NOVEMBER · 1950

electronics

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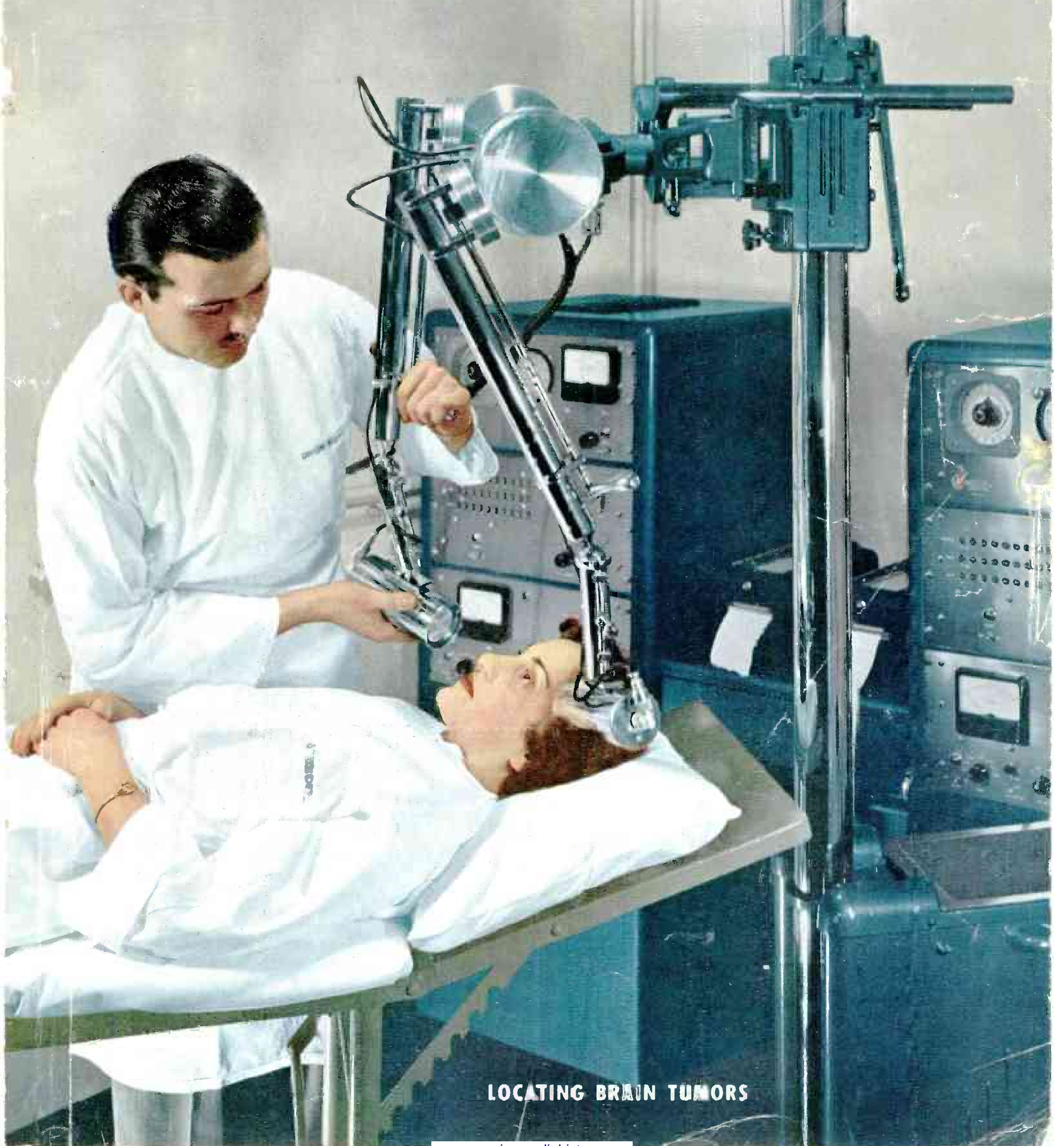


LOCATING BRAIN TUMORS

Linear Standard Units...

THE ULTIMATE IN QUALITY...

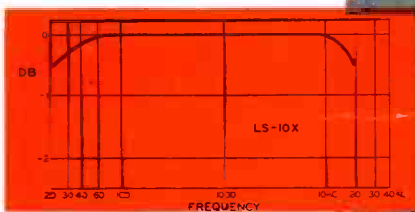
UTC Linear Standard Audio Transformers represent the closest approach to the ideal component from the standpoint of uniform frequency response, low wave form distortion, high efficiency, thorough shielding and utmost dependability.

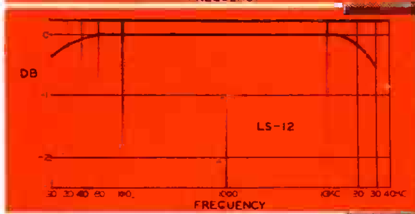
UTC Linear Standard Transformers feature . . .

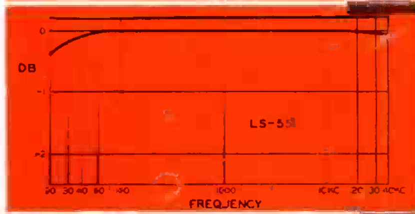
- **True Hum Balancing Coil Structure** . . . maximum neutralization of stray fields.
- **Balanced Variable Impedance Line** . . . permits highest fidelity on every tap of a universal unit . . . no line reflections or transverse coupling.
- **Reversible Mounting** . . . permits above chassis or sub-chassis 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	32.00
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	25.00
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	24.00
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	24.00
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	31.00
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	25.00
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	24.00
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	24.00
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	24.00
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	28.00







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	$28.00
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	28.00
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	20.00
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	42.00

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LOCATING BRAIN TUMORS .... COVER
Isotron, developed by the Nuclear Instrument and Chemical Corp., uses two Geiger counters to locate concentration of radioactive tracer in vicinity of brain tumor (see p 72)

DUAL STANDARDS FOR TELEVISION SCANNING 66
FCC proposal poses difficult technical questions. Possible answers are summarized

RADIATION COUNTERS AID BRAIN TUMOR DIAGNOSIS, by Richard G. Davis 72
Locate accumulation of radioactive material in vicinity of tumorous tissue

DESIGNING THE BRIDGEPORT UHF ANTENNA, by R. M. Scudder 76
Problem of obtaining high effective transmitter power at uhf is solved with high-gain omnidirectional antenna

COMPACT AMPLIFIER FOR AIRCRAFT TESTS, by John Foster and Taft Wrathall 81
Carrier amplifier with sensitivity of 8-μv input per ma output occupies 765 cu. in. complete with dynamotor

TIRE TREAD NOISE ANALYZER, by S. A. Lippmann and K. A. Ferguson 84
Photoelectric commutator ungates microphone circuit to select noise from one of many sample treads cut into tire

OVERTONE CRYSTAL OSCILLATOR DESIGN, by George H. Lister 88
Circuit permits direct operation on high-order overtones well above 100 mc with better stability than quartz crystal alone

32-CHANNEL HIGH-SPEED COMMUTATOR, by N. Alpert, J. Luongo and W. Wiener 94
All-electronic system provides sampling rates up to 1,000 cps

PRODUCTION EXPERIENCE WITH A 40-MC I-F RECEIVER, by D. W. Pugsley 98
How a 20-mc i-f receiver was redesigned to meet new standards

MICROWAVE SWEEP GENERATOR, by L. C. Eisaman 101
Motor-driven plunger sweeps klystron cavity from 2,600 to 3,400 mc

SHAPE RECORDING WITH RATIO-MODULATED TAPE, by Robert R. Perron 104
Memory for automatic machinery is accurate to 0.66 percent of radius in copying curves

QUENCH CONTROLLER FOR STEEL, by W. K. Halstead and L. D. Jaffe 109
Part plunged in water changes flux linkage between coils as it cools and actuates alarms

ELECTRICAL COLOR FILTERS, by V. Babits and H. Frank Hicks, Jr. 112
Varying electric and magnetic fields control color of transmitted light

GAIN-BANDWIDTH NOMOGRAPH (Reference Sheet), by Chester W. Young 116
Speeds calculations in designing single-tuned amplifiers and shows overall effect of varying any parameter

BUSINESS BRIEFS 60
CROSSTALK 65
TUBES AT WORK 120
ELECTRON ART 124
NEW PRODUCTS 128
NEWS OF THE INDUSTRY 132
NEW BOOKS 136
BACKTALK 136
INDEX TO ADVERTISERS .... (Last Page)

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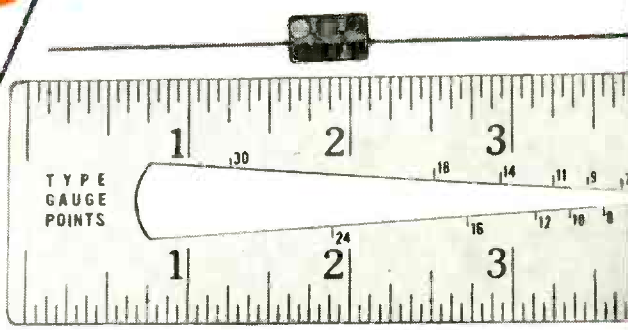

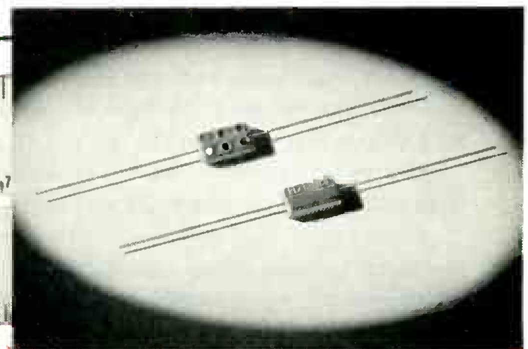

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A STANDARD OF ZERO LOSS ANGLE

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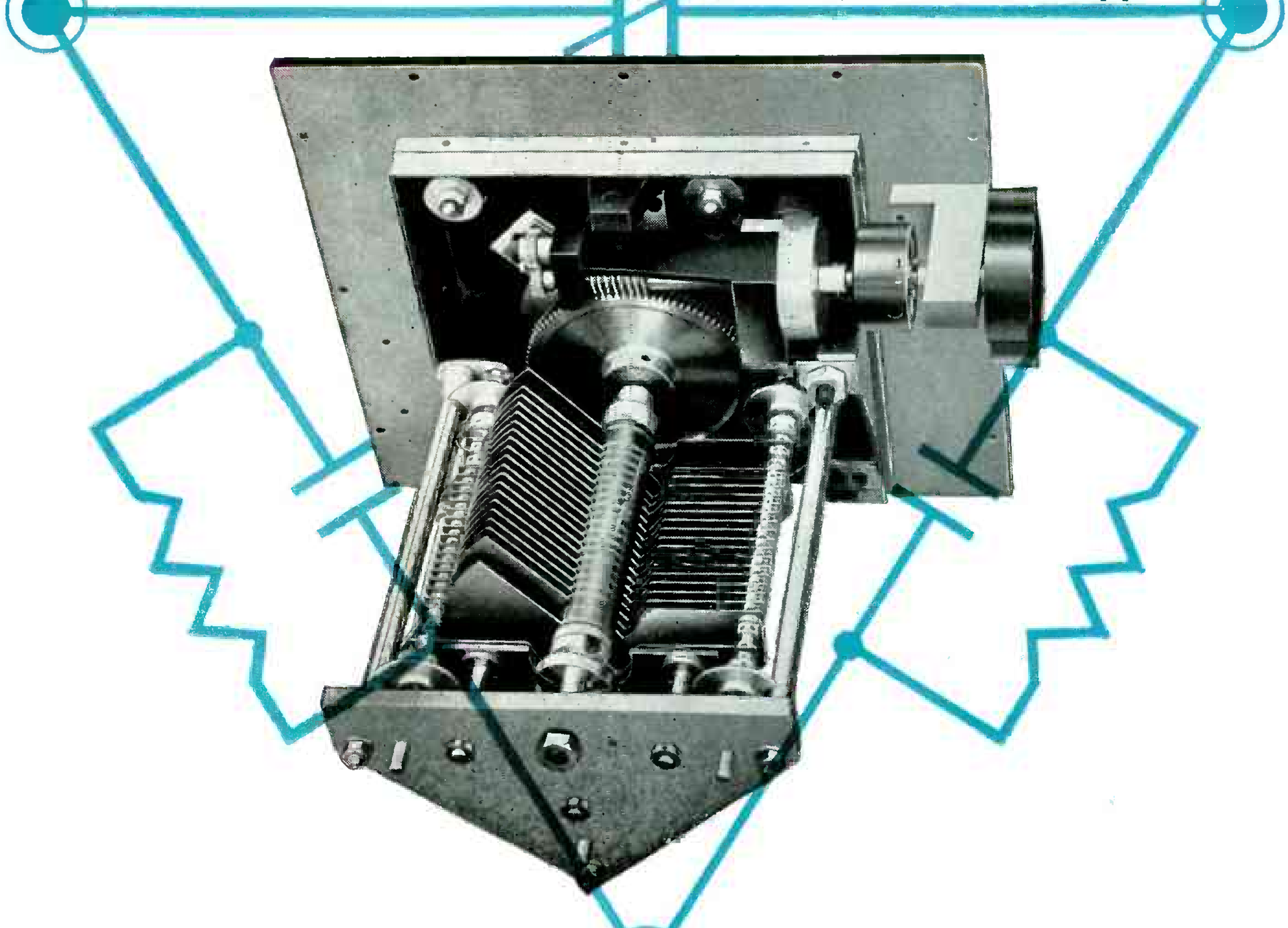

THIS three-terminal double-screened capacitor is provided with guard rings which ensure that the dielectric of the plate-to-plate capacitance is composed entirely of air. This, together with the special surface treatment of the plates, reduces the plate-to-plate power loss to a quantity which can be disregarded even when measuring the smallest power factors.

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CAPACITANCE: Type D-14-A: 1300$\mu\mu$F calibrated. Type D-14-B: 100$\mu\mu$F to 1000$\mu\mu$F direct reading.

LOSS ANGLE: Approx. 1 micro-radian in a dry atmosphere; 7 micro-radians at 75% relative humidity, for the frequency range 50c/s to 10,000c/s and any setting of the capacitor.

DRIVE: Worm reduction gear, 50 : 1 ratio.

SCALE: 5000 divisions. Subdivision to 1 part in 20,000 by interpolation.

BACKLASH: Not exceeding 1 part in 20,000.

DIMENSIONS: $12\frac{7}{8}$" x 10" x $13\frac{5}{8}$" (32·7 x 25·4 x 34·6cm.).

PRICE: Type D-14-A: \$365. Type D-14-B: \$390. Including packing and freight.

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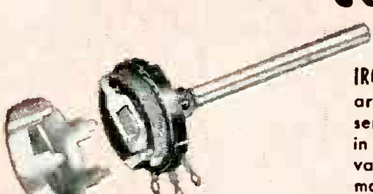
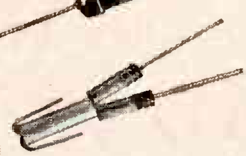
CONTROLS



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

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

PRECISION RESISTORS



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

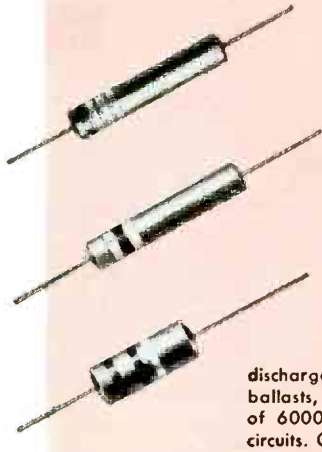
IRC Deposited Carbon PRECISTORS combine accuracy and economy for close-tolerance applications, where carbon compositions are unsuitable and wire-wound precisions too expensive. Catalog Bulletin B-4.

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

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

is essential

INSULATED COMPOSITION and WIRE WOUND RESISTORS



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

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

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

HIGH FREQUENCY and HIGH POWER RESISTORS

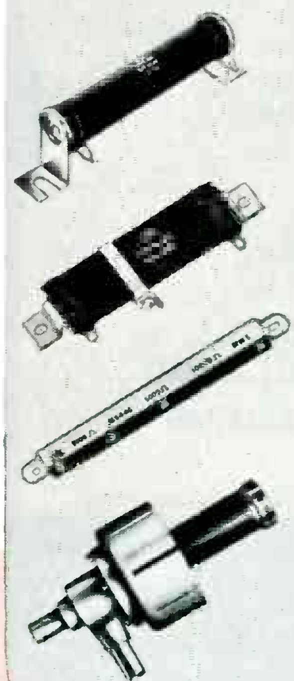
IRC Type MP High Frequency Resistors afford stability with low inherent inductance and capacity in circuits involving steep wave fronts, high frequency measuring circuits and radar pulse equipment. Available in sizes from ¼ to 90 watts. Catalog Bulletin F-1.

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

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

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

POWER RESISTORS



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

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

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

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

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☐ Bulletin B-1 (BTAV)	☐ Bulletin C-2 (PWW)	☐ Bulletin G-1 (MV)
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For 60 cps power sources — 22 styles — maximum output powers from ½ watt to 1200 watts.

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For complete details, write factory direct or see the -hp- sales representative in your area.

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GENERATORS

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10 to 500 mc -*hp*- 608A SIGNAL GENERATOR

Output range 0.1 μv. to 1.0 v. into 50 ohms. Accuracy ± 1 db. Direct reading frequency and output calibration, no charts or interpolation. CW, pulsed or amplitude modulated output (50 to 1,000,000 cps). Resetability better than 1 mc. Master oscillator power amplifier for widest modulation capabilities. Constant internal impedance 50 ohms. Maximum VSWR 1.2. $850 f.o.b. factory.

-*hp*- Model 608A

450 to 1,200 mc -*hp*- 610B SIGNAL GENERATOR

Output range 0.1 μv. to 0.1 v. into 50 ohms. Accuracy ± 1 db. Output and frequency directly set and read, no charts or interpolation. Modulation: internal or external pulsed, external amplitude, external square wave. Widely variable pulse length, repetition, and delay features. $925 f.o.b. factory.

-*hp*- Model 610B

800 to 2,100 mc -*hp*- 614A SIGNAL GENERATOR

Output range 0.1 μv. to 0.223 v. (1 mw). Accuracy ± 1 db. Single dial direct reading frequency and output, no charts or interpolation. CW, pulsed and FM output. Modulation: internal pulsed, FM, external pulsed. Widely variable pulsing, synchronizing, delay and triggering features. Extremely fast rise/decay time 0.1 μsec. Constant internal impedance 50 ohms, SWR 3 db. $1,950 f.o.b. factory.

-*hp*- Model 614A

1,800 to 4,000 mc -*hp*- 616A SIGNAL GENERATOR

Output range 0.1 μv. to 0.223 v. (1 mw). Accuracy ± 1 db. Single dial, direct reading frequency and output, no charts or interpolation. Output, modulation, and synchronization features identical with Model 614A. Like Model 614A, instrument automatically tracks frequency changes, requires no voltage adjustment during operation. $1950 f.o.b. factory.

-*hp*- Model 616A

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The critical requirements of television circuits demand better tubes with finer electrical alloys — alloys that are superior electrically, chemically and in physical properties. A logical source for metals to meet these new standards is the Wilbur B. Driver Company, largest producer of carbonized nickel ribbon and filament alloys *for more than twenty years.* Inquiries concerning critical tube applications will receive prompt, capable attention. Write today, outlining your requirements — there is no obligation.

WILBUR B. DRIVER CO.

150 RIVERSIDE AVE., NEWARK 4, NEW JERSEY

TOPHET FOR TOP HEAT

ADVENTURES IN ELECTRONIC DESIGN

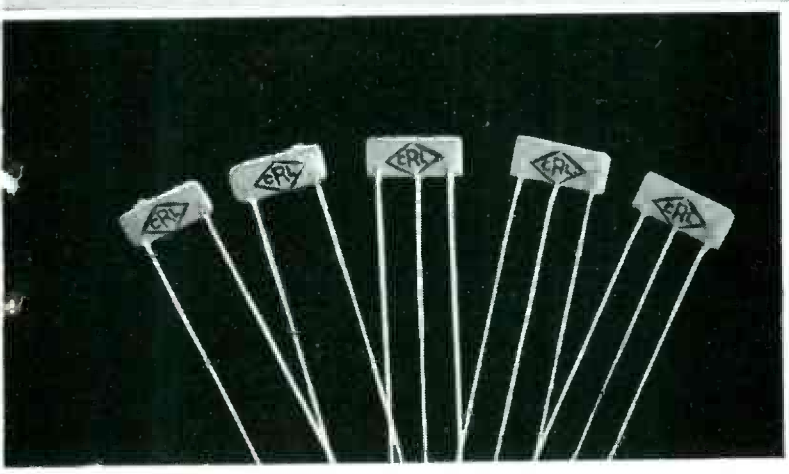
Centralab's Printed Electronic Circuits May Solve a Problem for You

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

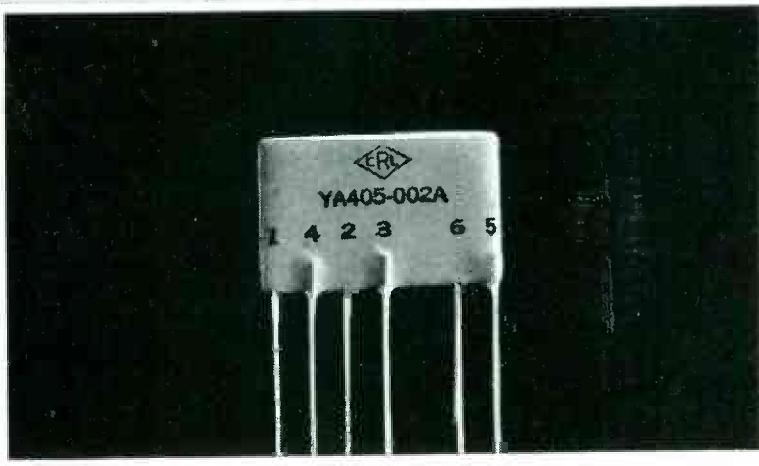
Centralab — DEVELOPMENTS THAT CAN HELP YOU

Division of GLOBE-UNION INC., Milwaukee

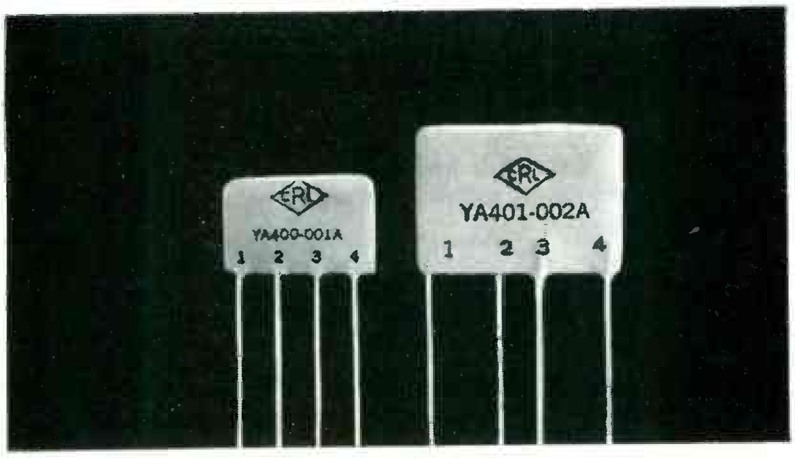
CUT ASSEMBLY COSTS
Conserve Resistors



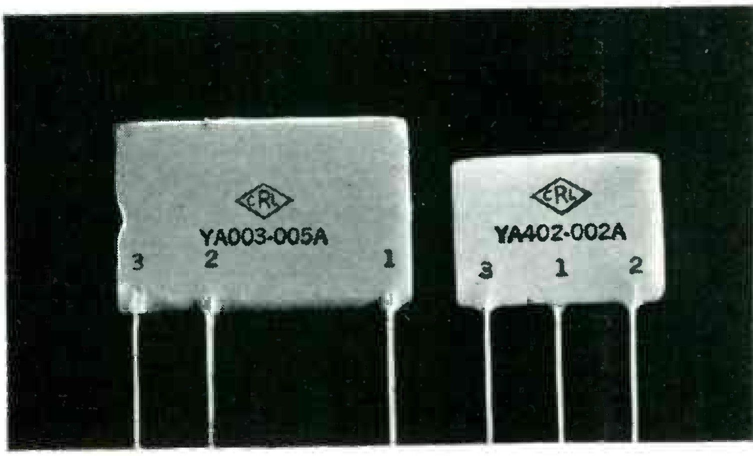
Actual size photograph of a group of plate capacitor, resistor, and resistor-capacitor units. Because of size and ease of installation, they readily fit all types of miniature and portable electronic equipment and overcome crowded conditions in TV, AM, FM and record-player chasses.



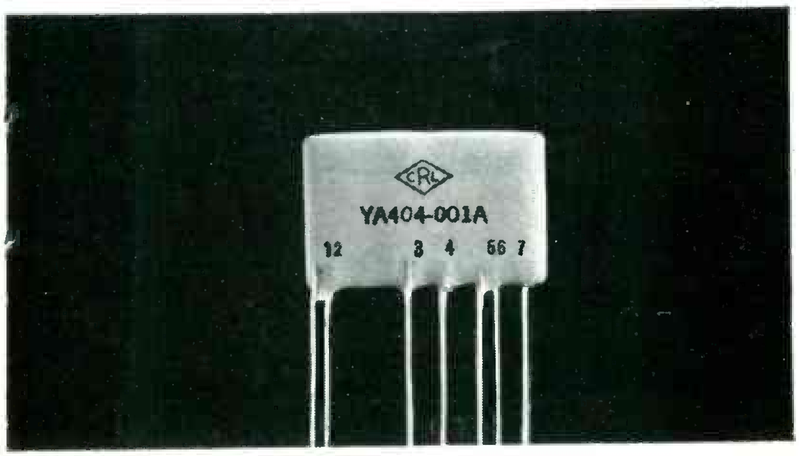
Pentode couplates are complete interstage coupling circuits consisting of 3 capacitors and 3 resistors on a small 6 lead ceramic plate. Compared with old-style audio circuits, they actually reduce soldered connections 50% — wiring errors accordingly. Saving in space and weight is obvious.



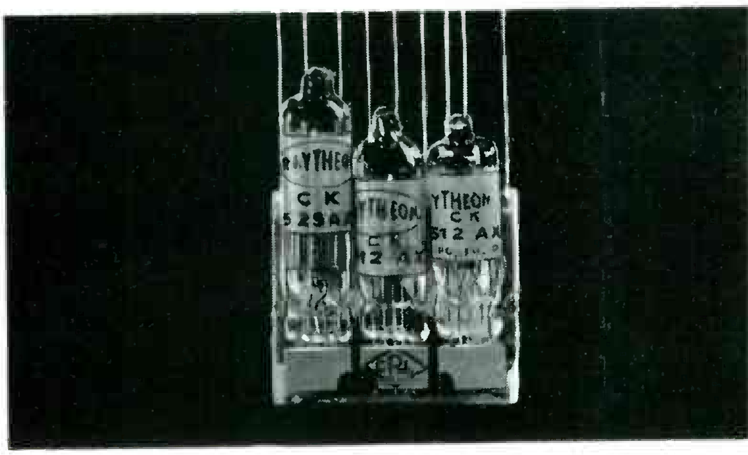
Centralab Triode Couplates save space and weight. They actually replace 5 components normally used in audio circuits. Triode Couplates are complete assemblies of 3 capacitors and 2 resistors bonded to a dielectric ceramic plate. Available in a variety of resistor and capacitor values.



Centralab Vertical Integrators give you big savings in assembly costs, particularly in TV vertical integrator networks. One type consists of 4 resistors and 4 capacitors brought out to 3 leads . . . reducing the formerly required 16 soldered connections to only 3! There's a big saving in the number of parts handled, too!



Audet P. E. C. units furnish all values of all components generally comprising the output stage of AC-DC radio receivers. They give you 4 capacitors and 3 resistors on a small plate with only 7 leads. Using Audet for output stage eliminates 50% of your usual soldered connections.



Ampec is a full 3-stage, 3-tube speech amplifier. Gives you truly highly efficient reliable performance. Size: $1\frac{1}{4}''$ x $1\frac{1}{8}''$ x .340″ over tube sockets! Widely used in hearing aids, mike preamps and other amplifier applications where small size and outstanding performance counts.

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999 — PENTODE COUPLATE — specialized P. E. C. coupling plate.
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42-10 — HI-VO-KAPS — high voltage capacitors for TV application.
42-59 — CERAMIC TUBULAR TRIMMERS — designed for TV and VHF application.
695 — CERAMIC TRIMMERS — CRL trimmer catalog.
981 — HI-VO-KAPS — capacitors for TV application. For jobbers.
42-18 — TC CAPACITORS — temperature compensating capacitors.
814 — CAPACITORS — high-voltage capacitors.
975 — FT HI-KAPS — feed-thru capacitors.

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Look to CENTRALAB in 1950! First in component research that means lower costs for the electronic industry. If you're planning new equipment, let Centralab's sales and engineering service work with you. For complete information on all CRL products, get in touch with your Centralab Representative. Or write direct.

CENTRALAB
Division of Globe-Union Inc.
914 East Keefe Avenue, Milwaukee, Wisconsin

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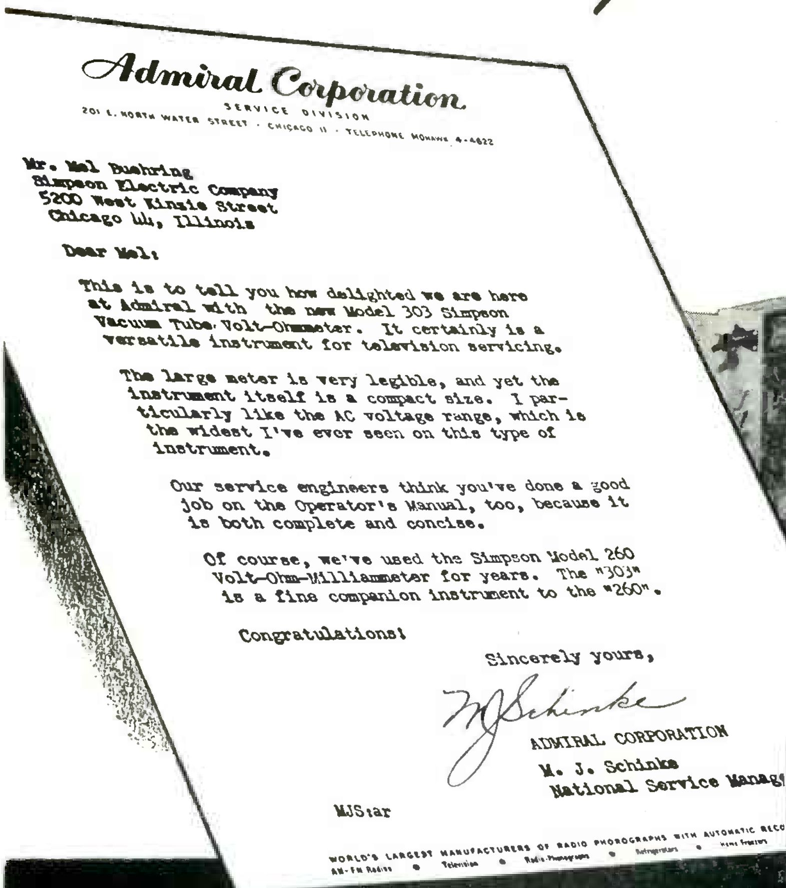
..this letter speaks for itself!



Admiral Corporation
SERVICE DIVISION
201 E. NORTH WATER STREET · CHICAGO 11 · TELEPHONE MOHAWK 4-4622

Mr. Mel Buehring
Simpson Electric Company
5200 West Kinzie Street
Chicago 44, Illinois

Dear Mel:

This is to tell you how delighted we are here at Admiral with the new Model 303 Simpson Vacuum Tube Volt-Ohmmeter. It certainly is a versatile instrument for television servicing.

The large meter is very legible, and yet the instrument itself is a compact size. I particularly like the AC voltage range, which is the widest I've ever seen on this type of instrument.

Our service engineers think you've done a good job on the Operator's Manual, too, because it is both complete and concise.

Of course, we've used the Simpson Model 260 Volt-Ohm-Milliammeter for years. The "303" is a fine companion instrument to the "260".

Congratulations!

Sincerely yours,

ADMIRAL CORPORATION
M. J. Schinke
National Service Manag

MJS:ar

WORLD'S LARGEST MANUFACTURERS OF RADIO PHONOGRAPHS WITH AUTOMATIC RECO
AM-FM Radios · Television · Radio-Phonographs · Refrigerators · Home Freezers

Model 303 VACUUM TUBE VOLT-OHMMETER

SPECIFICATIONS

DC Voltage
Ranges 1.2, 12, 60, 300, 1200 (30,000 with Accessory High Voltage Probe)
Input Resistance 10 megohms for all ranges
DC Probe with one megohm isolating resistor Polarity reversing switch

Ohms *Ranges 1000 (10 ohms center)*
100,000 (1000 ohms center)
1 megohm (10,000 ohms center)
10 megohms (100,000 ohms center)
1000 megohms (10 megohms center)

AC Voltage
Ranges 1.2, 12, 60, 300, 1200
Impedance (with cable) approx. 200 mmf shunted by 275,000 ohms

AF Voltage
Ranges 1.2, 12, 60
Frequency Response Flat to 100,000 cycles

Decibels
Ranges −20 to +3, −10 to +23, +4 to +37, +18 to +51, +30 to +63

Zero Power Level 1 M. W., 600 ohms

Galvanometer
Zero center for FM discriminator alignment and other galvanometer applications

R. F. Voltage
(Signal tracing with Accessory High Frequency Crystal Probe)
Range 20 volts maximum
Frequency Flat 20 KC to 100 M.C.
105-125 V. 60 cycles

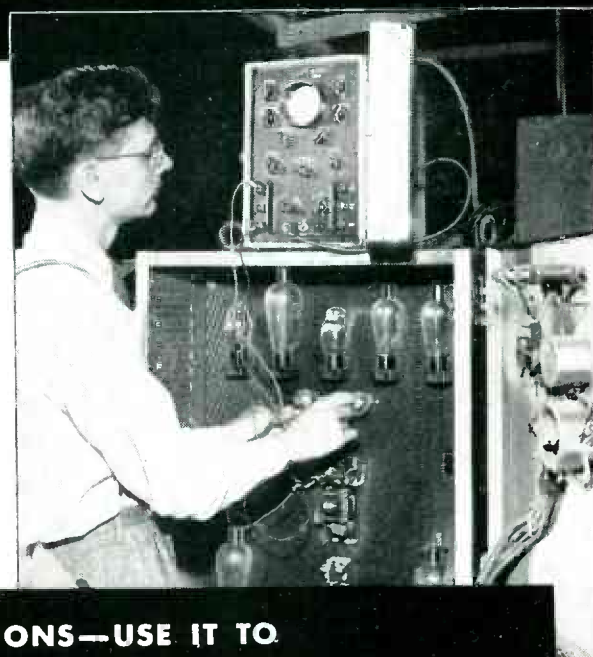
Size
5¼"x7"x3⅛" (bakelite case). Weight: 4 lbs. Shipping Wt.: 6½ lbs.

Dealer's Net Price
Model 303, including DCV Probe, ACV—Ohms probe and Ground Lead—$58.75;
Accessory High Frequency Probe, $7.50;
Accessory High Voltage Probe, $14.85
Also available with roll top case, Model 303RT—$64.75

Simpson ELECTRIC COMPANY
5200 WEST KINZIE STREET, CHICAGO 44, ILLINOIS • IN CANADA: BACH-SIMPSON, LTD., LONDON, ONTARIO
Phone: COlumbus 1-1221

INDUSTRIAL TEST EQUIPMENT

SHOOT TROUBLE *on the line*... REDUCE COSTLY SHUTDOWNS!



INDUSTRIAL OSCILLOSCOPE—For tracing circuit trouble in electronic-control equipment, this scope is fast, accurate, and dependable. Ideal for checking welding machines, high wave capacitor discharge panels, variable speed motor controls. Set it down anywhere—the case is insulated . . . carry it easily—weighs only 27 pounds . . . use it in many ways—tests both AC and DC.

★ Tests make-and-break of relay circuits

★ Checks waveforms in Thyratron control

★ Max. input voltage 550

★ Sensitivity 0.15 volts dc/inch; 0.18 volts rms/inch.

IN WELDING OPERATIONS—USE IT TO

★ check "hard-starting" ignitrons

★ observe voltage shapes on tube elements in timing sequence circuits

★ check instantaneous regulation on high current welder supply line

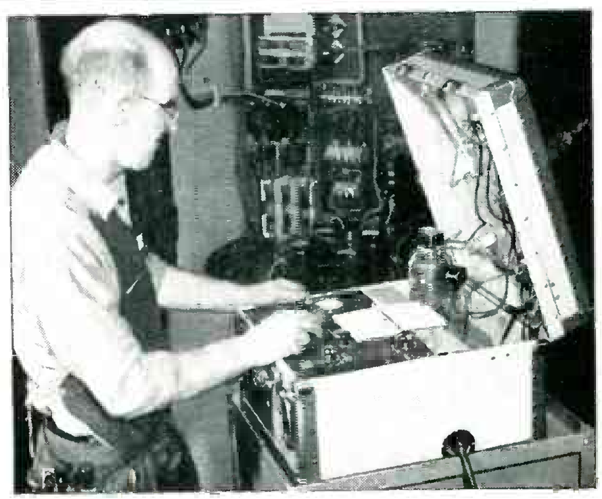
★ set "full heat limit adjustment"

★ check relays for bounce and high resistance contactors

★ check "on" and "off" time in seam welders

★ check behavior of peaking transformers

★ check high frequency interference switch transients caused by other equipment



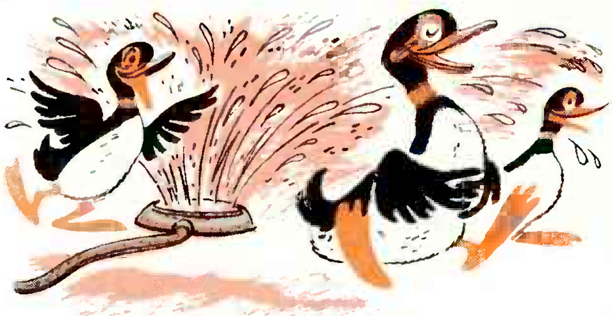
INDUSTRIAL TUBE ANALYZER—Which tubes are bad? Don't guess—check them quickly, easily with this Analyzer that pays for itself in the cost of tubes you would normally scrap. Tests Thyratrons and Phanatrons with ratings up to 100 amperes peak current. Can be operated by non-technical personnel after brief instruction. Backs up the G-E Industrial Oscilloscope to boost your maintenance efficiency, cut your costs.

GET THIS CATALOG—IT'S FREE!

Contains specifications and price information on instruments shown here as well as other items of G-E electronic test equipment. Write: *General Electric Company, Section 4110, Electronics Park, Syracuse, New York.*

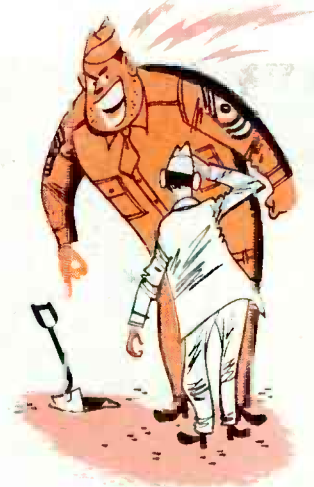
GENERAL ELECTRIC

It's a fact that



AlSiMag is impervious to moisture

AlSiMag is as light as aluminum



AlSiMag is harder than granite

AlSiMag does not rust, oxidize or corrode

AlSiMag is non-magnetic

AlSiMag has higher insulation at high temperature than fused quartz

AlSiMag withstands higher compressive loads than steel

AlSiMag is chemically inert

AlSiMag is permanently rigid

AlSiMag has lower coefficient of expansion than any commonly used metal

ALSIMAG

TRADE MARK REGISTERED U.S. PATENT OFFICE

CUSTOM MADE TECHNICAL CERAMICS

AlSiMag is the trade name of a large family of versatile ceramics. Among the many AlSiMag compositions, you may find one which has exactly the physical characteristics you need. AlSiMag makes parts to your blue prints, cooperates on design when desired. These parts come to you ready for your assembly line. They are uniform, dimensionally accurate, and are economically fabricated in quantity. The AlSiMag Property Chart is sent free on request.

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49TH YEAR OF CERAMIC LEADERSHIP

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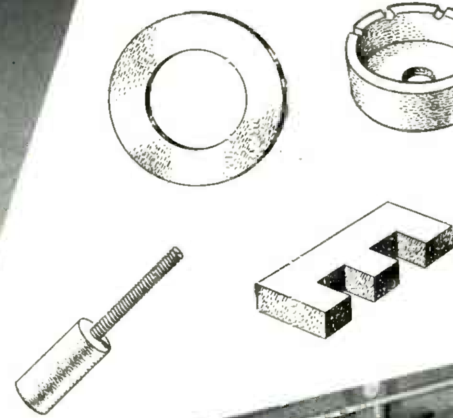
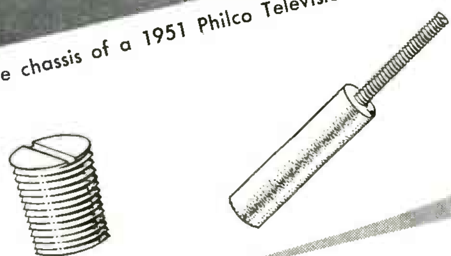
The chassis of a 1951 Philco Television Receiver





PHILCO CORPORATION

PHILADELPHIA 34
PENNSYLVANIA

September 5, 1950

Mr. T. R. Moore, Sales Manager
Antara Products - General Aniline & Film Corporation
444 Madison Avenue
New York 22, N. Y.

Dear Mr. Moore:

For the past two years Philco has tremendously increased its production of television receivers, and at the same time we have made a concerted drive to improve the quality of all components, as well as the complete receivers.

In line with this successful Quality Control program, we have found that your Carbonyl Iron Powders, used in powdered iron cores for fixed and variable inductances, in such parts as width and linearity coils, IF transformers and tuner coils, result in greater circuit efficiency. At the same time, it has also been possible to reduce the size of components which incorporated powdered iron.

Because of these advantages, reduced size and increased efficiency of components, as well as a uniformly high standard of quality, your Carbonyl Iron Powders have aided us in keeping the quality of Philco television receivers at the highest level. This has been particularly important because we have stepped up quantity of production so greatly along with quality. We are aiming at manufacturing more than 1,000,000 Philco television receivers in 1950.

Very truly yours,

PHILCO CORPORATION

F. M. Craig
Director of Engineering
Electronics Division

In the making of G A & F Carbonyl Iron Powders only the strictest methods of Quality Control are observed

G A & F® Carbonyl

SIZES REDUCED... EFFICIENCY INCREASED

for components of PHILCO Television Receivers through use of

CARBONYL IRON POWDERS

PHILCO Television Receivers are produced under rigid, scientific methods of Quality Control . . . So are G A & F Carbonyl Iron Powders . . . It was all but inevitable that the combination would produce components of high efficiency and top performance.

However, Philco was not blindly worshipping an abstract ideal. *Reduced sizes* became a second, highly desirable result. Third, as leading core makers have testified, it *costs less* to work with quality materials—such as G A & F Carbonyl Iron Powders.

The savings and the gains are both more numerous and more important than are here indicated. Let us send you the book described below . . . Ask your core maker, your coil winder, your industrial designer, how G A & F Carbonyl Iron Powders can improve the performance of the equipment you manufacture. It will cost you nothing to get the facts.

THIS FREE BOOK — fully illustrated, with performance charts and application data — will help any radio engineer or electronics manufacturer to step up quality, while saving real money. Kindly address your request to Department 51.

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DIVISION OF
GENERAL DYESTUFF CORPORATION
435 HUDSON STREET • NEW YORK 14, NEW YORK

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Iron Powders . . .

MEMBER mpa METAL POWDER ASSOCIATION

A NEW Insulating Laminate...

INSURAK* GRADE T-812

COMBINES:

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

*Reg. U. S. Pat. Off.

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

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

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

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

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

The RICHARDSON COMPANY

FOUNDED 1858—LOCKLAND, OHIO

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

SALES OFFICES: CLEVELAND • DETROIT
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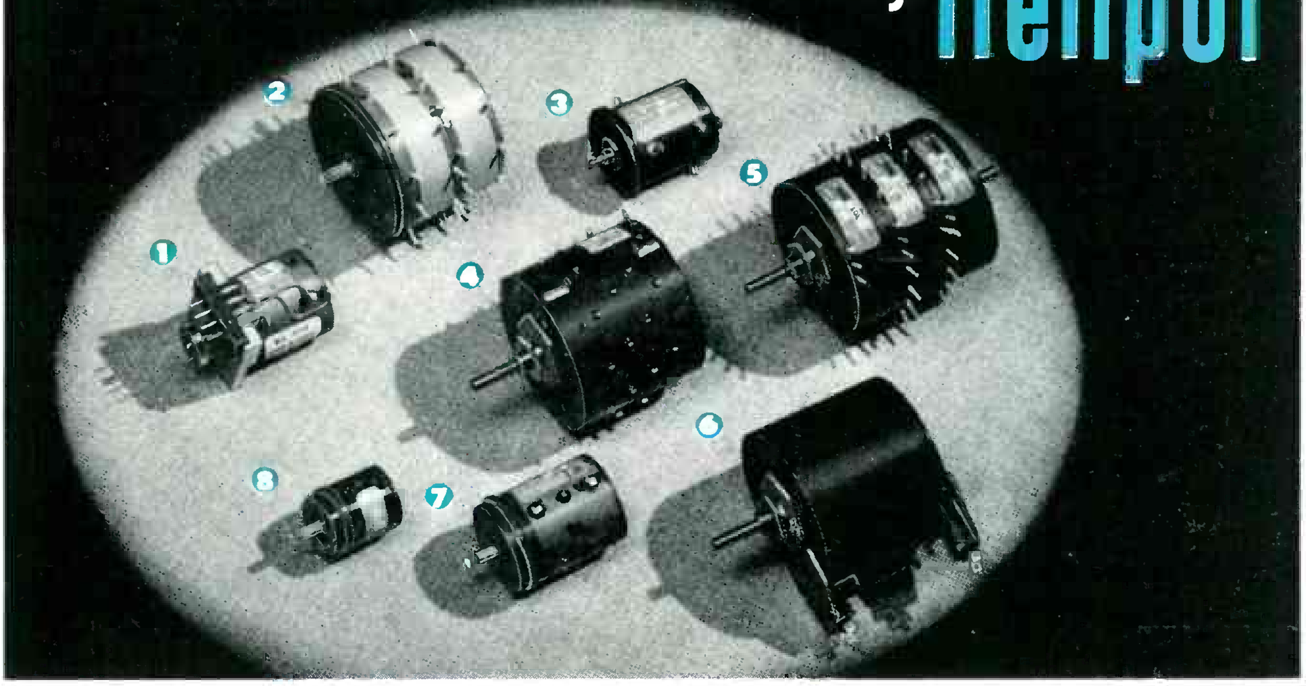
Typical of the TOUGH POTENTIOMETER JOBS solved by Helipot



Precise Accuracy + Maximum Versatility + Space-saving Compactness

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

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

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

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

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

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

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

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

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

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

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

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

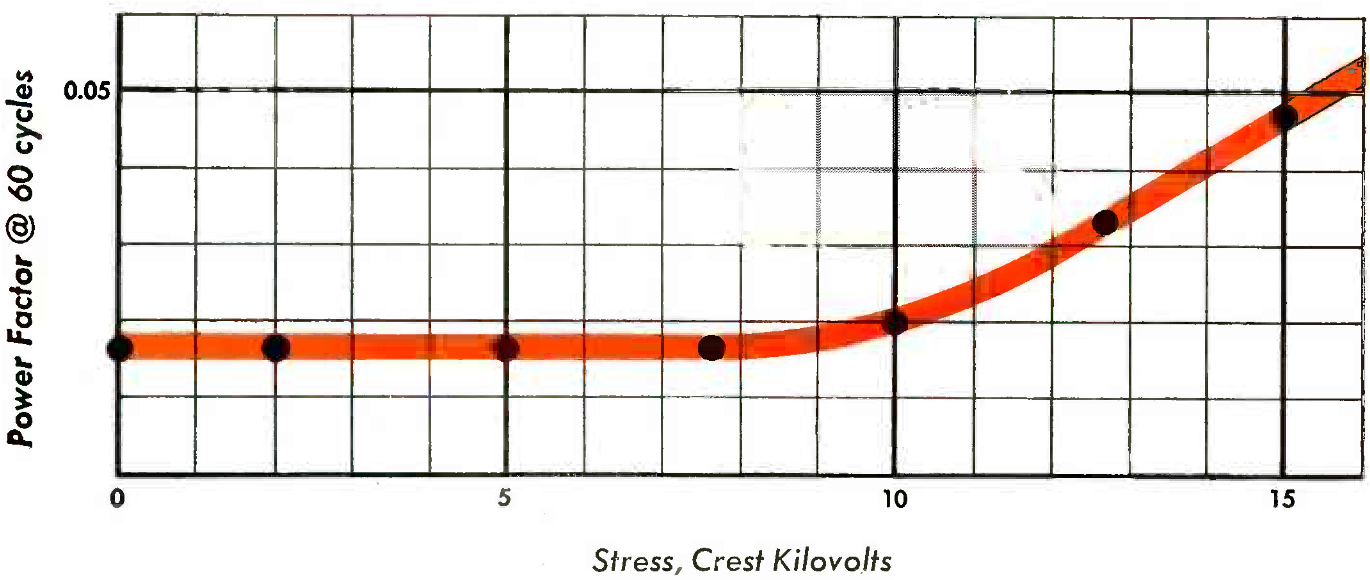
THE Helipot CORPORATION, SOUTH PASADENA 2, CALIFORNIA

An outstanding

MICO
ELECTRICAL INSULATION
Trade-mark

CEE Grade Lamicoid® #6050

It's in a class by itself!



The graph above shows power factor at 60 cycles for CEE Grade LAMICOID #6050 at various crest kilovolt stresses when tested in accordance with ASTM Designation D-150-47T after conditioning for 24 hrs. at 100° C.

DEVELOPMENT!

has exceptionally low power factor at 60 cycles!

new material tailored specifically for transformer applications means:

lower losses
higher dielectric strength
lower water absorption

Here's a brand new grade of LAMICOID developed by Mica Insulator Company especially to provide good electrical properties for high voltage use at commercial power frequencies.

Class A insulation, designed to withstand a "hottest-spot" temperature of 105 C (221 F), CEE Grade LAMICOID #6050 is ideal for oil-filled transformers, terminal boards and regulator switchplates. Here's why:

Its low power factor at 60 cycles provides an important advantage in transformers being manufactured to present-day specifications.

Because it is an exceptionally low loss material, LAMICOID #6050 does not heat up as readily as high loss materials when subjected to ordinary operating conditions.

Its dielectric strength parallel to the laminations is unusually high for canvas based laminates—60.0 KV plus when tested in oil at 85° C, using #3 taper pins 1" apart.

Its water absorption is unusually low for canvas based laminates—0.35% when tested in accordance with procedure outlined in ASTM designation D-570.

In addition, the new LAMICOID #6050 has good aging characteristics, and won't blister or delaminate in hot oil at 105° C. Made of selected quality fabric base material and special thermosetting resins, it's tough and strong—provides good mechanical support for conducting elements, coils, etc. LAMICOID #6050 can be supplied in sheets 36" x 42".

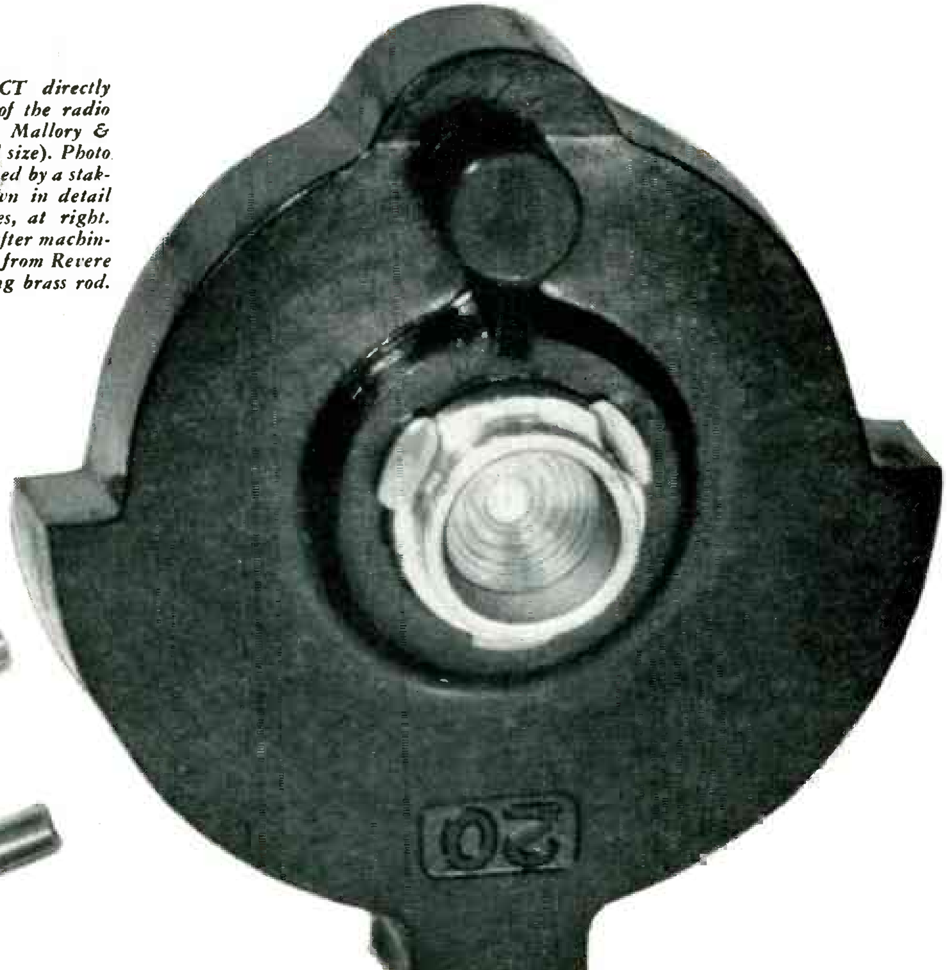
Products like LAMICOID #6050 are developed by getting down to cases. We've had 57 years' experience doing just that—*and* coming up with the answers, a line of high quality insulating materials. Your problem is our opportunity to make this experience pay off—for *both* of us. That's why we're glad to hear about your problems—and to work with you in developing materials tailored exactly to your requirements. Why not get in touch with our technical service staff today?

MICO ELECTRICAL INSULATION

MICA *Insulator* COMPANY

Schenectady 1, New York
Offices in Principal Cities

THE MUSHROOM-LIKE OBJECT directly below is the completed assembly of the radio volume control shaft made by P. R. Mallory & Co., Inc., Indianapolis, Ind., (actual size). Photo below it shows the plastic part attached by a staking operation. This staking is shown in detail in photo of part enlarged 7 times, at right. Photo at bottom shows control shaft after machining and before staking. Shaft is made from Revere Alloy 247 . . . ¼" round free cutting brass rod.



BY SWITCHING TO REVERE FREE CUTTING BRASS ROD P. R. MALLORY & CO., INC.,

SAVES ON 2 COUNTS!

Staking operation on radio volume control shaft performed without fracture . . . annealing operation eliminated.

The solution to the Mallory Company's problem was not as easy as it might appear. It was not simply a case of Revere Technical Advisory Service recommending ¼" round, free cutting brass rod. That rod had to possess the machinability to match Mallory's existing production machine set-up and at the same time be sufficiently workable so that annealing, prior to staking, could be eliminated; and that staking be accomplished without fracturing the metal.

After consulting with the Mallory Engineers, and discussing the tests which Mallory would subsequently conduct, Revere recommended a ¼" round, half hard riveting and turning rod mixture 247. Working tests made by Mallory showed this rod to possess all the necessary requirements.

As a result of those tests, P. R. Mallory & Company is now using this Revere free cutting brass rod to its complete satisfaction for the radio volume control shafts it manufactures. Not just any ¼" brass rod, but the *right* rod made it possible for them to save on 2 counts.

Perhaps Revere has a brass, a copper or some special alloy to help you in the development or improvement of your product . . . in cutting your production costs. So why not tell Revere *your* metal problems? Call the Revere Sales Office nearest you today.

REVERE

COPPER & BRASS INCORPORATED

Founded by Paul Revere in 1801

230 Park Avenue, New York 17, New York

• • •

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

IT'S UNOBTRUSIVE. Umber gray coloring blends it right into the TV picture. Minimum reflection.

In the show . . .
without stealing the act

RCA's new ribbon-pressure "STARMAKER"*

So SLIM YOU MUST LOOK sharply to see it . . . so skillfully styled its shape and coloring fade right into the scene . . . this tubular microphone has won the favor of entertainers and announcers wherever it has been shown.

Designed by RCA Laboratories after more than three years of painstaking research, the STARMAKER meets the long need of broadcasting, television, and show business for a high-fidelity microphone that—will not hide the features of performers—is easier to handle—*and yet retains all the high-quality features of RCA professional microphones.* Pick-up is non-directional. Frequency response is uniform, 50 to 15,000 cps.

Here is a "carry-around" microphone free from wind blast and air rumble. It contains no tubes, no condensers, no high-impedance circuits, no special amplifiers, or power supplies—is virtually impervious to mechanical shock.

The STARMAKER fits any standard microphone stand . . . and can be substituted for any professional high-quality RCA microphone. *No extra attachments needed!*

For price and delivery, call your RCA Broadcast Sales Engineer. Or write Dept. 36K, RCA Engineering Products, Camden, N. J.

**Selected from entries submitted by Broadcast Stations in national contest.*

IT'S COMFORTABLE TO HANDLE . . . weighs only 1 lb.

IT'S SMALL. Diameter of body is only 1¼ inches. Diameter of pick-up point is only ⅝ inch!

AUDIO BROADCAST EQUIPMENT

RADIO CORPORATION of AMERICA

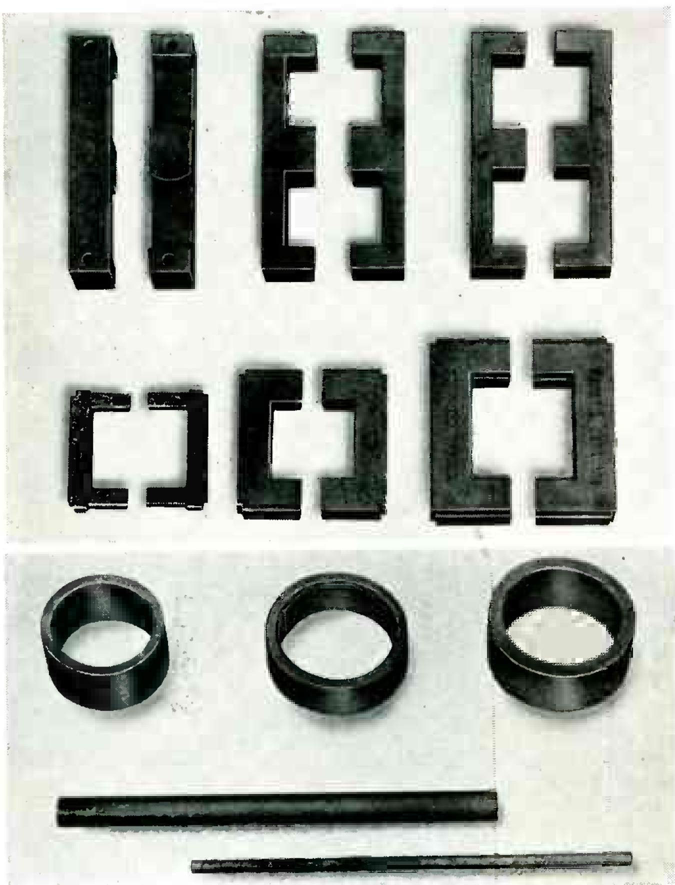
ENGINEERING PRODUCTS DEPARTMENT, CAMDEN, N.J.

In Canada: RCA VICTOR Company Limited, Montreal

FERRAMICS

by **GENERAL CERAMICS and STEATITE CORP.**

Ferramics are soft magnetic materials featuring high permeability, extremely high volume resistivity and lightweight. They are readily molded or extruded to practically any size or shape.



GENERAL
CERAMICS AND STEATITE CORPORATION
STEATITE INSULATORS

HIGH PERMEABILITY

Reduces size of components, increases circuit Q, results in greater overall efficiency.

HIGH VOLUME RESISTIVITY

Ferramics feature high volume resistivity, allow construction of solid cores with negligible eddy current losses.

HIGH EFFICIENCY

Permits cores of smaller cross-section, reduced cubic volume, improved circuit efficiency.

LIGHT WEIGHT

Ferramics are light in weight, permit important reductions in equipment weight.

NO LAMINATIONS

Ferramic cores are molded in solid shapes reducing the assembly cost of components.

Characteristics

FREQUENCY RANGE:
100 CYCLES TO MEGACYCLES

PERMEABILITY:
15 TO 3500

VOLUME RESISTIVITY:
10^{+4} TO 10^{+9} OHM/CCM

SATURATION FLUX DENSITY:
1000 TO 4000 GAUSS

COERCIVE FORCE:
.2 TO 2 OERSTED

SIZES:
DIE PRESSED OR EXTRUDED TO YOUR SPECIFICATION—A few typical shapes are shown above.

MAKERS OF STEATITE, TITANATES, ZIRCON PORCELAIN, FERRAMICS, LIGHT DUTY

If your product incorporates any of the following components, it will pay you to check, now, on the many advantages offered by FERRAMICS. Engineering data and information on many typical applications will be supplied on request.

TELEVISION HORIZONTAL OUTPUT TRANSFORMER CORES:

Smaller, more efficient cores.

TELEVISION YOKE COIL CORES:

Makes greater beam deflection possible and hence shorter cathode ray tubes.

RADIO BROADCAST RECEIVER ANTENNA CORES:

Improved reception, reduces antenna size.

TOROIDAL COIL CORES:

Increased induction, low coil loss.

CUP CORES:

Audio Frequencies — high Q, low loss, close shielding, lower cost due to bobbin wound coils.

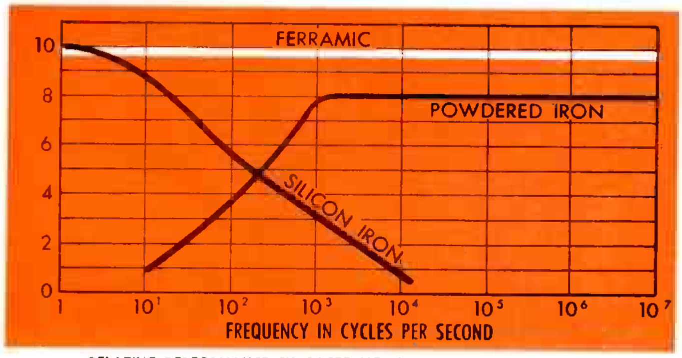
ELECTRONIC COMPUTERS:

Magnetic memory systems—stored data available more efficiently, eliminates vacuum tubes, reduces component size.

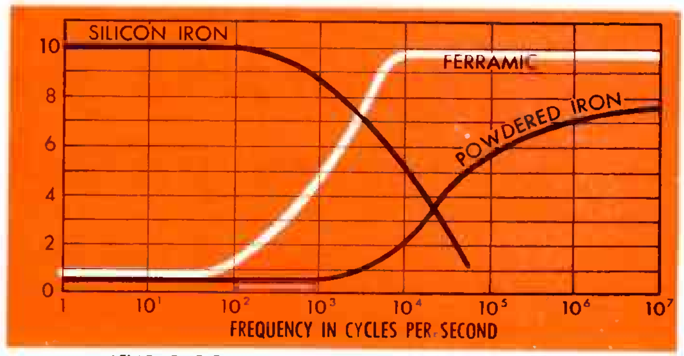
Pulse transformer cores—less distortion, lower core losses.

PERMEABILITY TUNING CORES:

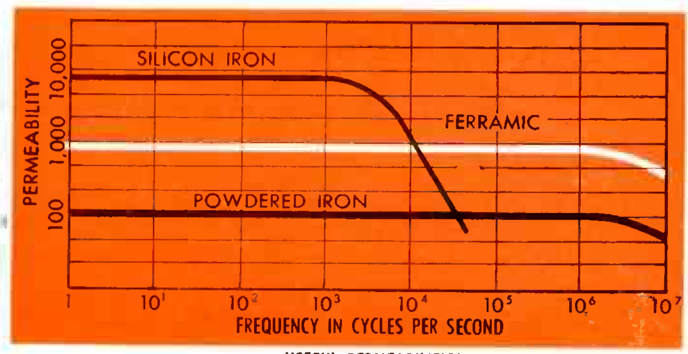
Increased tuning range due to higher permeability.



RELATIVE PERFORMANCE CHARACTERISTICS — NON-POWER APPLICATIONS



RELATIVE PERFORMANCE CHARACTERISTICS — POWER APPLICATIONS



USEFUL PERMEABILITIES

General CERAMICS AND STEATITE CORP.

GENERAL OFFICES and PLANT: KEASBEY, NEW JERSEY

REFRACTORIES, CHEMICAL STONEWARE, IMPERVIOUS GRAPHITE

How Karp Makes Custom-Built Metal Cabinets and Boxes at Prices that Compete with those of Stock Items

The advantages and true economies of Karp custom-built cabinets, boxes, or housings over stock items are these:

- Your own exclusive design distinguishes and "styles" your product . . . gives it more market value.
- Flexibility of construction details speeds and simplifies your final assembly —saving you time and money.
- Our vast stock of dies can save you special die costs.
- Our 70,000 square feet of modern plant, with hundreds of craftsmen, means ample capacity for many types of work—simple or elaborate—at one time.
- Plant is fully equipped with every mechanical facility that aids economical production.
- Finishing is done in dustproof paint shop, with latest water-washed spray booths and gas-fired ovens mechanically and electronically controlled.
- We make no stock items or products of our own. Our plant, time and effort are 100% for our customers' work.
- Our engineering staff can help solve any possible design and production problems.
- It's results that count—and we give you the results you want.

Write for illustrated data book describing our facilities and showing the wide range of sheet metal fabrication we do.

CABINETS • BOXES • CHASSIS • HOUSINGS • ENCLOSURES

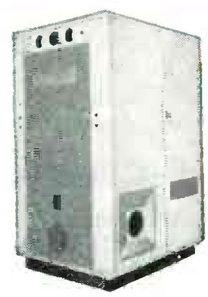
KARP METAL PRODUCTS CO., INC.

215 63rd STREET, BROOKLYN 20, NEW YORK

Specialists in Fabricating Sheet Metal for Industry

TV Monitor Console

Desk Panel Cabinet Rack



Induction Heater Housing

Chassis

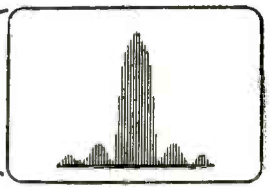
Marine Radio Housing

Cabinet

the FIRST all band-direct reading

SPECTRUM ANALYZER

10 MCS to 16,520 MCS



Polarad's Model LSA Spectrum Analyzer is the result of years of research and development. It provides a simple and direct means of rapid and accurate measurement and spectral display of an r.f. signal.

Outstanding Features:

- Continuous tuning.
- One tuning control.
- 5 KC resolution at all frequencies.
- 250 KC to 25 MCS display at all frequencies.
- Tuning dial frequency accuracy 1 per cent.
- No Klystron modes to set.
- Broadband attenuators supplied with equipment above 1000 MCS.
- Frequency marker for measuring frequency differences 0-25 MCS.
- Only three tuning units required to cover entire range.
- Microwave components use latest design non-contacting shorts for long mechanical life.
- Maximum frequency coverage per dollar invested.
- 5 inch CRT display.

The equipment consists of the following units:

Model LTU-1 R. F. Tuning Unit—10 to 1000 MCS.
Model LTU-2 R. F. Tuning Unit—940 to 4500 MCS.
Model LTU-3 R. F. Tuning Unit—4460 to 16,520 MCS.
Model LDU-1 Spectrum Display Unit.
Model LKU-1 Klystron Power Unit.
Model LPU-1 Power Unit.

Where Used:

Polarad's Model LSA Spectrum Analyzer is a laboratory instrument used to provide a visual indication of the frequency distribution of energy in an r.f. signal in the range 10 to 16,520 MCS.

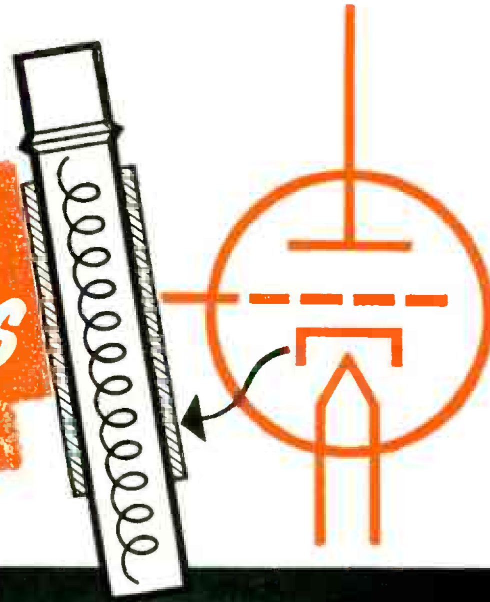
Other uses are:

1. Observe and measure sidebands associated with amplitude and frequency modulated signals.
2. Determine the presence and accurately measure the frequency of radio and/or radar signals.
3. Check the spectrum of magnetron oscillators.
4. Measures noise spectra.
5. Check and observe tracking of r.f. components of a radar system.
6. Check two r.f. signals differing by a small frequency separation.

Write for complete details

Polarad
Electronics Corporation
100 METROPOLITAN AVE. • BROOKLYN 11, N. Y.

Millimeters that do a Mammoth Job with Driver-Harris Alloys

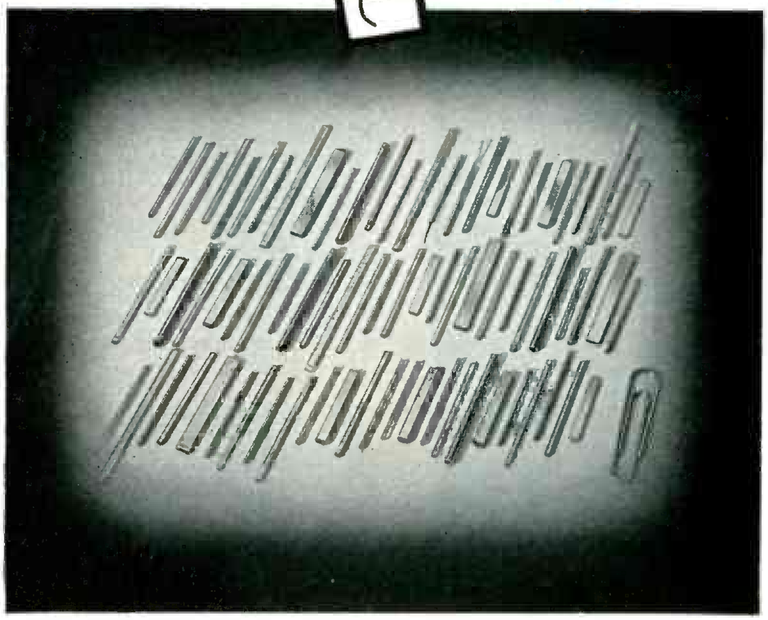


The introduction of the indirectly heated "cathode" brought about revolutionary improvement in the operation of electron tubes for radio and TV reception. It eliminated AC hum in receivers, and actually increased emission at lower filament voltage. Thus tubes became considerably more efficient, and operating life was greatly extended.

And all this as the result of employing a tiny component—customarily measured in millimeters, or very small fractions of an inch!

It stands to reason that an item of such importance as the cathode must be manufactured from materials that are carefully produced to exacting specifications. Superior Tube Company, leading manufacturers of nickel alloy cathodes, specifies Driver-Harris Alloys for both "active" and "passive" cathode base metals. "Active" materials, producing a high level of electron emission, are D-H Alloys 399, 599 and 799; "passive" materials, employed when freedom from grid back-emission is necessary, are D-H Alloys 499 and 999. All are produced free from oxides, and with extreme accuracy as to dimensions, temper and purity. The commercial grade of pure nickel does not meet specifications.

A consideration of major importance is *surface*. The surface of materials used for cathodes must possess sufficient "tooth" to enable coatings of chemical emitters (such as Barium-Strontium Oxide) to adhere successfully—without cracking or spalling. Driver-Harris furnishes the precise type of surface required.



D-H Alloy Cathodes, as produced by Superior Tube Company, Norristown, Pa., are made from thin strip stock, of thicknesses such as .002" and .0025"—handled by patented machines especially developed for the purpose of producing plain or beaded "Lockseam" type nickel cathode sleeves. Basic Dimensions: Max. OD—.100"; Min. OD—.040". Max. Length—42 mm.; Min. Length—11.5 mm. (Compare with paper clip.)

Here is but another example of the tremendous role played by D-H Alloys thruout industry—and the ability of Driver-Harris to produce *special alloys for special purposes.*

Whatever *your* particular alloy problem, let us have your specifications. We'll gladly put our specialized knowledge, and the skills acquired from fifty years of alloy manufacturing experience, at your disposal . . . make recommendations based upon your specific needs.

FIFTIETH ANNIVERSARY — SPECIAL PURPOSE ALLOYS SINCE 1899 — D H — TRADE MARK REG. U. S. PAT. OFF.

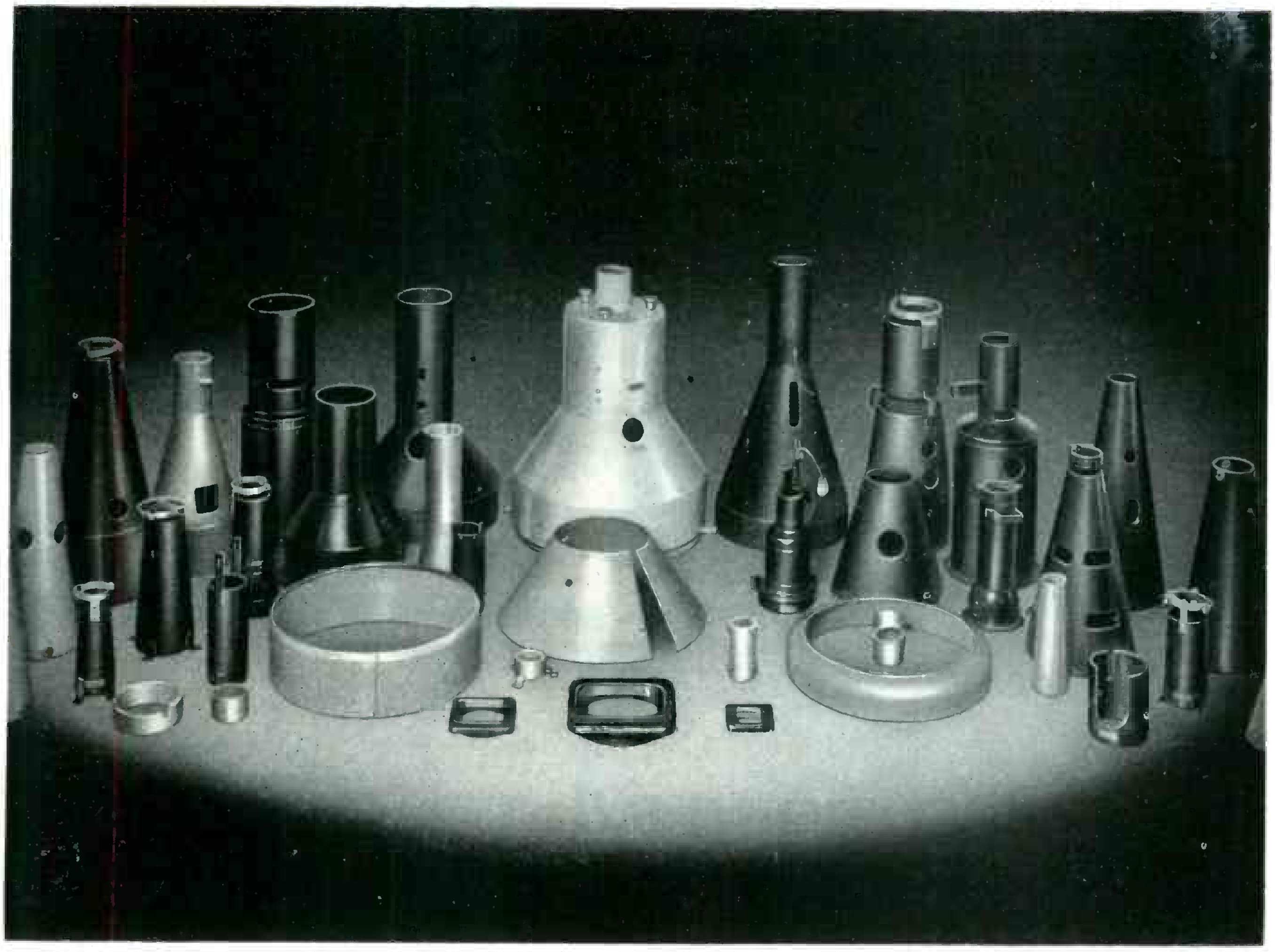
Manufacturers of world-famous Nichrome* and over 80 other alloys for the electronic, electrical and heat-treating industries

Driver-Harris Company

HARRISON, NEW JERSEY

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

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



Designed for Application

MU METAL SHIELDS

The James Millen Mfg. Co. Inc. has for many years specialized in the production of magnetic metal cathode ray tube shields for the entire electronics industry, supplying magnetic metal shields to manufacturing companies, laboratories and research organizations. Stock shields are immediately available for all of the more popular sizes and types of cathode ray tubes as well as bezels for 2", 3" and 5" size tubes.

Many production problems, however, make desirable special shields designed in conjunction with the specialized requirement of the basic apparatus. Herewith, are illustrated a number of such custom built shields. Our custom design and fabrication department is at the service of our customers for the development and manufacture of magnetic metal shields of either nicoloi or mumetal for such specialized applications.

Millen magnetic metal shields are illustrated and described in our Laboratory Equipment catalogue, a copy of which will be mailed upon request.

JAMES MILLEN MFG. CO., INC.
MAIN OFFICE AND FACTORY
MALDEN, MASSACHUSETTS, U. S. A.

IN MOTOR-CONTROL CIRCUITS...

for
- ✓ **economy**
- ✓ **reliability**
- ✓ **long life**

Specify G-E THYRATRONS!

Available now...new G-E tube socket (101J328) that resists the heat produced in heavy-duty service. Made of asbestos-filled phenolic material, with special high-temperature-alloy spring contacts that won't lose their elasticity, and an open design allowing generous air circulation. Universal type: takes both the medium 4-pin base used in the GL-3C23, and the super-jumbo base used in the GL-5544 and GL-5545. Mounts either above or beneath a panel.

More General Electric thyratron tubes are built and sold than any other make. Here is *leadership* . . . a signpost for the designer of motor-control circuits, pointing to where experience and proved tube quality are waiting!

Choice of types, too, is virtually unrestricted. In the wide range of G-E thyratrons will be found the right tube—small or large, ideal in its design characteristics—for *your* equipment.

Three popular G-E thyratrons are shown here. Each has its special area of application. The GL-3C23 is a gas-and-mercury-vapor tube for motor field control, where inductive loads are heavy. The GL-5544 and GL-5545 are gas-filled tubes especially suited to armature-control work, which involves a higher current—these thyratrons having a charge of inert gas twice that of less modern types, to offset any absorption.

Long, cost-saving life, from features like the higher gas charge of the GL-5544 and GL-5545, gives *extra tube value.* Let General Electric tube engineers work with you in choosing thyratrons that will accent your equipment's economy, help assure its reliability, extend its performance span! Phone your nearby G-E electronics office, or wire or write *Electronics Department, General Electric Company, Schenectady 5, New York.*

	GL-3C23	GL-5544	GL-5545
Filament voltage	2.5 v	2.5 v	2.5 v
Filament current	7 amp	12 amp	21 amp
Peak anode voltage, forward and inverse	1,250 v	1,500 v	1,500 v
Peak cathode current	6 amp	40 amp	80 amp
Avg cathode current	1.5 amp	3.2 amp	6.4 amp

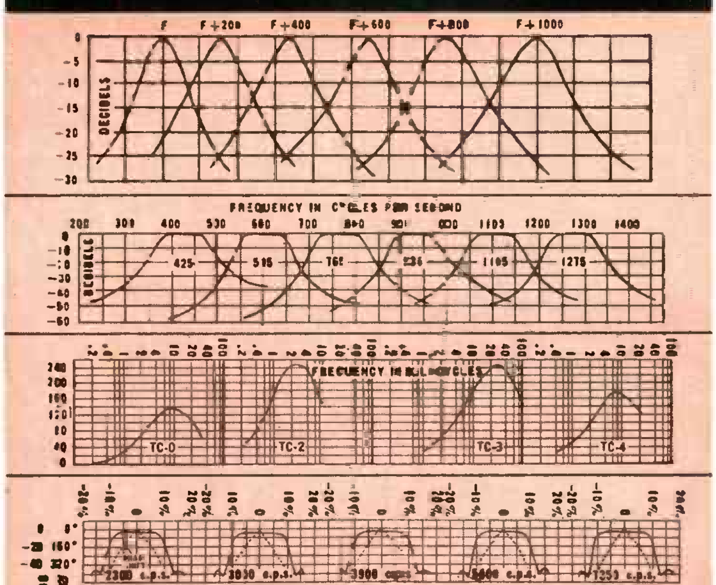
GENERAL ELECTRIC

180-J27

ARE THESE GATES '50 DECADE PRODUCTS MAKING MONEY FOR YOU?

1. 52-CS Studioette Speech Console.
2. BC-1F Air-conditioned 1KW Broadcast Transmitter.
3. SA-50 Dual Channel Speech Console.
4. Gates Antenna Coupling Equipment.
5. Typical 4-Tower Centralized Phasing Cabinet.
6. HF5-10 High Frequency Phone and Telegraph Transmitter.
7. SA-40 Single Channel Speech Console on CB4 Control Desk.
8. GY-48 Complete 250-watt Radio Broadcasting Station.
9. 50-watt Telephone and Telegraph Communications Transmitter.
10. BC-5B 5KW Transmitter with Phasor.
11. HF-15 15,000-watt Telegraph Transmitter.

→ Quality PLUS+++ makes GATES +++ a MUST →



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

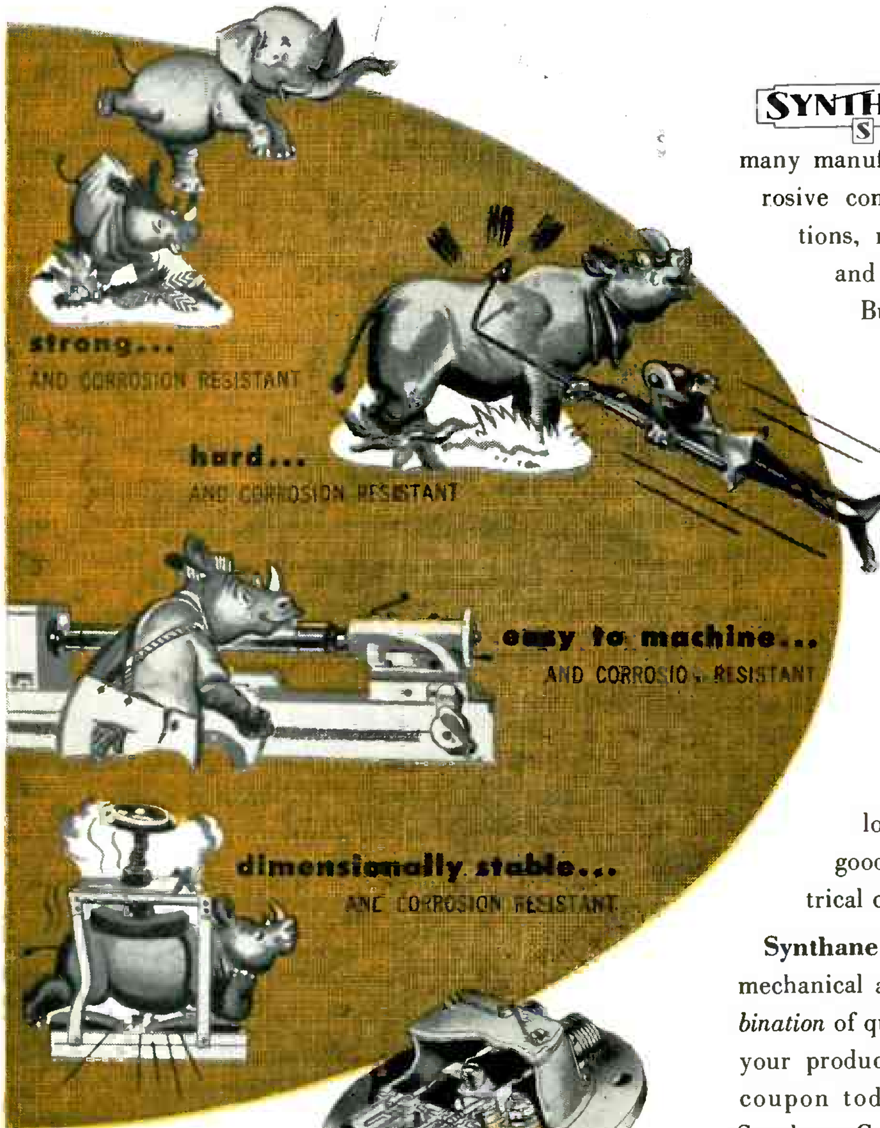
Exclusive Manufacturers of Communications Network Components

Burnell & Company

YONKERS 2, NEW YORK

CABLE ADDRESS "BURNELL"

Will Corrosion Resistance + "X"

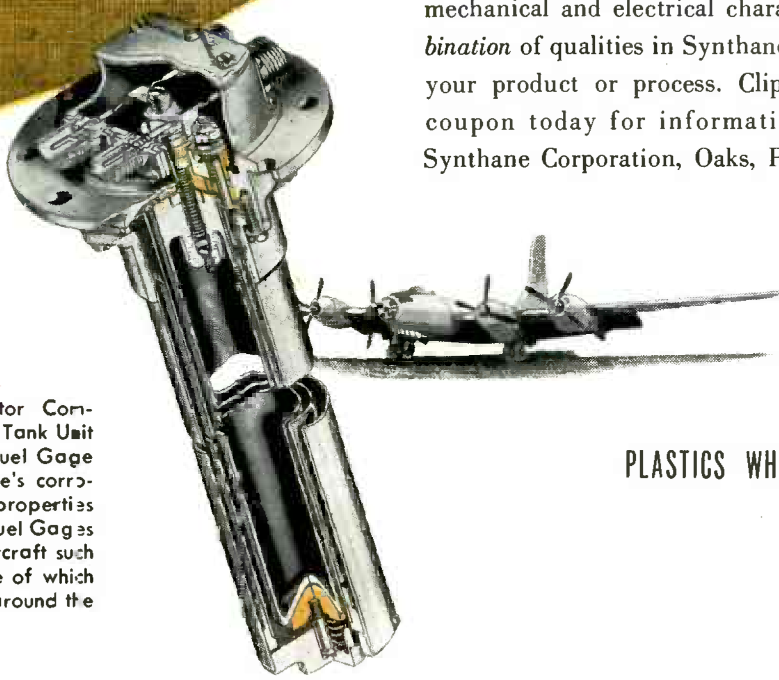


SYNTHANE plastic laminates have helped many manufacturers solve corrosion problems. Corrosive compounds, gases, various water compositions, moisture, oils, and gasoline have little, and often no, adverse effect upon Synthane. But corrosion resistance is only one of many other Synthane advantages abbreviated to the "X" above.

Synthane is also strong. Good tensile, flexural and compressive strengths, together with impact fatigue resistance and light weight, are other Synthane characteristics. Manufacturers may choose Synthane for one or more of these reasons.

Synthane is an excellent electrical insulator. Properties such as high dielectric strength, low power factor and low dielectric constant make Synthane a good material for any application where electrical currents must be held in check.

Synthane is a material for all industry. Chemical, mechanical and electrical characteristics form a *combination* of qualities in Synthane that you may need in your product or process. Clip and mail the handy coupon today for information about Synthane. Synthane Corporation, Oaks, Pa.



SYNTHANE AT WORK IN INDUSTRY

Minneapolis-Honeywell Regulator Company selected Synthane for the Tank Unit components of their electronic Fuel Gage equipment because of Synthane's corrosion resistance, good dielectric properties and dimensional stability. M-H Fuel Gages are standard in many USAF aircraft such as the famed Boeing B-50, one of which (the Lucky Lady) flew non-stop around the world last year.

PLASTICS WHERE PLASTICS BELONG

DESIGN · MATERIALS · FABRICATION · SHEETS · RODS · TUBES

NEW INDICATOR ION TRAP

Now in all Rauland Tubes

The response to Rauland's new Indicator Ion Trap, after its introduction in the 12LP4-A, has been so enthusiastic that this feature has now been incorporated in all Rauland tubes—as a standard feature of the new Rauland Tilted Offset Gun.

In the field or on the assembly line, this new Indicator Ion Trap reduces Ion Trap Magnet adjustment time to a matter of seconds, eliminates mirrors and guesswork, and assures accuracy of magnet adjustment. It can increase profits for every service man and service dealer—and at the same time assure better customer satisfaction.

A bright green glow on the anode of the picture tube signals when adjustment is incorrect. Correct adjustment is made instantly, by moving the magnet until the glow is extinguished or reduced to minimum.

Only Rauland offers this advanced feature—one of a half-dozen important post-war developments from Rauland.

RAULAND

The first to introduce commercially these popular features:

Tilted Offset Gun

Indicator Ion Trap

Luxide (Black) Screen

Reflection-Proof Screen

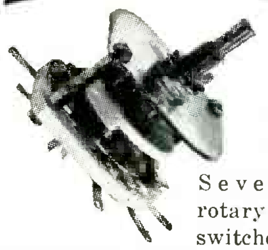
Aluminized Tube

THE RAULAND CORPORATION

Perfection Through Research

4245 N. KNOX AVENUE · CHICAGO 41, ILLINOIS

Something New



NEW OVAL SELECTOR SWITCHES

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

VERTICAL STYLE PRECISION RESISTORS FOR JAN USES

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

FLAT, METAL-ENCASED WIRE-WOUND RESISTORS

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

ADV.

HERE'S *Fast, Accurate* LAB OR PRODUCTION *Testing!*

A QUICK CHECK OF LOW RESISTANCE CONNECTIONS, BONDS, CONTACTS, etc.

Shallcross low resistance test sets greatly facilitate comparison tests between 2 and 800,000 micro-ohms. Their uses range from testing the electrical conductivity of bonds, welds and seals to contacts, filaments, armatures or for making any measurement under 1 ohm. Suitable units are available for either field, laboratory or production line use. Write for Bulletin LRT-1.

KELVIN plus WHEATSTONE RANGES IN ONE HANDY BRIDGE

Why pay for two instruments when one will do *both* jobs? Providing both Kelvin and Wheatstone ranges from 0.0001 ohm to 11.11 megohms, this Shallcross No. 638-R combined bridge is highly accurate and outstandingly convenient. Priced at only a little more than a single bridge with a limited range, it is a typical example of Shallcross instrument efficiency and economy.

DECADE RESISTANCE BOXES TO MATCH YOUR NEED... exactly

Over 40 Shallcross standard Resistance Boxes provide the widest assortment available today. Types range from 1 to 7 dials from 0.01 ohm to 111 megohms and are available in styles, sizes and prices for practically any laboratory or production testing need. Write for Bulletin.

SHALLCROSS

SHALLCROSS MANUFACTURING COMPANY
Collingdale • Penna.

*TRADE MARK

Combines all the Desirable Properties of Formvar and Nylon Coatings

Years of development work have produced this new and superior magnet wire insulation. Belden Nylclad* Magnet Wire combines the desirable properties of Formvar and Nylon types. Its tough, durable coating eliminates the need for paper or textile-covered wires (in many applications) and reduces winding space requirements. Nylclad* provides increased toughness, increased solvent resistance, and resistance to softening under heat; it is not subject to solvent crazing. Nylclad* means improved windability — more compact coils — many over-all plus values at *no* increase in price.

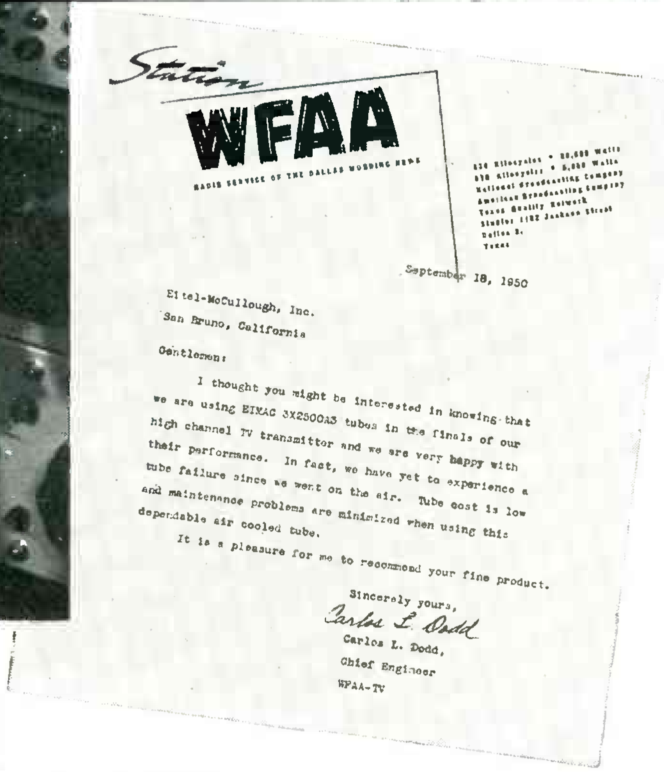
It will pay you to investigate Nylclad* Magnet Wire — another Belden development that makes for lower over-all costs. Write, today, for test data.

Belden

MAGNET WIRE

Belden Manufacturing Co., 4625 West Van Buren Street, Chicago, Illinois

From WFAA-TV, More Proven Performance of the Eimac 3X2500A3



Station
WFAA
RADIO SERVICE OF THE DALLAS MORNING NEWS

September 18, 1950

Eitel-McCullough, Inc.
San Bruno, California

Gentlemen:

I thought you might be interested in knowing that we are using EIMAC 3X2500A3 tubes in the finals of our high channel TV transmitter and we are very happy with their performance. In fact, we have yet to experience a tube failure since we went on the air. Tube cost is low and maintenance problems are minimized when using this dependable air cooled tube.

It is a pleasure for me to recommend your fine product.

Sincerely yours,
Carlos L. Dodd
Carlos L. Dodd,
Chief Engineer
WFAA-TV

The Eimac 3X2500A3 is one of the outstanding vacuum tube developments made during recent years. Consistent performance, long life, and low cost account for its filling the key socket positions in many important recently designed equipments.

The 3X2500A3 is a compact, air-cooled triode. Its coaxial construction results in minimum lead inductance, excellent circuit isolation, and convenience of use with coaxial plate and filament tank circuits. For AM service it is FCC rated for 5000 watts per tube as a high-level modulated amplifier. It has comparatively low plate-resistance, high transconductance, and will provide effective performance over a wide range of plate voltages at frequencies extending well into the VHF.

Reports from many engineers, like Mr. Dodd of WFAA-TV, confirm the outstanding transmitter performance, simplified maintenance, and low tube replacement cost made possible through the use of the Eimac 3X2500A3. Consider this unequalled triode for your applications . . . complete data are free for the asking.

Eimac 3X2500A3

GENERAL CHARACTERISTICS

ELECTRICAL	
Filament: Thoriated tungsten	
Voltage	7.5 volts
Current	48 amperes
Maximum starting current	100 amperes
Amplification Factor (Average)	20
Direct Interelectrode Capacitances (Average)	
Grid-Plate	20 uufd
Grid-Filament	48 uufd
Plate-Filament	1.2 uufd
Transconductance ($i_b = 830$ ma., $E_b = 3000$ v.)	20,000 umhos
MECHANICAL	
Cooling	Forced air
Maximum Overall Dimensions:	
Length	9.0 inches
Diameter	4.25 inches
Net Weight	5.8 pounds

RADIO FREQUENCY POWER AMPLIFIER
Ground-Grid Circuit
Class-C FM Telephony
TYPICAL OPERATION (110 Mc., per tube)

D-C Plate Voltage	3700	4000	volts
D-C Grid Voltage	—450	—550	volts
D-C Plate Current	1.8	1.85	amps.
D-C Grid Current	225	275	ma.
Driving Power (Approx.)	1600	1900	watts
Useful Power Output	6850	7500	watts

*COMPLETE DATA AVAILABLE FREE

EITEL-McCULLOUGH, INC.
SAN BRUNO, CALIFORNIA

Export Agents: Frazar & Hansen, 301 Clay St., San Francisco, California

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

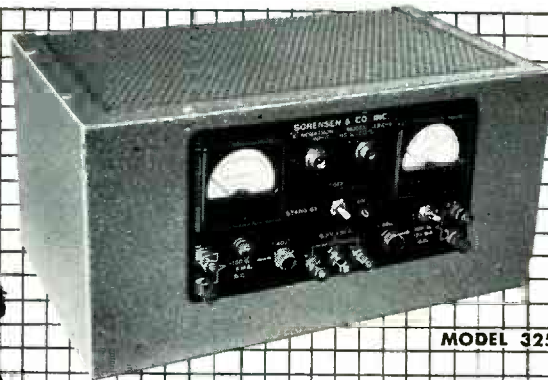
the 3X2500A3 is another Eimac contribution to electronic progress.

269

Specify Sorensen

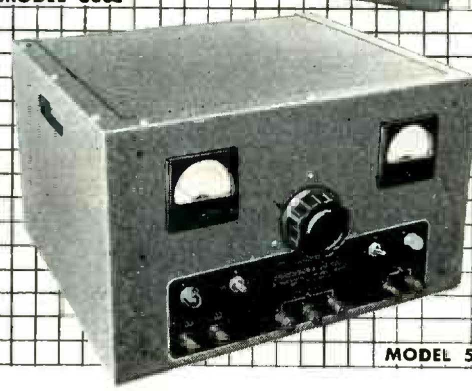
DC POWER SUPPLYS

Three *new* regulated DC units — 360B, 520B, 560B, — supplement Sorensen's dependable line of DC Power Supplys. As always, Sorensen combines the highest quality components with consistently fine workmanship. This means rugged construction and trouble-free operation, yet Sorensen prices are always reasonable!



MODEL 325B

MODEL 360B


MODEL 500B

DC POWER SUPPLY SPECIFICATIONS

MODEL No.	325B	360B	520B	560B	500B	1000B
Output voltage	0 — 325	175 — 360	200 — 500	0 — 500	0 — 500	200 — 1000
Output current	0 — 125 Ma.	0 — 120 Ma.	0 — 200 Ma.	0 — 200 Ma.	0 — 300 Ma.	0 — 500 Ma.
Output voltage, bias	0 — 150	....	....	0 — 150	0 — 150	....
Output current, bias	0 — 5 Ma.	....	....	0 — 5 Ma.	0 — 5 Ma.	....
Low AC voltage (center-tapped, unregulated)	6.3 at 10 amp.	6.3 at 10 amp.	6.3 at 10 amp.	6.3 at 10 amp.	6.3 at 10 amp.	....
Ripple	10 mv	10 mv	10 mv	10 mv	10 mv	20 mv

Regulation accuracy: ±0.5%.
Input: 105 — 125 volts AC, 50-60 cycles, single phase.
Units are normally self-contained. All can be provided with a front panel for rack mounting.
Models 325B, 500B, and 1000B are metered.

Write for Complete Literature

For regulated *low voltage supplys* investigate Sorensen's line of NOBATRONS.

POWER controlled converted

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

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

Atmosphere unlimited...

All-weather testing will

PROVE YOUR PRODUCT

Assure maximum value from each research dollar invested and from every hour of human effort expended in your development or manufacturing program by relying on Northern-Zaleski test chambers for complete, accurate test data—the soundest foundation on which to base your operation.

Northern-Zaleski atmospheric test chambers (with fully automatic cycling and recording systems, if desired) are your assurance of complete dependability and highest precision in meeting all test requirements. Temperature ranges of —150°F. to +200°F., humidity ranges of 10% to 98%, and simulated altitude ranges of 0 to 100,000 feet are available in standard chambers of from 3 to 800 cubic feet. Field construction to 25,000 cubic feet.

☐ REJECTED

TESTING

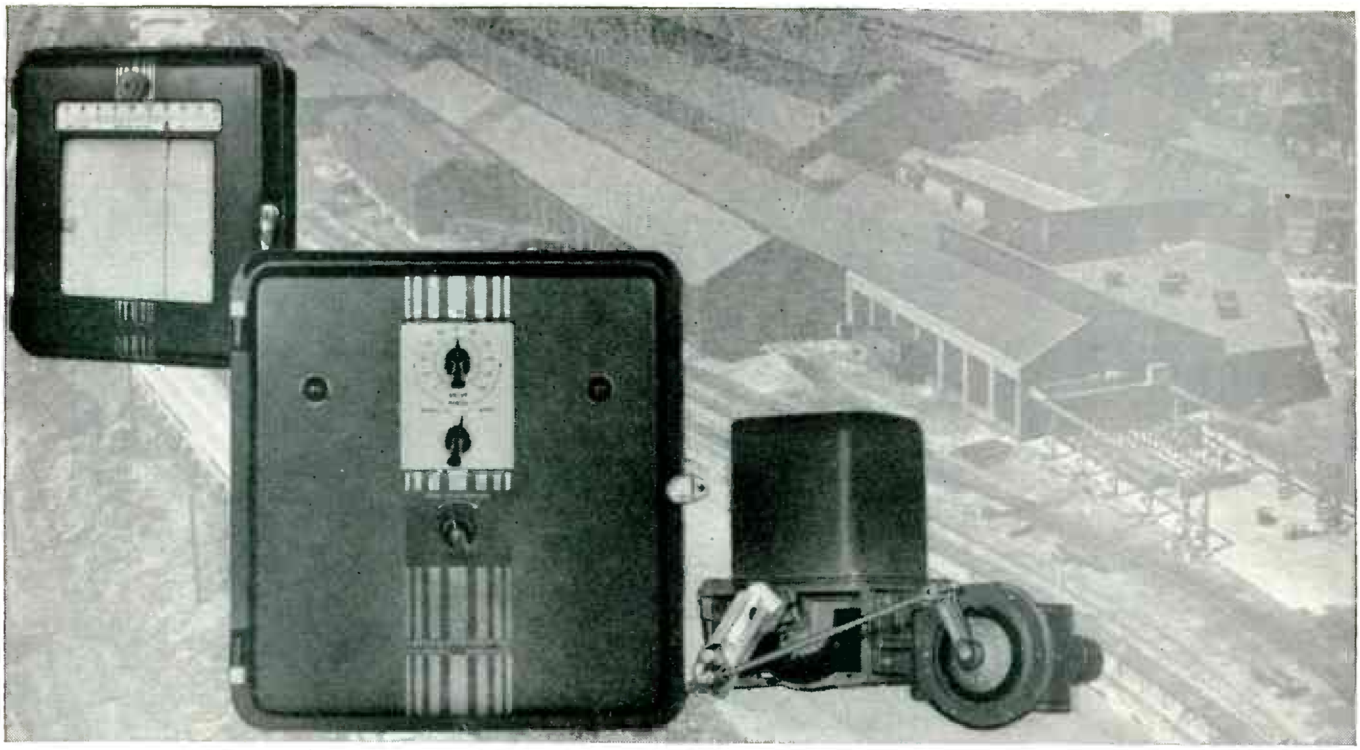
makes the difference!

☑ ACCEPTED

- *Laboratory facilities to run JAN spec tests*
- *Research and development services available*
- *Test chamber repair-rebuilding-maintenance*

Northern-Zaleski, Limited

PRATT OVAL, GLEN COVE, LONG ISLAND, N. Y.



Major Advance in Electric Control Increases Production From Industrial Operations

With production demands reaching toward fresh all-time highs, this new P.A.T.'50 Control comes at the ideal time to help thousands of firms increase the output of their industrial furnaces. Here's why:

This Control has something that's brand new. It acts on the *speed* of swings in furnace load, as well as on their size and permanence. Thus, if temperature changes gently, it is gently nudged back into line. But if it starts off briskly—as when the furnace door is opened—P.A.T.'50 reacts briskly. The faster the change, the further P.A.T.'50 moves the fuel valve. Then, at the instant this action begins to head off the change, the Control starts backing away. By putting on the brakes it brings temperature back in line smoothly, rapidly.

This "Rate Action" increases production because it reduces the length of time a furnace is off temperature. It means more heats per week.

P.A.T.'50 is the Only electric positioning control with Rate Action. It's a unique L&N contribution to automatic regulation.

Also, Proportioning and Reset Actions are more responsive than before. These two components have always been vital to automatic control, and of course continue so. They stop the normal, every-day temperature swings which are started by changes in the size and permanence of the furnace load.

When we gave P.A.T. its third component of rate action—and introduced it in this '50 model—we were able also to increase the sensitivity and range of adjustment of proportioning and reset components. The resulting improvement in control action shows up at all times, but especially when temperature is being stubborn—trying to edge away from the control point, or to level off incorrectly. Even without rate action, P.A.T.'50 would do a better-than-ever job. But with rate action, results are far superior to any previous electric control.

The News is in the Control Unit. Everything new in P.A.T.'50 is in the Control Unit—the device in center of above illustration which is usually mounted below the Speedomax or Micromax Recording Controller, and which links that instrument to the fuel-valve-driving mechanism. In line with our policy of making improvements readily available to users of our equipment, earlier installations of P.A.T. Control can be converted to P.A.T.'50 by replacing the Unit and making slight changes in the Controller. The new Unit is fully electronic—has no moving parts except two hermetically-sealed relays.

For complete details, contact our nearest office, or write us at 4979 Stenton Ave., Philadelphia 44, Pa.

MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES

LEEDS & NORTHRUP CO.

Jrl. Ad ND4-33(1)

they may look alike, *but:* there is only one C-D

COMPACT! DEPENDABLE!

Best . . . by Field Test

Type BBR MINIATURE ELECTROLYTIC CAPACITORS

anode risers connected directly to outer leads

. . . new construction eliminates shorts to the container!

Another C-D first! Positive lead, of round aluminum wire, is clamped to special aluminum center piece providing continuous metallic contact from foil to terminal lead. No foreign material sandwiched between inner and outer leads—a consistent cause of floating opens and high resistance contacts. Also eliminates shorts in container. Other features are:

High-purity aluminum electrodes—low electrical leakage! Cellulose-acetate wrap prevents "contamination" during assembly! Electrolyte centrifuged into container—fills section completely; provides reserve fluid for many years' use! Rubber bakelite insulation washer permits perfect seal! Stable electrolyte—a C-D exclusive—permits long shelf and operating life!

For further information on these and other C-D electrolytics, write for catalog. CORNELL-DUBILIER ELECTRIC CORPORATION, Dept. K11-0 South Plainfield, New Jersey. Other plants in New Bedford, Brookline and Worcester, Mass.; Providence, R. I.; Indianapolis, Ind., and subsidiary, The Radiart Corp., Cleveland, Ohio.

40TH ANNIVERSARY CORNELL DUBILIER CAPACITORS ® 1910 1950

CONSISTENTLY DEPENDABLE

CORNELL-DUBILIER

CAPACITORS • VIBRATORS • ANTENNAS • CONVERTERS

RADIART SUBSIDIARY

. . . this new campaign in THE SATURDAY EVENING POST means more business for manufacturers who assemble their products with

AMERICAN PHILLIPS SCREWS

For years, American has been a "PHILLIPS-HEADquarters" . . . engineering these modern fasteners into all types of products.

Today, American joins in this new campaign in which millions of users of manufactured products are being told to look for the clue of extra quality...

"The Phillips Cross-Recess Marks the Spot . . ."

A symbol that quality is built into a product with the modern Phillips fastener.

American, with its new plant and equipment at Willimantic, Connecticut, is in a stronger position than ever before to meet the ever growing demand for Phillips fasteners. In addition, the facilities at its Norristown, Pennsylvania, plant and the large warehouse stocks maintained in Chicago have been established to help service distributors and users of American Phillips Cross-Recessed-Head Screws. Write, telling us how American can be of help to you!

AMERICAN SCREW COMPANY

Plants at Willimantic, Conn., and Norristown, Pa.

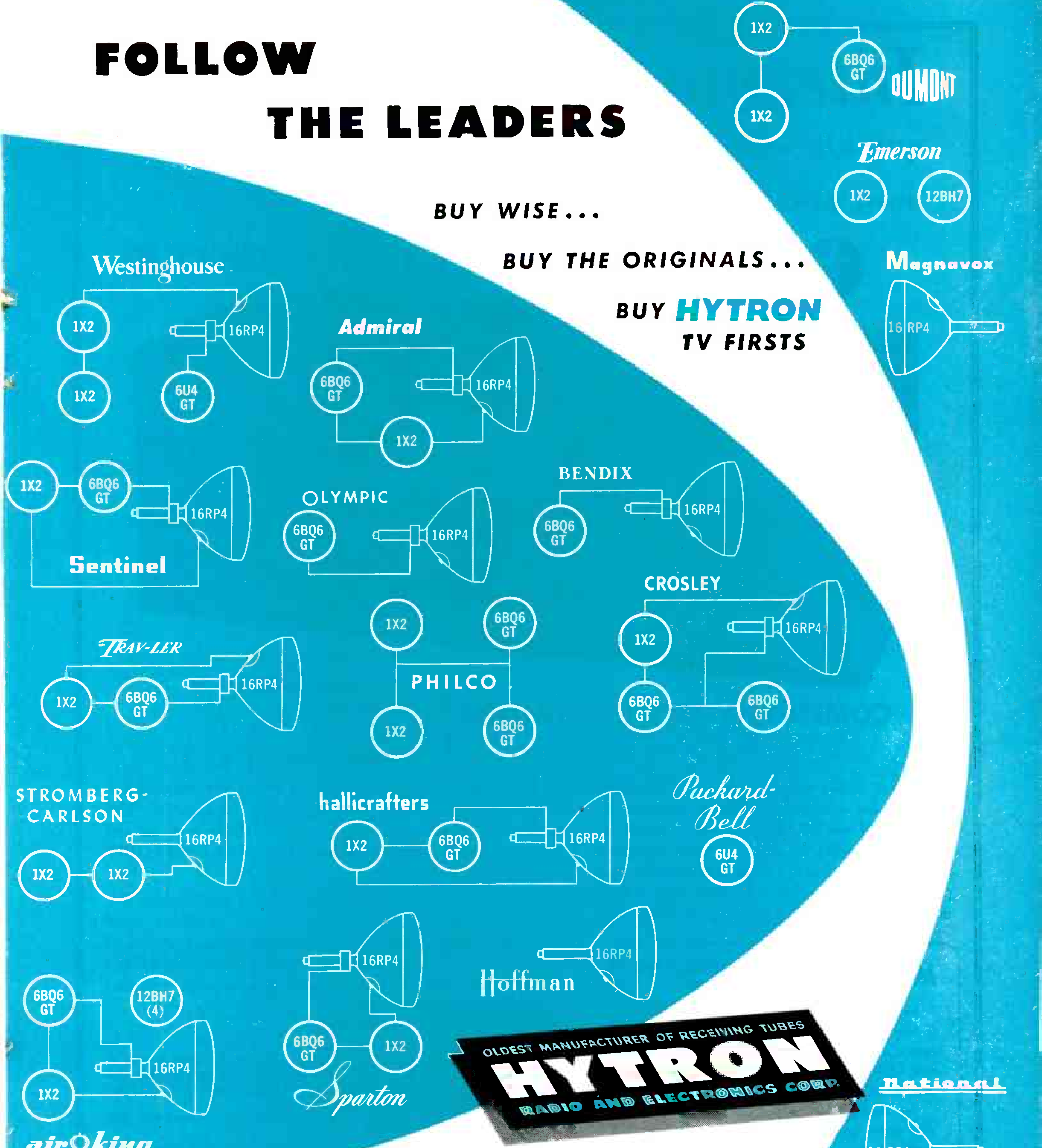
Warehouses at: Chicago 11: 589 E. Illinois St. Detroit 2: 502 Stephenson Bldg.

FOLLOW THE LEADERS

BUY WISE . . .

BUY THE ORIGINALS . . .

BUY HYTRON TV FIRSTS



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

MAIN OFFICE: SALEM, MASSACHUSETTS

Intermodulation can be measured quickly and accurately with MEASUREMENTS' new, portable MODEL 31

INTERMODULATION METER

COMPLETELY SELF-CONTAINED

- **TEST SIGNAL GENERATOR**
- **ANALYZER**
- **VOLTMETER**
- **POWER SUPPLY**

To insure peak performance from all audio systems; for correct adjustment and maintenance of AM and FM receivers and transmitters; checking linearity of film and disc recordings and reproductions; checking phonograph pickups and recording styli; checking record matrices; adjusting bias in tape recordings, etc.

MEASUREMENTS CORPORATION meets the demand for compact, easily-operated intermodulation equipment! The MODEL 31 is moderately priced, yet extremely accurate and built to the same rigid specifications of all "LABORATORY STANDARDS".

One section of the MODEL 31 supplies mixed audio frequencies to the apparatus under test; the resultant signal from the apparatus is then applied to the analyzer section of the MODEL 31 to be filtered, amplified, demodulated and metered. The meter is direct-reading in percentage of intermodulation and input volts.

Specifications:

GENERATOR

LOW FREQUENCY: 60 cycles.
HIGH FREQUENCY: 3000 cycles.
LF/HF VOLTAGE RATIO: Fixed 4/1.
OUTPUT VOLTAGE: 10 v. max. into high impedance or +5 DBM matched to 600 ohms.
OUTPUT IMPEDANCE: 2000 ohms.
RESIDUAL INTERMODULATION: 0.2% max.

ANALYZER

INPUT VOLTAGE: Full scale ranges of 3, 10 and 30 volts RMS. Less than one volt of mixed signal is sufficient for operation.
INPUT IMPEDANCE: Greater than 400 K ohms.
INTERMODULATION: Full scale ranges of 3, 10 and 30%.
ACCURACY: ±10% of full scale.
OSCILLOSCOPE connection at meter.

