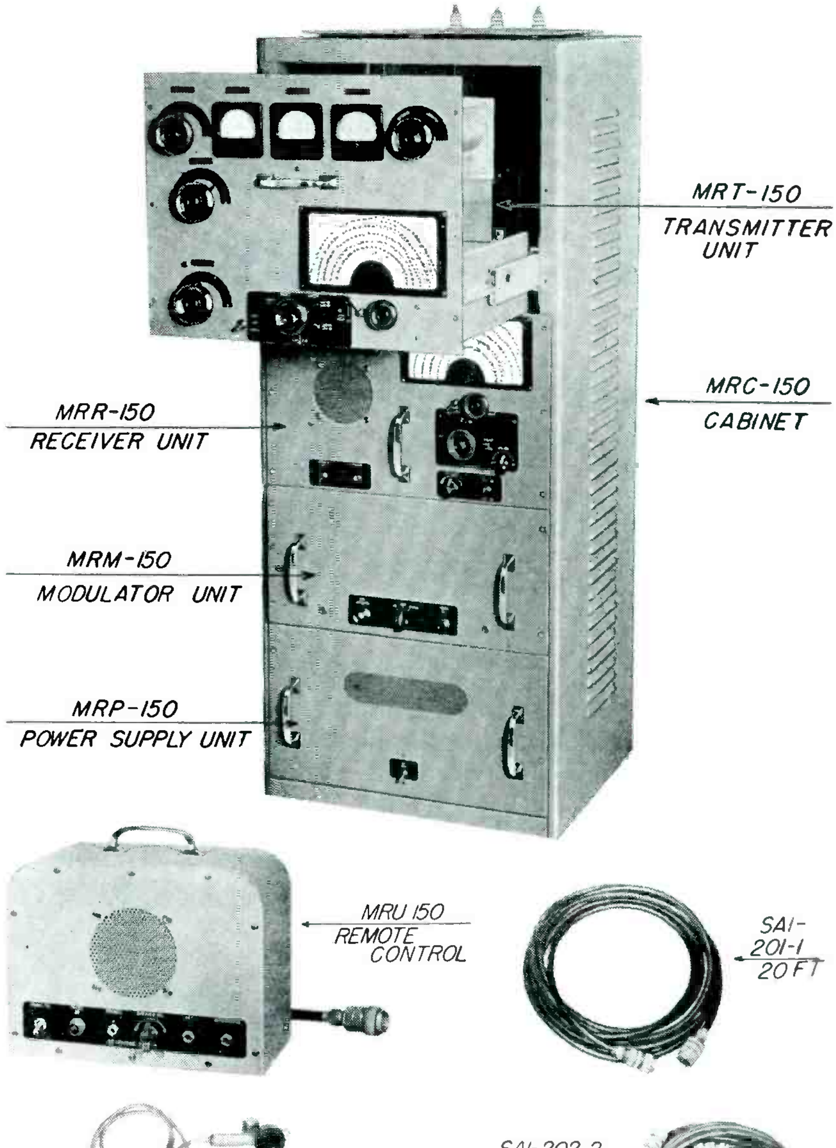
TYPE AN/FRC-1 TRANSMITTER & RECEIVER

An extremely versatile Transmitter Receiver with a very desirable frequency range from 1.5 mcs to 12.5 mcs (200-24 meters); Primary power source 90-120 and 200-230 volt 50/60 cycle, so practically suitable for any location.

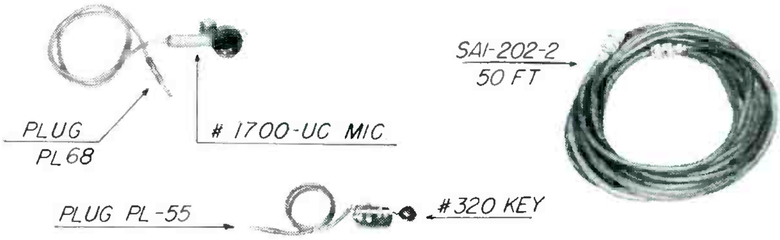
Transmitter master oscillator controlled covering full frequency range comes complete with remote control, cables, microphone, telegraphic key, ready to go on the air on either phone, CW or MCW. This fully 100% modulated Transmitter delivers approximately 250 watts on phone.

A complete radio installation for airport traffic control, ship-to-shore communications, point-to-point work. Both Transmitter and Receiver are finished in easy sliding-out decks containing power supply, modulator, superheterodyne receiver and transmitter.

This unit includes an excellent high-sensitivity radio receiver, covering the full frequency range, at a price far less than you will pay for the transmitter alone. This, we feel will be our very last possibility for the supply of radio communication equipment which can be used in almost any location for any kind of application, at such a favorable price.



Act at once. Contact us for Full Technical Information and Prices. All units subject to prior sale.



FRENCH-VAN BREEMS, Inc.

Electronic Engineering Experts

375 FAIRFIELD AVENUE **STAMFORD, CONNECTICUT, U. S. A.**

Cable Address: FREXVAN, STAMFORD, CONN.

CONDENSERS

IN COMMERCIAL QUANTITIES—IMMEDIATE DELIVERY

OIL CONDENSER SPECIAL

10 mfd.—600 V .... $ .75

Three term, bat. mntg. channel type. Dims. 3¾" x 3½" x 2". Two 5 mfd. sections rated 400 V at 72 deg. "C". 1800 V test. Meets commercial specs. for 600 V. operation up to 40 degs. "C". Ideal for filter or power factor application where ruggedness and durability are paramount. Carton of 24, weight 42 lbs. .... **$.65**

MFD	VOLTAGE	PRICE
.005-.005-.01	10 KV	$3.75
.012	25 KV	15.90
.02	20 KV	14.90
.075-.075	7.5 KV	7.90
.08	12.5 KV	9.90
.1	1500 V	.59
.1	2000 V	.69
.1	2500 V	1.20
.1	3000 V	1.75
.1	7500 V	1.95-4.25
.1-.1	7500 V	6.25
.1	10 KV	8.95
.1	15 KV	19.95
.1	25 KV	25.95
.2	10 KV	10.95
.25	800 V	.32
.25	2000 V	1.25
.25	3000 V	2.25
.25	6000 V	1.75
.25	18 KV	15.95
.25	20 KV	19.95
.25	32.5 KV	31.95
.4	10 KV	12.95
.5	400 V	.25
.5	500 V	.42
.5-5	600 V	.69
.5	1000 V	.65
.5	1500 V	1.02
.5	2000 V	1.39
.5	3000 V	2.69
.5	25 KV	39.95
.5-.1	2000 V	.85
1	400 V	.45
1	500 V	.58
1	600 V	.65
1	1000 V	.69
1	1500 V	.97
1	2000 V	1.95
1	2500 V	2.25
1	3000 V	3.29
1	5000 V	4.10
1	6000 V	5.10
1	15 KV	25.95
1	20 KV	29.95
1	25 KV	69.95
2	600 V	.59-.79
2 TLA	600 V	.80
2	1000 V	.95-1.45
2 TLA	1000 V	1.49
2	1500 V	1.65
2	2000 V	2.80

MFD	VOLTAGE	PRICE
2	2500 V	$3.39
2	4000 V	5.69
2	5000 V	10.95
2	12.5 KV	22.95
2-2	600 V	1.20
3	600 V	.69
3	4000 V	6.95
3-3	150 V	.25
3-3	600 V	.98
3-3-3	400 V	.75
3.75	1000 V	1.79
4	400 V	.85
4	600 V	1.25-1.75
4 TLA	600 V	1.40
4	1000 V	1.95
4	1500 V	2.69
4	2000 V	4.25
4	2500 V	4.95
4	3000 V	6.75
4	4000 V	9.95
4-4	1000 V	2.39
5	330 VAC	1.75
5	660 VAC	2.49
5	600 V	.99
5	10 KV	41.50
5-5	400 V	.75
5-5	600 V	1.29
6	600 V	1.35
6	1000 V	2.49
6	1500 V	3.25
6	2000 V	3.95
7	600 V	1.45-1.95
7	800 V	1.90
7	1000 V	3.15
8	500 V	1.35
8	600 V	1.98
8	660 VAC	4.75
8	1000 V	3.55
8	2000 V	4.95
8-8	600	1.75
10	330 VAC	3.95
10	400 V	.75
10	600 V	1.29-2.50
12	1000 V	4.50
17 TLAD	25V	.69
24	1500 V	8.50

BATHTUB CONDS.