Power supply: 117 volts, 50/60 cycles, 30 watts. Dimensions: 8" high x 19" wide x 9" deep. May be mounted in standard 7" relay rack panel space. Weight: 16 lbs.

MODEL 30 INTERMODULATION METER

This model has a test generator providing, a low frequency range of 40, 70 and 100 cycles, a high frequency range of 2000, 7000 and 12,000 cycles, either separate or mixed in a 1/1 or 4/1 ratio.

The analyzer will operate from 20 cycles to 200 cycles and from 2000 cycles to 20,000 cycles.

A direct-reading meter measures intermodulation percentages from 0.1% to 30%; test generator output voltages from .01 to 100 v. (−30 to +20 DBM); analyzer input voltages from .0001 to 100 v. (−70 to +40 DBM).

Detailed circular on request

MEASUREMENTS CORPORATION
BOONTON NEW JERSEY

REGENERATION? RADIATION?

ERIE TYPE 325

High Frequency By-Pass Capacitor Will Help Solve Your Problem

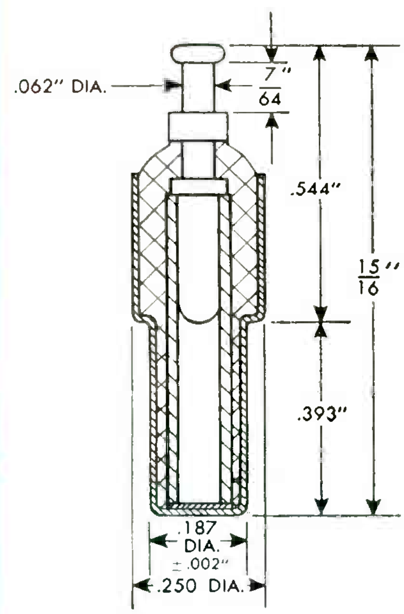
- **LOW INDUCTANCE**
- **UNIFORM INDUCTANCE FOR RESONANCE BY-PASSING**
- **RUGGED HIGH TERMINAL FOR TIE-POINT**
- **FULLY SHIELDED**

One solution to control of regeneration and radiation in TV sets lies in better by-passing . . . and Erie Style 325 Stand-Off Ceramicon provides the solution in concrete form. This ceramic capacitor is made especially for high frequency decoupling and offers an outstanding combination of features never before offered in the low-price field.

A by-pass to the ground is provided through the shortest possible path, in a completely sealed metal case. Full advantage is taken of the concentric cylindrical electrode configuration in maintaining this short path, resulting in extremely low series inductance and effective v.h.f. by-pass.

Push-on clip facilitates high speed assembly . . . or shell may be soldered directly into a hole in the chassis. Post terminal provides a sturdy tie-point for several connections, at tube socket terminal height. The capacitor possesses unusual mechanical ruggedness.

Write for detailed information and samples.

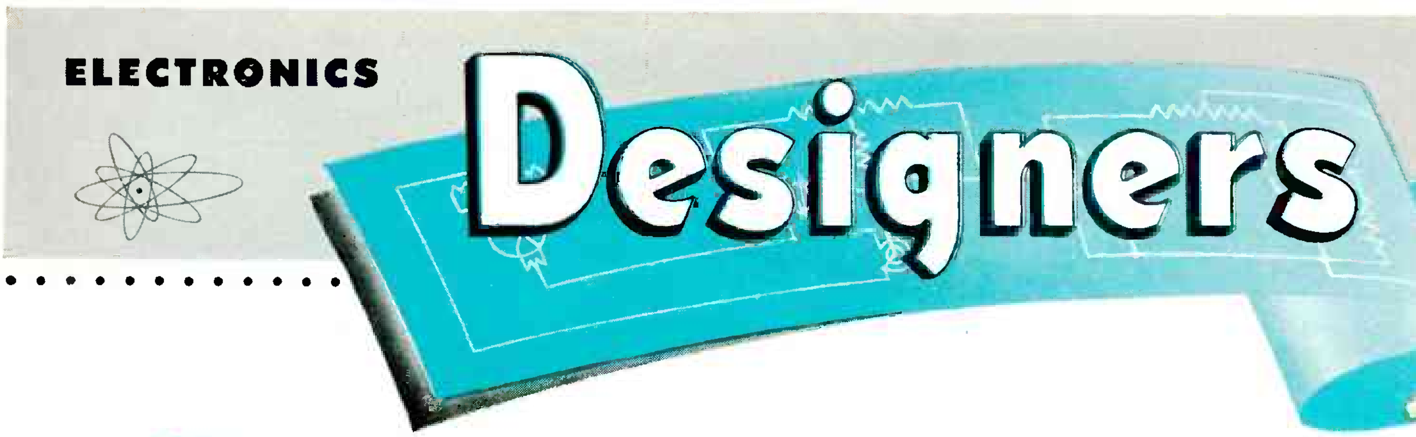


PATENT APPLIED FOR

Electronics Division

ERIE RESISTOR CORP., ERIE, PA.

LONDON, ENGLAND . . . TORONTO, CANADA



ELECTRONIC COMPONENTS

A HIGHEST QUALITY LINE

—constantly improved and added to—

for your equipment designs

When you're building any of thousands of complex industrial and military electronic devices, reliable components are a must.

To give you, the designers of these devices, the utmost in reliability, General Electric is constantly at work improving and redesigning in its ever growing line of electronic components.

The list at left only partially covers the thousands of parts in the complete G-E line. We'll tell you about as many of them as space will permit in these pages from month to month. *Apparatus Department, General Electric Company, Schenectady 5, N. Y.*

APPARATUS DEPARTMENT

- Meters and instruments
- Capacitors
- Transformers
- Pulse-forming networks
- Delay line
- Reactors
- Thyrite
- Inductrols
- Voltage stabilizers
- Fractional hp motors
- Timers
- Control switches
- Selsyns
- Relays
- Amplidynes
- Amplistats
- Terminal boards
- Glass bushings
- Thermistors
- Dynamotors

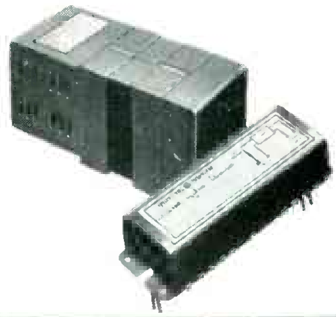
ELECTRONICS DEPARTMENT

- Tubes
- Television components
- Phono pickups
- Speakers
- Quartz crystal units
- Germanium diodes

GENERAL ELECTRIC

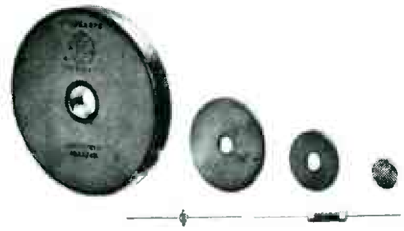
667-8

TIMELY HIGHLIGHTS ON G-E COMPONENTS



LINE-VOLTAGE STABILIZERS —get rid of ups and downs!

When you're after a steady 115 volts at the input of your equipment and the line is fluctuating anywhere between 95 and 130, use a G-E voltage stabilizer. These units use a special transformer circuit to provide a stabilized output voltage within ±1% of 115 volts for fixed, unity-power-factor loads. Fast response of G-E stabilizer restores normal output voltage in less than three cycles. 15-, 25- and 50-va stabilizers are small enough to mount on radio or electronic instrument chassis (2 inches high, 9 inches long). Standard ratings up to 5000 va are available in larger sizes. Write for Bulletin GEA-3634.



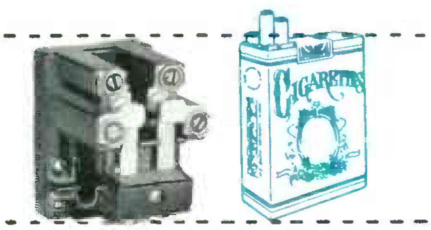
THYRITE— R varies inversely as E^4

With the unique electrical property of varying inversely in resistance as the fourth power (or even higher) of the applied voltage, Thyrite* resistance material has solved many problems for the design engineer.

Use it with a-c, d-c, or short duration pulses; for such applications as the limiting of voltage surges, stabilization of rectifier output voltages, controlling of voltage-selective circuits, and potentiometer division of voltages.

Thyrite comes in disk form in diameters from 0.25 to 6.00 inches, with or without mounting holes. Smaller sizes are furnished with wire leads. See Bulletin GEA-4138.

*Registered Trade Mark of General Electric Co.



TYPE HMA RELAYS—up to 30 amps, closing

The G-E Type HMA relay is only the size of cigarette package, but it closes at currents up to 30 amperes! HMA relays have self aligning, silver-to-silver contacts; are positive in action, instantaneous in operation. They're available in either back or front connected models. For coil voltages of 6, 12, 24, 32, 48, or 125 d-c; 115 or 230 a-c. Single- or double-break contacts. Bulletin GEA-5457.

General Electric Company, Section A667-8
Apparatus Department, Schenectady 5, N. Y.

Please send me the following bulletins:

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

☐ GEA-3634 Voltage stabilizers
☐ GEA-4138 Thyrite
☐ GEA-5457 HMA relays

Name__________

Company__________

Address__________

City__________ State__________

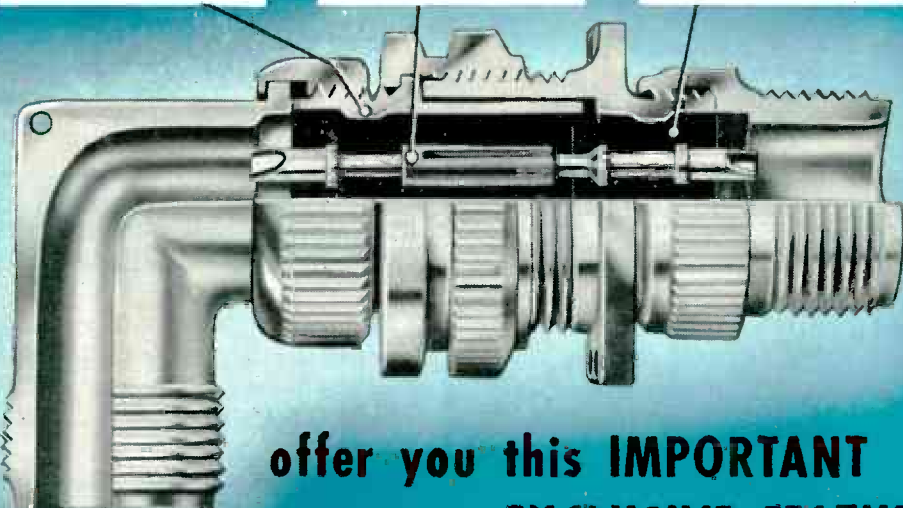
ONLY **BENDIX-SCINTILLA**

ELECTRICAL CONNECTORS

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

CONTACTS
High current capacity . . . Low voltage drop . . . No additional solder required.

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



offer you this IMPORTANT EXCLUSIVE FEATURE . . .

. . . PRESSURE TIGHT SOCKET CONTACT ARRANGEMENTS!

Outstanding design and fine workmanship, combined with materials that meet the requirements, assure the splendid performance of Bendix-Scintilla "pressurized" electrical connectors. These units include both pin and socket arrangements for *all* sizes of contacts.

★ **SCINFLEX** dielectric material is a new development that assures unequalled insert performance. It is available only in Bendix-Scintilla Electrical Connectors.

PLUS ALL THESE OTHER FEATURES

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

Write our Sales Department for detailed information.

BENDIX SCINTILLA

SCINTILLA MAGNETO DIVISION of

SIDNEY, NEW YORK

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

FACTORY BRANCH OFFICES.

117 E. Providencia Avenue, Burbank, Calif. • 23235 Woodward Avenue, Ferndale, Mich. • 7829 W. Greenfield Avenue, West Allis 14, Wisc.

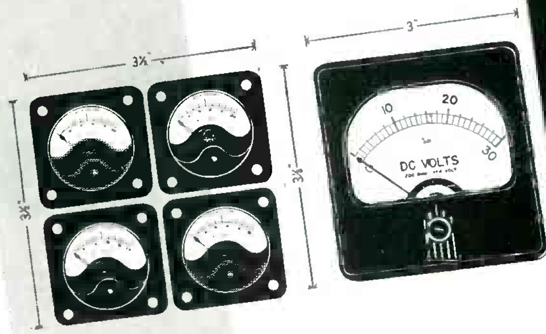
Bendix AVIATION CORPORATION

DeJUR makes great little meters . . .

Panel Meters

- Miniature 1½" square
- Waterproof sealed
- Obtainable with Lucite scales and Magnetic Shielding

Larger sizes available
2½" round
2½" square
3½" round
3½" square
4" square
JAN-I-6 and A.S.A. specifications



Built to Conform to Forthcoming JAN Spec. for 1½" Meters

POWER Rheostats . . .

NEW ALL METAL CONSTRUCTION
with
ALUMINUM FRAME
ALUMINUM WINDING CORE
Assuring Maximum Heat Dissipation
MODEL 245 — up to 50,000 ohms (25 Watt)
MODEL 241 — up to 75,000 ohms (50 Watt)

These exceptionally high resistances are possible because of new developments in material and design. Built to JAN-R-22 Specifications.

Ceramic models available for economy and where fine precision of all metal parts is not needed.

PRECISION Potentiometers

FEATURES

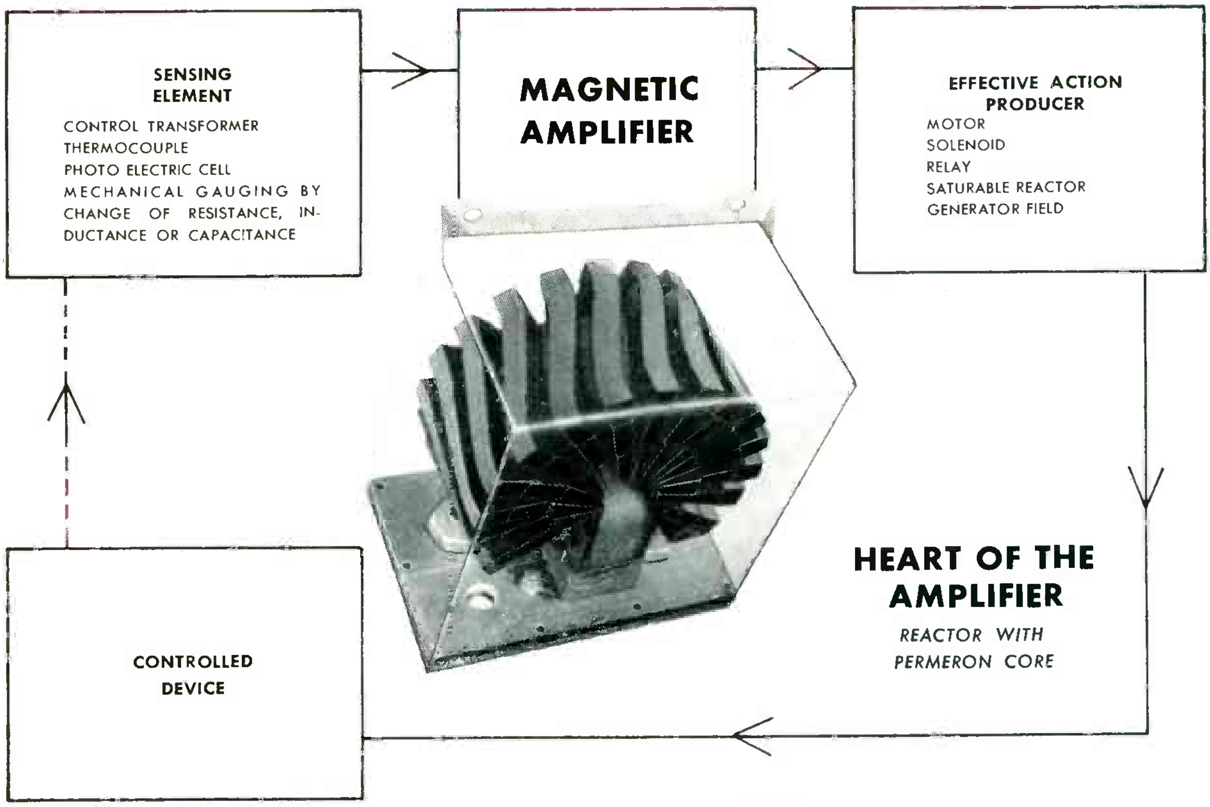
- Linearity Accuracy ±0.2%
- Resistance Accuracy ±1%
- High Humidity Models JAN-R-19 SPECS.
- Non-Linear Models

Send All Inquiries to Dept. E-1 for Full Information on Our Complete Line

DeJUR USA

DeJUR **AMSCO CORPORATION**
45-01 NORTHERN BOULEVARD, L. I. C. 1, N. Y.
MANUFACTURERS OF SCIENTIFIC PRECISION EQUIPMENT FOR OVER A QUARTER OF A CENTURY

Here's the ideal amplifier for control applications



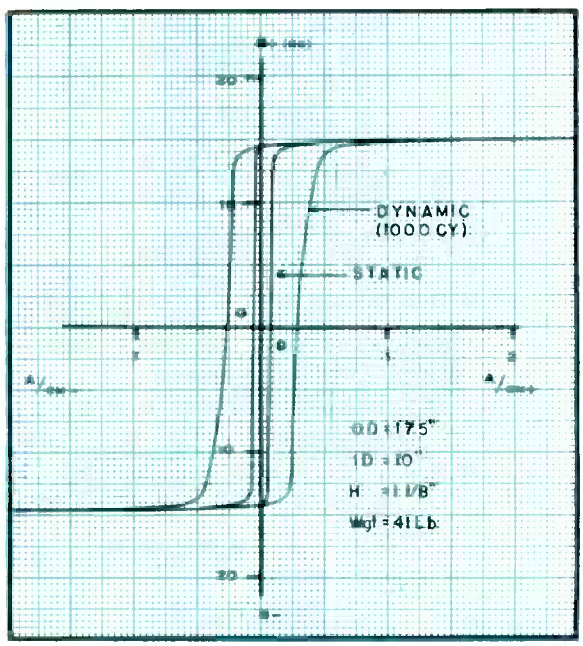
Why? Well, for one thing it's a *magnetic* amplifier. The advantages are obvious: there are no moving parts — hence, there's nothing to wear out. It's shock-proof and vibration-proof.

Secondly, it has a core of PERMERON — I-T-E's amazing new core material. We say "amazing" because *all* PERMERON cores have identical magnetization characteristics. This means designers can predict amplifier performance accurately and positively *before* undertaking the expensive job of winding and potting the reactor!

Furthermore, the lower control currents required in amplifiers made with PERMERON cores result in space-saving equipment with higher amplification factors and faster response time!

Magnetic amplifiers with PERMERON cores are now being produced by several large electrical manufacturers for an ever-expanding field of uses. These cores, with their amazing characteristics, have helped make magnetic amplifiers practical for many new uses and better for many old ones.

If *your* business is amplifiers, or controls, it will pay you to take another look at PERMERON!



For additional information write—I-T-E Rectifier Division, or consult your local I-T-E Representative

I-T-E PERMERON

A product of Rectifier Division, I-T-E CIRCUIT BREAKER COMPANY,
19th & Hamilton Streets, Philadelphia 30, Pa.

MECHANICAL RECTIFIERS • SWITCHGEAR • UNIT SUBSTATIONS • ISOLATED PHASE BUS STRUCTURES • RESISTORS • SPECIAL PRODUCTS

BUSINESS BRIEFS

By W. W. MacDONALD

Mobilization Miscellany: Industry and government have plans for mobilizing electronics production facilities to handle any military needs in the immediate future. From where we sit it seems as though the industry's planning is most advanced, and some people in Washington privately admit it.

Possible new government body is the Electronics Production Resources Agency, proposed as a means of coordinating requirements of the military departments under the direction of the Munitions Board. It would consist of two members from Army, two from Navy, two from the Air Forces and one Munitions Board observer, plus a combined military and civilian staff. It would work closely with the Electronics Division of the Defense Production Agency, which is under Department of Commerce auspices. Not yet approved but no doubt will be.

Add to the three industry bodies reported last month as engaged in mobilization planning the Electronic Parts Manufacturers Association, with offices in the Capitol. Representing "smaller independent parts manufacturers." No connection with RTMA.

Washington scuttlebutt has it that if the President asks for and gets an additional ten-billion dollars in early 1951 at least one of these billions will go for electronics equipment. This would be over and above the $2-$2.4-billion orders for the balance of 1950 and fiscal 1951 mentioned last month. The predicted pyramiding is already beginning, even before election.

Shortages of raw materials needed in our field are already developing. Watch, in particular, aluminum, copper, lumber, nickel, soda ash, steel, tin and tungsten. How much is real shortage and how much is the result of stockpiling no one seems to know.

Speaking Of Mobilization, it is becoming more and more evident that mobile communications equipment constitutes an important part of current civilian-defense planning.

Judging by many recent and dovetailing signs, people with such equipment to sell should, in this order, (1) step up normal contacts with local police officials, (2) backtrack among similar state officers who may have been neglected in recent years and, (3) cultivate a few federal men coordinating the nation's civilian-defense effort.

Most actual buying will probably be done by cities and towns, the present emergency constituting an excellent excuse to buy more mobile radio equipment they have wanted for a long time anyway. Some will be done by States egged into it from above and below. And Washington officials are worth cultivating if for no other reason than to see that any recommended equipment specifications are flexible.

Bracket Standards: The word "bracket", now part of television terminology, is of typographical rather than technical origin. It refers merely to the symbols embracing the wide range of scanning rates needed to cover existing black-and-white and proposed color transmissions, symbols such as we use here [?%$¢#!].

Public Confusion can be counted upon if and when bracket standards are adopted and stations start transmitting part or full time in color.

To begin with, existing receivers tuned to such stations will see nothing but a blur; accessories will be required to resolve the blur and provide a black-and-white picture.

Even with such accessories, or with a new set in which a switching circuit (see p 66) has been provided, the black-and-white picture obtained from a color program will have only about one third the detail to which the public is accustomed.

Finally, it will be necessary to buy another accessory, or another

Better TV picture resolution ...better picture gamma

...with this SYLVANIA Type 1N60 Germanium Diode

This diode is a point contact rectifier, designed for efficient and dependable service as a video detector diode for TV receivers.

In terms of set performance, the efficiency of this Sylvania Germanium Diode means better picture resolution, especially at low signal levels. The improved linearity means better picture gamma, or range of picture contrast, in the near white regions where human vision is most critical.

Rugged Construction

The Sylvania 1N60 has construction features which assure long, trouble-free life and electrical stability. Flexible tinned leads are swaged to nickel end caps which are welded to threaded brass plugs. These plugs are screwed and firmly cemented into a strong ceramic body, thus providing a thermal reservoir, insulating the pigtails from the active element and permitting close soldering. For further information mail the coupon today.

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5. Compact size and ease of mounting
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Station Economics could, we think, become quite involved when either color or black-and-white time is available to television sponsors.

How many people will initially constitute the color audience? How many who see the program will be looking at it in color and how many in black-and-white? Who will take the financial rap while the color audience is being built, the stations or the sponsors?

This, it seems to us, is where we came in.

Railroads are now using a whale of a lot of electronic communications equipment. Here's a list showing the number of radio and carrier-current transmitters in use as of July 15:

	Radio	Carrier
Alabama Great Southern	12	—
Alton & Southern	21	—
Apache	7	—
Atchison, Topeka & Santa Fe	454	—
Atlantic Coast Line	26	29
Baltimore & Ohio	44	4
Bangor & Aroostook	41	—
Barre & Chelsea	3	—
Bessemer & Lake Erie	10	5
Birmingham Southern	42	—
Boston & Maine	25	—
Brooklyn East. Dist. Term	4	—
Carbon County	3	—
Central of Georgia	11	—
Central Railroad of N. J.	12	—
Central Railroad of Pa	3	—
Chattahoochee Valley	3	—
Chesapeake and Ohio	267	5
Chicago & Eastern Illinois	5	—
Chicago & North Western	10	—
Chicago, Burlington & Quincy	278	6
Chicago Great Western	50	—
Chic., Milwaukee, St. Paul & Pac.	123	—
Chicago, Rock Island & Pacific	143	—
Chicago, South Shore & South Bend	78	—
Columbus & Greenville	2	—
Colorado & Southern	55	—
Delaware, Lackawanna & Western	49	—
Denver & Rio Grande Western	255	40
Des Moines and Central Iowa	11	—
Detroit, Toledo & Ironton	14	—
Duluth, Missabe & Iron Range	22	78
Elgin, Joliet & Eastern	8	—
Erie	293	—
Fort Worth and Denver City	55	—
Florida East Coast	20	—
Georgia Northern	8	—
Grand Trunk Radio Comm.	3	—
Great Northern	36	3
Gulf, Mobile & Ohio	61	—
Illinois Central	22	—
Jacksonville Term. Co	14	—
Kansas City Southern	—	74
Lake Terminal	26	—
Lehigh Valley	11	—
Los Angeles Junction	7	—
Louisville and Nashville	6	—
Louisiana & Arkansas	—	27
Louisiana & North West	10	—
Maryland & Pennsylvania	5	—
McKeesport Connecting	9	—
Minnesota, Dakota & Western	5	—
Missouri-Kansas-Texas	16	—
Missouri-Kansas-Texas of Texas	8	—
Missouri Pacific	210	22
Modesto & Empire Traction	3	—
Monessen Southwestern	11	—

Monongahela Connecting	13	—
New Orleans Terminal Co	13	—
New York Central	206	45
New York, Chicago & St. Louis	178	—
New York, New Haven & Hartford	24	3
Niagara Junction	10	—
Norfolk & Western	—	4
Northern Pacific	41	—
Pennsylvania	83	830
Pittsburgh & Ohio Valley	6	—
Point Comfort & Northern Ry	4	—
Richmond, Fredericksburg & Potomac	20	—
River Terminal	10	—
St. Louis-San Francisco	36	—
St. Louis-San Francisco & Texas	3	—
Seaboard Air Line	103	—
Southern Pacific	217	—
Southern	229	—
Steelton & Highspire	26	—
Terminal RR. Assoc. of St. Louis	—	1
Texas & Pacific	75	—
Texas & New Orleans	7	—
Toledo Terminal	16	—
Union Pacific	109	—
Union	13	—
Walla Walla Valley	6	—
Western Maryland	7	—
Western Pacific	52	—
West Virginia, Northern	3	—
	4,439	1,176

Radio-Telegraph Carriers engaged in interstate or foreign communications and doing $50,000 or more worth of business in 1949 employed 97 engineers and paid them an average of $104 weekly. Radio operators totalled 380 and received $68, and there were 120 marine-coastal operators receiving an average of $73 weekly. Figures from an FCC-Department of Labor joint report just released.

Speaking before the late-August convention of the National Electronic Distributors Association in Cleveland (attendance reported at 2,400) RCA's Hal Bersche predicted a one-billion-dollar electronics replacements parts business by 1955. He thought there might be 2,600 distributors, and 130,000 servicemen in the field by that time.

Remington Rand has, we are told, so far sold 25 industrial television systems to such users as universities having medical courses, to schools training artists for commercial programs, to the military and others.

Contrast between two industries with respect to communications equipment is emphasized by the story about the ferryboat that recently ran aground in a fog and unsuccessfully tried to summon assistance by means of whistle signals. It just happened that a radio-equipped taxicab was aboard, and a message through the cab's dispatching office brought a tug.

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CROSS TALK

▶ **COLOR REPORT** . . . On October 11, the FCC issued its final report based on the color television hearing, in which it decided to adopt the CBS field-sequential system. We do not intend to criticize this decision, as such. It was arrived at after an exhaustive hearing, according to due legal process, by a body specifically set up by Congress to make such decisions. The Commission decided to adopt a noncompatible system because in certain vital respects it performs best *now*, and to discount the promise that a compatible system would in the near future offer superior performance. The Commission elected to act on what it saw, rather than on what it foresaw.

This may turn out to be a mistaken judgment of the first magnitude. But it may also be a correct judgment, if the promise of the compatible systems fails to be realized. Only time, many months of time, could have settled that issue beyond doubt. The Commission was under crushing political pressure to make the decision now. It bowed to that pressure, and in so doing it took a calculated risk.

Such risks are a conspicuous feature of the commission form of governmental regulation. They must, we feel, be accepted as one of the costs of a much larger benefit, the democratic form of government.

At that point, however, we pull the emergency cord and get off the train. We view with the utmost seriousness two aspects of the FCC "first color report".

First, we are alarmed that the Commission has attempted to extend its jurisdiction to a part of the body politic over which the statutes give it no authority. The Commission has "suggested" that all manufacturers modify the designs of their receivers so as to go into production, by a date as early as November 15th, with "bracket standards." If the manufacturers could not, in substantial majority, agree to do so by September 29th, the adoption of the CBS system would become final forthwith. If they did agree, the decision would not be final before December 5th, and possibly not until January 5th. If the compatible systems show sufficient promise in that time, the decision might be put off indefinitely. Thus, the radio industry was asked to underwrite the CBS system *before* it was finally and officially adopted by the Commission. The industry wisely refused to act on the proposal.

Such action would have the effect of raising the list price of all new receivers by from $30 to $50, with no guarantee that the added equipment will be useful. Moreover, it removes from the public the choice of making an investment in the CBS system now, or waiting until the system establishes itself. Finally, the time schedule was patently unrealistic. In the 6½ weeks from September 29th to November 15th, the industry could not possibly convert designs, procurement and production as the Commission suggests. In the circumstances, the Commission's suggestion can only be interpreted as an attempt to force the industry into accepting responsibility for a decision in which it had no part. This is "commission politics" at its worst.

The second item concerns only one of the Commissioners, Robert F. Jones. Jones, in an 80-page annex to the FCC color report, presented "a study of the disgraceful treatment of the field-sequential system by the industry since 1940". The burden of this opus is that the industry committees, which have testified before the FCC on television matters, have systematically obstructed the introduction of color television by "sham engineering testimony".

The industry committees referred to are the 1940-41 National Television System Committee, and N.T.S.C. Panel 1, the Radio Technical Planning Board and its Television Panel, and the Joint Technical Advisory Committee, its supporting committees and consultants. According to Jones, none of the members of these groups, excepting the two CBS members, have presented consistent, reliable and trustworthy testimony during the past ten years.

We wonder whether the worthy Commissioner knows the men he so recklessly and immoderately attacks. The combined membership of these committees comprises 121 men, 45 of whom are fellows of the IRE, 25 directors, past and present, of the IRE, the present president of the IRE and eight past presidents, six men who hold the IRE Medal of Honor and four others who have won the IRE Morris Liebmann Memorial Prize.

An indictment of these men is an indictment of the whole profession of radio engineering. They have built the radio service of the United States from its earliest days, they have managed the technical effort in electronics during two wars. Without their cooperation, the FCC simply cannot function in regulating its highly technical domain.

When one man aligns himself against a whole profession, fair-minded men will conclude that the man is wrong. The only "systematic" aspect of the record presented by Jones is his own systematic rejection of any testimony that disagrees with his own notions. Moreover, the testimony is rejected not merely as wrong, but as intentionally dishonest. This is demagoguery. Any claim that *all* contrary testimony on a given subject has as its object the exploitation of the public is rubbish. While Jones' views stand, he disqualifies himself as a judicial servant of the people.

DUAL STANDARDS

Chapin and Roberts, of FCC staff, point to automatic bracket-standard switch they developed and installed on Bendix model 235M1 chassis

SINCE SEPTEMBER 1ST, when the FCC issued its report on future plans for color television service, equipment designers have been confronted with the prospect of redesigning transmitters and receivers to accommodate the so-called "bracket standards."

According to the report, the FCC may in the future authorize television stations to operate commercially on at least two sets of scanning standards, the present black-and-white 525-line, 60-field standard and the CBS 405-line, 144-field, field-sequential color standard. To this end, the Commission has requested receiver manufacturers to state whether or not they would be able to convert their designs so as to permit operation on any field-scanning rate from 50 to 150 cps and any line-scanning rate from 15,000 to 32,000 cps.

This wide range covers the existing black-and-white values (60 and 15,750) as well as the CBS color values (144 and 29,160) and, in addition, would leave room for later changes.

The FCC requested manufacturers to state by September 29th whether or not they would go along with this proposal. About 36 manufacturers replied, all of whom stated that they cannot, or will not, revise their designs within the time limit allowed. It was anticipated, therefore, that the FCC would proceed with its announced plan of adopting the CBS system at once, and color transmissions on 405/144 standards would be authorized.

The engineers of the industry are therefore much concerned with the problem of converting designs to encompass the dual values of 60–144 fields and 15,750–29,160 lines. The full bracket ranges of 50–150 and 15,000–32,000 are, for the moment at least, not being considered in design plans.

As a guide to designers, the Commission indicated that bracket-standard (b-s) receivers should have a manual or automatic switch which will select the scanning standards of the present black-and-white system (525/60) in one position and the CBS standards (405/144) in the other. The b-s receivers must be operated with equivalent picture brightness, picture size and scanning linearity in both positions of the switch.

The first and most obvious difficulty in operating any receiver on bracket standards is the fact that nonsynchronous operation is required. Accordingly, the interfering effect of the 60-cps power supply must be reduced to the vanishing point, which implies that filtering and shielding must be substantially better in the b-s system.

The Hum Problem

Hum difficulties arise in the form of three beat frequencies: 12, 24 and 84 cps. When a scene is televised in color by the field-sequential system, the scene is scanned once in each of the primary colors during three fields, or in $3/144 = 1/48$th second. Therefore, unless the intensity of the primaries is the same in each field (true only when the object is white or gray) the video signal has a strong 48-cps component. If a 60-cps hum component is also present, a 12-cps difference frequency appears. Since this frequency is well below the flicker fusion frequency, an annoying 12-cycle flicker appears. This effect arises in the video transmission circuit and is present whether or not the deflection circuits are hum-free.

Two other hum components appear, one as an 84-cps beat between the 60-cps power and the 144-per second field scanning rate, the other as a 24-cps beat between the 120-cps second harmonic of the power supply and the field rate. These beats are above the fusion frequency (except 24 cps at high picture brightness) and hence do not ordinarily produce flicker as such. But they can readily produce a shimmer or jitter of the scanning lines. This appears if any 60-cps or 120-cps hum component is present in the deflection coils, or if such components exist as stray magnetic fields near the picture tube deflection system. Even if the stray fields do not affect the deflection directly, they may induce currents in the turns of the scanning yoke which have the same effect as if the hum were present in the scanning generator itself.

for Television Scanning

Following industry turn-down on bracket-standards proposal, FCC is expected to adopt CBS field-sequential color standards and to authorize transmissions in near future. Redesign of receivers to accommodate dual scanning standards poses difficult questions regarding sync and deflection circuits, hum reduction and stray magnetic fields

Removal of hum from the transmitter involves nearly every item of equipment from camera to final r-f amplifier. In receivers, some attention must be paid to r-f, i-f and video amplifiers, particularly to avoid hum modulation of the first detector and direct hum injection in the video amplifiers. This may involve extra by-passing with higher voltage by-pass capacitors. Heater-cathode leakage in tubes (particularly the picture tube) must be controlled. One designer believes that three 400-volt electrolytic capacitor sections of 10 to 12 μf each will take care of the by-passing requirement. Finally, the basic filtering of the power supply must be improved in the majority of receivers.

Control of stray fields, to avoid direct or induced distortion of the scanning, starts at their source in the power transformer. If it were possible to locate the transformer three feet or more from the deflection system, no adverse effects would be noted, but this is possible only in large console models, and it may be impractical (due to fire-underwriter requirements) even in such sets. Three approaches to reduction of the external field at the transformer itself are possible: redesign of the transformer to use lower flux density, banding the iron core with a copper strap linking the stray field and external shielding with high-permeability alloy. It seems likely that at least two of these three methods will be necessary in combination to achieve a satisfactory result.

A final hum problem, in quite another category, appears in the operation of intercarrier-sound receivers. In such receivers, overmodulation at the transmitter or overload of any circuit, which reduces the amplitude of the intercarrier beat to zero momentarily during each line scan, produces a hum or buzz in the sound output, at the field-scanning rate and its harmonics. In conventional sets, this interference has a fundamental at 60 cps. This component and its second harmonic are not readily reproduced by the loudspeakers commonly used. In the b-s set, when scanning at 144 fields, the intercarrier interference and its second harmonic (144 and 288 cps) fall within the frequency range efficiently radiated by even a small speaker. The cures for this trouble are care in transmitter operation

Scanning Times in the Bracket System
(in microseconds)

	Standard Black-and-White (525/60)	*CBS Color (405/144)*	*Bracket Range*
Field scanning interval (V)....	16,667	6,944	6,667–20,000
Field blanking time (0.05 V to 0.08 V)..................	833–1,333	347–555	333–1600
Field retrace time (0.05 V or less)......................	833 or less	347 or less	333 or less
Line scanning interval (H).....	63.5	34.3	31.3–66.7
Line blanking time (0.16 H to 0.18 H)..................	10.2–11.4	5.5–6.2	5.0–12.0
Line retrace time (about 0.13 H)	8.3	4.5	4.1

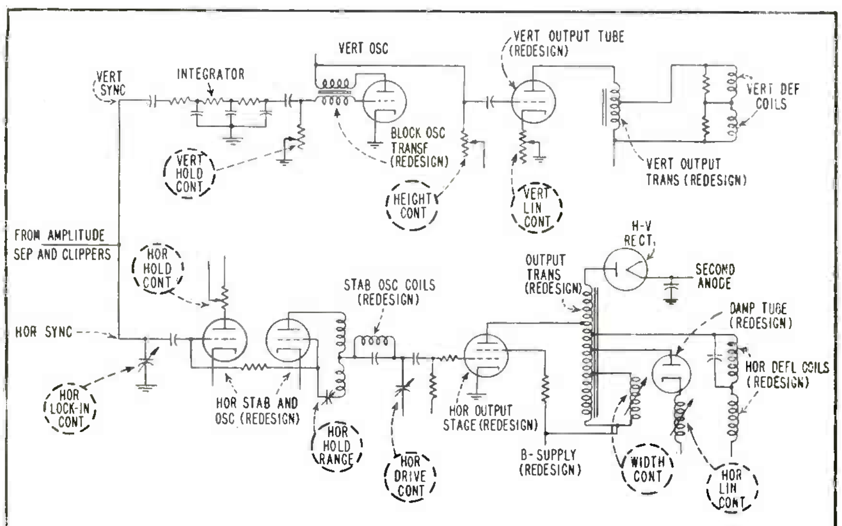

FIG. 1—Simplified vertical and horizontal sync, drive and output circuits of a 16-inch, 70-degree deflection chassis, showing elements that must be duplicated and switched (circled) and those requiring basic redesign

and particular care to avoid the possibility of overload in the receiver circuits.

Vertical Sync and Deflection

Turning now to the circuits in the b-s receiver which have to be switched, it is evident that the synchronization and deflection circuits are most intimately involved. The vertical circuits, which present a simpler problem than the horizontal, are considered first.

The sync signals are amplitude-separated following the second detector in the conventional manner; existing amplitude-separator circuits will serve without change. Following amplitude separation, frequency separation occurs. At this point it is believed desirable by some designers to design a new vertical integrator circuit, designed specifically for the 144-field rate. This circuit would be connected in the 405/144 position of the b-s switch, while the conventional 60-field integrator might be retained and connected in the 525/60 position.

Following the integrator, the frequency-determining element (a capacitor or resistor, or both) of the vertical scanning oscillator must be duplicated and switched. In addition, since the vertical retrace time is 347 μsec or less in the 405/144 position and 833 μsec or less in the 525/60 position, the discharge element must be duplicated and switched. In multivibrator oscillators using a stabilizing coil, the coil will probably have to be switched. Some designers doubt that the multivibrator circuit can operate satisfactorily over the range from 50 to 150 cps. The blocking oscillator circuit is considered suitable over this range when the proper components are connected to it.

The only vertical control normally available to the customer on the front of the cabinet is the vertical hold control. In some models this control is at the rear, together with the vertical size and linearity controls. In any case, it is the consensus that all three rear-of-chassis controls must be duplicated and switched to insure that the proper settings for synchronism, height and linearity are met at the two positions. The front-panel vertical-hold control would probably be planned as a vernier applicable to either position, rather than a control which would cover the whole range from 60 to 144 cps.

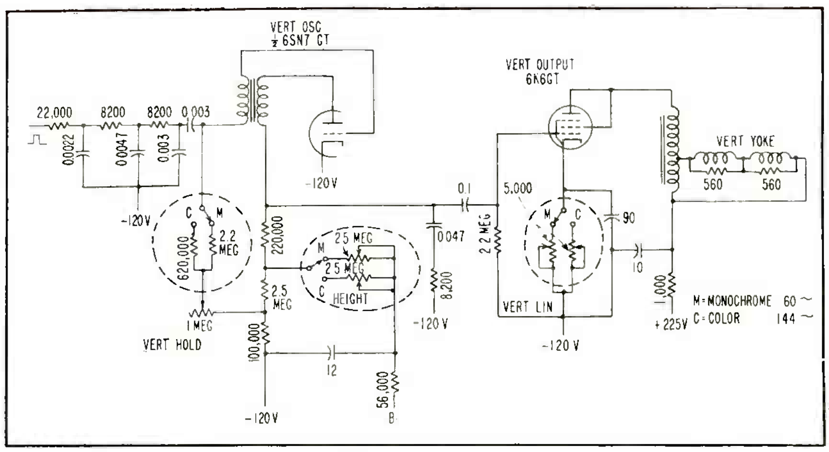

FIG. 2—Circuit modification of RCA 9T246 vertical drive and output stages, as designed by CBS engineers. The switched parts are circled

Vertical Deflection Output Circuit

The vertical output circuit must be considered from the standpoint og scanning power, efficiency and voltage stress. The condition stated by the FCC that picture brightness and size must be same at both positions of the b-s switch has been interpreted strictly to mean that the second-anode voltage on the picture tube shall not change between positions.

When the vertical scanning rate is changed from 60 to 144, substantially more power must be fed to the vertical deflection coils to produce the same peak-to-peak deflection current, which is required to produce the same size picture at the same second-anode voltage. Although the scanning power required is not strictly proportional to the field rate, since the vertical deflection coils have a substantial resistive component, it is believed that substantial additional vertical scanning power would be required, and in some receivers this means adding an additional vertical output tube, or installing a larger tube. In a few receivers, reserve power is available in existing designs.

The voltage-stress question arises because the retrace time is reduced in the 405/144 position by a factor of 2.4, while the peak-to-peak current range is unchanged. Therefore, unless the yoke is also switched to change the inductance, the Ldi/dt term in the retrace voltage peak is increased by 2.4 times. Many existing yokes and vertical output transformers are capable of withstanding the additional voltage stress, but others are not. The transformer, handling more power, will require a larger core for a b-s set than for a standard set. The yoke itself would not have to be redesigned in most cases, although some changes may be introduced when the horizontal portion of the yoke is worked over, as is required.

Examples of possible drives and output circuits are shown in Fig. 1 and 2. Figure 1 is a simplified diagram of the sync and deflection circuits. Figure 2 shows circuit changes designed by CBS engineers to modify the RCA type 9T246 chassis, which uses a blocking oscillator in the drive and autotransformer in the output. The vertical hold, height and linearity controls are duplicated and switched as shown. This circuit was designed before the FCC requirements regarding size and linearity were announced, and it is not claimed that the circuit will meet these requirements.

Horizontal Sync Drive

Modification of the horizontal drive circuit is complicated by the fact that substantially all modern receivers use horizontal stabilizing circuits. The first of these circuits, the afc type designed for the RCA 630TS chassis, is shown in Fig. 3.

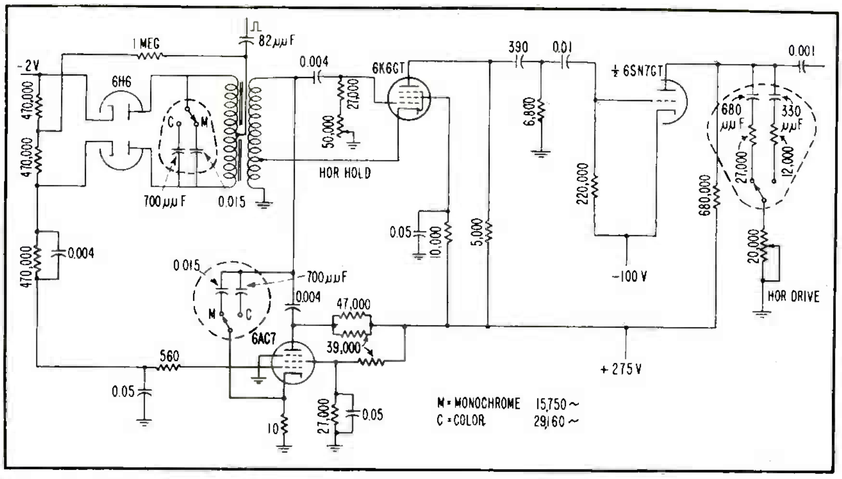

FIG. 3—Changes in a-f-c (synchrolock) stabilizer and horizontal drive of RCA 630TS chassis. Three double-pole switch sections are used in this CBS modification

The modifications shown were designed by CBS engineers. Here the switching involves a change in two capacitances, one across the discriminator transformer secondary and the other across the 6AC7 reactance tube. In addition the *RC* load of the 6SN7 horizontal drive tube must be duplicated and switched. Here, as in the circuit of Fig. 2, it is not claimed that this circuit will meet exactly the FCC requirements.

A more recent type of horizontal stabilized drive is shown in Fig. 4. This is the synchroguide circuit of the RCA 9T246 chassis, as modified by CBS engineers. The drive switching is considerably more complicated in this case, five double-pole positions being required to change the capacitances associated with the horizontal lock, frequency and drive controls.

The changes shown in Fig. 1 for these portions of the circuit follow the conclusion reached by most designers that the FCC requirements can be met only if a total of at least five horizontal drive functions are switched: horizontal hold control, lock-in adjustment, stabilizing circuit adjustment, discharge capacitor, (possibly also redesign of horizontal oscillator transformer where used) and drive capacitor across the grid of the output tube.

Horizontal Output Circuit

By far the most critical circuit in the b-s receiver is the horizontal output deflection and high-voltage circuit. This circuit, in existing receivers, consumes a large fraction of the total B-supply power and uses a large beam-tetrode (6BG6, 6BQ6, or 6CD6, all of which are variations of the type 807 transmitting tube). In view of its cost, no component of receivers has received closer attention in recent years than this. As a result, very substantial changes in design have occurred which permit 70-degree scanning angles to be achieved at 13,000 volts with less power in 1950 than was required to scan a 50-degree angle at 9,000 volts in 1946.

When the circuit is redesigned in strict accordance with the FCC requirements, it is found that from 30 to 50 percent more scanning power is required. This in turn requires (1) a radical redesign of the horizontal output transformer and the horizontal coils in the scanning yoke, (2) the addition of a second 6BQ6 or 6CD6 beam tetrode, and (3) the provision of 10 to 15 watts additional B-supply power. In view of these severe design requirements, most of the extra cost of the b-s operation is found in this circuit.

Less exacting approaches can, of course, be taken and will no doubt be adopted by many manufacturers. The horizontal output circuit shown in Fig. 4, for example, involves moderate additional B-supply power and uses but one 6BG6 tetrode, but is sufficient only for 55-degree deflection at 9,000 volts and is not guaranteed to provide the same size or brightness in both positions of the b-s switch. A new design of horizontal output transformer is required, with high-voltage switching at its secondary and at the screen dropping resistor of the output tube. When 70-degree scanning is in view, at voltages up to 13,000, and particularly when retrace-time requirements must be met in strict accordance with the proposed standards, no such simple a redesign as this will serve.

The clue to the difficulty is found in the horizontal retrace time, as shown in the accompanying table. The minimum horizontal blanking time specified by the FCC is 16 percent of the line scanning time, or 5.5 μsec at a line scanning frequency of 29,160 cps. If the upper limit of the scanning bracket is taken (32,000 cps) the blanking time is reduced to 5.0 μsec. Experience in production has proved that retrace time should not be greater than about 13 percent of the line scanning time, or 4.5 and 4.1 μsec respectively for 29,160 and 32,000 cps. These values are approximately one half the retrace time allowable in the black-and-white standards (8.3 μsec at 15,750 cps).

As previously noted, the scanning angle and second anode voltage remain unchanged in the two positions of the b-s switch. Accordingly the peak-to-peak scanning current must be the same, unless the number of turns on the deflection yoke is increased. But it is not practical to increase the deflection coil inductance appreciably, because the resonant period of coil and transformer secondary would thereby be increased and the retrace time lengthened beyond the allowable limit. Some designers feel that the yoke inductance can be increased from its present value of 8 to 10 millihenries to a maximum of about 14 millihenries. Others prefer to keep the yoke inductance substantially as it is.

In any event, switching of the yoke leads, which involves voltages as high as 6,000 volts above ground, is believed impractical. On the assumption that the yoke inductance remains unchanged, that the peak-to-peak deflection current is unchanged and the retrace time is reduced from 8.3 to 4.5 microseconds between switch positions, it follows the retrace voltage *Ldi/dt* will be about twice as high in the 405/144 switch position as it is in the 525/60 position. But this violates the requirement that the second-anode voltage remain unchanged. Accordingly, it appears necessary to keep the retrace time the same in both positions at its minimum value (4.5 or 4.1 μsec) and to increase the width of the picture at the 525/60 position by adjustment of the width control. This procedure avoids all high-voltage switching and appears to be a popular method at the present writing. Other circuits, involving yoke and transformer switching, are also being investigated.

In accordance with the above design procedure, taking the yoke inductance at its present value of 8 to 10 millihenries, it follows that the voltage developed across the yoke during retrace is about double that of present standard designs, or 6,000 volts. Since the deflection-current waveform and peak-to-peak amplitude are unchanged, it follows that the circulating power in the output circuit is doubled. Part of the circulating power is recovered via the damping tube, but at present it appears that the increase in power requirement is about 50 percent. Improved design of damper circuits and output transformers will probably reduce this to about 30 percent.

Translated into practical values, this means that 10 to 12 watts must be added to the 25 watts of B-supply currently needed for the horizontal deflection circuit. This might be met, for example, with an extra 100 volts of B-supply of 100 to 120-ma capacity. When the b-s switch is in the 525/60 position this extra power is not required, and some means is needed to dispose of it, since the operating point on the output tube characteristics must not be changed for a given output transformer. One suggested method of disposal is to convert the power into heat in a bleeder resistor which would be inserted on the 525/60 position. Another is to change the transformer primary connections so as to keep the tube-operating point correct, but this involves high-voltage switching.

One further difficulty is the fact that the short retrace time, in combination with the 15,750 cps line-scanning frequency in the 525/60 position, will feed half the normal charge per cycle to the high-voltage rectifier. It is likely, therefore, that the voltage regulation at the second anode will be poor in the 525/60 position, although satisfactory at the 405/144 position. Increasing the size of the high-voltage filter capacitor will not cure this trouble, because the internal impedance of the rectifier feeding it is very high.

The higher voltage across yoke and output transformer secondary means that the insulation of these parts, and of the connecting cables, must be improved. Also, the damper tube is subjected to twice the normal voltage. Present damper tubes work close to the limit in this respect. Tapping the damper tube lower on the output transformer secondary will cure this condition, but with very serious effect on horizontal linearity. It appears, therefore, that a new type of damper tube, with substantially higher inverse voltage rating, will be required.

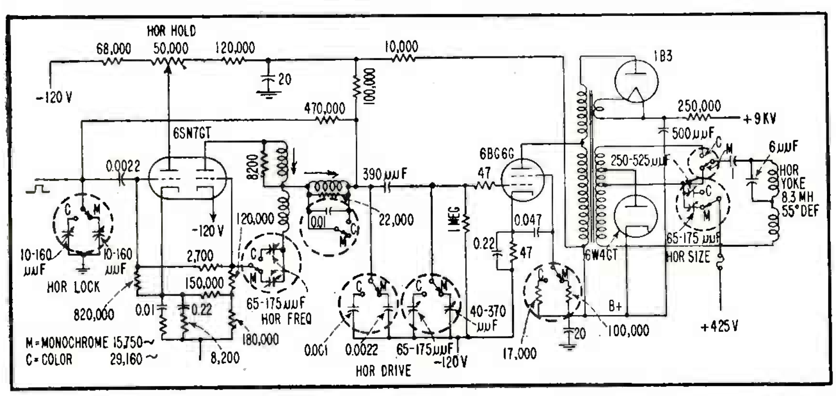

FIG. 4—Modern horizontal stabilizer circuits (synchroguide RCA 9T246) require more complicated switching. Output stage modifications shown here are suitable only for 55-degree deflection at 9 kv, probably will not meet FCC requirements

The output transformer itself must, of course, be completely redesigned. Since the secondary voltage is higher, the turns ratio must be reduced, and the core and windings must be capable of about 50 percent higher power dissipation. To get the extra power to feed to the transformer the output tube must have a higher voltage rating, a higher current rating or both. Since these tubes are now operated at the upper limit of the voltage rating, the higher-current method appears to be the only feasible approach. Thus two 6BG6 or 6CD6 tubes in parallel will be required until a new tube design becomes available.

The switching involved in the horizontal output circuit, designed on the above basis, is limited to the width control and linearity control, each of which must be duplicated and switched. One of these involves high currents, and the switch should be of the toggle type to avoid burning the contacts.

The B-S Switch Mechanism

A final consideration is the actual switch used to select the alternative circuits described above. If all the functions in a typical design are taken together, it is found that a 12-pole 2-position switch will be required. The majority of the switch contacts could be located on ordinary wafer sections, but at least two would involve high power or high current and would necessarily be toggle switches ganged in with the wafer mechanism. Since the lead length and circuit proximity of many circuits are critical, particularly in the horizontal sync and drive portions, it appears likely that a particular wafer would be assigned to these circuits and located in the immediate vicinity of the circuit to be switched. To assure that all the wafers would line up along the control shaft, rearrangement of present chassis layouts may be required.

One possible form of electronic mechanism is an automatic switch which measures the scanning rate of the signal to which the set is tuned and throws a relay to the corresponding position. Such a switch was developed by Chapin and Roberts of the FCC engineering staff and put in the record at the color hearing. The circuit of the Chapin-Roberts switch is shown in Fig. 5, as applied to a Bendix model 235M1 chassis. The circuit shown at the bottom of Fig. 5 performs the rate-recognition and switching function. The switched elements of the sync or deflection circuits, which are connected to the contacts of the electromechanical relay, are shown above. The circuit changes made in the upper diagram, like those in Fig. 2, 3 and 4, are not sufficient to meet the requirements of same size, same brightness and linearity on both positions.

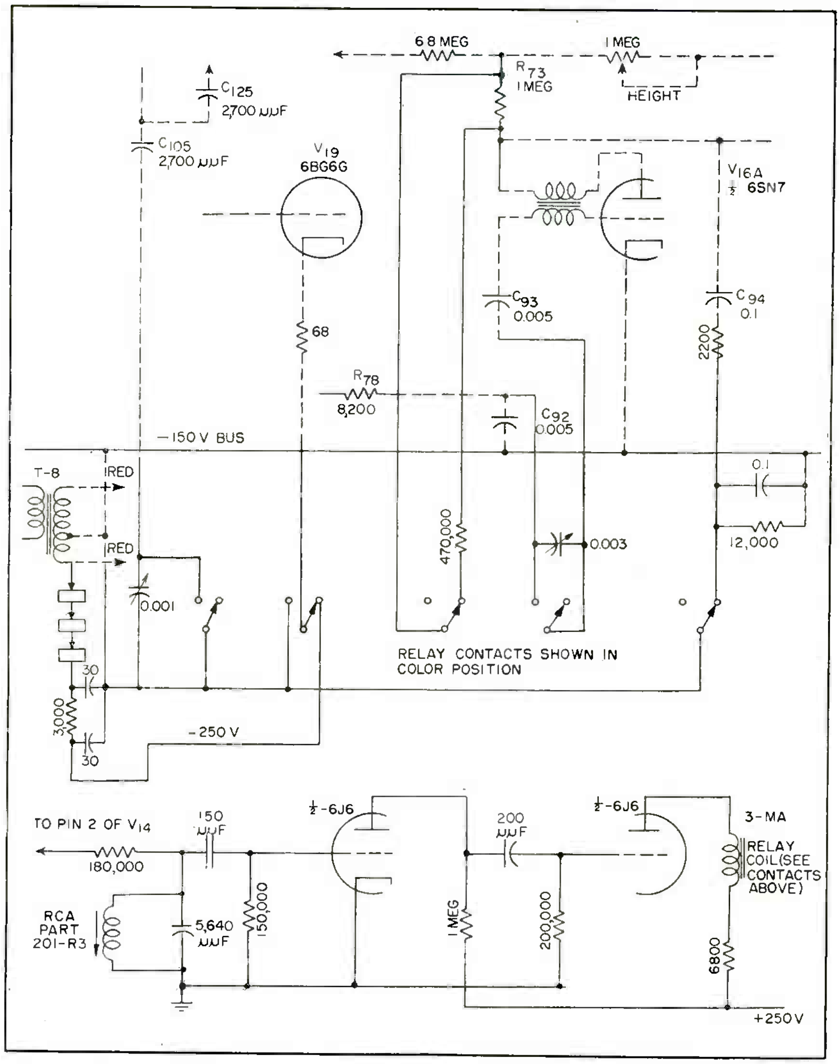

FIG. 5—Circuit of Chapin-Roberts automatic rate-recognition switch and deflection-circuit changes applied to Bendix 235M1 chassis. Circuit at bottom recognizes the scanning rate and throws relay. At top are shown 5-pole double-throw relay contacts which switch elements in deflection system

Changes in Transmitters

The principal problem facing transmitter designers (outside the procurement of color-cameras for live and film pick-ups) is the modification of existing equipment so as to operate on 144 fields per second without interference from the 60-cps power source. This modification is equivalent in many respects to operation on the 525-line 60-field system with 50-cps power supply. The changes involve improved filtering and by-passing of hum components throughout the system from camera to final r-f amplifier, so as to keep the hum level substantially below the 5-percent tolerance now permitted.

As previously noted, if power-supply hum is not rigorously excluded from the transmitted signal, a 12-cycle flicker will be evident on receiver screens and the scanning lines in the image may be subject to vertical and horizontal jitter, as outlined in detail above. The hum requirement applies not only to the 60-cps fundamental, but also to the lower-order harmonics, particularly the 120 and 180-cps components.

Three items of equipment will probably require so much modification as to make desirable entirely new designs: the color camera, the synchronization signal generator and the picture monitor. The hum requirement must be met, and complete control of stray magnetic fields is essential, in cameras and monitors. The sync generator must be hum-free, and provision must be made for generating the color-indexing pulse to keep the primary colors in step at transmitter and receiver. Thus far, in experimental transmission, cameras, monitors and sync generators have been operating from a separate motor-generator set producing 144-cps power. The requirement for such power is low, probably not more than one kilowatt if applied only to critical points. The alternator would, in this case, be locked in with the field frequency of the sync generator.

Estimates concerning cost and availability of such modified transmitting equipment vary widely. Many engineers believe that modifications of existing equipment, to render them hum free and to change scanning rates, can be accomplished in from 2 to 4 months, at costs running from 20 to 100 percent above the initial cost of the unit. One item of equipment which apparently cannot be modified but must be completely redesigned is the teletranscription unit.

Consideration has also been given to lighting. The average transmission loss of the color filters used in the CBS-type of filter-wheel camera is about 85 percent. To secure the same signal-to-noise ratio and depth of focus as with existing black-and-white equipment the lighting level would have to be increased about 7 times. In addition to providing more light, its color composition must be under better control and care must be taken to avoid flicker effects. Incandescent lamps on a-c supply and fluorescent lamps on d-c supply have been found satisfactory but single-phase fluorescents, unless operated from a 144-cps supply, produce noticeable flicker.—D.G.F.

Radiation Counters Aid

Differential radiation counters determine position of accumulation of radioactive material which, when added to bloodstream, collects in vicinity of tumorous tissue. Permit brain tumor recognition and location in matter of minutes

NEWLY PERFECTED methods of using radioactive isotopes as tracers in medical research have given rise to a need for high-speed counting equipment of greater versatility than has previously been available. It has been found necessary to provide improved indicating and recording devices, to use faster control and reset mechanisms, and to design new high-voltage supplies and input circuits to accommodate various types of detectors and permit greater flexibility.

The Isotron was designed to meet these requirements. The first model was built under contract for the Northwestern University Medical School with four specific applications in mind: (1) diagnosis and localization of brain tumors, (2) determination of thyroid iodine content as a means of diagnosing thyroid dysfunction, (3) investigation of peripheral vascular disease, and (4) investigation of blood circulation within the heart.

These specific projects introduce certain further requirements in addition to the generally desirable features mentioned. Heart research demands very rapid recording of the varying count rate. For this purpose a counting-rate meter is used with a high-speed magnetic oscillograph. Peripheral vascular investigations demand a detector housing which may be set in a wide range of positions, both vertically and horizontally. The tumor-detection technique necessitates a precise determination of the difference in counting rate at two separate points about the head. Thirty-two such difference readings are taken at two points simultaneously. An auxiliary circuit measures the difference between the two readings.

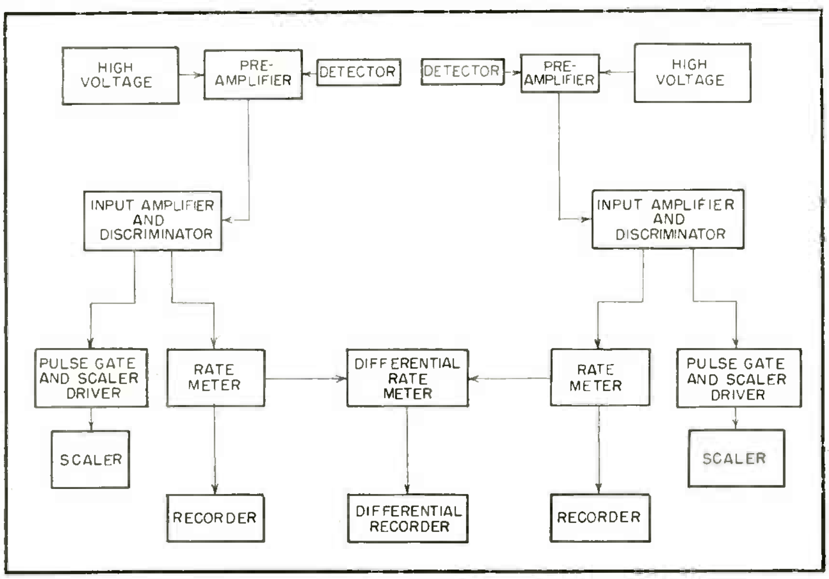

FIG. 1—Output of each detector and differential output are recorded for tumor location

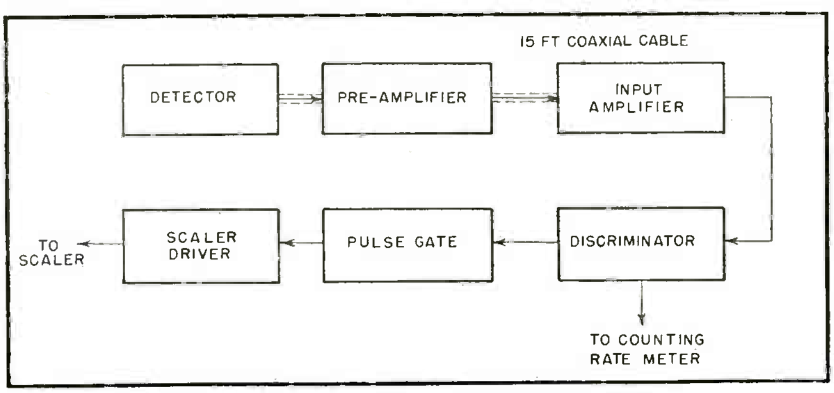

FIG. 2—Detector and preamplifier are housed in lead shields. Cathode-follower output from preamplifier permits use of 15-foot connecting cable

Basic Design

The equipment consists of two separate counting channels, each including a detector, a preamplifier, an input-pulse amplifying system and discriminator, a three-decade scaling circuit, a counting-rate meter, and a high-voltage power supply, as shown in Fig. 1. The detectors and preamplifiers are mounted on a mobile stand which was adapted from a commercial x-ray stand. The remaining units are housed in a mobile console containing six separate chassis in two stacks of three, each stack compris-

Brain Tumor Diagnosis

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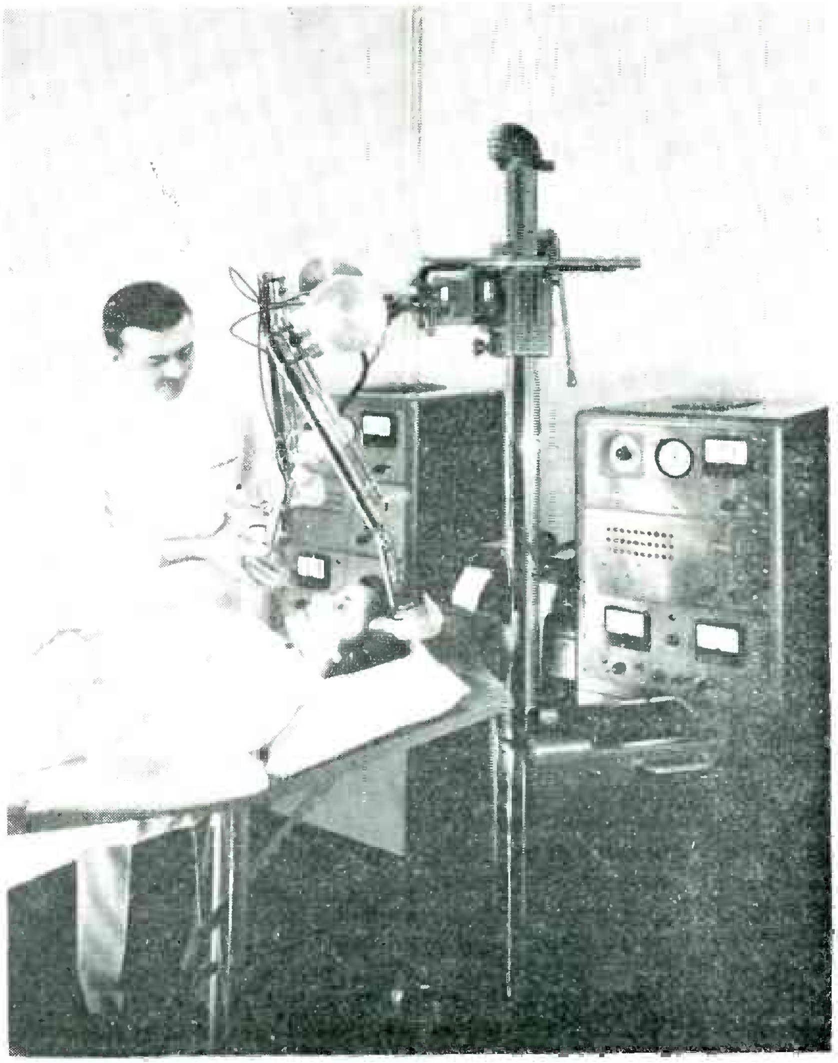

Special counter-balanced detector heads are placed at various positions around the head of the patient. Electronic counter circuits and recorders determine exact location of brain tumor, as indicated by high concentration of radioactive tracer material

ing one channel. The recorders are mounted at desk level between the two stacks, as shown in the photograph.

The two channels are identical in every respect except one channel, termed the slave channel, has a provision for switching the count-stopping and resetting control of its scalers to the corresponding circuits in the other channel. The other channel, termed the master channel, also houses a special voltmeter circuit which measures the difference between the two counting rates.

Detector Stand

The detectors are housed in lead shields to permit more accurate determination of count rate by minimizing the background count. The weight of these shields, some forty pounds altogether, necessitates the use of a counter-balanced stand. Considerable range in positioning is made possible by mounting the detectors on arms extending out from a yoke on the stand. This yoke is capable of vertical positioning and horizontal rotation. The arms themselves are easily moved both horizontally and vertically. Once a desired position is reached the entire system may be locked in place. For most positioning adjustments the yoke may remain locked as the arms are moved or the detector housings pivoted.

A short length of coaxial cable connects the detectors to the preamplifier housing. The preamplifiers are cathode followers whose low output impedance permits the use of a fifteen-foot cable to the input amplifier in the console.

High voltage for the detectors is provided by regulated supplies

TUMOR LOCATING TECHNIQUES

Physical symptoms of brain tumors are extremely difficult to identify with certainty. Prior to the development of radioactive tracer methods, the diagnosis of brain tumors could be accurate only to within 80 percent, and no information was available as to the location of such a tumor if present.

Radioactive diiodofluorescien, when injected into the bloodstream, has a tendency to concentrate around tumor tissue. Such concentrations permit diagnosis of tumors with accuracies of 95.5 percent. By using a pair of differential detecting elements, the exact location of the tumor can be determined within a few minutes.

The workings of the electronic portion of the latest development in this valuable field of medicine are presented here. This month's cover shows a full-color view of the instrument at work mapping the progress of the radioactive tracer materials through the brain

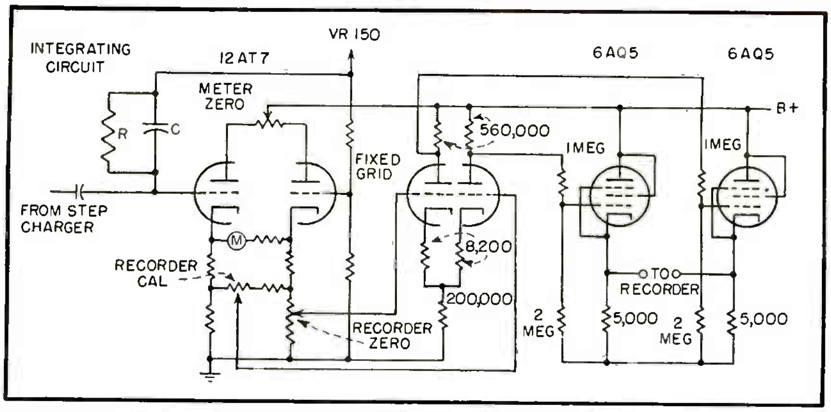

FIG. 3—Simplified schematic diagram of recorder-driving amplifier. Integrating circuit actually provides five choices of resistors and three capacitors for different counting rates from 400 to 40,000 per minute

whose outputs are continuously variable from 600 to 2,500 volts at currents as high as one milliampere. Conventional series-shunt regulators afford regulation within 0.01 percent per volt of line-voltage variation.

Input System

The input systems (Fig. 2) are capable of handling a wide range of pulse amplitudes. The four-tube input amplifier in each channel has a maximum gain of 400, and a high negative feedback factor makes gain independent of varying tube characteristics. A one-shot multivibrator using a 6J6 twin-triode functions as a pulse discriminator. The plate supply voltage to these stages is regulated to insure constant input sensitivity with varying line voltage. Adjustment of amplifier gain and of attenuation in the preamplifier provides threshhold sensitivities as low as one millivolt and as high as ten volts.

A pulse gate follows the discriminator. The pulse gate is a pentode amplifier whose screen grid is shorted through a low resistance to ground by the action of the scaler stop-count switching circuit. This action, in effect, closes the gate instantaneously. Returning the screen to its normal voltage permits the pulse to be coupled into the power amplifier that drives the scaler. The count-stopping circuits have no effect on the rate-meter input.

Scaling Circuits

The scalers each comprise three standard decades,[1] giving scale factors of 10, 100, or 1,000. The decades themselves consist of a ring of five bistable stages followed by a scale of two. They are operable at speeds up to 200 kc at line voltages from 95 to 130 volts. A mechanical register capable of speed up to 25 digits per second is housed in each scaler. A precision timing clock is controlled by the stop-count switching circuit in each channel. It is reset to zero by the scaler reset switch.

Counting with the scalers is greatly facilitated by the automatic stop-count switching circuits. In addition to a manual stop-count switch, the count may be stopped by an automatic internal timer or by a preselected count circuit. Either of these systems simultaneously stops the timing clock. The internal timer recycles automatically. Contacts in the mechanical register are arranged to stop the count at register reading of 10, 50, or 100 when desired, making available the following possible preselected counts: 10, 500, 1,000, 10,000, 50,000, 100,000, 500,000 and 1,000,000. This operation also recycles automatically when the register is reset and the stop-count switch thrown. The type of count stopping used is determined by a scaler OPERATION SELECTOR switch.

The slave channel is equipped with a control selector switch which disconnects its own stop-count and reset circuits and causes its scaler to be controlled by the corresponding circuits in the master channel. This operation automatically synchronizes the two scalers.

The counting-rate meters consist of a pulse-forming stage and a step-charging network which feeds a resistance-capacitance integrating circuit whose voltage is measured by the d-c vacuum-tube voltmeter circuit shown in Fig. 3. The pulse shaper is a cathode-coupled one-shot multivibrator. It is triggered by the output of the pulse discriminator tube and, through the step-charger, delivers uniform pulses to the integrator.

Range Switching

There are five ranges from 400 counts per minute full scale to 40,000 counts per minute full scale. Range switching is accomplished by changing the value of the resistor in the integrating circuit. The integrating capacitors are 10 μf, 0.5 μf, or 0.1 μf, affording 3, 10, or 20-percent statistical error. A switch provides a fast-charging circuit for those capacitors not in use so that changing switch positions will not produce large discontinuities in the rate-meter reading.

The voltmeter uses a 12AT7 twin-triode with one grid at a fixed potential and the other grid voltage varied in accordance with the voltage across the integrating capacitor.

Recorders

The need for high-speed recording of counting-rate variations resulted in the selection of a magnetic oscillograph with frequency response up to 100 cycles. Three such recording units are used, one to record the output of each of the two channels and one to record their difference. Circuits are also provided to allow for instant pulse recordings. Recording may be triggered directly from the discriminator output or from the scaler output.

The 25-milliampere movements of the recorders necessitate the use of amplifier circuits of the type shown in Fig. 3. The amplifiers used consist of a high-gain stage of voltage amplification followed by a push-pull cathode-follower power amplifier. A symmetrical differential voltage amplifier provides push-pull output from a single-ended input. Degeneration in the cathode circuit provides added stability. The output of the voltage amplifier is direct coupled to the 6AQ5 cathode fol-

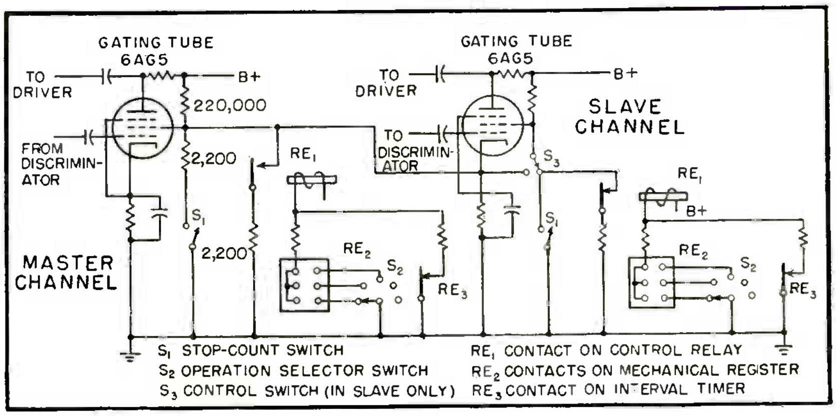

FIG. 5—Count-stopping circuits. It is possible to switch the count-stopping control of the slave channel to the circuits of the master channel by using S_3

lowers, with some voltage gain sacrificed to obtain proper operating points for the 6AQ5 grids.

The input to the voltage amplifier from a point in the cathode circuit of the rate-meter voltmeter tube is applied to one grid of the next tube. The other 12AX7 grid is fixed at a point determined by a potentiometer in the fixed cathode of the voltmeter which functions as a recorder zero adjustment. Recorder calibration is independent of rate-meter calibration.

The amplifier which drives the differential recorder is essentially similar to the others. It takes a d-c input from corresponding points in the cathode circuit of each voltage meter tube. A one-milliampere meter shunting the recorder gives a panel reading of the difference rate. This amplifier differs somewhat in the matter of zero levels. The recorders are of a zero-center variety so that the two amplifiers, each of which record the rate of a single channel, must be electrically biased to zero. Accordingly, equal and oppositely directed currents flow through the recorder movement at zero and full scale while a balance occurs at half scale and no current flows. This is not the case with the difference amplifier, whose output is a center zero reading with deflection in either direction to indicate which channel is counting the higher rate and to show the magnitude of the difference.

Control Circuits

The automatic count-stopping circuits associated with the scaler are made to function by the action of the control relay. When the relay coil circuit is closed, relay contacts simultaneously stop the count and shut off the timing clock by duplicating the action of the stop-count switch. The circuit which energizes the relay is closed either by the automatic interval timer or by the contacts on the register as determined by the OPERATION SELECTOR switch. When this control is set for manual operation, the coil circuit is held open and the count must be stopped manually. The stop-count and reset circuits in the master channel are shown in simplified form in Fig. 4 with the stop-count switch in the count position and the OPERATION SELECTOR in the PREDETERMINED COUNT position.

As shown in the simplified schematic in Fig. 5, it is possible to switch the count-stopping control of the slave channel to the circuits in the master channel by means of S_3. Provision is made for similar switching of the scaler reset by another pole of the CONTROL SWITCH.

Careful shielding of the input amplifiers and all signal leads into it is made necessary by the high gain of the amplifier itself. Considerable filtering of the amplifier plate supply voltage is necessitated by the line transients caused by the action of the timers.

The writer is indebted to John Cooper of Northwestern University Medical School and to Robert Buntaine of Nuclear Instrument and Chemical Corporation for consultation and advice in preparing this paper.

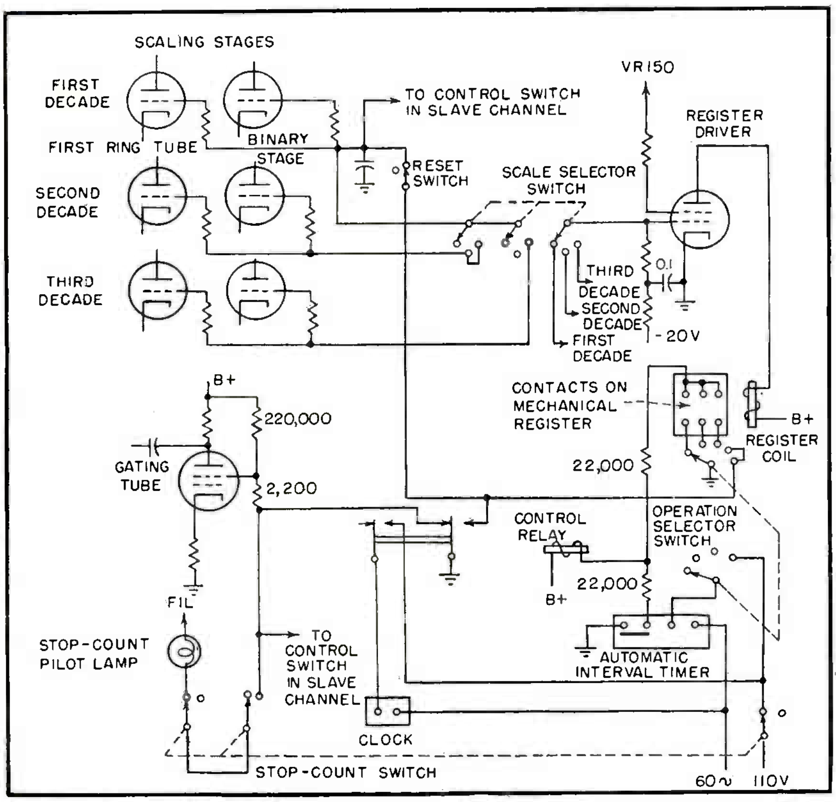

FIG. 4—Simplified schematic of scaler control circuits in master channel. Operation of selector switch permits timing of given count or counting during given time interval

REFERENCE

(1) R. Weissman, Stable Ten-Light Decade Scaler, ELECTRONICS, p 84, May 1949.

Designing the

Development and fabrication of a high-gain television radiator omnidirectional in the horizontal plane with vswr better than 1.15 over the band from 529 to 535 mc. The 40-foot self-supporting structure mounted atop a 500-foot tower has a gain of 17 and width of 3 degrees

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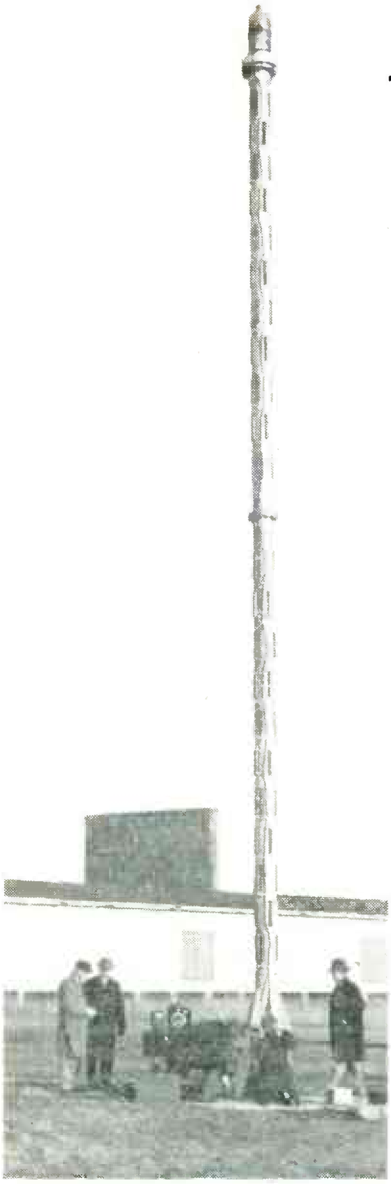


Bridgeport antenna undergoing final field tests

Scale model of the top half of antenna

An experimental uhf television transmitter has been installed at Bridgeport, Connecticut, to study program service characteristics[1]. In order to get proper coverage from the present 1-kw picture transmitter it was necessary that the antenna have high gain, a pattern omnidirectional in the horizontal plane and a low standing-wave ratio over the 529- to 535-mc band. The desired gain was approximately 20, which necessitated a vertical beamwidth of less than 2.5 degrees. A vswr of less than 1.11 throughout the specified frequency range was desirable to minimize ghosts.

The high-gain requirement dictated that the antenna should be made up of approximately 20 elements radiating omnidirectionally and in phase, each element having a gain close to that of a half-wave dipole. Since the radiation had to be horizontally polarized, yet omnidirectional in the horizontal plane, a linear array of dipoles could have been used except that the feed system would have been cumbersome and complex. A linear array of half-wave slots spaced electrically one wavelength apart along a rigid coaxial line allows the use of a simple feed system. It furnishes the necessary horizontal polarization, and is made up of elements whose power radiation can be readily controlled. By spacing four slots around the rigid coaxial line, the array radiates in an omnidirectional fashion. Figure 1 shows the center two of the 20 elements.

The outer conductor of the coaxial line is 10¾-inch diameter by ½-inch wall steel pipe to make the 40-foot structure self-supporting. The center conductor is standard 3⅛-inch copper tubing.

Antenna Feed

It was decided to feed all slots in each half of the antenna in phase, treating each layer of four slots as an individual element, and to match each individual layer independently of the others. The feed system consists of a single conductor in the center of the 10-inch pipe, with the pipe itself the outer conductor of a coaxial line. The antenna is fed from the center, so that there will be no net vertical beam tilt with changes of frequency. This system, therefore, employs a coaxial line broken at the center. It feeds the two halves of the antenna in series, out of phase, which necessitates placing the probes on opposite sides of the slots.

In order to check the feasibility of such an antenna with a minimum expenditure of time and money, a 0.1 scale model, illustrated, was built, representing half the total antenna. This approach was possible because the final antenna was to be fed from the center

Bridgeport UHF Antenna

and be made up of two identical halves, one being the mirror image of the other. At first only one layer (consisting of four slots spaced around the pipe) was cut in the model pipe, and from this single layer all the parameters of the various layers were determined. These parameters included power radiated by the layer for various exciting-probe depths, phase shift of layer for various exciting-probe depths, as well as the depth and position of a single probe placed between the slots for matching the layer. A single probe to match all four slots in the layer was considered desirable, since it would result in a minimum number of holes to be drilled in the full-scale model. The setup shown in Fig. 2 was made to determine dimensions.

A test run was made to determine the power radiated by the layer as a function of exciting probe depth. For each setting of the exciting-probe depth, the matching-probe depth and position with respect to the layer were varied until the layer was matched. The amount of power being radiated by the layer was measured by the drop in power indicated on the output meter shown in Figure 2. For each setting of the exciting-probe depth, the physical position and depth of the matching probe were recorded. This procedure was followed for a large number of probe depths, and a curve drawn.

To measure the phase shift of the layer for various exciting-probe depths, all probes were first removed and the bleeder cable and probe placed in the guide as shown. The position of the probe and the attenuator at the top of the setup were varied until a null was indicated on the output meter.

The position of this probe was then noted on a scale at the top of the lower guide as the zero phase-shift reference. The exciting probes and matching probes were then reset at various depths and positions, and the bleeder probe moved along the guide until a null was again read on the output meter. The difference between the new bleeder-probe setting and the reference gave directly the delay caused by the layer for the various probe settings. This phase-shift data was

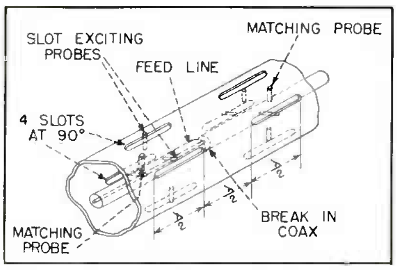


FIG. 1—Cross section of the feed system

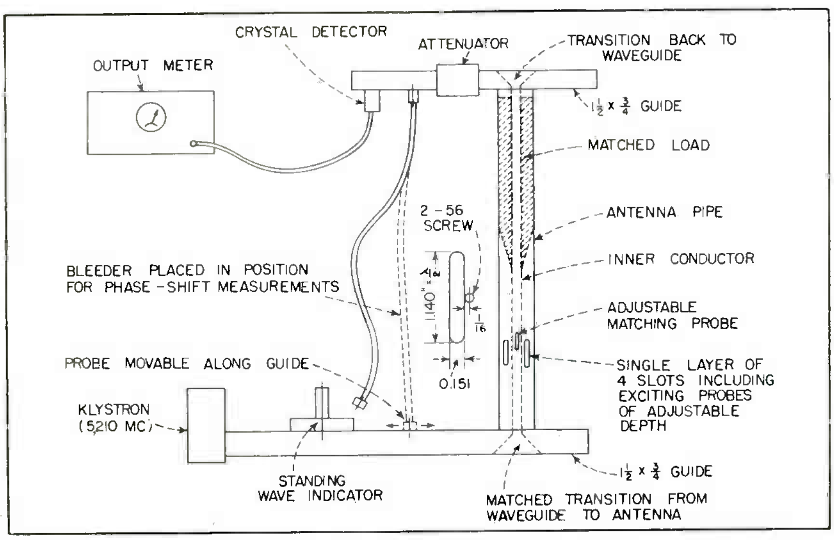


FIG. 2—Setup for determining antenna parameters

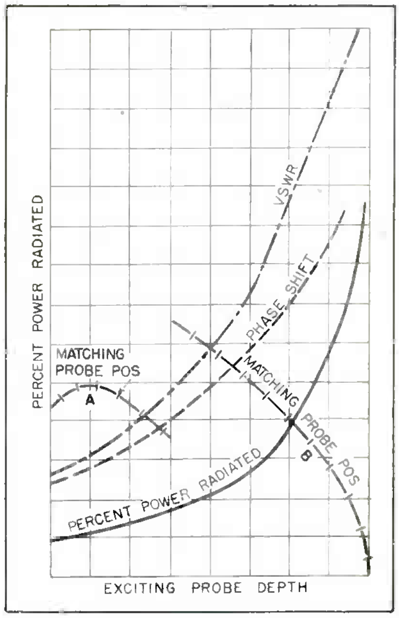


FIG. 3—Design data for scale model taken from measurements on single layer of slots

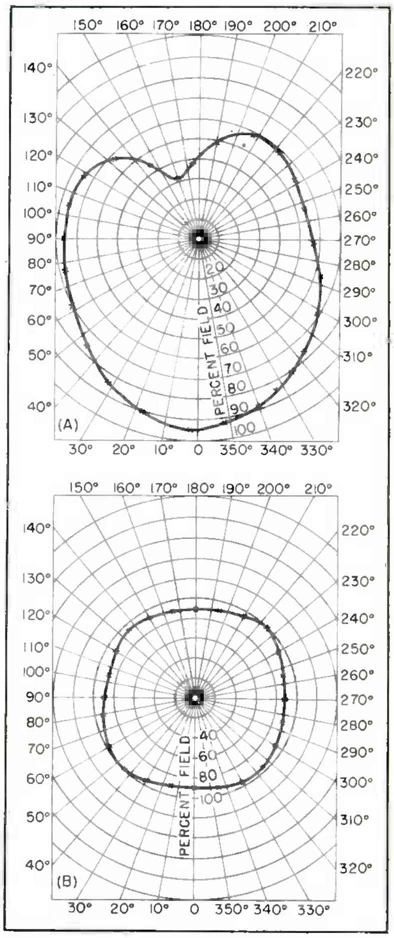


FIG. 4—Horizontal field pattern (A) of model antenna showing distortion from unwanted mode and (B) final pattern of scale model antenna

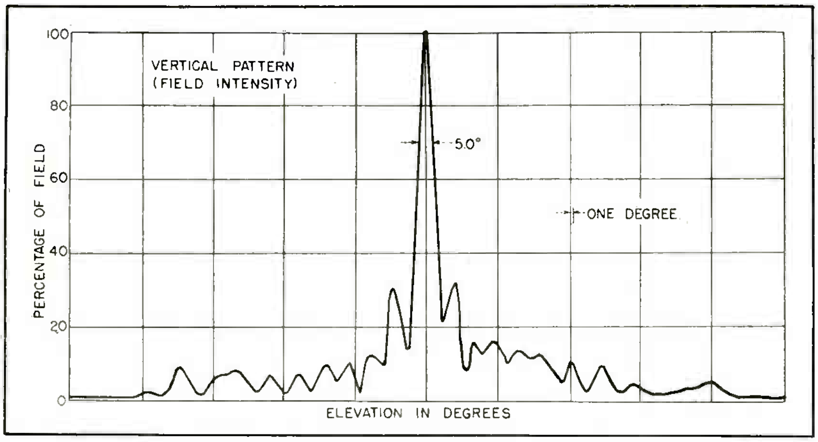


FIG. 5—Final vertical field intensity pattern of scale model antenna

then plotted on the same curve as the previous data.

The design of the complete antenna, including all probe settings and layer positions for in-phase excitation, was determined from the set of curves in Fig. 3. The phase-shift information indicated that eleven layers would be employed in each half of the antenna.

To make use of these curves, it was first necessary to determine how much power, relatively, should be radiated by each individual layer. Since the gain of the antenna is of prime importance, uniform illumination of the aperture is required. Therefore, all layers should radiate equal amounts of power. Consequently, the layer nearest the feed point (the center of the antenna, but the bottom of the scale model) should radiate 1/11 of the energy which reaches it; the second layer should radiate 1/10; and so on. It was then necessary only to pick off these various power levels from the curves and read off all other parameters, including phase shift. From the phase-shift information, the spacing between adjacent layers was calculated so that all layers would radiate in phase.

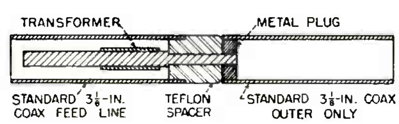
Using the information obtained from the curves, 10 more layers, including the matching-probe holes, were cut in the model. However, before the probes could be assembled, special attention had to be given to the last layer at the top of the scale model. Since this layer must radiate all the energy that reaches it, it alone must match the pipe with no other layers in operation. This effect was accomplished by experimentally adjusting the depth of the exciting probes and the position of a shorting plunger at the top of the pipe.

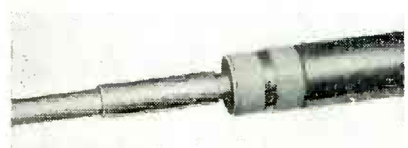
With this layer adjusted, the remaining layers were assembled according to the information on the curves. The vswr of the model, after complete assembly, was found to be approximately 1.15. This was considered sufficiently well matched for pattern measurements to proceed.

Pattern Measurements

The scale model was set up and a vertical pattern taken. This pattern was satisfactory in most respects, although the beam was tilted two tenths of a degree downward. This effect indicated that the top portion of the model was excited slightly ahead of the bottom section in phase, resulting in a gain loss of less than 2 percent.

The horizontal or azimuth pattern shown in Fig. 4A was found to depart excessively from circular. Upon investigation, it was learned that the numerous probes inside the pipe created an artificial dielectric that allowed the TE_{11} mode to be propagated up the pipe. This mode could be set up by either the waveguide transition at the bottom of the model, or any one of the matching probes along the pipe. Placing a suppressor at the bottom of the pipe and staggering the matching probes around the pipe in a spiral fashion failed to correct the condition. The propagation of this mode could have been prevented by reducing the size of the pipe, except that the pipe size had been determined from mechanical considerations. Eliminating any means of exciting the mode appeared to be the most practical solution. Circular symmetry along the full length of the pipe requires at least four matching screws for each layer. However, in order to allow for mechanical tolerances in both the scale model and the full-size antenna, it was thought advisable to use two matching probes per slot, or eight probes per layer. These two probes act as a two-stub tuner, and are placed $\frac{3}{16}$ wavelength apart. Such an arrangement permits easy correction of any change of slot impedance that





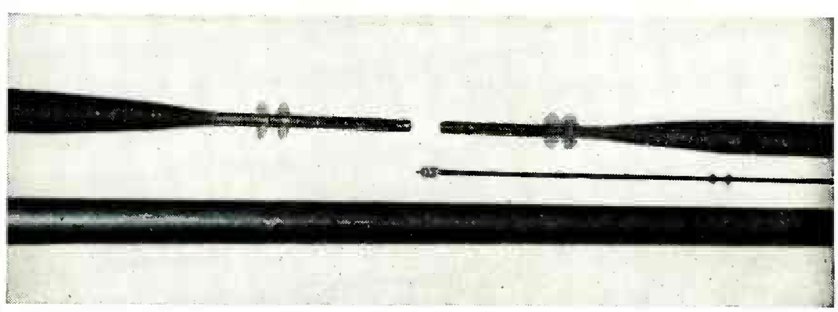


FIG. 6—Cross section drawing of the feed system (upper left) and photograph (upper right) taken with outer conductor removed to show quarter-wave transformer. The development feed system (below) uses space-cloth loads

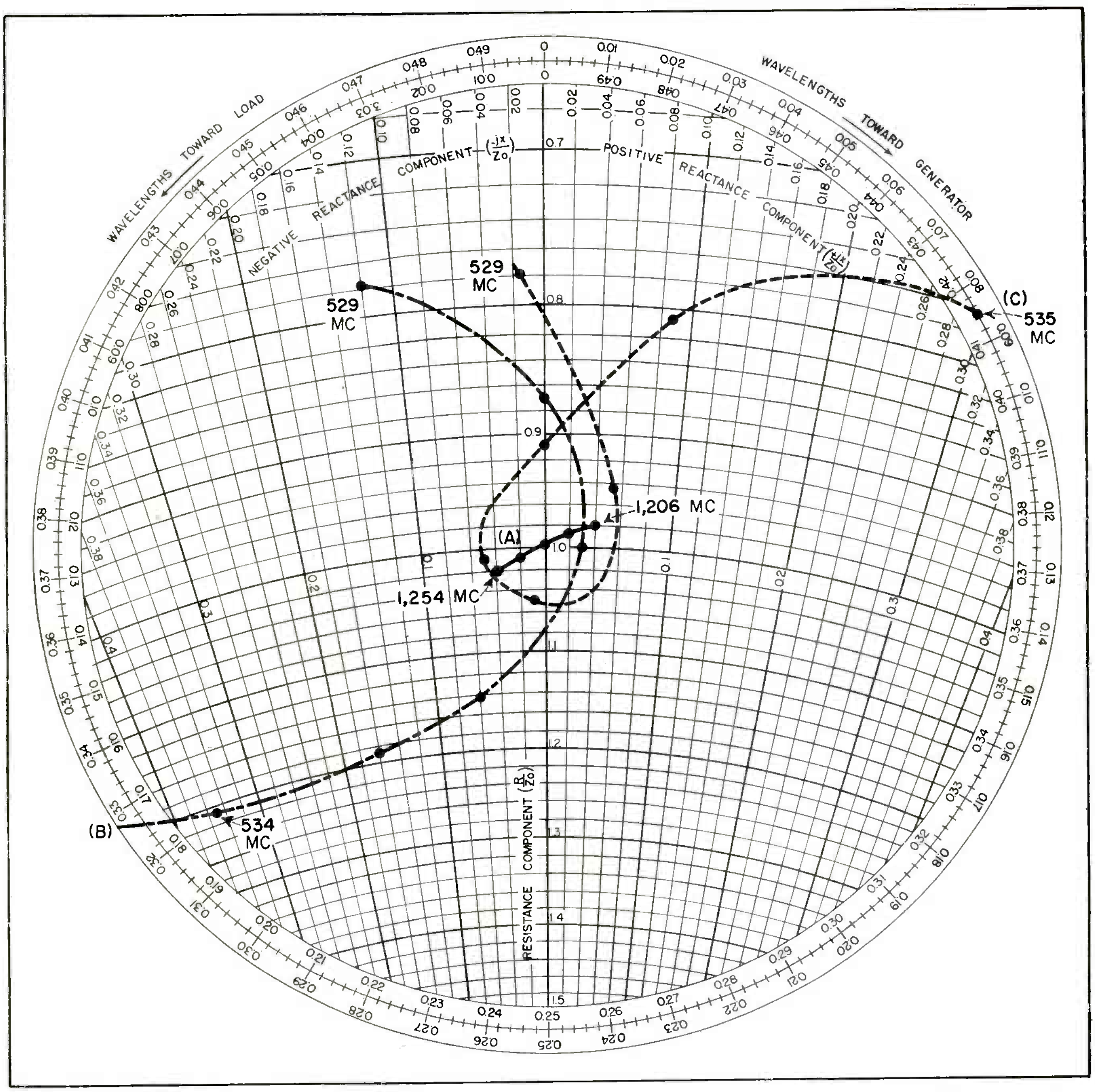


FIG. 7—Impedance characteristic of development model fed with quarter-wave transformer (A), of full-size model before adding transformer (B) and admittance characteristic of full-size model after addition of broad-band transformer (C)

might occur in the full-size model. A $\frac{1}{16}$-wavelength spacing between the probes was chosen so that the necessary reflection coefficient could be obtained from the pair without introducing phase shift appreciably greater than that introduced by a single probe.

After rematching the model, layer by layer, using these matching probes, another horizontal pattern was taken. This pattern, Fig. 4B, shows that the field strength varied from 100 down to 88 percent, which is about what was expected from such a slot arrangement. Such variations are quite acceptable.

A vertical pattern, shown in Fig. 5, indicates that the beam has an upward tilt of approximately 0.2 degree. Two matching screws per slot cause some increased phase shift between slots over that received with only one probe per layer. However, this pattern also is quite acceptable. The half-power beamwidth is 5 degrees. The relatively high side lobes are largely due to the uniformly illuminated aperture. Integration of this pattern indicates a gain of 11.2 over a half-wave dipole. This means a gain of approximately 22.4 for the full-size antenna, since these patterns are for half an antenna.

In order to check the calculated gain, the gain of a horn was measured by placing it in front of a conducting mirror and then measuring the reflection coefficient caused by the mirror. Using the horn as a standard for substitution measurements, the gain of the model measured 10.5, which would mean a gain of 21 for a full-size antenna. This is not the gain measured at the peak of a horizontal lobe, but rather the average gain between the peak and a low point in the azimuth pattern.

No impedance beamwidth measurements were made on the model, since the transition from waveguide to the coaxial antenna was not itself broadband. In order to make bandwidth measurements, all probes would have had to be removed and the transition readjusted for each frequency change. Therefore, it was decided to make these measurements on the full-size antenna.

In order to mount the full-scale antenna horizontally on 5-foot trestles, a convenient working distance from the ground, it was necessary to devise a means of preventing or correcting interference with the impedance measurements by the ground. The possibility of using space cloth was checked, using the scale model. A piece of space cloth (377 ohms per square), equivalent in width to 9 feet, separated by a quarter wave from a conducting plane, produced a vswr of 1.005 at an equivalent distance of 5 feet from the model. A Bakelite sheet a quarter-wave thick, with a dielectric constant of approximately 4, which very closely approximates the effect of ground with a dielectric constant of 16, was placed an equivalent distance of 5½ feet from the scale model. It produced a reflection coefficient corresponding to a vswr of 1.04. Accordingly, the full-size antenna was measured on the trestles with the space cloth beneath it.

Antenna Feed

The feed system previously outlined for the full-size antenna consisted of a standard 3⅛-inch 51.5-ohm coaxial line broken at the center of the antenna. Figure 6 includes a cross-section sketch of this system showing the break and the spacing insulation. The Teflon spacer gives not only a rigid gap in the line, but also acts as an end seal for the coaxial feed line.

The development of this feed system was done at approximately 2½ scale for ease and speed in handling. As shown in Fig 6, this feed system was inserted in a pipe corresponding in size to the 10-inch pipe in the full-scale model and space-cloth coaxial loads were placed inside the pipe to simulate a perfectly matched antenna. With no transformer in the feed line, the vswr was 1.86. By placing a 37.2-ohm transformer in the feed line (Fig. 6), the impedance characteristic became that shown in Fig 7A.

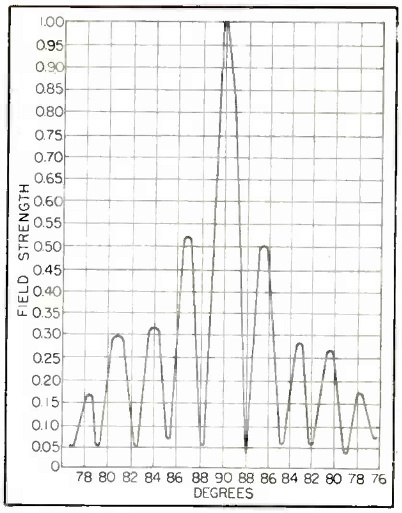


FIG. 8—Vertical field intensity pattern of full-size model at 532 mc

Power Division

A check was made, using this model, to determine whether the power fed into the antenna would divide equally between the top and bottom halves of the pipe. It was found that 50.9 percent of the power was fed into the top half, while 49.1 percent was fed into the bottom half. This power split was considered satisfactory. The feed system was supported by four sets of dielectric posts threaded into the 10-inch pipe, as well as the shorting plates at each end of the antenna.

The full-size antenna was constructed using the dimensions, including slot size, probe depths and slot spacing of the scale model and the half-scale feed system. The only departure from the scale model in the full-size antenna was that alternate layers of slots were rotated 45 degrees. This change was made to improve the circularity of the horizontal pattern, and to give some insurance against the propagation of the TE_{11} mode along the pipe. The final model employs $\frac{3}{32}$-inch thick polyethylene slot covers to weatherize the antenna. These have little effect on the impedance of the antenna.

An impedance check showed that it would be necessary to use the same matching technique employed on the scale model. However, before matching the antenna proper, the feed system was checked using a matched load in the 10-inch pipe and found to be satisfactory.

The procedure for matching the antenna proper was the same as that outlined for the scale model. The last layers were matched first by adjusting the probe depth and shorting-plate position. Adjustments proceeded towards the feed point layer by layer until the complete antenna was matched.

The matching probe settings in each layer were found to differ somewhat from the settings indicated by the scale model. Also, the settings of corresponding layers in the two halves of the antenna, which were presumably identical, were found to differ. These observations indicate that this type of radiating element is relatively sensitive to mechanical tolerances.

When the antenna was matched, an impedance versus frequency check was made. The resulting curve, shown in Fig. 7B indicates that the antenna is more frequency-sensitive than was anticipated. However, by using transformers in the feed system, the final impedance shown in Fig. 7C was obtained.

The vertical pattern of the full-size antenna at center frequency in Fig. 8 shows that the secondary lobe level is higher than that of the scale model, while the half-power beamwidth is somewhat less than half that of the scale model. This data indicates that the pipe is not uniformly illuminated along its length, but the illumination increases toward the top and bottom of the pipe.

A check of the horizontal pattern shows that the field strength varies less than 5 percent around the pipe, indicating that no TE_{11} mode exists in the antenna. By integrating the vertical pattern, the gain at center frequency was found to be 17.3. This is a figure somewhat short of the anticipated gain. It results chiefly from the nonuniform illumination.

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Compact Amplifier for Aircraft Tests

Design of carrier amplifiers required for measuring small-magnitude, high-frequency pressures or stresses in small aircraft, including data on stable carrier generator and voltage stabilizing circuits. Sensitivity is 8μv input per ma output up to 250 cps

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To EVALUATE an airplane successfully, many physical measurements must be made in flight. When measured magnitudes of pressure or stress are small or the frequencies high, carrier amplifiers are widely used to get higher sensitivity and better frequency response than can be obtained with direct-recording oscillographs.

To facilitate flight testing of airplanes in which space is at a premium the NACA has developed the miniature carrier amplifier described below. The most important features desired were: compactness; good amplitude stability with changes in supply voltage, temperature and vibration; flat frequency response to 250 cps; small phase lag difference between channels; high sensitivity.

To avoid errors caused by carrier frequency drift when using reactive-type pickups or wire strain gages having excessive line capacitances, an American Time Products type 2001-1A, 2,000-cps tuning fork was used as the frequency source. This fork has a frequency change less than 0.001 percent per deg C. The output from this fork is fed into a wave-shaping and amplitude-control circuit shown in Fig. 1. The shaping is achieved by the action of drawing grid current through the grid limiting resistors and by overdriving the amplifiers. When the signal reaches the toroid-tuned circuit it is essentially a square wave having a fundamental frequency of 2,000 cps. This tuned circuit has a high Q that sharply rejects all harmonics of the square wave. The output of the last stage is then a sine wave of constant amplitude. The function of the two 1N35 crystal rectifiers and bias voltage E is to maintain a constant-amplitude square wave across the toroid coil.

Voltage Supply

The maximum voltage variation in a typical airplane power supply is from not less than 23.5 to not more than 28.5 volts. This change causes a corresponding variation from 11.7 to 13.0 volts in the regulated filament voltage. The same supply voltage change causes less than 1-volt variation in the 280-volt plate supply. Type B-46 ballast tubes are used for filament regulation and a typical degenerative-feedback voltage regulator shown in Fig. 2 is used for the plate-voltage supply. As Table 1 shows, these small voltage changes have negligible effect on the carrier output. Six power-output stages operating with parallel inputs are pro-

Front of six-channel amplifier, showing size relative to rule at lower right

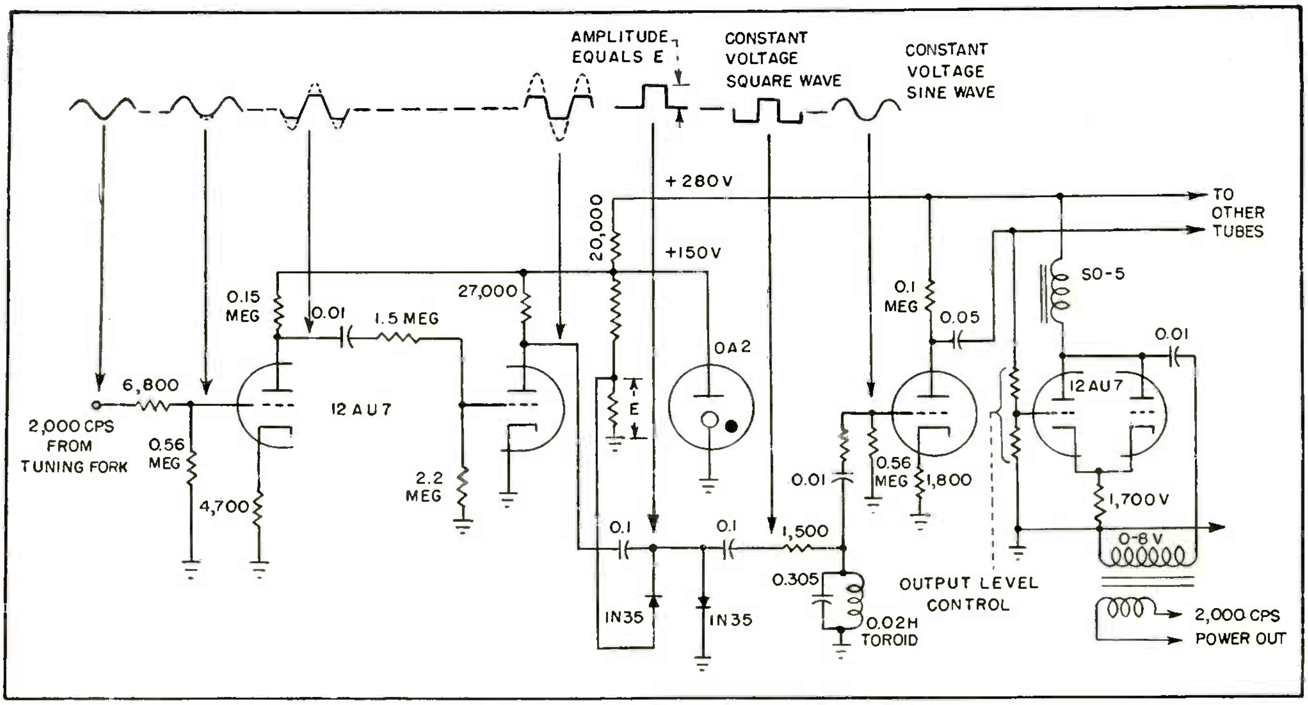


FIG. 1—Wave-shaper and amplitude control feeds six output tubes with parallel inputs similar to that shown

vided, one for each channel. Easily replaceable resistors are provided for individual adjustment of outputs. Figure 3 shows the maximum undistorted output of these regulator units at various load resistances.

The amplifier channels shown in Fig. 4 use Ouncer line-to-grid input transformers that are mounted in soft-iron magnetic shields. Cross-talk between channels is low enough to be considered negligible. Dual triodes used in the amplifiers are mounted on soft rubber to minimize the effect of vibration. The 12AY7 is less microphonic than the 12AX7 and is used except when maximum gain is desired. Twice the overall gain is achieved using the 12AX7 instead of the 12AY7 but the two are interchangeable in the circuit. Maximum voltage gain from the primary of the input transformer to the plate of the output tube is 25,000 using minimum feedback.

High stability is obtained by using large feedback that is adjusted with the gain control. More feedback decreases the gain. The final position of this switch puts the 0.5-μf cathode-bypass capacitor from the grid of the 12AU7 to ground, effectively giving zero output to permit galvanometer positioning. Phase-lag difference between channels without adjustment of galvanometer elements or special compensating networks is less than 6 degrees at 200 cps. The tuned circuit between the first and second stages eliminates hash and extraneous low-frequency vibration pickup. Shunt feed in the output stage prevents saturation of the small output transformer. Germanium

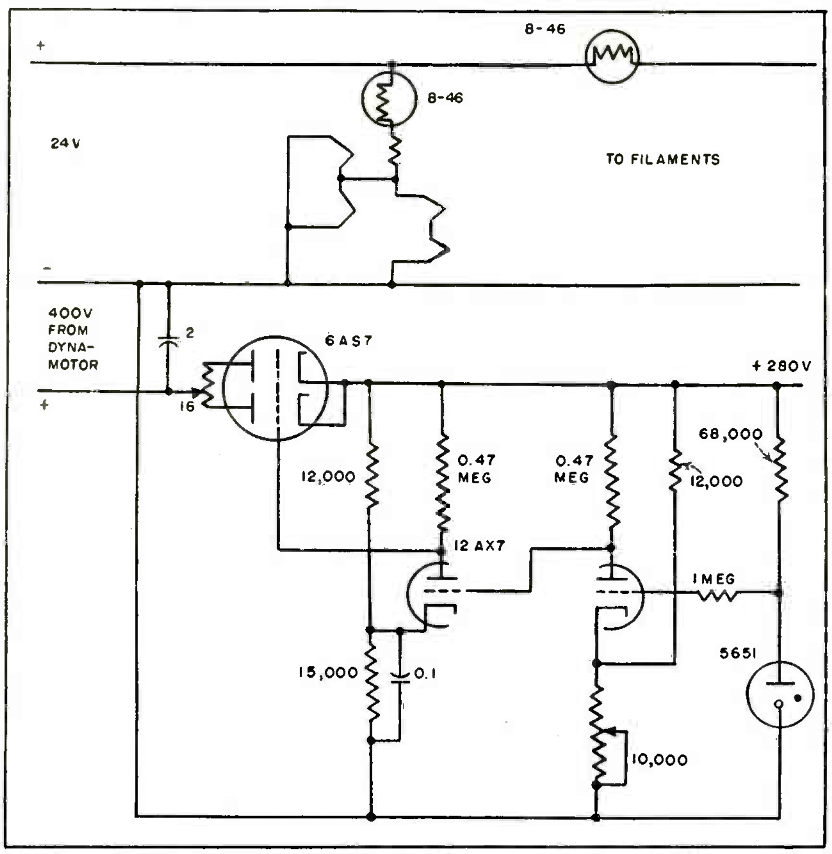


FIG. 2—Ballast tubes and a degenerative-feedback regulator control filament and plate respectively

Summary of Amplifier Characteristics

Maximum sensitivity	8 microvolts input per ma output
Output current range (± 1-percent linearity)	3 ma to 70 ma
Voltage gain to output transformer	230,000
Flat modulating frequency range	0–250 cps
Total physical volume	765 cu in.

Table I—Oscillator Output vs Filament and Plate Voltages

Filament Volts	Oscillator Volts	Plate Volts	Oscillator Volts
13.0	6.20	300	6.26
12.0	6.20	280	6.20
11.0	6.20	260	6.18
10.0	6.18	240	6.13
8.0	5.90	220	6.06

crystal rectifiers minimize temperature effects.

Most carrier systems have built-in circuits for reactive and resistive line balance. To conserve space a portable box of variable capacitors is used to determine capacitance values. Its plug-in construction permits rapid determination of these values after which small fixed units (C_x) are soldered to lugs on the amplifier chassis. Resistive balance is obtained by miniature potentiometers, one mounted on each amplifier unit. The six individual amplifiers are mounted in a 6-cell bank with a multiple-point plug on each unit. This plug automatically engages with the common power plug on the main chassis when pushed into place. A jack on the front of each unit permits the insertion of an external meter in series with the recording meter.

Figure 5 shows the overall modulated-frequency response from input to output.

All components were carefully selected for minimum size and temperature coefficient. Electrolytic capacitors are particularly critical, having a large change in capacitance with temperature. Most of those checked had a capacitance at −40 F to −60 F that was only 10 percent of their value at room temperature. In the final design only one electrolytic was used, in the power supply where the value is not critical.

Since the construction of this equipment, several possible improvements have been considered. A Wien-bridge oscillator could probably be used as the basic frequency source instead of a tuning fork. Such an oscillator employing a high-Q circuit is inherently stable even over a wide temperature range. This modification would allow the unit to be smaller and less expensive. Ordinarily, in designing instrumentation for small airplanes it is advantageous to break up the units into small cable-connected components to allow for placement in available but remote locations. Interconnecting cables add volume and circuit complication. With basically very small equipment, it becomes practicable to stack all components together into a single unit.

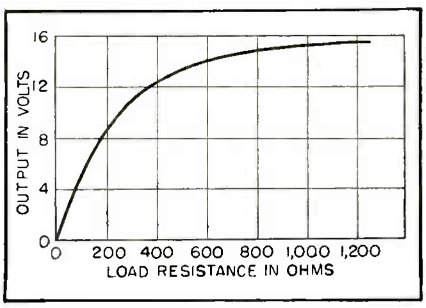


FIG. 3—Maximum undistorted output of the regulator unit of Fig. 2

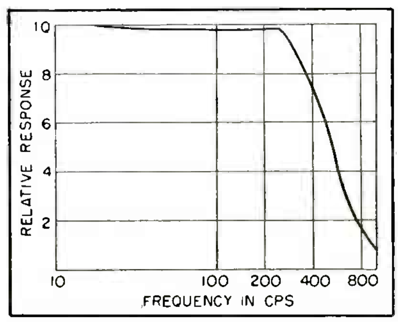


FIG. 5—Overall modulated-frequency response of an amplifier channel

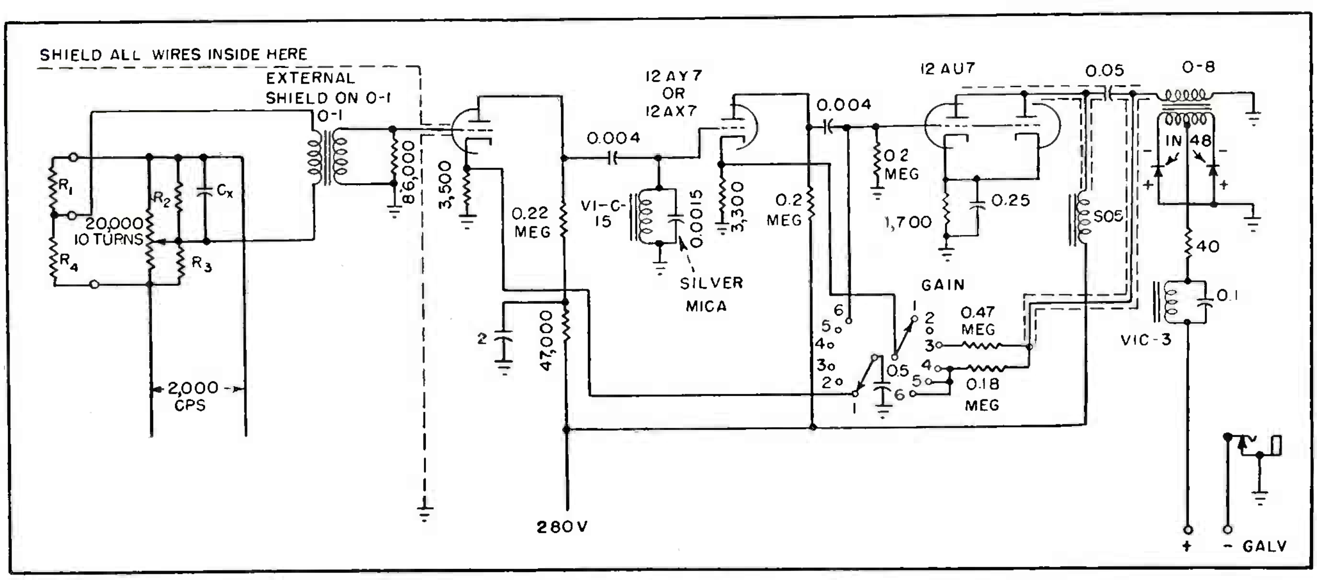
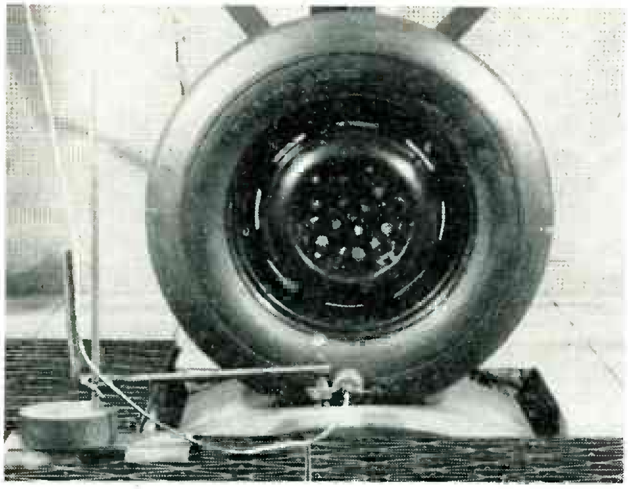
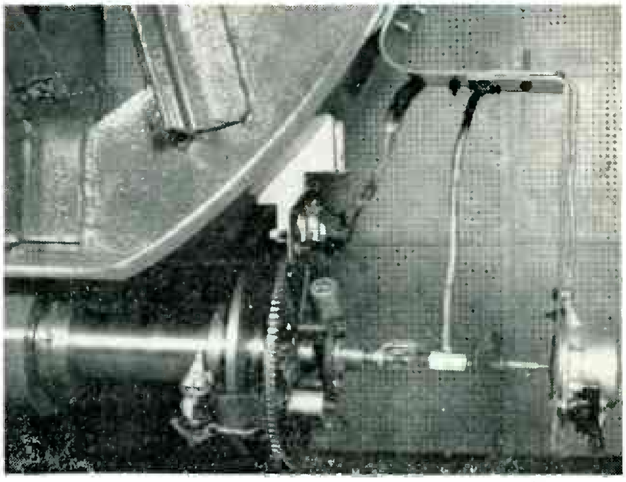


FIG. 4—Typical amplifier channel. Resistors R_1 and R_4 represent wire-wound skain gages. Capacitor C_x is adjusted for capacitance balance

Experimental tire mounted to bear against surface of five-foot steel wheel protruding through floor of sound-proofed room, with microphone clamped in position to pick up airborne tread noise, and photoelectric commutator used to generate synchronizing pulse for selecting noise from desired tread pattern sample on tire. Aperture disc is on same shaft as tire, and rotates between phototube and light source that are mounted on worm gear so they can be rotated 360 degrees

Tire Tread Noise Analyzer

Samples of various tread designs are cut into single tire, and photoelectric commutator is used to ungate microphone amplifier circuit when desired sample bears against rotating drum. Resulting noise signal is studied with resonant transient analyzer whose frequency is varied by adjusting gain of feedback circuit

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THE HISTORY of the automobile is reflected in large part in the development of the tire. In the 1920's, the foremost consideration in the mind of the buying public was reliability and adequacy of operation. The early tires were notorious for their poor performance, and the early automobile was a close second.

Through the years, cars have become powerful machines, capable of long periods of operation without failure, and capable of being maneuvered at high speeds. The pneumatic tire has had a parallel development, with emphasis on its mechanical function. The advances in car and tire design have been so successful that at the current time saleability no longer is determined in general by endurance and mechanical capabilities, but by comfort and appearance. Comfort, therefore, has become a matter of prime importance to the manufacturer of tires.

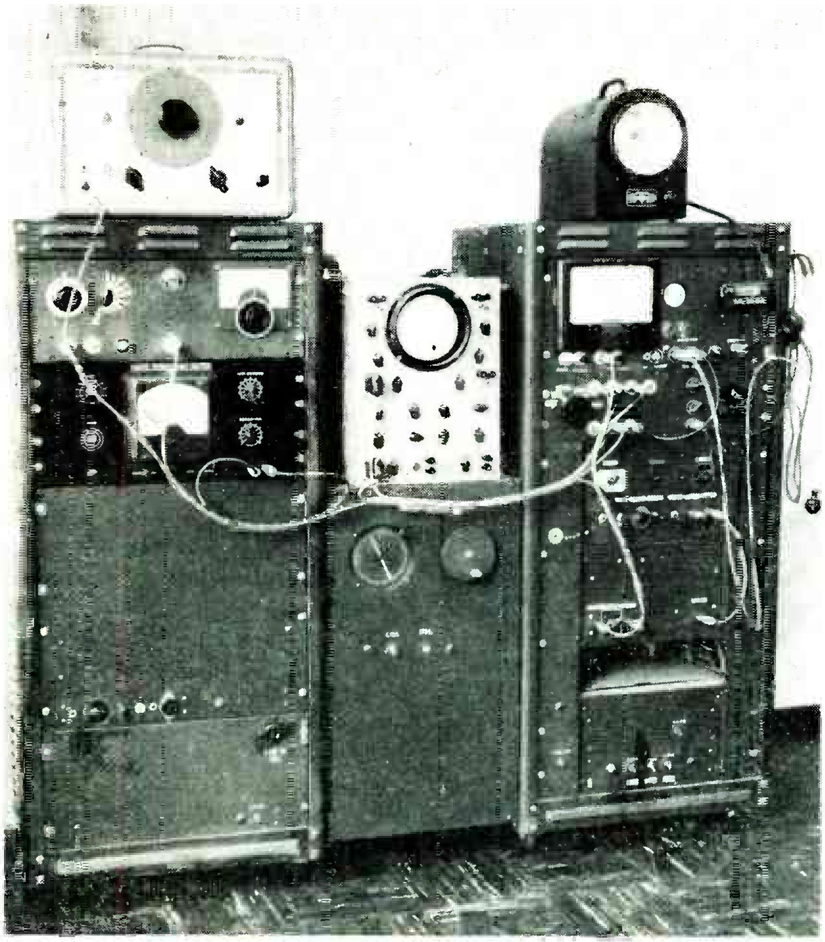
One of the many factors involved in riding comfort is the noise of tires speeding over a road. The importance of this tire noise has grown over the years with the suppression of more bothersome internally produced vibrations in the car. The improvement in the nation's roads has also helped in bringing this factor to the fore. In dealing with the problem, development engineers have found electronic instrumentation a powerful tool. The equipment employed in one phase of the problem is described here.

From the viewpoint of the tire engineer, it is desirable to uncover the processes which generate airborne tire noise. The investigation of these mechanisms is approached through the study of the sound generated by specific elements of the tread design while the tire is running as it would on the road.

Sampling Technique

In the case of standard tires, there is the problem of isolating the noise of a particular element in the presence of the many which result from the tread design. To avoid this difficulty, use is made of an otherwise smooth treaded tire with the particular elements in consideration cut into the tread at various positions along the circumference. If there is sufficient circumferential spacing between the elements, the noises generated by any two do not overlap in time.

With this scheme of testing and the proper sampling equipment, it is possible to compare a series of variations in design with each



Equipment used in analyzing noise signal output of microphone positioned near tread of rotating tire. Strobolume at top of right-hand cabinet is used for examining treads while tire is in motion during test

other and with a standard element, while using only one tire. Thus, drift in the measuring instruments and change in testing conditions become negligible.

The design of the sampling equipment must take into account the fact that the noise resulting from a tread element, while similar in successive revolutions, nevertheless shows considerable random variation. Consequently, the noise is best treated as a transient signal.

Electronic System

The method employed is to produce a triggering pulse, synchronized with the angular position of the tire, which then initiates the opening of a gating circuit and the firing of a driven-sweep oscilloscope. The signal, picked up by a microphone, is amplified and passed through the gate into a transient analyzer. The output of this analyzer or the original noise signal may be observed or photographed with an oscilloscope. In addition, the triggering pulse actuates a revolution counter and, for visual observation, a high-speed flash lamp.

The problem of extraneous sounds and of reverberations is met by running the tire against the surface of a five-foot steel wheel which extends into a sound-insulated room. A directional microphone, located close to that portion of the surface from which the radiation is desired, picks up the signal. A conventional feedback amplifier with a stepped gain control supplies an amplified signal at an impedance level of 20,000 ohms. The selection of the significant portions of this noise signal in time is carried out by the synchronizing system.

Photoelectric Commutator

The synchronizing pulse originates in a photoelectric commutator whose setting is continuously variable. The photoelectric method is preferable to simpler mechanical devices because of its noiseless operation and the excellent definition of the pulse. The commutator consists of an aperture disc that rotates on the same shaft as the tire, and a phototube and light source that are mounted on a worm gear. The gear couples to the main control panel through a worm and flexible shaft arrangement. Readings of the position of this gear to within ½ degree are available at the control panel through a selsyn re-

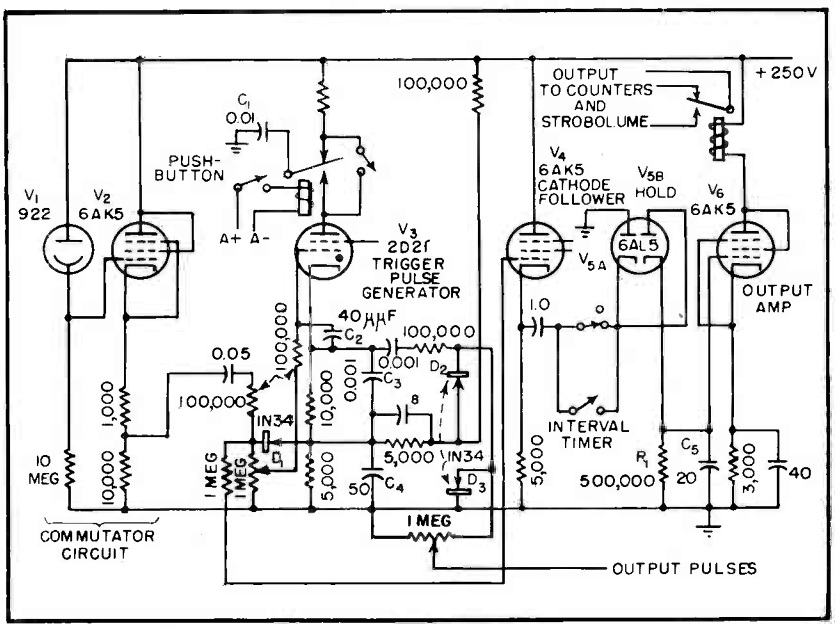


FIG. 1—Photelectric commutator and trigger pulse generator circuits

peater system. A cathode follower, also mounted on the worm gear, lowers the impedance level of the commutator signal. This avoids capacitive shunting in the shielded cable leading to the control panel.

The characteristic output of the commutator is not in itself satisfactory for tripping the subsequent circuits and therefore is used to actuate an intermediate trigger-generating circuit. The desired trigger pulse should be steep at the leading edge so that synchroniza-

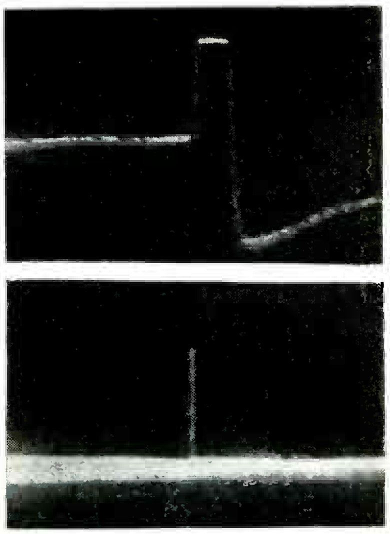


FIG. 2—Output signal from photoelectric commutator, showing clipping at top due to shorting action of crystal diode in trigger-generating circuit, and corresponding output pulse (approximately 20 microseconds wide at base) obtained from trigger-generating circuit

tion of the scope and the gate circuit is independent of speed and, in addition, should be stabilized and adjustable in amplitude. For photographic recording, the trigger pulse must occur only once after depressing a hand switch, with release of this switch required for resetting.

Figure 1 indicates the circuit designed to meet these requirements. The commutator output is adjusted to a level just adequate to ignite a normally quiescent thyratron. The output of the thyratron, properly shaped, is the trigger pulse. By employing a capacitor to power the thyratron, single-shot or continuous operation is available. For continuous operation, C_1 charges during the standby period, from B+ through a resistor too large to sustain the discharge in the thyratron. For single-shot operation, charged C_1 is switched from B+ to the plate of the thyratron by means of a relay. At the next appearance of a signal from the commutator, the thyratron fires, and cannot fire again until the relay switches C_1 back for recharging. The relay is inserted between a pushbutton hand switch and the pulse generator for safety purposes.

Capacitors C_3 and C_4 in the cathode circuit insure rapid discharge of power supply capacitor C_2 through the thyratron, while still allowing the standby bias chain to be low in current drain. There are three 1N34 diodes in this circuit. Diode D_3 eliminates restoration difficulties in the coupling capacitor, D_2 together with the bypassed potential divider sets the level of the output signal, and the grid of the thyratron is kept from being driven positive by the clipping action of D_1. The output of this circuit is highly repeatable in time and in shape. Figure 2 shows this output and the commutator pulse which initiates it.

The photoelectric commutator also drives a revolution-counting unit and an electronically operated relay for flashing a GR 1532A Strobolume. Electromechanical counters are slow in responding and will not follow the commutator at high speeds. However, with a pulse-widening circuit, the proper drive is available. The commutator is buffered from the ensuing circuit by cathode follower stage V_4 in Fig. 1. Crystal diode D_3 provides restoration for the coupling capacitor. Diode section V_{5B} and C_6 act as a holding circuit with R_1 as a leak. The output of this holding circuit subsequently activates an output relay that trips either the counter or the flash lamp.

Gating Circuit

Since the gate circuit presents the noise signal to a transient analyzer, the gate must not introduce spurious electrical signals such as spikes or pedestals. In addition, the gate must be operated from a signal taken with respect to ground, it must sometimes stay open for an appreciable interval, and must not produce much distortion. Such gating systems as varistors, mixers, and pentode circuits do not meet all these needs, but the circuit of Fig. 3 does.

In operation, the signal from the trigger-shaping unit feeds monostable multivibrator V_1. The output of the multivibrator controls two gating circuits operating on the cathode bias principle. The audio signal is inverted in stage V_2. The direct signal is fed to one gate,

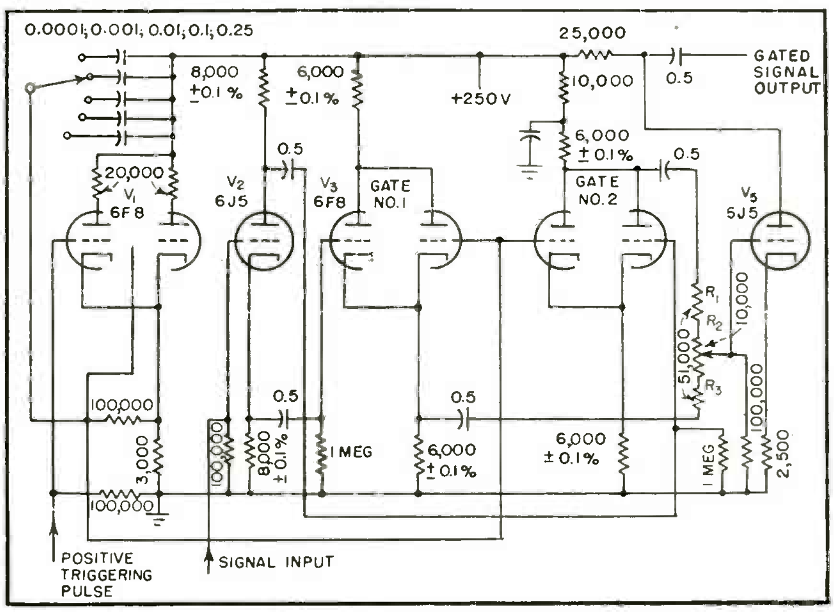


FIG. 3—Subtractive gating circuit for minimizing pedestals and transients

V_3, while the inverted signal is fed to the other identical gate, V_4. The outputs of these two circuits are subtracted in R_1, R_2 and R_3, thereby greatly reducing the effect of the pedestal and other transients. However, because of the phase inversion, the subtraction does not cancel the signal.

The analysis of the frequency content of the gate noise signal takes place in the resonant analyzer. This device essentially consists of a high-Q series-resonant circuit to which the noise signal is applied. In the limiting case where the resistance of the circuit is negligible, the voltage across the inductive element is

$$E_{\text{out}} = E_{\text{in}}(t) - 2\pi f \int_0^t [E_{\text{in}}(\tau)] \sin 2\pi f(t-\tau)\, d\tau \qquad (1)$$

where t = time, E_{out} = output voltage, E_{in} = input voltage, τ = variable of integration, and f = frequency to which resonant circuit is tuned. In the presence of resistance, a damping factor occurs in the integral. For the inductors used, this damping factor is unimportant and will be neglected here. For signals starting at $t = 0$ and terminating at time T, as for the gated noise signals, Eq. 1 reduces to a measure of the total amplitude of the harmonic content at f.

The circuit employed in the resonant analyzer is given in Fig. 4. Inductors L_{2A} or L_{2B} and capacitors C_1 to C_{10} form the nucleus of the analyzer. The input signal appears in the resonant circuit across 100-ohm resistor R_1, which is small enough not to affect the Q of the circuit materially. At the higher frequencies variable capacitor C_{11} permits continuous tuning of the analyzer.

For lower frequencies, the physical size makes the use of variable capacitors undesirable, and a feedback loop supplies the continuous adjustment. The signal across L_2 is inverted by V_3 and a fraction determined by R_2 is added to the input at cathode follower V_2. The total input signal E_s at R_1 then is

$$E_s = k_1 (E_{\text{in}} - k_2 E_{\text{out}}) \qquad (2)$$

where k_1 is the gain of the cathode follower V_2 and k_2 is the net gain of the feedback loop including the adding circuit and feedback amplifier V_3.

The second term $(-k_1 k_2 E_{\text{out}})$ supplements the potential difference across the inductors and adds to the effective inductance in the circuit. For this reason, the resonant frequency becomes

$$f = 1/2\pi\sqrt{LC(1 + k_1 k_2)} \qquad (3)$$

where L is inductance and C is capacitance. Potentiometer R_2 sets the value of the feedback gain k_2 and thus controls the frequency.

In general, it is desirable for the tapped capacitor bank to be employed in such a way that k_2 is as small as possible. Feedback of the resistive component of the drop across the inductor progressively lowers the Q of the resonant circuit as the gain k_2 increases. The additional stages contained in the resonant analyzer are for amplification, change of the impedance level, monitoring and isolation.

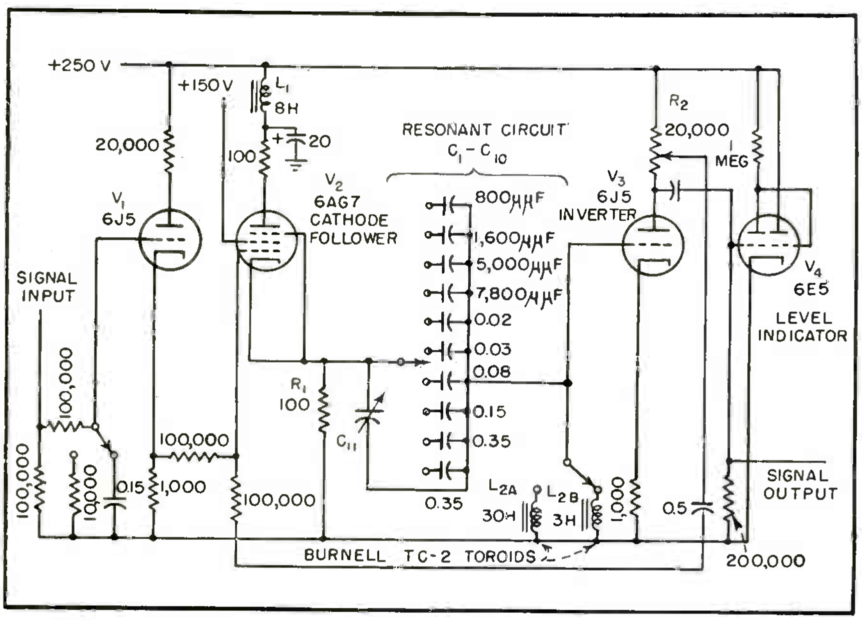


FIG. 4—Resonant analyzer used for determining harmonic content of signals

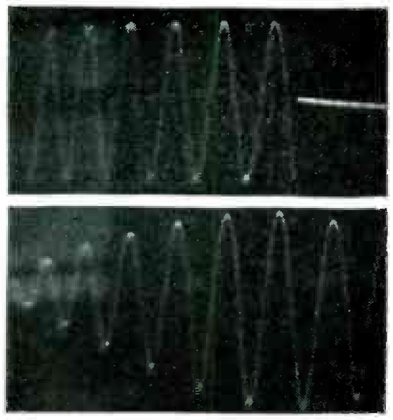


FIG. 5—Performance test of resonant analyzer. When upper 200-cps sine wave is applied to gating circuit output signal grows linearly during application of pulse and slowly dies out in quiescent period as in lower oscillogram

Performance

A typical performance test of the analyzer is shown in Fig. 5. The analyzer is set to resonate at the same frequency as a sinusoidal signal applied to the gating circuit. On firing the gate, the analyzer receives a pulsed wave train and reacts to this input in accordance with Eq. 1. The output signal is a sine wave whose amplitude increases linearly during the duration of the pulse, and maintains a relatively constant value thereafter.

Although the resonant analyzer is inherently a timing source, the nature of the input forcing functions makes it an uncertain time base. Consequently, it is desirable to incorporate an independent standard in the equipment for calibrating the sweep speed of the oscilloscope. This timing unit is composed of a Sylvania model 145 audio-frequency signal generator and a General Electric model DD7 frequency meter of the cycle-counting type.

The equipment has proven to be adaptable not only for the study of tire noise but also for examining other transient disturbances.

Overtone CRYSTAL

Quartz crystals can be made to operate directly on odd overtones up to 150 mc, with high power output and better stability than crystal would normally have at its fundamental. Technique involves shunting crystal with proper value of inductance and tuning plate tank for the desired overtone frequency

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THE INCREASING use of frequencies above 30 mc for limited-range communication and control purposes means that closely spaced channels are needed to provide for the many services that would like to use these frequencies. This close spacing, at least at the present state of the art, requires crystal control to provide the required carrier frequency stability.

Crystals can be ground to operate on fundamental frequencies as high as 30 mc. The Bureau of Standards has, in fact, processed crystals to 100 mc, but their commercial manufacture is probable only at some much later date. Making crystals physically thinner presents so many problems that some other means was sought for producing high frequencies directly from low-frequency crystals.

The goal was to find a circuit operating technique that in effect would slice a crystal electrically into the desired thinner plates, so that thick crystals could be made to vibrate with adequate power output at values much higher than their fundamental frequency. The development to be described achieves this goal by utilizing in a unique way the presence of overtone activity in certain types of quartz crystals. Overtone activity, to be described, should not be confused with operation as a frequency multiplier, wherein the plate tank is tuned to a harmonic of the fundamental.

Nature of Overtones

Many crystals, particularly BT and AT cuts, exhibit strong overtone activity wherein the crystal appears to consist of layers of active material operating in shear modes, with opposite outside faces going in opposite directions as shown in exaggerated form in Fig. 1. For the third overtone the crystal acts as if it had three equal layers; for the fifth, five layers; for the *n*th overtone, *n* layers, where *n* is always an odd number. The thickness of each vibrating layer is approximately 1/*n*th the thickness of the crystal at its fundamental.

Overtone crystals (improperly called harmonic crystals) have been on the market for some time, but most of these utilize the third overtone (generally around 30 mc) because higher-order overtones could not be developed by conventional circuitry. Investigation showed, however, that almost all carefully processed AT or BT-cut crystals exhibit activity on higher overtones such as the 5th, 7th, 9th, 11th and 13th. Many crystals even show activity at the 23rd overtone and a few have actually indicated activity on the 29th overtone, which for a 10-mc crystal would be around 290 mc.

The overtone frequency of a crystal is not an exact multiple, or harmonic, of the fundamental. Harmonics can only be obtained electrically, whereas crystal overtones are the result of pure mechanical vibration. The frequencies of overtones approach corresponding harmonic values but are either higher or lower by an unpredictable amount. For this reason, overtone crystals are ground to the desired overtone frequency and marked with that value, the fundamental being ignored.

An analogy is the string of a piano, which vibrates over its entire length to produce the fundamental note and over shorter lengths to produce overtones. The frequencies of these musical overtones are close to corresponding harmonic values but not equal to them, as any musician will testify.

It should also be pointed out that a crystal will vibrate at only one overtone at a time. The overtone at which it vibrates depends on the resonant frequency of the circuit of which the crystal is a part.

ADVANTAGES OF OVERTONE CRYSTAL OSCILLATORS

- Direct crystal control up to 150 mc with 10-mc or lower-frequency crystals
- Overtone frequency is only frequency present in circuit, hence no spurious radiation
- Direct frequency modulation is possible and practical, including carrier-frequency shift by d-c for keying or telemetering
- Temperature-frequency stability better than crystal itself
- Excellent voltage-frequency stability even up to 70 volts plate voltage change
- Vibration and severe jarring do not affect frequency
- Higher efficiency and much smaller vhf and uhf equipments, reducing battery drain and weight of mobile units

OSCILLATOR Design

- Example of 460-mc mobile unit using overtone crystal oscillator
- Developmental model shown delivers 22 watts frequency-modulated output at 468.72 mc with $\pm$10-kc carrier stability. Total current drain from 6-volt battery is 10 amp for receiver and 31 amp for transmitter. Total weight is 43 lb
- Transmitter crystal with fundamental of approximately 8.68 mc operates directly on 78.12 mc, which is 9th overtone. Reactance modulator for oscillator is driven by single a-f stage. Following crystal is low-power neutralized 6C4 isolating amplifier and 832A tripler stage with long-line plate tank coupled by balun to 4-150A final stage operating as doubler in cavity with 550 volts at 90 mc. Deviation is $\pm$25 kc, with automatic deviation control. Audio fidelity is within 2 db from 60 to 10,000 cps
- Overtone crystal oscillator in receiver operates at 76.46 mc and is followed by 6AK5 six-times multiplier to get ample injection voltage for mixer. Grounded-grid amplifier stage precedes mixer; following it are three 10-mc i-f stages, limiter, discriminator, squelch circuit and final audio stage delivering 0.8 watt output. Sensitivity is better than 1 microvolt for complete limiting

Overtone crystals are ordered to an exact frequency, which is the frequency at which the electrical reactances of the crystal are equal and opposite and thus cancel. This frequency value is the true overtone value of the crystal alone, without holder or circuit. The circuits referred to operate at frequencies slightly removed from this series resonance value.

Oscillator Circuit Analysis

A study of existing circuits was made to determine why crystals exhibiting higher-order overtone possibilities would not perform on these overtones in conventional circuits. The conventional crystal oscillator circuit of Fig. 2 contains all of the important elements affecting the operation of a crystal. Typical equivalent values for a 10-mc crystal having a Q of 160,000 are $L = 0.02533$ h, $C = 0.01$ μf and $R = 10$ ohms. A typical value for C_T, the sum of C_1, C_2, C_3 and C_4, is 35 $\mu\mu$f.

The curves in Fig. 3 correspond to conventional operation of a quartz crystal at its fundamental frequency. The reactances of L and C vary with frequency in the manner shown in Fig. 3A, giving the curve of X_T as the algebraic sum of the reactances of the crystal.

The susceptance of crystal reactance X_T is shown in Fig. 3B. When added to the susceptance of the shunt capacitance C_T existing across the crystal terminals, curve Y_T is obtained. The reactance curve of this total crystal circuit susceptance is given in Fig. 3C. This curve indicates that a crystal used in a conventional circuit will operate as a parallel resonant circuit at an antiresonant frequency f_1. At this frequency the total susceptance Y_T in Fig. 3B is prac-

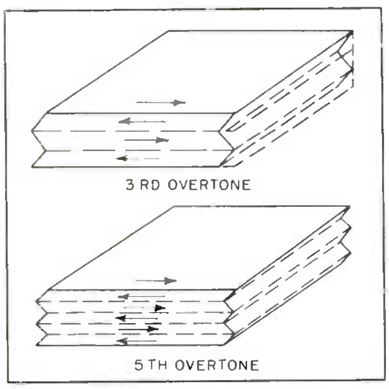

FIG. 1—How an overtone crystal works. The crystal acts as if electrically sliced into odd number of layers

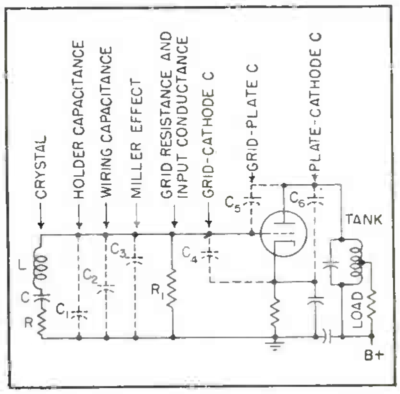

FIG. 2—Conventional crystal oscillator circuit, drawn to emphasize the important elements affecting crystal operation

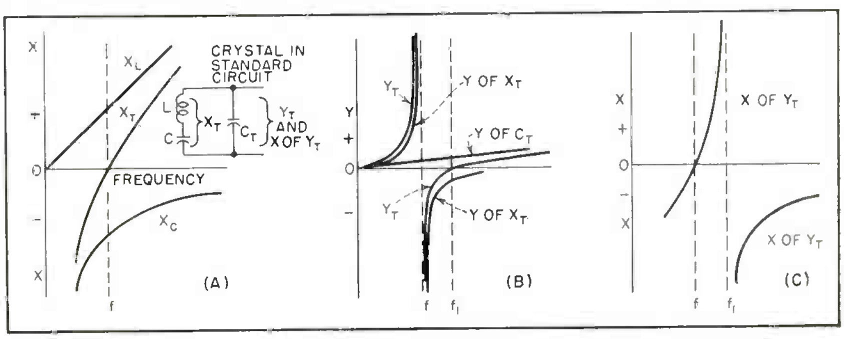

FIG. 3—Reactance and susceptance curves for standard crystal circuit

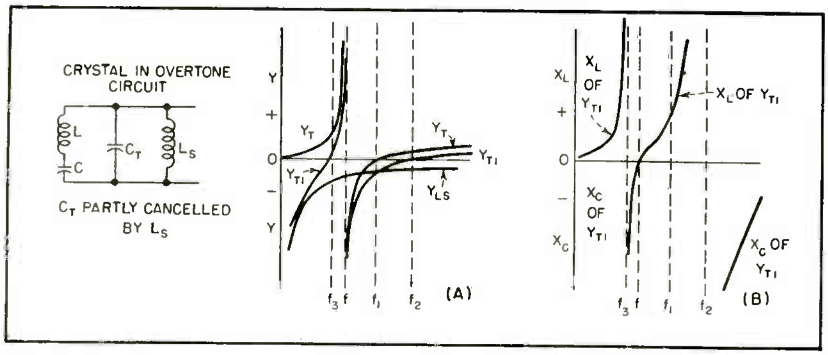

FIG. 4—Reactance and susceptance curves for overtone crystal oscillator operation. These curves are drawn for a crystal operating as an equivalent inductance. Similar curves may be drawn for the capacitive crystal

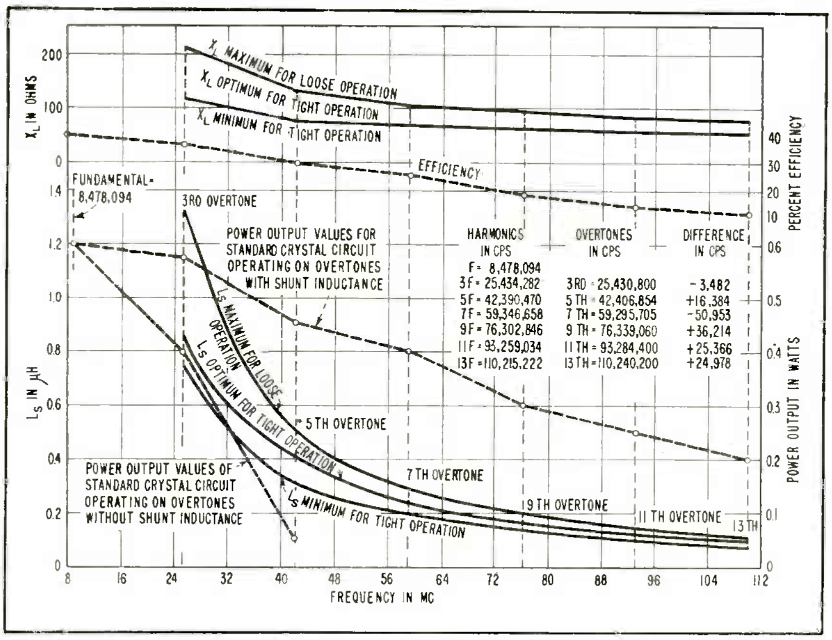

FIG. 5—Characteristics of typical crystal operated on overtones through 13th in circuit using 6J6 with 150 volts on plate

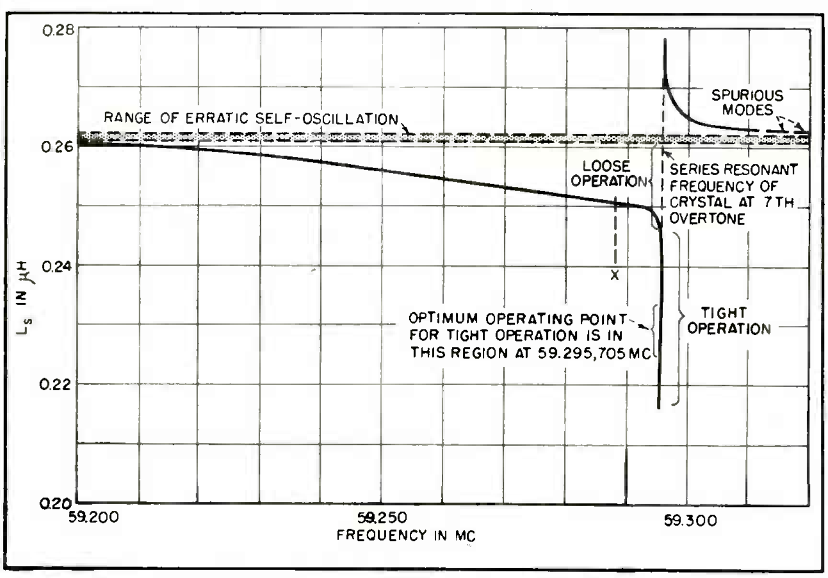

FIG. 6—Frequency characteristic at 7th overtone (59.295,705 mc) of quartz crystal having natural frequency of 8.478,094 mc, operating in 6J6 circuit

tically zero and the total reactance approaches infinity. This value f_1 is the fundamental frequency value stamped on the crystal holder, and represents the crystal in its usual circuit, not the crystal alone.

The fundamental crystal oscillator frequency f_1 is only slightly higher than the resonant frequency f of the crystal itself without holder or circuit. Due to the large ratio between C_T and C, slight changes in C_T have but a small effect on the oscillator frequency f_1, hence the conventional oscillator circuit has good frequency stability.

Now suppose that we add capacitance across the crystal. This causes the curve for Y of C_T in Fig. 3B to rise higher, so that Y_T crosses the X axis at a lower frequency and thereby makes f_1 approach f. Adding to C_T thus lowers the fundamental frequency of the crystal oscillator circuit slightly. This characteristic is widely used by engineers of radio and television stations for adjusting their carriers exactly to the assigned frequency. However, adding to C_T causes the impedance of the tuned grid circuit (comprising the crystal and circuit capacitance) to decrease. The result is lowered output, and added capacitance thus produces only a small frequency change while at the same time reducing output considerably in a conventional crystal circuit.

This brief review of crystal oscillator theory sets the stage for an explanation of how a crystal can be made to operate directly on an overtone in essentially this same circuit.

Overtone Operation

If a 10-mc crystal is used in the circuit of Fig. 2 as before but the plate circuit is tuned to approximately 30 mc, the value of C_T remains about the same as before, but the equivalent C of the crystal becomes approximately one-third of what it was at the fundamental. The equivalent L of the crystal is likewise reduced to approximately one-third. The ratio of C_T to C now is approximately three times that of the circuit at the fundamental, just as if we added capacitance to C_T at the fundamental.

Referring back to the values of the example, tuning the plate to approximately 30 mc so the crystal operates on its third overtone has the effect of adding capacitance of about 3 × 35 $\mu\mu$f across the crystal at the fundamental. The result is that the 10-mc crystal operates on its third overtone just as though it were a 30-mc crystal, except that now we have a low-impedance grid circuit and greatly reduced output.

When the plate circuit is tuned to the 5th overtone (about 50 mc in this example), the value of C_T again remains essentially the same as at the fundamental but C drops to about one-fifth of what it was at the fundamental. As a result the ratio of C_T to C goes up still more, the grid circuit impedance gets still lower, and power output drops practically to zero. Above the fifth overtone, the circuit will not oscillate at all.

Overtone Circuit Requirement

An oscillator circuit that will permit crystals to operate on high-order overtones must have a high grid-circuit impedance. One way of achieving this impedance is to utilize the ability of a piezoelectric crystal to appear as a capacitive impedance when energized at a frequency below the series resonant frequency of the crystal L and C. The crystal can then combine with an input circuit that is inductive to form an antiresonant grid circuit having high impedance as desired.

To make the input circuit appear inductive, the normal circuit capacitance C_T is shunted with an inductance of such value that the combination of the two appears as a high-value inductance at the operating frequency of the crystal.

The curves in Fig. 4 show how addition of shunt inductance L_S affects the susceptance and reactance of the crystal oscillator circuit of Fig. 3. The total susceptance Y_T of the grid circuit is added to susceptance Y_{LS} of the new shunt inductive reactance to get curves Y_{T1} for the combination. The resulting reciprocal curves (X_L of Y_{T1}) in Fig. 4B are the reactances of the combined input circuit without taking into account the values of resistance in the circuit. The curves indicate that two antiresonant frequencies are possible, f_2 being above and f_3 being below the series resonant frequency f of the crystal at the overtone selected. Actually, only f_3 is obtained in practice, because at that frequency the grid circuit has maximum impedance. The curves are intended to show only a method of obtaining a high grid circuit impedance (X_L of Y_{T1}) at operating frequency f_3, hence are not drawn to scale.

An overtone crystal is operated in the capacitive condition rather than in the inductive condition as is usual practice at low frequencies, for one important reason. AT or BT-cut crystals when flat or convex, as are most crystals, have spurious modes or activity points above the natural frequency of the crystal. This often results in erratic operation when the circuit is operated at crystal overtones in the inductive crystal condition. By deliberately choosing the capacitive crystal condition, operation is below the natural frequency of the crystal (or below the corresponding value for overtones) and spurious-mode operation is almost impossible.

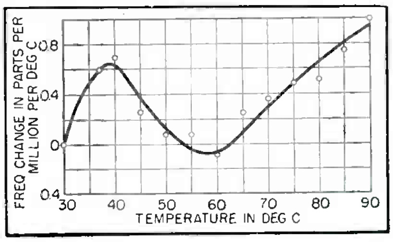

FIG. 7—Variation of frequency with temperature for 9th overtone at 77 mc, for typical overtone crystal operated 7.5 kc below series resonant frequency to permit frequency modulation

Overtone Oscillator Data

The curves in Fig. 5 show the characteristics of an overtone crystal calibrated, ground and finished to operate on its 9th overtone at 76.339,060 mc. The exact frequencies of this crystal operating at its many other overtones are tabulated, along with the differences between these overtones and the multiples or harmonics of the 8.478,094-mc fundamental crystal frequency.

The amount of inductive reactance needed to provide operation at the many overtones of this crystal when in the capacitive condition is also shown, along with the power output and efficiency of a test oscillator at each overtone. The plate tank circuit in all cases was inductively coupled to a Bird Termaline wattmeter for power measurement. Wherever possible the plate power input to the test oscillator was kept constant at the different overtones.

The results shown in Fig. 5 indicate that an overtone crystal can meet all of the requirements of a crystal oscillator of the power type up to the 11th mode. Such a crystal is satisfactory up to the 15th mode for a receiver local oscillator since such an oscillator has lower power requirements.

The overtone values of a crystal are not always fixed. Those given are for optimum operating conditions, but can easily be shifted to slightly higher values or considerably lower values by changing the value of shunt inductance L_S with a slug or other means. A study of the frequency characteristics at one overtone, the 7th, is shown in Fig. 6. The nominal or optimum overtone value is approximately in the middle of the vertical portion of the curve, corresponding to about 0.23 μh for L_S. Decreasing L_S from this value lowers the output but increases the frequency only a little.

Increasing L_S has a similarly negligible effect on frequency up to the knee of the curve, but further increases in L_S then make the overtone frequency decrease appreciably. The relation is quite linear, hence frequency modulation becomes a simple matter.

It should be pointed out that L_S can be a fixed inductance smaller than needed, shunted by a trimmer capacitor that is used for adjusting the operating frequency near the selected overtone.

Frequency Modulation

To produce frequency modulation, L_S is set to a value in the linear range such as at X, and a reactance tube or other variable reactance is connected across L_S to sweep its inductive reactance above and below the value for point X. Crystal frequency follows the variations in the reactance, giving the desired frequency modulation. Point X is here about 7.5 kc below the nominal overtone value, but the frequency excursion would be limited to about ± 5 kc in order to stay off the knee of the curve. In a uhf or vhf f-m transmitter, multiplier stages following the overtone oscillator would multiply this 5-kc deviation of the oscillator. Point X is still a stable crystal frequency but one that can be caused to change because the magnitude of change needed is not too great.

Greater frequency deviations could be obtained by moving point X further away from the knee of the curve, but circuit stability is then sacrificed. For this reason, overtone oscillators in f-m transmitters use relatively small crystal frequency swings and rely on frequency multipliers to provide the required deviation at the final carrier value.

A "tight" overtone crystal oscillator is defined as one that is operating over the nearly vertical portion of the curve of Fig. 6. Operation at other points on the curve is described as "loose," permitting adjustment of the output frequency or frequency modulation.

Stability

In the tight positions the temperature-vs-frequency stability of the overall circuit essentially is that of the crystal. However, in almost all loose positions the output frequency can be corrected by proper choice of temperature coefficients for components to result in an overall temperature-vs-frequency stability that is considerably better than that of the crystal itself. This is illustrated in Fig. 7; the entire curve is below the coefficient of the crystal itself, which is approximately 1.0 part per million per degree C.

Voltage stability of a typical overtone crystal oscillator operating at the 9th overtone at 77 mc is illustrated in Fig. 8. Even for the total 70-volt plate-voltage change represented by the entire curve, voltage stability is excellent with circuit component values shown.

Since the crystal frequency can be caused to change, a deliberate change by some element such as the plate bypass capacitor can, if that element is of the proper coefficient and size, correct the entire circuit for effects of temperature variations. Overtone crystal circuits have been produced which will maintain the frequency to better than one part per million over a temperature range of 0 to 185 F, which is many times better than the crystal itself in normal circuitry.

F-M Version

A study of Fig. 6 shows that if the circuit is frequency-modulated, large excursions of the variable reactance can cause the crystal to stop oscillating at either extreme of the change. If L_s is reduced below a certain critical value (about 0.215 μh in this case), the circuit stops oscillating. If L_s is increased above another critical value, the circuit goes into erratic self-oscillation. With further increases in L_s, the circuit will change over to a type of oscillation in which the crystal appears as an equivalent inductance, represented by the curve at the upper right. With still further increases, above about 0.27 μh, the circuit ceases oscillation.

A form of automatic deviation control becomes necessary to maintain assigned channel bandwidth and to make impossible the stopping of the oscillator with excessive amplitudes of the modulating voltage. Figure 9A shows a typical reactance modulator used with an overtone crystal oscillator, while

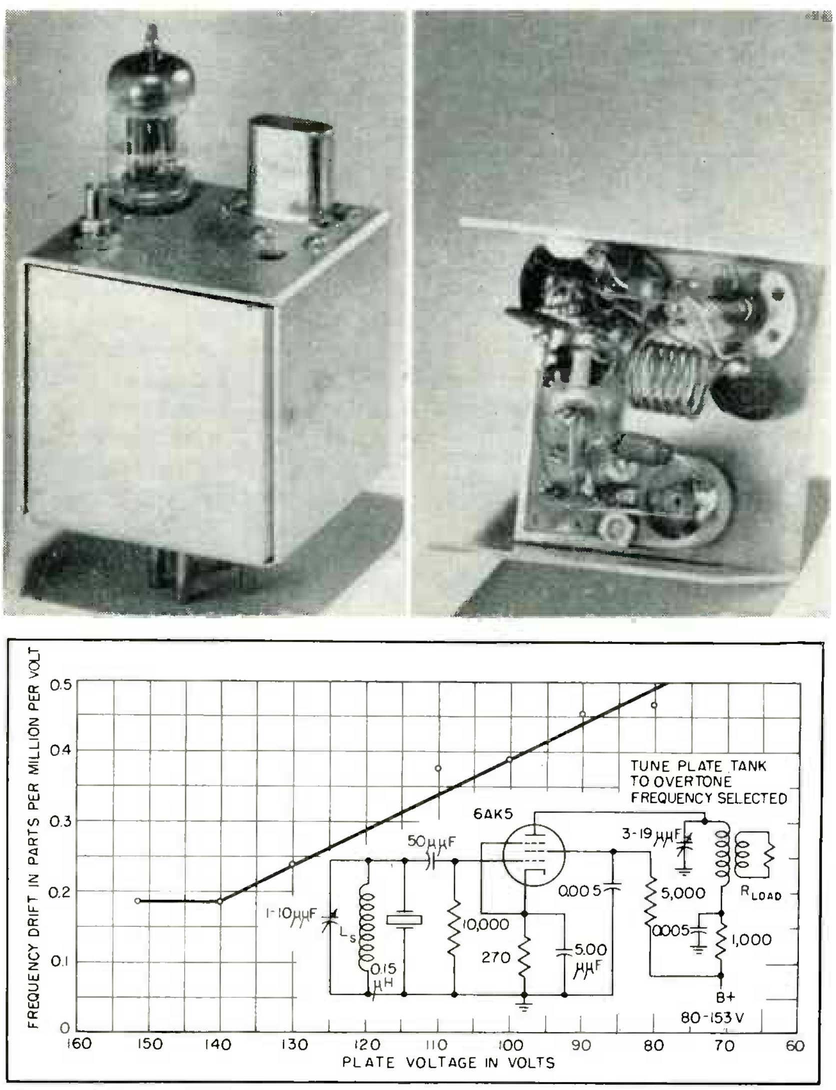

FIG. 8—Overtone crystal oscillator constructed as plug-in unit. Overtone frequency is 77.00 mc, which is 9th overtone of crystal having fundamental of approximately 8.55 mc. Power input is 1.8 watts and power output 0.3 watt for 150-volt plate supply. Curve shows stability of output frequency over 70-volt variation of plate voltage provided by external power supply

Fig. 9B shows the resultant injected capacitance C_I of the modulator circuit. Slight modifications in the circuit result in the C_I/E_g curve shown in Fig. 9C. By operating such a revised circuit at point X with no modulating voltage applied, and coupling that modulator through fixed-capacitor C of a value substantially equal to C_I at point X, the resultant C_I at the crystal appears as in Fig. 9D. The value of C_I then can vary between two limits, one of which is zero and the other the value of C. Such a simple automatic deviation control circuit holds the frequency excursion to definite limits. Even the failure of the modulator tube can only cause frequency changes that are within the channel assigned.

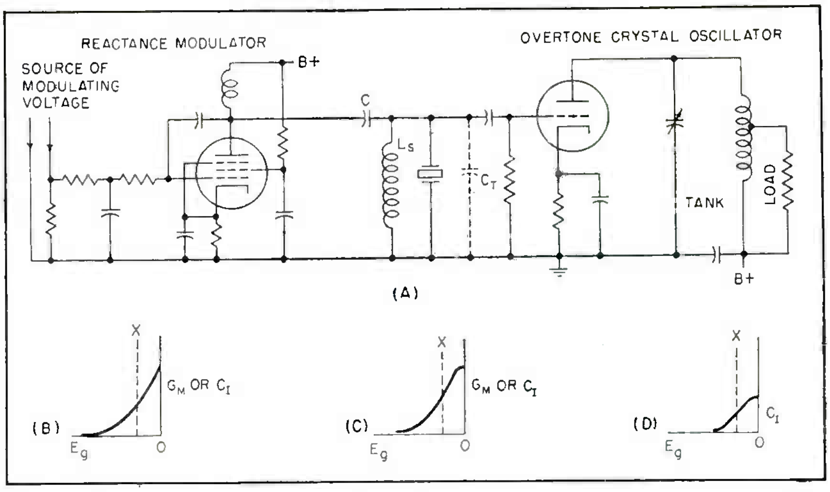

FIG. 9—Frequency-modulated crystal oscillator using overtone crystal, and curves showing injected capacitance provided by reactance modulator under various conditions

Crystal Heating

At the frequencies under consideration (70 to 110 mc, corresponding to the 7th, 9th or 11th overtone of a 10-mc crystal), the usual grid-to-plate capacitance of small triodes such as the 6C4 and 6J6 provides feedback that can be excessive. The rapid change in frequency which often occurs in the first few seconds after starting a crystal oscillator usually is the result of heating of the crystal due to excessive feedback and resultant high r-f voltage across the crystal electrodes.

In all antiresonant circuits the crystal is a capacitance with the quartz as a dielectric. Excessive r-f voltage across this capacitance will cause undue heating of the crystal which the holder cannot dissipate. The feedback should therefore be controlled to a point where only enough excitation is provided to permit satisfactory output from the circuit.

The use of a pentode or similar tube with properly adjusted feedback results in highly stable circuits with little crystal heating. Feedback adjustment is experimentally determined and subsequent production of oscillators for any given overtone of operation simply provides a fixed spacing and form factors of grid and plate coils.

Since an overtone crystal operates directly on its overtone value, with no output at the fundamental, sideband problems are practically nonexistent. For example, if a crystal is operated on its 9th overtone at 90 mc and fed to a doubler and tripler to get 540 mc, the lowest undesired component that can produce sidebands at 540 mc is 90 mc. This is too far off from the carrier to be of any consequence in properly designed circuits.

With conventional frequency multiplication to 540 mc from a 10-mc fundamental, sidebands removed from the carrier frequency by a value equal to the fundamental or double or triple the fundamental value are present in the output of the final stage. Frequency multiplication from a fundamental in both transmitters and receivers is thus a serious deterrent to close spacing of uhf channels.

Conclusions

Equipment using circuits meeting all of the requirements for both transmitting oscillators and local oscillators of receivers has been in operation over 18 months. Performance during that time has been entirely satisfactory for mobile and fixed station uses. Fixed stations in extremely unfavorable locations, such as on oil drilling rigs, have proven the circuits to be stable, efficient and adequate for all purposes investigated. The circuits operate at conservative values of plate voltage, plate current and plate dissipation, so that long and stable tube life can be expected.

The audio quality resulting from the frequency-modulated oscillators is exceptionally good and approaches that obtained by f-m broadcasters. It is dependent only on the small speech amplifier used ahead of the modulator and the point on the curve chosen to operate the crystal. Actually, the crystal may be modulated with d-c applied to the modulator grid, which causes instantaneous frequency shift in a direction depending on the polarity of the modulating voltage. The amount of the shift is determined by the limiting values in the circuit and the amplitude of the modulating voltage.

For cooperation in developing and testing the crystal overtone oscillators described here and for work leading to patent applications, the author expresses appreciation to A. R. Panetta, now with Boston University, and to R. C. Blauvelt and R. N. Lister, chief engineer and plant superintendent, respectively, of Electronic Research & Mfg. Corp.

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F. E. Terman, "Radio Engineers' Handbook," McGraw-Hill, 1943, p 493; Fig. 12 shows positioning of spurious modes of quartz crystals.

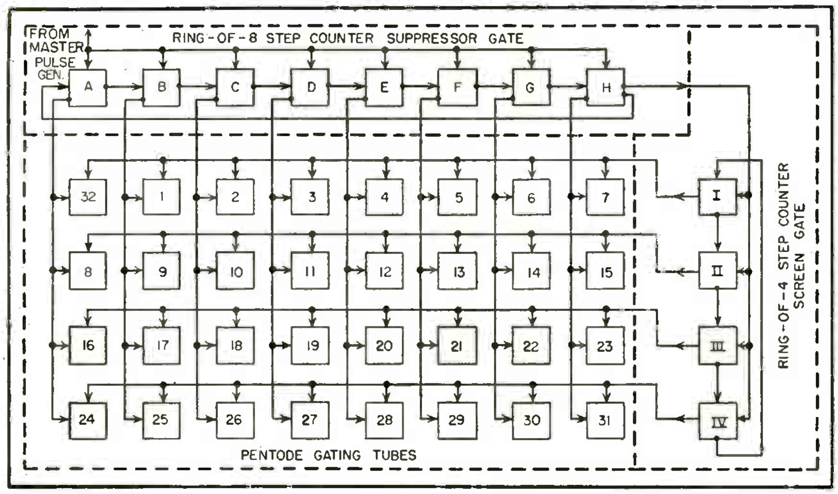


FIG. 1—Ring-of-8 and ring-of-4 counters feed coincidence voltages to screens and suppressors of pentode gating tubes

Master pulse generator operates the ring-of-8 counter chain

32-Channel High-Speed

System employs binary counters and a network of coincidence gating tubes to commutate 32 channels of information with essentially negligible switching time. Substitution of thyratrons in counting circuits reduces power supply requirements at some sacrifice in switching speed

HIGH-SPEED electronic commutators are inherently complex, especially when designed to have a negligible switching interval. Simplicity and straightforwardness are essential in reducing initial cost and servicing requirements.

In the 32-position commutator described here, almost 100 percent of the switching time is available for signal information. A minimum of tubes and components is used, and sampling rates of 1,000 cps may be obtained.

Binary System Used

For a given count, a binary counter uses a minimum number of tubes. If a binary counter were employed to obtain a count of 32, this could be done by making use of the fact that $2^5 = 32$ and only 5 double triodes would be required. However, to make use of this counter, coincidence gating would be employed. A gating tube having 5 separate grids plus a signal grid in addition to plate, cathode and heater would be required. There is no such tube commercially available. Even if one were obtainable, the interwiring problem would be unnecessarily complicated.

A practical 32-position commutator system employing a ring-of-8 combined with a ring-of-4 step counter can be used to coincidence gate the suppressor and screen respectively of the readily obtainable miniature type 6AS6 pentode. This requires only 12 counting tubes as compared with 32 formerly required, and the interwiring problem is comparatively simple.

A block diagram of a 32-step commutator using a ring-of-8 combined with a ring-of-4 step counter is shown in Fig. 1. If a 1,000-cps sampling rate is desired, the master pulse generator runs at 32,000 cps and operates the ring-of-8 step counter. After every 8th count, a pulse is sent from *H* to the ring-of-4 step counter and advances it from I to II, II to III, and so on. The ring-of-8 runs at 4,000 cps, while the ring-of-4 will run at 1,000 cps.

The outputs of the two ring counters gate the screen and suppressor respectively of the 32 gating tubes, as shown in Fig. 1.

By referring to the relative pulse outputs of the ring-of-4 and ring-of-8 counters shown in Fig. 2, it can be seen that the screen and suppressor pulse on any one gating tube will be simultaneously positive only once every 32 counts. Since any gating tube must have a coincidence of positive pulses at both suppressor and screen in order to conduct, a 32-position commutator results.

When such a sytem is used with an n position commutator, it can be shown that the minimum number of counting elements will result if $\sqrt{n}$ counts are placed in each step counter. This of course can only be done if n is an integer. As an example, in a 36-position commutator, two ring-of-6 step counters could be used, or a total of 12 tubes. A 100-position commutator requires two ring-of-10 counters, or a total of 20 tubes. If n is not an integer, the number of tubes in each counter should be chosen so that their product is n while their sum is a minimum. For the 32-position

Under-chassis components are potted in a thermosetting plastic

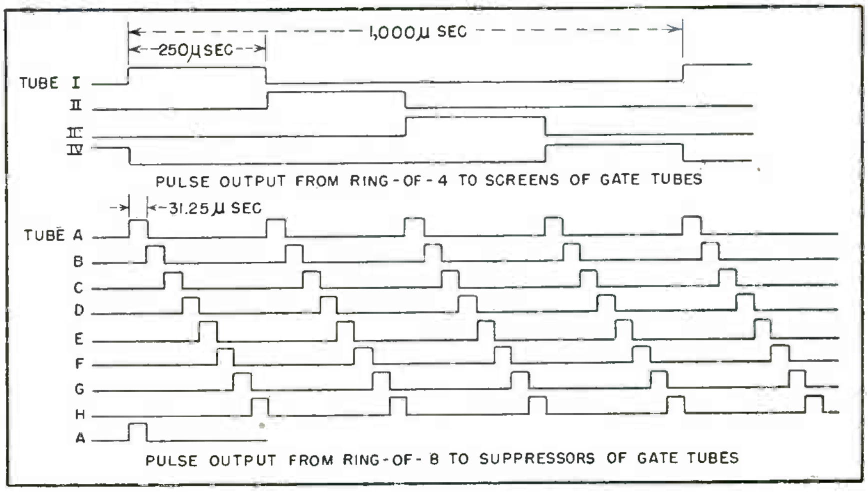


FIG. 2—Each gating tube is turned on for 31.25 microseconds once every millisecond by the ring-of-8 and ring-of-4 counter circuits

Commutator

By NORMAN ALPERT, JOSEPH LUONGO and WARREN WIENER

Servo Corporation of America
New Hyde Park, N. Y.

commutator previously described, $8 \times 4 = 32$ and $8 + 4 = 12$.

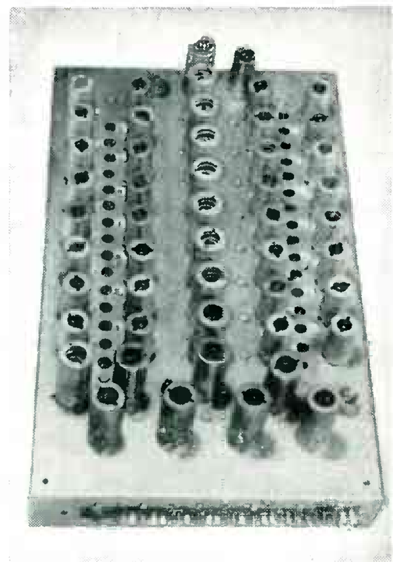
Vacuum-Tube Commutator

A schematic diagram of a 32-step vacuum-tube commutator using a ring-of-8 combined with a ring-of-4 step counter is shown in Fig. 3. Both step counters are composed of identical Eccles-Jordan flip-flop circuits using miniature 12AU7 tubes which are capable of speeds in excess of 200 kc. However, from the standpoint of negligible commutation interval and stability, the step-counter should not run at a rate much faster than 32 kc.

The ring-of-8 consists of stages *A* through *H*. Stages *B* through *G* have been omitted for simplicity—each of these stages is identical to stage *A*. The 32 gating-tube circuit numbers are shown in circles next to the signal input terminals in each case. Stages 2 through 6, 10 through 14, 18 through 22 and 26 through 30 have been omitted and they are identical to gating tube circuit 1. As indicated by the arrows, ring-of-8 counter stage *C* is connected to the suppressor grids of gating tubes 2, 10, 18 and 26; *D* is connected to 3, 11, 19 and 27, and so on. Horizontal rows of gating tubes have their screens gated by ring-of-4 counter circuits I through IV.

To obtain the 1,000-cps sampling rate, the master pulse generator supplies negative pulses of 32,000-cps repetition rate. These pulses trigger the ring-of-8 step counter to successive positions every 31.25 microseconds. After every eighth count, the trailing edge of the pulse from the counter tube *H* is differentiated, amplified and inverted by V_1 and negative pulses of 4,000-cps repetition rate are supplied to the ring-of-4 step counter. This counter is thus advanced successive positions every 250 microseconds.

Figure 2 is a graphic representation of the sequence of events. The outputs from the ring-of-4 are each used to pulse the screens of 8 gated miniature 6AS6 amplifier tubes. Coincidentally, the outputs from the ring-of-8 are each used to pulse the suppressors of 4 gated amplifier



Vacuum-tube commutator chassis samples 32 channels at a rate of 1,000 cps

tubes, one in each of the 4 rows of 8 gated tubes connected to the ring-of-4 stepping counter.

Sequential Gating

By using stepping counters totalling 12 stages, 32 amplifier tubes are gated sequentially and a 32-position commutator is the result. In the circuit shown in Fig. 3, gating tubes numbered 1 through 30 sample 30 individual input signals. The 31st and 32nd gating tubes provide separate constant-amplitude synchronizing pulses through cathode followers V_6 and V_8. If these synchronizing pulses are not required, the circuit is readily modified so that the 31st and 32nd tubes can sample 2 additional input signals.

As illustrated, the plates of gat-

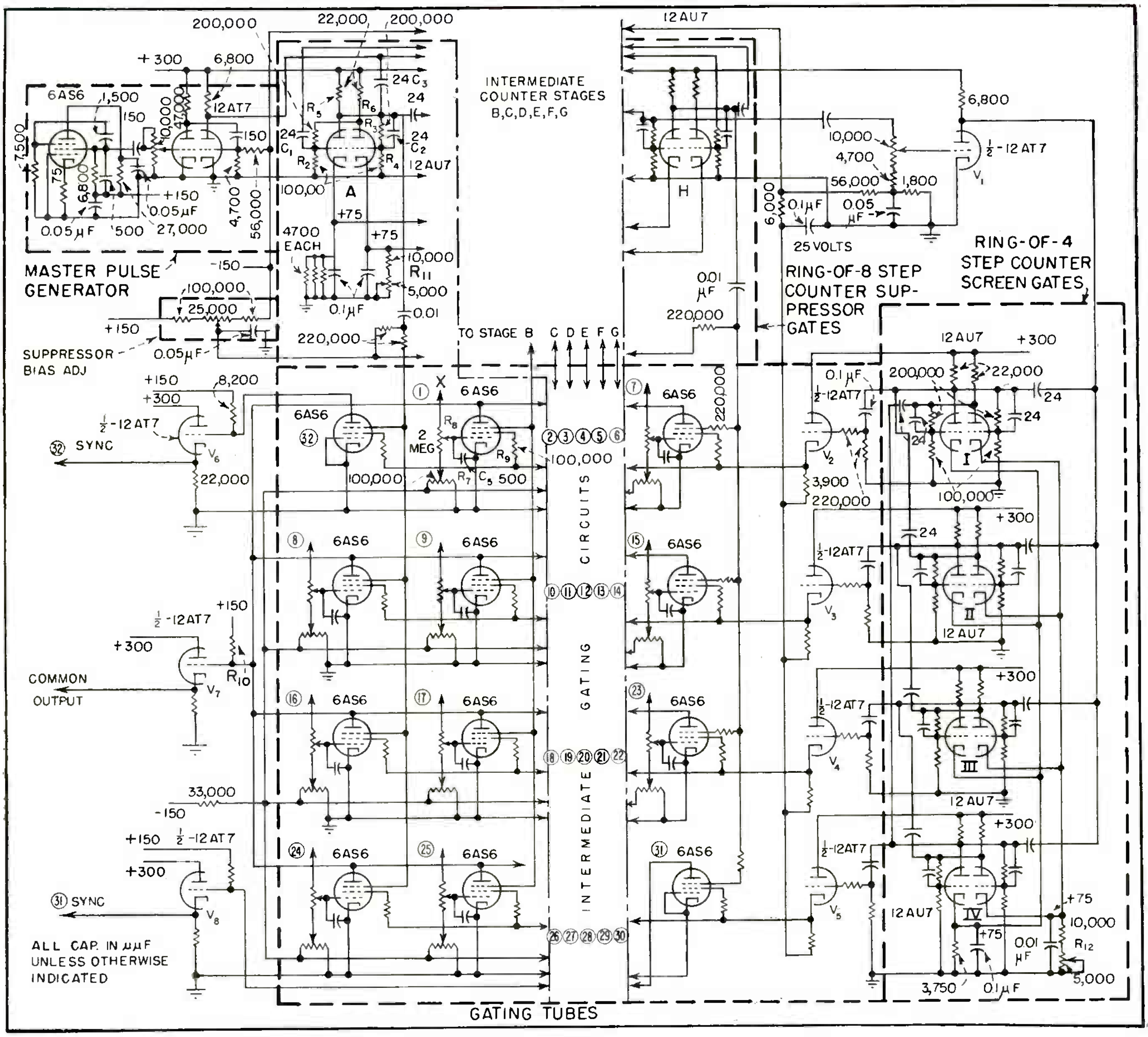


FIG. 3—Complete circuit of 32-channel electronic commutator. Five intermediate counter stages and twenty gating tube stages have been omitted. They are identical to companion circuits shown

ing tubes 1 through 30 are connected to a common plate load resistor R_{10} across which the combined commutated output is developed. This in turn is connected to cathode follower V_7 which provides a low-impedance output.

A typical gating-tube circuit such as No. 1 operates in the following manner. Gain control R_8 is adjusted for proper amplification of the signal connected to terminal X. Potentiometer R_7 sets the grid bias at a point in the middle of the linear portion of the dynamic curve in such a manner that the plate-voltage level is equal to all the pedestal levels of the other gating tubes.

The suppressor is normally held at cutoff by the common suppressor bias adjustment control while the screen voltage is normally −25 volts which also represents cutoff. In order for the gating tube to be turned on, the screen supply voltage, obtained from a cathode follower such as V_2, V_3, V_4 or V_5, becomes a positive pulse of about +100 volts which is applied to the screen through current-limiting resistor R_9. Simultaneously, the suppressor supply voltage obtained from the ring-of-8 stepping counter becomes a positive pulse of about 100 volts, thus driving the suppressor to saturation, and normal tube gain results.

The signal applied to the control grid will then appear across the common load resistor R_{10}. Capacitor C_5 attenuates any unwanted spikes which might be picked up by the control grid and thereby show up as fictitious signals in the combined output.

The ring counters shown in Fig. 3 are inherently very stable, require no components having close tolerances, will operate from an unregulated power supply and are not critical regarding trigger pulse waveform. Occasionally, over long periods of time, it may be necessary to adjust controls R_{11} and R_{12} in order to equalize the ring counter cathode voltages labeled +75 volts.

A detailed description of the operation of this circuit has been described previously in ELECTRONICS.[1]

Master Pulse Generator

The pulse generator used to operate the ring-of-8 counter employs a 6AS6 miniature pentode in a transitron oscillator circuit, as shown in the upper left hand corner of Fig. 3. The transitron oscillator is particularly adaptable as a pulse generator since crude pulses are generated at the screen of the pentode. Consequently less processing of pulse shape is required than with a conventional sinewave oscillator. Since the wave shape and amplitude of the pulse are dependent almost entirely on the R-C parameters, change in filament and electrode voltages will have slight effect on its operation.

The transitron screen output is differentiated and amplified by one-half of a 12AT7. The resultant signal is again differentiated and amplified by the second half of the 12AT7 to produce negative pulses of 120 volts peak amplitude, having a pulse width at the base of about 5 microseconds and a repetition rate of 32,000 cps as determined by the transitron oscillator. These pulses provide satisfactory operation of the ring-of-8 stepping counter.

Two photographs show the transitron pulse generator in which all components except the two tubes are potted in a thermosetting type of plastic to insure stability under adverse conditions of vibration and humidity.

Thyratron Commutator

A schematic diagram of a 32-step thyratron commutator using a ring-of-8 combined with a ring-of-4 step counter is shown in Fig. 4. Both step counters are composed of identical thyratron stepping counters using 2D21 thyratrons. Due to the deionization time of the thyratrons, the maximum rate at which this step counter can run with good stability is 16 kc, corresponding to a sampling rate of 500 cps.

A pulse generator (not shown but similar to the transitron pulse generator shown in Fig. 3) supplies positive pulses of 16,000-cps repetition rate. These trigger the ring-of-8 step counter to successive positions every 62.5 microseconds. The ring-of-4 counter operates in a manner similar to the vacuum-tube counter previously described. The outputs of the ring-of-8 and ring-of-4 counters are also applied to the 32 gating tubes as shown in Fig. 3.

The count is advanced by triggering one thyratron which in turn prepares the next thyratron for triggering and extinguishes the preceding thyratron by means of a 1,000-$\mu\mu$f capacitor connected between cathodes. The thyratron ring counters of Fig. 4 are very stable, require no components having close tolerances, will operate from an unregulated power supply and are not critical regarding trigger pulse wave form.

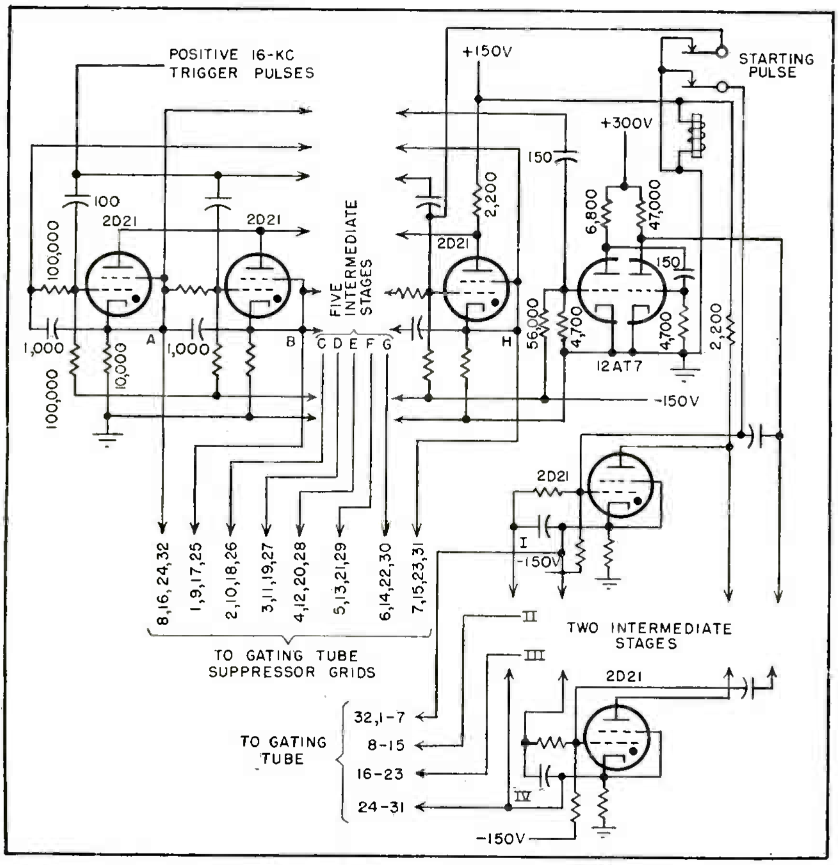


FIG. 4—Substitution of 2D21 thyratrons in counting stages reduces power supply requirements, since only one thyratron fires at a time. Sampling rate is reduced to 500 cps due to ionization time. Screen-grid leads to gates, lower center

Application

Using stepping counters totalling 12 stages, 32 amplifier tubes can be gated sequentially to produce an electronic commutator which will be equivalent to a 32-position selector switch rotating at speeds of the order of 1,000 revolutions per second.

If vacuum tubes are used in the ring counter section of the commutator, switching speeds in excess of 200 kc can be obtained, but since one half section of each counter tube is always drawing current, the continuous drain on the power supply is quite high. If thyratrons are used, only one thyratron is conducting at any one time and the drain on the power supply is negligible. However, to offset this advantage, the switching speeds of the thyratron ring counter cannot be much faster than about 16 kc due to the deionization time requirement.

An electronic commutator of the type described is superior to one in which a radial beam type of tube is employed in that almost 100 percent of the switching time is available for transmission of signal information and, in addition, it provides a more flexible and noncritical system.

REFERENCE

(1) Richard Weissman, Stable Ten-Light Decade Scaler, ELECTRONICS, p 84, May 1949.

Production Experience

Problems involved in converting a mass-produced television receiver having an i-f at the old 20-mc RMA Standard and the modifications required to manufacture the receiver with the new 40-mc Standard. Field experience shows minimum interference problems

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USE OF a 40-mc intermediate frequency in television receivers eliminates or minimizes all the problems attendant to the older 20-mc i-f and presents relatively few new problems not encountered at the lower frequency.

This paper discusses a present-day television receiver that incorporates a 40-mc i-f, the problems encountered in putting this receiver into production, the problems encountered during production, and the field experience with this receiver. Discussion is limited to problems connected directly or indirectly with the i-f.

The receiver was originally built, in large quantities, with a 20-mc i-f. It was then converted to 40 mc and again built in large quantities. Thus, actual production experience with both frequencies on the same basic chassis has been experienced.

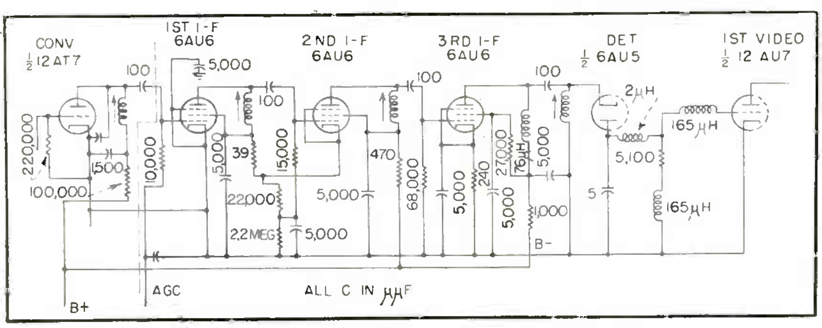


FIG. 1—Circuit of the 20-mc i-f amplifier first used in the receiver

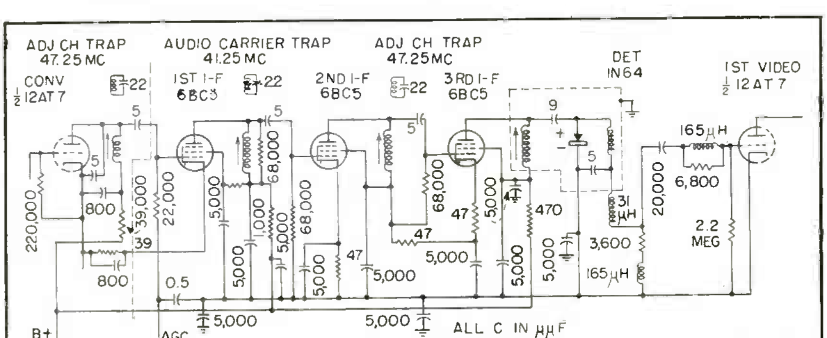


FIG. 2—Redesign for 40-mc operation involved changing tube type and adding traps

The chassis was originally brought out as model 805, an intercarrier receiver. For various reasons, the chassis was designed without a power transformer. Also, for U. L. reasons, the chassis was made cold, that is, not directly connected to the power line.

This receiver was put in production early in 1949. It was started with a 20-mc i-f because it was felt that not sufficient knowledge or experience with the 40-mc i-f was yet available. Also Major Armstrong still had a powerful f-m station broadcasting in the 40-mc region.

Change in production to the higher i-f was made after the Alpine f-m station had ceased broadcasting in that region. By this time several receivers had been built and field tested.

Much of the factory test equipment was converted during factory vacation shutdown. However, some duplication was necessary. For a period after vacation both frequencies were in use. Gradually, however, receivers incorporating the older frequency were built and shipped and only receivers incorporating the new frequency were left in production. The change in frequency was coordinated with a change in model numbers.

Simultaneously with the change in i-f, several other changes were made. These other changes tend to obscure, to some extent, a direct

with a 40-mc I-F Receiver

BACKGROUND

In 1945 the author, as a member of the RMA Television Receiver Committee, was appointed Chairman of the Subcommittee of Standards of Good Engineering Practice. This Subcommittee adopted an i-f of 21.25 to 21.9 mc for the sound i-f and 26.75 to 27.4 mc for the picture i-f.

Practical experience with the intermediate frequencies has been relatively good except for the problems engendered by oscillator radiation. In addition there have been several minor difficulties such as double conversion effects, direct i-f interference from amateurs, industrial equipment, international short-wave stations, and f-m station image interference.

The problem of oscillator radiation became so severe that in April 1948 the Television Receiver Committee met and rescinded its recommended standard i-f.

The author became chairman of a special task force which restudied the problem. Foremost among those involved in this study were John D. Reid and P. G. Holst. One year later, the Task Force recommended an i-f of 41.25 mc for sound and 45.75 mc for the picture. This was subsequently adopted as a standard by RMA

comparison of the before-and-after receiver. In the ensuing discussion, such factors will be mentioned and their effect eliminated from the comparison as nearly as possible.

Circuit Changes

Figure 1 shows a schematic diagram of the 20-mc i-f amplifier. Three stagger-tuned stages incorporating 6AU6 tubes were used.

Figure 2 shows a schematic diagram of the 40-mc i-f amplifier. Again three stagger-tuned stages are incorporated, but the tubes have been changed to type 6BC5.

The most difficult part of this development was to make the amplifier stable and symmetrical with all values of agc or contrast bias. This problem was aggravated by the fact that a transformerless cold-chassis receiver was involved. The fact that the problem was satisfactorily solved at 40 mc in such a receiver should lend encouragement to those engineers intending to develop a 40-mc i-f strip.

Figure 3A shows the i-f bandpass curve shape for the 20-mc amplifier at various values of bias voltage. The scale for the ordinates has been adjusted for each curve so that the curves may be laid on top of each other. It can be seen that this curve holds together fairly well, although it is certainly not perfect.

Figure 3B shows the bandpass curve shape for the 40-mc amplifier, again at various values of bias voltage. It shows that even better results were obtained than for the 20-mc amplifier.

These curves were taken on receivers built on the production line, and are fairly typical of average production. It should be pointed out, however, that at the start of the production lines not all receivers came out this well. A great deal of effort was expended on tracing down the variables before uniformity of production was achieved.

The cures adopted were the usual sort of things, such as very short lead lengths on certain critical bypass capacitors, bypassing to the right spots, elimination of common impedances, and so on. Very little shielding was actually necessary.

Gain Tests

To obtain realistic comparative gain measurements the following technique was adopted. Figure 4 shows the connections to the converter grid. First the r-f amplifier and oscillator connections were removed. Then the signal generator was connected to the grid through a 100-$\mu\mu$f capacitor. A bias of -2.5 volts was placed on the grid through 220,000 ohms.

A microammeter was placed in the second detector load circuit to measure output. The agc voltage was removed from all i-f stages and

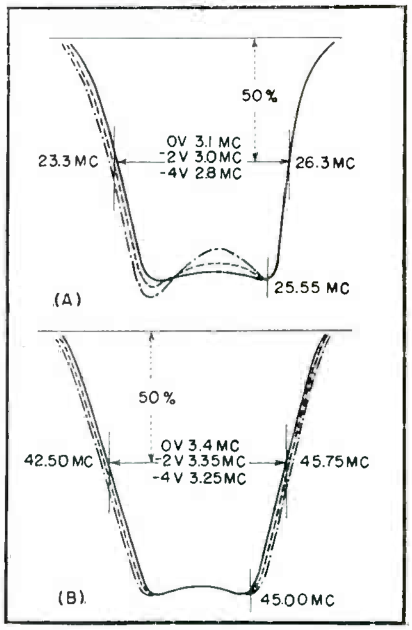


FIG. 3—Bandpass curves for the two amplifiers

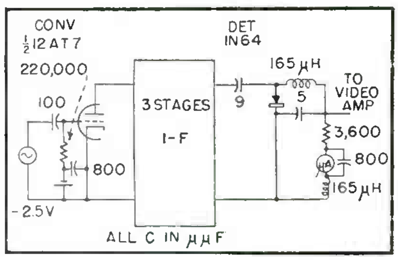


FIG. 4—Arrangement of circuit for measuring gain

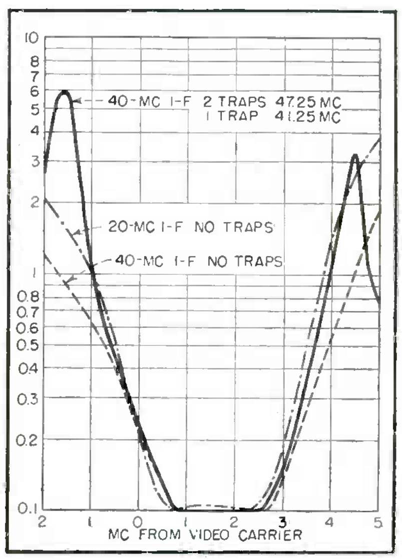


FIG. 5—Superimposed selectivity curves for direct comparison

a bias of −1 volt applied to all i-f tubes.

Using this technique, a gain of 66.4 db was measured for the 20-mc strip, and a gain of 69.4 db was measured for the 40-mc strip. Thus the gain of the 40-mc i-f amplifier was actually 3 db greater than the gain of the 20-mc amplifier.

The bandwidth of the 40-mc amplifier was made greater than the bandwidth of the 20-mc amplifier, being 3.0 mc at 20 mc and 3.25 mc at 40 mc. The increased gain and bandwidth were due to the change in tube type. Although this added to the cost of the receiver, the increased performance was felt to be worthwhile.

When the frequency was changed one own-channel sound trap and two adjacent-channel sound traps were added. These traps were all simple fairly low-Q traps for economy and to fit available space. The net result of this addition was that the adjacent-channel sound trappage was increased from 24 db to 35 db.

The selectivity curves of the 20-mc amplifier and of the 40-mc amplifier, with and without traps, are superimposed on each other in Fig. 5. The frequency scale is altered to show megacycle spacing from the video i-f carrier. Probably one of the added traps can be charged to improved performance, the other two being necessary to obtain equivalent performance.

One anticipated difficulty with the higher i-f was regeneration on channel 2 but the problem was solved without the necessity of adding neutralization to the 12AT7 converter tube. Figure 6 shows the converter plate circuit, and, as shown, no neutrolizing coil is used.

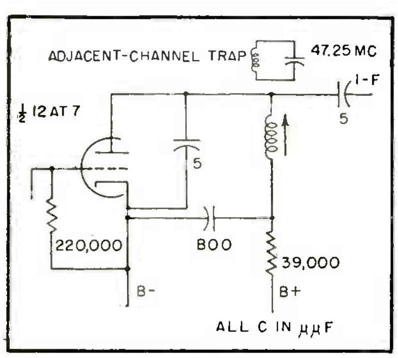
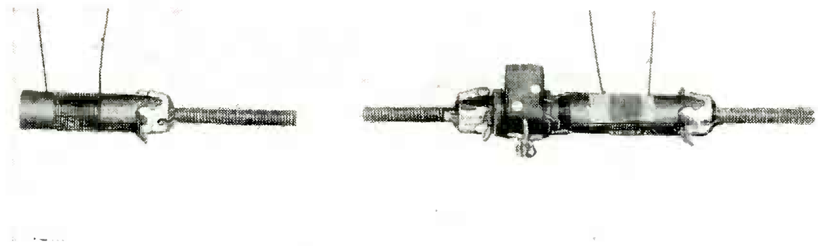


FIG. 6—Final converter does not require neutralization


Shown for cost comparison, a 20-mc i-f coil is at left and a 40-mc coil with added trap at right

This may or may not be true for some other tube.

Field Experience

Another of the anticipated difficulties was second harmonic i-f interference in channel 6. The second harmonic of the sound i-f is at 82.5 mc, which is $\frac{3}{4}$ of a megacycle below the picture carrier of channel 6. It was found possible to reduce the interference to a non-objectionable degree without elaborate precautions. The level of the interference was found to be roughly comparable to the level of third-harmonic i-f interference previously encountered with the 20-mc i-f on channel 5.

Another anticipated difficulty was that of direct i-f interference. Experience over a nine-month period has shown less difficulty with this i-f than with the 20-mc i-f. Very few actual cases of such interference have thus far been reported. In all cases the difficulty was solved with an i-f trap in the antenna lead-in.

Experience with this chassis shows that it may not be necessary to install an i-f trap in every receiver, but traps could be service parts, to be installed when and where necessary.

A 40-mc i-f receiver was subjected to intense 27.12-mc radiation alongside a diathermy unit by a large manufacturer of such equipment. This test was made by him because of the large number of complaints he had received due to his equipment causing tvi. As could be expected, during prolonged tests there was no sign of tvi.

UHF Provision

Combination vhf and uhf receivers would require an i-f higher than 20 mc. If the same i-f is to be used for both services, the highest practical one is 40 mc, unless one resorts to double conversion or some other stunt not normally employed. This i-f will be very practical at uhf, especially if the FCC follows the recommendation of RMA and JTAC that the allocation plan provide image protection for such an i-f.

Double-conversion problems exist at 40 mc as well as at 20 mc however; head end design must take this possibility into account.

One of the severe image problems encountered with the 20-mc i-f is caused by f-m stations being on the image of channel 2. This particular image problem is entirely eliminated at 40 mc. An image problem of similar magnitude at 40 mc has not been experienced.

One anticipated benefit was the elimination of interference between television receivers due to oscillator radiation. This result has been very satisfactory.

Extra Cost

The changeover from three 6AU6 i-f tubes to the 6AG5 type and later to 6BC5's resulted in a cost increase of 30 cents. At the same time, some increase in gain was obtained.

The cost of two traps should be charged to the conversion to 40 mc. The photograph shows a comparison of the 20-mc i-f coil without the trap and the 40-mc coil with the trap. The cost differentials may be judged from the illustration.

In addition there are five more capacitors used in the 40-mc amplifier, between the converter and second detector. Some of these may be charged to the change in i-f and some to improved performance and stability.

MICROWAVE SWEEP GENERATOR

Motor-driven plunger-cavity arrangement provides continuous klystron output from 2,600 to 3,400 mc at a sweep rate of 8 to 10 cps. Permits oscilloscope indication of match between wide-band traveling-wave tubes and transmission lines

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Microwave sweep generator facilitates adjustment of matching between wide-band tubes and transmission lines

THE SWEEP OSCILLATOR described here was developed to aid in the study of matching between traveling-wave tubes and transmission lines over a wide frequency range in the 10-cm region. Through its use, much valuable time is saved by providing continuous indication on a cathode-ray tube, rather than the time-consuming process involving point-by-point measurements with a manually-tuned signal generator.

During the course of development, attempts were made to use paddle arrangements in waveguide-type cavities. These did not give enough bandwidth, and the tracking of reflector voltage proved very difficult or impossible to achieve.

To provide adequate bandwidth, a sweep oscillator was built using a type 6BL6 reflex klystron[1]. This tube is designed for broad-band operation in a single mode over the range of 2,000 mc to 4,000 mc in a coaxial resonator cavity.

Cavity Resonator

The cavity used has a noncontacting plunger which is mechanically driven at the desired sweep frequency. The plunger clears the inner and outer conductors of the cavity by about 0.01 inch, as shown in Fig. 1. Spacing is maintained by three small rollers mounted directly behind the plunger and riding on three flats cut on the outside of the inner conductor. Another set of rollers ride outside the cavity. Springs give the plunger a degree of mechanical rigidity without impairing its back-and-forth motion. The rate of sweep, 8 to 10 cps, is

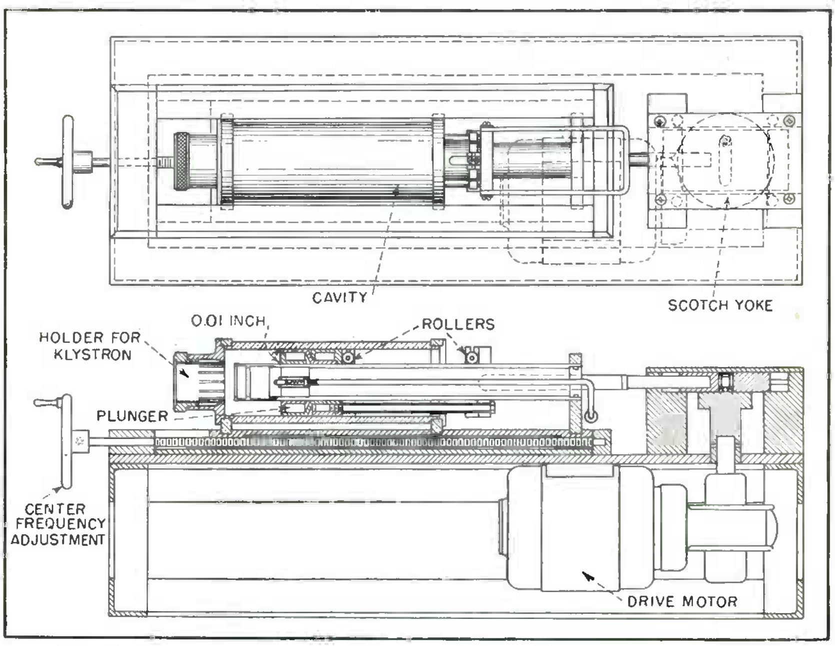


FIG. 1—Mechanical details of 2,600 to 3,400-mc klystron sweep generator

Work done under Bureau of Ships Contract No. NObsr-39160

low enough to prevent whipping, but high enough to provide continuous oscilloscope indication.

The cavity is operated in the $2\frac{3}{4}\lambda$ mode. The sweep from 2,600 to 3,400 mc requires a wavelength change of 2.78 cm and, therefore, the plunger displacement is 0.75 × 2.78 cm or approximately 0.93 inch. The plunger is driven by a scotch yoke operated by a 1/7-hp, 5,000-rpm universal motor with a 10-to-1 speed reduction gear. Motor speed is controlled by means of a variable transformer. The motor output shaft runs at about 260 rpm to give the correct sweep rate. The scotch yoke converts rotational motion into simple harmonic motion of the plunger.

Reflector Voltage Tracking

The klystron reflector voltage has to be varied as the frequency is changed to maintain oscillation over the desired range, as indicated by the reflector-mode characteristics in Fig. 2. In sweeping from 2,600 to 3,400 mc, the reflector voltage (working on the center line of the $2\frac{3}{4}$-mode area) must be increased from about 90 volts to 175 volts. If maximum power output at all frequencies were desired, the reflector voltage would have to follow this center line curve exactly. In this application, where the sweep length is relatively short, the voltage is varied linearly (with respect to wavelength) and stays well within the limits of the $2\frac{3}{4}$-mode area.

The linear relation is obtained by a small a-c generator coupled to the output shaft of the motor that drives the scotch yoke. The generator is excited by a 6-volt battery and produces one cycle of sinusoidal voltage per revolution of the motor. Thus the a-c voltage generated bears a linear relationship to the wavelength of the cavity resonator. The generator stator can be rotated by hand to obtain proper phase between a-c voltage and plunger displacement.

At such a low speed the output voltage provided by the a-c generator is only of the order of one volt rms. This output voltage is stepped up by a two-stage capacitance-coupled amplifier to provide the voltage required to track the reflector over the required range.

The d-c component of the reflector voltage is taken from a regulated supply and the a-c output of the amplifier is fed through a capacitor to the reflector. Since the cavity is at ground potential and the voltage is applied between cathode and reflector, the reflector supply is not grounded.

Circuit Connections

The block diagram in Fig. 3 shows how the complete circuit is connected to the klystron. The reflector sweep voltage also provides a synchronizing voltage for the X-axis of the oscilloscope used to view the r-f output of the cavity. This gives a picture of r-f output versus wavelength since the tracking voltage is a linear function of wavelength.

Due to the off-ground feature of the sweeping voltage, the 60-cycle hum presents a problem. Filter capacitors placed between reflector

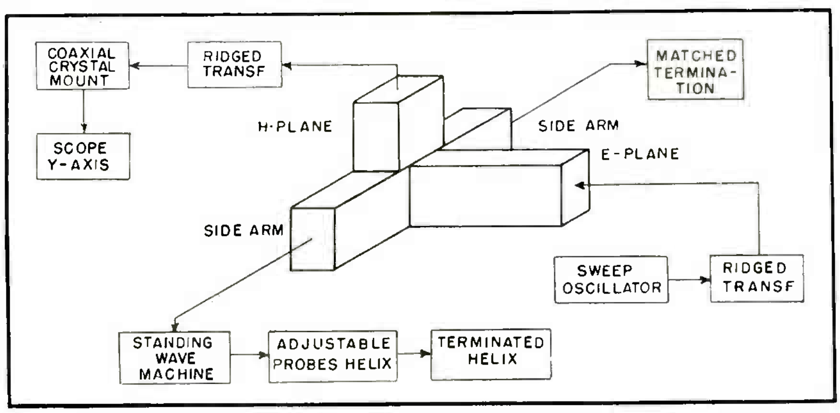


FIG. 4—Setup for studying match between broad-band microwave devices

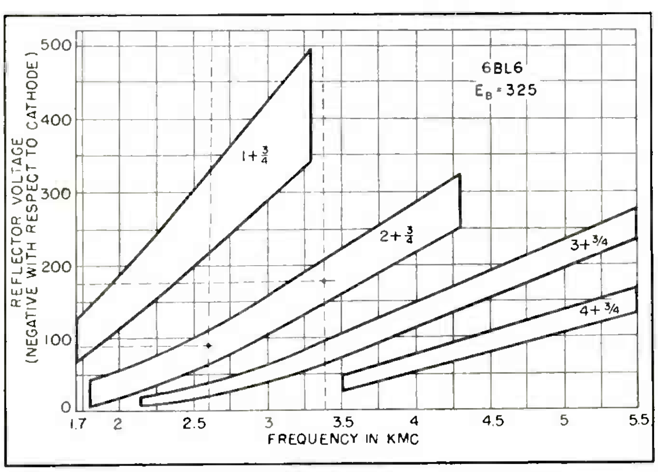


FIG. 2—Reflector-mode characteristics for the 6BL6 reflex klystron operating in a cavity resonator. The dashed lines show the frequency range usually swept

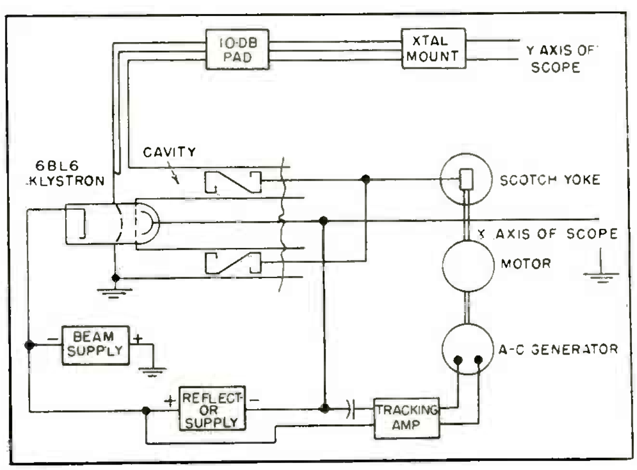


FIG. 3—Sweep oscillator block diagram. Reflector voltage is swept linearly with plunger displacement to maintain oscillation over the desired 800-kc range

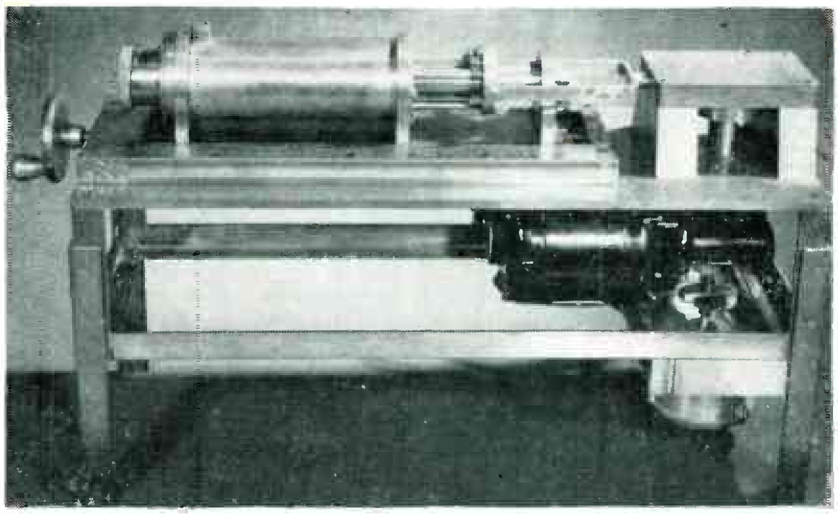
and ground reduce the amplitude of the sweep voltage. The filtering finally adopted is a compromise between these two factors.

The r-f output from the cavity is fed through a 10-db pad before it is detected or fed to a piece of test apparatus. The padding matches the load to the cavity, thereby giving cavity and tube a better chance to provide a more constant output over the band.

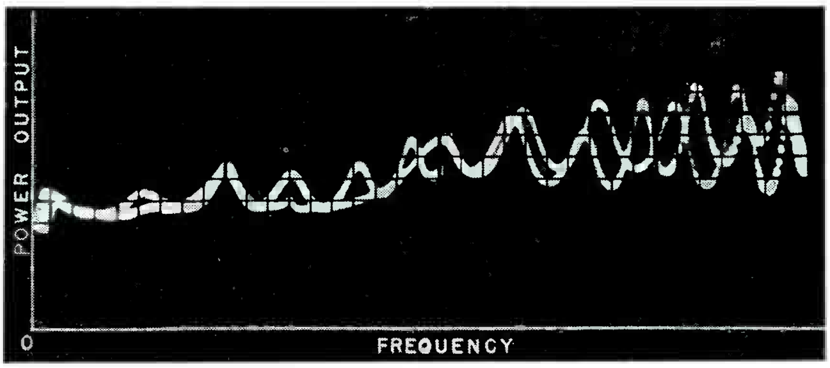
The r-f power, whether it is the power reflected from some matching transformer or the complete output of the sweep oscillator, is detected by means of a 1N21B crystal diode mounted at the end of a coaxial line. The crystal mount is adjustable to present a good match over the band.

The output of the sweep oscillator is shown in an oscillogram which was taken directly from the cathode-ray oscilloscope during operation. The double trace is due to the fact that the power output at any frequency is not a symmetrical function of reflector voltage. When the cavity is tuned, say from the high-frequency end, the power output is one value; but when the cavity is tuned from the other direction, the power output is slightly different.

To overcome this reverse trace, one can short out the crystal on the return stroke by using a cam-operated switch. This also gives a zero output line that is useful for matching purposes.



Motor-driven plunger sweeps cavity over wide range of frequencies in 10-cm region. Klystron pins are visible at left end of cavity



Double trace of output vs frequency oscillogram is due to asymmetry of reflector voltage-output curve

Application

The sweep oscillator is used to perfect matching sections between waveguides and helices in traveling-wave tubes, a magic tee being used for detecting the reflected power. The matching section is adjustable, and it is a simple procedure to perfect a match over the 800-mc range in a relatively short time.

The necessary equipment to do this is shown in Fig. 4. The parameters of the matching section are varied in such a fashion that the scope shows only a small amount of reflected power over the band.

This again is a compromise between a reasonably flat match over the entire band and a very good match over a much shorter band. Naturally, for broad-band work, the flat match is desirable.

From the trace on the oscilloscope one can estimate the amount of reflected power from the match by comparing it to a 100-percent mismatch. In practice such estimates have been correct within a few percent when checked by actual measurements of the voltage standing-wave ratio point-by-point over the band. The sweep oscillator has also been used to match into fluorescent noise sources and to check other broad-band equipment.

The sweep oscillator was designed to be as versatile as possible. The center frequency and, therefore, the whole band, may be changed by the handle shown in Fig. 1.

This moves the complete cavity so that the plunger displacement can be shifted all through the band of the cavity. Also, the same cavity with a different noncontacting plunger, operating in the $\frac{1}{4}\lambda$ mode, will generate power from 800 to 2,000 mc. The tube then employed would be the 6BM6 reflex klystron.

The author wishes to acknowledge the excellent work done by other members of the staff at these laboratories, particularly L. F. Ankersen, who did much of the actual mechanical designing, and W. Ramsey who designed and constructed the power supplies and the tracking amplifier.

REFERENCE

(1) P. G. Bohlke and F. C. Breeden, External Cavity Klystron, ELECTRONICS, p 114, July 1947.

Shape Recording with

A memory system for automatic machinery uses pairs of square waves to record the effect of position on a magnetic tape. A servo system replacing customary metal cams is actuated by the varying positive-negative relationship to position the reproducing tool

By **ROBERT R. PERRON**

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IT IS USUAL PRACTICE in automatic machinery to use metallic cams as memory devices for shapes or patterns and as methods of moving mechanisms or work through predetermined paths. Cams are satisfactory and inexpensive in many applications and when made of metal they have the feature of being able to exert considerable force upon followers and mechanisms. However, the nature of cams is such that they are often not sufficiently adaptable.

In the development of automatic machinery, devices are often of interest that have greater flexibility than cams in the sense that the shapes remembered thereon are easily impressed and changed. These memory systems can be defined as a means whereby a function of space can be recorded and later reproduced. This article describes a flexible memory system for the recording and reproducing of shapes by means of a new type of magnetic-tape recorder.

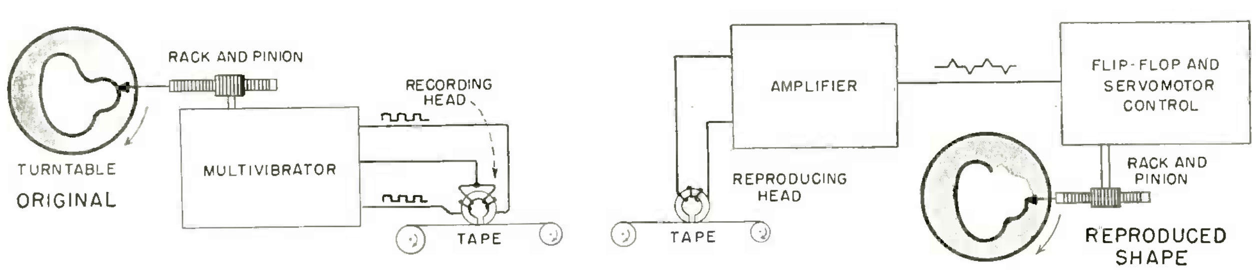
Conventional Systems

Existing methods of recording intelligence in a magnetic medium, such as amplitude modulation, amplitude-modulated carrier and frequency modulation[1,2] do not provide sufficient accuracy for precise shape recording. Amplitude modulation, in which the intensity of magnetization varies in accordance with the intelligence, has inaccuracies that arise for the following reasons:

(1) Demagnetization of the magnetic medium carrying the recorded intelligence represents a loss of about 25 db in output[3] after the first few playings. It causes the output to deviate considerably from the input. Even though little further loss would be encountered after initial aging, a means for automatically compensating for this loss is required.

(2) Magnetic tape or wire wound on a spool encounters crosstalk between adjacent turns[3]. A section of strongly magnetized

HOW THE SHAPE RECORDER WORKS



• **THE SHAPE** to be reproduced is fastened to a turntable that rotates at a constant, reproducible speed. A feeler, following changes in contour, actuates the multivibrator control through a rack and pinion. The multivibrator generates pairs of square waves of current. The ratio of the time length of the positive portion to the total length of a pair is proportional to the function being recorded. The square-wave pairs flow in sequence through a recording head and the resulting flux density is recorded on magnetic tape.

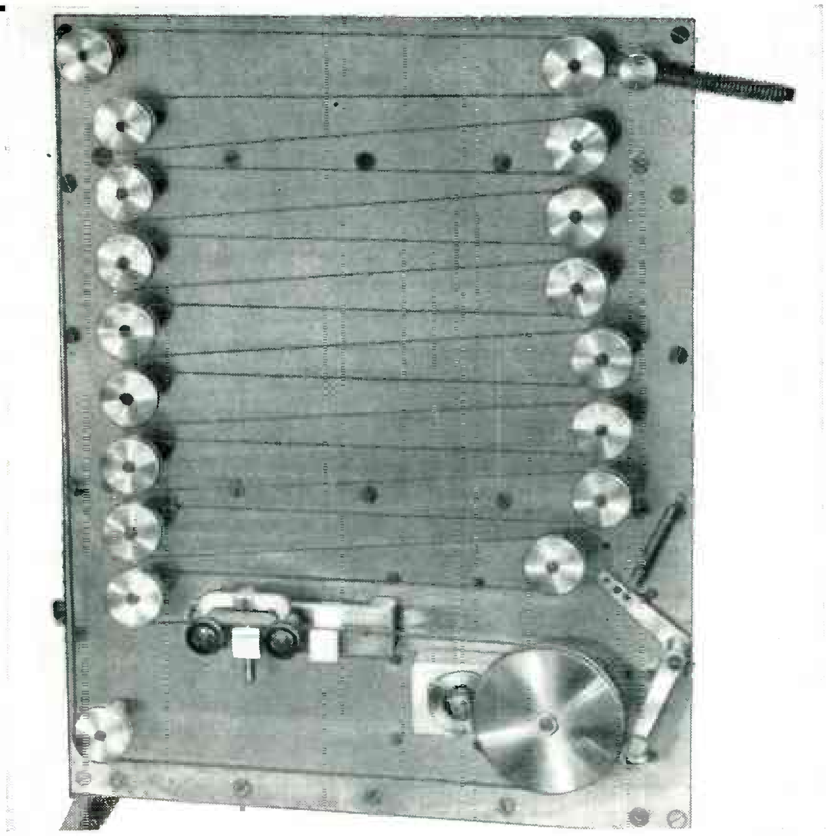
Pulses are used because with amplitude modulation, about 25 db of output would be lost after the first few playings. Frequency modulation is objectionable because speed changes result in amplitude distortion.

• **IN REPRODUCTION**, the head differentiates the recorded flux and the voltage peaks are fed to a flip-flop circuit that reconstructs the original square waves. A servomotor, driven in accordance with the conduction-time ratio, positions the stylus to generate a replica of the original shape.

The reproducing turntable must be driven at the same speed as the recording table, or, the relative speeds of turntable and tape must be maintained.

• **PRECISION** of reproduction is independent of playback velocity or changes in amplitude of the recording owing to demagnetization and crosstalk

Ratio-Modulated Tape



Endless-tape mechanism in which 24-foot tape repeats memorized orders to machine

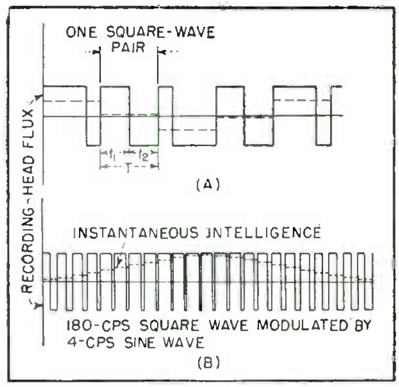


FIG. 1—Ratio-modulated low-frequency square wave (A) and the instantaneous intelligence (B) appearing in a square wave modulated by a sine wave

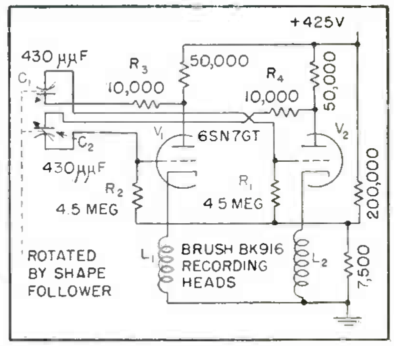


FIG. 2—Recorder multivibrator actuated by the shape follower

medium tends further to magnetize or demagnetize an adjacent section and distortion results. With coated magnetic tape, however, this effect is small because of the large ratio of paper to magnetic medium.

(3) The voltage generated in a pickup head by a magnetic tape having a flux ϕ is

$$E = KVN \frac{d\phi}{dt} \times 10^{-8} \text{ v}$$

where N is the number of turns in the pickup coil and V is the tape velocity. Hence, when ϕ is constant, so that $d\phi/dt = 0$, we have $E = 0$; and, therefore, constant flux recorded on the tape would generate no voltage. It would, therefore, not be possible to reproduce constant current representing a cam dwell, that is, a portion of a shape having constant radii. A modulated-carrier system would overcome this difficulty but would still be objectionable for lack of accuracy.

Frequency modulation is objectionable because any changes in speed or flutter in the playback of the recording always results in amplitude distortion of the reproduced shape.

Ratio Modulation

In a ratio-modulated system, devised to overcome these weaknesses, the ratio of the positive pulse duration to the total period of a square-wave pair is caused to vary in accordance with the intelligence to be recorded. Such a ratio-modulated square wave is shown in Fig. 1. One period of the wave pair is $t_1 + t_2 = T = 1/f$. Since the square-wave amplitude is kept constant after reproduction from the magnetic tape, the intelligence (shown by the dashed line) is continuously proportional to the average value of the square wave, which equals the ratio t_1/T. Because the intelligence is given by a function of a time ratio, changes in tape speed or magnetization density have no effect on the fidelity of reproduction.

A simplified diagram of the recorder is shown in the accompanying box labeled "How the Shape Recorder Works" and a schematic of the recorder multivibrator is shown in Fig. 2. The multivibrator frequency is determined by the time constants of R_1C_1 and R_2C_2. It was chosen to be about 180 cycles. With R_1 and R_2 fixed, the conducting time of each tube is determined by capacitors C_1 and C_2. They comprise a pair of 430-$\mu\mu$f straight-line variable capacitors geared together in such a way that when the capacitance of C_1 increases that of C_2 decreases. The total capacitance, $C_1 + C_2$, remains constant and consequently the multivibrator frequency is kept constant as the capacitors are varied differentially. The capacitors are gear-driven by a rack that follows the periphery of the shape to be recorded. The function of R_3 and

R_4 is to eliminate high-frequency parasitics.

The recording method used in the apparatus is shown in Fig. 3. Since in this method the magnetic medium is always driven to saturation, the recording process simultaneously erases all previous intelligence on the tape.

A square pulse of current is allowed to flow through recording-head coil L_1 (Fig. 2) by conduction of multivibrator tube V_1. The magnetizing force is equal to magnitude *EF* in Fig. 3, and the tape flux density is carried up from point *O* to saturation at *A* on the magnetization curve *OA*. The square-peaked magnetizing pulse *EFGH* produces the flux pulse *LMNP* on the tape. Tube V_2 of the multivibrator then conducts at point *G* and almost instantaneously current ceases to flow through coil L_1 and flows through L_2. The current is caused to flow through L_2 in such a direction that the flux polarity in the recording-head gap is reversed from that generated by the current in L_1. This current reversal causes pulse *HIJK*. The induction decreases along *ACD* of the hysteresis curve and reaches a maximum when saturation again occurs at *B*. Current pulse *HIJK* produces the flux pulse *PQRS* and then the cycle repeats itself.