MFD	Voltage	Price	MFD	Voltage	Price
.05-.05	600 V	.30	.3	400 V	.24
.1	600 V	.39	.5	600 V	.32-.45
.1-.1	600 V	.39	.5-.5	600 V	.58
.2	1000	.19	1	300 V	.30
.25	600 V	.41	1	400 V	.48
.25-.25	600 V	.45	1	600 V	.56
.25	1000 V	.45	2	600 V	.91

SPECIAL BATHTUB KIT...... 15 @ $1.00

CHANNEL CONDS.

MFD	Volt	Price	MFD	Volt	Price
.05-.05	600 V	.36	.4	600 V	.39
.1	600 V	.4	.5	600 V	.49
.1	2500V	1.20	.5	400 V	.19
.1-.1	400 V	.38	1	500 V	.58
.1-.1	600 V	.41	1	600 V	.65
.1-.1-.1	400 V.	.41			
.25	600 V	.43			

MICA CONDENSERS

5, 6, 8, 10, 15, 25, 30, 34, 39, 50, 70, 75, 100, 140, 150, 185, 200, 230, 240, 250, 300, 350, 390, 400, 470, 500, 510, 600, 650, 700, 750, 1000, 1200, 1250, 1400, 1500, 2000, 2200, 2400, 3000, 3300, 3700, 3900, 4000, 4700, 5000, 5100, 6000, 6200, 6500, 7900, 7950. 7960, 8000 & 9100 mmfd.

PRICE SCHEDULE

5 to 750 mmfd .... 5¢
2000 to 5100 mmfd .... 11¢
1000 to 1500 mmfd .... 7¢
6000 to 8000 mmfd .... 12¢

Special Mica Kit—100 @ $3.50

SILVER MICA CONDENSERS

7, 24, 25, 33, 50, 60, 75, 95, 100, 120, 150, 170, 200, 270, 300, 330, 390, 400, 450, 500, 750, 800, 1000, 1400, 1450, 1700, & 2500 mmfd.

PRICE SCHEDULE

7 to 95 mmfd .... 8¢
1000 to 1700 mmfd .... 14¢
100 to 800 mmfd .... 9¢
2500 mmfd .... 16¢

SPECIAL S.MICA KIT-100 @ $6.50

CERAMICON CONDS.

10, 56 & 100 mmfd @ .... .05
1000 to 5000 mmfd @ .... .06

MOLDED PAPER CONDS.

(W.E.)

.01 400 V Type CN 35 .09 ea. $ 7.50 per "C"
.01, .05, .06 400 V. 4¢ ea. $ 3.50 per "C"
.004, .01, .03 600 V. 5¢ ea. $ 4.50 per "C"
.1 1000 V. 8¢ ea. $ 7.50 per "C"
.01 1000 V. 15¢ ea. $13.50 per "C"

COAX CONNECTORS

83—1R	.50	83—IT	$1.30
83—1AP	.22	83—ISP	.48
83—1J	.69	83—1SP	.48

Coax assembly RG—59/U-6" in length, connected with 83 1SPN, 83—1J and Amphenol #8-M Connector. $ .89. Less 83-1J $ .32.

TYPE "AB" POTS

$1.35—$1.50

OHMS	Shaft	OHMS	Shaft
50	1/8 S	15000	1/8 S
60	1/8 LS	20000	1 1/4 & 1/8 LS
150	1/4 S	25000	3/8 & 1/8 S
300	3/8 S	3000	1/8 S
500	3/8 & 1/8 S	40000	1/8 LS
1000	1/8 S	50000	1/4 & 1/8 S
1500	1/4 S	50000	1/8 LS
2000	1/8LS & 3/8S	100000	1/2"
2500	1/8 S	150000	2 1/8
3000	1/8 LS	200000	1/8 LS
6000	1/4	250000	1/8 LS, 9/16 & 1/8 S
5000	1/8 LS & 3/8	300000 (2 terms.)	1/8 S
10000	3/8 & 1 1/7	1 Meg.	1/8 S & 1/8 LS
10000	5/16		

DUAL "AB" POTS—$2.75

OHMS	SHAFT	OHMS	SHAFT
1500	5/16"	20K	7/16"
1-5 meg	1/2"	1 meg	1/2"
		2 meg	1/8 S

TOGGLE & MU Switches

DPST AH & H 3/8" bushing, Bat Handle.. $.59
DPDT AH & H 1" bushing, Bat Handle.. .59

DPDT C-H 7/16 bushing #8824K4..... .70
SPDT C-H 7/16 bushing #8800K4..... .60

SPST 3A. 250 V. 3/8"bush. 1/8" SD Shaft.. .08
MU-SW. Lever Type MLB 321 15A. 125 V. (2 Cirs.) .... .65
MU-SW Pin Type YZ-2YST (Normally open) .... .55

TRANS. MICA CONDS.

MFD	WVDC	Price	MFD	WVDC	Price
.01	600 V	.33	.0003	6000 V	.99
.0125	6000 V	7.50	.004	2500 V	.40
.02	2000 V	.90	.005	1200 V	.40
.03	600 V	.49	.0001	3000 V	.89
.001	8000 V	3.60	.0002	5000 V	1.18
.001	2500 V	.40	.00025	1200 V	.20
.0024	5000 V	1.55	.0006	5000 V	1.38

RELAYS

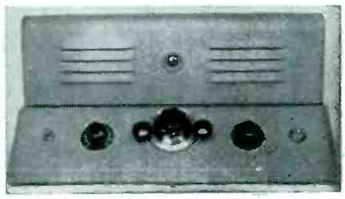
3PST Sters Dunn # 1CXX 100
DPDT Sters Dunn # 1X5X 103
115 V. 6A. Conts........$2.69
115 V. 6A. Conts........$2.39

QUOTATIONS ON

25 W.—50 W. Rheos., W. W. & Carbon Pots.

ELECTRONIC RADIO ALARM

Make It Secure



Guaranteed new, functionally perfect and designed by a leading manufacturer. Uses balanced bridge principle. Intrusion operates any external alarm system. (Bell, horn, light, etc.) Automatic reset. Protects any ungrounded object, room or bldg. (Safe, cabinet, window screen, screening under window or door. Protection against injury by high voltage, hazardous equip and locations. Added feature includes built in fire detector. Operates alarm at 160 deg. F. Complete with instructions. **$59.50**

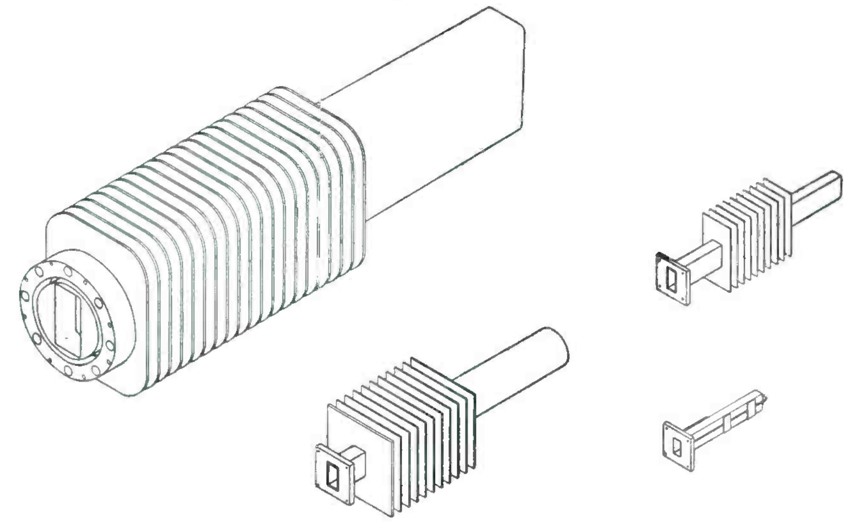
NEW BC 906 FREQ. METER

Range 150-225 MC—Bat. operation with precision velvet vernier dial, tuning charts, 0-500 D.C. microammeter, diode. Triode and plug-in antenna. Contained in black aluminum carrying case 12½ x 8¾ x 6½. Price **$15.95**