Advantages

An erasing head and oscillator are not necessary since the magnetizing force operating on the tape is made strong enough to align the magnetic domains of the tape in accord with the gap flux regardless of the previous tape history.

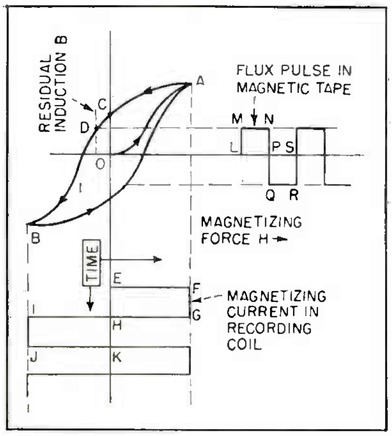


FIG. 3—Graphical analysis of the magnetizing effect of the ratio-modulated square wave

It is possible to derive a flux change from the tape at least twice as great as that obtainable from usual systems. This is possible since the magnetizing force is carried to tape saturation in a positive direction and then in a negative direction. As a result, the flux change is from *N* to *Q* in Fig. 3 whereas in a usual system, it would have a maximum change from *N* to *P*. A reproducing system with less gain can therefore be used.

Tape Drive

In the mechanism illustrated, approximately 24 feet of tape are driven over a series of idlers by means of a 4-inch-diameter driver. The tape is driven by a synchronous motor that maintains the tape speed constant at 1.25 feet per second. From a consideration of frequency response versus tape economy, this speed was found to

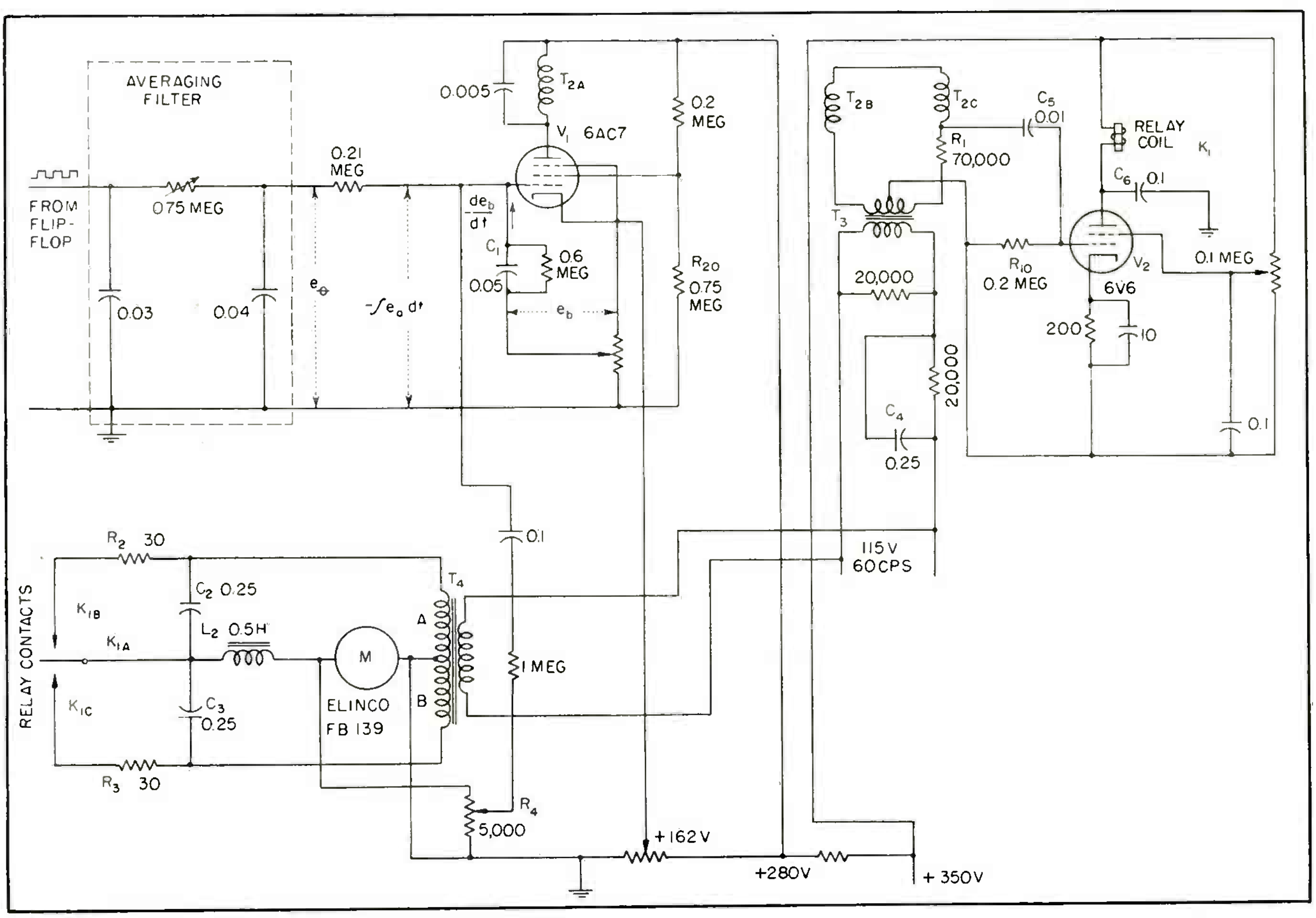
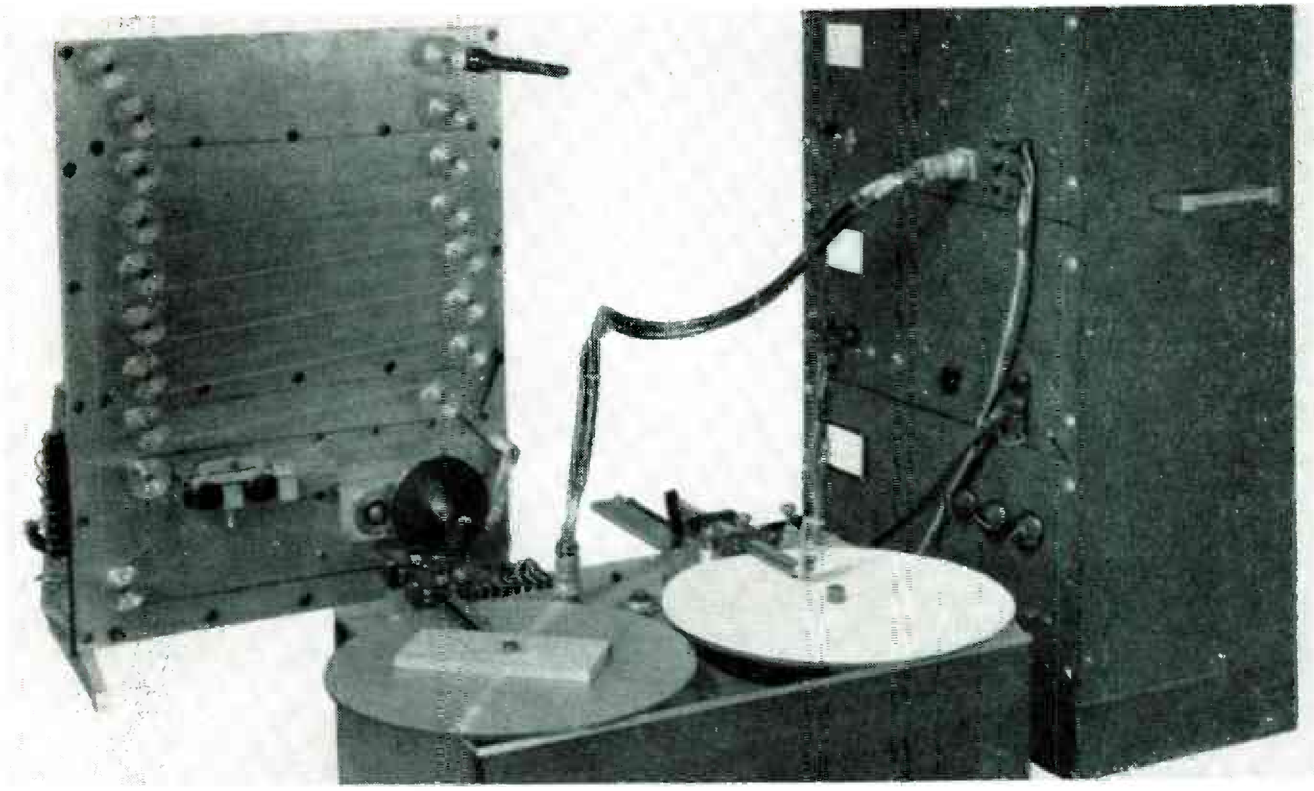


FIG. 4—Reproducing circuit that follows flip-flop wave shaper converts spiked signals to movement of servo stylus



Complete shape-recording and reproducing apparatus in which a stylus duplicates the shape of a rectangular block of wood

be optimum, and was therefore chosen.

In application of this system, the tape is driven in synchronism with its associated machine. The important factor is maintenance of synchronism between the tape and machine speed so that at any instant a particular portion of tape is always associated with a particular angular position of the machine cycle. One method for maintaining synchronism is the use of a perforated tape sprocket-driven by the machine.

Reproducer

The intelligence carried by the tape in the form of square pulses of flux causes spikes of voltage to be generated by the reproducing head. Alternating positive and negative spikes are produced because the reproducing head differentiates the square pulses of flux. The peaks are amplified and their amplitude is adjusted to trigger the flip-flop circuit.

The function of the flip-flop circuit is to construct a square wave, which is a replica of the original square peaked current wave flowing through the recording head, from the reproducing head peaks. The flip-flop output is then passed through an averaging filter and finally to a servo.

Servomechanism

Since the end result desired with this recorder is to reproduce the recorded shape by means of a stylus, a servomechanism is required, as shown in Fig. 4. The servo input voltage e_θ is impressed on the control grid of V_1. The plate current of V_1 flows through the primary T_{2A} of a saturable reactor T_2. The secondary coils T_{2B} and T_{2C} of the reactor and connected to a source of a-c voltage from T_3. The reactor secondary coils T_{2B} and T_{2C} in conjunction with resistor R_1 form a phase-shift circuit. Hence, a change in plate current of V_1 will cause the voltage applied to the grid of V_2 to change its phase relationship with the line voltage. In the plate circuit of V_2 is connected the coil of a Western Electric series 275-276 mercury relay. This relay has a spdt contact arrangement that vibrates in synchronism with the grid voltage of V_2. The phase relation of the relay armature with the line is determined by the plate current of V_1. In operation, contact K_{1A} of the relay remains connected to contact K_{1B} for 180 degrees of the a-c excitation and then rapidly transfer to contact K_{1C} for remaining 180 degrees of cycle.

The servomotor circuit consists of transformer T_4, choke L_2, motor-armature M, current-limiting resistors R_2 and R_3 and spark-suppressing capacitors C_2 and C_3. In operation, the relay becomes a full-wave rectifier and d-c flows through the motor armature. The direction and magnitude of current is determined by the phase relation between relay contact operation and voltage of the transformer T_4 secondary. When the relay and winding T_{4A} are in phase, contact K_{1A} of the relay transfers from one side of T_4 to the other at the zero-voltage points of the a-c voltage cycle. Full-wave rectification takes place, a maximum voltage appears across the motor armature and it rotates in a positive direction. A change in phase of 180 degrees in the relay operation causes the armature to rotate at a maximum velocity in a negative direction. When the servosystem is balanced, the phase relation between the relay and T_4 is 90 degrees, and the average current through the motor armature is zero. It has been found that stabilization of the servo can be obtained by adding to the input signal e_0 a derivative $-de_b/dt$ of the balancing voltage e_b and a degenerative integral $-\int e_a\, dt$ of the motor armature voltage e_a. The magnitude of $-de_b/dt$ is controlled by adjustment of capacitor C_1 for optimum performance and is then fixed. The magnitude of $-\ e_a dt$ is controlled by potentiometer R_4, which can be adjusted for optimum servo performance at different loading conditions.

Performance

A typical shape reproduction is shown in Fig. 5. The maximum deviation is 0.04 inch, which is a recording reproduction accuracy of 0.66 percent when expressed in terms of the maximum turntable radius. This initial precision was obtained without directing appreciable effort toward making the system a precision device.

This shape represents about the maximum pressure angle that could be followed with the straight-line follower mechanism employed. To follow the pressure angle that approaches 70 degrees on this shape, a very smoothly operating follower guided by ball bearings and exerting a minimum pressure against the pattern was required.

Tests conducted with the apparatus indicated that variations in playback velocity of ± 30 percent produced no perceptible change in the reproduced accuracy of the intelligence. The reproduction was also unaffected by reduction in tape flux which occurred during the first few playbacks.

Life tests conducted with Brush tape indicated that 1,000 playbacks could be obtained before erratic reproduction of the record began to occur. This erratic reproduction results from the wearing off of the 0.0005-in. coating of magnetite on the paper base. When it occurs, the quantity of magnetic material is reduced to such a point that the reproduced signal has insufficient strength to trigger the flip-flop circuit consistently.

Design Data

For many applications in which a short memory of only one or two cycles is required, paper tape can be used. If a record were called upon for more than a thousand reproductions, it would be necessary to use a metal tape.

The choice of multivibrator frequency is influenced by several factors. The frequency response of the system determined what the maximum square-wave frequency could be while still maintaining a good square-wave flux characteristic in the tape. A high-frequency square wave is desirable from the viewpoint of filtering the flip-flop output. The time constant for an averaging filter to smooth out lower-frequency waves would impose greater phase lags in the system's response.

On the other hand, a low-frequency square wave is also desirable. It will increase the precision of the system, particularly if the flip-flop circuit were to behave so that it triggered at different grid-voltage magnitudes during different cycles because of possible circuit instabilities.

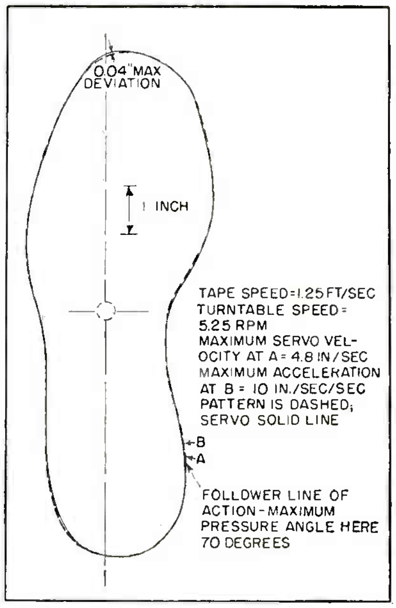


FIG. 5—Shoe-shape reproduction from magnetic-tape recording

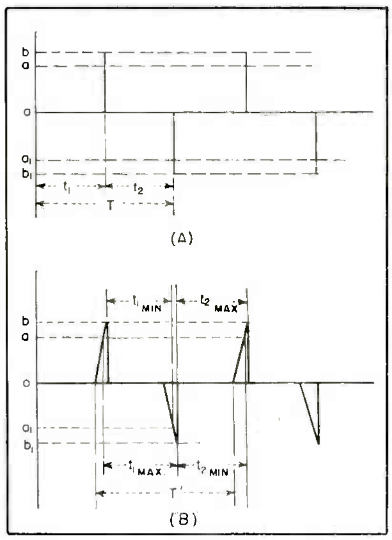


FIG. 6—Ideal peaks from reproducing head (A) and actual peaks (B) showing how noise can affect signal (slopes are exaggerated)

Optimum Frequency

With an ideal square-peaked flux wave, an immediate reversal of flux occurs in the tape and the voltage output of the recording head consists of spikes. Since the slope of the spikes would be infinite, variations in magnitude of the flip-flop grid voltage would cause no variations in the time at which the flip-flop triggers. This ideal is shown in Fig. 6A. Changes in grid voltage from a to b or a_1 to b_1 will not affect ratio t_1/T.

However, the reproduced peaks are as shown in Fig. 6B. This deterioration results from the frequency-response limitations of the reproducing head and the fringing and demagnetization effects that occur when the tape flux changes polarity. Let it be assumed that the flip-flop circuit does not always trigger at a uniform level of grid voltage but that it might trigger at grid voltages varying between the extremes ab or a_1b_1. Then maximum $\Delta t_1 = t_{1\,MAX} - t_{1\,MIN}$ and, due to the slope of peaks A and B (Fig. 3) the intelligence can have a maximum variation,

$$\Delta I_{MAX} = \frac{K\,(t_{1\,MAX} - t_{1\,MIN})}{T}.$$

It is, therefore, desirable that the peak wavefronts have a slope approaching infinity to minimize Δt_1. Since $\Delta I = K\ \Delta t_1/T$ and $f = 1/T$, then f should be kept low yet high enough to transmit readily the highest frequency of the intelligence.

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Quench Controller for Steel

Improved control of quench time in cooling heat-treated steel parts is obtained by taking advantage of the fact that hot steel is not ferromagnetic. The cooled part becomes magnetic and changes flux linkage between inductors so that an amplified signal actuates alarms

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At high temperatures (above 750 C), steel assumes a crystallographic structure known as austenite, which is not ferromagnetic. On cooling, the austenite tends to change to other structures which have undesirable mechanical properties. Formation of these undesirable structures takes time, however, and may be prevented by cooling the part very rapidly.

Quenching in cold water provides the most rapid as well as the most economical method of cooling. If the cooling is fast enough, the austenite will remain until the steel reaches a temperature known as M_s (martensite-start), which depends upon the composition and is usually between 100 and 400 C. On further cooling, the austenite progressively transforms to a structure known as martensite, which is desirable from the standpoint of mechanical properties and happens also to be ferromagnetic.

If rapid cooling is continued below the M_s temperature, through the range where martensite forms, the stresses set up by its formation are likely to crack the part, making it worthless. Thus, the part should be removed from the quench tank when it reaches the M_s temperature.

Actually, the steel at the surface of the part cools more rapidly than the steel in the interior, and may include a considerable percentage of martensite while the interior is still completely austenitic. Usually the metallurgist would like to stop the quench at such a point that the piece, on removal to the air, will equalize out at about the M_s temperature.

Up to the present, the best available instrument for controlling the quench has been a clock but this method has three drawbacks:

The M_s temperature desired varies significantly from lot to lot of steel. To determine it experimentally requires additional equipment, expense and delay.

Even when the M_s temperature is known, the time of quench necessary to reach it depends upon the size and shape of the steel part. To fix this time either additional experimental work or hit-and-miss trying is necessary.

The quenching time to reach a fixed temperature does not stay constant but changes significantly because of fluctuations in such factors as the temperature of the part when quenching starts, the amount and character of oxide scale on the surface of the steel prior to quenching and the temperature, agitation and impurity content of

Instrument at left rings bell and lights lamp when heat-treated steel part has been quenched sufficiently in cold water the quenching water that is used.

It was thought that these difficulties could be overcome by obtaining a signal from the part itself at the time that martensite formation began. To do this, advantage could be taken of the magnetic nature of martensite. As mentioned, it is generally desirable to interrupt the quench when the part would equalize near or at the M_s temperature, the surface portions being below M_s at the instant the quench is stopped and the innermost portions being above M_s. Accordingly, the signal is desired not at the instant that the first trace of magnetic material appears at the surface of the part, but rather after martensite formation has occurred to a depth predetermined by the metallurgist.

Design

The following requirements were considered in the design of the controller:

It must accommodate a wide range of sizes and shapes and indicate the amount of martensite formation to a good degree of accuracy. The measurement must be independent of the position of the part within the quench tank and not be affected by temperature or agitation of the quenching medium. The controller must be sufficiently free of drift to require only occasional recalibration, it must indicate the control point with a visual and audible alarm, and it must not interfere with normal practice.

The heart of the controller is a system of coils, essentially a loosely-coupled air-core transformer which is placed in the quench tank. Introduction of ferromagnetic material in the transformer field changes the flux linkages between the driver, or primary coil, and the pickup or secondary coils, resulting in a net useful signal. The choice of coil configuration is determined largely by the available space and the sensitivity and stability requirements. In any case, the controller as a whole should be designed to balance out any nonvarying signal from the inherent coupling between the coils as an air-core transformer, from the surrounding magnetic coupling paths and from the eddy currents of nearby conducting masses and of the sample itself.

Magnetic flux in the coil system is directly proportional to the exciting current and hence in phase with it, while induced voltages are proportional to the rate of change of flux and therefore lag 90 degrees behind a sinusoidal exciting current. Since eddy currents themselves are already the product of electromagnetic induction, the induced voltage caused in the pickup coil by eddy currents in adjacent metallic objects lags an additional 90 degrees behind the directly induced voltage between the driver and pickup coils. It is therefore possible to balance out the eddy-current pickup separately from the directly-induced voltage. This balancing can be done either in the coil system, or by injecting properly phased voltages into the controller amplifier.

Coil Circuit

The design of the coil system is shown in Fig. 1. The centrally located driver coil excites two identical pickup coils equidistant from the driver. The pickup coils are connected in series opposition so that the voltages induced in them cancel as long as the magnetic coupling in the two halves of the system are equal. This system was chosen because, for the high balance ratios required, greater stability is obtained from a geometrically balanced system.

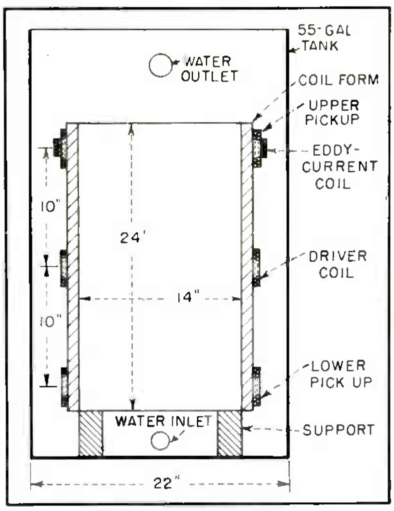

FIG. 1—System of coils installed in quench tank

When a ferromagnetic piece is introduced in the upper region, the coupling between the driver and upper pickup is increased, raising the induced voltage in the upper coil and resulting in a net signal at the output terminals. For a piece of given overall dimensions, the unbalance signal is a direct function of the thickness of the magnetic cross section.

Only one-half of the coil system can be used as a work space, since a sample in the other half would cause a signal of opposite phase; a sample straddling the driver coil yields no net signal at all.

Exact balance between the two pickup coils could be obtained in three ways: mechanically, by slight adjustments in the position of one of the coils; magnetically, by introducing a small piece of steel in the half with the lower coupling; and electrically, by winding one of the coils with a few more turns than the other, bringing out a tap from a previous turn so that the tapped section straddles the balance point and connecting a potentiometer across this section of the coil. The electrical method of balance was chosen to permit location of all adjustments and controls on the front panel of the controller.

With reasonable care in the original construction of the coil system, the tapped section needs to cover only a few percent of the total turns of its coil. In the in-

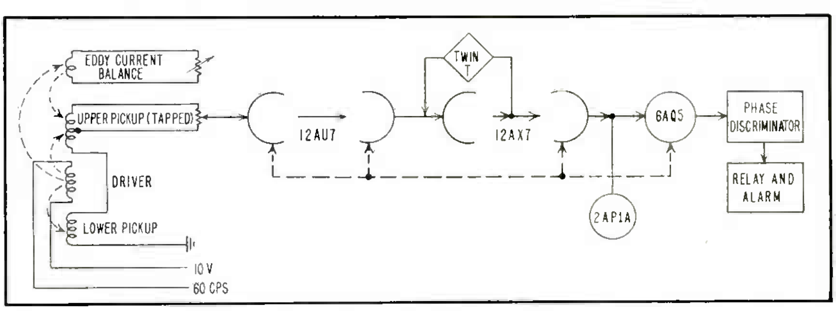

FIG. 2—Block diagram of the complete system

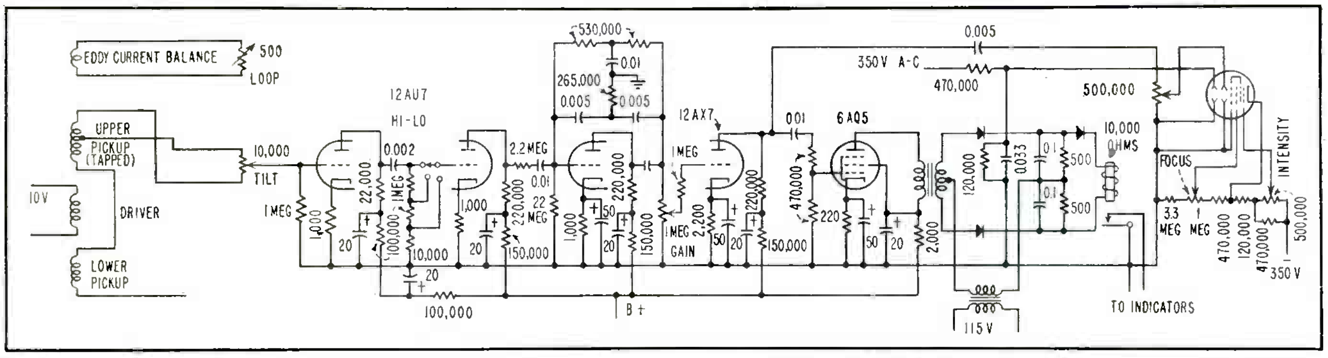

FIG. 3—Circuit of coil arrangement and electronic portion of the quench controller. The lower pickup coil returns to B—

strument, however, this same adjustment is used to establish the control point (see below). Therefore the tapped section of the upper coil covers about 20 percent of the turns. A ten-turn wire-wound potentiometer is connected across this section to permit adequate sensitivity of adjustment.

The above balance is good only for those signals which are derived from direct coupling between the driver and pickup coils; eddy-current balance must be obtained separately. These signals lag 90 degrees behind the direct-coupled signals. To balance them out, a few turns are wound on top of the upper pickup coil and connected to a rheostat in the controller. This eddy-current balance coil induces an adjustable signal of proper phase in the upper pickup coil.

The coil size and separation shown in Fig. 1 may seem unduly large when it is noted that the parts to be quenched do not exceed two inches in diameter by eight inches long. The size allows the part to be moved about in the tank during quenching in accordance with good heat-treating practice.

A block diagram of the controller is shown in Fig. 2. Sixty-cycle power was chosen for coil excitation. Four stages of voltage amplification and one output power stage are used.

The amplifier circuit is shown in Fig. 3. The heater of the first twin triode is operated from d-c to avoid the appearance of spurious sixty-cycle signals at the input.

A three-position attenuator switch after the first stage, with ratios of 100:10:1, allows for coarse adjustment of the quench controller to the size of sample to be quenched. A continuously variable gain control after the third stage gives fine adjustment between attenuator steps. The third stage is tuned to the fundamental frequency of the system by means of a twin-T feedback network.

The available amplification in this system may seem unduly large, but is necessary because of the combination of rather small samples (2 x $\frac{3}{8}$-inch diameter with a 10 to 20-percent magnetic cross section) with a rather large coil system ($17\frac{1}{2}$-inch I.D.). It was considered better to provide the extra gain than to use separate coil systems for samples of widely differing size.

From the final stage, the signal goes into a phase discriminator whose output operates a sensitive d-c relay. This relay responds only to in-phase signals caused by increased magnetic coupling in the upper half of the coil system.

The relay contact closes a six-volt circuit on a red signal light and an alarm bell. A jack for the connection of remote alarm equipment is also provided.

Monitor

A built-in two-inch cathode-ray oscilloscope serves as a balance indicator and signal monitor. The signal from the fourth amplifier stage is applied to the vertical deflection plates. The horizontal plates are driven by a sixty-cycle voltage of fixed amplitude and phase, adjusted so that it is in phase with a signal from the coils caused by magnetic unbalance alone.

The pattern on the crt is a horizontal line when direct as well as eddy-current pickup is in balance in the coil system. A pickup unbalance due to magnetic differences in the halves of the coil system causes the pattern to tilt. This can be corrected by adjusting the potentiometer across the tapped coil section (TILT control). An eddy-current unbalance causes the pattern to open up into a loop. This is corrected by adjustment of the current in the eddy-current balance coil (LOOP control).

Operation

In operation, after initial balance has been established, the gain control must be set. The most practical procedure for determining the gain setting appears to be as follows: prior to heat treating place the steel part, which is then ferromagnetic, in the work area. Adjust the gain until the alarm just operates, and read the gain setting. Increase the gain by a predetermined factor, which depends upon the amount of martensite desired in the part when the quench is to be stopped.

When, during heat treatment, the hot part is placed in the quench tank, an increased out-of-phase component immediately appears in the pickup coil because of eddy-currents in the part. An in-phase component does not appear until the surface of the part cools to the M_s temperature. As cooling continues and the amount of magnetic martensite in the part grows, the in-phase component increases until, at the preset amount, it trips the alarm.

The quench controller was developed for use in the metallurgical laboratory. Its reproducibility of operation has been established and it has proved amply sensitive and stable to indicate, for example, whether there is 10 or 20-percent martensite in steel parts of widely varying size.

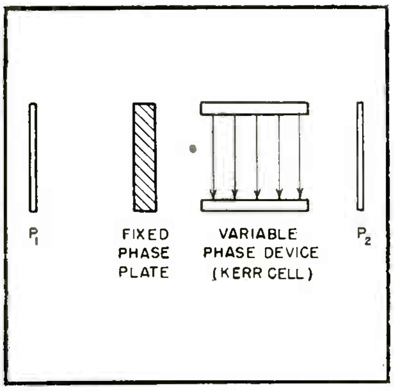

FIG. 1—Quadratic electro-optic effect employs perpendicular field

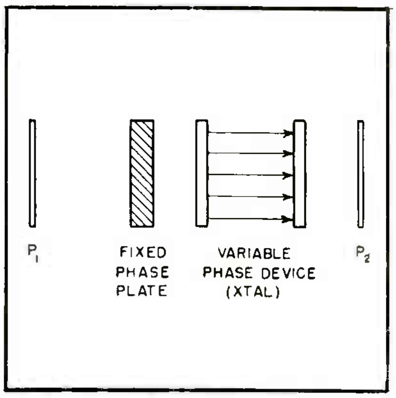

FIG. 2—Linear electro-optic effect is exhibited by many crystals

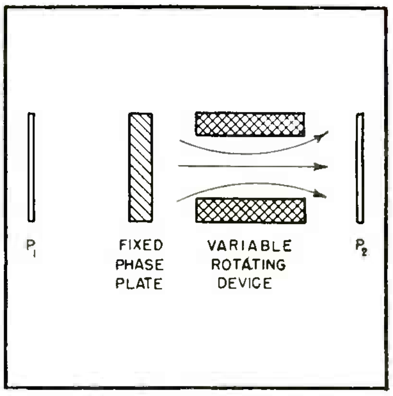

FIG. 3—Linear magneto-optic effect creates rotary polarization

Electrical Color Filters

Varying electric and magnetic fields are used to control color of transmitted light. Principle of double refraction is applied. Tests of system indicate possible color television applications

ELECTRICALLY AND MAGNETICALLY controlled color filters show promise for application in production of colored motion pictures on black and white film, in color facsimile transmission systems and, possibly, in color television.

Electrical color filters depend upon the fact that certain materials exhibit the property of birefringence, or double refraction, when electrically or magnetically stressed[1]. When polarized light is transmitted through such a birefringent material, a color-controlling phase shift may be introduced. Tuning, or changing colors, may be accomplished mechanically[2] by rotating the axis of a variable phase shifter, electrically or magnetically.

Early electrical color filters using crystals of zinc sulfide were unsuccessful since the crystals were small, colored and cloudy[3,4]. Crystals of ammonium dihydrogen phosphate or ammonium dihydrogen arsenate, $NH_4H_2PO_4$ or $NH_4H_2AsO_4$, have been grown and processed for optical purposes[5,6] furnishing more useful materials. Recently a patent has been granted[7] relating to color filters of this nature.

The phenomena which can be utilized in conjunction with polarized light in the electric or magnetic control of color are: the linear electro-optic, or Pockels effect; the quadratic electro-optic, or Kerr effect; the linear magneto-optic, or Faraday effect; the quadratic magneto-optic, or Cotton-Mouton effect; and the effect of a magnetized mirror on the plane of polarization of an incident beam of light. This latter effect is called the magneto-optic Kerr effect.

The authors have verified experimentally the feasibility of using each of these phenomena, with the exception of the magneto-optic Kerr effect, for the electric or magnetic control of color.

Quadratic Electric Effect

Of the electro-optic effects the most completely investigated is the quadratic or Kerr effect shown in Fig. 1. This effect is exhibited by many substances, notably nitrobenzene, which become birefringent when electrostatically stressed, their birefringence being a function of the electric field intensity. If a linearly-polarized light ray passes through such an electrically-stressed substance, it is split into two component rays, known as the ordinary and extraordinary rays. These rays are polarized at right angles to each other, and a phase difference introduced between them. The magnitude of the phase difference can be adjusted by control-

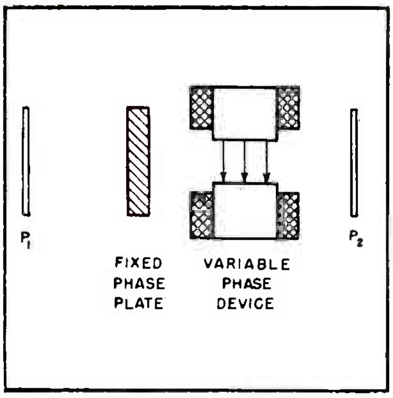

FIG. 4—Quadratic magneto-optic effect also uses perpendicular field

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ling the electric field.

On emergence, the light which was plane polarized when entering the substance will, in general, have become elliptically polarized. For certain values of electric field intensity the emergent light will be circularly polarized, and for certain values plane polarized. In the quadratic electro-optic effect, the electric field is perpendicularly applied to the light path. The angular phase difference introduced between a component of light polarized in the plane of the electric field and a component polarized normal to the plane of the electric field is

$$\delta = 2\,\pi\, JaE^2$$

where δ = angular phase difference; J = the Kerr constant, which in general is a function of the wavelength of light; a = length of light path in substance and E = electric field intensity.

The Kerr constant J is tabulated for many substances in such references as the "International Critical Tables".

Linear Electric Effect

The linear electro-optic effect shown in Fig. 2 is exhibited by many crystals. As in the quadratic electro-optic effect, an angular phase delay is introduced between the two mutually perpendicularly-polarized components of linearly-polarized light as the light passes through the electrically-stressed substance. In the linear electro-optic effect, the electric field is applied parallel to the light path, and the axes of resolution for the two components of light are determined by the crystal structure. The angular phase difference introduced between two perpendicularly polarized components is

$$\delta = 2\pi\, PaE = 2\pi\, PV$$

where: δ = angular phase difference; P = linear electro-optic constant which, in general, is a function of the wavelength of light; a = length of light path in substance and V = voltage applied to substance.

Values of the linear electro-optic constant are not readily available, but have been investigated[8,9].

If the incident light is linearly polarized, the emergent light will, in general, be elliptically polarized, except for phase differences which are odd multiples of 90 degrees or integral multiples of 180 degrees, when it will be circularly and linearly polarized, respectively.

Linear Magnetic Effect

The linear magneto-optic effect shown in Fig. 3 is exhibited by many substances in all states, and is evidenced predominantly by a rotation of the plane of polarization through the angle β, and by birefringence when light passes through a substance parallel to a magnetic field. This birefringence and rotation of the plane of polarization, or rotary polarization as it is sometimes called, may be explained by assuming the plane polarized light is, when entering the magnetically stressed substance, split into two oppositely circularly-polarized components which travel with unequal velocities in the substance. Since the substance becomes an optically active medium under the influence of the magnetic field the absorption coefficients of the substance for the ordinary and the extraordinary ray are different. This different absorption of the plus and minus circularly-polarized components is called circular dichroism.

Owing to the angular phase shift introduced between the two oppositely circularly-polarized components, and to circular dichroism, the light emerging from the magnetically-stressed substance is elliptically polarized, and its plane of polarization has been rotated through the angle β.

The angular rotation of the plane of polarization of linearly-polarized light passing through a substance displaying the linear electro-optic effect is

$$\beta = RaH \cos \gamma$$

where:

β = angular rotation of the plane of polarization of light; R = magneto-optic, or Verdet's constant, which is a function of the wavelength of light; H = magnetic field intensity; a = length of light path in substance and γ = angle between optical path in substance and magnetic lines of force. Values of the magneto-optic constant R are readily available in many references.

Quadratic Magnetic Effect

The quadratic magneto-optic effect shown in Fig. 4 has received the least attention of any of the usable optical effects enumerated. As in the quadratic electro-optic effect, the field is perpendicular to the optical path. Experimentally this effect appears to be very promising because of the ease with which the required field may be produced for some substances.

As we know, birefringence and rotary polarization are exhibited by many substances in the absence of externally applied electric or magnetic fields. These materials, along with the phenomena already enumerated, permit the development of devices which can introduce either fixed or variable amounts of phase difference, or rotate the plane of polarization of light by fixed or variable amounts according to the magnitude of the electric or magnetic field, the mechanical tension, the thickness of the substance or the concentration of a solution.

Theory of Color Filters

A simple optical system called a polariscope is shown in Fig. 5. The polarizer and analyzer may be Nicol prisms, or sheets of Polaroid. The polarizer and analyzer transmit light vibrating in a given sense only. Light vibrating in other senses is either totally reflected as in the Nicol prism, or absorbed as in Polaroid. If light incident upon the polarizer is completely unpolarized, the maximum transmission through the polarizer approaches 50 percent, although surface reflections and internal absorptions reduce this figure to some extent.

Standard derivations yield equations for the intensity of light emerging from the polariscope.

$$I'' = \frac{I_o}{2} \cos^2 \delta/2$$

$$I' = \frac{I_o}{2} \sin^2 \delta/2$$

where I'' = the intensity of the emergent light when polarizer and analyzer are parallel; I' = the intensity of the emergent light when polarizer and analyzer are perpendicular (crossed); I_o = intensity of unpolarized, incident light and δ = the angular phase difference introduced by the phase device. It should be noted that for both these equations the principal axis of vibration of the phase device is at 45 deg to the plane of polarization of the polarizer.

The angular phase difference δ can be either fixed or variable. If a fixed phase difference is introduced, δ_f is

$$\delta_f = \frac{2\pi\, ca}{\lambda}$$

where δ_f = fixed phase difference introduced; c = proportionality factor which, in general, is a function of wavelength; a = length of light path in device and λ = wavelength of light.

If a variable-phase device is used, the phase difference introduced is

$$\delta_v = \frac{2\,\pi\, bf\,(Z)}{\lambda}$$

where δ_v = variable phase difference introduced; b = constant of proportionality which, in general, is a function of the wavelength of light, and the length of the optical path and $f\,(Z)$ = some function of the field intensity.

Substituting the expression for δ_f in the equation for I'':

$$I'' = \frac{I_o}{2} \cos^2 \frac{\pi\, ca}{\lambda}$$

Thus I'' is a maximum at those wavelengths where ca is equal to some integral multiple of π. Assuming, for instance, that ca is chosen to be equal to $4\lambda_o$, where λ_o is the wavelength of the color which it is desired to transmit, the expression for I'' becomes

$$I'' = \frac{I_o}{2} \cos^2 \frac{4\,\pi\,\lambda_o}{\lambda}$$

A transmission maximum will occur at λ_o, and adjacent transmission minima will occur at $8/7\lambda_o$ and $8/9\lambda_o$, (neglecting dispersion). A four-wavelength phase device was chosen as an example because, if the wavelength of maximum transmission is chosen as 535 mμ, then the three wavelengths of interest will be identical to the wavelengths of light referred to as Primaries A, as recommended by the Subcommittee on Color, Panel Six of the Radio Technical Planning Board.

As a simple example for the magnetic control of color, assume the fixed-phase device to be a four-wavelength plate for the green primary. With polarizer and analyzer parallel, the transmitted light will be green. By inserting a variable, magnetically-controlled phase device between analyzer and polarizer, in addition to the fixed-phase device, and adjusting it so the angle of rotation of the polarization plane of the transmitted light is 90 deg, the light emerging from the whole system will be the complement of the green primary. The rotation through 90 deg achieved by the magnetic device has the effect of changing the transmission characteristic from a $\cos^2$ to a $\sin^2$ curve. The 90 deg rotation in space could also be obtained by a variable

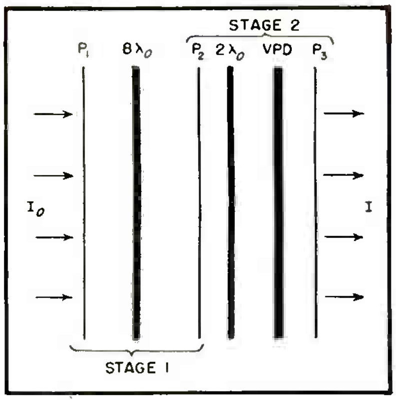

FIG. 6—Two-stage electrically-controlled color filter transmits green, red or blue light

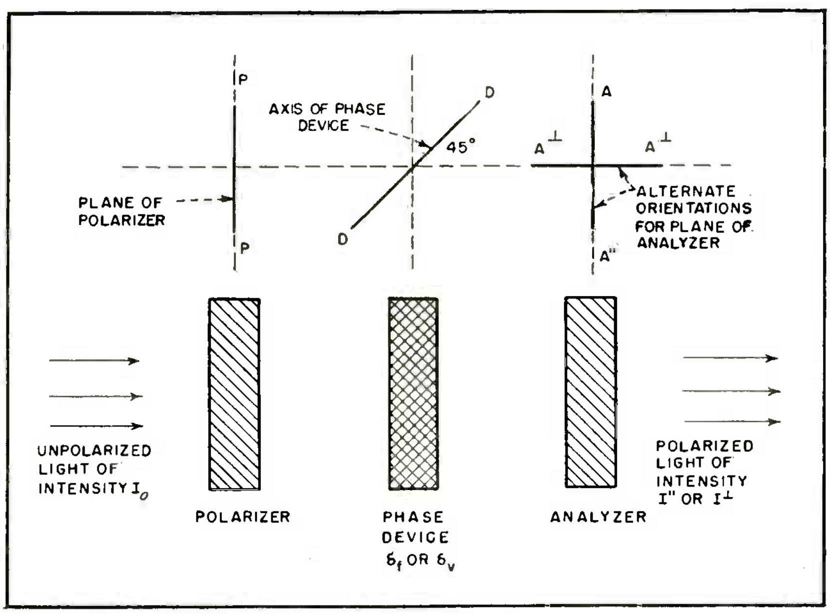

FIG. 5—Simple polariscope may be used with either fixed or variable phase device

electric-phase device adjusted to one-half wavelength.

As a second example, consider the possibility of passing white light through more than one polariscope. The intensity of the emergent light will be the product of the transmission characteristics for each individual polariscope.

A two-stage electrically-controlled filter, which has been built and operated, is indicated in Fig. 6. The first stage consists of a fixed-phase device in which *ca* is made equal to $8\lambda_o$. The value of λ_o is chosen to be 535 mμ, the green primary. The eight-wavelength plate is inserted between polarizer P_1 and analyzer P_2. The transmission characteristic for the first stage is shown in Fig. 7A. With the eight-wavelength phase device, the maxima adjacent to λ_o occur at $8/9\lambda_o$ and $8/7\lambda_o$. Thus three maxima in the visible portion of the spectrum define the three primaries of interest. The second stage consists of a fixed-phase device, in which *ca* is made equal to $2\lambda_o$, and a variable-phase device *VPD*, both inserted between polarizer P_2 and analyzer P_3. The variable-phase device used in the actual filter is a 2 in. × 2 in. crystal of ammonium dihydrogen phosphate. With no voltage applied, the transmission characteristic of the second stage is due to the two-wavelength plate only. The maximum of this second stage occurs at the green primary and green is transmitted. The transmission characteristic for the filter set to transmit green is illustrated in Fig. 7 B.

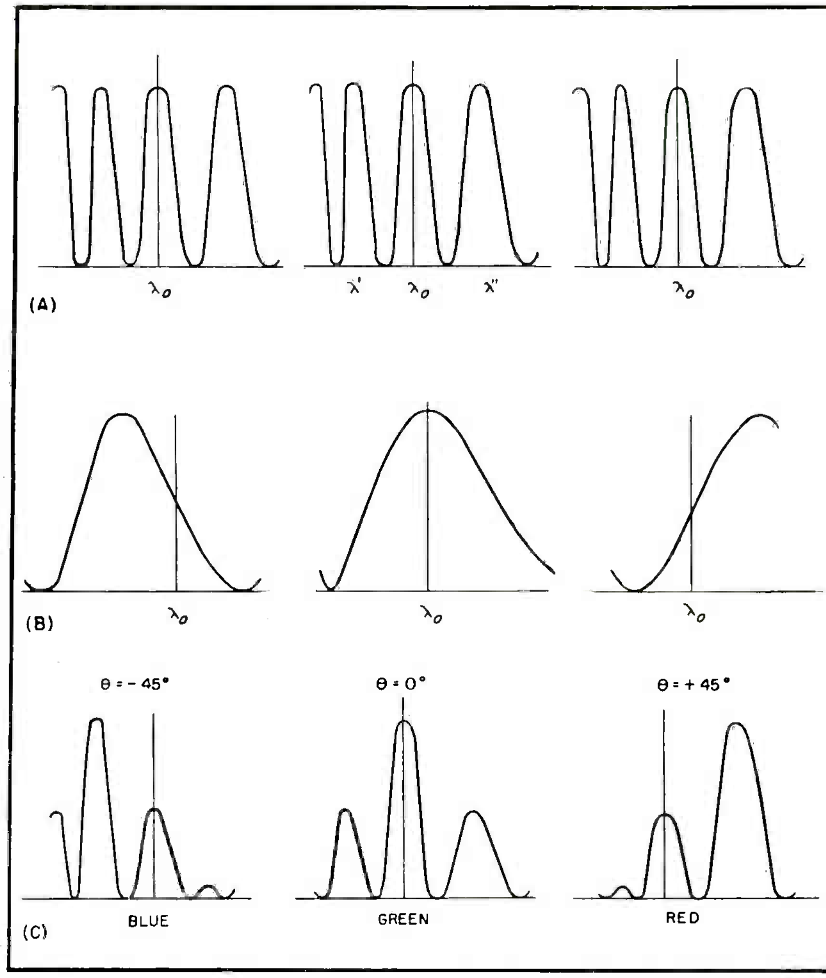

FIG. 7—Transmission characteristic of first stage (A) shows green primary and adjacent red and green maxima. With no voltage applied (B) only green passes second stage. Sequence of —4,500v, 0 v and +4,500v (C) yields blue, green and red

Electric Control

If voltage is applied to the variable-phase device in one direction, the phase difference introduced will add to that due to the fixed-phase device, shifting the peak of the transmission curve to coincide with the red primary λ''. The required phase shift is obtained by applying approximately 4,500 volts to the crystal. If the voltage is now applied in the opposite direction, the phase difference subtracts from that introduced by the fixed phase device and the peak is shifted to coincide with the blue primary λ'. These transmission characteristics are illustrated in Fig. 7 C.

For a color sequence of red, green and blue the voltages to be successively applied to the crystal are: plus 4,500 volts, zero volts, minus 4,500 volts. Since these voltages are of equal magnitudes and are applied for equal times, the average voltage is zero. Direct voltage can be applied to the crystal for no longer than one second without damaging the unit. This method of color control results in a feasible, electrically controlled color filter.

The system yields colors approximately 50 percent pure when an equienergy source is used. Other systems using two crystals, and based on the principles of the examples described above, yield colors which approach purities of 90 to 95 percent. The required waveforms in this system permit the use of standard electronic switching techniques.

Crystals in the system described may be replaced by any of the electrically or magnetically-controlled variable-phase devices enumerated earlier.

The total thickness of the two-stage filter may be reduced to somewhat less than one inch. Although the field angle through the crystal is limited to 6 to 8 degrees, the optical system can be designed so as to circumvent this limitation.

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Gain-Bandwidth Nomograph

Equations involved in design of single-tuned amplifier circuits are incorporated in one large nomograph to speed up design calculations. Shows overall effect of varying the parameters when seeking the most economical tube arrangement for desired gain and bandwidth

By CHESTER W. YOUNG

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Electronics and Guidance Section
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San Diego, Calif.

THE design of vacuum-tube amplifiers involves determining the maximum gain and/or bandwidth using the most economical tube arrangement. The most practical first-approximation calculation for single-tuned circuits such as cascaded synchronously tuned i-f stages was found to be $G_m/2\pi C_t$, and the nomograph on the following page was therefore based on this ratio. The nomograph encompasses all of the interdependent equations used in amplifier design, hence shows the effect of variations in each parameter on the others.

Practical values of G_m and C_t that include the effect of the coupling networks can be found by taking approximately 85 percent of the maximum G_m and 160 percent of the value of C_t given in tube manufacturer's data. This makes the usable gain-bandwidth about 53 percent of the ideal, or roughly one-half. This relationship is found in Table I.

The nomograph solves the following equations:

$$Q = f_o/B \quad (1)$$
$$A = G_m \times R_L \quad (2)$$
$$AB = A \times B \quad (3)$$
$$AB = G_m/2\pi C_t \quad (4)$$
$$B = 1/2\pi C_t R_L \quad (5)$$
$$A_{max} = 1/2\pi f_o C_{GP} R_L \quad (6)$$

where $Q = R \omega C$ = circuit quality, f_o = circuit resonant frequency, B = 3-db bandwidth, A = stage gain, G_m = tube transconductance, R_L = total damping resistance, C_t = total shunt capacitance, A_{max} = maximum usable gain, and C_{GP} = total effective grid-plate capacitance.

Since the bandwidth between two 3-db frequencies of a tuned circuit is equal to the 3-db frequency of a parallel or series R-C circuit, the nomograph can be used also for video types of circuits. Also, as Eq. 5 states that bandwidth is independent of L, the nomograph ignores L. Use of this nomograph is best illustrated by an example.

If the known values are f_o = 30 mc, B = 1 mc, C_t = 16 $\mu\mu$f, G_m = 5,000, and C_{GP} = 0.0082 $\mu\mu$f, find the values of Q, AB, A, R_L and A_{max}.

Step 1: Align points f_o = 30 mc and B = 1 mc, and read Q = 30.

Step 2: Align points C_t = 16 $\mu\mu$f and G_m = 5,000, and read AB = 50 mc.

Step 3. Align AB = 50 mc and B = 1 mc, and read A = 50.

Step 4: Align A = 50 and G_m = 5,000, and read R_L = 10,000.

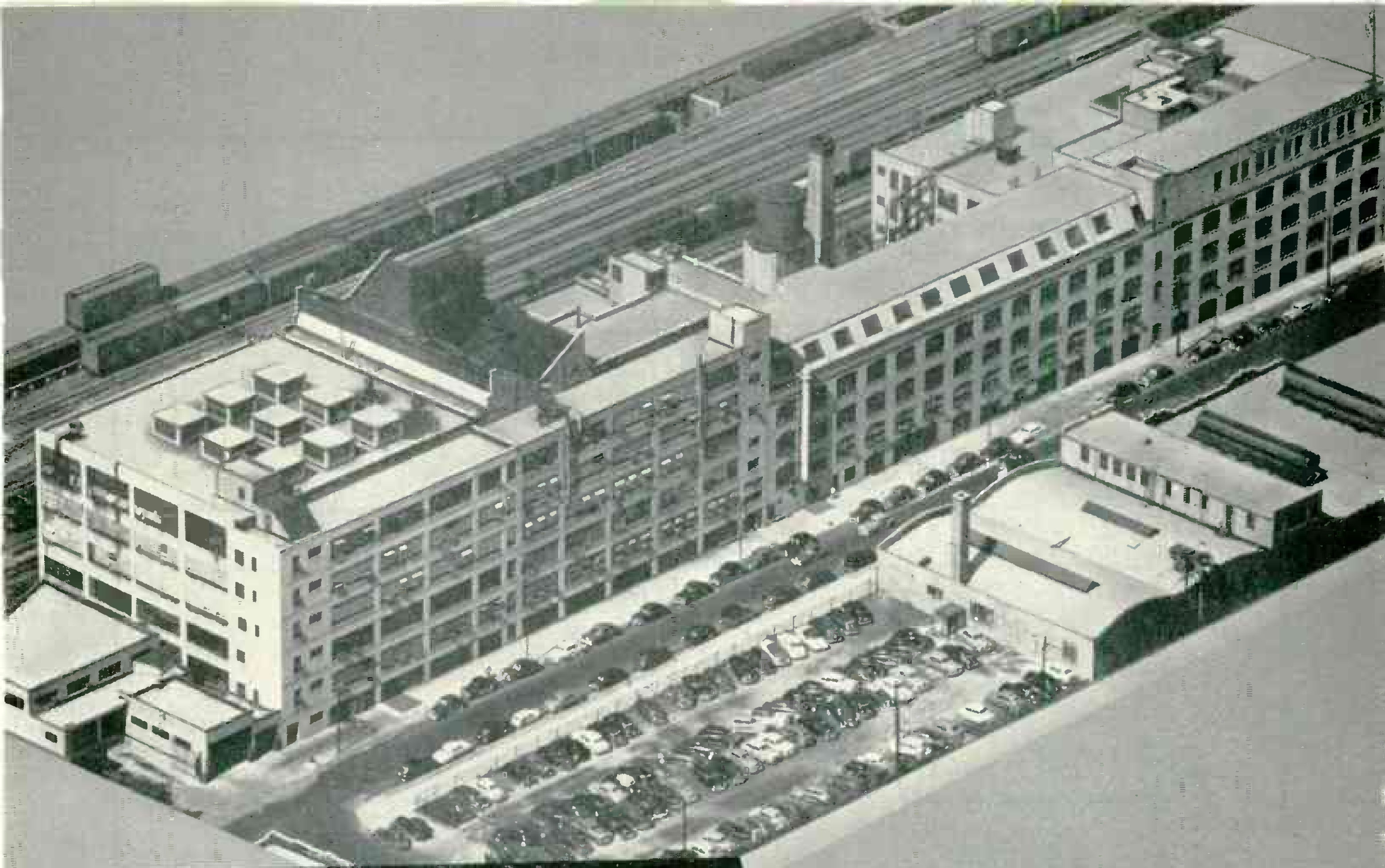
Step 4 (alternate): Since the loading resistance is directly related to bandwidth and shunt capacitance by means of Eq. 5, it may be found by aligning B = 1 mc and C_t = 16 $\mu\mu$f, giving R_L = 10,000 ohms as before.

Step 5: To ascertain whether A = 50 in Step 3 is a stable value of gain, a criterion of feedback through the tube grid-plate capacitance causing oscillation is determined. If the attenuation from plate to grid is set equal to the amplification from grid to plate as the critical value, then the desired gain must be less than the maximum usable gain. The value A_{max} is approximated by dividing R_L by the reactance of C_{GP} and thinking of this attenuation as a negative gain. This holds true when the input and output impedance are the

(Continued on page 118)

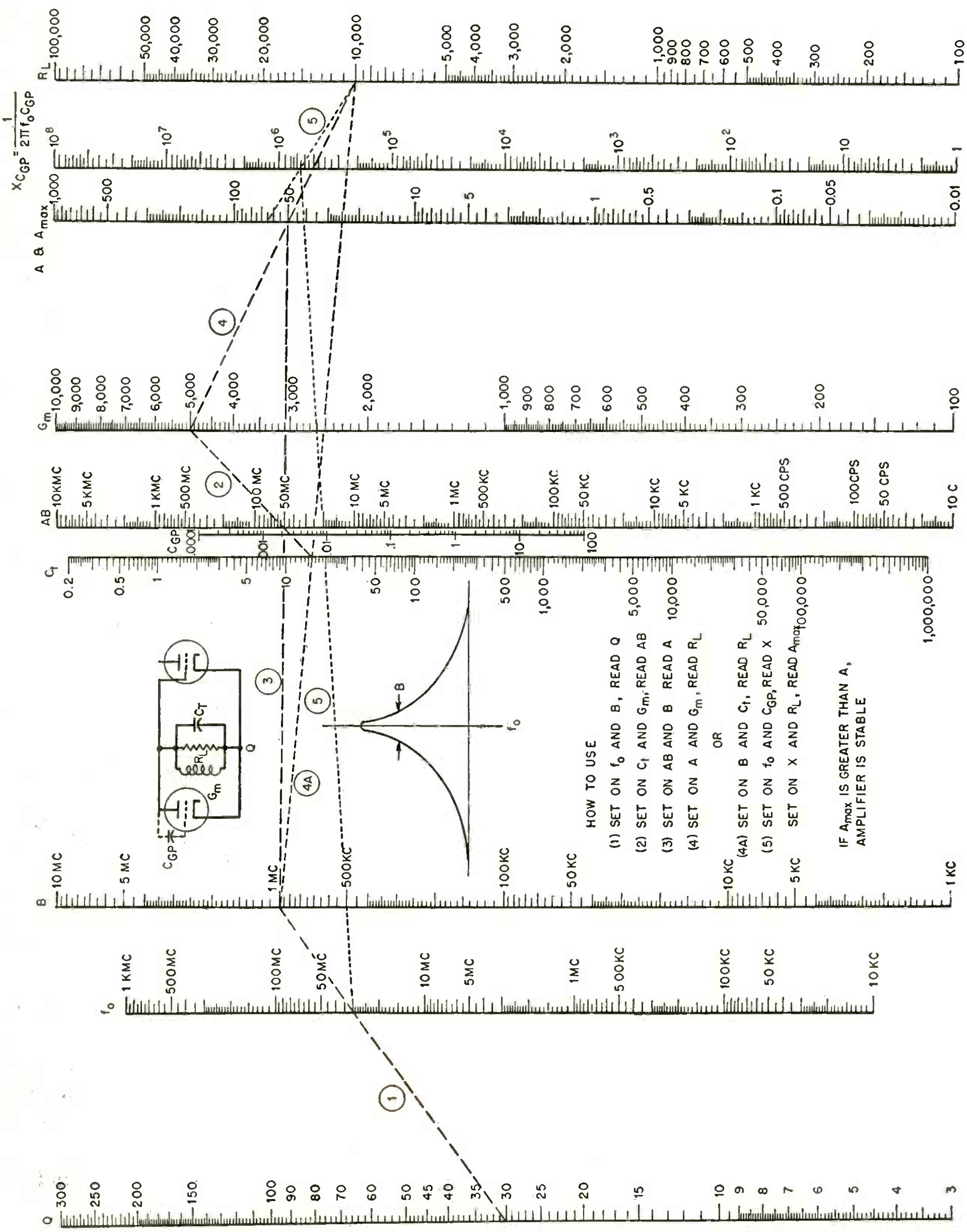
Table I—Examples of Ideal and Practical Tube Capacitances

Tube Type	C_g $\mu\mu f$	C_p $\mu\mu f$	C_t $\mu\mu f$	G_m/C_t mc
IDEAL				
6AC7	11.0	5.0	16.0	562
6AK5	4.0	2.8	6.8	750
PRACTICAL				
Tube Type	C_{in} $\mu\mu f$	C_{out} $\mu\mu f$	C_t $\mu\mu f$	G_m/C_t mc
6AC7	17.0	8.0	25.0	312
6AK5	6.7	4.4	11.1	378



Gain-Bandwidth Nomograph (Continued)

same, as in a multistage synchronous tuned i-f amplifier. The reactance of C_{GP} is determined by aligning f_o = 30 mc and C_{GP} = 0.0082 $\mu\mu$f and reading X = 6.5 × 10^5 ohms. Now align this value of X and R_L = 10,000 and read the maximum usable gain as 65 on the A_{max} scale. This value is greater than the desired gain of 50, so the amplifier is deemed to be stable.



Nomograph for designing single-tuned amplifier circuits like that shown. Numbered dashed lines indicate order of steps in designing an amplifier for desired stage gain and bandwidth and checking its stability

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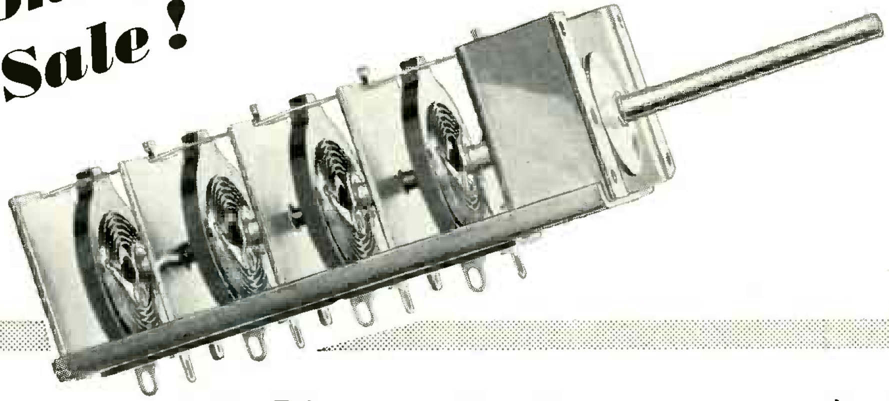

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TUBES AT WORK

Including INDUSTRIAL CONTROL

Edited by VIN ZELUFF

Standard Biscuits from Electronic Control 120
Filament Voltage Regulator 120
Television as Research Tool 122
Three-In-One Broadcast 174
Tower Carrier Alarm 182
Audio-Input Limiter for Mobile F-M 184
Disguised Antenna Design 188

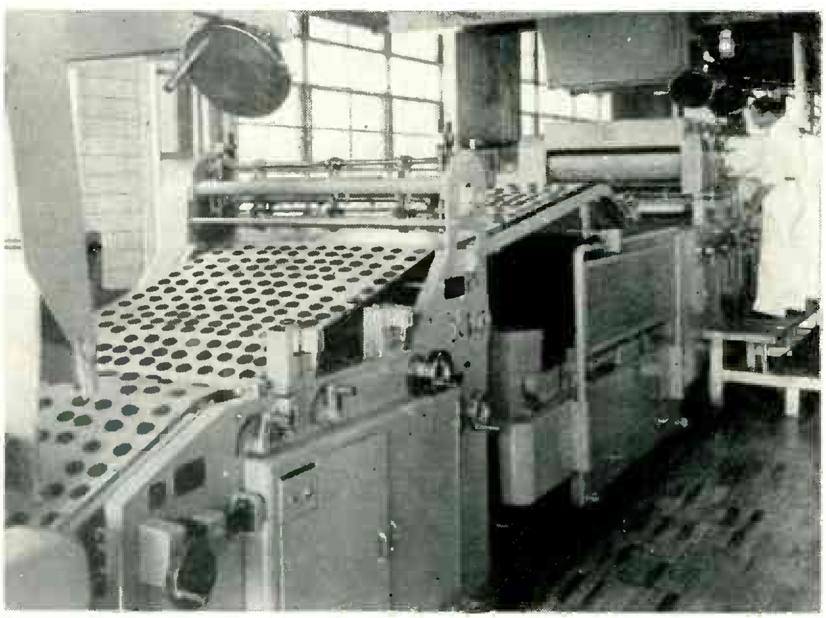
Standard Biscuits

VARIATION in biscuit-type baked products caused by human error has been practically eliminated through the electronic coordination of driven equipment at the Farm Crest Bakeries' new cookie plant at Columbus, Ohio.

When a bakery changes from one type of baking product to another, it is usually necessary to change the relative speeds of some of the drives. The speed of the dough-forming and extruding drives must be coordinated with the speed of the 200-foot continuous steel band oven, cooling conveyor, stacker and packing table. The speed of the over-all machine must also be adjusted to provide uniformity.

The change-over is accomplished with a minimum of effort through the use of G-E Coordinated Thy-mo-trol drive. The operator can vary the baking time from 3½ to 14 minutes by operating a push-button station. This controls a motor-operated rheostat in the master panel, which in turn controls over-all bake time and the speed of the various drives in the same proportion. The oven speed range is 4 to 1 and to cover the range of adjustments needed, some of the drives have a 20 to 1 range.

Fig bar production is a good example to demonstrate the coordinating ability of this control. The filled dough jacket is extruded at the entry end of the oven in a number of long, parallel forms and moves continuously through the long oven. After the strips leave the oven, they are cut into bars of correct length by a cutter which is driven by a Thy-mo-trol drive, the speed of which can be adjusted to set the desired length of the fig bar. The cutter automatically adjusts its speed to maintain the same bar length even when the baker changes oven speed.

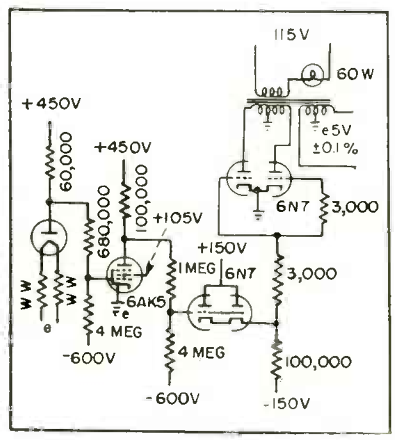


Canvas conveyor belt carries base cake for sandwiches to oven for baking. Coordinated G-E motor drive system permits baker to provide uniformity of baked products

Filament Voltage Regulator

A NOVEL circuit for stabilizing tube heaters is employed in the design of a differential analyzer by R. L. Garwin of the University of Chicago. One section of the analyzer makes use of a d-c feedback amplifier connected as an integrator.

The most difficult problem in the



Circuit for regulating a-c heater of amplifier tube

design was the input behavior of the d-c amplifier, that is, grid current and grid-cathode potential changes. It was felt that the use of standard receiving tube types was an important advantage worth considerable effort to achieve. Grid current was finally reduced to less than 10^{-9} amp without tube selection by using a 6AK5 at 100-μa plate current.

The grid-cathode potential was stabilized by regulating the average heater power to better than 0.1 percent by the scheme illustrated in the accompanying diagram. In this circuit, the filament of the first diode is operated at such current

that the emission is temperature-limited. It is then easily shown that the sensitivity of the space current to heater voltage variation gives about two-volt change in plate potential for 0.1 percent heater voltage change. This error signal is then amplified and applied through the power output tube and transformer. By this means, it is made to maintain a constant heater voltage.

Circuits of the stages of the differential analyzer and description appeared in *Review of Scientific Instruments*, p 411, May 1950.

Engineer checks test pattern on portable monitor. Camera, below monitor, is mounted in acoustic shield

Television as Research Tool

By Frank A. Friswold

Electrical Engineer
Lewis Flight Propulsion Laboratory of the National Advisory Committee for Aeronautics
Cleveland, Ohio

At this laboratory, the world's largest laboratory devoted to research on aircraft propulsion, the application of television has proved to be a valuable research facility. In particular, it has proved to be an aid to the proper operation of test facilities, a means of furnishing otherwise unobtainable information and a vital contribution to safety in hazardous test runs.

In modern wind tunnels, Schlieren and interferometer apparatus is extensively employed in the study of shock waves, air flow and attendant phenomena, because these methods permit evaluation of test conditions without the attendant disturbing effects associated with the use of test probes in supersonic air streams. The Schlieren apparatus, through an optical trick, makes air flow phenomena visible in the form of a projected picture and during the test runs these data pictures are recorded by cameras. However, while the test conditions are being set, it is necessary that tunnel operating personnel be provided with a means for viewing the Schlieren image.

At the Lewis Laboratory's eight- by six-foot supersonic wind tunnel the Schlieren equipment is located in a pressure-sealed capsule which encloses the test section and allows the adjustment of the test-section walls to conditions required at any given Mach number.

When the tunnel is in operation the atmospheric pressure within the capsule drops to just a few inches of mercury and the temperature often rises to over 150 F. It is obvious that it is impossible to station a human observer at the Schlieren apparatus to report to the control room. Television has been successfully used to transmit the Schlieren image from the test capsule to the control room, thus allowing the engineers operating the tunnel to set exactly the desired test conditions.

In addition to image transmission there is another advantage of television in this application. The size and brilliance of the Schlieren image is a function of the intensity of the light source. An inherent principle of the Schlieren system greatly reduces the amount of light available when a reasonable degree of sensitivity is required.

With a B-H6 primary light source the maximum size of the Schlieren picture that can be comfortably viewed under normal lighting conditions is limited to about 20 square inches. A picture of this size is of limited value, especially when a large number of people are dependent on it for the proper execution of their duties. Television in this instance can be utilized as an optical amplifier producing large brilliant images clearly visible to all.

Recently a ram jet or "flying stovepipe" was tested in the Lewis Laboratory's altitude wind tunnel. It was necessary to observe both the pattern of the shock wave at the front of the jet and the flame emanating from the rear. Two engineers stationed on the test section observation deck viewed the ram jet and reported their ob-

(continued on p 162)

Television camera at Lewis Flight Propulsion Laboratory views the test section of a small supersonic wind tunnel. Insert at lower right shows the received Schlieren image of the test section showing the shock pattern

THE INSIDE STORY:

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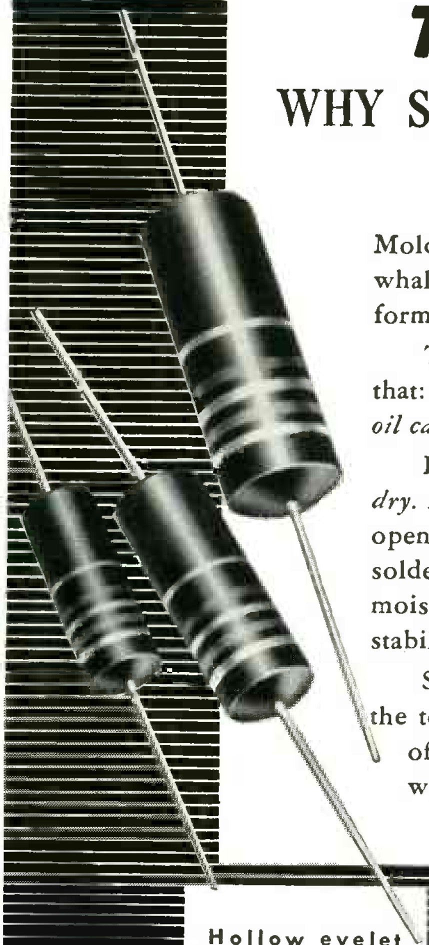

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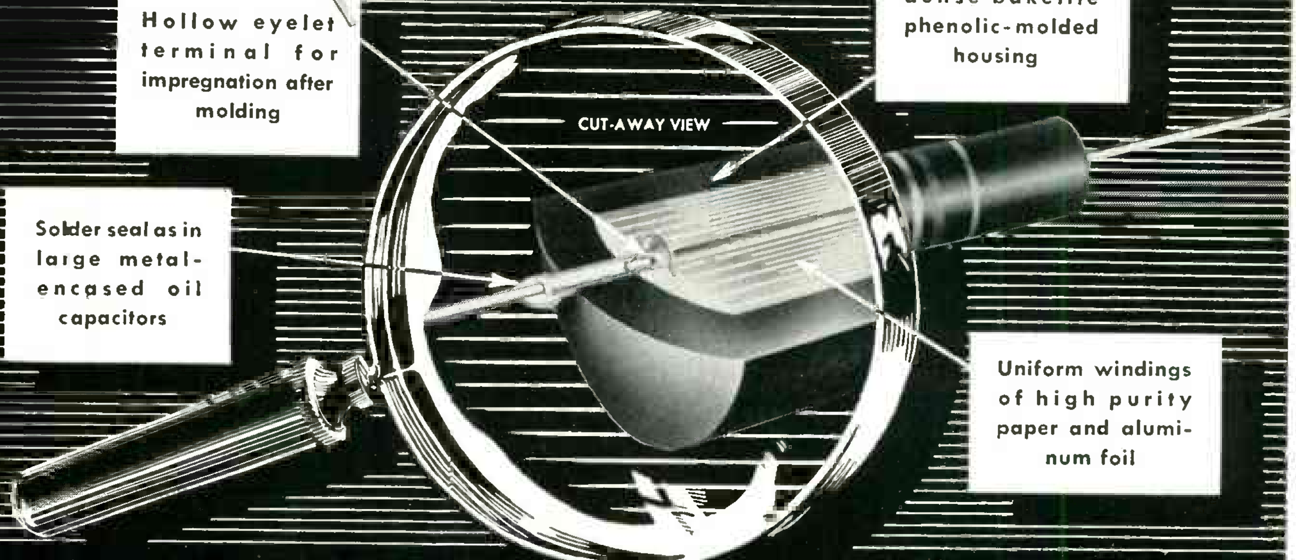

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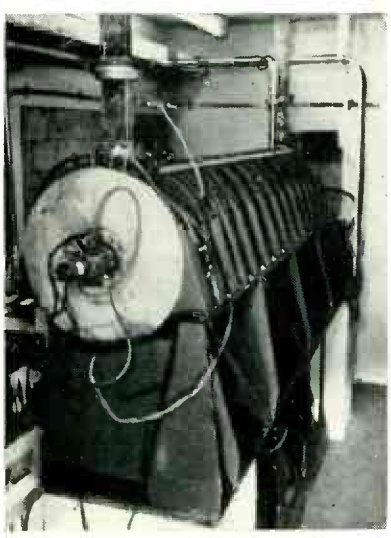
British Linear Accelerator 124
Measuring Moon Radiation at 24,000 Mc 124
Stereo Television at Argonne Laboratories 126
Positive Gate Counter Circuit 194
Graphical Solution for Feedback Amplifiers 204
Bridged-T Neutralization of Pentode Amplifiers 214
Survey of New Techniques 216

British Linear Accelerator

By Leonard G. Rule
Formerly attached to British Ministry of Supply

A NEW PARTICLE ACCELERATOR, built on the principle of traveling-wave linear acceleration as opposed to the cyclotron types, is being used for atomic energy research at Harwell, England. With the aid of this machine, of which there are only two earlier models, one in the U.S. and one in England, electrically-charged atomic particles can be accelerated almost to the speed of light.

Acceleration is accomplished by means of a powerful radio transmitter working at a wavelength of 10 cm. A beam of electrons is speeded up on the crest of electrical waves provided by this transmitter, which operates in short bursts of immense power. The electrons are aimed at a heavy metal target, and upon collision, gamma rays are emitted by the metal. In turn, the gamma rays enter a tank of heavy water. Neutrons are then emitted upon breaking up of the deuterium nuclei in the water.



The Traveling-wave Linear Accelerator inside its shelter at Britain's Atomic Energy Research Establishment at Harwell, in Southern England

While the new machine is working at constant speed, its chain of reaction may liberate as many as one billion neutrons per sec. Peak capacity during the 2-μsec pulse is 10^{12} neutrons per second.

Three and one-half million electron volts of energy can be generated by the traveling-wave accelerator. Basic research was carried out by Harwell scientists and the machine was built at the Mullard Electronic Research Laboratories of Phillips Electrical Ltd.

The accelerator is used primarily to study the effect of neutrons on nuclei of various elements, a problem of vital importance in the development of atomic energy. One of the main functions of fundamental and applied research on the atom is to find out what materials can be used in atomic piles. If these piles are to be used industrially, pipes will have to be run through them to make use of the heat generated. The materials of which these pipes are made must not absorb too many neutrons or the reaction will be slowed down. Also, the pipes must be able to stand up under the high pile temperatures and particle bombardment.

Measuring Moon Radiation at 24,000 MC

MEASUREMENTS have been made of the thermal radiation from the moon by means of special receiving equipment operating in the 24,000-mc region. From these measurements, estimates may be made of temperature far below the moon's surface, the surface temperature on the dark side of the moon, and much is learned about the nature of the surface of the moon.

The data are displayed in the form of moon temperature versus moon phase curves. These curves are found to be approximately sinusoidal with amplitudes of 52.0 K at the equator and 40.3 K for the average over the moon's surface. The temperature cycle lags the phase angle by about 45 degrees in both cases.

Equipment

The apparatus used in making these measurements is shown diagrammatically in Fig. 1. The 44-inch parabolic-reflector antenna has a pattern width of $\pm \frac{3}{8}$ degrees at half-power points and a power gain

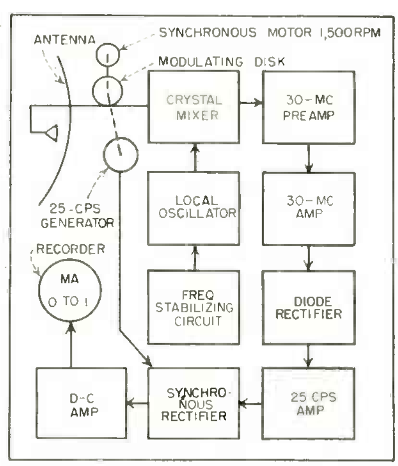
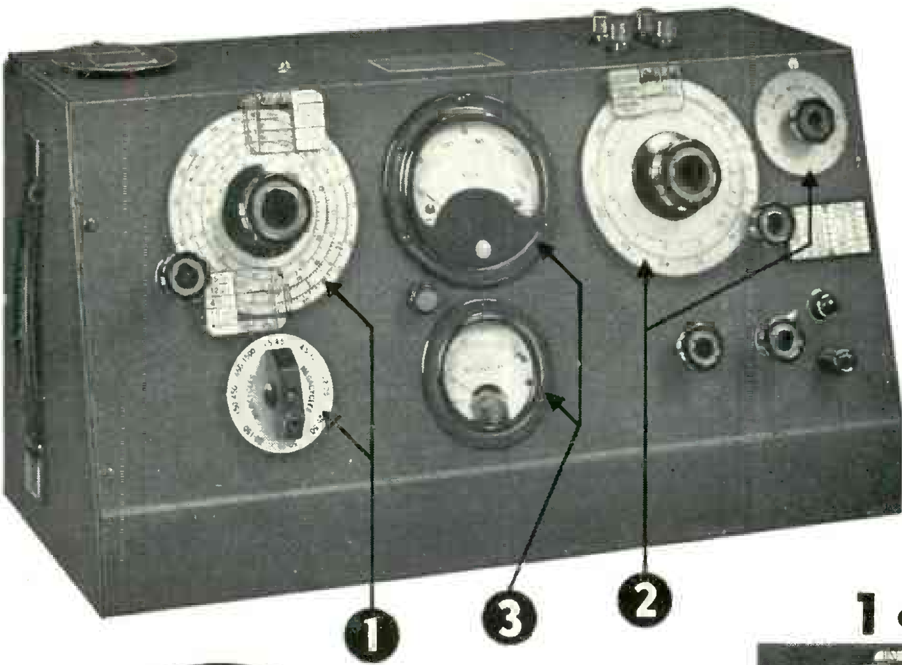


FIG. 1—Receiving equipment used to measure 24,000-mc radiation of the moon



EXAMINE THESE *Direct Reading Features* WHICH SIMPLIFY ACCURATE MEASUREMENTS

The Q METER
TYPE 160-A
50 kc. to 75 mc.

1 OSCILLATOR FREQUENCY DIAL.

This large 4½" open faced dial has eight overlapping frequency ranges, each calibrated *directly* in kilocycles or megacycles, with scales conveniently divided for maximum readability. A vernier dial drive enables fine settings to be made with ease. All frequency ranges are accurate to within ±1% except the 50-75 megacycle range which is accurate to ±3%. The clearly marked range change switch located directly beneath the frequency dial facilitates rapid and positive selection of the desired frequency band.

Radio frequency circuit design often requires the accurate measurement of Q, inductance and capacitance values. For this application the Type 160-A Q-Meter has become the uncompromising choice of radio and electronics engineers in this country and abroad.

Each component part and assembly used in the manufacture of this instrument is designed with the utmost care and exactness. Circuit tolerances are held to values attainable only in custom built instruments.

With the 160-A Q-Meter, as with other Boonton Radio Corporation instruments, the keynote in design is to embody accurate *direct reading* features which save time and simplify operation.

SPECIFICATIONS

Oscillator Frequency Range: 50 kc. to 75 mc. in 8 ranges.
Oscillator Frequency Accuracy: ±1%, 50 kc.—50 mc.
±3%, 50 mc.—75 mc.

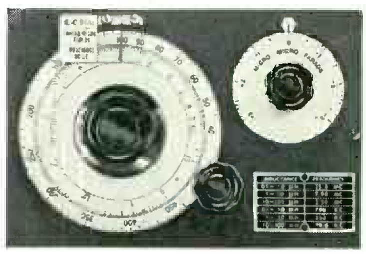
Q Measurement Range: Directly calibrated in Q, 20-250. "Multiply—Q—By" Meter calibrated at intervals from x1 to x2, and also at x2.5, extending Q range to 625.

Q Measurement Accuracy: Approximately 5% for direct reading measurement, for frequencies up to 30 mc. Accuracy less at higher frequencies.

Capacitance Calibration Range: Main capacitor section 30-450 mmf, accuracy 1% or 1 mmf whichever is greater. Vernier capacitor section +3 mmf, zero,—3 mmf, calibrated in 0.1 mmf steps. Accuracy ±0.1 mmf.

Catalog "H" containing further information available upon request.
(In Canada, direct inquiries to RCA Victor Co., Ltd., Montreal.)

2 Q-TUNING CAPACITANCE DIALS.



L-C dial serves twofold purpose of (1) conveniently and accurately indicating tuning capacitance *directly* in MMF, and (2) providing an effective inductance scale which also becomes *direct* reading at certain defined frequencies shown on frequency reference plate. Incremental capacitance dial at right calibrated from +3 MMF through zero to —3 MMF, accurate to ±0.1 MMF.

3 Q-VOLTMETER AND MULTIPLIER METER.

For the indication of Q values the 160-A Q-Meter employs a Weston Model 643 Meter calibrated *directly* in terms of Q over the range from 20-250. The damping of the meter movement is ideal for the rapid determination of exact resonance without sluggishness or overshoot. The lance type pointer enables Q readings to be obtained to the nearest unit. Located directly beneath the Q voltmeter is the "Multiply-Q-By" meter which provides Q multiplier factors of X1 to X1.5 in 0.1 steps, X2, and X2.5 thereby extending the useful range of Q indication to 625. This meter is carefully matched to a particular thermocouple element for maximum accuracy.

DESIGNERS AND MANUFACTURERS OF THE Q METER · QX CHECKER FREQUENCY MODULATED SIGNAL GENERATOR · BEAT FREQUENCY GENERATOR AND OTHER DIRECT READING INSTRUMENTS

BOONTON RADIO *Corporation*
BOONTON · N · J · U · S · A ·

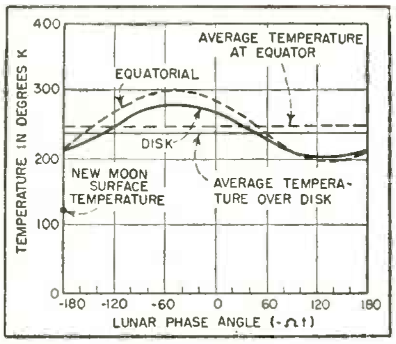


FIG. 2—Lunar temperature curves for the average microwave temperature over the moon's surface and at the moon's center

of aproximately 3×10^4. The energy received by the horn at the reflector focus is compared with the thermal radiation from a disc of absorbing material at a fixed temperature.

Comparisons are made by chopping the waveguide signal 25 times a second, beating the chopped signal against a klystron oscillator to produce a 30-mc modulated signal for the i-f amplifier whose output is demodulated to recover the 25-cps signal. This signal is converted to d-c by a rotary contactor, which is synchronized with the chopper, and used to drive a recording milliammeter.

In making measurements the antenna is pointed slightly ahead of the moon and the received signal recorded as the moon passes through the beam. By this means, cosmic noise and atmospheric radiation are held constant and do not affect readings. Receiver calibration is accomplished by substituting a resistor, whose temperature can be adjusted, for the antenna. Corrections must be made for variations of the solid angle subtended by the moon, for variation in gain of the antenna beam over the moon's surface, and for lunar emissivity which is assumed to be 0.9. Figure 2 shows the resulting curves.

Stated mathematically, the average temperature curve becomes $T_{(average)} = 239 + 40.3 \cos (\Omega t - 45°)$ and the equation for the equatorial temperature is $T_{(equatorial)} = 249 + 52.0 \cos (\Omega t - 45°)$ where Ω is the angular velocity of the moon and t the time elapsed since full moon.

The apparent disagreement between these results and similar measurements made previously in the 10-micron region appears to be due to the transparency of the moon to $1\frac{1}{4}$-cm waves. The surface of the moon is substantially opaque to radiation in the 10-micron region, which makes measurements in that region surface temperatures. The surface temperature variation propagates into the moon as an attenuating temperature wave with a progressively lagging phase. Integration of radiation from all contributing layers substantiates the microwave temperature which has smaller periodic variation and which lags the corresponding surface variation.

Estimates based on the results obtained indicate the temperature far below the surface of the moon to be 234 K, a maximum equatorial temperature of 249 K, and the space average surface temperature of the whole disk of the new moon is 145 K. Further examination of the results substantiate earlier claims of the existence of a layer of poorly-conducting dust on the moon's surface. This layer is probably of the order of 1 mm thick.

This work is described in detail in the *Australian Journal of Scientific Research*, Vol. 2, 1949, by J. H. Piddington and H. C. Minnett of the Division of Radio Physics, Council for Scientific and Industrial Research, Australia.

Stereo Television at Argonne Laboratories

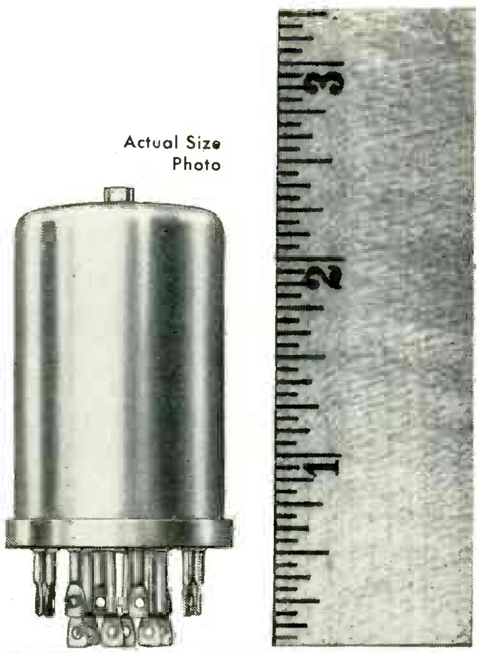
ARGONNE ENGINEERS have developed a system of stereoscopic television for viewing atomic-energy experiments at extreme distances, according to the recently released

(Continued on p 194)

DEVELOPING RADAR FIRE CONTROL FOR AIRCRAFT

Complete bench test set-up at The Glenn L. Martin Co. plant in Baltimore for testing advanced fire control systems for aircraft turrets. Major components of a modern system include (1) sighting system for determining direction and distance of target, (2) computing mechanism for determining where to point guns so bullets will hit target, and (3) motor-driven mechanisms for moving turret and guns and for supplying ammunition. In the more advanced modern systems the operator need only select his target on a radar screen and fire the guns when the target comes into range

Actual Size
Photo



Announcing

A NEW MINIATURE, HERMETICALLY SEALED

Aircraft Type Relay

by "Diamond H"

Apply this unmatched combination of important features to your weight and space requirements:

SIZE: ***smallest of its type, 1.5 cubic inches.***

WEIGHT: ***lightest of its type, 3.5 ounces.***

SHOCK RESISTANCE:
greatest of its type, 50 G.

TEMPERATURE RANGE:
widest of its type, —65° C. to +200° C.

4 POLE DOUBLE THROW

Plus These Other Specifications

1. CONTACT RATING: 2 A, 28 V, D.C.; 2A, 115 V, A.C., 400 cycle.
2. CONTACT OVERLOAD RATING: 12 A, 28 V, 20 sec.
3. ALTITUDE RATING: Dry, inert gas, pressure filled; hermetically sealed.
4. COIL RESISTANCE: 300 and 150 ohms.
5. COIL VOLTAGE: 28 V, D.C.; amperage .1.
6. TERMINAL ARRANGEMENT: Soldered connections.
7. MOUNTING: Variable.
8. VARIATIONS: Virtually innumerable, in voltage, amperage, number of poles (4 maximum) and temperatures.

★ ★ ★

Revolutionary in design, this new miniature relay was developed to meet a highly exacting set of requirements for air, ground and marine applications by The Hart Manufacturing Company . . . producer of dependable electrical controls and devices for over half a century. It incorporates a hitherto unmatched combination of characteristics. We'll gladly work with you to develop any special variation to meet your specific need.

Write today for complete information on this new "Diamond H" relay.

The Hart Mfg. Co.
202 Bartholomew Ave.
Hartford, Conn.

Send me further information about your new relay.

Name ______________________

Title ______________________

Company ______________________

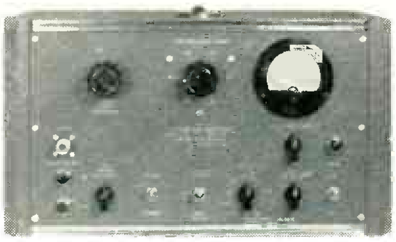
Street ______________________

City ____________ *State* ____________

NEW PRODUCTS

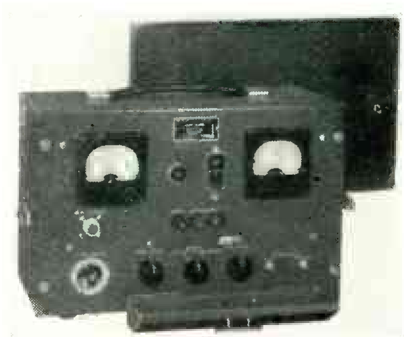
Edited by WILLIAM P. O'BRIEN

Miniature Components and Lab Devices in Increased Production . . . Television Equipment Holds Its Own . . . Available Manufacturers' Catalogs Are Announced



UHF Impulse Generator

EMPIRE DEVICES, INC., 38-25 Bell Boulevard, Bayside, N. Y., Model IG-102 uhf impulse generator produces a spectrum, flat within ± 0.5 db over the entire frequency range from 10 kc to 1,000 mc, corresponding to a pulse width of less than 0.001 μsec. Output is 70,000 μv per mc, adjustable over a 60-db range by means of a continuously variable 10-db attenuator and a resistive step attenuator. Continuously adjustable repetition rate from 2.5 cycles to 2,500 cycles is provided. Output impedance is 50 ohms, the vswr being better than 1.2 at all frequencies. The unit may be used for studying transient phenomena, and may also be employed for receiver alignment and bandwidth determination.



Sound Channel Equipment

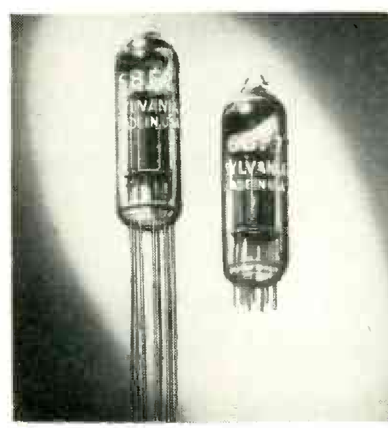
FEDERAL TELECOMMUNICATION LABORATORIES, INC., 500 Washington Ave., Nutley 10, N. J. The FTL 38-A sound channel equipment provides facilities for the transmission of high-fidelity sound and video over tv radio relay systems, such as the FTL27-A tv uhf radio relay link, eliminating the need for leased high-quality telephone circuits. The complete equipment consists of two units: a submitter (illustrated), which transforms the sound program into an f-m 5-mc subcarrier; and a subceiver, which detects the subcarrier signal at the receiving end and recovers the original sound program. Video input and output levels are 1 to 2.5 v peak-to-peak; video input and output impedances, 75 ohms; noise, 50 db below rated output; and distortion, 40 db below rated output.

Laboratory Monitor

NUCLEAR INSTRUMENT AND CHEMICAL CORP., 229 W. Erie St., Chicago 10, Ill., has announced the model 1615 laboratory monitor for alpha-beta-gamma detection. The instrument may be used for checking clothing, benches, glassware or hands for contamination, or for continuous monitoring of background air contamination or isotope decay. It may also be used to count samples with activities between 100 and 50,000 counts per minute where accuracy of measurement need not be better than 3-percent standard error.

TV Microphone

RADIO CORP. OF AMERICA, Camden N. J. Type BK-4A Starmaker ribbon-pressure microphone, designed especially for the tv industry, is now available for broadcast station uses. It has an output of 110 μv per dyne per cm for an output impedance in accordance with RMA standards of 30, 150 and 250 ohms. It is nondirectional and provides uniform frequency response between 50 and 15,000 cycles. Effective output level at 1,000 cycles is -50 dbm. Hum pickup level is -125 dbm. The microphone features a ⅜-in. diameter horn for increasing the response in the h-f regions.



Subminiature Tube

SYLVANIA ELECTRIC PRODUCTS INC., 500 Fifth Ave., New York 18, N. Y., has announced a new double-triode subminiature tube providing high performance for a wide range of applications in tv receivers, industrial electronic applications, servomechanisms and radio communications receivers. Transconductance is 4,800 μmhos and amplification

factor per triode section is 35 when 100 volts is used on plates. Input capacitance per plate is 2.0 $\mu\mu$f; output capacitance is 1.0 $\mu\mu$f.

Projection Slave Receiver

SNAIDER TELEVISION CORP., 540 Bushwick Ave., Brooklyn, N. Y., has announced a projection slave receiver that may be attached to any type of tv receiver, regardless of c-r tube size, and will deliver a picture up to 6 ft × 8 ft. It uses only the video signal and sound of the master set, having its own self-contained power supply. Sync and sweep circuits are independent of the master set and the slave unit holds sync even when master goes out of sync. Including the c-r tube there is a total of 21 tubes.

Railroad Radio Equipment

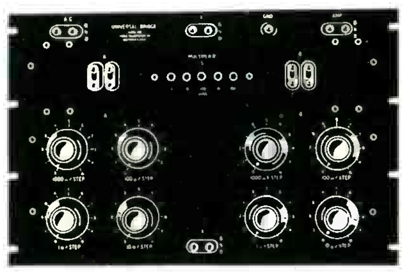
WESTINGHOUSE ELECTRIC CORP., Box 2099, Pittsburgh 30, Pa. Type FE heavy-duty railroad radio equipment contains all the necessary circuits for operation in end-to-end, train-to-train, and wayside-to-train communication. The transmitter is rated at 20 watts output for continuous service, and 30 watts output for intermittent service. The equipment is designed for broad-band operation, to permit multifrequency operation within the frequency band assigned by the FCC for railroad use.

TV Amplifier Tube

GENERAL ELECTRIC CO., Syracuse, N. Y., has available a new double-ended beam-power amplifier tube designed for use as the horizontal-deflection amplifier in tv receivers. When used with suitable components, the 6CD6-G tube is capable of fully deflecting any picture tube having a deflection angle up to 70 degrees and operating at anode voltages up to 14 kv. It is rated with a peak positive pulse plate voltage of 6,000 v; maximum d-c plate voltage of 700 v; plate dissipation, 15 watts maximum; d-c plate current, 170 ma maximum.

Geiger Counter for Prospectors

NUCLEAR INSTRUMENT & CHEMICAL CORP., Chicago, Ill. The Super Sniffer is a Geiger counter designed for uranium prospectors. It detects the radiation reaching the surface of the ground, no matter how deep the source, and indicates the radioactivity by both earphone clicks and neon flashes. When used to check samples its beta window makes it extremely sensitive, and it will detect both beta and gamma radiation. It weighs less than two pounds and is priced at $49.50.



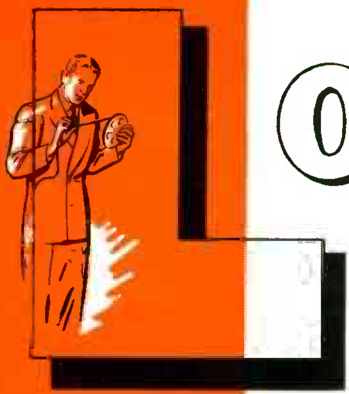
Universal Bridge

FREED TRANSFORMER CO. INC., 1718-36 Weirfield St., Brooklyn 27, N. Y., has introduced the No. 1150 universal bridge with a frequency range from 20 cycles to 20,000 cycles. The unit is designed as a laboratory instrument for measurements of inductors and capacitors, and determination of resistive and reactive components of impedances. It can also be used as a Maxwell bridge, Hay bridge, series resistance capacitor bridge, resonance bridge and parallel resistance capacitor bridge. Accuracy is 1 percent.

High-Fidelity Amplifier

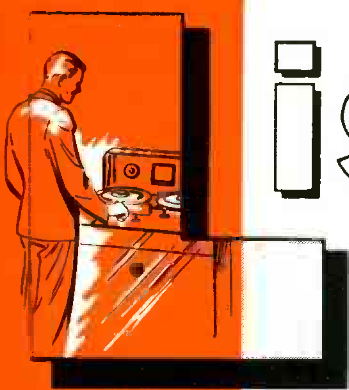
BELL SOUND SYSTEMS, INC., Columbus, Ohio. Model 2145 high-fidelity amplifier with remote control permits switching to and from phono-

(continued on page 220)



Look at the new audiotape*

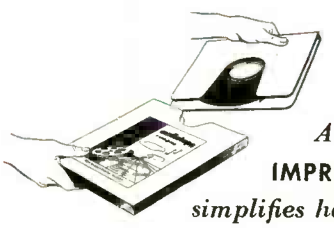
Yes, you can actually *see* the difference. The way it tracks and winds absolutely flat, due to superior, straight-line slitting. Its smooth, non-curling flexibility — and the way it rides snugly over the heads without humping away in the middle. And, compared under a microscope, you can see Audiotape's *superior dispersion* of the oxide particles—free from "clumping" which tends to increase background noise. You can tell a lot just by looking at Audiotape, but...



Listen to its matchless reproduction

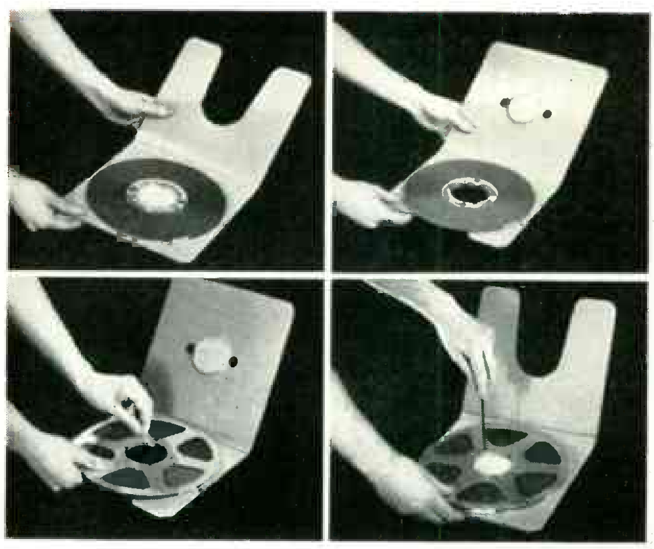
That's the real test. Audiotape actually does "speak for itself." Hear its brilliant high-frequency response —freedom from annoying background noise and distortion. There's *no friction squeal*—no rasping hum from low-frequency modulation noise. And a sensitive ear can appreciate the remarkable *uniformity* of output volume, varying not more than ±¼db for an entire 2500 foot reel.

Original recordings for phonograph records of America's leading artists are made on Audiotape. There must be a reason!



And see how Audio's
IMPROVED PACKAGING
simplifies handling and storage

All 2500 and 5000 foot rolls of Audiotape are individually boxed in specially designed containers (Pat. Pending) that make handling and storage safer and easier than ever before. Tape can be transferred from container to turntable (and vice versa) without danger of slipping from the hub or becoming unwound. Reel side flanges can be attached to hub without removing it from container. In storage, tape hangs from hub core — does not rest on edge of roll.



SEND FOR FREE 300 FOOT SAMPLE of plastic or paper base Audiotape today

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444 MADISON AVE., NEW YORK 22, N. Y.
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. . . the standard of disc recording quality for more than a decade

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NEWS OF THE INDUSTRY

Edited by WILLIAM P. O'BRIEN

Civilian Engineers Needed by Armed Services

ELECTRONIC ENGINEERS highly specialized in the communications field are still urgently needed to fill positions in the research and development laboratories of the various branches of the Armed Services. Also critically needed are experienced technical writers and training instructors with extensive electronics or communications equipment background. Details of some of the positions follow:

Intelligence Department, Air Materiel Command, Wright-Patterson Air Force Base, Dayton, Ohio

Air Technical Intelligence Specialist (Electronics) ($8,800). Supervises the branch responsible for estimation of performance, characteristics and technical capabilities of foreign airborne and ground radar, radio navigation, communications, and guided missile control systems.

Air Technical Intelligence Specialist (Guided Missile Control) ($7,600). Conducts air intelligence research in the determination of the performance characteristics and technical capabilities of foreign guided missile control systems.

Air Technical Intelligence Specialist (Radio Navigation) ($6,400). Conducts air intelligence research in the determination of the performance characteristics and technical capabilities of foreign radio navigation systems.

Air Technical Intelligence Specialist (Communications) ($6,400). Conducts air intelligence research in the determination of performance characteristics of communication systems.

Air Technical Intelligence Specialist (Electronics) ($8,800). Supervises the branch responsible for the estimation of capabilities of foreign developments in countermeasure equipment and methods. Supervises classified electronic projects.

Air Technical Intelligence Specialist (Electronics) ($7,600). Conducts air intelligence research in the determination of various parameters associated with electromagnetic propagation and radiation as they affect air force type equipment. Also conducts air intelligence research on a classified project.

Air Technical Intelligence Specialist (Electronics) ($8,800). Supervises the branch responsible for the determination of foreign technical accomplishments and capabilities in the fields of electronic components, wave propagation, military infrared developments, circuit analysis, high-frequency vacuum tubes and semiconductors, as they affect air force type equipment.

Air Technical Intelligence Specialist (Electronics) ($5,400). Conducts air technical intelligence research in the determination of alien accomplishments relative to electronic components and devices as they affect air force equipment.

Air Technical Intelligence Specialist (Electron Physics) ($7,600). Conducts air intelligence research in the determination of alien capabilities in the field of electron physics. Specifically, this research covers wave propagation, high-frequency vacuum tubes, semiconductors, infrared theory and devices, and circuit analysis as these affect air force type equipment.

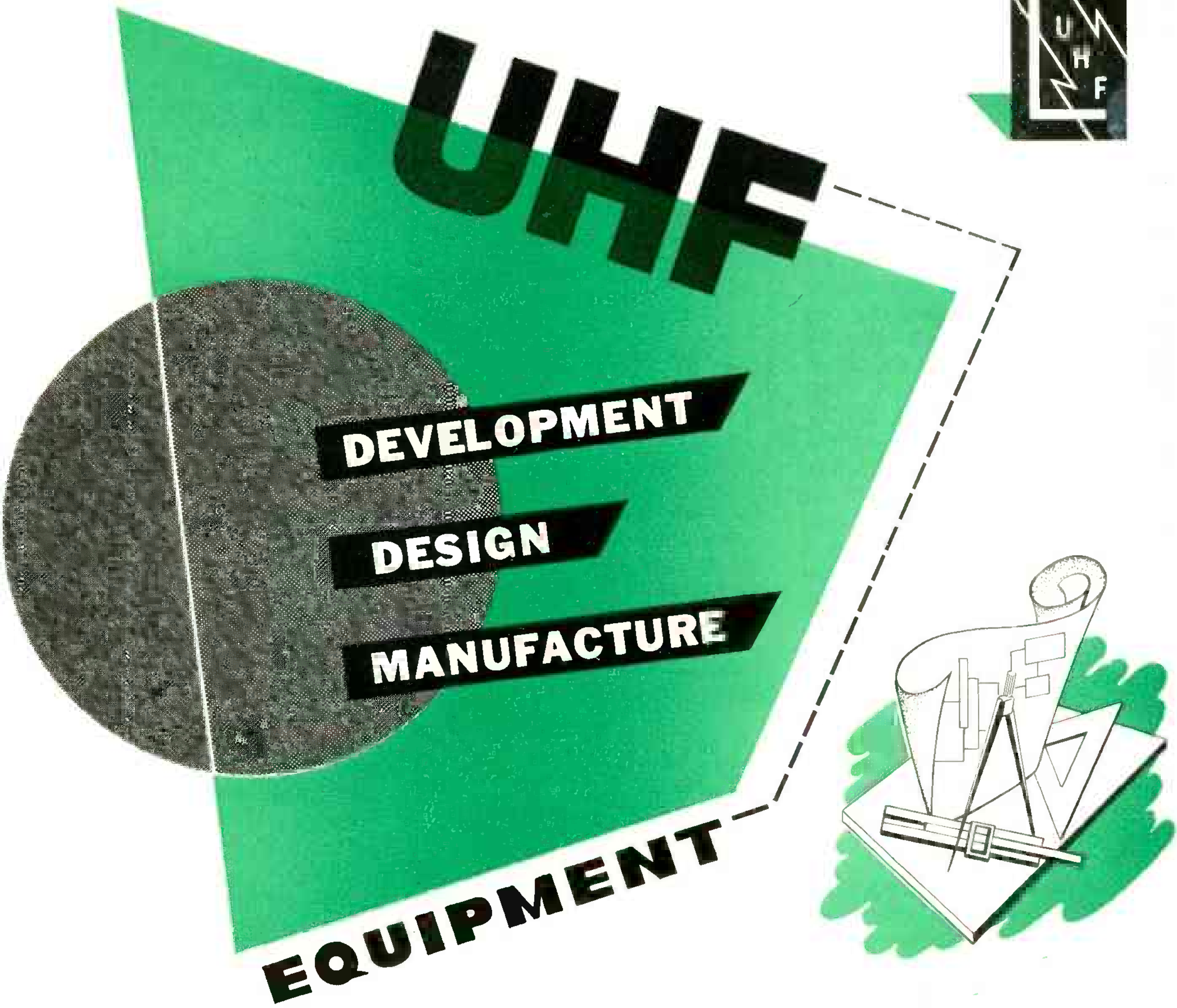
Signal Corps, Civilian Personnel Branch, Bldg. T-530, Fort Monmouth, N. J.

Electronic Engineer ($3,825 for grade GS-5 requiring 4 years college or 4 years engineering experience or any time-equivalent combination thereof, to $6,400 for grade GS-12 requiring 8 years of college education and engineering experience). Participates in the design, development, modification, construction and testing of electronic equipment such as radar, radio and wire communications equipment and components; electron tubes, electronic control and measurement instruments, sonar equipment and similar devices; plans and computes processes; prepares sketches; conducts performance tests; interprets and evaluates test findings, and prepares technical reports.

Technical Writer ($3,100 for grade GS-5 requiring 3 years writing experience or 4 years college education, to $5,400 for grade GS-11 requiring 5½ years professional experience or one year of appropriate education for each 9 months experience). Writes, edits and prepares technical publications, handbooks, pamphlets, circulars, instruction books, etc. Edits and revises scientific manuscripts on

SIGNAL CORPS RADIOS IMPROVED

Radically redesigned handie-talkie and walkie-talkie radios help to coordinate infantry, armor, artillery and supporting troops. Both are now frequency modulated. The new version walkie-talkie (right) weighs about 20 lb and measures 16 in. high x 9 in. wide x 3 in. deep. Its range is up to 5 mi. The new f-m battery-operated handie-talkie (left) has a range of about 1 mile



. . . *If* UHF design or development is a major problem with you, or . . .

. . . *If* low-unit manufacturing cost is essential to satisfactorily meet competition, or . . .

. . . *If* trustworthy, confidential collaboration is a highly necessary factor . . .

THEN Lavoie Laboratories, Inc. can be of invaluable assistance. We have the Engineering Staff . . . the shop techniques . . . a competent understanding of government contract procedures . . . and the reputation for satisfactorily meeting *all* of these requirements.

We welcome your inquiries on any phase of UHF design, development or production.

LAVOIE PRODUCTS INCLUDE:

RADAR RECEIVERS
RADIO RECEIVERS
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ANTENNA EQUIPMENT
PULSE GENERATORS
OSCILLOSCOPES
RADAR BEACONS
COMMUNICATION SYSTEMS
CRYSTAL IMPEDANCE METERS
ETC., ETC.

Lavoie Laboratories, Inc.

MORGANVILLE, N. J.

radio, radar, electronics, communications and photography. Writes instruction manuals on theory, operation and maintenance of Signal Corps equipment; determines media and method of presentation of material. Prepares charts, graphs, schematic diagrams, etc., for inclusion in technical literature.

Military Instructor ($3,100 for grade GS-5 requiring 4 years experience in testing, servicing and maintenance of communication equipment or 4 years college or trade or vocational school above high school level, to $4,600 for Grade GS-9 requiring 6 years experience and education). Instructs classes of military personnel in one or more of the following subjects: Microwave Radio Relay, Radar, Radio Electronics, Fixed Station Radio, Central Office Techniques, Teletype Installation and Maintenance, Repeater and Carrier, Dial Central Office Maintenance, and Theory of Electricity. For GS-9, also investigates and prepares course material and study guides and devises visual training aids. Theory of Electricity requires only three years of experience, education or a combination of both. Applicants hired at the Grade GS-5 level will be given six months intensive accelerated training in the plans, methods, and techniques of teaching before assignment as instructors.

MEETINGS

OCT. 23–27: AIEE Fall General Meeting, Skirvin Hotel, Oklahoma City, Okla.

OCT. 26–28: Second Audio Fair, sponsored by the Audio Engineering Society, Hotel New Yorker, New York City.

OCT. 30–NOV. 1: Radio Fall Meeting, sponsored jointly by IRE and RTMA engineering department, Hotel Syracuse, Syracuse, N. Y.

JAN. 10–12: Second High Frequency Measurements Conference, sponsored by AIEE, IRE and NBS, Hotel Statler and Dept. of Interior Auditorium, Washington, D. C.

MARCH 5–9: ASTM Spring Meeting and Committee Week, Cincinnati, Ohio.

MAR. 19–22: IRE Annual Convention, Hotel Waldorf Astoria and Grand Central Palace, New York City.

JUNE 18–22: ASTM Annual Meeting, Atlantic City, New Jersey.

IRE Announces Awards

THE Institute of Radio Engineers will award the 1951 Medal of Honor to Vladimir K. Zworykin, director of electronic research and vice-president of RCA Laboratories Division, Princeton, N. J. The Medal of Honor is awarded annually in recognition of distinguished service rendered through substantial and important advancement in the science and art of radio communication. It will be presented at the annual banquet during the IRE National Convention, March 19 to 22, 1951, at the Waldorf-Astoria Hotel, New York City.

In making this award the board of directors of the Institute also conferred the grade of Fellow, highest grade of membership in the IRE, upon 41 outstanding engineers and scientists in radio and allied fields. Recipients of the Fellow award, which will also be presented at the annual banquet, are as follows:

R. Adler of Zenith Radio Corp., Chicago, Ill.; J. G. Brainerd of U. of Pennsylvania, Philadelphia, Pa.; C. G. Brennecke of N. Carolina State College, Raleigh, N. C.; R. D. Campbell of AT&T Co., New York, N. Y.; R. W. Deardorff of The Pacific Tel. & Tel. Co., Portland, Oregon; J. H. DeWitt, Jr., of Radio Station WSM, Inc., Nashville, Tenn.; H. F. Elliott of Palo Alto, Calif.; C. G. Fick of GE Co., Schenectady, N. Y.; E. L. Ginzton of Stanford U., Calif.; W. M. Goodall of Bell Labs, Inc., Deal, N. J.; J. T. Henderson of National Research Council, Ottawa, Canada; C. J. Hirsch of Hazeltine Electronics Corp., Little Neck, N. Y.; W. E. Jackson of CAA, Indianapolis, Ind.; J. B. Johnson of Bell Labs Inc., Murray Hill, N. J.; A. G. Kandoian of Federal Telecommunication Labs, Inc., Nutley, N. J.; C. E. Kilgour of Avco Corp., Cincinnati, Ohio; T. J. Killian of ONR, Washington, D. C.; J. B. Knox of RCA Victor Co., Ltd., Montreal, Canada; V. D. Landon of RCA Labs, Princeton, N. J.; G. Lewis of IT&T Co., New York, N. Y.; H. R. Lubcke of Don Lee Broadcasting System, Hollywood, Calif.; D. G. C. Luck of RCA Labs., Princeton, N. J.; J. F. Morrison of Bell Labs, Whippany, N. J.; G. A. Morton of RCA Labs, Princeton, N. J.; G. W. Olive of Canadian Broadcasting Corp., Montreal, Canada; O. W. Pike of GE Co., Schenectady, N. Y.; L. E. Reukema of U. of Calif., Berkeley, Calif.; H. W. G. Salinger of Farnsworth Research Corp., Fort Wayne, Ind.; O. H. Schade of RCA Victor, Camden, N. J.; W. E. Shoupp of Westinghouse Electric Corp., Pittsburgh, Pa.; P. F. Siling of RCA Frequency Bureau, New York, N. Y.; H. R. Skifter of AIL, Inc., Mineola, N. Y.; B. R. Teare, Jr., of Carnegie Institute of Technology, Pittsburgh, Pa.; G. N. Thayer of Bell Labs, Inc., New York, N. Y.; H. P. Thomas of GE Co., Syracuse, N. Y.; W. C. Tinus of Bell Labs, Inc., Whippany, N. J.; E. Weber of Polytechnic Institute of Brooklyn, Brooklyn, N. Y.; R. H. Williamson of GE Co., Syracuse, N. Y.; W. T. Wintringham of Bell Labs, Inc., Murray Hill, N. J.; and G. A. Woonton of McGill U., Montreal, Canada.

RTMA Replies to FCC on Color Video

IN A LETTER to the secretary of the Federal Communications Commission, Robert C. Sprague, president of Radio-Television Manufacturers Association, stated that the RTMA "has never attempted to, and cannot require its members to build, or refrain from building, particular sets or sets of particular capabilities." The letter went on to say that decisions whether to build sets incorporating bracket standards for the reception of both CBS color and standard monochrome television transmissions would be left entirely up to the individual members.

This policy was decided during a three-day conference in New York from September 18 to 20. Although most members were present, big producers Philco and RCA were significantly absent. The meeting was called to discuss an answer to what RTMA calls "certain language in the Commission's report" (First Report of Commission—Color Television Issues) that "suggests that the Commission may have believed that the Radio-Television Manufacturers Association should, as a group, provide the Commission with the answer as to whether its members would, or would not, build sets to reflect bracket transmission standards".

At the same time, the Association indicated that it had disseminated copies of the Commission report to its membership and requested that the FCC advise RTMA if it feels the Association can do anything further to cooperate. Appropriate panels of the National Television System Committee will submit com-

(Continued on page 264)

NEW BOOKS

The Magnetic Amplifier

BY J. H. REYNER. *Stuart and Richards, London,* 1950, 119 *pages,* 15 *shillings.*

WITHIN very recent years the possibilities of saturable-core reactors as current-amplifying and current-control devices have come into considerable prominence. The literature on this subject is extensive but scattered and most of it is difficult to understand.