MONMOUTH RADIO LABORATORIES

BOX 159 **Long Branch 6-5192** **OAKHURST, N.J.**

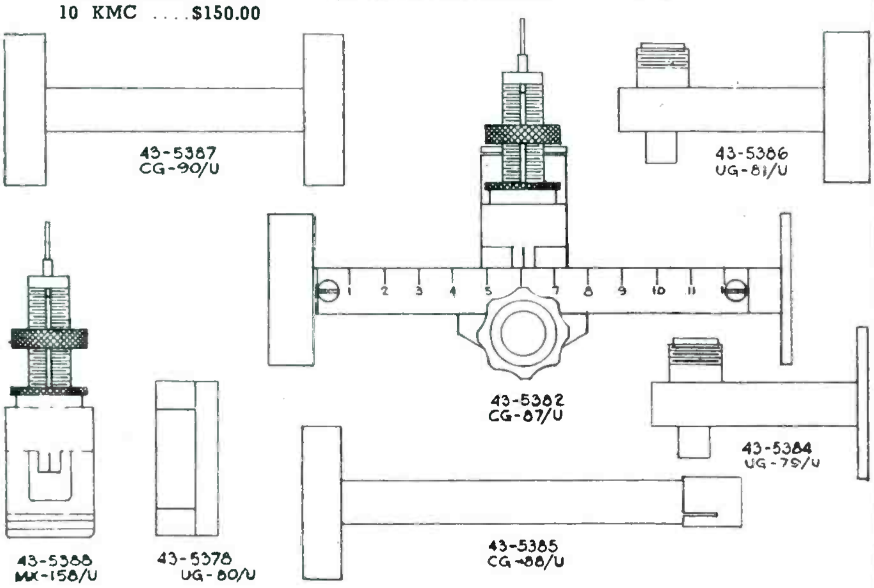
TEST EQUIPMENT



HI POWER X BAND TEST LOAD, dissipates 350 watts of average power for 5/8" x 1¼" waveguide. VSWR less than 1.15 bet. 7 and 10 KMC $150.00

Hi Power Dummy Load 1" x ½" wave guide, dissipates 250 watts average power—V. S. W. R. Less than 1.15 between 8,200 x 12,400 MC $125.00

HI POWER S BAND TEST LOAD, dissipates 1000 watts of average power, for 1½" x 3" waveguide, Range 2500 to 3700 mc.



X Band VSWR Test Set TS 12 (Unit 2, Plumbing)

consisting of:

1	Waveguide-coax adapter		UG-81/U
1	RF cable		CG.92/U
1	Sync cable		CG-91/U
1	Sync cable	3'6" long, with type 49195 connectors	CG-89/U
1	Waveguide-coax adapter	Coax end terminates in type 49285 connector. Waveguide end terminates in a choke	UG-81/U
1	Waveguide-coax adapter	Coax end terminates in type 49285 connector. Waveguide end terminates in a flange	UG-79/U
1	Slotted section	Gear driven probe assembly and crystal	CG-87/U
1	Probe assembly	Hand operated; includes crystal	MX-158/U
1	Terminating section	With four-inch (4") resistive strip. One end terminates in a choke coupling—the other end in a cap	CG-88/U
1	Adapter section	½" x 1" x .050 waveguide terminates in a choke coupling at each end	CG-90/U
2	Adapters	Large to small waveguide adapters; large ends with choke couplings, small ends with flange couplings	UG-80/U
2	Support blocks		

APR—4 Tuning Units
TN—16 38—80 MC
TN—19 1,000—2,000 MC
TN—54 2,000—4,000 MC

ELECTRO IMPULSE LABORATORY

62 White Street **Red Bank 6-0404** **Red Bank, N. J.**

COLUMBIA ELECTRONICS LTD.

SCR 291

Semi-portable Radio Direction Finder. Uses a U-Adcock type antenna array designed for ground station operation. The overall frequency range of this equipment when used for direction finding is continuously variable from 2 to 10 mcs. Receiver has continuous frequency range from 1.5 to 30 mcs., divided into 4 bands. Sensitivity is approx. 5—15 microvolts/meter for ±2° bearing readability. Power requirement 115 V. 60 cycles, single phase. Complete. New.

TEST EQUIPMENT
Complete Line!

Signal Generator 804-C
DuMont 224-A Oscilloscope
1-77 Hickok Tube Checker
I-208 FM Signal Generator
RPC Model 644 Multimeter
Ferris Microvolter Mod. 18-C

IE-36 (New)	TS-111/CP
I-139 METER	TS-126
I-212	TS-127/U
TS-3/AP	TS-170/ARN-5
TS-5/AP	TS-175/UP
TS-10B/APN	TS-182/UP
TS-19/APQ-5	TS-184A/AP
TS-24A/ARR-2	TS-204/AP
TS-34/AP	TS-250/APN
TS-36/AP	TS-348/AP
TS-61/AP	TS-375/U
TS-62/AP	UPM-1 (Complete)
SL-1 Slotted Line Test Set	WE I-193
TS-100/AP	Range Calibrator I-146
TS-102A/AP	

COUPLING HEAD BC-1201-A
MODULATOR UNIT BC-1203-A

RC-184 IFF EQUIPMENT
Complete. Brand new.

APS-4 Complete Radar
Mark 16 Complete Radar
APS-6 Radar Parts

RECEIVERS
APR-4 APR-5

SCR-720 Equipment
U/16 U PLUGS MG-19A New

HEADSETS
HS-33 Brand new

MK-20A/UP
Brand new. Individually boxed.

TELEVISION CAMERA

350 line resolution. Easily converted to present RMA standards. Circuits available with camera. Complete, like new.

VARIAC TRANSTAT AMERTRAN
Input 0-115 V., 50-60 cycles; output 115 V 100 amps. 11.5 Kva. Excellent condition.

SEE COLUMBIA ELECTRONICS AD ON PAGE 390

COLUMBIA ELECTRONICS LTD.
524 S. San Pedro St., Los Angeles 13
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Cable Address: COELECT
ALL ITEMS SUBECT TO PRIOR SALE

TS-100/AP TEST OSCILLOSCOPE

for pulse timing and test applications

★ **BRAND NEW**
★ **LIMITED QUANTITY**
★ **AVAILABLE ONLY AT RADIO SHACK**

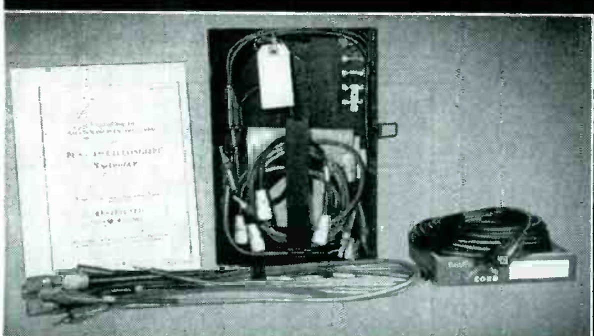
$750.00

Here's a rare opportunity to get this versatile research tool at a fraction of today's cost.

YOU CAN USE THIS 'SCOPE with its circular and linear sweeps to

- **Calibrate pulses and coincidence circuits**
- **Measure radar ranges to 5-yard accuracy**
- **Measure delay lines and pulse lengths**
- **Measure time intervals from 0.5 to 600 usec.**
- **Test synchronizers and radar sets**

Furnished complete with tubes, spare fuses, co-ax cables, power cord, and two 82-page operation and maintenance manuals.*



JUST OUT — Radio Shack's new 192-page catalog of radio and electronic parts and equipment. Write today for **YOUR FREE COPY!**

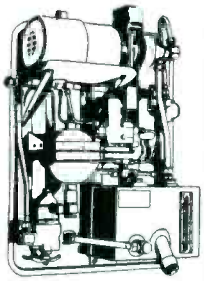
*For those who wish to study the application of this 'scope to their own needs, a limited number of these manuals can be furnished at $5.00 per copy.

ORDER NOW — QUANTITY IS LIMITED

RADIO SHACK CORPORATION
167 Washington St., Boston 8, Mass.

SURPLUS EQUIPMENT

HYDRAULIC PUMPING UNIT



A complete hydraulic system. Necessary units completely assembled and ready to work. Includes tank, gear pump 2½ HP dc electric motor, electric pressure unloading switch, relief valve, filter, accumulator, and connecting plumbing. 1500 PSI, 1½ GPM at 1800 RPM. Mounted on 19" x 25" aluminum frame.

Complete Unit .... $59.50 ea.

ALNICO FIELD MOTORS

(Approx. size overall . . . 3¾" x 1¼" diameter) **Delco**-Type 5069230: 27.5 volts; DC; 145 RPM $12.50 ea.

Delco-Type 5069600: 27.5 Volts; DC; 250 RPM .... $12.50 ea.

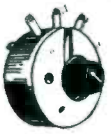
PIONEER TORQUE UNITS

TYPE 12604-3-A: Contains CK5 Motor coupled to output shaft through 125:1 gear reduction train. Output shaft coupled to autosyn follow-up (AY43). Ratio of output shaft to follow-up Autosyn is 15:1 $70.00 ea.

TYPE 12606-1-A: Same as 12604-3-A except it has a 30:1 ratio between output shaft and follow-up Autosyn.... $70.00 ea.

TYPE 12602-1-A: Same as 12606-1-A except it has base mounting type cover for motor and gear train........... $70.00 ea.

POWER RHEOSTATS



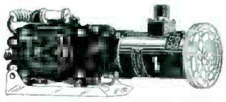
Standard Brands: 5 Ohms; 100 Watt; 4.48 amps 100 Ohms; 100 Watt; 1.0 amp.

Boxed, Brand New with Knob $2.50 each—or— $25.00 per Doz.

PIONEER AUTOSYNS

AY-1...... 26 Volt—400 Cycle....... $4.95
AY-5...... 26 Volt—400 Cycle....... $5.95
AY27D $25.50
AY6—26 Volt—400 cyc........... $4.95 ea.
AY30D—26 Volt—400 cyc....... $25.00 ea.

AIR COMPRESSOR, AIRCRAFT

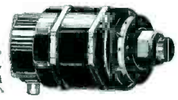


Rated pressure 1000 PSI, measures 13½" x 9¼"; driven by 27 VDC-1/3rd HP series wound motor; 11,000 RPM; 17 amp; cont. duty Mfg. General Electric Mod. # 5BA40EJ28B. $39.95 ea.

TACHOMETER INDICATOR SINGLE

Sensitive Type, Kollsman Mark V; Range 0-3500 RPM in 3½ revolutions of the indicating pointer. $9.95 ea.

TACHOMETER GENERATOR



Pioneer Instrument, Mark V, screw mount. Used with Kollsman Mark V Indicator $25.50 ea.

Tachometer Indicator and Generator (above) .... Both $33.50

SENSITIVE ALTIMETERS

Pioneer Part #1556-2K-A Sensitive altimeters. 0-35,000 ft. range . . . calibrated in 100's of feet. Barometric setting adjustment. No hook-up required.

$12.95 ea.

DC MOTORS

(Approx. size . . . 4" long x 1¼" dia. **General Electric**-Type 5BA10AJ37: 27 volts, DC; .5 amps; 8 oz. inches torque; 250 RPM; shunt wound; 4 leads; reversible $6.50 ea.

General Electric-Type 5BA10AJ52C: 27 Volts, DC; .65 amp; 14 oz. inches torque; 145 RPM; shunt wound; 4 leads; reversible $6.50 ea.

MICROPOSITIONER

Barber Colman AYLZ 2133-1 Polarized D.C. Relay: Double Coil Differential sensitive; Alnico P.M. Polarized field. 24 V contacts; .5 amps ; 28 V. Used for remote positioning, synchronizing, control, etc. $12.50 ea.

PIONEER GYRO FLUX GATE AMPLIFIER

Type 12076-1-A, complete with tubes $27.50 ea.

PIONEER TORQUE UNIT AMPLIFIER

Type 12077-1-A, A single tube amplifier designed for autosyn take off signal. Contains magnetic amplifier assembly. With tube .... $24.50 ea.

SERVO MOTOR 10047-2-A: 2 Phase; 400 Cycle; with 40-1 Reduction Gear $10.00 ea.

400 CYCLE MOTORS

AIRESEARCH: 115V; 400 CPS; Single phase; 6500 RPM; 1.4 amp; Torque 4.6 in. oz.; HP .03.................. $10.00 ea.

EASTERN AIR DEVICES TYPE JM6B: 200 VAC; 1 amp; 3 phase; 400 cycles; 6000 RPM .... $12.50 ea.

INVERTERS

PE 218 LELAND ELECTRIC

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DM-64	12	275	150	11.50
DM-65	12	400	440	22.50
BD-77	12	1000	350	25.00
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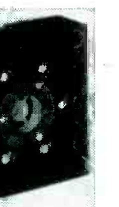

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TS-13	TS-100	I-56	BC-1203
TS-14	TS-101AP	I-95/A	BC-1287/A
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TS-19	TS-110/AP	I-145	LAD
TS-27/TS	TS-118/AP	I-177	LAF
TS-32A/TRC-1	TS-125/AP	I-178	LAG
TS-33	TS-131/AP	I-208/A	LU2
TS-34	TS-153	I-212	LU3
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TS-35A	TS-170/ARN-5	I-225	TTS-4BR
TS-36	TS-173/UR	I-233	TTX-10RH
TS-45/APM-3	TS-174	IE-21/A	TSS4SE
TS-47/APR	TS-175	IE-36	TSX4SE
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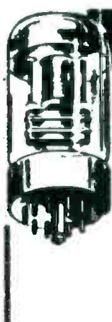

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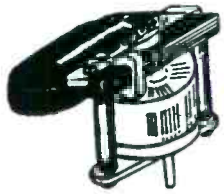

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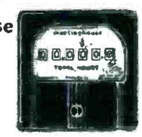

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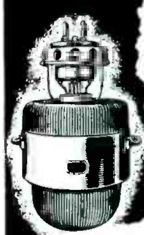

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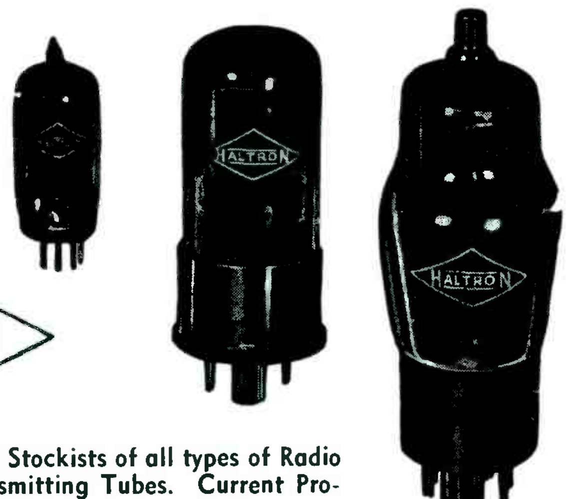

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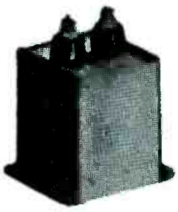

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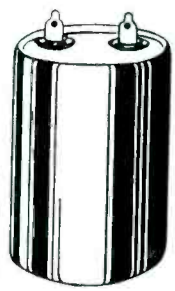

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e.g. RCH, FAL, RBO, DAK, DAG, TCS, ARC-1, ART-13, APN-7, APN-9, APS-4, APS-13 HANDIE-TALKIES—SCR-536, BC-611 SYNCHROS: 110V, 400 cycle, types 5F, 5G, etc.

SPECIAL PURPOSE TUBES

Give full details

Cash waiting.