The author of this book has set himself the task of bringing down to earth the basic principles of the transductor and its application to control problems. By comparing tube principles and circuits with transductors he has, virtually without mathematics, succeeded in making the subject clear.

This book is a "first reader" and does not go into the many intricate and erudite aspects of the matter, but having digested the contents of its hundred-odd pages, the reader should be prepared to go on to the more extensive literature.

The transductor plus the metal rectifier offer great future control possibilities. It is high time that electronic engineers get familiar with the principles and applications thereof.—K. H.

RELEASED THIS MONTH

Industrial High Frequency Power; E. May; Wiley; $5.00.

Ionization Chambers and Counters; D. H. Wilkinson; Cambridge University Press; $4.50.

Radio Communication at Ultra High Frequency; J. Thomson; Wiley; $4.50.

Survey of Modern Electronics; Paul G. Andres; Wiley; $5.75.

Transmission Lines and Filter Networks; J. J. Karakash; Macmillan; $6.00.

Transmission Lines and Networks; W. C. Johnson; McGraw-Hill; $5.00.

Television Servicing

BY SOLOMON HELLER AND IRVING SHULMAN. *McGraw-Hill Book Co., New York,* 1950, 434 *pages,* $5.50.

AN ATTEMPT at a practical view approached in a simplified language. In general it succeeds very well. On occasion it labors under excessive effort, but these instances are held to a minimum.

The authors' preface remarks indicate possible use as a textbook for servicemen. From the technical aspect it can very well fulfill this expectation.

There is sufficient information on each portion of the television circuit to enable the reader thoroughly to understand the operation, and

(continued on p 138)

BACKTALK

This Department is Operated as an Open Forum Where Readers May Discuss Problems of the Electronics Industry or Comment Upon Articles that ELECTRONICS has Published

Old Timer

DEAR SIRS:

IN REGARD to the $600 German Watch Rate tester (ELECTRONICS, p 170 June 1950) Mr. Drieselmann's invention is only a very poor variation of an old principle, which was, as much as I know, first filed for patent by A. P. Davis, February 5, 1927 (patent No. 1,769,988).

Drieselmann is measuring the time between coincidences of the strokes of a standard watch and the X-watch. This means for most watches a time difference of 0.2 second. If it takes 3 minutes to build up this difference, the X-watch is 96 seconds per day slow or fast. For ten seconds a day it will take about 30 minutes.

Therefore, this test device is usable only for very poor qualities of watches, not for good ones.

It is much better to get a line record of the actual phase difference of the two watches; the angle of the line to the center line of the chart gives the watch rate and it is possible to see within seconds (not minutes) what the speed is.

The most serious difficulty is, however, the watch itself. The speed changes very much depending on whether the watch is fully wound, 9/10 wound, half wound and so on. For a good test you have to make measurements at different spring tensions.

You can find many diagrams showing the speed of different types of watches in "ATM" (Archiv fuer Technisches Messen) under J 154, where I have published the diagrams from many tests about 15 years ago.

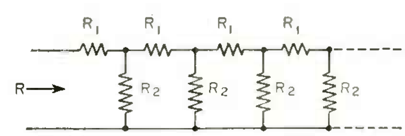
American watchmakers have been using such devices for more than 20 years. You may see them in many watchmakers' shops in the city. They are a great help to recognize a bad watch within a minute, but it is impossible to set the speed for a day's run within three minutes. This can only be done in mass production if you assume that all watches have the same uniform spring characteristic.

GEORGE KEINATH
Larchmont, New York

Electronics Quiz

THIS MONTH'S BRAIN-TEASER was submitted by Bob Wakeman of Bloomfield, New Jersey.

What is the impedance across the input terminals of the infinite ladder shown? Assuming R_1 to be 2 ohms, and R_2 to be 4 ohms, find R



The answer to this problem will appear in next month's Backtalk along with another problem. Readers are encouraged to submit puz-

(Continued on page 272)

yet not be burdened with extraneous material.

The authors have done very well with the difficult job of including a service analysis on each portion of the receiver. These thorough analyses can be used to extremely good advantage by the beginner who lacks the practical approach. A good practical serviceman must utilize a quick analytical approach which can be developed and sharpened by careful consideration of the analyses presented.

Unfortunately the book gets off to rather a slow start due apparently to the authors' lack of practical experience in antenna installation work. The first few chapters carry a few rather extraneous theoretical considerations and neglect many minor, but accumulatively important, practical considerations. This lack of the practical accounts for a lack of emphasis, leaving the beginner with that "textbook" feeling. The material presented is accurate technically but lacks this practical tempering. These deficiencies exclude the book from the "excellent" classification, but in spite of this criticism the book is well worth having. Practical additions to the early chapters could make a second edition top-notch.—EUGENE ECKLUND, *Bergen-Passaic Electronics, Inc., Bogota, N. J.*

The Principles of Scientific Research

BY PAUL FREEDMAN. *Public Affairs Press, Washington, D. C.*, 1950, 222 *pages*, $3.50.

THE AUTHOR says in the introduction that he has written this book for young men and women who are embarking on research as a career or are considering the possibility of doing so. He also has hopes that people in executive positions responsible for directing such young people will benefit from the ideas presented. He distinguishes clearly between the terms "science" and "scientific research", but states that scientific research is by far the most important constituent of science.

The first chapter is a very interesting history of the development of methods in scientific research. Such scholars as Aristotle believed

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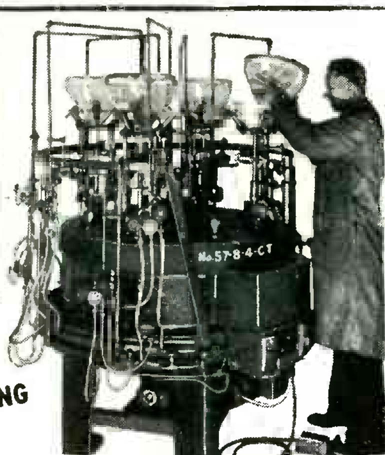

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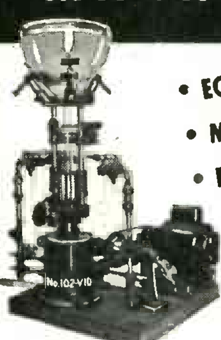

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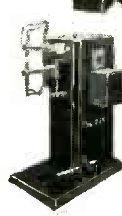

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that they could develop science by purely mental processes, and at a time when slavery was the custom they felt that any resort to use of their hands was beneath their status. This did a great deal to retard progress of science, and the author shows how gradually the experimental method became accepted as the basis for scientific research. The dual nature of matter growing out of quantum mechanics again places emphasis upon the importance of the hypothesis in scientific research, now used as a guide for experimental work rather than as something holy and unimpeachable in itself.

The society in which the scientist lives has a profound influence upon science. The author is frank in bringing out the hardships which this can impose upon a scientific research worker, but also points out the advantages that a scientist living today has in this regard in comparison with those of the past.

The correct mental approach is treated under the subjects: clarity of mind, a combination of imagination and caution, of receptivity and skepticism, of patience and thoroughness, and of ability to finalize, of intellectual honesty, of a love of discovery of new knowledge and understanding and of singleness of purpose. Education can be an asset, but the young research worker should have no illusion about how little it is compared with what he or she could acquire during succeeding years.

The planning of research is treated in considerable detail, including consideration of the nature of the problem, the method which the investigator proposes to apply, the thoroughness, the available resources, and the available time. The scientist who takes care of all the research himself is compared with the team organization, and the conditions are considered under which research can be successfully delegated. The accuracy required and the minimum number of essential observations are treated in terms of the desired result and the amount of effort required to achieve it. Since practically all research is sponsored, the scientific research worker should seek to know and understand the ways of patrons who

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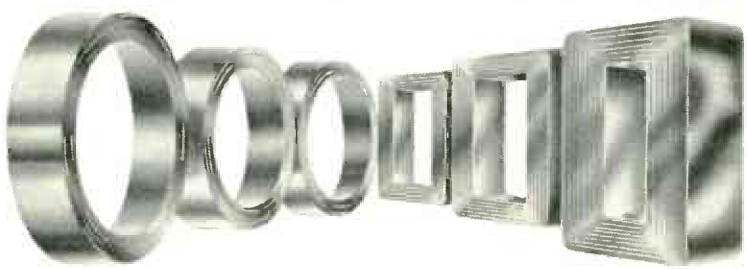

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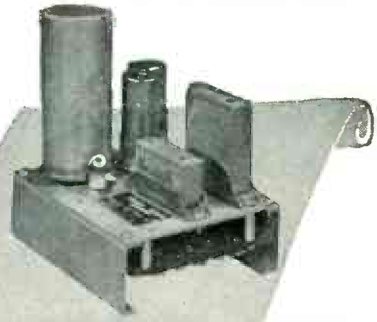

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The book is written in readable style with numerous examples. The author has given considerable original thought to the problems and presents viewpoints which are well worth considering. The book is recommended for interesting and instructive reading.—WALDO H. KLIEVER, *Director of Research, Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.*

Heaviside's Electric Circuit Theory

BY H. J. JOSEPHS, *Senior Physicist, Post Office Engineering Department. Methuen & Co., Ltd., London; John Wiley & Sons, Inc., New York. Second Ed.*, 1950, 113 *pages*, $1.25.

IT IS a real problem to present substantially all of Heaviside's important basic contributions to electric circuit analysis in one small monograph of 113 pages. The author has accomplished this, however, by a concise and clear treatment of the various fundamental methods of operational analysis as worked out by Heaviside and extended by Carson, Bromwich, and others. Just enough historical background is included to convey something of the boldness and originality of Heaviside's approach to circuit problems. Emphasis on the physical interpretation of results through numerous practical examples helps the reader appreciate the power of operational methods.

What the author calls "Heaviside's Last Theorem", of which the Carson integral theorem is a corollary, is used as a basis for establishing rigorously the various operational processes. However, one might debate the author's statement that this theorem had apparently "escaped the notice of engineers", since it is clearly pointed out by Bush in his *Operational Circuit Analysis*, to mention one case.

The usefulness of this monograph would be increased by the inclusion of even a modestly short table of operational expressions in an appendix. As it is, they are scattered throughout the volume and are difficult to locate. Some mention of the relation between Heaviside's operational approach and the now more generally used

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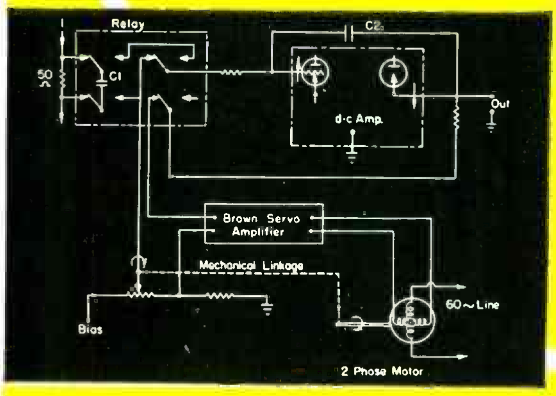

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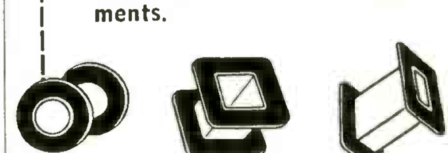

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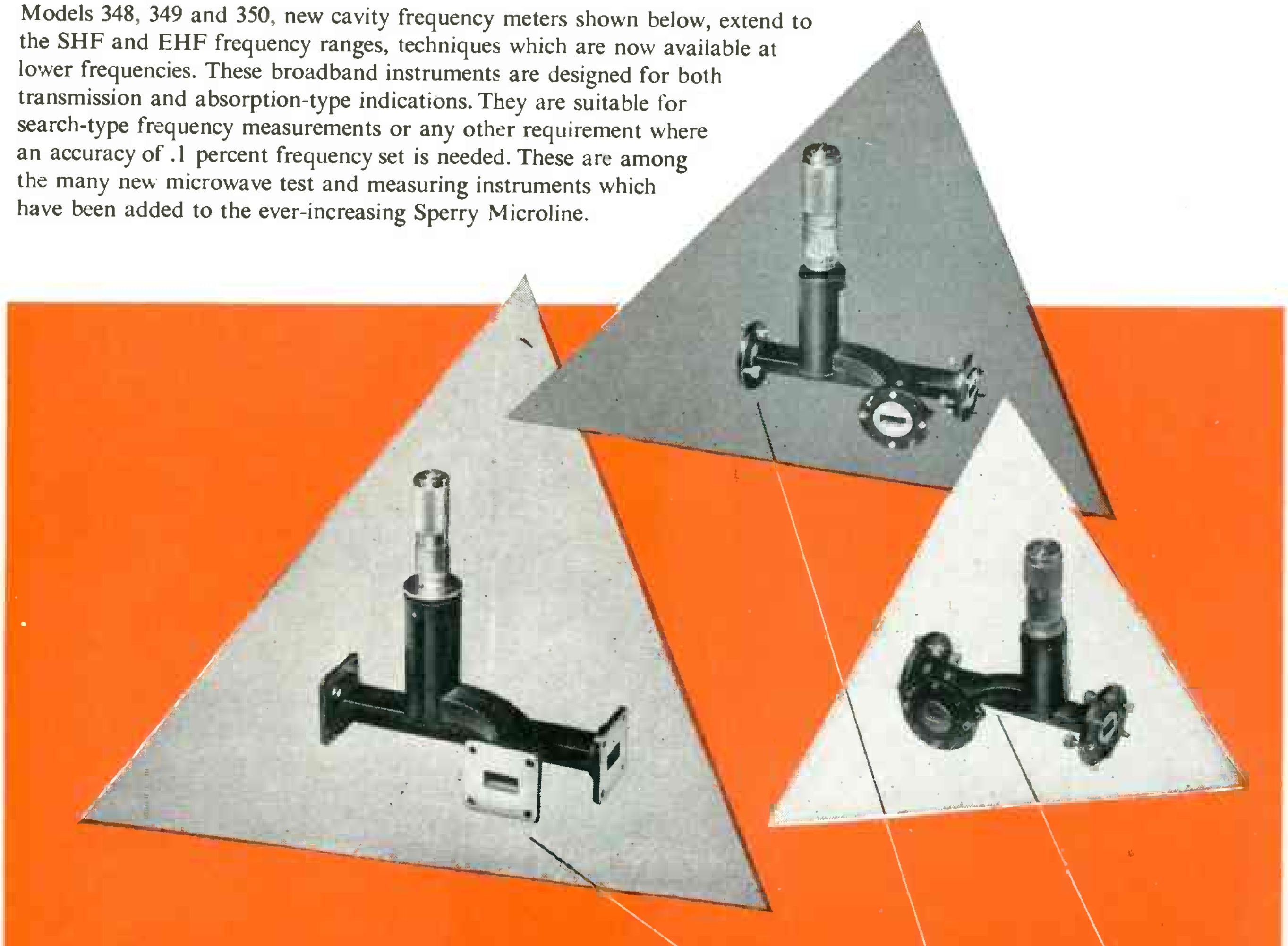

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Directional Coupler	388	12,400-17,000
Directional Coupler	429	32,000-39,000
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LaPlace transform methods would be desirable, but this perhaps is expecting too much for such a short monograph. This little volume should be useful for students or engineers with some background in basic mathematics and circuit theory, and for those desiring a concise exposition of Heaviside's methods.—J. GREGG STEPHENSON, *Airborne Instruments Laboratory, Mineola, N. Y.*

Acoustical Designing in Architecture

BY VERN O. KNUDSEN AND CYRIL M. HARRIS. *John Wiley and Sons, Inc., New York*, 1950, 457 *pages*, $7.50.

OF INTEREST not limited to just the profession indicated in the title. Anyone concerned with the production or reproduction of sound within natural or man-made enclosures will find much useful and helpful material within its pages.

The first three chapters briefly cover the general properties of sound and its propagation, the human hearing mechanism and its performance, and the energy-frequency distribution of noise, speech and music. The material is presented in what has become more or less the classical manner, based on such factors as contours of equal loudness. This reviewer hazards the guess that the average architect will emerge from these chapters with a somewhat bewildered impression. It would appear preferable to have such material presented instead in transmission characteristic form, showing for instance the fidelity or frequency response of the ear in decibels of relative loudness for constant input at various fixed sound intensity levels. This would allow direct comparison with the frequency characteristics of other elements in an overall sound system as usually presented in graph form.

After a chapter on the reflection and diffraction of sound waves by the surfaces normally encountered in rooms, the design of open-air theatres and stages is treated. The following two chapters on sound-absorptive materials and types of construction are of importance to anyone interested in modifying the acoustics of an enclosure, whether loudspeaker cabinet, living room or

Capacitors

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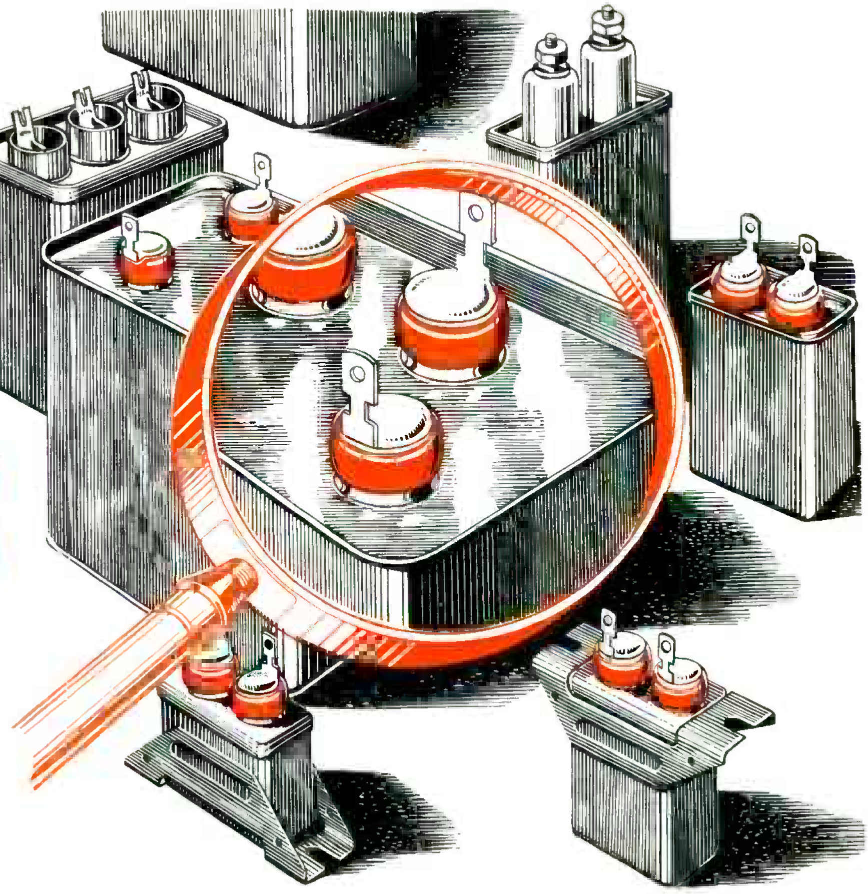

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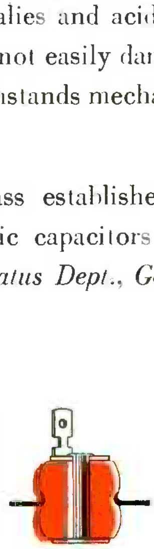

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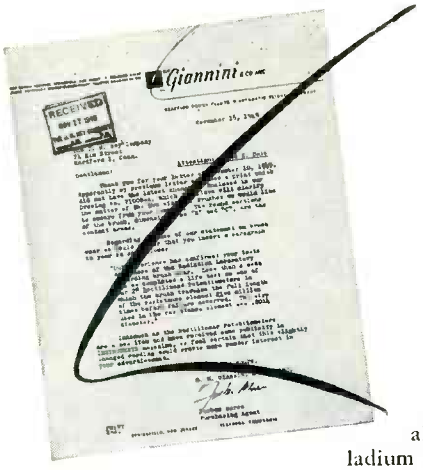

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And in addition, "R" Monel proved to be a *practical* metal . . . economical, machinable. "R" Monel is particularly well-adapted for use on automatic screw machines, since it may be machined at relatively high cutting speeds.

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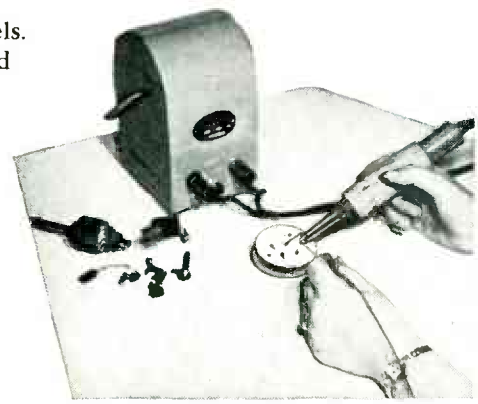

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a theatre. The phenomena resulting from resonances in the cavity or group of cavities which constitute a room is then considered; this chapter naturally leads to one on the control of room resonance, reverberation and propagation paths to provide desired characteristics.

Noise or undesired sound will invade the enclosures in which people live, work and relax through many, often minor, paths. Four chapters treat noise control, presenting the necessary structural devices and precautions which optimize acoustic signal-to-noise ratio within a room through noise reduction. When noise cannot be further reduced, obviously only an increase in signal level can improve the signal-to-noise ratio. A chapter is devoted to a consideration of the role of electrical amplification in reinforcing speech and music, by both monaural and stereophonic means.

The book concludes with six chapters which are more specifically concerned with definite design problems than is the preceding material. These cover auditoriums, theatres, school classrooms, lecture rooms, music rooms, commercial and public buildings such as restaurants and hospitals, homes and apartments, churches, and radio, television and recording studios. Three appendices are provided, including comprehensive tables of sound absorption coefficients of materials and sound insulation data for various types of partitions and structures, plus a brief table of conversion factors and physical constants.

There are many charts and graphs scattered through the text which summarize much useful acoustical information. It is perhaps to be regretted that a few additional words were not included in explanation of some items as, for instance, the chart for summation of two noise levels (Fig. 10.1) where the text does not make clear that the resultant is simply the sum of the sound energy or power of the two noises.

This reviewer cordially recommends the book as a welcome addition to the literature of engineering acoustics, as well as for its great potential usefulness to the architect, who, in turn, can benefit us all.

The opinions and assertions con-

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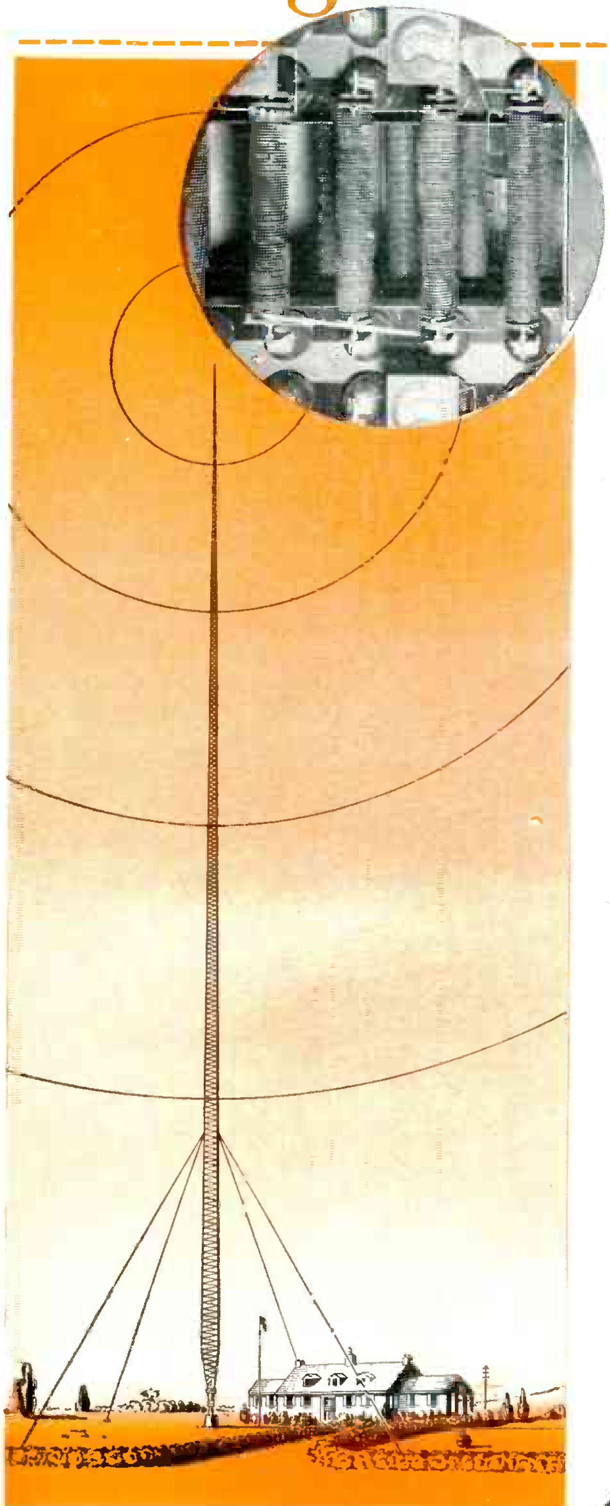

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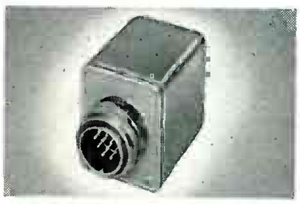

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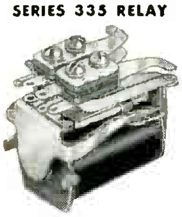
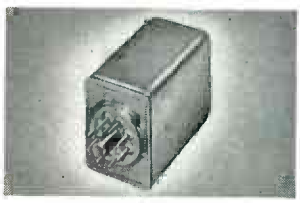


SERIES 595 RELAY



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A COMPLETE LINE OF RELAYS SERVING AMERICAN INDUSTRY tained in this review are those of the undersigned reviewer and are not to be construed as official or necessarily reflecting the views of the Department of the Navy.—EMERICK TOTH, *Radio Techniques Branch, Radio Division II, Naval Research Laboratory, Washington, D. C.*

THUMBNAIL REVIEWS

JOSEPH HENRY. By Thomas Coulson. Princeton University Press, Princeton, N. J., 1950, 352 pages, $5.00. Complete critical account of Henry's life and his contributions to science.

INPUT IMPEDANCE OF A SLOTTED CYLINDER ANTENNA. Engineering Experiment Station Circular Series No. 59, March 1950, University of Illinois, Urbana, 50 pages, 40 cents. Properties of antenna, derivation of transmission line equations, and mathematical procedure for calculating performance.

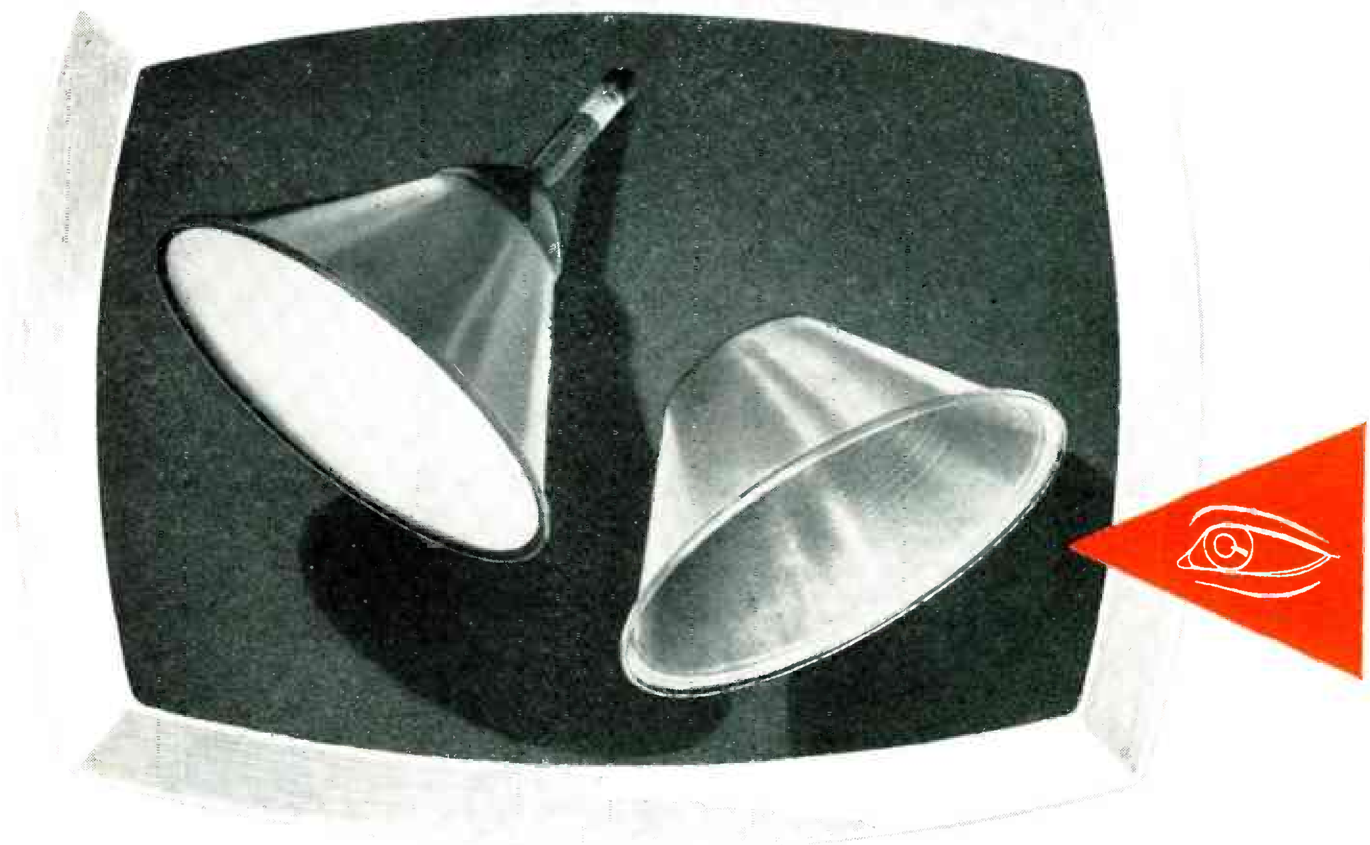
A.S.T.M. STANDARDS ON ELECTRICAL INSULATING MATERIALS, 1950 Edition. American Society for Testing Materials, 1916 Race St., Philadelphia. 670 pages, $4.85. Contains all of the standard and tentative test methods and specifications pertaining to insulating materials, many of which have been recently revised.

A BIBLIOGRAPHY IN AUDITION. Volume I—A-M; Volume II—N-Z. Mimeographed. Distributed by Harvard University Press, Cambridge 38, Mass., $3.00. Comprehensive bibliography (each volume is almost one inch thick, on 8½ by 11 sheets) prepared by Psycho-Acoustic Laboratory of Harvard under ONR contract. References are arranged alphabetically by author, and keyed to a separate classification by subject so that authors for any desired aspect of audition are easily located. Major classifications are anatomical, physiological, psychological, deafness, and auditory theory.

PROCEEDINGS OF THE NATIONAL ELECTRONICS CONFERENCE, Vol. V (1949). National Electronics Conference, 852 E. 83rd St., Chicago, Ill., 202 pages. $4.00. Includes in permanent cloth-bound form, with few exceptions, all of the papers presented at the Sept. 26-28, 1949 conference, along with tables of contents of previous issues of the proceedings. Still available is Vol. 2 (1946) at $3.50 and Vol. 3 (1947) and 4 (1948) at $4.00 each.

ELECTROMAGNETIC WAVES. By F. W. G. White. John Wiley & Sons, New York, 1950, Fourth Edition, 108 pages, $1.25. Part of Methuen's Monograph series. Despite occasional typographical errors and some over zealous condensation, the book contains a fairly complete outline of the theories of Maxwell and Lorentz and of radio waves in the upper atmosphere.

THE EFFECTS OF ATOMIC WEAPONS. Prepared for and in cooperation with the U. S. Atomic Energy Commission and Department of Defense under the direction of the Los Alamos Scientific Laboratory. McGraw-Hill Book Co., New York, 1950, 456 pages, $3.00. Summary of what is known today about effects of atomic explosions, with graphs and data on air blast damage, ground and underwater shock, thermal radiation, initial nuclear radiation and residual radiation at varying distances from ground zero. Chapters cover measurement of nuclear radiations, decontamination, effects on personnel and protection of personnel. Appendices cover computation of deformation of structures by blast waves, calculation of hazard from world-wide contamination, and Roentgen measurements.



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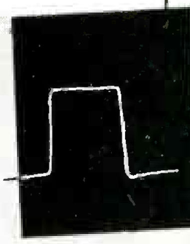

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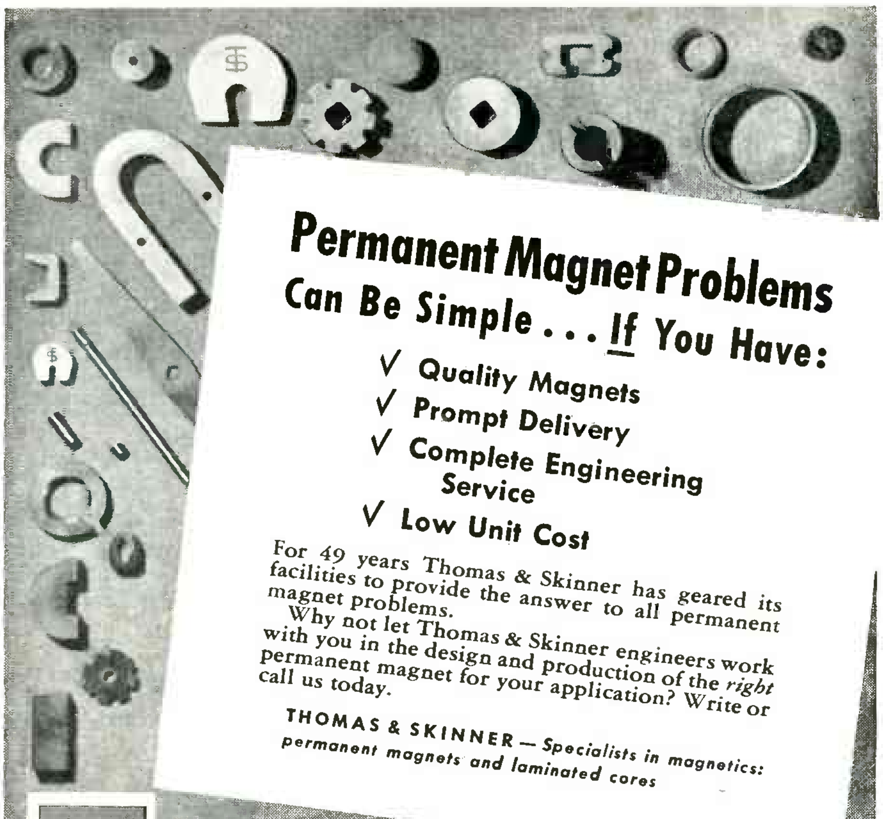

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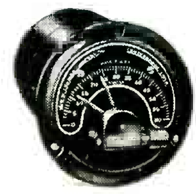

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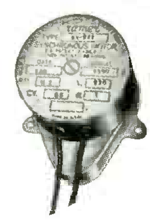

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TUBES AT WORK

(Continued on p 122)

servations by telephone to the operating personnel in the control room on the floor below. The numerous disadvantages of such a method are apparent and the system was soon abandoned and replaced by a television installation.

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Rocket Research

The NACA Lewis Rocket Laboratory has also made use of this new medium. A great deal of research is concerned with new and, as yet, untried compounds for use as propellants. Many of the fuels and oxidants exhibit poisonous, corrosive or explosive characteristics. They may be difficult to handle by themselves and, when they combine within the rocket engine, it is not always possible to predict the result. The Rocket Laboratory has a special test cell for hazardous experiments remotely located from the principle installations. This cell is equipped with television allowing personnel in the remote control room to view the rocket in operation. The cost and availability of many of these compounds and the hazards involved make it expedient to limit both the duration and number of test runs. The use of television has contributed greatly in regard to these aspects of rocket testing.

At a recent technical symposium, it was necessary to exhibit some interferometer images from a test installation located in a small test cell over a quarter-mile from the auditorium. The limited size of the test cell, its location in reference to the auditorium and several other factors made it impossible for the assembled group to view directly the images on the interferometer. Coaxial cable was installed, a television camera set up in the test cell and a kinescope viewer placed

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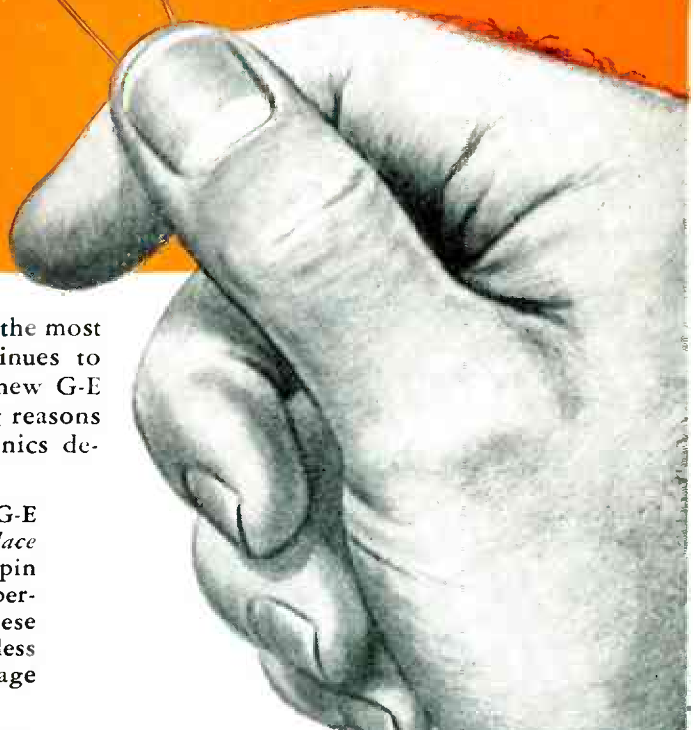
Peak Rectified Current (ma)	125	90
Surge Current (ma)	400	350
Temp. Range °C	−50 to +70	−50 to +70
Characteristics at 25°C		
Max Inverse Current at −50v(ma)	.85	.41
Max Inverse Current at −10v(ma)	.05	.01
Min Forward Current at +1v(ma)	5.0	3.0
Average Shunt Capacitance (mmfd)	0.8	0.8



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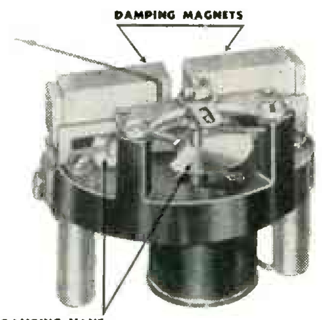

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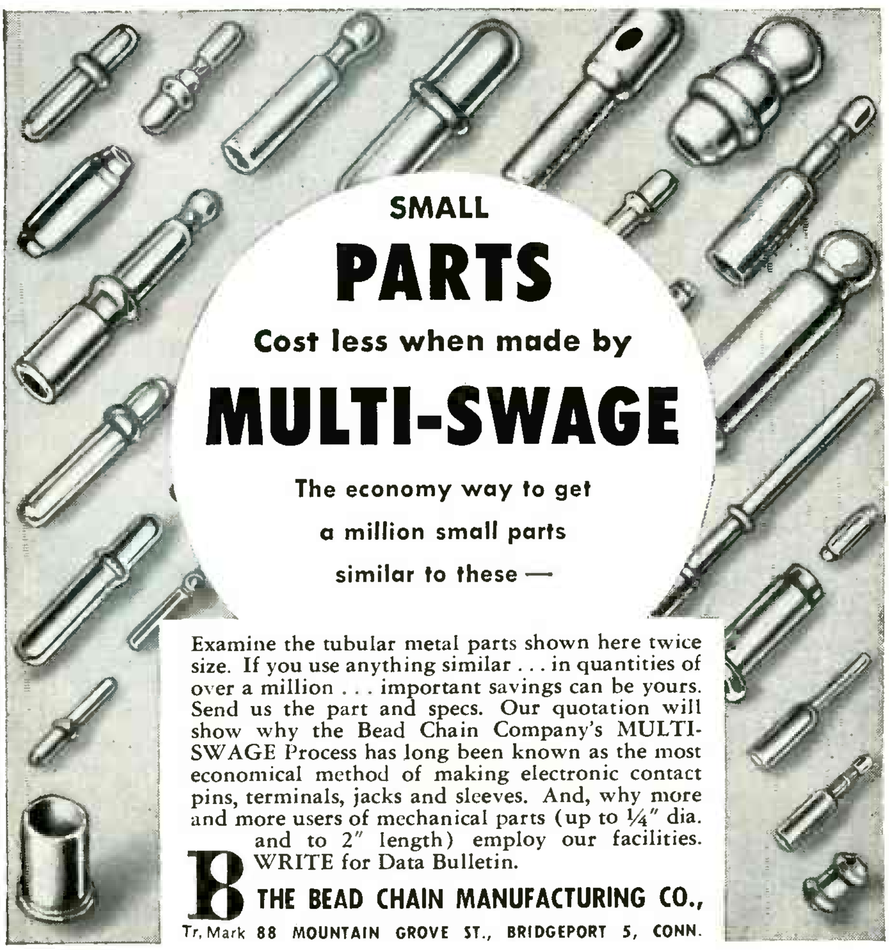

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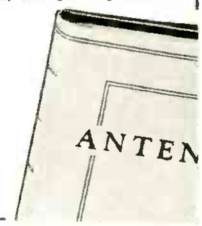

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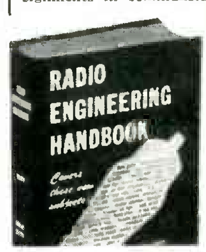

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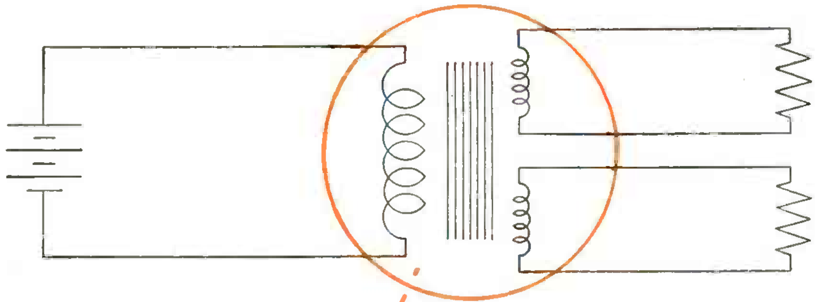

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in the auditorium. There the assembled group, without having the continuity of the discussion interrupted, was able to view images several times larger and more brilliant than the original.

Equipment

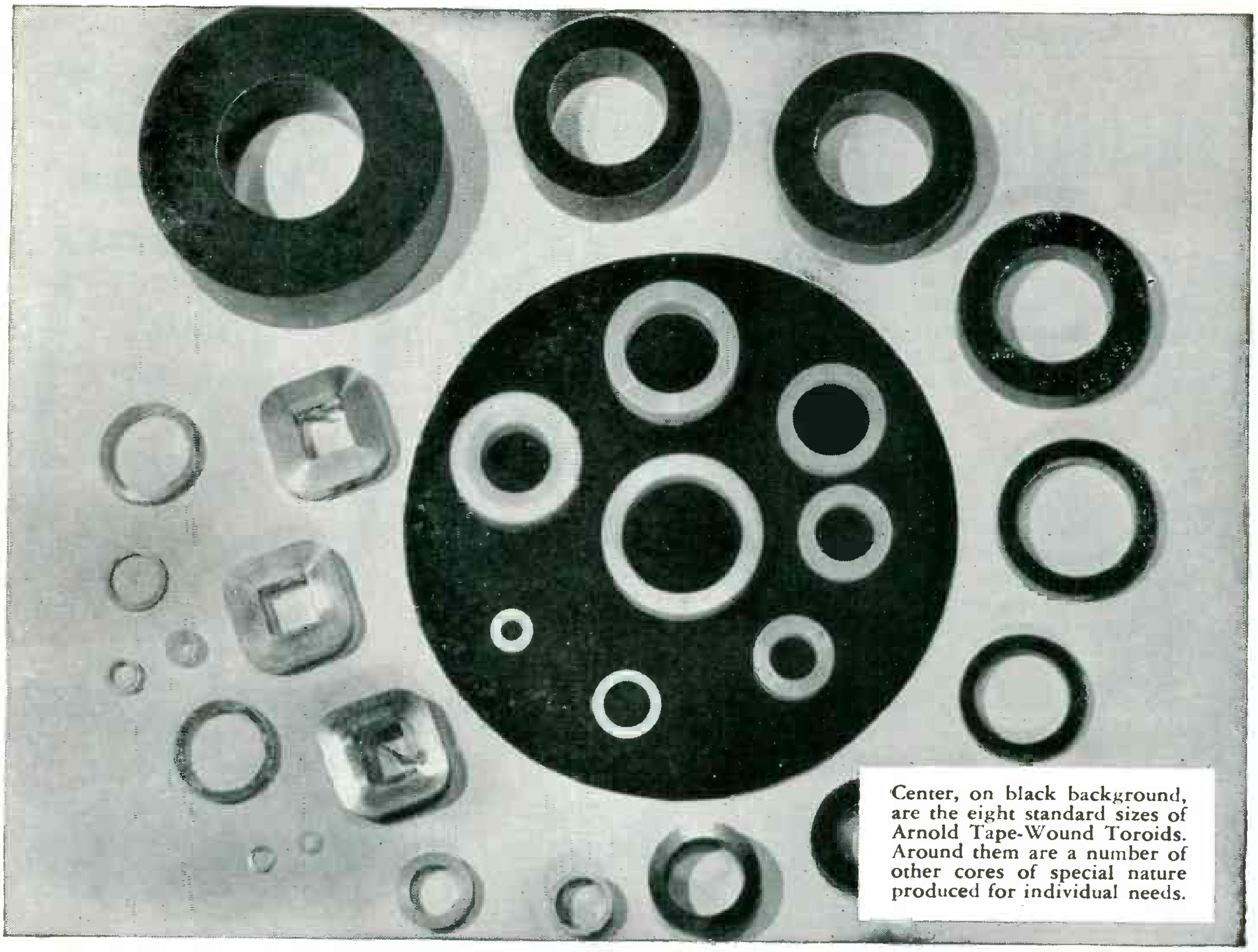
The television cameras used in these installations are revamped Army units formerly used in radio-controlled glide bombs which were becoming quite effective at the close of World War II. To minimize the flicker inherent in the original design, the verticle scanning rate was increased from 40 to 60 frames per second. The frame frequency was synchronized with the 60-cycle mains frequency to arrest the motion of any non-

Viewer on panel in control room of supersonic wind tunnel is ten-inch tube

linear portions of the picture. For greater detail the horizontal or line frequency was increased from 14,400 to 19,200 cycles per second, producing a 320-line picture.

In their original state all the camera controls were an integral part of the unit. It was then impossible to make adjustments during the test run and serious degradation in picture quality while the test was in progress might occur. Accordingly, the more important controls were removed from the camera unit and placed on a panel near the viewing equipment, so allowing the observer to keep the picture quality at a usable level. The limiting factor in achieving maximum resolution was apparently in the war-time image orthicon.

These cameras, designed for 24-



Center, on black background, are the eight standard sizes of Arnold Tape-Wound Toroids. Around them are a number of other cores of special nature produced for individual needs.

ARNOLD TAPE-WOUND TOROIDAL CORES

of DELTAMAX
4-79 MO-PERMALLOY
SUPERMALLOY*

In addition to the standard toroids described at left, Arnold Tape-Wound Cores are available in special sizes manufactured to meet your requirements—toroidal, rectangular or square. Toroidal cores are supplied in protective cases.

**Manufactured under licensing arrangements with Western Electric Company.*

W&D 3182

APPLICATIONS

MAGNETIC AMPLIFIERS
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RANGE OF SIZES

Arnold Tape-Wound Toroids are available in eight sizes of standard cores—all furnished encased in molded nylon containers, and ranging in size from ½" to 2½" I.D., ¾" to 3" O.D., and ⅛" to ½" high.

RANGE OF TYPES

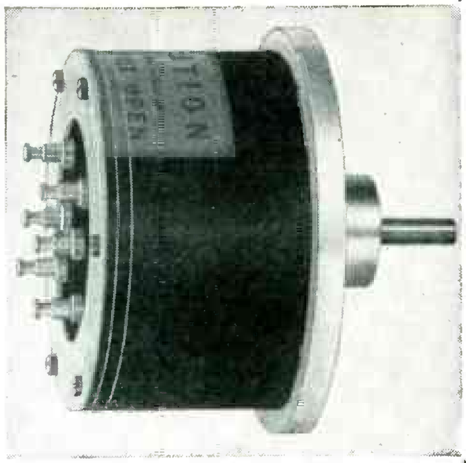
These standard core sizes are available in each of the three magnetic materials named, made from either .004", .002" or .001" tape, as required.

THE ARNOLD ENGINEERING COMPANY

SUBSIDIARY OF ALLEGHENY LUDLUM STEEL CORPORATION

General Office & Plant: Marengo, Illinois

PRECISION POTENTIOMETERS



Various types of potentiometers custom wound to specifications are available. They feature extremely close limits in electrical characteristics and mechanical construction, low electrical noise, low torque, and long life.

All types will operate within specified limits of performance at temperatures —55° C. to +55° C., 95% relative humidity at altitudes up to 50,000 feet. Corrosion resistant materials are used throughout and all insulating parts are fungicided. Our potentiometers meet AN-E-19 specifications.

We invite your inquiries and specifications.

A minor modification of the standard sinusoidal potentiometer type RL-11-C (as illustrated) permits operation up to 1800 RPM. After a test of 28 million cycles at 1800 RPM, one of these units showed negligible wear.

Write for Bulletin F-68.

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Unique twin beam flat face tube permits EXACT time comparison of two waveforms without phase or frequency error. Beams are independent vertically and locked in horizontal direction, can be separated, superimposed or crossed for any comparative test . . . and . . .

Model 1035 TWIN BEAM SCOPE (illustrated) offers these additional features:

DIRECT time measurement on calibrated controls from 150 millisec. to 1 microsec.

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Recurrent or triggered sweeps from 150 millisec. to 5 microsec. High gain, wideband amplifier,—3 de. at 7 Mc.

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SPRINGMAKING "know how"—and, of course, modern manufacturing facilities—can mean a lot to spring users. The three springs illustrated above are good examples of how Accurate can slash spring costs with modern methods. Where previously multiple operations and intensive inspection was required in the manufacture of these springs, Accurate was able to develop means of producing each in a single operation so accurately that inspection by the users could be eliminated or substantially reduced. And the unit price of each is a fraction of a cent! Since tens of millions of each of these are in daily use the overall savings are very sizable.

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Springs, Wire Forms, Stampings

For inserts in coaxial connectors, "Teflon" helps eliminate distortions in the circuit.

For high-frequency, high-voltage, high-temperature wires, the heat-resistance of "Teflon" makes it a superior insulator.

5 reasons why DU PONT "TEFLON"* gives unequaled efficiency in high-frequency transmission

Coaxial spacers molded of "Teflon" can boost transmission-line efficiency more than 10%.

In coaxial cables, "Teflon" is resilient and flexible and has high dielectric strength and low loss factor.

DU PONT'S NEW "TEFLON" tetrafluoroethylene resin is proving to be an excellent insulation for high-frequency wires and cables, coaxial transmission lines for FM radio and TV, and coaxial connectors. "Teflon" offers all these advantages:

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2. **Low loss factor**—The loss factor of "Teflon" is less than 0.0005 over the entire range of frequencies measured to date. Almost no power is lost through transmission-line spacers made of "Teflon."

3. **Heat-resistant**—The heat-resistance of "Teflon" is higher than that of any other thermoplastic (withstands up to 500°F.). And its electrical properties show little change up to 400°F.

4. **Tough and resilient**—"Teflon" withstands abuse—won't crack if dropped. It is resilient and flexible even at extremely low temperatures. Resists damage from vibration or bending when used as insulation on wires and cables.

5. **Zero moisture-absorption**—"Teflon" shows a moisture-absorption of 0.00% by A.S.T.M. D570-42. Hence its electrical properties are unaffected even after prolonged soaking in water.

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"TEFLON" is supplied by Du Pont in molding powders, tape, and water dispersions. We will gladly suggest molders or fabricators who can supply finished parts of "Teflon." Write today for more information. Our technical staff will be glad to help you. E. I. du Pont de Nemours & Co., (Inc.) Polychemicals Department, Sales Offices: 350 Fifth Ave., New York 1, N. Y.; 7 S. Dearborn St., Chicago 3, Ill.; 845 E. 60th Street, Los Angeles 1, California.

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PLASTICS
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volt d-c operation, were reworked and operated from power supplies energized by the 115-volt a-c mains.

The camera to be installed in the Schlieren receiver in the test capsule at the supersonic wind tunnel was subject to additional alteration. When the atmospheric pressure drops to 10-inch mercury, serious arcing takes place in the high-voltage circuits with corresponding deterioration of the picture. To overcome this difficulty a pressure-tight vessel was constructed and the camera placed within. This vessel was vented to atmosphere and service air allowed to flow through the interior for cooling

Acoustic Shields

Since the sync pulse generators, audio amplifiers and the voltage regulators are an integral part of the camera unit, means for adequate ventilation must be provided. In addition to the general cooling air circulating through the camera compartment, low-velocity jets of air were directed to the face of the orthicon and also to several components which had a tendency to operate at an elevated temperature. All these steps were helpful but there still remained a tendency toward picture deterioration which would begin after several hours.

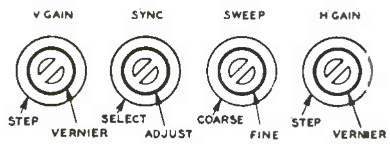
Cameras are often located in areas of high ambient noise level. To minimize microphonic pickup acoustic shields have been constructed and successfully used. Unfortunately most materials having favorable acoustic properties are also effective thermal insulators. Accordingly it was found necessary to make provisions for circulating cooling air through the interior of the acoustic chamber to maintain satisfactory operating temperature.

The viewing equipment consists mainly of commercial receivers. Ten-inch kinescopes are used in the control rooms. Where it is desired to accommodate a larger group of viewers, units employing sixteen-inch picture tubes have been installed. As a service device, a portable monitor with a three-inch tube has proved valuable for checking cameras and making minor adjustments. The horizontal oscillators on these units were altered to allow

Announcing a 7" TV 'scope...

RCA WO-56A

DUAL CONTROLS FOR "COARSE" AND "FINE" ADJUSTMENTS



No hunting or fumbling for controls when adjusting Vertical Amplifier Gain, Sweep Frequency, Sync Injection, and Horizontal Amplifier Gain.

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Suggested User Price

Includes set of matched probes and cables (direct probe and cable, low-capacitance probe and ground lead)

FEATURING—

- Giant RCA 7JP1 cathode-ray tube.
- Direct-coupled, 3-stage, push-pull, vertical and horizontal amplifiers.
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- A set of matched probes and cables.
- Panel-source of 3 volts peak-to-peak calibrating voltage.
- Identical vertical and horizontal amplifiers with equal phase-shift characteristics.
- Retractable light shield for convenience and visibility.
- New *green* graph screen with finely ruled calibrations.
- Magnetic metal shield enclosing CR tube to minimize hum-pickup from internal fields.

SPECIFICATIONS—

- Deflection Sensitivity: 10 rms millivolts per inch.
- Frequency Response: Flat within −2 db from dc to 500 kc; within −6 db at 1 Mc; useful beyond 2 Mc.
- Input Capacitance: Less than 10 uuf with WG-216A Low-Capacitance Probe.
- Square-Wave Response: Zero tilt and overshoot using dc input position. Less than 2% tilt and overshoot using ac input position.
- Linear Sweep: 3 to 30,000 cps with fast retrace.
- Trace Expansion: 3 times screen diameter in vertical and horizontal axis, with 3 times centering control.
- Size 13⅜" h, 9" w, 16⅝" d. Weight only 31 pounds (approx.)

ADVANCED SWEEP FACILITIES—

- Preset fixed sweep positions for vertical and horizontal television waveforms.
- Positive and negative syncing for easy lock-in of upright or inverted pulse waveforms.
- 60-cycle phase-controlled sweep and synchronizing.

Built for laboratory, factory, or shop use, the WO-56A combines the advantages of high-sensitivity and wide-frequency range in a *very small* instrument with a *large* cathode-ray tube.

Designed with the user in mind, this new 'scope can be depended upon to provide sharp, bright, large, and accurate pictures of minute voltage waveforms over the entire useful surface of the 7JP1 screen.

The direct-coupled amplifiers are provided with ac positions so that measurements can be made with or without the effects of any dc component.

Square-wave reproduction is excellent, whether the application is low-frequency TV sweep-alignment or observation of high-frequency steep-fronted sync and deflection waveforms.

The excellent linearity and fast retrace of the sweep or time base are functions of the Potter-type oscillator and the undistorted reproduction of the sawtooth by the wide-band horizontal amplifier. The preset-fixed positions provide rapid switching between vertical and horizontal waveforms in TV circuits.

Truly, the WO-56A is a most useful and practical instrument for everyday work in the fields of television, radio, ultra-sonics, audio, and a wide array of industrial applications.

For details, see your RCA Distributor, or write RCA, Commercial Engineering, Section K42X, Harrison, N.J.

RCA

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Video Oscillator TF 885 is a wide range beat frequency oscillator, impressive alike in performance, stability and appearance. It embodies thermally screened oscillators, dual frequency standardisation, a ladder - network attenuator and really effective automatic level control. The output, monitored by a vacuum tube meter, may be of sine or square waveform and is continuously variable from 316μV up to 31.6V—1 watt into 1000Ω sine, or 64V peak-to-peak. The frequency cover—2 bands on a generous 8-inch dial—is 25 c/s to 5 Mc/s sine and 50 c/s to 150 kc/s square. At full load individual harmonics are generally below 3%, falling considerably at lower outputs. The frequency characteristic is within 1db, as are the attenuator steps at other than extreme h.f. attenuation.

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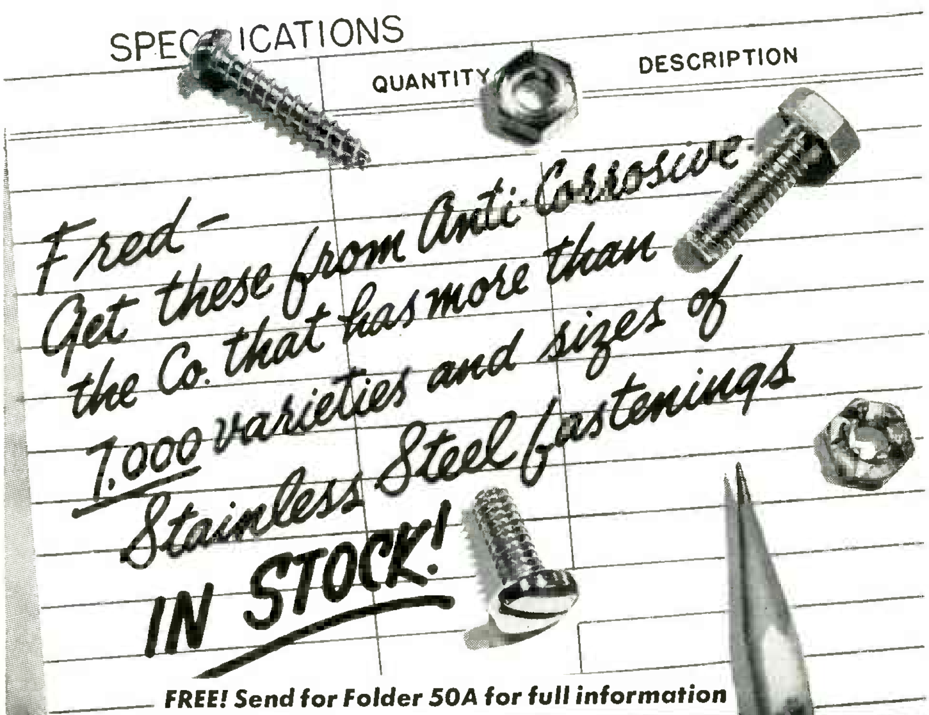

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77/100/5	19-21
115/50/5	28-32
COLOR	Tan
APPLICATION TEMPERATURE	285/350 F
SPECIFIC GRAVITY	0.91
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R-4005 for impregnating and dip coating coils, transformers, capacitors, etc., features high melting point, low impregnating viscosity, good electrical properties, resistance to low temperature crazing, good transparency and good adhesion. R-4005 is recommended for extreme high temperature applications on parts designed to operate up to 105-110°C, and its low temperature flexibility, coupled with its low degree of thermal shrinkage, make R-4005 well suited for units that must withstand extreme low temperatures down to minus 40°C. Its low electrical loss factor recommends R-4005 for impregnating special high quality coils. By altering wax bath temperatures and preheat cycles a wide latitude of single dip coating thicknesses can be obtained. The relatively transparent coatings are easily read through, and the surfaces obtained are semi-gloss and relatively non-blocking.

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For combustion study, the color of a flame contains a wealth of information concerning its characteristics. Observation of the flame becomes of increased importance when it is realized that such a procedure provides the only method of providing certain information. Unfortunately the group in charge of operating the combustor does not always have free access to viewing the unit while it is in the test chamber. Color television as a means for furnishing operating data would be invaluable.

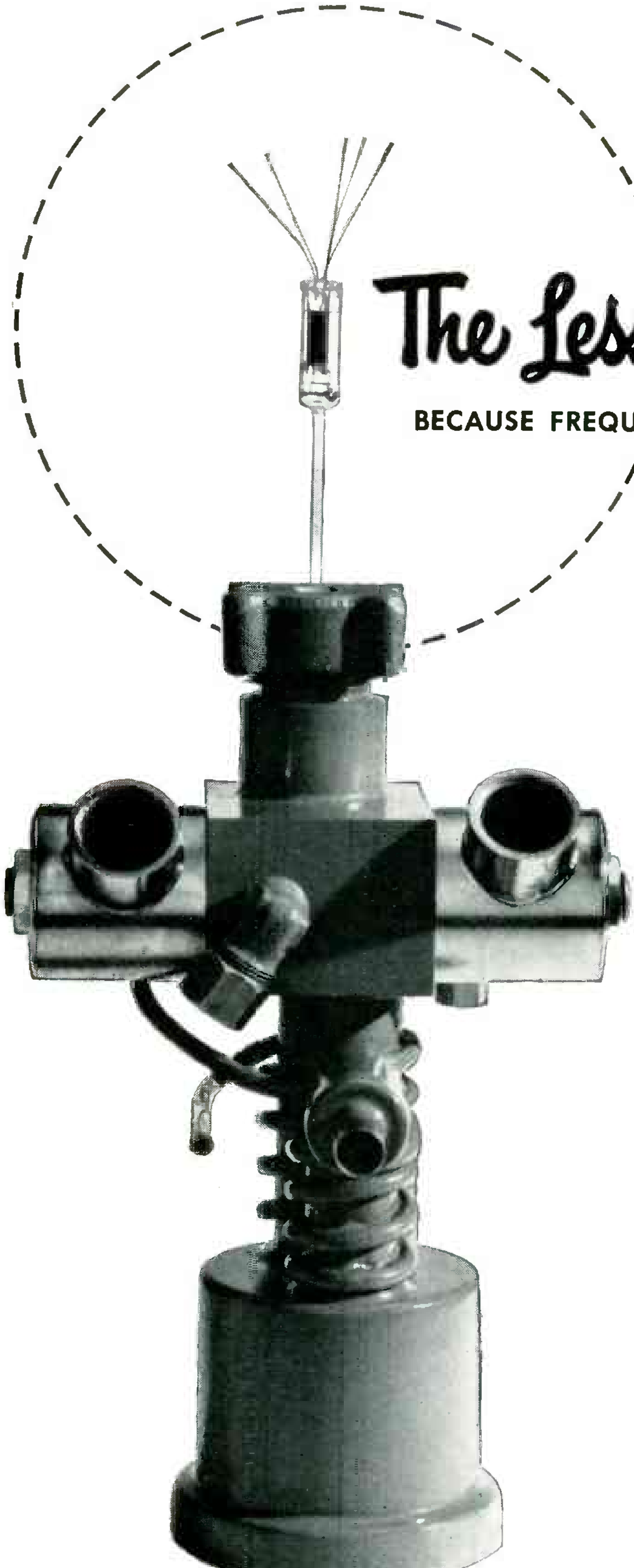
The frame sequential method with mechanical color separation appears to be a practical solution for industrial color television. Since all scanning wheels would be operated from the same power source, there is no difficulty in maintaining synchronism. The problem of compatibility does not exist in industrial television and, accordingly, the only limit to maximum bandwidth then is one of a technical nature.

The need for rugged, dependable television equipment for use in engine research is urgent. Equipment not affected by extreme temperature and pressure changes is a primary requirement. In addition, since all engine testing installations are noisy, the camera should be capable of producing picture signals relatively free from noise disturbances.

Three-In One Broadcast

LATEST system to increase the usefulness of f-m broadcast channels was recently demonstrated by William S. Halstead of Multiplex Development Corp. Using the facilities of former WGYN, New York City, he broadcast simultaneously a musical program heard on receivers tuned to 97.9 mc and a second musical program that could be picked up only with a special receiver. Later, a facsimile picture was transmitted over the second circuit, with no interference to the main program and no slop-over into adjacent channels.

The system is a simplification of



The Less Getter the Better

BECAUSE FREQUENCIES ARE HIGHER AND TUBES ARE SMALLER

If you manufacture small electronic tubes, DPi's new VMF-5 Exhaust Unit pictured here can provide a happy ending to your quest for lower, more consistent residual gas pressure.

With today's push toward ever-higher frequencies, you can't afford to ignore the effect of residual gas on the low capacitance demanded in tubes. And with the small size of today's tubes, you can't use much getter to "clean up" residual gas, because the metallic film deposited can result in serious inter-element leakage.

VMF-5 Exhaust Units quickly take pressure down to 0.1 micron Hg before the getter flash, as compared with the 10- to 100-micron pressures to which older equipment limits you. They come equipped with water-cooled ports that fit any standard tubulation or can be fitted with ports of your own design. Two a-c solenoid valves (or three if required by the design of your rotary exhaust machine) isolate the diffusion pump during roughing.

The VMF-5 is just one of a series of high vacuum pumps designed by DPi for the specific conditions of the electronics industry. They are made in a wide range of pumping speeds.

Before you go ahead with the design and production of a tube exhaust system, call on DPi. There's no obligation, of course, and chances are that DPi can help build better reliability into your product at less cost. Write: Vacuum Equipment Department, ***Distillation Products Industries,*** 727 Ridge Road West, Rochester 3, N. Y. (Division of Eastman Kodak Company)

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TWO-in-ONE

D·C·P* adds or subtracts two input voltages

*Differential Computing Potentiometer

"Two potentiometers in one" most aptly describes the Fairchild Differential Computing Potentiometer. This versatile unit makes it possible to combine two input variables and obtain an output that is proportional to their sum or difference.

Available in quantity, the D-C-P costs less than two separate type 748 units while offering high resolution and accuracy of a single potentiometer. Linearity of ±0.10%, high resolution, long life, low noise level, and low torque—all Fairchild Linear Potentiometer features—are built into the D-C-P.

Suggested applications include servomechanisms, instrument controls, and computing and analyzing instruments. The D-C-P will directly replace two single potentiometers when one is used for compensation or correction purposes. For more data, write to Fairchild Camera and Instrument Corporation, 88-06 Van Wyck Boulevard, Jamaica 1, N. Y. Dept. 140-12A.

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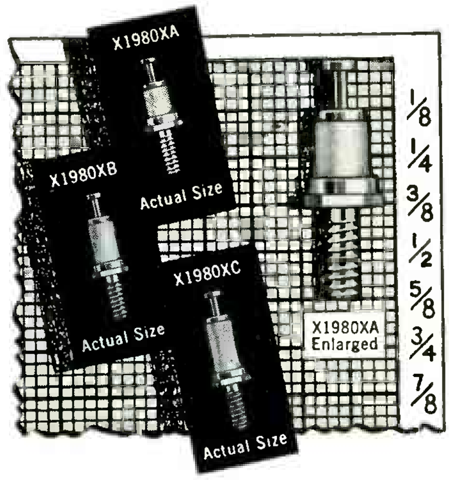
New Miniature Insulated Terminals

to help your miniaturization program



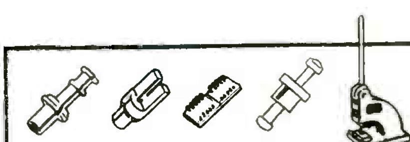
Featuring extremely small size combined with excellent dielectric properties, three new miniature insulated terminals are now available from CTC.

Designed to meet the requirements of the miniaturization programs now being carried out by manufacturers of electrical and electronic equipment, the terminals come in three lengths of dielectric and with voltage breakdown ratings up to 5800 volts. In addition, they have an extremely low capacitance to ground.

The X1980XA is the smallest terminal, having an over-all height of only three-eighths of an inch including lug. Insulators are grade L-5 ceramic, silicone impregnated for maximum resistance to moisture and fungi.

All terminals have hex-type mounting studs with 3/48 thread or .141″ OD rivet style mounting. Mounting studs are cadmium plated, terminals are of bright-alloy plated brass.

Write for additional data.



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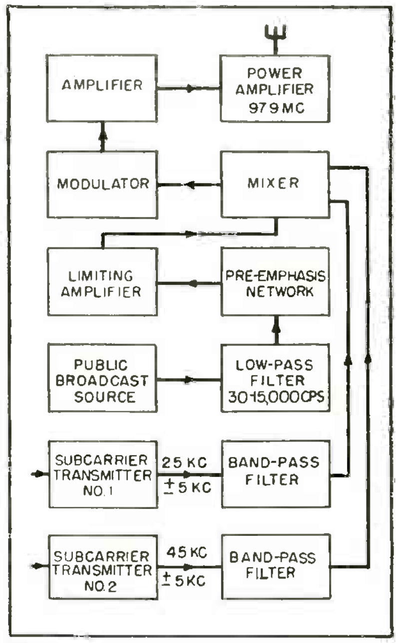

FIG. 1—Simplified block diagram of three-channel system using two subcarriers. Frequencies other than that of main carrier are representative

the technique first used by E. H. Armstrong in 1934.[1] Optimum results are obtained with an f-m modulator[2] having s/n ratio of better than 60 db from 30 to 15,000 cps. By keeping subcarrier modulation below −60 db, referred to normal program level of the main channel, no interference is experienced. One or more subcarrier f-m transmitters are used for additional channels, as shown in Fig. 1. The carriers are well above audible frequencies, those indicated in the block diagram being merely representative. Deviation or swing employed in modulating these subcarrier transmitters is low compared with standard broadcast practice of ±75 kc.

In the original Armstrong demonstration a receiver was required that could separate the signals. In the new development, the listener on the main channel is unaware of the additional intelligence. At the receiving point, Fig. 2, output from the regular f-m discriminator circuit is fed through a high-pass filter to the subcarrier receiver unit. Either of the subcarrier channels can be selected and the audio output connected to the amplifier and speaker.

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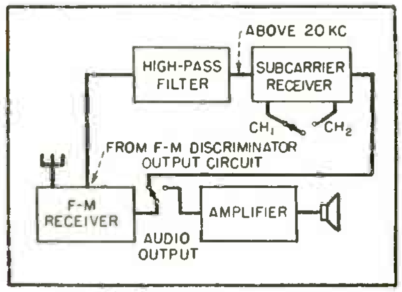

FIG. 2—Block diagram of demonstration receiving setup for three channels

has been made to extend the frequency range beyond 10 kc. At the same time, there is no deterioration to the regular 30-15,000-cps response to the main channel.

In the broadcast network application, the auxiliary channels can be used for teletypewriter, facsimile, audio program or even a program that is being relayed in a direction opposite to that in which the main broadcast network is set up. Alternatively, a station carrying one network program for listeners can at the same time relay a different network program for the benefit of another station or stations in the physical chain.

One variation of these arrangements is shown in Fig. 3. This possible combination shows three f-m broadcast stations with their

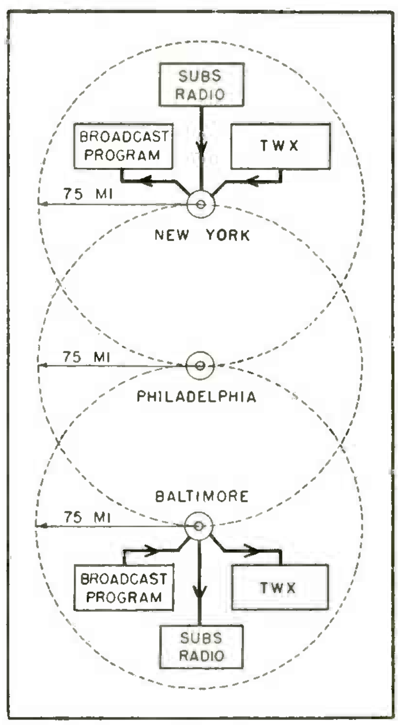

FIG. 3—A possible three-station f-m broadcast network with subcarrier subscription radio and teletype channels superimposed

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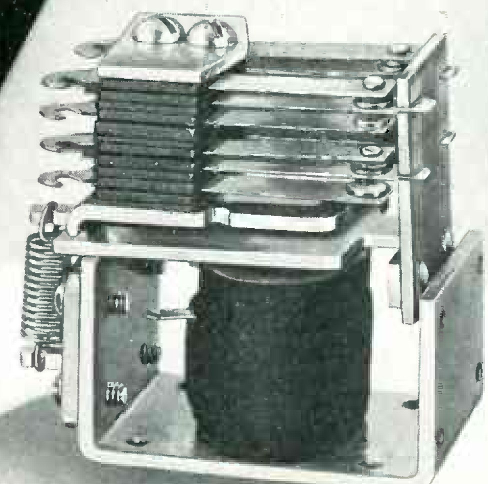

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COIL: To 115 volts D.C., 230 volts A.C.

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MAX. INPUT FOR 85° RISE: D.C. 5 watts
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MOUNTING: Base or end mounting

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

WEIGHT HERMETICALLY SEALED: 7.7 oz.

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

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overlapping service areas indicated by dashed lines. Conventional broadcast receivers, subscription radio receivers (capable of receiving special programs) and teletypewriter receivers are assumed to be located throughout each service area. The regular broadcast program is shown fed into the Baltimore transmitter whence it is relayed through Philadelphia to New York. It is also picked up by listeners in the three service areas. This program can be converted to audio in New York and put on a wire line or otherwise relayed.

The subscription radio channel, on the other hand, feeds from New York southward to Baltimore by means of a subcarrier. This program, too, can be picked up in each of the service areas but only by special receivers.

The teletypewriter subcarrier circuit originates in New York and terminates in Baltimore, but any other authorized agency within the service area of any of the relay broadcast stations can be equipped with a special receiver to copy messages.

REFERENCES

(1) E. H. Armstrong, A Method of Reducing Disturbances in Radio Signaling by a System of Frequency Modulation, *Proc. IRE*, p 689, May 1936.

(2) J. R. Day, Serrasoid F-M Modulator, ELECTRONICS, p 72, Oct. 1948.

Tower Carrier Alarm

By KARL NEUWIRTH
Transmitter Supervisor
WNEW Transmitter
Kearny, N. J.

THE PURPOSE of the alarm is to alert the operator in case of carrier failure at either tower of the two-tower array.

When normal energy is radiated, the two relays K_1 and K_2 shown in Fig. 1 are held with contacts open by the rectified r-f current fed back from each tower. An abnormal condition anywhere in the transmitter, transmission line or at either tower will cause a decrease in radiated power. Either or both relays will then fall out, causing an alarm bell to ring.

Sometimes static discharges or electric storms establish arcs at a transmitter tower gap. These are sustained by the transmitter output and yet are of insufficient propor-

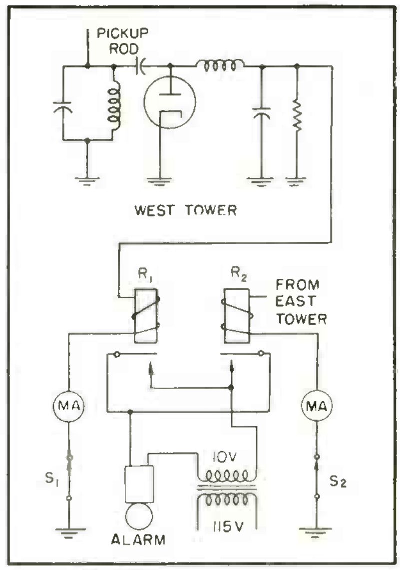

FIG. 1—Carrier-failure alarm used at WNEW. The East tower unit is similar to that used at the West tower

tion to trip the transmitter overload relays. The alarm described will quickly indicate such a condition. The arc is extinguished by cutting the carrier momentarily.

Switches S_1 and S_2 in the diagram are momentary-break types used to test the alarm. The milliammeters indicate visually the strength of current in each tower. The pickup rods are mounted close to the antenna-feed leads.

Audio-Input Limiter For Mobile F-M

By Lawrence C. Fuller Jr.
RCA-Victor Division
Radio Corporation of America
Camden, N. J.

Inexpensive and compact, the audio-input limiter described provides modulation limiting for mobile f-m transmitters. It permits maximum coverage for a given power by providing 100 percent modulation without the dangers of adjacent channel interference and receiver distortion from overmodulation. The limiter avoids the distortion introduced by conventional circuits and may be used in public address systems to prevent acoustic feedback. Its application is restricted to use with a carbon microphone.

Basic Circuit

The microphone shown in Fig. 1 receives direct current from the B

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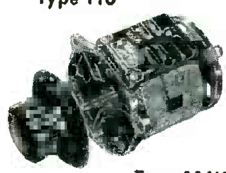

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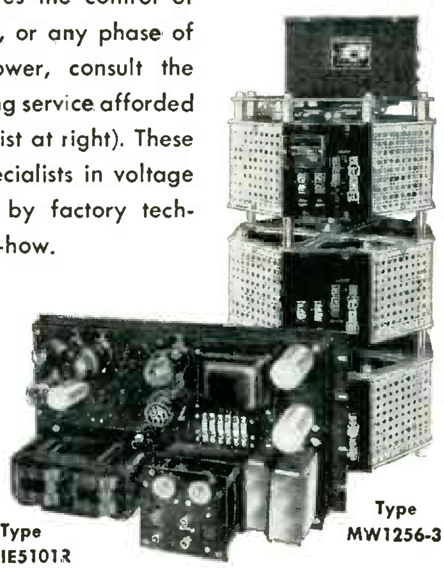

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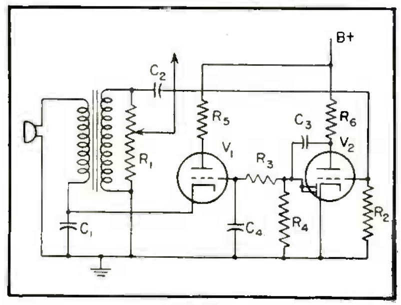

FIG. 1—Basic audio-limiter circuit

supply through V_1 in series with the primary of the audio transformer. Capacitor C_1 completes the audio circuit consisting of the microphone and transformer primary. With no signal into the microphone, the current is set to a given level. The audio signal is stepped up by the transformer to a higher level, which in some cases is sufficient to modulate the transmitter without further amplification. Part of this audio component is amplified by the triode section of V_2 and rectified by the diode, causing a negative voltage to appear at the grid of V_1 proportional to the average audio-signal level entering the microphone. The louder the audio signal, the more negative the bias, consequently, the less current will be supplied to the microphone. Since the output of the microphone is proportional to the direct current through it below saturation, the output is reduced and limiting action obtained. For example, if current is reduced to 5 ma by an audio signal, and the signal increased 20 db, the microphone current will be further reduced to 0.5 ma maintaining constant output.

Audio Amplifier

Since the audio current is not amplified before reaching the modulator tube, there is no chance

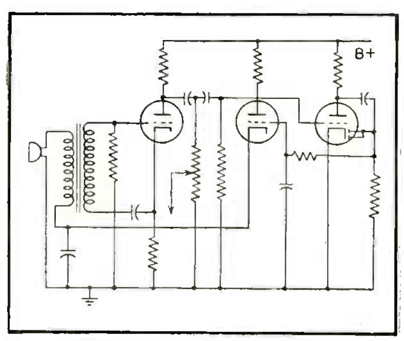

FIG. 2—Limiter circuit with audio amplifier

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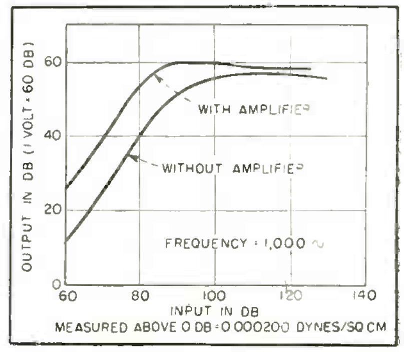


FIG. 3—Curves show effect of amplifier in limiter circuit

for the introduction of microphonics. If amplification were necessary, it would be done at a high audio level as shown in Fig. 2 and the gain would probably be small. The distortion contributed by this circuit depends on the quality of the transformer and can easily be made negligible. The carbon microphone is left as the only source of noise and distortion. The limiting action is good and curves are shown in Fig. 3.

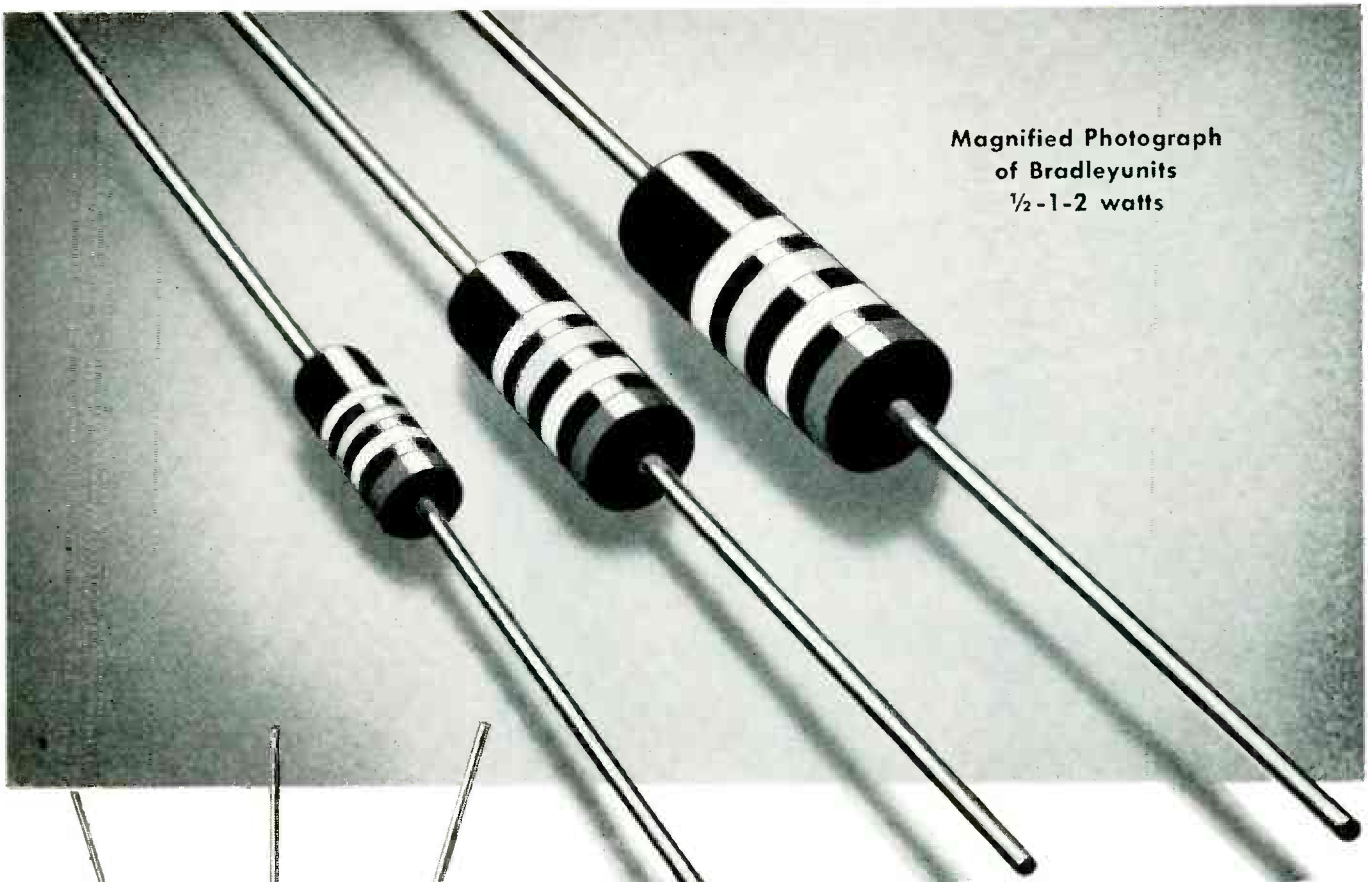
The attack and decay time is dependent on the time constants of R_3, R_4, C_3 and the diode, and can be adjusted to give satisfactory results. First syllable of a word following a pause will over-modulate. This is not very noticeable and is unimportant to intelligibility.

With phase modulation, it is desirable to limit proportional to frequency as well as the amplitude of the audio signal. This may be done by making a differentiating circuit of R_2 and C_2 which will cause V_2 to amplify the high frequencies more than the low frequencies.

Disguised Antenna Design

To DISGUISE the transmitting features of the normal police antenna so that it conforms with the appearance and placement of an ordinary car radio aerial, engineers at Ward Products Corporation have designed an antenna whose appearance is identical to that installed on a standard radio-equipped pleasure car. To best accomplish this deception, a standard automotive antenna was modified to give permanent electrical connections at the telescopic joints of the tube assembly.

As a transmitting antenna in 152 to 174-mc use, the 55½-inch whip of



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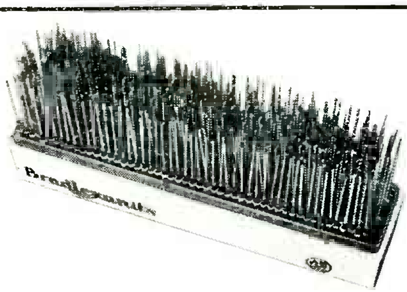

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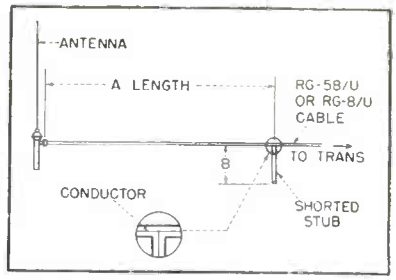


FIG. 1—Dimensions for the stub and line to load the antenna at frequencies from 24 to 50 mc are given in the text

the new antenna operates as a ¼-wavelength antenna and adjusting or loading the antenna is not necessary. However, it is advantageous to bring the Ward SPPB71 antenna as close as possible to the corner post of the windshield. The antenna then operates as an apparent J with the corner post acting as the ¼-wave-length grounded leg. The normal output circuit of commercial transmitters will load to the antenna without difficulty.

For 25 to 50-mc services, the antenna is basically short and it is necessary to load the antenna with a simple stub arrangement to obtain minimum standing wave ratio. The diagram of Fig. 1 illustrates the most convenient loading method.

The basic theory of the loading method is that an antenna less than a ¼ wavelength long presents an impedance at its base of $R - jX$, which varies as shown in Fig. 2.

A ⅛-wavelength antenna impedance is thus approximately 15-j100. Connecting a transmission line of $Z_o = 52 + j0$ (RG-8/U) or $53.5 + j0$ (RG-58/U) ohms to the antenna will result in a mismatch and improper loading of the transmitter.

A shorted transmission line stub B less than a quarter wavelength long presents a pure inductive reactance of $0 + jX_L$ ohms. In the SPPB71, moving along the trans-

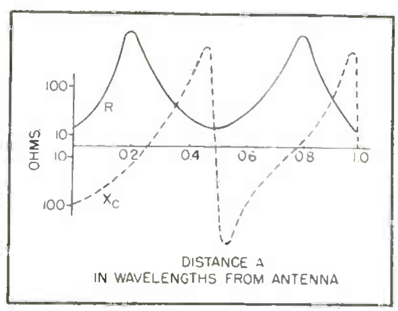
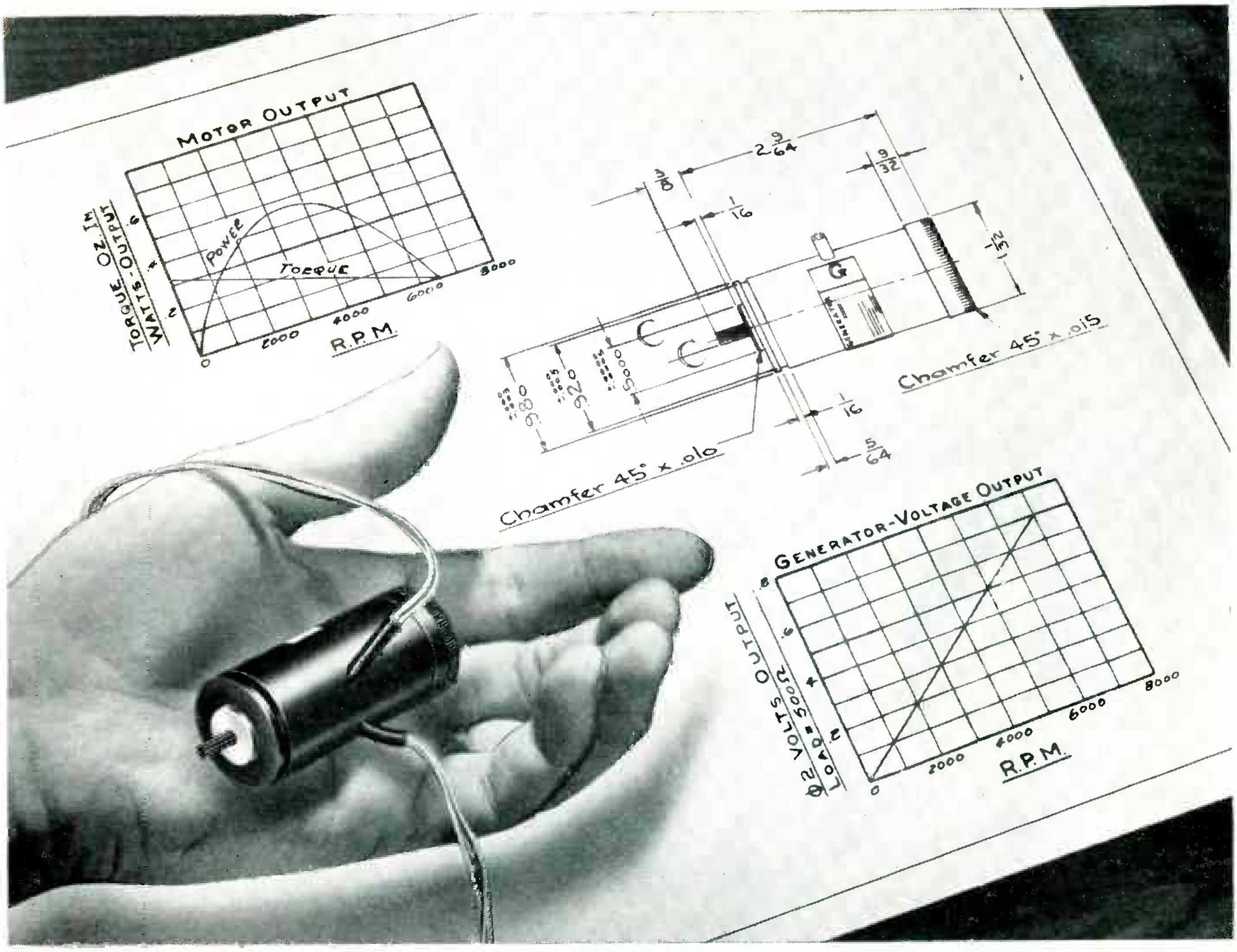


FIG. 2—Variation of impedance at base of antenna as a function of its length



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For further information on the 1623 and others in the complete Kollsman group of miniature special purpose AC motors—or if you require a unit to your own specifications—write: Kollsman Instrument Division, Square D Company, 80-08 45th Avenue, Elmhurst, N. Y.

Type 1623 Motor-Driven Induction Generator

Motor characteristics: Maximum torque at stall—smooth-running (will not "cog")—fast-reversing—operates from two-phase source, or from single-phase with phase-shifting condenser—available for 60 or 400 cycle operation.

Generator characteristics: Low residual voltage and voltage "spread"—constant frequency output—amplitude directly proportional to speed.

Unit characteristics: Both rotors mounted on same shaft, assuring positive alignment—stainless steel housing—hardened beryllium copper shaft—corrosion-resistant nickel steel laminations—high temperature insulation (up to 200° C. total temperature)—stainless steel precision ball bearings—weight: 4.2 ounces.

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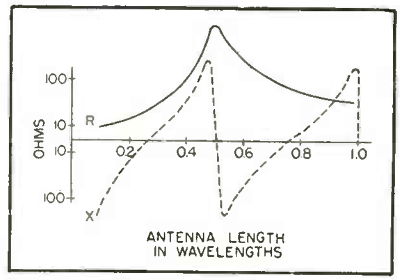

FIG. 3—Variation of R and X^c along the transmission line

mission line from the antenna, the values of R and X_c, looking toward the antenna, vary as shown in Fig. 3.

At some point on the line (for example $A = 0.2$), the resistive component of the impedance is equal to the characteristic impedance of the transmission line. At this point, stub B is connected to cancel out the capacitive reactance of the line. In this way the total reactance is brought to zero. From this point, looking toward the antenna, we see an impedance of $52 + j0$ ohms after connecting the stub. Therefore a transmission line connected to the stub network will see a good match with maximum energy transfer.

The following table gives the required lengths for cables A and B of Fig. I.

Loading Chart

Freq in Mc	*A in inches*	*B in inches*
24	60	3
25	56¼	3
26	53⅛	3
27	50½	3⅛
28	47¾	3⅛
29	45	3⅛
30	42½	3¼
31	40	3¼
32	37¾	3⅜
33	35½	3⅜
34	33¼	3½
35	31¼	3¾
36	29	3⅞
37	27	4⅛
38	25	4⅜
39	23	4¾
40	21¼	5
41	19½	5½
42	17½	5¾
43	15	6¼
44	14	6¾
45	12½	7⅜
46	10½	8
47	8½	8¾
48	6¼	9¾
49	3¾	10¾
50	1	12

The output circuits of commercial transmitters will load to the antenna without difficulty.

The polar plot of the antenna radiation pattern indicates the SPPB71 pattern is more nondirectional than the rear or bumper mounted ¼ wavelength whip and less nondirectional than the roof top mounted ¼ wavelength whip.

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THE ELECTRON ART
(continued from p 126)
Eighth Semi-Annual Report of the Atomic Energy Commission.

Ordinary tv reproduces width and height clearly but gives poor perception of depth, the report states. To overcome this handicap, stereoscopic television makes use of the same principle embodied in binoculars and the stereoscope.

In the Argonne stereo-tv system, the camera has twin lenses set approximately eyes-width apart, which pick up slightly different images on the screen. The single picture consisting of two images is then handled through the camera in conventional fashion, transmitted by coaxial cable and reconstructed in the receiver.

The original model receiver projected the images side by side on a single picture tube. Ninety-degree-opposed polarizing filters were mounted on the halves of the tube face and the two images were viewed through spectacles polarized in the same 90-degree pattern and fitted with prisms. An improved system developed a little later uses twin receivers with picture tubes pointing together at right angles. The electronic impulses for both images flow into each receiver but the controls are set to project only the right-eye image on one tube, only the left-eye image on the other. The two picture tubes are equipped with polarizing filters, and a half-silvered mirror bisects the right angle between them.

A person looking at the mirror sees the reflected image from one tube superimposed on the transmitted image from the other. With the naked eyes, the resultant single picture is flat and blurred. With properly polarized spectacles, the blurring disappears and the result is a clear picture in which differences of depth are vivid.

Positive Gate Counter Circuit

BY A. G. RATZ
Computation Center
McLennan Laboratory
University of Toronto
Toronto, Canada

IN APPLICATIONS demanding extreme reliability, conventional counter circuits do not always meet requirements. The type of counter described here is less sensitive to variations in circuit values

and properties of trigger pulses. Its maximum speed is limited only by stray capacitance. The counter was developed especially for use in high-speed electronic computers, an application where accuracy of computing demands circuits of exceptional reliability. At the same time, the counter is sufficiently versatile to be adapted to other uses.

Basic Circuit

The Eccles-Jordan trigger circuit shown in Fig. 1A can be converted into a counter. The block diagram, Fig. 1B, shows the essential parts of a counter circuit. Voltages at points P_1 and P_2 control the gates, G_1 and G_2. Depending upon the state of the flip-flop, only one of these gates lets the trigger pulse pass. Flip-flop inputs are designated Q_1 and Q_2.

A conventional counter is shown schematically in Fig. 1C. Points P_1 and P_2, Q_1 and Q_2 coincide at the grids of V_2 and V_1 respectively.

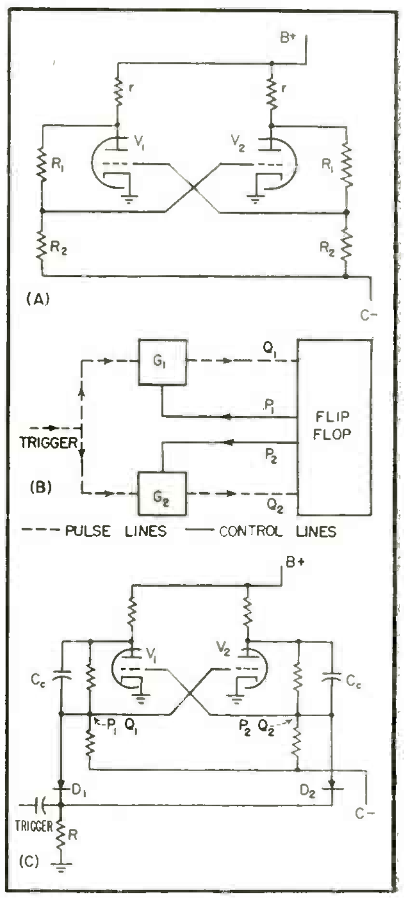

FIG. 1—Basic flip-flop (A) may be used in counter circuits (B). Diodes provide gating action in conventional grid-triggered circuit (C)

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Diodes D_1 and D_2 represent gates G_1 and G_2.

When the flip-flop changes state, the diodes interchange roles. Unless the trigger pulse is very short, this interchange can occur within the time the pulse is applied causing the pulse to affect the opposite side of the counter from that originally intended.

Cross-coupling capacitors C_c are added to make sure that a change of state actually occurs. Their charging time constants are made considerably longer than the pulse duration and counter speed is limited by the time required to recharge these capacitors.

Although there are other refinements[2] which offer some improvement over the circuit in Fig. 1C, this example shows the basic weaknesses of all conventional counter circuits.

Triggering

Usually the triggering waveform originates in a high-impedance circuit. Circuits such as Fig. 1C, however, require that the trigger be supplied from a source of low impedance. Strictly speaking, the circuit needed to provide the necessary impedance transformation should be regarded as an integral part of the counters. While the new counters may at first appear to require more tubes than conventional circuits, it is easy to arrange a high-impedance input using no extra components.

The simplest, though not the fastest of the new counters is shown in Fig. 2A. The principle parts of G_1 and G_2 are made up of the double triodes V_3 and V_4 respectively. A positive pulse superimposed on the correct d-c level triggers the counter.

If the circuit of Fig. 2A is one of a series of identical counters arranged to make up a divider of 2^n where n = the number of units in series. The trigger input is directly connected to the appropriate plate of the previous stage. The high input impedance of the cathode followers eliminates any possibility of interaction.

The potential at the plate of the conducting tube of each unit is +50 volts; that at the plate of the nonconducting tube is +120 volts. Thus, depending upon the state of

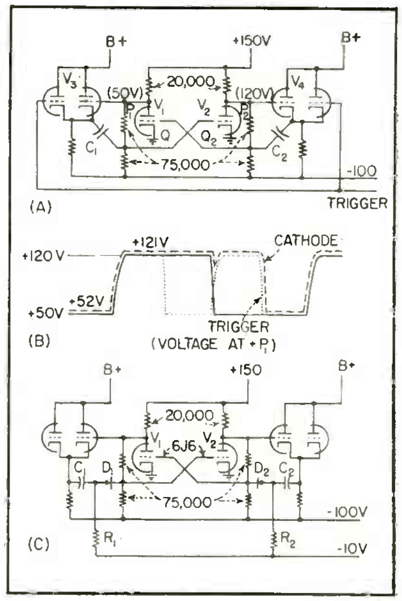
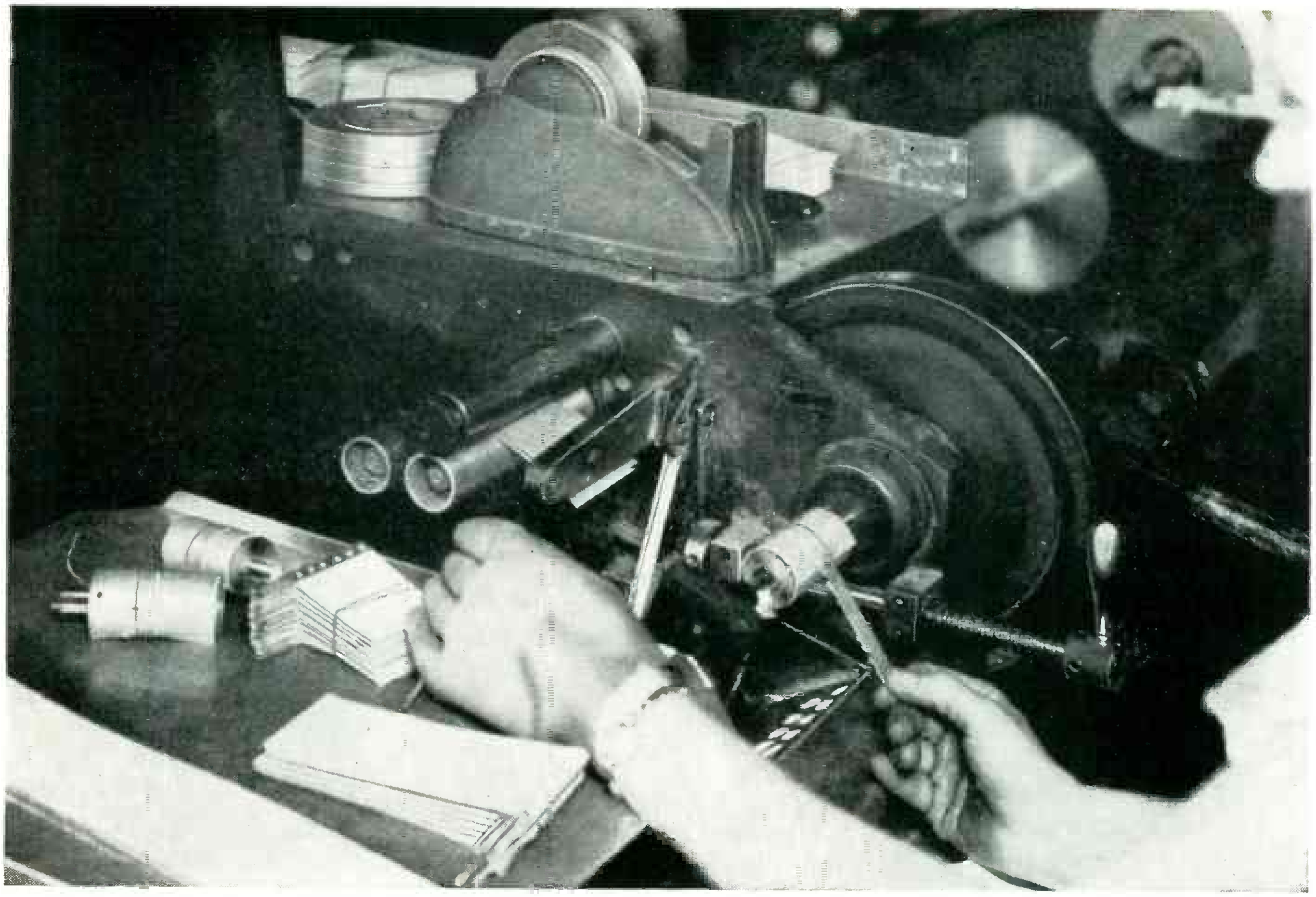


FIG. 2 — Postitive-gate counter (A) waveforms indicate circuit operating points. Slight modification of basic circuit (C) permits high-speed operation

the unit to which the trigger line is connected, the input potential is either +50 volts or +120 volts.

The counter is triggered when the previous unit changes state to produce at the input a positive waveform changing from +50 volts to +120 volts. Since the cathode potentials of the cathode-follower gates made up of V_3 and V_4 are always slightly more positive than the most positive grid, as shown in Fig. 2B, the trigger pulse reaches only one side of the flip-flop. For instance, suppose V_1 is conducting, then P_1 is at +50 volts, P_2 at +120 volts. If the trigger input voltage is +50 volts, the cathode of V_3 has a potential of +52 volts; that of V_4, +121 volts. When the input potential changes from +50 volts to +120 volts, the cathode potential of V_3 rises to +121 volts. This transition is transferred through C_1 to Q_1. Since V_4 cathode is already at +121 volts, no pulse reaches Q_2.

The positive pulse reaching Q_1 permits V_2 to conduct, and the flip-flop changes state. Thus the voltage at P_1 rises to +120 volts and that at P_2 drops to +50 volts. The positive transient at P_1 can only assist the trigger pulse in causing V_2 to conduct. The only possible effect of the negative transient at P_2 is to help render V_1 non-conducting, although this may be partially or even completely masked by the rising potential at the trigger in-



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General Export: DUREX ABRASIVES CORP., *New Rochelle, N. Y.* • *In Canada:* CANADIAN DUREX ABRASIVES LTD., *Brantford, Ontario* put as seen in Fig. 2B. Thus changes in the potentials controlling the gates can be beneficial only.

The counter is not upset when the trigger potential returns to +50 volts. Only the output of that gate controlled by the plate potential of the conducting tube of the flip-flop is affected, permitting the negative transient to reach the grid of the nonconducting tube. This of course, does not upset the flip-flop. The wave form at the cathode of V_3 for a complete cycle is shown in Fig. 2B.

Operation

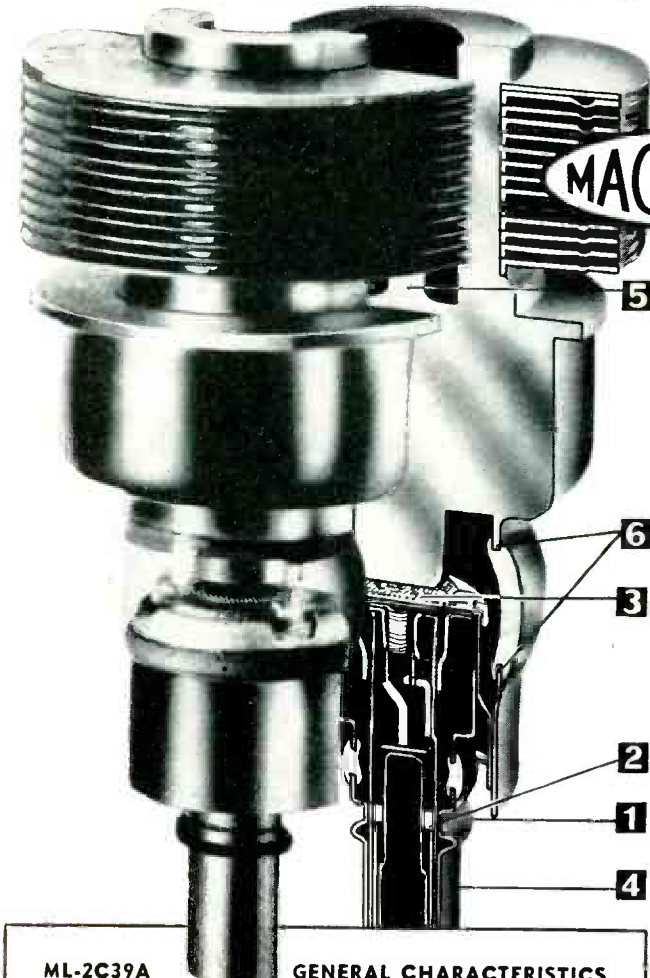
The maximum speed of the counter of Fig. 2A is determined by the time required to recharge C_1 and C_2. There is a minimum value for which these capacitors are effective. This value is determined by the input capacitances of the flip-flop tubes. The addition of R_1 and R_2 in Fig. 2C allows the time-constants associated with C_1 and C_2 to be equal to or less than those due to the stray capacitances in the circuit. The germanium diodes D_1 and D_2 prevent R_1 and R_2 from upsetting the flip-flop.

The circuit can be further speeded up by decreasing the transition time of the flip-flop. Small cross-coupling capacitors similar to those of Fig. 1C can be added to decrease the a-c impedances coupling the plates to the grids. Clipping diodes at the plates and grids of the flip-flop will also help. The substitution of pentodes for triodes decreases the input capacitances of the flip-flop grids.

The circuit of Fig. 2A operates reliably up to a speed of 500 kc and that of Fig. 2C up to 750 kc. Using cross-coupling capacitors of value 10 $\mu\mu$f, the latter operated reliably at over 2 mc. A substitution of two 6AK5 pentodes for the 6J6 double triodes shown in Fig. 2C increases the speed of operation to over 5 mc. In all cases, the speed is limited by the transition time of the flip-flop.

There are several alternative schemes that can be used for designing the gates G_1 and G_2 other than the circuits of Fig. 2A, and 2C. Some of these involve slight modifications of the circuits shown. Others are completely different: for

The New ML-2C39A*...



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5. Machlett's high vacuum processing for good cathode activation and freedom from gasiness.

6. Stronger glass-metal seals. Less breakage inserting and removing tubes.

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ML-2C39A GENERAL CHARACTERISTICS

Electrical

Cathode: Coated Unipotential	
Heater Voltage	6.3 volts
Heater Current	1.0 amperes
Amplification Factor (Average)	100
Direct Interelectrode Capacitances (Average)	
Grid Plate	1.95 µµfd.
Grid Cathode	6.50 µµfd.
Plate Cathode	0.035 µµfd.
Transconductance (i_b = 70 ma., E_b = 600 v.) (Average)	23,000 µmhos

Radio Frequency Power Amplifier
Class-C FM Telephony or Telegraphy
(key-down conditions, 1 tube)

Maximum Ratings	
D-C Plate Voltage	1000 max. volts
D-C Cathode Current	125 max. ma.
D-C Grid Voltage	−150 max. volts
Peak Positive R-F Grid Voltage	30 max. volts
Peak Negative R-F Grid Voltage	−400 max. volts
Plate Dissipation	100 max. watts
Grid Dissipation	2 max. watts

ML-381 FOR PULSED APPLICATIONS

Maximum Ratings (Tentative)

e_p, peak	3500 volts
i_p, peak	4.5 amps
i_g, peak	2.0 amps
I_p, ave	30 MA
I_g, ave	15 MA
T, pulse length	5 µ sec.
duty	1%
E_f	5.5 volts ± 5%

In all other respects the ML-381 is electrically and mechanically interchangeable with the 2C39A.

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MACHLETT — OVER 50 YEARS OF ELECTRON TUBE EXPERIENCE instance, a gate can easily be devised by moving the common resistors from the cathode side to the plate circuit of V_3 and V_4. The resultant gate, however, although capable of amplifying the trigger pulse, is not as useful as the gates of Fig. 2A and 2C since it does not possess a high-impedance input.

REFERENCES

(1) "Ultra - High - Frequency Techniques," Chapter 4, Brainerd, Koehler, Reid and Woodruff, Van Nostrand.
(2) "Waveforms," Chapters 5, 17, Chance, Hughes, MacNichol, Sayre, Williams, McGraw-Hill.

Graphical Solution for Feedback Amplifiers

By LEROY D. BARTER
Seattle, Washington

THE GAIN of any amplifier may be expressed as the maximum gain times a function that shows the variation in the gain.

$$A = \frac{A_m}{P(A)} \tag{1}$$

where A_m is the maximum gain of an amplifier, $P(A)$ is a complex function, showing both the change in magnitude and phase shift of the gain. In an amplifier with feedback the gain will be

$$A_{fb} = \frac{A}{1 - A\beta} = \frac{\dfrac{A_m}{P(A)}}{1 - \dfrac{A_m}{P(A)}\beta} \tag{2}$$

$$\frac{A_{fb}}{A_m} = \frac{1}{P(A) - A_m\beta}$$

$$\frac{A_m}{A_{fb}} = P(A) - A_m\beta \tag{3}$$

Now if $P(A)$ can be conveniently expressed, the gain with feedback can be solved by means of Eq. 3. The remainder of the paper demonstrates the method of finding $P(A)$ and its use.