AMBER COMPANY

393 Greenwich St. N. Y. 13, N. Y.
BEekman 3-6510

CRITICALLY NEEDED

We are in dire need of: TS-125's, TS-155's, TS-13's, TS-34's, TS-117's, TS-268's

If you have any of these pieces, write, wire or telephone collect. (Wellesley 5-0933)

OVERBROOK CO., Overbrook 81, Massachusetts

WANTED

High quality quartz crystal blanks,

MANY TYPES

If you can supply us regularly please send quotations or write:

W-2173, Electronics
520 N. Michigan Ave., Chicago 11, Ill.

WILL BUY

TESTING CHAMBERS

Approx. 9 cu. ft. plus or minus. Cold and Hot minus 65° F. to plus 125° F. with controls Indicators preferred.

PHONE — WIRE — WRITE

KINGS COUNTY MACHINERY EXCHANGE

408 Atlantic Avenue, Brooklyn 17, N. Y.
Dept. "E"

GET OUR PRICE for your RADIO & AIRCRAFT EQUIPT!

We'll go the limit to buy your parts or equipment. Send us a description of the type and condition of equipment you have—tell us your top dollar asking price—and be pleasantly surprised at the fast action you'll get!

HARJO SALES CO., Suite 310
341 S. Vermont Ave., Los Angeles 5, Calif.

$52,000.00 AVAILABLE

TO BUY NEEDED SURPLUS ELECTRONIC EQUIPMENT

Top $ paid. Send description, condition and asking price. Prompt replies!

URGENT! NEEDED AT ONCE: BC-611 Handie-Talkies, ARC-1, ART-13, I-152C, BC-788C, BC-348. Complete units or parts.

WEST REGION ELECTRONICS
1437 S. Norton Ave. Los Angeles 19, Calif.

COLUMBIA ELECTRONICS LTD.

EQUIPMENT WANTED!

We want to buy all types of surplus electronic equipment. We are one of the largest buyers in U. S. We buy more because we give every seller top prices and a fair deal. TELL US WHAT YOU HAVE. USE COUPON BELOW—AND MAIL TODAY!

Use following numbers to indicate conditions: N-1, brand new; N-2, used, like new; N-3, used.

ITEM	CONDITION	PRICE WANTED

To: COLUMBIA ELECTRONICS LTD., 524 S. San Pedro St., Los Angeles 13, Calif.

Name ....

Address ....

SEE COLUMBIA ELECTRONICS AD ON PAGE 374

An Investment!

Productive advertising is an INVESTMENT rather than an EXPENDITURE.

"Searchlight" advertisers almost invariably report prompt and satisfactory results.

BE CONVINCED — send us your advertisement TODAY.

Address Classified Advertising Division

ELECTRONICS

330 W. 42nd St., New York 18, N. Y.

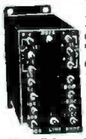
BLOWERS

40 CFM 28 vacdc...$5.98
70 CFM 115v/400 cy ... 4.49
250 CFM 28 vacdc.. 9.95
250 CFM with 28 to 115 vac Trans..11.95
175 CFM 220 vac...11.98
40 CFM 24 vdc 6.90

BANTAM 1-WATT XMITTER

With This Bargain Foundation Unit Free Instructions. Takes 2 plug-in FT-243 Xtals & Coil. w/140mmf Cndsr & Xtal Socket ......2 for 49¢
Complete with Xtals & Coil....2 for $1.69

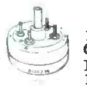
RCA UNIV OUTPUT TRANS



10W to 10KC, Matches ANY Line or Spkrs w/VC's 3 to 4 or 150 ohms to ANY Load & Tube IMP bet 50 & 10240 ohms. Over 1000 combinations! Acts as EXC Band pass Fltr or Freq. Attn Unit for Dyn Mike. Cuts Hi's or Lows. IDEAL Lazy Q-5 action CWor Phone. Gets ONLY Signal you WANT to hear. W/data $1.89; 3 for $4.98.

"TAB" THAT'S A BUY

VARIABLE CONDENSERS

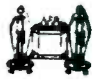


150mmf/300VGap HF MILLEN, CARDWELL $1.39
BUD Dual 75mmf ea. Sect 1000V Gap. HF $1.29
JOHNSON 70H30 70 mmf/3000VGap $1.29
Cardwell Neut ZT/12 mmf 500 Volt Gap. w/Locknut ......98¢
E. CARDWELL TK-300-US 53 to 312 mmf. Can be made Split Stator. New....$10.95
Vernier Drive 10 to 369mmf, each......69¢
Midget 3 to 15 mmf, Midline, each.....39¢
Phasing Condenser 90 Degree Quadrants, 4 Taps, 360deg Sinewave Gen..........$4.98
2½ Meter Butterfly Cndsr 30mmf w/RF Tank & Choke ....59¢; 2 for 98¢
Planetary Drive 5 to 1 Croname...... .98

UHF ANTENNA

UHF ANTENNA 12" 30CM AT5/ARR1 Usable Citzn & Ham Band Ins Coax Term Silv Pl Cont Wpf Gask & H'ware.....30¢; 4 for $1.00
GE-2J1G1 Selsyns As Is.....2 for 49¢
GE-2J1H1 Selsyns Exc Cond 2/$6.98
TV CONICAL ANTENNA (Dubl-X) Sturdy Prefab Const Versatile 72, 150 or 300 ohm Match. Incl 8 elements & 100 ft. All-Copper Twinex, Cross Bar & Hd'ware, Brand New..$8.49
Dubl-Stacked Conical Array Similar above, but with 16 elements & all hardware plus 2 crossbars & 100 ft. Twinex.....$12.98

866A KIT and XFORMER



2 Tubes, Sckts, xfmr 115v 60cyc Inpt, outpt 2.5vct/10a/10Kvins $6.98

DIODE PROBE TUBE!

Unexcelled for NO-LOSS UHF Testing. Ultra-Sensitive Sub-Miniature—Envelope App. 1¼"x⅜". Element & Probe at Tip. Low Pwr. Htr. BRAND NEW w/Data. VR92 ....25¢; 5 for $1

INFRARED SNOOPERSCOPE

Image-Converter Tube Hisensitivity simplified design 2" dia. Willemite, Screen-Resolution up to 350 lines/in. Complete data & tube TAB Special Each $4.98; 2 for $9.49

Large Stock of Fuses and Fuse Holders All Types

MERCURY THERMO REGULATOR

Dual Ckt. 32°&105°F. Extremely Sensitive & Accurate—FIRE PREY, FREEZE Pt or MAX-MIN TEMP CONTROL, RESEARCH. Brand New. Individ Boxed. List over $20. SPECIAL....98¢; 12 for $10

PARTS CABINETS

50 Draw Heavy Steel 34½H/18"W/9"L 65 Lbs Draws 3"W/2½"H/8"L @ $38.00
100 Draw as above @ $63.00
27 DRAW Hvy Steel 37"H/30¾"W/14¼"L/120 Lbs Draws 3"H/9"W/12"L @....$39.95
Write for Quantity Price "Extend Do"

TUBES

"TAB" TESTED & GUARANTEED

Prices Subject to Change

OA2	1.58	2C43	26.75	6AC7	.99
OA3/VR75	1.47	2C43/464A	9.49	6AD6G	.98
OA4G	1.45	2C44	1.20	6AD7G	1.49
OB2	1.58	2C51	6.95	6AE5	.89
OB3/VR90	1.23	2C52	5.98	6AF6G	1.33
OC3/VR105	1.43	2D21	1.49	6AG5	.89
OD3/VR150	.98	2E5	1.19	6AG7	1.99
OY4	2.53	2E22	1.25	6AH5G	1.49
OZ4	.79	2E24	4.85	6AH6	1.99
VS-1	12.49	2E25/HY65	5.15	6AJ5	2.16
C1A	9.75	2E30	2.19	6AK5	1.39
O1A	.69	2J21	10.69	6AK5W	2.98
1A3	1.10	2J21A	9.25	6AK6	1.49
1A4P	.79	2J22	7.90	6AL5	.69
1A5GT	.79	2J31	29.75	6AL7GT	1.29
1A6	1.49	2J31A	79.95	6AN5	5.95
1A7GT	.98	2J32	59.95	6AQ5	.69
1AE4	1.80	2J33	39.39	6AQ5W	5.98
1B3/8016	.89	2J34	38.50	6AQ6	1.25
1B4P	.89	2J36	120.00	6AQ7GT	1.19
1B5/25S	.99	2J37	12.70	6AR5	.79
1B7GT	.99	2J38	17.75	6AR6	2.98
1B21/471A	2.85	2J39	49.50	6AS5	.79
1B22	3.23	2J42	250.00	6AS6	2.79
1B23	9.90	2J48	28.50	6AS7G	4.98
1B24		2J49	39.45	6AT6	.59
Watnghs	8.75	2J50	27.50	6AU5GT	1.49
1B24 Sylv.	17.49	2J52	249.50	6AU6	.69
1B26	2.65	2J56	199.50	6AV5GT	1.29
1B27	24.00	2J62	49.45	6AV6	.59
1B32/532A	3.90	2K25	31.95	6AW6	1.89
1B35	11.98	2K25/723AB		6AX5GT	.79
1B37	18.00		29.45	6B4G	1.39
1B38	29.95	2K29	23.95	6B5	1.19
1B40	4.95	2V3G	1.29	6B6G	.89
1B41	49.95	2W3GT	.98	6B7	1.19
1B42	18.00	2X2	.69	6B8G	1.09
1B46	1.98	2X2A	1.89	6BA6	.79
1B53	49.95	3A4	.99	6BA7	1.19
1B56	38.50	3A5	1.69	6BC5	.69
1B58	350.00	3A8GT	1.59	6BC7	1.23
1B60	69.75	3B4	2.69	6BD5GT	1.65
ELIC	2.70	3B5	.98	6BD6	.89
1C5GT	.89	3B7/1291	.69	6BE6	.79
1C6	.79	3B23/RK22	4.95	6BF6	1.49
1C7G	.89	3B24	5.40	6BG6G	1.65
1D5GP	.99	3B25	4.50	6BH6	.89
1D7G	.89	3B26	3.70	6BJ6	.99
1D8GT	.89	3B28	8.80	6BL7GT	2.75
1E5	.99	3C6/XXB	1.49	6BN6	1.49
1E7G	.99	3C22	64.25	6BQ6GT	1.29
1F4	.69	3C23	10.98	6C4	.69
1F5G	.79	3C31/C1B	3.45	6C5GT	1.69
1F6	.89	3C24/HK24	5.49	6BN7	1.69
1F7G	.89	3C45	19.90	6C7	1.26
1G4GT	.89	3D6/1299	.69	6C8G	.89
1G5G	.89	3D21A	1.95	6C21	29.45
1G6GT	.79	3D23	4.90	6CB6	.89
1H4G	.89	3E29	14.95	6CD6G	2.49
1H5GT	.89	3LF4	1.29	6D4	2.85
1H6GT	.79	3Q4	.79	6D6	.89
1J5G	1.20	3Q5GT	1.29	6D7G	.89
1J6GT	.79	3S4	.79	6D8G	.89
1L4	.69	3V4	.79	6E5	.89
1L6	.98	4-125A	29.95	6E6	1.39
1LA4	1.19	4-250A	40.95	6E7	1.39
1LA6	.99	4-1000A	108.50	6F4	6.35
1LB4	1.29	4B27	4.98	6F5	.79
1LC5	.79	4C25/HK54	5.98		.99
1LC6	.89	4C33	59.00	6F6GT	.79
1LD5	.99	4C36	15.98	6F7	1.39
1LE3	.99	4E27/257	14.98	6F8G	1.29
1LH4	.89	4J22	148.50	6G6G	1.39
1LN5	.89	4J31	95.00	6H4GT	.98
1N5GT	.99	4J34	194.00	6H6	.89
1P5GT	.79	4J42/700	27.00	C6J	6.95
1P42	4.32	[illegible]	260.00	6J4	7.65
1Q5GT	.89	4J47CY	198.00	6J5GT	.59
1Q26	69.00	4J52	350.00	6J6	1.29
1R4/1294	1.29	4T4/2	5.95	6J7	1.19
1R5	.79	4X-500F	85.00	6J8G	1.19
1S4	1.19	5AX4GT	.54	6K4	3.39
1S5	.79	4X150A	45.00	6K5GT	1.09
1S21	6.90	5C30/C5B	3.95	6K6GT	.79
1T4	.79	5D21	24.30	6K7	.85
1T5GT	.99	5D23/RK65		6K8	.99
1U4/5910	.69		24.95	6L5G	1.79
1U5	.79	5J29	12.40	6L6	2.43
1V	.79	5R4G Spec.	1.49	6L6G	1.69
1V2	.70	5R4WGY	2.98	6L6GA	1.69
1X2	.79	5T4	2.49	6L6GAY	2.29
1Z2	3.98	5U4G	.59	6L7	1.19
2A3	1.19	5V4G	1.39	6N4	2.39
2A4G	1.19	5W4	.89	6N6G	1.69
2A5	.69	5X4G	.79	6N7GT	1.29
2A6	.69	5Y3GT	.49	6P5GT	.89
2A7	.69	5Y4G	.79	6Q7	.89
2AC15	4.98	5Z3	.99	6R7	.99
2AS15	4.98	5Z4	1.29	6R8	1.39
2B7	.89	C6A	6.75	6S4	.98
2B22	3.90	6A3	1.59	6S7G	.89
2C21/1642	.67	6A4	1.89	6S8GT	.99
2C22/7193	.33	6A5G	2.39	6SA7GT	.89
2C26	.19	6A6	.89	6SA7GTY	3.37
2C26A	.47	6A7	1.39	6SB7Y	1.19
2C33	2.98	6A8GT	1.09	6SC7	1.39
2Y2	6.98	6AB4	1.09	6SD7GT	.99
2C34/RK34	.69	6AB5/6N5	1.33	6SF5	.89
2C39	33.98	6AB7/1853	1.39	6SF7	.89
2C40	9.98	6AC5GT	1.09	6SG7	1.39
2C40JAN	19.90	6AC6G	1.49	6SH7	.99

6SJ7	.89	12H6	.89	37	.69	CV148	4.98	718CY	48.45	2050	1.79
6SK7GT	.89	12J5GT	.69	38	.59	150T	14.50	719A	49.95	2051	1.19
6SL7GT	.89	12J7GT	.99	RK39	2.89	VT158	14.49	721A	2.49	R4340	36.00
6SN7GT	.79	12K7GT	.89	39/44	.59	FG166	49.00	722A/287	2.45	5516	7.75
6SN7WGT	2.25	12K8	.99	CRC40	.59	FG172	42.50	723A	9.75	5517	3.39
6SQ7GT	.79	12Q7GT	.79	T40	4.29	182B	1.20	723A/B	14.49	5594	6.65
6SR7	.69	12S8GT	.79	TZ40	3.98	FG190	12.80	724A	3.95	5608A	5.95
6SS7	1.09	12SA7GT	.89	40	1.09	T200	22.98	724B	3.45	5651	3.30
6ST7	1.33	12SC7	1.39	HY40Z	3.75	201A/CX301A		725A	6.49	5654	4.79
6SU7GTY	3.37	12SF5GT	.79	41	.79		.98	726A	6.90	5656	9.98
6SZ7	1.05	12SF7GT	.59	42	.69	203A	5.98	726B	59.95	5663	1.85
6T7G	.89	12SG7	.89	43	.85	205B/VT2	1.69	726C	69.95	5670	5.98
6T8	1.09	12SH7	1.10	45	.69	CE206	3.15	801A	.45	5684	14.98
6U4GT	.89	12SJ7GT	.79	45S/VT52	.34	211/VT4C	1.89	802	3.98	5686	4.23
6U5/6G5	.99	12SK7	.89	45Z3	.69	CE215	8.98	803	3.89	5687	5.75
6U6GT	1.09	12SL7GT	.79	45Z5GT	.89	RX215	9.95	804	8.95	5692	7.69
6U7G	.69	12SN7GT	.89	46	.89	WE215A	.18	805	3.90	5693	7.69
6V6	2.25	12SQ7GT	.79	47	.99	217C	8.75	807	1.67	5694	3.65
6V6GT	.69	12SR7	.98	48	1.99	227A	4.98	808	2.98	5726	4.39
6V8	1.99	12X3	.90	RK48A	14.85	231	1.20	809	2.43	5749	4.39
6W4GT	.69	12Z3	.89	RK49	7.50	242C	8.49	810	10.98	5751	5.98
6W6GT	.89	14A4	1.09	49	.83	244A	4.15	811	2.90	5763	1.70
6W7G	1.33	14A7/12B7	.99	50	1.19	247A	9.95	812	2.90	5812	2.99
6X4	.49	14AF7/XXD		EF50	.98	250R	9.90	813	8.65	5814	5.49
6X5GT	.49		1.19	50A5	1.19	250TH	22.25	814	3.85	X6030	4.49
6Y6G	1.27	14B6	.99	50B5	.79	250TL	19.40	815	2.90	UX6653	.69
6Y7G	.89	14B8	.89	50C5	.69	HK254	14.49	816/866Jr.	1.09	8002R	99.50
								826	.95	8005	5.85
								828	11.29	8008	6.49
								829	11.49	8012	2.89
								829B	13.45	8013	2.75
								830B	3.49	8013A	4.79