Single-Stage Amplifier

The gain of a single-stage amplifier can be thought of as containing a gain element that is independent of frequency, within the range considered, and an element that depends upon frequency for its voltage relationships. In Fig. 1A is a single-stage amplifier that may have negative feedback or not depending upon the position of the switch. The gain then is that due to the tube, and the consequent re-

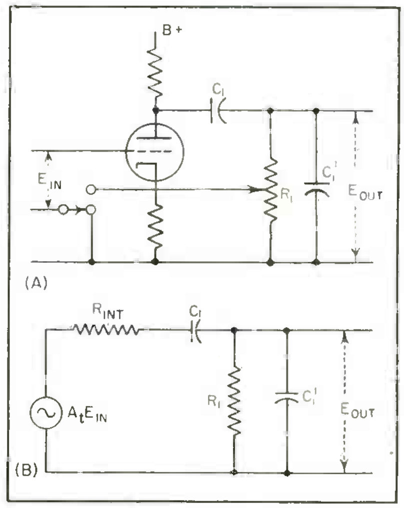


FIG. 1—Simple amplifier in which negative feedback may be introduced

duction in gain due to the external circuit shown in Fig. 1B. In the normal case the effects of C_1 occur at the lower frequencies while the effects of C_1' occur at the higher frequencies. Hence we may write two equations that will express the variation of gain due to frequency.

$$A_{LF} = \frac{E_{out}}{E_{in}} = A_t\left(\frac{R_1}{R_1 + R_{int} - \frac{j}{\omega C}}\right)$$

$$= A_t\left(\frac{R_1}{R_1 + R_{int}}\right)\left(\frac{1}{1 - \frac{j}{\omega C_1(R_1 + R_{int})}}\right)$$

Let $R_{LF} = R_1 + R_{int}$

and let $A_m = A_t\left(\frac{R_1}{R_1 + R_{int}}\right)$

$$A_{LF} = A_m\left(\frac{1}{1 - \frac{j}{\omega C_1 R_{LF}}}\right) \quad (4a)$$

$$A_{HF} = \frac{E_{out}}{E_{in}} = A_t\left(\frac{Z_1}{R_{int} + Z_1}\right)$$

$$= A_t\left(\frac{1}{\frac{R_{int}}{Z_1} + 1}\right)$$

where $\frac{1}{Z_1} = \frac{1}{R_1} + j\omega C_1'$

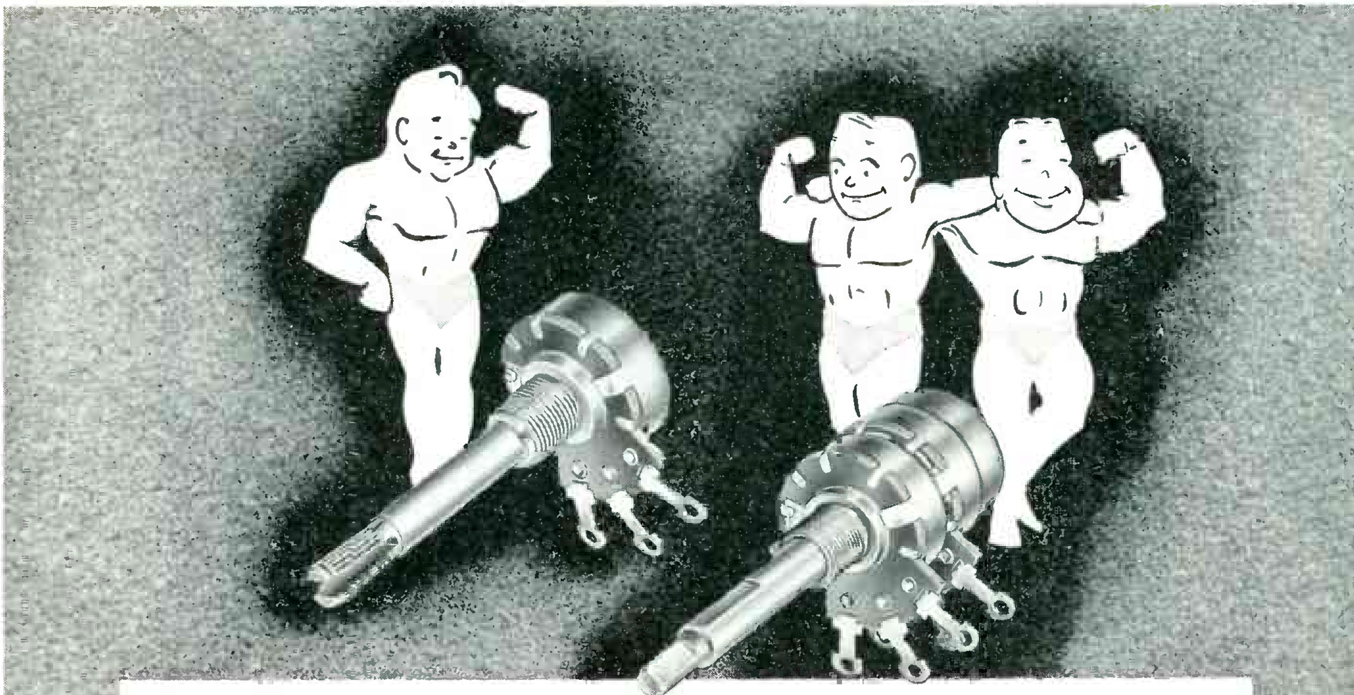
$$A_{HF} = A_t\left(\frac{1}{\frac{R_{int}}{R_1} + j\omega C_1' R_{int} + 1}\right)$$

$$= \frac{A_t R_1}{R_{int} + R_1}\left(\frac{1}{1 + \frac{j\omega C_1' R_{int} R_1}{R_{int} R_1}}\right)$$

Let $R_{HF} = \frac{R_{int} R_1}{R_{int} + R_1}$

and let $A_m = \frac{A_t R_1}{R_{int} + R_1}$

(Continued on p 208)



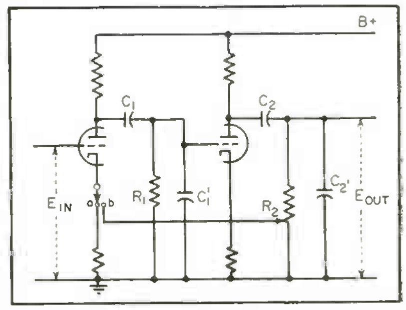


FIG. 2—Two-stage amplifier with optional negative feedback

$$A_{HF} = A_m \left(\frac{1}{1 + j\omega C_1' R_{HF}} \right) \quad (4b)$$

Therefore
$$P_L(A) = 1 - \frac{j}{\omega C_1 R_{LF}} \quad (5a)$$

$$P_H(A) = 1 + j\omega C_1' R_{HF} \quad (5b)$$

Insertion of Eq. 5 into Eq. 3 gives

Low frequency $\frac{A_m}{A_{fb}} =$

$$1 - \frac{j}{\omega C_1 R_{LF}} - A_m\beta$$
$$= (1 - A_m\beta)\left(1 - \frac{j}{\omega C_1 R_{LF}(1 - A_m\beta)}\right) \quad (6a)$$

High frequency $\frac{A_m}{A_{fb}} =$

$$1 + j\omega C_1' R_{HF} - A_m\beta$$
$$= (1 - \beta A_m)\left(1 + j\frac{\omega C_1' R_{HF}}{1 - A_m\beta}\right) \quad (6b)$$

Hence the feedback has the effect of modifying the RC circuits by the feedback factor $(1 - A_m\beta)$. With this new value of RC and the universal gain curves[2] the gain of an amplifier with one pair of RC's in the circuit can easily be determined.

Two-Stage Amplifier

The usefulness of Eq. 3 is more readily apparent when there are two pair of RC's in the circuit. In Fig. 2 there are two stages of amplification similar to that in Fig. 1. The gain will now be the product of the gain of the two stages. Then for two stages

$$P_L(A) = \left(1 - \frac{j}{\omega C_1 R_{LF1}}\right)\left(1 - \frac{j}{\omega C_2 R_{LF2}}\right)$$

Let $S_1 = \frac{1}{\omega C_1 R_{LF1}}$ and $S_2 = \frac{1}{\omega C_2 R_{LF2}}$

$$P_L(A) = (1 - jS_1)(1 - jS_2) = 1 - S_1S_2 + j(S_1 + S_2) \quad (7a)$$

$$P_H(A) = (1 + j\omega C_1' R_{HF1})(1 + j\omega C_2' R_{HF2})$$

Let $S_1 = \omega C_1' R_{HF1}$ and $S_2 = \omega C_2' R_{HF2}$

$$P_H(A) = (1 + jS_1)(1 + jS_2) = 1 - [S_1S_2 - j(S_1 + S_2)] \quad (7b)$$

Figures 3 shows a plot of the por-

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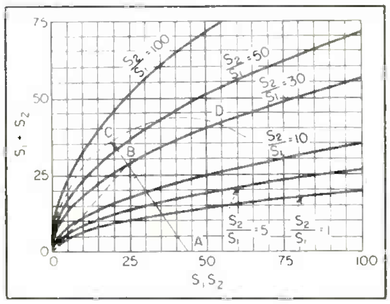

FIG. 3—Curves for graphical analysis of feedback amplifiers

tion of $P(A)$ that is in brackets. Each curve corresponds to a particular ratio of S_2/S_1. They also correspond to a ratio of the RC's since ω will cancel out. For the frequencies above midfrequency $S_1 + S_2$ will be proportional to ω. Then for the low frequencies $S_1 + S_2$ will be proportional to $1/\omega$.

The solution of Eq. 3 can now be done graphically.

$$\frac{A_{mf}}{A_{fb}} = 1 - A_m\beta - [S_1S_2 \pm j(S_1 + S_2)] \qquad (8)$$

Since for negative feedback, β is negative, (switch in position b in Fig. 2), $1 - A_m\beta$ will be a positive number and can be plotted in Fig. 3 as the distance OA. The quantities in the brackets will be the distance OB. Then the value of $P(A)$ will be the vector difference of OB and OA and is equal to AB. In order to visualize what the curves say, draw a circle through O and with the center at A. Then the radius of this circle will represent the magnitude of the gain at the midfrequency. Since Eq. 3 and consequently Eq. 8 represent the denominator of Eq. 2, the gain at the frequency of B will equal the distance AC divided by AB, or $A/A_m = AC/AB$. Hence when AB is less than AC, the gain will be larger than that at midfrequency. Now as B varies along the curve the gain versus frequency can be visualized.

The phase shift can also be determined. For the case of no feedback the phase shift from midfrequency will be the angle O-1-B. With feedback the angle will be O-A-B.

Now the ratio of the RC's can be intelligently chosen to produce a flat frequency response. If AB is less than AC, there will be a point D where the gain is again equal to the gain at midfrequency. If we impose the condition that the gain in the pass band should not vary

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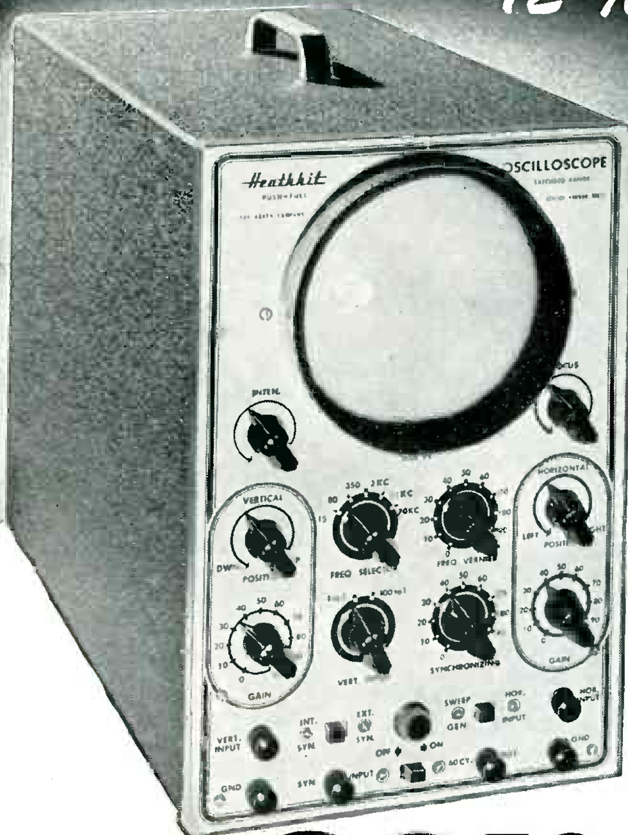

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more than $\pm m$ percent from the midfrequency gain, the correct ratio of the RC's can be chosen. Since the curves are a family of parabolas this can be done mathematically.

The gain will be a maximum when AB is a minimum. This minimum will be at the point where AB is perpendicular to the parabola. Therefore it is possible to express the minimum AB as a function of S_2/S_1. As this derivation is rather lengthy and outside the immediate interest of this paper, the results only will be given.

$$\frac{S_2}{S_1} = \frac{B}{2}\left(1 + \sqrt{1 - \frac{4}{B}}\right) - 1 \quad (9)$$

$$B = 2(1 - A_m\beta)\,(1 - (\sqrt{1 - D^2})$$

$$D = \frac{\text{length } AC}{\text{length } AB}$$

Then the point where AB is greater than AC by m percent will be

$$S_1S_2 = (1 - A_m\beta)\,(\sqrt{1 - d^2})$$

$$\left(1 + \sqrt{1 + \frac{1}{d^2}}\right) \quad (10)$$

Equation 9 gives the ratio of the RC's while Eq. 10 gives the magnitude of the RC's which will produce the desired cutoff frequency.

An amplifier was designed, using the circuit in Fig. 2, to have a gain of approximately 10 with a maximum variation of gain with frequency of 5 percent. Also the low-frequency cutoff was to be as near 10 cps as convenient. These strict requirements were necessary for it was to be used in some measuring equipment for the University of Washington Engineering Experiment Station. For these conditions the ratio of the RC's must be 100. The values are shown in Fig. 4. Gain tests were run on this amplifier showing no variation of gain between 20 cps and 10,000 cps, with

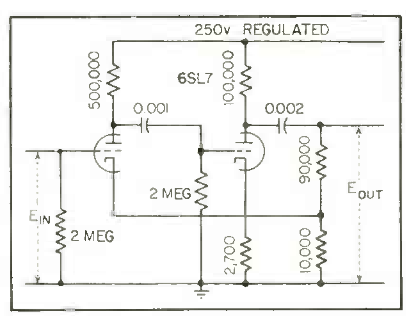


FIG. 4—Two-stage amplifier circuit used to substantiate graphical method

HOW SELETRON RECTIFIERS GAVE CHICAGO A LIFT

PARTIAL LIST OF ELEVATOR INSTALLATIONS USING SELETRON RECTIFIERS IN THE CHICAGO AREA

BUILDING	NO. OF RECTIFIERS	APPROX. NO. OF ELEVATORS
Drake Hotel Towers, 179 E. Lake Shore Dr.	4 ea. 35 KW	6
Garden City Plating, 1750 N. Ashland Ave.	2 ea. 40 KW	2
Jewish Charities, 241 S. Wells	2 ea. 20 KW	3
1366 North Dearborn Building	3 ea. 27½ KW	4
60 E. Scott Street Building	2 ea. 14 KW	2
Bernstein Building, 14 S. Clinton	2 ea. 10 KW	2
Bush Temple, 100 North Clark	2 ea. 20 KW	3
Clinton Realty, 522B Clinton	2 ea. 20 KW 1 ea. 14 KW 1 ea. 15 KW	4
Lansing Hotel, 1036 N. Dearborn	2 ea. 20 KW	2
Plaza Hotel, 1559 N. Clark	3 ea. 10 KW	3
Sears & Roebuck Co., 312 N. May	3 ea. 25 KW	2
Covenant Club, 10 North Dearborn	2 ea. 20 KW	3
Churchill Apts. 1261 North State	2 ea. 17 KW	2
Western Elec. Bldg. 1706 S. Wabash	2 ea. 10 KW	2
70 East Cedar	2 ea. 14 KW	3
Michael Reese Hospital	4 ea. 50 KW	10
Steinway Drug Bldg.	3 ea. 10 KW	3
Graphic Arts Bldg.	4 ea. 25 KW	6
Walton Motors	2 ea. 20 KW	2
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.	1 ea. 7 KW	1
242 E. Walton Building	1 ea. 7 KW	1
Clinton Machine Co.	3 ea. 10 KW	2
Western Electric Building	2 ea. 20 KW 1 ea. 14 KW 1 ea. 10 KW	6
Gozzola Drug Company	1 ea. 10 KW	1
A. Rubloff Building	3 ea. 14 KW	4
Goldenberg Furniture Company	1 ea. 10 KW	1
210 E. Pearson Street Building	3 ea. 20 KW	4
Illinois Electrotype	1 ea. 20 KW	2
Car Service Company	4 ea. 20 KW	4
St. Clair Hotel	4 ea. 25 KW	5
Eastgate Hotel	4 ea. 25 KW	4

WHEN THE POWER COMPANY changed over to alternating current in certain Chicago areas it meant that existing elevators operating on D.C. had to be converted fast, or the good people of the town would be "grounded."

Ther Electric & Machine Works of Chicago solved elevator rectification problems for considerably more than 100 famous buildings in the Windy City by designing complete power supply and regenerative braking equipment employing SELETRON rectifiers. The illustration shows a typical 3 bank unit with regenerative control, built for the Clinton Realty Co.

Of course, elevator operation is but one of many uses for SELETRON. These rugged, efficient selenium rectifiers are versatile – useful in hundreds of varying industrial applications for economical conversion of alternating current to D.C.

Your *own* rectification problems may easily be solved by SELETRON engineers. Write us now describing them – and request our new Bulletin No. ES-33

Seletron

SELETRON DIVISION

RADIO RECEPTOR COMPANY, INC.

RR *Since 1922 in Radio and Electronics* RR

Sales Dept: 251 West 19th St., New York 11, N. Y.
Factory: 84 North 9th St., Brooklyn 11, N. Y.

a 10-percent rise at 20,000 cps. This was the frequency limit of the oscillator that was available.

The effect on the gain of any amplifier with negative feedback due to two RC's in tandem, or in general to any two parameters, can be visualized when they are expressed as in Eq. 3 and then plotted as in Fig. 3.

Bridged-T Neutralization of Pentode Amplifiers

By H. K. Bradford
Electronics Engineer,
The Glenn L. Martin Company
Baltimore, Maryland

In a high-frequency amplifier using a small unbypassed cathode resistor to reduce Miller effect, a modified bridged-T network can be used for neutralization. High and completely stable gain can be realized with this arrangement.

The equivalent circuit (essential elements) may be represented as in Fig. 1A. To complete the bridged T network would normally require additions as in Fig. 1B, which shows R_1, R_2, and C added.

Since there is an essential 90 degree phase shift across C_{PK} there need be no phase shift across R_2 and hence C should actually be a resistor. Rearranging for actual

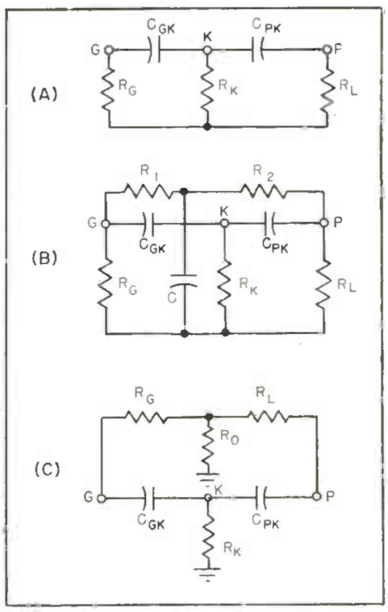
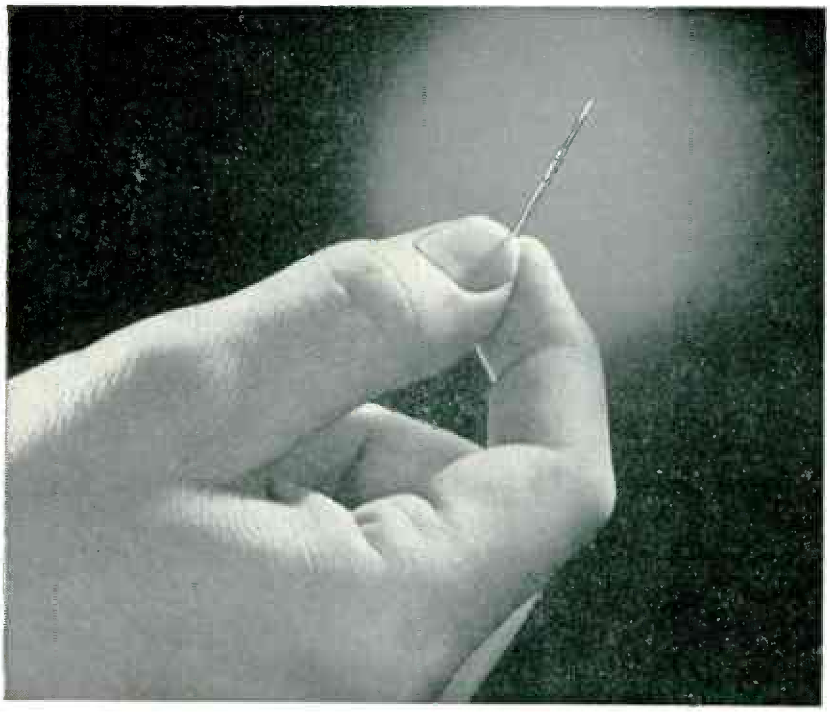


FIG. 1—Modified-bridged-T network may be used to neutralize amplifier with unbypassed cathode

Trim Assembly Time with the Tube with the Tab

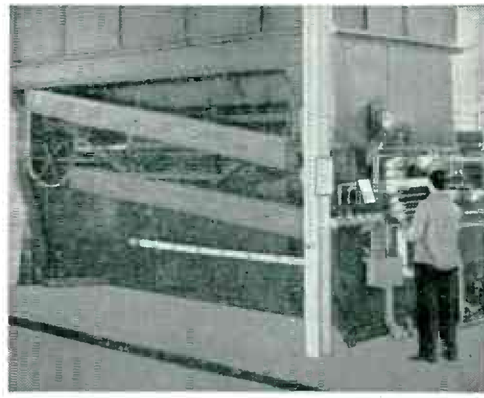
Electronic Engineering — Life test rack and emission test set. Checking Superior assembled standard diodes under simulated customer conditions to determine if material meets minimum requirements.



● Superior's pioneering in tubing technology is constantly at work to bring electronic manufacturers new developments—to help them produce better equipment, faster, at lower costs. Newest of these improvements is the integral tabbed round Lockseam* cathode. It is designed to eliminate a welding operation, cut assembly time, and provide superior performance.

These integral tabbed round Lockseam* cathodes may be valuable to you . . . but whether they are or not one thing is sure. If you use Seamless or Lockseam* cathodes in your product a Superior tube is available to do a Superior job. Our research and engineering facilities are ready at all times to help solve your tubing problems.

For more information about Superior Tubing and its possible place in your operation write to Superior Tube Co., 2500 Germantown Ave., Norristown, Pa.



To guard against contamination by processing lubricants, Superior tubing is thoroughly degreased before each annealing operation.

Part of inspection procedure on Lockseam Nickel Cathodes as they come off the production machine. Each cathode must undergo many rigid tests before being approved.

Which Is The Better For Your Product . . .

SEAMLESS . . . ? The finest tubes that can be made. Standard production is .010″ to .121″ O.D. inclusive, with wall thicknesses of .0015″ to .005″. Cathodes with larger diameters and heavier walls will be produced to customer specification.

Or LOCKSEAM*. . . ? Produced directly from thin nickel alloy strip stock, .040″ to .100″ O.D. in standard length range of 11.5 mm to 42 mm. Round, rectangular or oval, cut to specified lengths, beaded or plain.

Superior

THE BIG NAME IN SMALL TUBING

All analyses .010″ to ⅝″ O.D.
Certain analyses (.035″ max. wall) Up to ¾″ O.D.

**Mfd. under U. S. Pats.—SUPERIOR TUBE COMPANY • Electronic Products for export through Driver-Harris Company, Harrison, New Jersey.*

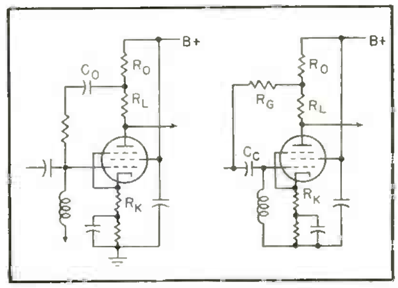


FIG. 2—Practical circuit of amplifier using modified bridged-T neutralization

use the circuit is represented as in Fig. 1C.

For the potential generated at P to be completely cancelled at G through the two paths shown, the attenuation must be identical through the two paths and the phase shift must total 180 degrees. The following relations are needed to make this possible:

$$\frac{R_L}{R_O} = \frac{Xc_{PK}}{R_K} \qquad \frac{R_L}{R_G} = \frac{Xc_{PK}}{Xc_{GK}}$$

$$R_O = \frac{R_L R_K}{Xc_{PK}} \qquad R_G = \frac{R_L Xc_{GK}}{Xc_{PK}}$$

If there is any doubt about the four given values R_o can be made variable to adjust the feedback magnitude exactly. The phase remains within better than 1 degree correct due to the condition of the problem with usual values and the magnitude can be trimmed through wide values with R_o.

Two practical circuits are shown in Fig. 2. Coupling capacitor C_o is added for d-c isolation of the grid. Resistance R_G serves the dual function of grid damping plus feedback.

SURVEY OF NEW TECHNIQUES

ULTRASONIC ENERGY has proved useful in breaking up gall stones inside the intestines of dogs and rabbits. This technique, revealed by the Yale School of Medicine, may make possible the removal of gall stones from human gall bladders in inoperable situations.

AN ANALOG COMPUTER has been developed at Northwestern University which is capable of predicting performance characteristics of the oil and gas industry's multi-com-

'MAKING A BAKER'S DOZEN'

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12th AND 13th Induction Motors for high performance servo applications

THE 18A 400 AND 1A 400

ANNOUNCING . . . 5 New UNITS

Making available a wider choice of

ARMA Induction Motors

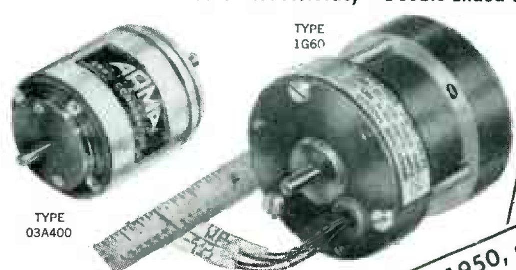
Designed specifically for high performance servo applications

TYPICAL SPECIFICATIONS

	TYPE	DWG. No.	FREQ.	FIELD VOLTAGES PHASE	MAIN	CONTROL	(Min.) NO LOAD SPEED R.P.M.	MAX. WATTS OUTPUT at R.P.M.	STALLED TORQUE (Min.) Oz. In.	ROTOR INERTIA Oz. In.²	WEIGHT lbs.
New	03A60	715758-1	60	2	24	24	1600	0.55 at 875	1.3	0.040	0.25
New	03B60	715758-2	60	2	24	24	3000	1.0 at 2000	1.0	0.040	0.25
	1A60	213377-2	60	2	40	40	3100	1.5 at 1750	1.7	0.030	0.8
	1B60	213251-1	60	2	115	115	3000	2.4 at 2000	3.0	0.25	1.4
	1D60	213251-2	60	2	115	115	3000	6.5 at 2000	8.0	0.25	1.4
New	1F60	64913	60	3	115		3200	13.0 at 2000	16.	0.048	1.5
New	1G60	65016 (715759)	60	2	115	40	1500	1.0 at 750	3.0	0.051	0.56
	5A	213079-1	60	2	75	90	3000	6.3 at 1800	8.0	0.32	4.0
	5C	213261-1	60	2	90	75	3000	7.5 at 2000	8.0	5.51	4.3
	6	213069-1	60	2	115	90	3000	18.0 at 2000	16.5	1.38	9.8
New	03A400	715640-1	400	2	24	24	10,000	1.8 at 6000	0.7	0.036	0.25

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

TYPE 1G60



TYPE 03A400

INDUCTION MOTOR BOOKLET JUST PRINTED GIVES CO... DETA...

ARMA COR... 254 36th STRE... SUBSIDIARY OF ... TION

This announcement in June, 1950, created wide interest. The 18A400 and 1A400 units should have equal appeal to engineers and designers.

TYPICAL SPECIFICATIONS

TYPE	DWG. No.	FREQ.	FIELD VOLTAGES PHASE	MAIN	CONTROL	(Min.) NO LOAD SPEED R.P.M.	MAX. WATTS OUTPUT at R.P.M.	STALLED TORQUE (Min.) Oz. In.	ROTOR INERTIA Oz. In.²	WEIGHT lbs.
18A400	786662	400	2	24	24	10,000	3.6 at 5000	1.6	0.030	0.8
1A400	213377-1	400	2	115	115	9,800	1.5 at 5000	0.80	0.030	0.8

If these two newest units are not listed in the booklet you already have titled "Arma Induction Motors and Generators" then send for the newly printed latest edition. It contains complete characteristics and performance curves.

ARMA CORPORATION

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

SUBSIDIARY OF AMERICAN BOSCH CORPORATION

ARMA PRODUCTS RELEASED FOR PRIVATE INDUSTRY

ARMA ELECTRICAL RESOLVERS* ▫ ARMA SYNCHROS ▫ ARMA INDUCTION MOTORS ▫ ARMA INDUCTION GENERATORS ▫ ARMA MECHANICAL DIFFERENTIALS ▫ ARMA ALTERNATING VOLTAGE COMPARATOR ▫ COMPUTING MECHANISMS ▫ INDUSTRIAL CONTROLS ▫ STABILIZATION DEVICES ▫ NAVIGATIONAL EQUIPMENT ▫ LIMITRON AUTOMATIC INSPECTION SYSTEM

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QUALITY ARMA INSTRUMENT PRECISION

ponent fractionating towers. Until recently, such calculations have been the cause of considerable trial-and-error computations. The computer's results are not only much more reliable, but they are produced in a small fraction of the time previously required. The new machine is expected to aid in the design of new equipment and in redesigning old equipment for more efficient operation.

THE RELATION between force applied to aircraft controls during flight test and the actual deflection of the controls is measured by an instrument developed by the National Bureau of Standards. Called the stick-force indicator, it operates satisfactorily on varying aircraft voltages and makes possible a complete photographic record of the forces applied in both required directions.

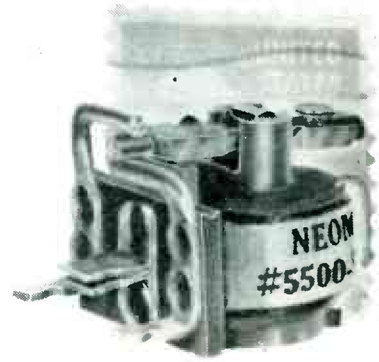
The standard stick handle is replaced by one containing a cantilever spring. Deflection of the spring causes rotary motion of a selsyn transmitter. The selsyn indicators are calibrated to read directly in force. The entire equipment exclusive of leads weighs only three pounds.

AN INSTRUMENT for indicating pressures in cylinders of engines has been developed in France. A beam of light passes through a slit, one side of which is fixed, the movements of the other being controlled by the deflection of a diaphragm under pressure. The light modulations are registered by means of a photoelectric cell connected to a cathode-ray oscillograph.

A HERETOFORE waste material resulting from the manufacture of atomic bombs will shortly be put to practical use. A radio-active gas will be used by the American Broadcasting Company to detect leaks in the coaxial cable systems serving the net's tv transmitters in the five cities, permitting almost instantaneous adjustments in the cables and thereby preserving power and quality of the telecast signal as its maximum. The new process is expected to solve one of telecasting's most vexing problems.

NEW PRODUCTS
(continued from page 130)

graph and radio or television, besides choosing correct equalization for all types of domestic and foreign recordings. The all-triode unit, with maximum output of 30 w, applies 100-percent negative feedback, including drivers, output tubes and output transformer. Frequency response is within ± 0.25 db from 20 to 30,000 cycles. Hum and noise level is 80 db below rated output. Output impedances are 4, 8 and 16 ohms. A total of 12 tubes is utilized in the power amplifier and remote control unit. High gain tubes are shock-mounted. Power consumption is 150 w.



Subminiature Relays

NEOMATIC, INC., 879 Wellesley Ave., Los Angeles 49, Calif. Developed to meet the exacting space requirements of manufacturers of aircraft, airborne equipment, guided missiles, rockets, radar and electronic components, the new series M antivibration relays measure less than $\frac{5}{8}$ in. × $\frac{3}{4}$ in. × $2\frac{1}{16}$ in. and weigh less than $\frac{1}{2}$ ounce. Coils are available in ratings from 1 to 72 volts d-c, with resistances ranging from below 1 ohm to 5,000 ohms.

Sweep & Marker Generator

KAY ELECTRIC CO., Pine Brook, N. J., has announced Marka-Sweep,

EXACTLY RIGHT for tight spots

RIGHT for performance too!

Sangamo Type 60 Capacitors

Where exceptionally small filter capacitors are a necessity Sangamo Types 62 and 64 Capacitors are your best choice. These capacitors are mineral oil impregnated for E characteristic and assure long life and excellent performance at temperatures from —55° C to + 85° C. They are ideal for aircraft, guided missile work, or commercial applications.

Types 62 and 64 paper capacitors are hermetically sealed in seamless drawn steel cases, *smaller* than the size requirements of joint Army-Navy specification JAN-C-25, CP 60 Series. Non-magnetic copper or brass cases can be supplied, if desired. Standard capacitors are supplied with top terminals and brackets for upright mounting, or with bottom terminals and brackets for inverted mounting. For further information, send for your copy of Catalog No. 832.

Whenever you need capacitors, choose from the complete Sangamo line of paper, mica, electrolytic and button capacitors for every industrial, electronic and radio application.

Your Assurance of The SANGAMO Tribe *Dependable Performance*

PAPER·MICA·SILVER·ELECTROLYTIC CAPACITORS

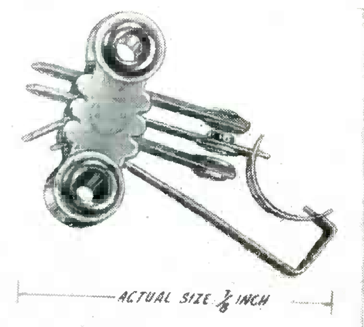
SANGAMO ELECTRIC COMPANY

SPRINGFIELD, ILLINOIS

IN CANADA: SANGAMO COMPANY LIMITED, LEASIDE, ONTARIO

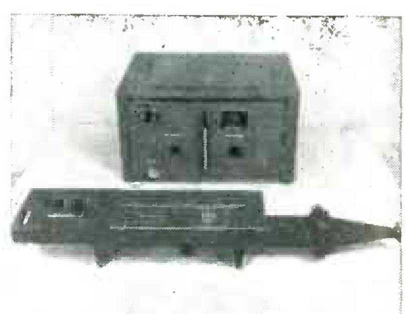
SC4913A

model IF, a new electronic sweep and marker generator for production alignment of tv receiver i-f systems. A three-position switch selects the 20-to-30, 30-to-40 or 40-to-50-mc range with overlap. Sweep width is approximately 15 mc. The output level may be varied between 50 μv and 250 μv across the 70-ohm unbalanced output. A panel switch narrows the sweep and recenters it to make it suitable for sound-channel measurements.



Midget Switch

ACRO MFG. CO., Columbus 16, Ohio. Model M-OM midget snap-action switch has particular application for condensed timing and sequence operations. Contact points are silver, 99.7 percent pure. Current carrying capacity is 3 amperes at 125 volts a-c. Rated capacity life is 500,000 actuations.



Calorimetric Wattmeter

VACUUM TUBE PRODUCTS, 302 N. Clementine St., Oceanside, Calif., has developed a new portable calorimetric wattmeter (Cubic Micro-Cal) to measure absolute microwave power in both laboratory and field use. Consisting of two units, liquid circulator and calorimetric termination, it gives a direct read-

For Temperature Ranges from 500° F. to -85° F.

Varglas Silicone Electrical Insulating Tubing and Sleeving

Lead Wire and Tying Cord

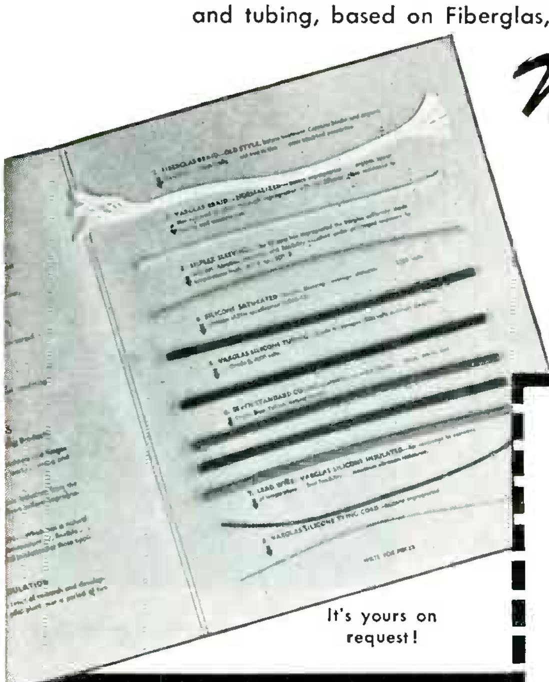
VARGLAS SILICONE is a sensationally new electrical insulating sleeving and tubing developed by our laboratory and pilot plant during the war. It is a product which combines Varglas and Silicone to bring revolutionary possibilities to electrical insulation.

VARGLAS SILICONE is efficient under a wide temperature range...to 500°F. or more in some applications, yet remains completely flexible at –85°F. It has excellent resistance to moisture and lubricating oil, is flame resistant and self-extinguishing, *and is the strongest of the accepted insulating materials.*

VARGLAS SILICONE, pioneered by VARFLEX CORPORATION, is the first combination of these outstanding features:

1. **VARGLAS**—Continuous filament Fiberglas—a moisture and fungus proof material which will not burn and is chemically inert—strong and flexible at high and low temperatures.
2. **NORMALIZING**—Removes binder and organic inclusions from the Fiberglas—improves electrical qualities and allows uniform impregnation.
3. **SILICONE HIGH TEMPERATURE RESIN**—Which has a natural affinity for the Fiberglas, renders it abrasion-resistant, flexible and non-fraying.

VARFLEX CORPORATION, manufacturers of electrical insulating tubing and sleeving, are insulation specialists. If you require special insulation, write us about your problems. We will gladly quote on your individual requirements or ASTM specifications. We have a complete line of sleeving and tubing, based on Fiberglas, cotton, and extruded plastics.



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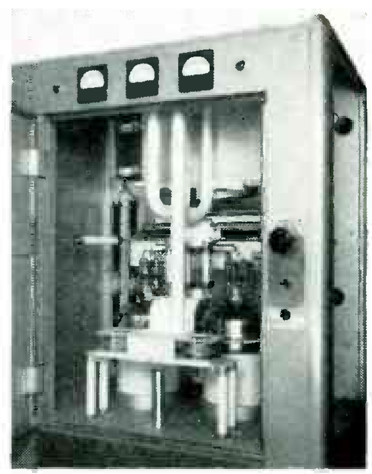
ing in watts on the basis of incident microwave power being dissipated into the calorimetric termination. A curve is furnished with the unit, allowing any liquid flow rate to be adjusted. The Cubic Micro-Cal can be used to calibrate other secondary-type power devices such as thermally activated wattmeters. Frequency range is from 2,600 to 90,000 mc. Two full scale ranges are available—100 w and 500 w.

High-Power Amplifier

RAULAND-BORG CORP., 3523 Addison St., Chicago 18, Ill. Model 1960 Bi-Power (biased power) amplifier is designed to handle the requirements of large p-a installations. Rated output is 60 watts at 5 percent or less total harmonic distortion (measured at 100, 400 and 5,000 cycles); 85 watts peak power. Frequency response is ± 1 db, 40 to 15,000 cps. Output impedances are 4, 8, 80 (70 volts), 250, 500 ohms.

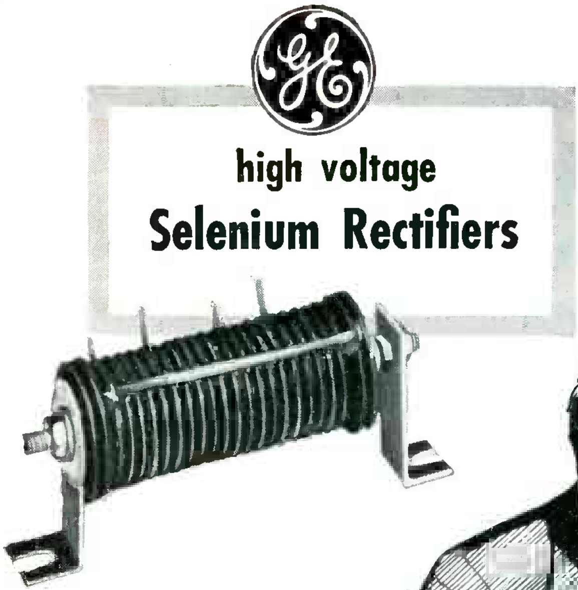


Electronic Power Generator

RADIO CORP. OF AMERICA, Camden, N. J. The 15-CH self-contained

Make your own COMPARISON TEST

Know Which Is Best



Since most selenium rectifiers look alike, but vary greatly in quality, it is important to the user to have some simple means of determining quality. Side-by-side comparison tests are the time-honored way to compare quality. Take any 26-volt RMS selenium rectifier stack on the market—get a new G-E high-voltage stack of similar ratings and see for yourself which is the better.

These new G-E 26-volt cells thrive on comparison tests because they are outstanding in the three characteristics which mean quality in selenium rectifiers.

LOW FORWARD RESISTANCE

G.E.'s new 26-volt cells have extremely low forward resistance. This means a low voltage drop giving higher output, cooler operation, and greater rectifier efficiency. This often results in savings to you in the design and costs of other circuit components.

LOW BACK LEAKAGE

Since reverse current through a rectifier serves no useful purpose but does increase losses and heating, the low back leakage of these cells results in higher output, higher efficiency, and cooler operation.

DEPENDABLE LONG LIFE

These cells are the slowest aging of any selenium cells we have tested. These dependable cells have a life expectancy of well over 60,000 hours.

Prove for yourself the superiority of these new G-E selenium cells. *Write Section 461-13, Apparatus Department, General Electric Company, Schenectady 5, New York* for a copy of GEA-5524 which gives complete instructions for comparative testing. Contact your local General Electric Apparatus Sales Representative or authorized G-E agent to arrange your sample purchase.

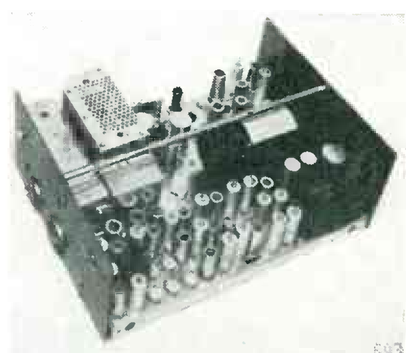
GENERAL ELECTRIC

461-13

power generator for medium power dielectric heating applications is capable of developing a power output of 18 to 21.8 kw at frequencies of 5.5 to 41 mc. The high-frequency output is obtained from a stabilized, self-excited oscillator employing two heavy-duty, air-cooled 889R-A power tubes that are supplied with high-voltage d-c by a three-phase, full-wave rectifier. It is designed to meet industrial requirements for a medium-sized unit, and incorporates the latest electrical and mechanical developments.

Precision Attenuators

GENERAL RADIO CO., 275 Massachusetts Ave., Cambridge 39, Mass., has available precision decade attenuators for laboratory use and for building into other equipment. Type 829 units can be built into speech and ultrasonic equipment and measuring devices. Characteristic impedance is 600 ohms for both H and T types. Type 1450 consists of an assembly of attenuator units in metal cabinets for laboratory bench use. Two- and three-dial boxes are available with maximum attenuation of 110 db.



Two-Way Mobile Radio

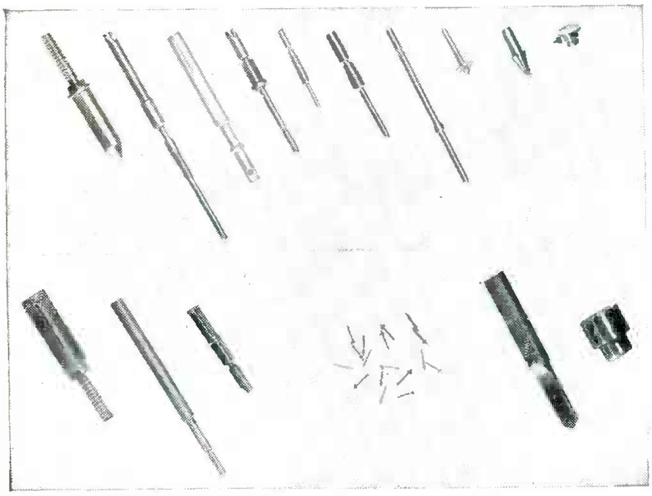
RADIO CORP OF AMERICA, Camden, N. J. Model CMV-4A Carfone is

COPPER ALLOY BULLETIN

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

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

Radar, Television Parts Accurately Turned in Swiss Screw Machine



Brass electronic parts, produced on Swiss screw machines, are shown in first row. Tiny parts in center are for watches. Phosphor bronze connector components at lower left. Brass bushing and flat drill at lower right. Courtesy: Iseli Swiss Screw Machine Products, Terryville, Conn.

Small, precision brass and bronze connectors and components for ultra-high frequency equipment, including radar and television, have gradually grown in demand during the past few years.

These parts are produced in the small Swiss screw machines due to the extreme accuracy and concentricity required. Since the cutting is done close to the guide bushing as the stock is fed into the tools, variations usually encountered through tool pressure on over-hanging parts are eliminated.

Excellent finishes are maintained through elimination of whipping and chattering, although spindle speeds are in excess of 6000 rpm.

Three Reasons For Brass

Three main factors are involved in the choice of brass and bronze for these parts: 1. corrosion resistance which insures unchanged electrical characteristics despite varied operating circumstances; 2. ease with which copper-base alloys can be plated with silver and gold without preparation other than the normal cleaning and the ability to hold these plates; 3. high machinability of these alloys which permits high-speed production with a minimum of tool wear.

Radar equipment is used in many climates and under adverse conditions in battle circumstances. Due to the nature of high-frequency currents it is essential to eliminate losses which come about through faulty contacts and varying resistance.

Gold, Silver Plate Used

Gold and silver plate are used mainly for their electrical conductivity and superior corrosion resistance. High frequency currents are conducted in a manner known as "skin effect" along the outside surfaces of the conductor.

Although free turning brass rod has top machinability characteristics, it is customary in Swiss machines to use tungsten carbide tools both to insure long life and good finishes.

Standard high-speed drills are used for some jobs but generally a flat drill ground from a solid piece of tungsten carbide is excellent where finish is essential. The carbide is first ground radially to the desired hole diameter with a slight back taper. It is then ground flat on both sides in a surface grinder. Finally, a 25-to-30 degree angle is ground on the cutting face with a slight cutting angle on the faces. Such a drill will give weeks of service without resharpening on brass.

Finish, Concentricity Vital

The bushing in the lower right of the photograph, although large for Swiss machines, was turned with perfect concentricity and extreme accuracy and finish on the bore.

The small parts in the photograph are those usually associated with Swiss machines. They are made from free machining brass rod and are only 3/16 in. long. The largest diameter is only 0.030 in. and is turned in the form of a cone. The two shanks are only 0.012 in. These are used in watches.

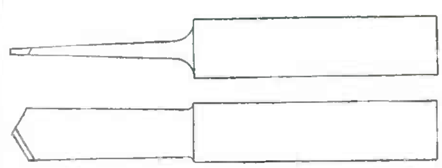
The long connector, second from left at top, is 2 1/16 long and has a 3-48 thread at the center. The other diameters are 0.062, 0.100 and 0.104 in. respectively.

At the lower left phosphor bronze is used for these connectors as high strength and ductility are required due to coldworking at assembly. High corrosion resistance of this material is also utilized.

Rod Dimensions Important

Rod for Swiss screw machine work must be carefully drawn and roll-straightened. Out-of-roundness would be reflected in the turned diameters, since a guide bushing is used.

For information and help in selecting and working copper-base alloys, contact our nearest district office or write directly to Bridgeport.



Tungsten carbide flat drill for Swiss screw machine work. Courtesy: Iseli Swiss Screw Machine Products, Terryville, Conn.

designed to supply over 30 watts of power output over the entire 152 to 174-mc range, embracing the commercial and government frequency bands. The equipment includes a grounded-grid r-f-input tube for high sensitivity; a special filter to reduce spurious emissions by at least 100 db in the band, and all other emissions and all harmonics by at least 85 db. The unit provides stability within 0.001 percent without use of oven or within 0.0005 percent with oven between 22 and 140 F.

Variable Electronic Filter

SPENCER-KENNEDY LABORATORIES, INC., 186 Massachusetts Ave., Cambridge 39, Mass. Model 300 variable electronic filter features a continuously variable cutoff within the frequency range of 20 cycles to 200 kc. Attenuation rate is 18 db per octave. Several filters can be cascaded so that attenuation rates of 36 and 54 db or more per octave can be realized. Low noise level and versatility make it an ideal research instrument for noise analysis or acoustic measurements in the automotive, aircraft, machine tool industry or general laboratory use.

Metal Fasteners

ELASTIC STOP NUT CORP., 2330 Vauxhall Road, Union, N. J. The Rollpin is an all-purpose pressed-fit

pin introducing a new idea of design and application in metal fasteners. A self-locking pin with chamfered ends, it was designed to replace the variety of dowel, pivot, tapered and grooved pins, which ordinarily require a key or some supplementary fastening method to hold them in place. They can be used as an important assembly in a 35-mm projector for television, as shafts for assembly of gear trains on a metering device or as shafts to mount plastic gears. They are available in 13 sizes to fit hole diameters ranging from 0.078 (5/64 in.) up to 0.500 (½ in.). The fasteners are made from SAE 1095 steel and type 420 stainless steel, and can also be furnished in beryllium copper.

Lightweight Soldering Gun

WELLER ELECTRIC CORP., Easton, Pa. Model WD-135 small lightweight soldering gun features dual spotlights to eliminate shadows and over-under terminals to brace the tip and improve visibility. Useful to radio and tv technicians, the instrument has dual heat (100 and 135 watts) for all light and delicate soldering, 5-second heating to save time and current, and trigger-switch control that adjusts heat to the work and eliminates need of unplugging the gun between jobs. A descriptive catalog bulletin is available.

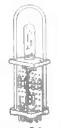
Five-Inch Oscilloscope

THE TRIPLETT ELECTRICAL INSTRUMENT CO., Bluffton, Ohio. Model 3440 five-in. oscilloscope for tv and general use features an exclusive pattern reversing switch; calibrated meter for peak-to-peak volt-

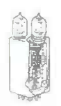
Alden Components for *Plug-In Unit* Construction

ALDEN PLUG-IN BASES AND HOUSINGS

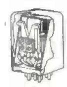
Alden has the bases, housings and sockets along with the resistor cards, tube mounts, brackets, etc. to make plug-in units of your electronic circuits, relays and other components. A whole series of bases and housings are available from the standard 7 and 9 pin layout for miniature units to the Alden Non-interchangeable 11 and 20 pin bases for larger units. The Non-interchangeable Series is designed with variable pin patterns that insure positive isolation of critical voltages or current . . . strong, stubby pins and elimination of bosses correct the bugaboos of the bent pins and broken bosses of conventional octal or loctal base design.



Open 20 pin plug-in assembly

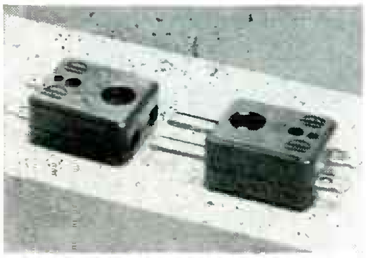


Shielded 20 pin plug-in assembly



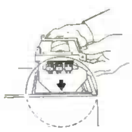
Shielded 11 pin plug-in assembly

Miniature 9 pin plug-in assembly

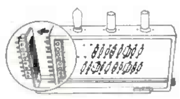


ALDEN BACK CONNECTORS

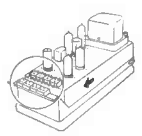
Here are back connectors that make possible slide-in chassis that go together and come apart easily. Generous bell mouthed entries and floating clip action provide wide mating tolerances — do away with critical chassis alignment problems. Wiring to color-coded back connectors instantly identifies each lead for circuit checks — makes wiring accessible for easy servicing. Can be mounted flushed or stacked to meet space requirements.



Mechanical units



Decade units

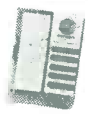


Miniature chassis

MODERN ELECTRONIC DESIGN MEANS PLUG-IN UNIT CONSTRUCTION

The trend in modern design is toward smaller, lighter, better looking equipment. Yet modern design demands easy servicing, rapid changeover, and fool-proof performance. To get these results, more and more modern design engineers are turning to plug-in unit construction with basic elements grouped as units that plug in, slide in, lock in, pull out easily. Up to now there has been no one place where components specifically designed for plug-in, unit construction were available. To get this type of construction — it has been necessary for engineers to design and have parts custom made or improvise with standard components in makeshift arrangements.

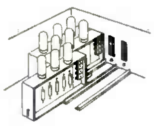
For many standard applications Alden has a whole series of plug-in components that can meet many of your unitization needs. On new or special designs, we feel we have the conception and facilities necessary to take your whole problem — to design, develop and manufacture plug-in components tailored to fit your needs — to give you the advantages of components specifically designed for plug-in unit construction, advantages not found in standard components.



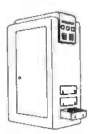
Write for new booklet on "Components for Plug-in Unit Construction."

ALDEN SLIDE-IN LOCK-IN CHASSIS

Designed for quick, positive insertion and removal, slide-in lock-in chassis utilizes bullet nosed dowels which pull in, lock, and eject chassis quickly and easily. Simple ½ twist of handles gives positive lock against vibration shock in any position. Pilot action of locking dowels eliminates critical sheet metal tolerances. Slide-in lock-in chassis are built for racks or as separate units, miniature or standard size.

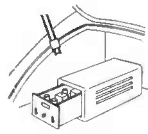


Instrumentation



Electronic

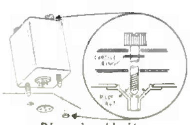
Communication



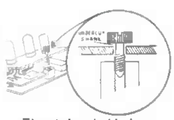
Mobile

CAP-CAPTIVE CONVENIENCE SCREW

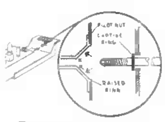
Concave surface of head and arced notch quickly center production tools on screw for rapid tightening against lockwasher. In the field, no special tools are necessary — arced slot in head is of such proportion that even a coin gives sufficient leverage to back it off lockwasher. Can readily be made captive, so it's ideal for holding detachable mechanical units, plug-in housings, miniature chassis.



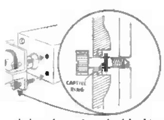
Plug-in Units



Electrical Units



Electronic Units



Mechanical Units

ALDEN PLUG-IN UNIT CABLING

For years cabling did not keep pace with the speed of electronic design — Manufacturers had to be satisfied with cables designed as an afterthought — cabling utilizing mongrel connectors and wire, designed for a job, yes, but not designed for a specific job. In the past this poorly designed cabling has led to malfunctions, time delays, excessive production costs and high service cost in the field.

With today's higher voltages, frequencies, and critical signals, more and more engineers are turning to Alden for the solution to their cabling problems because ***Alden's is the one place where specially designed connectors and large stocks of wire are obtainable under the same roof.***

Here is what Alden engineers can do for you — take your prototype model, engineer to your specific requirements unit cables incorporating Alden's 20 years of technical design and development of connectors and wire services — give you economic and efficient cables of good appearance that are built as units — allow instant continuity checks and rapid replacement in the field.

Alden's series connectors enable the engineer to select, and know that he will get, the right connector for the job. For critical connections, Alden has special non-interchangeable connectors with plugs that can only mate with the correct socket and thereby absolutely prevent mismating and the costly damage of burned out sets. All connectors used have forward connected, low resistance contacts which provide individual strain relief for each lead. Production design connector bodies with well-isolated clip and wire pockets provide 100% insulation. Less material — less space, features of Alden top connected contact connectors, allow Alden to design and produce a cable that is more compact and more easy to handle.

Wire is supplied from stock that include sizes and insulation of any type. It is ready to be formed, laced, braided, or shielded — in production quantities — as needed. By pooling wire requirements, a flexible high-speed braiding department, special tools, trained operators and mingling of orders, the most exacting schedules of customers can be met at production line cost.

For quotations or suggestions about design, submit your inquiries or blueprints — Alden engineers are always ready to work with you on cabling problems.

NA-ALD

ALDEN PRODUCTS COMPANY

117 NORTH MAIN STREET, BROCKTON 64E, MASSACHUSETTS

age measurements; vertical sensitivity of 0.009 rms volt per inch; linear sweep voltages up to 60 kc; and a frequency range from 20 cycles to over 1 mc. A demodulator probe is also available for signal tracing.

D-C Power Supply

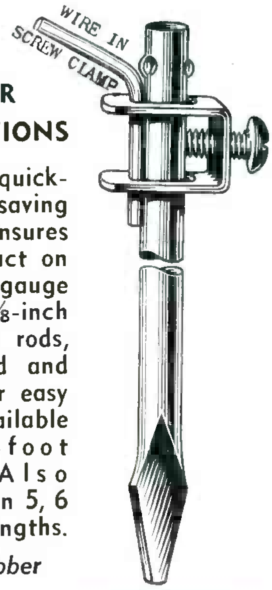
FREED TRANSFORMER CO., INC., 1718–36 Weirfield St., Brooklyn 27, N. Y., has introduced the No. 1170 stabilized power supply intended for use as a d-c supply with the company's incremental inductance bridge No. 1110. It provides 4 continuously variable current ranges: 5 ma, 25 ma, 100 ma and 500 ma. Maximum output voltage is 270 v d-c. Noise level is −92 db.

Oscillograph Tube

RADIO CORP. OF AMERICA, Harrison, N. J. Model 7MP7 is a seven-inch, directly viewed, c-r tube of the magnetic deflection and magnetic-focus type intended primarily for use in radar indicator service, but also useful in general oscillographic applications where a temporary record of electrical phenomena is desired. It uses a long-persistence, cascade (two-layer) screen, which exhibits bluish fluorescence of short persistence and greenish-yellow

PREMAX

THE FASTEST SELLING
Ground Rods



For TV
AND OTHER INSTALLATIONS

With a new quick-acting, time-saving clamp that insures positive contact on #4 to #14 gauge conductor. ⅜-inch solid steel rods, copper plated and pointed for easy driving. Available in 4 and 6-foot lengths. Also ½-inch rods in 5, 6 and 8-foot lengths.

At your Jobber

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Plays 10½" Reels!

Complete, for console installation with single or dual track heads: **$345.00**

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■ The *professional quality* tape recorder you have been waiting for! NAB standards; triodes throughout; 40-15000 cycles at 15", 40-8000 cycles at 7½". Three motors; flutter less than 0.1%; signal-to-noise better than 50 db. Three heads for simultaneous erase, record, playback. Quick change from single to dual track. *Write for booklet.*

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HERE'S BIG HELP IN TERMINAL WIRING!

The correct wire to correct terminal every time!

The New
JONES FANNING STRIP

Connections are made through Fanning Strip, on bench or anywhere apart from barrier strip, and quickly slipped into assembly.

9-141 Barrier Strip

9-161 Fanning Strip. Pat. applied for.

Use with Jones Barrier Terminal Strips, Nos. 141 and 142, for 1 to 20 terminals.

Simplifies soldering. Insures correct connections. Saves time. Ideal for harness or cable assembly. Brass terminals, cadmium plated. Bakelite mounting. Send for complete data.

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3. Positions open for engineers with background and experience in the field of sonar.

Salary commensurate with ability and experience. Excellent opportunity for suitably qualified personnel.

Submit detailed resumé.

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Pacific Division
Bendix Aviation Corporation
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Easy Accessibility!

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WITH DETACHABLE SOCKETS

This popular series permits bulb installation from front—or from rear by means of a detachable spring bracket. Jewel is 1" diameter in friction type holder with polished chrome bezel. Available in red, green, amber, blue, opal or clear with miniature screw socket, candelabra screw socket or miniature bayonet socket. Choice of faceted or smooth jewel. All fit 1" hole.

JOHNSON carries in stock a complete line of standard light assemblies to meet every ordinary need. Special assemblies, to meet your most exacting requirements, can also be furnished in production quantities on special order. Your inquiries are invited.

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

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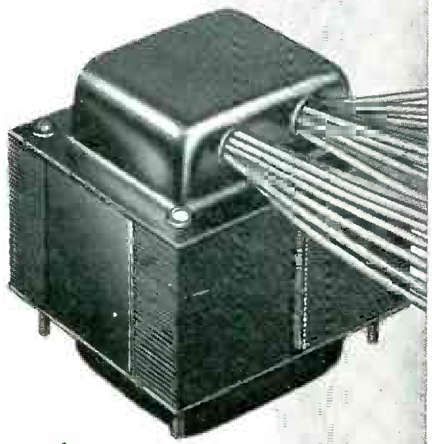

Specified as original components by the biggest radio and TV set makers in the industry. They have to be good!

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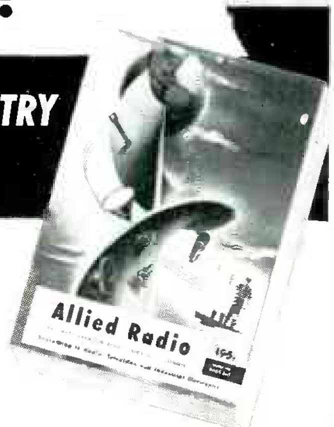
- ***BROADCAST STATION SUPPLIES***



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Simplify your purchasing problems—send your consolidated orders to ALLIED—the single, complete source for *all* electronic supplies. Rely on ALLIED for the world's largest stocks of parts, tubes, test instruments, audio equipment, accessories—complete quality lines of electronic supplies ready for *immediate shipment from stock.* ALLIED'S expert Industrial and Broadcast Station supply service saves you time, effort and money. Send today for your FREE copy of the 1951 ALLIED Catalog—the only *complete* guide to electronic supplies for industrial and broadcast station applications.

212 PAGES: Equipment for Research, Development, Maintenance and Production Operations

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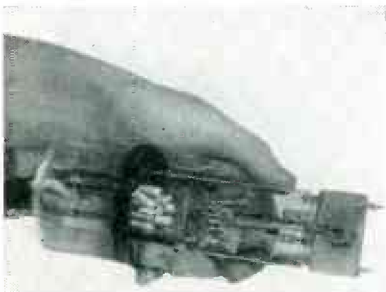
Everything in Electronics from ONE Source

phosphorescence, which persists for several minutes. An eight-page bulletin now available gives full description including characteristics charts, dimensional outline and socket connections.



Mass Spectrometer Tube

GENERAL ELECTRIC CO., Schenectady 5, N. Y. The ion resonance mass spectrometer tube illustrated was designed for high-precision measurements in special analysis problems. Approximately 150 volts d-c and r-f voltages of about 1 volt at frequencies up to 5 mc are employed. The tube has a glass envelope and requires a magnet with a 1-in. gap and a field strength of several thousand gauss.

Q Indicator

FREED TRANSFORMER CO., INC., 1718-36 Weirfield St., Brooklyn 27, N. Y., have introduced the No. 1030 low-frequency Q indicator designed specifically to measure the Q factor of coils. It can also be used to measure inductance, distributed capacitance, impedances and dielectric losses. The Q range is from

0.5 to 500. Frequency range is from 20 cycles to 50 kc.

Count Rate Meter

NUCLEAR INSTRUMENT AND CHEMICAL CORP., 229 W. Erie St., Chicago 10, Ill. Model 2611 count rate meter for checking electromagnetic radiation in hospitals and laboratories is battery operated. Probe has a thin mica end window with a density of 1.4 milligrams per sq cm. The meter at one end of the unit reads directly in counts per minute and, for gammas, in milliroentgens per hour. For monitoring large quantities of radiation, the instrument is provided with three ranges and a selector switch, permitting choice of 0.2, 2 or 20 milliroentgens per hour full scale.

Wide-Band Oscilloscope

TELEVISION EQUIPMENT CORP., 238 William St., New York 7, N. Y. Model T-601-A oscilloscope is a general-purpose high-quality cro, which has been designed for laboratory engineering use. It features 17 tubes including 5-in. crt, 10-mv

Don't Overlook the LECTROHM FERRULE TERMINAL RESISTOR

Perhaps the most dependable resistor you can use. *Convenient*—it slips tightly into place with perfect contact. *Trouble-free*—ferrules are of monel metal and therefore non-oxidizing and non-corrosive. Windings are permanently *silver soldered* to ferrules. All parts are integrally embedded in vitreous enamel—a lifetime construction. Tube ends are left open for *thru-ventilation*.

Seven standard sizes, ranging from 13 to 190 Watts, available from stock.

Write for Bulletin #99 illustrating this and many other Lectrohm quality resistors

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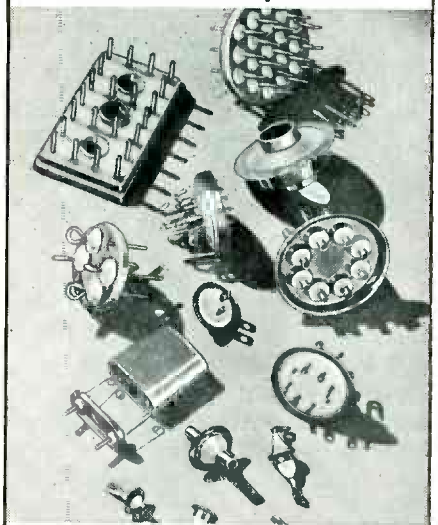

Quality plus unlimited shapes

The only seals you can hot tin dip at 525°F. for easy assembly soldering, for a strain and fissure-free sealed part with resistance of over 10,000 megohms!

Hermetic headers withstand high vacuum, high pressure, temperature cycling, salt water immersion and spray etc., and are used extensively by America's leading industries and government agencies.

TERMINALS AND HEADERS ARE AVAILABLE IN RMA COLOR CODE

Free!

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HERMETIC SEAL PRODUCTS COMPANY
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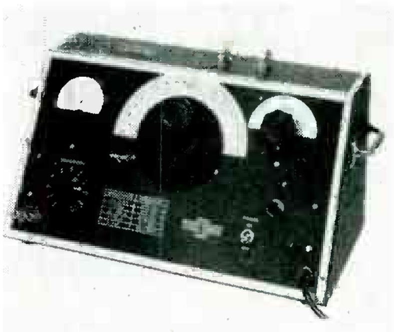
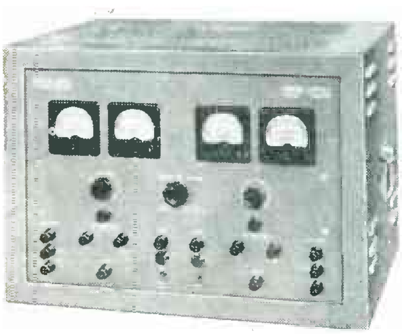
sensitivity, continuously variable calibrator and sweep magnification to five times screen size.



Coil Checker

CLOUGH BRENGLE CO., 6014 Broadway, Chicago 40, Ill. Model 301A coil checker combines a vtvm, a calibrated variable capacitor and an amplifier tube into a single instrument. When coupled with any r-f oscillator the unit measures inductance, distributed capacitance and the Q of any inductor, as well as the capacitance of mica capacitors.



Dual Voltage-Regulated Power Supply

KEPCO LABORATORIES, INC., 149–14 41st Ave., Flushing, N. Y. Model 510 features two completely independent voltage-regulated power supplies. Each d-c output voltage is continuously variable from 200 to 500 v, 0 to 200 ma. For all output voltages the output voltage variation is less than 0.5 percent for both line fluctuation from 105 to 125 v and load variation from minimum to maximum current. Ripple voltage is less than 5 mv. Each a-c output is 6.3 v, 6 amperes, center-

Arc Resistance — 135 SECONDS

HYSOL 6000

For Screw Machine Components, Gears and Punched Press Parts

A New Insulating Material with Outstanding Electrical Properties

An extremely high dielectric strength coupled with resistance to moisture and chemical attack make this new material ideal for electrical insulation. Hysol 6000 has good dimensional stability and does not require fabric backing. Available in rod, tube, sheet and casting resin form, Hysol 6000 may be exposed to 140° C for 100 days without embrittlement. *Write for technical details and samples.*

ELECTRICAL PROPERTIES

Power Factor	0.005 at 60 cycles
Dielectric Constant	3.70 at 60 cycles
Loss Factor	0.009 at 60 cycles
Dielectric Strength	350 volts/mil.
Arc Resistance	135 seconds

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The New STAVER MINI-SHIELD

TRADE MARK REG. AND PAT. PEND.

The shield that fits all Miniature Tubes

A flexible shield that snugly fits all miniature tubes because it compensates for all variations in tube dimensions. Mini-Shields are made for both T5½ and T6½ bulb tubes. Send for catalog sheet.

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FOR ORIGINALITY LOOK TO XCELITE

Now — 13 Tools For Nut Driving And Screwdriving — In This $10.95 Kit!

In the "99" durable plastic kit, we've replaced the reamer with the #1 and 2 Phillips reversible blade AT NO EXTRA COST. So you get 9 nut drivers and 4 screwdrivers (2 Phillips, 2 regular)! ASK YOUR SUPPLIER! NOTE: THIS SAME "99" SET IN METAL CONTAINER WILL AGAIN BE AVAILABLE AS SOON AS SHEET METAL BECOMES OBTAINABLE.

Quality Tools PREFERRED BY EXPERTS

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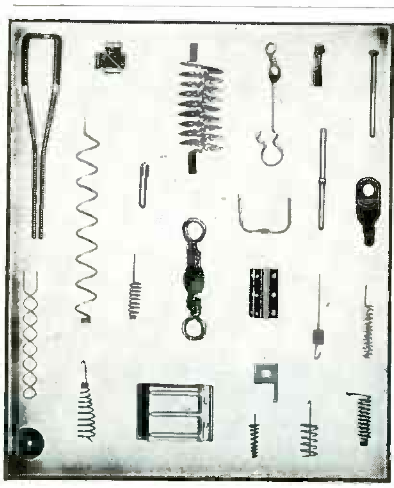
Canadians Send Orders Direct to: Chas. W. Pointon, Canadian Warehouse Distributor, 1926 Gerrard St., E. Toronto, Ont.



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Filaments, anodes, supports, springs, etc. for electronic tubes. Small wire and flat metal formed parts to your prints for your assemblies. Double pointed pins. Wire straightened and cut diameter up to ⅛-inch. Any length up to 12 feet.

LUXON fishing tackle accessories.

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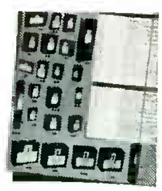

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tapped, unregulated. Power requirement is 600 watts. The d-c outputs may be used separately in parallel, in series, and bucking.

Mobile Combination

General Electric Co., Syracuse, N. Y. Mobile combination 204 is a 50-watt unit for use in the 148 to 174-mc band. It features easily adjustable tuned circuits having triple-tuned transformers and a built-in low-pass harmonic filter in the antenna output circuit which attenuates harmonics at least 70 db. Receiver circuit elements provide better than 100-db adjacent-channel selectivity. Standby battery drain for the new unit is 11 amperes at 6.3 v and transmit drain is 60 amperes at 6.3 v.

Spectrum Analyzer

Robert R. Waters, Inc., 4 Gordon St., Waltham 54, Mass. The Vectron spectrum analyzer has been engineered to avoid obsolescence by making provisions for rapid interchange of r-f heads that will provide coverage of the microwave spectrum to 30,000 mc. The unit features a functionally designed housing incorporating a 5-in. c-r

CORRECTION

RE: CORES, HIGH PERMEABILITY MAGNETIC
CORES, IRON
CORES, POWDERED IRON
CORES, SLUG TUNING UNITS

Your attention is called to the omission in the above listings of the following:

NATIONAL MOLDITE COMPANY

1410 CHESTNUT AVE • HILLSIDE 5, N. J.

in the 1950 Mid-June Electronics Buyers' Guide

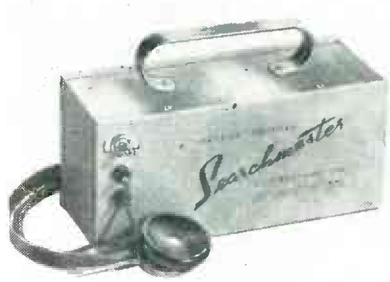
See this Company's advertisement on page 200 in the Buyers' Guide

Please make this correction on page D-36 of the Directory Section of your Buyers' Guide issue.

tube indicator with a mounting that permits convenient use of a 35-mm camera for recording information from the c-r tube.

Sealed Relay

ADVANCE ELECTRIC AND RELAY CO., 2435 North Naomi St., Burbank, Calif. Part 8744–1 small hermetically sealed relay features three-stud mounting and solder lug terminals. It is designed for a variety of commercial, industrial, portable and military applications in various electronic equipments. The enclosure will accommodate three-ampere-rated relays in contact combinations up to and including 4 pole-double throw. Measurements are $1\frac{7}{16}$ in. x $1\frac{5}{8}$ in. x $1\frac{1}{16}$ in. high.



Geiger-Counter Kit

SCIENCE KITS, LTD., 5514 Hollywood Blvd., Hollywood 28, Calif., has developed the Searchmaster Kit containing everything needed to assemble a high-quality Geiger

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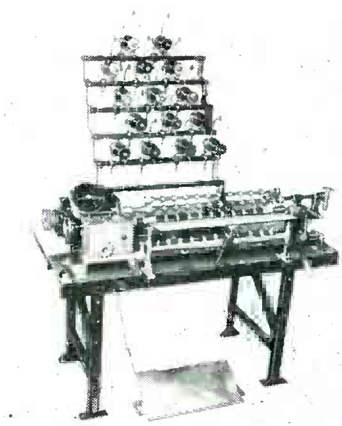
counter capable of detecting both beta and gamma radiation. Each set includes tubes, batteries, resistors, capacitors, sockets, type SK-1 Geiger tube, headset and a metal case 9¼ in. × 4 in. × 3½ in. A radioactive specimen is also included for demonstration purposes. Price is $29.95.

Heavy-Duty Inverters

AMERICAN TELEVISION & RADIO CO., 300 E. 4th St., St. Paul, Minn., announces a line of superheavy-duty inverters for operation on d-c input voltages ranging from 6 to 220 v, having output of 110 v a-c 60 cycles at capacities ranging from 175 watts to 1,000 watts. The line is designed especially for heavy-duty applications including tape recorders, television sets, portable transmitters and similar electronic and electrical equipment within the output capacity ranges indicated.



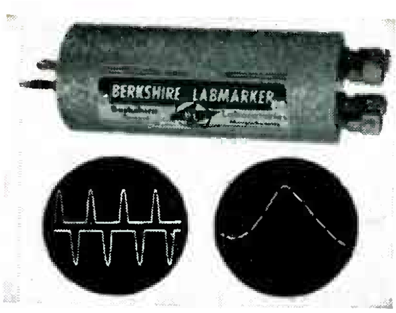
Transformer Winder

GEO. STEVENS MFG. CO., INC., Chicago 30, Ill. New transformer winder model 37S will multiple-wind power, audio, automotive, fluorescent ballast and similar types of coils up to 9-in. o. d. Unit has a screw feed, assuring accurate margins by eliminating the possibility of overruns. Mandrels up to 30 in. long may be used for maximum economy. Thirty or more coils can be wound simultaneously. All turns are accurately registered by a 6-in. full-vision, clock-face dial counter. Highly polished wire guide rollers

are ball-bearing mounted for free running. Traverse is quickly adjusted from 1/16 in. to 6 in. Unit is powered with a variable speed, uniform torque $\frac{1}{2}$-hp motor with foot-treadle control.

Amplifier

RAULAND-BORG CORP., 3523 Addison St., Chicago 18, Ill. Model 1916 Green Gem amplifier is rated 16 watts at 5 percent or less harmonic distortion (measured at 100, 400 and 5,000 cycles); 20 watts peak output. Frequency response is ± 1 db, 40 to 20,000 cps. Output impedances are 4, 8, 16, 250, 333 (70 volts), 500 ohms. Gain characteristics are as follows: For the mike —130 db (2 meg); 117 db (100,000 ohms); 117 db (150 ohms). Phono —85 db (0.5 meg). Voltage required for rated output is as follows: high impedance input—0.0015; low impedance—0.0001; phono—0.1 v.

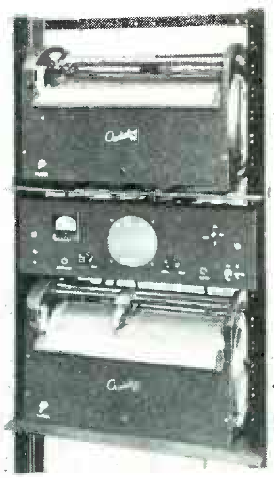


Wave-Shaping Device

BERKSHIRE LABORATORIES, P. O. Box 70, Concord, Mass. Model 1-U Labmarker is a wave-shaping device for producing timing marks in c-r oscillography. It converts a sinusoidal input of up to 30 volts rms into a series of sharp unidirectional pulses. Approximate characteristics are: pulse duration, one-third of a cycle; pulse amplitude, one-half of the rms input voltage; frequency range, 25 cycles to 1 mc.

Insulation Tester

GENERAL ELECTRIC CO., Schenectady 5, N. Y., has announced a new instrument for electrical testing of insulating materials, the current-limited high-potential tester. It is designed to aid electrical manufacturing plants and service shops in testing insulation of electrical components and assemblies such as coils, relays, motors and appliances. The unit operates from a power supply of 105 to 125 volts a-c, 60 cycles.



Communications Recorder

AUDIOLOG CORP., 440 Peralta Ave., San Leandro, Calif. The Audiolog is a new recording unit especially designed for logging and monitoring radio and phone communications. An important feature is the use of a thin, flexible, reusable sleeve or tube of magnetic material upon which an entire hour of speech or code communications can be recorded. Use of the sleeve elimi-

nates the usual spooling and reeling. The sleeves can be telescoped so that a 24 hour log can be filed as a compact unit. Tests indicate that they will retain the recording indefinitely.

Mercury Battery

P. R. Mallory & Co., Inc., North Tarrytown, N. Y. Type RM-1C mercury A battery is suitable for applications in miniature radios, hearing aids, meters, instruments and penlights. At a current drain of 250 ma service life is indicated to be approximately 10 hours, depending upon required minimum voltage. It has an extremely constant voltage discharge rate, long shelf life and resistance to extremes of temperature, pressure, shock and humidity.

Counter Tachometer

Potter Instrument Co., Inc., 115 Cutter Mill Road, Great Neck, N. Y., announces its new electronic counter tachometer for high-accuracy revolution and frequency measurements. This unit can be used to measure frequencies up to 100,000 cycles with an accuracy of ± 1 cycle. The instrument sums the number derived from the source being measured during a precisely established time interval of 0.6 sec, the interval being determined by counting 60,000 cycles of the 100-kc

"We have found Metex Electronic Gaskets excellent for HF currents inexpensive to assemble."
Sylvania Electric Products Inc.

Sylvania has been using Metex gaskets for over a year as conductive shields for their TR tubes used in radar and micro-wave ranging equipment.

To quote their experience: "We have found Metal Textile knitted wire gaskets excellent for conducting high frequency currents without boundary arcing. The gaskets are resilient, and yet do not deform too readily. Best of all, the material is inexpensive to assemble through soft soldering techniques."

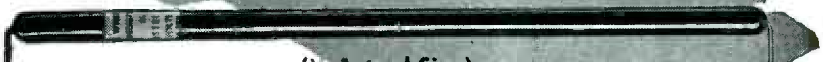
A Sylvania Electric TR tube showing Metex gasket loose and in position

The properties—electrical and physical—which make Metex Electronic Gaskets effective in this, and other demanding HF and UHF applications are due to their being made from *knitted* (not woven) wire mesh. The hinge-like action of the knitted mesh permits controlled resiliency of the finished gaskets. These can be die-formed to close dimensional tolerances, when required. There is practically no limit to the metal or alloy which can be used.

If the equipment you are manufacturing or designing requires a resilient conductive or shielding material, our engineers will welcome the opportunity of working with you. A letter, addressed to Mr. R. L. Hartwell, Executive Vice President and outlining your requirements, will receive immediate attention.

METAL TEXTILE CORPORATION
641 EAST FIRST AVE., ROSELLE, N. J.

The new S.S.WHITE 80X HIGH VOLTAGE RESISTOR



(½ Actual Size)

4 watts • 100 to 100,000 megohms

Developed for use as potential dividers in high voltage electrostatic generators, S.S.White 80X Resistors have many characteristics—particularly negative temperature and voltage coefficients—which make them suitable for other high voltage applications.

They are constructed of a mixture of conducting material and binder made by a process which assures adequate mechanical strength and durability. This material is non-hygroscopic and, therefore, moisture - resistant. The resistors are also coated with General Electric Dri-film which further protects them against humidity and also stabilizes the resistors.

WRITE FOR BULLETIN 4906

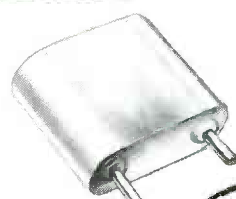
It gives complete information on S.S.White resistors. A free copy and price list will be sent on request.

THE S.S.White DENTAL MFG.CO. INDUSTRIAL DIVISION
Dept. R 10 East 40th St.
NEW YORK 16, N. Y.

CRYSTAL GAZING ELECTRONICS STYLE

There's no room for "guess work" in the manufacture of crystals! That's why so many so often specify JK stabilized crystals when they want to be sure of utmost dependability.

Happily, this preference for the best costs no more. You, too, will be pleasantly surprised to find that The James Knights Company can furnish you outstanding quality at modest cost—in single units or production quantities.



JK STABILIZED H17

Frequency range 200 kc to 100 mc. The pin spacing is such that two units can be mounted in a loctal socket. A small extremely light weight hermetically sealed unit. Moisture and dust-proof. Designed especially for use where space is at a premium. The crystal is plated and wire mounted. Will stand maximum vibration. Pin diameter of the H17 is .050.

The H17L and the H17W are also available in the same frequency range except that the H17L has a pin diameter .093, and the H17W has wire leads.

CRYSTALS FOR THE CRITICAL JK

The James Knights Company
SANDWICH, ILLINOIS

crystal oscillator contained in the unit. This reading is displayed on a direct-reading, four-digit electronic counter using ten neon glow lamps for each digit. After each measurement and display period, the instrument automatically resets and recycles. The display time is adjustable over a period of from 0.5 to 4 sec, or can be set to hold the count indefinitely. In addition to the electronic counter registration of the measured frequency, the unit also includes a count-rate meter that can be used when an unknown frequency source is being adjusted.

Industrial Oscilloscope

WATERMAN PRODUCTS CO., INC., Philadelphia 25, Pa., has announced model S-14-A Hi-Gain industrial Pocketscope weighing 12¾ lb and featuring an amplifier sensitivity of 10 mv rms per in. Its utility in examining low-level aperiodic electrical impulses is evidenced by its linearized time base continuously variable, either repetitive or triggered, from 0.5 cps to 50 kc. Fidelity is within 2 db from 0 to 50 kc. Internal sine-wave calibration of trace amplitude is provided and attenuators and gain controls are non-frequency-discriminating.

Literature

Capacitor Bulletin. Cornell-Dubilier Electric Corp., South Plainfield, N. J. Bulletin NB-138 deals with the type IN series of automotive generator and radio noise capacitors. It describes their outstanding features, ratings and dimensions, and uses.

Parts & Equipment Catalog. Radio Shack Corp., 167 Washington St., Boston 8, Mass., has just published its 1951 catalog of electronic parts, complete equipment and kits. Major sections of the 172 pages include: test and service instruments, public-address and high-fidelity music systems, amateur radio equipment, tubes, transformers, connectors, wire and cable, capacitors, resistors, batteries and

books. It is distributed free upon written request.

Magnetic Power Amplifiers. Magnetics, Inc., 135 Bloomfield Ave., Bloomfield, N. J. Bulletin No. 1000-1-H49 is an 8-page folder containing much informative data on the 400-cycle series magnetic power amplifiers. Included are a description, functional operation, advantages, applications, electrical data, response charts and typical schematic circuits.

Alloy Data Sheet. The Riverside Metal Co., Riverside, N. J., announces a new data sheet that correlates ASTM, Federal, Army and Navy specifications with 40 different alloys of phosphor bronze, nickel silver, beryllium copper and cupro nickel. In addition to correlating the five specification systems, the new data sheet gives general characteristics and typical uses of the above-mentioned alloys.

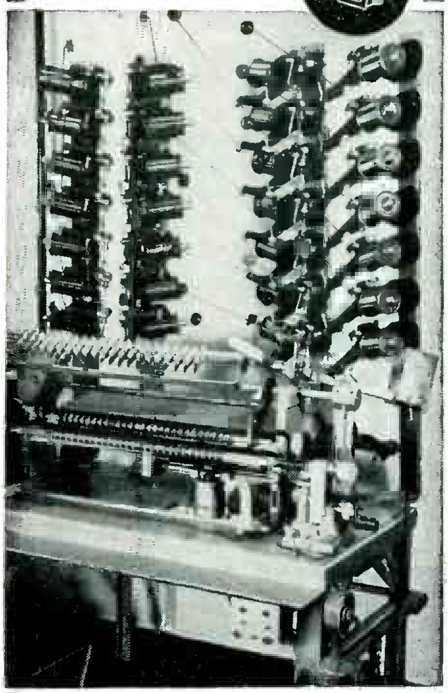
Radiation Laboratory Equipment. General Electric Co., Schenectady 5, N. Y. A new catalog contains condensed facts, pictures, prices and ordering information for over thirty special-purpose equipments for radiation laboratories. Items such as radiation detectors, particle accelerators, power supplies and general instruments are listed.

Capacitors. Astron Corp., 255 Grant Ave., East Newark, N. J. Dry electrolytics, molded paper tubulars, oil paper capacitors and the new self-healing subminiature metallized paper capacitor are illustrated and fully covered in catalog AC-2. Also treated is a helpful listing of standard r-f filters for aircraft and heavy-duty applications.

Variable Transformer. The Superior Electric Co., Hannon Ave., Bristol, Conn., has available a folder describing the newly redesigned Powerstat variable transformer types 116 and 216. Discussed are the new brush assembly, the new fusing arrangement, the new cast aluminum terminal box, the new coil and core design and polarity identification. A rating chart together with circuit drawings of individual types permit easy

WIND more COILS faster

WITH YOUR PRESENT COIL-WINDING MACHINE!



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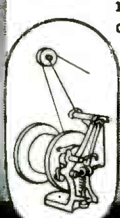
PAMARCO

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.



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Distinguished for its

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Electro-deposited in pure copper, pure nickel, or nickel-on-copper—in regular commercial production with counts from 25 to 400 per inch—in lengths up to 100 feet and widths up to 36 inches—with tolerances on hole size and thickness suitable for the most critical uses—LEKTROMESH is ideal for precise filtration, for fabricated products such as fuel filters and electronic shields. For full details let us send our Bulletin on LEKTROMESH. Address Department 17.

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- Size: 9⅝" (H) x 13¼" (L) x 19⅛" (D)
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AUTOMATIC OSCILLOGRAPH *Recorder*

Developed for simplicity and ease of operation, the HEILAND Automatic Oscillograph Recorder saves time...reduces costs. Flexibility of operation permits the recording of strain, vibration, pressure, acceleration and temperatures.

Write for complete detailed information

HEILAND RESEARCH CORPORATION
137 East Fifth Avenue   Denver, Colorado

selection of the type best suited to a particular requirement. Mounting and outline dimensions are also shown.

Direct-Coupled Amplifier. Electro-Mechanical Research, Inc., Ridgefield, Conn. has issued a single-sheet bulletin giving a general description, quantitative data on performance and applications of the model 36B amplifier. The unit under discussion is a versatile broad-band instrument designed for operation in the frequency range from d-c to 1,000,000 cycles. A precision attenuator allows the maximum amplification of 10,000 to be reduced in 10-db steps over a range of 60 db.

Loudspeaker System. Jensen Mfg. Co., 6601 S. Laramie Ave., Chicago 38, Ill. Data sheet 160 deals with the model G-610 Triaxial loudspeaker system. Included are the system's objectives, results, performance, design features, applications, specifications and prices.

Speaker Catalog. Cleveland Electronics, Inc., 6611 Euclid Ave., Cleveland 3, Ohio, has announced catalog 127 M dealing with radio and tv replacement speakers, listing the complete line in permanent-magnet types and electrodynamic models. Also featured are the new weatherproof speakers and tv lightning arresters.

D-C Indicating Amplifier. Leeds & Northrup Co., 4908 Stenton Ave., Philadelphia 44, Pa. A recent 8-page folder describes and illustrates the various applications of a new stabilized d-c indicating amplifier. Two pages of specifications are given.

Photoelectric Equipment. De-Tec-Tronic Laboratories, Inc., 1227 N. Clark St., Chicago 10, Ill., is now offering a new 8-page catalog describing in detail a complete line of the latest in photoelectric equipment. It features 33 items of equipment and accessories for industrial applications, production control, counting, boiler and ventilating smoke detectors, burglar and warning devices. The catalog also describes an engineering serv-

ice for photoelectric equipment requiring special design.

Magnet Wire. General Electric Co., Bridgeport 2, Conn. Complete information on Formex and Deltabeston magnet wires is now available in a new 32-page booklet. It combines the listing of both film-type and asbestos and glass-insulated magnet wires, and fully covers the development, properties, applications, advantages and available sizes of these wires. Test data, graphs, illustrations and pertinent specification tables are included. A section is devoted to installation details such as methods of stripping, soldering, and welding, as well as a complete discussion on varnish treatment.

Beryllium Copper Springs. Instrument Specialties Co., Inc., Little Falls, N. J., has published catalog No. 6 showing chief advantages and typical applications for its many types of microprocessed beryllium copper springs. The informative and well-illustrated publication also contains a price list.

Miniature Transformers. New York Transformer Co., Inc., Alpha, N. J. Bulletin B-300 covers a line of Hornet miniature transformers. A table of standard dimensions, specifications, materials and construction and distinctive features are included.

Shock and Vibration Mounts. The Barry Corp., 179 Sidney St., Cambridge, Mass. Catalog 504 lists and describes in 12 pages a line of shock and vibration mounts for protection of industrial, marine and mobile equipment, ranging from heavy machinery to sensitive instruments. Correlated photographs and dimension drawings show mounting methods. Isolation characteristics, applications and construction notes accompany the listing of each type.

R-F Components. Selectar Industries, Inc., 401 E. 138th St., New York 54, N. Y., presents in a recent 4-page folder a condensed listing of cable connectors, adapters, transmission lines, couplings and radio-frequency components, as a ready reference. Inquiries are invited on

products to government or individual specifications.

Miniature Speed Changers. Metron Instrument Co., 432 Lincoln St., Denver 9, Col. Bulletin No. 100 covers a line of miniature speed changers designed to solve fixed-ratio gearing problems in instruments, servomechanisms, controls, regulators and all low-power devices. General description, ordering information and data on other miniature components are included.

Microphotometer. American Instrument Co., Inc., Silver Spring, Md. Bulletin 2182 gives detailed information on the new light-scattering microphotometer, which measures 20 micromicrolumens of scattered light and has a sensitivity approximately 100 times greater than similar instruments. The instrument described is portable and completely a-c operated.

Microphone Systems. Stephens Mfg. Corp., 8538 Warner Drive, Culver City, Calif. Bulletin M-1 describes and illustrates a group of three microphone systems for swivel, stand and lapel applications. General characteristics, accessories and prices are shown. The microphones described eliminate conventional preamplifiers.

Transformer Catalog. Acme Electric Corp., Cuba, N. Y., has issued the revised catalog SD179 covering step-down transformers and voltage and frequency compensating transformers. In describing the voltage and frequency changing type transformers the catalog points out the advantages and economy of using this type of transformer in connection with standard 60-cycle equipment in areas where only a 50-cycle electrical frequency is supplied.

Glass-Sealed Connectors. Cannon Electric Development Co., Division Cannon Mfg. Corp., 3209 Humboldt St., Los Angeles 31, Calif. Bulletin GS-2 gives photographs, drawings and tabular data on a line of connectors made with A-type layouts in pin contact arrangements. The shells and contacts are steel. Contacts are set in glass, which is fused to both contact and shell. The GS-

MOVING?

If you are moving (or have moved), tell us about it, won't you? Your monthly copies of ELECTRONICS will not follow you unless we have your new address immediately. Make sure you don't miss a single important issue . . . and help us make the correction as speedily as possible by giving us your old address, too

ELECTRONICS

CIRCULATION DEPT.

330 W. 42nd St. — New York 18, N. Y.

types treated are adaptable to working temperatures up to 800 F and meet salt spray tests of 76 hours, and also ruggedness and thermal shock tests.

Small Parts Welders. Federal Tool Engineering Inc., 532 Mulberry St., Newark 5, N. J. An eight-page folder composed of four bulletins deals with Tweezer-Weld small parts welders. It contains an illustrated description of bench model capacitor power units, hand and bench electrodes and automatic welding equipment.

Paper Tubulars. Cornell-Dubilier Electric Corp., South Plainfield, N. J. Bulletin RT349 contains technical information on Royal Tiger paper tubular capacitors utilizing Polykane, a solid synthetic thermosetting compound. The capacitors described are humidity proof, can be used at ambient temperatures from −35 to +100 C, and are available in all popular commercial capacity ratings at 100, 200, 400, 600 and 1,000 volts d-c.

Magnetic Recording. Armour Research Foundation of Illinois Institute of Technology, 35 W. 33rd St., Chicago 16, Ill., has available bulletin No. 64 comprising a bibliography on magnetic recording. It contains 371 references to previous articles on the subject as well as a reprint of what is believed to be the earliest reference to magnetic recording.

Sound Equipment. Rek-O-Kut Co., Inc., 38-01 Queens Blvd., Long Island City 1, N. Y. A recent 4-page catalog covers a line of high-fidelity recording and transcription equipment. A complete listing, description, specifications and prices are given.

Transformer Catalog. United Transformer Co., 150 Varick St., New York 13, N. Y., has just published a new 28-page illustrated catalog. Specified as Catalog 500, it contains a complete listing of a line of transformers, reactors and filters. It includes descriptions, applications, specifications, amplifier circuits, curves and useful charts.

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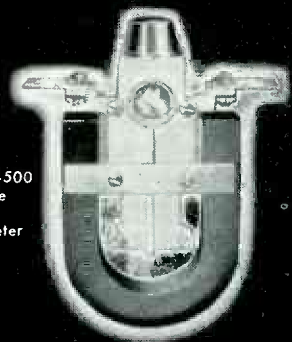
GALVANOMETERS

AND MOVEMENTS...



Series 570-500 Mirror-Type D-C Galvanometer

Ideal as a built-in component of other instruments—with the sensitivity and ruggedness that is especially desirable for Colorimetry, Densitometry, and various other measurements. Unit includes mirror movement, magnet and zero correction knob. Choice of 4 standard models.

Write us about your application and requirements

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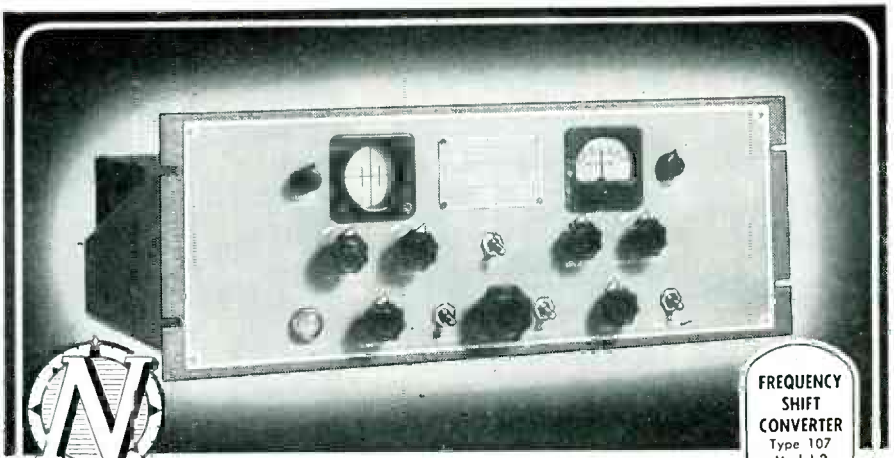

FREQUENCY SHIFT CONVERTER Type 107 Model 2

BIGGEST PERFORMANCE-Smallest Size

Four exclusives are yours with the Northern Radio FREQUENCY SHIFT CONVERTER —utmost simplicity of operation, precision tuning, highest quality performance, and smallest size in the industry.

For single and diversity FS receiving systems, this dual channel unit converts mark and space tones into DC pulses, and drives teleprinters and other recorders directly. Its unique 2" oscilloscope provides the industry's most meaningful tuning pattern for precise receiver adjustment—during initial setup and while keying. Its specially designed limiter and discriminator afford an exceptionally high degree of performance. Polar or neutral output is available. Keying speeds up to 600 w.p.m. It's only 19" wide x 7" high x 15" deep.

This unit may also be used as a make and break CW or ICW demodulator.

See the specifications on this outstanding model in the 1950 Electronics Buyers Guide. For complete data on the precision-built Northern Radio line, write today for your free latest Catalog E-3.

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Pace-Setters in Quality Communication Equipment

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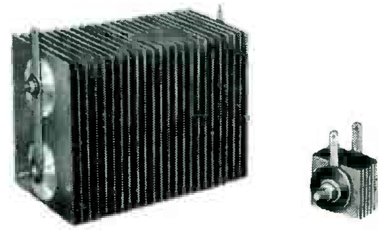

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NEWS OF THE INDUSTRY

(continued from page 134)

ments on the proposed bracket standards.

Stereocasting Demonstrated

FIRST demonstration of stereophonic sound broadcasting using one transmitter was made recently by William S. Halstead of Multiplex Development Corp. in New York. At the transmitter, studio microphones were placed about ten feet apart. Musicians playing different instruments were stationed near each microphone and a third musician moved between the two positions. In the receiving studio, loudspeakers connected to their respective radio channels were placed 15 feet apart. One sound channel comprised the regular f-m broadcast facilities of station KEA2XKH and was heard by broadcast listeners. The other sound channel was multiplexed (see *Tubes At Work* in this issue) as a subcarrier and picked up by a special receiver. Even though the experimental facilities did not reproduce frequencies above 10 kc, the effect of presence and the apparent movement of the performers appeared to compensate for the lack of frequency range in the fidelity of the performance.

H-F Measurements Conference

THE SECOND high-frequency measurements conference sponsored jointly by the American Institute of Electrical Engineers, the Institute of Radio Engineers and the National Bureau of Standards will be held in Washington, D. C. on January 10 to 12, 1951. Conference headquarters will be at the Hotel Statler, with the technical session held in the auditorium of the Department of the Interior. The Conference program will include about 25 technical papers, an evening demonstration, a luncheon and conducted inspection tours.

Four sessions will be devoted to measurements in the following categories and are being organized by the individuals noted: frequency and time, by Harold Lyons of NBS, transmission and reception, by

E. P. Felch of BTL, impedance, by R. A. Braden of RCA, and power and attenuation, by E. W. Houghton of BTL.

The conference is under the general direction of the Joint AIEE-IRE Committee on High Frequency Measurements, of which Ernst Weber of the Microwave Research Institute of the Polytechnic Institute of Brooklyn is chairman. Harold Lyons of the National Bureau of Standards is chairman of the local arrangements committee and Frank Gaffney of the Polytechnic Research and Development Co. is chairman of the technical program committee. Finances are being handled by Ivan Easton of General Radio Co. and publicity by E. P. Felch of the Bell Telephone Labs.

FCC Acts to Restore State Guard Radio Service

A PROPOSAL has been made by the FCC to amend its rules governing public safety radio services in order to reactivate a State Guard Radio Service. Such a service (which is distinctive from the National Guard) was operative during World War II for emergency purposes. Nearly 30 state guard authorizations were then outstanding, covering in each instance operation of from 40 to 200 or more low-power portable or mobile stations by state guard personnel only. This service was deactivated July 1, 1948.

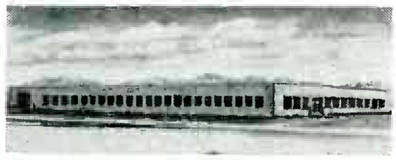
Because of current developments, it is planned to recreate this service. Such stations would, primarily, handle emergency communications relating to public safety and the protection of life and property, and, secondarily, those essential for training and organization maintenance. They would share the 2,726-kc frequency with stations in the special emergency radio service. Comments were received on the proposal up to Oct. 16, 1950.

BUSINESS NEWS

METAL POWDER ASSOCIATION, New York City, N. Y., has established an Electronic Core Division to develop and promulgate standards for both the manufacturers and users of iron-powder cores.

NATIONAL ELECTRONICS, INC., industrial tube manufacturers, have completed an 80-percent expansion of total floor space at their Geneva, Ill., plant to increase production of thyratrons, rectifiers and mercury pool tubes.

ACME ELECTRIC CO., Cuba, N. Y., has begun construction of a new 25,000-sq ft building at Allegany, N. Y., to improve and increase facilities for manufacturing and assembling of transformer components for military as well as peacetime applications.



Acme Electric's new Allegany, N. Y., plant

CORAL DESIGNS, division of Henry G. Dietz Co., formerly located in Forest Hills, N. Y., is now operating in its new expanded quarters at 12-16 Astoria Blvd., Long Island City 2, N. Y. Its facilities, besides being devoted to its standard line of controls, include all of the necessary equipment for small-scale production of specialized electronic equipment.

SYLVANIA ELECTRIC PRODUCTS INC., has built a 30,000-sq ft plant in Warren, Pa., to specialize in the production of plastic and plastic-metal components for radio and television.

THE PYRAMID ELECTRIC CO., Paterson, N. J., manufacturer of electrolytic capacitors, has purchased the former Solar plant, North Bergen, N. J., for $300,000.

PERSONNEL

WILLIAM A. WILDHACK, formerly chief of the missile instrumentation section of the National Bureau of Standards, has been named head of the office of basic instrumentation recently established at the Bureau. The new office will coordinate a pro-

gram of evaluation and improvement of instruments for measuring basic physical quantities which has been initiated in cooperation with the department of Defense.

DONALD C. MCDONALD was recently promoted from supervisor of instrumentation to chief engineer of the Cook Research Laboratories, a division of the Cook Electric Co., Chicago, Ill. He is a member of the Guidance and Control Working Group on the Panel on Countermeasures, Guided Missiles Committee of the Research and Development Board.

D. C. McDonald

H. R. Terhune

HAROLD R. TERHUNE, previously in charge of electrical components standardization for RCA Victor, has joined the Mycalex Tube Socket Corp. of New York, N. Y., and Clifton, N. J., as vice-president, and will head the standards department of both this company and its affiliate, Mycalex Corp. of America. For the past five years he has been chairman of the RTMA Transmitter Section Tube Socket Committee.

RALPH L. PALMER, electronics engineer with IBM since 1932, has been made laboratory manager of the engineering laboratory of International Business Machines Corp., Poughkeepsie, N. Y.

JOHN A. P. OHMAN, a former vice-president of Geovision, Inc., of New York, and chief engineer for the Rieber Research Laboratory of the same city, has been appointed a senior research engineer in the physics department of Southwest Research Institute.

DALE POLLACK, consulting engineer, has joined with Spectrum Engineers, Inc., Philadelphia, Pa. in forming the New London Instrument Co., New London, Conn., to engage in research, development and manufacturing.

WILFRED ROTH, formerly head of the Servo Section of Raytheon Mfg. Co. and STANLEY R. RICH, formerly head of the Servo-Sonic Dept. at Raytheon have formed the Rich-Roth Laboratories.

W. Roth

S. R. Rich

The new organization located at 673 Connecticut Blvd., East Hartford, Conn., specializes in servomechanisms, ultrasonics, magnetics, electronics, transducers and applied mathematics.

RAYMOND O. ANDERSON, assistant director of research, has been designated by Minneapolis-Honeywell Regulator Co. as its representative in an atomic energy study program for industry being sponsored by the AEC. He will undertake a year's research at the Knolls Atomic Power Laboratory, Schenectady, N Y.

LARRY C. F. HORLE recently retired as chief engineer of the Radio-Television Manufacturers Association.

Larry C. F. Horle (left), retiring RTMA chief engineer, is presented with a scroll and a Philco tv combination by D. G. Fink, editor of ELECTRONICS. The tv receiver was a gift from the JETEC, to which L. C. F. Horle was a consultant zlers for this department. A payment of $5.00 will be made for each acceptable entry (with solution). Answers to problems will be published in the issue succeeding each problem.

Last Month's Solution

Last month's problem was:

What is the power dissipated by the plate resistor of a class A audio amplifier when both a sinusoidal and d-c component of plate current are present?

Solution. Let the maximum value of the a-c component alone be e_1, and let the d-c component be e_2. The power dissipated over one cycle is given by

$$P = \frac{1}{2\pi R}\int_0^{2\pi} (e_1 \sin\theta + e_2)^2 d\theta$$

$$= \frac{e_1^2}{2R} + \frac{e_2^2}{R} + \frac{2e_1e_2}{\pi R} \qquad (1)$$

If the power dissipated due to the d-c component alone is P_2, then the ratio of the total power to P_2 is

$$\frac{P}{P_2} = 1 + \frac{X^2}{2} + \frac{2X}{\pi} \qquad (2)$$

where X is the ratio of peak value of the a-c component e_1 to the d-c component e_2. It is evident that a convenient nomograph of Eq. 2 could be plotted. However, the maximum value that X may have for class A conditions is unity so that a nomograph is hardly necessary. For X equal to unity in Eq. 2, one obtains a value of total power that is 2.136 times the d-c power.

One must further assume that the amplifier might be required to pass square waves indefinitely, for which case the power dissipated would approach the ratio of the square of the supply voltage to the resistance used.

Television Coverage

DEAR SIRS:

THE FCC is currently engaged in hearings to allocate television stations throughout the country. They have announced that first priority is being given to the establishment of at least one television service to the entire area of the United States. Notice that this priority does not

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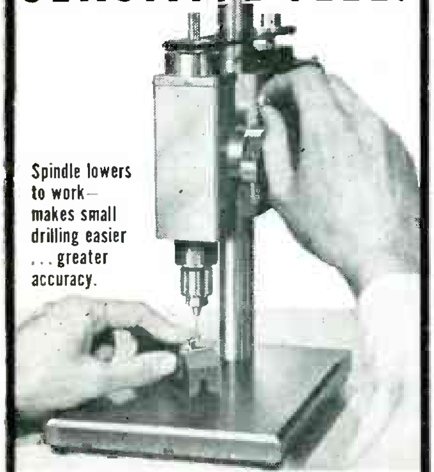

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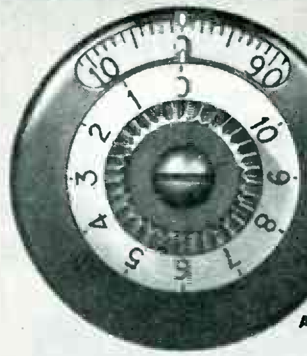
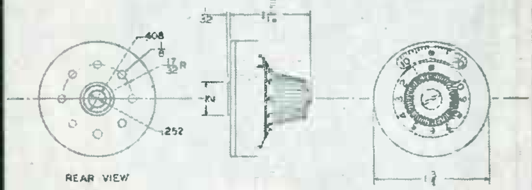


ACTUAL SIZE



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consider distribution of population. Furthermore, the assumptions upon which coverage and interference are computed do not consider topography.

All of the allocation plans which have been suggested to date involve locating stations in towns and cities. This is a very unsatisfactory approach to accomplishment of their stated first priority. A more realistic approach would be to locate stations by geographic coordinates only. All the stations on one channel could be arranged in a pattern which would permit the greatest number of stations on that channel. This pattern might resemble Fig. 1A. It can be extended indefinitely in all directions.

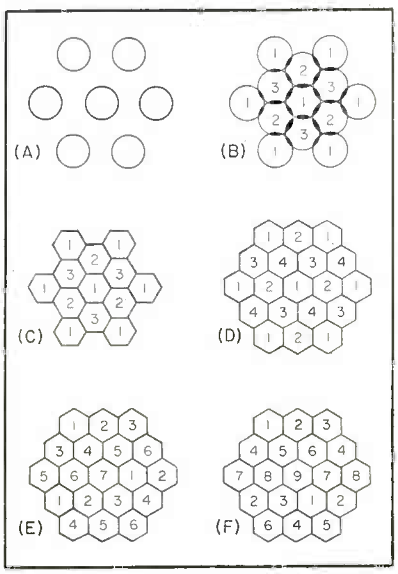

FIG. 1—Proposed allocation of television stations for most efficient use of channels

There remains considerable "white area" in Fig. 1A. This can be filled in by stations on other channels, arranged in the same pattern but shifted slightly with respect to the first. The number of channels needed to cover any area completely then becomes a simple function of the ratio of the cochannel spacing to the service area radius.

Figure 1B shows locations for stations on three channels, with a ratio of cochannel spacing to service area radius of 3.3. It can be seen that there is still a slight amount of "white area", and also some overlapping. Figure 1C shows the same station arrangement as Fig. 1B, but the service areas have been altered to hexagons, each hexagon having the same area as the corresponding circle in Fig. 1B. Of course no station will provide coverage in the shape of a hexagon, but I have never seen measured coverage that was exactly circular either. Considering such factors as the nature of fringe area reception and the effects of topography, the assumption of hexagonal coverage is probably as justifiable as the assumption of circular coverage.

In Fig. 1D, E and F are shown various other possible arrangements of stations, utilizing additional channels, and providing greater relative cochannel spacing. Figure 1D provides complete coverage of any area with four channels. Twelve channels would provide complete coverage with three services.

Although this fundamental idea in its present form would hardly be acceptable to any of the parties concerned, it does represent the most effective utilization of channels, and therefore might well be utilized as the basis for some more acceptable allocation.

JAMES H. GREENWOOD
Pittsburgh, Pa.

References Omitted

DEAR SIRS:

IN MY BRIEF ARTICLE entitled "Wideband Series-Parallel Transformer Design", published in the *Electron Art* department of ELECTRONICS for July 1950, two references were omitted. One referred to unpublished Bell System Memoranda, and the other to a paper by E. K. Sandeman. The latter article was entitled, "Coupling Circuits as Band-Pass Filters," and it appeared in *Wireless Engineer*, 18, p 316, 1941.

VINCENT C. RIDEOUT
Assoc. Prof. of Elec. Engr.
The University of Wisconsin
College of Engineering
Madison, Wisconsin

(EDITOR'S NOTE. Our policy is to print all references submitted by an author, especially where they are essential to understanding the material presented. In some instances, physical factors prevent our carrying out this policy, as in the case cited above.)

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[SEAL]

ELVA G. MASLIN
(My commission expires March 30, 1952)

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supplements other advertising in this issue with these additional announcements of products essential to efficient and economical production and maintenance. Make a habit of checking this page, each issue.

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NEW ADVERTISEMENTS received by October 29th will appear in the December issue, subject to limitation of space available.

The publisher cannot accept advertising in the Searchlight Section which lists the names of the manufacturers of resistors, capacitors, rheostats, and potentiometers or other names designed to describe such products.

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(Continued on page 280)

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MINIMUM REQUIREMENTS:

1. M.S. or Ph.D. in Physics or E.E.
2. Not less than five years experience in advanced electronic circuit development with a record of accomplishment giving evidence of an unusual degree of ingenuity and ability in the field.
3. Minimum age 28 years.

Hughes Aircraft Company
Attention: Mr. Jack Harwood
CULVER CITY, CALIFORNIA

MECHANICAL DESIGN ENGINEERS

COLLINS RADIO COMPANY, one of the leading manufacturers of radio and electronics equipment, has openings for mechanical design engineers. The work calls for the ability to lay out and design intricate mechanisms consisting of fine pitch gears, cams, and linkages as well as sheet metal structures. A thorough knowledge of working tolerances applicable to the above design functions is essential. Good advancement opportunities, excellent working conditions. Send resume of education and experience to:

Glenn G. Johnson
COLLINS RADIO COMPANY
Cedar Rapids, Iowa

ANALOGUE COMPUTER ENGINEER

Experienced graduate electrical engineer with extensive background in analogue computer development, required to supervise analogue computer section. This engineer must be able to assume full technical responsibility and planning for projects ranging from single equipments to complete system development. Here is a life time opportunity for the individual who can organize a rapidly expanding facility. Submit detailed resume. Personal interview will be arranged.

ENGINEERING RESEARCH ASSOCIATES, INC.
1902 West Minnehaha Avenue
St. Paul 4, Minnesota

ENGINEERS— PHYSICISTS

SENIORS

- *What do you want in a position?*
- *What are your aims and ambitions?*

The W. L. Maxson Corporation offers special opportunities if you are heavily experienced in research and development on radar, computers and associated equipment.

Please address your job requirements and resume to A. Hoffsommer for individual attention.

THE W. L. MAXSON CORPORATION
460 W. 34th St., N. Y. 1, N. Y.

RCA VICTOR Camden, N. J.

Requires Experienced Electronics Engineers

RCA's steady growth in the field of electronics results in attractive opportunities for electrical and mechanical engineers and physicists. Experienced engineers are finding the "right position" in the wide scope of RCA's activities. Equipment is being developed for the following applications: communications and navigational equipment for the aviation industry, mobile transmitters, microwave relay links, radar systems and components, and ultra high frequency test equipment.

These requirements represent permanent expansion in RCA Victor's Engineering Division at Camden, which will provide excellent opportunities for men of high caliber with appropriate training and experience.

If you meet these specifications, and if you are looking for a career which will open wide the door to the complete expression of your talents in the fields of electronics, write, giving full details to:

National Recruiting Division
Box 920, RCA Victor Division
Radio Corporation of America
Camden, New Jersey

NEEDED AT ONCE

Experienced

Physicists, Chemists and Engineers— Mechanical, Electrical, Electronic and Chemical

For Work on an Atomic Energy Project in the San Francisco Bay Area

by

CALIFORNIA RESEARCH & DEVELOPMENT COMPANY

Airmail complete summary education, training, experience, expected salary, and references to Standard Oil Company of California— Employment Office, 225 Bush Street, San Francisco 20, California.

PHYSICISTS SR. ELECTRONIC ENGINEERS

Familiar with ultra high frequency and micro wave technique.
Experience with electronic digital and/or analog, computer research and development program.
Salaries commensurate with experience and ability. Excellent opportunities for qualified personnel.

Contact:
C. G. Jones, Personnel Department
GOODYEAR AIRCRAFT CORPORATION
Akron 15, Ohio

Additional Positions Vacant Ads on pages 278, 280 & 281

(Continued from page 278)

ELECTRONICS Sales Engineers

Positions open for sales engineers having practical experience in application of radio frequency heating. A good knowledge of electronics and of mechanisms, such as are used in quantity production lines, is a requirement. The work involves application engineering and sales of induction and dielectric heating generators and associated work handling apparatus. Locations in Detroit, Boston, Buffalo and Richmond, Virginia. For application write:

Manager, Technical Employment
Westinghouse Electric Corporation
306 Fourth Avenue
Pittsburgh 30, Pennsylvania

RESEARCH AND DEVELOPMENT ENGINEERS

MECHANICAL, ELECTRICAL, and ELECTRONIC ENGINEERS and ENGINEERING PHYSICISTS

Excellent positions on experimental research and development projects related to intricate electro-mechanical and electronic devices.

Men with advanced degrees or equivalent experience may qualify for permanent positions in our laboratories in New York State.

Give full details of education and experience indicating age and marital status.

P-7894, Electronics
330 W. 42 St., New York 18, 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
180 S. Alvarodo St. Los Angeles, Calif.

WANTED

Acoustic or Audio Engineer

Position available in research and development on loudspeakers and microphones. College training plus several years practical experience required. Applicant should be fairly well grounded in the physics of vibrating systems, audio reproduction and laboratory technique pertaining to audio and acoustic measurements. Engineer who has had employment with a loudspeaker manufacturer would be most desirable.
A progressive concern with extensive and up-to-date research facilities located in New York suburban area.
Salary liberal and open depending upon qualifications of applicant.

P-7907, Electronics
330 W. 42nd St., New York 18, N. Y.

ELECTRONICS TECHNICIANS WANTED

The RCA Service Company, Inc., a Radio Corporation of America subsidiary, needs qualified electronics technicians for U.S. and overseas assignments. Candidates must be of good character and qualified in the installation or maintenance of RADAR or COMMUNICATIONS equipment or TELEVISION receivers. No age limits, but must have at least three years of practical experience.

RCA Service Company offers comprehensive Company-paid hospitalization, accident and life insurance programs; paid vacations and holidays; periodic review for salary increases; and opportunity to obtain permanent position in our national and international service organization, engaged in the installation and maintenance of AM, FM and TV transmitters, electronic inspection devices, electron microscopes, theatre and home television, R-F heating equipment, mobile and microwave communications systems, and similar electronic equipment.

Base pay, overseas bonus, payments for actual living and other expenses, and benefits mentioned above add up to $7,000 per year to start for overseas assignments, with periodic review of base salary thereafter. Openings also available at proportionately higher salaries for specially qualified technicians with supervisory ability.

Qualified technicians seeking an advantageous connection with a well-established company, having a broad-based, permanent peacetime and wartime service program, write to:

MR. G. H. METZ
Personnel Manager
RCA SERVICE COMPANY, INC.
Camden 2, New Jersey

ELECTRONIC

INSTRUMENTATION ENGINEERS

Manufacturer of meteorological instruments requires

PROJECT ENGINEERS

Experience in computer circuits, marker generators, display networks and pulse modulator design mainly for airborne equipment. Design experience with subminiature components is desirable

PROJECT ENGINEERS

Several years experience in micro-wave techniques in the 1 centimeter region, capable of designing antennas, direction couplings, mixers, etc.

ENGINEERS

Experience in the design of transformers, coils, etc., for electronics equipment.

Send complete resume to:

Personnel Department

Friez Instrument Division
Bendix Aviation Corporation
Taylor Avenue at Loch Raven Blvd.
Baltimore 4, Md.

RADAR, COMMUNICATIONS *and* SONAR TECHNICIANS WANTED

For Overseas Assignments

Technical Qualifications:

1. At least 3 years' practical experience in installation and maintenance.
2. Navy veterans ETM 1/c or higher.
3. Army veterans TECH/SGT or higher.

Personal Qualifications:

1. Age, over 22—must pass physical examination.
2. Ability to assume responsibility.
3. Must stand thorough character investigation.
4. Willing to go overseas for 1 year.

Base pay, bonus, living allowance, vacation add up to $7,000.00 per year. Permanent connection with company possible.

Apply by Writing to
A-1, P. O. Box 3414
Philadelphia 22, Pa.

Men qualified in RADAR, COMMUNICATIONS or SONAR give complete history. Interview will be arranged for successful applicants.

ELECTRONIC ENGINEERS

Los Angeles Firm

DESIGN ENGINEER

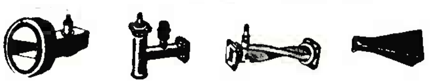
Minimum five years experience in electronic development and circuit design for production.

PRODUCTION ENGINEER

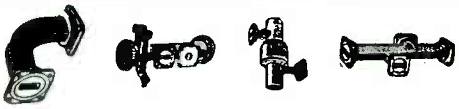
Several years experience in electronic equipment production. Experience desirable both in large quantity commercial equipment and high quality equipment to government specifications.

P-7861, Electronics
1111 Wilshire Blvd., Los Angeles 17, Calif.

Additional Positions Vacant Ads on pages 278, 279 & 280



MICROWAVE



23,000 to 27,000 mc. BENCH TEST PLUMBING

1/2" to 1/4" Waveguide

Precision Slotted Line. Adjustable probe $200.00
Directional Coupler-Wavemeter Mnt. 12DB $60.00
Precision Var Attenuator, mfg. Bernard Rice $90.00
Low Power Load $20.00
Shunt Tee $35.00
Waveguide Lengths, 2" to 6" long, gold-plated with circular flanges and coupling nuts .... $2.25 per inch
APS-34 Rotating Joint $49.50
Right Angle Bend E or H Plane, specify combination of couplings desired $12.00
45° Bend E or H Plane, Choke to cover $12.00
Directional coupler CU-103/APS32 .... $49.50
Mitered Elbow, cover to cover $4.00
TR-ATR Section, choke to cover $4.00
Flexible Section 1" choke to choke $5.00
"S" Curve Choke to cover $4.50
Adaptor, round to square cover $5.00
Feedback to Parabola Horn with pressurized window $27.50
Low Power Load, less cards $18.50
K Band Mixer Block $45.00
Waveguide 1/2 to 1/4" .... $1.00 per ft.
90° Twist $10.00
"K" Band Directional Coupler CU104/APS-34 20 DB .... $49.50 ea.
3J31 Magnetrons $55.00

8500 Mc to 9600 Mc BENCH TEST PLUMBING

1" x 1/2" Waveguide

Klystron Mount. DeMornay Budd type DB380 for 2K25, etc., includes tunable termination $70.00
Variable Stub Tuner. DB536. 180 degree phase shifting capacity ..$70.00
Flap Attenuator. DB385. Maximum Attenuation 10DB $25.00
Wave Guide to Type "N" Adapter. DB377 .... $15.00
Low Power Termination. DB381 .... $18.50
Uni-Directional Coupler. DB390. 23DB type "N" output $18.50
Pick Up Horn. Type "N" output $4.50
Wavemeter. 8500 to 9400 mcs. with calibration. Micrometer adjust head. Reaction type $85.00
Waveguide Lengths. Plated and fitted with couplings available in 6", 12", 24", 30", 60" sections .... $2.00 per ft.
90 Degree Elbows. E or H plane, 2 1/4" radius $12.50
Mitered Elbows. E plane $10.00
90 Degree Twist. 6" long $8.00
Bulkhead Feed-Thru Assembly. $15.00
Pressure Gauge Section. 15 lb. gauge and press. nipple $10.00
Pressure Gauge. 15 lbs. $2.50
Dual Oscillator-Beacon Mount. P/O APS10 Radar for mounting two 723A/B klystrons with crystal mts. matching slugs, shields $42.50
Dual Oscillator Mounts. (Back to back) with crystal mount, tunable termination, attenuating slugs $18.50
Directional Coupler, UG-40/U Take off 20 DB $17.50
Directional coupler, APS-6 type "N" take off 20 DB calibrated $17.50
Rotary Joint Choke to Choke. $10.00
2K25/723 AB Receiver local oscillator Klystron Mount, complete with crystal mount, Iris coupling and choke coupling to TR $22.50
TR-ATR Duplexer section for above $8.50

1 1/4" x 5/8" WAVEGUIDE

Tunable Termination. Precision adjust $65.00
Low Power Termination $25.00
Magic Tee $45.00
Oscillator Mount. for four 723AB klystron $38.50
90 Degree Elbows. E or H plane $12.50
Waveguide Lengths. Cut to size and supplied with 1 choke, 1 cover, per length .... $2.00 per ft.
Wavemeter. Absorption type. Precision micrometer adjust. Very high "Q" $150.00

6000 Mc to 8500 Mc BENCH TEST PLUMBING

1 1/2" x 3/4" Waveguide

Klystron Mount. DB356 complete with shield and tunable termination $125.00
Flap Attenuator. DB361 .... $45.00
Variable Stub Tuner $90.00
Waveguide to Type "N" Adapter $18.50
Wavemeter Tee. DB352 .... $32.50
Magic Tee $80.00
Directional Coupler. two hole 25DB coupling, type "N" output $25.00
Precision Crystal Mount. Equipped with tuning slugs and tunable termination $125.00
Tunable Termination. Precision adjust $70.00
Low Power Load $35.00

4000 to 6000 Mcs BENCH TEST PLUMBING

2" x 1" Waveguide

Slotted Line. DEMornay type 332 complete with probe, etc. $600.00
Flap Attenuator $48.00
Variable Stub Tuner and Low Power Termination $48.00
Wavemeter Tee $48.00
Adapters: Choke to choke $18.00
Cover to cover $14.00
Choke to cover $16.00
Waveguide to Type "N" Adapter $45.00
Directional Coupler. Two hole type, type "N" output $48.00
Klystron Mount. Equipped with tunable termination and micrometer adjust. klystron antenna tuning $110.00
Crystal Mount. Equipped with tunable termination and micrometer adjust crystal tuning $125.00
Tunable Termination. Precision adjust $90.00

3000 Mc BENCH TEST PLUMBING

TEST EQUIPMENT

10 CM Wavemeter WE type B435490 Transmission type, type N Fittings, Veeder Root Micrometer dial., Gold Plated W/Calib. Chart P/O Freq. Meter X66404A. New $99.50
AS14A/AP-10 CM Pick up Dipole with "N" Cables $4.50
LHTR. LIGHTHOUSE ASSEMBLY. Part of RT39 APG 5 & APG 15. Receiver and Trans Cavities w/assoc. Tr. Cavity and Type N CPLG. To Revr. Uses 2C40, 2C43, 1B27. Tunable APX 2400-2700 MCS. Silver Plated ..$49.50
Beacon Lighthouse cavity 10 cm with miniature 28 volt DC FM motor. Mfg. Bernard Rice .... $47.50 ea.
Magnetron to Waveguide Coupler with 721A Duplexer Cavity, gold-plated $45.00
721A TR Box complete with tube and tuning plungers $12.50
McNally Klystron Cavities for 707B or 2K28. Three types available $4.00
F-29/SPR-2 Filters, Type "N" input and output $12.50
726 Klystron Mount. Tunable output, to type "N" complete, with socket and mounting bracket $12.50
WAVEGUIDE TO 7/8" RIGID COAX "DOORKNOB" ADAPTER, CHOKE FLANGE, SILVER PLATED BROAD BAND $32.50
WAVEGUIDE DIRECTIONAL COUPLER, 27 db. Navy type CABV-47AAN, with 4 in. slotted section $32.50
SQ. FLANGE to rd choke adapter, 18 in. long OA 1 1/2 in. x 3 in. guide, type "N" output and sampling probe $27.50
AN/APR5A 10 cm antenna equipment consisting of two 10 cm waveguide sections, each polarized. 45 degrees .... $75.00 per set
POWER SPLITTER: 726 Klystron input dual "N" output $5.00

7/8" RIGID COAX

10 CM FEEDBACK DIPOLE ANTENNA, in lucite ball, for use with parabola 7/8" Rigid Coax Input. $8.00
721A TR cavities, heavy silver plated .... $2.00 ea.
Magnetron Coupling with TR Loop $7.50
Sperry Rotating Joint, pressurized $22.50
5 Ft. Lengths Stub Supported, gold-plated, per length $7.50
Short Right Angle Bends (for above) $2.50

RADAR SYSTEMS AND COMPONENTS IN STOCK

APS-2 10 CM Airborne
APS-3 3 CM Airborne
APS-4 3 CM Airborne
APS-6 3 CM Airborne
APS-6A 3 CM Airborne
APS-10 3 CM Airborne
APQ-13 3 CM Airborne
APS-15 3 CM Airborne
APS-31 3 CM Airborne
CPN-8 10 CM Ground Beacon
CEXH 10 CM Ground Beacon
FD-MARK 4 800 MC Ship Gunlaying
MARK 10 10 CM Ship Gunlaying
SA 200 MC Ship Air Search
SC 200 MC Ship Air Search
SD 200 MC Submarine
SE 10 CM Surface Search
SF 10 CM Surface Search
SG 10 CM Surface Search
SJ 10 CM Submarine
SK 200 MC Air Search
SL 10 CM Surface Search
SN 10 CM Portable
SO (All Series) 10 CM Surface Search
SQ 10 CM Portable
SW 200 MC Portable
SCR 518 400 MC Altimeter
SCR 520 10 CM Airborne
SCR 533 200 MC Airsearch
SCR 545 10 CM Tracking 800 MC Search
SCR 663 Searchlight Track

SONAR SYSTEMS AND COMPONENTS IN STOCK

QBF
QBG
QC
QCJ
QCL
QCO
QCS
QCU
WEA

ARMY-NAVY TEST SETS

LU-1 FREQ. Meter and Test Oscillator. Type CRV-60ACL.
TVN-9HU POWER SUPPLY, MIT Rad. Lab.
TVN-8SE KLYSTRON POWER SUPPLY. MIT. Rad. Lab.
CS60ABW WATT METER — Wavemeter, 3 CM.
APR5 RECEIVER—1000 to 6000 mcs.
AN/CPN-8—10 centimeter 40 kw. output RF package. Includes magnetron oscillator, complete modulator, complete receiver, complete signal and power analyzer with 5" scope. 115V AC input.
Dehydrator Unit CPD 10137 Automatic cycling. Compressor to 50 lbs. Compl. for Radar XSMN. Line. New $425.00
SO-3 Receiver, 30 mc. IF. 6 stages 6AC7, 10 MC. Band width inpt. 5.1 mc B.W. per stg. 9.6 volt gain per stage as desc. in ch. 13 vol. 23, M.I.T. Rad. Lab. Series $99.50
TS12 3CM Slotted Line
TS13 3CM Signal Generator
TS33 3CM Frequency Meter
TS35 3CM Signal Generator
TS36 3CM Power Meter
TS45/APM3 3CM Signal Generator
TS62 3CM Echo Box
TS102
TS108 Dummy Load

MICROWAVE ANTENNAS

RELAY SYSTEM PARABOLIC REFLECTORS: approx. range: 2000 to 6000 mc. Dimensions: 4' x 3' rectangle, new $35.00
TDY "JAM" RADAR ROTATING ANTENNA, 10 cm. 30 deg. beam. 115 v.a.c. drive. New $100.00
SO-13 ANTENNA 24" dish with feedback dipole 360 deg. rotation, complete with drive motor and selsyn. New $128.00
Used $45.00
DBM ANTENNA. Dual, back-to-back parabolas with dipoles. Freq. coverage 1,000-4,500 mc. No drive mechanism $65.00
AS125/APR Cone type receiving antenna, 1080 to to 3208 megacycles. New $4.50
140-600 MC. CONE type antenna, complete with 25' sectional steel mast, guys, cables, carrying case, etc. New $49.50
ASD 3 cm. antenna, used, ex. cond. $49.50
YAGI ANTENNA AS-46A. APG-4, 5 elements .... $14.50 ea.
Dish for Parabola 30" $4.85
AN 122 .... $22.50
RC 224 .... $99.50
AS 17/APS
DAK Directional Finder Loops
Adcock Arrays
SA-1 Radar
200 MC. Bed Spring
LP21-A Airborne Dir. Find. Loop, w/ Selsyn & Loop Housing
APS 4 Ant.
AN 128A 200 MC. Array
Write for Info and Price

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 1/4 microsec. @ 600 PPS $39.50
W.E. #166173 Hi-Volt input transformer, W.E. impedance ratio 50 ohms to 900 ohms, Freq. range: 10 kc to 2 mc. 2 sections parallel connected, potted in oil $36.00
W.E. KS 9800 Input transformer, Winding ratio between terminals 3-5 and 1-2 is 1.1:1, and between terminals 6-7 and 1-2 is 2:1. Frequency range: 380-520 c.p.s. Permalloy core $6.00
G.E. #K2731 Repetition Rate: 635 PPS, Pri. Imp: 50 Ohms Sec. Imp: 450 Ohms, Pulse Width: 1 Microsec. Pri. Input: 9.5 KV PK. Sec. Output: 28 KV PK, Peak Output: 800 KW Bifilar 2.75 Amp. $64.50
W.E. #D169271 Hi Volt Input pulse Transformer $27.50
G.E. K2450A. Will receive 13KV. 4 micro-second pulse on pri. secondary delivers 14KV. Peak power out 100KW G.E. $34.50
G.E. #K2748A. Pulse Input, line to magnetron $36.00
#9262 Utah Pulse or Blocking Oscillator XFMR Freq. limits 790-810 cy-3 winding turns ratio 1:1:1 Dimensions 1 13/16 x 1 1/8" 19/32 $1.50
Pulse 131-AWP L-421435 .... $6.00
Pulse 134-BW-2F L-440895 .... $2.25
RAY—WX4298F $39.50
G.E.—K6824730 .... $50.00
G.E.—K9216945 .... $50.00
#7766489—9332 .... ——
A 7766490— .... ——

PULSE NETWORKS

15A—1-400-50: 15 KV, "A" CKT, 1 microsec., 400 PPS, 50 ohms imp $42.50
G.E. #6E3-5-2000-50P2T, 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
7-5E3-3-200-6PT. 7.5 KV, "E" Circuit, 3 microsec. 200 PPS, 67 ohms imp. 3 sections $12.50

MAGNETRON MAGNETS

Gauss	Pole Diam.	Spacing	Price
4850	3/4 in.	5/8 in.	$12.50
5200	11/32 in.	3/4 in.	$17.50
1300	1 5/8 in.	1 5/16 in.	$12.50
1860	1 5/8 in.	1 1/2 in.	$14.50

Electromagnets for magnetrons .... $24.50 ea.

GE Magnets type M7765115, GI Distance Between pole faces variable. 2 1/16" (1900 Gauss) to 1 1/2" (2200 Gauss) Pole Dia. 1 5/8" New Part of SCR 584 .... $34.50

MAGNETRONS

QK 61 2J32	2J61	720CY	
QK 60 2J37	2J62	725-A	
2J21	2J38	3J31	730-A
2J22	2J39	5J30	728
QK 915 2J26	2J40	714AY	706
QK 62 2J27	2J49	718DY	700
QK 59 2J31	2J34	720BY	

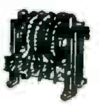
Klystrons 723A, 707B, 417A, 2K41

UG CONNECTORS COUPLINGS

UG/15U .... $ .75
UG206U .... .90
UG87U 1.25
UG27U 1.69
UG21U .... .89
UG167U 2.25
UG29U .... .90
UG254U 1.60
UG86U 1.40
UG342U 3.25
UG85U 1.45
UG58U .... .60
UG9U .... .89
UG102U .... .45
UG103U .... .45
UG255U 1.65
UG 40/U Specl. for Mixer Assy. .... .75
UG 40A 1.10
UG 343 Cover 2.35
UG 344 Choke 3.00
UG 425 Contact 2.00
UG 116 Cover & Coup Ring 1.95
UG 117 Choke 2.50
UG 51 Cover 1.00
UG 52 Choke 1.35
UG 210 Cover 1.85
UG 212 Choke 2.40
7/8 Coax Female Ring .50
7/8 Coax Male Fitting .95
X Band Circ. Choke Flange .... .50
X Band Flat Contact Flange 1/8 Thk. .... .25
Contact Ring 1/4" Thk 1 3/8 dia. hole .... .25
UG 53/U, Cover .. 4.00
UG 54/U, Choke .. 4.75
UG 55/U, Cover .. 4.00
UG 56/U, Choke .. 4.75
UG 65/U, Contact. 6.50
UG 149/U, Cover .. 3.00
UG 148/U, Choke .. 4.00
UG 150/U, Contact. 3.00
UG 39/U, Cover .. .60
UG 40/U, Choke .. .80
Write us your needs.

FILAMENT TRANSFORMER

for above 115V/60 cy Pri: four 6.3V/4A Sec. 50000VT $27.50
Magnetron Kit of four QK's 2675-3375 inc. w/trans special $250.00



All merch. guar. Mail orders promptly filled. All prices, F.O.B. N.Y.C. Send M.O. or Chk. Only shipping chgs. sent C.O.D. Rated concerns send P.O.

MIN. ORDER $3.00

COMMUNICATIONS EQUIPMENT CO.

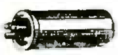
131 Liberty St., New York, N. Y. Dept. E-11 P. J. PLISHNER Phone: MAin 4-8373

SCREW MTG
Wireleads D Type

Mfd	Volt	Price
4	600	$0.35
8	250	.25
8–8	450	.50
16	450	.40
20	450	.45
30	450	.50
29	250	.45
12	250	.30
8	600	.60
8	450	.30
16	600	.80
30	450	.50
20	150	.30
240	250	.80
30–30	450	.75

MINICAPS PIGTAIL

Mfd.	Volt	Price
30	450	$0.49
30	300	.45
30	350	.48
40	450	.50
40	525	.70
16	350	.35
16	525	.45
16	450	.40
16	100	.24
20	25	.20
20	80	.25
20	450	.40
24	350	.30
8	400	.30
8	150	.15
10	150	.20
10	50	.15
4	50	.10
4	150	.14



ELECTROLYTICS Prong Mount D. Y. Type
18¢ ea.—10 for $1.75

Mfd.	Volt
40	150
80	150
10	200
8	450
16	450
20-20	25
10-10	150
20-20	150
40-40	150
20-30	250
3x20	450
40	250
30	300
80	350
10	450
15	450
30-30	25
20-10	150
40-20	150
50-30	150
20-1	350
10-1	300

29¢ ea.—10 for $2.75

Mfd.	Volt
6	400
50	400
40	450
30-20	150
50-50	150
20-20	350-25
20-20	400-25
40-20-10	150
40-30-20	150-25
50-50-20	150-25
60-40-10	150-25
60	300
30	450
32	450
30-30	150
70-30	150
30-20	350-25
10-20	450
40-20-20	150
40-30-20	150
3x50	150
40-10-100	150-10

Ceramicons

Mmf	
1	25
3	27
3.4	35
4	30
5	47
6	50
7	57
8.5	58
11	60
15	62
20	67
24	70
79	220
115	240
125	250
150	350
180	1000
200	$7.50 per 100
100	

Button	Feed Thru
40	100	50
180	200	
175	500	470
185	108	

$8.50 per 100

OIL CONDENSERS FAMOUS MAKES BRAND NEW

Mfd.	Volt	Price
15	220AC	$2.20
.5-.5	400	.50
1	600	.45
6	600	.98
7	600	1.05
.5	750AC	1.69
7	800	1.20
.5	1K	.69
1.5	1K	.75
2	1K	.99
4	1K	.98
.25	1.5K	1.05
1	1.5K	.89
1.5	1.5K	.95
2	1.5K	1.05
6	1.5K	2.25
1	2K	.98
.1	2.5K	1.20
.15	4K	2.95
.1.1	4.8K	2.95
.4	5K	2.95
.1	6K	2.79
.15.15	6K	3.95
1.5	6K	9.75
.1.1	7K	3.39
.1	7.5K	2.95
1	7.5K	12.95
.15.15	8K	4.95
.1	10K	14.95
.0016	15K	7.95
1	15K	30.95
.015	16K	6.95
.25	20K	16.95
.5	25K	36.95
1	25K	83.95
4	50	.29
1	100	.15
2.5	100	.23
	200VDC	
2x.1	2ST	.15
2x.1	3TT	.15
2x1	4ST	.16
2	2ST	.20
.5	2TT	.15
.5	2ST	.15
	400VDC	
2x.25	3ST	.21
2x.1	3ST	.21
2x.1	2TT	.20
3x.1	3ST	.25
.1	2TT	.19
.5	1TT	.19
1	2ST	.23
	600VDC	
.1	2BT	.20
.1	2ST	.21
2x.1	3ST	.27
2x.1	3BT	.25
2x.1	2ST	.26
3x.1	ST	.25
2x.25	3ST	.23
.25	2TT	.20
1	2ST	.30
	1000VDC	
1	2ST	.45

MANY OTHERS

RECTIFIER CAPACITORS

Mfd	Volt	Price
6000	12	$2.75
1000	15	.90
3000	15	1.95
2x500	15	1.75
300	25	.95
500	25	.95
100	30	.70
1000	35	1.39
1000	35	3.49
2000	25	1.59
3x290	50	2.25
500	80	1.40
125	150	1.40
250	150	1.69
2x1000	6	1.10
75	250	.75

Wholesale Qtys Available

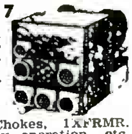
110 volt AC CONDENSERS

Mfd	Price
20-24	1.00
26-30	1.00
31-37	1.00
38-42	1.00
43-48	1.00
43-65	1.25
50-75	1.25
72-87	1.25
86-96	1.45
88-106	1.50
107-129	1.50
124-138	1.75
130-150	1.75
130-180	1.90
161-180	1.75
158-191	2.00

MANY OTHERS

RL 26 REEL UNIT
Gasoline driven wire lacing & Pick up unit. Reversible Engine. Many uses (can be used for Ski Tow) ..$250.00

RL 9 or RL 7



Interphone Amplifier Convert to High Fidelity Phone Amp. or Spch. Amp. Compl. w / 12A6, 12SL7, 2 Chokes, 1XFRMR. DYN for 24v operation, etc. $2.75

CABLE CLAMPS
Tinn #1, 3, 4, 6, 7A, Lock Type Rubber 6¢ ea. 10 for 55c.

Line FILTER, GE 100 Amp Filter w/2x5Mfd 50V oil cond. Operates on 110V AC DC......$1.98

Aircraft Radio Transmitter CRV 52233, 28VDC ATB Equip. RCA less T. U. As Is..........$39.95

R-9A APN4 Loran Rec Power Supply 400 cy 31FS Quad. Tuned switches connect etc. N. G. As Is. Less tubes...$14.95

ID6 APN4 Scope 5" Loran. Full of Resis. Micas Basic Assy for Scope. N. G. As Is. Less Tubes..$9.95

BC433 Mod or unmod CW Reception 200-1750KC in 3 bands 14 or 24V & 115V AC ADF. Radio Compass As Is. Less Tubes.
Poor Condition...$11.95

BC929 A3BP1 Scope Indicator containing Ant. Switch & Motor w/Tubes 2—6H6GT, 2—6SN7, 1—6H6, 1—6X5, 1—3BP1, 1—2x2, P/o SCR 729 & APN2. New......$25.95 w/Conver. Dia. to 110V 60 cy.

Motor Driven Yagi Switch 24V 1800 RPM. REF # 110FB/81 English Type. Price $3.95

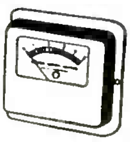
BC434 CONTROL BOX
Remote Control for 433 Radio Compass contains 0-5MA Meter, Dial Control $3.95

TVI Line Filter 110VAC 1 Amp Reject Range .15-150 MC Chassis Mt. Herm sealed 1⅛"1¼"x2". Price 69c

GP7 Aircraft XMTTR. Good Condition. As is. Less T. U. $17.50

Avail. in Stock. Dual XMTTR & Dual Rec. Triple Rack Mounts MT63—MT 65MT71 Bent & Banged Up. Sold As Is. No Refund. Repairable $1.00

6-VOLT RELAY PANELS
Comes complete with relays mounted on bakelite panel with 25 terminals: 1—SPST (NC) 1—DPST (NO) 1—SPST (NO)2—DPST Make 1, break 1) Board Dim: 10" lg x 6" W x 2⅝" H $5.49



0-5 Ma & 0-5 V Scale w/10V Movement 2" Metal Case Readrite Meter 98¢ ea. 10 for 9.00

HEADSETS
Dynamic Mike and Headset Combination. A high quality, efficient unit, used in B-10 tank Xmtrs. Mike and phones complete new. $3.75

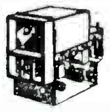
Inserts, M-300, for HS-30 **HEADSETS**..$4.00/M

RADIOSONDE TRANSMITTERS, T-49/AMT-1. $3.75 ea.

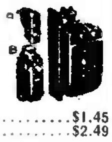
TRANSFORMERS for Collins ART13 Transmitters. GE #7472063, GE #7472-065.

RADIART MALLORY OAK VIBRATORS IN STOCK 12, 28, 32V.

MOUNTINGS
FT 234A For 274N Trans
FT 232A For 274N Trans
FT 229A For 274N, BC442
FT 225A For 274N, BC456
MT 62 For ARC/5, ARR2
MT 78/ARC5 Control Unit
MT 85/ARC5 Junction Box
FT 141 6⅜x4⅜
MT 80 ARC5 Junction Box
FT 282A P/o SCR 518A
FT 308A P/o PE119A
MT 167 U SAR
FT 340 P/o SCR 540
FT 265A P/o BC-701
MT 171A U SAR
MT 7/ARR2 R4/ARR2
MT 5/ARR2 6¾x10¾
Write for Many others

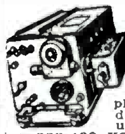


BC605 Interphone Amplifier
Easily converted to an ideal inter communications set for office—home—or factory.
Brand New $4.75



Heineman Ckt Bkrs. For AC DC Operation. Amperes .010. 3, 7, 50, 80, 100, 150. Ea. $1.45
Dual $2.49

UHF ANTENNA
12"/30cm AT5/ARR1 Convertible Citizen's Band Threaded Coax Term Insulated Silv Pl Cont w/waterproof gask flange & hardware for MOBILE mtg BRAND NEW 39c; 4/$1.00 PL259 for Above......29c



BC 429 RECEIVER
High sensitivity; 3 gain T.R.F. Complete with one dual tuning unit. Covering 200-400 KC and 2500 to 4700 KC with tubes. An ideal marine receiver for small boats and yachts. Now only $3.93
Extra tuning unit..... 1.95

WHOLESALE ONLY
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Digby 9-4124
ATT. MR. C. ROSEN

1,000,000	Bathtubs
4,000,000	Micas
300,000	Sil. Micas
100,000	Oil Cond.
4,000,000	Resistors
400,000	Electrolytics
400,000	H. V. Micas
5,000	K. V. Cond.
150,000	Prec. Resis.
500,000	Tube Clamps
1,000,000	An Connectors
50,000	Dynamotors
20,000	Power Xfmrs
20,000	Chokes
100,000	Antennas
50,000	Audio Xfrmrs
100,000	400 Cy Xfrmrs
100,000	Shock Mts.
25,000	Magnetrons
5,000	Magnets
50,000	Pulse Xfmrs
50,000	Control Boxes
500,000	Tubes
300,000	Relays
500,000	Pots
35,000	Vibrators
200,000	UG Connectors
2,000	Scopes
1,500	Asst Phones
20,000	Headsets
5,000	Mikes
100,000	Elements
Tons of	Nuts & Bolts Screws, Etc.
1,000	Gibson Girls
500	BC 375 Complete
500,000	Insulators
150,000	Binding Posts
200,000	Water Switches
300,000	Ceramicons
500,000	Ferrule Resis.
50,000	PL 54
25,000	JK 26

AUDIO XFRMRS

SUB OUNCER SPECIAL — Mult. match, mike to grid, plate to grid, plate to line, etc. Ideal for transceivers; 200 ohm /15000 ohm c.t. / 100000 ohm / 20000 ohm. Level 4 V.U. Special 69c

UTC 80707 ouncer Pl. to Mult. Gds. $1.29

5119—Ouncer Pl. to line 49c

901 — Pl. to V. coil 75c

6262—Pl. to Hdst. or line 69c

5640 — Mike or Line to Grid.$1.29

T202—6V6 Pl. to 811 Gds...$1.45

765—Line to Grd. 98c

25 — Pl. to Line 98c

837—1:1-1:2 Ratio 75c

622—1:2.28 Ratio 75c

9449 — PP6V6 to PP805 Class B, 10 Watt ..$4.95

353 AB1 PP 6L6 to 250 ohm Line 9 voice coils 20 ohm, 12 ohm, 1.7 ohm, 16 ohm, 25 watt $3.95

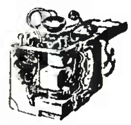
959 Dyn. & Carbon Mike to PP Grids 79c

Universal Output Transformer
Amertran Silcor, PRI: 20,000/16.-000/5000/4000 ohms. Sect. 500/15/7.5/5/3.75/1.25 ohms. 30 db. contin. Flat to 17,000 CY, w/ Diag. & Inst. for 6 watt amplifier $4.75

TUNING UNIT FOR BC 223
TU 18A 3-4-5 MC. Price $2.50
TU 25 3.5-5.2 MC. Price $2.50

SUPER PRO EQUIP.
1st and 2nd RF 10-20 MC Coil PT-SA111. — RF ANT OTPT 2.5-5 MC Coil SA-116.—ANT INPT 200-400 KC Coil SA161. — ANT INPT 200-400 KC SA 48. — HI FREQ OSC 2.5-5MC Coil SA118.—ANT OTPT 10 - 20 MC Coil SA110.
Price Each..

M.O. COIL
1800-2250KC
P/o Collins 32RA Plug in 59c



EE89A Telephone Repeater
Used to extend range of field telephones. Simplex Teleg. and 20 cycle ringing possible over lines equipped with unit. Supplied w/305 tube. Phone supplied. (Featherweight) $9.49

EE65E Telephone Test Set
To locate any kind of trouble on Tel lines: can be used as telephone. Includes ringing circuit, etc. A valuable unit ..$17.95

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	500000

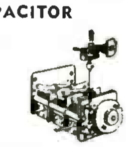
Above Ea...40¢ Ten For..$3.50

1,000,000 ohms........Each 75¢

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.

Hi Gain Dynamic Mike Xfmr
Comb hi-gain DynMike Xfmr UTC/Super Elec 3wdg. 600 ohm CT&4000ohms Tapped 250x150 ohms. Fully Shielded H'sld. Price Each...... 49¢

VFO CAPACITOR



High Grade Unit. Consists of 3 Gang Capacitor, 20 mmf per sect. Ceramic ins. Low drift w/Worm Gear (reduction) 120:1 w/ext. Shaft and Veeder 4 digit Counter. $3.95

Loading Coil C114
Same as WE No. 632 but in waterproof case to counter-balance cap. in line gives clear signal. Army used W/W110 & W130 wire ....85¢ ea.

LAMPS
#1488 - 14/ 10/50¢
#623 — 24-28V 10/50¢
1251 — 24-28V 10/50¢
LM37 13V 10/50¢
Hed 10W 60V 8¢ ea.

WING LIGHT
for planes aqua blue. Mfg. Grimes NAF 1021-12 ea. 40¢

INVERTERS
PE 218-E: Input: 25 28 vdc. 92 amp. Output: 115 v. 350-500 cy 1500 volt-amperes. Dim: 17"x 6½"x10". New (as shown) $29.50
PE 218-H: Same as above except size: 16½" x 6" x 10". New $29.50
PE 218H, used, good cond.... $22.00
PE 208: Input: 28 vdc, 38 amps. Output: 80 v, 800 cy, 500 volt-amps. Dim: 13" x 5½" x 10½". New $12.50

THERMISTORS
D-167332 (tube) ...$1.50
D-170396 (head) ..$1.50
D-167613 (button) $1.50
D-164699 for MTG in "X" Band Guide $2.50
D-167018 (tube) ...$1.50

VARISTORS

D-170225	$1.25
D-167176	$1.50
D-168617	$1.50
D-171812	$1.50
D-171528	$1.50
D-171528	$1.50
D-168442	$3.00
D-165593	$1.25
D-98836	$2.00
D-161871A	$2.85
D-171121	$1.50
D-98836	$1.50
D-162356 (308A)	
D-163357	$2.00
D-59946	$2.95

TUBES! LARGE QUANTITIES AVAILABLE

01-A	7E5	615	EF50
1B26	7E6	704-A	F-127
2C21	10Y	705A	FC258A
2C22	12A6	724B	
2X2/879	12K8Y	800	GL532
3BP1	12SF7	801-A	FC271
2C24	12SR7	804	GL562
3C30	15P	815	GL623
3D6	28D7	836	GL697
3CP1	30 (Spec.)	837	ML100
3D21-A	45 (Spec.)	843	QK59
3DP1	39/44	860	QK60
3EP1	35/51	861	QK61
3FP7	227A	874	QK62
3Q5	225	876	VR91
5BP1	268-A	1005	VR130
5BP4	355-A	1619	VR135
5CP1	417	1624	VR137
5FP7	530	1629	VU120
5J30	531	1961	VU134
6G	532	9002	WL532
6SC7	559	9004	WN150
7C4I	562	CEQ72	WT260

NEW TEST EQUIP. IN STOCK
I-185A Oscillator
I-158 Range Calibrator
I-233—Range Calibrator
BC 438 Freq. Meter
RF Preamp
G.R. Capacity Brdg #216
G.R. Uni Galvo Shunt #229
G.R. 1000 Aud. Osc. #213
TS 226A/AP Pwr. Mtr. 0-1000W.
Sig Gen #804 8-330 MC

1619—1619—1619
Octal Base Pentode. A Versatile 2½V 6L6 High Perveance Tube, 5 for $1.00 21¢

POTS

Mod J	225Ω	.47A	$1.10
Mod J	1000Ω	.22A	1.10
Mod H	15Ω	25ω	.89
Mod J	800Ω	50ω	1.10
	5Ω	250ω	2.79
	5000Ω	4ω	.69
	20KΩ	8ω	1.10
	100KΩ	10ω	2.25

RELAYS

GE CR 2791

B100-F3	.69
B100-J3	.69
B100-J4	.69
B100-C3	.69
B100-D4	.59
D101-F3	1.10
B109-P36	1.10
G110-F2	.35
C104-B28	1.49
F100-G3	1.49
B106-J3	1.39
J105-AS3	2.95

MANY OTHERS

ALLIED BJ

DPDT	24V	.98
DPDT	28V	.98
SPST	12V	.98

BOX

DPST	90MA	1.10
3PDT	26V	.98
SPDT	24V	1.10

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All merch. guar. Mail orders promptly filled. All prices, F.O.B. N. Y. C. Send M.O. or Chk. Only shipping chgs. sent C.O.D. Rated concerns send P.O.

Min. Order $3.00 **COMMUNICATIONS EQUIPMENT CO.** Min. Order $3.00

131 Liberty St., New York, N. Y. Dept. E-11 CHAS. ROSEN **Phone: Digby 9-4124**

FULLY GUARANTEED

BRAND NEW SURPLUS OFFERED BY A LEADING

A.C. MOTORS

5071930, Delco, 115 V., 60 Cycle, 7000 r.p.m. **Price $4.50 each net.**

36938-2, Haydon Timing Motor, 110 V., 60 cycle, 2.2 w., 4/5 r.p.m. **Price $3.00 ea. net.**

Type 1600 Haydon Timing Motor—110 V., 60 cycle, 3.2 w., 4 r.p.m., with brake **Price $4.00 each net.**

Type 1600 Haydon Timing Motor—110 V., 60 cycle, 2.2 w., 1/240 r.p.m. **Price $3.00 each net.**

Type 1600 Haydon Timing Motor 110 V., 60 cycle, 2.3 w., 1 r.p.m. **Price $2.70 each net.**

Type 1600 Haydon Timing Motor, 110 V., 60 cycle, 2.2 w., 1 1/5 r.p.m. **Price $2.70 each net.**

Type 1600 Haydon Timing Motor 110 V., 60 cycle, 3.5 w., 1 r.p.m. With shift unit for automatic engaging and disengaging of gears. **Price $3.30 each net.**

Type 1600 Haydon Timing Motor, 110 V., 60 cycle, 2.2 w., 1/60 r.p.m. **Price $3.00 each net.**

Eastern Air Devices Type J33 Synchronous Motor 115 V., 400 cycle, 3 phase, 8,000 r.p.m. **Price $8.50 each net**

Telechron Synchronous Motor, Type B3, 115 V., 60 cycle, 2 r.p.m., 4 w. **Price $5.00 each net.**

Barber-Colman Control Motor, Type AYLC 5091, reversible 24 volts D.C. .7 amps 1 R.P.M., Torque 500 in. lbs. Contains 2 adjustable limit switches with contacts for position indication. Ideal for use as a remote positioner or a beam or television antenna rotator, will operate on A.C. 60 cycle. **Price $6.50 each net**

SERVO MOTORS

CK 1, Pioneer, 2 phase, 400 cycle. **Price $10.00 each net.**

CK 2 Pioneer, 2 phase, 400 cycle. **Price $4.25 each net**

10047-2-A Pioneer 2 phase, 400 cycle, with 40:1 reduction gear. **Price $7.25 each net.**

FPE-25-16 Diehl Low-Inertia 20 V., 60 cycle, 2 phase, 1600 r.p.m., 85 amps. **Price $10.00 each net.**

CK2, Pioneer, 2 phase, 400 cycle, with 40:1 reduction gear. **Price $6.50 each net.**

CK5 Pioneer, 2 phase, 400 cycle. **Price $20.00 ea. net.**

MINNEAPOLIS-HONEYWELL TYPE B Part No. G303AY, 115 V., 400 cycle, 2 phase, built-in gear reduction, 50 lbs. in torque. **Price $10.00 each net.**

Kollsmon Type 776-01 400 cycle 2 phase drag-up type, fix phase voltage 29, variable phase 35V. maximum, frequency 400 cycle. **Price $10.50 each net.**

REMOTE INDICATING MAGNESYN COMPASS SET

Pioneer Type AN5730-2 Indicator and AN5730-3 Transmitter 26 V., 400 cycle.
Price $40.00 per set new sealed boxes.

Kollsman Remote Indicating Compass Set Transmitter part No. 679-01, indicator part No. 680k-03, 26 V., 400 cycle. **Price $12.50 each net.**

GYROS

Schwein Free & Rate Gyro type 45600. Consists of two 28 V. D.C. constant speed gyros. Size 8" x 4.25" x 4.25".
Price $15.00 ea. net.

Sperry A5 Directional Gyro, Part No. 656029, 115 volts, 400 cycle, 3 phase.
Price $17.50 each net.

Sperry A5 Vertical Gyro, Part No. 644841, 115 V., 400 cycle, 3 phase. **Price $20.00 each net.**

Sperry A5 Amplifier Rack Part No. 644890. Contains Weston Frequency Meter. 350 to 450 cycle and 400 cycle, 0 to 130 voltmeter. **Price $10.00 each net.**

Sperry A5 Control Unit Part No. 644836. **Price $7.50 each net.**

Sperry A5 Azimuth Follow-Up Amplifier Part No. 656030. With tube. **Price $5.50 each net.**

Sperry A5 Autopilot Indicator: contains Pioneer AY20 Autosyn 26 V., 400 cycle. **Price $9.50 ea. net.**

Pioneer Type 12800-1-D Gyro Servo Unit. 115 V., 400 cycle, 3 phase. **Price $10.00 each net.**

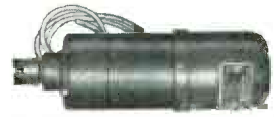
Norden Type M7 Vertical Gyro. 26 V., D.C. **Price $19.00 each net.**

Allen Calculator, Type C1 Bank and Turn Indicator, Part No. 21500, 28 V. D.C. Contains 28 V. D.C. constant speed gyro. **Price $10.00 each net.**

Type C1 auto-pilot formation stick, part No. G1080A3. **Price $15.00 each net.**

GOVERNMENT approved instrument repair station No. 3564.

D.C. MOTORS



5069625, Delco Constant Speed, 27 V., 120 r.p.m. Built-in reduction gears and governor. **Price $4.50 each net.**

A-1755, Delco Constant Speed Shunt Motor, 27 V., 2.4 amps., 3600 r.p.m., 1/30 h.p. Built-in governor. **Price $6.25 each net.**

C-28P-1A, John Oster Series Motor, 27 V., 0.7 amps., 7000 r.p.m., 1/100 h.p. **Price $4.50 each net.**

Jaeger Watch Co. Type 44-K-2 Contactor Motor, Operates on 3 to 4.5 volts D.C. Makes one contact per second. **Price $2.00 each net.**

General Electric Type 5BA10AJ52C, 27 V. D.C., 0.65 amps., 14 oz. n. torque, 145 r.p.m. Shunt Wound, 4 lead reversible. **Price $5.00 each net.**

General Electric Type 5BA10AJ37C, 27 V.D.C., 0.5 amps., 8 oz., in. torque, 250 r.p.m. Shunt Wound, 4 leads reversible. **Price $6.50 each net.**

General Electric Type 5BA10J18D, 27 V. 0.7 amps. 110 R.P.M. 1 oz. ft. torque. **Price $4.75 ea. net.**

D.C. ALNICO FIELD MOTORS

S. S. FD6-16, Diehl, 27 V., 10,000 r.p.m. **Price $4.50 each net.**

S. S. FD6-18, Diehl, 27 V., 10,000 r.p.m. **Price $4.50 each net.**

S. S. FD6-21, Diehl, 27 V., 10,000 r.p.m. **Price $4.50 each net.**

5069600 Delco 27.5 V. 250 R.P.M. **Price $10.00 each net.**

706343 Delco 27.5 V. 10,000 R.P.M. Shaft 0.5 in. long. **Price $7.50 ea. net.**

5068571 Delco 27.5 V. 10,000 R.P.M. with blower assembly. **Price $10.00 ea. net.**

5071895 Delco 27.5 V. 250 R.P.M. **Price $10.00 ea. net.**

5072400 Delco 27.5 V. 10,000 R.P.M. Shaft 0.5 in. long with worm gear. **Price $6.75 ea. net.**

GENERAL ELECTRIC D. C. SELSYNS

8TJ9-PDN Transmitter, 24 V. **Price $3.75 each net.**

8TJ9-PAB Transmitter 24V. **Price $3.75 each net.**

8DJ11-PCY Indicator, 24 V. Dial marked —10° to +65°. **Price $4.50 each net.**

8DJ11-PCY Indicator, 24 V. Dial Marked 0 to 360°. **Price $7.50 each net.**

AMPLIFIER

Pioneer Gyro Flux Gate Amplifier, Type 12076-1-A. **Price $17.50 ea. net, with tubes.**

G. E. Servo Amplifier Type 2CV2A1, 115 V. 400 cycle. **Price $10.00 ea. net.**

Minneapolis Honeywell Amplifier Type G403, 115 V. 400 cycle. **Price $8.00**

INSTRUMENT ASSOCIATES

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SUPPLIER OF ELECTRONIC & AIRCRAFT EQUIPMENT

IMMEDIATE DELIVERY

INVERTERS

Wincharger Corp. Inverter PU/16 type MG 750, Input 24 V.D.C., 60 amps. Output 115 V, 400 cycle, 1 phase, 6.5 amps. **Price $60.00 each net.**

153F, Holtzer Cabot, Input, 24 V.D.C. Output 115 V., 400 cycle, 3 phase, 750 V.A. and 26 V., 400 cycle, 1 phase, 250 V.A. Voltage and frequency regulated also built in radio filter. **Price $115.00 each net.**

149H, Holtzer Cabot. Input 28 V. at 44 amps. Output 26 V. at 250 V.A., 400 cycle and 115 V. at 500 V.A., 400 cycle. **Price $40.00 each net.**

149F, Holtzer Cabot. Input 28 V. at 36 amps. Output 26 V. at 250 V.A., 400 cycle and 115 V. at 500 V.A., 400 cycle. **Price $40.00 each net.**

12117, Pioneer. Input 12 V.D.C. Output 26 V., 400 cycle, 6 V.A. **Price $22.50 each net.**

12117-2 Pioneer. Input 24 V.D.C. Output 26 V. 400 cycle, 6 V.A. **Price $20.00 each net.**

12116-2-A Pioneer. Input 24 volts D.C., 5 amps. Output 115 volts 400 cycle single phase 45 watts. **Price $100.00 each net.**

5D21NJ3A General Electric. Input 24 V.D.C. Output 115 V., 400 cycle at 485 V.A. **Price $15.00 each net.**

PE 218, Ballentine. Input 28 V.D.C. at 90 amps. Output 115 V., 400 cycle at 1.5 K.V.A. **Price $50.00 each net.**

METERS

Weston Frequency Meter, Model 637, 350 to 450 cycles, 115 volts. **Price $10.00 each net.**

Weston Voltmeter. Model 833, 0 to 130 volts, 400 cycle. **Price $4.00 each net.**

Weston Voltmeter. Model 606, Type 204 P, 0 to 30 volts D. C. **Price $4.25 each net.**

Weston Ammeter. Model 506, Type S-61209, 20-0 100 amps. D. C. **Price $7.50 each net with ext. shunt.**

Weston Ammeter. Type F1, Dwg. No. 116465, 0 to 150 amps. D. C. **Price $6.00 each net. With ext. shunt $9.00 each net.**

Westinghouse Ammeter. Type 1090-D-120, 120-0-120 amp. D. C. **Price $4.50 each net.**

Weston Model 545. Type 82PE Indicator. Calibrated 0 to 3000 RPM. 2¾" size. Has built-in rectifier, 270° meter movement. **Price $15.00 each net.**

RECTIFIER POWER SUPPLY

General Electric, Input 230 V. 60 cycle 3 phase. Output 130 amps. at 28 V. D.C. Continuous duty, fan cooled, has adjustable input taps. G.E. model No. 6RC146F. Size: Height 46", width 28", depth 17½". **Price $200.00 each net.** New

PIONEER AUTOSYNS

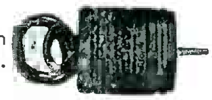
AY1, 26 V., 400 cycle. **Price $5.50 each net.**

AY14D, 26 V., 400 cycle, new with calibration curve. **Price $15.00 each net.**

AY20, 26 V., 400 cycle. **Price $7.50 each net.**

AY5, 26V., 400 cycle. Has hollow shaft. **Price $7.50 ea. net.**

PRECISION AUTOSYNS



AY101D, new with calibration curve.

PRICE—WRITE OR CALL FOR SPECIAL QUANTITY PRICES

AY131D, new with calibration curve. **Price $35.00 each net.**

AY201-2-A. **Price $35.00 each net.**

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Type 5907-17. Dial graduated 0 to 360°, 26 V., 400 cycle. **Price $15.50 each net.**

Type 6007-39, Dual, Dial graduated 0 to 360°, 26 V., 400 cycle. **Price $30.00 each net.**

PIONEER TORQUE UNIT

Type 12602-1-A. Price $40.00 each net.

Type 12606-1-A. Price $40.00 each net.

Type 12627-1-A. Price $80.00 each net.

MAGNETIC AMPLIFIER ASSEMBLY

Pioneer Magnetic Amplifier Assembly Saturable Reactor type output transformer. Designed to supply one phase of 400 cycle servo motor. **Price $8.50 each net.**

PIONEER TORQUE UNIT AMPLIFIER

Type 12073-1-A, 5 tube amplifier, Magnesyn input, 115 V., 400 cycle. **Price $17.50 each net with tubes.**

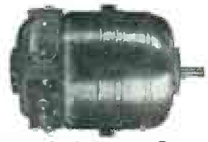
ALL PRICES, F. O. B. GREAT NECK, N. Y.

BLOWER ASSEMBLY MX-215/APG

John Oster, 28 V.D.C., 7000 r.p.m. 1/100 h.p. **Price $4.50 each net.**

Westinghouse Type FL Blower, 115 V., 400 cycle, 6700 r.p.m., Airflow 17 C.F.M. **Price $3.70 each net.**

RATE GENERATORS



F16, Electric Indicator Co., two-phase, 22 V. per phase at 1800 r.p.m. **Price $12.00 each net.**

J36A, Eastern Air Devices, .02 V. per r.p.m. **Price $9.00 each net.**

B-68, Electric Indicator Co., Rotation Indicator, 110 V., 60 cycle, 1 phase. **Price $14.00 each net.**

PM-1-M Electric Indicator Co. Same as type B35. 2 V. per 100 R.P.M. Max. speed 5,000 R.P.M. Can be used as D.C. motor, 1/77 H.P. 115 V. D.C. **Price $9.75 ea. net.**

SINE-COSINE GENERATORS

(Resolvers)

FPE 43-1, Diehl, 115 V., 400 cycle. **Price $20.00 each net.**

SYNCHROS

1F Special Repeater, 115 V., 400 cycle. Will operate on 60 cycle at reduced voltage. **Price $15.00 each net.**

7G Generator, 115 V., 60 cycle. **Price $30.00 each net.**

2J1F3 Selsyn Generator 115 volts, 400 cycle. **Price $5.50 each net.**

2J1M1 Control Transformer 105/63 V., 60 cycle. **Price $20.00 each net.**

2J1G1 Control Transformer, 57.5/57.5 V., 400 cycle. **Price $1.90 each net.**

2J1H1 Selsyn Differential Generator, 57.5/57.5 V., 400 cycle. **Price $3.25 each net.**

W. E. KS-5950-L2, Size 5 Generator, 115 V., 400 cycle. **Price $10.00 each net.**

5G Generator 115 volts, 60 cycle. **Price $50.00 each net.**

5SF Repeater, 115/90 V., 400 cycle. **Price $19.00 each net.**

2J1F1 Selsyn Generator, 115 V., 400 cycle. **Price $3.50 each net.**

5SDG Differential Generator 90/90 V., 400 cycle. **Price $12.00 each net.**

1CT Control Transformer, 90/55 volts, 60 cycle. **Price $40.00 each net.**

POSITION TRANSMITTER

Pioneer Type 4550-2-A Position Transmitter, 26 volts 400 cycle, gear ratio 2:1. **Price $15.00 each net.**

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BC-605 INTERPHONE AMPLIFIER

Easily converted to an ideal intercommunication set for office — home — or factory.

Original—New $1.95
Like New 3.95
(With Schematic)

See April 1950 Radio News for complete conversion data.

BC-604 TRANSMITTER FM 20-28 MC

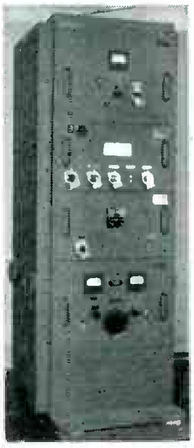
11 and 15 meters. Can be operated on 10 meters—10 channel push button crystal. With all tubes and meter but less dynamotor.
Excellent Condition **$19.95**

Crystals—
Set of 80 .... **$19.95**

BC 603

Receiver—Good. Used **$24.95**

RC 100 B RADIO EQUIPMENT



Consisting of the following:

- **CH-118** Standard 19" rack 5 feet tall.
- **BC-769** Transmitter — 470 megacycles.
- **BC-770** Keying unit for transmitter.
- **BC-768** Receiver — 493.5 megacycles.
- **RA-52** Rectifier unit for Transmitter (Metered with 0-15 KV and 0-20 MA meters and controlled with transtat).
- **AN-82B** Antenna system.
- **FL-25** Wave Trap.
- **MC-377** ⅞ inch, 70 ohm air dialectric concentric line for transmission.
- **BC-773** Control Box.
- **BC-783** B Amplifier.
- **M-349** Air Compressor
- **M-348** Oven (dehydrator).
- **BC-771** Frequency meter.
- **TM 11-1113B** Technical manual.

This equipment may be purchased as a unit or any component separately. Prices will be furnished on request.

CONDENSERS

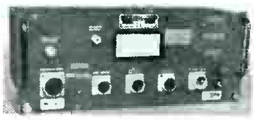
	Each
1 mfd. 6000 VDC. OIL FILLED	$1.98
.00025 mfd. 25000 VDC. OIL FILLED	2.95
.4 mfd. 1500 VDC. OIL FILLED	.29 10 for 2.49
2 mfd. 600 VDC. OIL FILLED	.39 3 for 1.00
1 mfd. 600 VDC. OIL FILLED	.24 5 for 1.00
4 mfd—500 VDC oil filled	49¢
1-1-1—1200 VDC. OIL FILLED	.59 2 for 1.00
50 mmfd—5KV—5 Amp. Vacuum Cond	1.19

IS-185 Weston Voltmeter Model 433—0 to 150 VAC 25 to 2400 cycles.
New **$24.95**

FLAP PITCH MOTOR

24 VDC. will operate on AC—3300 or 11,000 R.P.M. Complete with gear box and limit switches .... ea. **$2.95**

RT7/APN1 TRANSCEIVER UNIT—



Used as an altimeter, it may be converted for signalling control circuits, etc. Complete with 14 tubes and dynamotor they are in good used condition at the amazingly low price of **$4.95**

Miscellaneous SPECIALS

	Used	New
R 7/APS 2 Receiver-Indicator	—	$79.50
R 7/APS-15 Receiver-Indicator	34.50	—
ASB 7 Indicator Scope	12.95	—
SCR 522 Transceiver 100 to 150 MC	34.95	75.00
MN 26 C	17.50	24.95
RA 10 DA Receiver	17.50	24.95
RT7/APN1 Transceiver	4.95	9.95
APN 1 Complete	—	24.50
BD 71 6 Pos. Switchboard	9.95	12.95
EE 8 Field Phones	7.95	
BC 347 Interphone Amplifier	—	2.95
I-70 Tuning Meter	—	.89
BC 461 Veeder Root Counter	—	.59
BC 442 Less Condenser	1.49	1.95
APS 13 UHF Antenna, Pair	—	.98
FL 8 Filter	—	2.95
I-97 Bias Meter	3.95	4.95
RM 29 Remote Telephone Control	7.95	9.95
RL 42 Antenna Gearbox Motor and Reel	4.95	7.50
TS 10—Sound powered phones	6.50	

BC 1066 A—150 to 225 MC Portable Receiver adaptable to many amateur uses. In Canvas Carrying Bag. New $6.95

Tuning Units for BC 375—Presently most numbers are available in excellent condition with case at .... $2.95 ea.

BC 306—Antenna Tuning Unit for BC 375. Excellent condition .... $1.50 ea.

One Tube Interphone Amplifier—Small compact aluminum case fully enclosed. 2¼"x3¾"x5¾". Less Tube .... 79¢

96Q1 Complete Autotune assembly with motor and frame as used in **ARC-1** Transmitter. New $35.00

BC 709 Battery operated lightweight interphone amplifier. Complete with tube and shock mount, but less battery .... New $3.95

SCR 183 Complete .... New $49.50

220 MA Circuit Breaker .... New 59¢

Collins VFO Dial—5 calibrated ham bands from 3.2 Mc to 32 Mc; complete with pointer, gears, logging dial and flywheel. Scale 6" on 8" plate. **New 95¢ ea.**

C-18 Antenna coil assmbly slug tuned used in BC 603 receiver. Frequency range 20-27.9 Mc.—fully shielded .... **New 10 for $1.95**

I-82 F—Five Inch 360 degree compass indicator and selsyn receiver .... New $4.95

A-81-2 Transmitter selsyn for 182 indicator $2.45 (Both 182F & Trans. Selsyn for $7.00)

MC 385A—Headset Adapter .... New 49¢

Information and Prices on Request

- **BC 639** Receiver with **RA 42** Rectifier.
- **RTA 1B** Transceiver
- **TA 2J24** Transmitter and **MP 10G** Power Pack
- **SCR 269** Compass Installation
- **R 5/ARN 7** Compass Installation
- **MN 26** Compass Installation
- **I. L. S.** Installation (**R 89-BC733**)
- **MD-22-URA/T1**, Radar Modulator
- **AN APR1** Receiver and Tuning Units
- **ASB7** Complete Radar Installation

PORTABLE VHF COMMUNICATION UNIT

Two-way radio telephone equipment designed for operation between 152 and 162 megacycles FM. Adaptable for many uses, a complete unit including the rechargeable storage battery weighs but fifteen pounds, and is housed in a sturdy case 11½"x9"x4¼", provided with shoulder straps.

This brand new set of big name manufacture comes complete with battery, battery tray, and handset but less crystal **$89.50**

Battery charger is extra at $19.95

MOBILE VHF COMMUNICATION UNIT

Adaptable for many mobile uses, this is a compact unit 3½"x8"x15½", operating on 152 to 162 megacycles FM. It is six-volt powered direct from storage battery, and is complete with the tone filter and crystal; handset, control box, antenna and installation kit. Brand new, ready to go **$129.50**

Extra 18" stub type antennae are available $2.95

BC 620

Receiver-Transmitter — 2 crystal channels—20 to 27.8 MC FM—13 tubes. Metered. Plate and Filament .... Used $9.95

PE 97 or **PE 117** or **PE 120** Power Supply for above 6-12 volt vibrator type.
Used less tubes, vib. & con $2.95
Used Complete $6.95

FT 250 Mount for both BC 620 and PE 97. New $1.50

BC 659

Receiver-Transmitter similar to BC 620 with frequency range of 27.9 to 38 Mc F.M.
Excellent — used $19.95

4 mfd—500 VDC oil filled .... each 49¢

BC 223

Brand new Transmitter with all three tuning units, two tuning unit cases, spare tube carrying case, shock mount and brace; but less tubes at new low price of **$29.95**

Set of 5 tubes $3.95
Tuning units are available separately at .... Ea. $2.50
PE 125—12-volt Vibrator Pack .... New $12.95
Used 8.95

BC 906—FREQUENCY METER

Range 150-225 MC with modification possible for lower frequencies of TV, etc. Contains 0-500 DC microammeter and uses Battery pack of 1.5 V and 45 VDC.
Like New—Less Batteries **$10.95**

HERMETICALLY SEALED CHOKES

10 H. 100 M.A.	59c
59 H. 100 M.A.	95¢
3. 7 H. 145 M.A.	59c
10 H. 20 M.A.	39c

TEST EQUIPMENT

EV-10 Precision Vacuum Tube Test Set	used	$28.00
No. 772 Weston Multi Tester	used	40.00
No. 492 Radio City Products. Volt-Ohm Meter	used	25.00
No. 471 Radio City Products Output Meter	used	10.00
No. 803 Radio City Products Tube Tester & Set Tester	used	35.00
No. 777 Weston Tube Checker	used	29.00
No. E 200 Precision Signal Generator	used	25.00
No. M-652 Jackson Audio Oscillator	used	30.00
No. 224 A Dumont Oscilloscope	used	80.00
No. 155 A RCA Oscilloscope	used	90.00
No. M-840 Triumph Oscilloscope	used	75.00
BC-1287 Oscilloscope	used	75.00
BC-221 Frequency Meter	Like New	90.00
Others as Low as		49.50

PRICE UPON REQUEST

I-98-A	TS13/AP
I-114 P/O BC-68	TS16/APN
I-135 P/O IE-17	TS19/APQ5
I-167 Weston Anal. # 772	TS27/TSM-1
	TS34/AP
I-183 Freq. Meter	TS36/AP
I-185 Oscillator	TS47/AP
I-187 Synchronizer	TS59/APN-1
I-189 Calibrator	TS62/AP
IE-19	TS102A/AP
IS-185 Voltmeter	TS126/AP
TS3/AP	TS-251 Less Xtal
TS10A/APN	

HEADSETS—MIKES

HS-23 Hi Imp. Headsets	New	$2.95
HS-33 Lo Imp. Headsets	New	2.95
HS-30 Hi Imp. Headsets	New Used	1.50 .79
HS-38 Lo Imp. Headsets	Used	.75
T-17D Carbon Mike	New Used	2.75 1.50
T-24 Hi Imp. Carbon Mike	New	1.19
T-30 Throat Mike	New	.98
T-45 (or Navy) Lip Mike	New	.98

RC 150 EQUIPMENT

Receiver BC 1161 A	New	$29.95
Transmitter BC 1160 A	New	29.95
Control unit BC 1162 A. New but less tubes		14.95
Signal Generator I 198 A	New	24.95

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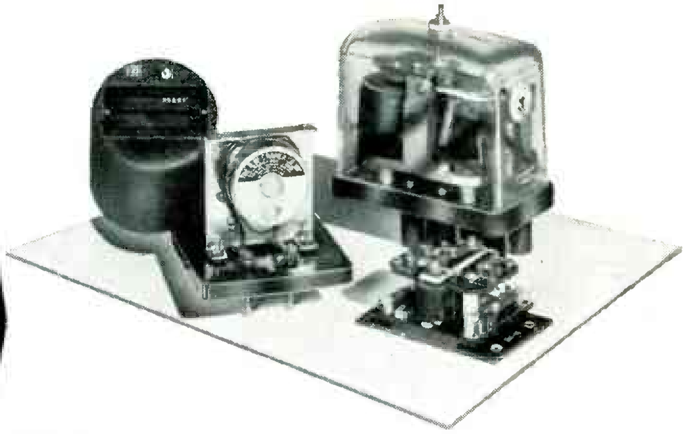

This list represents only a few types of Special Relays. We also have huge stocks of Standard D.C. Telephone Relays, Midget Relays, Contactors, Keying Relays, Rotary and Slow Acting Types as well as many others. Write or wire us about your requirements.

STOCK NO.	VOLTAGE	OHMAGE	CONTACTS	MANUFACTURER & NUMBER	PRICE
R-503	12/32 VDC.	100	3A, 2C	G.E. Ant. Keying 500W 2C6530-653AR1	$ 2.25
R-749	600 VDC.	...	Max. 28 Amps.	Allen Bradley 810 Dashpot	5.95
R-804	550 VAC.	...	1B/38 Amps.	Culter Hammer C-261173A34 Contactor	3.50
R-250	115 VAC.	...	Adj. Cir. Breaker .04-.16A	Westinghouse MN Overload	12.95
R-579	220 VAC.	...	1B	Adlake 60 Sec. Thermo Delay	6.95
R-294	27.5 VDC.	200	1B	Edison 50 Sec. Thermo Delay	4.25
R-686	115 VAC.	...	2C	Leach 1157T-5/20 Sec. ADJ. Delay	4.95
R-246	115 VAC.	...	1B	Cramer 2 Min. Adj. Time Delay	8.95
R-246A	115 VAC.	...	1A	Cramer 2 Min. Adj. Time Delay	8.95
R-611	24 VAC.	...	1A/30 Amps.	Durakool BF-63	4.25
R-283	12 VDC.	125	AC/10 Amps.	Onan Rev. Current 3H4512/R24	1.00
R-614	18/24 VDC.	60	1A/15 Amps.	Rev. Current Cutout 3H2339A/E1	3.50
R-262	....	200	1C	W. U. Tel. Co. 41C Single Current	3.75
R-245	12 VDC.	25	4 In. Micalex Lever	....	.95
R-527	6/12 VDC.	50/50	In Series	2Z7668 For Scr-274N	.95
R-544	12/24 VDC.	60/60	1C	G.E. Push Button Remote Relay #CR2791-R-106C8	1.65
R-255	....	...	1A	G.E. Pressure Switch #2927B100-C2	.95
R-669	75 VAC.	400 CYC.	1B, 1A	Clare 400	.95
R-660	6 VDC.	...	3/8" Stroke	Cannon Plunger Relay #13672	.95
R-651	24 VDC.	100	Solenoid Valve	....	2.50
R-295	12 VDC.	275	Annuncitar Drop	....	2.15
R-230	5/8 VDC.	2	2A, 1C	Guardian Ratchet Relay	2.15
R-813	12 VDC.	12	Wafer	Ratchet Relay From Scr-522	4.25
R-275	12 VDC.	750	1A, 1B, 1C	Guardian BK-10	2.75
R-716	24 VDC.	70	2A/5 Amps.	BK-13	1.45
R-620	6/12 VDC.	35	2C, 1A	Guardian BK-16	1.05
R-629	9/14 VDC.	40	1C 10 Amps.	Guardian BK-17A	1.25
R-778	8 VDC.	4500	1C 5 Amps.	Kurman BK-24	2.10
R-720	24 VDC.	50	2C, Ceramic	45A High Power	1.35
R-500	12 VDC.	10/10	2C 6 Amps.	Str. Dunn. Latch & Reset	2.85
R-816	12 VDC.	10/15	2C 6 Amps.	Guardian Latch & Reset	2.85
R-811	48 VDC.	8000	1C	Sigma 4R	1.65
R-524	24 VAC/DC.	...	....	Edwards Alarm Bell	.95
R-838	90/120 VDC.	925	2A	Allen Bradley-Bulletin #702 Motor Control	4.50
R-839	100/125 VDC.	1200	3A	Allen Bradley-Bulletin #200E Motor Control	4.50
R-840	115 VDC.	1200	2A	Allen Bradley-Bulletin #209 Size 1 Motor Control W Type "N" Thermals	5.50
R-841	115 VDC.	1200	4A	Allen Bradley-Bulletin #709 Size 2 Motor Control W Type "N" Thermals	25.00
R-842	115 VDC.	925	3A	Allen Bradley-Bulletin #709 Motor Control W Type "N" Thermals	5.50
R-843	115 VDC.	1200	3A	Allen Bradley-Bulletin #200 Motor Control	4.50
R-844	115 VDC.	1200	3A, 1B	Allen Bradley-Bulletin #202 Motor Control	4.50
R-845	220 VAC.	Intermit.	3A	Allen Bradley-Bulletin #704 Motor Control	4.50
R-831	7.5/29 VDC.	6.5	1A/250A, 1000A Surge	Leach B-8	3.50
R-837	110 VAC.	...	2A 30 Amps.	Leach 6104	2.75
R-835	24 VDC.	2800	1A Dble. Brk./10 Amps.	Wheelock Signal, B1/39	1.95
R-836	220 VAC.	...	2A Ddle. Brk./10 Amps.	Wheelock Signal, A7/37	3.45
R-566	115 VAC.	(Coil only, Not a complete relay)		Leach #6104	.75
R-710	....	150-Ohms. Coil Only		Guardian #38187	.50

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Each relay is new, individually boxed, and unconditionally guaranteed by Wells

World's Largest Display of Radio and Electronic Components

9,000 Square Feet of Display All On One Floor

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MOTOR GENERATORS DYNAMOTORS, INVERTERS, ETC.

2.5 KVA MG SET. Diehl Elec. Co. 120V DC to 120V AC, 60 cy, 1 Ph. Complete with Magnetic Controller, 2 Field Rheos and Full Set of Spare Parts including Spare Armatures for Generator and Motor. Full specs. on request. New............. **$285.00**

2 KVA MG SET. O'Keefe and Merritt. 115V DC to 120V AC, 50 cy. Idles as 3 Ph. syncs motor on 208V, 50 cy. New. Export crated $165.00

1.25 KVA MG SET. Allis-Chalmers. 115V DC to 120V, AC, 60 cy, 1 Ph. Fully enclosed. Splashproof. Ball Bearings. New.$97.50

Same machine but for 230V DC operation.$110.00

Spare Parts for either machine..........$15.00

MG SET FOR NAVY TBS TRANSMITTER. Type CG-21302. 440V AC, 60 cy. 3 Ph. 1500 VA to 875V DC and 300V DC. New $69.50

DYNAMOTOR. Navy Type CAJO-211444. 105/130V-DC to 13V DC at 40A or 26V DC at 20A. Radio filtered. Complete with Line Switch. New $69.50

DYNAMOTOR. Elcor. 32V DC to 110V AC, 60 cy, 1 Ph, 2.04 Amps. New...........$24.50

DYNAMOTOR. Elcor. 32V DC to 110V AC, 60 cy. 1 Ph, 0.43 Amps. New...........$17.50

AMPLIDYNE—G. E. Model 5AM31NJ9A. 530 Watts. 7500 R.P.M. Input: 27V DC, Output: 60V. DC. Weight 34½ lbs. New........$10.50

AMPLIDYNE—G. E. Model 5AM21JJ7. 4600 R.P.M. Motor Compound wound. 150 Watts. Input: 27V. DC. Output: 60V. DC Sig. Corps. U. S. Army MG-27-B. New...........$26.50

INVERTER—Leland Elec. Co. Model PE206A. Input: 28V. DC, 38 Amps. Output: 80V., 800 cy, 485 VA. New.....................$12.50

INVERTER—G. E. Model 5D-21NJ3A. Input: 24V. DC, Output: 115V. 400 cy, 485 Va. New $12.50

PE 218 INVERTER—G. E. J8169172. Input: 28V. DC, Output: 115V, 400 cycles at 1.5 KVA $50.00

D. C. MOTOR—G. E. Model 5BA 50LJ2A 0.5 HP. Armature: 27V. at 8.3 Amps. Field: 60V. at 2.3 Amps. R.P.M. 400. New.........$12.50

DYNAMOTOR—Type PE94C. For use with SCR522 Transmitter-Receiver. Brand new in export cases $9.50

U. S. NAVY SOUND POWERED BATTLE PHONES

Western Electric No. D173312, Type O. Combination headset and chest microphone as illustrated. Brand new including 20 ft. of rubber covered cable........... **$17.50**

Automatic Elec. Co. No. GL843AO. Similar to above but including Throat microphone in addition to chest microphone. Brand new with 20 ft. rubber covered cable.. **$13.50**

SYNCHRO GENERATORS

Brand new—Gov't. sealed and inspected—Packed in overseas cans. Synchro Transmitters 115 V., 60 cy. operation. Precision accuracy made for gun fire control. Cost Gov't $90.00 each. Wgt. 5 lbs. Dimensions: 4½" L x 3¼". Brand New **$17.50** Per Pair

S. G. RADAR EQUIPMENT

Navy Yard Spares for Model SG Radar

Consisting of the following:

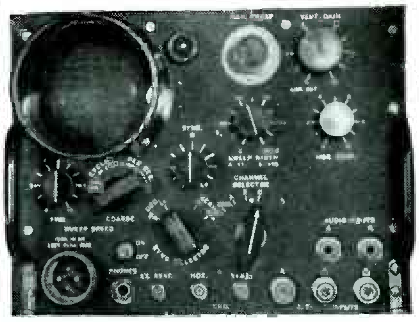
2—CRP-20ABM Rectifier Power Units for modulation generators.
2—CRP-20ABM Rectifier Power Units for Radar Receivers.
2—CRP-35AAH Modulation Generators.
2—CRP-46ABD-1 Radar Receivers (including R-906 Gain Controls for Range and Train Indicators).
2—CRP-60AAN Signal Monitors.
2—Complete Transmitter R.F. System coupling assemblies including—10087 magnets and Duplexing tube cavity assemblies.
1—Complete Power Control Chassis.
2—Complete Driver and modulator assembly including driver chassis with delay line, Modulator and Driver Rectifier Tube Assembly and Driver Rectifier Power Unit.
2—Complete sets of equipment spare part sconsisting of R.F. Assemblies, motors and accessories, switches, interlocks, fuses, fuse holders, fuse links, relays, contacts, crystals, thermostats, R.F. inductors, capacitors, sockets, test equipment, cables, resistors, etc., as listed in Navy Spare Parts List WX3885.

All above in new and unused condition packed in original metal spare parts boxes.

RADAR COMPONENTS

CRP-23AGC Load Dividers for use with S.G. Modernization Kits. New.
CBM-50AFO Navy type Radar Repeater Adapters. New and complete with 14 tubes, coax fittings, installation plans and wiring diagram.
Synchro Amplifiers. New.
Type CARD 23AEK Bearing Control Units. New.
Type T.D.Y., SO-1, SO-13, SO-3 Radar Antenna Assemblies. New.
Radar Crystals Raytheon 98.35 KC.
Type SO-11 Radar Modulator.
Type SO-1 Transmitter Receivers.

MODEL AN/APA-10 PANORAMIC ADAPTER



Provides 4 Types of Presentation: (1) Panoramic (2) Aural (3) Oscillographic (4) Oscilloscopic

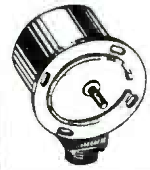
Designed for use with receiving equipment AN/ARR-7, AN/ARR-5, AN/APR-4, SCR-587 or any receiver with I.F. of 455kc. 5.2mc. or 30mc. With 21 tubes including 3" scope tube. Converted for operation on 115 V. 60 cycle source.

PRICE **$245.00**
AN/APA-10 80 Page Tech Manual.......... **$2.75**

MICROWAVE TUNING UNITS

Tuning Units for APR-1 or APR-4, TN-16 (38-95 mc.) TN-17 (74-320 mc) TN-18 (300-1000 mc.) These front ends may be used with any 30 mc. IF amplifier or as converters into receivers tuned to 30 mc.

LINEAR SAWTOOTH POTENTIOMETER



W.E. KS-15138

Has continuous resistance winding to which 24 volts D.C. is fed to two fixed taps 180° apart. Two rotating brushes 180° apart take off linear sawtooth wave voltage at output.

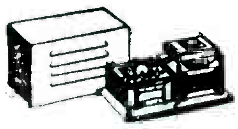
Brand New $5.50

LAVOIE FREQ. METER MICRO-WAVE

375 to 725 MCS

Model TS-127/U is a compact, self-contained, precision (± 1 MC) frequency meter which provides quick, accurate readings. Requires a standard 1.5V "A" and 45V "B" battery. Has 0-15 minute time switch. Contains sturdily constructed HI-"Q" resonator with average "Q" of 3000 working directly into detector tube. Uses 957, LS6 and 3S4 Tubes. Complete, new with inst. book, probe and spare kit of tubes. Less batteries. Write for descriptive circular **$69.50**

RAYTHEON VOLTAGE REGULATOR Adj. input taps 95-130V., 60 cy. 1 Ph Output: 115V., 60 Watts, ½ of 1% Reg. Wt. 20 lbs. 6⅛" H x 8¼" L x 4⅝" W. Overload protected. Sturdily constructed. Tropicalized.



Special.... **$14.75**

400 CYCLE TRANSFORMERS

AUTO. 400 cy. G.E. Cat. No. 80G184 KVA .945S—.520P. Volts 460/345/230/115. New $3.45

FILAMENT. 400/2600 cy. Input: 0/75/80/85/105/115/125V. Output: 5V3A/5V3A/5V3A/5V3A/5V6A/5V6A/6.3V6A/6.35A. New $1.95

THYRATRON POWER. 400/1600 cy. Raytheon UX-8876. 400/1600 cy. Pri: 115V, Sec: 50-0-50V at 0.5A, 6.3V at 1.2A. Test r.m.s. 1780. New $2.75

PLATE WECO KS9560. 400/800 cy. Pri: 115V. Sec: 1350-0-1350 at .057A (2700 V Total). Elecstat shlded. Wt. 2.3 lbs. New..............$2.95

SCOPE PL. & FIL. WECO 9556. 400/2400 cy. Pri: 115. HV. Wdg. 1125V at .008A. Fil. Wdgs. 6.4V4A/2.5V1.75A/6.4V.6A. Elecstat shlded. Wt. 1.4 lbs. New $2.75

FILAMENT. 400/2400 cps. WECO KS9553. Pri: 115V, Sec: 8.2V1.25A/6.35V1.5A. Elecstat shlded. Wt. 0.5 lbs. New...................$1.65

PLATE & FIL. 400/2600 cy. Pri: 0/80/115V. Sec #1=1200VDC at 1.5MA, Sec#2=400VDC at 130MA. Fil. Secs: 6.4V4.3A/6.35VO.8A. (ins 1500V)/5V2A/5V2A $3.95

RETARD. 400 cy. WECO KS9598. 4 Henry 100MA $1.00

400 CY. SERVO TRANSFORMERS

G.E. #68G665X Pri: 57.5V. Sec:#1=28.75V. Sec: #2=28.75V $1.50

G.E. #68G666X Pri: 57.5V. Sec: 115V C.T. $1.50

G.E. #68G667 Pri: 220V C.T. Sec: 220V C.T. $1.50

G.E. #68G668X Pri: 115V. Sec: 275V/275V/275V/275V/230V/230V/6.3V CT/6.3V CT..$3.50

60 CYCLE TRANSFORMERS

1.5 KVA STEPDOWN. G.E. Cat. No. 76G173. Pri: 115/230V Sec: 23/11.5V. Either high voltage connection may be used with either low voltage connection $23.95

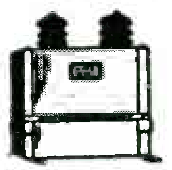
50KVA STEPDOWN. Standard Trans Corp. trans type MD. Pri: 450V111A, Sec: 117V427A. Navy type. Ambient temp. 50 Deg. C.........$125.00

FILAMENT. Raytheon Hypersil Core. Pri: 115V. Sec: 6.3V22A/6.3V2.4A/6.3V2.25A/6.3VO.6A Ins. for 1700V $3.95

PULSE TRANSFORMER

PULSE. WECO KS-9563. Supplies voltage peaks of 3500V from 807 tube. Tested at 2000 Pulses/sec and 5000V peak. Wdg. 1-2=18 ohms. Wdg. 1-3=72 ohms. L of Wdg. 1-3=.073-.082H at 100 cps $5.50

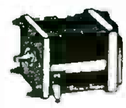
High Voltage Capacitors Oil Filled



.25 MFD., 20KV.......$17.75
.25 MFD., 15KV.......$15.75
.5 MFD., 25KV........$26.50
1 MFD., 15KV........$18.50
1 MFD., 7.5KV........$ 7.95

All brand new. Made by prominent manufacturers.

SWEEP GENERATOR CAPACITOR



High speed ball bearings. Split stator silver plated coaxial type 5/10 mmfd. Brand new.

$2.50

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**

All prices indicated are F O B Tuckahoe, New York. Shipments will be made via Railway Express unless other instructions issued.

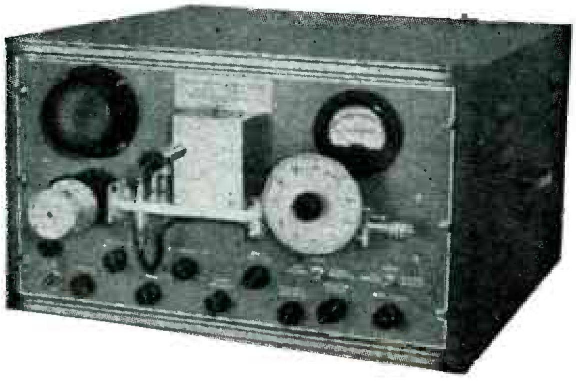
ELECTRONICRAFT INC.

5 WAVERLY PLACE TUCKAHOE 7, N. Y.
PHONE: TUCKAHOE 3-0044

All merchandise guaranteed. Immediate delivery, subject to prior sale.

All Prices Subject to Change Without Notice

TEST EQUIPMENT



X Band Spectrum Analyzer 8500-9600 Mc., calibrated linear below cut-off attenuator, calibrated frequency meter, tuned mixer, 4 i.f. stages, 3 video stages overall gain 125 db., regulated power supply.

S Band Spectrum Analyzer 2700-3900 Mc., similar to above.

X Band Test Load low power low power $20.00

X Band Below Cut-Off Wave Guide Attenuator, with calibrated dial, type N input connector, output connects to ½" x 1" wave guide..........$55.00

X Band Test Load, low power....$15.00

TS-62 X Band Echo Box with r.f. cable and pick-up antenna.

TS-33 X Band Frequency Meter, 8500-9600 Mcs. Crystal detector and 50 micro-amp. meter. Indicates Resonance. Connection for scope available.

TS-45A-APM-3 Signal Generator, 8700-9500 mc., 110 V. 60-800 cps.

TS-35/AP X Band Signal Generator, pulsed, calibrated power meter, frequency meter, 8700-9500 mc.

30 MC I.F. STRIP, VIDEO, and AUDIO AMPLIFIER AND 110 Volt 60-2600 cps POWER SUPPLY, Bandwidth 10 mc, new, part of APR-5 Receiver $65.00 less tubes

AMPLIFIER STRIP AM-SSA/SPR-2 contains I. F. amplifier, detector, video amplifier, pulse stretcher and audio amplifier and Rectifier Power Unit PP-155A/SPR-2 bandwidth 10 mc, center frequency 30 mc, sensitivity 50 microvolts for 10 milliwatts output. Power supply 80/115 V ac, 60-2600 cps 1.3 amps.

X Band Test Load, 50 watts, average power ½" x 1" waveguide. Sand load TS 108..................$35.00

HI POWER X BAND TEST LOAD, dissipates 280 watts of average power for ⅝" x 1¼" waveguide, VSWR less than 1.15 between 7 and 10 KMC $150.00

S Band Signal Generator Cavity With Cut-Off Attenuator, 2300-2950 mc., 2C40 tube, with modulator chassis $30.00

High Pass Filter F-29/SPR-2, cuts off at 1000 mc. and below; used for receivers above 1000 mc...............$12.00

UPN-1 S Band Beacon Receiver-Transmitter $75.00

S Band Test Load TPS-55P/BT, 50 ohms $12.00

High Pass Filter F-29/SPR-2, cuts off at 1000 mc and below; used for receivers above 1000 mc...............$12.00

TS-125 CALIBRATED S BAND POWER METER with attenuator.

TS-155 S BAND SIGNAL GENERATOR and Power Meter.

S Band Mixer, tunable by means of slider, type N connector for the R. F. and local oscillator input, U.H.F. connector for the I.F. output, variable oscillator injection $30.00

TS-110 S Band Echo Box 2400-2700 mc, portable $110.00

HI POWER S BAND TEST LOAD, dissipates 1000 watts of average power, for 1½" x 3" waveguide. Range 2500 to 3700 MC.

TS-203/AP CALIBRATED SELSYN..$10.00

GENERAL RADIO PRECISION WAVEMETER TYPE 724A, range 16 kc to 50 mc. 0.25% accuracy, V.T.V.M. resonance indicator, complete with accessories and carrying case NEW....$175.00

HEWLETT - PACKARD - AUDIO SIGNAL GENERATOR 205A...........$230.00

RADIO RECEIVER BC-967T2, 18-160 mc, 3 bands FM/AM, 110 V, 60 cps. $200.00

RADIO RECEIVER BC-969-B, 15-150 kc. $150.00

MEASUREMENTS 78E, 50-75 mc, calibrated output.................$100.00

FERRIS MODEL, 22A SIGNAL GENERATOR, 85 kc to 25 mc. Output, 2 microvolts to 1 volt, modulation variable, good working order...........$175.00

FERRIS MODEL, 10B SIGNAL GENERATOR, 85 kc to 25 mc, calibrated output, good working order..........$100.00

TS-184 Echo Box and Attenuator for APS-13.

TS-226 Peak Power Meter for APS-13.

TS-89 Voltage Divider for measuring high video pulses, ratios 1:10 and 1:100 transmission flat within 2 db 150 c.p.s. to 5 mc., with cable for attaching to syndroscope.

Waveguide Below Cut-off Attenuator L 101-A U.H.F. Connectors at each end calibration 30-100 db...........$10.00

FIXED ATTENUATOR PADS, 20 db+0-2 db DC-1200 mc, 50 ohms, VSWR 1.3 or less, 2 watts average power....$30.00

WAVEGUIDE BELOW CUT-OFF ATTENUATOR, Type N connectors, rack and pinion drive, attenuation variable 120 decibles, calibrated 20-120 db, frequency range 300-3000 mc..........$35.00

WAVEGUIDE BELOW CUT-OFF ATTENUATOR same as above except input is matched in range of 2200-3300 mc. VSWR less than 1.2............$54.00

PULSE TRANSFORMER 132-AWP...$8.00

PULSE TRANSFORMER GE 69G, 828 G-1 $6.00

HYPERSIL CORE CHOKE, 1 Henry, Westinghouse L-422031 or L 422-32....$3.00

PULSE FORMING NETWORK, 20 kv., .92 micro-second, 50 ohms, 800 p.p.s. $40.00

PULSE INPUT TRANSFORMER, permalloy core, 50 to 4000 kc., WE-D161310, impedance ratio 120 to 2350 ohms..$3.00

TRANSFORMERS, 115 volts, 60 cps primaries:

1. 6250, 3250 and 200 volts, tapped primary voltage doubler, 12.5 kv. ins. $14.00
2. 6250 volts 80 ma. G.E. voltage doubler, 12.5 kv. ins...........$12.00
3. 2 secondaries at 500 volts 5 amps each, at 210 pounds.........$50.00

W.E. NETWORKS: D161638, D-161844, D-162627, D-162629, D-162631, D-162632, D-162624, D-162635 ....$1.00 each

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

SQ RADAR, used but in good working order, complete with antenna, control unit $650.00

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

UG-27/U TYPE N RIGHT ANGLE ADAPTERS 10 for $5.00; 1000 for $250.00

U.H.F. RIGHT ANGLE ADAPTER 10 for $2.50; 1000 for $125.00

ELECTRO IMPULSE LABORATORY

P. O. Box 250 Eatontown 3-0007 Red Bank, N. J.

1000 KC crystal BT cut $3.95
3" scope shield 1.29
2 speed dial drive for ¼" shaft ratios 5:1 1 to 1 .39
ATC 100 mmfd air trimmer screwdriver shaft .... .29
—10 +5 Weston modulation meter Weston 301 . 8.95
J37 key .... .69
500 watt 12.5 ohm power rheostat 3.49

R·H·S

SPECIALS OF THE MONTH

50 mmfd 5 KV GE vacuum condenser $1.49
2v, 6v, 12v vibrators any type .... .98
Rotary switch GE Mycalex, 2 deck SP3T .... .39
1 mfd 5000v oil condenser Micamold 2.98
2 mfd 3000v oil condenser Aerovox 3.25
3 mfd 4000v oil condenser Micamold 3.95
24 mfd 1500v DC 3KV flash. Excellent for speed lamp 3.95

TUBES!! BRAND NEW! STANDARD BRANDS! NO SECONDS! COMPARE! TUBES!!

0A3/VR75 $ 1.05
0B3/VR90 .89
0C3/VR105 .74
0D3/VR150 .48
1B22 ... 2.95
1B23 ... 8.75
1B24 ... 4.95
1B26 ... 2.95
1B27 ... 24.50
1B29 ... 2.75
1B32 ... 1.79
1B36 ... 24.96
1B38 ... 32.50
1N21 Xtal .59
1N21A Xtal .89
1N21B Xtal 1.39
1N22 Xtal .89
1N23 Xtal .79
1N23A Xtal .79
1N23B Xtal 2.95
1N27 Xtal 1.69
1N34 Xtal .79
1N34A Xtal .85
1P23 ... 2.95
1P24 ... .79
1P36 ... 2.69
1S21 ... 3.79
2AP1 ... 4.95
2AP5 ... 4.95
2C21/RK33 .35
2C22/7193 .19
2C26A .. .19
2C34/RK34 .27
2C39 ... 24.50
2C40 ... 3.45
2C43 ... 8.95
2C44 ... .98
2C46 ... 6.95
2C51 ... 5.75
2D21 ... 1.25
2E22 ... 1.19
2E24 ... 4.69
2E26 ... 3.39
2E30 ... 2.29
2J21A .. 7.95
2J22 ... 8.45
2J26 ... 6.50
2J27 ... 10.95
2J30 ... 39.50
2J31 ... 8.49
2J32 ... 12.95
2J33 ... 18.95
2J34 ... 18.95
2J36 ... 97.50
2J37 ... 12.75
2J38 ... 9.95
2J39 ... 19.95
2J40 ... 24.50
2J46 ... 49.50
2J48 ... 15.75
2J49 ... 39.50
2J50 ... 22.50
2J54B .. 22.95
2J55 ... 69.50
2J61 ... 24.50
2J62 ... 34.50
2K25 ... 19.75
2K28 ... 24.95
2K29 ... 24.50
3AP1 ... 4.59
3B22/ELIC 1.35
3B23/RK22 4.85
3B24 ... 1.59
3B24W... 2.89
3B25 ... 4.39
3B26 ... 1.49
3B27 ... 1.95
3B28 ... 7.95
3BP1 ... 2.59
3C22 ... 39.50
3C23 ... 5.95

3C24/24G $ .39
3C31/C1B. 3.49
3C45 ....12.75
3CP1 .... 1.39
3CP1-S1.. 2.25
3DP1 .... 3.10
3DP1A ... 3.95
3DP1-S2A 4.75
3D21A ... .98
3E29 .... 9.95
3FP7 .... 1.15
3GP1 .... 4.45
3HP7 .... 2.89
4-65A ...14.21
4-125A ...26.95
4-250A ...29.95
4AP10 ... 3.95
4B22/EL5B 9.95
4B24/EL3C 4.75
4B25/6CF. 7.50
4B26/2000 4.95
4B28 .... 2.95
4B32 .... 9.95
4C27/CV92 49.50
4C35 ....22.50
4D22 .... 9.95
4D32 ....12.95
4E27/257B 14.95
5AP1 .... 1.79
5AP4 .... 1.79
5BP1 .... 2.29
5BP4 .... 2.39
5CP1 .... 1.39
5CP7 .... 3.49
5C22 ....49.50
5D21 ....18.95
5FP7 .... 1.19
5GP1 .... 2.69
5JP1 ....24.45
5JP2 .... 8.95
5JP4 ....24.45
5J23 ....12.95
5J29 ....12.95
5J30 ....49.50
5LP1 ....11.95
5NP1 .... 2.49
6C21 ....18.95
6F4 .... 5.79
6J4 .... 4.59
7BP7 .... 4.49
9GP7 .... 8.95
9JP1 .... 5.95
9LP1 ....19.95
9LP7 .... 3.49
10BP4 ...18.95
7DP4 ....17.95
10 ...... .25
12DP7 ...11.95
12GP7 ...12.75
12HP7 ...12.75
12LP4 ...22.50
15E 1.19
15R .... .59
16AP4 ...42.50
16CP4 ...42.50
19T8 .... .87
23D4 .... .19
28D7 .... .39
30 SPEC.. .25
35TG 5.95
45 SPEC.. .19
53A 5.95
75TL 5.95
100R .... .89
100TH ... 9.95
121A 2.65
203A 5.95
211 ..... .39
212E 49.50
215A .... .19
217C 6.75

227A/5C27 $2.49
249C 1.75
250R 5.95
250TH ...18.95
250TL ...18.95
274A 5.50
274B 1.95
276A 6.95
293A 2.98
294A 3.95
300B 9.95
304TH ... 3.65
304TL ... 1.29
305A 24.95
307A/RK75 6.95
310A 6.95
316A .... .45
323A/B ..24.50
327A/5C37 2.49
328A 12.95
331A 12.95
350A 1.98
350B 1.69
368AS ... 2.39
371A .... .59
371B .... .39
388A .... .79
393A 3.49
394A 3.49
417A 8.95
434A 2.95
446A 1.25
446B 1.79
450TH ...19.95
450TL ...44.50
527 ..... 9.75
559 ..... .98
562 .....97.50
575A 11.95
701A 2.95
702A 2.69
703A 2.39
704A 1.05
705A .... .89
706B 24.95
706CY ...16.95
706FY ...42.50
706GY ...42.50
707B 14.95
708A 3.59
709A 3.95
710A/8011 .85
713A .... .79
714AY ... 3.52
715A 6.49
715B 6.85
715C 22.45
717A .... .55
721A 2.25
722A 2.95
723A 6.75
723A/B ..12.95
724B 2.69
725A 6.45
726A 4.95
726B 29.50
726C 49.50
730A 8.95
750TL ...79.50
800 ..... 1.69
801A .... .25
802 ..... 3.89
803 ..... 3.10
804 ..... 6.45
805 ..... 3.65
806 .....29.95
807 ..... 1.49
808 ..... 1.29
809 ..... 2.25
810 ..... 9.55
811 ..... 2.10

812 .....$2.45
812H 6.90
813 ..... 6.85
814 ..... 2.25
815 ..... 2.25
816 ..... 1.05
826 ..... .39
828 ..... 9.95
829 ..... 7.45
829B 9.95
830B 3.19
832 ..... 4.95
832A 7.95
833A 33.95
836A 1.25
837 ..... 1.35
838 ..... 2.35
841 ..... .33
843 ..... .27
845 ..... 3.75
849 .....29.50
851 .....13.95
852 ..... 6.25
860 ..... 6.95
861 .....10.95
864 ..... .29
865 ..... 1.45
866A 1.05
866JR ... 1.05
869B 26.50
872A 1.25
874 ..... .89
876 ..... .35
878 ..... 1.69
884 ..... 1.39
885 ..... 1.39
902 ..... 3.39
905 ..... 2.59
908 ..... 7.95
918 ..... 1.49
919 ..... 1.95
923 ..... .72
927 ..... 1.09
930 ..... .79
931A 3.59
954 ..... .19
955 ..... .24
956 ..... .24
957 ..... .22
958 ..... .22
959 ..... .49
991/NE16 .22
1603 .... 1.98
1613 .... .49
1614 .... 1.29
1616 .... .59
1619 .... .24
1622 .... 1.49
1624 .... .98
1625 .... .18
1626 .... .24
1629 .... .25
1630 .... .98
1631 .... .85
1632 .... .79
1633 .... .69
1634 .... .75
1636 .... 2.95
1638 .... .65
1644 .... .98
1654 .... 2.39
1665 .... 1.19
1851 .... .89
1960 .... .79
1961 .... 4.99
2050 .... 1.19
2051 .... .39
8005 .... 4.59
8011 .... .49
8012 .... 1.29
8013 .... 1.39

8014 ...$19.95
8020 .... .89
8025 .... 3.69
9001 .... .39
9002 .... .32
9003 .... .49
9004 .... .34
9005 .... 1.49
9006 .... .18
C1JA 9.95
C5B 6.75
C6A 7.95
C6J 4.45
C100D ... 1.49
CK502AX. 2.95
CK503AX. 2.95
CK505AX. 2.25
CK506AX. 2.25
CK507AX. 2.25
CK512AX. 2.25
CK571AX. 8.45
CK1005 .. .15
CK1006 .. .63
E1148 ... .29
EF50 .... .69
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F127A ...22.50
F128A ...89.50
F606 ....37.50
F660 ....49.50
F862 ...397.50
FG17 .... 3.95
FG27A ... 8.75
FG32 .... 7.95
FG57 ....12.95
FG81A ... 3.29
FG105 ... 8.95
FG172 ...29.50
GL146 ... 8.95
GL434A .. 2.69
GL451 ... .89
GL502A .. 1.85
GL562 ...49.50
GL592 ...14.95
HF125 ...14.95
HF300 ...19.95
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HY115 ... .79
HY615 ... .19
KC4 .....37.50
KU610 ... 6.95
ML101 .. 49.50
REL21 ... .98
RK20 .... 7.95
RK25 .... 4.19
RK33 .... .24
RK34 .... .27
RK48A ...14.95
RK59 .... 1.49
RK65 ....24.50
RK72 .... .59
RK73 .... .59
RX21A ... 2.39
RX120 ... 8.95
V70D 7.35
VR78 .... .29
VR91 .... 1.10
VR92 .... .69
VT127A .. 1.98
VT158 ...14.95
VU29 .... 2.95
VU111 ... .49
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WL530 ..12.75
WL531 .. 1.75
WL532 .. 1.89
WL578 .. .89
WL616 ..37.50
WL619 ..18.95
WL677 ..34.50
WL681 ..22.50

0A2, 0A4G, 0B2, 0Z4, 01A, 1A3, 1A4P, 1A5GT, 1A6, 1A7GT, 1AB5, 1B3/8016, 1B4, 1B5/25S, 1B7GT, 1C5GT, 1C6, 1C7G, 1D5GP, 1D7G, 1D8GT, 1E5GT, 1E7G, 1F4, 1F5G, 1G4GT, 1G6GT, 1H4G, 1H5GT, 1H6GT, 1J6GT, 1L4, 1LA4, 1LA6, 1LB4, 1LC5, 1LC6, 1LD5, 1LE3, 1LG5, 1LH4, 1LN5, 1N5GT, 1P5GT, 1Q5GT, 1R4, 1R5, 1S4, 1S5, 1T4, 1T5GT, 1U4, 1V, 2A3, 2A4G, 2A5, 2A6, 2A7, 2B7, 2V3G, 2X2, 2X2A, 3A4, 3A5, 3A8, 3B7/1291, 3D6/1299, 3LF4, 3Q4, 3Q5GT, 3S4, 3V4, 5R4GY, 5T4, 5U4G, 5V4G, 5W4, 5X4G, 5Y3GT, 5Y4G, 5Z3

DUE TO THE CURRENT NATIONAL EMERGENCY AND THE CRITICAL RECEIVING TUBE SHORTAGE, TUBES WILL BE SHIPPED AT PREVAILING PRICES.

5Z4, 6A3, 6A4LA, 6A6, 6A7, 6A8, 6AB7, 6AC5GT, 6AC7, 6AD7G, 6AE6G, 6AF6G, 6AG5, 6AG7, 6AH6, 6AJ5, 6AK5, 6AK6, 6AL5, 6AQ5, 6AQ6, 6AR5, 6AT6, 6AU6, 6AV6, 6B4G, 6B6G, 6B7, 6B8G, 6BA6, 6BE6, 6BF6, 6BG6G, 6BH6, 6BJ6, 6C4, 6C5, 6C6, 6C8G, 6D6, 6D8G, 6E5, 6F5, 6F6, 6F6GT, 6F7, 6F8G, 6G6G, 6H6, 6H6GT, 6J5, 6J5GT, 6J6, 6J7, 6J7GT, 6K5GT, 6K6GT, 6K7, 6K8, 6L5G, 6L6, 6L6G, 6L6GA, 6L7, 6L7G, 6N7, 6Q7, 6R7, 6S7G, 6S8GT, 6SA7, 6SC7, 6SD7GT, 6SF5, 6SF5GT, 6SF7, 6SG7, 6SH7, 6SJ7, 6SK7, 6SL7GT

DUE TO THE CURRENT NATIONAL EMERGENCY AND THE CRITICAL RECEIVING TUBE SHORTAGE, TUBES WILL BE SHIPPED AT PREVAILING PRICES.

6SN7GT, 6SQ7, 6SR7GT, 6SS7, 6ST7, 6SU7GTY, 6SV7, 6T7G, 6T8, 6U5G, 6U6GT, 6U7G, 6V6, 6V6GT, 6W4, 6W7G, 6X4, 6X5GT, 6Y6G, 6Y7G, 6Z7G, 6ZY5G, 7A4/XXL, 7A5, 7A6, 7A7, 7A8, 7AG7, 7B4, 7B5, 7B6, 7B7, 7C4, 7C5, 7C6, 7C7, 7E5, 7E6, 7E7, 7F7, 7H7, 7K7, 7L7, 7N7, 7Q7, 7R7, 7S7, 7V7, 7W7, 7X7, 7Y4, 7Z4, 12A, 12A6, 12A7, 12A8GT, 12AH7GT, 12AL5, 12AT6, 12AT7, 12AU6, 12AU7, 12AV6, 12BA6, 12BE6, 12C8, 12F5GT, 12H6, 12J5GT, 12J7GT, 12K7GT, 12K8, 12Q7, 12SA7GT, 12SC7, 12SF5, 12SF7, 12SG7, 12SH7

DUE TO THE CURRENT NATIONAL EMERGENCY AND THE CRITICAL RECEIVING TUBE SHORTAGE, TUBES WILL BE SHIPPED AT PREVAILING PRICES.

12SJ7, 12SK7, 12SL7, 12SN7, 12SQ7, 12SR7, 12Z3, 14A4, 14A7, 14B6, 14F7, 14F8, 14H7, 14J7, 14N7, 14Q7, 14R7, 19, 24A, 25L6GT, 25Z5, 25Z6GT, 26, 27, 28D7, 30, 31, 32, 32L7GT, 33, 34, 35/51, 35A5, 35B5, 35C5, 35L6GT, 35W4, 35Y4, 35Z3, 35Z4, 35Z5, 36, 37, 38, 39/44, 41, 42, 43, 45, 45Z3, 45Z5, 46, 47, 48, 49, 50A5, 50B5, 50C5, 50L6GT, 50Y6, 53, 56, 57, 58, 59, 70L7, 71A, 75, 76, 77, 78, 80, 82, 83, 83V, 84/6Z4, 85, 89Y, 117L7/M7, 117N7, 117P7, 117Z3, 117Z6

DUE TO THE CURRENT NATIONAL EMERGENCY AND THE CRITICAL RECEIVING TUBE SHORTAGE, TUBES WILL BE SHIPPED AT PREVAILING PRICES.

SELENIUM RECTIFIERS
FULL WAVE BRIDGE TYPE

Input 0-20V AC Type No.	Current	Output 0-14.5V DC Price
20D1	1.2 Amps.	$ 2.49
20E1	2.4 Amps.	3.49
20F1	6.4 Amps.	4.95
20K1	13.0 Amps.	8.95
20J1	17.5 Amps.	11.95
20K2	26.0 Amps.	17.95
20K3	39.0 Amps.	24.95
20K4	52.0 Amps.	29.95
20K5	65.0 Amps.	35.95
0-40v AC	Current	0-34v DC
40D1	.6 Amps.	$ 2.95
40E1	1.2 Amps.	3.89
40F1	3.2 Amps.	5.25
40K1	6.0 Amps.	9.95
40J1	9.0 Amps.	12.95
40K2	12.0 Amps.	18.95
40J2	18.0 Amps.	22.45
40K4	24.0 Amps.	32.50
40K5	30.0 Amps.	34.95
40J4	36.0 Amps.	39.50
0-120v AC	Current	0-100v DC
40D1A	.6 Amps.	$ 7.85
40E1A	1.2 Amps.	10.76
40F1A	3.2 Amps.	16.65
40K1A	6.0 Amps.	24.75
40J1A	9.0 Amps.	32.95

CENTER TAPPED RECTIFIERS
Single Phase Full Wave Bridge

10-0-10v AC	Current	0-8v DC
10D1	1.2 Amps.	$ 1.89
10E1	2.4 Amps.	2.25
10F1	6.4 Amps.	3.87
10K1	12.0 Amps.	4.95
10J1	16.0 Amps.	7.95
10K2	24.0 Amps.	10.75
10K3	36.0 Amps.	14,75
10K4	48.0 Amps.	17.75
10K5	60.0 Amps.	19.95
10K6	72.0 Amps.	25.57
10K7	81.0 Amps.	27.95
10J6	96.0 Amps.	32.50
10K10	120.0 Amps.	42.50

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TRANSFORMERS—115V 60 CY
HI-VOLTAGE INSULATION

6250v or 3850v or 2600v @ .056 arms $13.95
2700v @ 2 MA; 6.3v @ .6A; 2.5v @ 1.75A .. 4.95
2500v @ 15 MA 3.49
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925v @ 10 MA; 525-0-525v @ 60 MA; 2X5v @ 3A; 6.3v CT @ 3.6A; 6.3v @ 2A; 6.3v @ 1A 5.55
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500-0-500v @ 175 MA 4.55
430-0-430v @ 340 MA; 6.3v CT @ 6.3A; 5v @ 6A 4.85
425-0-425v @ 75 MA; 6.3v @ 1.5A; 5v @ 3A 3.65
415-0-415v @ 60 MA; 5v CT @ 2A; 115/230 Duel Pri 4.97
405-0-405v @ 150 MA; 6.3v CT @ 2½A; 5v @ 3A; 2.5v CT @ 5A 4.35
400-315-0-100-315v @ 200 MA; 2x6.3v @ 9A; 5v @ 3A; 2.5v @ 2A 5.35
500-385-0-385v @ 200 MA; 3x6.3v @ .6A; 5v @ 3A; 2.5v @ 2A 4.75
325-0-325v @ 12 MA; 255-0-255v @ 240 MA. 4.25
300-0-300v @ 65 MA; 6.3v @ 2.5A; 6.3v @ 1A; 2x5v @ 2A 3.25
80-0-80v @ 225 MA; 5v @ 2A; 5v @ 4A 2.97
0-17.4/21.6/25.8v @ 400 MA; 6.4v @ .5A; 2.6v CT @ 2.5A Pri 115/230 .... 3.85
18 or 36v @ 15A..$8.75 13.5v CT @ 3.25A. 2.17
12.6v CT @ 10A; 11v CT @ 6.5A 6.35
3x10.3v CT @ 7A..$6.95 6.3v @ 1A .... .77
6.5v @ 12A; 6.3v @ 2A; 115v @ .1A 3.50
6.4v @ 10A; 6.3v @ .6A 2.77
6.5v @ 8A; 6.5v @ 6A; 2.5v @ 1.75A ...... .17
6.3v @ 1A; 2.5v @ 2A..$2.29 4-0-4v @ 1A .87
6.3v CT @ 3.5A; 2x2.5v CT @ 3A 2.97
5v CT @ 20A; 10 KV INS 8.95
.6v @ 15A RMS 1.47

TRANSFORMERS—220v 60 Cyc

512.5-0-512.5 @ 427 MA .... $ 5.35
3x5v @ 6A; 4v @ .25A 2.95
3x6.3v CT @ 3A; 6.3v CT @ 1.6A 2.95
10v CT @ 6.5A; 6.3v CT @ 2.5A; 6.3v CT @ 1.8A 220/440 Pri 3.95
Step Up/Down 110/220, 500 watt 10.95
Step Up/Down 110/220, 220/440 600 watt.. . 14.95

EQUIPMENT SPECIALS

APN-1 Altimeter Xceiver	Like New	$ 7.95
ATR Inverter 12v DC in 110v AC Out 125 w Int. 100 w Cont.	New	14.95
AN/CRW-2 UHF Receiver	New	5.95
BC357 Beacon Receiver	Good	3.45
BC433 Receiver	Good	24.94
BC456 Modulator	Good	1.98
BC434A Control Box/BC433	Used	1.95
BC458 Transmitter	New	8.95
BC602A Control Box/SCR522	Used	.39
BC778 Gibson Girl	Good	3.95
BC958-121 Xmitter 100-156 MC	New	39.50
BC1016 Tape Recorder	New	459.50
BC1206A Beacon Receiver	Good	4.95
CF1 Navy Unit w/200KC Crystal	New	14.95
DM 19 Dynamotor 12v DC in 500v 200 MA Cont. Out	Good	4.95
EE8 Foundation Unit	Good	4.95
MN26C Compass Receiver	Good	24.95
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PE94 Dynamotor/SCR522	Good	1.98
PE97A Vibrator Power Supply	New	6.95
PE104 Vibrator Supply	Excellent	24.95
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R89/ARN5 Receiver Less Tubes, Covers	Good	4.95
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.025 HY @ 1.36A. $1.98
.05 HY @ 15A 7.95
.065 HY @ 2.5A.. 2.49
.1 HY @ 5A 6.95
2 HY @ 175 MA.. 1.49
3 HY @ 50 MA.. .39
3/30 HY @ 250 MA 3.65
5 HY @ 70 MA/.2 HY 350 MA Duel 2.39
5.3 HY @ 775 MA 9.95
10 HY @ 55 MA.. .89
10 HY @ 100 MA. 1.49
10 HY @ 200 MA. $2.15
10/20 HY @ 85 MA 1.49
13 HY @ 130 MA. 1.55
13 HY @ 250 MA. 2.95
14/3.5 HY @ 40/400 MA 6.95
15 HY @ 25 MA.. .59
15 HY @ 70 MA.. 1.15
26.5 HY 125 MA.. 1.98
200 HY @ 10 MA. 2.95
325 HY @ 2 MA.. 2.95
600 HY @ 1 MA.. 2.95

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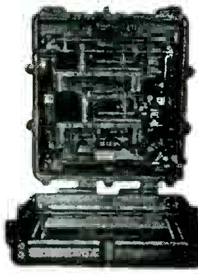
BROWN TELEPLOTTER RECEIVER



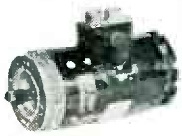
Model 791X1R

115 volt 60 cycles

Contains a pen driven by two balancing motors which writes on rear of a translucent chart. Pen arm position is in terms of two coordinates supplied balancing motors thru two amplifiers. Originally intended for recording plotted or written data from central plotting board. Writes at one half scale on 18 in. chart. Discriminator input circuit designed to operate unit as function of two varying R.F. frequencies varying about mean of approx. 430 KC. Further data on request. (Shipping weight 435 lbs.)

Price $375.00

Aircraft Generator Eclipse NEA-3



Output 115 VAC; 10.4 amps 800 cycles at 2400 rpm. Also 30 VDC at 6 amps. Stock #SA-306. **Price $39.50 each.**

400 Cycle Generators

Homelite 18A120D28-1 400 cycle out at 1 phase 115 v. 39 amps. Also a d-c output of 28 v. and 17.9 amps. **Special at $175.00 each.**

C-1 Autopilot Amplifier

Three channel servo amplifier for use in C-1 Autopilot. 7 tubes. Stock #SA. 172. **Price $24.50 each.**

Pioneer Servo Motor

Type 10047-2A. 2 ϕ 400 cycle low inertia. 26 v fixed phase. 45 v. max. variable phase. Stock #SA-90. **Price $12.50 each.**

PRECISION AUTOSYN

Pioneer Type AY-150 Control Autosyn. Precision type. 26 v. 400 cycle. Stock #SA-297. **Special low price $14.50 each.**

SYNCHROS

Navy Types

1G, 1CT, 5G, 5F, 5CT, 5DG, 5HCT, 5SF, 5HSF, 5SDG, 6DG, 7G, etc.

Prices on Request

Compass Indicator

1-82F Compass Indicator. 0-360°-5 in. dial. 26 v. 400 cy. 8-12 v. 60 cy. Ideal position indicator. Stock #SA-284.

Price $6.50 each

SWEEP GENERATOR CAPACITOR

Hi-speed bearings. Split stator. Silver-plated coaxial type. 5-10 mmf.

Stock #SA-167 **Price $2.75 each**

ALSO IN STOCK

C-1 AUTOPILOT COMPONENTS
A-5 AUTOPILOT GYROS
GENERAL ELECTRIC D-C SELSYNS
AC and DC RATE GENERATORS

400 CYCLE AC BLOWERS

E. A. D. J-151—115 v. 400 cy. 22 c.f.m.
Westinghouse Type FL—115 v. 400 cy. 17 c.f.m.

DC MOTORS

Haydon-0666. ½ rpm. 29 v. d-c, 100 ma.
Delco 5069625—120 rpm. Gov. cont. 27 v.
General Electric 5BA50LJ66—½ hp. 27 v. field. Arm. v. 60, Amplidyne controlled.
Delco-A-7155—1/30 hp. 3600 rpm. Gov. cont.
W. E. KS-5603-LO2—1/100 hp. 4 lead shunt.
National Mineral—90600. 1 hp. Int. duty. Fan cooled.
Diehl FDE-53-5—3600 rpm. Gov. cont. 1/30 hp.
G. E. 5BA25MJ409—24 v. 7500 rpm. Cont. duty.
Airsearch—Actuator—25800-24. 2" travel.
Barber Colman—Actuator—YLc-2066-2. 200 in/lb. 135 degrees in 45 seconds.
Airsearch—Actuator (Manual Flap) 25080.
Airsearch—Actuator—(Automatic Flap) 25040.
Holtzer Cabot—RBD-2220—½ hp. 27 v. 3600 rpm.
Arma Latitude Motor — 8413-30 (Step motor)
Elinco B-64—1/165 hp. 3100 rpm. 27 v. f. 80 v. armature. (Thyratron control)
John Oster—A-21E-12R—Split field series reversible. 28 v. 0.4 amps. 2 watts output.
General Electric 5PS56HC18 — Split field series rev. 60 v. 1.4 A. 5500 rpm.