Use Your Priority for **SPEEDY DELIVERY** Extend Your DO and Contract Number

6Z7G	.89	14C5	1.09	50C6	1.49	262B	3.98	832	5.65
6ZY5G	.89	14C7	1.09	50L6GT	.69	274B/5R4	1.90	832A	9.75
7A4/XXL	.89	14E6	.99	50X6	.89	276A	9.89	833A	48.90
7A5	.99	14E7	1.09	50Y6GT	.79	T300	26.98	834	5.95
7A6	.79	14F7	1.09	50Z7G	.98	304TH	11.25	836	4.75
7A7	.99	14F8	1.29	52	.99	304TL	11.25	837	1.55
7A8	.89	14H7	.99	53	.69	307A/RK75	4.85	838	3.98
7AD7	1.49	14J7	1.19	T55	8.79	310A	6.75	843	.39
7AF7	.89	14N7	1.49	55	1.06	311A	7.90	845	4.90
7AG7	1.99	14Q7	1.09	56	.85	313C	2.98	849	29.45
7AH7	1.19	14R7	1.19	57	.79	316A	1.49	852	19.98
7B4	.79	14S7	1.09	58	.79	323A	24.25	860	4.90
7B5	.79	14W7	1.49	RK59	1.45	327A	4.95	861	23.95
7B6	.79	14X7	1.23	59	1.78	350B	5.90	868/CEIC	3.49
7B7	.89	15E	1.47	T60	10.49	353A	4.75	865	1.29
7B8	.89	15R	.89	HY69	4.98	HK354	24.98	866A	1.35
7C4/1203A	.79	FG17	4.95	70A7	1.59	355A	14.15	869	36.95
7C5	.79	18	.98	70L7GT	1.59	371B	.90	872A	2.35
7C6	.99	19	.69	71A	.79	368AS	7.75	GE872A	4.98
7C7	1.49	19BG6G	1.79	72	.95	388A	1.49	874	1.39
7C23	72.00	19T8	1.09	CRP72	1.37	393A	8.90	878	1.95
7C29	69.95	19V8	1.62	CRP73	1.49	394A	4.90	884/6Q5G	1.80
7E5/1201	1.29	T20/1623	3.79	73	1.67	FP400	15.98	885	1.45
7E6	.89	TUF20	5.19	NR74	.29	X400	14.98	893A	250.00
7E7	.89	TZ20	3.79	HY75	4.59	417A	8.95	922	.95
7F7	1.09	20	1.17	75	.79	GL434	14.98	923	1.00
7F8	2.19	RK20A	8.95	75TL	6.89	446/2C40	1.19	927/CE25	1.49

Sell Your **SURPLUS TUBES & EQUIPMENT** — Send List & Prices

7G7/1232	1.29	RX21	3.75	76	.79	446B	3.89	929	1.33
7H7	.89	22	.99	77	.69	450TH	39.00	930	.98
7J7	1.09	24	.85	78	1.05	450TL	44.00	931A	6.90
7K7	1.29	24A	1.10	79	.89	460/HE200	15.95	954	.29
7L7	1.19	24G/3C24	1.90	80	.69	WL468	13.95	955	.40
7N7	1.19	25A6	1.09	81	1.69	GL471A	2.69	956	.39
7Q7	.79	25A7	3.17	FG81A	3.90	GL502A	1.79	957	.45
7R7	.99	25AC5GT	1.59	82	1.19	RH507	9.98	958A	.67
7S7	1.09	25AV5GT	1.29	82V	1.39	GL530	22.00	991	.39
7T7	1.03	25BQ6GT	1.29	83	1.89	531	6.98	FM1000	1.50
7V7	1.39	25C6	1.18	83V	1.89	WL532	3.89	CK1005	.85
7W7	1.19	25L6GT	.69	84/6Z4	.99	550P1	19.95	CK1006	3.49
7X7/XXFM	1.19	25W4GT	.85	85	.79	575A975	13.75	CK1007	.89
7Y4	.69	25Y5	.79	89	.75	WL579	10.49	CK1090	2.69
7Z4	.69	25Z5	.79	VR92	.25	WL579B	12.98	R1100	5.00
8DC-15	4.98	25Z6GT	.99	FG98	19.95	601B	.19	R1130	12.00
10Y	.49	26	.79	100TH	8.89	HY615	.25	E1148	1.35
12A	.89	27	.69	102D	2.98	616	37.00	HY1231Z	5.39
12A5	1.39	FG27A	8.70	102G	2.98	KU627	18.00	1612	1.98
12A6	.89	RK28A	4.89	FG104	37.98	WL670A	11.98	1613/6F6X	.98
12A7	1.29	28D7		FG105	18.98	701A	5.89	1616	.90
12A8GT	.79	30	.79	VU111	1.45	702A	3.29	1619	.29
12AC7	1.45	31	.59	HY114B	.75	702B	5.98	1620	5.75
12AH7GT	1.99	HY31Z	2.75	HY115/145	.79	703A	5.98	1622	2.69
12AK5	1.98	32	.49	117L/M7GT		704A	.98	1624	1.90
12AK5W	2.98	FG32	12.90		1.59	705A/8021	2.79	1625	.42
12AL5	1.11	32L7GT	1.49	117N7GT	1.79	707A	10.49	1626	.42
12AT6	.59	33	.59	117P7GT	1.39	707B	17.49	1629	.35
12AT7	1.39	34	.69	117Z3	.59	710A/8011	.95	1630	.97
12AU6	.89	35/51	.89	117Z4GT	1.39	713A	1.00	1631	1.25
12AU7	.95	35A5	.79	117Z6GT	1.19	NL714	5.95	1632	.77
12AV6	.69	35B5	.79	117Z7GT	1.49	714AY	5.90	1633	.73
12AW6	1.79	35C5	.69	CK118		715A	6.45	1634	.73
12AX7	.99	35L6GT	.79	F123A	8.49	715B	9.65	1635	1.49
12AY7	2.95	35T	4.89	T125	12.49	715C	24.25	1636	3.19
12BA6	[illegible]	35TG	3.45	F127A	19.98	717A	1.49	1644	.95
12BA7	.79	35W4	.49	VT127A	3.90	718BY	48.45	2000T	149.50
12BD6	1.75	35Y4	.69						
12BE6	.89	35Z3	.79						
12BF6	.85	35Z4GT	.69						
12BH7	1.29	35Z5GT	.59						
12C8	1.39	REL36/6J4	.49						
12F5GT	.79	36	.65						