AC SERVO MOTORS

Kollsman—776-01—400 cy. 2 ϕ drag cup type.
Diehl FP-25-3—2 ϕ 60 cy. 20 v. 2.5 watts out.
Pioneer CK-2—2 ϕ 400 cy. 1.05 in/oz. stall.
Pioneer CK-17—2 ϕ 400 cy.
Minneapolis Honeywell G303AY2CA4. Built in gear reduction. 2ϕ 400 cy.

AUTOSYNS (Pioneer)

B-9A—Dual Oil Pressure Indicator (6007-4F-7A)
B-9A—Oil Pressure Transmitter. (4150-3B3)
Pioneer Types—AY-1, AY-14, AY-54, 2320, etc.
C-14A—Fuel Pressure Transmitter.
Pioneer I-81A and I-82A Compass Indicators.

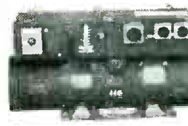
Subfractional Horsepower AC Motors

Eastern Air Devices-J-72B—115 v. 400 cy. 1/50 hp. Cont. duty. 4700 rpm.
E. A. D. J-31—115 v. 400 cy. 1/100 hp.
E. A. D. J-49B—115 v. 400 cy. 1/250 hp.
E. A. D. J-33—115 v. 3ϕ 400 cy. Int. duty.
Diehl FBF-24-1—115 v. 400 cy. 1/100 hp.
Synchron-600—110 v. 60cy. 1 rpm.
Haydon 36228—115 v. 60 cy. 1 rpm.

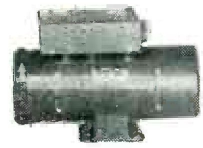
MAGNESYNS

Pioneer Type CL-3, 6 power.
Pioneer 1006-1E-B1 Indicator. AN-5730-2.

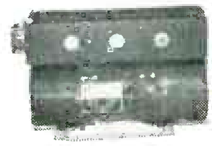
INVERTERS



Wincharger PU-7/AP Input 28 VDC at 160 amps. Output 115 v. 400 cy. 1 ϕ at 2500 VA. Voltage and frequency regulated. Cont. duty. Stock #SA-164. **Price $89.50 each.**

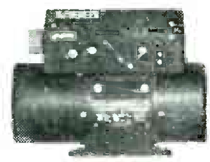


G.E. 5AS131NJ3 (PE-118) Input 26 VDC at 100 amps. Output 115 v. 400 cy. 1 ϕ at 1500 VA. PF 0.8 W.E. Spec. KS-5601L1. Stock #SA-286. **Price $29.50 ea.**



PE-218E Inverters

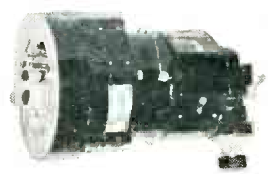
Russel Electric and Leland. Input 28 VDC at 92 amp. Output 115 v. 400 cycles at 1500 VA. PF 0.9. Stock #SA-112A. **Price $49.50 each.**



Pioneer 12130-4-B

Input 28 VDC at 14 amps. Output 120 v. 400 cy. Single Phase at 1.15 amps. (140 VA.) Voltage and frequency regulated. Made 1949. Stock #SA-304. **Price $89.50 each.**

JACK AND HEINTZ STARTER



Dwg. 6-950-R Aircraft engine starter. 28 VDC. Stock #SA-305. **Price $19.50 each**

DC SERVO MOTOR

Elinco Type B-64. 1/165 hp at 3100 rpm. Field volts 27.5 Max. armature voltage 80. Ideal for thyratron servo control. Stock #SA-211. **Price $12.50 each.**

MAGNETIC AMPLIFIER ASSEMBLY

Sperry 661824. Saturable reactor type output transformer. Designed to supply one phase of 400 cycle servo motor. Stock #SA-266. Price $6.75 each

FORD INS'T SERVO MOTOR

115 volt 60 cycle two phase low inertia motor. 15 watts output. BuOrd. 207927. Stock #SA-291. **Price $49.50 each.**

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4 Godwin Ave. Paterson, N. J.

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WIRE WOUND PRECISION RESISTORS, 1% OR BETTER

1/4 WATT—25c

6.68Ω	12.32Ω	16.37Ω	125Ω	414.3Ω
10.48	13.02	62.54	147.5	705
10.84	13.52	79.81	220.4	2193
11.25	13.89	105.8	301.8	59,148
11.74	14.98	123.8	366.6	100,000

1/2 WATT—25c

:250Ω	1.53Ω	75Ω	260Ω	4,000Ω	8,500Ω
:334	2.04	90	270	4,451	14,825
:444	11.1	97,8	298,3	5,000	15,000
.502	13.15	100	400	5,900	15,750
.557	18.75	125	723.1	6,500	17,000
.627	46	180	2,500	7,000	30,000
.76	52	210	2,850	7,500	37,000
1.01	55.1	235	3,427	8,000	79,012
					100,000

1 WATT—30c

1.01Ω	5.21Ω	270Ω	9,000Ω	55,000Ω
2.58	10.1	3,300	18,000	65,000
3.39	10.9	7,000	20,000	60,000

1 WATT—40c

100,000Ω	128,000Ω	320,000Ω	600,000Ω
120,000	130,000	522,000	700,000

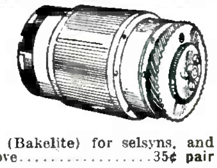
1 Megohm—1 Watt 1%—65c; 5%—40c

Orders for 100 precision resistors—

10% Discount

SELSYNS

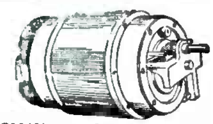
115 V., 60 Cyc.
#C78248
3⅜" dia. x 5⅝" long
$8.50 pair



Mounting Brackets — (Bakelite) for selsyns, and differentials shown above..................35¢ pair

DIFFERENTIAL

115 V., 60 Cyc.
#C78249
3⅜" dia. x 5⅝" long
$2.95 ea.



Used between two #C78248's as dampener. Can be converted to 3600 RPM Motor in 10 minutes. Conversion sheet supplied. (Converted).....$3.50

CAPACITORS

POSTAGE STAMP MICAS

MMF	MMF	MMF	MMF	MMF	MFD	MFD
5	43	100	250	580	.0013	.0051
8.2	47	110	300	600	.00136	.006
10	50	120	330	620	.0015	.0062
15	51	125	350	680	.001625	.0065
20	56	130	370	750	.002	.0068
22	60	150	390	800	.0025	.007
24	62	160	400	820	.0026	.0075
25	68	175	430	910	.0027	.008
30	75	180	470	MFD	.003	.0082
35	82	200	500	.001	.0033	.009
39	85	220	510	.0011	.0047	.01
40	90	240	560	.0012	.005	

Price Schedule

5 MMF to .0011 MFD........................5¢
:0012 MFD to .002 MFD........................7¢
.0023 MFD to .009 MFD........................12¢
.01 MFD........................18¢

SILVER MICAS

MMF	MMF	MMF	MMF	MMF	MMF	MFD
10	50	120	270	466	800	.00282
18	51	125	300	470	815	.002826
20	60	130	325	488	820	.003
22	62	150	330	500	875	.0033
23	66	180	360	510	MFD	.0039
24	68	200	370	525	.001	.005
30	75	208	390	560	.001625	.0051
33	82	225	400	660	.0022	.0056
39	100	240	410	680	.0023	.006
40	110	250	430	700	.0024	.0068
45	115	260	450	750	.0027	.0082

Price Schedule

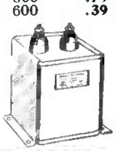
8 MMF to .001 MFD........................10¢
:0012 MFD to .0027 MFD........................20¢
.00282 MFD to .0082 MFD........................50¢

OIL FILLED

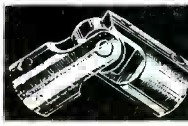
MFD	V. D. C.	Price
.25	20,000	$15.75
.03	16,000	1.95
.375 @	16,000 and	
.75 @	8,000	5.95
.1	7,500	1.55
.1-.1	7,000	1.55
.01	6,000	.95
:03-03	6,000	1.25
.02-.02	7,000	1.25
1	6,000	5.25
2	4,000	2.25
.25	3,000	1.10
.2	750 AC	.49
8	2,000	4.85
4	2,000	3.95

MFD	V. D. C.	Price
1	2,000	$.95
3	1,000	.80
2	1,000	.65
1	800	.39
4	600	.79
2	600	.39

2 mfd
4,000
V.D.C.
G.E.
SPECIAL
$2.25



UNIVERSAL JOINT



3/16" hole x 3/8" O.D.
11/8" long
Steel or Aluminum
50¢

JONES BARRIER STRIPS

Type	Price	Type	Price	Type	Price
2-140Y	$0.10	4-141¾W	.25	3-142	.17
3-140¾W	.15	5-141	.22	3-142Y	.23
4-140Y	.19	5-141¾W	.30	4-142¾	.30
6-140	.20	5-141Y	.30	5-142	.26
9-140¾W	.40	7-141	.29	5-142¾W	.37
10-140¾W	.44	7-141¾W	.41	10-142¾W	.71
11-140¾W	.48	7-141Y	.41	11-142Y	.78
12-140¾W	.53	8-141	.33	14-142	.68
13-140	.40	8-141¾W	.47	2-150	.31
14-140Y	.61	9-141¾W	.52	2-150¾W	.38
2-141	.10	9-141Y	.52	3-150	.44
3-141¾W	.19	10-141Y	.58	4-150	.57
3-141W	.19	15-141Y	.85		
4-141W	.25	17-141Y	.96		

METERS

Brand New—Guaranteed

0-1 Amp. RF, 2½"........................$3.29
0-300 V. D. C., 2½"........................3.50
0-500 Microamp, 2½"........................3.85
0-7.5 V. A. C., 3½"........................3.46

VERNIER DRUM (From BC-221)

0-50 in 180°. Black with silver marks..............85¢

VERNIER DIAL (From BC-221)

2 ⅝" Dia. 0-100 in 360°. Black with silver marks. Has thumblock ....85¢

3AG FUSES

AMP	Per 100	AMP	Per 100	AMP	Per 100
⅛	$4.00	1	$2.50	5	$2.50
¼	4.00	1½	2.50	10	3.00
½	4.00	2	2.50	15	3.00
¾	4.00	3	2.50	20	3.00

Fuse Holder—for 3AG Fuse. (Littlefuse or Buss)....25¢

4AG FUSES

AMP	PER 100	AMP	Per 100	AMP	Per 100
1/10	$4.00	2	$2.00	10	$2.50
1/4	3.50	3	2.00	15	2.50
1/2	3.50	3.2	2.00	20	2.50
1	2.00	5	2.00	25	2.50
				30	2.50

Fuse Holder—for 4AG Fuse. (Littlefuse or Buss)....18¢

Wrapped—BALL BEARINGS—New

Mfg	ID	OD	Width	Price
Fafnir 33K5	3/16"	1/2"	5/32"	$0.25
MRC 205A	63/64"	2 3/64"	19/32"	1.10
N.D. 5202C13M	1/2"	1 3/8"	1/8"	1.00
Fafnir 7308W	1 37/64"	3 9/16"	5/16"	2.00
SKF466430	6"	8"	1"	5.00
Fafnir 545	2 1/16"	2 5/8"	15/32"	1.00

NEEDLE BEARINGS

B108 1/2" wide	5/8"	13/16"	30¢
GB34X 1/4" wide	3/16"	11/32"	25¢

ALLEN SET SCREWS

4-40 x 1/8 8-32 x 1/8 8-32 x 5/16
4-40 x 3/16 8-32 x 3/8
ALL SIZES..............................$1.50 per 100

HAYDON TIMING MOTOR

4 R.P.M., 115 V., 60 Cycle.........$1.79

SOUND POWERED HANDSET

Brand New!
Includes 6 ft. cord. No batteries or external power source used.
$8.92 ea. — $17.60 pr.

CERAMICONS

2 MMF	30 MMF
5.6	35
10	39
12	45
15	62
20	82
22	150
	200

$6.50 per hundred

500 Volt Ceramic Condensers

MMF	MMF	MMF	MMF
2	18	62	150
3.44	22	68	180
4.7	27	82	200
8	30	91	220
12	33	100	270
13	40	110	330
15	47	115	1,000
16	56	140	

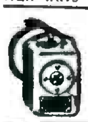
$5.00 per hundred

PRECISION CAPACITOR—W.E.

D-161270, 1 mfd @ 200 VDC: —40° to +65°C....$8.50

SELENIUM RECTIFIERS

Full wave—200 ma., 130 V in, 115 V out..........$1.57
Half wave—100 ma., 130 V in, 115 V out.......... .72



TIME DELAY RELAY

Raytheon CPX 24166 KS 10193-60 Sec. • 115 V., 60 Cycle • Adj. 50-70 Seconds • 2½ second recycling time—spring return • Micro-switch contact, 10A. • Holds ON as long as power is applied • Fully cased • ONLY $6.50

DELAY NETWORK—ALL 1400Ω

T 113—Approx. 1.2 micro sec. delay................85¢
T 114—Approx. 2.2 micro sec. delay................85¢
T 115 Similar to T 114 with tap brought out........85¢

Get On Our Mailing List!

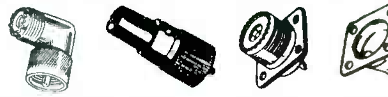
COAXIAL CABLES

GUARANTEED!! NEW!!

	Ohms	Price per 1,000 ft		Ohms	Price per 1,000 ft
RG-5/U	53.5	$70	RG-29/U*	53.5	$50
RG-6/U	76	150	RG-34/U	71	175
RG-7/U*	97.5	65	RG-35/U	71	450
RG-8/U*	52	65	RG-37/U	55	40
RG-9/U*	51	135	RG-39/U	72.5	180
RG-10/U	52	125	RG-41/U	67.5	550
RG-15/U	76	160	RG-54/U	58	65
RG-18/U	52	450	RG-54/AU	54	75
RG-21/U	53	100	RG-55/U	53.5	65
RG-22/U*	95	110	RG-57/U*	95	100
RG-24/U	125	240	RG-58/U*	53.5	55
RG-25/U	48	575	RG-74/U	52	250
RG-26/U	48	75	RG-77/U*	48	100
RG-27/U	48	290	RG-78/U	48	80
RG-28/U		160			

*No minimum order—others 250' minimum
Add 25% for orders less than 1,000 feet

COAXIAL CABLE CONNECTORS



Angle Adapter	Plug	Socket	Hood
15¢	40¢	40¢	9¢
M-359	PL-259A	SO-239	83-1H
83-1AP	83-1SPN	83-1R	

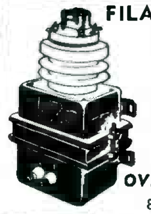
Adapter for PL-259 A for use on small coax.
12¢ each ....$10.00 per 100

83-1AC	$0.42	UG-21/U	.67	UG-85/U	.88
83-1J	.80	UG-22/U	.86	UG-87/U	.79
83-1RTY	.45	UG-23/U	.85	UG-102/U	.60
83-1SP	.40	UG-24/U	.67	UG-103/U	.48
83-1T	1.12	UG-25/U	.60	UG-104/U	.85
83-22AP	1.10	UG-27/U	.68	UG-167/U	2.00
83-22F	1.48	UG-29/U	.83	UG-171/U	1.33
83-22R	.48	UG-30/U	1.20	UG-175/U	.15
83-168	.15	UG-33/U	14.80	UG-176/U	.15
83-185	.15	UG-34/U	16.00	UG-197/U	1.33
UG-7/AP	2.14	UG-36/U	12.80	UG-206/U	.63
UG-12/U	.63	UG-37/U	12.80	UG-255/U	1.22
UG-13/U	.63	UG-58/U	.63	UG-264/U	1.74
UG-18/U	.63	UG-59/U	.60	UG-281/U	.60
UG-19/U	.73	UG-61/U	.60		

FILAMENT TRANSFORMER

Pri., 115 V., 60 Cyc.—Sec., 5V., 115 A. 6000 volt Insulation ....$9.95 each

FILAMENT TRANSFORMER



Amertran Type WS
For High Voltage Rectifiers. PRI. 115V., 60/60 Cycle.
SEC. 5V., C/T @ 10 Amp.
35 KV R.M.S. Test 12 KV D.C. Operating. Uses 872 Tube or other tubes.
NEW OVERSEAS PACKED $10.95
872-A Tube...... $1.88

PULSE TRANSFORMERS

X 124 T2, UTAH, marked 9262, 9340, small gray case. Ratio 1:1:1; hypersil core........................$2.75
D161310, 50 Kc to 4 Mc. 1¾" dia. x 1⅞" high. 120 to 2350 ohms........................$1.50
352-7178—Spec. 10, 111 Chicago Trans. equivalent to 9262 (above) $1.50
D-166638 W. E. Permalloy core, Semi-toridal windings $1.25
KS9800, Ratio, 1:1:1, 2:1, Freq. range 380 to 520 C.P.S. $3.50
D106173, W.E. Freq. resp. 10KC to 2 MC........ $9.80
800 KVA G.E. #2731, 28,000 Volt peak output: Bilifar; one microsecond pulse width............$28.50

PRECISION CONTROLS

6 WATT

20,000Ω	Muter	314A	$1.70
6,000	De jur	260	1.70
6,000	Muter	314A	1.70
5,000	Muter	314A	2.50
2,000	De jur	260	1.70

12 WATT

10,000	Muter	471A	$2.00
10,000Ω	De jur	271T	2.00
5,000	De jur	271T	2.00
100K	GR	471A	2.75

4 WATT

200Ω	GR	301	$1.25
500Ω	Centralab	48-501	1.00
50	De jur	292	1.00
20	De jur	292	1.00
12	GR	301	1.10
12	De jur	292	1.00
2	GR	301	1.25

2J1G1 SELSYNS

BRAND NEW
400 Cycle
Can be used on 24 V.D.C. or 110 V.A.C.
$1.65

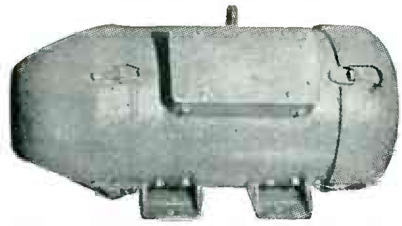
Minimum Orders $3........All orders f.o.b. PHILA, PA.

RELIANCE MERCHANDIZING CO.

Arch St. Cor. Croskey Phila. 3, Pa. Telephone RIttenhouse 6-4927

Exceptional Values From
AMERICA'S LARGEST ELECTRICAL CONVERSION HOUSE

ALLIS-CHALMERS MOTOR GENERATORS



Input: 115 VDC at 14 amp. 3600 RPM. Ball Bearings. Output: 1.25 KVA; 80% PF 120 Volts, AC. 1 Ph. 60 cyc. 10.4 amp. Centrifugal automatic controller permits line-start operation. Fully enclosed. **Brand New** $99.95. Also available for 230 VDC operation at the same price.

FLEXARC TRANSFORMER TYPE WELDER

Operates at 440/550, single phase, 60 cycles, 300 ampere adjustable output. Rebuilt like new.

SPECIAL PRICE $119.75

General Electric Type B Flange Motor for hoisting duty. 6¾ H. P. separately excited. Marine Duty. Brand New, original cases; 235 Volts, DC. 1100 RPM $65.00

GE Relays; 110 VAC—10 Amp. 60/60 cy. in steel case 5 x 5 x 6½ $3.90

Shaded Pole Motor with gear train on mounting bracket, 110 VAC $1.65

ONAN 800 CYCLE MG SETS; Operative at 110/220 VAC, 1 ϕ, 60 cyc. belted to alternator rated 1.5 KVA; 115 V, 1 ϕ, 800 Cy....$251.00

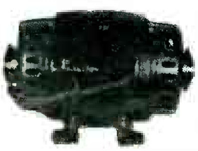
Above unit with 220/440-3-60 motor....$227.00

ONAN 500 CYCLE MG SETS; 4 KVA—Operative with 110-220 VAC, 1 ϕ, 60 Cy. Motor, rep-ind. Output single ph $450.00

With 3 Ph. 220/440 Motor.... ....$395.00

Westinghouse Transformer Controller contains 300 watts 120-220 volt transformer with multi-taps. The transformer with tap switch alone is worth more than the **special price**....$6.25

ELECTRIC SPECIALTY DC TO DC MG UNITS



Operate at 220 Volts, DC to deliver 110 Volts, 3.5 amperes. Two of these units can be used on 220 VDC to obtain 110-0-110 Volts DC. **Special Price**..$15.54

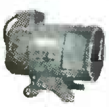
HOLTZER-CABOT 153F

Input: 28 Volts DC at 52 Amp. Output: 115 Volts, 400 cps. 3 phase, 750 va; .9 P. F. also secondary output of 26 Volts, 400 cycles, single phase at 250 va; voltage and frequency regulated. **REBUILT LIKE NEW.** $59.50

HOLTZER-CABOT MG149F

Input 28 Volts, DC at 36 amps. Output 26 Volts at 250 V. A. 400 cps. and 115 Volts at 500 V. A., 400 cycles. Rebuilt like new....$24.75

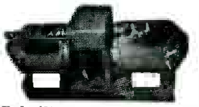
ESCO CONVERTERS



Rebuilt like new. Input: 86 VDC 2.85 amp. 3600 R.P.M. Output: 115 VAC, 2.18 amp. .50 P.F. Ball Bearings. Base for table or side mounting. Special $9.80

ESCO DC/AC MG SETS. Motor: 115 Volts, 1½ HP, line start; built in voltage regulator, frequency control, filtered; ideal for television, radar or any application requiring constant voltage and frequency. Brand New. $120.00

MARATHON MOTOR GENERATORS



Input: 110 VDC. Output: 110VAC 1 phase, 60 cy. 500 VA. Marine Type with voltage regulator and frequency controller.

Rebuilt $75.00

Same unit as above with 32 VDC Input and same Output. 300 V.A. $64.00

GEN. ELECTRIC AMPLIDYNES

Model 5AM78AB47; 750 watts; Input: 440-3-60; Output: 250 Volts, DC; 3 amperes; 3450 RPM....$185.00
Coupled directly to control motor on common base. Model 5BC76AB109; 60 volts, D-C. 12.5 amp. Special $255.00

Model 5AM78AB50A; 1500 watts input: 440-3-60; Output: 250 Volts, DC; 6 amperes; 3450 RPM....$225.00

Model 5AM78AB10; Input: 32 VDC, 60 amp. 2 H.P. 2200 RPM; Output: 250 Volts, D.C. 3 amperes; 750 watts. $165.00

Model 5AM45DB20; Input: 115 Volts, single phase, 60 cyc. 5 Amps. Output: 250 Volts, D. C. .6 amp. 150 watts. 3450 RPM....$58.50

Model 5AM49AB30; Input: 440 Volts, 3 phase, 60 cyc. 1 amp. output: 115 Volts, D. C. 3.25 amp. 3450 RPM $78.50

Model 5AM49AB3; Input: 440 Volts, 3 ph. 60 cyc. 1 amp. Output: 250 Volts, D. C. 1.5 amp. 375 watts. $88.00

Model 5AM73AB58; Input: 110/220 volts, single phase, 60 cyc. Output: 250 Volts, D. C. 1.5 amp. 375 watts. 3450 RPM $78.00

Model 5LY132A4; Input: 440 Volts, 3 ph. 60 cyc. 3.5 H.P. 7 amps. 3570 RPM; Output: 105 Volts, D. C. 18 amp. 1.9 K. W....$225.00

Model 5AM610A10 Amplidyne Generator. 3 K.W. 125 Volts, DC 24 amp. 1765 RPM. BB, DP....$160.00

General Electric Synchronous Motor or Alternator; excitation 2 Volts; operating at or delivering 110 volts, 3 phase, 60 cycles at 1800 speed; no name plate, but lab tests determined specs as above $9.50

General Electric Type B Flange Motor for hoisting duty. 6¾ H. P. separately excited. Marine Duty. Brand New, original cases; 235 Volts, DC. 1100 RPM..$65.00

HERE IS EXCEPTIONAL VALUE

Robbins and Myers Motor Generator Units. Operate at 110 Volts, AC, single phase, 60 cyc. and deliver 32/40 Volts, DC. Can be used with field rheostat to supply 24/28 VDC for the operation of aero equipment from lighting line. Rated at 40 watts but will deliver 200 watts for intermittent operation. Gear head built into one end rotates external shaft at 225 RPM. An exceptional value at $18.75 each. With field rheostat $20.00. Also available for operation at 115 VDC at $12.50 and with rheostat at $13.75 each. Both units have 1/4 HP Motor. Stock up on these sets while they are available. Special price on quantity. Rebuilt.

TAPE WINDERS

These tape winders consist of a motor operative at 110 volts D. C., .6 amperes; 180 speed. A motor which is separable from the rest of the unit and which can be employed for a multitude of purposes, alone or with the gear reduction box to which it is connected. Motor is shunt wound and the speed thereof is controlled by a built-in rheostat. This makes an invaluable laboratory unit. Special Price....$10.99

Electric Specialty High Frequency Converter Units. Primary: 32 VDC, 16 amperes, 3000 R.P.M. Ball Bearings. Secondary: 350 volts, 1500 cycles, .75 amps. 275 V.A. Single Ph. Built-in frequency control. Specially Priced at $30.00

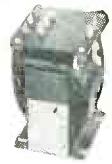
ELECTRIC SPECIALTY FREQUENCY CHANGERS Type BFS52/BFRS354 Input: 220 Volts, 3 Ph. 60 cyc. 3600 RPM. Output: 250 Volts, 20 amp. single ph. 180 Cyc. 5000 VA. 3000 Watts. Brand New. Compact ball bearing units for operation of Hi-cycle equipment. SPECIAL PRICE $160.00

GENERAL ELECTRIC HIGH FREQUENCY UNIT. Operative at 440-3-60 .75 amp. Output: 70 Volts, 3 ph. 148 cyc. 220 Watts, 1.8 amperes. An ideal unit for experimental work or for operation of equipment. SPECIAL PRICE $34.50

GENERAL ELECTRIC DC/AC MG SETS

Four Bearing Marine Units: 25 HP 230 Volts, DC coupled to alternator 18.75 KVA; 80% PF; 1800 RPM Ball Bearings. 4 bearing set; marine duty. Brand New $545.00

WESTINGHOUSE TRANSFORMERS



399 VA: 115/240 Volts; Brand New.

SPECIAL PRICE $3.35

GEN. ELECTRIC TRANSFORMERS

1 KVA: 460/230-230/115. Brand New. $19.60

Used, guaranteed, do....$12.50

5KVA, Auto transformer 110/220. Brand New $26.00

JANETTE ROTARY CONVERTERS

110 VA. Input: 110 VDC; Output: 110 VAC, single phase, 60 cycles; 3600 speed. With filter for elimination of radio interference. Reliably Rebuilt. Special Price $19.95

PINCOR ROTARY CONVERTERS

300 VA; Filtered; Brand New. Input: 115 VDC, 4.2 Amp. Output: 220 VAC, 1.36 Amp.
SPECIAL PRICE $38.00

KATO ROTARY CONVERTERS

Type 1205A Model 26KA54 Input: 24 VDC, 28A. 1800 RPM. Output: 115 VAC 1 phase 60 cy. 1 KVA. Compact and ruggedly built for cont. duty oper. Filtered. Shock mounted. New $90.00

ONAN HIGH FREQUENCY MG UNITS

ONAN 400 CYCLE MG SETS; 4 KVA—Operative with 110/220 VAC, 1 ϕ, 60 Cy. Motor rep-ind. Output single ph $540.00
With 3 Ph. 220/440 Motor....$455.00

500 CYCLE M-G SETS

British made motor generator, 8 KW, 2 bearing unit, input 180-240 VDC, output 180 volts, 1 ϕ weight app. 1000 lbs. price....$425.00

RAYTHEON HIGH VOLTAGE TRANSFORMERS: Pri: 214/246 Volts; Sec: 5500 Volts, 1.0 amperes; test 13,500 V. Brand New....$72.00

INDUCTION VOLTAGE REGULATOR

Type IRT, form M, 1.64 KVA, 3 phase, 60 cycles, cont. duty. Outdoor service. Primary: 208 V., 10.5 load amps. Oil-filled. Wgt. 365 lbs. 33 x 17" x 14"....$83.00

G. E. MOTOR CONTROLLED VOLTAGE REGULATOR

Cat. #837625, Type 'Tirs', Form — .568 KVA. cont. duty, 60 cy., Primary volts 115, Load Amps 16.2. Indoor service. Voltage controlled by mtr. 120/1/60.1/40 HP 39.50

IF IT'S FROM ONE FREQUENCY TO ANOTHER; FROM DC TO AC OR AC TO DC; IF IT'S FROM ONE VOLTAGE TO ANOTHER, THEN CALL ON US.

Established in 1922 **WILLIAM I. HORLICK COMPANY** *Tel HAncock 6-2480*

409 ATLANTIC AVE. BOSTON, 10, MASSACHUSETTS

GENERAL ELECTRIC TUBE SPECIALS

Brand New Mfd. by G.E.

12GP7	12.85	FG-95	20.60	GL-415/	
1P24	.79	FG-105	10.95	5550	22.00
FG-32	4.25	FG-172	19.50	8020	1.39
FG-33	11.95	FG-190	12.15	189048	3.79
FG-81A	4.95	2C39	21.50	189049	3.79

GENERATORS

- Eclipse-Pioneer type 716-3A (Navy Model NEA-3A) Output—AC 115V 10.4A 800 to 1400 cy 1 ϕ; DC 30 Volts 60 Amps. Brand New — Original Packing $38.50
- Eclipse-Pioneer type 1235-1A. Output—30 Volts DC 15 Amps. Brand New—Original Packing....$9.50

PIONEER SERVO SYSTEM UNITS

- Type 12073-1A Torque Amplifier, Input 115 V 400 cy. Complete with Tubes................$14.95
- Magnetic Amplifier Assy. Saturable Reactor Type to supply one phase of 400 cycle Servo Motor $5.95

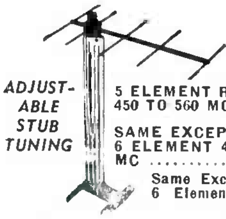
COAXIAL CABLE

REG-8/U—$65.00 per 1000 ft.—Other types in stock

SPRAGUE PULSE NETWORKS

7.5 E3-1-200-67P, 7.5 KV, "E" Circuit 1 microsec. 200 PPS, 67 ohms imped. 3 sections........$4.30
7.5 E3-3-200-67P, 7.5 KV. "E" Circuit 3 microsec. 200 PPS, 67 ohms imped. 3 sections........$6.75
7.5 E4-16-67P, 7.5 KV, "E" Circuit 4 sections, 16 microsec. 60 PPS, 67 ohms imped........$8.25
15—E4-1.5-600-50P, 15 KV "E" Circuit 1.5 microsec. 600 PPS, 50 ohms imped. 4 sections..$12.00
15—E6-5-180-50P, 15 KV. "E" Circuit 5 microsec. 180 PPS, 50 ohms imped. 6 sections......$25.00

ASB YAGI ANTENNA



ADJUSTABLE STUB TUNING

5 ELEMENT ROTATABLE ARRAY—450 TO 560 MC **$7.00**

SAME EXCEPT DOUBLE STACKED 6 ELEMENT 450 TO 560 MC **$12.70**

Same Except Double Stacked 6 Element 370 to 430 MC **$29.40**

Double stacked antennas can be supplied with hydraulic remote controls at $29.50 per set additional.

SELENIUM RECTIFIER STACKS

FULL WAVE BRIDGE

MAXIMUM RATINGS AC VOLTS INPUT - 18 DC VOLTS OUT - 14.5		MAXIMUM RATINGS AC VOLTS INPUT - 40 DC VOLTS OUT - - 34	
1.2 Amps	$2.64	0.6 Amps	$3.00
2.4	3.07	1.2	3.44
6.4	4.09	3.2	5.15
13.0	7.67	6.0	9.32
17.5	8.69	9.0	10.05
26	15.33	12	18.64
39	23.00	18	20.12
52	30.67	24	35.96
65	38.33	36	41.24

All voltage and current ratings based on continuous operation in 35°C. (95°F.) ambient, self-cooled. Current ratings can be increased up to 2½ times normal ratings by intermittent operation or forced cooling.

PULSE TRANSFORMERS

UTAH 9262..............................$2.75
UTAH 9278..............................$2.75
G. E. 68G-627..........................$4.75
AN/APN-9 (901756-501)..................$1.50
AN/APN-9 (901756-502)..................$1.50
AN/APN-4 Block, Osc....................$1.25

W. E. MERCURY CONTACT RELAYS

Glass sealed mercury wetted SPDT contact assemblies. Magnetically operated. Used in Western Electric D-168479 high speed plug in relays. Supply your own coil ....$2.00 each

CONSTANT VOLTAGE TRANSFORMERS

Federal Constant Voltage Transformer Input 95-135V 50/60cy Output 115V 210W................$34.00
Sola Constant Voltage Transformer Input 95-125V 60cy-Output 15.8V 285VA.................$24.70
Sola Constant Voltage Transformer Input 105-125V 60cy-Output 115V 80VA....................$15.95

TYPE "J" POTENTIOMETERS

75¢ each

Resis.	Shaft	Resis.	Shaft	Resis.	Shaft
100	SS	10K	SS	100K	5/16"
200	SS	15K	½"	100K	⅝"
500	½"	15K	SS	100K	7/16"
650	½"	20K	SS	100K	SS"
5000	⅜"	25K	1½"	150K	½"
6500	SS	25K	SS	200K	SS
10K	⅜"	30K	1⅛"	250K	SS
10K	½"	50K	SS	1 MEG	SS

Triple 100K - ⅛" Shaft - 1.47
All shaft lengths beyond bushing - SS (screw slot)

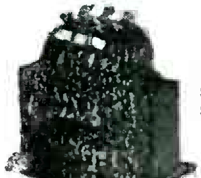
STANDARD BRANDS ONLY

TUBE SPECIALS

BRAND NEW FIRST QUALITY

COMPLETE STOCK OF RECEIVING, TRANSMITTING, CATHODE RAY, THYRATRON, IGNITRON, MAGNETRON, KLYSTRON, PHOTOCELL, T-R & ATR TUBES.
QUOTATIONS UPON REQUEST

WESTINGHOUSE HYPERSIL TRANSFORMER



PRI-115V. 60CY ¾ KVA
SEC #1 - 240V - 1.56A
SEC #2 - 240V - 1.56A

WT. 30 LBS.

$11.50 EACH

KOLLSMAN INSTRUMENT

LOW INERTIA SERVO MOTORS

Type 937-0240—85/68 Volts—100 Cycles 2 Phase—5 Watts—2650 RPM
Will Operate Satisfactorily at 60 Cycles
Original Price $34.50—Our Price—$8.22 ea.

$7.50 EACH—Lots of 10

SOUND POWERED TELEPHONES

- U. S. INSTRUMENT Type A-260
- WESTERN ELECTRIC Type D-173013
- AUTOMATIC ELECTRIC Type GL-832BAO

U. S. NAVY TYPE M HEAD AND CHEST SETS

These are high quality heavy-duty units not to be confused with cheaper units now available. Designed to withstand exacting shock, vibration, salt water corrosion, temperature and pressure tests. ANY TYPE ....$14.88 ea., $28.00 per pair.
TS-10 HANDSETS ....$8.92 each

MISCELLANEOUS EQUIPMENT

ID-6APN-4 Indicator	$29.50
R-7/APS-2 Receiver	49.50
R-78/APS-15 Receiver	49.50
SCR-522 Transceiver	32.50
RT-7/APN-1 Transceiver	8.95
FL-8 1020 cycle filter	1.37
RM-29 remote control unit	8.95
RM-14 remote control unit	8.95
RTA-1B 12/24 V dynamotor	30.00
BC-1206-CM2 Receiver	7.95
AIA Antenna—3cm conical scan	120.00
AT-38A/APT antenna (70-400 MC)	13.70
AT-49/APR-4 antenna (300-3300 MC)	13.70
CY-230/MPG-1 Radar Console	575.00
G.E. Type JP-1 portable current transformer	32.50
AT-8/AP Antenna	3.95
ASB-4 Radar equip. Complete	69.75
DZ-2 loop antenna with pedestal	14.50

MONTHLY BULLETINS

SEND IN YOUR NAME AND ADDRESS TO GET ON OUR MAILING LIST

All material brand new and fully guaranteed. Terms 20% cash with order, balance C. O. D. unless rated. All prices F.O.B. our warehouse, Phila., Penna., subject to change without notice.

COAXIAL CONNECTORS

83-1AC	.42	UG-12/U	.63	UG-86/U	1.22
83-1AP	.15	UG-21/U	.67	UG-87/U	.79
83-1F	1.12	UG-22/U	.86	UG-171/U	1.33
83-1H	.10	UG-23/U	.85	UG-175/U	.15
83-1J	.80	UG-24/U	.67	UG-176/U	.15
83-1R	.40	UG-27/U	.68	UG-180A/U	3.82
83-1SP	.40	UG-29/U	.83	UG-191/AP	.63
83-1SPN	.40	UG-30/U	1.20	MX-195/U	.41
83-1T	1.12	UG-34/U	12.80	UG-197/U	1.33
83-22AP	1.10	UG-36/U	12.80	UG-206/U	.63
83-22F	1.48	UG-37/U	12.80	UG-255/U	1.22
83-22R	.48	UG-58/U	.63	UG-264/U	1.74
83-22SP	.85	UG-85/U	.88	UG-290/U	.85

FULL LINE OF JAN APPROVED COAXIAL CONNECTORS IN STOCK

COMPONENT SPECIALS

FUSES	4AG	10 Amp.	$3.00/c
	4AG	20 Amp.	$3.00/c

MOLDED PAPER CONDENSERS—

.02 MFD	200 VDC	.04½ Ea.	$3.00 per 100
.05	200	.04½	3.00
.1	200	.04½	3.00
.25	200	.06	4.00
.1	400	.09	6.00
.005	600	.04½	3.00
.01	600	.07	4.75
.05	600	.08	5.50

CRYSTAL DIODES—

1N21	.79	1N22	.89	1N34	.69
1N21A	1.19	1N23	1.19	1N45	.94
1N21B	2.25	1N27	1.09	1N63	1.39

Phase shift capacitor—Type D—150734—4 stator single rotor $2.69

HIGH VOLTAGE MICA CAPACITORS—

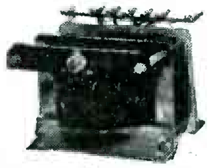
Type G-1	.004 mfd	6 KV	$6 .3
Type G-3	.00015 mfd	20 KV	12.75
Type UC-3260	.0005 mfd	20 KV	6.90
Type UC-2317K	.0035 mfd	4 KV	3.10
Type UC-2938K	.002 mfd	5 KV	3.15
Type UC-3135A	.00005 mfd	35 KV	11.95

OIL-FILLED CAPACITORS

50 MFD	220 VAC	$3.95
60 MFD	330 VAC	$5.75
32 MFD	2500 VDC	$12.80
7 MFD	660 VAC	$2.95
3.5-.5 MFD	1000 VDC	.95
.1 MFD	7000 VDC	$1.79
.045 MFD	16 KVDC	$4.70

SPECIAL
2 MFD 12,500 VDC
INERTEEN TYPE FP
$23.95

RCA HI-VOLTAGE TRANSFORMER



Pri—115/230V. 60Cy
Sec—6000V—80 MA

$11.80

Insulated for Voltage Doubler Use

TEST EQUIPMENT

- Alfred W. Barber Labs. Mod. VM-25 VTVM * $86.00
- General Radio Model P-500A Standard Signal Generator (Same as G. R. 805A except covers 9KC to 32 MC) ....* $450.00
- TS-10A/APN Delay Line Test Set.........$25.00
- TS-19/APQ-5 Calibrator $75.0
- AT-48/UP "X" Band Horn...................$3.95
- REL W-1158 Frequency Meter 160-220 MC..$32.95
- CWI-60AAG Range Calibrator for ASB, ASE, ASV and ASVC Radars $39.95
- CRV-14AAS Phantom Antenna for Transmitters up to 400 MC...............................$11.75
- TS-146/AP X-Band Test Set. Price on request.
- TS-184/AP. ....Price on request.
- CPR-60AAJ and CPR-60AAK—IFF Test Sets. (pair) $16.95

AN/APA-23 Recorder $147.50
TN-18/APR-1 Tuning Unit.......................$95.00
- C-D Quietone Filter Type IF-16 110/220 V AC/DC 20 Amps ....* $9.00

All Items New Except Where Noted * (Exc. Used Condition)

FILAMENT TRANSFORMERS

(All 115V 60cy primary except where noted)

UTC herm. sealed 5V @ 1A..............1.22
UTC herm. sealed 6.3V @ 0.6A 1.33
UTC herm. sealed 6.3V @ 3.2A..........2.21
Raythoen herm. sealed 6.3VAC @ 0.6A 1.35
Raytheon herm. sealed 6.3VCT @ 3A, 6.3V @ 0.5A 2.31
G.E.—6.3V @ 13A, 6.3V @ 1.2A 3.82
Pri. 115/230V—Sec. 11V @ 15A-25KV insul. 48.00
Pri. 115/230V—Sec. 9VCT @ 35A..............7.65
Amertran—5V @ 190A—35KV insul. 19.50
6.3VCT @ 5A, 6.3VCT @ 2A, 6.3VCT @ 2A, 2½VCT @ 5A, 2½VCT @ 5A..............4.77

GENERAL ELECTRIC AMPLIDYNE Motor-Generator

Consists of G.E. 1HP 115V 1 ph 60 cy 11.5A 8450 RPM continuous duty motor coupled to G.E. model 5AM65FB31 250V DC 2A 0.5KW 3450 RPM Amplidyne generator.

Brand New $107.50

LECTRONIC RESEARCH LABORATORIES

1021-A CALLOWHILL ST. PHILA. 23, PA

Telephones - MARKET 7-6590 and 6591

THE BEST IN ELECTRONIC SURPLUS

BC-610 Transmitters with BC-614 Speech Amplifier. 4 Plug-in Coils and Exciter Units for 10, 20, 40, and 80 meter operation. Output 400 watts A1, 300 watts A3. Operates from 110/1/50-60 cycles AC. Used in SCR-299,399,499 eqpt. Spares available at extra cost. Condition Excellent to like new. Export Packed. **PRICE, EACH** $900.00

SF-1 Radar Eqpts. 10 Centimeter, Brand NEW with complete spares to insure over 10 years of continuous operation. Includes motor-generator set in each, all wave-guide plumbing, instruction books, etc. 19 cases per set, export packing. **PRICE, EACH** $2,500.00

TCS. Collins Ship Transmitter-Receivers, for 12 V. DC operation, radio telephone and radiotelegraph at 20 & 40 watts, 1.5 to 12.0 mc. Complete with all accessories. Excellent, like new condition. **EACH** $300.00

Beachmaster, 250 watt Portable Sound Amplifier Systems, with nine speaker rack, tubes, mike, cables, and spares. Operation from 110 volts, one phase, 60 cycles AC. Excellent and New condition units, **PRICE, EACH** $495.00
PRICE, less case of spares $395.00

Western Electric Model HLAS, 500 watt Sound Amplifier Systems, consisting of 40 watt Pre-Amplifier; 500 watt Power Amplifier with built-in power supply, expander-compressor circuit, internal blower-ventilation, 30 kc erasing oscillator circuit for magnetic tape recording, volume and meter controls; two speaker racks, each with 6-60 watt dynamic horn units. Operation from 115/3/60 AC. New, Unused. Complete with tubes, cables, connectors and instruction manual. **EACH** $695.00

RMCA, Model 8010 I.F. Ship Main Radio Transmitter, 325 to 500 KC. types CA & E. Excellent condition. Less motor generators. **PRICE, EACH** $475.00

RMCA, Model 8019A/H.F. Ship Transmitter, complement to 8010 above, for H.F. transmission A1 and A2, 200 watts output. Excellent Condition, less tubes and MG (mg with 8010 powers this unit.) **PRICE, EACH** $400.00

RMCA, 8003 Emergency Transmitter, 500 KC. 50 watts output with 12/115 V. DC. motor generator set, and battery charging unit. Excellent Condition. Complete with tubes. **PRICE, EACH** $275.00

RMCA, 8007 Lifeboat Transmitter-Receiver, 500 KC, for permanent installation. Complete with installed 12 V. Dynamotor. Excellent Condition. **PRICE, EACH** $100.00

RMCA, 8600X Auto Alarm Receivers, 500 KC Automatic SOS (4-second dash actuated) Alarm Unit. Complete with Relay Control Box and warning light. For 110 V. DC operation. Excellent Condition, with tubes. **PRICE, EACH** $250.00

RMCA, 8506B Ship. Receiver, 85 to 570 KC and 2 to 23 mc., low radiation superheterodyne. With tubes. Excellent Condition. **PRICE, EACH** $200.00

RMCA, 8707 Direction Finder. (Int. Freq.) consists of receiver, loop, shaft, rotating wheel. Excellent Condition except shaft housing not available (can be easily improvised). With tubes. **PRICE**....$750.00

Mackay, Model 150-AY, I.F. Ship Transmitter. 325 to 500 KC, A1 and A2 emission. Excellent Condition. **PRICE** with MG, 115 V. DC. **EACH**..$350.00
PRICE without MG. **EACH** $275.00

RC-163 Radio Beacon Eqpt. 20-40 MC. Converts SCR-508/528/608/628 to directional transmitters and receivers. Ideal for airports for homing application. NEW and complete eqpt. Export packed. **EACH** $90.00

SCR-511 "Pogo Stick" Walky-Talky. Portable low-power AM radiotelephone for 2 to 6 mc operation, with 12 plug-in tuning coils containing crystals for crystal control of both receiver and transmitter. Transmitter-Receiver BC-745 of this SCR-511 includes telescopic antenna and "Press-Talk" Switch as well as all cables. Range 5 miles, plus. With PE-157 Vibrator Power Supply 2-volt battery (less electrolyte). P-17 mike, ready for immediate operation. **PRICE, EACH** $75.00

32 Volt DC to AC Rotary Converter, mfd. by Kato. For yachts, workboats, or farm installation. Output 110 V., 60 cycles AC, rated 225 watt but good to 300 watts. All NEW Units. **PRICE, EACH** $39.95

Deck Entrance Insulators, bowl and flood type. 8⅞" dia. with heavy galvanized metal flange and bell. Top bell 6¼" dia. x 11"; brass feed thru rod. Very high voltage insulation. Individually packed in cartons, all NEW. **12 FOR** $18.00

General Electric Amplidyne M. G. Set, generator type #V-5875677, motor type #73AB58, Navy #CG-21ABU, 115/230 V., 60 cycles, motor rated at ¾ HP., generator output 250 V. DC at 375 watts. NEW. **PRICE, EACH** $60.00

SD-5 Radar Transmitters, only; 200 cm. Contains variable co-ax for tuning hi-power to frequency, numerous transformers (except plate), meters, variac, capacitors, etc., in fact complete transmitter but less tubes & plate transformer. Excellent Condition. **Price, Each** $115.00

YJ-1 I.F.F. Eqpt. Consists of dual transmitters and dual receivers, each working in "A" and "B" bands, 176 and 515 mcs respectively. Includes power supply (115-230 volts, 60 cycles AC) and tubes, all in one metal cased unit. UNUSED eqpt. **Price, Each** $165.00

T-9/APQ-2 Radio Transmitters. Noise-modulated Jamming Transmitter, using Electron-Multiplier Photocell. For Jamming certain types radar eqpt. New unused transmitters only, with Electron-Multiplier tube, less other tubes. **EACH** $32.50

SB-23/GTA-2 & SB-14/GY Switchboards & Power Supply, for operation from 110V. 60 cycles AC (with storage batteries). Each in individual metal cabinet. NEW. **Price, Each Set** $300.00

BC-319-A Transmitter, CW only 300 watts output. Freq. range 4.0 to 13.4 mc. Operates from 110/220 volts, 60 cycles AC. Excellent condition. Less tubes. **PRICE, EACH** $300.00

Wilcox, 96-200-A 2-KW RF section. Large cabinet with complete RF end containing the VFO, intermediate sections and PA stage. Almost new, but lacks PA inductance only. Less tubes. **PRICE**.$300.00

Wilcox 96C 3 KW RF Units, 2.0 to 20.0 mc, crystal controlled. Four of these units with Rectifier 36A and Modulator 50A make a complete 4-channel Point-to-Point and Radioteletype fixed station. Good Condition, less tubes. **LOT PRICE, EACH**..$400.00

TBK-10, 500 watt, 2-18.1 MC, CW Telegraph Transmitter designed for ship installation. Almost new condition, complete with tubes, less MG set and accessories. **PRICE, EACH** $350.00

Wilcox 98-A. Ground Station, A-3 emission 50 to 200 mc. 50 W. output, 4-channels dial telephone selection, with receiver for above frequency coverage, and remote control unit. For 110 volts AC. Excellent condition. With tubes. **PRICE, EACH**...$600.00

Link FM Transmitter-Receiver, 70-100 mc, 50 watts output. Model 1498 DC. Wall style cabinet containing transmitter, receiver and 14 V.D.C. power supply, handset. Dim.: 34" x 21" x 11". NEW Condition. Complete with tubes, crystals, special telescopic antenna, instruction book. **PRICE, EACH** $500.00

"SNOOPERSCOPE" TUBE

Infra-Red Image Converter Tube (British) to make "Snooperscopes," "Sniperscopes," and other devices that see in the dark. Has many useful industrial applications. Operates with invisible infra-red rays, without scanning or amplifiers. Supplied with technical data and diagrams. Every tube **guaranteed! WE WILL NOT BE UNDERSOLD.**
EACH $4.95
6 for $25.00

BAUSCH & LOMB Front-End Lens Assembly, for best images. F2.1, 3.5 in. E.F. **EACH**..........$10.00

MOUNTED LENS UNIT, also for front-end, results as good as B & L unit. Speed F1.9 f. 1, 91.44 mm. outside dia. at one end 60 mm, length of mount 64 mm. **PRICE, EACH** $7.00

580-765 MC SUPERHET RECEIVER, WITH WAVEMETER

Easily modified for Citizen's Band reception, or for experimental use on VHF Television. Uses a 955 Autodyne detector-oscillator into 3-stage resistance-coupled IF amplifier. Output is for headphones. Includes VR-150 voltage regulator tube, 6E5 tunning-eye, and 5Y3 rectifier. For 110 volts, 50/60 cycles AC. Calibrated Wavemeter mounted as separate portion, with variable tuning rod and hand-plotted calibration curve for each, permits checking frequency of incoming signal. NEW unused surplus. With instruction sheets and diagram, plus calibration curve, and tubes. **PRICE, EACH** $75.00

RADAR TRAINING SET—MARK V

For Student, Schools, Labs, or actual radar application. Operates in the 580 to 765 mc region, designed especially to illustrate how radar eqpt. functions, and permits making numerous experiments to put over radar fundamentals. Uses above described receiver; separate transmitter using 8025 triode with 1.5 watts at antenna, with 400 KC internal modulator using two 811 tubes; External modulator, generating audio frequencies of 16,000, 4,000, and 1,000 cycles, and RF at 750, 350, and 175 KC, with selection switch for modulation frequency and wave form control, using 3 tubes, 807, 6N7, and 6J5; set of Antenna Dipole rods. Supplies with full instruction sheets, diagrams, calibration curves, tubes, NEW unused surplus. **PRICE, Per Set** $175.00

Technical Manual (Complete Instruction Book) for the BC-312 & BC-342 Receiver. PRICE, Postpaid. **$1.50**

20-40 MC FIELD STRENGTH AND WAVEMETER

Uses a 0-100 Micro-ammeter with a 1S4 Pentode, to receive signals in the 20-40 mc range. 1.5 volts battery required. Tuning dial has dial lock, for fixing position, and telescopic Antenna permits adjusting for strong or weak signals. Calibration must be self-performed. With instruction sheet and diagram NEW, unused eqpt. Dim: 6½"x4¼"x5½". **PRICE, Each** $14.95

PE-95G & H, 10-12 KVA Gas Engine Generators, 110/220 V. AC, 1-phase, 60 cycles output. NEW, in original export packing, with spare parts and tools. Shpg. wt. 2128 lbs.; cu. ft. 70. **PRICE, EACH.** $1,450.00

HOMELIGHT 1.5 KW GAS-Engine Generators, 110 V., 60 cycles, 1-phase AC. Almost New, all units thoroughly tested and guaranteed. **PRICE, EACH.** $235.00

AN/CRT-1A Sonobuoy Transmitters, for mine and submarine detection. With parachute, tubes, etc., ready for operation (except standard types dry batteries). Operates at 67.7 mc. Excellent to New condition. **PRICE, EACH** $35 00

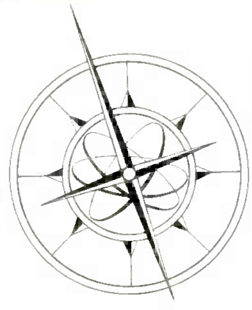
T-17, T-18, T-19 TUNING UNITS, for APR-4. NEW. **EACH** $95.00

Prices quoted are net, FOB N.Y.C. our warehouse. Export packing extra, except where included in specifications. All material is guaranteed as represented, and offered Subject to prior sale.

TELEMARINE COMMUNICATIONS COMPANY

CABLE ADDRESS:
TELEMARINE, N. Y.

540 W. 27th St., N. Y. 1, N. Y.



ALL MERCHANDISE GUARANTEED

Prices fob our whse, N. Y. C.

Immediate Delivery subject to prior sale or disposition

PHONE and CW TRANSMITTERS

100 Watt W. E. radiotelephone w/selective ringer ship or shore, 10-channel, 110 ac oper'n.
25 Watt RCA RT, 32 vdc, 4-channel.
MANY NAVY MODELS, including TDE, TCS, TBK, TBM, TAJ, etc. to choose from. Write for info.

FOR FOREIGN GOVERNMENT, PRIVATE YACHT, or SHORE STATION WESTERN ELECTRIC RADIO 400-800 Watts

Operates from 110-220 volts AC
Freq. Range: 2.0-18.1 mcs
New and complete with spares
This is the same transmitter used on famous SS. "QUEEN MARY"!

SONAR— 30 complete, new model **NAA,** "Herald" underwater anti-submarine units. See "Electr. Eng.," for Feb. 1949 for description.
QBG—12 volt, portable, new....................$300.
Also, **WEA, QBE, QCO,** et. al.

RADAR— SN—10 cm. portable, easily set up. Has 2, 5 & 25 mile ranges; 5-in. A-scope. Complete w/full spares....................$685.
SQ—10 cm, PPI ....Write
Submarine—SJ and SD....................Write
Navigation Beacons—Navy Models **CXEH** and **CPN-8,** for 115-230 VAC.
Airborne APS3 and APS-4: also new **ASB** 515 mcs, complete w/ant. & hydraulic controls. Only..$285.
— Many other types in stock —

TEST EQUIPMENT

3 cm., multipurpose, portable, field and bench test set, model **TS-263A/TPS-10.** Brand new $575.

THIS MONTH'S SPECIALS* IN:

TUBES

1H4G	$ .75	464	$8.50
1H6G	.75	829	4.90
1J6G	.75	829A	7.50
6AC7	2.25	860	12.50
6SN7GT	2.25	861	32.50
6V6		872A	1.95
6SL7GT		715B	6.75
446B	1.75		

MAGNETRONS, KLYSTRONS

2J26	$ 6.50	700 A-C	$18.50
2J27	11.09	706 D-GY	49.00
2J61	24.00	707A	12.00
2K25	24.00	728 AY	20.00
4J31	95.00	728 GY	24.00
4J33	110.00	D161145 (W.E.)	150.60

INSULATORS

12-inch standoff with brass or bronze cap and 2-hole base $1.00

We have more than ½-million in stock stand-off, strain, feed-thru—in porcelain, ceramic, pyrex, etc.

WRITE US YOUR INSULATOR NEEDS

CAPACITORS (oil-filled)

.01 mfd 500 vdc	$1.00	10 mfd 600vdc	$1.00
.1 mfd 6000 vdc	2.50	2 mfd 1000vdc	1.25
1.25 mfd 330 vdc	.75	15 mfd 600vdc	3.00
2 mfd 600 vdc	.60	1 mfd 10 kv dc	14.00
4 mfd 600	.85	.25 mfd 20 kv dc	25.00

DYNAMOTORS (first number is dc volts input)

A. 28 @ 1.25 a to 250 @ 60 ma....................$ 3.00
B. 28 @ 7 a to 540 @ 250 ma.................... 5.00
C. 13/26 @ 12/6 a to 400/800.................... 6.50
D. 14 @ 46 a to 515/1030 and 2/8, 50 ma up.. 9.50
E. 28 @ 10 a to 300/150/14.5, 10 ma up.....10.00
F. 32 @ 13 a to 430/6.3 @ 350/8.0..........35.00
G. 13 @ 13 a to 250/300 @ 60/225 ma.......15.00

AND MANY OTHERS

COAX CONNECTORS

83 1SP	$ .35	UG 87 U (Gold pl w/hood)	1.25
83-1AP	.17	UG 65 U	6.50
83-R	.35	UG 56 U	4.75
83-1H	.08		
UG 58 U	.60		

METER MULTIPLIER

High precision resistor, 20 megohms at 20,000 volts with accuracy of ½ of 1%. Mfrs. Weston, Sprague. Only $24.25

*New only. Some quantities limited.

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COMMUNICATIONS CO.

393 Greenwich Street, New York 13, N. Y.
Cable: Compradio, New York
Phone: BEekman 3-6510

"TAB" THAT'S A BUY

PRECISION RESISTORS—

Over 2½ Million in Stock

"TAB"—Specialists in Precision Resistors
No Mfrs. Choice—We Ship Types In Stock

0.116	209.4	700	1919	6140	23400	147000
0.42	216	711	1922	6200	23500	150000
0.425	220	733	1924	6300	24000	155000
0.607	220.4	740	1926	6495	24600	160000
0.7	225	750	1960	6500	25000	165000
1.03	230	800	1980	6840	25200	166750
1.3	235	806	2000	6990	25400	167000
1.75	240	850	2045	7000	25833	169200
2.5	245	854	2080	7320	26000	175000
3	245.4	899	2095	7500	26500	180000
3.83	250	900	2141	7700	26600	180600
4.35	260	910	2142	7717	27000	185000
5	271	917	2145	7900	27500	186600
5.025	275	946	2150	7930	28000	190000
6.25	280	978	2160	7950	28430	198000
6.5	286	1000	2180	8000	28500	200000
7	289	1030	2187	8094	29000	201000
7.8	299	1056	2195	8250	29500	205000
7.9	300	1059	2200	8500	29990	210000
8	310	1067	2250	8700	30000	215000
10.38	311.5	1100	2300	8770	31000	220000
11.25	320	1110	2400	9000	31500	225000
12	325	1150	2450	9100	32000	229000
13.52	330	1155	2463	9445	33000	230000
14.2	340	1162	2485	9500	35000	235500
14.25	350	1200	2490	9710	37000	238000
14.5	360	1225	2500	9800	38140	240000
15	366.6	1250	2525	9900	38500	245000
16	370	1260	2600	9902	39000	250000
17	375	1300	2625	10000	39500	265000
19	380	1350	2635	10430	40000	268000
19.2	389	1355	2700	10500	42000	270000
20	390	1400	2750	10600	43000	275000
22	400	1488	2850	10900	45000	294000
23	410	1495	2860	10936	47000	300000
24	414.3	1500	2870	11000	47500	307500
25	418.8	1510	2900	11400	48000	311000
26	425	1518	3000	11500	48660	314000
28	426.9	1600	3100	11690	49000	316000
30	427	1640	3163	12000	50000	325000
31.5	440	1646	3259	12500	52000	330000
37	450	1650	3290	12600	55000	330000
48	452	1670	3333	13000	56000	333500
49	460	1680	3384	13100	57065	350000
50	470	1710	3500	13500	58333	353500
51.78	475	1712	3509	13550	60000	375000
55	478	1740	3700	13600	61430	380000
56.7	480	1770	3730	14000	62000	400000
60	487	1800	3760	14250	64000	402000
63	500	1818	4000	14400	65000	420000
68	520	1830	4030	14500	66600	422000
74	525	1865	4200	14550	66650	425000
75	540	1892	4220	14600	67500	450000
80	550	1894	4280	15000	68000	458000
81.4	575	1895	4300	16000	70000	478000
88	580	1896	4314	16500	72000	500000
89.8	588	1897	4440	16800	73500	520000
95	600	1898	4444	17000	75000	521000
100	612	1899	4500	17500	80000	525000
101	625	1900	4720	17977	82000	543000
105	633	1901	4750	18000	84000	550000
105.7	640	1902	4850	18300	85000	570000
107	641	1903	4885	18380	85750	575000
120	645	1904	4900	18500	88000	600000
121.2	649	1905	5000	18800	90000	620000
125	650	1906	5100	19000	91000	650000
130	657	1907	5210	19500	93300	654000
135	665	1908	5235	20000	95000	660000
147.5	668	1909	5270	20441	100000	690000
150	670	1910	5300	20500	110000	700000
160	673	1911	5500	21000	115000	750000
165	675	1912	5600	21500	116667	761300
170	680	1913	5730	22000	120000	800000
175	681	1914	5770	22500	130000	813000
179	684	1915	5910	22990	135000	850000
182	689	1916	6000	23000	140000	900000
182.4	697	1917	6100	23150	141000	930000
200	699	1918	6125	23325	145000	950000

Any Size Above. Each 35c; Ten for $3.29

MEGOHMS

1.	1.579	2.5	3.9	6.7	10
1.1	1.65	2.7	4	7	11.55
1.2	1.75	2.75	4.23	7.5	12
1.25	1.8	2.8	4.25	7.62	12.83
1.3	1.9	2.855	4.5	7.74	13
1.35	2	3	5	8	13.85
1.39	2.11	3.3	5.5	8.02	
1.4		3.5	6	8.5	
1.5	2.2	3.673	6.5	9.05	
1.57	2.25	3.75	6.6	9.5	

Any Size Above. Each 70c; Ten for $6.49

Vacuum Precision Hi Volt Resistors

Megohms — .12/.25/.6/.75/.83/.99/1/1.5/2/3/3.75/ ½% Accy Ea. $1; 10/$7.50

MV Resistors — High Voltage

Megs.	Type	Watts	Peak	Each	10 for
.2	MVP	10	15Kv	$1.98	
.5	MVG	4	5Kv	1.29	$9.98
.75	MVG	4	5Kv	1.29	9.98
.8	MVP	10	15Kv	1.69	
1	MVP	10	15Kv	1.69	13.49
1	MVZ	20	25Kv	1.98	16.98
2.5	MVA	20	25Kv	1.98	16.98
2.5	MVT	5	7.5Kv	1.29	9.98
5	MVP	10	15Kv	1.69	13.49
10	MVG	4	5Kv	1.29	9.98
10	MVP	10	15Kv	1.69	13.49
15	MVA	20	25Kv	1.98	
50	MVE	25	40Kv	1.98	16.98

"TAB" That's a Buy

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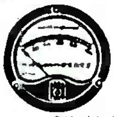
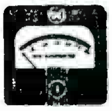
Phone COrtlandt 7-6443 7-6488

SELECTED AND GUARANTEED SURPLUS AT A FRACTION OF ORIGINAL COST.
188 WASHINGTON ST., NEW YORK 7, N.Y.

PANEL METERS



GE=General Electric
WH=Westinghouse
SU—Sun
W=Weston S=Simpson
SQ=Square Case
*=Spec. Scale



2" METERS

0-20 UA, S* $4.50
0-500 UA, S, WH* 2.95
0-5 ma, S, Sq* 2.45
0-5 ma, GE* 1.95
0-20 ma, S* 1.75
0-25 ma, SU* 1.75
0-50 ma, SU Sq*.. 1.95
0-50 ma, GE 2.45
0-2 amp RF, S Sq. 1.95
0-4 amp RF, GE.. 1.95
0-9 amp RF, WH.. 1.95
0-250 ma AC, GE.. 2.95
0-20 Volt DC, SU.. 1.75
0-20 Volt DC, W.. 2.45
0-30 Volt DC, GE.. 2.45
0-30 amp DC, GE.. 1.95

6" METERS

0-1.5 amp DC, GE.. 6.95
0-300 volt, AC GE.. 7.95
0-12 KV DC, GE..12.95

3" METERS

0-20 UA, W $12.50
40-0-40 UA W* 7.95
50-0-50 UA, GE... 8.95
0-75 UA, GE 9.95
0-1 ma, S* 4.50
0-2 ma, WH/S 3.95
0-5 ma, GE Sq 3.95
0-10 ma, WH* 2.95
0-20 ma, S/WH 3.95
0-20 ma, GE Sq.... 3.95
0-30 ma, GE Sq.... 3.95
0-80 ma, WE 2.95
0-100 ma, GE Sq... 3.95
0-200 ma, GE Sq... 3.95
0-300 ma, GE Sq... 3.95
0-2 amp, GE Sq.... 3.95
0-2 amp, WH 3.95
0-15 volt AC, GE.. 3.95
0-300 VAC, GE Sq 4.95
0-30 Volt DC, DA.. 2.75
0-800 VDC, GE Sq 4.50
0-2 KV DC 6.95
0-3 KVDC, GE Sq 7.95

LINK TEST SET

Type #1410. Contains two 3½ meters—a 75-0-75 microamp Galvanometer and a 0-1 MA multi-scale meter. Has tap switch for changing range. Ranges are as follows: 75-0-75 microamps, 1MA 2.5 MA, 50 MA, 25 volts, 500 volts. Ideal for balancing discriminators and general lab use. Housed in hard wood case with hinged cover. 10" x 8" x 4½". Only .... $14.95 ea.

PANEL METER KIT

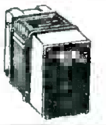
Here's what you get:

- 2" Sq. bakelite cased meter. Govt. Surplus.
- Scales for all the following ranges: 0-50 ma, 0-100 ma, 0-200 ma, 0-500 ma. Precalculated shunt sizes for all ranges.
- Complete instructions.

Only $2.50 ea. 3 for $6.75

SCR 522 TRANSMITTER RECEIVER

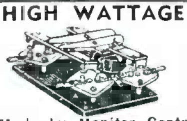
Complete with tubes and separate Dynamotor Power Supply. Excellent condition $36.50



RAYTHEON SWINGING CHOKE

2 to 12 Henrys. 1 Amp to 100 Ma, 15 Ohms DC fully cased. High voltage insulation, ceramic insulators. Very conservatively rated. Weight 60 Lbs. $14.95 ea

HIGH WATTAGE ANTENNA RELAY



110/220 volt 60 cycle Solenoid. D.P.D.T. Heavy duty parallel contacts rated 15 amps at 5000 volts. Sturdy construction. Isolantite insulation. Base 8" x 10½".

Made by Monitor Controllers $18.50
Same specs. as above but DPST 12.50
Same specs. as above but SPDT 12.50

GUARDIAN LATCHING RELAY

S.P.D.T.. 110 volt 60 cy. coil. 15 amp contacts..$1.95

SENSITIVE RELAY

2000 ohm coil, SPDT, breaks at 3 ma. Plugs into 5 prong socket .... .99 ea.

WESTINGHOUSE SELENIUM RECTIFIER

Hermetically sealed. Oil Immersed Full Wave Bridge. 32 Volts AC Input. 24 Volts at 2 Amps Output. Size 2⅝x2⅝x3⅞ hi .... $3.75 ea.

Mattory-Vibropack Transformer 6 Volt Input. Output 300 Volts at 100 MA $3.95

MISCELLANEOUS BARGAINS

.02 400 volt dc .... 15 for $0.99
.01 600 volt dc pigtail micas .... 10 for .99
Butterfly cond. 2 to 11 mmf ball brngs.. 3 for .99
Var. cond. 150 mmf .07 spacing .... 2 for .99
Variable ceramicon 20 to 125 mmf ...... 5 for .99
.35 at 16 KV plus .75 at 8 KV Oil Cond 3.95
.1 MFD 7500 VDC Oil Cond .... .89
.05 MFD VDC Oil Cond .... .75
75 MFD 330 VAC OIL Cond .... .69
25 ohm 675 watt Rheostat 2.95
50 meg 35 watt resistor .... .99
10 meg 10 watt .... .49
2 meg 5 watt .... .39
250 mmf midget var. ceramic ins .... .69
4 Pole ST lever switch .... .95
Ceramic RF switch, SP 11 pos .... .95

WIRE WOUND RESISTORS

5 watt ohms: 25-50-200-470-2500 .... .09 ea.
10 watt ohms: 25-40-84-400-470-1325-2K-4K. .15 ea.
20 watt ohms: 50-70-100-300-750-1K-1.5K 2.5K-2.7K-5K-10K-16K-20K .... .20 ea.

PIGTAIL MICAS

MMF: 5, 20, 50, 60, 100, 250, 300, 400, 500, 750, 800, 1000, 2000, 3000 .... $0.08 ea.

LEACH RELAY

4 Pole Double Throw.
4200 ohm coil .... 2.50 ea.

POWER TRANSFORMER BARGAIN

740 volts CT @ 185 ma, 6.3 volts @ 5 amp, 5 volts @ 3 amp. Pri. 110 volt 60 cy. Half shell mounting. Only .... $3.49 each.

WESTON PORTABLE AC VOLTMETER

Mod. 433, 0-150 volts AC. ¾ of 1% accuracy. 25 to 2400 cycles. 28 ohms Res. mirrored scale. Bakelite case 5"x6"x3½" with leather handle $28.50

METER MULTIPLIERS

2 Meg 1/5 of 1% Cage Enclosed 2 KV $3.95
2 Meg 1/2 of 1% Tubular 2 KV 1.95
4 Meg 1/2 of 1% Tubular 4 KV 3.75

SOLA CONSTANT VOLTAGE TRANSFORMER

2 KVA., 17.4 amps., Input 95 to 135 volts 60 cy. Output 115 volts constant. Type 4, single phase. 31¼" long, 9½" high, 7½" wide ...... $137.00 each

OIL CONDENSERS

56	mfd	220 vdc—$3.95	8	mfd	2000 vdc— 3.95
4	mfd	600 vdc— .59	10	mfd	2000 vdc— 4.95
6	mfd	600 vdc— .79	2	mfd	4000 vdc— 4.90
8/8	mfd	600 vdc— 1.39	1	mfd	5000 vdc— 4.50
10	mfd	600 vdc— 1.35	.1/.1	mfd	7000 vdc— 2.25
6	mfd	1500 vdc— 2.95	2	mfd	6000 vdc— 9.95
10	mfd	1500 vdc— 3.75	2	mfd	7500 vdc—12.75
2	mfd	2000 vdc— 2.25	.65	mfd	12,500 vdc—12.95

HIGH CURRENT MICAS

Type G4 Ceramic Case 5¾" High, 5" Diameter Tolerance 5% or Better.

CAP MFD	Amps 1 Mc	KV DC	Price Each	CAP MFD	Amps 1 Mc	KV DC	Price Each
.08	60	4	$27.50	.009	40	15	$29.50
.1	70	4	29.50	.0047	23	15	24.50
.05	60	5	24.50	.002	20	20	28.50
.037	45	6	26.50	.0031	20	20	29.50
.02	40	9	29.50	.001	12	30	27.50
.0117	40	14	24.50	.0005	10	30	27.50
TYPE G1				TYPE G2			
.00024	4	6	$3.95	.01	25	7	6.95

(.0075 | 39 | 15 | 24.50 follows .0117 in the left column.)

BAKELITE CASED MICAS

MFD	VDC	Price	MFD	VDC	Price
.001	600	$ .18	.025	2500	1.25
.01	600	.26	.002	2500	.50
.02	600	.26	.004	2500	.60
.027	600	.26	.005	3 KV	.70
.01	1 KV	.45	.0001	5 KV	.70
.02	1200	.35	.0015	5 KV	1.60
.024	1500	.65	.005	5 KV	2.50
.033	1500	.75	.0005	8 KV	2.90
.02	2 KV	.90	.0003	8 KV	2.50
.005	2500	.55	.007	5 KV	3.50

CHOKE BARGAINS

O open frame C cased

6 hy 50 ma. O .... $ .39 4 hy 450 ma C 3.95
6 hy 80 ma. O .... .79 10 hy 250 ma. C 2.75
8 hy 175 ma. C .... 1.49 5 hy 175 ma. C 1.35
6 hy 400 ma. C .... 3.69 20 hy 36 ma. C .... .89

POWER TRANSFORMERS

Hermetically sealed. Pri. 110 volts 60 cy.
1110 volts CT 60 MA, 920 volts CT 160 MA. 6.3V, .18A, 6.3V, 1.25A, 5V2A, 5V2A ....$4.95 ea.
300 volts CT 300 MA, 2.5V7A, 2.5V7A. 0.3V, 1.5A 2.75
1050 volts @ 20 ma, 20V, 4A, 2.5V, 5A 2.75
1000 VCT @ 425 ma. 65 volt bias tap 7.95
880 VCT 100 ma, 6.3V 4A, 5V 3A 2.79
4400 V @ 4.5 ma, 5V @ 3A, 15 KV insul 4.95

FILAMENT TRANSFORMERS

110 V 60 CY Primaries—Full Casings.
6.3V 12 Amp $1.95 2.5V 20A, 2.5V 20A $6.95
2.5V 10A HV ins..$3.95 5V 4A, 6.3V 3A .... $2.5?

CERAMICONS

MMF: 1.5, 2, 3, 8, 10, 20, 22, 120, 500 .... $ .05

SILVER MICA CAPACITORS

MMF: 10, 47, 50, 60, 340, 750, 780, 1000 .... $ .09

MOTOR & GEAR BOX

Type RL42B, Motor 24 Volts DC, ⅛ HP—1 min. with Gear Reduction Box .... $2.25 each

30 WATT WIRE WOUND RESISTORS

Ohms: 100-2500-3k-4500-5300-18k .... 8 for .99

ADJUSTABLE SLIDER RESISTORS

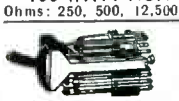
20 Watt: 1, 5, 50 Ohms .... .25
50 Watt: 100, 500 Ohms .... .35
75 Watt: 100, 150, 200 Ohms .... .39
100 Watt: 20, 50, 75, 120, 500 Ohms .... .49

PRECISION 1% W.W. RESISTORS

Ohms: 2K, 5K, 8500, 50K, 95K .... .25 ea.

100 WATT NON INDUCTIVE RESISTORS

Ohms: 250, 500, 12,500 .... .75 ea.



MOSSMAN SWITCH

4 Pole Single Throw.. .88 ea.

CAN'T KINK

3 cond. 5/16" dia. Tough rubber cov. cable. For remote or Ant. Control-Foot switch etc.
Cut to your order Min. 50 ft......... **3½¢ ft.**
550 ft. Metal reels Express Collect.... **$15.00**

RCA 100A

Free Floating Cone Type-Magnetic-Loud Speaker. Removed from rooms of a large N. Y. Hotel. Original cost $32.00........................$1.85
3 for $5.00

W.E.
24 & 12 volt Telephone lamp..........doz. **$1.50**

C/H
4 pole 35 ampere 115v. AC relay.......... **$4.90**

3 ampere G.E. Mercury Switch
½" glass tube.......................3 for **$2.50**

GRAIN OF WHEAT LAMPS

Used for illuminating meters, compass, dials, airplane instruments, etc. Soldering iron removes lamp from base to use in models, doll houses, miniature trains, Xmas trees, etc.
Mazda G.E. 323 3V..19.A — Mazda G.E. 328 6V..2A
Either type, doz. **$1.80**

MARKTIME 5 HOUR SWITCH

A 10 amp. timing device. Pointer moves back to zero after time elapses. Ideal for shutting off radios and TV sets when you go to bed. Limited supply at this special PRICE.... **$3.90**

Also available in 15 min.-30 min.-1 hr. at $5.90

ISOLATION TRANSFORMER $1.95

Nat. known Mfgrs. 50 watt 2 windings, 115 V. to 115 V. 60 cy. Ideal to prevent shocks from small radios and medical and electronic devices.
Shipping Weight 5 lbs.
Other sizes and 220-110 in stock.

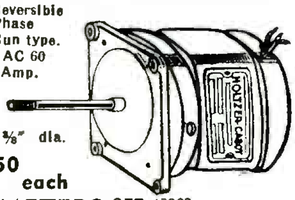
Kilowatt Demand Meter Totalizer containing heavy duty TELECHRON B-7, 1 RPM motor and hundreds of watch size gears, clutches, springs, etc. Shipping weight 2 lbs.
5 for $10.00 **$2.50**

RADAR MAGNETS ....$5.00 to $17.50

DPDT 6 volt Battery D.C. 10 ampere Relay .... 2 for **$1.95**

DPDT H&H Toggle Switches
10 for **$4.50**

NEW HOLTZER-CABOT TOTALLY ENCLOSED MOTORS



50 R.P.M. Reversible Single Phase Capacitor-Run type. 115 Volts AC 60 cycle 0.3 Amp. Torque 100 oz. Inches. 4¾" shaft ⅜" dia.

$17.50 each

GONIOMETERS CFT-47263 CFT-47372 in stock

We are Authorized Wholesalers for Micro Switch Corp. and carry the largest stock of Allen-Bradley Solenoids. Potter & Broomfield Relays. Guardian Electric Co. Solenoids and Relays and Haydon Clock Motors in all speeds. Electric Counters.

EST. 1923 **BLAN** EST. 1923

Experimenters and Inventors Supplies

64 Dey St., New York 7, N. Y.

RADAR EQUIPMENT

APS-3 3cm Search Radar
APS-4 3cm Search Radar
SCR-717B 10cm Search Radar
SO-9 10cm Search Radar
APR-4 Receivers & Tuning Units
TS-12 Standing Wave Amplifier
Test Equipment and Signal Generators for 10 and 3cm

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LERU LABORATORIES, INC.
360 Bleecker St., New York 14, N. Y.
OREGON 5-3525

SELENIUM RECTIFIERS and ASSOCIATED COMPONENTS

SINGLE PHASE

Full Wave Bridge

Input: 0-18 VAC — Output: 0-12 VDC

Type No.	Current	Price
B1-250	250 Ma.	$ .98
B1-1	1.0 Amp.	2.49
B1-1X5	1.5 Amp.	2.95
B1-3X5	3.5 Amp.	4.50
B1-5	5.0 Amp.	5.95
B1-10	10.0 Amp.	9.95
B1-20	20.0 Amp.	15.95
B1-30	30.0 Amp.	24.95
B1-40	40.0 Amp.	27.95
B1-50	50.0 Amp.	32.95

Input: 0-36 VAC — Output: 0-26 VDC

Type No.	Current	Price
B2-150	150 Ma.	$ .98
B2-250	250 Ma.	1.25
B2-300	300 Ma.	1.50
B2-2	2.0 Amp.	4.95
B2-3X5	3.5 Amp.	6.95
B2-5	5.0 Amp.	9.95
B2-10	10.0 Amp.	15.95
B2-20	20.0 Amp.	27.95
B2-30	30.0 Amp.	36.95
B2-40	40.0 Amp.	44.95

Input: 0-115 VAC — Output: 0-90 VDC

Type No.	Current	Price
B6-250	250 Ma.	$ 2.95
B6-600	600 Ma.	5.95
B6-750	750 Ma.	6.95
B6-1X5	1.5 Amp.	10.95
B6-3X5	3.5 Amp.	18.95
B6-5	5.0 Amp.	24.95
B6-10	10.0 Amp.	36.95
B6-15	15.0 Amp.	44.95

Full Wave Center Tap

Input: 10-0-10 VAC — Output: 0-8 VDC

Type No.	Current	Price
C1-10	10.0 Amp.	$ 6.95
C1-20	20.0 Amp.	10.95
C1-30	30.0 Amp.	14.95
C1-40	40.0 Amp.	17.95
C1-50	50.0 Amp.	20.95

THREE PHASE

Full Wave Bridge

Input: 0-234 VAC — Output: 0-250 VDC

Type No.	Current	Price
3B13-1	1.0 Amp.	$ 22.00
3B13-2	2.0 Amp.	32.00
3B13-4	4.0 Amp.	56.00
3B13-6	6.0 Amp	81.50
3B13-10	10.0 Amp.	105.00
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For Types B1 through B6, and Type C1 $.35 per set
For Types 3B........................ 1.05 per set

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0-12 Amperes DC
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Any range $2.49 each

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GENERAL PURPOSE Low voltage DC power supplies, with variable outputs. Rugged—Dependable—precision control.

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- √ Long life Full Wave Selenium Rectifiers
- √ Output Voltage Continuously Adjustable from Zero to Maximum
- √ 3" Voltmeter and Ammeter 2% acc'y.
- √ Stepless Control
- √ Instant Power—No Warm-Up Period
- √ Assembled and Ready to Operate
- √ For 115 VAC 60 Cycles
- √ Dimensions 8½" x 16¾" x 8"

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GPA1210	0–12 VDC	10 Amps.	75.00
GPA2810	0–28 VDC	10 Amps	85.00

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CF-6	4000 MFD	30 VDC	3.25
CF-19	500 MFD	50 VDC	1.95
CF-16	2000 MFD	50 VDC	3.25
CF-21	1200 MFD	90 VDC	3.25
CF-9	200 MFD	150 VDC	1.69
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All Primaries 115 VAC 50/60 Cycles

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TXF36-2	36	2	6 lbs.	4.95
TXF36-5	36	5	8 lbs.	6.50
TXF36-10	36	10	12 lbs.	9.95
TXF36-15	36	15	20 lbs.	11.95
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All TXF Types are Tapped to Deliver 32, 34, 36 volts. XFC Type is Tapped to Deliver 16, 17, 18 Volts Center-tapped.

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3 terms. bot. mntgs flanged type. Dims. 3¾ x 3½ x 2. Tested at 1800v. Meets commercial specs. for 600v. operation up to 40 degrees C. Currently being used for power factor correction. Numerous applications for this high quality condenser. See symbol "F".

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B	.005-.005-.01	10KV	#26F344	3.50
B	.01	3000V		.50
Special	.02	20KV		10.50
E	.03	16KV	#26F380	7.75
B	.05-.05	2000VAC		.95
B	.1	1500V		.28
1 Term	.1	2000V		.32
F	.1	2500V		.40
G	.1	3500V		.55
G	.1	7000V	1 Term	.95
E	.1	7500V	#25F475	.85
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B	.1	25KV	#14F52	20.95
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D	.5	500V		.16
F	.5	600V		.24
G	.5	1500V		.29
B	.5	2000V		1.25
B	.5	3000V		1.65
B	.5	25KV		29.95
B	.5—.1	2000V		.89
B	.5—.5	600V		.24
B	.65	12.5KV		10.75
D	.75	1000V		.25
F	1	400V		.18
D	1	500V	#23F266	.24
F	1	500V	#23F225	.24
F	1	600V		.28
B	1	600V		.24

Symbol	Capacity	Voltage	Type	Price
B	1	1000V		.3[illegible]
B	1	2500V	#23F121	1.2[illegible]
B	1	15KV		17.7[illegible]
B	1	20KV	#14F35	28.7[illegible]
D	2	600V		.38
B	2	600V	#26F407	.39
G	2	600V	TLA	.15
B	2	1000V		.50
G	2	1000V	TLA	.60
B	2	2500V		2.50
B	2	4000V	#23F47	3.95
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B	2–2	600V		.65
B	3	600V	Can	.39
B	3	4000V		5.25
B	3–3	150V		.25
B	3–3	600V		.70
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B	4	500V	#26F796	.55
B	4	600V	#23F317	.69
G	4	600V	TLA (2) Terms	.69
G	4	600V	TLA	.69
B	4	1000V		1.15
B	5	600V		.59
B	5	1500V		2.75
B	6	600V		.74
B	7	600V		.79
B	7	800V		.89
B	8	600V		.95
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F	8–8	600V		1.20
B	10	600V		1.10
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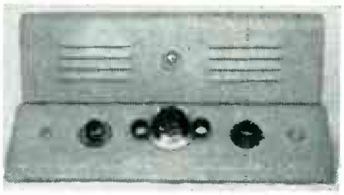

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SYMBOLS: LS—Locking Type Shaft
S—Screwdriver, R—Round

Ohms	Shaft	Ohms	Shaft
50	1/4 S	20,000	1 1/4 R
200	1/8 LS	25,000	3/8 R
1000	1/8 LS	25,000	1/8 LS
1000	1/4 S	25,000	1/8 S
2000	3/8 LS	50,000	1/5/16 R
2500	1/2 R	50,000	1/8 S
2000	1/8 LS	50,000	1/4 S
3000	1/8 LS	50.000	1/8 LS
3000	1/2 R	100,000	1/8 LS
5000	1/8 S	100,000	1/2 R
5000	1/8 LS	100,000	1/0 R
10,000	1/4 S	100,000	1/8 S
10,000	3/8 R	150,000	2 1/8 R
10,000	1/8 LS	200,000	9/16 R
10,000	5/16	250,000	1/8 S
15,000	1/8 S	300,000 (2 Terms)	1/8 S
15,000	1 1/8 R	1 Meg	1/8 S
20,000	3/8 S	1 Meg	1/8 LS
20,000	1/8 LS		

TYPE "JJ" $1.00

2K	3/8 R	10K-50K (10K 2 term .) 1/2 R
1K–5K	3/8 R	
100K	1/2 R	

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83–1SP	$.28	83–1J	$.64
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150—225 megacycles. Brand new. Boxed.
Price $11.95

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Connectors

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Output #2—28.5 v. d-c., 60 a.
Size: 6½" dia. 13½" O.A. length incl. ⅞" dia. splined shaft 2" long. Flange mounting. Wt. 42 lbs. Rotation counter clockwise viewed from drive end. Generators are self excited. Brand new in original boxes. Mfd. by Bendix. Special Price $27.50 ea. 2 for $50.00.

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701A	3.50	872A	1.75
702A	2.75	C5B	7.75
703A	2.75	C6A	8.25
704A	1.00	C6J	4.75
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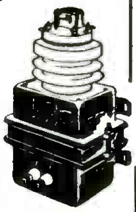

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Outstanding precision instrument for any electronic lab.
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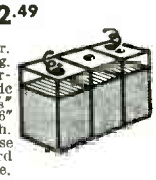
$2.49



3 amp. hr. rating. Transparent plastic case. 3⅝" x1 13/16" x2⅝" high. New. Use standard electrolyte.

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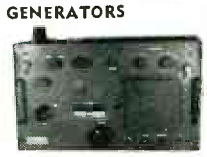

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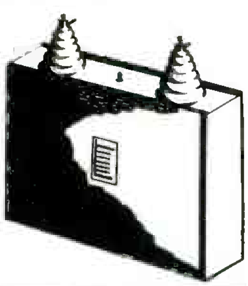

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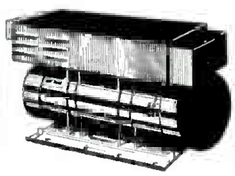

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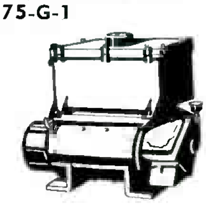

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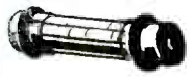

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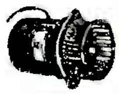

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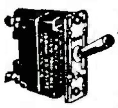

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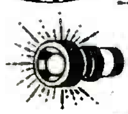

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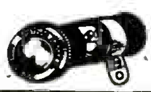

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1B29	.84	2E25 HY65	4.20	6AC7W	3.60	6R7	1.33	12A7	1.60
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1LA4	1.33	3B5	.98	6B7	1.60	6W4GT	1.80	12SH7	.98
1LA6	1.33	3B7/1291	.29	6B8G	1.42	6W5GT	.75	12SJ7GT	1.65
1LB4	1.33	3B22	2.45	6BA4	1.08	6W7G	1.33	12SK7	1.49
1LC5	1.33	3B24	1.75	6BA6	1.80	6X4	1.50	12SL7GT	1.09
1LC6	1.33	3B25	4.75	6BA7	1.20	6X5GT	1.50	12SN7GT	2.20
1LD5	1.33	3B28	7.85	6BC5	2.00	6Y5	1.85	12SQ7GT	1.50
1LE3	1.33	3C6/XXB	1.60	6BD6	1.06	6Y6G	2.40	12SR7	.98
1LG5	1.41	3C23	5.85	6BE6	1.80	6Y7G	.98	12X3	.90
1LH4	1.33	3C31/C1B	3.45	6BF6	1.49	6Z5 12Z5	1.18	12Z3	1.33
1LN5	2.39	3C45	12.85	6BG6G	4.80	6Z7G	1.95	14A4	1.33
1N5GT	1.80	3D6/1299	.29	6BH6	2.00	6ZY5G	1.10	14A7/12B7	1.98
1N6G	.98	3D21A	1.98	6BJ6	2.00	7A4/XXL	1.00	14AF7/	
1P5GT	1.33	3E29	10.98	6BQ6GT	3.20	7A5	1.10	XXD	1.26
1P24	.84	3LF4	1.33	6C4	1.65	7A6	.90	14B6	1.98
1Q5GT	1.33	3Q4	1.98	6C5GT	.83	7A7	1.62	14B8	1.10
1Q26	69.00	3Q5GT	2.16	6C6	.89	7A8	.90	14C5	1.33
1R4/1294	1.33	3S4	1.80	6C7	1.26	7AD7	2.39	14C7	1.20
1R5	1.80	3V4	1.80	6C8G	1.42	7AF7	.90	14E6	1.10
1S4	1.20	4C33	81.00	6C21	19.62	7AG7	.98	14E7	1.33
1S5	1.62	4C35	34.90	6CB6	2.00	7AH7	1.10	14F7	1.10
1T4	1.80	4E27 257	12.39	6CD6G	6.00	7B4	1.62	14F8	1.33
1T5GT	1.33	4J31	95.00	6D4	2.75	7B5	1.62	14H7	1.20
1U4/5910	1.80	4J42/700	29.85	6D6	.83	7B6	1.62	14J7	1.33
1U5	1.62	4J47	260.00	6D8	1.60	7B7	.90	14N7	1.33
1V	1.10	4J52	250.00	6E5	1.10	7B8	.90	14Q7	1.98
1V2	1.50	4T4/2	9.95	6E6	1.90	7C4/1203A	.33	14R7	1.33
1X2	2.65	5C22	59.95	6E7	1.20	7C5	.79	14S7	1.33

14W7	1.33	NR74	.29	710A/8011	.69	1634	.77	9-3	.49
14X7	1.33	75	.83	713A	1.00	1635	1.49	10-4B	.49
14Y4	1.20	HY75A	4.59	715A	7.98	1641/RK60	.98	13-4	.49
15E	1.17	76	.83	715B	7.98	2050	1.80	20-4	.49
15R	.49	77	.83	715C	24.98	2051	.89	K49A	.36
FG17	3.98	78	.83	717A	.61	R3430	36.00	K55B	.36
RK18	.98	79	1.33	720CY	45.00	5514	4.85	M55B	.36
19	1.60	80	1.35	721A	2.19	5516	5.85	L62A	.49
19BG6G	6.00	81	1.95	722A/287A	9.95	5517/		K80B	.36
19J6	3.20	FG81A	4.45	723A	6.95	CK1013	1.89	WL121A	2.61
19T8	2.90	82	1.33	723A/B	14.98	5656	18.90	C376	2.98
20	1.17	82V	1.39	724A/B	2.89	5686	4.23	ZB583	3.98
RK20A	6.98	83	1.33	725A	6.39	5812	2.99	876	.29
PJ21	4.98	83V	1.60	726A	5.98	UX6653	.69	**Mazda Pilots**	
REL21	4.85	84/6Z4	.90	726C	29.98	8012A	1.25	44, Box 10	.50
RX21	2.33	85	1.10	730A	9.89	8013A	7.98	49, Box 10	.60
PJ22		89	.32	801A	.29	8020	1.25	55, Box 10	.50
CE1C	1.49	VR92	.25	802	4.69	9001	2.79	64, Ea.	.07
HY24	1.39	FG104	14.98	803	2.89	9002	2.25	S6 T4 3W	.18
24A	1.10	FG105	8.89	804	6.90	9003	2.79	100W 20V	.25
24G/3G24	.69	VU111	.49	805	3.59	9004	.24	291, Box 10	.36
25A6	1.60	HY114B	1.25	807	2.39	9005 RC4B	1.95	311 28V	.15
25A7	3.27	HY115 145	.57	808	.95	9006	.15	313 28V	.15
25AC5GT	1.95	117L7	1.95	809	2.45	**C'Ray Tubes**		323 3V	.10
25B5	1.39	117N7GT	1.95	810	11.96	2AP1	3.55	Sylvania S6/	
25B6	2.49	117P7GT	1.95	811	2.29	2AP5	7.98	6W 120V	.15
25BQ6GT	3.20	117Z3	1.35	812	2.50	3AP1	4.69	Wstghs C7/	
25C6	1.18	117Z4GT	1.45	813	11.75	3BP1	2.39	7W 120V	.09
25L6GT	1.65	117Z6GT	1.20	814	2.29	3BP1A	7.98	Med. Scr. Base	
25N6	1.69	117Z7GT	1.49	815	1.37	3CP1S1	2.49	15W/125V	.08
25W4GT	2.00	F127A	15.89	816	1.18	3DP1	3.75	25W 125V	.08
25Y5	1.45	CV148	4.98	826	.39	3DP1-S2	4.65	**Neon Bulbs**	
25Z5	.75	155	.98	SD828	1.98	3EP1	2.45	NE16/991	.36
25Z6GT	1.35	FG166	49.00	829	6.48	3FP7	1.69	NE20	.10
26	.90	FG172	29.50	829B	11.98	3GP1	4.89	NE32	.35
27	.75	FG190	12.80	832	7.98	3HP7	4.80	NE45 1/4W	.27
FG27A	6.89	205B/VT2	1.69	832A	10.64	3HP14	9.98	NE51 NE20	.07
28D7	.29	CE206	3.15	836	1.98	3JP1	19.50	Bull's Eye Lite	
30	1.00	211/VT4C	.37	837	1.29	3JP12	19.95	Dialco Type	
HY31Z	4.89	RX215	9.95	838	2.21	4AP10	4.70	Chromed. Less	
31	.57	WE215A	.25	842	2.75	5AP1	3.75	Bulb 59¢;	
32	1.78	227A	2.65	843	.39	5BP1	2.25	2 for 98¢	
FG32	4.89	231	1.20	845	5.95	5BP4	4.50	**Tel. Slide**	
32L7GT	1.60	250TH	18.75	851	29.98	5CP1	1.75	**Lamps**	
33	1.60	250TL	18.75	860	5.70	5CP7	3.70	6/12/24/48/	
FG33	7.89	282B	8.49	861	9.89	5FP7	1.26	55V, ea.	.18
34	1.60	304TH	3.45	864	.29	5FP14	18.98	**Xtal Diodes**	
35/51	1.00	304TL	4.98	865	1.39	5GP1	6.95	1N21	1.80
35A5	.90	307A/RK75	6.45	866A	.98	5HP1	4.95	1N21A	2.00
35B5	2.00	310A	6.98	866Jr	1.04	5HP4	6.75	1N21B	2.60
35C5	2.00	316A	.29	868 PJ23	1.90	5JP1	39.95	1N22	2.00
35L6GT	1.49	323A	8.98	869	25.98	5JP2	11.75	1N23	2.40
35W4	2.00	327A	2.50	872A	1.29	5LP1	11.89	1N23A	2.80
35Y4	1.62	350	1.49	GE872A	2.98	5MP1	4.75	1N23B	3.75
35Z3	.90	350B	1.65	874	.35	5NP1	3.98	1N25	4.80
35Z4GT	.75	355A	14.15	878	1.95	7BP7	4.65	1N26	5.20
35Z5GT	1.50	371B	.98	884 6Q5G	1.45	7CP1	12.95	1N27	3.50
REL36 6J4	.54	380A	.79	885	.96	7JP4	16.49	1N29	3.50
36	1.33	388A	1.69	920	2.70	9GP7	8.89	1N32	18.00
37	.90	393A	3.45	922	1.19	9LP7	10.98	1N34	.75
38	1.10	394A	4.98	923	.77	10BP4	19.49	1N35	1.95
39/44	1.33	395A	4.95	927/CE25	1.20	10FP4	24.50	1N46	.89
CRC40	.54	FP400	7.98	929	1.33	12DP7	12.45	1N48	.70
41	.83	WL414	63.95	930	.90	12GP1	49.98	1N51	.70
42	.83	417A	9.49	954	.39	12GP7	12.70	1N52	.95
43	.83	GL434	2.69	955	.49	12JP4	27.00	1N63	.98
45S VT52	.18	446A/2C40	1.19	956	.39	12KP4	34.00	**Thermistors**	
45Z3	.90	446B	1.75	957	.39	12LP4	24.35	D167019 Vol	
45Z5	.90	450TH	19.75	958	.39	12QP4	32.00	Limiter	2.95
46	1.33	450TL	44.25	SD968	1.98	12RP4	36.00	D168391	
47	1.20	GL451	1.90	991	.36	15DP4	56.00	Thermal	
49	1.33	460		FM1000	1.20	16AP4	49.00	Comp	1.00
50	1.95	HF200	13.95	CK1005	.49	16DP4	49.98	D170396 HF	
EF50	.69	WL468	5.89	CK1006	.64	16FP4	57.50	Pwr Meas	.90
50A5	1.98	RH507	9.98	CK1007	.89	16RP4	49.98	1C Bulb Time	
50B5	1.80	527	8.98	CK1089	3.98	16TP4	49.98	Delay	.90
50C5	1.80	530	12.69	CK1090	2.69	19AP4	96.00	**Varistors**	
50C6	1.28	WL531	3.75	R1100	5.00	19CP4	85.00	CW20259/	
50L6GT	1.65	GL534/		R1130B	12.00	905	2.45	USN 38C	2.95
50X6	1.10	1S21	3.89	HY1231Z	5.39	910 3AP1	4.63	WEco 41A	1.50
50YGT6	.90	544	4.98	HY1269	5.39	912	89.98	**Xtal Freq**	
50Y7GT	1.00	GL546	1.69	1273	1.15	914A	45.00	**Stds**	
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HY69	4.95	701A	2.90	1622	1.75	PM4	.98	Kc. Ea.	14.98
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70L7GT	1.95	703A	3.98	1625	.49	PM5	.98	Open Fil &	
71	1.00	704A	2.98	1626	.49	6-11	.49	B'kage Via	
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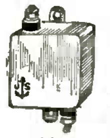

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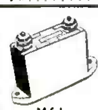

Mfd.	Each	Mfd.	Each
250 VDC		**3000 VDC**	
.05	$ .39	.005	$1.35
.2	.59	.008	1.49
1500 VDC		**3500 VDC**	
.04	.75	.000033	.65
.05	.90	**5000 VDC**	
2000 VDC		.000051	.75
.003	.90	.000082	1.35
.005	.98	.0001	1.49
.006	1.05	.00015	1.89
.01	1.19	.00018	1.98
.015	1.39	.0002	2.09
.02	1.69	.0003	2.29
.03	1.98	.00043	2.35
2500 VDC		.0006	2.98
.0025	.90	.001	3.29
.006	1.35	.005	3.69
3000 VDC		.01	3.98
.00005	.65	**6000 VDC**	
.0001	.90	.0006	3.49
.0003	.95	.001	3.69
.0007	.98	.002	3.98
.0055	1.49	Others—Write!	

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Mfd.	Kv/Amps	Ea.	Mfd.	Kv/Amps	Ea.
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.005	5Kv/20A	6.49	.0015	10Kv/14A	7.49
.00015	6Kv/4A	4.29	Others, Write		

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CK709	1N40	3.98
CK710	1N21B, 1N28, G-7	1.35

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INDEX TO ADVERTISERS

Accurate Paper Tube Co. 265
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Aeronautical Communications Equipment, Inc. 156
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Alden Products Co. 231
Allen-Bradley Co. 189
Allen Co., Inc., L. B. 277
Allied Control Company, Inc. 181
Allied Radio Corp. 234
Allison Radar Corporation 259
Altec Lansing Corporation 259
American Chronoscope Corporation 180
American Lava Corp. 21
American Microphone Co. 172
American Phenolic Corporation 138
American Screw Company 50
American Television and Radio Co. 242
American Time Products, Inc. 145
Ampex Electric Corporation 266
Andrew Corporation 182
Antara Products Division of General Dyestuff Corporation 22, 23
Anti-Corrosive Metal Products Co., Inc. 172
Arma Corporation 217
Arnold Engineering Company 167
Art Wire & Stamping Company 240
Assembly Products, Inc. 277
Audio Devices, Inc. 131

Ballantine Laboratories, Inc. 150
Barker & Williamson, Inc. 198
Barrett Varnish Co. 277
Barry Corporation 62
Bead Chain Manufacturing Co. 164
Beaver Gear Works Inc. 180
Belden Manufacturing Co. 44
Bell Telephone Laboratories 205
Bendix Aviation Corporation
Pacific Division 233
Red Bank Division 165
Berkeley Scientific Company 260
Bird & Co., Inc., Richard H. 273
Bird Electronic Corp. 270
Birtcher Corporation 266
Biwax Corporation 257
Bliley Electric Company 210
Boonton Radio Corporation 125
Borg Corporation, George W. 272, 273
Bowser, Inc. 244
Bracke-Sieb X Ray Co., Inc. 261
Breeze Corporations, Inc. 269
Bridgeport Brass Co. 227
Browning Laboratories, Inc. 216
Burgess Battery Company 238
Burlington Instrument Co. 164
Burnell and Company 39

Cambridge Thermionic Corp. 176
Cannon Electric Development Co. 184
Capitol Radio Engineering Institute 236
Carboloy Company 16
Carnegie-Illinois Steel Corp. 159
Centralab, Div. Globe-Union Inc. 11, 12, 13, 14
Chicago Transformer, Div. of Essex Wire Corp. 196
Cinch Manufacturing Corp. 117
Cleveland Container Company 187
Clippard Instrument Laboratory Inc. 249
Cohn Corporation, Sigmund 234
Communications Accessories Company 226
Condenser Products Company 7
Consolidated Engineering Corporation 58
Cornell-Dubilier Electric Corp. 49
Corning Glass Works 183
Cornish Wire Company, Inc. 190
Cossor (Canada) Limited 168
Coto-Coil Co., Inc. 258
Cramer Co., R. W. 160
Cross Co., H. 277

Dano Electric Company 269
Daven Co. .... Third Cover
De Jur Amsco Corporation 57
Dial Light Company of America 148
Distillation Products Industries 175
Dollar Company, Robert, The Communication Equipment Division 271
Donnelly Electric & Mfg. Co. 139
Dow Corning Corporation 277
Driver Co., Wilbur B. 10
Driver-Harris Company 34
Dumont Electric Corporation 253
Du Mont Laboratories, Inc., Allen B. 15, 199
du Pont de Nemours and Co., Inc., E. I. 169

Eastman Kodak Company
Industrial Photographic Div. 137
Eitel-McCullough, Inc. 45
Eiseler Engineering Company, Inc. 140, 277
Electric Indicator Co. 265
Electrical Industries, Inc. 253
Electrical Reactance Corp. 143
El-Tronics, Inc. 277
Electronic Associates Inc. 250
Electronic Instrument Co., Inc. 243
Electronic Tube Corporation 212

Electro Motive Mfg. Co., Inc. 2
Electro Products Laboratories 261
Electro Tec Corporation 269
Emsco Derrick & Equipment Co. 274
Enthoven & Sons Ltd., H. J. 156
Erie Resistor Corp. 53

Fairchild Camera & Instrument Corp. 176,224
Fairchild Recording Equipment Corporation 272
Falstrom Company 268
Federal Telecommunication Laboratories, Inc. 17
Fidelity Chemical Products Corp. 144
Filtron Co., Inc., The 19
Fisher-Pierce Company, Inc. 266
Fisher Radio Corp. 233

Gamewell Company 168
Gates Radio Company 38
General Ceramics & Steatite Corp. 30, 31
General Electric Company
Apparatus Dept. 54, 55, 151, 179, 214, 225
Electronics Dept. 20, 37, 163
Lamp Dept. 186
General Industries Co. 177
General Radio Company 193
Glaser Lead Co., Inc. 162
G-M Laboratories Inc. 263
Graphite Metallizing Corp. 246
Green Instrument Co. 263
Grieve-Hendry Company 259
Guardian Electric Mfg. Co. 157

Handy & Harman 249
Hart Mfg. Co., The 127
Hathaway Instrument Co. 245
Haydon Mfg. Company, Inc. 204
Heath Company, The 211
Heiland Research Corporation 255
Helipot Corporation 25
Hermetic Seal Products Company 238
Hewlett-Packard Company 8, 9
Hickok Electrical Instrument Co. 202
Houghton Laboratories, Inc. 240
Hudson Wire Company 176
Hytron Radio and Electronics Corp. 51

I-T-E Circuit Breaker Company 59
Industrial Condenser Corp. 265
Instrument Electronics 248
Instrument Resistors Company 264
International Nickel Company, Inc. 153
International Rectifier Corp. 202
International Resistance Co. 4, 5

J F D Manufacturing Co., Inc. 202
Jelliff Manufacturing Corporation, C. O. 255
Johnson Co., E. F. 233, 246
Jones Div. Howard B. Cinch Mfg. Corp. 233

Kahle Engineering Co. 214
Karp Metal Products Co., Inc. 32
Kartron 277
Kenyon Transformer Company, Inc. 148
Kepco Laboratories, Inc. 135
Kester Solder Company 121
Knights Co., James 251
Kollsman Instrument Div., Square D Company 191

Lambda Electronics Corporation 259
Lampkin Laboratories, Inc. 277
Lavoie Laboratories, Inc. 133
Leach Relay Co. 166
Lectrohm Incorporated 238
Leeds & Northrup Co. 48
Lewis Engineering Co. 244
Lewis Spring & Manufacturing Co. 146
Liberty Mirror Division, Libby-Owens-Ford Glass Co. 211
Littelfuse, Inc. 202
Lord Manufacturing Company 142

Machlett Laboratories 203
Magnecord, Inc. 235, 247
Magnetic Core Corp. 265
Magnetics, Inc. 144
Mallory and Company Inc., P. R. 64, 119
Marconi Instruments, Ltd. 172
MB Manufacturing Company, Inc. 209
McGraw-Hill Book Co. 164
Measurements Corporation 52
Mercoid Corporation 266
Metal Textile Corporation 251
Metaplast Process, Inc. 252
Mica Insulator Company 26, 27
Millen Mfg. Co., Inc., James 35
Milo Radio & Electronics Corp. 154
Miniature Precision Bearing Inc. 277
Minneapolis-Honeywell Regulator Co. Industrial Division 147

Minnesota Mining & Mfg. Co. 201
Mitchell-Rand Insulation Co., Inc. 173
Mosinee Paper Mills Company 158
Muirhead & Co., Ltd. 3
Murex Ltd. 260
Mycalex Tube Socket Corp. 36

National Company, Inc. 144
National Moldite Company 232, 242
National Varnished Products Corporation, The 141
Ney Company, J. M. 152
North American Aviation, Inc. 152
Northern Radio Co., Inc. 263
Northern Zaleski, Limited 47

Panoramic Radio Products, Inc. 257
Paper Machinery & Research, Inc. 255
Paramount Paper Tube Corp. 246
Park Metalware Co., Inc. 240
Peerless Electrical Products Division Altec Lansing Corporation 160
Permoflux Corp. 222
Pfanstiehl Chemical Company 265
Phillips & Hiss Co., Inc. 273
Plastics & Electronics Co. 277
Polarad Electronics Corporation 33
Potter Instrument Co., Inc. 275
Precision Apparatus Co., Inc. 307
Precision Paper Tube Co. 148
Premax Products, Div. Chisholm-Ryder Co., Inc. 233
Presto Recording Corporation 194
Progressive Mfg. Co. 256
Pyramid Electric Co. 60
Pyroferric Co. 266

Radio Corp. of America .... 29, 171, 208, 230 Back Cover
Radio Receptor Company, Inc. 213
Rahm Instruments, Inc. 236
Railway Express Company, Air Express Division 254
Rauland Corporation 42
Raytheon Manufacturing Co. 129
Remler Company, Ltd. 264
Revere Copper & Brass Inc. 28
Richardson Company 24
Robinson Aviation, Inc. 269
Rome Cable Corporation 239

Sangamo Electric Company 221
Scientific Electric Div. of "S" Corrugated Quenched Gap Co. 274
Scintilla Magneto Division of Bendix Aviation Corp. 56
Scovill Manufacturing Co. 271
Shallcross Mfg. Co. 43
Shure Brothers, Inc. 188
Sigma Instruments, Inc. 63
Simpson Electric Company 18
Societe Industrielle ALFA 277
Sorensen and Company, Inc. 46
Specialty Battery Company 240
Sperry Gyroscope Company 149
Spincraft, Inc. 210
Sprague Electric Company 123
Stackpole Carbon Co. 207
Standard Piezo Company 236
Standard Pressed Steel Co. 253
Standard Telephones and Cables Limited 200
Standard Transformer Corporation 234
Stayer Company, Incorporated 240
Steinen Mfg. Co., Wm. 156
Stevens Arnold Inc. 268
Steward Manufacturing Co., D. M. 259
Stoddart Aircraft Radio Co. 161
Stupakoff Ceramic & Manufacturing Co. 170
Superior Electric Co. 185
Superior Tube Company 215
Sylvania Electric Products, Inc. 61
Synthane Corporation 40, 41
Syntron Co. 263

Tech Laboratories 152
Technology Instrument Corp. 218
Tektronix, Inc. 270
Telechron, Inc. 197
Teletronics Laboratory, Inc. 277
Television Equipment Corp. 249
Tenney Engineering, Inc. 192
Terpening Company, L. H. 228
Thomas & Skinner Steel Products Company 160
Transicoil Corporation 267
Transradio, Ltd. 242
Triplett Electrical Instrument Co. 229
Turner Company 206

Ungar Electric Tool Co., Inc. 236
Unique Devices, Inc. 273
United States Electronics Corporation 308
United States Steel Corp. 159
United States Testing Company, Inc. 275
United Technical Laboratories 257
United Transformer Co. .... Second Cover
Universal Mfg. Co., Inc. 261

Varflex Corporation 223
Varian Associates 220
Veeder-Root, Inc. 219
Vickers Electric Division, Vickers Inc. 6
Victoreen Instrument Company 262

Ward Leonard Electric Company 174
Ward Products Corp. 237
Waters, Robert A., Inc. 140

Westinghouse Electric Corp. 155
White Dental Mfg. Company, S. S. 178, 251
Whitehead Stamping Company 236

PROFESSIONAL SERVICES 276

SEARCHLIGHT SECTION
(Classified Advertising)

EMPLOYMENT
- Positions Vacant 278, 279, 280, 281
- Positions Wanted 280
- Selling Opportunities Wanted 280
- Employment Agencies 280
- Employment Services 278, 279

SPECIAL SERVICES 280
- Contract Work 280

NOTICES
- Auction 282
- Legal 277

EQUIPMENT
- (Used or Surplus New) For Sale 280-306

WANTED
- Equipment 280

ADVERTISERS INDEX

Alexander, F. 280
Alvaradio 302
Selling Opportunities Wanted ....
American Electrical Sales Co. 300
American Tecnion Society 278, 280
Arrow Sales, Inc. 289
Blan 300
Boulevard Engineering Personnel 280
Brooks Co., Inc., B. D. 280
Burden Sales Co. 305
C & H Sales Co. 303
Celab 280
Collins Radio Co. 279
Columbia Electronics, Ltd. 304
Communications Equipment Co. 283, 284, 285
Compass Communications Co. 298
Cornell Aeronautical Laboratory, Inc. 278
Cottone & Co., A. 304
Cunningham Engineering Co. 280
East Coast Radio Co. 303
Electro Impulse Laboratory 292
Electronic Engineering Co. of Calif. 281
Electronicraft, Inc. 291
Electronic Transformer Co., Inc. 305
Embassy Engineering Co. 304
Empire Electronics 280
Engineering Research Assoc., Inc. 279
EPCO 301
Federated Purchaser 302
Finnegan, Helen 280
Friez Instrument Div. — Bendix Aviation Corp. 281
Goodyear Aircraft Corp. 279
Green, Gould 280
Greenberg, David 304
Greene, Leonard 305
Grossman & Co., T. R. 282
Horlick Co., William I. 296
Hughes Aircraft Co. 279
Instrument Associates 286, 287
Lectronic Research Laboratories 297
Legri S. Co., Inc. 288
Leru Laboratories, Inc. 300
Life Electronic Sales 304
Maritime Switchboard 303
Maxson Corp., The W. L. 279
Metropolitan Overseas Supply Corp. 305
Mogull Co., Inc., Alexander 305
Monmouth Radio Laboratories 301
National Union Research Div. 278
Opad-Green Co. 300
Ostby & Barton Co. 280
Peak Electronics Co. 299
Precision Electrical Instrument Co. 300
RCA Service Co., Inc. 281
Radio & Electronic Surplus 300
Radio Corp. of America—R.C.A. Victor Div. 279
Radio Ham Shack, Inc. 293
Raytheon Manufacturing Co. 304
Reliance Merchandizing Co. 295
Servo-Tek Products Co., Inc. 294
Sonotone Corp. 278
Standard Oil Co. of Calif. 279
Standard Radio-Electrical Products 302
Tab 299, 306
Taub Co., The 280
Telemarine Communications Co. 298
Tomsett Associates 280
Universal General Corp. 304
Victor-Bernard Industries 280
Wells Sales, Inc. 290
Westinghouse Electric Corp. 278, 281
Wilgreen 301

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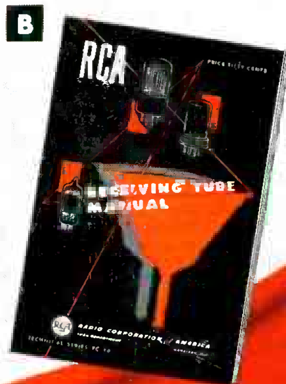

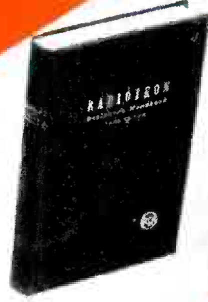

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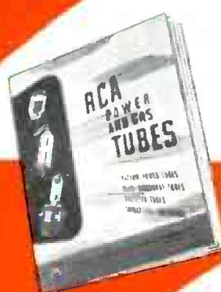

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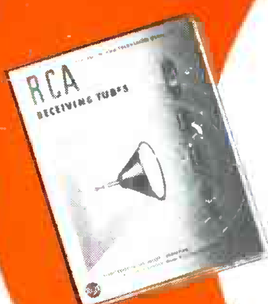

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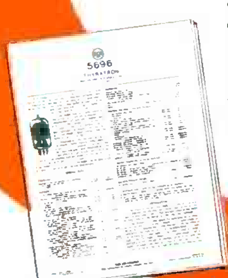

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