8014A	28.95
8020	1.25
8025	5.79
9001	1.65
9002	1.29
9003	1.19
9004	.59
9006	.29
Sub-Miniatures	
1AD4	2.95
2E31	1.49
2E36	1.49
2E43	1.39
CX501X	1.26
CK501AX	1.26
CK502AX	1.79
CK503AX	1.79
CK505AX	1.79
CK506AX	1.79
CK509AX	1.26
CK512AX	1.79
CK522AX	1.79
CK525AX	1.79
CK526AX	1.98
CK528AX	1.79
CK529AX	1.98
CK531DX	.98
CK532DX	.98
CK533AX	1.39
CK534AX	.89
CK536AX	.89
CK537AX	4.98
CK538DX	.89
CK539DX	.98
CK541DX	1.98
CK542DX	.98
CK543DX	.98
CK544DX	.98
CK546DX	1.98
CK547DX	1.98
CK571AX/5886	6.98
SD828	.98
SD969	.98
CK1028	9.98
CK1089	4.69
CK1090	4.69
5638	4.79
CK5672	3.15
CK5676	2.98
CK5678	2.45
CK5697	5.98
CK5702	5.98
CK5704	5.79
CK5783	6.69
CK5784	
5829	5.98
CK5875	1.98
C'Ray Tubes	
2AP1	11.90
3AP1	12.95
3AP1A	14.25
3BP1	7.95
3BP1A	14.98
3CP1	2.20
3DP1	4.85
3EP1	5.85
3FP7	1.89
3FP7A	14.98
3GP1	4.70
3HP7	3.85
3HP14	14.98

3JP7	12.50
3JP12	19.95
3JP14	16.95
4AP10	4.69
5AP1	3.65
5BP1	4.89
5BP1A	14.98
5BP4	4.75
5CP1	4.89
5CP7	4.95
5FP7	2.95
5FP14	18.98
5HP1	9.75
5HP4	9.75
5JP2	24.40
5LP1	29.95
5MP1	9.75
5NP1	5.85
7BP1	4.95
7BP7	6.75
7JP4	18.39
9GP7	14.89
9LP7	10.95
10BP4	18.29
10FP4	24.50
12DP7	16.89
12DP7A	49.50
12GP1	49.98
12GP7	16.89
12HP7	16.89
12JP4	27.00
12KP4	47.00
12LP4	21.25
16KP4	47.29
16LP4A	36.98
16MP4A	43.98
16RP4	36.49
16TP4	39.98
16YP4	43.98
17BP4	43.45
17BP4A	36.49
19DP4A	67.65
20CP4	68.25
902	10.65
905	3.49
912	89.98
913	11.98
914A	45.00

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50	15	7.98
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50	20	9.98
55	20	9.98
25	25	12.95
100	20	12.98
150	20	14.98
12	32	12.98
25	32	14.98

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195528	2.49
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289881	2.50
859483	2.95
Ballast	
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JFD "B"	.49
JFD "C"	.49
1P1	.49
PM3	.98
PM4	.98
3-40	.49
4A1	1.29
PM5	.98
6-11	.49
PM6	.98
6B	.49
PM7	.98
PM8	.98
9-3	.49
10-T1	.49
10-4B	.49
13-4	.49
20-4	.49
23D4	.43
L42B	.36
K49A	.36
KL45	.40
L55B	.36
M55B	.36
NL62A	.49
K80B	.36
100-77	.49
WL121A	2.61
C376	2.98
ZB583	3.98
876	.29
Mazda Pilots	
49, box 10	.60
51, box 10	.55
55, box 10	.50
64, Each	.07
S6/T4/3W	.18
100W/20V	.25
291, box 10	.36
311/28V	.15
313/28V	.15
323/3V	.25
Sylvania	
S6/6W120V	.15
Wstghs C7/7W/120V	.15
MedScrewBase	
15W/125V	.08
25W/125V	.08
Neon Bulbs	
NE16/991	.40
NE20	.10
NE21	.45
NE32	.35
NE45/2W	.27
NE51/NE20	.10
Bull's Eye Lite Dialco Type Chromed Less Bulb	.59; 2/.98
Tel Slide Lamps 6/12/24/48/55V Each	.18
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1N21	.89
1N21A	1.65
1N21B	3.98
1N21C	26.70
1N22	1.25
1N23	1.49
1N23A	2.98
1N23B	4.98
1N25	7.45
1N26	6.45
1N27	1.65
1N29	3.50
1N32	18.00
1N34	.69
1N34A	.89
1N35	1.95
1N38	1.62
1N39	5.65
1N40	9.98
1N45	1.39
1N46	.89
1N48	.70
1N51	.52
1N52	.95
1N54	.89
1N55	2.99
1N56	.89
1N57	.89
1N58	1.19
1N60	.60
1N61	1.98
1N62	Write
1N63	3.89
1N64	.75
1N67	1.95
1N69	1.98
K34	1.39
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CK706	.54
CK707	1.80
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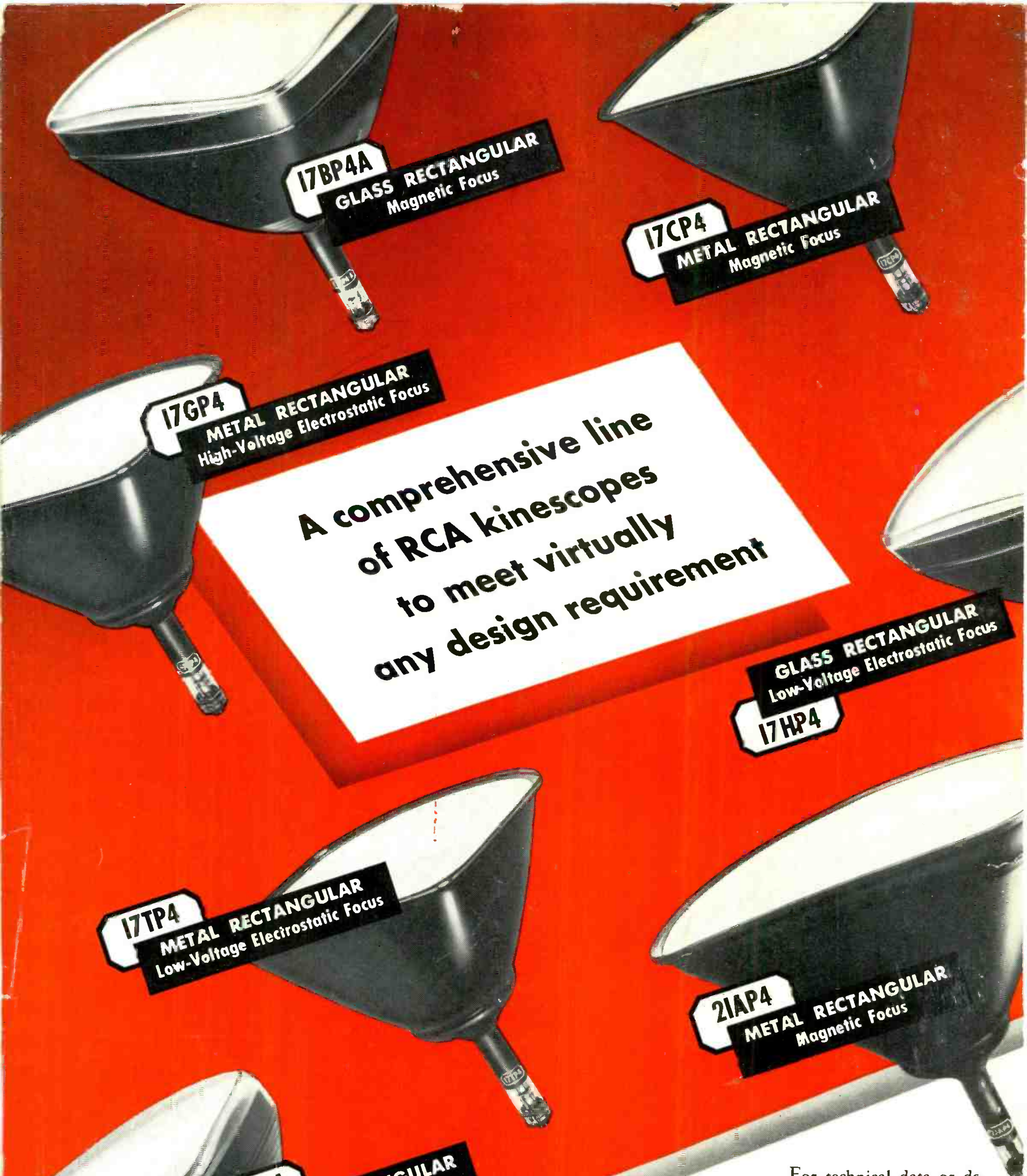

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